Coal Resources of Arkansas, 1954

GEOLOGICAL SURVEY BULLETIN 1072-P

Prepared with the cooperation of the Arkansas Geological and Conservation Commission

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By BOYD R. HALEY

CONTRIBUTIONS TO ECONOMIC GEOLOGY

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By BOYD R. HALEY

ABSTRACT

Coal of Pennsylvanian (Des Moines) age underlies approximately 1,700 square miles in the western part of the Arkansas Valley region in west-central Arkansas. The coal ranges in rank from low-volatile bituminous to semianthracite; the greater part is classed as low-volatile bituminous. Coal produced in this area is mined from the Lower and Upper Hartshorne coal beds of the McAlester formation and from the Charleston and Paris coal beds of the Savanna formation in Sebastian, Scott, Logan, Franklin, Johnson, and Pope Counties. The Lower Hartshorne coal bed at the base of the McAlester formation has been the source of most of the coal.

Reserves of coal in the Arkansas Valley coal field are estimated as follows: original reserves 2,272 million short tons; remaining reserves 2,080 million short tons; and recoverable reserves 1,040 million short tons. The estimated original reserves included 1,816 million short tons of low-volatile bituminous coal and 456 million short tons of semianthracite. These summary reserve estimates are subdivided in this report and listed in categories of rank, county, and individual coal bed. The estimates are also qualified in relation to coal-bed thickness, amount and reliability of data, and amount of overburden.

Lignite is present discontinuously in rocks that are exposed over an area of approximately 6,125 square miles in the Gulf Coastal Plain of Arkansas. The lignite-bearing rocks are in the Tokio formation of Cretaceous age, and the Wilcox group, the Claiborne group, and the Jackson formation of Eocene age. The lignite beds are lenticular, and individual beds probably do not extend over an area larger than about 2 square miles. The original reserves of lignite in known deposits under less than 100 feet of overburden are listed by counties in this report and are estimated to be 32 million short tons. The total reserves of lignite in Arkansas are tentatively estimated to be 350 million short tons. The total amount of lignite mined in Arkansas since the beginning of mining probably does not exceed 100 thousand short tons.

INTRODUCTION

LOCATION OF COAL RESERVES

Important reserves of low-volatile bituminous coal and semianthracite occur in the west-central part of Arkansas, and lignite occurs in the southern and eastern parts of the State (pl. 58). The bituminous coal and semianthracite is produced from an area of about 1,700 square miles in the western part of the Arkansas Valley region. All the coal

produced in this area for out-of-State consumption and most of the coal produced for local consumption has been mined from coal beds of Pennsylvanian age, including the Lower Hartshorne and Upper Hartshorne coal beds of the McAlester formation and the Charleston and Paris coal beds of the Savanna formation, in Sebastian, Scott, Logan, Franklin, Johnson, Crawford, and Pope Counties. Coal is produced for local use from other coal beds in these counties and in Perry, Conway, Yell, Washington, and White Counties, but the total production is small and the reserves in these coal beds are negligible.

Lignite has been produced from lignite-bearing rocks that are exposed discontinuously over an area of approximately 6,125 square miles in the Gulf Coastal Plain of Arkansas (pl. 58). More than 95 percent of the lignite has been produced from the lignite-bearing rocks of the Wilcox group of Eocene age in Ouachita, Dallas, Hot Spring, Saline, and Pulaski Counties.

PURPOSE AND LIMITATIONS OF THIS REPORT

This report on the coal resources of Arkansas was prepared by the U.S. Geological Survey in its program of compiling a comprehensive and detailed State-by-State estimate of the coal reserves of the United States. It is the most accurate estimate that can be made with the information now available. However, when additional information on thickness of coal beds has been obtained by further surface and subsurface exploration, and when detailed geologic maps have been prepared for coal-bearing areas that have not been adequately mapped, it will be possible to improve the accuracy of the estimate, particularly by increasing knowledge about measured and indicated reserves.

The sporadic distribution of the lignite beds and the scarcity of thickness data have precluded the preparation of a complete estimate of lignite reserves. A more complete estimate of the lignite reserves would require an intensive mapping and core-drilling program.

ACKNOWLEDGMENTS

The estimates of reserves in this report are based upon data obtained from published reports and unpublished records of the U.S. Geological Survey and the Arkansas Geological and Conservation Commission; published reports of the U.S. Bureau of Mines; drill-hole records of the Reynolds Mining Corp., Little Rock, Ark.; well logs; reports by local residents; field observations by the writer; and mine maps in the files of county clerks.

This report was prepared with the cooperation of the Arkansas Geological and Conservation Commission. Its preparation also was aided by the information and cooperation provided by many individuals and other organizations. N. F. Williams, director, Arkansas

Geological and Conservation Commission, provided aerial photographs of Johnson County, county maps, and data from the files of the commission. M. E. Barker, former director of the Institute of Science and Technology at the University of Arkansas, made available aerial photographs of Logan County in the files of the university. J. W. Fitzjarrell and J. H. Berry, former and present Arkansas State mine inspectors, supplied information about the production of coal. J. H. Moser, chief geologist, Reynolds Mining Corp., provided data on Arkansas lignite.

RESERVES OF LOW-VOLATILE BITUMINOUS COAL AND OF SEMIANTHRACITE IN THE ARKANSAS VALLEY COAL FIELD

The coal-mining industry in Arkansas is centered in the Arkansas Valley coal field (pl. 58), where coal, ranging in rank from low-volatile bituminous to semianthracite, has been mined for at least 80 years. The original reserves of coal before mining in the Arkansas Valley coal field are estimated to have been 2,272 million short tons. The accumulated production to January 1, 1954, totaled 96,284,973 tons, and the losses in mining over this period are estimated to have been equal to the production. Subtracting the estimated production and mining losses from the original reserves leaves remaining reserves of 2,080 million short tons. Subtracting estimated future mining losses of 50 percent from the estimated remaining reserves leaves recoverable reserves of 1,040 million short tons. A summation of these reserves, by counties and for the State, is listed in table 6.

The distribution of the estimated original reserves by coal bed, county, rank, thickness of the coal, abundance and reliability of data, and amount of overburden is shown in bar graphs (figs. 43 and 44). All coal included in the estimates is overlain by less than 3,000 feet of overburden except for about 417,000 short tons in the Lower Hartshorne coal bed in Sebastian County (pl. 59). This small tonnage, which has an overburden only slightly in excess of 3,000 feet, is included in tables 1 and 5 under the category for coal with more than 2,000 feet of overburden and is included in that category in figure 44.

In making an estimate of the coal reserves of a large coal field, the total amount of coal included in the estimate is dependent upon such factors as (a) geologic characteristics of the coal field, (b) amount and distribution of the information on the thickness and other characteristics of the coal beds, and, to some extent, (c) the interpretations used by the individual in making the estimate. A comparison of the coal reserves estimate for Oklahoma (Trumbull, 1957, fig. 2, tables 1 and 2) with this estimate of Arkansas coal reserves illustrates the effect of these variables upon the estimate of reserves.

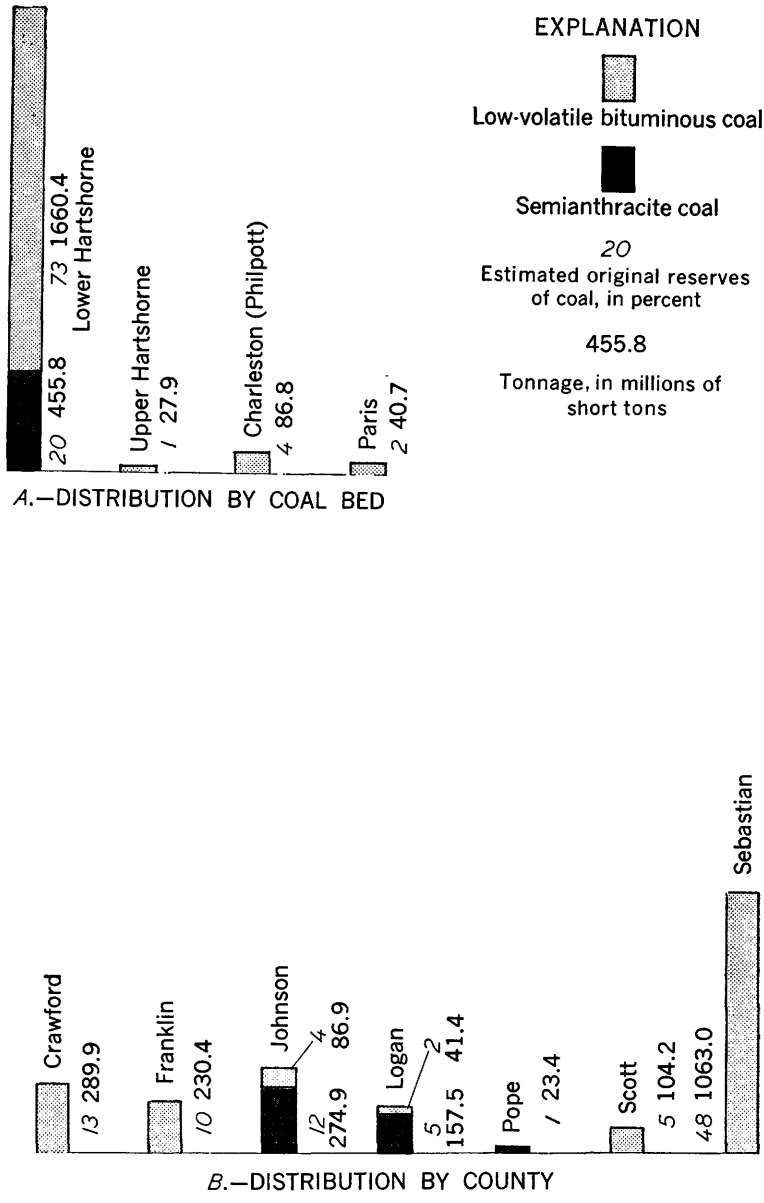

FIGURE 43.—Distribution of coal reserves of different rank, by bed and county.

In the Oklahoma coal field, which has an overall area of approximately 14,550 square miles, the reserves originally present before mining are estimated to be 3,673 million short tons, and in the

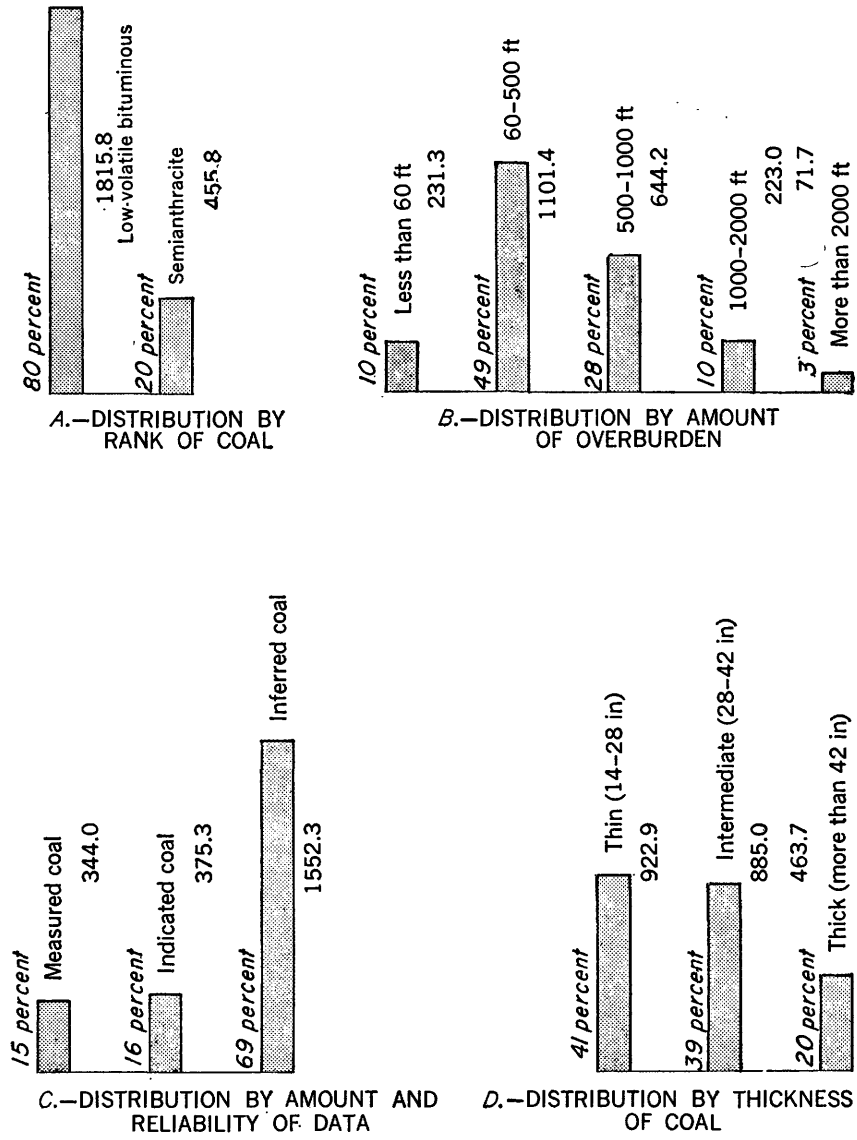

FIGURE 44.—Distribution of original reserves of coal by rank, amount of overburden, amount and reliability of data, and by thickness of the coal. Tonnages in millions of short tons.

Arkansas Valley coal field, which has an approximate area of about 1,700 square miles, the original reserves are estimated to be 2,272 million short tons. The two coal fields are underlain by about the same number and thickness of coal beds. This apparent anomaly of

adjoining coal fields having an area ratio of 8.5 to 1 and an estimated reserves ratio of only 3 to 2 is caused by the different geologic characteristics of the two coal fields and by the relative amount and distribution of coal thickness information.

The more important coal beds in the southern part of the Oklahoma coal field have dips in excess of 45° for long distances along the outcrop, are more than 3,000 feet below the surface in much of the coal-bearing area, are irregular in thickness and extent, and cannot be correlated on opposite sides of the large synclines. The coal beds in the northern part of the Oklahoma coal field are generally less than 14 inches thick and dip gently and uniformly to the west, but are unpredictable in thickness and continuity. Therefore, the estimate of Oklahoma coal reserves does not include large amounts of coal that probably exist in many areas where data are lacking and, in the opinion of the appraiser, could not be extrapolated from nearby areas, nor does it include the large amounts of coal that fall beyond the cutoff points established for inclusion in the reserves estimate, namely a minimum bed thickness of 14 inches and a maximum overburden thickness of 3,000 feet.

The coal beds in the Arkansas Valley coal field have gentle dips, are everywhere less than 3,200 feet deep, and can be correlated by surface mapping or stratigraphic similarity on opposite sides of the synclines. These three characteristics, together with abundant coal-thickness information, permit liberal extrapolation of data over large areas in Arkansas. As a result, the total estimated reserves of coal in Arkansas include a larger percent of estimated inferred reserves than the total estimated reserves of coal in Oklahoma. Also, the total estimated reserves of coal per unit area is larger in Arkansas than in Oklahoma.

CLASSIFICATION OF RESERVES

The estimate of the reserves of low-volatile bituminous coal and of semianthracite in the Arkansas Valley coal field was prepared according to procedures adopted by the U.S. Geological Survey in 1949 (Averitt, 1949, p. 225, 226). The estimate is based on original reserves of coal in the ground before mining, because areas in which the coal had been mined could not be accurately delineated with available mine maps. In calculating the reserves the coal was classified according to rank, weight, thickness, thickness of overburden, and availability of data. The criteria used in this classification are described in the following paragraphs. The resulting estimates of coal reserves of different rank are listed in tables 1 and 2 by county and coal bed; the estimates are subdivided into categories of abundance and reliability of information, thickness of the coal bed, and amount of overburden.

TABLE 1.—*Estimated original reserves of low-volatile bituminous coal in the Arkansas Valley coal field*

Overburden (feet)	Reserves, in millions of short tons, in beds of thickness stated															
	Measured				Indicated				Inferred				Total all categories			Grand Total
	14–28 inches	28–42 inches	42+ inches	Total	14–28 inches	28–42 inches	42+ inches	Total	14–28 inches	28–42 inches	42+ inches	Total	14–28 inches	28–42 inches	42+ inches	
CRAWFORD COUNTY																
Lower Hartshorne coal bed																
0–60					0.1			0.1	7.8	1.4		9.2	7.9	1.4		9.3
60–500	1.2	2.2	4.8	8.2	4.4	5.7	8.2	18.3	102.6	44.7	11.8	159.1	108.2	52.6	24.8	185.6
500–1,000			2.7	2.7			4.8	4.8	22.3	22.8	9.8	54.9	22.3	22.8	17.3	62.4
1,000–2,000										28.1	4.5	32.6		28.1	4.5	32.6
2,000–3,000																
Total	1.2	2.2	7.5	10.9	4.5	5.7	13.0	23.2	132.7	97.0	26.1	255.8	138.4	104.9	46.6	289.9
FRANKLIN COUNTY																
Lower Hartshorne coal bed																
0–60	4.3	2.6	6.9	13.8	2.1	0.3	0.2	2.6	14.8	0.4		15.2	21.2	3.3	7.1	31.6
60–500	5.0	7.3	16.9	29.2	4.5	2.4	1.1	8.0	60.5	1.5		62.0	70.0	11.2	18.0	99.2
500–1,000	.1			.1	1.2			1.2	34.3			34.3	35.6			35.6
1,000–2,000									10.5			10.5	10.5			10.5
2,000–3,000									4.4			4.4	4.4			4.4
Total	9.4	9.9	23.8	43.1	7.8	2.7	1.3	11.8	124.5	1.9		126.4	141.7	14.5	25.1	181.3
Charleston coal bed																
0–60	5.5			5.5	3.0			3.0	4.6			4.6	13.1			13.1
60–500	1.7			1.7	3.0			3.0	5.0			5.0	9.7			9.7
500–1,000					1.0			1.0	8.0			8.0	9.0			9.0
1,000–2,000									8.5			8.5	8.5			8.5
2,000–3,000																
Total	7.2			7.2	7.0			7.0	26.1			26.1	40.3			40.3

See footnotes at end of table.

TABLE 1.—*Estimated original reserves of low-volatile bituminous coal in the Arkansas Valley coal field*—Continued

Overburden (feet)	Reserves, in millions of short tons, in beds of thickness stated															
	Measured				Indicated				Inferred				Total all categories			Grand Total
	14–28 inches	28–42 inches	42+ inches	Total	14–28 inches	28–42 inches	42+ inches	Total	14–28 inches	28–42 inches	42+ inches	Total	14–28 inches	28–42 inches	42+ inches	
FRANKLIN COUNTY—Continued																
Paris coal bed																
0–60	1.5			1.5	2.7			2.7	0.7			0.7	4.9			4.9
60–500	1.3			1.3	1.3			1.3	.7			.7	3.3			3.3
500–1,000					.6			.6					.6			.6
1,000–2,000																
2,000–3,000																
Total	2.8			2.8	4.6			4.6	1.4			1.4	8.8			8.8
All coal beds																
0–60	11.3	2.6	6.9	20.8	7.8	0.3	0.2	8.3	20.1	0.4		20.5	39.2	3.3	7.1	49.6
60–500	8.0	7.3	16.9	32.2	8.8	2.4	1.1	12.3	66.2	1.5		67.7	83.0	11.2	18.0	112.2
500–1,000	.1			.1	2.8			2.8	42.3			42.3	45.2			45.2
1,000–2,000									19.0			19.0	19.0			19.0
2,000–3,000									4.4			4.4	4.4			4.4
Total	19.4	9.9	23.8	53.1	19.4	2.7	1.3	23.4	152.0	1.9		153.9	190.8	14.5	25.1	230.4
JOHNSON COUNTY																
Lower Hartshorne coal bed																
0–60	1.5	4.5	2.7	8.7	1.5	0.8		2.3	4.8	1.9		6.7	7.8	7.2	2.7	17.7
60–500	1.2	2.7	.1	4.0	2.7	2.7		5.4	14.5	6.5		21.0	18.4	11.9	.1	30.4
500–1,000					.6			.6	13.1			13.1	13.7			13.7
1,000–2,000																
2,000–3,000																
Total	2.7	7.2	2.8	12.7	4.8	3.5		8.3	32.4	8.4		40.8	39.9	19.1	2.8	61.8

Charleston (Philpott) coal bed

0–60	9.6			9.6	3.6			3.6	6.8			6.8	20.0			20.0
60–500	.2			.2	1.5			1.5	3.4			3.4	5.1			5.1
500–1,000																
1,000–2,000																
2,000–3,000																
Total	9.8			9.8	5.1			5.1	10.2			10.2	25.1			25.1

All coal beds

0–60	11.1	4.5	2.7	18.3	5.1	0.8		5.9	11.6	1.9		13.5	27.8	7.2	2.7	37.7
60–500	1.4	2.7	.1	4.2	4.2	2.7		6.9	17.9	6.5		24.4	23.5	11.9	.1	35.5
500–1,000					.6			.6	13.1			13.1	13.7			13.7
1,000–2,000																
2,000–3,000																
Total	12.5	7.2	2.8	22.5	9.9	3.5		13.4	42.6	8.4		51.0	65.0	19.1	2.8	86.9

LOGAN COUNTY

Lower Hartshorne coal bed

0–60									2.1			2.1	2.1			2.1
60–500									3.2	3.7		6.9	3.2	3.7		6.9
500–1,000																
1,000–2,000																
2,000–3,000																
Total									5.3	3.7		9.0	5.3	3.7		9.0

Charleston coal bed

0–60	(1)			(1)	(2)			(2)	(3)			(3)	0.1			0.1
60–500	0.1			0.1	0.1			0.1	0.2			0.2	.4			.4
500–1,000									(2)			(2)	(2)			(2)
1,000–2,000																
2,000–3,000																
Total	0.1			0.1	0.1			0.1	0.2			0.2	0.5			0.5

See footnotes at end of table.

TABLE 1.—*Estimated original reserves of low-volatile bituminous coal in the Arkansas Valley coal field*—Continued

Overburden (feet)	Reserves, in millions of short tons, in beds of thickness stated															Grand Total
	Measured				Indicated				Inferred				Total all categories			
	14–28 inches	28–42 inches	42+ inches	Total	14–28 inches	28–42 inches	42+ inches	Total	14–28 inches	28–42 inches	42+ inches	Total	14–28 inches	28–42 inches	42+ inches	
LOGAN COUNTY—Continued																
Paris coal bed																
0–60	6.9	1.7		8.6	0.5	0.4		0.9		0.6		0.6	7.4	2.7		10.1
60–500	4.3	1.2		5.5	6.1	1.7		7.8	4.2	1.8		6.0	14.6	4.7		19.3
500–1,000		(4)		(4)	.4	.6		1.0	1.0	.5		1.5	1.4	1.1		2.5
1,000–2,000																
2,000–3,000																
Total	11.2	2.9		14.1	7.0	2.7		9.7	5.2	2.9		8.1	23.4	8.5		31.9
All coal beds																
0–60	6.9	1.7		8.6	0.5	0.4		0.9	2.1	0.6		2.7	9.6	2.7		12.3
60–500	4.4	1.2		5.6	6.2	1.7		7.9	7.6	5.5		13.1	18.2	8.4		26.6
500–1,000		(4)		(4)	.4	.6		1.0	1.0	.5		1.5	1.4	1.1		2.5
1,000–2,000																
2,000–3,000																
Total	11.3	2.9		14.2	7.1	2.7		9.8	10.7	6.6		17.3	29.2	12.2		41.4
SCOTT COUNTY																
Lower Hartshorne coal bed																
0–60	0.7	0.1	0.7	1.5	0.2	0.1	1.3	1.6	0.9	0.8	0.3	2.0	1.8	1.0	2.3	5.1
60–500	.9	.2	2.9	4.0	2.6	1.0	7.7	11.3	4.7	1.6	4.0	10.3	8.2	2.8	14.6	25.6
500–1,000	.2			.2	.8	1.7	1.9	4.4	7.9	6.6	7.7	22.2	8.9	8.3	9.6	26.8
1,000–2,000		.9		.9		1.4	.1	1.5	17.8	8.1	6.3	32.3	17.8	10.5	6.4	34.7
2,000–3,000		.6		.6		.7		.7	4.2	5.8	.7	10.7	4.2	7.1	.7	12.0
Total	1.8	1.8	3.6	7.2	3.6	4.9	11.0	19.5	35.5	23.0	19.0	77.5	40.9	29.7	33.6	104.2

SEBASTIAN COUNTY

Lower Hartshorne coal bed

0–60	4.9	9.1	22.7	36.7	2.0	4.2	6.2	12.4	6.5	2.4	0.4	9.3	13.4	15.7	29.3	58.4
60–500	2.1	32.7	63.8	98.6	7.2	60.3	42.2	109.7	117.3	100.6	8.5	226.4	126.6	193.6	114.5	434.7
500–1,000	.3	8.1	17.1	25.5	2.3	21.2	39.1	62.6	94.9	137.2	25.0	257.1	97.5	166.5	81.2	345.2
1,000–2,000	-------	1.0	3.3	4.3	-------	8.2	6.5	14.7	22.6	66.2	12.8	101.6	22.6	75.4	22.6	120.6
2,000–3,000	-------	(4)	-------	(4)	-------	.7	.1	.8	10.5	23.7	[5] 20.3	[5] 54.5	10.5	24.4	[5] 20.4	[5] 55.3
Total	7.3	50.9	106.9	165.1	11.5	94.6	94.1	200.2	251.8	330.1	[5] 67.0	[5] 648.9	270.6	475.6	[5] 268.0	[5] 1,014.2

Upper Hartshorne coal bed

0–60	1.4	(4)	-------	1.4	1.3	-------	-------	1.3	1.8	-------	-------	1.8	4.5	(4)	-------	4.5
60–500	3.6	0.1	-------	3.7	4.9	-------	-------	4.9	11.5	-------	-------	11.5	20.0	0.1	-------	20.1
500–1,000	(1)	-------	-------	(1)	.2	-------	-------	.2	2.7	-------	-------	2.7	2.9	-------	-------	2.9
1,000–2,000	-------	-------	-------	-------	-------	-------	-------	-------	.4	-------	-------	.4	.4	-------	-------	.4
2,000–3,000	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
Total	5.0	.1	-------	5.1	6.4	-------	-------	6.4	16.4	-------	-------	16.4	27.8	.1	-------	27.9

Charleston coal bed

0–60	1.9	-------	-------	1.9	3.0	-------	-------	3.0	4.0	-------	-------	4.0	8.9	-------	-------	8.9
60–500	1.9	-------	-------	1.9	3.8	-------	-------	3.8	3.4	-------	-------	3.4	9.1	-------	-------	9.1
500–1,000	-------	-------	-------	-------	.4	-------	-------	.4	2.0	-------	-------	2.0	2.4	-------	-------	2.4
1,000–2,000	-------	-------	-------	-------	-------	-------	-------	-------	.5	-------	-------	.5	.5	-------	-------	.5
2,000–3,000	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
Total	3.8	-------	-------	3.8	7.2	-------	-------	7.2	9.9	-------	-------	9.9	20.9	-------	-------	20.9

All coal beds

0–60	8.2	9.1	22.7	40.0	6.3	4.2	6.2	16.7	12.3	2.4	0.4	15.1	26.8	15.7	29.3	71.8
60–500	7.6	32.8	63.8	104.2	15.9	60.3	42.2	118.4	132.2	100.6	8.5	241.3	155.7	193.7	114.5	463.9
500–1,000	.3	8.1	17.1	25.5	2.9	21.2	39.1	63.2	99.6	137.2	25.0	261.8	102.8	166.5	81.2	350.5
1,000–2,000	-------	1.0	3.3	4.3	-------	8.2	6.5	14.7	23.5	66.2	12.8	102.5	23.5	75.4	22.6	121.5
2,000–3,000	-------	(4)	-------	(4)	-------	.7	.1	.8	10.5	23.7	[5] 20.3	[5] 54.5	10.5	24.4	[5] 20.4	[5] 55.3
Total	16.1	51.0	106.9	174.0	25.1	94.6	94.1	213.8	278.1	330.1	[5] 67.0	[5] 675.2	319.3	475.7	[5] 268.0	[5] 1,063.0

See footnotes at end of table.

TABLE 1.—*Estimated original reserves of low-volatile bituminous coal in the Arkansas Valley coal field*—Continued

Overburden (feet)	Reserves, in millions of short tons, in beds of thickness stated															
	Measured				Indicated				Inferred				Total all categories			Grand Total
	14–28 inches	28–42 inches	42+ inches	Total	14–28 inches	28–42 inches	42+ inches	Total	14–28 inches	28–42 inches	42+ inches	Total	14–28 inches	28–42 inches	42+ inches	
ALL COUNTIES																
Lower Hartshorne coal bed																
0–60	11.4	16.3	33.0	60.7	5.9	5.4	7.7	19.0	36.9	6.9	0.7	44.5	54.2	28.6	41.4	124.2
60–500	10.4	45.1	88.5	144.0	21.4	72.1	59.2	152.7	302.8	158.6	24.3	485.7	334.6	275.8	172.0	782.4
500–1,000	.6	8.1	19.8	28.5	4.9	22.9	45.8	73.6	172.5	166.6	42.5	381.6	178.0	197.6	108.1	483.7
1,000–2,000	-------	1.9	3.3	5.2	-------	9.6	6.6	16.2	50.9	102.5	23.6	177.0	50.9	114.0	33.5	198.4
2,000–3,000	-------	.6	-------	.6	-------	1.4	.1	1.5	19.1	29.5	[5] 21.0	[5] 69.6	19.1	31.5	[5] 21.1	[5] 71.7
Total	22.4	72.0	144.6	239.0	32.2	111.4	119.4	263.0	582.2	464.1	[5] 112.1	[5] 1,158.4	636.8	647.5	[5] 376.1	[5] 1,660.4
Upper Hartshorne coal bed																
0–60	1.4	[4]	-------	1.4	1.3	-------	-------	1.3	1.8	-------	-------	1.8	4.5	[4]	-------	4.5
60–500	3.6	0.1	-------	3.7	4.9	-------	-------	4.9	11.5	-------	-------	11.5	20.0	0.1	-------	20.1
500–1,000	[1]	-------	-------	[1]	.2	-------	-------	.2	2.7	-------	-------	2.7	2.9	-------	-------	2.9
1,000–2,000	-------	-------	-------	-------	-------	-------	-------	-------	.4	-------	-------	.4	.4	-------	-------	.4
2,000–3,000	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
Total	5.0	0.1	-------	5.1	6.4	-------	-------	6.4	16.4	-------	-------	16.4	27.8	0.1	-------	27.9
Charleston (Philpott) coal bed																
0–60	17.0	-------	-------	17.0	9.6	-------	-------	9.6	15.4	-------	-------	15.4	42.1	-------	-------	42.1
60–500	3.9	-------	-------	3.9	8.4	-------	-------	8.4	12.0	-------	-------	12.0	24.3	-------	-------	24.3
500–1,000	-------	-------	-------	-------	1.4	-------	-------	1.4	10.0	-------	-------	10.0	11.4	-------	-------	11.4
1,000–2,000	-------	-------	-------	-------	-------	-------	-------	-------	9.0	-------	-------	9.0	9.0	-------	-------	9.0
2,000–3,000	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
Total	20.9	-------	-------	20.9	19.4	-------	-------	19.4	46.4	-------	-------	46.4	86.8	-------	-------	86.8

525832—60—2

Paris coal bed

0–60	8.4	1.7	-------	10.1	3.2	0.4	-------	3.6	0.7	0.6	-------	1.3	12.3	2.7	-------	15.0
60–500	5.6	1.2	-------	6.8	7.4	1.7	-------	9.1	4.9	1.8	-------	6.7	17.9	4.7	-------	22.6
500–1,000	-------	(4)	-------	(4)	1.0	.6	-------	1.6	1.0	.5	-------	1.5	2.0	1.1	-------	3.1
1,000–2,000	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
2,000–3,000	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
Total	14.0	2.9	-------	16.9	11.6	2.7	-------	14.3	6.6	2.9	-------	9.5	32.2	8.5	-------	40.7

All coal beds

0–60	38.2	18.0	33.0	89.2	20.0	5.8	7.7	33.5	54.8	7.5	0.7	63.0	113.1	31.3	41.4	185.8
60–500	23.5	46.4	88.5	158.4	42.1	73.8	59.2	175.1	331.2	160.4	24.3	515.9	396.8	280.6	172.0	849.4
500–1,000	.6	8.1	19.8	28.5	7.5	23.5	45.8	76.8	186.2	167.1	42.5	395.8	194.3	198.7	108.1	501.1
1,000–2,000	-------	1.9	3.3	5.2	-------	9.6	6.6	16.2	60.3	102.5	23.6	186.4	60.3	114.0	33.5	207.8
2,000–3,000	-------	.6	-------	.6	-------	1.4	.1	1.5	19.1	29.5	[5] 21.0	[5] 69.6	19.1	31.5	[5] 21.1	[5] 71.7
Total	62.3	75.0	144.6	281.9	69.6	114.1	119.4	303.1	651.6	467.0	[5] 112.1	[5] 1,230.7	783.6	656.1	[5] 376.1	[5] 1,815.8

[1] Between 31 and 40 thousand short tons.
[2] Between 11 and 20 thousand short tons.
[3] Between 21 and 30 thousand short tons.
[4] Between 41 and 50 thousand short tons.
[5] 417 thousand short tons overlain by 3,000 feet or more of overburden.

TABLE 2.—*Estimated original reserves of semianthracite in the Lower Hartshorne coal bed, Arkansas Valley coal field*

Overburden (feet)	Reserves, in millions of short tons, in beds of thickness stated															
	Measured				Indicated				Inferred				Total all categories			Grand total
	14–28 inches	28–42 inches	42+ inches	Total	14–28 inches	28–42 inches	42+ inches	Total	14–28 inches	28–42 inches	42+ inches	Total	14–28 inches	28–42 inches	42+ inches	
Johnson County																
0–60	3.1	2.0	0.4	5.5	2.6	1.3	-------	3.9	3.5	23.8	-------	27.3	9.2	27.1	0.4	36.7
60–500	2.0	22.9	4.7	29.6	7.0	25.4	4.4	36.8	22.7	58.6	37.7	119.0	31.7	106.9	46.8	185.4
500–1,000	.8	.8	-------	1.6	1.6	2.0	.5	4.1	12.7	24.7	9.7	47.1	15.1	27.5	10.2	52.8
1,000–2,000	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
2,000–3,000	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
Total	5.9	25.7	5.1	36.7	11.2	28.7	4.9	44.8	38.9	107.1	47.4	193.4	56.0	161.5	57.4	274.9
Logan County																
0–60	0.1	2.3	-------	2.4	0.1	-------	-------	0.1	1.0	-------	-------	1.0	1.2	2.3	-------	3.5
60–500	1.5	6.2	0.6	8.3	2.3	1.3	0.5	4.1	17.6	13.0	6.9	37.5	21.4	20.5	8.0	49.9
500–1,000	3.2	1.4	2.0	6.6	1.4	8.2	4.7	14.3	32.9	21.3	13.8	68.0	37.5	30.9	20.5	88.9
1,000–2,000	-------	.7	-------	.7	-------	1.9	-------	1.9	4.6	8.0	-------	12.6	4.6	10.6	-------	15.2
2,000–3,000	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
Total	4.8	10.6	2.6	18.0	3.8	11.4	5.2	20.4	56.1	42.3	20.7	119.1	64.7	64.3	28.5	157.5
Pope County																
0–60	0.6	0.2	1.0	1.8	1.4	0.3	0.3	2.0	1.5	-------	-------	1.5	3.5	0.5	1.3	5.3
60–500	3.5	.8	.4	4.7	3.3	1.2	-------	4.5	7.5	-------	-------	7.5	14.3	2.0	.4	16.7
500–1,000	.6	.3	-------	.9	.2	.3	-------	.5	-------	-------	-------	-------	.8	.6	-------	1.4
1,000–2,000	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
2,000–3,000	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
Total	4.7	1.3	1.4	7.4	4.9	1.8	.3	7.0	9.0	-------	-------	9.0	18.6	3.1	1.7	23.4

All counties

0–60	3.8	4.5	1.4	9.7	4.1	1.6	0.3	6.0	6.0	23.8	-------	29.8	13.9	29.9	1.7	45.5
60–500	7.0	29.9	5.7	42.6	12.6	27.9	4.9	45.4	47.8	71.6	44.6	164.0	67.4	129.4	55.2	252.0
500–1,000	4.6	2.5	2.0	9.1	3.2	10.5	5.2	18.9	45.6	46.0	23.5	115.1	53.4	59.0	30.7	143.1
1,000–2,000	-------	.7	-------	.7	-------	1.9	-------	1.9	4.6	8.0	-------	12.6	4.6	10.6	-------	15.2
2,000–3,000	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
Total	15.4	37.6	9.1	62.1	19.9	41.9	10.4	72.2	104.0	149.4	68.1	321.5	139.3	228.9	87.6	455.8

RANK OF COAL

The rank of coal in the Arkansas Valley coal field was determined according to the classification established by the American Society for Testing Materials (1939, p. 1–6); the classification is given in table 3. The percentage of dry mineral-matter-free fixed carbon in the coal ranges from about 80 percent in the southwestern part of the coal field to about 89 percent in the eastern part. Therefore, the coal ranges in rank from low-volatile bituminous coal to semianthracite. The percentage of dry mineral-matter-free fixed carbon in the coal was determined by using the following approximation formula:

$$\text{Dry mineral-matter-free fixed carbon} = \frac{FC}{100-(M+1.1A+0.1S)} \times 100$$

where: FC = percentage of fixed carbon,
M = percentage of moisture,
A = percentage of ash, and
S = percentage of sulfur.

TABLE 3.—*Classification of coals by rank*[1]

[Symbols: FC, fixed carbon; VM, volatile matter; Btu, British thermal units. From American Society for Testing Materials (1939, p. 2)]

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]

See footnotes at end of table.

TABLE 3.—*Classification of coals by rank*—Continued

[Symbols: FC, fixed carbon; VM, volatile matter; Btu, British thermal units. From American Society for Testing Materials (1939, p. 2)]

Class	Group	Limits of fixed carbon or Btu mineral-matter-free basis	Requisite physical properties
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, namely, Variety 1, agglomerating and nonweathering; Variety 2, agglomerating and weathering; Variety 3, nonagglomerating and nonweathering.

The percentage of dry mineral-matter-free fixed carbon in low-volatile bituminous coal and in semianthracite at each of 24 localities in the Arkansas Valley coal field was determined from the averaged coal analyses listed in table 4. The generalized distribution of the coal, shown on plates 59, 60, 61, and 62 was determined by plotting and contouring the percentages. The coal analyses are from reports by Fitzjarrell (1953, tables 2 and 4), Croneis (1930, p. 361–365 and pl. 45), Hendricks and Parks (1937, p. 209 213), Fieldner, Smith, and others (1918, p. 29–30, 160–163), Fieldner, Selvig, and Paul (1922, p. 22–24, 119–124), Fieldner, Cooper, and Osgood (1928, p. 7–21), and from U.S. Bureau of Mines analyses of samples collected by the writer and others.

WEIGHT OF COAL

The average weight of coal used in calculating the coal reserves of the Arkansas Valley coal field is 1,800 short tons per acre-foot for bituminous coal and 2,000 short tons per acre-foot for semianthracite.

THICKNESS OF COAL

In calculating and reporting the reserves of low-volatile bituminous coal and of semianthracite, the following standard categories, based on thickness, have been used: thin (14–28 inches), intermediate (28–42 inches), and thick (more than 42 inches).

TABLE 4.—*Averaged analyses of coal from the Arkansas Valley coal field*

[Samples on "as received" basis]

Sample No. (pl. 62)	Mine	Coal bed	Number of analyses	Proximate analyses, in percent				Sulfur (percent)	Dry mineral-matter-free fixed carbon (percent) [1]
				Moisture	Volatile matter	Fixed carbon	Ash		
1	Central No. 10	Lower Hartshorne.	8	2.6	18.2	69.9	9.3	1.0	80.2
2	Central No. 1	do	4	3.3	17.5	70.6	8.6	1.8	81.1
3	Central No. 6	do	6	3.4	17.9	69.0	9.7	2.0	80.5
4	Majestic Coal Co	do	3	3.4	16.4	71.6	8.6	.9	82.2
5	Bianca	do	3	5.7	15.5	73.3	5.5	1.5	83.2
6	Skinner	do	3	3.9	16.2	77.0	2.9	.7	82.9
7	Barr Coal Co	do	3	3.9	15.4	75.8	4.9	1.0	83.7
8	Great Western	do	3	2.0	17.0	71.7	9.3	1.6	81.8
9	Central No. 12	do	2	.9	17.6	73.4	8.2	2.3	81.7
10	Western No. 18	do	3	2.0	14.7	77.0	6.3	1.1	84.6
11		Paris	1	1.0	20.0	74.3	4.7	2.5	79.4
12	Superfuel Co	do	4	1.8	18.1	69.1	11.7	2.5	81.2
13	Eureka Coal and Mining Co.	do	3	1.7	17.5	71.4	9.4	2.6	81.4
14	Jewel Mining Co	do	2	2.2	16.6	72.2	9.0	2.2	82.3
15	Quality Coal Co	Lower Hartshorne.	3	3.0	14.5	78.4	4.1	.7	84.8
16	Western Coal and Mining No. 2.	do	2	2.7	14.0	73.5	9.8	3.2	85.3
17	Melton No. 1	do	3	2.6	14.0	76.3	7.1	1.9	85.3
18	Fernwood Coal Co	do	3	2.3	11.2	80.3	6.2	1.2	88.5
19	Clark and McWilliams Coal Co.	do	7	2.8	11.9	76.2	9.1	2.4	87.6
20	Arkansas Coal Co	do	4	6.6	11.7	77.8	3.9	.7	87.2
21	Jack Lee	Charleston (Phillpott).	1	1.1	16.1	73.6	9.2	6.1	83.5
22	Skidmore Bros	do	1	1.4	14.4	79.8	4.4	1.0	85.2
23	New Deal Coal Co. and K & S Coal Co.	Lower Hartshorne.	5	4.6	11.6	77.1	6.7	1.5	87.7
24	Bernice No. 3	do	4	2.7	11.2	77.0	9.1	2.0	88.4

[1] Calculated by means of formula on p. 810.

Thicknesses of coal beds used in computing the reserves have been adjusted to exclude partings of rock more than three-eighths of an inch thick and benches of coal normally left in mining. Areas in which the partings constitute more than one-half the coal bed were omitted from the calculations.

THICKNESS OF OVERBURDEN

The major overburden categories that have been adopted by the U.S. Geological Survey (Averitt, Berryhill, and Taylor, 1953) have been modified in this report by dividing the 0- to 1,000-foot category into three parts: 0 to 60 feet, 60 to 500 feet, and 500 to 1,000 feet. The reserves of coal that can be obtained by strip mining are listed in the 0- to 60-foot category. The reserves that are most easily and economically mined by underground methods are listed in the 60- to 500-foot category, and the reserves of coal to be mined after depletion of the shallower reserves are listed in the 500- to 1,000-foot category.

Reserves of coal are also listed in the 1,000- to 2,000-foot and the 2,000+ foot overburden categories.

ABUNDANCE OF RELIABLE DATA

In the Arkansas Valley coal field, the reserves of each coal bed are classified as measured, indicated, or inferred, depending upon the amount and reliability of data on coal thickness.

Measured reserves are computed for areas in which positive information is available from mine workings, drill holes, and outcrops. The points of known thickness of the coal are spaced so closely that the calculated-reserve tonnage is believed to be accurate within 20 percent of the true tonnage. Coal classed as measured is usually less than one-quarter of a mile from a point of known coal thickness, but in some areas of known coal bed continuity, measured reserves may be as far as three-eighths of a mile from the point of known thickness.

Indicated reserves are computed from data projected a reasonable distance from a point of known coal thickness, the amount of projection being dependent upon the continuity and known change of thickness of the coal bed, and upon known geologic structure in the immediate area. In general, reserves classed as indicated are in a belt one-quarter to three-quarters of a mile wide surrounding a block of measured reserves.

Inferred reserves are computed from more widely scattered points of known coal thickness, from assumed continuity and change in thickness of the coal bed, and from geologic characteristics of the coal field. Inferred reserves are computed from data projected beyond the area of measured and indicated reserves and are more than half a mile from any point of known coal thickness. In areas of known coal-bed continuity, the coal may be classified as inferred because of insufficient data on coal thickness.

The coal reserves are listed in figure 44*C* and in tables 1, 2, and 5 as measured, indicated, or inferred, but the areas of measured and indicated reserves have been combined and shown as one area unit on plates 59 and 60.

ORIGINAL, REMAINING, AND RECOVERABLE RESERVES

The estimated reserves listed by rank, county, and coal bed in tables 1, 2, and 5 are original reserves; that is, they are the amount of coal believed to have been present before mining began. Total original reserves of all coal in each county in the Arkansas Valley coal field are listed in table 6, together with the remaining reserves (original reserves less the coal mined and lost in mining), and the recoverable reserves (remaining reserves less the estimated future mining losses).

TABLE 5.—*Estimated original reserves of coal of all ranks in all coal beds of the Arkansas Valley coal field*

Overburden (feet)	Reserves, in millions of short tons, in beds of thickness stated															
	Measured				Indicated				Inferred				Total all categories			Grand Total
	14–28 inches	28–42 inches	42+ inches	Total	14–28 inches	28–42 inches	42+ inches	Total	14–28 inches	28–42 inches	42+ inches	Total	14–28 inches	28–42 inches	42+ inches	
0–60	42.0	22.5	34.4	98.9	24.1	7.4	8.0	39.5	60.8	31.3	0.7	92.8	127.0	61.2	43.1	231.3
60–500	30.5	76.3	94.2	201.0	54.7	101.7	64.1	220.5	379.0	232.0	68.9	679.9	464.2	410.1	227.2	1,101.4
500–1,000	5.2	10.6	21.8	37.6	10.7	34.0	51.0	95.7	231.8	213.1	66.0	510.9	247.7	257.7	138.8	644.2
1,000–2,000	-------	2.6	3.3	5.9	-------	11.5	6.6	18.1	64.9	110.5	23.6	199.0	64.9	124.6	33.5	223.0
2,000–3,000	-------	.6	-------	.6	-------	1.4	.1	1.5	19.1	29.5	[1] 21.0	[1] 69.6	19.1	31.5	[1] 21.1	[1] 71.7
Total	77.7	112.6	153.7	344.0	89.5	156.0	129.8	375.3	755.6	616.4	[1] 180.2	[1] 1,552.2	922.9	885.0	[1] 463.7	[1] 2,271.6

[1] 417 thousand short tons overlain by 3,000 feet or more of overburden.

METHOD OF RECORDING DATA AND MAKING CALCULATIONS

The estimated reserves of low-volatile bituminous coal and of semianthracite presented in this report were calculated from worksheets compiled for each coal bed. Data plotted on the worksheets were as follows: State and county boundaries; faults; anticlinal and synclinal axes; strikes and dips of the strata; outcrops of the coal beds; and extent, depth, and thickness of the coal beds. The worksheets were constructed at the scale of 1:24,000 from published and unpublished topographic maps.

TABLE 6.—*Estimated original, remaining, and recoverable reserves of coal of all ranks in the Arkansas Valley coal field, through 1954*

[In millions of short tons]

County	Original reserves	Production and mining losses [1]	Remaining reserves	Recoverable reserves [2]
Crawford	289.9	[3]	289.9	144.9
Franklin	230.4	24.0	206.4	103.2
Johnson	361.8	29.8	332.0	166.0
Logan	198.9	19.6	179.3	89.6
Pope	23.4	6.5	16.9	8.4
Scott	104.2	1.9	102.3	51.2
Sebastian	1,063.0	109.3	953.7	476.9
Other counties and (or) small mines	[4]	[5] 1.4		
Total	2,271.6	191.1	2,080.5	1,040.2

[1] Mining losses are considered to be equivalent to tonnage of coal produced.
[2] Remaining reserves less estimated future mining losses, assuming 50 percent recoverability.
[3] No production recorded for Crawford County.
[4] No reserves estimated.
[5] Not included in total because no reserves estimated.

Lines showing changes in thickness of 1 inch were drawn between points of known coal thickness, thereby establishing the areas of thin, intermediate, and thick coal beds and also providing a basis for determining the weighted-average thickness of the coal. Areas in different overburden categories were delineated by lines of equal overburden thickness drawn between points of observed and computed depths to the coal. The areas of low-volatile bituminous coal or semianthracite were delineated by a generalized rank line (pl. 62).

The areas defined by political and geologic boundaries, and by categories of rank, overburden, and thickness of coal, were subdivided into areas of measured, indicated, or inferred reserves, this classification being dependent upon the number and reliability of observations of coal thickness. Each subdivision on the worksheet was measured with a planimeter to determine the acreage. The acreage, the weighted-average thickness of coal in the area, and the weight of coal per acre-foot were multiplied together to produce a tonnage estimate for each subdivision. The combined estimates for each of the sub-

divisions are totaled and tabulated in the appropriate categories in tables 1, 2, and 5.

The tonnages of coal reserves recorded in this report represent a minimum total. Additional information about the thickness and extent of the coal beds will, in all probability, increase the estimated total tonnage of original reserves, and will certainly increase the amounts of measured and indicated reserves.

COMPARISON OF PAST AND PRESENT ESTIMATES

Original estimates of the coal reserves in the Arkansas Valley coal field by Campbell (1908) and Steel (1910, p. 4) cite the original reserves of coal at 1,626 million and 1,095 million short tons, respectively. Campbell's estimate is more acceptable because it is based on data pertaining to all coal beds thicker than 14 inches in an area of 1,600 square miles, whereas Steel assumed that all the coal in Arkansas was equivalent to one coal bed with an average thickness of 3 feet over an area of 310 square miles. Subsequent estimates by Hendricks in 1939 (p. 283, table 3) and by Averitt, Berryhill, and Taylor in 1953 (p. 4, table 1) are based on Campbell's estimate, with minor modifications to account for production and estimated mining losses. The estimate presented in this report is larger than the previous ones, but is regarded as more accurate because it is based on more complete information about the thickness and lateral extent of the coal beds and the geology of the coal field.

GEOLOGY OF THE ARKANSAS VALLEY COAL FIELD

The Arkansas Valley coal field includes all the areas in the Arkansas Valley region that are underlain by the Hartshorne sandstone. The extent of each of these areas is limited by the location on the surface of the ground of either the contact between the Atoka formation and the Hartshorne sandstone, or of the trace of a fault between the Atoka formation and a younger formation.

Four formations crop out in the area of the Arkansas Valley coal field. From oldest to youngest, they are the Hartshorne sandstone, and the McAlester, Savanna, and Boggy formations (pls. 58 and 63). These formations are the productive coal measures described in this and previous reports.

STRATIGRAPHY

The generalized columnar section (fig. 45) and most of the descriptions of formations were obtained from reports published by Collier (1907, p. 11–22), Croneis (1930, p. 116–147), Hendricks, Dane, and Knechtel (1936, p. 1342–1356), Hendricks (1937, p. 1403–1421), and Hendricks and Parks (1950, p. 69–80). The writer has modified the

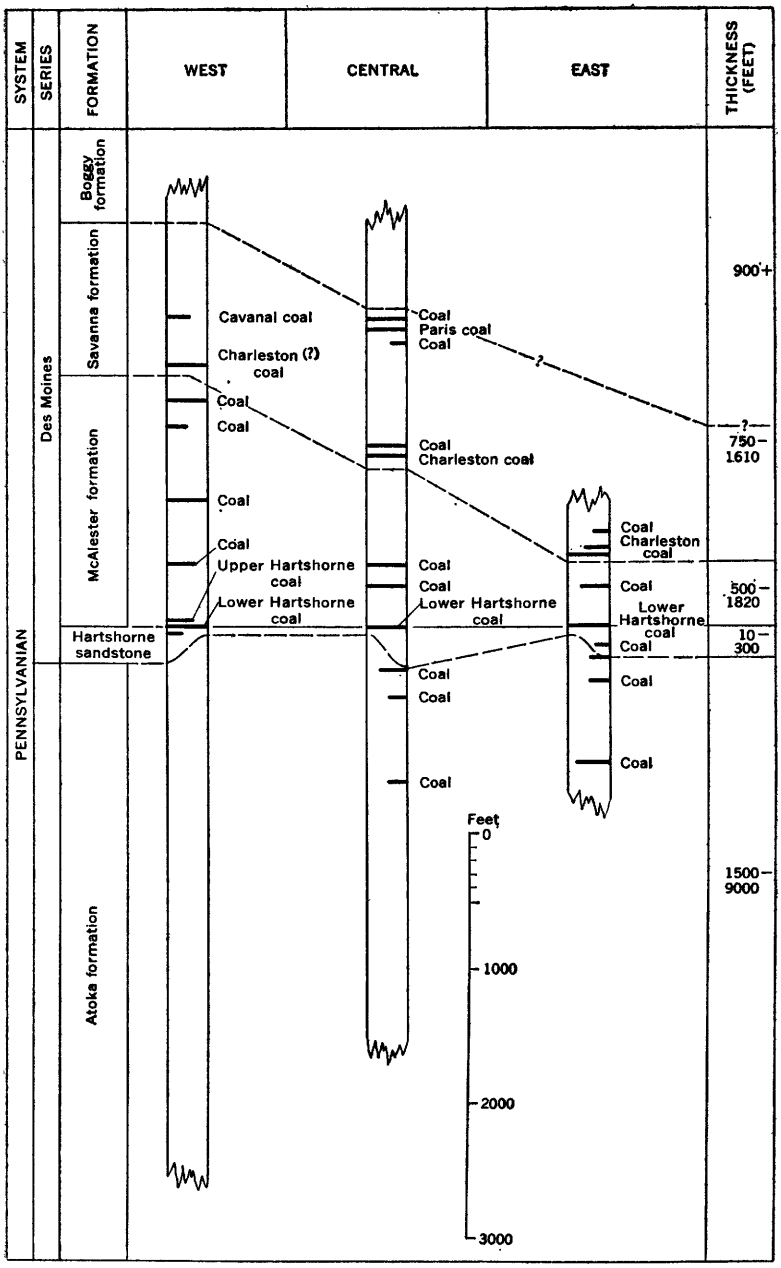

FIGURE 45.—Generalized columnar section of the formations and coal beds in the Arkansas Valley region.

generalized columnar section and the formation descriptions from these older reports to accord with his observations in the field. In this report the areas of the outcropping Atoka formation are not included in the Arkansas Valley coal field. However, the Atoka formation is described in this report because it contains coal and underlies the areas of the productive coal measures.

ATOKA FORMATION

The Atoka formation of Pennsylvanian age consists of beds of sandstone, siltstone, shale, and a few thin beds of coal and is the oldest coal-bearing formation exposed in the Arkansas Valley region. The lower part of the formation has been intruded at places by igneous rock, but little metamorphism is evident in adjacent rocks (Croneis and Billings, 1930, p. 153). The thickness of the formation ranges from about 1,500 feet in the northern part of the area to more than 9,000 feet in the southern part (Hendricks, Dane, and Knechtel, 1936, fig. 3).

The coal beds in the Atoka formation are not mined on a large scale because of the thinness and poor quality of the coal, but two of them have been mined on a small scale to supply local demand. The most extensively mined coal bed in the Atoka formation is near Centerville in Yell County (pl. 61). Reserves have not been calculated for any of the coal beds in the Atoka formation.

HARTSHORNE SANDSTONE

The Hartshorne sandstone of Pennsylvanian (Des Moines) age is defined in this and in previous reports as the first continuous sandstone below the Lower Hartshorne coal bed. The Hartshorne sandstone overlies the Atoka formation with a contact that has been regarded as unconformable by Hendricks and Parks (1950, p. 73). The Hartshorne sandstone is a continuous sandy zone composed of a single bed of sandstone or clayey sandstone, or several quartzose sandstone beds intercalated with thin beds of shale. In some localities, thin lenticular coal beds are present in the shale members. The Hartshorne sandstone ranges in thickness from about 10 feet to about 300 feet and is the basal stratigraphic unit of the productive coal measures of this report.

McALESTER FORMATION

The McAlester formation of Pennsylvanian (Des Moines) age, which conformably overlies the Hartshorne sandstone, consists of sandstone, siltstone, shale, and coal. The thickness of the McAlester formation ranges from about 500 feet in the northeastern part of the

area to 1,820 feet in the western part (Hendricks, Dane, and Knechtel, 1936, fig. 4; Hendricks and Parks, 1937, p. 199).

Four of the eight coal beds in the McAlester formation have been mined, but only the Lower Hartshorne and the Upper Hartshorne are considered to be of economic importance. The Lower Hartshorne coal bed is near the base of the McAlester formation, and the Upper Hartshorne coal bed is 60 to 90 feet above the Lower Hartshorne coal.

SAVANNA FORMATION

The Savanna formation of Pennsylvanian (Des Moines) age, which overlies the McAlester formation with a minor unconformity (Hendricks and Parks, 1950, p. 76), consists of shale, siltstone, sandstone, coal, and a few thin beds of limestone. The thickness of the Savanna formation ranges from 750 feet in the eastern part of the area to 1,610 feet in the western part (Hendricks, Dane, and Knechtel, 1936, fig. 5; Hendricks and Parks, 1937, p. 199).

The Savanna formation contains the Charleston, Cavanal, Paris, and five unnamed coal beds. The Charleston and Cavanal coal beds are in the lower part of the formation and the Paris coal bed is in the middle part. Only the Charleston and Paris coal beds have been mined. The Cavanal coal bed is reported to be 18 inches thick in a locality in the southwestern part of the area.

BOGGY FORMATION

The Boggy formation of Pennsylvanian (Des Moines) age overlies the Savanna formation unconformably (Hendricks, Dane, and Knechtel, 1936, p. 1350). Only 900 feet of beds in the lower part of the formation is present in Arkansas, and this sequence consists of shale, limy shale, siltstone, and sandstone. Coal has not been found in the Boggy formation in Arkansas.

STRUCTURE

The Arkansas Valley coal field is in a composite syncline containing a number of anticlines and smaller synclines and is cut by normal and reverse faults. The structural relief is more than 2,350 feet as measured on the Lower Hartshorne coal bed, which ranges from about 600 feet above sea level to an estimated depth of 1,750 feet below sea level.

Structurally, the area may be divided into two parts along a line from Bonanza through Charleston to Russellville. South of this line, the rocks have been strongly folded and in some areas overturned as much as 15° beyond the vertical. The faults have relative displacements indicative of reverse or thrust faulting. North of the line, the rocks have been less strongly folded and generally dip less than 25°. Most of the faults are normal faults, but a few reverse faults are

present. Coal mining is adversely affected by the folds and faults, particularly in the southern structural parts.

COAL BEDS

Nineteen coal beds were studied before estimating and computing the reserves of coal in the Arkansas Valley coal field. Only four of these coal beds, the Lower Hartshorne, Upper Hartshorne, Charleston, and Paris, are considered to be of economic importance, and the estimates of reserves in this report are restricted to coal in these four beds. The Cavanal coal bed, which has been mined in Oklahoma, is reported to be 18 inches thick, locally, in western Arkansas but its reserves of coal were not computed. Mining of other thin coal beds provides a small amount of coal for local use. The production and reserves of these and the Cavanal coal bed are considered negligible. The location, extent, and thickness of most of these thin coal beds are shown on plate 61.

LOWER HARTSHORNE COAL BED

The Lower Hartshorne coal bed is the most extensive coal bed in Arkansas and has been the source of most of the coal produced in the State. It extends over an area of about 1,300 square miles and is more than 14 inches thick over an area of approximately 740 square miles (pl. 59). It is more than 8 feet thick in an area west of Huntington in Sebastian County. The rank of the Lower Hartshorne coal ranges from low-volatile bituminous in the western part of the Arkansas Valley coal field to semianthracite in the eastern part (pl. 59); however, most of the Lower Hartshorne coal is considered to be of low-volatile bituminous rank.

UPPER HARTSHORNE COAL BED

The Upper Hartshorne coal bed extends over an area of about 28 square miles and is more than 14 inches thick over an area of about 16 square miles (pl. 60). It has a maximum thickness of about 34 inches, and is considered to be a low-volatile bituminous coal.

CHARLESTON COAL BED

The Charleston coal bed extends over an area of about 120 square miles and is more than 14 inches thick over an area of approximately 52 square miles (pl. 60). It has a maximum thickness of about 23 inches. All of the Charleston coal in the western part of the Arkansas Valley coal field, where it is thicker than 14 inches, is considered to be of low-volatile bituminous rank. Some of the Charleston coal in the eastern part of the field, where it is less than 14 inches thick, may be semianthracite (pl. 60). The coal bed in Franklin and Johnson Counties that is known locally as the Philpott coal bed is considered

to be a part of the Charleston coal bed. The estimated original reserves of Philpott coal have been listed with the estimated original reserves of Charleston coal in table 1, but are identified by the coal-bed name of Charleston (Philpott).

PARIS COAL BED

The Paris coal bed underlies three small areas in Franklin and Logan Counties (pl. 60). It covers an aggregate area of 18 square miles and ranges in thickness from 14 to 32 inches. The Paris coal is considered to be of low-volatile bituminous rank.

PRODUCTION OF COAL IN THE ARKANSAS VALLEY COAL FIELD

Written reports on Arkansas coal date back to 1818, according to Winslow (1888, p. 27), and the existence of coal must have been known long before that. Coal was mined by manual methods from small wagon mines and strip mines prior to the construction of the steam-operated Old Spadra mine in Johnson County during 1870. Coal mining did not become economically important until 1873, when the Little Rock and Fort Smith Railroad reached the Coal Hill area in Johnson County. The production of coal increased approximately 100 percent in 1883 when the St. Louis and San Francisco Railroad reached the Hackett-Greenwood area in Sebastian County. Other coal-bearing areas in the Arkansas Valley coal field became commercially productive as railroad transportation became available.

The recorded tonnage of coal produced in Arkansas, as listed in table 7, includes indeterminate amounts of bituminous coal from White and Washington Counties and lignite from Ouachita County. Corrections to table 7 have not been made for this small amount of coal produced outside the Arkansas Valley coal field.

A blend of low- and high-volatile bituminous coal produces a coke of good quality and high yield per ton of coal. Because of the rapid expansion of the western steel industry in the postwar period, increasing quantities of low-volatile bituminous coal from Arkansas have been shipped to Colorado, Utah, California, and Texas for use in coking-coal blends. The amount of Arkansas coal shipped to coking plants, by State and year, is shown in table 8.

FUTURE OF COAL MINING IN THE ARKANSAS VALLEY COAL FIELD

The recorded production of coal mined in the Arkansas Valley coal field for the calendar year ending December 31, 1954, was 477,268 short tons, the lowest recorded production since 1890. The coal is used for steam generation, home heating, blacksmithing, and in steel mills and metallurgical plants. As more fuel oil, natural gas, and possibly atomic power become available, the amount of coal

TABLE 7.—*Recorded production of coal, in short tons, in the Arkansas Valley coal field, 1880–1954*

[Source of data for years 1880–1923: U.S. Geological Survey (1885, 1888–1918, 1921–23), except as noted; for years 1924–54: U.S. Bureau of Mines (1924–33, 1934–54), except as noted]

Year	County							State total
	Franklin	Johnson	Logan	Pope	Scott	Sebastian	Other counties and (or) small mines	
1880								14,778
1881								[1] 20,000
1882								[1] 25,000
1883								50,000
1884								75,000
1885								100,000
1886								125,000
1887		81,900		8,200		39,500		129,600
1888		106,037		10,240		160,594		276,871
1889	1,688	105,998		6,014		165,884		279,584
1890	[1] 3,000	89,000		4,000		300,888	[2] 3,000	399,888
1891	[1] 5,000	80,000		5,000		451,379	[2] 1,000	542,379
1892	[1] 7,000	91,960		17,500		420,098		536,558
1893	9,879	97,733		12,250		448,901	6,000	574,763
1894	147,728			17,788		341,110	6,000	512,626
1895	[3] 125,012	127,926		(4)		339,384	6,000	598,322
1896	115,380	[3] 107,331		(5)		446,663	6,000	675,374
1897	164,297	[3] 117,002		(5)		568,891	6,000	856,190
1898	[3] 328,412			(6)		871,067	6,000	1,205,479
1899	[2] 234,496		[1] 5,000	17,700		580,358	6,000	843,554
1900	[2] [3] 293,330	139,136	[1] 10,000	(4)		999,479	6,000	1,447,945
1901	[2] [3] 343,721	146,225	[1] 15,000	(4)		1,305,190	6,000	1,816,136
1902	338,013	193,258	21,751	34,966	[7] 30,763	1,325,181		1,943,932
1903	394,884	198,999	27,286	48,836	[8] 30,279	1,528,888		2,229,172
1904	408,494	217,667	35,300	51,488	[9] 61,708	1,234,794		2,009,451
1905	420,384	214,234	26,090	39,685	[9] 44,825	1,189,455		1,934,673
1906	[1] 330,000	[2] 159,434	26,647	34,776	[9] 34,914	1,278,497		1,864,268
1907	423,452	243,283	29,970	47,753	[9] 50,594	1,875,386		2,670,438
1908	203,312	197,683	30,723	35,481	(10)	1,580,778	[11] 30,380	2,078,357
1909	281,399	171,102	25,169	56,344	(10)	1,818,781	[11] 24,362	2,377,157
1910	296,725	133,365	15,492	13,240	(10)	1,425,347	[11] 21,789	1,905,958
1911	421,591	137,081	11,974	45,935	(10)	1,484,532	[11] 5,676	2,106,789
1912	373,314	192,326	15,272	64,216	(10)	1,454,128	[11] 1,563	2,100,819
1913	346,682	166,208	5,028	79,608	(10)	1,635,379	[11] 1,202	2,234,107
1914	168,746	148,845	7,172	75,938	(10)	1,423,202	[12] 12,637	1,836,540
1915	190,237	176,457	29,505	[9] 93,517		1,153,494	8,896	1,652,106
1916	243,118	243,774	42,128	[9] 103,773		1,352,402	9,720	1,994,915
1917	210,152	306,948	46,950	[13] 127,544		1,433,355	18,630	2,143,579
1918	240,149	371,704	49,368	112,692		1,447,268	6,188	2,227,369

1919	144,541	211,036	42,937	118,061		903,414	9,031	1,429,020
1920	278,450	257,517	66,636	[9] 126,528		1,321,465	53,000	2,103,596
1921	164,046	58,792	74,962	[9] 103,156		826,821		1,227,777
1922	168,564	132,331	59,861	[9] 32,599		692,691	24,000	1,110,046
1923	254,041	179,791	[14] 101,364	[14] 51,883	[2 9] 20,284	642,717	63,650	1,313,730
1924	229,404	290,952	159,519	[14] 62,059	[2] 6,383	[14] 737,588		1,485,905
1925	191,014	318,380	[14] 222,850	[14] 22,355	[2] 14,028	468,125		1,236,752
1926	[14] 229,969	337,141	[14] 224,081	57,945	[9] 14,428	600,559		1,464,123
1927	[14] 359,963	287,818	179,625	88,261		710,305		1,625,972
1928	[14] 286,988	298,008	[14] 212,789	104,329		792,021		1,694,135
1929	263,370	325,876	[14] 277,413	[14] 107,773	[2] 13,827	[14] 839,851		1,828,110
1930	226,737	262,759	318,567	96,809		628,562		1,533,434
1931	[14] 125,222	177,319	263,319	86,393		[14] 506,560	[14 15] 338	1,159,151
1932	[14] 155,023	136,245	[14] 232,577	[14] 54,961	[2] 15,038	[14] 451,350	[14 15] 100	1,045,294
1933	[14] 145,981	[14] 120,176	[14] 259,818	[14] 41,297	[14] 1,042	[14] 402,714	[14 16] 1,074	972,102
1934	[14] 162,195	94,262	283,815	[14] 47,033	[14] 607	322,908	[14 16] 248	911,068
1935	[14] 163,684	148,776	[14] 340,462	49,016	[14] 12	460,459	[14 16] 112	1,162,521
1936	191,273	228,941	466,718	62,520		673,335		1,622,787
1937	172,252	209,417	451,155	51,817		626,112		1,510,753
1938	158,703	154,766	396,433	38,675		448,470		1,197,047
1939	112,644	194,007	359,363	57,786		428,238		1,152,038
1940	125,469	184,506	448,564	85,321		609,751		1,453,611
1941	77,118	256,679	466,094	34,599		739,682		1,574,172
1942	[3] 152,027	304,386	572,680	[4]		956,300		1,985,393
1943	139,529	335,831	465,244			777,331		1,717,935
1944	162,309	435,131	419,865	59,127		896,009		1,972,441
1945	156,546	432,788	354,267	157,753		752,572		1,853,926
1946	161,144	344,210	310,650	61,299	153,345	600,826		1,631,474
1947	118,261	444,586	287,271	48,380	86,430	886,021		1,870,949
1948	140,924	406,821	259,918	57,613	84,825	712,086		1,662,187
1949	82,956	202,247	186,894	35,733		453,681		961,511
1950	68,298	485,103	185,882	41,666	70,000	318,119		1,169,068
1951	80,350	422,353	165,565	23,459		414,978		1,106,705
1952	18,393	330,270	108,163	13,246		403,016		873,088
1953	14,196	355,983	65,565			339,463		775,207
1954	[10]	213,406	[10]			226,907	[17] 36,955	477,268
Total	[18] 11,995,842	[18] 14,920,356	[18] 9,796,711	[18] 3,245,361	[18] 958,057	54,651,260	[18 19] 717,386	96,284,973

[1] Hendricks and Parks (1937, p. 204).
[2] U.S. Geological Survey or U.S. Bureau of Mines figure for two or more counties combined, minus Hendricks and Parks (1937) or Gibson (1936) figure for other county.
[3] Includes an indeterminate amount of bituminous coal from Pope County.
[4] Included with Franklin County.
[5] Included with Johnson County.
[6] Included with Franklin and Johnson Counties.
[7] Includes an indeterminate amount of lignite from Ouachita County.
[8] Includes an indeterminate amount of lignite from Ouachita County and bituminous coal from Perry County.
[9] Includes an indeterminate amount of bituminous coal from Washington County.
[10] Included with "Other counties and (or) small mines."
[11] Includes an indeterminate amount of bituminous coal from Scott and Washington Counties.
[12] Includes an indeterminate amount of lignite from Ouachita County and bituminous coal from Scott and Washington Counties.
[13] Includes an indeterminate amount of lignite from Ouachita County and bituminous coal from Washington County.
[14] Gibson (1936, table 9).
[15] White County.
[16] Washington County.
[17] Includes an indeterminate amount of bituminous coal from Franklin and Logan Counties.
[18] The county total includes a proportion, according to total production, of production reported as combined in some years for two or more counties.
[19] Includes total production for State for years 1880–86.

TABLE 8.—*Amount of Arkansas low-volatile bituminous coal used by the coking industry*

[In short tons. From U.S. Bureau of Mines (1943–52, and 1954)]

Year	State in which coal was used—							Total
	Alabama	California	Colorado	Illinois	Texas	Utah	Other States	
1943								
1944		38,662				2,626		41,288
1945		44,673	7,958	2,401		169		55,201
1946		34,566	60,140	674		54	175	95,609
1947		58,776	58,317	5,075	56,988	182		179,338
1948		57,455	120,706		64,072	147,761		389,994
1949	7,024	64,661	47,849	4,833	9,260		8,303	141,930
1950		81,557	173,370					254,927
1951		90,146	201,636			384		292,166
1952		62,529	174,279			270,491		507,299
1953		45,541	221,436			324,259		591,236
Total	7,024	578,566	1,065,691	12,983	130,320	745,926	8,478	2,548,988

mined will be dependent upon the requirements of the steel and metallurgical industries and upon the needs of small consumers. The demand by the steel and metallurgical industries of the United States for Arkansas coal was 591,236 short tons for the year ending December 31, 1953 (U.S. Bureau of Mines, 1954, p. 12, table 15).

RESERVES OF LIGNITE

The estimate of the lignite reserves in Arkansas was prepared on a basis of original reserves of lignite before mining. The original reserves of lignite in known deposits are estimated to be 32 million short tons. This estimated total pertains to known deposits of lignite thicker than 30 inches and under less than 100 feet of overburden. Lignite under more than 100 feet of overburden has been found in cores from core drilling and in rock cuttings from wells drilled for oil throughout much of the Gulf Coastal Plain. Therefore, an estimate of 32 million short tons in beds less than 100 feet below the surface probably represents less than 10 percent of the total reserves of lignite in Arkansas. On the basis of this assumption, the total reserves of lignite in Arkansas are tentatively estimated to be 350 million short tons. A more accurate estimate of the lignite reserves in Arkansas would be dependent upon data obtained by an intensive mapping and core-drilling program.

METHOD OF RECORDING DATA AND MAKING CALCULATIONS

The estimate of the lignite reserves in Arkansas was prepared by the following method. Thickness data pertaining to lignite deposits more than 30 inches thick and under less than 100 feet of overburden were plotted on a worksheet having State and county boundaries. Each lignite deposit represented by a thickness figure was assumed

to have an extent of 40 acres. The weight of the lignite was assumed to be 1,750 short tons per acre-foot. The thickness of the lignite, in feet, the weight per acre-foot of lignite, and the assumed acreage were multiplied together to produce an estimated tonnage for the lignite deposit. The estimated tonnages of lignite in all lignite deposits in each county were totaled (table 9).

The minimum lignite thickness of 30 inches and the weight of 1,750 short tons per acre-foot of lignite are standards adopted by the U.S. Geological Survey (Averitt, 1949, p. 226). The overburden limit of 100 feet is adopted by the author in order to present information about shallow reserves of lignite, which are of greatest current interest. The unit of 40 acres per lignite deposit is used in this report because the lignite is in lenticular beds that cannot be traced or correlated with any certainty over distances greater than half a mile.

TABLE 9.—*Estimated original reserves of lignite in deposits more than 30 inches thick and lying beneath less than 100 feet of overburden*

[In thousands of short tons]

County	Total	County	Total
Ashley	(1)	Greene	200
Bradley	300	Hot Spring	300
Calhoun	200	Nevada	400
Clark	300	Ouachita	5,200
Clay	(1)	Poinsett	700
Cleveland	200	Pulaski	12,500
Craighead	(1)	Saline	6,500
Cross	(1)		
Dallas	4,900	Total	32,000
Grant	300		

[1] Incomplete thickness data, or lignite less than 30 in. thick.

COMPARISON OF PAST AND PRESENT ESTIMATES

The first estimate of the reserves of lignite in Arkansas was made by Taff (1900, p. 325), who estimated that a single township in Ouachita County contained more than 75 million short tons of lignite. Taff made his estimate on the assumption that the lignite beds were of continous extent and thickness. In all probability, Taff's assumption of continuity is erroneous because the lignite beds are abruptly lenticular elsewhere in the Gulf Coastal Plain of Arkansas. Campbell (1908) estimated the reserves of lignite in Arkansas to be 90 million short tons. Subsequent authors (Hendricks, 1939, p. 283, table 3, and Averitt, Berryhill, and Taylor, 1953, p. 4, table 1) have quoted Campbell's estimate. The estimate of 32 million short tons in beds less than 100 feet below the surface and the tentative estimate of 350 million short tons for total reserves are a more useful and accurate pair of figures than the single figure previously available.

GEOLOGY OF THE LIGNITE DEPOSITS

Rocks containing lignite are exposed in an area of about 6,125 square miles in the Gulf Coastal Plain of Arkansas (pls. 58 and 64). From oldest to youngest, these rocks are the Tokio formation of Cretaceous age, and the Wilcox group, the Claiborne group, and the Jackson formation of Eocene age. These rocks contain numerous beds of lignite ranging in thickness from a fraction of a foot to more than 22 feet. Beds of lignite are more abundant and generally thicker in the Wilcox group.

STRATIGRAPHY

TOKIO FORMATION

The Tokio formation has a maximum thickness of about 350 feet and consists of beds of sand, clay, clay containing fragments of lignite, and one reported bed of lignite (Dane, 1929, p. 177). The formation is exposed in Sevier, Howard, Hempstead, Pike, and Clark Counties (pl. 64). The extent and thickness of the lignite bed is not recorded.

WILCOX GROUP

The Wilcox group, about 650 feet thick, consists of beds of gravel, sand, clay, sand containing fragments of lignite, clay containing fragments of lignite, and beds of lignite. The Wilcox is exposed in 11 counties in southern Arkansas and in 4 counties in northeastern Arkansas (pl. 64). Lenticular beds of lignite and lignitized plant fragments are present throughout the Wilcox group, but most of the lignite beds are in the lower and middle parts of the group. The beds of lignite are lenticular and cannot be traced by surface or subsurface methods over a distance greater than half a mile. Thickness measurements of as much as 22 feet have been recorded for some of the lignite beds in the Wilcox group.

CLAIBORNE GROUP

The Claiborne group ranges in thickness from 500 to 700 feet and consists of beds of sand, clay, clay containing fragments of lignite, and lenticular beds of lignite. The Claiborne group is exposed in 12 counties in southern Arkansas and in 2 counties in northeastern Arkansas (pl. 64). The lignite beds attain a thickness of 6 feet in Ouachita County, but generally they are thin and of small extent.

JACKSON FORMATION

The Jackson formation ranges in thickness from 100 to 700 feet and consists of beds of clay, limy clay, marl, and a few thin beds of lignite. The formation is exposed in 6 counties in southeastern Arkansas (pl. 64). The lignite beds are thin and of small extent.

STRUCTURE

The strata in the Gulf Coastal Plain of Arkansas have a regional dip of about 5°S. or SE. Normal faults are present in Miller, Lafayette, Columbia, Nevada, Ouachita, and Union Counties. Broad anticlines and shallow synclines interrupt the regional dip in some areas.

LIGNITE

Lenticular beds of lignite and fragments of lignitized tree limbs, trunks, and stumps are present at many different stratigraphic positions in the Wilcox and Claiborne groups. However, most of the lignite beds are in the lower and middle parts of the Wilcox group. The extent of the beds of lignite is difficult to determine but it is probable that any one bed does not extend over an area of more than 2 square miles.

The lignite is dark brown to brownish black and, where free of impurities, massively bedded. It is soft but tough, and breaks with a conchoidal fracture. When exposed to weathering, the lignite turns black and tends to crack irregularly from the surface inward. An average of the proximate analyses of 14 lignite samples, on an "as received basis" (Selvig and others, 1950, p. 22–23, table 2), is as follows: moisture, 39.1 percent; volatile matter, 30.2 percent; fixed carbon, 21.1 percent; and ash, 8.6 percent. An analysis of the chemical and physical properties of representative samples of extractable material (principally montan wax) from Arkansas lignite is listed in table 10. The properties of samples of three commerical grades of montan wax are included in table 10 for comparison.

PRODUCTION OF LIGNITE IN ARKANSAS

Lignite has been mined intermittently in Ouachita County since the early part of the 19th century. Originally, the lignite was mined as fuel for sawmills, cotton gins, steam locomotives, and steam generating plants. The lignite was reported to yield from 10 to 38 gallons of oil per ton when processed in oil-distilling plants (White and Thiessen, 1913, p. 18). Lignite as a solid fuel was replaced by natural gas and petroleum by 1900, when the liquid product of the lignite distilling plants could not match the low cost of the petroleum. Only that amount of lignite needed locally for fuel was mined from about 1910 to 1938. From 1938 to 1945 a processing plant used Arkansas lignite as a source of "Vandyke brown," a type of dye. The amount of lignite used in this plant is unknown but the total over those years probably was less than 10,000 short tons.

Data pertaining to the amount of lignite mined in Arkansas are incomplete, but total cumulative production is estimated to be less than 100,000 short tons.

TABLE 10.—*Physical and chemical properties of extractable products obtained from lignite in Arkansas by benzene and benzene-alcohol extraction, and comparison with commercial-grade montan wax*

[Symbols: B, benzene method of extraction; B-A, benzene-alcohol method of extraction. After Selvig and others (1950, p. 34)]

Laboratory No.	Source of lignite		Commercial grade wax	Extract (including "resin" and "asphaltic material")									
				Yield of extract, air-dried coal basis (percent)		Melting point (°C.)		Acid value		Saponification value		Ester value	
	County	Locality		B	B-A	B	B-A	B	B-A	B	B-A	B	B-A
45738	Dallas	American Dyewood Co., mine		7.8	12.0	80–83	96–103	40	69	87	121	47	52
46084	Hot Spring	Outcrop		9.5	14.9	78–82	91–95	39	62	90	122	51	60
46085	do	do		11.1	16.4	78–82	92–96	38	61	89	121	51	60
46088	Ouachita	Garner mine		6.3	10.4	81–84	90–94	36	63	82	118	46	55
45737	do	Old Big House mine		6.7	10.2	80–82	86–90	38	59	79	106	41	47
46089	do	Prospect pit		6.9	11.7	80–82	92–96	36	62	78	113	42	51
46234	Poinsett	Outcrop		7.6	11.6	78–81	82–86	39	65	81	113	42	48
46087	Saline	do		5.7	9.6	81–85	93–97	36	66	83	126	47	60
46086	do	Prospect pit		9.4	14.4	79–83	88–92	37	58	95	123	58	65
46036			Crude montan wax (not deresinified).			81–85		27		95		68	
46037			Deresinified montan wax			82–86		24		103		79	
45846			Czechoslovakian montan wax			73–75		36		89		53	

Laboratory No.	Extract (including "resin" and "asphaltic material")				"Resin" (percent)								"Asphaltic material" (percent)	
	Ash (percent)		Specific gravity at 20°C.		Benzene-alcohol solubility		Ethyl ether solubility		Ethyl acetate solubility		Ethyl alcohol solubility			
	B	B–A	B	B–A	B	B–A	B	B–A	B	B–A	B	B–A	B	B–A
45738	0.2	0.2	1.07	1.09	74	97	68	60	56	54	51	55	7	31
46084	.1	.2					60	51						
46085	.1	.2	1.05	1.08			59	52						
46088	.1	.2					60	53						
45737	.2	.3	1.05	1.08	71	94	68	60	57	55	49	50	7	31
46089	.1	.1					68	58						
46234	.2	.3	1.05	1.09			60	48						
46087	.1	.1					63	53						
46086	.1	.1					45	41						
46036	0.3		1.03		28		23				21		3	
46037	.4		1.04		19		14							
45846	.4		1.06		45		45				43		5	

FUTURE OF LIGNITE MINING IN ARKANSAS

The lenticular nature and small extent of the individual lignite beds in Arkansas prohibit the large-scale mining necessary to meet the demands of large steam-generating plants or heavy industry. Therefore, the amount of lignite produced in Arkansas in the future will probably depend upon the requirements of small processing plants using the lignite as a source of "Vandyke brown," montan wax, basic chemical compounds used in making plastics, and possibly such rare elements as vanadium, cobalt, nickel, gallium, and germanium.

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