Bureau of Mines
Report of Investigations 5159

ESTIMATE OF KNOWN RECOVERABLE RESERVES AND THE PREPARATION AND CARBONIZING PROPERTIES OF COKING COAL IN MARION COUNTY, TENN.

BY LLOYD WILLIAMS, R. E. HERSHEY, AND B. W. GANDRUD

United States Department of the Interior — October 1955

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UNITED STATES DEPARTMENT OF THE INTERIOR
Douglas McKay, Secretary
BUREAU OF MINES
J. J. Forbes, Director

October 1955

FOREWORD

Since its creation by Congress in 1910, the Bureau of Mines has borne a heavy responsibility for technical progress in the mining, preparation, and utilization of our national fuel reserves. Similarly, it has pioneered in scientific studies leading to better health and safety in mining and more efficient conservation of fuel resources.

Conservation means a full but prudent use of the national resources with avoidance of waste. Conservation requires an inventory to determine the extent, availability, and condition of our resources, for without these facts it is impossible for either industry or Government to plan for sustained production and maintenance of the industrial capacity so essential for our peacetime prosperity and wartime survival. This is true particularly of fuels needed for special purposes, such as metallurgical coking coals that must possess certain favorable properties. Heavy use of our limited reserves of good coking coal has resulted in severe depletion and, in some areas, exhaustion of the thickest and best beds.

At the request of the Munitions Board, Department of Defense, the Bureau of Mines made preliminary arrangements early in 1948 for an investigation of known minable reserves of coal that were or could be made suitable for the manufacture of metallurgical coke. In August of that year, actual field work began in the low- and medium-volatile coking coal fields of the Appalachian region, specifically central Pennsylvania and southern West Virginia. As both the economic and technologic factors that determine whether a particular coal can be used for producing metallurgical coke will vary with changing conditions, the investigation was planned to cover three phases:

1. Determination, from available data, of coal reserves with coking properties that occur in beds thick enough and within depths considered economically minable by present methods, together with such additional reserves as may become economically minable under future conditions of improved technology and greater need.

2. Study of the preparation characteristics of the reserves thereby developed to determine (a) which coals are suitable under present standards for producing metallurgical coke either as mined or after beneficiation by conventional preparation methods, and (b) which coals would require special and more intensive treatment in mining, preparation, or both.

3. Study of the carbonizing properties of the reserves thus developed to determine the yield and quality of coke, gas, and chemical products that can be obtained from coals carbonized singly and in blends.

This report is one in a series, by counties, covering in detail the estimated known minable coking-coal reserves determined under the first phase of the investigation. It also includes the study, as determined under the second and third phases of the investigation, of the preparation and carbonizing properties of the most important beds and a table of analyses of typical coals from the county.

The estimates of coking-coal reserves in these reports were derived from data made available to the Bureau of Mines by coal companies, landowners, Federal, State, and municipal engineers, geologists, land-record officials, and others having authentic records of the occurrence and characteristics of the coal in the respective counties. All of the data were assembled from mine maps, records of core drilling, test pitting and tranching, and related sources of information, for no new core-drilling or geologic exploration was undertaken. Consequently, there are areas covered by these reports wherein the known data now available are inadequate to estimate reserves of measured and indicated coal, as these are defined in the reports. Geologic data also may indicate the presence of large reserves of inferred coal in these areas, but no estimates of inferred reserves are presented in these reports. As their titles indicate, they include only known, minable reserves of measured and indicated coal and <u>not</u> total estimated reserves of coal. Therefore, any comparison of these and other coal-reserve estimates should be made with this distinction clearly understood.

The percentage recovery shown in these reports is a weighted average, based on the thickness of clean coal, less all partings 3/8-inch or more thick, recovered from the mined-out areas in each bed. Thus, it is an overall net areal percentage recovery that, in many cases, will be lower than the recovery estimated by operators who eliminate from their calculations coal pillars left at property boundaries, under roads, and elsewhere. It is based on all coal removed since the beginning of mining operations and therefore may vary from that of recent operations in which recovery either has been improved substantially by technologic advances or has declined, owing to flooding or other conditions that make it expedient to leave more coal in the ground. As the estimates are dated and represent a factual record of all past operations in the particular area, the percentage recovery and estimate of minable coal may be adjusted by operators to suit their particular conditions at any given time.

This investigation was made possible only through the complete cooperation of the coal operators, landowners, and others who have made available to the Bureau their confidential records and data relating to mining operations, drill-core and test-pit operations, etc. This cooperation and assistance is appreciated and is gratefully acknowledged. To protect the confidence of data from private records, the Bureau of Mines is assembling and publishing the estimates on a countywide basis only and will not release any supplementary or more detailed information.

This investigation will serve a triple purpose:

1. By providing an inventory of known, minable reserves of coking coal that are or can be made suitable for the manufacture of metallurgical coke.

2. By providing an inventory of known minable reserves of coal with coking properties but unsuited for metallurgical coking-coal use by present standards and

techniques because of high sulfur, high ash, or weakly coking properties. When warranted by economic and technologic developments, these reserves later may be adapted to metallurgical use by suitable preparation, blending, carbonizing, or metallurgical techniques.

3. By ascertaining the approximate location and magnitude of areas in which geologic data indicate the presence of inferred reserves but where exploratory work has been too limited to determine measured and indicated reserves. It is in these areas that more intensive exploratory work is needed in the future to complete the coking-coal inventory.

The first of these objectives is of prime importance for the present and immediate future, and the second for the more distant future. Accomplishment of the third objective will be of major aid to both industry and State and Federal agencies in more effectively planning and executing coal exploratory and testing investigations.

RALPH L. BROWN
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ESTIMATE OF KNOWN RECOVERABLE RESERVES AND THE PREPARATION AND CARBONIZING PROPERTIES OF COKING COAL IN MARION COUNTY, TENN.

by

Lloyd Williams,[1/] R. E. Hershey,[2/] and B. W. Gandrud[3/]

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CONCLUSIONS

Reserves

1. The investigation shows that the Sewanee bed is the only bed of major importance in Marion County, 97 percent of the coal mined in the county having come from this bed. There are coal reserves in minor quantity in the Battle Creek bed, and production from this bed depends on a few small truck mines. The Richland bed, or Lower Sewanee, has been mined in the past, but no coal has been produced from it in late years. There are no production records of any other beds in the county, although some coal has been produced from them.

2. Known measured and indicated reserves in all beds, based on a minimum thickness of 14 inches and on 1,800 tons per acre-foot of coal in place, are estimated to be 61 million short tons as of January 1, 1953. Of this total, 55 million short tons is in beds 28 inches and more thick. Areas in each bed were omitted from the estimate where available data relative to the bed characteristics are too meager to permit making an estimate that conforms with the definitions of measured and indicated coal adopted for this study. Should future drilling or development prove reserves in these areas, such reserves should be added to the total estimated reserves.

3. Recoverable reserves of coal are estimated in beds 28 inches and more thick. This recovery is based on total thickness of coal in the bed (less partings 3/8-inch thick or more), rather than on the thickness of the coal actually mined. This thickness is about the minimum now being mined by hand loading onto conveyors in the Appalachian Region. The combined weighted average recovery for the Sewanee and Battle Creek beds in Marion County, as determined by this investigation, is 60.9 percent. Based on this, the recoverable reserves of coal in Marion County are estimated at 34 million tons.

Coal Analyses

Analyses of 22 samples from the Sewanee and Battle Creek beds have been tabulated. The analyses show that the coal from these two beds is of the high-volatile A bituminous rank. The most significant feature of the analyses is that all samples in the northern part of the county from Whitwell north and northwest to the Grundy and Sequatchie County lines show a low sulfur content. This is the area in which nearly all of the remaining coal reserves of Marion County occur. In other parts of the county, the samples show, in general, a much higher sulfur content.

Preparation

Crushing, screening, and float-and-sink tests were made on 2 mine-run tipple samples and 1 mine sample from the Sewanee bed and 1 mine-run tipple sample from the Battle Creek bed. One of the mine-run samples from the Sewanee bed analyzed only 0.7 percent sulfur and its ash analysis was 9.0 percent. Consequently, there would be no sulfur problem in connection with the preparation of this coal for use in making metallurgical coke, and the 9.0 percent ash content is low enough so that this run-of-mine coal would, in most cases, be acceptable as metallurgical coking coal without any preliminary cleaning or preparation. The crushing and float-and-sink tests showed that the ash-forming impurities in this coal are mostly inherent rather than extraneous. The separations at 1.60 specific-gravity gave float products that analyzed 8.8, 8.3, and 8.4 percent ash, respectively, for samples crushed to 1-1/2-inch, 3/8-inch, and 14-mesh. In separations at 1.40 specific gravity, the corresponding ash analyses were 8.4, 7.4, and 6.9 percent. This indicates that there would be little to gain by trying to wash this coal at a specific gravity lower than 1.60 or by crushing it to size finer than 1-1/2-inch before washing. Washing the coal at a specific gravity of 1.60, however, should give a very satisfactory metallurgical coal from the standpoint of ash and sulfur analyses. The other two preparation samples from the Sewanee bed were of the high-sulfur type. The crushing and float-and-sink tests showed that no available commercial process would give a chemically satisfactory grade of metallurgical coking coal from the one with the highest sulfur analysis. Coal represented by the other sample could, after crushing to a top size of 14-mesh, be made to yield a product of satisfactory grade, chemically, for making metallurgical coke, but the treatment involved would be expensive and not economically feasible at present. The analytical, crushing, and float-and-sink data assembled for this report indicate that the potential sources of coking coal in the Sewanee bed in Marion County are confined almost entirely to the general area around Whitwell and north-northwest to the Grundy and Sequatchie County lines.

The tipple sample from the mine in the Battle Creek bed analyzed 16.1 percent ash and 2.20 percent sulfur. Crushing and float-and-sink tests on this sample showed that, although conventional methods of washing would reduce the ash to about 10 percent, the sulfur was so finely disseminated throughout the coal that no commercial preparation process now available would reduce this impurity to an acceptable value for metallurgical coking coal.

Carbonization

Sewanee coal from the Reels Cove mine yielded coke with physical properties satisfactory for metallurgical use. The sample expanded 5.8 percent in the sole-heated oven test, and caution should be used in its commercial carbonization. However, with its high coke strength indexes, this coal could be carbonized singly as well as in blends.

INTRODUCTION

The investigation to evaluate the reserves of coking coal is being made by the Bureau of Mines in three parts: (1) To estimate known (measured and indicated) recoverable reserves of all coking coal, (2) to study upgrading of marginal coals through effective preparation, and (3) to study the carbonizing properties of coals and coal blends not now widely used for metallurgical coke making.

This is the 23d of a series of reports giving the results of studies, by counties, of known minable reserves of coking coal (see Appendix). This report covers Marion County, Tenn., one of the counties in the southern part of the Tennessee coal field. It is the third report from Tennessee. All three phases of the investigation are covered in this report.

Marion County comprises all of Orme, Whitwell, South Pittsburg, and Sequatchie 7-1/2-minute quadrangles and parts of Monteagle, Doran Cove, Tracy City, Palmer, White City, Bridgeport, Shellmound, Daus, Ketner Gap, Wauhatchie, Chattanooga, and Hooker quadrangles. (See fig. 1.) Data on the coal beds in this county were obtained by personal reconnaissance and from landowners, mine operators, State agencies, and other authentic sources of information. Samples used for analyses, preparation, and carbonization studies were obtained from commercial operations in Marion County.

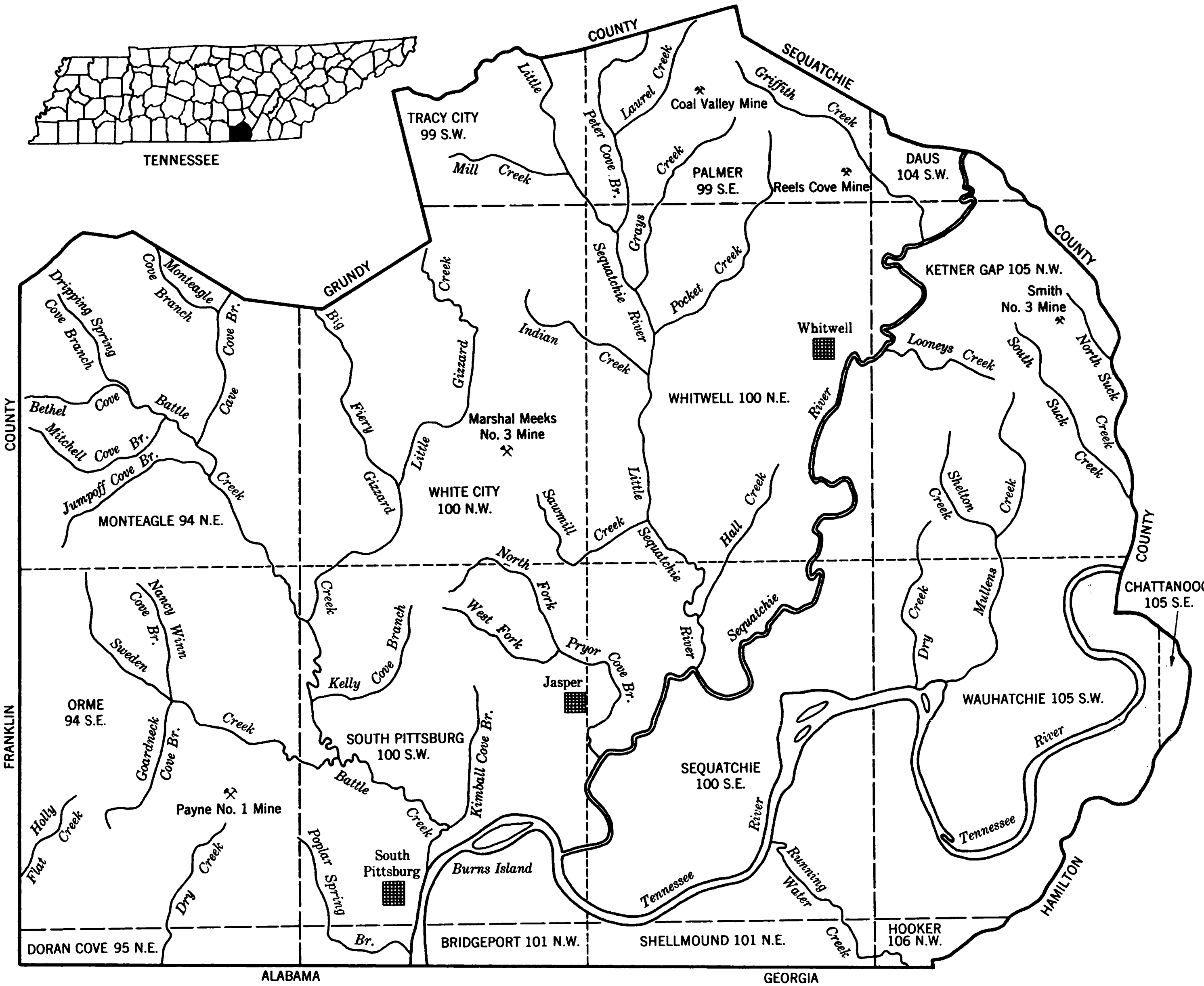

Figure 1. - Key map of Marion County, Tenn.

ACKNOWLEDGMENTS

The information contained in this report could not have been obtained without the wholehearted cooperation of the officials of the companies and individual landowners whose property records were studied, and their cooperation and courtesies extended are gratefully acknowledged. The advice and assistance of the Coal Resources Committees of both the National Bituminous Coal Advisory Council and American Institute of Mining and Metallurgical Engineers, members of the staffs of the Tennessee Division of Mines and the Tennessee Division of Geology, and consulting mining engineers are appreciated. The assistance and cooperation of the State geologist, William D. Hardeman, in this investigation has been particularly helpful and are sincerely appreciated.

The Tennessee Valley Authority, through R. A. Kampmeier, assistant manager of power, and Jack London, chief, Fuel Engineering Section, have made a major contribution to the conduct of this investigation, and their cooperation and assistance are gratefully acknowledged.

PART I - ESTIMATION OF KNOWN RECOVERABLE RESERVES

by

Lloyd Williams and Robert E. Hershey

Premises and Definitions of Terms Used

An estimate of coal reserves is the opinion of an individual or group of individuals based on certain premises and limitations adopted for that estimate. Therefore, to compare estimates, it is necessary to compare not only the final results but also the premises on which the estimates are based. The definitions "measured" coal and "indicated" coal used in this report have been agreed upon by the Federal Bureau of Mines and the Federal Geological Survey. The premises and definitions of terms follow:

Coking Coal. - All bituminous coals in the Appalachian region are potentially coking. All known reserves of coal in the county are considered as coking coal in preparing the reserve estimates. The results of this survey establish the coking qualities of the coal. The possibilities of using these coals for metallurgical coke-making are discussed in the preparation and carbonization portions of this report.

Unit area. - The unit area used in estimating reserves is the 15-minute topographic quadrangle. All unit area estimates within the county are combined to give the county total estimates.

Bed-thickness range. - Reserves in each coal bed are tabulated in bed-thickness ranges, as follows:

14 to 28 inches,
28 to 42 inches,
42 inches and more.

These measurements represent total bed thickness, including all coal and partings in the bed. If the top or bottom bench of a coal bed is separated from the remainder of the bed by a parting of equal or greater thickness and usually is not mined, such bench and partings are omitted in determining the bed thickness.

Measured coal. - Measured coal is coal for which tonnage is computed from dimensions revealed in outcrops, mine workings, and drill holes. The points of observation and measurement are so closely spaced, and the thickness and extent of the coal are so well defined that the computed tonnage is judged to be accurate within 20 percent or less of the true tonnage. Although spacing of the points of observation necessary to demonstrate continuity of coal will vary in different regions according to the habit of the coal beds, the points of observation are, in general, about one-half mile apart. The outer limit of a block of measured coal, therefore, shall be about one-fourth mile from the last point of positive information (that is, roughly one-half the distance between points of observation).

Where no data are available other than measurements along the outcrop, but where the continuity of the outcrop is measured in miles and suggests the presence of coal at great distances in from the outcrop, a smooth line drawn roughly one-half mile in from the outcrop shall be used to mark the limit under cover of a block of coal that can also be classed as measured.

Indicated coal. - Indicated coal is coal for which tonnage is computed partly from specific measurements and partly from projection of visible data for a reasonable distance on geologic evidence. In general, the points of observation are about 1 mile apart but may be as much as 1-1/2 miles for beds of known geologic continuity. For example, if drilling on 1/2-mile centers has proved a block of measured coal of fairly uniform thickness and extent, the area of measured coal, according to the judgment of the estimator, is larger than the actual area of drilling by as much as 1/4 mile on all sides. If, from geologic evidence, the bed is believed to have greater continuity, the area of measured coal is surrounded by a belt of indicated coal, which, according to the judgment of the appraiser, may be as much as 1-1/2 miles wide.

Where no data are available, other than measurements along the outcrops, but where the continuity of the outcrop is measured in miles and suggests the presence of coal at great distances in from the outcrop, two lines drawn roughly parallel to the outcrop, one 1/2 mile in from the outcrop and one 2 miles in from the outcrop, define a block of coal that may be classed as indicated.

Inferred coal. - As no estimate of reserves has been made from geologic inference alone, inferred coal is not included in this report.

Areas excluded from estimate. - In each bed are areas in which coal may be present but for which reserves have not been estimated. There are too few or no bed sections from drill holes, mine workings, or coal outcrops in the area on which to base estimates that would qualify under the definitions of "measured" or "indicated" reserves. These areas correspond approximately to areas of inferred reserves and frequently contain significant quantities of coal.

Overburden. - This includes all of the material that overlies the coal bed. All known reserves in Marion County are under less than 700 feet of overburden.

Thickness of coal. - In computing the volume of reserves in each thickness category for each bed, the total thickness of clean coal in the bed section is used. If the top or bottom bench of coal described under definition of "bed thickness range" usually is not mined, the thickness of the bench is not used in computing volume of reserves. A weighted average thickness, in each thickness category, is computed to be used for limited areas, not to exceed a 7-1/2-minute quadrangle.

Weight of coal. - Estimated coal in place is based on 1,800 short tons per acre-foot.

Percentage of recovery. - The weighted average percentage of recovery usually is computed for each bed in each 15-minute quadrangle. The total number of tons of coal produced from each mine is obtained from either the mine operator or the published reports of the Tennessee Division of Mines. An estimate is made of the tons of coal originally in place in the mined-out area of each mine. The percentage of recovery for each mine is the ratio of the total number of tons produced from a mine (to January 1, 1953, the date of this estimate) to the total tons originally in place in the mined-out area. The weighted average percentage of recovery for all mines in the same bed in a 15-minute quadrangle (for this report) is the percentage of recovery used in calculating recoverable reserves for that bed in the quadrangle.

All coal remaining for any reason within the mined-out area of a mine is considered a loss. No distinction is made between avoidable or unavoidable losses. Included in these losses is some coal considered too thin to mine, also coal that legally is required to be left unmined, such as coal under some highways, railroads, and rivers; coal left to protect gas and oil wells; and coal left in barrier pillars between mines and adjacent to property boundaries.

Recoverable reserves. - The recoverable reserves are estimated tons of unmined coal in beds 28 inches and more thick, as of the date of the estimate, multiplied by the percentage of recovery. Twenty-eight inches is about the minimum thickness of coal being mined by handloading onto conveyors. Certain areas in some of the beds in this county are not economically minable at present because of conditions considered adverse today.

Methods Used to Compute Reserves

A base map for each coal bed in each 15-minute quadrangle was prepared to scale 1 inch equals 2,000 feet. This scale was adopted as it is the scale of the Tennessee Valley Authority 7-1/2-minute quadrangles, which are the latest topographic maps available for all of Marion County. A 15-minute quadrangle is composed of four 7-1/2-minute quadrangles, each covering an area 7-1/2 minutes of longitude by 7-1/2 minutes of latitude. The 15-minute quadrangles are identified by number; the corresponding 7-1/2-minute quadrangles are identified by directional quarter of the 15-minute quadrangle number. The 7-1/2-minute quadrangles are also identified by name.4/ Names for the 15-minute quadrangles are available only on special Federal Geological Survey index maps for administrative planning. The key map is divided into 7-1/2-minute quadrangles (see fig. 1), which are identified by the directional quarter of the 15-minute quadrangle number and the 7-1/2-minute quadrangle name.

The coal-bearing areas in Marion County comprise parts of the following 15-minute quadrangle areas with the corresponding 7-1/2-minute quadrangles.

15-minute area No.	Name	7-1/2-minute quadrangle names
94	Monteagle	Monteagle, Orme
95	Fackler	Doran Cove
99	Altamont	Tracy City, Palmer
100	Jasper	White City, Whitwell, South Pittsburg, Sequatchie
101	Long Island	Bridgeport, Shellmound
104	Dunlap	Daus
105	Lookout Mtn.	Ketner Gap, Wauhatchie, Chattanooga
106	Rossville	Hooker

Mine workings, locations of drill holes, outcrop and thicknesses of bed, and total clean coal thicknesses were plotted on the base maps. Isopach lines were then drawn to limit areas of known unmined reserves in beds up to 14 inches thick, 14 to 28 inches thick, 28 to 42 inches thick, and over 42 inches thick. These areas of coal reserves also were divided into measured and indicated categories. All areas in each thickness range and in each category, mined-out areas, areas excluded from the estimate but which may contain reserves based only on geologic inference, and areas outside the outcrop were measured by planimeter on the base maps. These areas were adjusted to conform to the theoretical area based on Federal Coast and

4/ Index to topographic mapping in Tennessee, Geological Survey.

Geodetic Survey data for each quadrangle. Estimates of total reserves 14 inches and more thick for individual beds were prepared from these data. In Marion County, pillars have not been recovered generally; therefore, in most areas shown as "mined out" there are still reserves in pillars that have not been included in the tabulations.

Description of Coal Measures

Marion County, Tenn., is in the extreme southern part of the Tennessee coal field and adjacent to Alabama and Georgia. The coal measures are divided into two parts by the Sequatchie Valley, which cuts through the entire county in a northeasterly direction. The vast majority of the estimated reserves underlie the plateau west of the valley. The coal measures in this county are in the Lee group of the Lower Pottsville series of the Pennsylvanian system. The known coal beds from the uppermost bed in descending order are: Sewanee (or Main Sewanee, or Oak Hill), Richland (or Lower Sewanee, Coke Oven, Kelley, or #7 Seam), Angel, Battle Creek (or Aetna or Nelson), Goodrich, Dade, Rattlesnake, and Sale Creek (see fig. 2). The Richland coal bed has been mined in only one isolated area in the southeastern corner of Marion County. In this area the bed is known as the Kelley coal bed. About 1,200 acres have been mined, including both underground and strip mining. There was not enough information available to indicate any minable coal in the Richland bed; nevertheless, the bed is a persistent coal horizon approximately coextensive with the Sewanee coal bed. The geology and coal beds are more completely described in other publications.5 6/

Sewanee Bed (See fig. 3 and table 1)

The Sewanee coal bed is in the Whitwell shale and is 40 to 50 feet above the hard massive Sewanee conglomerate. (See fig. 2.) The Sewanee conglomerate forms a prominent bench, in some areas, with the overlying shale rising in a gentle slope. There has been some strip mining in these areas. The coal bed usually has a clay bottom and a shale top; however, in some areas the shale top has been replaced by a dense, fine-grained sandstone. The Sewanee coal bed is a widespread coal horizon, but being higher in the rock section it is more limited in area than the Battle Creek coal bed owing to postdepositional erosion. The largest area underlain by the Sewanee coal bed is west of the Sequatchie Valley near Whitwell, Tenn. The Sewanee coal bed is about 400 feet higher on the eastern side of the Sequatchie Valley as a result of being on the upthrust side of a fault from the southeast that coincides with the Sequatchie Valley. The coal bed is relatively uniform in thickness west of the valley. Small scattered areas of Sewanee coal occur some distance from the Sequatchie Valley as erosional remnants. The Oak Hill coal bed, which is mined in the southeastern margin of the county, has been correlated with the Sewanee coal bed by the Tennessee Division of Geology. This correlation was used in estimating reserves for the Sewanee bed. The bed generally is clean but sometimes has one or two thin partings.

Most of the recoverable reserves are in the northern part of the county, but there are some in the southeastern part of the county. The sample taken from the Marshal Meeks No. 3 mine for preparation study was 37-3/4 inches thick. This bed section and others follow:

5/ Nelson, W. A., The Southern Tennessee Coal Field: Tennessee Division of Geology Bull. 33A, 1925, 239 pp.

6/ Wanless, H. R., Pennsylvanian Geology of a Part of the Southern Appalachian Coal Field: Geological Society of America, Mem. 13, 1946, 155 pp.

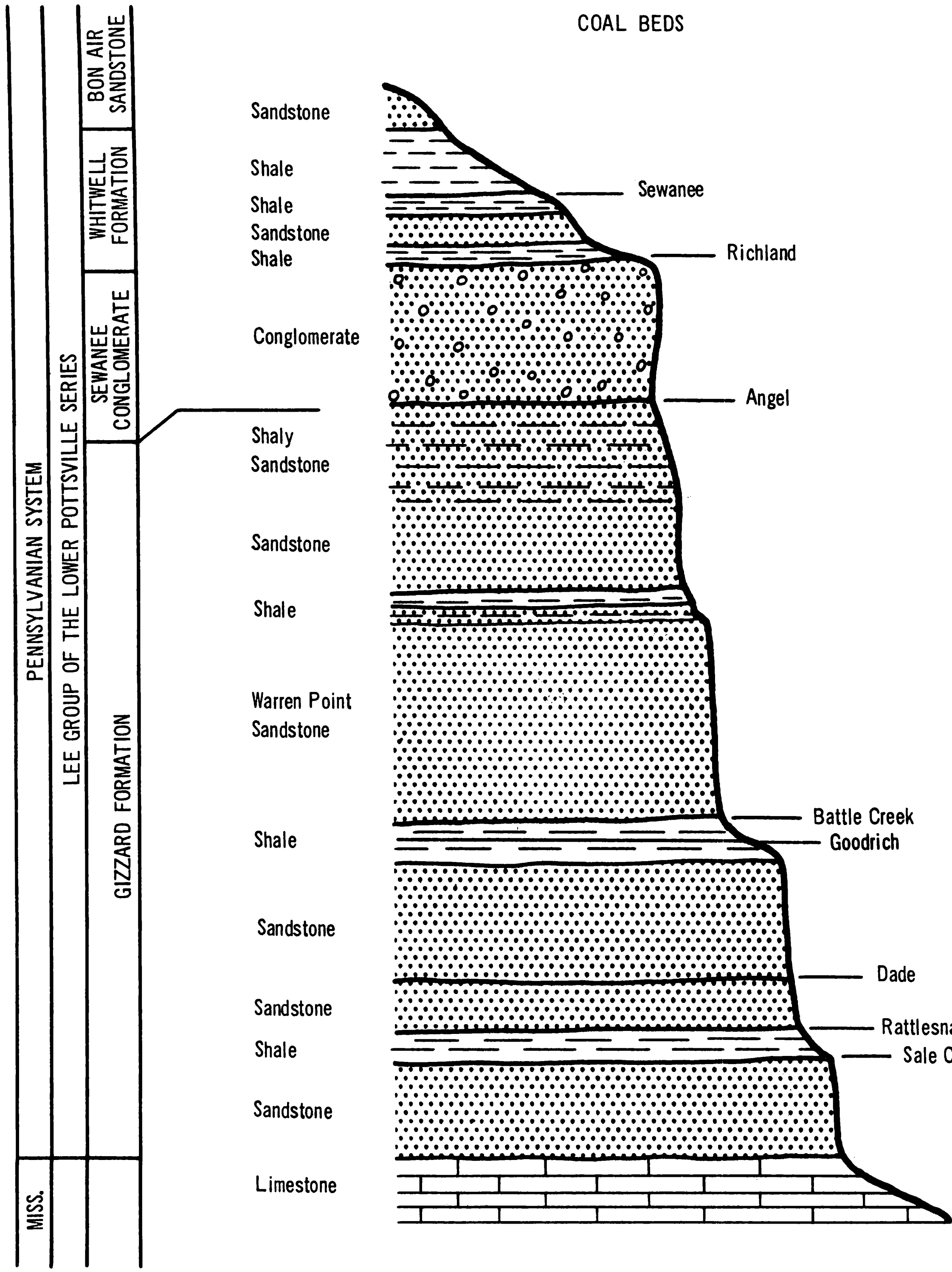

Figure 2. - Composite section of coal measures in Marion County, Tenn.

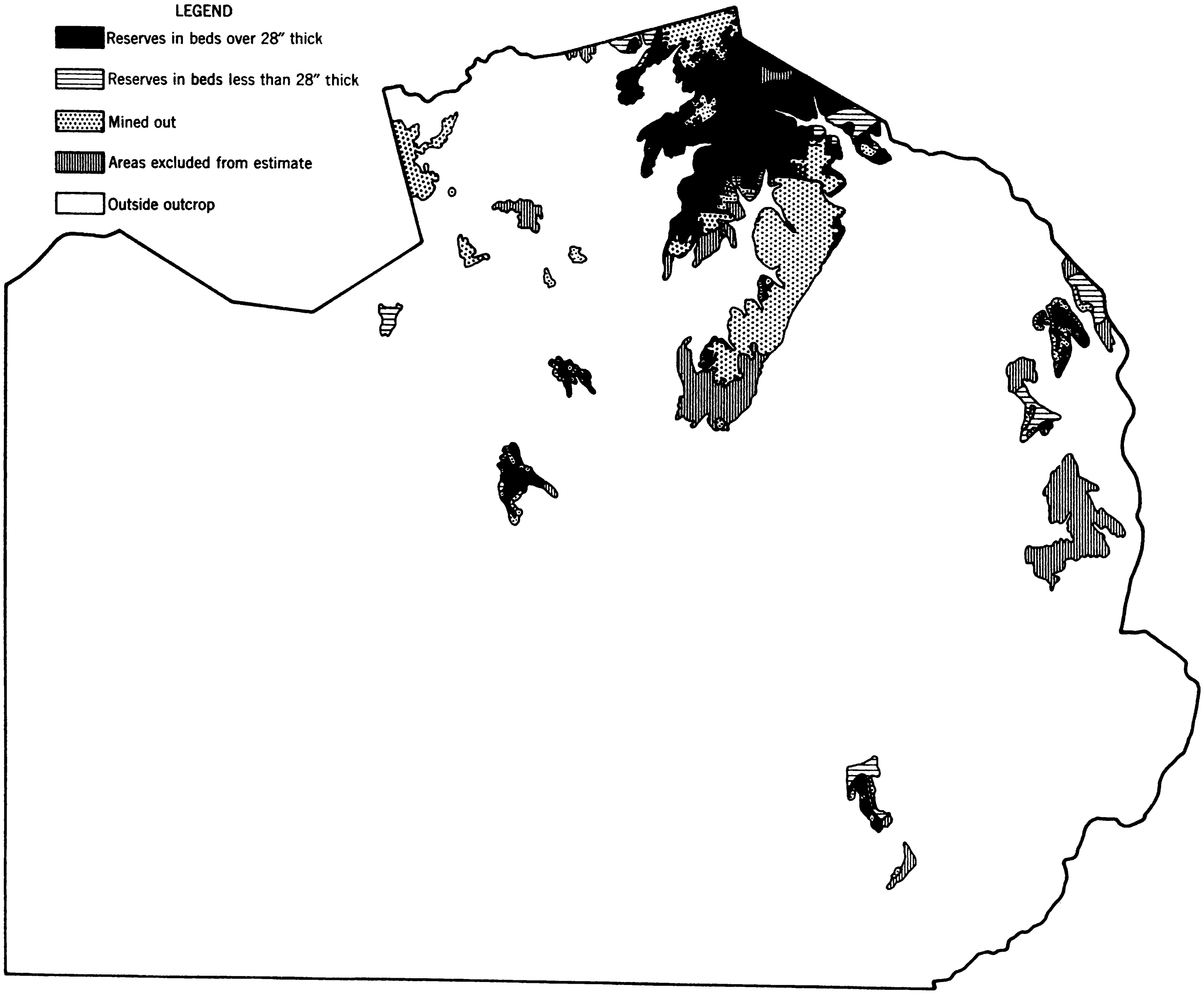

Figure 3. - Sewanee bed, Marion County, Tenn., January 1, 1953

MARION COUNTY

TABLE 1. - RESERVES IN SEWANEE BED, January 1, 1953

15' Quadrangle	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Area of quadrangle in county, acres	Areas excluded from estimate, 1/ acres	Area outside outcrop, acres	Underlain by coal 0" to 14" thick, acres	Coal over 14" thick, in place originally, acres	Mined out, acres	Coal over 14" thick remaining, acres	Measured Indicated	Estimated coal reserves, in tons of 2,000 lb.						Total reserves, in tons of 2,000 lb.				Percentage recoverable, including all mining losses	Estimated recoverable reserves 28" and more thick, thousands of tons
									14" to 28" thick		28" to 42" thick		Over 42" thick		14" and more thick		28" and more thick			
									Acres	Thousands of tons	Acres	Thousands of tons	Acres	Thousands of tons	Acres	Thousands of tons	Acres	Thousands of tons		
99 (Altamont)	26,192	325	14,853	-	11,014	2,800	8,214	Measured	300	792	3,396	19,429	199	1,364	3,895	21,585	3,595	20,793		12,601
								Indicated	210	753	3,985	23,692	124	851	4,319	25,296	4,109	24,543		14,873
								Total	510	1,545	7,381	43,121	323	2,215	8,214	46,881	7,704	45,336	60.6	27,474
100 (Jasper)	152,688	2,146	144,327	-	6,215	4,284	1,931	Measured	321	1,268	1,029	5,476	16	105	1,366	6,849	1,045	5,581		3,572
								Indicated	115	449	450	821	-	-	565	1,270	450	821		525
								Total	436	1,717	1,479	6,297	16	105	1,931	8,119	1,495	6,402	64.0	4,097
104 (Dunlap)	2,957	-	2,783	-	174	23	151	Measured	28	102	89	460	34	217	151	779	123	677		415
								Indicated	-	-	-	-	-	-	-	-	-	-		-
								Total	28	102	89	460	34	217	151	779	123	677	61.3	415
105 (Lookout Mtn.)	65,937	2,602	61,935	-	1,400	208	1,192	Measured	308	1,201	530	2,630	-	-	838	3,831	530	2,630		1,612
								Indicated	354	1,330	-	-	-	-	354	1,330	-	-		-
								Total	662	2,531	530	2,630	-	-	1,192	5,161	530	2,630	61.3	1,612
Remaining quadrangles	85,305	-	85,305	-	-	-	-	Measured	-	-	-	-	-	-	-	-	-	-		-
								Indicated	-	-	-	-	-	-	-	-	-	-		-
								Total	-	-	-	-	-	-	-	-	-	-	-	-
								Measured	957	3,363	5,044	27,995	249	1,686	6,250	33,044	5,293	29,681		18,200
								Indicated	679	2,532	4,435	24,513	124	851	5,238	27,896	4,559	25,364		15,398
Total	333,079	5,073	309,203	-	18,803	7,315	11,488	Total	1,636	5,895	9,479	52,508	373	2,537	11,488	60,940	9,852	55,045	61.0	33,598

TABLE 2. - RESERVES IN BATTLE CREEK BED, January 1, 1953

15' Quadrangle	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Area of quadrangle in county, acres	Areas excluded from estimate, 1/ acres	Area outside outcrop, acres	Underlain by coal 0" to 14" thick, acres	Coal over 14" thick, in place originally, acres	Mined out, acres	Coal over 14" thick remaining, acres	Measured Indicated	Estimated coal reserves, in tons of 2,000 lb.						Total reserves, in tons of 2,000 lb.				Percentage recoverable, including all mining losses	Estimated recoverable reserves 28" and more thick, thousands of tons
									14" to 28" thick		28" to 42" thick		Over 42" thick		14" and more thick		28" and more thick			
									Acres	Thousands of tons	Acres	Thousands of tons	Acres	Thousands of tons	Acres	Thousands of tons	Acres	Thousands of tons		
94 (Monteagle)	70,596	33,695	35,055	776	1,070	993	77	Measured	-	-	-	-	-	-	-	-	-	-		-
								Indicated	-	-	72	379	5	42	77	421	77	421		211
								Total	-	-	72	379	5	42	77	421	77	421	2/50.0	211
Remaining quadrangles	262,483	112,808	148,735	875	65	65	-	Measured	-	-	-	-	-	-	-	-	-	-		-
								Indicated	-	-	-	-	-	-	-	-	-	-		-
								Total	-	-	-	-	-	-	-	-	-	-	-	-
								Measured	-	-	-	-	-	-	-	-	-	-		-
								Indicated	-	-	72	379	5	42	77	421	77	421		211
Total	333,079	146,503	183,790	1,651	1,135	1,058	77	Total	-	-	72	379	5	42	77	421	77	421	2/50.0	211

1/ No information available from core drilling, mine workings, or coal outcrops on which to base estimates of measured and indicated reserves. These areas may contain additional geologically inferred reserves.

2/ Estimated

Northern Part of County

Material	Inches	Material	Inches
COAL	1/2	Coal and shale	8
Sulfur streaks	1/4	Shale and coal streaks ...	4
COAL	37	COAL	24
Thickness	37-3/4	Thickness	36

Material	Inches	Material	Inches
COAL, pyritic	1	COAL	39
COAL	15	Thickness	39
COAL, pyrite kidneys	4		
COAL	12		
Thickness	32		

Southeastern Part of County

Material	Inches	Material	Inches
COAL	20	COAL	20
Coal and pyrite	2	Coal and pyrite streaks ..	3
COAL	23	COAL	17
Thickness	45	Thickness	40

Northeastern Part of County

Bed sections obtained from channel samples from the Reels Cove mine in 1951 in connection with a study of carbonizing properties of Sewanee coal7/ follow:

Material	Inches	Material	Inches
COAL	4-1/4	COAL	9
Bony	0-1/8	Bony	1
COAL	5-1/2	COAL	2
Bony	0-1/8	Bony	0-1/2
COAL	25	COAL	23-1/2
Bony	0-1/2	Bony	1
COAL	11-1/8	COAL	3-1/2
Thickness	46-5/8	Thickness	40-1/2

Battle Creek Bed (See table 2)

The Battle Creek bed occurs within the Gizzard formation immediately beneath the cliff-forming Warren Point sandstone. (See fig. 2.) This coal bed covers a widespread area forming a persistent horizon throughout the county; however, this coal is too thin to mine in most areas. An area near South Pittsburg, Tenn., is the only place where there has been extensive mining. In this area the coal thickness varies quite radically, changing from 20 feet to 2 inches in 150 feet. Therefore, the reserve estimates of this bed were based on measurements much less than the maximum measured and indicated tolerances as described in the definition of measured and indicated coal as used in this report.

7/ Reynolds, D. A., Davis, J. D., Birge, G. W., Brewer, R. E., Wolfson, D. E., Ode, W. H., and Naugle, B. W., Carbonizing Properties: Tennessee Coals From the Jellico bed in Campbell County and the Sewanee bed in Marion County: Bureau of Mines Bull. 523, 1953, p. 3.

Recoverable reserves are in the southwestern part of the county. A section of the bed in that area follows:

Material	Inches
COAL	9
Shale	9
COAL	10
Thickness	28

No data were available to estimate reserves in the remaining lower coal beds.

Coal Reserves

The location and extent of the Sewanee bed in Marion County, Tenn., is shown in figure 3. The county is divided into 5 areas: (1) Beds 28 inches and more thick, (2) beds less than 28 inches thick, (3) mined out areas, (4) areas excluded from estimate, and (5) outside outcrop. Detailed estimates of known measured and indicated reserves of coal in the Sewanee and Battle Creek beds, as of January 1, 1953, are given in tables 1 and 2. Total reserves 14 inches and more thick are estimated at 61,361,000 short tons as of January 1, 1953. Of this total, 55,466,000 short tons is in beds 28 inches and more thick. The weighted average recovery for both beds in the county is 60.9 percent. Based on this recovery, the know recoverable reserves 28 inches and more thick in Marion County, Tenn., are estimated at 33,809,000 short tons as of January 1, 1953.

Marion County is one of the major coal-producing counties in Tennessee. It has increased in rank from second largest producer of coal in 1952 to first in 1953, when it produced 22.1 percent of the total coal mined in Tennessee for the year. The 1953 production was 1,208,866 tons,8/ which is an increase of 287,000 tons over the previous year. These figures are based on records of coal produced from mines with portals in Marion County. The Sewanee bed accounts for 97 percent of the total production for the county, and the remaining 3 percent is from the Battle Creek bed.

A total of 30,138,000 tons of coal has been mined in Marion County between 1852 and January 1953, as compiled from Annual Reports of Tennessee Division of Mines, Bureau of Mines Mineral Market Summaries, and some unpublished records. This production amounts to 8.6 percent of the total coal mined in Tennessee.

ANALYSES OF MARION COUNTY COALS

Table 3 gives chemical analyses of tipple and mine samples and samples of delivered coal from Marion County. All of the samples are from the Sewanee and Battle Creek beds--the two beds on which estimates of reserves were made. The table is arranged in accordance with the years in which the samples were taken. The 1953-54 group was taken specifically for analyses and preparation tests in connection with the present survey. Locations of the mines from which these samples were obtained are shown on the key map, figure 1. All tipple samples in the 1953-54 group were taken over a period of 1 shift.

The two sets of analyses of delivered coal in fiscal year 1952 represent coal delivered on Government fuel contracts from the originating source shown in columns 1 and 2. The tipple samples taken at the Reels Cove, Smith No. 3, and Payne No. 1

8/ Bureau of Mines, Bituminous Coal and Lignite in 1953: Mineral Market Summary No. 2339.

mines, and the mine sample taken at the Marshal Meeks No. 3 mine in 1953-54 were used in laboratory tests to determine the preparation characteristics of the coal. The 1953 sample from the Coal Valley mine was crushed and riffled down to a 3-pound sample and submitted to the laboratory as a sample for analysis. All tipple samples taken before 1953 were analyzed in connection with Government fuel requirements. The mine samples shown in table 3 were in most cases composites of several samples to obtain a mine average. Analyses of the samples taken in 1953-54 are published for the first time in this report. Analyses of samples taken in fiscal year 1952 and before July 1947 have been published.9 10/

The suitability of any coal for use in making metallurgical coke depends, among other things, on whether or not its sulfur content is low enough. Because of this limitation it is significant that all of the samples in table 3, which originated in the Sewanee bed in the northern part of Marion County in the general area of Whitwell and from there north-northwest to the Grundy and Sequatchie County lines, are low in sulfur, whereas all the other samples of Sewanee bed coal in this table, except the sample from Monteagle, are high in sulfur. It is also to be noted that this area in the northern part of the county is where nearly all of the reserves of coal in the Sewanee bed occur in this county. The Smith No. 3 mine, although shown under Whitwell in column 1, is actually located about 6 miles east of Whitwell. The Panther Creek mines are in this same area, and mines around Jasper, Monteagle, Orme, and Tracy City are in the southern and western parts of the county. The reports referred to in footnotes 12 and 13 show numerous analyses of samples from the Sewanee bed in Grundy County just north of the Marion County boundary, and virtually all of them are of the low-sulfur type, indicating that the area of low-sulfur coal extends through the northern part of Marion into adjoining Grundy County.

The Reels Cove sample taken in 1953 had an unusually low sulfur analysis--only 0.7 percent. However, to show to what extent it might be possible to reduce the ash content of this coal by present-day washing methods, this sample, together with the samples from the Smith No. 3, the Payne No. 1, and the Marshal Meeks No. 3 mines, was subjected to crushing, screening, and float-and-sink tests in the laboratory. The results of these tests will be discussed in the following section on Preparation Characteristics.

9/ For fiscal year 1952: Aresco, S. J., and Haller, C. P., Analyses of Tipple and Delivered Samples of Coal (Collected During the Fiscal Year 1952): Bureau of Mines Rept. of Investigations 4972, 1953, 84 pp.

10/ For years before July 1947: Fieldner, A. C., Nelson, W. A., Toenges, A. L., Fraser, Thomas, Crentz, W. L., Anderson, R. L., Bell, C. H., Snyder, N. H., Cooper, H. M., Abernethy, R. F., Tarpley, E. C., and Swingle, R. J., Analyses of Tennessee Coals (Including Georgia): Bureau of Mines Tech. Paper 671, 1945, 243 pp.

TABLE 3. - Analyses of coal from Marion County, Tenn.

						Proximate, percent				Ultimate, percent					Calorific value								
						As received	Dry coal																
Town and mine	Bed	Rank1/	Size of coal	Approx. tons sampled	Kind of sample2/	Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	B.t.u., as received basis	B.t.u., dry basis	Number of analyses averaged	Ash softening temperature, °F.	Number of ash softening temperatures averaged	Agglomerating index	Free-swelling index	Hardgrove grindability index	Date
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Samples taken in 1953 and 1954																							
Palmer (Grundy County):																							
Coal Valley	Sewanee	-	Run-of-mine	500	T	2.4	28.8	60.7	10.5	0.9	-	-	-	-	-	-	-	-	-	-	-	-	Oct. 8, 1953
South Pittsburg:																							
Payne No. 1	Battle Creek	-	do.	30	T	3.4	34.4	49.5	16.1	2.2	-	-	-	-	12,080	12,500	-	-	-	-	-	-	July 20, 1954
Tracy City (Grundy County):																							
Marshal Meeks No. 3	Sewanee	-	-	-	M	2.9	32.3	52.4	15.3	5.8	-	-	-	-	12,320	12,690	-	-	-	-	-	-	July 23, 1954
Whitwell:																							
Reel's Cove	do.	-	Run-of-mine	1,000	T	2.5	28.7	62.3	9.0	.7	-	-	-	-	13,500	13,850	-	-	-	-	-	-	Oct. 11, 1953
Smith No. 3	do.	-	do.	45	T	1.4	28.5	56.7	14.8	2.0	-	-	-	-	12,820	13,000	-	-	-	-	-	-	July 21, 1954
Samples taken during fiscal year 1952																							
Big Fork:																							
Panther Cr. 1, 2, and 3..	Sewanee	-	3- by 5-inch	971	D	1.3	27.5	57.1	15.4	4.5	-	-	-	-	12,610	12,770	-	-	-	-	-	-	Fiscal year 1952
Do.	do.	-	1-1/4- by 2-1/2-inch	159	D	1.6	29.0	58.0	13.0	3.2	-	-	-	-	13,040	13,250	-	-	-	-	-	-	Do.
Whitwell:																							
Reel's Cove	do.	Hvab	2-1/2-inch lump crushed	240	T	2.1	29.1	62.2	8:7	.6	4.8	78.8	1.6	5.5	13,620	13,910	1	2,660	1	-	-	-	Mar. 24, 1952
Do.	do.	do.	0 by 2-1/2-inch	550	T	2.7	29.1	60.9	10.0	.6	-	-	-	-	13,320	13,690	1	2,650	1	-	6-1/2	58	Do.
Star Gap	do.	do.	Run-of-mine	100	T	4.1	28.4	61.2	10.4	.9	4.8	76.9	1.6	5.4	13,090	13,640	1	2,710	1	-	7-1/2	61	Dec. 11, 1951
Samples taken before July 1947																							
Jasper:																							
Shadrick	do.	do.	-	-	M	2.8	33.0	56.8	10.2	2.4	-	-	-	-	13,210	13,590	-	2,340	-	Cg	-	-	Sept. 11, 1939
Thomas	do.	do.	-	-	M	2.5	33.0	54.3	12.7	2.6	-	-	-	-	12,840	13,160	-	2,400	-	Cg	-	-	Do.
Monteagle:																							
Arthor Long	do.	do.	-	-	M	2.5	34.6	59.2	6.2	1.2	-	-	-	-	13,950	14,300	-	2,460	-	Cf	-	-	Sept. 28, 1939
Orme:																							
Battle Creek No. 12	Battle Creek (Nelson)	-	4-inch lump	10	T	2.2	39.4	52.5	8.1	2.8	5.2	76.6	1.5	5.8	13,540	13,840	-	2,270	-	Cf	-	-	Feb. 11, 1942
Do.	do.	-	2- by 4-inch	6	T	2.2	38.2	51.6	10.2	3.2	-	-	-	-	13,150	13,440	-	2,230	-	Cf	-	-	Do.
Do.	do.	-	2-inch nut and slack	15	T	2.8	32.3	49.7	18.0	2.4	-	-	-	-	11,840	12,180	-	2,540	-	Cf	-	-	Do.
Sewanee:																							
Dunwoody North	Battle Creek	Hvab	-	-	M	2.8	33.6	57.1	9.3	5.1	-	-	-	-	13,250	13,630	-	2,110	-	Cf	-	-	Sept. 28, 1939
Dunwoody South	do.	do.	-	-	M	2.9	35.2	56.5	8.3	4.7	-	-	-	-	13,380	13,780	-	2,110	-	Cf	-	-	Do.
Tracy City (Grundy County):																							
Pryor Ridge	Sewanee	do.	-	-	M	3.1	30.5	58.9	10.6	2.3	4.7	76.3	1.5	4.6	13,120	13,530	-	-	-	-	-	-	May 18, 1915
Whitwell:																							
C. E. Brown	do.	do.	-	-	M	3.5	29.1	61.9	9.0	.7	-	-	-	-	13,330	13,810	-	2,880	-	Cf	-	-	Sept. 21, 1939
Goforth No. 1	do.	-	Run-of-mine	20	T	4.4	28.9	61.3	9.8	.7	4.7	77.9	1.6	5.3	13,050	13,650	-	2,800	-	Cg	-	-	Feb. 12, 1942
Whitwell	do.	Mvb	-	-	M	3.3	29.0	62.6	8.4	.6	4.8	79.4	1.5	5.3	13,460	13,920	-	-	-	Cg	-	-	Sept. 22, 1939

1/ Hvab - High-volatile A bituminous.
Mvb - Medium-volatile bituminous.

2/ T - Tipple sample.
D - Delivered sample.
M - Mine sample.

PART II - PREPARATION CHARACTERISTICS OF MARION COUNTY COAL

by

B. W. Gandrud

Test Procedure

The tipple samples at the Reels Cove, Smith No. 3, and Payne No. 1 mines were obtained by collecting increments of mine-run coal over a 1-shift operation as it was being loaded into trucks or railroad cars. The large gross samples were crushed in the field to pass a 1-1/2-inch round-hole screen and reduced in volume, and test lots of several hundred pounds of the 1-1/2-inch by 0 coal were sent to the laboratory for float-and-sink testing. The mine sample at the Marshal Meeks No. 3 mine was taken underground in the conventional manner. At the point of sampling, the Sewanee bed was 3 feet 1-3/4 inches thick, and no well-defined partings or binders were noticeable.

The tipple samples crushed to 1-1/2-inch top size in the field were riffled, and a riffled portion of each 1-1/2-inch by 0 sample was screened at 100-mesh. The 1-1/2-inch by 100-mesh coal was float-and-sink tested. To determine the effect of crushing upon the release of impurities, the remainder of the 1-1/2-inch by 0 sample was crushed to 3/8-inch top size and riffled. One-half of the 3/8-inch by 0 crushing was dedusted over a 100-mesh sieve, and the 3/8-inch by 100-mesh coal was float-and-sink tested. The duplicate portion of the 3/8-inch by 0 test lot was crushed to 14-mesh top size and dedusted to remove the 100-mesh by 0 dust, and the 14-mesh by 100-mesh sample was tested. The flowsheet (fig. 4) shows the steps taken in preparing the samples for the float-and-sink test.

The samples were tested on specific gravities of 1.30, 1.35, 1.40, 1.45, 1.50, 1.55, and 1.60. All tests were made with carbon tetrachloride mixed either with white gasoline or bromoform, depending on the desired specific gravity.

The mine, or face, sample was prepared for float-and-sink testing by crushing the entire test lot to 1-1/2-inch top size and dedusting over a 100-mesh sieve. From this point on the procedures that were followed in crushing, screening, and float-and-sink testing the different sizes were the same as those used for the tipple samples.

The float-and-sink test for determining the washing characteristics of a coal has been used for many years, and the descriptions of the procedure have appeared frequently in the literature. The construction of washability charts and the interpretation of float-and-sink data have been explained carefully by Coe.[11]

The 100-mesh by 0 dust was removed from all samples before separation into specific-gravity fractions to expedite the float-and-sink test. In commercial practice it is wasteful to discard this dust, but including it in the washed coal increases somewhat the ash and sulfur percentages shown in the washability data for the dedusted coal samples. Usually the quantity of fine dust produced during crushing does not become a serious problem unless the coal is crushed finer than 1-1/2-inch top size.

In interpreting preparation characteristics of coal from float-and-sink data it must be remembered that these data are based on precise specific-gravity

11/ Coe, G. D., An Explanation of Washability Curves for the Interpretation of Float-and-Sink Data on Coal: Bureau of Mines Inf. Circ. 7045, 1938, 10 pp.

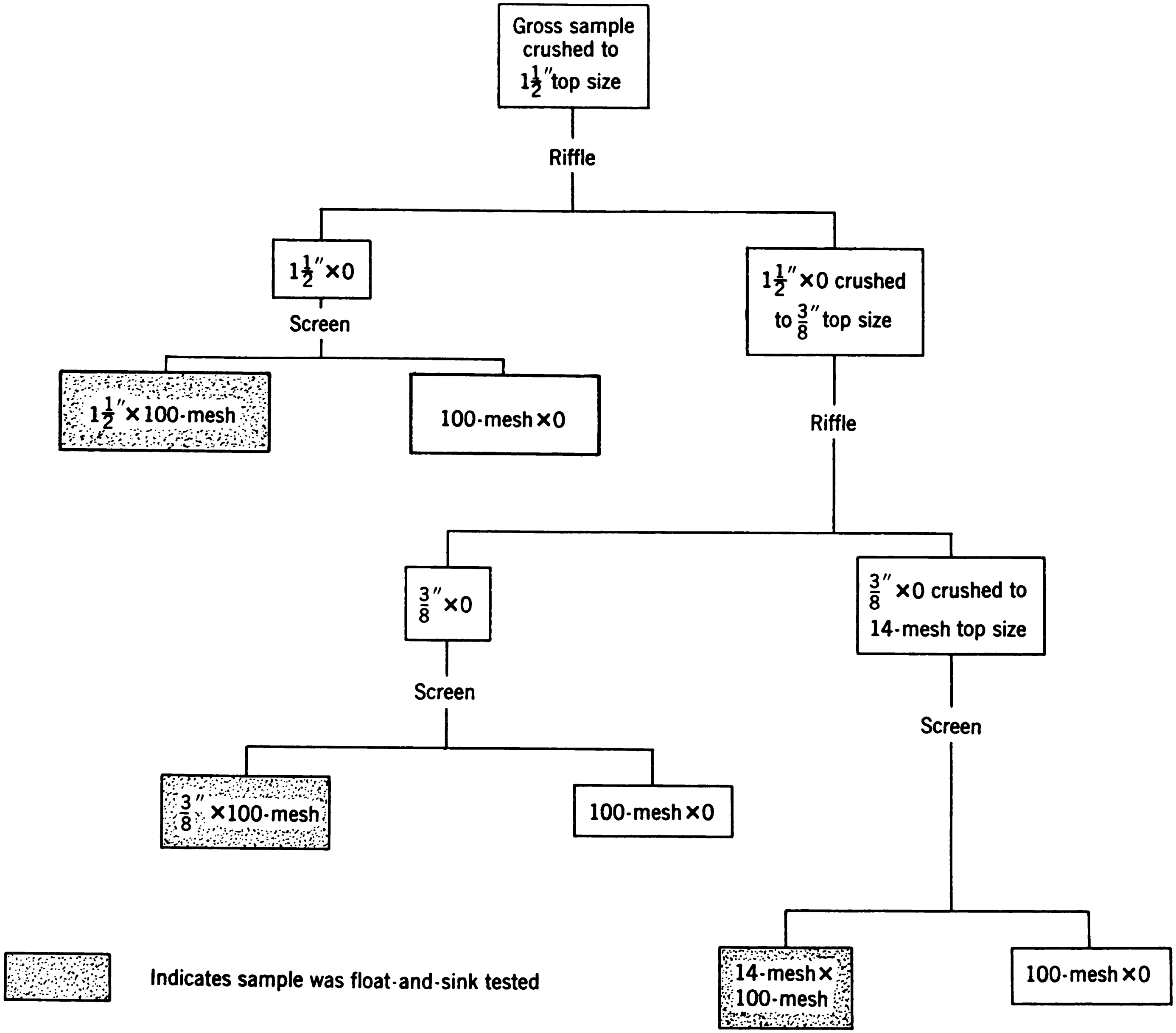

Figure 4. - Flow diagram, showing preparation of samples.

separations that are approached but not equaled in commercial practice. During washing, even in an efficient, modern preparation plant, it is to be expected that some refuse will be misplaced in the clean coal and that some clean coal will be rejected with the refuse.

Experimental Results

Tables 4 to 15, inclusive, give the washing characteristics for samples of the Sewanee and Battle Creek coal beds.

Sewanee Bed

As already noted, the mines sampled on the Sewanee bed are shown on the key map, figure 1. Tables 4, 5, and 6 show the crushing and float-and-sink data on the Reels Cove sample. According to the analyses in table 3, the mine-run coal from Reels Cove contained 0.7 percent sulfur and 9.0 percent ash. It was, therefore, an unusually low-sulfur coal with only moderately high ash. The 0.7 percent sulfur is probably considerably lower than the average for coals used in this country for making metallurgical coke, and there seemed to be no point in analyzing the float-and-sink products for data on sulfur. In fact, the 9.0 percent ash content is low enough so that this run-of-mine coal would, in most cases, be acceptable as metallurgical coking coal without any preliminary cleaning or preparation.

The data in tables 4, 5, and 6 show that most of the ashforming impurities in this coal are inherent rather than extraneous. The separations at 1.60 specific gravity gave float products that analyzed 8.8, 8.3, and 8.4 percent ash, respectively, for the samples crushed to 1-1/2-inch, 3/8-inch, and 14-mesh. Furthermore, the yield percent at this specific gravity was about the same for all three samples. This shows that the impurities were not liberated any better at 1.60 specific gravity after crushing to minus-14-mesh than in the original 1-1/2-inch by 0 sample. It is also apparent from this that washing this coal at 1.60 specific gravity would give no better ash reduction when crushed to a top size of 14-mesh than at a top size of 1-1/2-inch.

Tables 4, 5, and 6 also show what the results would be if the coal could be washed at other specific gravities. The separations at 1.40 specific gravity gave float products analyzing 8.4, 7.4, and 6.9 percent ash, respectively, for the minus -1-1/2-inch, minus-3/8-inch, and minus-14-mesh samples. This is probably about the lowest gravity at which it would ever be practical to wash coking coal owing to the high loss of coal in middling products at lower gravities. The heavy medium process is probably the only one available for washing at such a low gravity, and this process is not practical for treating material finer than approximately 4-mesh. After crushing to 14-mesh the entire size range would be too fine for treatment by heavy medium. Even at a size of 3/8 inch to 0 it would be rather impractical to wash the coal by means of a heavy medium process because a large proportion of the coal would be too fine size for such treatment.

The data in tables 4, 5, and 6 therefore indicate that, owing to the inherent nature of the ash-forming impurities in this coal, there would be little to gain as far as ash-reduction efficiency is concerned by crushing it to a size finer than 1-1/2-inch or by trying to wash it at a specific gravity lower than 1.60. Washing the coal at a specific gravity of 1.60, however, should give a very satisfactory metallurgical coal from the standpoint of ash and sulfur analyses. In fact, the run-of-mine sample on which these tests were made was extremely low in sulfur and, by usual standards, low enough in ash, as mined, to be used for making metallurgical coke.

TABLE 4. - Washing characteristics of mine-run tipple sample, Reels Cove mine, Sewanee bed. Sample crushed to 1-1/2-inch top size; data in percent

Size	Specific gravity fraction	Weight Direct	Weight Cumulative	Ash[1/] Direct	Ash[1/] Cumulative
1-1/2-inch by 100-mesh (97.2% of sample)	Float 1.30	8.3	8.3	4.2	4.2
	1.30 - 1.35	69.3	77.6	8.1	7.7
	1.35 - 1.40	16.0	93.6	11.7	8.4
	1.40 - 1.45	2.6	96.2	15.3	8.6
	1.45 - 1.50	1.2	97.4	18.4	8.7
	1.50 - 1.55	.5	97.9	22.0	8.7
	1.55 - 1.60	.3	98.2	25.9	8.8
	1.60 - Sink	1.8	100.0	63.7	9.8
100-mesh by 0 (2.8% of sample)				10.5	

1/ Moisture-free basis.

TABLE 5. - Washing characteristics of mine-run tipple sample, Reels Cove mine, Sewanee bed. Sample crushed to 3/8-inch top size; data in percent

Size	Specific gravity fraction	Weight Direct	Weight Cumulative	Ash[1/] Direct	Ash[1/] Cumulative
3/8-inch by 100-mesh (85.8% of sample)	Float 1.30	32.7	32.7	3.7	3.7
	1.30 - 1.35	43.8	76.5	8.6	6.5
	1.35 - 1.40	12.8	89.3	12.7	7.4
	1.40 - 1.45	4.9	94.2	15.9	7.8
	1.45 - 1.50	2.5	96.7	18.6	8.1
	1.50 - 1.55	.7	97.4	22.8	8.2
	1.55 - 1.60	.2	97.6	25.7	8.3
	1.60 - Sink	2.4	100.0	58.3	9.5
100-mesh by 0 (14.2% of sample)				8.7	

1/ Moisture-free basis.

TABLE 6. - Washing characteristics of mine-run tipple sample, Reels Cove mine, Sewanee bed. Sample crushed to 14-mesh top size; data in percent

Size	Specific gravity fraction	Weight		Ash[1/]	
		Direct	Cumulative	Direct	Cumulative
14-mesh by 100-mesh (69.3% of sample)	Float 1.30	42.3	42.3	3.6	3.6
	1.30 - 1.35	26.9	69.2	8.5	5.5
	1.35 - 1.40	15.4	84.6	13.0	6.9
	1.40 - 1.45	6.6	91.2	16.7	7.6
	1.45 - 1.50	3.6	94.8	20.1	8.1
	1.50 - 1.55	1.7	96.5	23.1	8.3
	1.55 - 1.60	.6	97.1	26.7	8.4
	1.60 - Sink	2.9	100.0	55.0	9.8
100-mesh by 0 (30.7% of sample)				8.7	

1/ Moisture-free basis.

TABLE 7. - Washing characteristics of face sample, Marshal Meeks No. 3 mine, Sewanee bed. Sample crushed to 1-1/2-inch top size; data in percent

Size	Specific gravity fraction	Weight		Ash[1/]		Sulfur[1/]	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
1-1/2-inch by 100 mesh (98.9% of sample)	Float 1.30	6.8	6.8	5.2	5.2	2.06	2.06
	1.30 - 1.35	43.6	50.4	9.1	8.6	2.36	2.32
	1.35 - 1.40	26.4	76.8	12.1	9.8	2.98	2.55
	1.40 - 1.45	5.8	82.6	15.5	10.2	3.97	2.65
	1.45 - 1.50	3.0	85.6	19.0	10.5	4.89	2.73
	1.50 - 1.55	1.7	87.3	22.0	10.7	6.75	2.80
	1.55 - 1.60	.8	88.1	24.4	10.8	7.17	2.84
	1.60 - Sink	11.9	100.0	45.2	14.9	25.21	5.50
100-mesh by 0 (1.1% of sample)				13.0		3.06	

1/ Moisture-free basis.

TABLE 8. - Washing characteristics of face sample, Marshal Meeks No. 3 mine, Sewanee bed. Sample crushed to 3/8-inch top size; data in percent

Size	Specific gravity fraction	Weight		Ash 1/		Sulfur 1/	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
3/8-inch by 100-mesh (94.0% of sample)	Float 1.30	10.3	10.3	4.0	4.0	1.93	1.93
	1.30 - 1.35	41.5	51.8	8.3	7.4	2.26	2.19
	1.35 - 1.40	20.9	72.7	12.5	8.9	2.68	2.33
	1.40 - 1.45	7.7	80.4	16.3	9.6	3.32	2.43
	1.45 - 1.50	3.7	84.1	19.4	10.0	4.30	2.51
	1.50 - 1.55	2.5	86.6	21.9	10.4	5.20	2.59
	1.55 - 1.60	1.0	87.6	24.4	10.5	6.72	2.64
	1.60 - Sink	12.4	100.0	48.8	15.3	27.43	5.71
100-mesh by 0 (6.0% of sample)				12.3		4.04	

1/ Moisture-free basis.

TABLE 9. - Washing characteristics of face sample, Marshal Meeks No. 3 mine, Sewanee bed. Sample crushed to 14-mesh top size; data in percent

Size	Specific gravity fraction	Weight		Ash 1/		Sulfur 1/	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
14-mesh by 100-mesh (85.6% of sample)	Float 1.30	16.2	16.2	4.2	4.2	2.08	2.08
	1.30 - 1.35	28.6	44.8	7.5	6.3	2.39	2.28
	1.35 - 1.40	21.1	65.9	11.9	8.1	2.64	2.39
	1.40 - 1.45	10.8	76.7	15.8	9.2	2.90	2.46
	1.45 - 1.50	5.2	81.9	19.2	9.8	3.41	2.52
	1.50 - 1.55	3.0	84.9	22.1	10.3	4.15	2.58
	1.55 - 1.60	1.5	86.4	23.9	10.5	4.69	2.62
	1.60 - Sink	13.6	100.0	47.9	15.6	26.88	5.92
100-mesh by 0 (14.4% of sample)				14.1		5.54	

1/ Moisture-free basis.

TABLE 10. - Washing characteristics of mine-run tipple sample, Smith No. 3 mine, Sewanee bed. Sample crushed to 1-1/2-inch top size; data in percent

Size	Specific gravity fraction	Weight		Ash[1/]		Sulfur[1/]	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
1-1/2-inch by 100-mesh (97.9% of sample)	Float 1.30	5.5	5.5	3.3	3.3	0.97	0.97
	1.30 - 1.35	50.9	56.4	8.2	7.7	1.29	1.26
	1.35 - 1.40	25.1	81.5	11.4	8.9	1.67	1.39
	1.40 - 1.45	5.6	87.1	14.3	9.2	2.12	1.43
	1.45 - 1.50	2.1	89.2	17.4	9.4	2.76	1.46
	1.50 - 1.55	1.1	90.3	19.4	9.5	4.91	1.51
	1.55 - 1.60	.4	90.7	23.0	9.6	5.91	1.53
	1.60 - Sink	9.3	100.0	66.3	14.9	7.96	2.12
100-mesh by 0 (2.1% of sample)				21.7		2.60	

1/ Moisture-free basis.

TABLE 11. - Washing characteristics of mine-run tipple sample, Smith No. 3 mine, Sewanee bed. Sample crushed to 3/8-inch top size; data in percent

Size	Specific gravity fraction	Weight		Ash[1/]		Sulfur[1/]	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
3/8-inch by 100-mesh (93.3% of sample)	Float 1.30	14.6	14.6	3.5	3.5	1.03	1.03
	1.30 - 1.35	42.1	56.7	7.9	6.7	1.12	1.10
	1.35 - 1.40	22.0	78.7	11.8	8.2	1.59	1.23
	1.40 - 1.45	7.5	86.2	14.9	8.8	1.57	1.26
	1.45 - 1.50	3.1	89.3	18.2	9.1	2.03	1.29
	1.50 - 1.55	1.3	90.6	20.6	9.3	3.07	1.32
	1.55 - 1.60	.4	91.0	22.7	9.3	3.94	1.33
	1.60 - Sink	9.0	100.0	67.5	14.5	8.77	2.00
100-mesh by 0 (6.7% of sample)				14.7		2.21	

1/ Moisture-free basis.

TABLE 12. - Washing characteristics of mine-run tipple sample, Smith No. 3 mine, Sewanee bed. Sample crushed to 14-mesh top size; data in percent

Size	Specific gravity fraction	Weight		Ash[1/]		Sulfur[1/]	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
14-mesh by 100-mesh (84.7% of sample)	Float 1.30	23.6	23.6	3.1	3.1	0.93	0.93
	1.30 - 1.35	27.1	50.7	7.4	5.4	1.05	.99
	1.35 - 1.40	20.5	71.2	11.9	7.3	1.17	1.04
	1.40 - 1.45	11.3	82.5	14.3	8.2	1.18	1.06
	1.45 - 1.50	4.3	86.8	18.3	8.7	1.49	1.08
	1.50 - 1.55	2.6	89.4	20.7	9.1	1.86	1.11
	1.55 - 1.60	.7	90.1	22.6	9.2	2.53	1.12
	1.60 - Sink	9.9	100.0	63.2	14.5	8.77	1.88
100-mesh by 0 (15.3% of sample)				14.8		2.26	

1/ Moisture-free basis.

TABLE 13. - Washing characteristics of mine-run tipple sample, Payne No. 1 mine, Battle Creek bed. Sample crushed to 1-1/2-inch top size; data in percent

Size	Specific gravity fraction	Weight		Ash[1/]		Sulfur[1/]	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
1-1/2-inch by 100-mesh (98.3% of sample)	Float 1.30	19.4	19.4	5.2	5.2	1.56	1.56
	1.30 - 1.35	42.7	62.1	7.6	6.9	1.68	1.64
	1.35 - 1.40	13.6	75.7	13.1	8.0	1.64	1.64
	1.40 - 1.45	6.1	81.8	17.7	8.7	2.00	1.67
	1.45 - 1.50	3.0	84.8	22.7	9.2	2.08	1.68
	1.50 - 1.55	2.2	87.0	26.0	9.6	2.63	1.71
	1.55 - 1.60	1.2	88.2	29.5	9.9	2.51	1.72
	1.60 - Sink	11.8	100.0	54.0	15.1	6.45	2.28
100-mesh by 0 (1.7% of sample)				24.5		2.13	

1/ Moisture-free basis.

TABLE 14. - Washing characteristics of mine-run tipple sample, Payne No. 1 mine, Battle Creek bed. Sample crushed to 3/8-inch top size; data in percent

Size	Specific gravity fraction	Weight		Ash[1]		Sulfur[1]	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
3/8-inch by 100-mesh (93.5% of sample)	Float 1.30	23.2	23.2	4.4	4.4	1.36	1.36
	1.30 - 1.35	35.8	59.0	7.4	6.2	1.34	1.35
	1.35 - 1.40	12.5	71.5	13.0	7.4	1.59	1.39
	1.40 - 1.45	6.7	78.2	18.2	8.3	1.70	1.42
	1.45 - 1.50	3.9	82.1	22.7	9.0	2.11	1.45
	1.50 - 1.55	2.4	84.5	26.5	9.5	2.22	1.47
	1.55 - 1.60	1.2	85.7	29.5	9.8	2.43	1.48
	1.60 - Sink	14.3	100.0	54.5	16.2	6.57	2.21
100-mesh by 0 (6.5% of sample)				18.1		2.21	

1/ Moisture-free basis.

TABLE 15. - Washing characteristics of mine-run tipple sample, Payne No. 1 mine, Battle Creek bed. Sample crushed to 14-mesh top size; data in percent

Size	Specific gravity fraction	Weight		Ash[1]		Sulfur[1]	
		Direct	Cumulative	Direct	Cumulative	Direct	Cumulative
14-mesh by 100-mesh (84.8% of sample)	Float 1.30	24.1	24.1	4.0	4.0	1.28	1.28
	1.30 - 1.35	29.5	53.6	6.8	5.5	1.20	1.24
	1.35 - 1.40	18.2	71.8	12.4	7.3	1.36	1.27
	1.40 - 1.45	6.1	77.9	17.8	8.1	1.56	1.29
	1.45 - 1.50	4.0	81.9	22.2	8.8	1.62	1.31
	1.50 - 1.55	2.8	84.7	27.0	9.4	1.74	1.32
	1.55 - 1.60	1.1	85.8	30.1	9.7	1.87	1.33
	1.60 - Sink	14.2	100.0	54.3	16.0	6.39	2.05
100-mesh by 0 (15.2% of sample)				16.9		2.37	

1/ Moisture-free basis.

It was pointed out in the section on analyses that the analyses of samples from the Sewanee bed in the area of Whitwell and north-northwest of Whitwell show uniformly low-sulfur contents. Therefore, it seems probable that practically all of the Sewanee bed coal in this area would be similar to the sample from the Reels Cove mine, on which preparation tests have been made, and that, from the standpoint of ash and sulfur content, it could be used as metallurgical coking coal with only a simple preparation treatment in any case, and probably without any such treatment at all if proper precautions could be taken to prevent appreciable amounts of top or bottom rock from getting into the coal during mining.

The samples from the Smith and Marshal Meeks mines are perhaps typical of the parts of the Sewanee bed in Marion County that are high in sulfur. The Marshal Meeks sample is rather extreme in this respect with a sulfur analysis of 5.8 percent according to table 3. The data in tables 7 to 12 are an indication as to how coals represented by these samples would respond to preparation treatment. Tables 7, 8, and 9 give the data on the sample from the Marshal Meeks mine. It is obvious from these data that coal represented by this sample cannot be considered as a metallurgical coking coal if the customary figure of 1.25 percent is assumed as the maximum allowable percentage of sulfur in such coal. Table 9 shows that even after crushing the sample to a top size of 14-mesh, the lowest sulfur content in any of the float-and-sink fractions was 2.08 percent.

According to table 3, the sample from the Smith No. 3 mine analyzed 14.8 percent ash and 2.0 percent sulfur on the moisture-free basis. The results of the crushing and float-and-sink tests on this sample are shown in tables 10, 11, and 12. After crushing to 1-1/2-inch, according to table 10, only the "float 1.30" product contained less than 1.25 percent sulfur and it represented only 5.5 percent by weight of the original sample. A separation at 1.35 specific gravity yielded 56.4 percent of the sample with a sulfur analysis of 1.26 percent. To make such a separation in a plant would be impractical, however, as the heavy medium process would have to be used, and only the sizes coarser than about 4-mesh can be treated by this process. On this basis, the actual yield of cleaned coal would probably be only about half of the 56.4 percent obtained in the float-and-sink tests. Table 11 shows the float-and-sink results after crushing to a top size of 3/8-inch. The figures in this table show that a separation at about 1.43 specific gravity would give a fairly high yield of clean coal with not over 1.25 percent sulfur. Unfortunately, a separation at this specific gravity would not be possible with jigs or tables, and a feed of 3/8-inch to 0 is too fine for treatment with the heavy medium process. With jigs and tables it probably would not be practical to make a separation at a lower specific gravity than 1.60. According to table 11, this would give a cleaned coal analyzing 9.3 percent ash and 1.33 percent sulfur. The float-and-sink results after crushing to a top size of 14-mesh are shown in table 12. These results show that fairly good liberation of the sulfur was obtained by crushing to 14-mesh. The cumulative float product at 1.60 specific gravity analyzed 9.2 percent ash and 1.12 percent sulfur with a yield of 90.1 percent. On a feed crushed as fine as 14-mesh, it would not be practical to use either jigs, tables, or the heavy medium process. Probably the only practical process for a feed of this size would be the recently developed kerosene-flotation process.12 13/ This process would very likely make a separation on the 14-mesh feed at 1.60 specific gravity

12/ Gandrud, B. W., and Riley, H. L., Recent Developments in Combination Cleaning and Dewatering of Fine Sizes of Coal: Bureau of Mines Rept. of Investigations 4707, 1950, 28 pp.

13/ Schiffman, L. E. and White, E. D., Floating Fines With Kerosene: Coal Age, vol. 56, March 1951, pp. 78-82.

with a fairly good recovery efficiency. To treat mine-run coal crushed to this size would probably be uneconomic at the present time even with the kerosene-flotation process, however, considering the costs involved. The floated product would have to be mechanically dewatered and probably heat dried in order to meet specifications for metallurgical coking coal.

On the basis of the above discussions of the samples from the Marshal Meeks No. 3 and the Smith No. 3 mines, it appears that the high-sulfur coals from the Sewanee bed in Marion County would not be suitable for use in preparing a chemically satisfactory grade of coal for making metallurgical coke. Under these circumstances and in view of the analyses in table 3, it is doubtful if the Sewanee bed in Marion County contains any appreciable amounts of coal suitable for making metallurgical coke outside of the general area around Whitwell and from there north-northwest to the Grundy and Sequatchie County lines.

Battle Creek Bed

Tables 13, 14, and 15 show the results of crushing and float-and-sink tests on the sample from the Payne No. 1 mine on the Battle Creek bed. The Payne mine, as indicated on the key map, figure 1, is located in the southwest corner of Marion County about 2 miles north of Orme. The analyses in table 3 show that this sample contained 16.1 percent ash and 2.2 percent sulfur on a moisture-free basis. Tables 13 and 14 show that the float-and-sink tests on the samples crushed to 1-1/2-inch and 3/8-inch gave no products with sulfur as low as 1.25 percent. The cumulative float products at 1.60 specific gravity analyzed 9.9 percent ash and 1.72 percent sulfur and 9.8 percent ash and 1.48 percent sulfur, for the 1-1/2-inch and 3/8-inch crushings, respectively. Table 15 gives the float-and-sink results on the sample crushed to 14-mesh top size. It shows that a cumulative float product with 1.24 percent sulfur and 53.6 percent yield was obtained at 1.35 specific gravity and indicates considerably better release of the sulfur than was obtained on the samples crushed to 1-1/2-inch and 3/8-inch. There is, however, at present no practical method available for cleaning a 14-mesh by 0 product at a specific gravity as low as 1.35. It is to be concluded, therefore, that a product good enough to comply with the usual chemical requirements for metallurgical coking coal could not be prepared on a commercially economic basis from the coal represented by the sample from the Payne No. 1 mine.

CARBONIZING PROPERTIES OF COAL FROM THE SEWANEE BED

The carbonizing properties of coal from the Sewanee bed in Marion County have been published previously by the Bureau of Mines.14/ The results shown establish the Sewanee coal as a coking coal satisfactory for metallurgical use.

The Sewanee sample contained 68.7 percent fixed carbon on the dry, mineral-matter free basis and had a heating value of 14,960 B.t.u. on the moist, mineral-matter free basis. The coal ranks high in the high-volatile A bituminous rank.

Sewanee coke was large and exceptionally strong for coke made entirely from high-volatile coal. The indexes of the 900° C. cokes were: 2-inch shatter, 86; 1-inch tumbler, 57; and 1/4-inch tumbler, 67. The shatter indexes of the 900° C.

14/ Reynolds, D. A., Davis, J. D., Birge, G. W., Brewer, R. E., Wolfson, D. E., Ode, W. H., and Naugle, B. W., Carbonizing Properties: Tennessee Coals From the Jellico Bed in Campbell County and the Sewanee bed in Marion County: Bureau of Mines, Bull. 523, 1953, 31 pp.

coke were raised by using a blend of 60 percent Sewanee and 40 percent Pocohontas No. 3 but this blending did not alter the other physical properties appreciably. The 70:30 Sewanee-Blair blend coked about as strongly as 100-percent Sewanee. Blending Sewanee with 30 percent Pittsburgh lowered the average size and shatter indexes of the coke; these effects were greater when 50 and 70 percent Pittsburgh coal was used.

Sewanee coal expanded 5.8 percent in the sole-heated oven at the standard bulk density of 55.5 pounds per cubic foot. Blends of Sewanee and other coals expanded (+), or contracted (-), as follows: 40 percent Pocahontas No. 3, +8.8; 30 percent Blair, -0.4; 30 percent Pittsburgh, +5.2; and 50 percent Pittsburgh, +1.2.

APPENDIX

Estimate of Known Recoverable Reserves

Completed reports giving results of studies by counties under part (1) of the investigation follow:

DOWD, J. J., TURNBULL, L. A., TOENGES, A. L., COOPER, H. M., ABERNETHY, R. F., REYNOLDS, D. A., and FRASER, THOMAS. Estimate of Known Recoverable Reserves of Coking Coal in Cambria County, Pa. Bureau of Mines Rept. of Investigations 4734, 1950, 25 pp.

DOWD, J. J., TURNBULL, L. A., TOENGES, A. L., COOPER, H. M., ABERNETHY, R. F., REYNOLDS, D. A., and CRENTZ, W. L. Estimate of Known Recoverable Reserves of Coking Coal in Indiana County, Pa. Bureau of Mines Rept. of Investigations 4757, 1950, 22 pp.

DOWD, J. J., TURNBULL, L. A., TOENGES, A. L., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Pike County, Ky. Bureau of Mines Rept. of Investigations 4792, 1951, 34 pp.

_____. Estimate of Known Recoverable Reserves of Coking Coal in Armstrong County, Pa. Bureau of Mines Rept. of Investigations 4801, 1951, 20 pp.

_____. Estimate of Known Recoverable Reserves of Coking Coal in Westmoreland County, Pa. Bureau of Mines Rept. of Investigations 4803, 1951, 16 pp.

_____. Estimate of Known Recoverable Reserves of Coking Coal in Fayette County, Pa. Bureau of Mines Rept. of Investigations 4807, 1951, 19 pp.

_____. Estimate of Known Recoverable Reserves of Coking Coal in Floyd County, Ky. Bureau of Mines Rept. of Investigations 4813, 1951, 16 pp.

DOWD, J. J., TOENGES, A. L., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Jefferson County, Pa. Bureau of Mines Rept. of Investigations 4840, 1952, 18 pp.

_____. Estimate of Known Recoverable Reserves of Coking Coal in Raleigh County, W. Va. Bureau of Mines Rept. of Investigations 4893, 1952, 37 pp.

_____. Estimate of Known Recoverable Reserves of Coking Coal in Knott County, Ky. Bureau of Mines Rept. of Investigations 4897, 1952, 20 pp.

WALLACE, J. J., DOWD, J. J., TAVENNER, W. H., PROVOST, J. M., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in McDowell County, W. Va. Bureau of Mines Rept. of Investigations 4924, 1952, 26 pp.

_____. Estimate of Known Recoverable Reserves of Coking Coal in Wyoming County, W. Va. Bureau of Mines Rept. of Investigations 4966, 1953, 39 pp.

WALLACE, J. J., DOWD, J. J., WILLIAMS, LLOYD, ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Allegany County, Md. Bureau of Mines Rept. of Investigations 4970, 1953, 18 pp.

WALLACE, J. J., DOWD, J. J., BOWSHER, J. A., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Somerset County, Pa. Bureau of Mines Rept. of Investigations 4998, 1953, 20 pp.

WALLACE, J. J., DOWD, J. J., TRAVIS, R. G., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Letcher County, Ky. Bureau of Mines Rept. of Investigations 5016, 1953, 26 pp.

WALLACE, J. J., DOWD, J. J., PROVOST, J. M., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Allegheny County, Pa. Bureau of Mines Rept. of Investigations 5003, 1953, 16 pp.

WILLIAMS, LLOYD, LOWE, ROBERT, TURNBULL, L. A., CARMAN, E. P., CRENTZ, W. L., REYNOLDS, D. A., and ABERNETHY, R. F. Estimate of Known Recoverable Reserves and the Preparation and Carbonizing Properties of Coking Coal in Putnam County, Tenn. Bureau of Mines Rept. of Investigations 5029, 1954, 21 pp.

WALLACE, J. J., DOWD, J. J., TRAVIS, R. G., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Harlan County, Ky. Bureau of Mines Rept. of Investigations 5037, 1954, 26 pp.

WALLACE, J. J., DOWD, J. J., TAVENNER, W. H., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Mingo County, W. Va. Bureau of Mines Rept. of Investigations 5068, 1954, 57 pp.

WALLACE, J. J., DOWD, J. J., TAVENNER, W. H., PROVOST, J. M., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Mercer County, W. Va. Bureau of Mines Rept. of Investigations 5077, 1954, 20 pp.

WALLACE, J. J., DOWD, J. J., TRAVIS, R. G., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Perry County, Ky. Bureau of Mines Rept. of Investigations 5083, 1954, 26 pp.

WILLIAMS, LLOYD, HERSHEY, R. E., ABERNETHY, R. F., GANDRUD, B. W., REYNOLDS, D. A., and others. Estimate of Known Recoverable Reserves and the Preparation and Carbonizing Properties of Coking Coal in Sequatchie County, Tenn. Bureau of Mines Rept. of Investigations 5136, 1955, 28 pp.

WALLACE, J. J., DOWD, J. J., PROVOST, J. M., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Washington County, Pa. Bureau of Mines Rept. of Investigations 5109, 1955, 23 pp.

WALLACE, J. J., DOWD, J. J., PROVOST, J. M., ABERNETHY, R. F., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves of Coking Coal in Greene County, Pa. Bureau of Mines Rept. of Investigations 5143, (In press).

WILLIAMS, LLOYD, HERSHEY, R. E., ABERNETHY, R. F., GANDRUD, B. W., REYNOLDS, D. A., and WOLFSON, D. E. Estimate of Known Recoverable Reserves and the Preparation and Carbonizing Properties of Coking Coal in Overton County, Tenn. Bureau of Mines Rept. of Investigations 5131, 1955, 27 pp.

Preparation Studies

Completed reports giving results of studies by counties under part (2) of the investigation follow:

CRENTZ, W. L., and STEELE, FERN. Preparation Characteristics of Coal Occurring in Cambria County, Pa. Bureau of Mines Rept. of Investigations 4747, 1950, 40 pp.

CRENTZ, W. L., STEELE, FERN, and BAILEY, A. L. Preparation Characteristics of Coal Occurring in Indiana County, Pa. Bureau of Mines Rept. of Investigations 4763, 1951, 33 pp.

_____. Preparation Characteristics of Coal Occurring in Armstrong County, Pa. Bureau of Mines Rept. of Investigations 4788, 1951, 25 pp.

CRENTZ, W. L., BAILEY, A. L., and MILLER, J. W. Preparation Characteristics of Coal From Fayette County, Pa. Bureau of Mines Rept. of Investigations 4815, 1951, 16 pp.

_____. Preparation Characteristics of Coal Occurring in Westmoreland County, Pa. Bureau of Mines Rept. of Investigations 4823, 1951, 17 pp.

_____. Preparation Characteristics of Coal From Somerset County, Pa. Bureau of Mines Rept. of Investigations 4834, 1951, 23 pp.

_____. Preparation Characteristics of Coal From Clearfield County, Pa. Bureau of Mines Rept. of Investigations 4894, 1952, 27 pp.

CRENTZ, W. L., and MILLER, J. W. Preparation Characteristics of Coal From Pike County, Ky. Bureau of Mines Rept. of Investigations 4910, 1952, 28 pp.

_____. Preparation Characteristics of Coal From Floyd County, Ky. Bureau of Mines Rept. of Investigations 4920, 1952, 21 pp.

_____. Preparation Characteristics of Coal From Jefferson County, Pa. Bureau of Mines Rept. of Investigations 4941, 1953, 21 pp.

_____. Preparation Characteristics of Coal From Knott County, Ky. Bureau of Mines Rept. of Investigations 4993, 1953, 30 pp.

WILLIAMS, L., LOWE, R., TURNBULL, L. A., CRENTZ, W. L., CARMAN, E. P., and REYNOLDS, D. A. Estimate of Known Recoverable Reserves and the Preparation and Carbonizing Properties of Coking Coal in Putnam County, Tenn. Bureau of Mines Rept. of Investigations 5021, 1954, 21 pp.

MILLER, J. W., JOLLEY, T. R., and SOKASKI, M. Preparation Characteristics of Coal From Raleigh County, W. Va. Bureau of Mines Rept. of Investigations 5070, 1954, 32 pp.

_____. Preparation Characteristics of Coal From McDowell County, W. Va. Bureau of Mines Rept. of Investigations 5094, 1954, 41 pp.

_____. Preparation Characteristics of Coal From Wyoming County, W. Va. Bureau of Mines Rept. of Investigations 5112, 1955, 26 pp.

Int. - Bu. of Mines, Pgh., Pa. 6934