Geology and Coal Resources of the Coal-Bearing Rocks of Alabama

By WILLIAM C. CULBERTSON

CONTRIBUTIONS TO ECONOMIC GEOLOGY

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A detailed estimate of the reserves of coal in Alabama and a description of the stratigraphy of the coal-bearing rocks

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GEOLOGY AND COAL RESOURCES OF THE COAL-BEARING ROCKS OF ALABAMA

By William C. Culbertson

ABSTRACT

The bituminous coal resources of Alabama are contained in the Pennsylvanian Pottsville Formation in four coal fields, the Coosa, Cahaba, Warrior, and Plateau fields. The two southeasternmost fields, the Coosa and Cahaba, lie in narrow northeast-trending folded and truncated synclinal troughs. The large Warrior field lies in a shallow basin that is modified by the narrow Sequatchie anticline, the Blue Creek basin, a few shallow flexures, and numerous short en echelon normal faults. The Plateau field lies in the northeastern part of Alabama where the lower resistant sandstone beds of the Pottsville form the caprock of mesas or synclinal mountains.

In Alabama, as of January 1, 1958, the remaining reserves of bituminous coal that is under less than 3,000 feet of overburden and that is in beds in which the coal is 14 inches or more thick are estimated to total 13.8 billion tons. Of this amount, 7.9 billion tons are in coal beds in which the coal is 28 inches or more thick. The total reserves are divided among the four coal fields as follows: 11.9 billion tons in 16 coal beds in the Warrior field; 1.8 billion tons in about 13 coal beds in the Cahaba field; 42 million tons in 5 coal beds in the Plateau field; and 41 million tons in 7 coal beds in the Coosa field. The rank of most of the coal is high-volatile A bituminous. A minor amount in the Warrior and Plateau fields is medium-volatile bituminous, and a few million tons on Lookout Mountain in the Plateau field are low-volatile bituminous.

The reserves of coal were estimated on the basis of individual beds, which were not projected beyond a reasonable distance from the last point of information. The present estimate for Alabama is much lower than the previous estimate of 67.6 billion tons, principally because the present estimate excluded large areas on which information on the coal beds was insufficient and because abundant core hole data showed that the coal beds are thinner and less persistent than previously estimated.

In the Warrior field the productive part of the Pottsville Formation contains seven groups of coal beds containing 2 to 10 beds each. These are from the base up: Black Creek, Mary Lee, Pratt, Cobb, Gwin, Utley, and Brookwood. The Utley coal group is a new name, resulting from the discovery of a third coal group between the Pratt and the Brookwood coal groups in addition to the two previously reported. In the Cahaba coal field the productive part of the Pottsville Formation contains more than 35 coal beds, many of which are restricted

to isolated structural basins. In the Coosa coal field the upper 2,000 feet of the Pottsville in the Wattsville basin contains 14 relatively thin coal beds. In the remainder of the Coosa coal field and in the Plateau coal field data on thickness and number of coal beds are sparse, and most of the known coal beds are thin or lenticular.

The Parkwood Formation is of Late Mississippian and Early Pennsylvanian age in the Cahaba field and is probably of Early Pennsylvanian age in the Warrior and Plateau fields. The Parkwood ranges in thickness from 460 feet in the northeast part of the Coosa field to 2,200 feet in the northeast part of the Cahaba; it thins abruptly northwestward and ranges from 0 to more than 600 feet in thickness in the Warrior and Plateau coal fields. The Parkwood Formation contains a few thin lenticular coal beds, one of which, the Cliff coal bed, has been mined in several places in the Plateau and Warrior fields.

The Pottsville Formation in Alabama is of Early and Middle Pennsylvanian age and consists of interbedded sandstone, shale, coal beds, and numerous zones of marine and brackish-water megafossils. In all coal fields the lower part contains one or two massive resistant beds of orthoquartzite sandstone, one or both of which contain rounded pebbles of quartz. In the Cahaba coal field the upper 3,000 feet is characterized by thick beds of conglomerate that contain pebbles and cobbles of quartz, black, green, brown, and red chert, conglomerate, and metamorphic rocks. These pebbles were evidently derived locally from formations to the south and east. In the Warrior field a conglomeratic sandstone of similar composition, the Lick Creek Sandstone Member, may be the correlative of the most persistent of these conglomerates, the Straven Conglomerate Member.

The original thickness of the Pottsville Formation is nowhere preserved in Alabama. The Pottsville that remains thickens south and southeast not only by the preservation of younger beds, but also by the thickening of beds and addition of new beds. In the Warrior field, for example, the interval between the Pratt and Mary Lee coal beds thickens southward at the rate of about 10 feet per mile. The Pottsville has a maximum thickness of 9,000 feet in the Cahaba coal field, 7,400 feet in the Coosa field, and 1,400 feet in the Plateau field. In the southeastern part of the Warrior field the Pottsville is calculated to be 4,500 feet thick, but it is probably thicker in the southwestern part of the field, where it is unconformably overlain by Upper Cretaceous rocks.

Lignite is present in Alabama in formations of Cretaceous, Paleocene, and Eocene age, but only the Coal Bluff lignite bed in the Paleocene Naheola Formation in Marengo County is considered to have sufficient thickness, continuity, and heating value to be a possible source of reserves. Available analyses indicate that the lignite has an average as-received moisture content of about 50 percent and a heating value of about 5,000 Btu.

INTRODUCTION

The Warrior, Cahaba, Coosa, and Plateau coal fields of northern Alabama (fig. 1) contain large reserves of bituminous coal in beds of the Pottsville Formation of Early and Middle Pennsylvanian age. The coal not only has been a prime source of heat and power for Alabama, but since the 1870's much of it has been converted to coke for use by the iron and steel industry of Alabama. This report presents an estimate of the coal resources of Alabama as part of the

U.S. Geological Survey's program of compiling a detailed State-by-State estimate of the coal resources of the United States. In this new estimate the coal resources are classified according to thickness and rank of coal in the beds, thickness of overburden, and abundance and reliability of coal thickness data; they are tabulated by coal bed, county, and coal field. This estimate is probably the most precise one that could be made from the information available; however, it does not represent the entire coal resources of Alabama because it

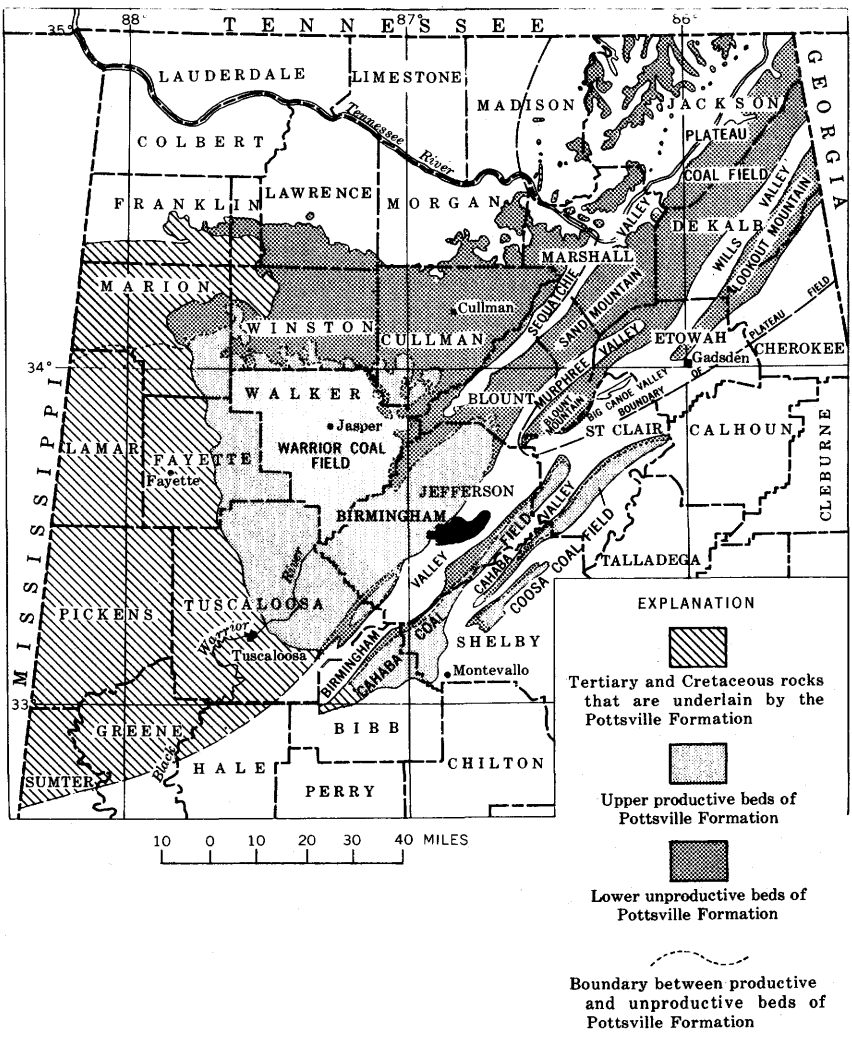

FIGURE 1.—Map of northern Alabama showing location of coal fields and area underlain by the Pottsville Formation of Early and Middle Pennsylvanian age.

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does not include large areas for which there is a lack of information on the coal beds.

Lignite is present in formations of Cretaceous, Paleocene, and Eocene age in the central part of the State, but it has not been mined commercially. The sparse information available on the lignite beds indicates that only in a small area does the lignite have sufficient thickness, continuity, and heating value to contain potentially minable reserves.

This new estimate of coal resources is based on published reports, on data furnished by coal mining companies, oil companies, the Geological Survey of Alabama, the University of Alabama, and the Alabama Department of Industrial Relations and on mapping and stratigraphic studies done in the course of this investigation.

ACKNOWLEDGMENTS

Without the assistance and the information provided by many individuals in the coal and oil industries as well as in government agencies, both State and Federal, this project could not have been successfully completed. The author wishes to acknowledge their help, especially the advice and assistance of Arthur Blair, Milton Fies, and R. Q. Shotts. Walter B. Jones, State Geologist, also provided helpful information and cooperation.

Valuable assistance in the collection of data and computation of reserves was given by John J. Yanchosek, Bernice L. McCraw, and Jane Welch.

LOCATION AND STRUCTURE OF COAL FIELDS

The bituminous coal-producing area of Alabama is divided into four coal fields, Plateau, Warrior, Coosa, and Cahaba, on the basis of the structure of the area (fig. 1). The Cahaba and Coosa fields lie in two troughs in the intensely folded and faulted southern part of the Appalachian Mountain system, which is part of the Valley and Ridge physiographic province (Johnston, 1930, fig. 1). The Warrior and Plateau fields lie northwest of the mountain system in a gently folded or flat-lying area that is classified as the Cumberland Plateau province.

The Plateau field is the name given to the several separate coal areas in the northeastern part of Alabama (Butts, 1926, p. 209) where resistant sandstone beds in the lower part of the Pennsylvanian sequence form the caprocks of isolated mesas and flat-topped mountains or plateaus. Wills, Sequatchie, and Murphree Valleys are folded and faulted northeast-trending anticlines, and Lookout, Sand, and Blount Mountains are shallow synclines. The regional dip of the beds is about 30 feet per mile to the southwest. Blount Mountain, at the southern end of the field, is sharply downfaulted on its northwest flank.

The Warrior coal field lies in a large gentle monoclinal or slightly basinal structure that extends westward into central Mississippi. Regionally the beds dip southwestward from 30 to 200 feet per mile. The southeastern boundary of the field (fig. 1), where it can be seen, is a large thrust fault that locally passes into a sharply folded anticline. In the southern part of the field this boundary is concealed by beds of Cretaceous age, and its location was estimated from data gathered from coal test holes in Tuscaloosa County and from sparse oil and gas test holes in Sumter and Greene Counties (fig. 1).

The regional southwest dip of the strata in the Warrior field is modified by at least two anticlines and three synclines or basins. On the southeast margin of the Warrior field, the Blue Creek basin is separated from the main part of the Warrior field by the asymmetric Blue Creek anticline (fig. 2). On the southeast flank of the Blue Creek basin the coal-bearing strata dip about 15° NE; on the northwest flank they dip 20°–40° SE; and in the center they lie relatively flat. A small northeast-trending anticline modifies the northern part of the basin.

In the eastern part of the Warrior field, the northeast-trending Sequatchie anticline separates the Coalburg syncline, also called Pratt basin, from the Warrior syncline (fig. 2). To the northeast in Blount County the Sequatchie anticline is asymmetric and tightly folded; southwestward in northern Jefferson County it is gently folded, and in southern Jefferson County it dies out, as do the accompanying Coalburg and Warrior synclines. In much of the Coalburg syncline the strata are relatively flat lying, dipping about ½° SW in conformity with the regional dip. On the western flank the dip increases to as much as 15° SE. In a narrow band along the eastern flank, the strata are steeply dipping northwestward or are overturned along the boundary fault of the Warrior field. The Warrior syncline has a steeply dipping east flank but a very gently dipping west flank.

In the central part of the Warrior field (fig. 2), the Wiley dome is a small fold that has a closure of about 200 feet. Further exploration probably would show other folds of this type in the Warrior field.

A notable feature of the Warrior field is the presence of numerous en echelon faults trending north and northwest. According to C. S. Blair (Semmes, 1929, p. 191) these are normal faults as much as 4 miles in length and 200 feet in displacement. The structure map, figure 2, shows many of these faults, but many others undoubtedly exist in the parts of the Warrior field that have not been thoroughly mapped.

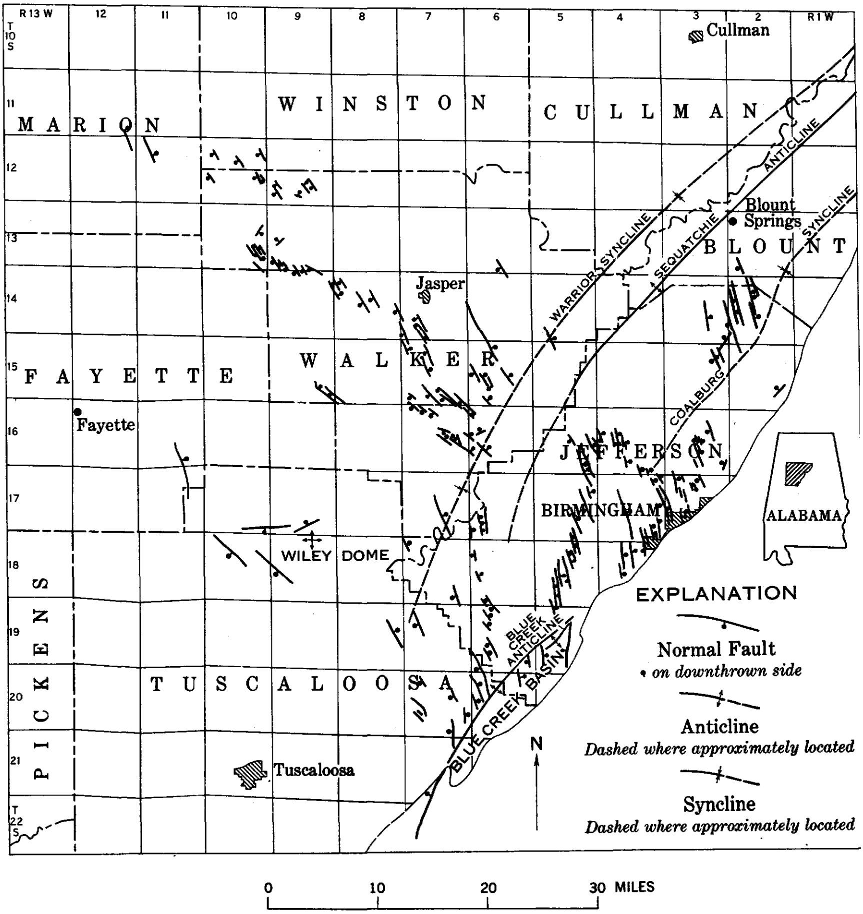

FIGURE 2.—Structure map of a part of the Warrior coal field, Alabama. Modified from D. R. Semmes (1929, map 2).

The Cahaba coal field lies in a long trough that extends from St. Clair County southwest into Bibb County where its southwestern end is concealed by overlapping Cretaceous beds. The Cahaba trough is a narrow syncline whose northwest limb dips about 20° SE and whose southeast limb is truncated by a large thrust fault that forms the eastern and southern boundary of the Cahaba field. The trough is divided by cross folds and faults into several basins (pl. 1). At the southwestern end the trough widens, and a relatively shallow northeast-trending anticline divides it into two parts—the Blocton basin on the west and the larger Montevallo basin on the east. Although the Cahaba field is steeply folded, it is relatively free of small cross faults such as are abundant in the Coosa and Warrior coal fields.

The Coosa coal field is the southeasternmost coal field and is parallel to the Cahaba field (pl. 1). As described by Rothrock (1949, p. 31),

> The Coosa coal field lies in the bottom of the Coosa trough, a composite synclinal structure along the southeast margin of the Appalachian Mountains. The trough extends northeast from Shelby County for about 70 miles through St. Clair County and into Calhoun and Etowah Counties. Its southern end consists of two parallel synclines separated by closely folded and faulted rocks. The southeastern syncline contains the Yellow Leaf basin and the northwestern syncline contains the Cunningham and Howard basins. Northeast of the Howard basin the syncline widens and overlaps the Yellow Leaf basin. Parts of it are known as the Black Ankle, Coal City, Fairview, and Ragland basins. As the Black Ankle area is not a readily distinguishable unit, it is considered to be part of the Coal City basin of this report.
>
> The Coosa trough in the vicinity of these basins is a cigar-shaped syncline that trends N. 45° E. Its northwest limb dips 20 to 15 degrees; its flat bottom is from one-quarter to one-half mile wide; and its southeast limb is deeply truncated by longitudinal high-angle thrust faults, the principal faults in the area. Other modifying structures are subsidiary longitudinal folds and faults in the northwest limb of the trough, bedding plane faults, and transverse faults near the bottom of the trough.

Jones (1929, p. 7) uses the name Wattsville basin to refer to the area previously known as the Black Ankle, Coal City, and Fairview basins, a usage that will be followed in this report.

The Yellow Leaf basin is the most intensely folded basin in this field, having dips ranging from 20° to 70°. Its southeast limb is truncated by thrust faults along which the strata are vertical or overturned.

STRATIGRAPHY

Two formations in Alabama contain bituminous coal, the Parkwood Formation of Mississippian and Pennsylvanian age and the Pottsville Formation of Pennsylvanian age. The Parkwood contains only a few thin beds of coal, some of which have been mined in parts of the Warrior and Plateau fields. The Pottsville is the principal coal-bearing formation and is the surface rock in all coal fields except in the southwestern part of the Warrior field, where it is unconformably overlain by Upper Cretaceous and Tertiary strata as much as 1,000 feet thick.

PARKWOOD FORMATION

The Parkwood Formation consists of alternating beds of gray shale, siltstone, and sandstone and of one or more thin coal beds. It unconformably overlies either the Pennington Formation of Mississippian age or the Mississippian Floyd Shale and is conformably overlain by the Pottsville Formation. The Parkwood Formation is of Late Mississippian and Early Pennsylvanian age in the Cahaba coal field and probably of Early Pennsylvanian age in the Warrior and Plateau coal fields (Culbertson, 1963).

The top of Parkwood is the base of the lowest conglomeratic sandstone bed of the Pottsville (pl. 2). The Parkwood is 465 feet thick in the northeastern part of the Coosa coal field (Rothrock, 1949, p. 19), thickens to a maximum of 2,200 feet in the northern part of the Cahaba field (Butts, 1926, p. 206), and then abruptly thins westward and northward into the Warrior and Plateau fields where it is 0 to more than 600 feet thick. It is missing in a few places along the eastern edge of the Warrior field and at places along the Sequatchie anticline.

In the Cahaba and Coosa coal fields, sparse data indicate that the coal beds in the Parkwood Formation are less than 1 foot thick. Along the northern outcrop in the Warrior coal field several thin coal beds lie from 1 to 100 feet below the top of the Parkwood. These beds rarely exceed 18 inches in thickness and are not persistent; so no reserves were estimated. In the Plateau field, however, the Cliff (Castle Rock) coal bed is minable in many places.

CLIFF COAL BED

In most of the Plateau field the coal bed that directly underlies the lower conglomerate (pl. 3) is called Cliff coal bed by McCalley (1891) and Castle Rock coal bed by Coulter (1947). The thickness of the Cliff coal bed ranges from a few inches to about 4 feet, but along most of the outcrop it does not exceed 18 inches.

The rank of the Cliff coal bed is high-volatile A bituminous in northern Jackson County, grading to low volatile on Lookout Mountain in DeKalb and Cherokee Counties. On Lookout Mountain it has low sulfur content and moderate ash content (table 1).

Coal beds at the horizon of Cliff coal bed have been mined intermittently in the Plateau field, principally in northern Jackson County west of the Tennessee River (fig. 1) since the late 1800's. The total recorded production of coal from Jackson and DeKalb Counties is about 600,000 tons. Probably 400,000 to 500,000 tons of this total came from the Cliff coal bed. Presumably many millions of tons of coal remain in lenticular beds at this horizon, but reserves were not calculated for this bed because of the lack of detailed data on the thickness of the bed.

POTTSVILLE FORMATION

The Pottsville Formation in Alabama consists of gray shale, gray thin-bedded sandstone, massive beds of sandstone 10 to 100 feet thick, conglomeratic orthoquartzite beds as much as 250 feet thick, some beds of pebble to cobble conglomerate, and many bituminous coal

TABLE 1.—*Analyses of coal in Plateau coal field, Alabama*

[Analyses by U.S. Bur. of Mines on as-received basis. Rank: LV, low-volatile bituminous; MV, medium-volatile bituminous; HVA, high-volatile A bituminous. Samples are from mine faces except as noted]

Bed	Proximate analysis (percent)				Ultimate analysis (percent)				Sulfur (percent)	Btu	Ash-softening temperature (° F)	Rank
	Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen				
DeKalb County (Sand Mountain)												
Underwood	3.9	22.6	65.3	8.2	------	------	------	------	1.3	13,630	--------	MV
Castle Rock	5.1	25.9	57.9	11.1	------	------	------	------	3.9	12,910	--------	MV
DeKalb County (Lookout Mountain)												
Castle Rock	1.9	20.2	68.4	9.5	4.2	77.8	1.1	6.4	1.0	13,380	--------	LV
Underwood	.9	24.6	58.7	15.8	4.3	72.4	1.2	3.3	3.0	12,720	--------	MV
Upper Cliff 2	7.5	17.7	58.2	16.6	4.5	67.0	1.0	9.9	1.0	11,630	2,910	LV
Upper Cliff 1 [1]	2.5	20.9	69.4	7.3	4.6	80.7	1.3	4.9	1.3	14,300	2,450	MV
Sewanee [2]	1.0	21.2	75.1	2.7	4.7	86.9	1.5	3.5	.7	15,140	2,420	LV
Blount County (Blount Mountain)												
Swansea	3.4	27.7	55.8	13.1	------	------	------	------	1.2	12,740	--------	HVA
Altoona [3]	3.5	32.6	60.8	3.1	5.5	80.6	1.7	7.8	1.3	13,850	2,220	HVA

[1] Average of 44 analyses of coal from diamond-drill cores. Rank is LV in some places, MV in others.
[2] Diamond-drill core.
[3] Average of three composite analyses of face samples.

beds and associated underclays. The original thickness of the Pottsville Formation is nowhere preserved in Alabama, but the remaining observed thickness reaches a maximum of about 9,000 feet in the southern part of the Cahaba coal field. The Pottsville Formation, in general, thickens south and southeast, not only by the preservation of higher beds, but also by the thickening of beds and the addition of new beds into the sequence. Because of this thickening and change in lithology, the coal beds in one field cannot be correlated confidently with those in adjacent fields or even, as in the Coosa and Plateau fields, with those in other parts of the same field. Consequently, the coal beds and lithology of the Pottsville Formation in each coal field are discussed separately.

On the "Geologic map of Alabama" (Butts, 1926) the Pottsville Formation in the Warrior, Coosa, and Cahaba fields is informally divided into two parts—the lower unproductive beds and the upper productive beds—on the basis of the presence or absence of thick coal beds. The area of outcrop of these parts is shown on figure 1. The dividing line between productive and unproductive beds is drawn at the Black Creek coal bed in the Warrior field, at the Gould coal bed in the Cahaba field, and at the top of the Pine Sandstone Member in the Coosa coal field (pl. 3).

The age of the Pottsville Formation, as determined paleobotanically by David White (Butts, 1926, p. 215), is "lower and middle Pottsville" (Early Pennsylvanian) in the Warrior field, and "lower, middle, and upper Pottsville" (Early and Middle Pennsylvanian) in the Cahaba field. In the Cahaba field the boundary between Early and Middle Pennsylvanian is provisionally placed at the Yeshic coal bed. In the Plateau field the Pottsville is probably of Early Pennsylvanian age because the equivalent rocks in the Warrior field (pl. 3) and in adjacent Georgia and Tennessee (Wanless, 1946) are of that age. In the northeastern part of the Coosa field, the finding of a *Mariopteris Pottsvillea* in the youngest rocks (Rothrock, 1949, p. 29) indicates that the Pottsville in this part of the field is also Early Pennsylvanian.

PLATEAU COAL FIELD (EXCLUDING BLOUNT MOUNTAIN)

In the Plateau coal field, excluding Blount Mountain, the maximum thickness of the Pottsville Formation is about 800 feet. The most conspicuous beds are two conglomeratic orthoquartzite beds as much as 150 feet thick, called "Upper Conglomerate" and "Lower Conglomerate" by McCalley (1891), that form the caprock of most of the hills and mountains. In this part of the Plateau coal field the coal generally occurs in a few thin beds or occurs as lenses that vary abruptly in thickness; these are locally channelled. The coal beds contain known reserves of coal only on Lookout Mountain.

The Pottsville Formation on the northeastern half of Lookout Mountain (fig. 1) was studied in 1944 by N. M. Denson and R. K. Hose in connection with a core drilling program by the U.S. Bureau of Mines (Coulter, 1947). Denson and Hose generously furnished the following description of the rocks on Lookout Mountain, together with the composite columnar section shown as locality 1, on plate 3 and the description of the core of FP–1 shown as locality 6 on plate 2.

The rocks above the upper conglomerate consist of fine- to medium-grained, thin-bedded sandstone with much interbedded sandy, black, and greenish-gray shale. The maximum thickness of these rocks is about 350 feet. Two coal beds at about 60 and 140 feet stratigraphically above the top of the upper conglomerate are the only stratigraphic markers in these strata.

The most readily identifiable unit is the conglomerate and conglomeratic sandstone (upper conglomerate), which averages about 60 feet thick but reaches a maximum thickness of about 150 feet. It is characteristically a sugary, coarse-grained sandstone containing numerous well-rounded milky-white quartz pebbles averaging ¼ inch in diameter. At most places it is in massive beds averaging 10 to 15 feet in thickness, but at a few localities it occurs in beds 5 to 12 inches thick. Beds of dark-brown, fine-grained quartzite and dark-gray shale occur locally in the conglomerate but are not common and are normally less than 7 feet thick. In most places a zone 6 inches to 10 feet thick at or near the base of the conglomerate contains numerous angular shale inclusions. This zone normally weathers to a conspicuous vesicular rock that is very useful in locating the approximate geographic position of the underlying Upper Cliff No. 1 coal bed.

Sandstone units as much as 130 feet thick separated by shale units ranging from 10 to 50 feet thick comprise the main part of the formation between the upper and lower conglomerates. Throughout most of the area this series displays a multiplicity of lateral and vertical variations, and stratigraphic markers of regional value do not occur. The beds have a maximum thickness of about 250 feet in the northeastern part of the area, and a minimum thickness of less than 100 feet at places along the west side.

The lower conglomerate is 20 to 100 feet thick, is similar lithologically to the upper conglomerate, but is not as persistent. At places it grades laterally into a massive thick-bedded coarse-grained sandstone.

Between the Mississippian Pennington Formation and the lower conglomerate is a unit of variable thickness that averages about 50 feet, consisting of greenish-gray regularly bedded shales and thin, fine-grained sandstone beds.

The last described unit is regarded as Parkwood Formation in this report.

UNDERWOOD COAL BED

A coal bed that occurs locally a few feet above the lower conglomerate on Sand and Lookout Mountains is called the Underwood coal bed (pl. 3). On Sand Mountain the coal is medium volatile in rank, but on Lookout Mountain it ranges from medium-volatile to low-volatile bituminous and has high ash and sulfur contents (table 1). The bed is estimated to contain reserves of coal in an area of about 10 square miles on the east side of Lookout Mountain (fig. 3), where the bed ranges in thickness from 14 to 33 inches (table 2).

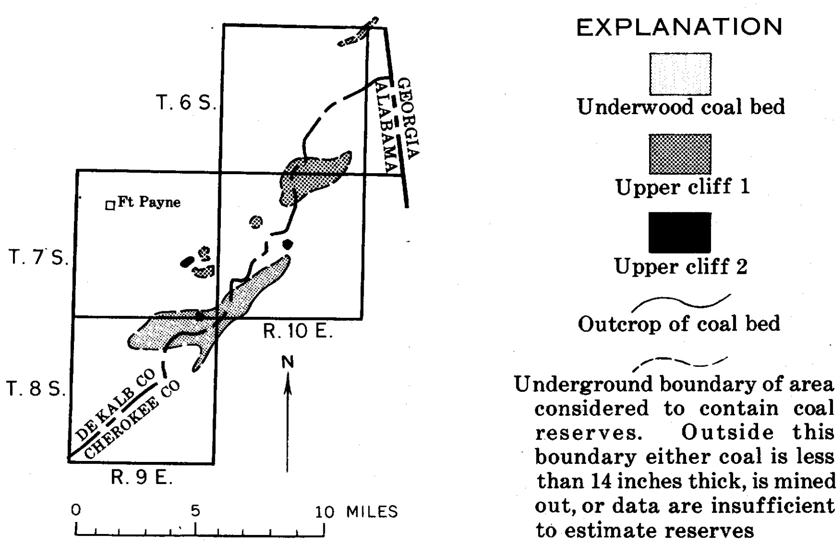

FIGURE 3.—Location of coal reserves in the Underwood and Upper Cliff coal beds on Lookout Mountain, Ala. Coal is under less than 1,000 feet of overburden.

TABLE 2.—*Estimated remaining reserves of coal in the Plateau coal field, Alabama, as of Jan. 1, 1958, by county, bed, and rank*

[All reserves are under less than 1,000 ft of overburden. Rank: LV, low-volatile bituminous; MV, medium-volatile bituminous; HVA, high-volatile A bituminous]

Bed	Rank	Reserves, in millions of short tons, for thickness of beds, in inches as shown								
		Measured and indicated			Inferred			Total all categories		Grand total
		14–28	28–42	Total	14–28	28–42	Total	14–28	28–42	
Cherokee County (Lookout Mountain)										
Upper Cliff 1	LV	2.2	------	2.2	------	------	------	2.2	------	2.2
	MV	2.7	------	2.7	------	------	------	2.7	------	2.7
Total, Upper Cliff 1	------	4.9	------	4.9	------	------	------	4.9	------	4.9
Upper Cliff 2	MV	------	------	------	0.1	------	0.1	.1	------	.1
Underwood	LV	.5	------	.5	------	------	------	.5	------	.5
	MV	4.9	------	4.9	------	------	------	4.9	------	4.9
Total, Underwood	------	5.4	------	5.4	------	------	------	5.4	------	5.4
Total	------	10.3	------	10.3	.1	------	.1	10.4	------	10.4
DeKalb County (Lookout Mountain)										
Upper Cliff 1	LV	1.1	------	1.1	0.1	------	0.1	1.2	------	1.2
	MV	.9	------	.9	.3	------	.3	1.2	------	1.2
Total, Upper Cliff 1	------	2.0	------	2.0	.4	------	.4	2.4	------	2.4
Upper Cliff 2	LV	.7	------	.7	------	------	------	.7	------	.7
Underwood	LV	9.0	1.6	10.6	------	------	------	9.0	1.6	10.6
	MV	3.0	------	3.0	------	------	------	3.0	------	3.0
Total, Underwood	------	12.0	1.6	13.6	------	------	------	12.0	1.6	13.6
Total	------	14.7	1.6	16.3	.4	------	.4	15.1	1.6	16.7
Blount County (Blount Mountain)										
Altoona	HVA	------	------	------	1.4	2.7	4.1	1.4	2.7	4.1
Swansea	HVA	------	------	------	1.6	2.9	4.5	1.6	2.9	4.5
Total	------	------	------	------	3.0	5.6	8.6	3.0	5.6	8.6
Etowah County (Blount Mountain)										
Altoona	HVA	------	------	------	2.6	3.2	5.8	2.6	3.2	5.8

UPPER CLIFF COAL BEDS

At many places on Lookout Mountain a coal bed called "Upper Cliff" by McCallie (1904, p. 107) lies directly under the upper conglomerate (pl. 3). At a few places a second coal bed is present about 30 feet below this bed. To distinguish between the two beds the upper bed is called the Upper Cliff 1 and the lower bed the Upper Cliff 2 (Coulter, 1947, p. 4).

The Upper Cliff 2 coal bed ranges in thickness from 0 to 20 inches at most places, but it is as much as 28 inches thick locally. It is high in ash and low in sulfur (table 1), and its rank is on the border between medium-volatile and low-volatile bituminous. Two small areas (fig. 3) are estimated to contain reserves of coal in this bed (table 2).

The Upper Cliff 1 coal bed is as much as 25 inches thick in several large lenses on Lookout Mountain (fig. 3), but locally it is missing. The analyses of many cores of this bed show that it has a low sulfur content and a moderate ash content (table 1) and that its rank is on the border between medium-volatile and low-volatile bituminous. According to Coulter (1947, p. 9), the Upper Cliff 1 is a good coking coal.

Because the coal is good for coking, it has been mined intermittently on a small scale on Lookout Mountain. The general thinness and lenticularity of the bed, however, have discouraged large-scale operations. Data on the thickness of this bed obtained by the U.S. Bureau of Mines are sufficient to estimate reserves of coal in several areas (table 2 and fig. 3).

SEWANEE AND TATUM COAL BEDS

In the strata above the Upper Cliff 1 bed on Lookout Mountain are two thin persistent coal beds named Sewanee and Tatum (Coulter, 1947, p. 4). The Sewanee coal lies about 120 feet above the Upper Cliff 1, and the Tatum lies from 60 to 90 feet above the Sewanee. In most places both beds are less than 14 inches thick; so, reserves were not estimated for them.

PLATEAU COAL FIELD (BLOUNT MOUNTAIN)

Blount Mountain (fig. 1) is capped by a sequence of Pottsville beds that have been described by Gibson (1891 and 1893) and in part by Butts (1910). According to Gibson (1891), there are four conglomerates on Blount Mountain, called, from the bottom up, the "First, Second, Third, and Fourth Conglomerates" (pl. 3, loc. 3). Gibson says that the "First Conglomerate," 50 to 100 feet thick, is much more conglomeratic than the "Second Conglomerate." The "Third Conglomerate," according to Gibson (1893, p. 22), is not a conspicuous rock and is "a coarse dark-colored rock in its upper parts, and near the base a reddish conglomerate formed of good-sized, but not well-rounded pebbles, firmly cemented with carbonate of iron." Its thickness is 100 to 120 feet (Gibson, 1891, p. 115).

The "Fourth Conglomerate" (Gibson, 1893, p. 22) consists of the following sections: An upper section 10 to 15 feet thick that is light colored and weathers to abundant well-rounded large pebbles; a second section that is about 40 feet thick and ferruginous; and a lower section that is about 100 feet thick and consists of quartzitic granular rocks and several good coal seams. The "Fourth Conglomerate" is about 50 feet beneath the highest strata exposed on Blount Mountain and underlies only a small area in the northwestern part of T. 12 S., R. 3 E. The remaining strata, according to Gibson's detailed section (1893, p. 29), consist of shales, thin- and thick-bedded sandstone, clay ironstone, underclay, and coal beds.

Unfortunately, Gibson's reports on the thickness of the strata and the number of coal beds differ so greatly that considerable doubt is cast on the accuracy of his observations. For example, the interval between the "Third" and "Fourth Conglomerates" is 220 feet thick and contains 4 coal beds according to the 1891 report (Gibson, 1891, p. 114), but is 1,125 feet thick and contains 15 coal beds according to the 1893 report (Gibson, 1893, p. 29). The strata above the "Second Conglomerate" total either 800 feet in thickness with 11 coal beds (Gibson, 1891, p. 114) or 2,390 feet in thickness with 25 coal beds (Gibson, 1893, p. 29). In the 65 years since Gibson's report, the recorded production of coal from Blount Mountain has been primarily from two coal beds, the Swansea and the Altoona. Consequently, it seems likely that most of the many coal seams described by Gibson either are too thin to be of value, are only local pockets of thick coal, or are correlative with one of the mined coal beds.

Charles Butts (1910) mapped the southwest one-quarter of Blount Mountain (west of 86°30′ long.) as part of his Birmingham quadrangle investigation. Butts (1910, p. 8) mentions that the Boyles Sandstone Member is 600 feet thick at one locality on the west side but makes no specific mention of the thickness or lithology of the strata above the Boyles Sandstone Member except for the Rosa coal bed. From a study of the reports by Gibson and Butts, the author concludes that the Boyles Sandstone Member is the equivalent of the "First" and "Second Conglomerates" of Gibson and that the Pottsville is probably not more than 1,400 feet thick on Blount Mountain.

SWANSEA COAL BED

On Blount Mountain the Swansea coal bed is probably the Lowes coal bed of Gibson (fig. 5, col. 3) and is the Rosa coal bed of Butts, which lies about 100 to 200 feet above the Boyles Sandstone Member (Butts, 1910). It has been mined at many places in the southwestern part of Blount Mountain, principally along the northwest edge, under names such as Swansea, Inland, and Jagger. It is a fairly persistent bed that ranges in thickness from a few inches to about 3½ feet. The coal, which has a high ash content and a low sulfur content, ranks as high-volatile A bituminous (table 1). Near the northern line of T. 13 S., R. 2 E., the outcrop of the Swansea coal bed terminates against a fault forming the northwest border of Blount Mountain, and the bed is not exposed to the north. There are few precise data on the thickness of the coal and the extent of mining, but about 4.5 million tons of coal probably remain in the Swansea coal bed in the southwestern part of the mountain (table 2 and fig. 4).

ALTOONA COAL BED

The Altoona or Underwood coal bed underlies the "Fourth Conglomerate" in the northeastern part of Blount Mountain. It is possibly equivalent to the Carnes bed of Gibson (1891). The Altoona coal bed is a good quality coking coal, having a low ash and low sulfur content (table 1). It has been mined extensively both underground and by stripping along its outcrop on the northwestern side of Blount Mountain, where its thickness averages about 30 inches. Little is known of the thickness of the bed away from the outcrop, but about 9.9 million tons of coal probably remain in the Altoona coal bed in Blount and Etowah Counties (table 2 and fig. 4).

BYNUM COAL BED

Directly overlying the "Fourth Conglomerate" in a small area in T. 12 S., R. 3 W., on Blount Mountain is the Bynum coal bed. In most places the bed is too thin to mine independently, but locally it has been recovered in the strip mining of the underlying Altoona

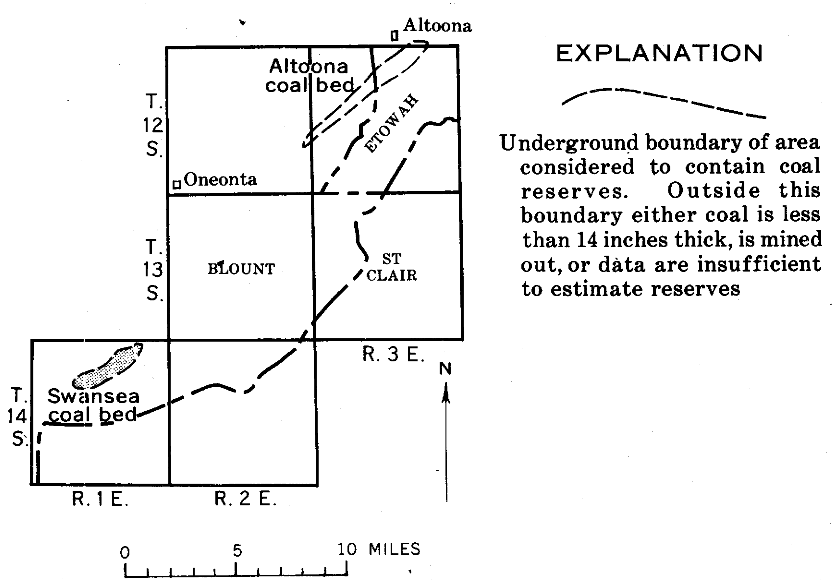

FIGURE 4.—Approximate location of coal reserves in the Swansea and Altoona coal beds on Blount Mountain, Ala. Coal is under less than 1,000 feet of overburden.

coal bed. Gibson (1893, p. 63) reported a thickness of 52 inches for this bed in sec. 17, T. 12 S., R. 3 E., but presumably this thickness is local. Reserves were not estimated for this bed because of its general thinness and the lack of thickness data.

WARRIOR COAL FIELD

The Pottsville Formation in the Warrior coal field is characterized by a basal resistant conglomeratic orthoquartzite unit from 200 to 700 feet thick called the Boyles Sandstone Member and an upper rhythmical sequence of undetermined maximum thickness that contains numerous commercial coal beds.

The Pottsville Formation thins to a feather edge to the north, thickens southward and southeastward, and is more than 4,500 feet thick in the southwestern part of the field. This southward-thickening trend resulted partly from the preservation of higher strata and partly from the thickening of the entire rock section. For example, the interval between the Mary Lee and Pratt coal beds thickens southward at an average rate of about 10 feet per mile (fig. 5).

In the area of outcrop of the Pottsville, the maximum thickness penetrated in a well is 2,915 feet, in the Southern Natural Gas Co. Phelan Shephard et al. 1 in sec. 35, T. 17 S., R. 9 W. (pl. 3, loc. 5). However, in Tps. 19 and 20 S., R. 7 W., where the youngest Pennsylvanian rocks in the Warrior field crop out, the maximum thickness is calculated as 4,500 feet. The upper 2,300 feet (above the Mary Lee coal bed) is known from coal test holes and measured sections, but the lower 2,200 feet is based on an interpolation between thicknesses of 1,700 feet in T. 17 S., R. 9 W. (pl. 3, loc. 5) and 2,700 feet in T. 20 S., R. 6 W. (pl. 3, loc. 6).

In the southwestern part of the field, where the Pottsville is covered with Cretaceous and younger rocks, no holes have penetrated the entire thickness of the formation. However, partial thicknesses of 3,700 and 4,550 feet of Pennsylvanian rocks have been reported in two holes, in sec. 17, T. 23 N., R. 1 W., in Greene County and in sec. 34, T. 19 S., R. 16 W., in Pickens County, respectively.

The Boyles Sandstone Member consists of one or more persistent orthoquartzite sandstone beds interbedded with varying amounts of gray shale, thin-bedded micaceous sandstone, and locally one or more thin coal beds (pl. 2). The lower part of the Boyles is conglomeratic nearly everywhere, and the upper part nonconglomeratic, although thin conglomeratic lenses are present in the upper part in a few places. The thickness of the Boyles Sandstone Member ranges from 200 to 700 feet, as determined from outcrop measurements and oil and gas test hole logs. These resistant sandstone beds from the

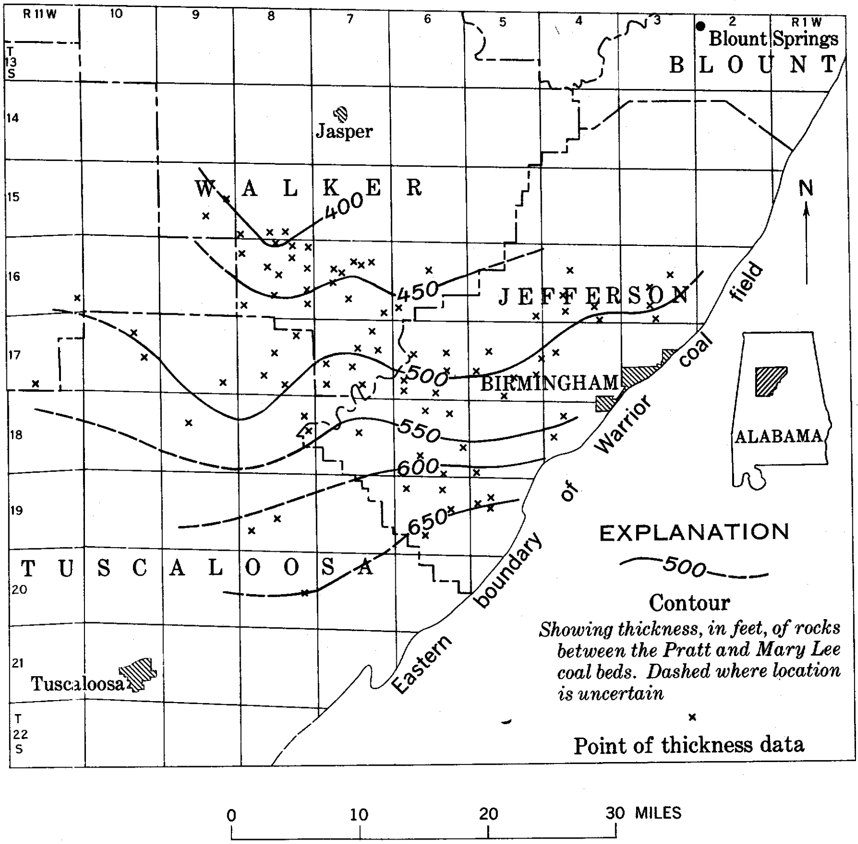

FIGURE 5.—Isopach map of interval between the Pratt and Mary Lee coal beds in the Warrior coal field, Alabama.

flat tablelands and steep bluffs along the northern edge of the field, the prominent ridges along the southeastern edge of the field, and the ridges bordering the Sequatchie Valley.

The Boyles Sandstone Member is thinnest along the southeast margin of the Warrior field in the vicinity of Birmingham (pl. 2, loc. 3), and thickens westward and southwestward in the subsurface. In most parts of the field the Boyles Sandstone Member can be divided into two sandstone units separated by a predominantly shaly unit. In a few places, such as along the southeast edge of the Blue Creek basin, a third sandstone unit can be distinguished. In several other places the intervening shaly unit either has graded to sandstone, has been cut out by the overlying sandstone bed, or is insignificantly thin. In places the upper boundary of the Boyles Sandstone Member is difficult to determine because the resistant orthoquartzite beds grade upward to dark micaceous sandstone beds.

The upper part of the Pottsville Formation, the part above the Boyles Sandstone Member, is a somewhat rhythmical sequence of sandstone, underclay, coal beds, shale, and zones of marine and brackish-water megafossils. Shale is the predominant rock type, ranging from medium-gray silty shale to grayish-black carbonaceous shales. Shale grades vertically and laterally into argillaceous siltstone and very fine grained sandstone, and in many places is intimately interbedded with them. Much of the shale contains nodules or layers of iron carbonate (siderite) or iron magnesium carbonate (ankerite). Most nodules are lenses less than 3 inches long, but the siderite also occurs as lenses as much as 1 foot thick and several feet long. In some places layers of siderite less than 1 inch thick are interbedded with shale.

The most prominent rock types are the massive- to thick-bedded, fine- to coarse-grained well-indurated sandstone beds, 10 to 100 feet thick. They differ from the orthoquartzite beds of the Boyles Sandstone Member in that they are darker gray and contain mica, clay, and carbonaceous material. They are well cemented with iron carbonate, clay, and silica. Coalified plant fragments are common in these beds. Because these are the most conspicuous beds in the upper part of the Pottsville Formation in the Warrior field, several of them have been named members of the Pottsville Formation (pl. 3), which from the base up are: the Bremen Sandstone Member, Lick Creek Sandstone Member, the Camp Branch Sandstone Member, and the Razburg Sandstone Member. The Bremen Sandstone Member, not shown on plate 3, lies stratigraphically just above the Black Creek coal group, although locally it cuts out the upper coal beds of this group. It is a coarse-grained thick-bedded sandstone averaging about 80 feet in thickness that is restricted to southern Cullman County and the adjacent parts of Walker County. Its southern edge can be precisely located at the southern boundary of T. 13 S., R. 5 W. The Lick Creek Sandstone Member (pl. 3, loc. 2) is restricted to northern Jefferson County, lying northeast of the latitude of Birmingham. It is a fine- to coarse-grained sandstone, conglomeratic in part, that averages about 50 feet in thickness. The Lick Creek Member differs from the quartz-pebble conglomeratic sandstone of the Boyles Sandstone Member in that it contains rounded pebbles, as much as an inch in diameter, of quartz or quartzite, black, gray, green, brown, and red chert, and occasional metamorphic rock fragments. Sandstones in the upper 500 feet of the exposed Pottsville (pl. 3, loc. 5) also contain a few pebbles of these rock types.

The Camp Branch Sandstone Member is a medium-grained thick-bedded blanket of sandstone about 40 feet thick that seems to be the most persistent of the sandstone members named. It forms a resistant ledge on its outcrop in southern Jefferson, southern Walker, and northern Tuscaloosa Counties and is recognizable in the subsurface in northern Tuscaloosa and eastern Fayette Counties, where it varies considerably in thickness. The Razburg Sandstone Member is a fairly extensive bed about 20 feet thick that crops out as a ledge in much of southern Jefferson and northeastern Tuscaloosa Counties.

Many linear channel-fill sandstones also occur throughout the Pottsville Formation. Figure 6 is an isopach map of one of these large sandstone lenses. Locally, an elongate medium- to coarse-grained northwest-trending channel sandstone as much as 70 feet thick replaces the Pratt coal bed and overlying shale.

Coal beds and the associated underclay seem to be the most persistent units in the Pottsville Formation. The coal beds consist of banded bituminous coal and partings of clay, siltstone, or siderite. They range in thickness from a few inches to as much as 10 feet. Most of the coal occurs in groups of beds that persist across the outcrop area of the Warrior field, although individual beds within the group pinch out, coalesce, or split. The underclay beneath the coal bed is characterized by a lack of bedding, by its white weathering color, and by an abundance of root marks (*Stigmaria*). In places

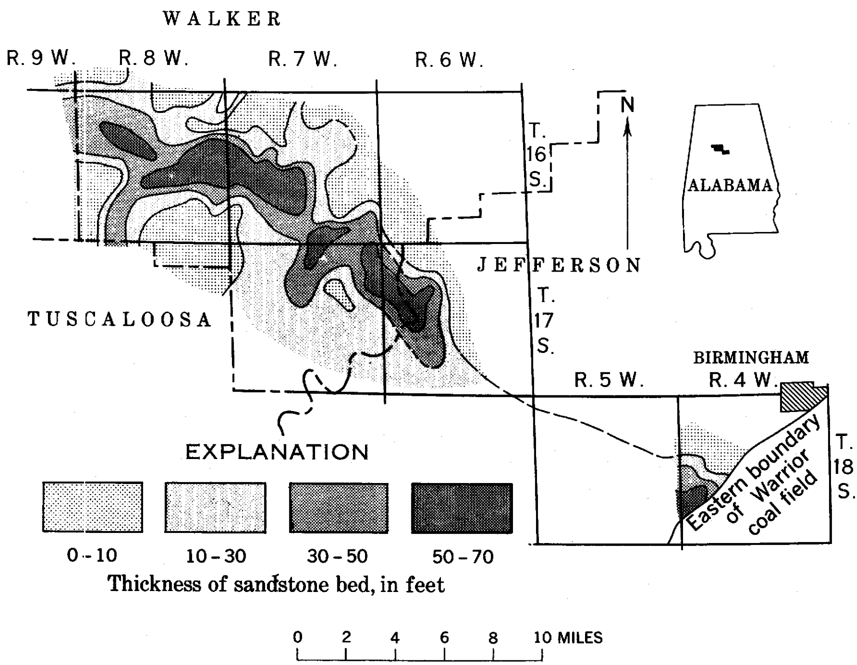

FIGURE 6.—Isopach map showing thickness of the sandstone bed in the Pratt coal group, Warrior coal field, Alabama.

these beds are even more persistent than the associated coal beds, continuing into areas where the overlying coal is absent.

Invertebrate megafossils—including brachiopods, pelecypods, gastropods, and crinoids—are relatively abundant in the upper part of the Pottsville. The fossils are marine and brackish-water types and are either scattered sparsely through shale beds or concentrated in beds 2 or 3 inches thick of sandy shale or shaly sandstone. Lists of fossils may be found in two reports by Butts (1926, p. 213; and 1927, p. 14).

In general, the Pottsville Formation in the Warrior field comprises a number of sedimentary cycles consisting of a basal massive sandstone, an underclay, a coal bed or beds, shale, and interbedded shale and siltstone. Thin zones of megafossils in many places occur only a few feet above the coal bed. These cycles, however, are not as persistent as the cyclothems of the midcontinent region. The cycles are interrupted at many places by recurrence of a coal or sandstone, by the alternation of coal and shale, or by sandstones that fill channels in the shale. Coal beds split, or pinch out, and locally new coal beds appear. Conditions of deposition evidently were less stable in this area.

In the Warrior coal field, almost all coal production has come from seven groups of coal beds: the Black Creek, Pratt, Mary Lee, Cobb, Gwin, Utley, and Brookwood (pl. 3). The Pottsville Formation below the Black Creek group contains only a few thin or nonpersistent coal beds at most places. Some of these beds have been mined at numerous places along the outcrop, usually to obtain coal for blacksmiths or other local markets. The thinness of these beds and the uncertainty of their continuity and quality have deterred large-scale development.

BEAR CREEK COAL BED

The Bear Creek coal bed reportedly reaches a thickness of about 3 feet in only the northeastern part of Marion County and adjacent parts of Winston and Franklin Counties, where numerous small mines have been opened. Analyses of the coal from this bed were not available, but it is reported to be a dirty coal with a high sulfur content. This bed lies a few feet above the lower conglomeratic part of the Boyles Sandstone Member. It was not found in a nearby core hole (pl. 2, loc. 1); only locally are thin coal beds found at this horizon (for example, pl. 2, loc. 2). The lack of detailed thickness data prevented computing of reserves.

J, K, L, AND M COAL BEDS

In the Blue Creek basin of the Warrior field (pl. 3, loc. 6) the 2,000 feet of strata beneath the Black Creek coal bed is reported to contain at least four persistent coal beds, which in descending order are the J, K, L, and M beds (Semmes, 1929, fig. 36). The J bed, which is about 300 feet below the Black Creek coal bed, is reported to have an average thickness across the basin of about 30 inches. Detailed data on the thickness and grade of the four beds are lacking; so, no reserves of coal were estimated. Presumably these beds would contain high-rank coking coal similar to the Blue Creek coal bed in this basin (table 3).

TABLE 3.—*Average analyses of coal in Warrior coal field, Alabama*

[Analyses by U.S. Bur. of Mines on as-received basis. The analyses of the Mary Lee, Blue Creek, Pratt, and Utley coal beds in Jefferson County are medium-volatile bituminous in rank; all others are high-volatile A bituminous. The analyses of the Jefferson, Blue Creek, Mary Lee, and Pratt coal beds in Tuscaloosa County are from diamond-drill core samples; all others are from mine faces]

Coal bed	Proximate analysis (percent)				Ultimate analysis (percent)				Sulfur (percent)	Btu	Ash softening temperature (° F)	Number of analyses averaged
	Moisture	Volatile matter	Fixed Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen				
Jefferson County												
Black Creek	3.0	31.6	62.1	3.3	5.3	81.4	1.8	7.5	0.7	14,310	2,500	4
Jefferson	2.3	31.9	58.5	7.3	5.1	76.7	1.6	6.2	3.1	13,780	2,300	3
Blue Creek	3.1	23.4	63.6	9.9	4.9	76.7	1.5	6.2	.8	13,530	2,900	1
Mary Lee	2.4	27.2	58.1	12.3	4.8	73.8	1.6	6.4	1.1	12,840	2,680	10
Newcastle	3.0	30.5	52.7	13.8	5.0	69.9	1.6	7.7	2.0	12,590	2,450	1
American	3.1	30.5	59.6	6.6	5.2	78.1	1.5	7.2	1.2	13,650	2,480	2
Nickel Plate	2.3	29.2	59.2	9.2	4.9	75.5	1.4	6.7	2.2	13,540	2,420	2
Pratt	2.5	29.4	62.6	6.4	5.1	79.4	1.6	5.9	1.4	14,250	2,460	10
Utley [1]	1.2	24.5	65.3	9.0	4.7	77.4	1.4	6.2	1.3	13,360	2,690	2
Marion County												
Jefferson	5.2	37.3	54.1	3.3	5.6	76.0	1.6	12.0	1.3	13,600	2,250	2
Tuscaloosa County												
Jefferson	1.4	32.6	61.4	4.6	------	------	------	------	1.4	14,310	--------	1
Blue Creek	1.4	30.5	52.2	15.9	------	------	------	------	2.3	12,400	--------	1
Mary Lee	1.0	32.5	51.0	15.5	------	------	------	------	1.6	12,580	--------	1
Pratt	1.4	36.6	53.5	8.3	------	------	------	------	2.0	13,650	--------	1
Carter	3.2	31.1	59.9	5.8	------	------	------	------	.9	14,020	2,800	1
Milldale	3.8	31.4	59.9	4.9	5.4	78.3	1.4	8.6	1.4	14,030	2,320	3
Brookwood	3.5	28.7	58.0	9.7	5.1	74.5	1.5	8.1	1.0	13,270	2,850	2
Walker County												
Black Creek	3.0	36.3	58.1	2.5	5.6	80.4	1.8	8.8	0.9	14,280	2,460	5
Jefferson	4.1	36.7	55.0	4.2	5.5	76.3	1.7	10.8	1.5	13,590	--------	1
Jagger	3.8	33.1	50.4	12.5	5.1	67.9	1.6	11.4	1.2	12,210	2,730	2
Mary Lee	3.3	30.5	53.5	12.7	5.0	70.4	1.6	9.7	.7	12,280	2,740	12
American	2.3	32.5	52.9	12.3	5.0	71.5	1.5	8.0	1.6	12,530	2,720	2
Pratt	2.0	34.8	54.9	8.3	5.3	75.4	1.7	7.2	2.1	13,420	2,360	3
Corona [2]	2.4	38.9	49.0	9.7	5.4	71.3	1.7	9.6	2.3	12,880	2,400	1

[1] This coal bed is called Clements, where sampled.
[2] The Corona coal bed at the western edge of Walker County is equivalent to the Pratt coal bed.

SAPP COAL BED

In Blount County, Butts (1910) named three coal beds in the interval between the Boyles Sandstone Member and the Black Creek coal bed, but available evidence indicates that there is only one persistent bed. The lowest coal bed, named the Tidmore, is local and only a few inches thick. It lies about 25 feet above the Boyles Sandstone Member. The other two coal beds are the Sapp and the Rosa, both of which have a maximum thickness of about 15 inches. According to Butts (1910) the Rosa coal bed lies about 160 feet above the Boyles Sandstone Member, and the Sapp coal bed lies about 230 feet below the Black Creek coal bed. In this area the Black Creek coal bed is only about 400 feet above the Boyles; so, the Rosa coal bed is probably the same bed as the Sapp. This assumption was corroborated by an examination of new exposures near the type locality of the Sapp coal bed that showed no coal beds beneath the Sapp coal bed.

Only sparse data are available, but evidently the Sapp coal can be found throughout almost all the northern part of the coal field, although the thickening of the interval between the Black Creek coal bed and the Boyles Sandstone Member makes correlations uncertain. In eastern Marion County and western Winston County a coal bed called the Polecat may be the correlative of the Sapp coal bed. Because of the thinness of the Sapp coal bed, it was not estimated to contain reserves of coal.

BLACK CREEK COAL GROUP

In a stratigraphic interval of 50 to 150 feet, the Black Creek coal group, the basal coal group of the productive part of the Pottsville Formation, consists of three named coal beds, which in ascending order are the Black Creek, Jefferson, and Lick Creek. In places one or more thin unnamed beds are also present in this group, but none are known to contain appreciable reserves of coal. Only the lower two coal beds, the Black Creek and Jefferson, are estimated to contain reserves of coal (tables 4 and 5). The Lick Creek coal bed is thin and contains one or more partings at most of its exposures.

The Black Creek coal bed contains a high-quality, parting-free coal along most of its outcrop in northern Jefferson and northeast Walker Counties (pl. 4). In most places the bed is 20 to 36 inches thick, although it ranges in thickness from a few inches to as much as 52 inches. It consists of a high-volatile A bituminous coal, having the lowest ash and sulfur contents of any of the major coal beds in the Warrior coal field (table 3). This combination of properties, plus low friability in Walker County, has made the Black Creek a premium coal in the domestic market. Hundreds of mines have been opened on the outcrop of this bed, and, despite its thinness, many square miles of coal have been mined by underground methods and by stripping. Much of this coal mined in the eastern part of the Warrior coal field has been used in making coke and byproducts.

Westward along the outcrop in northwestern Walker, southern Winston, and southeastern Marion Counties, the Black Creek coal bed is probably only a few inches thick or consists of only carbonaceous shale. The coal bed that is mined extensively in this area is sold as Black Creek coal, but according to geologists who have traced the bed westward across Walker County it is the Jefferson coal bed. Scattered core-hole data, however, indicate that the Black Creek coal bed contains significant reserves of coal in southern Walker County (pl. 4 and table 4).

Reserves of coal were calculated from published thickness data (McCalley, 1900) for a bed called the Black Creek coal bed in a few small areas in southern Jefferson County and in northeastern Tuscaloosa County. It is possible, however, that these thicknesses were measured on a bed that lies a considerable distance below the Black Creek coal bed as defined elsewhere.

In large areas in Cullman County (pl. 4) numerous reported outcrop measurements indicate that the Black Creek coal is 2 to 3 feet thick (table 4). However, the lack of extensive mining in this area indicates that the coal bed may not be as suitable for mining as the reported data suggest. One possibility is that the thickness of the coal is variable in this area because of local erosion of the bed prior to deposition of the Bremen Sandstone Member.

The Jefferson coal bed lies a few inches to as much as 50 feet above the Black Creek coal bed in northern Jefferson and eastern Walker Counties. The bed ranges in thickness from 0 to 60 inches, but in most places it consists of 10 to 30 inches of coal and partings. The coal is high-volatile A bituminous, has a moderate ash content but as much as 3 percent sulfur (table 3). Because of its variable thickness and high sulfur content the Jefferson coal bed has not been mined extensively in this area. In northern Jefferson County, however, a small amount has been used in making coke.

In western Walker, southern Winston, and eastern Marion Counties, the Jefferson coal bed is a persistent bed 40 to 100 feet above the Black Creek coal bed (pl. 4). It is 20 to 36 inches thick throughout most of this area. In contrast to the Jefferson coal in Jefferson County, the coal in this area is a parting-free, low-ash, low-sulfur, low-friability coal that is used as a domestic fuel. In spite of its thinness, it has been mined extensively in this area.

TABLE 4.—*Estimated remaining reserves of coal in the Warrior coal field, Alabama, as of Jan. 1, 1958, by county and bed*

[Rank is high-volatile A or medium-volatile bituminous]

Coal bed	Overburden (feet)	Reserves, in millions of short tons, for thickness of beds, in inches as shown											Grand total
		Measured and indicated				Inferred				Total all categories			
		14–28	28–42	>42	Total	14–28	28–42	>42	Total	14–28	28–42	>42	
Blount County													
Black Creek	0–1,000	11.9	1.8		13.7					11.9	1.8		13.7
Cullman County													
Black Creek	0–1,000	41.3	30.4	1.9	73.6	55.2	11.3		66.5	96.5	41.7	1.9	140.1
Fayette County													
Cobb	0–1,000	31.0			31.0	3.6			3.6	34.6			34.6
Pratt	0–1,000	21.9	22.7	67.3	111.9	120.0	75.8	83.0	278.8	141.9	98.5	150.3	390.7
Fire Clay	0–1,000	1.8			1.8					1.8			1.8
Mary Lee	0–1,000	2.4	7.1		9.5	304.2	246.1		550.3	306.6	253.2		559.8
	1,000–2,000					57.7	5.1		62.8	57.7	5.1		62.8
Total, Mary Lee		2.4	7.1		9.5	361.9	251.2		613.1	364.3	258.3		622.6
Jagger	0–1,000					9.0	4.7	1.5	15.2	9.0	4.7	1.5	15.2
Jefferson	0–1,000					16.2			16.2	16.2			16.2
Black Creek	0–1,000					20.9			20.9	20.9			20.9
Total	0–1,000	57.1	29.8	67.3	154.2	473.9	326.6	84.5	885.0	531.0	356.4	151.8	1,039.2
	1,000–2,000					57.7	5.1		62.8	57.7	5.1		62.8
Grand total		57.1	29.8	67.3	154.2	531.6	331.7	84.5	947.8	588.7	361.5	151.8	1,102.0

Jefferson County

Utley	0-1,000	------	1.5	.7	2.2	------	1.0	1.0	2.0	------	2.5	1.7	4.2
Gwin	0-1,000	20.3	53.4	21.5	95.2	15.8	9.9	.8	26.5	36.1	63.3	22.3	121.7
Cobb	0-1,000	12.6	------	------	12.6	10.8	------	------	10.8	23.4	------	------	23.4
Pratt	0-1,000	41.8	88.6	83.4	213.8	106.7	133.4	57.8	297.9	148.5	222.0	141.2	511.7
Fire Clay	0-1,000	80.6	12.5	------	93.1	63.4	10.3	------	73.7	144.0	22.8	------	166.8
American	0-1,000	36.9	27.9	20.1	84.9	82.4	8.3	------	90.7	119.3	36.2	20.1	175.6
Mary Lee group [1]	0-1,000	138.7	87.2	390.9	616.8	185.9	150.3	331.9	668.1	324.6	237.5	722.8	1284.9
	1,000-2,000	13.2	5.4	38.2	56.8	138.4	136.2	350.2	624.8	151.6	141.6	388.4	681.6
Total, Mary Lee group	------	151.9	92.6	429.1	673.6	324.3	286.5	682.1	1,292.9	476.2	379.1	1,111.2	1,966.5
Jefferson	0-1,000	42.7	16.4	3.9	63.0	40.7	19.4	------	60.1	83.4	35.8	3.9	123.1
Black Creek	0-1,000	159.5	21.4	------	180.9	402.1	20.1	1.4	423.6	561.6	41.5	1.4	604.5
	1,000-2,000	------	------	------	------	14.2	------	------	14.2	14.2	------	------	14.2
Total, Black Creek	------	159.5	21.4	------	180.9	416.3	20.1	1.4	437.8	575.8	41.5	1.4	618.7
Total, all beds	0-1,000	533.1	308.9	520.5	1,362.5	907.8	352.7	392.9	1,653.4	1,440.9	661.6	913.4	3,015.9
	1,000-2,000	13.2	5.4	38.2	56.8	152.6	436.2	350.2	639.0	165.8	141.6	388.4	695.8
Grand total	------	546.3	314.3	558.7	1,419.3	1,060.4	488.9	743.1	2,292.4	1,606.7	803.2	1,301.8	3,711.7

Marion County

Jefferson	0-1,000	27.5	115.1	------	142.6	86.4	25.1	------	111.5	113.9	140.2	------	254.1

[1] The reserves in the New Castle, Mary Lee, Blue Creek, and Jagger coal beds are tabulated as the Mary Lee group of beds in Jefferson County because of the uncertainty of the identification of each bed.

TABLE 4.—*Estimated remaining reserves of coal in the Warrior coal field, Alabama, as of Jan. 1, 1958, by county and bed*—Con.

[Rank is high-volatile A or medium-volatile bituminous]

Coal bed	Overburden (feet)	Reserves, in millions of short tons, for thickness of beds, in inches as shown											Grand total
		Measured and indicated				Inferred				Total all categories			
		14–28	28–42	>42	Total	14–28	28–42	>42	Total	14–28	28–42	>42	
Tuscaloosa County													
Brookwood	0–1,000	14.6	40.4	52.2	107.2	15.1	19.9	9.2	44.2	29.7	60.3	61.4	151.4
Milldale	0–1,000	1.5	4.8		6.3	9.3	4.7		14.0	10.8	9.5		20.3
Johnson	0–1,000	44.8	19.1		63.9	32.1	21.0		53.1	76.9	40.1		117.0
Clements	0–1,000	.2	5.8		6.0	1.7	5.8		7.5	1.9	11.6		13.5
Gwin	0–1,000	1.2			1.2	6.3			6.3	7.5			7.5
Cobb	0–1,000	12.7			12.7	94.7			94.7	107.4			107.4
Pratt	0–1,000			28.3	28.3	196.0	479.7	428.2	1,103.9	196.0	479.7	456.5	1,132.2
American	0–1,000					30.2	22.1		52.3	30.2	22.1		52.3
Mary Lee	0–1,000			17.5	17.5	6.9	42.4		49.3	6.9	42.4	17.5	66.8
	1,000–2,000					396.1	591.3	761.6	1,749.0	396.1	591.3	761.6	1,749.0
	2,000–3,000					70.0			70.0	70.0			70.0
Total, Mary Lee				17.5	17.5	473.0	633.7	761.6	1,868.3	473.0	633.7	779.1	1,885.8
Black Creek	0–1,000	3.1	2.3		5.4	3.7			3.7	6.8	2.3		9.1
	1,000–2,000						2.6		2.6		2.6		2.6
Total, Black Creek		3.1	2.3		5.4	3.7	2.6		6.3	6.8	4.9		11.7
Total, all beds	0–1,000	78.1	72.4	98.0	248.5	396.0	595.6	437.4	1,429.0	474.1	668.0	535.4	1,677.5
	1,000–2,000					396.1	593.9	761.6	1,751.6	396.1	593.9	761.6	1,751.6
	2,000–3,000					70.0			70.0	70.0			70.0
Grand total		78.1	72.4	98.0	248.5	862.1	1,189.5	1,199.0	3,250.6	940.2	1,261.9	1,297.0	3,499.1

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Walker County

Cobb	0-1,000	11.1	-----	-----	11.1	40.0	-----	-----	40.0	51.1	-----	-----	51.1
Pratt	0-1,000	87.5	70.1	1.1	158.7	67.3	37.2	.7	105.2	154.8	107.3	1.8	263.9
Fire Clay	0-1,000	19.9	-----	-----	19.9	8.2	-----	-----	8.2	28.1	-----	-----	28.1
American	0-1,000	46.1	122.5	52.2	220.8	74.8	24.9	-----	99.7	120.9	147.4	52.2	320.5
New Castle	1,000-2,000	-----	-----	-----	-----	19.7	-----	-----	19.7	19.7	-----	-----	19.7
Mary Lee	0-1,000	79.0	306.4	114.9	500.3	45.3	383.4	67.3	496.0	124.3	689.8	182.2	996.3
	1,000-2,000	.6	5.2	1.5	7.3	-----	5.9	121.4	127.3	.6	11.1	122.9	134.6
Total, Mary Lee	-----	79.6	311.6	116.4	507.6	45.3	389.3	188.7	623.3	124.9	700.9	305.1	1,130.9
Blue Creek	0-1,000	13.7	-----	-----	13.7	44.5	-----	-----	44.5	58.2	-----	-----	58.2
Jagger	0-1,000	8.6	8.8	1.7	19.1	21.0	8.0	3.6	32.6	29.6	16.8	5.3	51.7
Jefferson	0-1,000	162.1	22.6	-----	184.7	146.6	2.0	-----	148.6	308.7	24.6	-----	333.3
Black Creek	0-1,000	174.8	15.2	-----	190.0	563.5	118.5	-----	682.0	738.3	133.7	-----	872.0
Total, all beds	0-1,000	602.8	545.6	169.9	1,318.3	1,011.2	574.0	71.6	1,656.8	1,614.0	1,119.6	241.5	2,975.1
	1,000-2,000	.6	5.2	1.5	7.3	19.7	5.9	121.4	147.0	20.3	11.1	122.9	154.3
Grand total	-----	603.4	550.8	171.4	1,325.6	1,030.9	579.9	193.0	1,803.8	1,634.3	1,130.7	364.4	3,129.4

Winston County

Jefferson	0-1,000	43.5	8.7	-----	52.2	-----	-----	-----	-----	43.5	8.7	-----	52.2
Black Creek	0-1,000	.9	-----	-----	.9	1.4	-----	-----	1.4	2.3	-----	-----	2.3
Total, all beds	-----	44.4	8.7	-----	53.1	1.4	-----	-----	1.4	45.8	8.7	-----	54.5

TABLE E.—*Summary by bed of estimated remaining reserves of coal in the Warrior coal field, Alabama, as of Jan. 1, 1958*

Coal bed	Overburden (feet)	Reserves, in millions of short tons, for thickness of beds, in inches as shown											
		Measured and indicated				Inferred				Total all categories			Grand total
		14–28	28–42	>42	Total	14–28	28–42	>42	Total	14–28	28–42	>42	
Brookwood	0–1,000	14.6	40.4	52.2	107.2	15.1	19.9	9.2	44.2	29.7	60.3	61.4	151.4
Milldale	0–1,000	1.5	4.8	----------	6.3	9.3	4.7	----------	14.0	10.8	9.5	----------	20.3
Johnson	0–1,000	44.8	19.1	----------	63.9	32.1	21.0	----------	53.1	76.9	40.1	----------	117.0
Clements	0–1,000	.2	5.8	----------	6.0	1.7	5.8	----------	7.5	1.9	11.6	----------	13.5
Utley	0–1,000	----------	1.5	.7	2.2	----------	1.0	1.0	2.0	----------	2.5	1.7	4.2
Gwin	0–1,000	21.5	53.4	21.5	96.4	22.1	9.9	.8	32.8	43.6	63.3	22.3	129.2
Cobb	0–1,000	67.4	----------	----------	67.4	149.1	----------	----------	149.1	216.5	----------	----------	216.5
Pratt	0–1,000	151.2	181.4	180.1	512.7	490.0	726.1	569.7	1,785.8	641.2	907.5	749.8	2,298.5
Fire Clay	0–1,000	102.3	12.5	----------	114.8	71.6	10.3	----------	81.9	173.9	22.8	----------	196.7
American	0–1,000	83.0	150.4	72.3	305.7	187.4	55.3	----------	242.7	270.4	205.7	72.3	548.4
Mary Lee group	0–1,000	242.4	409.5	525.0	1,176.9	616.8	834.9	404.3	1,856.0	859.2	1,244.4	929.3	3,032.9
	1,000–2,000	13.8	10.6	39.7	64.1	611.9	738.5	1,233.2	2,583.6	625.7	749.1	1,272.9	2,647.7
	2,000–3,000	----------	----------	----------	----------	70.0	----------	----------	70.0	70.0	----------	----------	70.0
Total	----------	256.2	420.1	564.7	1,241.0	1,298.7	1,573.4	1,637.5	4,509.6	1,554.9	1,993.5	2,202.2	5,750.6
Jefferson	0–1,000	275.8	162.8	3.9	442.5	289.9	46.5	----------	336.4	565.7	209.3	3.9	778.9
Black Creek	0–1,000	391.5	71.1	1.9	464.5	1,046.8	149.9	1.4	1,198.1	1,438.3	221.0	3.3	1,662.6
	1,000–2,000	----------	----------	----------	----------	14.2	2.6	----------	16.8	14.2	2.6	----------	16.8
Total, Black Creek	----------	391.5	71.1	1.9	464.5	1,061.0	152.5	1.4	1,214.9	1,452.5	223.6	3.3	1,679.4
Total, all beds	----------	1,410.0	1,123.3	897.3	3,430.6	3,628.0	2,626.4	2,219.6	8,474.0	5,038.0	3,749.7	3,116.9	11,904.6

MARY LEE COAL GROUP

The Mary Lee coal group is the most widespread and contains the most coal reserves in the Warrior field (table 5). According to McCalley (1900), this group contains five coal beds (from the bottom): Ream, Jagger, Blue Creek, Mary Lee (Horse Creek), and New Castle. McCalley (1900) used the name Horse Creek for the group and the main bed, but this name is no longer used by the mining industry of Alabama.

The lowest bed of the coal group is the Ream, which lies 50 to 200 feet above the Black Creek coal group. Where present, it is thin or contains many partings. McCalley (1900) reports that the coal in the Ream bed is 2 feet or more thick in a few localities on the eastern side of the Warrior field, but data are insufficient to estimate reserves.

The Jagger coal bed, which lies from 30 to 65 feet above the Ream, is a bed of variable thickness and quality along the outcrop in the Coalburg syncline. In the northern half of Jefferson County it directly overlies the Lick Creek Sandstone Member of the Pottsville Formation and is thin, or contains much interbedded shale (Butts, 1910, p. 9). Sparse drill hole data indicate that it has a maximum thickness of about 2 feet at places in the Coalburg syncline, but in many places it is missing, either because it pinches out or coalesces with younger coal beds.

In the western part of the Warrior field, the Jagger is sufficiently thick to be of commercial value in only the northwestern part of Walker County and in the northeast tip of Fayette County (pl. 4 and table 4), where it occurs in lenses. In the central part of the lenses, it is 5 to 6 feet thick with a thin parting, and at the margins it thins to a few inches. Most of the coal in these lenses has been mined out. The Jagger has a relatively high ash content but a low sulfur content (table 3).

The Blue Creek coal bed is a thick bed prominent only in the Blue Creek basin in southern Jefferson County. In the southwestern part of this basin, it is about 9 feet thick and contains about 1 foot of partings. Northeastward, it splits into two benches, and at the northeast end of the basin the thin top bench is about 40 feet above the 8-foot-thick main Blue Creek coal bed. In the Blue Creek basin most of the coal in the Blue Creek coal bed has been mined out. Reserves in the Blue Creek coal bed in Jefferson County have been combined with those of other coals of the Mary Lee group because of difficulties of correlation. The Blue Creek coal bed here is medium volatile in rank and has a low sulfur content but a relatively high ash content (table 3). It has been used extensively for making coke.

In the eastern part of the Warrior field, outside the Blue Creek basin, the Blue Creek coal bed is not easily identified; in the western part of the field, it is usually very thin or nonexistent. Reserves were estimated for this bed in a few small areas in Walker County (pl. 4 and table 4), where the Blue Creek coal bed exceeds 14 inches in thickness, is free of partings, and is very persistent. Analyses of coal in this area were not available.

In Jefferson County the upper part of the Mary Lee coal group—the Blue Creek, Mary Lee, and New Castle coal beds—consist of one to four coal beds, or benches, that vary considerably in thickness and that split and coalesce. For this reason it is difficult to apply individual bed names with any assurance. For example, at the New Castle mine in sec. 18, T. 16 S., R. 2 W., the upper part of the Mary Lee coal group consists of the New Castle coal bed that is 4 to 6 feet thick and contains 1 to 2 feet of partings, and the Mary Lee coal bed 40 feet below that is 2 to 3 feet thick, including several inches of partings. Several miles to the southwest in the Mary Lee mine in sec. 36, T. 16 S., R. 3 W., the New Castle coal bed is thin and lies 20 to 30 feet above the Mary Lee coal bed 4 to 6 feet thick that contains a "middleman" parting a foot or two thick. Core holes in the area indicate that the bed called New Castle at the New Castle mine may have split southwestward into two benches and that the lower bench may have coalesced with the underlying Mary Lee to make the thick bed at the Mary Lee mine. Westward from the Mary Lee mine, the upper part of the Mary Lee group consists of three benches or beds each 1 to 3 feet thick, spaced through a vertical interval of 20 to 50 feet of shale. Farther westward, on the west side of the Coalburg syncline, the three beds come close together to form a single minable bed 10 feet or more thick in some places. In the Blue Creek basin the bed called Blue Creek at the southern end may represent a coalescence of beds called Blue Creek, Mary Lee, and New Castle at other places. Because of the difficulty of correlating individual beds from one place to another, the reserves of coal in the Mary Lee coal group in Jefferson County are not separated according to beds, but are tabulated under Mary Lee coal group (table 4). In the southern part of Jefferson County, outside the Blue Creek basin, the Mary Lee coal group consists of two to four benches of coal ranging from 6 to 70 inches in thickness; intervals between the benches range from 1 to 22 feet in thickness. In Tuscaloosa County only one bed in the Mary Lee group is thick enough to contain reserves of coal; these reserves are tabulated as the Mary Lee coal bed.

In Walker County and adjacent parts of Fayette and Marion Counties, individual beds in the upper part of the Mary Lee group are more readily identified. In this area the New Castle coal bed is almost everywhere either less than 12 inches thick or is missing entirely. The persistent Mary Lee coal bed ranges from a few inches to 9 feet in thickness and usually contains several partings.

The Mary Lee coal bed is known as a "dirty" or high-ash coal, but it has a low sulfur content (table 3). It has been used extensively for coking in the eastern part of the Warrior field. In the western part of the field, the Mary Lee has been mined extensively as a railroad fuel because of its low sulfur content and its high ash-softening temperature.

PRATT COAL GROUP

In most places the Pratt coal group consists of five named coal beds, which in ascending order are: the Gillespie, Curry, American, Fire Clay and Pratt (pl. 3, loc. 5). These beds occur within an interval 100 to 250 feet thick. The actual number of coal beds in the group ranges from 3 or less on the western side of the field to as many as 10 on the eastern side. The interval of rock between the Pratt coal bed and the Mary Lee coal bed thickens from about 400 feet at its northernmost outcrops in Walker County to about 650 feet at the southernmost point of information in eastern Tuscaloosa County (fig. 5).

The Gillespie and Curry coal beds, although persistent, are almost everywhere less than 14 inches thick and coal reserves were not computed for these beds.

The American coal bed, which is 40 to 100 feet above the Curry coal bed, is an important bed only in southern Walker County and adjacent parts of Jefferson and Tuscaloosa Counties (pl. 4 and table 4). In most of this area it is 30 to 60 inches thick and contains 2 to 30 inches of partings. Westward, the American coal bed thins and disappears. In Jefferson County it is erratic in thickness and in most places is too thin to contain reserves of coal. It ranks as high-volatile A bituminous and has a low-sulfur content and moderate ash content (table 3). In Walker County a large quantity of the coal has been used for generating electricity.

From 20 to 40 feet above the American coal bed is the Fire Clay coal bed, also called Nickel Plate or Cardiff coal bed. The Fire Clay, although persistent, is a thick bed only along its northern outcrop in central Jefferson County (pl. 4 and table 4), where it is a high-volatile A bituminous coal bed that has a moderate ash and sulfur content (table 3). In this area the bed contains 20 to 38 inches of coal and 1 to 6 inches of partings. Production began in this area before the turn of the century, and most of the thicker coal is now mined out.

Elsewhere in the Warrior coal field, the Fire Clay coal bed is thin and worthless except for a few places in Walker and southern Jefferson Counties, where the bed exceeds 14 inches in thickness over a considerable area (pl. 4). In Jefferson County more than one coal bed is present between the American and Pratt coal beds at most places. Wherever two of these beds contain reserves of coal, the reserves of both were assigned to the Fire Clay coal bed (table 4).

The Pratt coal bed is the top bed of the Pratt group and lies from a few inches to 20 feet above the Fire Clay coal bed. In most of the Coalburg syncline the Pratt coal is medium-volatile bituminous in rank, ranges from 30 to 75 inches in thickness and averages about 45 inches, and contains from 2 to 12 inches in partings. Because it is thick and persistent, and is an excellent coking coal that contains relatively little ash and sulfur, the Pratt coal bed in Jefferson County has in past years been the most important source of coking coal in Alabama. The major part of the coal in the Pratt coal bed in the Coalburg syncline has been mined out (pl. 4).

Southwestward from Birmingham the Pratt coal bed splits into two beds. In the southwestern part of Jefferson County the thin upper bench of the Pratt is as much as 50 feet above the lower bench. The reserves of coal in the lower bench are tabulated under the Pratt coal bed (table 4), although in places where this coal is mined it is called Nickel Plate or American.

In Walker County the Pratt coal bed is persistent but is not as thick as it is in Jefferson County. Along the outcrop, the Pratt coal bed is a high-volatile A bituminous coal that in most places is less than 36 inches thick. It has a somewhat higher ash and sulfur content than the Pratt coal in Jefferson County. Reserves were not estimated for the Pratt coal in a northwest-trending zone about 3 miles wide through Walker County and part of Jefferson County (pl. 4) because only a coarse sandstone bed is present at the Pratt horizon in this area.

In western Walker County a thick bed of coal has been mined extensively under the name of the Corona coal bed. Most of the thick coal has been mined out, but some reserves of thin coal remain. The Corona coal bed is the equivalent of the Pratt coal bed, and the reserves are tabulated as Pratt reserves (table 4). The volatile-matter content of the Corona coal (table 3) is higher than that of the Pratt coal bed elsewhere.

COBB COAL GROUP

From 210 to 330 feet above the Pratt coal group is the Cobb coal group. The Cobb group in most places includes an upper and a lower Cobb coal bed, but in a few places it consists only of one bed, the Cobb. Although the Cobb coal bed or beds are persistent and crop out extensively in southern Walker and Jefferson Counties, eastern Fayette and northern Tuscaloosa Counties, the thickness of the bed or beds rarely exceeds 2 feet. Core holes indicate that several large areas are underlain by a Cobb coal bed that exceeds 14 inches in thickness and is free of partings (pl. 4 and table 4). Analyses of the Cobb coal bed are not available. This group of coal beds is underlain by the persistent Camp Branch Sandstone Member.

GWIN COAL GROUP

The Gwin coal group in most places consists of two coal beds, the Thompson Mill coal bed below and the Gwin coal bed above, in a vertical interval as much as 35 feet thick. It lies from 120 to 160 feet above the Cobb coal group. The Thompson Mill coal bed is not sufficiently thick to be of value in the Warrior field. The thickness data for the Thompson Mill coal bed in Tuscaloosa County reported by McCalley (1900) are probably those of the overlying Utley coal bed.

The Gwin coal bed is a fairly persistent bed but is erratic in thickness. Because of its high stratigraphic position, it crops out only in the southern part of the Warrior coal field. The sparse data on the Gwin coal bed indicate that in most of Tuscaloosa and Fayette Counties the bed is either too thin or contains too many partings to be of value. Sufficient data were available to estimate reserves of coal in the Gwin coal bed in the highlands of southern Jefferson County (pl. 4) where the coal ranges from 14 to 52 inches in thickness and the partings are as much as 14 inches thick (table 4). Analyses of the Gwin coal bed are not available. Although only a small amount of coal has been mined, the Gwin coal bed has become increasingly important because much of the coal can be recovered by low-cost stripping methods. Underlying the Gwin coal bed, and in places enclosing the Thompson Mill coal bed, is the Razburg Sandstone Member.

UTLEY COAL GROUP

According to the nomenclature of McCalley (1898, 1900) and Butts (1905, p. 368), the Brookwood coal group is the next coal group above the Gwin. However, an unnamed group of two to six coal beds in a vertical interval of 20 to 150 feet is present about 250 to 320 feet above the Gwin coal group and 200 to 300 feet below the Brookwood coal group (pl. 3). This coal group is here named the Utley coal group from the exposure of the main bed at the abandoned Utley mine in the center of the SW¼ of sec. 11, T. 18 S., R. 10 W., Tuscaloosa County. A core hole drilled at the mouth of the Utley mine shows this bed to be about 730 feet above the Pratt coal bed, about 450 feet above the Cobb coal bed, and about 250 feet above the Gwin coal group. Its position below the Brookwood coal group is determined by a comparison of descriptions of core holes eastward to the type locality of the Brookwood coal bed (T. 20 S., Rs. 7 and 8 W.) and by surface mapping by McCalley (1898), and by S. W. Welch (oral communication, 1958).

The Utley mine is now flooded, but McCalley (1900, p. 190) describes the bed, which he calls Thompson Mill, as being about 51 inches thick and containing three or more partings totaling about 10 inches in thickness. In the vicinity of the Utley mine, two or three thin coal beds are exposed in the shale above the Utley coal bed. Below the Utley coal bed is a massive coarse-grained sandstone as much as 60 feet thick that is a persistent mappable unit across several townships, according to S. W. Welch (oral communication, 1958).

In the few holes that have cored these beds, the Utley coal group consists of a lower bed of erratic thickness and of one to five coal beds, each less than 10 inches thick. In southern Jefferson County a bed identified as a member of the Brookwood coal group on McCalley's (1898) map of the Warrior coal field underlies the higher parts of the hills (pl. 4 and table 4). This bed, here correlated with the Utley coal bed, is more than 30 inches thick and contains several inches of partings. This coal bed is medium-volatile bituminous in rank, has a low sulfur content and a moderate ash content (table 3).

BROOKWOOD COAL GROUP

The stratigraphically highest coal group in the Warrior coal field is the Brookwood coal group, which lies 200 to 300 feet above the Utley coal group. It consists of five named coal beds, which in ascending order are: the Clements, Johnson (Carter), Milldale, Brookwood, and Guide. The Brookwood coal group crops out only in Tuscaloosa County and in the southern part of Jefferson County. Outcrop and mine thickness data on this group are fairly abundant in eastern Tuscaloosa County but are sparse to nonexistent to the north and west of the city of Tuscaloosa. Consequently, coal reserves are estimated for only the eastern part of the county although it is probable that the Brookwood coal group contains coal beds thick enough to mine in the western part of Tuscaloosa County (table 4).

The lowest coal bed, the Clements, is thin or absent along most of its outcrop. It reaches a thickness of 30 to 36 inches in a few small areas in T. 21 S., Rs. 7 and 8 W., where it has been mined to some extent (pl. 4). Analyses of the coal are not available.

The Johnson coal bed, also called the Carter coal bed (table 3), is relatively thin and lies about 30 to 60 feet above the Clements coal bed. East of the Black Warrior River in Tuscaloosa County the coal bed is fairly persistent, but west of the river little is known of it. In the area estimated to contain reserves of coal (pl. 4 and table 4), the bed averages about 25 inches in thickness and reaches a maximum thickness of about 48 inches. At most exposures the Johnson coal bed contains 1 to 8 inches of partings. According to one analysis (table 3), the coal in this bed is high-volatile A bituminous and has low ash and sulfur contents. It has been mined to a small extent in T. 20 S., Rs. 7 and 8 W.

The Milldale coal bed is 30 feet or more above the Johnson coal bed. It is a fairly persistent coal bed, but it rarely exceeds 30 inches in thickness. However, the absence of partings and the low ash and sulfur contents (table 3) have made this bed a source of desirable domestic coal. In most of Tps. 19 and 20 S., Rs. 7 and 8 W., the Milldale is 1 to 4 feet below the overlying Brookwood coal bed and is mined together with the Brookwood (pl. 4). Reserves of coal in the combined Brookwood and Milldale coal beds are tabulated under the Brookwood coal bed (table 4).

The Brookwood coal bed, which lies 1 to 40 feet above the Milldale, is the thickest, most extensive, and most persistent of the coal beds in the Brookwood coal group. In most places it is 40 to 50 inches thick and includes two to five partings as much as 3 inches thick. Where the Milldale coal bed coalesces with the Brookwood, the combined thickness is 70 to 80 inches. The Brookwood coal bed is a high-volatile A bituminous coal having a moderate ash content and a low sulfur content (table 3). In the past, it has been extensively mined underground, largely for coking coal. More recently, it has been strip mined for coal to be used in generating electricity.

The Guide coal bed, which lies as much as 30 feet above the Brookwood, is present only locally and is too thin to contain appreciable reserves of coal.

CAHABA COAL FIELD

In the Cahaba coal field the Pottsville reaches a maximum thickness of 9,000 feet and is of Early and Middle Pennsylvanian age. The lower part is characterized by two thick orthoquartzite sandstone beds, the middle part by shale, sandstone, and commercial coal beds, and the upper part by thick conglomerate beds and commercial coal beds.

The Shades Sandstone Member and the Pine Sandstone Member (pl. 2) are two units of conglomeratic orthoquartzite sandstone nearly identical in lithology with the Boyles Sandstone Member in the Warrior field. According to Butts (1910, 1911, 1927, 1940), the Shades Member, which is the basal member, is a thick-bedded coarse-grained quartzose sandstone, somewhat conglomeratic at the base, that maintains an average thickness of about 200 feet throughout the length of the Cahaba coal field. The Pine Sandstone Member is also a thick-bedded coarse-grained quartzose sandstone, somewhat less conglomeratic than the Shades, and it grades upward to a flaggy fine-grained sandstone. It increases in thickness from 250 feet in the northern part of the Cahaba field to 400 feet in the southern part. The interval of rock between these members consists predominantly of shale and, locally, of one or two thin nonpersistent coal beds. The interval of rock increases in thickness from 200 feet in the northern part of the Cahaba field to 500 feet in the southern part. Thus, according to Butts' data, the average thickness of the lower part of the Pottsville ranges from 650 feet in the northern part to 1,100 feet in the southern part. In the center of the field, however, a core hole (pl. 2, loc. 4) shows these beds to be 457 feet thick.

The middle part of the Pottsville, as the term is used here, is the interval between the Pine Sandstone Member and the Straven Conglomerate Member (pl. 3). It consists of 3,000 to 4,700 feet of gray shale, siltstone, sandstone, a few thin conglomerate beds, and 12 to 15 commercial coal beds which increase in abundance toward the top. The number of coal beds varies from place to place, principally because of splitting, coalescing, and pinching out of individual beds. The Nunnally coal group, for example, consists of two coal beds in some places and as many as six beds in other places. Although some of its individual beds are not persistent, the Nunnally coal group is persistent as a unit throughout the Cahaba field as is the underlying Gould coal group. Other coal beds are generally persistent through one or more coal basins, although correlation between many isolated coal basins is difficult. Invertebrate megafossil zones similar to the ones in the Warrior coal field occur throughout this sequence (Semmes, 1929, p. 46; Butts, 1927, p. 14).

Two conspicuous sandstone units in this part of the section, the Chestnut Sandstone Member and the Rocky Ridge Sandstone Member, have been named members of the Pottsville Formation. The Chestnut Sandstone Member is a quartzose sandstone that makes a prominent ridge along the entire Cahaba coal field. It is about 100 feet thick at the northern end and thickens to about 200 feet in the southern part, where it contains a thick shale parting. According to Butts (1927, p. 14; 1940, p. 11), it is separated from the underlying Pine Sandstone Member by 500 to 800 feet of strata that is mostly shale and that contains the Gould coal bed or beds (pl. 3). The Rocky Ridge Sandstone Member is a thick-bedded conglomeratic quartzose sandstone about 50 to 100 feet thick that lies about 2,400 feet above the Chestnut Sandstone Member in the interval between the Buck and Pump coal beds. It forms a prominent ridge in the Little Cahaba syncline in parts of T. 18 S., Rs. 1 and 2 W., and in T. 19 S., R. 1 W., but is not recognized outside this area.

The upper part of the Pottsville (Straven Conglomerate Member and overlying beds) has a maximum thickness of about 3,000 feet in the southwestern part of the Cahaba field. This sequence is made up of sandstone, shale, coal beds, and—in the southwestern part—a large proportion of very coarse ridge-forming conglomerate beds as much as 100 feet thick (Butts, 1940, p. 11). Many of the coal beds are generally persistent despite the conglomeratic nature of the enclosing rocks. The Helena coal bed, for example, has been correlated from one end of the Cahaba field to the other. The Yeshic coal bed, although usually only about 12 inches thick, is a persistent stratigraphic marker across much of the southern half of the coal field.

Cores of numerous holes drilled in 1957 in the Montevallo and Maylene basins (pl. 1) provided many data on the upper part of the Pottsville. From 10 to 20 percent of the entire sequence in this area consists of fine-grained thin-bedded micaceous sandstone, shale, underclay, and about 20 coal beds, of which 8 have been mined commercially. Although many of the coal beds are less than a foot thick, they are remarkably persistent. No limestones or zones of marine megafossils were seen. More than 50 percent of the sequence consists of fine- to coarse-grained sandstone in beds as much as 100 feet thick. The remaining 25 percent consists of conglomerate and conglomeratic sandstone of an unusual composition. The conglomerate consists of subrounded to well-rounded pebbles and a few cobbles of quartzite, black, gray, green, brown, and red chert, metamorphic rocks, and other conglomerates, in a matrix of well-cemented fine to coarse grains of quartz and chert. Most of the conglomerate grades laterally into sandstone in places and varies greatly in thickness within short distances. The basal unit of this sequence, the Straven Conglomerate Member, is distinctive because it has larger pebbles and cobbles (as much as 8 inches in diameter), a higher proportion of pebbles to matrix, and is more persistent than the other conglomerates. It ranges in thickness from about 30 to 50 feet throughout most of the Montevallo and Maylene basins, but in places it is as much as 75 feet thick. According to Butts (1910, p. 10), it thins to the north; in T. 16 S., R. 1 E., the Straven is only a sandstone 5 to 10 feet thick containing a few scattered pebbles.

Butts (1940, p. 13) suggests that the quartzite and conglomerate pebbles were derived from the erosion of the Precambrian or Paleozoic Waxahatchee Slate, Brewer Phyllite, and Wash Creek Slate, and from the Lower Cambrian Weisner Quartzite, and that the chert pebbles were derived from the erosion of the Upper Cambrian Copper Ridge Dolomite. All these formations are exposed a few miles southeast of the Cahaba field, and presumably underlie the Cretaceous rocks to the south of the field.

TABLE 6.—*Estimated remaining reserves of coal in the Cahaba coal field, Alabama, as of Jan. 1, 1958, by county and bed*

[Rank is high-volatile A bituminous]

Coal bed	Inferred reserves, in millions of short tons, by thickness of coal, in inches, as shown															Grand total
	0–1,000 ft of overburden				1,000–2,000 ft of overburden				2,000–3,000 ft of overburden				0–3,000 ft of overburden			
	14–28	28–42	>42	Total	14–28	28–42	>42	Total	14–28	28–42	>42	Total	14–28	28–42	>42	
Bibb County																
Montevallo	9.8	4.6	--------	14.4	--------	--------	--------	--------	--------	--------	--------	--------	9.8	4.6	--------	14.4
Helena	1.8	2.8	--------	4.6	--------	--------	--------	--------	--------	--------	--------	--------	1.8	2.8	--------	4.6
Upper Thompson	7.8	18.1	83.0	108.9	3.9	--------	--------	3.9	--------	--------	--------	--------	11.7	18.1	83.0	112.8
Gholson	9.3	9.3	1.6	20.2	5.5	7.0	--------	12.5	--------	--------	--------	--------	14.8	16.3	1.6	32.7
Clark	23.1	21.7	12.1	56.9	39.8	11.4	1.7	52.9	--------	--------	--------	--------	62.9	33.1	13.8	109.8
Youngblood	37.0	34.3	9.0	80.3	51.0	26.6	1.5	79.1	--------	--------	--------	--------	88.0	60.9	10.5	159.4
Buck	3.0	10.2	2.6	15.8	8.9	19.5	1.3	29.7	--------	--------	--------	--------	11.9	29.7	3.9	45.5
Pump	3.1	8.6	--------	11.7	17.9	13.9	--------	31.8	--------	--------	--------	--------	21.0	22.5	--------	43.5
Nunnally	4.1	19.7	7.5	31.3	35.2	34.2	2.2	71.6	29.3	8.5	--------	37.8	68.6	62.4	9.7	140.7
Total	99.0	129.3	115.8	344.1	162.2	112.6	6.7	281.5	29.3	8.5	--------	37.8	290.5	250.4	122.5	663.4
Jefferson County																
Helena	--------	--------	10.5	10.5	--------	--------	13.2	13.2	--------	--------	--------	--------	--------	--------	23.7	23.7
Clark	5.6	--------	--------	5.6	--------	--------	--------	--------	--------	--------	--------	--------	5.6	--------	--------	5.6
Wadsworth	--------	1.0	5.8	6.8	2.9	5.1	6.6	14.6	--------	--------	--------	--------	2.9	6.1	12.4	21.4
Harkness	2.8	7.2	4.0	14.0	7.2	12.0	3.6	22.8	3.6	8.3	--------	11.9	13.6	27.5	7.6	48.7
Nunnally	10.8	16.3	10.6	37.7	21.5	14.0	1.0	36.5	5.7	.9	--------	6.6	38.0	31.2	11.6	80.8
Gould	4.2	4.7	1.5	10.4	6.1	2.7	.8	9.6	4.0	--------	--------	4.0	14.3	7.4	2.3	24.0
Total	23.4	29.2	32.4	85.0	37.7	33.8	25.2	96.7	13.3	9.2	--------	22.5	74.4	72.2	57.6	204.2

Shelby County

Montevallo	8.0	15.8	29.8	53.6	--------	4.8	3.2	8.0	--------	--------	--------	--------	8.0	20.6	33.0	61.6
Helena	18.6	18.9	5.0	42.5	26.4	8.8	3.9	39.1	--------	--------	--------	--------	45.0	27.7	8.9	81.6
Upper Thompson	6.5	7.1	2.0	15.6	11.4	6.2	--------	17.6	--------	--------	--------	--------	17.9	13.3	2.0	33.2
Lower Thompson	3.4	17.6	9.1	30.1	--------	2.4	1.9	4.3	--------	--------	--------	--------	3.4	20.0	11.0	34.4
Gholson	17.2	17.6	3.1	37.9	18.6	44.9	13.9	77.4	8.5	27.5	6.4	42.4	44.3	90.0	23.4	157.7
Clark	20.7	13.6	4.9	39.2	20.3	50.0	8.3	78.6	18.7	10.1	--------	28.8	59.7	73.7	13.2	146.6
Youngblood	8.5	10.9	1.4	20.8	41.6	27.9	4.0	73.5	13.0	10.4	--------	23.4	63.1	49.2	5.4	117.7
Buck	2.7	8.7	2.0	13.4	14.0	24.8	5.1	43.9	4.0	2.7	--------	6.7	20.7	36.2	7.1	64.0
Pump	5.1	--------	--------	5.1	--------	--------	--------	--------	--------	--------	--------	--------	5.1	--------	--------	5.1
Wadsworth	4.3	7.2	1.9	13.4	9.0	5.2	.4	14.6	5.2	2.8	--------	8.0	18.5	15.2	2.3	36.0
Nunnally	13.0	6.3	1.4	20.7	25.3	6.0	1.8	33.1	19.2	2.1	--------	21.3	57.5	14.4	3.2	75.1
Gould	4.3	1.0	1.2	6.5	11.1	3.4	--------	14.5	24.8	--------	--------	24.8	40.2	4.4	1.2	45.8
Total	112.3	124.7	61.8	298.8	177.7	184.4	42.5	404.6	93.4	55.6	6.4	155.4	383.4	364.7	110.7	858.8

St. Clair County

Helena	--------	--------	2.9	2.9	--------	--------	3.5	3.5	--------	--------	--------	--------	--------	--------	6.4	6.4
Clark	5.8	--------	--------	5.8	--------	--------	--------	--------	--------	--------	--------	--------	5.8	--------	--------	5.8
Harkness	2.7	1.4	2.8	6.9	3.2	9.9	2.4	15.5	4.8	0.5	--------	5.3	10.7	11.8	5.2	27.7
Total	8.5	1.4	5.7	15.6	3.2	9.9	5.9	19.0	4.8	.5	--------	5.3	16.5	11.8	11.6	39.9

In the Cahaba coal field, the productive part of the Pottsville Formation (Gould coal bed and above) contains more than 35 coal beds in about 6,500 feet of section (pl. 3). Although each of these beds may be thick enough to be locally minable, only about 13 beds are sufficiently thick and widespread to be included in coal reserve estimates according to the available data (table 6). The coal in the Cahaba coal field is high-volatile A bituminous in rank (table 7).

TABLE 7.—*Average analyses of coal in Cahaba coal field, Alabama*

[Analyses by U.S. Bur. of Mines on as-received basis. Rank is high-volatile A bituminous. Samples are from mine faces]

Bed	Proximate analysis (percent)				Ultimate analysis (percent)				Sulfur (percent)	Btu	Ash softening temperature (° F)	Number of analyses averaged [1]
	Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen				
Bibb County												
Youngblood	2.7	34.7	57.4	5.2	5.3	79.7	1.4	7.1	1.3	14,160	2,050	1
Woodstock	3.1	34.7	57.1	5.1	5.3	78.5	1.4	8.7	1.1	13,930	2,260	4
Thompson	4.1	34.8	56.0	5.0	5.3	76.6	1.3	10.5	1.1	13,660	2,140	2
Yeshic	4.5	31.1	47.8	16.6	4.9	65.6	1.2	10.5	1.2	11,590	2,330	1
Jefferson County												
Gould	3.0	30.2	58.9	7.9	5.0	76.2	1.6	7.5	1.8	13,620	2,450	1
Lower Nunnally	2.3	33.6	57.4	6.7	5.3	77.5	1.7	7.3	1.5	13,860	2,160	1
Upper Nunnally	2.2	31.1	54.3	12.4	5.0	73.3	1.6	7.0	.7	12,980	2,430	1
Harkness	2.6	32.9	54.9	9.5	5.2	74.4	1.6	8.1	1.0	13,230	2,350	2
Helena	2.0	34.3	56.3	7.4	5.3	77.1	1.7	8.1	.4	13,660	2,460	1
Shelby County												
Clark	2.3	35.0	54.3	8.2	5.1	75.9	1.4	8.6	0.6	13,580	2,200	2
Gholson	4.0	34.7	58.2	3.1	5.5	79.3	1.5	10.0	.7	14,150	2,170	3
Thompson	2.8	29.9	54.8	12.4	5.0	71.4	1.2	8.6	1.2	12,620	2,200	2
Helena	2.7	32.8	55.0	9.4	5.2	74.6	1.4	8.8	.4	13,210	2,480	2
Montevallo	2.9	37.9	51.9	7.2	5.3	75.4	1.0	10.3	.7	13,490	2,370	2
Dogwood	2.7	35.0	54.6	7.7	5.3	75.8	1.3	9.0	.9	13,470	2,100	1
Maylene	3.0	36.6	53.0	7.4	4.9	74.7	1.2	11.4	.4	13,380	2,350	1
St. Clair County												
Harkness	2.2	33.7	55.9	8.2	5.1	75.3	1.7	7.5	2.1	13,520	2,200	3
Clark	2.5	36.7	55.6	5.2	5.4	78.4	1.4	8.6	1.0	13,940	2,230	1
Helena	4.7	33.4	56.9	5.0	5.5	76.4	1.6	10.6	.9	13,610	1,920	1

[1] Each analysis averaged is a composite of three or more samples.

Most of the mining in the past and most of the remaining reserves in the Cahaba coal field (pl. 1) are restricted to the many structural basins where the upper coal beds have been protected from the erosion. Because the basins are somewhat isolated and because the beds split and coalesce, correlation of these coal beds from one part of the field to another has always been a problem. The published reports on the Cahaba field list several names for each of the coal beds, particularly those in the interval between the Wadsworth to Thompson coal beds. The names used in this report are those used by Butts (1927, 1940) augmented by names used locally. Butts (1910) describes two coal beds beneath the Pine Sandstone Member, but these beds are thin and nonpersistent. The oldest coal beds that are included in the coal-reserve estimates are in the Gould coal group.

GOULD COAL GROUP

The Gould coal group is from 200 to 500 feet above the Pine Sandstone Member. According to Butts (1927, p. 18), the Gould consists of more than one bed, but at no place is there more than one bed of workable thickness. Only in the central part of the Cahaba coal field is this Gould coal bed sufficiently thick to be included in the reserve estimates (pl. 1 and table 6). In this area the Gould coal bed has an average thickness of about 2 feet and a moderate sulfur and ash content (table 7).

NUNNALLY COAL GROUP

About 1,000 to 1,500 feet above the Gould coal bed is a group of two to six beds called the Nunnally coal group. One or more coal beds of this group have a maximum thickness of 5 feet of coal throughout most of the Cahaba coal field southwest of the Henryellen basin (pl. 1). In most places only one coal bed of the Nunnally coal group is included in the coal reserves, but locally the reserves in two coal beds are tabulated under the Nunnally coal bed (table 6). Because the Nunnally is stratigraphically low, it is under thick overburden in the central part of the basins and only a few data are available on its thickness. The Nunnally beds are low in sulfur but have varying amounts of ash (table 7).

HARKNESS COAL BED

About 500 feet above the Nunnally beds is the Harkness coal bed. This bed is of value only in the Henryellen and the Little Cahaba basins where it is as much as 5 feet thick with a few inches of partings (pl. 1 and table 6). It has been mined extensively in Henryellen basin. It has a low sulfur content and a moderately high ash content (table 7).

WADSWORTH COAL BED

About 500 feet above the Harkness bed is the Wadsworth or Waterworks coal bed. This bed is of value only in the Eureka, Helena, Acton, and Little Cahaba basins, where it reaches about 6 feet in thickness, averaging about 3 feet, and contains a few inches of partings (pl. 1 and table 6). This bed has been mined extensively in the Little Cahaba basin.

BIG BONE COAL BED

About 300 feet above the Wadsworth bed is a thick dirty coal bed called the Big Bone or Coke Oven. Its name is derived from the fact that in parts of the Blocton basin this bed is 12 to 16 feet thick and consists mostly of impure coal or "bone." It thins to about 4 feet on the west side of the Montevallo basin and is not known to exist north of this basin. Reserves were not estimated for this bed because of its high ash content, but it may be of value in the future.

PUMP COAL BEDS

The Pump coal beds, also called Alice and Jones, are two coal beds about 25 feet apart lying about 300 feet above the Big Bone coal bed. At most localities they are too thin to be of value, but in a few places (pl. 1) in the Blocton and Montevallo basins one of the coal beds is as much as 30 inches thick. In a few places both beds exceed 14 inches in thickness; in these places reserves were calculated for both beds and tabulated under the Pump bed (table 6). Butts (1940, p. 14) reports that in the Montevallo basin these beds appear to be very high quality coal.

BUCK COAL BED

About 300 feet above the Pump beds is the Buck or Atkins coal bed. According to available data, this bed is of minable thickness only in parts of the Montevallo basin (pl. 1 and table 6). Along the northwest edge of this basin, the Buck coal bed is as much as 4 feet thick, containing a few inches of partings. Elsewhere, however, the thickness of the coal and the thickness of the partings vary widely.

YOUNGBLOOD COAL BED

About 100 to 150 feet above the Buck bed is the Youngblood or Coke coal bed. It is persistent and uniformly thick in the Blocton and Montevallo basins and is variable in thickness in the Maylene, Dry Creek, Eureka, and Acton basins (pl. 1 and table 6). In the remainder of the Cahaba field, however, thickness data are insufficient to estimate coal reserves. The thickness of the bed averages about 36 inches in the southern part of the Cahaba field and is as much as 55 inches in some places. Only a moderate amount of coal has been mined from this bed. This coal has low ash and sulfur contents (table 7).

CLARK COAL BED

About 500 feet above the Youngblood bed is a bed called Woodstock in the Blocton basin and Clark in the remainder of the field. It is one of the most persistent beds in the Cahaba field and is of minable thickness in all the basins except in the Helena, Acton, and Little Cahaba (pl. 1). It contains 36 to 48 inches of coal and a few inches of parting in most of the Blocton and Montevallo basins, where it has been mined extensively. In the Dry Creek, Eureka, and Maylene basins, it is variable in thickness and quality, but it is locally valuable (table 6). In much of the Henryellen basin in the northern part of the Cahaba field, the Clark(?) coal bed has an average thickness of about 2 feet. In the Montevallo basin the Clark apparently splits into two benches as much as 40 feet apart. It has moderately low ash and sulfur contents (table 7).

GHOLSON COAL BED

The Gholson coal bed is 20 to 70 feet above the Clark coal bed. The Gholson is estimated to contain reserves of coal only in the Eureka, Dry Creek, Maylene, and Montevallo basins (pl. 1 and table 6). It is a persistent bed along the northwest edge of the Montevallo basin, where it averages about 40 inches in thickness and has been mined extensively. Farther northeast the Gholson varies considerably in thickness. The coal has a low ash and sulfur content (table 7).

Two thin coal beds, named Quarry and Smithshop, that are about 40 and 130 feet above the Gholson coal bed, respectively, are not known to contain coal reserves.

THOMPSON COAL BEDS

About 200 to 250 feet above the Gholson bed are two Thompson coal beds in a stratigraphic interval as much as 100 feet thick. They consist of an Upper and a Lower Thompson coal bed separated by the Straven Conglomerate Member. Only one of these beds is of minable thickness at any one place. The Lower Thompson is found in the Acton, Helena, and Eureka basins in the central part of the Cahaba field (pl. 1), where it is locally as much as 5 feet thick and contains few or no partings. The Upper Thompson is present in the Dry Creek, Maylene, and Montevallo basins, where it is variable in thickness. In the Blocton basin and most of the Montevallo basin, however, the Upper Thompson is a thick and valuable bed (table 6). It is 40 to 70 inches thick over a large area and, locally, contains a few partings. The coal has low ash and sulfur contents. Much of the coal bed has been mined out in the Blocton basin.

HELENA COAL BED

About 160 feet above the Upper Thompson bed is the Helena coal bed, which is persistent throughout most of the Cahaba coal field (pl. 1). It is thickest in the northern part of the Cahaba field (Henryellen basin), where it is called the Mammoth or Henryellen and contains more than 100 inches of coal with a few inches of parting. In the Henryellen basin nearly all this coal is mined out. In the Acton, Helena, Eureka, and Dry Creek basins, the Helena is a valuable bed, although it is variable in thickness (table 6). In the Maylene and Montevallo basins the Helena is thinner and more erratic. The Helena apparently splits into two beds as much as 60 feet apart in the Montevallo basin. In the Blocton basin the Helena is too thin to be minable. The Helena has low percentages of ash and sulfur (table 7).

YESHIC COAL BED

About 110 to 225 feet above the Helena bed is the Yeshic bed. The Yeshic bed is a thin persistent coal in the Montevallo and adjacent Blocton and Maylene basins. Butts (1940, p. 15) reports that an opening was made on an 18-inch bed called Yeshic near Garnsey in sec. 7, T. 22 S., R. 4 W., Bibb County. The sparse data on the thickness of the Yeshic elsewhere indicate that it is too thin to contain significant reserves of coal.

MONTEVALLO COAL BED

The persistent Montevallo coal bed lies 380 to 430 feet above the Yeshic bed in the Maylene, Dry Creek, and Montevallo basins. The Montevallo coal has been mined for nearly 100 years near Aldrich in sec. 19, T. 22 S., R. 3 W., Shelby County. In the Aldrich mine the Montevallo bed consists of about 35 inches of coal and locally has a few partings. Along its outcrop on the northwest side of the Montevallo quadrangle, however, the coal thins and the number of partings increase. Reserves are estimated in the Montevallo and Maylene basins (pl. 1 and table 6) but not in the Dry Creek basin, where its thickness is unknown. The Montevallo coal has a low sulfur content and a moderate ash content (table 7). According to Hertzog and others (1940), it is the least friable and grindable of all the coals tested in the Cahaba coal field. These factors have made the Montevallo a desirable domestic coal.

COAL BEDS BETWEEN THE MAYLENE AND MONTEVALLO COAL BEDS

Between the Montevallo and Maylene coal beds in the Maylene basin is a sequence of sandstone, conglomerate, and shale that averages about 1,300 feet in thickness and that in places contains as many as 15 coal beds. Some of these beds are also present in the Montevallo and Dry Creek basins, where the upper part of this sequence has not been preserved. Many of these coal beds are less than 14 inches thick, but locally a few are as much as 4 feet thick. Butts (1927, fig. 5) names seven beds in this interval in descending order as follows: Lovelady, Wooten, Luke, Stein, Dogwood (Upper and Lower), and Airshaft (pl. 3). Of these, only the two Dogwood coal beds have been mined to any extent. The Upper and Lower Dogwood coal beds lie about 500 feet above the Montevallo coal bed in the Montevallo, Maylene, and Dry Creek basins. In most places they are thin and dirty coal beds, but locally one of them, usually the Lower Dogwood, is of minable thickness. So little is known of the thickness and extent of the Dogwood beds, or of any of the other coal beds in the Montevallo-Maylene interval, that no attempt was made to calculate reserves.

MAYLENE COAL BEDS

From 1,150 to 1,400 feet above the Montevallo coal beds are the Upper and Lower Maylene coal beds. The Lower Maylene, which is 8 to 40 feet below the Upper Maylene, is 4 to 5 feet thick including partings and, according to its analysis (table 7), has a moderate ash content and a low sulfur content. It underlies only a small area in the Maylene basin and is reported to be worked out; therefore, no reserves were estimated in this bed. The Upper Maylene is evidently too thin to be minable.

About 200 to 250 feet above the Maylene beds is a thin noncommercial bed called the Polecat coal bed. This coal bed is the highest coal bed in the Pottsville Formation in the Cahaba coal field.

COOSA COAL FIELD (NORTHEASTERN PART)

In the northeastern part of the Coosa coal field, which comprises the Wattsville and Ragland basins (pl. 1), the Pottsville Formation has a maximum thickness of 5,500 feet (pl. 3, loc. 4). It is divisible into three parts: a lower part consisting of the Shades and Pine Sandstone Members, a middle "barren" part, and an upper coal-bearing part.

According to Rothrock (1949), the Shades Sandstone Member is a sparsely conglomeratic quartzose sandstone about 190 feet thick separated from the overlying Pine Sandstone Member by 200 to 300 feet of shale and fine-grained sandstone. The Pine Member is more conglomeratic than the Shades and ranges in thickness from 210 to 250 feet. Above the Pine Sandstone Member in the Wattsville basin is as much as 4,800 feet of Pottsville strata. The upper 2,000 feet of these beds consists of fine- to medium-grained sandstone, carbonaceous claystone, and siltstone, all of which are generally gray and lenticular, interbedded with 14 named beds of bituminous coal (pl. 3, loc. 4). The coal beds vary considerably in persistence—some are notably discontinuous, whereas others persist throughout the area of outcrop. At 200 feet above the Coal City coal bed is a prominent 150-foot-thick sandstone bed containing scattered quartz pebbles; this is the Fourth or Upper Conglomerate of Gibson (1895, p. 79). Rothrock (1949, p. 27) says this bed is similar to the Pine Sandstone Member but is more shaly and less conglomeratic. Below the upper coal-bearing sequence is 2,800 feet of lenticular sandstone, siltstone, and claystone beds that locally contain three nonpersistent coal beds, which are less than 12 inches thick. No marine fossils or limestone were found by Rothrock in the entire Pottsville section.

According to Prouty (1909, p. 923) the Ragland coal basin contains eight coal beds, of which four are "workable" (18 inches or more thick) in places. As no details are available on these beds, reserves are not estimated. It is probable, however, that the best coal has been mined out and that the potential coal reserves are small.

The Wattsville (Coal City and Fairview) basin has been the subject of a coal investigation by Jones (1926) and of a field mapping investigation by Rothrock (1949) in connection with an intensive core drilling program by the U.S. Bureau of Mines (1949). These reports are the basis for the following descriptions of the beds in the Wattsville basin.

CHAPMAN COAL BEDS

The lowermost of the "productive" coal beds in the Wattsville basin are the Upper and Lower Chapman coal beds, which are about 100 feet apart stratigraphically. The Lower Chapman is generally less than 14 inches thick. The Upper Chapman, however, is a single bed of bright coal that reaches a thickness of 24 inches in two small areas (pl. 1) and has a 1-inch parting. It is abruptly lenticular in places. The Upper Chapman is a medium-volatile bituminous coal having moderately high ash and sulfur contents (table 8).

At 175 feet above the Upper Chapman coal bed is the New coal bed, which averages 11 inches in thickness in the central part of the Wattsville basin.

TABLE 8.—*Average analyses of coal in Coosa coal field, St. Clair County, Ala.*

[Analyses by U.S. Bur. of Mines on as-received basis. Coal samples are from diamond-drill cores and from mine faces. Rank is high-volatile A bituminous, except for Fairview coal bed which is medium-volatile bituminous in places]

Bed	Proximate analysis (percent)				Ultimate analysis (percent)				Sulfur (percent)	Btu	Ash softening temperature (° F)	Number of analyses averaged
	Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen				
Upper Chapman	0.7	27.0	63.5	8.9	4.6	79.3	1.1	3.5	2.8	13,990	2,130	2
Fairview	1.5	26.7	57.9	13.9	4.5	72.7	1.2	3.7	4.1	13,010	2,230	25
Gann	.8	29.7	60.2	9.3	4.8	77.7	1.3	2.9	4.1	13,950	2,110	4
Marion	1.7	30.1	60.0	8.3	5.0	78.2	1.3	4.3	2.9	14,010	2,240	8
Broken Arrow	2.6	28.8	59.7	8.9	5.0	77.6	1.3	6.3	.9	13,680	2,360	1
Coal City	2.3	32.2	60.8	4.7	5.3	81.4	1.5	6.1	.8	14,450	2,230	2
Hammond	4.4	29.4	54.6	11.7	5.1	73.0	1.4	7.7	1.2	13,050	2,700	3

FAIRVIEW COAL BED

The Fairview coal bed is the thickest of the beds that are widespread in the Wattsville basin (pl. 1). It lies 350 feet stratigraphically above the Upper Chapman coal bed. The Fairview consists generally of two coal layers separated by a claystone parting ranging in thickness from a few inches to as much as 5½ feet. Each coal layer averages about 14 inches in thickness. The lower layer, however, is not present south of sec. 14, T. 16 S., R. 3 E. The Fairview coal bed contains more than half of the coal reserves in the Wattsville basin (table 9) and is the only bed in the Wattsville basin for which the U.S. Bureau of Mines (1949, p. 21) estimated reserves of coal. The Fairview bed ranges from medium-volatile bituminous to high-volatile A in rank and has high ash and sulfur contents (table 9).

About 70 feet above the Fairview bed is the persistent Higginbotham coal bed, which averages 12 inches in thickness.

GANN COAL BED

About 90 feet above the Fairview coal bed is the Gann coal bed. The Gann coal is less than 14 inches thick throughout the Wattsville basin except in two areas in T. 15 S., R. 4 E. (pl. 1 and table 8), where it contains 14 to 16 inches of clean coal.

About 250 feet above the Gann coal is the discontinuous Brown coal bed that averages about 10 inches in thickness. Above the Brown coal bed are one to four discontinuous coal beds called the Bibby coal zone. Although one or more of these coal beds have been mined locally, they are not continuous enough to be included in coal reserve estimates.

MARION COAL BED

The Marion coal bed, which is 710 feet above the Fairview coal, is a persistent bed in this area. Its thickness averages 15 inches in the northern part of the Wattsville basin and 22 inches in the southern part (pl. 1 and table 9). The coal has a moderate ash content and a high sulfur content (table 8).

BROKEN ARROW COAL BED

About 85 feet above the Marion coal bed is a persistent bed called the Broken Arrow bed. It is a relatively thick bed but generally includes many claystone partings which locally are thicker than the coal. In the central part of the Wattsville basin (pl. 1), however, the clay partings almost disappear, and the bed contains a maximum thickness of 54 inches of coal (table 9). It has a moderate ash content and a low sulfur content (table 8).

Above the Broken Arrow coal bed is the Inman coal bed, which was mined extensively prior to 1858. It was reported to be as much as 42 inches thick, but the thick coal has probably been mined out.

TABLE 9.—*Estimated remaining reserves of coal in the Coosa coal field, Alabama, as of Jan. 1, 1958, by county and bed*

[Rank is high-volatile A bituminous and medium-volatile bituminous]

Coal bed	Overburden (feet)	Reserves, in millions of short tons, for thickness of beds, in inches as shown											
		Measured and indicated				Inferred				Total all categories			Grand total
		14-28	28-42	>42	Total	14-28	28-42	>42	Total	14-28	28-42	>42	
St. Clair County [1]													
Hammond	0-1,000						0.4		0.4		0.4		0.4
Coal City	0-1,000	0.6	0.2		0.8			0.5	.5	0.6	.2	0.5	1.3
Broken Arrow	0-1,000	1.0	.8		1.8					1.0	.8		1.8
Marion	0-1,000	2.9			2.9	3.0			3.0	5.9			5.9
Gann	0-1,000	1.7			1.7					1.7			1.7
Fairview	0-1,000	13.5	.6		14.1	1.9			1.9	15.4	.6		16.0
	1,000-2,000		1.0		1.0	1.6			1.6	1.6	1.0		2.6
Total, Fairview		13.5	1.6		15.1	3.5			3.5	17.0	1.6		18.6
Upper Chapman	0-1,000	1.1			1.1					1.1			1.1
Total, all beds	0-1,000	20.8	1.6		22.4	4.9	.4	.5	5.8	25.7	2.0	.5	28.2
	1,000-2,000		1.0		1.0	1.6			1.6	1.6	1.0		2.6
Grand total		20.8	2.6		23.4	6.5	0.4	.5	7.4	27.3	3.0	.5	30.8
Shelby County													
Martin	0-1,000		1.2	3.0	4.2						1.2	3.0	4.2
	1,000-2,000						1.0	2.7	3.7		1.0	2.7	3.7
	2,000-3,000						.7	2.0	2.7		.7	2.0	2.7
Total			1.2	3.0	4.2		1.7	4.7	6.4		2.9	7.7	10.6

[1] All reserve figures for St. Clair County are derived from the reserve figures by Rothrock (1949, p. 88-89).

COAL CITY COAL BED

From 1,045 to 1,166 feet above the Fairview coal bed lies the Coal City coal bed. Because of its position high in the stratigraphic section, it underlies only a small area in the Wattsville basin (pl. 1 and table 9). The lower 39 to 50 inches of this bed consists of clean coal, and the upper 24 inches consists of interbedded coal and claystone. It has low ash and sulfur contents (table 8).

About 130 feet above the Coal City bed is the Brewer coal bed. This bed ranges from 11 to 81 inches in thickness and consists of alternating layers of coal and claystone. No reserves were estimated for this bed.

HAMMOND COAL BED

The Hammond coal is the youngest coal in the Pottsville Formation in the Wattsville basin. It is about 340 feet above the Coal City bed. It reaches a maximum thickness of 91 inches in a small area of outcrop in secs. 1 and 12, T. 16 S., R. 3 W. (pl. 1 and table 9). It contains a large proportion of clay and thins abruptly to the southwest. Its analyses show a high ash content and a moderate sulfur content (table 8).

COOSA COAL FIELD (SOUTHWESTERN PART)

In the southwestern part of the Coosa coal field, the maximum thickness of the Pottsville Formation, 7,400 feet, is contained in the Yellow Leaf basin (Butts, 1927). The Pottsville here offers a sharp contrast with the northeastern part of the Coosa coal field in that no thick coal-bearing section is present (pl. 3, loc. 8). In this part of the field, the Shades and Pine Sandstones pinch and swell, and the interval between them varies greatly. According to the structure map of Butts (1927), the Pine Sandstone ranges from about 200 to 500 feet in thickness, and the Shades Sandstone ranges in thickness similarly. The interval between them is about 200 feet on the northwest side of the field, and thickens to more than 1,000 feet on the southeast side. In a section measured by the author in the Yellow Leaf basin, the unit mapped by Butts (1927) as the Shades Sandstone is a conglomeratic sandstone 80 feet thick; the unit mapped as the Pine Sandstone is 440 feet thick and is divided into three parts by two shale partings, 16 feet and 56 feet thick. Only the lower part of the Pine Sandstone is conglomeratic. At this locality the Shades and Pine Members are separated by 650 feet of concealed strata, presumably shale.

In the Yellow Leaf basin the strata overlying the Pine Sandstone Member have a maximum thickness of 5,800 feet. According to Butts (1927, p. 14), the upper 2,000 feet is composed of shale and thin sandstone layers, in which red shale occurs as lentils at 1,000 and 1,500 feet below the top. The lower 3,800 feet is composed of shale and sandstone and contains two named sandstone members and seven coal beds. The Wolf Ridge Sandstone Member, which lies about 1,200 feet above the Pine Sandstone Member, is a persistent hard quartzitic sandstone 50 to 100 feet thick that makes a prominent ridge. The Straight Ridge Sandstone Member is a resistant ridge-forming sandstone bed about 800 feet above the Wolf Ridge Sandstone Member.

The only coal bed for which reserves are estimated is the Martin (pl. 3, loc. 8). All others are thin or their thickness and continuity are unknown. The Cunningham coal bed is reported to be 7 feet thick in the NW¼ sec 10, T. 20 S., R. 2 W. (Butts, 1927, p. 19), but coal of this thickness is apparently confined to a very small area.

MARTIN COAL BED

The Martin coal bed, which lies 4,400 feet above the base of the Pottsville Formation, is the most persistent bed in the southwestern part of the Coosa field. Its thickness is variable, ranging from a few inches to more than 12 feet along about 20 miles of outcrop in the Yellow Leaf basin. A few small mines have been opened on this bed, but mining operations are hampered by the steep dips of the coal, which are as much as 50°. As a result of the steep dip, only a narrow strip along the outcrop is underlain by coal reserves that are under less than 3,000 feet of overburden (table 9 and pl. 1). Analyses of this coal are not available.

CORRELATION OF BEDS BETWEEN COAL FIELDS

The correlation of coal beds, or other units, between coal fields has always been extremely difficult because the Pottsville Formation differs in thickness and lithology from one coal field to the other and because the Cahaba and Coosa coal fields are isolated from the Warrior and Plateau coal fields. In the only published correlation of coal beds, Butts (1927, p. 14) quotes David White, who correlated on paleobotanical evidence the Rosa coal bed, Black Creek, Mary Lee, and Pratt coal beds in the Warrior coal field with the Gould, Harkness, Wadsworth, and Clark coal beds, respectively, in the Cahaba coal field (pl. 3).

The lower part of the Pottsville Formation in each coal field contains one or two persistent massive resistant orthoquartzite beds, one or both of which contain small rounded quartz pebbles. On the basis of the distinctive lithology and the persistence of these beds within each coal field, these orthoquartzites are correlated as shown on plates 2 and 3 (Culbertson, 1963).

The only other beds that seem to offer a reasonable basis for correlation between the Warrior and Cahaba fields are the beds of conglomerate that contain varicolored pebbles of chert, quartz, and metamorphic rocks. In the Cahaba coal field the upper part of the Pottsville Formation is characterized by numerous beds of this type. In the Warrior coal field the Lick Creek Sandstone Member contains pebbles of a similar composition. Because the lithology is similar, it seems reasonable to correlate the Lick Creek Sandstone Member with the coarsest and most extensive bed of conglomerate in the Cahaba coal field, the Straven Conglomerate Member. If these are equivalent beds, then the areal distribution of these beds indicates that the source of the conglomerate is south of the Cahaba field and that the conglomerate was deposited in a northward direction; that is, from locality 7 to locality 2 on plate 3. This correlation would also indicate that the Mary Lee coal bed, which overlies the Lick Creek Member, should correlate with a bed higher than the Straven Conglomerate Member, the Helena coal bed for example. As the basis for White's correlations of the Mary Lee with the Wadsworth coal bed was not published and his plant collections are no longer available, it is not known whether his paleobotanical correlations were precise enough to cast doubt on the validity of the Straven and Lick Creek correlation.

PHYSICAL AND CHEMICAL CHARACTERISTICS OF ALABAMA COAL

The coal of Pennsylvanian age in Alabama is, in general, high-grade banded "bright" bituminous coal that ranges in rank from high-volatile A to low volatile. Tables 1, 3, 6, and 8 show average or typical chemical analyses of the coal beds on an as-received basis. Most coal beds contain from 5 to 15 percent ash, and the Black Creek coal bed in the Warrior coal field consistently contains about 3 percent or less. The sulfur content of most of the coal in Alabama is less than 2 percent.

According to the U.S. Bureau of Mines (1949, p. 22) most of the coals in the Wattsville (Coal City and Fairview) basin of the Coosa field are bright and contain an appreciable amount of fusain. Pyrite is a conspicuous constituent, occurring as lenses, as crystals on the joint faces, and as disseminated pyrite in the fusain. The prominence of pyrite is reflected in the relatively high sulfur content of many of the coals in this part of the Coosa field (table 8).

RANK

The bituminous coal in Alabama varies in rank within rather narrow limits. Most of the coal is high-volatile A bituminous, a relatively minor amount is medium-volatile bituminous, and a few million tons on Lookout Mountain is low-volatile bituminous (fig. 7). The coal is classified by rank in accordance with the standard classification of the American Society for Testing Materials (table 10). The rank of Alabama coals is determined by their percentage of fixed carbon calculated on a dry, mineral-matter-free basis.

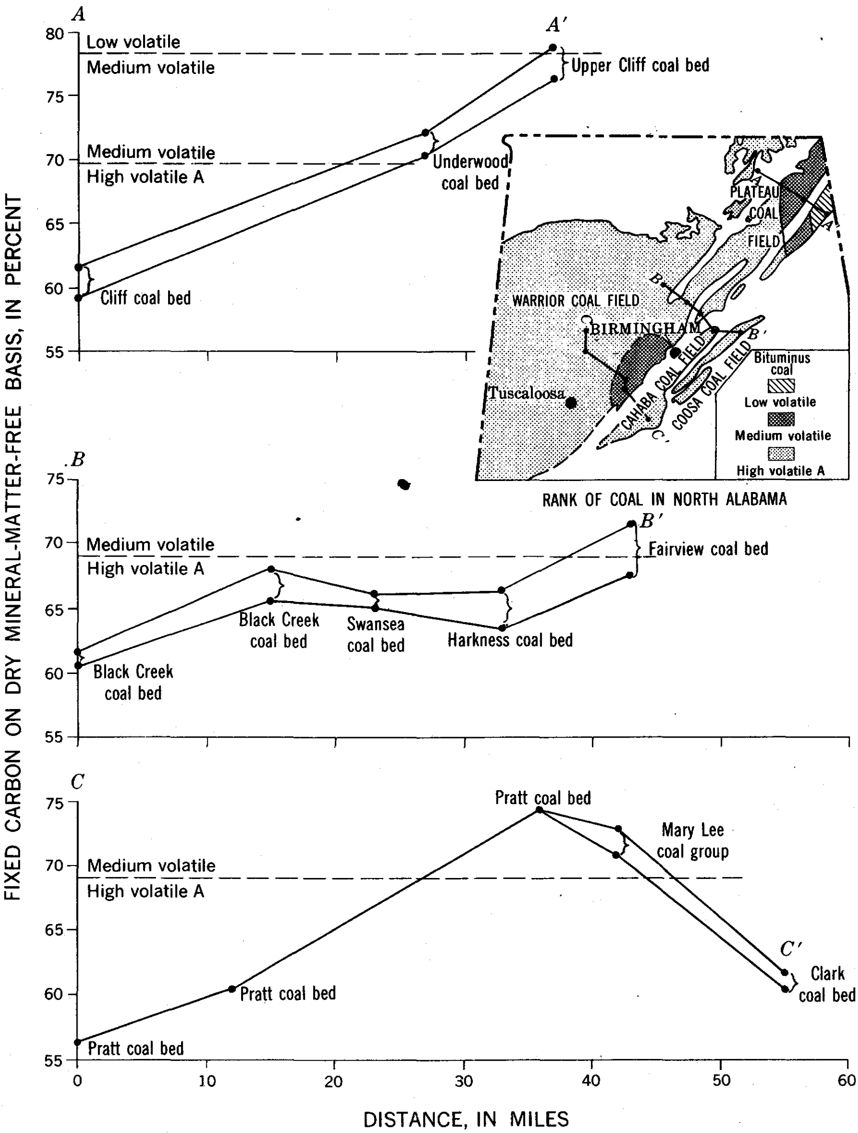

FIGURE 7.—Variation in rank of bituminous coal beds across the coal fields of Alabama. Analyses by U.S. Bureau of Mines. Names on cross sections are coal beds whose stratigraphic position is shown on plate 3. Upper and lower lines show maximum and minimum fixed carbon content for the coal bed at each locality.

TABLE 10.—*Classification of coals by rank*[1]

Legend: FC, fixed carbon; VM, volatile matter; Btu, British thermal units

[From American Society for Testing Materials (1955, pt. 5, p. 1023)]

Class	Group	Limits of fixed carbon or Btu, mineral-matter-free basis	Requisite physical properties
I. Anthracitic	1. Meta-anthracite	Dry, FC, 98 percent or more (dry, VM, 2 percent or less).	
	2. Anthracite	Dry, FC, 92 percent or more and less than 98 percent (dry, VM, 8 percent or less and more than 2 percent).	
	3. Semianthracite	Dry, FC, 86 percent or more and less than 92 percent (dry, VM, 14 percent or less and more than 8 percent).	Nonagglomerating.[2]
II. Bituminous[3]	1. Low-volatile bituminous coal.	Dry, FC, 78 percent or more and less than 86 percent (dry, VM 22 percent or less and more than 14 percent).	
	2. Medium-volatile bituminous coal.	Dry, FC, 69 percent or more and less than 78 percent (dry, VM, 31 percent or less and more than 22 percent).	
	3. High-volatile A bituminous coal.	Dry, FC., less than 69 percent (dry VM, more than 31 percent); and moist[4] Btu., 14,000[5] or more.	
	4. High-volatile B bituminous coal.	Moist[4] Btu, 13,000 or more and less than 14,000.[5]	
	5. High-volatile C bituminous coal.	Moist Btu, 11,000 or more and less than 13,000.[5]	Either agglomerating or nonweathering.[6]
III. Subbituminous	1. Subbituminous A coal	Moist Btu, 11,000 or more and less than 13,000.[5]	Both weathering and nonagglomerating.
	2. Subbituminous B coal	Moist Btu, 9,500 or more and less than 11,000.[5]	
	3. Subbituminous C coal	Moist Btu, 8,300 or more and less than 9,500.[5]	
IV. Lignitic	1. Lignite	Moist Btu, less than 8,300	Consolidated.
	2. Brown coal	Moist Btu, less than 8,300	Unconsolidated.

[1] This classification does not include a few coals which have unusual physical and chemical properties and which come within the limits of fixed carbon or Btu of the high-volatile bituminous and subbituminous ranks. All of these coals either contain less than 48 percent dry, mineral-matter-free fixed carbon or have more than 15,500 moist, mineral-matter-free Btu.

[2] If agglomerating, classify in low-volatile group of the bituminous class.

[3] It is recognized that there may be noncaking varieties in each group of the bituminous class.

[4] Moist Btu refers to coal containing its natural bed moisture but not including visible water on the surface of the coal.

[5] Coals having 69 percent or more fixed carbon on the dry, mineral-matter-free basis shall be classified according to fixed carbon, regardless of Btu.

[6] There are three varieties of coal in the high-volatile C bituminous coal group: (1) agglomerating and nonweathering, (2) agglomerating and weathering, and (3) nonagglomerating and nonweathering.

The rank increases generally from northwest to southeast, with some notable exceptions (for example, section *C–C′*, fig. 7). This areal variation in rank is probably due to such interacting factors as the variation in the amount of horizontal compression from mountain-building forces, variation in composition of the coal, and variation in the weight of the overlying beds during the maximum depth of burial of the coal bed. The available data in Alabama are inconclusive as to the effect of horizontal compression, but coal analyses from several deep core holes shed some light on the effect of weight of the overlying beds. A plot (fig. 8) of the fixed carbon content of the coal beds in

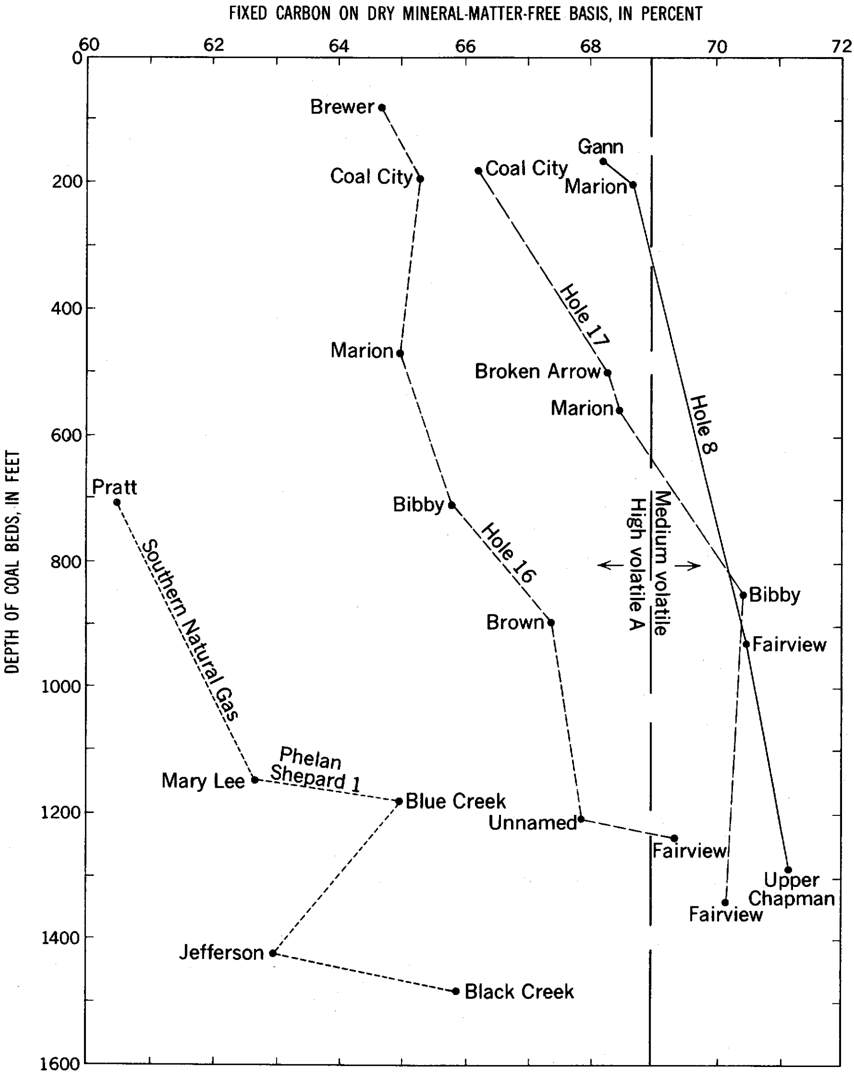

FIGURE 8.—Rank of coal bed in relation to depth in three core holes in the Coosa coal field and in one core hole in the Warrior coal field, Alabama. Hole 8, SE¼NE¼ sec. 31, T. 15 S., R. 4 E.; hole 17, SE¼SE¼ sec. 1, T. 16 S., R. 3 E.; hole 16, NW¼NW¼ sec. 14, T. 16 S., R. 3 E.; Southern Natural Gas Phelan Shephard 1, SE¼SE¼ sec. 35, T. 17 S., R. 9 W. Analyses by U.S. Bureau of Mines.

relation to their depth in the core holes shows an average increase of 0.3 to 0.4 percent of fixed carbon per 100 feet of depth in the northeastern part of the Coosa field, and an increase of about 0.5 percent of fixed carbon per 100 feet of depth in the Warrior field. This average rate of increase is interpreted to be the result of the increase of weight of overlying beds with increasing depth; the variations of the points from a straight line on the graph are interpreted to be the result of variations in composition between coal beds. It seems likely that a large part of the southeastward increase in rank of a coal bed in the Warrior coal field is due to a southeastward thickening of the overlying beds toward the axis of geosynclinal deposition. However, the original thickness of the overlying beds is nowhere preserved in Alabama; so, it is difficult to say how much of this southeastward increase in rank is due to this factor.

GRINDABILITY

Hertzog and others (1940) have published a comprehensive study of the grindability of coal from 34 mines in the Warrior field, 14 mines in the Cahaba field, and 1 mine in the Blount Mountain part of the Plateau field. The range in the grindability indices and rank of the samples of coal from each of three areas are as follows:

	Grindability index [1] (percent)	Percent of fixed carbon (dry, mineral-matter-free basis)
Coalburg syncline, Warrior field (Jefferson County)	45–67	65–72
Northwestern part of Warrior field (Walker and Marion Counties)	31–40	56–65
Cahaba field (all counties) and Plateau field (Blount County)	35–42	60–64

[1] Grindability index is defined as 50,000 divided by number of revolutions of a ball mill required to grind 80 percent of the sample of coal through a 200-mesh sieve. Thus the lower the index, the longer it takes to grind the coal.

The coals in the Coalburg syncline (fig. 2) are without exception more grindable than the coals in the northwestern part of the Warrior coal field or in the Cahaba and Plateau coal fields. The narrow range in grindability of the Cahaba field coals is interesting, because the 14 samples were collected from all parts of the Cahaba field and through a stratigraphic range of at least 2,500 feet.

A plot of grindability in relation to percentage of fixed carbon (Hertzog and others, 1940, fig. 8) shows that in general the grindability index of Alabama coals increases as the rank increases. In the Coalburg syncline, however, grindability varies widely, but the rank of the coal stays within a narrow range. This variation cannot be explained by the stratigraphic or geographic position of the coal sample, for these factors showed no correlation with the grindability index. Perhaps the more grindable samples were located near one of the numerous normal faults in this area.

Composition of the coal bed may affect grindability, but its effect is probably small as is indicated by the large variation in the grindability of samples from the same coal bed.

LIGNITE

PHYSICAL AND CHEMICAL CHARACTERISTICS

Lignite is a yellowish-brown to black low-rank coal that has a high moisture content and a low heating value. It is woody textured in places, is tough rather than brittle, and tends to break in slabs when mined. Lignite that contains large amounts of ash, however, is usually soft and crumbly. When exposed to air, lignite loses moisture rapidly and breaks or crumbles into small fragments.

Lignite has not been mined commercially in Alabama. Available data on the physical and chemical characteristics of Alabama lignites are limited to the results of two field investigations by the Geological Survey of Alabama, one by Barksdale (1929) and the other by Pallister and Morgan (1950). Barksdale published several proximate analyses of lignite, but these analyses do not show heating values, and only a few show the sulfur content. The moisture content of these samples is relatively low, ranging from 10 to 37 percent, possibly indicating that the samples may have air dried somewhat before analysis. Pallister and Morgan show seven ultimate analyses made by the U.S. Bureau of Mines (table 11); the samples used for these analyses were collected in airtight containers. Excluding sample 2, which has 39 percent ash, the samples show the following, on an as-received basis: Moisture contents ranging from 44 to 61 percent, sulfur contents ranging from 0.6 to 2.1 percent, and heating values ranging from 3,160 to 5,730 Btu.

OCCURRENCE OF LIGNITE

Lignite occurs in formations of Late Cretaceous, Paleocene, and Eocene age in central Alabama. The lignite beds in the Upper Cretaceous formations are reported to occur only as thin lenses of no foreseeable value. Lignite beds as much as 4 feet thick have also been reported from the Nanafalia, Tuscahoma, and Hatchetigbee Formations of the Wilcox Group of Eocene age, but the sparse data indicate that these beds are thin and lenticular. The only bed here considered to contain reserves of lignite is the Coal Bluff lignite bed in the Naheola Formation, which is the topmost formation of the Paleocene Midway Group.

The Coal Bluff lignite is a single bed more than 4 feet thick in places; in other places it consists of one or more thin beds. Figure 9 shows the location of reported measurements of the Coal Bluff lignite bed in Sumter, Choctaw, Marengo, and Wilcox Counties. A few measurements on this bed also have been reported from Pike, Coffee, and Barbour Counties which are in the southeastern part of

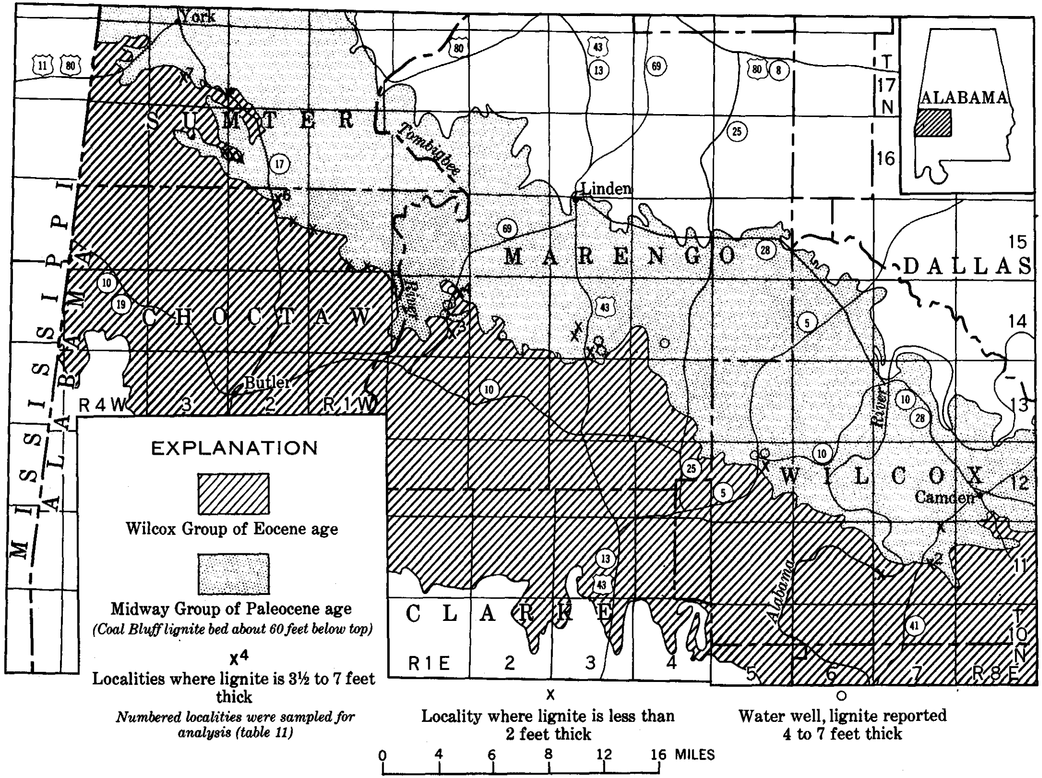

FIGURE 9.—Localities of measurements of the Coal Bluff lignite bed. Localities are from Pallister and Morgan (1950) and are plotted on the route map of the Guidebook of the 10th Field Trip of the Mississippi Geological Society (1953). Regional dip is southwestward at about 50 feet per mile.

Alabama. The correlation of this bed is usually based on its position 60 to 80 feet below the beds that contain *Ostrea thirsae* in the Nanafalia Formation at the base of the Wilcox Group. According to Toulmin, LaMoreaux, and Lanphere (1951, p. 42), the Coal Bluff lignite bed is unconformably overlain by a sandy marl about 60 feet thick in most of central and western Alabama.

RESERVES OF LIGNITE IN THE COAL BLUFF LIGNITE BED

Reserves of lignite in the Coal Bluff lignite bed were estimated only in the western part of Marengo County. Several measurements in secs. 2, 11, 12, and 13, T. 14 N., R. 1 E., indicate that this lignite bed, 4 to 7 feet thick and under less than 100 feet of overburden, averages about 5 feet in thickness across at least 2,500 acres. If it is assumed that the lignite weighs 1,750 tons per acre-foot, the reserves of lignite in this area total 22 million tons. The heating value of the lignite averages about 5,500 Btu (table 11, samples 3 and 4). As the overburden is thin and easily removed, this bed is suitable for recovery by strip-mining methods.

No reserves were estimated in Barbour, Pike, and Coffee Counties because of insufficient thickness data and the high ash and moisture contents of the lignite and because the beds evidently vary greatly in thickness within short distances. In one area in Pike County lignite as much as 31 feet thick was reported from churn-drill holes (Pallister and Morgan, 1950). However, a sample of the lignite has a low heating value and relatively high ash content (table 11, sample 1).

Many thicknesses of approximately 4 feet are reported for the Coal Bluff lignite bed in Wilcox County (fig. 9). South and southwest of Camden in T. 11 N., R. 8 E., Pallister and Morgan (1950, p. 9) report that the lignite bed is 3½ to 4 feet thick. A sample of the lignite (table 11, sample 2) from this bed, however, has a high ash content and low heating value; so, lignite reserves were not estimated in this area.

In western Wilcox County in T. 12 N., R. 5 E., numerous reports indicate that the lignite bed may average about 4 feet in thickness at shallow depths in an area of several square miles. Because of the absence of an analysis of the lignite and because most of the thicknesses are unsubstantiated, the data are not considered sufficient to estimate reserves.

The Coal Bluff lignite is 6⅔ feet thick at locality 6 in Choctaw County (fig. 9), and a bed that may be the Coal Bluff is 7½ feet thick at locality 7 in Sumter County (fig. 9). In both places the lignite seems to occur only in a local lens, for no other thick lignite is known in their vicinities.

Table 11.—*Analyses of lignite*

[From Pallister and Morgan, 1950.[1] Analyses by U.S. Bureau of Mines]

Sample [2]	Source and location	Formation and bed and bed thickness	Sample condition [3]	Proximate analysis (percent)				Ultimate analysis (percent)				Sulfur	Btu
				Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen		
1	Dug well in NE¼NE¼ sec. 28, T. 8 N., R. 19 E., Pike County.	Naheola(?) Coal Bluff(?) lignite; 5 ft.	1	58.7	15.8	15.0	10.5	7.7	20.5	0.5	60.2	0.6	3,160
			2	12.2	33.6	31.8	22.4	3.8	43.6	1.0	27.8	1.4	6,710
			3	--------	38.3	36.2	25.5	2.7	49.6	1.1	19.6	1.5	7,650
			4	--------	51.4	48.6	--------	3.7	66.6	1.5	26.1	2.1	10,260
2	Outcrop on Gravel Creek in SE¼ sec. 15, T. 11 N., R. 7 E., Wilcox County.	Naheola Coal Bluff lignite; 3 ft 6 in.	1	36.6	15.6	8.9	38.9	5.7	14.6	.3	39.1	1.4	2,550
			2	5.5	23.2	13.3	58.0	3.0	21.8	.5	14.6	2.1	3,800
			3	--------	24.6	14.0	61.4	2.5	23.1	.6	10.1	2.3	4,020
3	Outcrop on Landrum Creek in SE¼ sec. 23, T. 14 N., R. 1 E., Marengo County.	Naheola Coal Bluff lignite; 7 ft.	1	48.2	24.2	21.5	6.1	7.4	31.0	.5	53.2	1.8	5,180
			2	9.0	42.4	37.8	10.8	4.6	54.4	1.0	26.0	3.2	9,100
			3	--------	46.6	41.5	11.9	4.0	59.7	1.0	19.9	3.5	9,990
			4	--------	52.9	47.1	--------	4.5	67.8	1.2	22.6	3.9	11,340
4	Channel and auger sample in gulch in SW¼ sec. 12, T. 14 N., R. 1 E., Marengo County.	Naheola Coal Bluff lignite; 5 ft 1 in.+	1	49.2	22.0	25.3	3.5	7.7	33.2	.6	53.1	1.9	5,710
			2	7.7	40.0	46.0	6.3	4.9	60.3	1.0	24.0	3.5	10,370
			3	--------	43.3	49.8	6.9	4.4	65.3	1.1	18.5	3.8	11,240
			4	--------	46.5	53.5	--------	4.7	70.1	1.2	19.9	4.1	12,070
5	Roadcut in SE¼ sec. 27, T. 14 N., R. 3 W., Choctaw County.	Hatchetigbee unnamed; 3 ft 5 in.	1	61.3	17.1	13.0	8.6	8.2	18.6	.4	62.4	1.8	3,120
			2	9.1	40.1	30.6	20.2	4.3	43.9	1.0	26.3	4.3	7,340
			3	--------	44.1	33.7	22.2	3.6	48.2	1.0	20.3	4.7	8,070
			4	--------	56.6	43.4	--------	4.6	62.0	1.3	26.0	6.1	10,370
6	Auger sample on road in SE¼ sec. 3, T. 15 N., R. 2 W., Choctaw County.	Naheola Coal Bluff lignite; 6 ft 8 in.	1	59.3	20.1	15.9	4.7	8.0	23.4	.5	62.8	.6	3,700
			2	9.8	44.5	35.3	10.4	4.2	51.8	1.0	31.2	1.4	8,180
			3	--------	49.4	39.0	11.6	3.4	57.5	1.1	24.8	1.6	9,070
			4	--------	55.8	44.2	--------	3.9	65.0	1.3	28.0	1.8	10,260
7	Railroad cut in sec. 28, T. 17 N., R. 3 W., Sumter County.	Naheola(?) Coal Bluff(?) lignite; 7 ft 5 in.	1	44.4	24.4	24.5	6.7	7.3	33.2	.6	50.1	2.1	5,730
			2	7.0	40.8	40.9	11.3	4.7	55.5	.9	24.0	3.6	9,580
			3	--------	43.9	44.0	12.1	4.2	59.7	1.0	19.1	3.9	10,300
			4	--------	49.9	50.1	--------	4.8	67.9	1.2	21.7	4.4	11,720

[1] Pallister, H. D., and Morgan, Charles, 1950, Preliminary investigations of the lignite deposits of south Alabama: Alabama Geol. Survey unpublished report.

[2] Location of samples 2, 3, 4, 6 and 7 shown on figure 9.

[3] 1, sample as-received; 2, air dried; 3, dried at 105° C; 4, moisture and ash free.

METHOD OF PREPARING COAL RESERVE ESTIMATES

The method of preparing the coal-reserve estimates of Alabama is generally that described by Averitt and others (1953) with some modifications described below.

CLASSIFICATION ACCORDING TO CHARACTERISTICS OF THE COAL

The characteristics of the coal used for classifying the coal reserves of Alabama are: the rank of the coal, the thickness of the coal beds, and the thickness of overburden. No attempt was made to classify the reserves according to grade or coking qualities. The term "grade" usually refers to the amount of ash, sulfur, or other deleterious components of coal, and sufficient analyses were not available to divide the reserves on this basis.

Adequate criteria are not available at this time to differentiate coking coals from noncoking coals; therefore, this basis was not used in classifying the coal reserves of Alabama. Most of the coke produced in Alabama, however, has been made from the coal beds in the Warrior coal field that lie southeast of the Black Warrior River (fig. 1). The coal beds in the Coosa and Cahaba coal fields and on Lookout and Blount Mountains have also furnished coking coal.

The weight of coal per unit volume varies with the percentage of ash and the rank of the coal. In the United States, bituminous coal on the average weighs 1,800 tons per acre-foot (Averitt and others, 1953, p. 7). In Alabama only a few specific-gravity determinations of coal beds were available; so, the national average was used in computing the weight of the coal in the ground.

RANK OF COAL

The coal reserves of Alabama are classified in two categories according to rank: (1) low-volatile bituminous and (2) combined medium-volatile and high-volatile A bituminous. The rank classification system used is that of the American Society for Testing Materials (table 10).

THICKNESS OF THE BEDS

According to the classification of the U.S. Geological Survey, bituminous coal reserves are divided into three categories of thickness of coal: 14 to 28 inches, 28 to 42 inches, and more than 42 inches (Averitt and others, 1953, p. 7). In Alabama only a small tonnage of coal is produced at present from beds less than 28 inches thick, but the improvement of mining machinery and techniques may make these thin beds more valuable in the future.

The bed thickness used in calculating coal reserves is the net thickness of the coal in the bed, and excludes all partings more than threeeighths of an inch thick. Beds and parts of beds made up of alternating layers of thin coal and partings are omitted if the partings make up more than one-half of the total thickness. Benches of coal less than 14 inches thick that lie above or below thick partings and that normally would be left in mining are also omitted.

THICKNESS OF OVERBURDEN

Coal reserve estimates of Alabama are further divided into the three standard categories of thickness of overburden: 0 to 1,000 feet, 1,000 to 2,000 feet, and 2,000 to 3,000 feet. Coal at depths greater than 3,000 feet has been excluded from the estimate.

In Alabama, coal production has been primarily from beds under less than 1,000 feet of overburden. Only in a few places have miners followed seams to depths as much as 1,500 feet. Production of coal by stripping methods, although small in comparison with production by underground mining methods, has been increasing because of the efficiency of this method in areas of shallow overburden. Strip mining has generally been confined to narrow strips along the outcrop where the overburden does not exceed 80 feet in thickness. No attempt has been made in this report to estimate reserves of strippable coal because of insufficient detailed data.

CLASSIFICATION ACCORDING TO ABUNDANCE AND RELIABILITY OF DATA

In this report the coal reserves of Alabama are divided into a combined "measured and indicated" class and an "inferred" class on the basis of abundance and reliability of data.

MEASURED AND INDICATED RESERVES

Measured and indicated reserves are reserves for which tonnage is computed partly from specific thickness measurements and partly from projection of thickness data for a reasonable distance on the basis of geologic evidence. The points of information can be as much as 1½ miles apart for coal beds of known continuity. Only reliable data, such as bed thicknesses measured in pits and in mines or from drill cores, are used for measured and indicated reserves.

INFERRED RESERVES

Inferred reserves are the reserves of coal outside the body of "measured and indicated" coal. Estimates of inferred reserves are based on a broad knowledge of the geologic character of the bed and on sparse thickness data. Where the coal bed is known to crop out around the rim of a basin, it is assumed to underlie the basin unless subsurface data indicate its absence.

Wherever thickness data and geologic evidence indicated that a coal bed continuously underlies an area of tens or hundreds of square miles, the limit of inferred reserves was determined by drawing a smooth line enclosing the body of thickness data. The distance of the line from the outermost points of thickness data varied according to the continuity of the bed, but did not exceed 6 miles.

In Alabama, inferred reserves also include bodies of coal that would be otherwise included in the "measured and indicated" category, except that the principal thickness data of these coal bodies are considered to be less reliable. Thickness data that are obtained from the drilling of water wells, or data from any source that is judged to be only approximately reliable are considered to be suitable only for calculating inferred reserves.

DISTINCTION BETWEEN ORIGINAL, REMAINING, AND RECOVERABLE RESERVES

The coal reserves of Alabama were for the most part estimated on the basis of original reserves, which are the reserves present before mining began, then calculated to the basis of the reserves remaining as of January 1, 1958. The remaining reserves are calculated by subtracting from original reserves the coal mined and rendered unminable up to January 1, 1958.

The recoverable reserves are the coal reserves that can eventually be recovered from the remaining reserves. No attempt was made to calculate the recoverable coal reserves in Alabama because the percentage of coal that will be recovered in the future is influenced by many variable factors, such as the type of mining machinery used, the size of the pillars left, the amount of coal left along the outcrop or under rivers, or whether strip mining or underground mining techniques are used. For the United States as a whole, it is estimated that in the past about 50 percent of the coal in place has been recovered in underground mining and about 80 percent in strip mining (Averitt and others, 1953, p. 13).

METHOD OF COMPUTING COAL RESERVE ESTIMATES

The method of computing coal reserve estimates differed somewhat among the coal fields of Alabama because of the variation in the persistence of the coal beds, in the amount of coal thickness data available, and in the structure and stratigraphy of the coal-bearing rocks. The methods used in each coal field are described below.

In the Warrior coal field (fig. 1) the coal beds are generally persistent, the coal-bearing strata lie nearly flat, and the coal thickness and stratigraphic data are abundant in the eastern part of the field. In this field the original reserves of coal were computed as follows: (1)

The outcrop and coal thickness data for each coal bed were plotted on a base map, (2) the boundary lines of the body of "measured and indicated" coal and of the body of "inferred" coal were determined, (3) three isopach lines that connected points where the coal is 14, 28, and 42 inches thick were plotted, (4) three isopach lines that connected points where the overburden is 1,000, 2,000, and 3,000 feet thick were plotted, (5) the area underlain by the coal bed in each reserve classification was measured by planimeter, and (6) the area was multiplied by the weighted average thickness of coal in the bed and by the average weight of coal per acre to obtain the original reserves of coal in each classification.

In the Warrior coal field, complete data were not available to outline the mined-out areas; so, it was not possible to determine by direct measurement on the base map the remaining reserves of coal. The remaining reserves were therefore computed indirectly by using the production figures from the records of the State of Alabama. The total tonnage produced from each coal bed was divided into the three thickness-of-coal categories, and these figures were doubled so that resultant figures would include not only the mined coal but also the coal rendered unminable and the coal mined but unreported. These doubled figures were subtracted from the appropriate thickness-of-coal category in that part of the original reserves that is under less than 1,000 feet of overburden and that is classified as "measured and indicated." The resultant figures, together with the original reserves in the other categories, are judged to represent the remaining reserves of coal in the Warrior coal field.

In the Cahaba coal field the stratigraphic section is exceptionally thick and contains numerous coal beds. These coal beds for the most part are preserved only in several structural basins, where the dip of the strata is as much as 20°. Thickness data consist of a few outcrop measurements from published reports and a larger amount of reported and confidential data. Because of the scarcity of reliable thickness measurements, the difficulty in correlating coal beds between the structural basins, and the lack of sufficient structural control to determine the thickness of overburden precisely, the reserves of coal in the Cahaba field are classified as inferred. In this field the original reserves of coal were computed by (1) plotting the outcrop and coal thickness data on a base map, (2) determining the boundary of inferred coal and the location of the isopach line connecting points where the overburden is 3,000 feet thick, (3) measuring with a planimeter the areas in each category defined by these lines, (4) multiplying each area by an appropriate factor to give the true area of the body of coal wherever the dip of the coal bed exceeded 5°, (5) multiplying the area by a weighted average thickness of the coal in the bed and by the average weight of coal per acre, and (6) estimating the amount of coal in each thickness-of-coal category and in each thickness-of-overburden category.

The coal reserves remaining as of January 1, 1958, were calculated by the same method outlined in the discussion of the Warrior field.

In the Coosa coal field, except for a small area at its northeastern end in St. Clair County, the strata dip steeply and contain only a few lenticular coal beds. The coal reserves in this part of the field were computed as outlined in the discussion of the Cahaba coal field. In the northeastern part of the field, a small area in St. Clair County is underlain by numerous coal beds, and the strata lie nearly flat and contain many faults. In St. Clair County the remaining reserve figures of Rothrock (1949, p. 81) were used with only slight modification of categories. Since Rothrock made his estimate, practically no production has been recorded from the Coosa field. His estimate is therefore assumed to be representative of reserves remaining as of January 1, 1958.

In the Plateau field the coal-bearing sequence is relatively thin and in general contains only a few coal beds that pinch and swell abruptly. Coal reserves were not computed in most of the Plateau field because of the lack of sufficient coal thickness and stratigraphic data. On Lookout Mountain in DeKalb and Cherokee Counties, however, a drilling program by the U.S. Bureau of Mines (Coulter, 1947) supplemented by field mapping by the U.S. Geological Survey produced detailed information on the coal beds in an area 20 miles long by 7 miles wide. In this area the drilling showed the coal beds to be thin and lenticular; so, the coal bed was inferred to extend only a short distance beyond the known points of information. All areas of mined-out coal were excluded from the known coal-bearing area, and the remaining reserves were computed directly by the method outlined for computing original reserves in the Warrior field. Because coal production has been negligible since Coulter's investigation, the remaining reserves calculated as of that time are assumed to be the remaining reserves as of January 1, 1958. In the Blount and Etowah Counties area (Blount Mountain) the coal beds are more persistent but few thickness data are available. The reserves of this area were computed as in the Cahaba field.

ESTIMATES OF COAL RESERVES IN ALABAMA

The coal reserves remaining in Alabama as of January 1, 1958, are estimated to total 13,753.8 million tons in beds that are under less than 3,000 feet of overburden and in which the coal is 14 inches or more thick (table 12). The Warrior coal field contains 11,904.6 million tons, or 86 percent of the total amount; the Cahaba coal field contains 1,766.3 million tons, or 13 percent; and the Coosa and Plateau coal fields contain 41.4 and 41.5 million tons, respectively, or 0.3 percent each. Most of the coal is at shallow depths; 9,987.5 million tons, or 73 percent of the total, are under less than 1,000 feet of overburden (table 12). About 57 percent, or 7,982.6 million tons, are in coal beds in which the coal is more than 28 inches thick. Jefferson, Tuscaloosa, and Walker Counties together contain 77 percent of the total reserves of coal in Alabama.

In the Warrior coal field, Jefferson County leads in the amount of coal reserves, accounting for 31 percent of the total of 11,904.6 million tons (table 4). Tuscaloosa and Walker Counties follow closely, accounting for 29 and 26 percent, respectively. The Mary Lee group of coal beds contains 5,750.6 million tons in all categories (table 5), which is more than the combined total of coal reserves in the other three coal fields.

In the Cahaba coal field, 86 percent of the total of 1,766.3 million tons of coal lies in the southern half of the field (Bibb and Shelby Counties; table 7). The Cahaba field is the only coal field in Alabama that is estimated to contain a sizable amount of coal at depths greater than 2,000 feet. A total of 221 million tons, or about 12 percent, is estimated to lie under 2,000 to 3,000 feet of overburden.

In the Coosa coal field, 30.8 million tons of coal is estimated to lie in seven coal beds in St. Clair County (table 8). The remainder of the coal reserves, 10.6 million tons, is contained in the Martin bed in Shelby County.

Lookout and Blount Mountains contain the estimated remaining coal reserves of the Plateau field, a total of 41.5 million tons (table 2).

AREAS AND BEDS EXCLUDED FROM COAL RESERVE ESTIMATES

Because of the restrictions placed on coal reserve estimates by the preceding definitions of reserves, coal reserves were not estimated in several areas or stratigraphic intervals. The largest area is the 3,000 square miles in the Warrior field lying west of an imaginary line running through the cities of Tuscaloosa and Fayette. This imaginary line is about the western limit of coal prospect holes, and little is known about the coal-bearing rocks to the west. In addition, the coal-bearing rocks are overlain unconformably by Upper Cretaceous rocks that thicken southwestward to more than 1,000 feet. Because of the lack of data, no coal reserves could be estimated.

TABLE 12.—*Summary of coal field and county of estimated remaining reserves of coal in Alabama, as of Jan. 1, 1958*

Coal field or county	Overburden (feet)	Reserves, in millions of short tons, for thickness of beds, in inches as shown											
		Measured and indicated				Inferred				Total all categories			Grand total
		14–28	28–42	More than 42	Total	14–28	28–42	More than 42	Total	14–28	28–42	More than 42	
Summary by coal field													
Cahaba	0–1,000					243.2	284.6	215.7	743.5	243.2	284.6	215.7	743.5
	1,000–2,000					380.8	340.7	80.3	801.8	380.8	340.7	80.3	801.8
	2,000–3,000					140.8	73.8	6.4	221.0	140.8	73.8	6.4	221.0
Total, Cahaba						764.8	699.1	302.4	1,766.3	764.8	699.1	302.4	1,766.3
Pleateau	0–1,000	25.0	1.6		26.6	6.1	8.8		14.9	31.1	10.4		41.5
Coosa	0–1,000	20.8	2.8	3.0	26.6	4.9	.4	.5	5.8	25.7	3.2	3.5	32.4
	1,000–2,000		1.0		1.0	1.6	1.0	2.7	5.3	1.6	2.0	2.7	6.3
	2,000–3,000						.7	2.0	2.7		.7	2.0	2.7
Total, Coosa		20.8	3.8	3.0	27.6	6.5	2.1	5.2	13.8	27.3	5.9	8.2	41.4
Warrior	0–1,000	1,396.2	1,112.7	857.6	3,366.5	2,931.9	1,885.3	986.4	5,803.6	4,328.1	2,998.0	1,844.0	9,170.1
	1,000–2,000	13.8	10.6	39.7	64.1	626.1	741.1	1,233.2	2,600.4	639.9	751.7	1,272.9	2,664.5
	2,000–3,000					70.0			70.0	70.0			70.0
Total, Warrior		1,410.0	1,123.3	897.3	3,430.6	3,628.0	2,626.4	2,219.6	8,474.0	5,038.0	3,749.7	3,116.9	11,904.6
Total, all fields	0–1,000	1,442.0	1,117.1	860.6	3,419.7	3,186.1	2,179.0	1,202.6	6,567.7	4,628.1	3,296.1	2,063.2	9,987.4
	1,000–2,000	13.8	11.6	39.7	65.1	1,008.5	1,082.8	1,316.2	3,407.5	1,022.3	1,094.4	1,355.9	3,472.6
	2,000–3,000					210.8	74.5	8.4	293.7	210.8	74.5	8.4	293.7
Grand total		1,455.8	1,128.7	900.3	3,484.8	4,405.4	3,336.4	2,527.2	10,269.0	5,861.2	4,465.1	3,427.5	13,753.8
Summary by county													
Bibb	0–1,000					99.0	129.3	115.8	344.1	99.0	129.3	115.8	344.1
	1,000–2,000					162.2	112.6	6.7	281.5	162.2	112.6	6.7	281.5
	2,000–3,000					29.3	8.5		37.8	29.3	8.5		37.8
Total, Bibb						290.5	250.4	122.5	663.4	290.5	250.4	122.5	663.4

Blount	0–1,000	11.9	1.8		13.7	3.0	5.6		8.6	14.9	7.4		22.3
Cherokee	0–1,000	10.3			10.3	.1			.1	10.4			10.4
Cullman	0–1,000	41.3	30.4	1.9	73.6	55.2	11.3		66.5	96.5	41.7	1.9	140.1
DeKalb	0–1,000	14.7	1.6		16.3	.4			.4	15.1	1.6		16.7
Etowah	0–1,000					2.6	3.2		5.8	2.6	3.2		5.8
Fayette	0–1,000	57.1	29.8	67.3	154.2	473.9	326.6	84.5	885.0	531.0	356.4	151.8	1,039.2
	1,000–2,000					57.7	5.1		62.8	57.7	5.1		62.8
Total, Fayette		57.1	29.8	67.3	154.2	531.6	337.7	84.5	947.8	588.7	361.5	151.8	1,102.0
Jefferson	0–1,000	533.1	308.9	520.5	1,362.5	931.2	381.9	425.3	1,738.4	1,464.3	690.8	945.8	3,100.9
	1,000–2,000	13.2	5.4	38.2	56.8	190.3	170.0	375.4	735.7	203.5	175.4	413.6	792.5
	2,000–3,000					13.3	9.2		22.5	13.3	9.2		22.5
Total, Jefferson		546.3	314.3	558.7	1,419.3	1,134.8	561.1	800.7	2,496.6	1,681.1	875.4	1,359.4	3,915.9
Marion	0–1,000	27.5	115.1		142.6	86.4	25.1		111.5	113.9	140.2		254.1
Shelby	0–1,000		1.2	3.0	4.2	112.3	124.7	61.8	298.8	112.3	125.9	64.8	303.0
	1,000–2,000					177.7	185.4	45.2	408.3	177.7	185.4	45.2	408.3
	2,000–3,000					93.4	56.3	8.4	158.1	93.4	56.3	8.4	158.1
Total, Shelby			1.2	3.0	4.2	383.4	366.4	115.4	865.2	383.4	367.6	118.4	869.4
St. Clair	0–1,000	20.8	1.6		22.4	13.4	1.8	6.2	21.4	34.2	3.4	6.2	43.8
	1,000–2,000		1.0		1.0	4.8	9.9	5.9	20.6	4.8	10.9	5.9	21.6
	2,000–3,000					4.8	.5		5.3	4.8	.5		5.3
Total, St. Clair		20.8	2.6		23.4	23.0	12.2	12.1	47.3	43.8	14.8	12.1	70.7
Tuscaloosa	0–1,000	78.1	72.4	98.0	248.5	396.0	595.6	437.4	1,429.0	474.1	668.0	535.4	1,677.5
	1,000–2,000					396.1	593.9	761.6	1,751.6	396.1	593.9	761.6	1,751.6
	2,000–3,000					70.0			70.0	70.0			70.0
Total, Tuscaloosa		78.1	72.4	98.0	248.5	862.1	1,189.5	1,199.0	3,250.6	940.2	1,261.9	1,297.0	3,499.1
Walker	0–1,000	602.8	545.6	169.9	1,318.3	1,011.2	574.0	71.6	1,656.8	1,614.0	1,119.6	241.5	2,975.1
	1,000–2,000	.6	5.2	1.5	7.3	19.7	5.9	121.4	147.0	20.3	11.1	122.9	154.3
Total, Walker		603.4	550.8	171.4	1,325.6	1,030.9	579.9	193.0	1,803.8	1,634.3	1,130.7	364.4	3,129.4
Winston	0–1,000	44.4	8.7		53.1	1.4			1.4	45.8	8.7		54.5
Grand total		1,455.8	1,128.7	900.3	3,484.8	4,405.4	3,336.4	2,527.2	10,268.9	5,861.2	4,465.1	3,427.5	13,753.8

The second category of possible coal reserves that are not included in the present estimate consists of an unknown number of coal beds lying at depths from about 1,500 to 3,000 feet in the southeastern part of the Warrior coal field and in the southwestern part of the Cahaba coal field. Because few coal test holes have penetrated more than 1,500 feet, few data are available on the coal beds in the deeper parts of these fields.

The third category is the coal beds in the Parkwood Formation and the lower part of the Pottsville Formation. Closely spaced thickness data were deemed necessary to outline reserves of coal in these beds because these beds are generally lenticular. This restriction excluded most of the Coosa and Plateau fields from the coal reserve estimates because few thickness data were available.

An estimate of the possible coal reserves in these excluded areas would be little more than a guess without additional data on the coal beds. In the largest area, the southwestern part of the Warrior field, several factors would have to be considered. First, the southward-thickening trend of the Pottsville Formation might indicate that more coal beds are present in the southwestern part than in the main part, or it might indicate that the Pottsville is changing to a thick sandy facies with few coal beds similar to the Pottsville in the southwestern part of the Coosa coal field (pl. 3). The latter possibility is given some support by the tendency of coal beds to thin and pinch out westward in the main part of the Warrior coal field. Similar considerations would govern the estimate of possible coal reserves in the deeper part of the Warrior and Cahaba coal fields. In the third category, the lower part of the Pottsville and the Parkwood Formation, the available data indicate that this part of the section is very unlikely to contain thick continuous coal beds. Consequently, the possible coal reserves in this category probably will not exceed several hundred million tons.

In the author's opinion the potential coal reserves in the areas and beds excluded from the present estimate will probably total about 20 billion tons in beds more than 14 inches thick and under less than 3,000 feet of overburden. Of course, the final total may be several times this amount, or only a small fraction of it. It should be pointed out, however, that the coal in these possible reserves is almost entirely in beds that are at greater depths or that are farther from potential markets than the coal in the present reserve estimate.

COMPARISON OF PAST AND PRESENT ESTIMATES OF COAL RESERVES OF ALABAMA

Estimates of the coal reserves of parts of the coal-bearing area of Alabama have been published at intervals since the late 1800's. In general, each of the estimates was based on a different minimum thickness of the coal beds, different maximum thickness of overburden, and different assumptions about the continuity of the coal beds. These estimates are discussed in the following paragraphs, by coal field.

One of the first estimates of coal reserves of the Warrior coal field based on extensive fieldwork was published in 1886 by Henry McCalley of the Geological Survey of Alabama. McCalley (1886, p. 7) estimated that the Warrior field contained 113 billion tons of coal, of which 108 billion tons was in seams 18 inches or more thick. This estimate was based on the assumption that the average thickness of the coal beds throughout the entire Warrior coal field was equal to the average of the known coal beds. The next and last estimate for the Warrior coal field was presented by M. R. Campbell (1913) of the U.S. Geological Survey. The original coal reserves of the combined Warrior and Plateau fields were estimated to be about 63 billion tons of coal in beds 14 inches or more thick to a depth of 3,000 feet.

As the result of extensive fieldwork, Squire (1890, p. 13) estimated that the Cahaba coal field contained 3,626 million tons of coal in workable seams 2 feet or more thick to a depth of 4,700 feet. The first revision of this figure was made by Charles Butts of the U.S. Geological Survey after a geologic investigation of the Cahaba field. Butts (1907, p. 113) estimated that coal in the northern part of the Cahaba field would total 566 million tons, and in 1911 he (Butts, 1911, p. 143) estimated that coal in the southern part of the field would total 2,626 million tons. These estimates, which totaled 3,192 million tons, included coal in beds 2 feet or more thick to a maximum depth of 5,500 feet, and were made on the assumption that the coal beds would average the same thickness underground as on the outcrop. Campbell (1913) estimated that the Cahaba field contained 3.6 billion tons of coal in beds 14 inches or more in thickness to a maximum depth of 3,000 feet, a figure almost identical to Squire's original estimate.

Prouty (1909, p. 923) estimated that the Coosa coal field contained a total of 81 million tons of coal in beds whose minimum thickness was 18 inches "where the coal is of excellent grade and not too deep." Campbell (1913) estimated that the coal reserves in the Coosa field totaled about 300 million tons in beds 14 inches or more in thickness to a depth of 3,000 feet.

The Wattsville basin contains the coal reserves most favorable for future mining in the Coosa coal field, and the amount of these reserves has been estimated by three authors. Jones (1929, p. 45) estimated that the recoverable reserves of coal in the Wattsville basin were 151.7 million tons, using a minimum average coal bed thickness of 1.8 feet and assuming 60 to 80 percent recovery. Rothrock (1949,

p. 88), after a geologic investigation in connection with a core-drilling program of the U.S. Bureau of Mines, calculated that the remaining coal reserves of this same area were 30 million tons in beds 14 inches or more thick. The U.S. Bureau of Mines (1949, p. 15–21), using the data from the same core-drilling program, estimated that the total remaining reserves were 14.6 million tons in this area, without, however, specifying a minimum thickness for the coal beds.

No separate estimate of the reserves of the Plateau coal field is known. The lenticularity of the coal beds and the difficulties in correlation seem to have discouraged all efforts of this nature.

Only M. R. Campbell seems to have published an original estimate for the coal reserves of the entire State of Alabama. Campbell (1929) estimated that the original reserves of coal in Alabama totaled 67,570 million tons in beds 14 inches or more thick and under less than 3,000 feet of overburden.

The present estimate of coal reserves is much lower than the previous estimates because of several factors: (1) reserves were not calculated for large areas where data were not available; (2) data from abundant diamond-drill coal test holes in the Warrior field have shown a definite westward-thinning of minable coal; and (3) in this estimate assumptions concerning the thickness of coal away from areas of proved thickness were more conservative. It is also very possible that the early estimates used average thicknesses of coal beds that were higher than the true average. Thickness data were obtained from measurements in small drift mines and on the outcrop. Drift mines were usually opened on the thickest part of the bed, and thick sections of coal were easier to find on the outcrop than thin ones. The present practice of prospecting by regularly spaced diamond drill holes gives a more accurate picture of the average thickness of the coal beds.

HISTORY OF COAL PRODUCTION IN ALABAMA

The first coal produced commercially in Alabama was probably mined from coal outcrops in the Black Warrior River near Tuscaloosa a few years prior to 1832 (Jones, 1834). This coal was transported on barges down the river to Mobile, Ala., where it was sold in competition with coal from England. In succeeding years coal was also mined from the Cahaba and Coosa fields, usually from coal beds that cropped out in the beds of rivers. In 1850 the first large-scale underground mine, the Montevallo mine in Shelby County, was opened. At that time production in Alabama was about 2,000 tons a year, but it increased to about 10,000 tons by 1860. During the war years a maximum of 15,000 tons a year was mined to supply the needs of the Confederacy.

In the early 1870's the infant iron and steel industry needed large reserves of coking coal near Birmingham. The thick, continuous Pratt coal bed in Jefferson County filled the requirements of the industry, and as the industry developed coal production rapidly increased (fig. 10). By 1890 the yearly production was 4 million tons, and by 1917 it was more than 20 million tons. The coal requirements of the railroads and the domestic market contributed to this rapid rise in production. The peak production was 21.5 million tons in

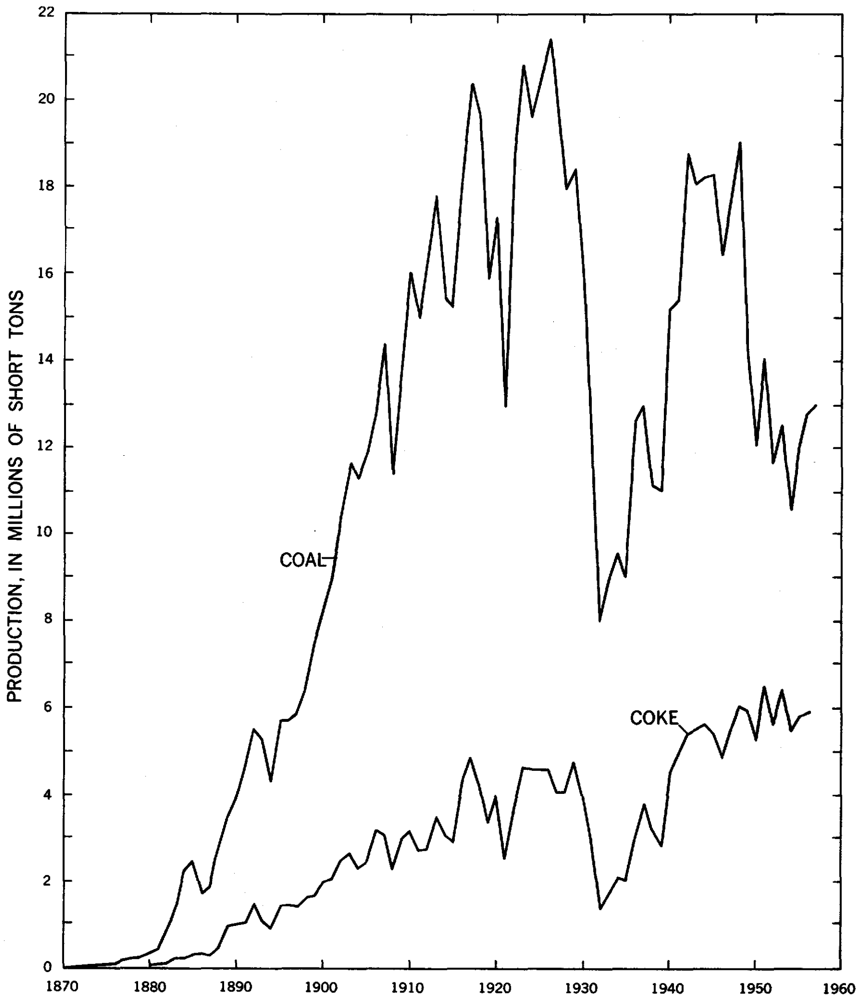

FIGURE 10.—Bituminous coal and coke production in Alabama. (From annual statistical reports of the Division of Safety and Inspection, Department of Industrial Relations, State of Alabama. Prior to 1939, figures are for calendar year; after 1939, figures are for fiscal years ending September 30.)

1926. During the Depression years production dropped sharply and it was not until World War II that coal production again increased.

After World War II the pattern of coal use changed. The dieselization of the railroad industry, the use of other fuels in the domestic market, and decreasing overseas markets caused a drastic drop in coal production from 1948 through 1953. Only 10.6 million tons of coal was produced in 1954. The steel industry, however, continued to use large amounts of coal for coking, and the power industry increased its use of coal for generating electricity. As a result, coal production began an upward trend that continued through the 1950's.

By the end of 1957 a total of 931.7 million tons of coal had been mined in Alabama. The largest part of this production came from Jefferson and Walker Counties in the Warrior coal field.

SELECTED BIBLIOGRAPHY

Aldrich, T. H., Sr., and Jones, W. B., 1930, Footprints from the coal measures of Alabama: Alabama Geol. Survey Mus. Paper no. 9, 64 p.

American Society for Testing Materials, 1955, Standards on coal and coke (with related information): Philadelphia, Pa., Am. Soc. for Testing Materials.

Armes, Ethel, 1910, The story of coal and iron in Alabamà: Cambridge, Mass., Univ. Press,.581 p.

Averitt, Paul, Berryhill, L. R., and Taylor, D. A., 1953, Coal resources of the United States (a progress report, Oct. 1, 1953): U.S. Geol. Survey Circ. 293, 49 p.

Barksdale, Jelks, 1929, Lignite in Alabama: Alabama Geol. Survey Bull. 33, 64 p.

Blair, Arthur, 1958, Generalized cross section of Birmingham Valley, Alabama, figure 2 *in* Guidebook to field trips of the southeastern section, Geological Society of America—Birmingham area and celebrated coastal plain fossil localities: Alabama Geol. Survey Inf. Ser. 13, 76 p.

Brewer, W. H., 1893, The Coosa coal field in Alabama: Eng. Mining Jour., v. 56, p. 7–8.

Burchard, E. F., and Butts, Charles, 1910, Iron ores, fuels and fluxes of the Birmingham district, Alabama, *with chapters on* The origin of the ores, by E. C. Eckel: U.S. Geol. Survey Bull. 400, 204 p.

Butts, Charles, 1905, The Warrior coal basin in the Brookwood quadrangle, Alabama: U.S. Geol. Survey Bull. 260, p. 357–381.

——— 1906, The Warrior coal basin in the Birmingham quadrangle, Alabama: U.S. Geol. Survey Bull. 285, p. 211–222.

——— 1907, The northern part of the Cahaba coal field, Alabama: U.S. Geol. Survey Bull. 316, p. 76–115.

——— 1910, Description of the Birmingham quadrangle: U.S. Geol. Survey Geol. Atlas, Folio 175.

——— 1911, The southern part of the Cahaba coal field, Alabama: U.S. Geol. Survey Bull. 431, p. 89–146.

——— 1925, Analyses of Alabama coals: U.S. Bur. Mines Tech. Paper 347, 111 p.; Alabama Geol. Survey Bull. 31, 113 p.

Butts, Charles, 1926, The Paleozoic rocks, *in* Adams, G. I., Butts, Charles, Stephenson, L. W., and Cooke, Wythe, Geology of Alabama: Alabama Geol. Survey Spec. Rept. 14, p. 40–230.

——— 1927, Description of the Bessemer and Vandiver quadrangles: U.S. Geol. Survey Geol. Atlas, Folio 221.

——— 1940, Description of the Montevallo and Columbiana quadrangles: U.S. Geol. Survey Geol. Atlas, Folio 226.

Campbell, M. R., 1913, The coal reserves of the United States: Internat. Geol. Cong., 12th, Canada, The coal resources of the world, v. 2, p. 525–539.

——— 1929, Coal resources of the United States: U.S. Geol. Survey press release.

Coulter, D. M., 1947, Coking coal deposits on Lookout Mountain, DeKalb and Cherokee Counties, Alabama: U.S. Bur. Mines Rept. Inv. 4030, 89 p.

Crane, W. R., 1905, The Pratt coal mines in Alabama: Eng. Mining Jour., v. 79, p. 177–180.

Culbertson, W. C., 1963, Correlation of the Parkwood Formation and lower members of the Pottsville Formation in Alabama: U.S. Geol. Survey Prof. Paper 450–E, art. 193, p. 47–50.

Frazer, Persifor, Jr., 1891, The Warrior coal field of northern Alabama: Am. Geologist, v. 7, p. 305–320.

Gesner, William, 1876, On the coal and iron resources of Alabama: Philadelphia, Acad. Nat. Sci. Proc., p. 163–165.

Gibson, A. M., 1886, The Raccoon Mountain coal field, *in* McCalley, Henry, On the Warrior coal field: Alabama Geol. Survey Spec. Rept. 1, p. 544–555.

——— 1891, The Coal measures of Blount County, *in* McCalley, Henry, Report on the coal measures of the plateau region of Alabama: Alabama Geol. Survey Spec. Rept. 3, p. 110–215.

——— 1893, Report on the coal measures of Blount Mountain: Alabama Geol. Survey Spec. Rept. 5, 88 p.

——— 1895, Report upon the Coosa coal field: Alabama Geol. Survey Spec. Rept. 7, 143 p.

Hayes, C. W., 1892, Report on the geology of northeastern Alabama and adjacent portions of Georgia and Tennessee: Alabama Geol. Survey Bull. 4, 86 p.

——— 1895, Description of the Stevenson sheet: U.S. Geol. Survey Geol. Atlas, Folio 19.

——— 1896, Description of the Gadsden quadrangle: U.S. Geol. Survey Geol. Atlas, Folio 35.

——— 1902, The Southern Appalachian coal field: U.S. Geol. Survey Ann. Rept. 22, pt. 3, p. 227–263.

Hertzog, E. S., Cudsworth, J. R., Selvig, W. A., and Ode, W. H., 1940, Friability, grindability, chemical analyses and high- and low-temperature carbonization assays of Alabama coals: U.S. Bur. Mines Tech. Paper 611, 59 p.

Johnston, W. D., Jr., 1930, Physical divisions of northern Alabama: Alabama Geol. Survey Bull. 38, 47 p.

Jones, Alexander, 1834, Bituminous coal: Am. Jour. Sci., v. 26, p. 190–191.

Jones, W. B., 1926, Index to the mineral resources of Alabama: Alabama Geol. Survey Bull. 28, 250 p.

——— 1929, Summary report on the Wattsville Basin of the Coosa Coal Field: Alabama Geol. Survey Circ. 6, 7 pls., 48 p.

Lavine, Irvin, 1941, Lignite in the United States: Fuel, v. 20, no. 1, p. 14–19; no. 2, p. 31–38.

Lyell, Charles, 1846, Coal field of Tuscaloosa, Alabama: Am. Jour. Sci., ser. 2, v. 1, art. 4, p. 371–376.

MacNeil, F. S., 1946, Summary of Midway and Wilcox stratigraphy of Alabama and Mississippi: U.S. Geol. Survey Mineral. Inv. Prelim. Rept. 3–195.

——— 1946, Geologic map of Tertiary formations of Alabama: U.S. Geol. Survey Oil and Gas Inv. Prelim. Map 45.

McCalley, Henry, 1886, On the Warrior coal field: Alabama Geol. Survey Spec. Rept. 1, 571 p.

——— 1891, Report of the coal measures of the Plateau region of Alabama, *including a report on* The coal measures of Blount County, by A. M. Gibson: Alabama Geol. Survey Spec. Rept. 3, 238 p.

——— 1896, On the Tennessee Valley region, pt. 1 *of* Report on the valley regions of Alabama (Paleozoic strata): Alabama Geol. Survey Spec. Rept. 8. 436 p.

——— 1897, On the Coosa Valley region, pt. 2 *of* Report on the valley regions of Alabama (Paleozoic strata): Alabama Geol. Survey Spec. Rept. 9, 862 p.

——— 1898, Map of the Warrior coal basin, with columnar sections: Alabama Geol. Survey Map 2.

——— 1900, Report on the Warrior Coal Basin: Alabama Geol. Survey Spec. Rept. 10, 327 p.

McCallie, S. W., 1904, A preliminary report on the coal deposits of Georgia: Georgia Geol. Survey Bull. 12, 121 p.

McGlamery, Winnie, 1955, Subsurface stratigraphy of northwest Alabama: Alabama Geol. Survey Bull. 64, 503 p.

Mellen, F. F., 1947, Black Warrior basin, Alabama and Mississippi: Am. Assoc. Petroleum Geologists Bull., v. 31, no. 10, p. 1801–1816.

Mississippi Geological Society, 1953, Guidebook, 10th field trip, Wilcox and Midway groups, west central Alabama: 60 p.

Moore, R. C., chm., 1944, Correlation of Pennsylvanian formations of North America: Geol. Soc. America Bull., v. 55, no. 6, p. 657–706.

Pallister, H. D., and Morgan, Charles, 1950, Preliminary investigations of the lignite deposits of south Alabama: Alabama Geol. Survey unpublished rept.

Phillips, W. B., 1912, Iron making in Alabama, 3d ed.: Alabama Geol. Survey Mon. 7, 254 p.

Prouty, W. F., 1909, The Coosa coalfield of Alabama: Eng. Mining Jour., v. 88, pt. 2, p. 921–923.

——— 1912, Map of the Coosa coalfield, with sections: Alabama Geol. Survey Map 5.

Rothrock, H. E., 1949, Geology and coal resources of the northeast part of the Coosa coal field, St. Clair County, Alabama: Alabama Geol. Survey Bull. 61, pts. 1 and 2, 163 p.

Selvig, W. A., Ode, W. H., Parks, B. C., and O'Donnell, H. J., 1950, American lignites—geological occurrence, petrographic composition, and extractable waxes: U.S. Bur. Mines Bull. 482, 63 p.

Semmes, D. R., 1929, Oil and gas in Alabama: Alabama Geol. Survey Spec. Rept. 15, 408 p.

Shotts, R. Q., 1954, The identity and equivalency of persistent coal zones, sandstone beds and conglomerates of southern Tennessee and the Plateau region of Alabama, based upon a study of the literature: Alabama Acad. Sci. Jour., v. 26, p. 37–46.

——— 1955, A study of the rank and composition of Alabama coals analyzed by the U.S. Bureau of Mines since 1925: Alabama Acad. Sci. Jour., v. 27, p. 28–39.

Shotts, R. Q., 1956, A compilation of complete analyses of Alabama coals published since 1925, Warrior and Plateau fields: Alabama State Mine Expt. Sta. Bull. 6, 31 p.

——— 1956a, Further studies of the rank and composition of Alabama coals analyzed by the U.S. Bureau of Mines since 1925: Alabama Acad. Sci. Jour., v. 28, p. 44–61.

——— 1956b, The structure of a portion of Lookout Mountain in Alabama: Alabama State Mine Expt. Sta. Tech. Rept. 20; Alabama Acad. Sci. Jour., v. 28, p. 62–68.

——— 1960a, Correlations in the "Coal Measures" of the southeast: Alabama Acad. Sci. Jour., v. 31, p. 427–446.

——— 1960b, Coal analyses made at the Alabama State Mine Experiment Station, 1944–60, and some other unpublished analyses: Alabama State Mine Expt. Sta. Bull. 7, 39 p.

Smith, E. A., 1876a, Report of progress for 1875: Alabama Geol. Survey Prog. Rept., 220 p.

——— 1876b, Report of progress for 1876: Alabama Geol. Survey Prog. Rept., 99 p.

——— 1878, Outline of geology of Alabama, *in* Berney, Safford, Handbook of Alabama: Mobile Register Print, p. 129–196.

——— 1879, Report of progress for 1877–78: Alabama Geol. Survey Prog. Rept., 159 p.

——— 1880, General description of the Black Warrior from Tuscaloosa to Sipsey Fork: U.S. 46th Cong., 3d sess., Sen. Ex. Doc. 42, p. 5–34.

——— 1881, Report of progress for 1879 and 1880: Alabama Geol. Survey Prog. Rept., 158 p.

——— 1905, Revised map of the southeastern part of the Cahaba coal field: Alabama Geol. Survey Map 4.

Spencer, J. W. W., 1889, Economic geological survey in Georgia and Alabama, throughout the belt traversed by the Macon and Birmingham Railway: Athens, Ga., 86 p.

Squire, Joseph, 1890, Report on the Cahaba coal field, with an appendix on the Geology of the valley regions adjacent to the Cahaba field by E. A. Smith: Alabama Geol. Survey Spec. Rept. 2, 189 p.

Thiessen, Reinhardt, and Sprunk, G. C., 1935, Microscopic and petrographic studies of certain American coals: U.S. Bur. Mines Tech. Paper 564, 71 p.

Toulmin, L. D., LaMoreaux, P. E., and Lanphere, C. R., 1951, Geology and ground-water resources of Choctaw County, Alabama: Alabama Geol. Survey Spec. Rept. 21 and County Rept. 2, 197 p.

Tuomey, Michael, 1850, First biennial report on the geology of Alabama: Alabama Geol. Survey, 176 p.

——— 1876, Appendix A, *in* Smith, E. A., Report of progress for 1875: Alabama Geol. Survey Prog. Rept., p. 205–212.

U.S. Bureau of Mines, 1949, Investigation of coal deposits in the Fairview and Coal City Basins, Coosa field, St. Clair County, Ala.: U.S. Bur. Mines Tech. Paper 719, 104 p.

Wanless, H. R., 1946, Pennsylvanian geology of a part of the Southern Appalachian coal field: Geol. Soc. America Mem. 13, 162 p.

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