

VIRGINIA DIVISION OF MINERAL RESOURCES
PUBLICATION 122

**COAL SAMPLE ANALYSES FROM THE SOUTHWEST
VIRGINIA COALFIELD**

Gerald P. Wilkes, Linda J. Bragg, Karen K. Hostettler,
Charles L. Oman, and S. Lynn Coleman

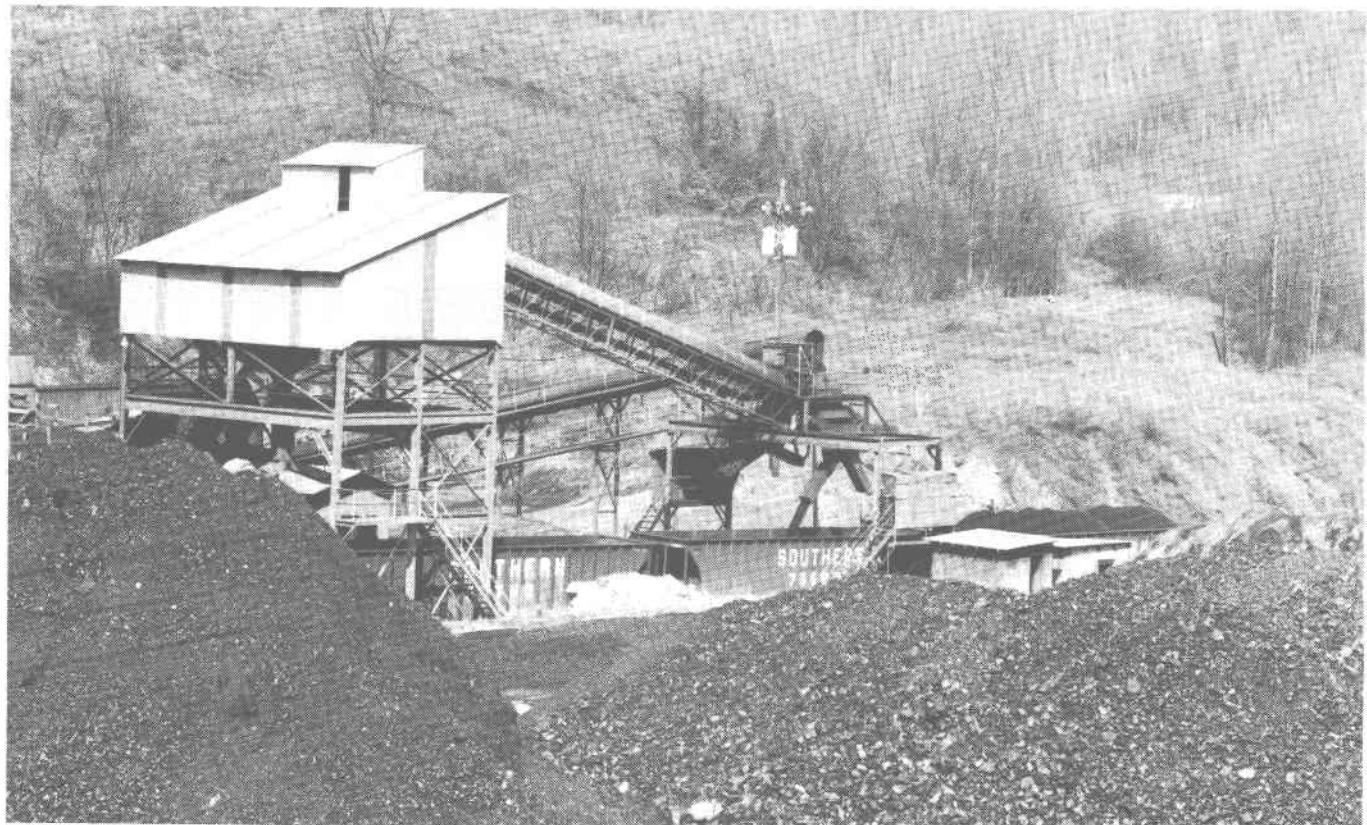


COMMONWEALTH OF VIRGINIA
DEPARTMENT OF MINES, MINERALS AND ENERGY
DIVISION OF MINERAL RESOURCES
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FRONT COVER: Coal tipple near Glamorgan, Wise County, Virginia. Photograph by T.M. Gathright, II.

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DEPARTMENT OF MINES, MINERALS AND ENERGY
RICHMOND, VIRGINIA
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COAL SAMPLE ANALYSES FROM THE SOUTHWEST VIRGINIA COALFIELD

Gerald P. Wilkes¹, Linda J. Bragg², Karen K. Hostettler¹,
Charles L. Oman², and S. Lynn Coleman²

ABSTRACT

The Virginia Division of Mineral Resources, in cooperation with the U.S. Geological Survey, began a coal sampling program in 1975 to assess the quality of Virginia coal. For each of the three-hundred seventy-five samples collected from the Southwest Virginia coalfield, more than one hundred quality characteristics were determined. These include proximate and ultimate analyses, physical properties, and major- and minor-oxide and trace element concentrations. Descriptive and statistical information is provided by bed and sample locations are depicted on both regional and detailed maps.

INTRODUCTION

Pennsylvanian coal of the Appalachian basin occurs in a seven county area of Southwest Virginia. From 1975 to 1988 Virginia Division of Mineral Resources personnel collected 375 samples from a six county area for 38 coal beds in the Southwest Virginia coalfield (Figures 1 and 2). Coal samples were processed in the field and sent to laboratories for chemical and physical analyses. Descriptions of the sampled coals and results of the analyses were entered into the U.S. Geological Survey's National Coal Resources Data System (NCRDS).

Analytical results for 217 samples collected through 1980 are reported in Virginia Division of Mineral Resources Publication 33 (Henderson and others, 1981—134 samples) and Publication 63 (Henderson and others, 1985—83 samples). Due to recorrelation of coal beds based on detailed mapping by the Virginia Division of Mineral Resources, many of the coal beds reported in the aforementioned 1981 and 1985 publications were renamed. This report reflects those recorrelated name changes and presents analytical results for samples collected after 1980 as well as the results for the previous 217 samples. The coal analyses are organized by ascending stratigraphic order of coal beds in the Southwest Virginia coalfield (Figures 3 and 4).

Information for each coal bed is presented in the same format, starting with a description of the coal bed which includes local names, areal outcrop extent, 1989 production, range of thickness, megascopic description, and a synopsis of analytical results. Following the coal bed description is a regional map which shows all sample locations of the coal bed in question. These maps have a topographic grid overlay which relate to the topographic map names in Figure 5.

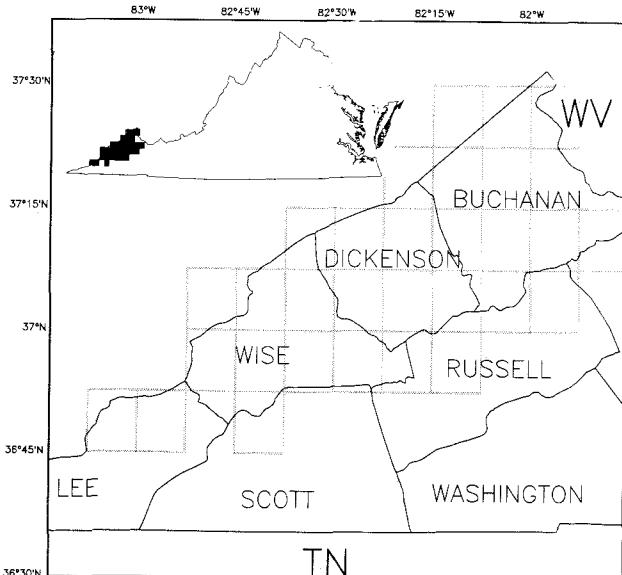


Figure 1. State and county index map of Southwest Virginia. Grid indicates location of 7.5-minute quadrangle maps used in this report (see Figure 5).

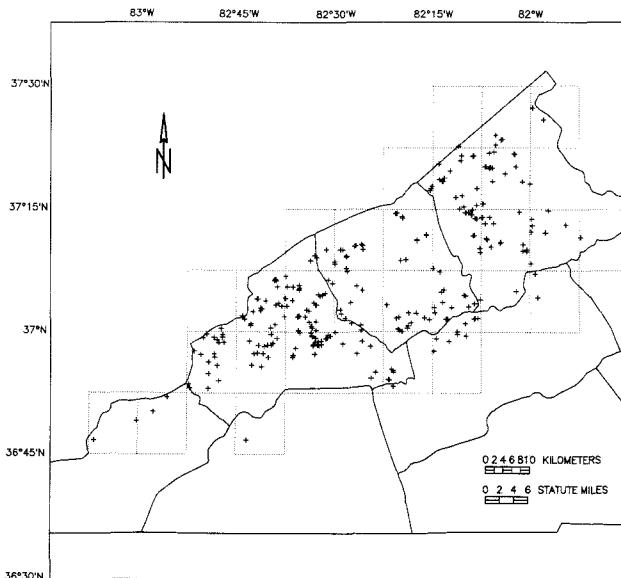


Figure 2. Areal distribution of coal samples.

Regional maps are not intended to give precise sample locations, but rather to illustrate the distribution of the collection points. Next are a series of tables devoted to the analytical parameters of individual coal samples, and statis-

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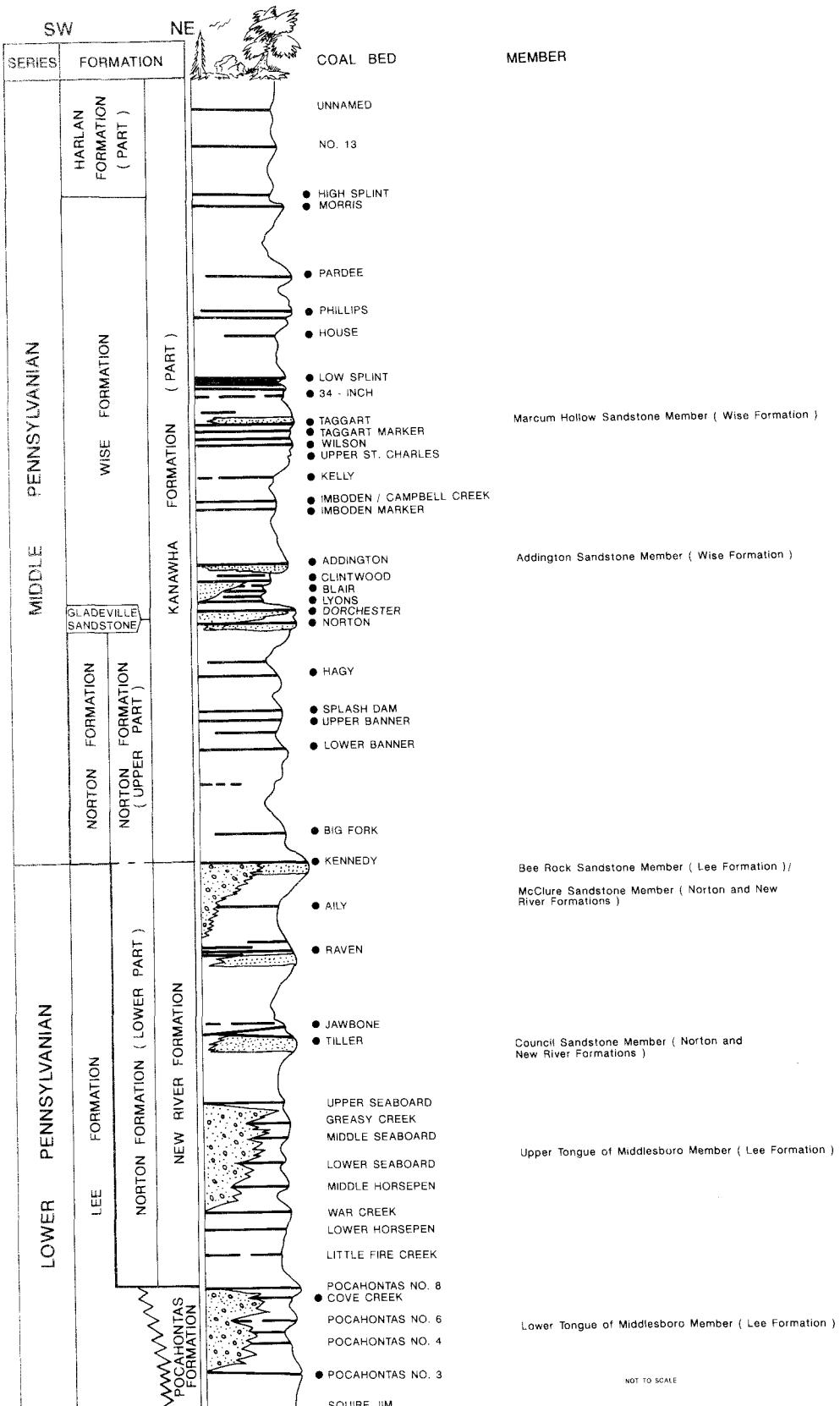


Figure 3. Stratigraphic relationship of coal beds sampled for this report. Because of the proximity of the Southwest Virginia coalfield to coalfields in other states, formation name changes occur. This change is depicted at the top of the formation name column from southwest to northeast across the Southwest Virginia coalfield. Beds marked with a dot are those that have been sampled for this report.

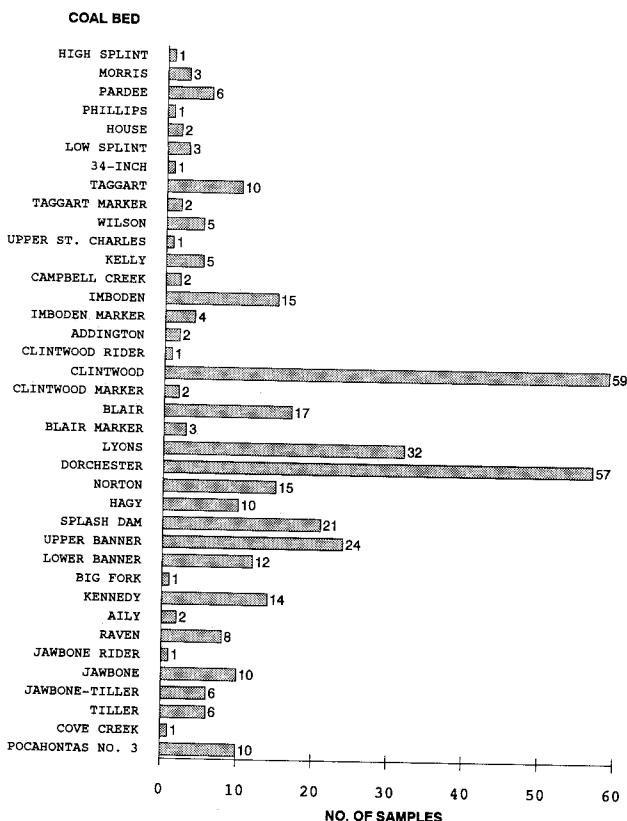


Figure 4. Coal sample distribution by bed.

tical comparisons to other Appalachian basin coals where applicable.

Three appendices are provided to enhance the use of this publication. Appendix I contains 1:50,000-scale topographic map locations to be used in conjunction with the body of the paper (see Figure 5). Appendix II cross-references all identification numbers assigned to each sample, and Appendix III describes the sampling procedure used by Virginia Division of Mineral Resources field personnel.

In order to insure the comparability of the analytical data derived from sampling, strict adherence to standardized procedures was maintained throughout this study. The basis of any work of this nature requires methodical and consistent sampling and laboratory techniques in order for results to be meaningful.

All analytical data presented in this report are available in ASCII format on a 5.25-inch diskett. Contact the Virginia Division of Mineral Resources Sales Office in Charlottesville for the price.

ACKNOWLEDGEMENTS

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Much needed first-hand information on boiler operation was supplied by James W. Wilkes, Sr. (Pittsburgh, Pennsylvania) and Wayne Apperson, Dennis Via, and Mindy Wayland at the Bremo Bluff power station of Virginia Power Company.

The following members of the Virginia Division of Mineral Resources assisted with the collection of the coal samples: Joseph J. Arnold, Stephen C. Bell, Peter D. Crowley, Kevin C. DeVanney, James A. Henderson, Jr., Donald C. LeVan, Palmer C. Sweet, Jack W. Webb, and William W. Whitlock. Their help was invaluable to the coal sampling program.

Last and certainly not least, the Virginia Division of Mineral Resources acknowledges the many coal companies in the Southwest Virginia coalfield that permitted sampling in their operations. Without that cooperation, reports such as this would not be possible.

COAL TESTING

Industrial applications of coal require the raw material to have only slight variance in chemical and physical properties. Figure 6 illustrates some analytical parameters as they relate to the proper function of a steam boiler. For example, the amount of sulfur contained in the coal will effect the amount of scrubbing required of the flue gasses and therefore the economy of the fuel. More will be discussed on this aspect later in this paper. Coal character assessment, or coal quality, is determined by standard analytical methods. The most frequently used methods ("classical analyses") are the proximate analysis (including air-dry loss), ultimate analysis, heating value (heat content), ash-fusion temperatures, free-swelling index, and grindability. Major- and minor-oxides and trace element content of the ash and/or whole coal are useful in assessing potential environmental impact and, from a geologic view, modeling paleoenvironments.

PROXIMATE ANALYSIS

The proximate analysis, commonly used in industrial applications, includes the percentage of volatile matter, fixed carbon, ash, and moisture in coal. The first two constituents, volatile matter and fixed carbon, contribute to combustion while ash and moisture are non-combustible. The relative amount of each constituent dictates the suitability of the coal as a fuel. Volatile matter is the gaseous matter, exclusive of moisture, released during combustion (about 950°C). Volatile matter consists of a mixture of flammable gases including hydrogen, carbon monoxide, methane, and carbon dioxide.

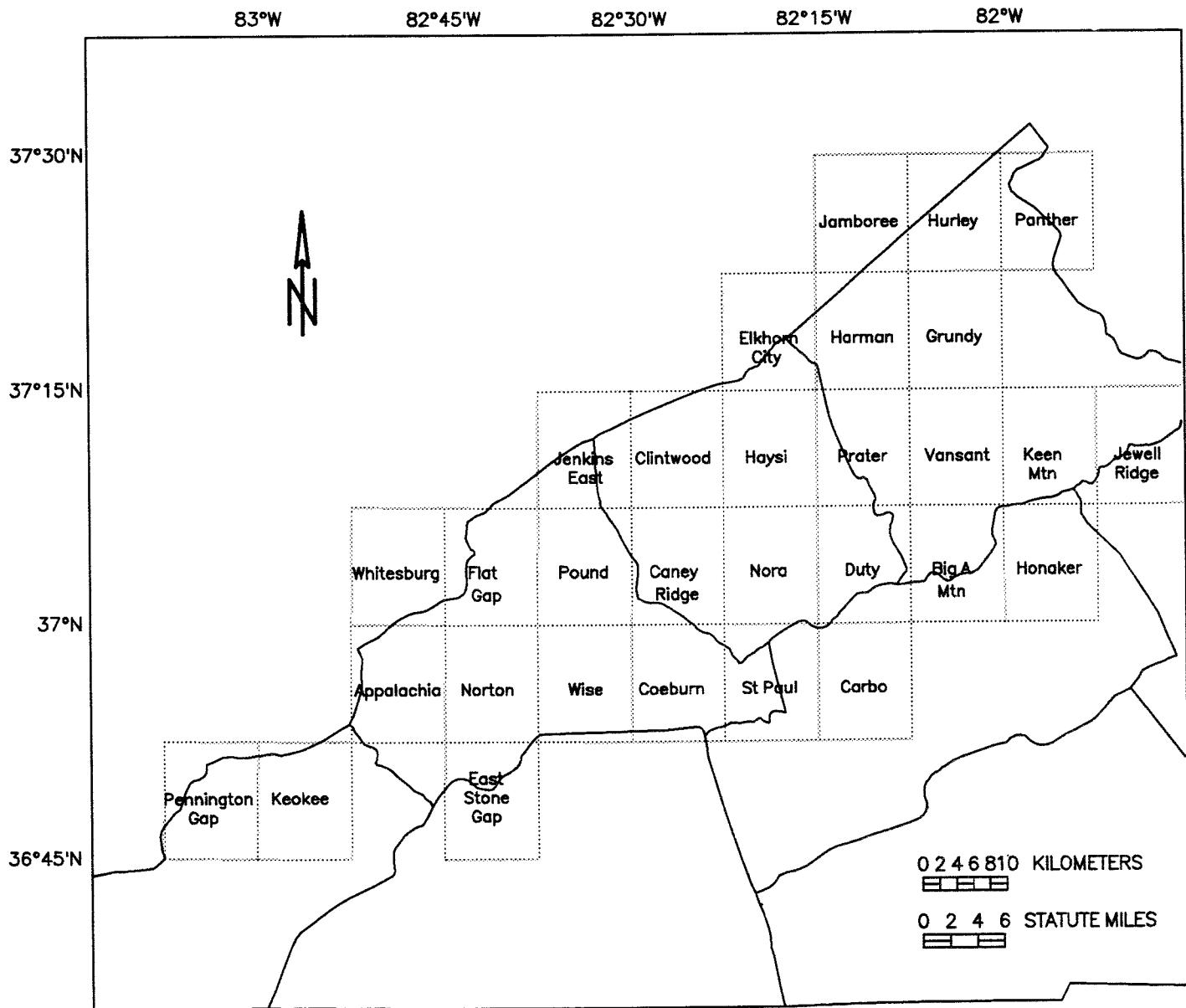


Figure 5. Topographic quadrangle index map of the Southwest Virginia coalfield (7.5-minute).

Fixed carbon is the material that remains after all the volatiles have been driven out of the coal. The fixed carbon value is not a specific compound and is determined mathematically by difference.

Ash is the inorganic residue remaining after the combustion of the coal at a temperature of 700° to 750° C. It can be intrinsic to the coal bed or introduced through external conditions, such as roof- and floor-rock contamination. Ash is primarily composed of compounds of silicon, aluminum, and iron with lesser amounts of calcium, magnesium, and alkalis.

Moisture (water) occurs in two ways: moisture inherent to the coal bed and surface moisture introduced into the coal by groundwater, rain, and coal preparation. The air-dry loss is the weight loss, expressed in percent, resulting from air drying the coal sample.

ULTIMATE ANALYSIS

The ultimate analysis is the composition of coal, in percent, of ash, sulfur, carbon, hydrogen, nitrogen, and oxygen (by difference). This elemental composition is used in various industrial applications to provide a basis for evaluation of the coal.

HEATING VALUE

Coal varies in the amount of heat energy it releases during the combustion process. In terms of the proximate analyses, volatile matter contributes about a third of the heating potential and fixed carbon supplies the remainder. High concentrations of the non-combustible components of

COAL-FIRED ELECTRIC GENERATING PLANT

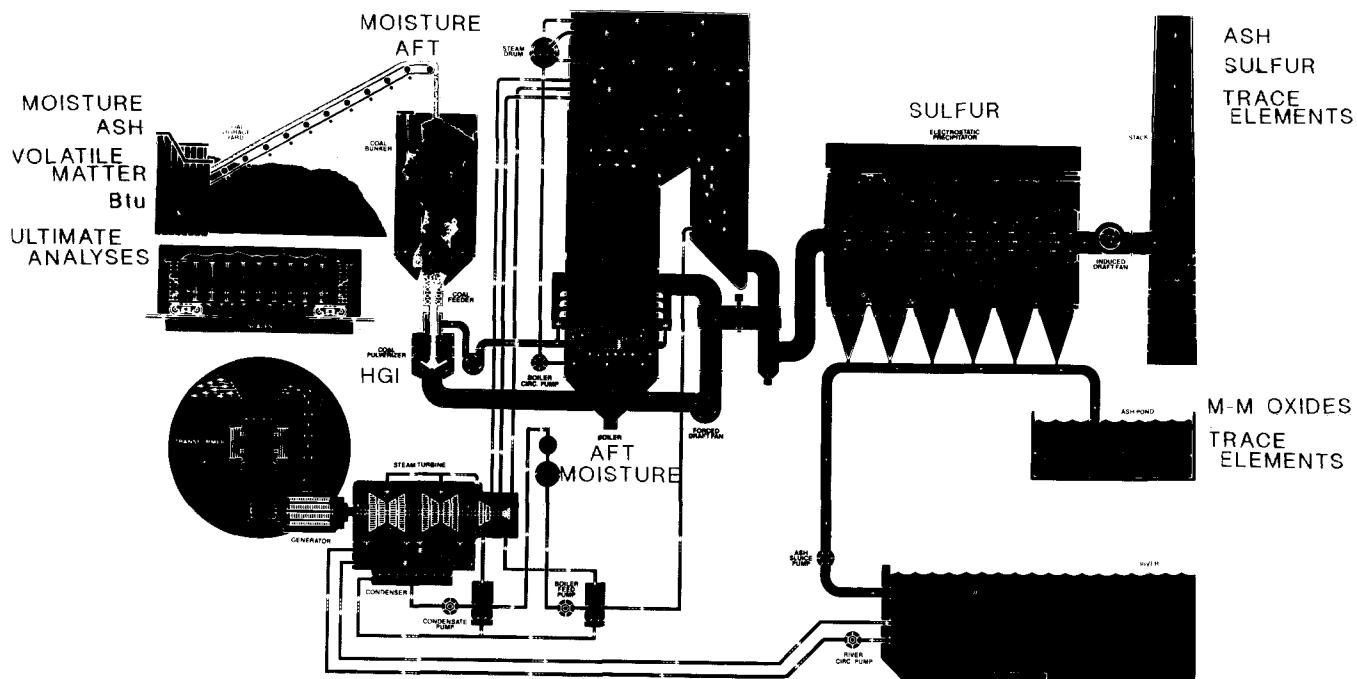


Figure 6. Relationship of analytical parameters to boiler operations. AFT = ash fusion temperature, Btu = British thermal unit, HGI = Hardgrove grindability index, M-M OXIDES = major- and minor-element oxides (Modified from Erwin and others, 1986. Drawing courtesy of Virginia Power Company).

ash and moisture will lower the potential heating value of the coal. Laboratory-derived values for the heat of combustion (heat content) of coal is expressed in British thermal unit per pound of coal (Btu/lb.)

ASH-FUSION TEMPERATURES

In order to predict slagging characteristics of a coal, an ash-fusion temperature analysis is performed. A small cone of coal ash is heated in a laboratory furnace at standardized temperatures and pressures. As the tip of the cone begins to melt, this marks the initial deformation temperature and corresponds to early stages of slagging. The softening temperature is the temperature when the cone melts to a spherical lump where the height is equal to the width of the base. The final stage is the fluid temperature at which the ash has melted to a layer less than 1/16-inch thick. Ash will become molten and flow at this temperature and may form slag and clinkers in boilers.

FREE-SWELLING INDEX

The free-swelling index gives an indication of the caking characteristics of the coal. It is not generally used as an indicator of the swelling properties of coal in carbonization processes. Caking during combustion in the boiler furnace can cause heat loss by insulating steam tubes from the heat source.

HARDGROVE GRINDABILITY INDEX

Hardness of coal is a function of maturity, thickness of homogeneous layers in the coal, abundance of inorganic matter, depositional, and postdepositional events which influenced peat deposition and coal bed formation. Most industrial applications require the coal to be crushed and ground before use and the hardness of the coal directly relates to wear on crushing and grinding equipment. Boiler parts are also eroded by the abrasion of coal particles entering the boiler under pressure. The Hardgrove grindability index (HGI) measures the difficulty of grinding coal in comparison to a standard (ASTM, 1982). Virginia's coals are generally high-volatile and exhibit low HGI values. These coals are moderately easy to pulverize.

MAJOR- AND MINOR-OXIDES AND TRACE ELEMENTS

Major- and minor-oxide and trace element concentrations have been analyzed on ash- and whole-coal basis by the U. S. Geological Survey's Branch of Geochemistry following the schematic shown in Table 1. Throughout the body of this paper, the symbol for elements and oxides are used for sake of brevity. All U. S. Geological Survey analyses are performed in Reston, Virginia, with the exception of U, which is performed in Denver, Colorado. Table 2 shows the symbols used for the major- and minor-oxides, and the trace elements.

The element Hg is analyzed by flameless atomic absorption and the element F is analyzed by specific ion electrode on the whole-coal. Cl and P are analyzed by x-ray fluorescence on the whole-coal. Instrumental neutron activation analysis provides data for the following trace elements on a whole coal basis: As, Br, Ce, Co, Cr, Cs, Eu, Hf, La, Lu, Rb, Sb, Sc, Se, Sm, Ta, Tb, Th, W, and Yb. U is determined by delayed neutron activation. Cd, Cu, Li, Mg, Mn, Na, Pb, and Zn are determined by atomic absorption on coal ash. Optical emission spectrographic analysis with automated plate reader provides the following 32 elements on an ash-basis: Ag, Au, B, Ba, Be, Bi, Dy, Er, Ga, Gd, Ge, Ho, In, Ir, Mo, Nb, Nd, Ni, Os, Pd, Pr, Pt, Re, Rh, Ru, Sn, Sr, Tl, Tm, V, Y, and Zr. The following list of elements analyzed by the previous method are found to be below their detection limits for all 375 samples: Au, In, Ir, Os, Pt, Re, Rh, and Ru. Analyses for the oxides Al_2O_3 , CaO , Fe_2O_3 , K_2O , SiO_2 , SO_3 , and TiO_2 are provided by x-ray fluorescence on coal ash. Data for the oxides MgO , Na_2O , and MnO are calculated from the Mn, Mg, and Na data provided by atomic absorption. Data tables with a suffix of "c" provide the major- and minor-oxide data on an ash basis. Tables with a suffix of "d" provide the major- and minor-oxide data calculated to an elemental whole-coal basis as well as the trace element data on a whole-coal basis. The whole-coal determinations are performed on air-dried coal (32°C) and the ashed-sample determinations were performed on coal ashed at 525°C. Analytical procedures used by the USGS are described by Swanson and Huffman (1976).

Some trace elements retained in fly ash, such as Ge and Zn, may have economic potential (Cobb and others, 1980). The trace elements As, B, Pb, Mo, and Se are environmentally hazardous; their excessive concentration in the atmosphere can contaminate surface and groundwaters (Harvey and Ruch, 1986).

SULFUR EMISSIONS

Simply stated, compliance coal is that which does not exceed EPA sulfur dioxide emission standards, without the benefit of sulfur-reducing coal preparation. Public concern for air quality was exemplified by the passage into law of the Air Quality Act in 1963 and its' later revisions, the Clean Air Acts of 1970 and 1990. The United States Environmental Protection Agency (EPA) was created, in part, to develop and enforce regulations that maintain environmentally acceptable emissions of man-made pollutants into the biosphere. The "smoke stack" industries, especially coal-burning electric power generation plants, are particularly affected by EPA emission limitations of sulfur dioxide, nitrogen oxides, and particulate matter into the atmosphere.

Coal-burning emission sources are currently operating in compliance with the EPA's New Source Performance Standards and it's amendments (EPA, 1989). Sulfur dioxide emissions for power plants of greater than 250 million British thermal units (Btu) consumption and constructed before 1971 must emit at or below 2.64 pounds of sulfur dioxide per million Btu. Those built after 1971 must have emission levels

less than 1.2 pounds of sulfur dioxide per million Btu. Plants built after 1978 must also meet the 1.2 sulfur dioxide limit and additionally reduce the amount of sulfur in raw coal by 90 percent.

The amount of sulfur which could potentially be released during coal combustion may be reduced before, during, or after combustion in order to meet standards. Coal preparation during and immediately after mining can reduce total sulfur delivered to the power plant. Utilization of limestone and quicklime in the combustion process will also reduce the total amount of sulfur given off as the coal burns (Sweet and others, 1987). Finally, various flue scrubber systems can reduce total sulfur in stack gases. The quality of coal being used as a fuel will dictate the amount and type of potential emissions, and therefore the type of coal preparation.

Sulfur dioxide in stack emissions results from the chemical alteration of sulfur forms which are naturally present in coal. Sulfur occurs in three forms in coal: sulfide minerals (also known as the pyritic fraction), as sulfate minerals, and as organically bound sulfur. Pyrite and marcasite are the dominant sulfide minerals found in coal and occur as discrete balls, lenses, and films. Reduction of sulfide sulfur of the coal may be accomplished by physical means such as washing and grinding (Cavallaro and Deurbrouck, 1965). Indeed, if significant amounts of sulfide are extracted by cleaning, it may be economical to produce sulfuric acid or elemental sulfur as by-products (Lasaga, 1981). Also able to be physically removed from the coal is the sulfate sulfur, which comprises a relatively small percent of the total sulfur found in coal. Organic sulfur is intrinsically associated with the original organic matter from which coal was formed; it cannot be separated from coal by mechanical means but fortunately contributes little to the total sulfur content of Virginia coals.

Calculation of potential sulfur dioxide emissions has been demonstrated by Cavallaro and others (1976) by utilizing the equation:

$$\text{Pounds SO}_2 \text{ per million Btu} = \frac{(20,000) (\% \text{ total sulfur})}{\text{Btu per pound}}$$

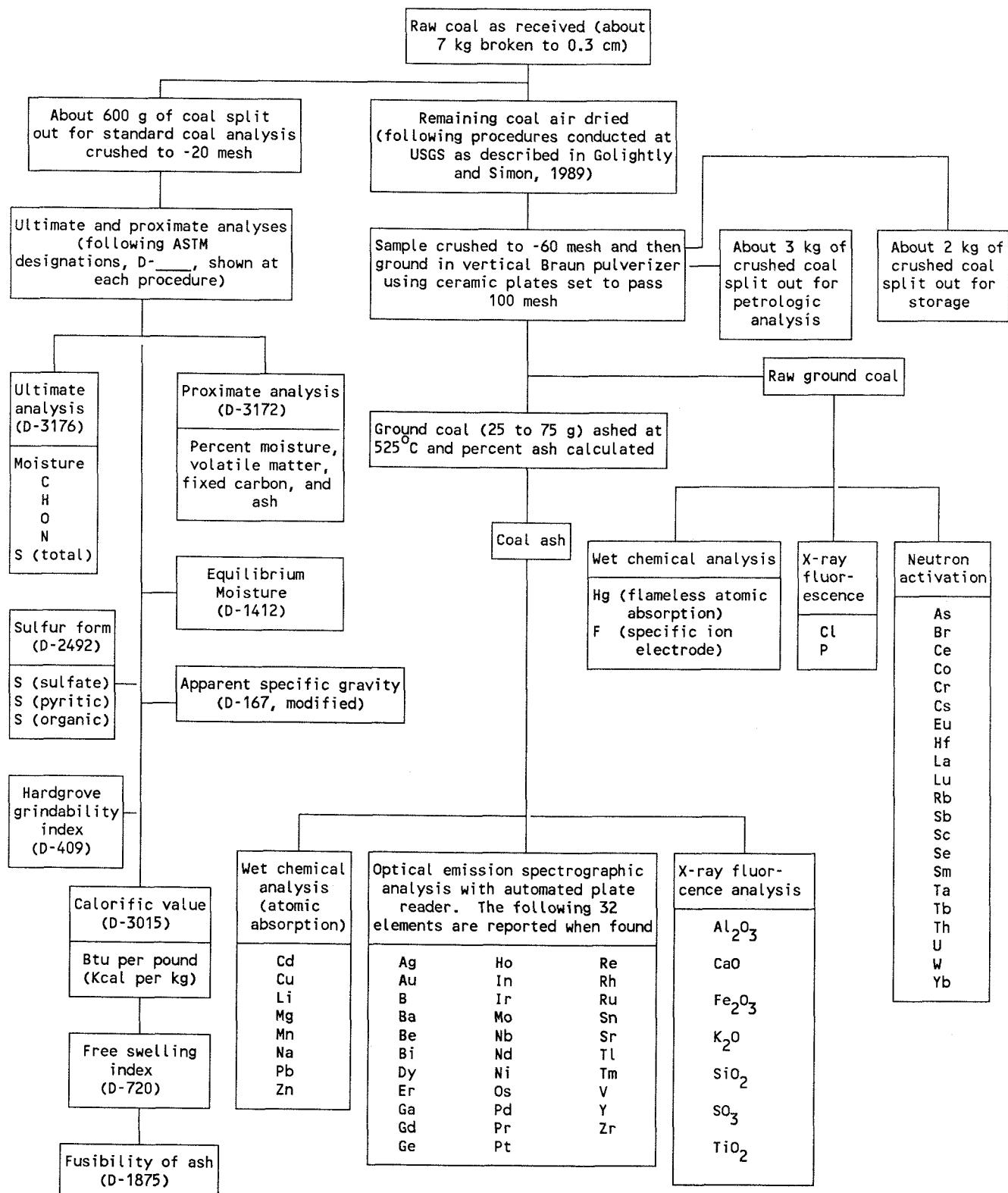
Cobb and others (1982) showed that the sulfur and Btu values can be derived from either the as-received, moisture-free, or moisture- and mineral matter-free basis; the same result will be obtained using any of these categories.

COAL BED DESCRIPTION, LOCATION, AND ANALYTICAL RESULTS

EXPLANATION OF TERMS USED IN TABLES AND DISCUSSIONS

Elemental concentrations entered in the statistical summary tables (tables with suffixes e, f, g) are based on calculations utilizing only unqualified values, i.e., those which are not modified by "L" (less than), "G" (greater than), "B" (not determined), "N" (looked for but not found), and "H" (inter-

Table 1. Flow diagram of procedures used for the analysis of coal samples collected. (ASTM - American Society for Testing Materials - analyses performed by U.S. Bureau of Mines, U.S. Department of Energy, and Geochemical Testing Company; remaining analyses performed by the USGS - U.S. Geological Survey.)



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Table 2. Symbols for major- and minor-oxides, major- and minor-elements, trace elements.

Major- and Minor-Oxides		Major- and Minor-Elements	
Al ₂ O ₃	Aluminum oxide	Al	Aluminum
CaO	Calcium oxide	Ca	Calcium
Fe ₂ O ₃	Ferric oxide	Fe	Iron
K ₂ O	Potassium oxide	K	Potassium
MgO	Magnesium oxide	Mg	Magnesium
MnO	Manganese oxide	Mn	Manganese
Na ₂ O	Sodium oxide	Na	Sodium
P ₂ O ₅	Phosphorus pentoxide	P	Phosphorous
SiO ₂	Silicon dioxide	Si	Silicon
SO ₃	Sulfur trioxide (sulfate)		
TiO ₂	Titanium dioxide	Ti	Titanium
Trace Elements			
Ag	Silver	Nb	Niobium
As	Arsenic	Nd	Neodymium
Au	Gold	Ni	Nickel
B	Boron	Os	Osmium
Ba	Barium	Pb	Lead
Be	Beryllium	Pd	Palladium
Bi	Bismuth	Pr	Praseodymium
Br	Bromine	Pt	Platinum
Cd	Cadmium	Rb	Rubidium
Ce	Cerium	Re	Rhenium
Cl	Chlorine	Rh	Rhodium
Co	Cobalt	Ru	Ruthenium
Cr	Chromium	Sb	Antimony
Cs	Cesium	Sc	Scandium
Cu	Copper	Se	Selenium
Dy	Dysprosium	Sm	Samarium
Er	Erbium	Sn	Tin
Eu	Europium	Sr	Strontium
F	Fluorine	Ta	Tantalum
Ga	Gallium	Tb	Terbium
Gd	Gadolinium	Th	Thorium
Ge	Germanium	Tl	Thallium
Hf	Hafnium	Tm	Thulium
Hg	Mercury	U	Uranium
Ho	Holmium	V	Vanadium
In	Indium	W	Tungsten
Ir	Iridium	Y	Yttrium
La	Lanthanum	Yb	Ytterbium
Li	Lithium	Zn	Zinc
Lu	Lutetium	Zr	Zirconium
Mo	Molybdenum		

Miscellaneous abbreviations and symbols

BMASH	Sample ashed at 700° to 750°C by U.S. Bureau of Mines (referred to in text as BMASH and called ash in tables with suffix "b")
BTU/LB	British thermal unit per pound of coal
C	Carbon
H	Hydrogen
N	Nitrogen
O	Oxygen
S	Sulfur
USGSASH	Sample ashed at 525°C by U.S. Geological Survey (referred to in text as USGSASH and called ash in tables with suffix "a")

ference for an element which cannot be resolved by any routine method), and only for those coal beds which have five or more samples. In the statistical summary tables (tables with prefix of e, f, and g), three dashes for the value "n" indicates that all samples are below the detection limit for that parameter. The geometric mean is used because trace elements concentrations in natural materials commonly have positively skewed frequency distributions. These frequency distributions are normalized on a logarithmic basis and are referred to as lognormal distributions. The unweighted geometric mean (GM) is calculated by taking the logarithm of each analytical value, summing the logarithms, dividing the sum by the total number of values, and then obtaining the anti-logarithm of the result.

The geometric means for the individual coal beds in Southwest Virginia are compared with the geometric means of 5,262 bituminous samples for the Appalachian basin which are stored in NCRDS's USCHEM data base. This data set includes all sampled coal beds in the Appalachian basin. For comparison purposes, a percent difference is calculated between the geometric means. A geometric mean is considered to be substantially higher for the coal bed if the percent difference between the geometric mean of the Appalachian basin and the geometric mean of the coal bed is negative and greater than or equal to 50 percent. It is considered to be substantially lower for the coal bed if the percent difference for the geometric means is positive and greater than or equal to 50 percent. Elements that are below the detection limits are listed as looked for but not found for each bed; the substantially higher and substantially lower elements are also listed. There is no other interpretation of the data.

All samples were taken from the freshest exposures possible and were collected using channel sampling as suggested by Schopf (1960) and ASTM (1982). Unless otherwise noted in the descriptive tables, all samples were collected in a fresh condition. Terminology concerning the portion of the coal bed that was sampled follows that of the U. S. Geological Survey (Tewalt, 1989). In this report, a split is a coal that is separated from other coal by one foot or more of non-coal material. A bench has less than one foot of non-coal parting material. The samples may or may not be contiguous. The term, partial, is used when only part of the coal bed is sampled. A composite sample is when two or more coal samples from different localities were combined into one. Full thickness sample indicates that all the coal was sampled from a complete coal bed. Descriptive terminology concerning the condition of the roof in underground mines is modified from Milici and Gathright, 1985. All tonnages are given as short tons. Ash values of the proximate analyses and the major and minor oxides may vary slightly due to analytical testing by different laboratories.

POCAHONTAS FORMATION

POCAHONTAS NO. 3 COAL BED

The Pocahontas No. 3 coal bed crops out in Tazewell County and occurs in the subsurface in Buchanan, Dickenson, Russell, and Wise Counties. The Burtons Ford coal bed of Russell and Scott Counties may be stratigraphically equivalent to the Pocahontas No. 3. In 1989, a total of 9.3 million tons were produced from this coal, making it the most mined coal in Virginia (Virginia Division of Mines, 1990). The range of thickness is from 1.7 to 11 feet (Henderson, 1979). At locations sampled for this report (Figure 7), the average coal thickness is from 4 to 5 feet. The coal displays a well-developed, very fine cleat and abundant thin banding. There are usually two or more shale partings that have a collective thickness less than 0.5 foot. Slickensides were noted at one sample location where a rare sample of cone-in-cone structure in coal was collected by the senior author. This structure has been interpreted as being related to earthquake activity at a time before lithification of the coal bed. The roof at all sample localities is stable shale containing abundant plant fossils. Methane gas readily escapes from the coal in the shaft mines and is controlled by in-mine ventilation and by bleeding the gas through vertical drill holes placed in advance of mining.

The Pocahontas No. 3 coal bed is a low-sulfur, high fixed carbon coal and is Virginia's best coking-coal. Coke is produced from the Pocahontas No. 3 at the Jewell Smokeless Coal Company coke ovens on Dismal Creek, Buchanan County. Most production comes from shaft mines in Buchanan County, which are the deepest coal mines in Virginia (Figure 8). The mines have an average depth of 1,500 feet and a coal elevation within tens of feet above sea level.

The description and location data are available in Table 3a. Analyses of 10 samples from the Pocahontas No. 3 coal bed are reported in Tables 3b, 3c, and 3d. Statistical summaries are included in Tables 3e, 3f, and 3g. In addition to the previously listed elements which are below the detection limits for all 375 coal samples, Bi, Ho, Pd, Tl, and Tm are found to be below detection limits in the Pocahontas No. 3 coal samples. The elements Dy, Pn, Rb, and W have less than five values, therefore the means were not calculated. In comparing the geometric means of these 10 samples of the Pocahontas No. 3 coal bed in Tables 3e, 3f, and 3g with the geometric means of the 5,262 bituminous coal samples from the Appalachian basin, CaO, MgO, Na₂O, MnO, SO₃, Br, and Cl are found to be substantially higher for the Pocahontas No. 3 samples. The geometric means for B, Cd, Ga, Ge, Hg, Sn, Zn, moisture, oxygen, sulfur, pyritic sulfur, and air-dried loss in the Pocahontas No. 3 coal samples are determined to be substantially lower than the geometric means for the samples in the Appalachian basin.

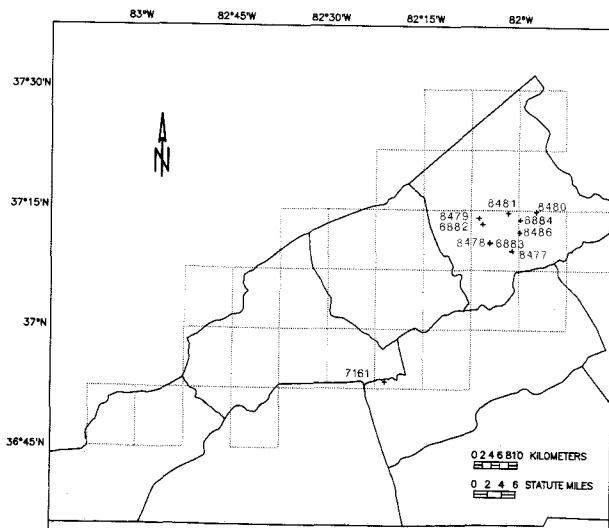


Figure 7. Locations for samples from the Pocahontas No. 3 coal bed, SW VA.

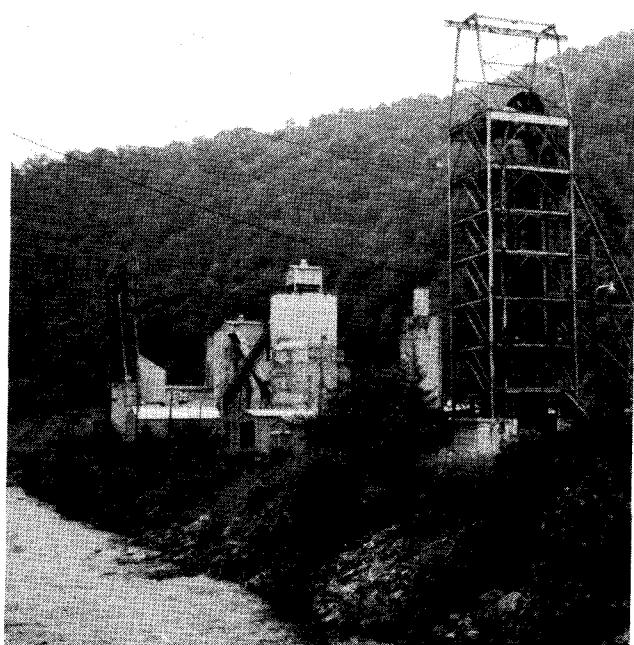


Figure 8. Virginia Pocahontas No. 4 mine complex of the Island Creek Coal Company. This and other shaft mines in Buchanan County are mining the Pocahontas No. 3 coal bed.

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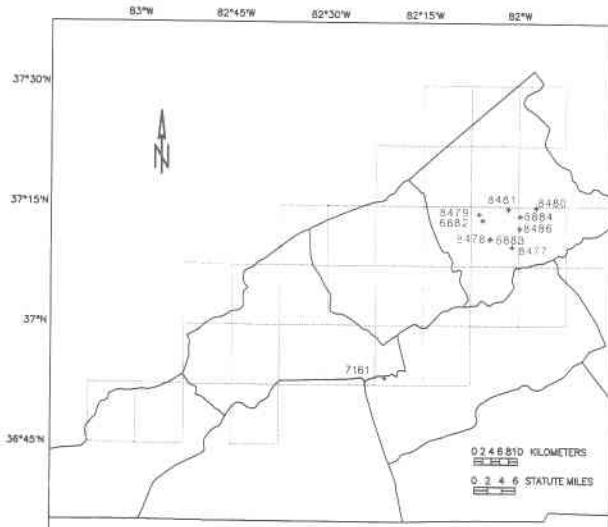


Figure 7. Locations for samples from the Pocahontas No. 3 coal bed, SW VA.

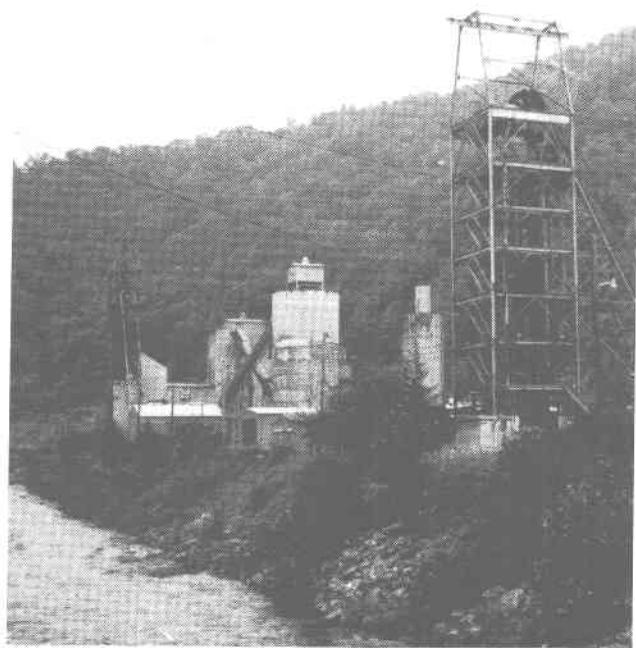


Figure 8. Virginia Pocahontas No. 4 mine complex of the Island Creek Coal Company. This and other shaft mines in Buchanan County are mining the Pocahontas No. 3 coal bed.

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Table 3a.--Descriptions and locations for 10 bituminous coal samples from the Pocahontas No. 3 coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-6882	W193935	88A-1	371059N	820427W	Vansant (7.5')	Buchanan	67.32	Underground mine	Full Thickness
R-6883	W193934	88A-2	371059N	820428W	Vansant (7.5')	Buchanan	65.64	Underground mine	Full Thickness
R-6884	W193933	87B-1	371349N	815945W	Keen Mountain (7.5')	Buchanan	53.04	Underground mine	Full Thickness
R-7161	W199465	59A-4	365324N	822057W	St. Paul (7.5')	Russell	56.40	Surface mine, s.l.	Full Thickness
R-8477	W214764	88A-8	370956N	820102W	Vansant (7.5')	Buchanan	62.40	Underground mine	Full Thickness
R-8478	W214765	88A-9	371051N	820431W	Vansant (7.5')	Buchanan	64.80	Underground mine	Full Thickness
R-8479	W214766	88A-10	371400N	820614W	Vansant (7.5')	Buchanan	55.80	Underground mine, s.l.	Weathered
R-8480	W214762	87B-7	371450N	815713W	Keen Mountain (7.5')	Buchanan	42.60	Underground mine, s.l.	Weathered
R-8481	W214767	88A-11	371439N	820136W	Vansant (7.5')	Buchanan	46.80	Underground mine, s.l.	Weathered
R-8486	W214763	87B-9	371214N	815949W	Keen Mountain (7.5')	Buchanan	54.00	Underground mine, s.l.	Weathered

Table 3b.--Approximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 10 bituminous coal samples from the Pocahontas No. 3 coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, ash-fusion temperatures, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. G for ash-fusion temperatures means greater than value shown. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	Moisture	PROXIMATE ANALYSIS			ULTIMATE ANALYSIS			HEAT CONTENT			Lab Number	
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	
R-6882	1.2	15.3	67.5	16.0	4.0	74.8	1.0	3.3	0.9	7,130	12,840	W193935
	--	15.5	68.3	16.2	3.9	75.7	1.0	2.3	.9	7,220	12,990	
	--	18.5	81.5	--	4.7	90.3	1.2	2.7	1.1	8,610	15,500	
R-6883	.8	17.6	69.2	12.4	4.0	78.4	1.0	3.3	.9	7,480	13,470	W193934
	--	17.7	69.8	12.5	3.9	79.0	1.0	2.6	.9	7,540	13,580	
	--	20.3	79.7	--	4.5	90.3	1.2	3.0	1.0	8,620	15,520	
R-6884	.9	15.6	76.0	7.5	4.3	83.6	1.1	2.9	.6	8,010	14,420	W193933
	--	15.7	76.7	7.6	4.2	84.4	1.1	2.1	.6	8,080	14,450	
	--	17.0	83.0	--	4.6	91.3	1.2	2.3	.7	8,740	15,740	
R-7161	2.5	32.2	61.5	3.8	5.1	82.2	1.1	7.3	.4	7,970	14,350	W199465
	--	33.0	63.1	3.9	4.9	84.3	1.1	5.2	.4	8,170	14,710	
	--	34.4	65.6	--	5.1	87.7	1.2	5.4	.4	8,510	15,310	
R-8477	1.2	18.3	68.3	12.2	4.0	78.7	1.1	3.3	.7	7,510	13,520	W214764
	--	18.5	69.2	12.4	3.9	79.7	1.1	2.2	.7	7,610	13,690	
	--	21.1	78.9	--	4.5	91.0	1.3	2.5	.8	8,680	15,620	
R-8478	1.1	18.8	70.0	10.0	4.2	79.7	1.1	4.1	.8	7,720	13,890	W214765
	--	19.0	70.8	10.1	4.1	80.6	1.2	3.2	.8	7,810	14,050	
	--	21.2	78.8	--	4.5	89.7	1.3	3.5	.9	8,690	15,640	
R-8479	1.6	20.3	73.9	4.2	4.6	85.2	1.2	4.3	.6	8,150	14,670	W214766
	--	20.6	75.1	4.3	4.5	86.6	1.2	2.9	.6	8,280	14,900	
	--	21.5	78.5	--	4.7	90.4	1.2	3.1	.6	8,650	15,560	
R-8480	1.5	17.7	76.4	4.4	4.3	85.0	1.2	4.5	.6	8,190	14,740	W214762
	--	17.9	77.6	4.4	4.2	86.3	1.2	3.2	.7	8,310	14,960	
	--	18.8	81.2	--	4.4	90.3	1.2	3.3	.7	8,700	15,660	
R-8481	1.4	18.0	76.9	3.6	4.3	85.8	1.2	4.5	.7	8,210	14,770	W214767
	--	18.3	78.0	3.7	4.2	87.0	1.2	3.2	.7	8,330	14,990	
	--	19.0	81.0	--	4.4	90.4	1.2	3.4	.7	8,650	15,570	

VIRGINIA DIVISION OF MINERAL RESOURCES

Table 3b.-Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 10 bituminous coal samples from the Pocahontas No. 3 coal bed, Southwest Virginia.--continued

Sample Number	Air-dried Loss	FORMS OF SULFUR			ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number	
		Sulfate	Pyritic	Organic	Initial Deformation	Softening	Fluid				
R-6882	.7	.01	.26	.60	4.5	1,495	1,540	---	1.40	W193935	
	---	.01	.26	.61							
	---	.01	.31	.72							
R-6883	.4	.01	.38	.47	6.5	1,210	1,265	1,315	---	1.34	W193934
	---	.01	.38	.47							
	---	.01	.44	.54							
R-6884	.5	.01	.19	.45	3.5	1,285	1,330	1,370	---	.83	W193933
	---	.01	.19	.45							
	---	.01	.21	.49							
R-7161	.6	.02	.02	.40	3.5	1,320	1,350	1,525	---	.56	W199465
	---	.02	.02	.41							
	---	.02	.02	.43							
R-8477	.6	.02	.19	.49	7.5	1,325	1,370	1,425	---	1.04	W214764
	---	.02	.19	.50							
	---	.02	.22	.57							
R-8478	.3	.04	.28	.52	6.5	1,295	1,360	1,410	---	1.15	W214765
	---	.04	.28	.53							
	---	.05	.32	.59							
R-8479	.6	.04	.05	.47	5.0	1,170	1,210	1,255	---	.82	W214766
	---	.04	.05	.48							
	---	.04	.05	.50							
R-8480	.6	.06	.14	.45	3.0	1,245	1,305	1,355	---	.81	W214762
	---	.06	.14	.46							
	---	.06	.15	.48							
R-8481	.5	.09	.11	.46	3.5	1,205	1,280	1,325	---	.95	W214767
	---	.09	.11	.47							
	---	.09	.12	.48							

Table 3b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 10 bituminous coal samples from the Pocahontas No. 3 coal bed, Southwest Virginia.--continued

Sample Number	PROXIMATE ANALYSIS					ULTIMATE ANALYSIS					HEAT CONTENT		
	Moisture	Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/KG	Btu/lb	Lab Number	
R-8486	1.6	18.0	75.0	5.5	4.4	84.8	1.1	3.6	0.6	8,060	14,510	W214763	
---	---	18.3	76.2	5.6	4.3	86.1	1.1	2.3	.6	8,190	14,740		
---	---	19.3	80.7	--	4.5	91.2	1.2	2.4	.6	8,670	15,610		

Sample Number	FORMS OF SULFUR					ASH-FUSION TEMPERATURE (°C)							
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid	Hardgrove grindability index	Compliance Number	Lab Number		
R-8486	0.6	0.05	0.09	0.46	2.5	1,190	1,265	1,320	---	0.83	W214763		

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Table 3c.--Major- and minor-oxide concentrations in the laboratory ash of 10 bituminous coal samples from the Pocahontas No. 3 coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. L means less than the concentration shown. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-6882	16.9	42	28	4.0	0.61	0.65	1.6	3.6	1.3	0.19	0.32	W193935
R-6883	11.8	28	13	20	1.6	.63	.72	9.1	.88	.15	16	W193934
R-6884	5.7	31	17	14	1.3	.53	.78	12	1.2	.12	13	W193933
R-7161	4.0	40	26	6.4	.88	.39	.52	14	1.1	.13	9.7	W199465
R-8477	12.9	43	19	13	1.4	.80	1.2	7.1	1.2	.12	8.2	W214764
R-8478	8.1	31	20	12	2.3	1.2	2.5	13	.80	.12L	11	W214765
R-8479	4.2	28	19	15	1.7	1.4	.82	10	.82	.24L	15	W214766
R-8480	5.9	40	20	10	1.4	.49	1.2	13	1.1	.17L	8.8	W214762
R-8481	8.8	51	24	5.0	.88	.82	.83	7.4	1.4	.11L	4.1	W214767
R-8486	18.3	58	32	24	.85	.53	1.1	4.8	1.8	.12	3.0	W214763

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Table 3d. --Major-, minor-, and trace-element composition of 10 bituminous coal samples from the Pocahontas No. 3 coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means less than the value shown; B, not determined; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-6882	3.3	2.5	0.48	0.062	0.081	0.23	0.43	0.13	0.035	13	W193935
R-6883	1.5	.80	1.7	.12	.055	.071	.75	.062	.018	15	W193934
R-6884	.83	.52	.57	.045	.022	.037	.48	.041	.031	6.3	W193933
R-7161	.75	.56	.18	.021	.012	.017	.38	.027	.017	2.8	W19465
R-8477	2.6	1.3	1.2	.11	.076	.13	.64	.092	.048	12	W214764
R-8478	1.2	.87	.69	.11	.075	.17	.74	.039	.019	30	W214765
R-8479	.54	.42	.46	.042	.042	.029	.30	.021	.008	2.7	W214766
R-8480	1.1	.64	.44	.051	.021	.057	.55	.058	.035	7.2	W214762
R-8481	2.1	1.1	.31	.047	.054	.061	.45	.073	.044	10	W214767
R-8486	5.0	2.3	.42	.093	.071	.17	.62	.19	.097	9.8	W214763

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-6882	15	150	2.4	62	0.10	24	B	3.8	21	0.90	W193935
R-6883	11	110	.98	50	.083	17	B	6.2	10	.30	W193934
R-6884	4.3	52	1.7	75	.035	15	B	8.9	9.0	.50L	W193933
R-7161	15	21	.76	86	.038	9.0	B	1.8	4.5	.70L	W19465
R-8477	14	170	1.2	39	.021	17	1,300	5.9	12	.60	W214764
R-8478	19	120	.28	33	.036	12	1,500	3.2	8.8	.80	W214765
R-8479	6.3	71	.71	38	.008	7.0	2,100	2.6	3.8	.20	W214766
R-8480	2.7	65	1.5	51	.026	11	1,400	6.6	6.4	.30	W214762
R-8481	7.6	86	2.5	47	.018	17	1,800	5.8	9.3	.30	W214767
R-8486	15	130	3.7	44	.044	34	1,200	7.4	16	.80	W214763

Table 3d.--Major-, minor-, and trace-element composition of 10 bituminous coal samples from the Pocahontas No. 3 coal bed,
Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Cu (ppm)	Dy-S (ppm)	Er-S (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	Lab Number
R-6882	24	5.4L	2.0	0.43	.58	4.6	1.1L	0.78L	1.3	0.078	W193935
R-6883	15	3.8L	1.2L	.30	.29	3.1	1.3	.54L	.70	.11	W193934
R-6884	17	1.8L	.80	.26	.23	1.9	1.5	.86	.60	.060	W193933
R-7161	13	1.2	.40L	.15	.64	1.1	.84	.12	.30	.016	W199465
R-8477	25	3.7	1.3L	.32	.70	2.5	2.7	.30	.70	.050	W214764
R-8478	14	1.8L	.81L	.21	.80	2.5	1.2L	.12L	.40	.072	W214765
R-8479	8.4	.92L	.42L	.15	.40	.92	.63L	.07	.20	.050	W214766
R-8480	14	1.3L	.59L	.21	.30	2.4	1.6	.83	.40	.056	W214762
R-8481	17	1.9L	1.2	.28	.70	2.5	1.3L	.67	.60	.072	W214767
R-8486	38	4.0L	1.8L	.73	.30	5.1	2.7L	.66	1.5	.085	W214763

Sample Number	La (ppm)	Li (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Lab Number
R-6882	13	29	0.19	22	2.7	4.1	7.8L	8.3	140	9.1	W193935
R-6883	10	11	.13	46	1.9	1.2	5.4L	5.8	79	1.2	W193934
R-6884	8.0	7.4	.13	19	1.9	1.1	2.6L	6.3	31	1.7	W193933
R-7161	6.0	6.0	.04	10	1.2	.68	3.4	8.8	22	2.7	W199465
R-8477	11	7.7	.10	39	3.0	3.2	6.6	10	70	7.2	W214764
R-8478	6.0	2.9	.05	.27	2.1	.28	2.6L	4.5	44L	5.8	W214765
R-8479	5.0	1.6	.04	.18	3.2	.67	5.0	3.2	44L	2.2	W214766
R-8480	6.0	6.5	.08	.23	3.3	.71	7.1	11	44L	5.3	W214762
R-8481	10	11	.11	14	4.2	2.4	11	13	44L	5.6	W214767
R-8486	22	24	.14	20	2.7	4.4	8.8	18	96	18	W214763

Table 3d. --Major-, minor-, and trace-element composition of 10 bituminous coal samples from the Pocahontas No. 3 coal bed,
Southwest Virginia, reported on a whole-coal basis. -continued

Sample Number	Pr-S (ppm)	Rb (ppm)	Sb (ppm)	Sc (ppm)	Se (ppm)	Sm (ppm)	Sn-S (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Lab Number
R-6882	11L	10	1.1	4.6	4.5	2.4	1.1L	100	0.28	0.37	W193935
R-6883	8.0L	9.0L	1.1	2.2	3.9	1.7	.80L	99	.18	.24	W193934
R-6884	3.9L	9.0L	1.1	2.0	1.2	1.5	.54	52	.24L	.27	W193933
R-7161	2.7L	33L	1.0L	1.2	3.0	.75	.06L	180	.070	.11	W199465
R-8477	8.8L	30L	.60	2.4	2.7	1.4	.65	210	.22	.24	W214764
R-8478	5.5L	30L	.90	1.9	3.7	.90	.28	110	.12	.17	W214765
R-8479	3.1	20L	.20	.82	1.6	.70	.06L	100	.050	.13	W214766
R-8480	4.0L	10	.80	1.7	2.0	1.0	.10	65	.13	.21	W214762
R-8481	6.0L	30L	.70	2.3	2.7	1.2	.43	110	.20	.26	W214767
R-8486	12L	17	1.0	3.9	4.3	2.8	.92	180	.53	.43	W214763

Sample Number	Th (ppm)	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)		Lab Number
R-6882	4.6	2.3	24	1.4L	11	1.1	9.6	37	W193935	
R-6883	2.3	1.4	8.4	1.2L	5.8	.80	3.2	18	W193934	
R-6884	1.7	.88	8.0	1.3L	6.3	.80	3.2	13	W193933	
R-7161	1.0	.18L	6.0	.60L	3.6	.25	2.8	7.6	W199465	
R-8477	2.4	.96	14	.50	6.7	.70	4.3	36	W214764	
R-8478	1.6	.49	7.5	.70L	2.1	.40	6.5	6.0	W214765	
R-8479	.60	.28L	5.5	.70L	4.2	.40	1.3	12	W214766	
R-8480	1.3	.34L	8.9	.40	4.8	.80	6.5	11	W214762	
R-8481	2.0	.34L	14	.40	8.0	.80	4.8	26	W214767	
R-8486	4.4	1.6	18	.90	7.5	1.3	5.7	33	W214763	

Table 3e.--Arithmetic mean, observed range, and geometric mean of proximate and ultimate analyses, heat content, forms of sulfur, and ash-fusion temperatures for 10 bituminous coal samples from the Pocahontas No. 3 coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included.

[All values are in percent except Btu/lb, Kcal/kg, ash-fusion temperatures, and free-swelling index and are reported on an as-received basis. $^{\circ}\text{F} = 9/5 \ ^{\circ}\text{C} + 32$; Kcal/kg = 0.556 Btu/lb; (n) is number of samples per parameter.]

	Pocahontas No. 3 coal bed				Appalachian basin		
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean
			Min.	Max.			(n)
Proximate and ultimate analyses							
Moisture	(10)	1.39	0.80	2.50	1.32	3.23	2.69 (4,760)
Volatile matter	(10)	19.18	15.30	32.20	18.76	32.46	31.72 (4,760)
Fixed carbon	(10)	71.47	61.50	76.86	71.31	52.48	51.76 (4,760)
Ash	(10)	7.96	3.64	16.00	6.92	11.83	9.83 (4,760)
Hydrogen	(10)	4.31	3.99	5.10	4.30	5.02	5.00 (4,760)
Carbon	(10)	81.82	74.80	85.76	81.74	70.69	70.17 (4,760)
Nitrogen	(10)	1.11	1.00	1.17	1.10	1.39	1.37 (4,757)
Oxygen	(10)	4.11	2.90	7.30	3.98	8.92	8.22 (4,756)
Sulfur	(10)	.68	.40	.90	.66	2.15	1.63 (4,974)
Heat content							
KCal/kg	(10)	7,849	7,138	8,214	7,841	7,030	6,979 (4,759)
Btu/lb	(10)	14,117	12,838	14,773	14,103	12,644	12,553 (4,759)
Forms of sulfur							
Sulfate	(10)	0.03	0.01	0.09	0.03	0.08	0.04 (4,245)
Pyritic	(10)	.17	.02	.38	.13	1.36	.65 (4,392)
Organic	(10)	.48	.40	.60	.47	.82	.70 (4,393)
Ash-fusion temperature ($^{\circ}\text{C}$)							
Initial deformation	(9)	1,274	1,171	1,496	1,271	1,255	1,246 (4,063)
Softening	(9)	1,304	1,210	1,371	1,303	1,287	1,280 (3,722)
Fluid	(10)	1,367	1,254	1,527	1,365	1,334	1,328 (3,449)
Free-swelling index	(10)	4.60	2.50	7.50	4.33	5.53	4.68 (4,603)
Air-dried loss	(10)	0.55	0.31	0.70	0.54	1.83	1.13 (3,868)

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Table 3f.--Arithmetic mean, observed range, and geometric mean of ash content and concentrations of 11 major- and minor-oxides in the laboratory ash of 10 bituminous coal samples from the Pocahontas No. 3 coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. (n) indicates the number of samples per oxide.

[All samples were ashed at 525°C; all data are in percent.]

	Pocahontas No. 3 coal bed				Appalachian basin			
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
			Min.	Max.				
(Ash)	(10)	9.7	4.0	18	8.5	13	10	(5,262)
SiO ₂	(10)	39	28	58	38	43	41	(5,229)
Al ₂ O ₃	(10)	21	13	28	21	24	23.	(5,229)
CaO	(10)	10	3.2	20	8.8	2.2	1.5	(5,227)
MgO	(10)	1.3	.61	2.3	1.2	.85	.75	(5,258)
Na ₂ O	(10)	.74	.39	1.4	.69	.43	.34	(5,194)
K ₂ O	(10)	1.1	.52	2.6	1.0	2.0	1.7	(5,229)
Fe ₂ O ₃	(10)	9.4	3.6	14	8.6	19	13	(5,215)
MnO	(10)	.04	.014	.05	.03	.03	.02	(5,260)
TiO ₂	(10)	1.2	.80	1.8	1.1	1.2	1.1	(5,203)
P ₂ O ₅	(6)	.14	.12	.19	.14	.50	.22	(3,389)
SO ₃	(10)	8.9	.32	16	6.3	2.5	1.9	(5,063)

Table 3g.--Arithmetic mean, observed range, and geometric mean of concentrations of 54 trace elements in 10 bituminous coal samples from the Pocahontas No. 3 coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. Dashed values (---) represent less than five samples; (n) indicates the number of samples per element. [All data are in parts-per-million and are reported on a whole-coal basis.]

	Pocahontas No. 3 coal bed				Appalachian basin		
	Arith. mean (n)	Observed range		Geom. mean	Arith. mean	Geom. mean	(n)
		Min.	Max.				
Ag (10)	0.04	0.008	0.10	0.03	0.07	0.05	{4,565}
As (10)	11	2.7	30	8.6	35	13	{5,197}
B (10)	11	2.7	19	9.4	30	20	{5,076}
Ba (10)	98	21	170	85	90	63	{5,134}
Be (10)	1.6	.28	3.7	1.3	2.5	2.0	{5,247}
Bi ---	---	---	---	---	1.5	1.1	(108)
Br (10)	53	33	86	50	22	13	{4,892}
Cd (10)	.04	.008	.10	.03	.10	.07	{4,978}
Ce (10)	16	7.0	34	15	21	17	{5,075}
Cl (6)	1,600	1,200	2,100	1,500	780	510	{3,646}
Co (10)	5.2	1.8	8.9	4.7	7.4	5.7	{5,217}
Cr (10)	10	3.8	21	8.9	18	15	{5,205}
Cs (8)	.52	.20	.90	.46	1.3	.85	{4,831}
Cu (10)	18	8.4	38	17	19	15	{5,239}
Dy (2)	---	1.2	3.7	---	3.3	2.6	(759)
Er (3)	---	.80	2.0	---	1.5	1.2	(1,200)
Eu (10)	.30	.14	.73	.27	.44	.37	{5,032}
F (10)	49	23	80	45	99	71	{4,860}
Ga (10)	2.7	.92	5.1	2.4	6.6	5.4	{5,046}
Gd (5)	1.6	.84	2.7	1.5	2.6	1.9	{1,773}
Ge (7)	.50	.071	.85	.36	4.7	2.5	{4,608}
Hf (10)	.67	.20	1.5	.56	.79	.62	{4,932}
Hg (10)	.06	.016	.11	.06	.22	.15	{5,031}
Ho ---	---	---	---	---	.76	.61	(378)
La (10)	9.7	5.0	22	8.8	11	8.9	{5,147}
Li (10)	11	1.6	29	7.8	22	14	{5,243}
Lu (10)	.10	.035	.19	.09	.16	.14	{4,885}
Mn (10)	24	10	46	22	31	15	{5,260}
Mo (10)	2.6	1.2	4.2	2.5	3.7	2.3	{4,889}
Nb (10)	1.9	.28	4.4	1.3	2.6	1.9	{5,005}
Nd (6)	6.9	3.4	11	6.5	13	9.9	{4,231}
Ni (10)	8.9	3.2	18	8.0	17	14	{5,240}
Pb (10)	5.9	1.2	18	4.4	8.8	6.2	{5,172}
Pd ---	---	---	---	---	.17	.14	(18)
Pr (1)	---	3.1	3.1	---	6.1	3.6	(960)
Rb (3)	---	10	17	---	28	22	{2,232}
Sb (9)	.83	.20	1.1	.75	1.4	.91	{5,003}
Sc (10)	2.3	.82	4.6	2.0	4.4	3.6	{5,218}
Se (10)	2.9	1.2	4.5	2.7	3.6	2.8	{5,052}
Sm (10)	1.4	.70	2.8	1.3	2.0	1.6	{5,005}
Sn (6)	.48	.10	.91	.40	1.6	.86	{2,352}
Sr (10)	120	52	210	110	110	79	{5,146}
Ta (9)	.20	.050	.53	.16	.24	.19	{4,369}
Tb (10)	.24	.11	.43	.22	.34	.29	{4,852}
Th (10)	2.2	.60	4.6	1.8	3.0	2.3	{5,098}
Tl ---	---	---	---	---	3.4	2.1	(382)
Tm ---	---	---	---	---	1.7	.38	(46)
U (6)	1.3	.49	2.3	1.1	1.8	1.3	{4,990}
V (10)	11	5.5	24	10	24	19	{5,241}
W (4)	---	.40	.90	---	.94	.80	{4,421}
Y (10)	6.0	2.1	11	5.5	8.5	7.2	{5,234}
Yb (10)	.73	.25	1.3	.66	1.1	.92	{5,151}
Zn (10)	4.8	1.3	9.6	4.2	22	14	{5,243}
Zr (10)	20	6.0	37	16	24	17	{5,238}

COVE CREEK COAL BED

The Cove Creek coal bed crops out in Scott and Wise Counties and may be correlative to the Pocahontas No. 7 coal bed in Buchanan and Tazewell Counties, and the Tacus or Starns coal bed in Wise County. In 1989, the total production was 40,861 tons, all from Scott County (Virginia Division of Mines, 1990). One sample (R-8808) was collected from a 2.9 foot thick coal at a new face for an underground mine (Figure 9). The coal had been sheared by tectonic activity; all signs of cleat have been destroyed, and display well-developed slickensides. Rock enclosing the coal bed is also distorted from high- and low-angle jointing and faulting (Figure 10).

Only one sample for the Cove Creek coal bed was collected, therefore a discussion of the geometric means is not possible. The descriptive and location data are reported in Table 4a. The analytical data are reported in Tables 4b, 4c, and 4d. The elements Bi, Cl, Dy, Er, Gd, Hg, Ho, Pd, Rb, Tl, and Tm are below detection limits in this sample in addition to the elements below detection limits for all 375 Virginia samples described in this paper.

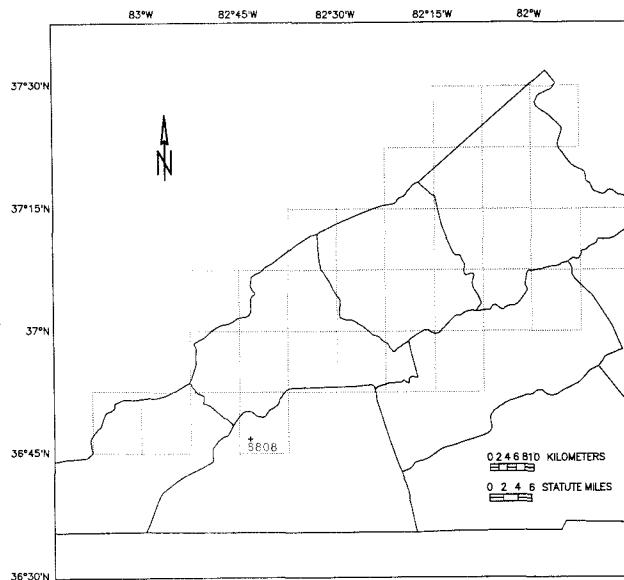


Figure 9. Location for sample from the Cove Creek coal bed.



Figure 10. Cove Creek coal bed, Scott County.

COVE CREEK COAL BED

The Cove Creek coal bed crops out in Scott and Wise Counties and may be correlative to the Pocahontas No. 7 coal bed in Buchanan and Tazewell Counties, and the Tacus or Starns coal bed in Wise County. In 1989, the total production was 40,861 tons, all from Scott County (Virginia Division of Mines, 1990). One sample (R-8808) was collected from a 2.9 foot thick coal at a new face for an underground mine (Figure 9). The coal had been sheared by tectonic activity; all signs of cleat have been destroyed, and display well-developed slickensides. Rock enclosing the coal bed is also distorted from high- and low-angle jointing and faulting (Figure 10).

Only one sample for the Cove Creek coal bed was collected, therefore a discussion of the geometric means is not possible. The descriptive and location data are reported in Table 4a. The analytical data are reported in Tables 4b, 4c, and 4d. The elements Bi, Cl, Dy, Er, Gd, Hg, Ho, Pd, Rb, Tl, and Tm are below detection limits in this sample in addition to the elements below detection limits for all 375 Virginia samples described in this paper.

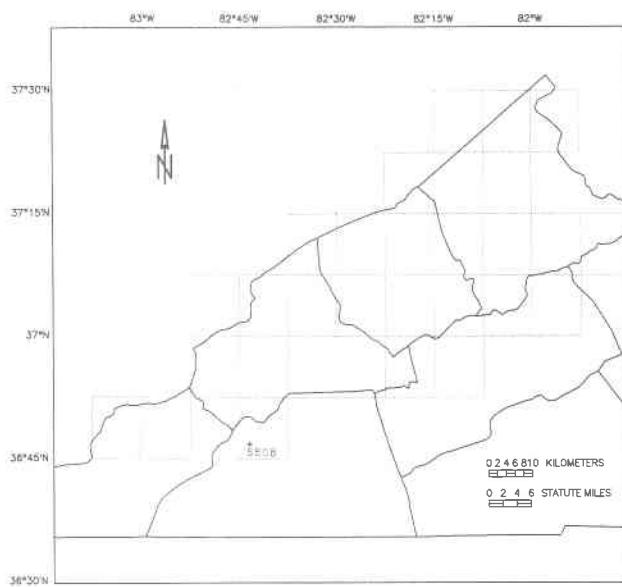


Figure 9. Location for sample from the Cove Creek coal bed.



Figure 10. Cove Creek coal bed, Scott County.

Table 4a.--Description and location for 1 bituminous coal sample from the Cove Creek coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-8808	W238471	60C-1	364647N	824322W	East Stone Gap (7.5')	Scott	34.80	Underground mine	Full Thickness

Table 4b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance number for 1 bituminous coal sample from the Cove Creek coal bed, Southwest Virginia.

[All analyses except heat content, free-swelling index, ash-fusion temperatures, Hardgrove grindability index, and compliance number in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. Sample number is VDMR identification number. Lab number is the USGS Laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	PROXIMATE ANALYSIS			ULTIMATE ANALYSIS				HEAT CONTENT			Lab Number	
	Moisture	Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/Kg	Btu/lb	
R-8808	3.2	34.8	52.8	9.3	5.3	74.2	1.6	9.0	0.7	7,350	13,220	W238471
---	35.9	54.5	9.6	5.1	76.6	1.6	6.4	.7	7,590	13,660		
---	39.7	60.3	---	5.6	84.7	1.8	7.1	.8	8,390	15,100		

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)				Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free- swelling index	Initial Deformation	Softening	Fluid			
R-8808	2.2	0.01	0.19	0.46	4.5	1,165	1,205	1,240	46	1.06	W238471
---	0.01	.20	.48	.22	.53						
---	.01										

Table 4c.--Major- and minor-oxide concentrations in the laboratory ash of 1 bituminous coal sample from the Cove Creek coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO_2	Al_2O_3	CaO	MgO	Na_2O	K_2O	Fe_2O_3	TiO_2	P_2O_5	SO_3	Lab Number
R-8808	10.4	30	16	20	2.8	0.14	1.1	7.9	0.59	1.3	15	W238471

Table 4d.--Major-, minor-, and trace-element composition of 1 bituminous coal sample from the Cove Creek coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Cu (ppm)	Mo-S (ppm)	Lab Number
R-8808	1.5	0.89	1.5	0.18	0.010	0.095	0.57	0.036	0.042	7.6	W238471		

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Lab Number
R-8808	25	230	0.78	51	0.025	14	14	6.9	0.73	8.2	W238471		

Sample Number	Eu (ppm)	F (ppm)	Ga-S (ppm)	Ge-S (ppm)	Hf (ppm)	La (ppm)	Li (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Lab Number		
R-8808	0.26	30	3.0	0.68	0.41	8.2	4.4	0.12	79	1.7	W238471		

Table 4d.--Major-, minor-, and trace-element composition of 1 bituminous coal sample from the Cove Creek coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Nb-S (ppm)	Mn-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Pr-S (ppm)	Sb (ppm)	Sc (ppm)	Se (ppm)	Sm (ppm)	Lab Number
R-8808	1.1	4.7	15	570	3.1	1.4	0.31	1.8	1.1	1.5	W238471
Sample Number	Sn-S (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Lab Number
R-8808	0.84	300	0.13	0.16	1.5	0.47	8.0	0.45	5.6	0.58	W238471

Sample Number	Zn (ppm)	Zr-S (ppm)	Lab Number
R-8808	8.8	14	W238471

LEE FORMATION OR LOWER PART OF THE NORTON FORMATION

TILLER COAL BED

The Tiller coal bed crops out in Buchanan, Dickenson, Russell, Tazewell, and Wise Counties. The majority of production is from Buchanan County but this coal is also produced in Dickenson, Russell, and Tazewell Counties. Total production of the Tiller coal bed in 1989 was 0.2 million short tons (Virginia Division of Mines, 1990). Miller (1974) reports a thickness range of 1.5 to 5 feet. Thicknesses at sample locations (Figure 11) range from 1.5 to 4.2 feet and the coal typically has a poorly-developed medium- to fine-cleat and moderate medium banding. There is usually a parting less than 0.2 foot thick which is bony in places. The roof rock is typically stable shale or sandstone.

In addition to the previously listed elements below detection limits, Bi, Dy, Er, Ho, Pd, Pr, Tl, and Tm are not found above detection limits for the 6 Tiller coal samples. Sulfate and the elements Ag, Cl, Hg, Nd, Rb, and Sn have less than five values, therefore the means were not calculated. The geometric means for CaO, MgO, Na₂O, MnO, SO₃, Be, Br, F, Mn, and free-swelling index are found to be substantially higher in the Tiller coal bed than in the Appalachian basin samples. P₂O₅, As, B, Cd, Cr, Ga, Gd, Mo, Nb, Ni, Sc, V, Zn, sulfur, pyritic sulfur, and air-dried loss geometric means are found to be substantially lower in the Tiller coal samples than in those of the Appalachian basin. The descriptive and location data are reported in Table 5a. Analytical data are reported in Tables 5b, 5c, and 5d. Statistical results are shown in Tables 5e, 5f, and 5g.

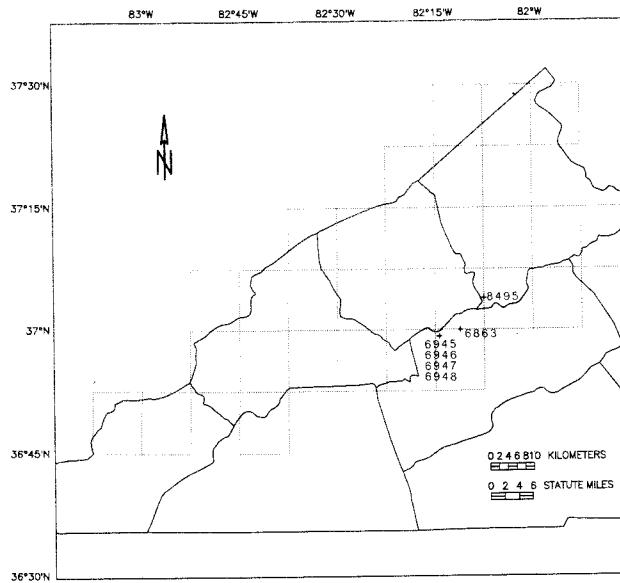


Figure 11. Locations for samples from the Tiller coal bed.

Table 5a.--Descriptions and locations for 6 bituminous coal samples from the Tiller coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-6863	W192709	88C-2	370001N	821109W	Duty (7.5')	Russell	50.76	Underground mine	Full Thickness
R-6945	W197303	58B-7	365912N	821422W	Carbo (7.5')	Russell	35.88	Underground mine	Full Thickness
R-6946	W197304	58B-8	365912N	821422W	Carbo (7.5')	Russell	5.40	Underground mine	Full Thickness
R-6947	W197305	58B-9	365912N	821422W	Carbo (7.5')	Russell	9.00	Underground mine	Full Thickness
R-6948	W197306	58B-10	365912N	821422W	Carbo (7.5')	Russell	37.20	Underground mine	Full Thickness
R-8495	W215450	88C-19	370357N	820732W	Duty (7.5')	Buchanan	68.40	Underground mine, sl. weathered	Full Thickness

Table 5b - Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 6 bituminous coal samples from the Tiller coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, ash-fusion temperatures, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. Sample number is VDMR identification number. Lab number is the USGS Laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	Moisture	PROXIMATE ANALYSIS			ULTIMATE ANALYSIS			HEAT CONTENT			Lab Number	
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	
R-6863	1.8	29.2	56.8	12.2	4.9	75.2	1.3	5.8	0.6	7,370	13,260	W192709
---	29.7	57.8	12.4	4.8	76.6	1.3	4.3	.6	.6	7,500	13,510	
---	34.0	66.0	---	5.5	87.4	1.5	4.9	.7	.7	8,570	15,420	
R-6945	1.6	31.5	60.8	6.1	5.1	81.5	1.4	5.4	.5	7,970	14,350	W197303
---	32.0	61.8	6.2	5.0	82.8	1.4	4.0	.5	.5	8,100	14,580	
---	34.1	65.9	---	5.3	88.3	1.5	4.3	.5	.5	8,630	15,540	
R-6946	1.8	32.9	60.9	4.4	5.3	81.7	1.4	6.6	.6	8,090	14,560	W197304
---	33.5	62.0	4.5	5.2	83.2	1.4	5.1	.6	.6	8,240	14,830	
---	35.1	64.9	---	5.4	87.1	1.5	5.3	.6	.6	8,620	15,520	
R-6947	1.2	33.6	62.3	2.9	5.3	83.7	1.4	6.2	.6	8,350	15,030	W197305
---	34.0	63.1	2.9	5.2	84.7	1.4	5.2	.6	.6	8,450	15,210	
---	35.0	65.0	---	5.4	87.3	1.5	5.4	.6	.6	8,700	15,670	
R-6948	1.3	32.0	60.7	6.0	5.2	81.7	1.3	5.2	.5	8,000	14,400	W197306
---	32.4	61.5	6.1	5.1	82.8	1.3	4.1	.5	.5	8,100	14,590	
---	34.5	65.5	---	5.5	88.1	1.4	4.4	.5	.5	8,630	15,530	
R-8495	1.9	28.5	65.9	3.7	5.1	83.6	1.4	5.7	.6	8,220	14,800	W215450
---	29.0	67.2	3.8	4.9	85.3	1.4	4.1	.6	.6	8,380	15,090	
---	30.2	69.8	---	5.1	88.6	1.5	4.2	.6	.6	8,710	15,680	

Table 5b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 6 bituminous coal samples from the Tiller coal bed, Southwest Virginia.--continued

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)				Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid			
R-6863	.9	0.00	0.00	0.50	0.0	1,265	1,305	1,325	---	0.90	W192709
	---	.00	.00	.51							
	---	.00	.00	.58							
R-6945	.4	.02	.04	.46	9.0	1,230	1,260	1,290	---	.70	W197303
	---	.02	.04	.47							
	---	.02	.04	.50							
R-6946	.6	.02	.08	.48	9.0	1,170	1,200	1,290	---	.82	W197304
	---	.02	.08	.49							
	---	.02	.09	.51							
R-6947	.2	.02	.10	.46	8.5	1,140	1,195	1,250	---	.80	W197305
	---	.02	.10	.47							
	---	.02	.10	.48							
R-6948	.3	.00	.03	.50	8.5	1,195	1,220	1,275	---	.69	W197306
	---	.00	.03	.51							
	---	.00	.03	.54							
R-8495	1.2	.03	.04	.49	7.0	1,190	1,260	1,325	---	.81	W215450
	---	.03	.04	.50							
	---	.03	.04	.52							

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Table 5c.--Major- and minor-oxide concentrations in the laboratory ash of 6 bituminous coal samples from the Tiller coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. Sample number is the VDMR identification number. Lab number is the USGS Laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-6863	11.4	4.2	18	10	1.1	1.1	2.3	6.5	0.94	0.044	8.0	W192709
R-6945	8.4	3.9	24	9.0	1.6	.97	3.6	9.0	1.0	.036	8.3	W197303
R-6946	4.3	3.3	21	9.5	2.0	1.2	2.3	15	.85	.070	13	W197304
R-6947	4.1	3.4	17	1.8	.58	.58	2.5	19	.94	.073	11	W197305
R-6948	6.3	4.1	22	7.9	1.5	.62	2.6	10	1.2	.048	9.8	W197306
R-8495	3.7	4.1	24	6.2	1.7	.23	.93	13	1.6	.51	7.8	W215450

Table 5d.--Major-, minor-, and trace-element composition of 6 bituminous coal samples from the Tiller coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means less than the value shown; B, not determined; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMM identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-6863	2.2	1.1	0.81	0.074	0.090	0.22	0.52	0.064	0.011L	2.5	W192709
R-6945	1.5	1.1	.54	.081	.061	.25	.53	.050	.008L	2.1	W197303
R-6946	.66	.48	.29	.052	.038	.082	.44	.022	.016	7.3	W197304
R-6947	.65	.45	.50	.045	.018	.084	.54	.023	.017	17	W197305
R-6948	1.2	.74	.36	.057	.029	.13	.45	.044	.007	1.7	W197306
R-8495	.71	.46	.16	.037	.006	.029	.34	.035	.021	4.7	W215450

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-6863	21	130	1.8	6.3	0.039	16	B	4.1	10	0.98	W192709
R-6945	8.2	130	1.3	46	.029	13	B	7.7	10	1.2	W197303
R-6946	2.5	73	4.7	58	.015	7.5	B	5.1	6.1	.40	W197304
R-6947	2.1	49	6.6	60	.011	6.0	B	5.0	5.5	.40	W197305
R-6948	5.9	45	2.5	45	.021	11	B	7.4	6.2	.50	W197306
R-8495	3.4	37	5.2	18	.030	12	910	1.8	6.8	.10	W215450

Sample Number	Cu (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	La (ppm)	Li (ppm)	Lab Number
R-6863	15	0.30	66	3.2	1.5	0.52L	0.68	0.034	8.5	8.2	W192709
R-6945	21	.23	860	2.2	.92	1.3	.50	.010L	7.0	13	W197303
R-6946	9.0	.18	200	3.3	.52	2.8	.40	.010L	4.0	7.3	W197304
R-6947	8.2	.17	68	4.1	.53	6.6	.30	.010L	3.0	9.0	W197305
R-6948	16	.20	60	1.8	.69	.22	.60	.010L	6.0	11	W197306
R-8495	11	.29	30	1.8	.56L	1.3	.50	.15	5.0	5.2	W215450

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Table 5d. --Major-, minor-, and trace-element composition of 6 bituminous coal samples from the Tiller coal bed, Southwest Virginia,
reported on a whole-coal basis.--continued

Sample Number	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Rb (ppm)	Sb (ppm)	Lab Number
R-6863	0.12	36	1.1	2.9	9.1	6.4	22	3.8	18	0.22	W192709
R-6945	.13	45	.47	1.0	3.9L	5.5	13	5.7	17	.85	W197303
R-6946	.10	37	.32	.28	2.0L	4.7	13	3.5	19L	1.3	W197304
R-6947	.10	74	.35	.57	1.9L	5.3	13	5.7	19L	1.8	W197305
R-6948	.10	29	.31	.63	2.9L	4.5	13	4.0	20L	.40	W197306
R-8495	.09	10	.52	.67	2.9	3.2	83	2.2	20L	.40	W215450

Sample Number	Sc (ppm)	Se (ppm)	Sm (ppm)	Sn-S (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	U (ppm)	V-S (ppm)	Lab Number
R-6863	2.4	2.9	1.4	0.78L	100	0.17	0.24	2.1	0.71	15	W192709
R-6945	2.3	4.3	1.1	.13L	130	.11	.21	1.8	1.5	8.4	W197303
R-6946	1.4	2.3	.80	.06L	140	.055	.18	.90	.95	5.2	W197304
R-6947	1.4	2.1	.70	.06L	110	.060	.15	.80	.99	5.7	W197305
R-6948	1.5	3.1	1.0	.09L	130	.10	.17	1.5	1.3	5.7	W197306
R-8495	1.6	2.8	.90	.19	78	.13	.24	1.3	.32	4.4	W215450

Sample Number	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)						Lab Number
R-6863	0.34	9.6	0.70	4.6	27						W192709
R-6945	.40	5.4	.75	3.4	10						W197303
R-6946	1.5	3.1	.60	3.1	3.8						W197304
R-6947	1.4	3.9	.50	4.9	6.2						W197305
R-6948	.80	4.0	.60	2.3	9.5						W197306
R-8495	.40	3.3	.70	1.2	6.7						W215450

Table 5e.--Arithmetic mean, observed range, and geometric mean of proximate and ultimate analyses, heat content, forms of sulfur, and ash-fusion temperatures for 6 bituminous coal samples from the Tiller coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included.

[All values are in percent except Btu/lb, Kcal/kg, ash-fusion temperatures, and free-swelling index and are reported on an as-received basis. $^{\circ}\text{F} = 9/5 \, ^{\circ}\text{C} + 32$; Kcal/kg = 0.556 Btu/lb; dashed values (---) represent less than five samples; (n) is number of samples per parameter.]

	Tiller coal bed				Appalachian basin		
	Arith. mean (n)	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
Proximate and ultimate analyses							
Moisture	(6)	1.61	1.20	1.94	1.58	3.23	2.69 (4,760)
Volatile matter	(6)	31.28	28.48	33.60	31.22	32.46	31.72 (4,760)
Fixed carbon	(6)	61.23	56.80	65.90	61.17	52.48	51.76 (4,760)
Ash	(6)	5.88	2.90	12.20	5.25	11.83	9.83 (4,760)
Hydrogen	(6)	5.14	4.90	5.30	5.14	5.02	5.00 (4,760)
Carbon	(6)	81.23	75.20	83.70	81.18	70.69	70.17 (4,760)
Nitrogen	(6)	1.36	1.30	1.40	1.36	1.39	1.37 (4,757)
Oxygen	(6)	5.82	5.20	6.60	5.80	8.92	8.22 (4,756)
Sulfur	(6)	.56	.50	.60	.56	2.15	1.63 (4,974)
Heat content							
KCal/kg Btu/lb	(6)	8,005 14,398	7,374 13,263	8,354 15,026	7,999 14,386	7,030 12,644	6,979 12,553 (4,759)
Forms of sulfur							
Sulfate	(4)	---	0.02	0.03	---	0.08	0.04 (4,245)
Pyritic	(5)	.06	.03	.10	.05	1.36	.65 (4,392)
Organic	(6)	.48	.46	.50	.48	.82	.70 (4,393)
Ash-fusion temperature ($^{\circ}\text{C}$)							
Initial deformation	(6)	1,198	1,138	1,263	1,197	1,255	1,246 (4,063)
Softening	(6)	1,240	1,193	1,307	1,239	1,287	1,280 (3,722)
Fluid	(6)	1,292	1,249	1,327	1,292	1,334	1,328 (3,449)
Free-swelling index	(5)	8.40	7.00	9.00	8.37	5.53	4.68 (4,603)
Air-dried loss	(6)	0.59	0.20	1.16	0.50	1.83	1.13 (3,868)

VIRGINIA DIVISION OF MINERAL RESOURCES

Table 5f.--Arithmetic mean, observed range, and geometric mean of ash content and concentrations of 11 major- and minor-oxides in the laboratory ash of 6 bituminous coal samples from the Tiller coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. (n) indicates the number of samples per oxide.

[All samples were ashed at 525°C; all data are in percent.]

	Tiller coal bed				Appalachian basin			
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
(Ash)	(6)	6.4	3.7	11	5.8	13	10	(5,262)
SiO ₂	(6)	38	33	42	38	43	41	(5,229)
Al ₂ O ₃	(6)	22	18	24	21	24	23	(5,229)
CaO	(6)	10	6.2	17	9.4	2.2	1.5	(5,227)
MgO	(6)	1.6	1.1	2.0	1.6	.85	.75	(5,258)
Na ₂ O	(6)	.78	.23	1.2	.68	.43	.34	(5,194)
K ₂ O	(6)	2.4	.92	3.6	2.2	2.0	1.7	(5,229)
Fe ₂ O ₃	(6)	12	6.5	19	11	19	13	(5,215)
MnO	(6)	.09	.036	.23	.07	.03	.02	(5,260)
TiO ₂	(6)	1.1	.85	1.6	1.1	1.2	1.1	(5,203)
P ₂ O ₅	(6)	.13	.040	.51	.07	.50	.22	(3,389)
SO ₃	(6)	9.7	7.8	13	9.5	2.5	1.9	(5,063)

Table 5g.--Arithmetic mean, observed range, and geometric mean of concentrations of 54 trace elements in 6 bituminous coal samples from the Tiller coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. Dashed values (---) represent less than five samples; (n) indicates the number of samples per element. [All data are in parts-per-million and are reported on a whole-coal basis.]

(n)	Arith. mean	Tiller coal bed			Appalachian basin		
		<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
		Min.	Max.				
Ag {4}	---	0.007	0.02	---	0.07	0.05	(4,565)
As {6}	5.8	1.7	17	4.1	35	13	{5,197}
B {6}	7.1	2.1	21	5.1	30	20	{5,076}
Ba {6}	76	37	130	67	90	63	{5,134}
Be {6}	3.7	1.3	6.6	3.2	2.5	2.0	{5,247}
Bi ---	---	---	---	---	1.5	1.1	(108)
Br {6}	39	6.3	60	31	22	13	{4,892}
Cd {6}	.02	.011	.04	.02	.10	.07	{4,978}
Ce {6}	11	6.0	16	10	21	17	{5,075}
Cl {1}	---	910	910	---	780	510	(3,646)
Co {6}	5.2	1.8	7.7	4.7	7.4	5.7	{5,217}
Cr {6}	7.5	5.5	10	7.2	18	15	{5,205}
Cs {6}	.59	.10	1.2	.46	1.3	.85	{4,831}
Cu {6}	13	8.2	21	13	19	15	{5,239}
Dy ---	---	---	---	---	3.3	2.6	(759)
Er ---	---	---	---	---	1.5	1.2	(1,200)
Eu {6}	.23	.17	.29	.22	.44	.37	{5,032}
F {6}	210	30	860	110	99	71	{4,860}
Ga {6}	2.7	1.8	4.1	2.6	6.6	5.4	{5,046}
Gd {5}	.83	.52	1.5	.76	2.6	1.9	{1,773}
Ge {5}	2.4	.22	6.6	1.5	4.7	2.5	{4,608}
Hf {6}	.50	.30	.68	.48	.79	.62	{4,932}
Hg {2}	---	.034	.15	---	---	---	(5,031)
Ho ---	---	---	---	---	.22	.15	(378)
La {6}	5.6	3.0	8.5	5.3	11	.61	{5,147}
Li {6}	8.8	5.2	13	8.5	22	14	{5,243}
Lu {6}	.11	.090	.13	.11	.16	.14	{4,885}
Mn {6}	39	10	74	33	31	15	{5,260}
Mo {6}	.52	.31	1.1	.46	3.7	2.3	{4,889}
Nb {6}	1.0	.28	2.9	.76	2.6	1.9	{5,005}
Nd {2}	---	2.9	9.1	---	13	9.9	{4,231}
Ni {6}	4.9	3.2	6.4	4.8	17	14	{5,240}
Pb {6}	4.2	2.2	5.7	4.0	8.8	6.2	{5,172}
Pd ---	---	---	---	---	.17	.14	(18)
Pr ---	---	---	---	---	6.1	3.6	(960)
Rb {2}	---	16	18	---	28	22	{2,232}
Sb {6}	.82	.22	1.8	.64	1.4	.91	{5,003}
Sc {6}	1.8	1.4	2.4	1.7	4.4	3.6	{5,218}
Se {6}	2.9	2.1	4.3	2.8	3.6	2.8	{5,052}
Sm {6}	.99	.70	1.4	.96	2.0	1.6	{5,005}
Sn {1}	---	.19	.19	---	1.6	.86	{2,352}
Sr {6}	110	78	140	110	110	79	{5,146}
Ta {6}	.10	.055	.17	.10	.24	.19	{4,369}
Tb {6}	.20	.15	.24	.19	.34	.29	{4,852}
Th {6}	1.4	.80	2.0	1.3	3.0	2.3	{5,098}
Tl ---	---	---	---	---	3.4	2.1	(382)
Tm ---	---	---	---	---	1.7	.38	(46)
U {6}	.96	.32	1.5	.86	1.8	1.3	{4,990}
V {6}	7.4	4.4	15	6.7	24	19	{5,241}
W {6}	.81	.34	1.5	.67	.94	.80	{4,421}
Y {6}	4.9	3.0	9.6	4.5	8.5	7.2	{5,234}
Yb {6}	.64	.50	.75	.64	1.1	.92	{5,151}
Zn {6}	3.3	1.2	4.9	3.0	22	14	{5,243}
Zr {6}	11	3.8	27	8.6	24	17	{5,238}

JAWBONE-TILLER COAL BED

The Jawbone and Tiller coal beds coalesce in Russell and Dickenson Counties and in the subsurface in parts of Buchanan and Dickenson Counties (Miller, 1974). The thickness of the coal zone ranges from 7 to 18 feet (Miller, 1974). At one sample site the bed thickness is 10.1 feet, which includes a total of one foot of parting material (Figure 12, Samples R-6873, R-6874, and R-6875).

The location and descriptive data for the Jawbone-Tiller coal samples are shown in Table 6a. Analytical data can be found in Tables 6b, 6c, and 6d. The statistical data is located in Tables 6e, 6f, and 6g. The geometric means for USGSASH, CaO, MnO, Ba, Ce, Co, Cr, Cs, Eu, F, Hf, La, Li, Lu, Mn, Nb, Sm, Sr, Ta, Tb, Th, U, Y, Zr, and BMASH are substantially higher for the six Jawbone-Tiller coal samples than for the Appalachian basin coal samples. Fe₂O₃, As, Hg, sulfur, and pyritic sulfur geometric means of the Appalachian basin samples are substantially higher than the geometric means of the Jawbone-Tiller coal samples. Bi, Ho, Pd, Pr, and Tm are found to be below the detection limits in addition to the elements previously listed below the detection limits for all Virginia coal samples. Sulfate, fluid temperature, Ag, Cl, Dy, Er, Ge, Rb, Sn, and Tl have less than five values, therefore the means were not calculated.

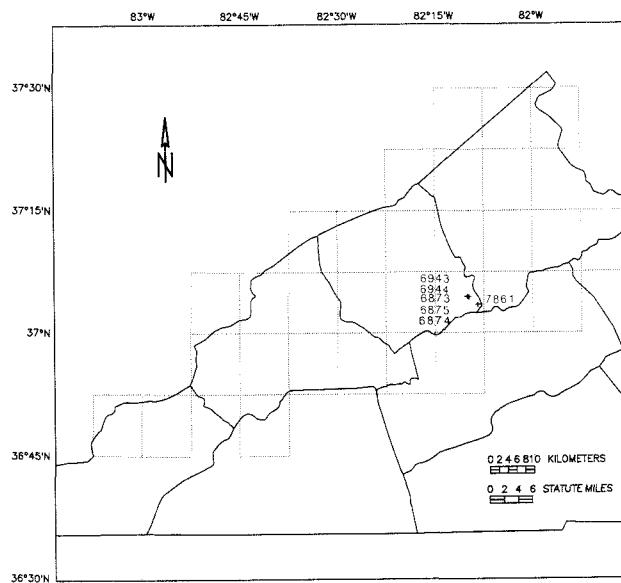


Figure 12. Locations for samples from the Jawbone-Tiller coal bed.

Table 6a.-Descriptions and locations for 6 bituminous coal samples from the Jawbone-Tiller coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-6873	W193665	88C-4	370329N	820827W	Duty (7.5')	Dickenson	27.12	Underground mine	Upper Split
R-6874	W193666	88C-5	370329N	820827W	Duty (7.5')	Dickenson	27.00	Underground mine	Middle Split
R-6875	W200130	88C-6	370329N	820827W	Duty (7.5')	Dickenson	60.12	Underground mine	Lower Split
R-6943	W197307	88C-8	370430N	821002W	Duty (7.5')	Dickenson	30.00	Underground mine	Lower Split
R-6944	W197308	88C-9	370430N	821002W	Duty (7.5')	Dickenson	26.64	Underground mine	Upper Split
R-7861	W211169	88C-13	370425N	820946W	Duty (7.5')	Dickenson	15.60	Underground mine, sl. weathered	Lower Split

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Table 6b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 6 bituminous coal samples from the Jawbone-Tiller coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. G for ash-fusion temperatures means greater than value shown. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	Moisture	PROXIMATE ANALYSIS			ULTIMATE ANALYSIS			HEAT CONTENT			Lab Number
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	
R-6873	3.3	25.6	55.7	15.4	4.6	70.7	1.2	7.2	0.8	6,950	12,510
	--	26.5	57.6	15.9	4.4	73.1	1.2	4.4	.8	7,190	12,940
	--	31.5	68.5	---	5.2	87.0	1.5	5.2	1.0	8,550	15,390
R-6874	1.7	23.2	45.8	29.3	4.0	59.1	1.0	6.1	.6	5,770	10,390
	--	23.6	46.6	29.8	3.9	60.1	1.0	4.7	.6	5,870	10,570
	--	33.6	66.4	---	5.5	85.7	1.4	6.7	.9	8,360	15,060
R-6875	1.9	26.4	58.7	13.0	4.7	75.4	1.3	5.2	.5	7,340	13,220
	--	26.9	59.8	13.3	4.6	76.9	1.3	3.6	.5	7,480	13,470
	--	31.0	69.0	---	5.3	88.6	1.5	4.1	.6	8,630	15,530
R-6943	2.2	16.5	32.7	48.6	2.8	41.8	.8	5.7	.4	3,960	7,120
	--	16.9	33.4	49.7	2.6	42.7	.8	3.8	.4	4,050	7,280
	--	33.5	66.5	---	5.2	85.0	1.6	7.6	.8	8,040	14,470
R-6944	2.6	24.9	63.1	9.4	4.7	78.4	1.5	5.2	.7	7,550	13,590
	--	25.6	64.8	9.7	4.5	80.5	1.5	3.0	.7	7,750	13,950
	--	28.3	71.7	---	5.0	89.1	1.7	3.3	.8	8,580	15,440
R-7861	1.8	23.4	56.5	18.3	4.4	70.0	1.2	5.5	.6	6,790	12,220
	--	23.8	57.6	18.6	4.3	71.2	1.2	4.0	.6	6,910	12,440
	--	29.3	70.7	---	5.3	87.5	1.5	5.0	.8	8,490	15,280

Table 6b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 6 bituminous coal samples from the Jawbone-Tiller coal bed, Southwest Virginia.--continued

Sample Number	Air-dried Loss	FORMS OF SULFUR			ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number
		Sulfate	Pyritic	Organic	Free-swelling index	Initial deformation	Softening			
R-6873	2.6	0.01	0.17	0.65	8.5	1,375	1,440	1,500	---	1.28
	---	.01	.18	.67						W193665
	---	.01	.21	.80						
R-6874	1.0	.01	.03	.51	5.5	1,520	1,540	1,540G	---	1.15
	---	.01	.03	.52						W193666
	---	.01	.04	.74						
R-6875	1.4	.00	.05	.44	8.5	1,215	1,260	1,305	---	.76
	---	.00	.05	.45						W200130
	---	.00	.06	.52						
R-6943	1.1	.00	.04	.34	1.5	1,520	1,550	1,600	---	1.12
	---	.00	.04	.35						W197307
	---	.00	.08	.69						
R-6944	1.6	.01	.07	.64	9.0	1,260	1,290	1,390	---	1.03
	---	.01	.07	.66						W197308
	---	.01	.08	.73						
R-7861	.9	.03	.04	.53	9.0	1,425	1,470	1,510	---	.98
	---	.03	.04	.54						W211169
	---	.04	.05	.66						

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Table 6c.--Major- and minor-oxide concentrations in the laboratory ash of 6 bituminous coal samples from the Jawbone-Tiller coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-6873	13.9	53	25	2.8	1.4	0.35	2.7	6.2	1.3	0.050	3.5	W193665
R-6874	28.3	52	30	3.0	.68	.30	3.5	2.9	1.8	.15	1.6	W193666
R-6875	9.4	47	16	11	.98	.24	1.7	7.0	.91	2.0	7.4	W200130
R-6943	51.8	60	25	2.1	1.2	.31	3.5	2.8	1.7	.091	.98	W19307
R-6944	8.6	43	23	8.9	1.7	.31	1.6	8.2	1.2	.070	5.8	W197308
R-7861	21.5	52	28	5.5	.86	.16	2.2	2.5	1.9	.26	1.7	W211169

Table 6d.-Major-, minor-, and trace-element composition of 6 bituminous coal samples from the Jakbone-Tiller coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means less than the value shown; B, not determined; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-6873	3.4	1.8	0.28	0.11	0.036	0.31	0.60	0.11	0.024	1.2	W193665
R-6874	6.9	4.4	.61	.12	.062	.83	.57	.31	.037	1.3	W193666
R-6875	2.1	.81	.77	.055	.017	.14	.46	.051	.009L	1.9	W200130
R-6943	14	6.9	.78	.38	.12	1.5	1.0	.54	.088	3.1	W197307
R-6944	1.7	1.0	.55	.086	.020	.12	.49	.062	.009L	11	W197308
R-7861	5.2	3.2	.85	.11	.026	.40	.37	.24	.041	1.5	W211169

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	C _L (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-6873	12	110	1.3	18	0.075	25	B	10	20	2.1	W193665
R-6874	28	180	2.4	18	.057	58	B	11	47	2.5	W193666
R-6875	9.1	55	1.6	27	.041	14	900	4.5	8.0	.50	W200130
R-6943	43	310	4.1	13	.12	88	B	10	67	5.8	W197307
R-6944	4.0	71	1.4	22	.024	15	B	9.1	11	.90	W197308
R-7861	15	130	1.8	19	.030	49	490	17	47	1.4	W211169

Sample Number	Cu (ppm)	Dy-S (ppm)	Er-S (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	Lab Number
R-6873	18	4.4L	1.4L	0.43	96	6.7	1.1	1.3	1.1	0.16	W193665
R-6874	31	9.1L	2.8L	.90	170	13	2.4	1.3L	2.8	.040	W193666
R-6875	13	2.1	1.4	.29	2,100	2.6	1.9	.14L	.70	.010L	W200130
R-6943	41	11L	5.2L	1.3	350	17	5.7	.78L	5.0	.010	W197307
R-6944	14	1.9L	.86L	.27	20L	3.3	1.3	.34	.60	.010	W197308
R-7861	26	4.7L	2.2L	.86	170	8.6	3.2L	.75	1.7	.12	W211169

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Table 6d. -Major-, minor-, and trace-element composition of 6 bituminous coal samples from the Jawbone-Tiller coal bed, Southwest Virginia, reported on a whole-coal basis.

Sample Number	La (ppm)	Li (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Lab Number
R-6873	13	21	0.15	32	2.1	1.5	6.4L	11	31	7.9	W193665
R-6874	33	57	.36	48	1.3	3.1	14	18	180	14	W193666
R-6875	8.0	7.4	.13	37	1.1	1.8	5.5	9.4	830	3.1	W200130
R-6943	47	180	.60	73	1.6	12	44	26	210	21	W197307
R-6944	8.0	9.5	.11	24	1.3	1.7	4.3	8.6	26	4.0	W197308
R-7861	26	26	.27	24	2.2	7.3	12	28	240	12	W211169

Sample Number	Rb (ppm)	Sb (ppm)	Sc (ppm)	Se (ppm)	Sm (ppm)	Sn-S (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	Lab Number
R-6873	23	0.62	4.0	1.7	2.1	0.95L	74	0.25	0.31	3.3	W193665
R-6874	44	.71	9.8	3.4	4.8	1.9L	99	.69	.71	10	W193666
R-6875	9.0	.33	1.9	2.5	1.5	.14L	170	.18	.27	1.8	W200130
R-6943	77	1.0	14	3.5	6.9	3.5	250	1.0	1.1	14	W197307
R-6944	20L	.40	2.7	1.4	1.4	.19	140	.14	.22	2.0	W197308
R-7861	50L	1.0L	7.0	5.1	3.4	2.6	260	.59	.90	7.4	W211169

Sample Number	Tl-S (ppm)	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)			Lab Number
R-6873	1.4L	1.9	24	0.58	5.3	0.85	22	15			W193665
R-6874	2.8L	3.6	42	1.4	12	2.1	13	37			W193666
R-6875	.30L	B	11	2.0L	10	.70	3.6	40			W200130
R-6943	1.7L	5.6	78	1.9	31	3.6	39	98			W197307
R-6944	.35	1.9	11	.40	6.2	.60	5.1	20			W197308
R-7861	.99L	3.0	39	.80	15	1.7	17	71			W211169

Table 6e.--Arithmetic mean, observed range, and geometric mean of proximate and ultimate analyses, heat content, forms of sulfur, and ash-fusion temperatures for 6 bituminous coal samples from the Jawbone-Tiller coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included.

[All values are in percent except Btu/lb, Kcal/kg, ash-fusion temperatures, and free-swelling index and are reported on an as-received basis. $^{\circ}\text{F} = 9/5 \, ^{\circ}\text{C} + 32$; Kcal/kg = 0.556 Btu/lb; dashed values (---) represent less than five samples; (n) is number of samples per parameter.]

	Jawbone-Tiller coal bed				Appalachian basin		
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean
			Min.	Max.			(n)
Proximate and ultimate analyses							
Moisture	(6)	2.24	1.70	3.30	2.18	3.23	2.69 (4,760)
Volatile matter	(6)	23.34	16.50	26.40	23.07	32.46	31.72 (4,760)
Fixed carbon	(6)	52.09	32.70	63.10	50.94	52.48	51.76 (4,760)
Ash	(6)	22.33	9.40	48.60	19.13	11.83	9.83 (4,760)
Hydrogen	(6)	4.20	2.80	4.70	4.14	5.02	5.00 (4,760)
Carbon	(6)	65.90	41.80	78.40	64.54	70.69	70.17 (4,760)
Nitrogen	(6)	1.17	.80	1.50	1.14	1.39	1.37 (4,757)
Oxygen	(6)	5.82	5.20	7.20	5.79	8.92	8.22 (4,756)
Sulfur	(6)	.60	.40	.80	.59	2.15	1.63 (4,974)
Heat content							
KCal/kg Btu/lb	(6)	6,398	3,959	7,557	6,257	7,030	6,979 (4,759)
	(6)	11,508	7,121	13,591	11,254	12,644	12,553 (4,759)
Forms of sulfur							
Sulfate	(4)	---	0.01	0.03	---	0.08	0.04 (4,245)
Pyritic	(6)	.07	.03	.17	.06	1.36	.65 (4,392)
Organic	(6)	.52	.34	.65	.51	.82	.70 (4,393)
Ash-fusion temperature ($^{\circ}\text{C}$)							
Initial deformation	(6)	1,386	1,216	1,521	1,381	1,255	1,246 (4,063)
Softening	(5)	1,402	1,260	1,549	1,397	1,287	1,280 (3,722)
Fluid	(4)	---	1,307	1,510	---	1,334	1,328 (3,449)
Free-swelling index	(6)	7.00	1.50	9.00	6.03	5.53	4.68 (4,603)
Air-dried loss	(6)	1.43	0.89	2.60	1.34	1.83	1.13 (3,868)

Table 6f.--Arithmetic mean, observed range, and geometric mean of ash content and concentrations of 11 major- and minor-oxides in the laboratory ash of 6 bituminous coal samples from the Jawbone-Tiller coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. (n) indicates the number of samples per oxide.

[All samples were ashed at 525°C; all data are in percent.]

	Jawbone-Tiller coal bed					Appalachian basin		
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
			Min.	Max.				
(Ash)	(6)	22	8.6	52	18	13	10	(5,262)
SiO ₂	(6)	51	43	60	51	43	41	(5,229)
Al ₂ O ₃	(6)	24	16	30	24	24	23	(5,229)
CaO	(6)	5.6	2.1	11	4.6	2.2	1.5	(5,227)
MgO	(6)	1.1	.68	1.7	1.1	.85	.75	(5,258)
Na ₂ O	(6)	.28	.16	.35	.27	.43	.34	(5,194)
K ₂ O	(6)	2.5	1.6	3.5	2.4	2.0	1.7	(5,229)
Fe ₂ O ₃	(6)	4.9	2.5	8.2	4.4	19	13	(5,215)
MnO	(6)	.03	.014	.05	.03	.03	.02	(5,260)
TiO ₂	(6)	1.5	.91	1.9	1.4	1.2	1.1	(5,203)
P ₂ O ₅	(6)	.44	.05	2.0	.17	.50	.22	(3,389)
SO ₃	(6)	3.5	.98	7.4	2.7	2.5	1.9	(5,063)

Table 6g.--Arithmetic mean, observed range, and geometric mean of concentrations of 54 trace elements in 6 bituminous coal samples from the Jawbone-Tiller coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. Dashed values (---) represent less than five samples; (n) indicates the number of samples per element. [All data are in parts-per-million and are reported on a whole-coal basis.]

	Jawbone-Tiller coal bed				Appalachian basin		
(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
Ag (4)	---	0.024	0.09	---	0.07	0.05	{4,565}
As (6)	5.1	1.2	12	3.4	35	13	{5,197}
B (6)	19	4.0	43	14	30	20	{5,076}
Ba (6)	140	55	310	120	90	63	{5,134}
Be (6)	2.1	1.3	4.1	1.9	2.5	2.0	{5,247}
Bi ---	---	---	---	---	1.5	1.1	(108)
Br (6)	19	13	27	19	22	13	{4,892}
Cd (6)	.06	.024	.12	.05	.10	.07	{4,978}
Ce (6)	42	14	88	33	21	17	{5,075}
Cl (2)	---	490	900	---	780	510	{3,646}
Co (6)	10	4.5	16	9.6	7.4	5.7	{5,217}
Cr (6)	33	8.0	67	25	18	15	{5,205}
Cs (6)	2.2	.50	5.8	1.6	1.3	.85	{4,831}
Cu (6)	24	13	41	22	19	15	{5,239}
Dy (1)	---	2.1	2.1	---	3.3	2.6	(759)
Er (1)	---	1.4	1.4	---	1.5	1.2	(1,200)
Eu (6)	.68	.27	1.3	.57	.44	.37	{5,032}
F (5)	580	96	2,100	290	99	71	{4,860}
Ga (6)	8.5	2.6	17	6.9	6.6	5.4	{5,046}
Gd (5)	2.5	1.1	5.7	2.0	2.6	1.9	{1,773}
Ge (3)	---	.34	1.3	---	4.7	2.5	(4,608)
Hf (6)	2.0	.60	5.0	1.5	.79	.62	{4,932}
Hg (5)	.07	.010	.16	.04	.22	.15	{5,031}
Ho ---	---	---	---	---	.76	.61	(378)
La (6)	22	8.0	47	18	11	8.9	{5,147}
Li (6)	50	7.4	180	27	22	14	{5,243}
Lu (6)	.27	.11	.60	.22	.16	.14	{4,885}
Mn (6)	40	24	73	36	31	15	{5,260}
Mo (6)	1.6	1.1	2.2	1.6	3.7	2.3	{4,889}
Nb (6)	4.6	1.5	12	3.3	2.6	1.9	{5,005}
Nd (5)	16	4.3	44	11	13	9.9	{4,231}
Ni (6)	17	8.6	28	15	17	14	{5,240}
Pb (6)	10	3.1	21	8.5	8.8	6.2	{5,172}
Pd ---	---	---	---	---	.17	.14	(18)
Pr ---	---	---	---	---	6.1	3.6	(960)
Rb (4)	---	9.0	77	---	28	22	{2,232}
Sb (5)	.61	.33	1.0	.57	1.4	.91	{5,003}
Sc (6)	6.6	1.8	14	5.2	4.4	3.6	{5,218}
Se (6)	2.9	1.4	5.1	2.6	3.6	2.8	{5,052}
Sm (6)	3.3	1.4	6.9	2.8	2.0	1.6	{5,005}
Sn (3)	---	.19	3.5	---	1.6	.86	{2,352}
Sr (6)	170	74	260	150	110	79	{5,146}
Ta (6)	.48	.14	1.0	.37	.24	.19	{4,369}
Tb (6)	.58	.22	1.1	.48	.34	.29	{4,852}
Th (6)	6.5	1.8	14	4.8	3.0	2.3	{5,098}
Tl (1)	---	.35	.35	---	3.4	2.1	(382)
Tm ---	---	---	---	---	1.7	.38	(46)
U (5)	3.2	1.8	5.6	2.9	1.8	1.3	{4,990}
V (6)	34	11	78	27	24	19	{5,241}
W (5)	1.0	.40	1.9	.87	.94	.80	{4,421}
Y (6)	13	5.3	31	11	8.5	7.2	{5,234}
Yb (6)	1.6	.60	3.6	1.3	1.1	.92	{5,151}
Zn (6)	17	3.6	39	12	22	14	{5,243}
Zr (6)	47	15	98	38	24	17	{5,238}

JAWBONE AND JAWBONE RIDER COAL BEDS

The Jawbone coal bed crops out in Buchanan, Dickenson, Russell, Tazewell, and Wise Counties. In Tazewell County, the Jawbone is called the Iaeger coal bed; in Buchanan County it is called the Lower Jewell coal bed; in Dickenson County it is known as the No. 5 or the Ratliff coal bed; and in Wise County, it is known as the Shannon or Imboden No. 2 coal bed. Total production of this coal in 1989 was 3.7 million short tons (Virginia Division of Mines, 1990). Most Jawbone coal production is from Buchanan County. Sampled thickness ranges from 2.5 to 8.6 feet. The Jawbone coal bed is typically hard, displaying a poorly-developed medium cleat, and moderate amounts of thin banding. Visible traces of pyrite and calcite have been noted and there are usually more than two partings of either rashy coal or bone coal. Roof rock is stable shale. In Dickenson and Russell Counties, the coal may be split into two or three benches.

In the analyses for the 10 Jawbone coal samples (see Figure 13 for location of samples and Table 7a for the descriptive and location data), Bi, Ho, Pd, Tl, and Tm are found in addition to the eight previously listed elements to be below the detection limits (Tables 7b, 7c, and 7d). Pr and Dy have only one unqualified value and thus calculation of geometric means is not possible. The geometric means (Tables 7e, 7f, and 7g) for USGSASH, BMASH, CaO, MnO, TiO₂, Ba, Ce, Cr, Cs, Cu, F, Hf, La, Li, Mn, Nb, Nd, Pb, Rb, Sc, Sm, Sn, Sr, Ta, Th, U, and Zr are found to be substantially higher for the Jawbone coal samples. Fe₂O₃, P₂O₅, As, Ge, sulfur, sulfate, and pyritic sulfur geometric means are found to be substantially lower.

As only one sample was collected for the Jawbone Rider coal bed (Figure 14), a discussion of geometric means is not possible. The descriptive and location data are shown in Table 8a and the analytical data are shown in Tables 8b, 8c, and 8d. The elements B, Bi, Cl, Dy, Er, Ho, Nd, Pb, Pd, Pr, Rb, Sn, Tb, Tl, and Tm are below detection limits for this coal sample in addition to those elements which are below detection limits for all the Virginia coal samples described in this paper.

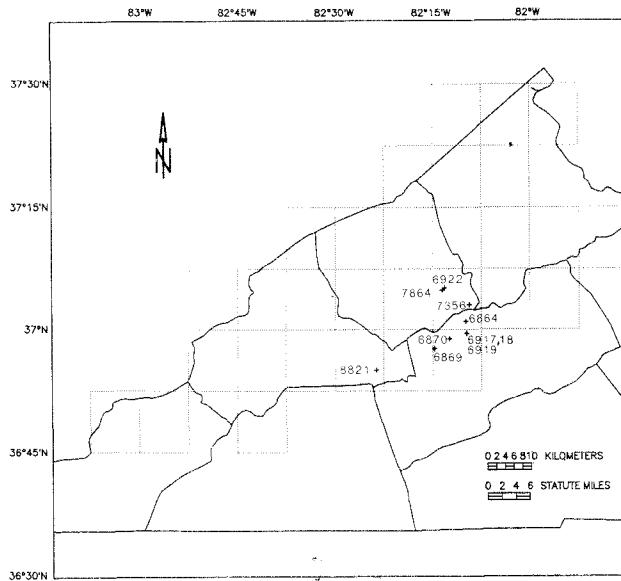


Figure 13. Locations for samples from the Jawbone coal bed.

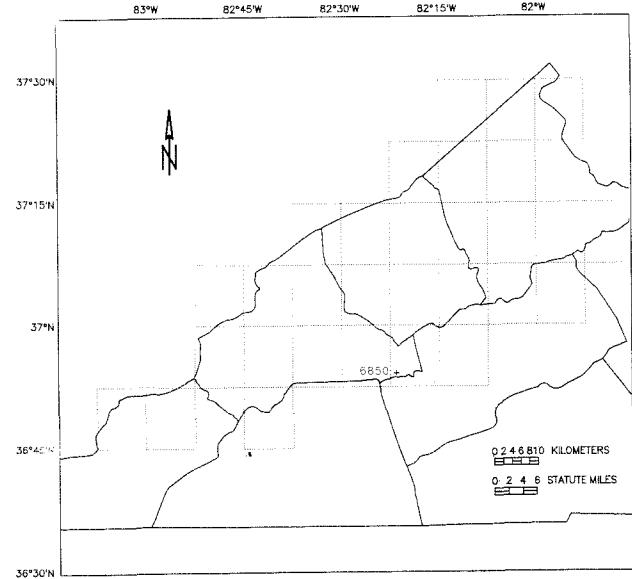


Figure 14. Locations for samples from the Jawbone Rider coal bed.

Table 7a.-Descriptions and locations for 10 bituminous coal samples from the Jawbone coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-6864	W192707	88C-3	370101N	820954W	Duty (7.5')	Russell	77.76	Underground mine	Full Thickness
R-6869	W192708	58B-2	365741N	821443W	Carbo (7.5')	Russell	49.20	Underground mine	Full Thickness
R-6870	W192706	58B-3	365853N	821225W	Carbo (7.5')	Russell	40.56	Underground mine	Full Thickness
R-6917	W195445	58B-4	365932N	820946W	Carbo (7.5')	Russell	21.72	Surface mine, s.l.	Bench Sample
R-6918	W195446	58B-5	365932N	820946W	Carbo (7.5')	Russell	10.80	Surface mine, s.l.	Bench Sample
R-6919	W195447	58B-6	365932N	820946W	Carbo (7.5')	Russell	30.00	Surface mine, s.l.	Weathered
R-6922	W195440	88C-7	370509N	821309W	Duty (7.5')	Dickenson	29.52	Surface mine,	Full Thickness
R-7356	W204159	88C-10	370305N	820920W	Duty (7.5')	Dickenson	59.88	Surface mine	Full Thickness
R-7864	W211171	88C-15	370452N	821331W	Duty (7.5')	Dickenson	33.00	Underground mine	Full Thickness
R-8821	W238940	59B-11	365505N	822338W	Coeburn (7.5')	Wise	27.60	Surface mine	Full Thickness

Table 7b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 10 bituminous coal samples from the Jawbone coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa. and a commercial testing laboratory following ASTM standards. G for ash-fusion temperatures means greater than value shown. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	Moisture	PROXIMATE ANALYSIS			ULTIMATE ANALYSIS			HEAT CONTENT			Lab Number
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	
R-6864	2.6	22.6	45.2	29.6	4.0	58.2	1.2	6.5	0.5	5,660	10,190
	---	23.2	46.4	30.4	3.8	59.8	1.2	4.3	.5	5,810	10,470
	---	33.3	66.7	---	5.5	85.8	1.8	6.2	.7	8,350	15,040
R-6869	1.2	31.3	53.7	13.8	4.7	72.7	1.4	6.8	.6	7,140	12,850
	---	31.7	54.4	14.0	4.6	73.6	1.4	5.8	.6	7,220	13,000
	---	36.8	63.2	---	5.4	85.5	1.6	6.7	.7	8,400	15,110
R-6870	1.6	28.1	54.2	16.1	4.6	71.3	1.3	6.1	.6	6,950	12,500
	---	28.6	55.1	16.4	4.5	72.5	1.3	4.8	.6	7,060	12,710
	---	34.1	65.9	---	5.4	86.6	1.6	5.7	.7	8,440	15,190
R-6917	2.3	29.9	50.6	17.2	4.8	69.2	1.3	6.5	1.0	6,870	12,360
	---	30.6	51.8	17.6	4.7	70.8	1.3	4.6	1.0	7,030	12,650
	---	37.1	62.9	---	5.6	86.0	1.6	5.5	1.2	8,530	15,350
R-6918	2.6	21.5	36.9	39.0	3.6	49.2	.8	6.9	.4	4,640	8,360
	---	22.1	37.9	40.0	3.4	50.5	.8	4.7	.4	4,770	8,580
	---	36.8	63.2	---	5.7	84.2	1.4	7.9	.7	7,950	14,310
R-6919	2.3	32.3	55.3	10.1	5.0	75.7	1.4	7.1	.7	7,440	13,390
	---	33.1	56.6	10.3	4.9	77.5	1.4	5.2	.7	7,610	13,700
	---	36.9	63.1	---	5.4	86.4	1.6	5.8	.8	8,490	15,280
R-6922	2.5	18.7	47.9	30.9	3.8	57.7	1.0	5.8	.8	5,590	10,070
	---	19.2	49.1	31.7	3.6	59.2	1.0	3.7	.8	5,740	10,330
	---	28.1	71.9	---	5.3	86.6	1.5	5.4	1.2	8,400	15,120
R-7356	4.0	25.6	57.0	13.4	4.8	72.1	1.4	7.7	.6	7,080	12,740
	---	26.7	59.4	14.0	4.5	75.1	1.5	4.3	.6	7,370	13,270
	---	31.0	69.0	---	5.3	87.3	1.7	5.0	.7	8,570	15,420
R-7864	1.5	19.8	53.6	25.1	4.0	64.2	1.1	5.1	.5	6,220	11,200
	---	20.1	54.5	25.5	3.9	65.2	1.1	3.8	.6	6,320	11,370
	---	26.9	73.1	---	5.2	87.4	1.4	5.2	.7	8,480	15,260

Table 7b. -Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 10 bituminous coal samples from the Jawbone coal bed, Southwest Virginia. --continued

Sample Number	Air-dried Loss	FORMS OF SULFUR			ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number
		Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening			
R-6864	1.7	0.00	0.10	0.30	5.0	1,490	1,525	1,540	---	0.98
	--	.00	.10	.31						W192707
	--	.00	.15	.44						
R-6869	.4	.00	.00	.50	5.0	1,215	1,285	1,320	---	.93
	--	.00	.00	.51						W192708
	--	.00	.00	.59						
R-6870	.9	.00	.00	.50	6.5	1,325	1,400	1,430	---	.96
	--	.00	.00	.51						W192706
	--	.00	.00	.61						
R-6917	1.5	.01	.35	.63	.0	1,515	1,540	1,540G	---	1.62
	--	.01	.36	.64						W195445
	--	.01	.43	.78						
R-6918	1.8	.01	.08	.30	1.0	1,330	1,380	1,435	---	.96
	--	.01	.08	.31						W195446
	--	.02	.14	.51						
R-6919	1.3	.00	.04	.66	8.0	1,285	1,345	1,395	---	1.05
	--	.00	.04	.68						W195447
	--	.00	.05	.75						
R-6922	1.5	.01	.36	.43	7.5	1,540	1,540G	1,540G	---	1.59
	--	.01	.37	.44						W195440
	--	.02	.54	.65						
R-7356	3.4	.01	.12	.46	8.0	1,540	1,540G	1,540G	---	.94
	--	.01	.12	.48						W204159
	--	.01	.15	.56						
R-7864	.6	.05	.10	.40	7.5	1,515	1,540	1,540G	---	.89
	--	.05	.10	.41						W211171
	--	.07	.14	.55						

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Table 7b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 10 bituminous coal samples from the Jawbone coal bed, Southwest Virginia.

Sample Number	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT			
	Moisture	Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/KG	Btu/lb	Lab Number
R-8821	2.4	30.9	49.1	17.6	4.7	67.2	1.2	7.3	1.9	6,690	12,050	W238940
	---	31.7	50.3	18.0	4.6	68.8	1.2	5.4	2.0	6,850	12,330	
	---	38.7	61.3	---	5.6	84.0	1.5	6.5	2.4	8,350	15,040	

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)						
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid	Hardgrove grindability index	Compliance Number	Lab Number
R-8821	1.1	0.06	1.27	0.60	3.5	1,420	1,475	1,540	42	3.16	W238940
	---	.06	1.30	.61							
	---	.07	1.59	.75							

Table 7c.--Major- and minor-oxide concentrations in the laboratory ash of 10 bituminous coal samples from the Jawbone coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-6864	28.6	57	23	3.6	0.23	0.34	3.4	4.0	1.4	0.11	2.2	W192707
R-6869	13.8	38	18	15	1.8	.89	.91	5.7	1.4	.080	8.8	W192708
R-6870	17.6	46	18	13	.80	.18	1.4	4.6	1.7	.12	5.4	W192706
R-6917	16.4	52	28	1.6	1.1	.22	3.1	7.0	1.4	.043	2.5	W195445
R-6918	41.6	57	19	5.6	1.0	.20	3.1	3.2	1.7	.019	1.3	W195446
R-6919	11.2	36	18	17	1.1	.16	.97	5.9	1.3	.28	5.0	W195447
R-6922	30.5	63	26	.56	.75	.19	2.8	3.0	2.6	.19	.49	W195440
R-7356	14.1	58	26	.90	.73	.81	1.8	3.2	2.1	.23	1.0	W204159
R-7364	28.7	58	28	.56	.93	.22	3.4	3.3	2.3	.091	.93	W211171
R-8821	18.8	51	28	1.4	.07	.18	1.0	12	2.1	.13	2.6	W238940

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Table 7d.--Major-, minor-, and trace-element composition of 10 bituminous coal samples from the Jawbone coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means less than the value shown; B, not determined; S, after elements title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-6864	7.7	3.5	0.74	0.040	0.072	0.81	0.80	0.24	0.040	3.3	W192707
R-6869	2.5	1.3	1.5	.15	.091	.10	.55	.12	.014L	2.8	W192708
R-6870	3.8	1.7	1.6	.084	.023	.21	.57	.18	.018L	2.7	W192706
R-6917	3.9	2.4	.19	.11	.026	.42	.80	.14	.016L	33	W195445
R-6918	11	4.2	1.7	.26	.062	1.1	.93	.42	.042L	3.9	W195446
R-6919	1.9	1.0	1.4	.073	.013	.091	.46	.087	.011L	3.8	W195447
R-6922	8.9	4.1	.12	.14	.043	.71	.64	.48	.031L	15	W195440
R-7356	3.8	1.9	.090	.062	.085	.21	.31	.18	.025	2.4	W204159
R-7864	7.8	4.3	.11	.16	.046	.80	.67	.39	.040	11	W211171
R-8821	4.5	2.8	.18	.007	.024	.16	1.6	.24	.075	22	W238940

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-6864	37	250	2.3	9.0	0.080	36	B	5.1	31	2.6	W192707
R-6869	39	150	1.4	11	.028	22	B	7.6	14	.60	W192708
R-6870	18	140	2.1	21	.063	28	B	6.4	22	1.3	W192706
R-6917	8.2	77	2.0	9.0	.074	33	B	14	22	2.0	W195445
R-6918	17	170	2.0	6.0	.13	70	B	3.5	56	3.4	W195446
R-6919	4.1	48	.49	10	.031	16	B	3.4	12	.40	W195447
R-6922	13	140	2.7	34	.046	60	B	10	53	3.8	W195440
R-7356	17	160	1.4	13	.071	32	.420	4.6	24	1.0	W204159
R-7864	25	180	2.4	28	.086	45	.530	6.9	43	3.0	W211171
R-8821	38	110	3.0	7.4	.075	40	.180	8.0	27	.69	W238940

Table 7d.--Major-, minor-, and trace-element composition of 10 bituminous coal samples from the Jawbone coal bed, Southwest Virginia,
reported on a whole-coal basis.--continued

Sample Number	Cu (ppm)	Dy-S (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	La (ppm)	Lab Number
R-6864	23	9.2L	0.54	150	10	2.4	1.5	2.1	0.040	20	W192707
R-6869	21	4.4L	.32	54	3.9	1.9	.63L	1.1	.055	13	W192708
R-6870	21	5.6L	.39	66	5.5	3.0	1.1	1.5	.016	17	W192706
R-6917	26	3.6L	.59	130	3.9	1.4	.36	1.6	.33	18	W195445
R-6918	34	9.2L	.90	260	9.2	3.2	.62L	3.3	.14	41	W195446
R-6919	15	2.5L	.24	48	2.4	1.2	.17L	.70	.10	9.0	W195447
R-6922	30	6.7L	.71	160	8.5	2.1L	.55	4.0	.10	38	W195440
R-7356	20	3.1L	.46	260	6.2	2.1L	.21L	1.6	.030	19	W204159
R-7864	29	6.3L	.61	210	11	4.3L	1.0	2.2	.41	27	W211171
R-8821	41	.94	.61	60	9.2	1.7	1.8	1.9	.19	27	W238940

Sample Number	Li (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Pr-S (ppm)	Lab Number
R-6864	51	0.22	.37	1.1	8.3	21	12	140	10	19L	W192707
R-6869	22	.11	.69	1.3	5.4	9.1	7.0	48	5.7	9.4L	W192708
R-6870	28	.16	100	1.5	8.8	15	10	92	7.7	12L	W192706
R-6917	25	.24	210	1.2	.77	10	12	31	9.7	11L	W195445
R-6918	54	.39	120	.92L	3.3	19L	6.7	35	20	28L	W195446
R-6919	12	.10	.84	.56	.78	5.2L	3.9	140	4.5	7.6L	W195447
R-6922	79	.38	.17	.67L	9.5	15	13	250	17	21L	W195440
R-7356	28	.20	9.0	1.3	4.2	17	12	140	10	9.6L	W204159
R-7864	37	.28	15	.57	9.2	19	13	110	15	20L	W211171
R-8821	49	.17	16	3.6	8.5	30	18	100	11	3.4	W238940

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Table 7d.--Major-, minor-, and trace-element composition of 10 bituminous coal samples from the Jawbone coal bed, Southwest Virginia,
reported on a whole-coal basis.--continued

Sample Number	Rb (ppm)	Sb (ppm)	Sc (ppm)	Se (ppm)	Sm (ppm)	Sn-S (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	Lab Number
R-6864	48	0.44	6.9	2.7	2.6	4.0	160	0.52	0.42	6.5	W192707
R-6869	24L	.37	3.0	2.8	1.5	1.2	580	.27	.19	3.8	W192708
R-6870	19	.58	4.5	2.7	1.9	2.3	190	.43	.30	5.8	W192706
R-6917	29	1.1	4.8	3.0	3.2	.89	61	.35	.37	4.7	W195445
R-6918	76	.60	11	4.9	5.3	1.6	180	1.1	.66	14	W195446
R-6919	22L	.40	2.7	1.4	1.3	.63	110	.27	.24	2.5	W195447
R-6922	75	1.1	10	4.3	4.3	1.8	95	1.1	.62	13	W195440
R-7356	22	.40	4.8	1.0	2.6	1.2	160	.38	.35	5.1	W204159
R-7864	38	1.0	9.1	4.8	2.9	2.5	180	.87	.72	9.2	W211171
R-8821	27L	.68	7.2	4.5	3.4	3.2	150	.67	.36	6.7	W238940

Sample Number	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)	Lab Number
R-6864	2.0	.43	0.63	14	1.3	13	74	W192707
R-6869	1.3	15	.58	8.6	.70	2.9	47	W192708
R-6870	2.0	25	.53	14	.90	3.5	110	W192706
R-6917	2.5	20	.60	4.8	1.4	14	11	W195445
R-6918	4.3	34	.40	7.9	2.2	14	32	W195446
R-6919	1.5	7.4	.70	2.9	.60	3.2	13	W195447
R-6922	3.8	30	1.9	8.2	2.3	16	61	W195440
R-7356	1.6	25	.65	9.0	1.2	6.3	25	W204159
R-7864	3.0	49	1.0	13	1.7	32	80	W211171
R-8821	2.9	36	1.2	16	1.4	5.6	71	W238940

Table 7e.--Arithmetic mean, observed range and geometric mean of proximate and ultimate analyses, heat content, forms of sulfur, and ash-fusion temperatures for 10 bituminous coal samples from the Jawbone coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included.

[All values are in percent except Btu/lb, Kcal/kg, ash-fusion temperatures, and Kcal/kg = 0.556 Btu/lb; dashed values (---) represent less than five samples; (n) is number of samples per parameter.]

	Jawbone coal bed				Appalachian basin		
	(n)	Arith. mean	Observed range		Geom. mean	Arith. mean	Geom. mean
			Min.	Max.			(n)
Proximate and ultimate analyses							
Moisture	(10)	2.30	1.20	4.00	2.19	3.23	2.69 (4,760)
Volatile matter	(10)	26.07	18.70	32.30	25.60	32.46	31.72 (4,760)
Fixed carbon	(10)	50.35	36.90	57.00	50.00	52.48	51.76 (4,760)
Ash	(10)	21.28	10.10	39.00	19.55	11.83	9.83 (4,760)
Hydrogen	(10)	4.40	3.60	5.00	4.38	5.02	5.00 (4,760)
Carbon	(10)	65.75	49.20	75.70	65.23	70.69	70.17 (4,760)
Nitrogen	(10)	1.21	.80	1.40	1.19	1.39	1.37 (4,757)
Oxygen	(10)	6.59	5.15	7.70	6.55	8.92	8.22 (4,756)
Sulfur	(10)	.77	.40	1.93	.69	2.15	1.63 (4,974)
Heat content							
KCal/kg	(10)	6,432	4,647	7,442	6,373	7,030	6,979 (4,759)
Btu/lb	(10)	15,568	8,358	13,385	11,461	12,644	12,553 (4,759)
Forms of sulfur							
Sulfate	(6)	0.02	0.01	0.06	0.02	0.08	0.04 (4,245)
Pyritic	(8)	.30	.04	1.27	.17	1.36	.65 (4,392)
Organic	(10)	.48	.30	.66	.46	.82	.70 (4,393)
Ash-fusion temperature (°C)							
Initial deformation	(8)	1,386	1,213	1,516	1,382	1,255	1,246 (4,063)
Softening	(6)	1,403	1,285	1,527	1,400	1,287	1,280 (3,722)
Fluid	(4)	---	1,321	1,435	---	1,334	1,328 (3,449)
Free-swelling index	(9)	5.78	1.00	8.00	5.03	5.53	4.68 (4,603)
Air-dried loss	(10)	1.42	0.40	3.40	1.23	1.83	1.13 (3,868)

Table 7f.--Arithmetic mean, observed range, and geometric mean of ash content and concentrations of 11 major- and minor-oxides in the laboratory ash of 10 bituminous coal samples from the Jawbone coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. (n) indicates the number of samples per oxide.

[All samples were ashed at 525°C; all data are in percent.]

(n)	Jawbone coal bed				Appalachian basin		
	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
		Min.	Max.				
(Ash)	(10)	22	11	42	20	13	10 (5,262)
SiO ₂	(10)	52	36	63	51	43	41 (5,229)
Al ₂ O ₃	(10)	23	18	28	23	24	23 (5,229)
CaO	(10)	5.9	.56	17	2.9	2.2	1.5 (5,227)
MgO	(10)	.86	.066	1.8	.65	.85	.75 (5,258)
Na ₂ O	(10)	.34	.16	.89	.27	.43	.34 (5,194)
K ₂ O	(10)	2.2	.91	3.4	1.9	2.0	1.7 (5,229)
Fe ₂ O ₃	(10)	5.2	3.0	12	4.7	19	13 (5,215)
MnO	(10)	.05	.007	.17	.03	.03	.02 (5,260)
TiO ₂	(10)	1.8	1.3	2.6	1.8	1.2	1.1 (5,203)
P ₂ O ₅	(10)	.13	.02	.28	.10	.50	.22 (3,389)
SO ₃	(10)	3.0	.49	8.8	2.1	2.5	1.9 (5,063)

Table 7g.--Arithmetic mean, observed range, and geometric mean of concentrations of 54 trace elements in 10 bituminous coal samples from the Jawbone coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. Dashed values (---) represent less than five samples; (n) indicates the number of samples per element. [All data are in parts-per-million and are reported on a whole-coal basis.]

	Jawbone coal bed				Appalachian basin		
(n)	Arith. mean	Observed range		Geom. mean	Arith. mean	Geom. mean	(n)
Ag (4)	---	0.025	0.08	---	0.07	0.05	{4, 565}
As (10)	9.9	2.4	33	6.3	35	13	{5, 197}
B (10)	22	4.1	39	18	30	20	{5, 076}
Ba (10)	140	48	250	130	90	63	{5, 134}
Be (10)	2.0	.49	3.0	1.8	2.5	2.0	{5, 247}
Bi ---	---	---	---	---	1.5	1.1	{108}
Br (10)	15	6.0	34	13	22	13	{4, 892}
Cd (10)	.07	.028	.13	.06	.10	.07	{4, 978}
Ce (10)	38	16	70	35	21	17	{5, 075}
Cl (3)	---	180	530	---	780	510	{3, 646}
Co (10)	7.0	3.4	14	6.4	7.4	5.7	{5, 217}
Cr (10)	30	12	56	27	18	15	{5, 205}
Cs (10)	1.9	.40	3.8	1.5	1.3	.85	{4, 831}
Cu (10)	26	15	41	25	19	15	{5, 239}
Dy (1)	---	.94	.94	---	3.3	2.6	{759}
Er ---	---	---	---	---	1.5	1.2	{1, 200}
Eu (10)	.54	.24	.90	.50	.44	.37	{5, 032}
F (10)	140	48	260	120	99	71	{4, 860}
Ga (10)	7.0	2.4	11	6.3	6.6	5.4	{5, 046}
Gd (7)	2.1	1.2	3.2	2.0	2.6	1.9	{1, 773}
Ge (6)	1.1	.36	1.8	.92	4.7	2.5	{4, 608}
Hf (10)	2.0	.70	4.0	1.8	.79	.62	{4, 932}
Hg (10)	.14	.016	.41	.09	.22	.15	{5, 031}
Ho ---	---	---	---	---	.76	.61	{378}
La (10)	23	9.0	41	21	11	8.9	{5, 147}
Li (10)	39	12	79	34	22	14	{5, 243}
Lu (10)	.22	.10	.39	.20	.16	.14	{4, 885}
Mn (10)	69	9.0	210	43	31	15	{5, 260}
Mo (8)	1.4	.56	3.6	1.2	3.7	2.3	{4, 889}
Nb (10)	5.9	.77	9.4	4.4	2.6	1.9	{5, 005}
Nd (8)	17	9.1	30	16	13	9.9	{4, 231}
Ni (10)	11	3.9	18	10	17	14	{5, 240}
Pb (10)	11	4.5	20	10	8.8	6.2	{5, 172}
Pd ---	---	---	---	---	.17	.14	{18}
Pr (1)	---	3.4	3.4	---	6.1	3.6	{960}
Rb (7)	44	18	76	38	28	22	{2, 232}
Sb (10)	.67	.37	1.1	.61	1.4	.91	{5, 003}
Sc (10)	6.5	2.7	11	5.8	4.4	3.6	{5, 218}
Se (10)	3.2	1.0	4.9	2.8	3.6	2.8	{5, 052}
Sm (10)	2.9	1.3	5.3	2.6	2.0	1.6	{5, 005}
Sn (10)	1.9	.63	4.0	1.7	1.6	.86	{2, 352}
Sr (10)	190	61	580	160	110	79	{5, 146}
Ta (10)	.59	.26	1.1	.52	.24	.19	{4, 369}
Tb (10)	.42	.19	.72	.39	.34	.29	{4, 852}
Th (10)	7.1	2.5	14	6.2	3.0	2.3	{5, 098}
Tl ---	---	---	---	---	3.4	2.1	{382}
Tm ---	---	---	---	---	1.7	.38	{46}
U (10)	2.5	1.3	4.3	2.3	1.8	1.3	{4, 990}
V (10)	28	7.4	49	25	24	19	{5, 241}
W (10)	.82	.40	1.9	.74	.94	.80	{4, 421}
Y (10)	9.9	2.9	16	8.8	8.5	7.2	{5, 234}
Yb (10)	1.4	.60	2.3	1.2	1.1	.92	{5, 151}
Zn (10)	11	2.9	32	8.2	22	14	{5, 243}
Zr (10)	52	11	110	42	24	17	{5, 238}

Table 8a.—Description and location for 1 bituminous coal sample from the Jawbone Rider coal, Southwest Virginia.

Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
2-4950	U10290n	50A-1	365411N	822133W	St. Paul (7.5')	Wise	15.12	Surface mine, sl. weathered	Full Thickness

Table 8b.-Approximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, grindability index, and compliance number for 1 bituminous coal sample from the Jawbone Rider coal bed, Southwest Virginia.

[All analyses except heat content, free-swelling index, Hardgrove grindability index, and compliance number in percent. All For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Table 8c.--Major- and minor-oxide concentrations in the laboratory ash of 1 bituminous coal sample from the Jawbone Rider coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO_2	Al_2O_3	CaO	MgO	Na_2O	K_2O	Fe_2O_3	TiO_2	P_2O_5	SO_3	Lab Number
R-6850	13.6	13	8.0	6.6	2.0	1.1	0.93	48	0.43	0.10	13	W192590

Table 8d.--Major-, minor-, and trace-element composition of 1 bituminous coal sample from the Jawbone Rider coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Eu (ppm)	Lab Number
R-6850	0.83	0.58	0.64	0.16	0.11	0.11	4.6	0.035	0.054	45	W192590	
Sample Number	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Cu (ppm)	Eu (ppm)	Mn (ppm)	Lab Number
R-6850	67	0.76	3.5	0.11	12	4.1	8.8	0.40	12	0.29	W192590	

Sample Number	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	La (ppm)	Li (ppm)	Lu (ppm)	Mn (ppm)	Lab Number
R-6850	70	3.0	2.0	2.6	0.30	0.22	6.0	45	0.10	31	W192590

Table 8d.--Major-, minor-, and trace-element composition of 1 bituminous coal sample from the Jawbone Rider coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Mo-S (ppm)	Nb-S (ppm)	Ni-S (ppm)	P (ppm)	Sb (ppm)	Sc (ppm)	Se (ppm)	Sm (ppm)	Sr-S (ppm)	Ta (ppm)	Lab Number
R-6850	2.7	1.1	6.0	61	0.34	2.0	2.1	1.2	52	0.055	W192590
Sample Number	Th (ppm)	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)	Zn (ppm)	Zr-S (ppm)	Lab Number
R-6850	1.0	0.75	7.3	0.54	2.9	0.55	94	5.4	5.4	5.4	W192590

RAVEN COAL BED

This coal crops out in Buchanan, Dickenson, Russell, and Wise Counties. Other names for the Raven coal bed include the Lower Douglas coal bed in Tazewell County, the Raven Red Ash or Red Ash coal bed in Buchanan County, the No. 6 coal bed in parts of Dickenson County, and the Raven, Garden Hole, or Imboden coal bed in Buchanan, Dickenson, and Wise Counties (there is no correlation between the Imboden coal bed of the Wise Formation and the Imboden coal bed mentioned here). Most production of the Raven coal bed is from Buchanan and Dickenson Counties with lesser amounts being produced from Russell, Tazewell, and Wise Counties. Total production in 1989 was 2.1 million tons (Virginia Division of Mines, 1990). Sampled thickness ranges from 3.5 feet to 5.1 feet. At sample locations (Figure 15), the coal is characterized by moderate- to well-developed medium cleat with moderate thin- and medium-banding. Pyrite occurs in one or two shale partings, which also may be bony. The roof is normally shale in irregular contact with the coal, but sandstone roof occurs in several Raven mines.

The location and descriptive data for the Raven samples are shown in Table 9a and the analytical data are in Tables 9b, 9c, and 9d. Geometric means (Tables 9e, 9f, and 9g) for CaO, MgO, MnO, SO₃, Br, F, Li, Mn, Sr, Th and the free-swelling index in the 8 Raven coal samples are substantially higher than for the Appalachian basin samples. Ag, Ge, sulfur, sulfate, and pyritic sulfur means are substantially lower for the Raven coal samples than for the rest of the Appalachian basin samples. In addition to the elements below the detection limits for all the Virginia samples, Bi, Dy, Pd, Tl and Tm are below the detection limits for the 8 Raven coal samples. Pr, with only one unqualified value, has no geometric mean calculated.

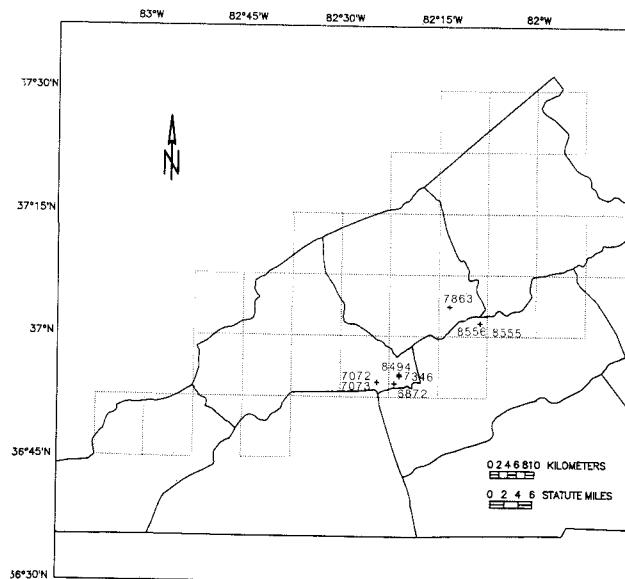


Figure 15. Locations for samples from the Raven coal bed.

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Table 9a.--Descriptions and locations for 8 bituminous coal samples from the Raven coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-6872	W197664	59A-3	365413N	822142W	St. Paul (7.5')	Wise	42.84	Surface mine, sl. weathered	Full Thickness
R-7072	W197301	59B-3	365423N	822418W	Coeburn (7.5')	Wise	19.32	Surface mine, sl. weathered	Bench Sample
R-7073	W197302	59B-4	365423N	822418W	Coeburn (7.5')	Wise	25.44	Surface mine, sl. weathered	Bench Sample
R-7346	W203384	59A-5	365507N	822054W	St. Paul (7.5')	Wise	42.00	Surface mine	Full Thickness
R-7863	W211170	88C-14	370338N	821318W	Duty (7.5')	Dickenson	60.60	Underground mine, weathered	Full Thickness
R-8494	W215446	59A-6	365519N	822057W	St. Paul (7.5')	Wise	68.40	Surface mine, sl. weathered	Full Thickness
R-8555	W217595	88C-21	370137N	820835W	Duty (7.5')	Russell	17.64	Underground mine, sl. weathered	Bench Sample
R-8556	W217594	88C-20	370137N	820835W	Duty (7.5')	Russell	23.52	Underground mine, sl. weathered	Bench Sample

Table 9b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 8 bituminous coal samples from the Raven coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, ash-fusion temperatures, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

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Sample Number	Moisture	PROXIMATE ANALYSIS			ULTIMATE ANALYSIS			HEAT CONTENT			Lab Number	
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	
R-6872	1.5	32.9	50.6	15.0	4.7	70.9	1.4	6.8	1.2	6,960	12,540	W193664
	---	33.4	51.4	15.2	4.6	72.0	1.4	5.5	1.2	7,070	12,730	
	---	39.4	60.6	---	5.4	84.9	1.7	6.5	1.4	8,340	15,010	
R-7072	2.2	33.0	55.2	9.6	4.9	75.7	1.4	7.6	.8	7,490	13,480	W197301
	---	33.7	56.4	9.8	4.8	77.4	1.4	5.8	.8	7,660	13,780	
	---	37.4	62.6	---	5.3	85.8	1.6	6.4	.9	8,490	15,280	
R-7073	2.2	33.6	55.9	8.3	5.2	76.8	1.4	7.6	.7	7,530	13,550	W197302
	---	34.4	57.2	8.5	5.1	78.5	1.4	5.8	.7	7,690	13,850	
	---	37.5	62.5	---	5.5	85.8	1.6	6.3	.8	8,410	15,130	
R-7346	3.6	21.4	64.2	10.8	5.1	73.7	1.4	8.0	.9	7,200	12,970	W203384
	---	22.2	66.6	11.2	4.9	76.5	1.5	5.0	.9	7,470	13,450	
	---	25.0	75.0	---	5.5	86.1	1.6	5.6	1.1	8,420	15,150	
R-7863	2.0	22.9	50.5	24.6	4.1	63.6	1.2	6.0	.5	6,260	11,260	W211170
	---	23.4	51.5	25.1	4.0	65.0	1.2	4.3	.5	6,390	11,490	
	---	31.2	68.8	---	5.3	86.7	1.6	5.7	.7	8,520	15,340	
R-8494	1.6	31.9	52.5	14.0	4.8	72.0	1.5	6.5	1.1	7,110	12,790	W215446
	---	32.4	53.4	14.2	4.7	73.3	1.5	5.1	1.1	7,220	13,000	
	---	37.8	62.2	---	5.5	85.4	1.8	6.0	1.3	8,420	15,160	
R-8555	1.7	31.1	58.2	9.0	5.1	77.4	1.6	6.2	.7	7,620	13,710	W217595
	---	31.6	59.2	9.2	5.0	78.8	1.6	4.7	.8	7,750	13,950	
	---	34.8	65.2	---	5.5	86.7	1.7	5.2	.8	8,540	15,370	
R-8556	1.8	30.3	63.8	4.1	5.1	82.4	1.4	6.1	.8	8,070	14,530	W217594
	---	30.8	65.0	4.2	5.0	83.9	1.4	4.7	.8	8,220	14,800	
	---	32.2	67.8	---	5.3	87.6	1.5	4.9	.8	8,580	15,440	

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Table 9b.--Proximate and ultimate analyses, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 8 bituminous coal samples from the Raven coal bed, Southwest Virginia. --continued

Sample Number	Air-dried Loss	Forms of Sulfur			Ash-Fusion Temperature (°C)			Hardgrove grindability index	Compliance Number	Lab Number
		Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening			
R-6872	.6 --- ---	0.01 .01 .01	0.49 .50 .59	0.71 .72 .85	6.0	1,205	1,260	1,305	---	1.91 W193664
R-7072	.5 --- ---	.02 .02 .02	.19 .19 .22	.55 .56 .62	7.0	1,445	1,470	1,555	---	1.19 W197301
R-7073	.8 --- ---	.01 .01 .01	.10 .10 .11	.60 .61 .67	6.5	1,355	1,410	1,600	---	1.03 W197302
R-7346	2.2 --- ---	.05 .05 .06	.19 .20 .22	.70 .73 .82	6.5	1,325	1,375	1,425	---	1.39 W203384
R-7863	1.0 --- ---	.02 .02 .03	.03 .03 .04	.45 .46 .61	8.0	1,375	1,465	1,540	---	.89 W211170
R-8494	.6 --- ---	.01 .01 .01	.40 .41 .47	.69 .70 .82	6.5	1,425	1,470	1,510	---	1.72 W215446
R-8555	.8 --- ---	.03 .03 .03	.03 .03 .03	.68 .69 .76	8.0	1,365	1,445	1,510	---	1.02 W217595
R-8556	.9 --- ---	.04 .04 .04	.07 .07 .07	.66 .67 .70	8.5	1,265	1,355	1,440	---	1.10 W217594

Table 9c.--Major- and minor-oxide concentrations in the laboratory ash of 8 bituminous coal samples from the Raven coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. L means less than the concentration shown; B not determined. Sample number is the VDMR identification number. Lab number is the USGS Laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-6872	15.1	41	20	14	1.1	0.24	0.69	7.0	1.4	0.34	9.1	W193664
R-7072	10.6	50	26	2.1	1.6	.23	3.1	8.9	1.3	.075	3.7	W19301
R-7073	9.3	48	28	3.0	1.5	.24	2.9	7.9	1.3	.16	5.1	W197302
R-7346	10.3	50	26	3.3	1.0	.13	.82	9.3	1.8	.65	5.0	W203384
R-7883	27.5	53	28	1.6	1.8	.45	4.1	5.2	1.2	.036L	1.7	W211170
R-8494	16.1	55	24	2.2	1.1	.30	1.7	5.7	1.8	.29	2.8	W215446
R-8555	13.0	52	24	1.6	1.6	.55	2.8	5.9	1.4	.15	B	W217595
R-8556	4.8	40	24	4.8	1.5	.53	1.1	11	1.7	.42	B	W217594

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Table 9d.--Major-, minor-, and trace-element composition of 8 bituminous coal samples from the Raven coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means less than the value shown; B, not determined; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-6872	2.9	1.6	1.5	0.10	0.027	0.087	0.74	0.13	0.015L	13	W193664
R-7072	2.5	1.4	.16	.10	.018	.28	.66	.083	.020	.17	W197301
R-7073	2.1	1.4	.20	.086	.017	.23	.52	.072	.012	.10	W197302
R-7546	2.4	1.4	.25	.063	.010	.070	.67	.11	.015	.8.3	W203384
R-7863	6.8	4.1	.31	.30	.091	.95	1.0	.19	.039	2.7	W211170
R-8494	4.1	2.1	.26	.11	.035	.23	.64	.18	.019	7.6	W215446
R-8555	3.2	1.7	.15	.12	.053	.30	.54	.11	.039	2.7	W217595
R-8556	.90	.60	.16	.042	.019	.043	.36	.050	.028	6.0	W217594

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-6872	30	110	1.3	11	0.030	25	B	4.4	18	0.50	W193664
R-7072	13	54	2.0	71	.059	24	B	12	16	1.2	W197301
R-7073	16	54	1.2	68	.088	24	B	9.5	22	1.1	W197302
R-7546	16	60	1.3	81	.064	21	1,700	4.1	14	.45	W203384
R-7863	33	260	2.2	8.6	.066	31	230	5.8	26	4.4	W211170
R-8494	31	120	1.0	20	.069	38	740	6.0	26	1.3	W215446
R-8555	13	100	1.6	7.4	.065	26	400	3.1	14	1.9	W217595
R-8556	4.8	46	1.0	13	.034	17	700	13	8.3	.20	W217594

Table 9d.--Major-, minor-, and trace-element composition of 8 bituminous coal samples from the Raven coal bed, Southwest Virginia,
reported on a whole-coal basis.--continued

Sample Number	Cu (ppm)	Er-S (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	Ho-S (ppm)	Lab Number
R-6872	23	1.5L	0.35	.64	3.8	1.5	0.69L	1.2	0.055	1.0L	W193664
R-7072	22	1.1L	.53	.20L	3.5	1.5	1.1	.70	.040	.72L	W197301
R-7073	24	1.1	.52	1,900	3.2	1.0	.14L	.60	.040	.63L	W197302
R-7346	20	1.5	.31	48	4.9	1.5L	.37	1.0	.13	.70L	W203384
R-7863	22	2.8L	.59	260	9.4	4.1L	.41L	1.0	.37	1.9L	W211170
R-8494	19	1.6L	.61	70	4.0	2.4L	.24L	1.8	.19	1.1L	W215446
R-8555	16	.60L	.43	210	5.2	2.0L	.72	1.0	.13	.88L	W217595
R-8556	12	.22L	.37	250	2.0	2.2	.62	.60	.11	.53	W217594

Sample Number	La (ppm)	Li (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Lab Number
R-6872	15	24	0.15	47	2.4	2.3	6.9L	7.6	220	3.9	W193664
R-7072	11	34	.23	21	1.2	1.6	10	12	35	7.0	W197301
R-7073	11	26	.19	23	1.0	1.1	8.0	9.3	66	7.6	W197302
R-7346	14	49	.14	29	2.1	3.5	7.8	11	290	7.2	W203384
R-7863	17	28	.18	36	.28L	4.1	16	16	44L	22	W211170
R-8494	20	47	.14	35	1.3	4.2	14	11	210	8.9	W215446
R-8555	13	12	.14	23	1.6	3.5	18	11	87	4.4	W217595
R-8556	9.0	3.7	.10	9.6	1.7	1.0	8.6	12	87	2.1	W217594

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Table 9d.--Major-, minor-, and trace-element composition of 8 bituminous coal samples from the Raven coal bed, Southwest Virginia,
reported on a whole-coal basis.--continued

Sample Number	Pr-S (ppm)	Rb (ppm)	Sb (ppm)	Sc (ppm)	Se (ppm)	Sm (ppm)	Sn-S (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Lab Number
R-6872	10L	6.5	0.87	4.1	2.9	1.9	1.0L	180	.31	.29	W193664
R-7072	7.2L	19	1.1	4.4	1.9	2.5	.20	100	.17	.46	W197301
R-7073	6.3L	17	.80	5.5	2.4	2.6	.28	93	.14	.43	W197302
R-7346	7.0L	20L	.55	3.3	2.8	1.3	.33	380	.25	.21	W203384
R-7863	19L	30	1.0L	5.8	2.7	2.5	1.3	210	.37	.73	W211170
R-8494	11L	12	.60	5.9	3.8	2.2	.92	210	.58	.37	W215446
R-8555	8.8L	14	.40	3.5	2.1	1.9	1.1	130	.29	.34	W217595
R-8556	5.3	20L	.50	1.8	2.4	1.4	.27	140	.19	.30	W217594

Sample Number	Th (ppm)	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)			Lab Number
R-6872	4.4	1.8	20	0.66	6.0	0.85	4.4	27			W193664
R-7072	3.2	1.6	17	.75	9.8	1.4	30	13			W197301
R-7073	4.1	1.8	20	.70	5.6	1.2					W197302
R-7346	3.5	1.3	24	.70	10	.80	5.7	35			W203384
R-7863	5.0	2.8	49	.60	10	1.3	7.7	28			W211170
R-8494	6.6	1.9	23	.65	7.6	1.2	5.6	40			W215446
R-8555	3.9	1.4	21	.50	7.4	1.1	6.2	17			W217595
R-8556	2.3	.69	9.1	.40	5.3	.80	4.2	9.6			W217594

Table 9e.--Arithmetic mean, observed range and geometric mean of proximate and ultimate analyses, heat content, forms of sulfur, and ash-fusion temperatures for 8 bituminous coal samples from the Raven coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included.

[All values are in percent except Btu/lb, Kcal/kg, ash-fusion temperatures, and free-swelling index and are reported on an as-received basis. $^{\circ}\text{F} = 9/5 \, ^{\circ}\text{C} + 32$; Kcal/kg = 0.556 Btu/lb; (n) is number of samples per parameter.]

	Raven coal bed				Appalachian basin		
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean
			Min.	Max.			(n)
Proximate and ultimate analyses							
Moisture	(8)	2.08	1.50	3.60	2.01	3.23	2.69 (4,760)
Volatile matter	(8)	29.63	21.40	33.60	29.25	32.46	31.72 (4,760)
Fixed carbon	(8)	56.36	50.49	64.20	56.14	52.48	51.76 (4,760)
Ash	(8)	11.93	4.12	24.59	10.65	11.83	9.83 (4,760)
Hydrogen	(8)	4.88	4.12	5.20	4.87	5.02	5.00 (4,760)
Carbon	(8)	74.08	63.64	82.41	73.89	70.69	70.17 (4,760)
Nitrogen	(8)	1.41	1.17	1.56	1.40	1.39	1.37 (4,757)
Oxygen	(8)	6.85	5.98	8.00	6.81	8.92	8.22 (4,756)
Sulfur	(8)	.84	.50	1.20	.81	2.15	1.63 (4,974)
Heat content							
KCal/kg Btu/lb	(8)	7,285 13,103	6,261 11,261	8,080 14,533	7,267 13,070	7,030 12,644	6,979 12,553 (4,759)
Forms of sulfur							
Sulfate	(8)	0.02	0.01	0.05	0.02	0.08	0.04 (4,245)
Pyritic	(8)	.19	.03	.49	.12	1.36	.65 (4,392)
Organic	(8)	.63	.45	.71	.62	.82	.70 (4,393)
Ash-fusion temperature ($^{\circ}\text{C}$)							
Initial deformation	(8)	1,346	1,207	1,443	1,344	1,255	1,246 (4,063)
Softening	(8)	1,407	1,260	1,471	1,405	1,287	1,280 (3,722)
Fluid	(6)	1,458	1,307	1,554	1,455	1,334	1,328 (3,449)
Free-swelling index	(8)	7.13	6.00	8.50	7.07	5.53	4.68 (4,603)
Air-dried loss	(8)	0.93	0.50	2.20	0.84	1.83	1.13 (3,868)

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Table 9f.--Arithmetic mean, observed range, and geometric mean of ash content and concentrations of 11 major- and minor-oxides in the laboratory ash of 8 bituminous coal samples from the Raven coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. (n) indicates the number of samples per oxide.

[All samples were ashed at 525°C; all data are in percent.]

	Raven coal bed					Appalachian basin		
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
			Min.	Max.				
(Ash)	(8)	13	4.8	28	12	13	10	(5,262)
SiO ₂	(8)	49	40	55	48	43	41	(5,229)
Al ₂ O ₃	(8)	25	20	28	25	24	23	(5,229)
CaO	(8)	4.0	1.6	14	3.1	2.2	1.5	(5,227)
MgO	(8)	1.4	1.0	1.8	1.4	.85	.75	(5,258)
Na ₂ O	(8)	.33	.13	.55	.30	.43	.34	(5,194)
K ₂ O	(8)	2.2	.69	4.1	1.8	2.0	1.7	(5,229)
Fe ₂ O ₃	(8)	7.6	5.2	11	7.4	19	13	(5,215)
MnO	(8)	.03	.017	.04	.03	.03	.02	(5,260)
TiO ₂	(8)	1.5	1.2	1.8	1.5	1.2	1.1	(5,203)
P ₂ O ₅	(7)	.30	.08	.65	.25	.50	.22	(3,389)
SO ₃	(6)	4.6	1.7	9.1	4.0	2.5	1.9	(5,063)

Table 9g.--Arithmetic mean, observed range, and geometric mean of concentrations of 54 trace elements in 8 bituminous coal samples from the Raven coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. Dashed values (---) represent less than five samples; (n) indicates the number of samples per element. [All data are in parts-per-million and are reported on a whole-coal basis.]

	Raven coal bed				Appalachian basin		
	(n)	Arith. mean	<u>Observed range</u>		Arith. mean	Geom. mean	(n)
			Min.	Max.			
Ag	(7)	0.02	0.012	0.04	0.02	0.07	0.05 (4,565)
As	(8)	8.5	2.7	17	7.1	35	13 (5,197)
B	(8)	20	4.8	33	17	30	20 (5,076)
Ba	(8)	100	46	260	85	90	63 (5,134)
Be	(8)	1.5	1.0	2.2	1.4	2.5	2.0 (5,247)
Bi	---	---	---	---	---	1.5	1.1 (108)
Br	(8)	35	7.4	81	23	22	13 (4,892)
Cd	(8)	.06	.030	.09	.06	.10	.07 (4,978)
Ce	(8)	26	17	38	25	21	17 (5,075)
Cl	(5)	750	230	1,700	600	780	510 (3,646)
Co	(8)	7.3	3.1	13	6.4	7.4	5.7 (5,217)
Cr	(8)	18	8.3	26	17	18	15 (5,205)
Cs	(8)	1.4	.20	4.4	.94	1.3	.85 (4,831)
Cu	(8)	20	12	24	19	19	15 (5,239)
Dy	---	---	---	---	---	3.3	2.6 (759)
Er	(2)	---	1.1	1.5	---	1.5	1.2 (1,200)
Eu	(8)	.46	.30	.61	.50	.44	.37 (5,032)
F	(7)	400	48	1,900	180	99	71 (4,860)
Ga	(8)	4.5	2.0	9.4	4.1	6.6	5.4 (5,046)
Gd	(4)	---	1.0	2.2	---	2.6	1.9 (1,773)
Ge	(4)	---	.37	1.1	---	4.7	2.5 (4,608)
Hf	(8)	.98	.60	1.8	.92	.79	.62 (4,932)
Hg	(8)	.13	.040	.37	.10	.22	.15 (5,031)
Ho	(1)	---	.53	.53	---	.76	.61 (378)
La	(8)	14	9.0	20	13	11	8.9 (5,147)
Li	(8)	28	3.7	49	22	22	14 (5,243)
Lu	(8)	.16	.10	.23	.15	.16	.14 (4,885)
Mn	(8)	28	9.6	47	26	31	15 (5,260)
Mo	(7)	1.6	1.0	2.4	1.5	3.7	2.3 (4,889)
Nb	(8)	2.7	1.0	4.2	2.3	2.6	1.9 (5,005)
Nd	(7)	12	7.8	18	11	13	9.9 (4,231)
Ni	(8)	11	7.6	16	11	17	14 (5,240)
Pb	(8)	7.9	2.1	22	6.4	8.8	6.2 (5,172)
Pd	---	---	---	---	---	.17	.14 (18)
Pr	(1)	---	5.3	5.3	---	6.1	3.6 (960)
Rb	(6)	16	6.5	30	15	28	22 (2,232)
Sb	(7)	.68	.40	1.0	.65	1.4	.91 (5,003)
Sc	(8)	4.3	1.8	5.9	4.0	4.4	3.6 (5,218)
Se	(8)	2.6	1.9	3.8	2.6	3.6	2.8 (5,052)
Sm	(8)	2.0	1.3	2.6	2.0	2.0	1.6 (5,005)
Sn	(7)	.62	.20	1.3	.49	1.6	.86 (2,352)
Sr	(8)	180	93	380	160	110	79 (5,146)
Ta	(8)	.28	.14	.57	.26	.24	.19 (4,369)
Tb	(8)	.39	.20	.73	.37	.34	.29 (4,852)
Th	(8)	4.1	2.3	6.7	4.0	3.0	2.3 (5,098)
Tl	---	---	---	---	---	3.4	2.1 (382)
Tm	---	---	---	---	---	1.7	.38 (46)
U	(8)	1.6	.69	2.8	1.6	1.8	1.3 (4,990)
V	(8)	23	9.1	50	21	24	19 (5,241)
W	(8)	.62	.40	.75	.61	.94	.80 (4,421)
Y	(8)	7.8	5.3	10	7.5	8.5	7.2 (5,234)
Yb	(8)	1.1	.80	1.4	1.0	1.1	.92 (5,151)
Zn	(8)	9.7	4.2	30	7.6	22	14 (5,243)
Zr	(8)	22	6.0	40	18	24	17 (5,238)

AILY COAL BED

The Aily coal bed crops out in Buchanan, Dickenson, Russell, Tazewell, and Wise Counties. Wise County accounted for all 70,974 tons produced in 1989 (Virginia Division of Mines, 1990). Other names for the Aily include the Hog Wallow, Raven, No. 3, or the Jawbone coal bed. The Aily varies in thickness from 1.5 to 2 feet. At sample locations (Figure 16), the coal displays poorly-developed medium cleat with medium and thin banding. Pyrite commonly occurs on both cleat and bedding.

The elements Bi, Er, Ho, Pd, Pr, Tl, and Tm are below the detection limits for the 2 coal samples from this coal bed in addition to the elements below the detection limits for all 375 Virginia coal samples described in this paper. The geometric means will not be discussed because there are only two samples. The descriptive and location data for these samples can be found in Table 10a and the analytical data can be found in Tables 10b, 10c, and 10d.

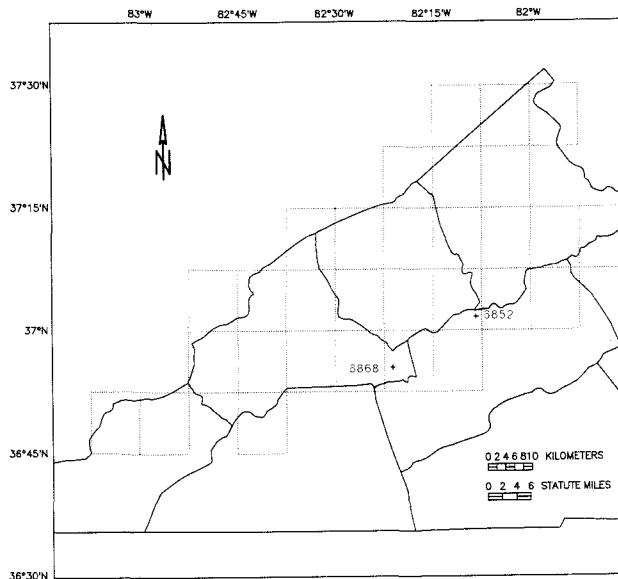


Figure 16. Locations for samples from the Aily coal bed.

Table 10a.--Descriptions and locations for 2 bituminous coal samples from the Aily coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-6852	W192607	88C-1	370141N	820822W	Duty (7.5') St. Paul (7.5')	Russell Wise	24.48 20.52	Surface mine, sl. Surface mine, sl.	weathered weathered
R-6868	W200126	59A-2	365529N	822112W					Full Thickness Full Thickness

Table 10b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 2 bituminous coal samples from the Aily coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, ash-fusion temperatures, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	PROXIMATE ANALYSIS			ULTIMATE ANALYSIS				HEAT CONTENT			Lab Number	
	Moisture	Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	
R-6852	4.6	27.3	59.6	8.5	5.1	74.6	1.2	9.9	0.7	7,300	13,140	W192607
	--	28.6	62.5	8.9	4.8	78.2	1.3	6.1	.7	7,650	13,770	
	--	31.4	68.6	--	5.3	85.8	1.4	6.7	.8	8,400	15,120	
R-6868	3.0	31.7	55.4	9.9	5.0	74.1	1.4	8.8	.8	7,290	13,130	W200126
	--	32.7	57.1	10.2	4.8	76.4	1.4	6.3	.8	7,520	13,530	
	--	36.4	63.6	--	5.4	85.1	1.6	7.0	.9	8,370	15,070	

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Table 10b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 2 bituminous coal samples from the Aily coal bed, Southwest Virginia. --continued

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)				Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid			
R-6852	0.0	0.02	0.66	0.03	8.0	1,320	1,380	1,440	---	1.07	W192607
	---	.02	.69	.03	.03	1,220	1,265	1,295			
R-6868	1.4	.00	.30	.50	4.0	1,265	1,295	---	---	1.22	W200126
	---	.00	.31	.52	.57	1,220	1,265	1,295			

Table 10c.--Major- and minor-oxide concentrations in the laboratory ash of 2 bituminous coal samples from the Aily coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-6852	9.4	49	23	3.1	1.6	0.54	3.5	10	1.4	0.085	4.1	W192607
R-6868	10.9	43	24	5.4	2.0	.42	2.7	8.6	1.2	.16	6.1	W200126

Table 10d. -Major-, minor-, and trace-element composition of 2 bituminous coal samples from the Aily coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means less than the value shown; B, not determined; S, after element title indicates determinations by automatic plate reading computer assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDNR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-6852	2.1	1.1	0.21	0.093	0.038	0.27	0.68	0.079	0.010	8.6	W192607
R-6868	2.2	1.4	.42	.13	.034	.24	.66	.078	.011L	7.5	W200126

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-6852	10	47	2.4	19	0.038	12	B	3.1	11	2.0	W192607
R-6868	38	120	1.4	19	.050	12	850	2.5	11	1.7	W200126

Sample Number	Cu (ppm)	Dy-S (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	La (ppm)	Lab Number
R-6852	13	3.0L	0.22	82	3.1	0.64L	1.8	0.53	0.018	6.0	W192607
R-6868	14	2.5	.22	820	4.1	1.4	.40	.55	.010L	6.5	W200126

Sample Number	Li (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Rb (ppm)	Lab Number
R-6852	16	0.11	23	0.94	1.4	5.7	5.0	35	3.3	24	W192607
R-6868	20	.11	28	1.9	1.5	5.0L	7.2	74	3.3	24	W200126

Table 10d.--Major-, minor-, and trace-element composition of 2 bituminous coal samples from the Aily coal bed, Southwest Virginia,
reported on a whole-coal basis.--continued

Sample Number	Sb (ppm)	Sc (ppm)	Se (ppm)	Sm (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	U (ppm)	Lab Number
R-6852	0.38	2.2	2.3	1.0	0.77	.44	0.15	0.17	1.7	W192607
R-6868	.35	2.6	1.8	1.1	.16L	370	.16	.19	1.9	W200126

Sample Number	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)	Lab Number
R-6852	12	0.47	4.0	0.57	10	9.4	W192607
R-6868	20	.70	8.3	.60	7.8	19	W200126

NORTON FORMATION (UNDIVIDED) OR UPPER PART OF THE NORTON FORMATION

KENNEDY COAL BED

This coal crops out in Buchanan, Dickenson, Russell, Tazewell, and Wise Counties and within the area may also be called the Widow Kennedy, Harris, Grundy, Lower Banner, or Douglas coal bed. Production in 1989 was 1.6 million tons (Virginia Division of Mines, 1990), mostly from Buchanan County. Sampled thickness ranges from 1.9 to 4.3 feet and averages 2.5 feet. The Kennedy coal bed has moderate thin banding with a poorly-developed medium- and fine-cleat. There are two or more thin mudstone partings which contain pyrite. Near the Russell Fork fault in Dickenson County, the upper half of the coal is severely sheared and in mines from which coal samples were taken the roof rock was unstable shale containing abundant plant fossils. Figure 17 shows Kennedy coal bed sample distribution and Table 11a is descriptive and location information.

In addition to the eight elements below detection limits for the 375 Virginia coal samples, Bi, Dy, Er, Ho, Pd, and Tm are below the detection limits for the Kennedy samples (Tables 11b, 11c, and 11d). Tl has only one unqualified value and therefore calculation of geometric mean is not possible. MgO, K₂O, MnO, Br, Ho, Pr, and free-swelling index geometric means of the 14 Kennedy coal samples are found to be substantially higher than for the Appalachian coal basin samples. B, Cd, Ni, Zn, sulfur, and pyritic sulfur geometric means are found to be substantially lower in the Kennedy coal samples than in the Appalachian basin samples (Tables 11e, 11f, and 11g).

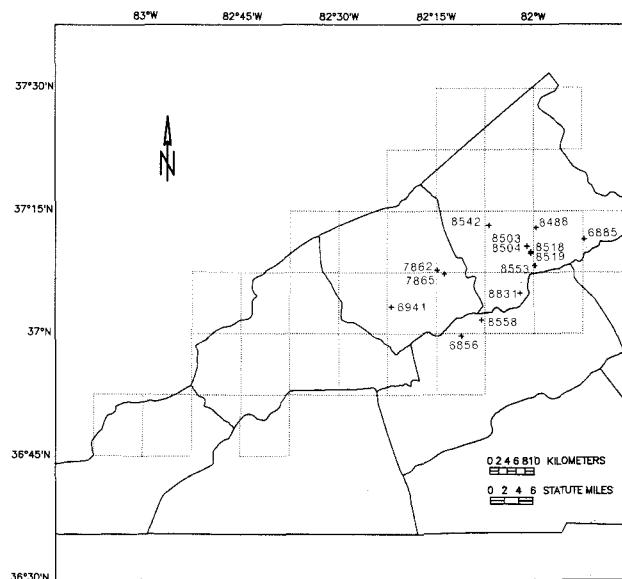


Figure 17. Locations for samples from the Kennedy coal bed.

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Table 11a.-Descriptions and locations for 14 bituminous coal samples from the Kennedy coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-6856	W192606	58B-1	365943N	821107W	Carbo (7.5') Jewell Ridge (7.5')	Russell Buchanan Dickenson Dickenson Dickenson	24.00	Surface mine, weathered	Full Thickness
R-6885	W193932	87A-1	371135N	815215W	Nora (7.5') Prater (7.5') Duty (7.5')	Buchanan Dickenson Dickenson	28.20	Surface mine, s.l. weathered	Full Thickness
R-6941	W196290	89D-2	370319N	822154W			40.80	Surface mine, s.l. weathered	Full Thickness
R-7862	W211168	88B-7	370748N	821449W			41.40	Underground mine, s.l. weathered	Full Thickness
R-7865	W211172	88C-16	370720N	821347W			24.00	Underground mine, weathered	Full Thickness
R-8488	W215412	87B-8	371259N	815940W	Keen Mountain (7.5') Vansant (7.5') Vansant (7.5') Vansant (7.5') Vansant (7.5')	Buchanan Buchanan Buchanan Buchanan Buchanan	22.20	Underground mine, s.l. weathered	Full Thickness
R-8503	W215448	88A-13	371043N	820101W			28.80	Underground mine, weathered	Upper Split
R-8504	W215449	88A-14	371043N	820101W			33.60	Underground mine, weathered	Lower Split
R-8518	W215876	88A-15	370951N	820028W			27.00	Underground mine, s.l. weathered	Full Thickness
R-8519	W215877	88A-16	371003N	820027W			27.60	Underground mine, s.l. weathered	Full Thickness
R-8542	W217397	88A-17	371315N	820655W	Vansant (7.5') Keen Mountain (7.5') Duty (7.5') Big A Mountain (7.5')	Buchanan Buchanan Russell Buchanan	32.40	Underground mine	Full Thickness
R-8553	W217592	87B-10	370822N	815950W			21.00	Underground mine	Full Thickness
R-8558	W217597	88C-23	370141N	820801W			46.80	Underground mine	Full Thickness
R-8831	W213993	88D-1	370458N	820204W			27.00	Underground mine, s.l. weathered	Full Thickness

Table 11b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 14 bituminous coal samples from the Kennedy coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, ash-fusion temperatures, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa. and a commercial testing laboratory following ASTM standards. G for ash-fusion temperatures means greater than value shown. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT		
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	Lab Number
R-6856	2.4	27.9	50.4	19.3	4.8	67.2	1.4	6.5	0.8	6,650	11,970	W192606
	---	28.6	51.6	19.8	4.6	68.9	1.4	4.5	.8	6,810	12,260	
	---	35.6	64.4	--	5.8	85.8	1.8	5.6	1.0	8,490	15,290	
R-6885	2.7	25.0	69.0	3.3	5.1	83.4	1.4	6.1	.6	8,200	14,760	W193932
	---	25.7	70.9	3.4	4.9	85.7	1.4	3.8	.6	8,420	15,160	
	---	26.6	73.4	--	5.1	88.7	1.5	3.9	.6	8,720	15,700	
R-6941	1.8	25.8	55.8	16.6	4.6	71.6	1.4	5.1	.6	7,070	12,730	W196290
	---	26.3	56.8	16.9	4.5	72.9	1.4	3.6	.6	7,200	12,960	
	---	31.6	68.4	--	5.4	87.7	1.7	4.3	.7	8,670	15,600	
R-7862	1.4	20.8	55.3	22.6	4.1	64.6	1.2	6.8	.7	6,500	11,700	W211168
	---	21.1	56.1	22.9	4.0	65.5	1.2	5.7	.8	6,590	11,860	
	---	27.3	72.7	--	5.2	84.9	1.6	7.4	1.0	8,550	15,380	
R-7865	2.5	19.1	48.8	29.5	3.9	58.3	1.1	5.7	1.4	5,780	10,400	W211172
	---	19.6	50.1	30.3	3.7	59.8	1.1	3.6	1.5	5,930	10,670	
	---	28.1	71.9	--	5.3	85.8	1.6	5.1	2.1	8,510	15,310	
R-8488	1.2	23.5	72.6	2.8	4.9	86.1	1.6	4.0	.7	8,420	15,160	W215412
	---	23.7	73.5	2.8	4.8	87.2	1.6	3.0	.7	8,520	15,340	
	---	24.4	75.6	--	4.9	89.7	1.6	3.1	.7	8,770	15,780	
R-8503	1.7	24.8	70.5	3.1	4.8	84.9	1.7	4.5	.9	8,270	14,880	W215448
	---	25.2	71.7	3.1	4.7	86.4	1.7	3.1	1.0	8,410	15,140	
	---	26.0	74.0	--	4.9	89.2	1.8	3.2	1.0	8,680	15,620	
R-8504	1.6	23.6	69.5	5.3	5.0	83.9	1.5	3.7	.6	8,210	14,770	W215449
	---	24.0	70.6	5.4	4.9	85.3	1.5	2.3	.6	8,340	15,020	
	---	25.4	74.6	--	5.1	90.2	1.6	2.4	.7	8,820	15,870	
R-8518	3.1	25.2	67.0	4.7	5.0	81.6	1.5	6.4	.7	8,010	14,420	
	---	26.0	69.1	4.8	4.8	84.2	1.6	3.8	.8	8,270	14,880	
	---	27.4	72.6	--	5.1	88.5	1.7	4.0	.8	8,690	15,640	

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Table 11b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 14 bituminous coal samples from the Kennedy coal bed, Southwest Virginia. --continued

Sample Number	Air-dried Loss	FORMS OF SULFUR			ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number
		Sulfate	Pyritic	Organic	Initial Deformation	Softening	Fluid			
R-6856	0.0	0.02	0.48	0.28	7.5	1,305	1,445	---	1.34	W192606
	---	.02	.49	.29						
	---	.03	.61	.36						
R-6885	1.8	.00	.06	.58	9.0	1,245	1,290	1,340	---	W193932
	---	.00	.06	.60						
	---	.00	.06	.62						
R-6941	.8	.01	.19	.45	9.0	1,380	1,435	1,515	---	W196290
	---	.01	.19	.46						
	---	.01	.23	.55						
R-7862	.6	.05	.24	.45	8.0	1,405	1,500	1,540	---	W211168
	---	.05	.24	.46						
	---	.07	.32	.59						
R-7865	1.5	.24	.73	.48	8.0	1,305	1,415	1,540	---	W211172
	---	.25	.75	.49						
	---	.35	1.07	.71						
R-8488	.4	.05	.05	.58	9.0	1,275	1,380	1,415	---	W215412
	---	.05	.05	.59						
	---	.05	.05	.60						
R-8503	.8	.02	.30	.62	8.0	1,205	1,315	1,360	---	W215448
	---	.02	.31	.63						
	---	.02	.31	.65						
R-8504	.9	.03	.08	.50	8.0	1,540	1,540G	1,540G	---	W215449
	---	.03	.08	.51						
	---	.03	.09	.54						
R-8518	2.0	.03	.11	.60	8.0	1,210	1,270	1,315	---	W215876
	---	.03	.11	.62						
	---	.03	.12	.65						

Table 11b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, grindability index, and compliance numbers for 14 bituminous coal samples from the Kennedy coal bed, Southwest Virginia.--continued

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT		
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/Kg	Btu/lb	Lab Number
R-8519	3.4	25.3	67.0	4.3	5.2	82.1	1.6	6.0	.8	8,040	14,470	W215877
	---	26.2	69.3	4.5	5.0	85.0	1.7	3.1	.8	8,320	14,980	
	---	27.4	72.6	---	5.2	89.0	1.7	3.2	.9	8,710	15,680	
R-8542	1.3	24.1	69.1	5.5	4.9	82.8	1.5	4.5	.7	8,110	14,590	W217397
	---	24.4	70.0	5.6	4.8	83.8	1.6	3.4	.7	8,210	14,780	
	---	25.9	74.1	---	5.1	88.8	1.7	3.6	.8	8,700	15,660	
R-8553	1.7	28.4	65.2	4.6	5.0	82.4	1.4	5.9	.7	8,080	14,540	W217592
	---	28.9	66.3	4.7	4.9	83.8	1.4	4.4	.7	8,220	14,790	
	---	30.4	69.6	---	5.2	88.0	1.5	4.6	.7	8,630	15,530	
R-8558	1.8	31.7	57.6	8.8	5.1	77.0	1.5	6.8	.8	7,600	13,670	W217597
	---	32.3	58.7	9.0	5.0	78.4	1.5	5.3	.8	7,740	13,920	
	---	35.5	64.5	---	5.5	86.1	1.7	5.8	.9	8,500	15,300	
R-8831	2.3	33.3	60.4	4.0	5.2	80.2	1.7	8.0	.9	8,030	14,460	W213993
	---	34.1	61.8	4.1	5.1	82.1	1.7	6.1	1.0	8,230	14,810	
	---	35.5	64.5	---	5.3	85.6	1.8	6.3	1.0	8,580	15,440	

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Table 11b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 14 bituminous coal samples from the Kennedy coal bed, Southwest Virginia.--continued

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening			
R-8519	2.4 ---	0.06 .06	0.16 .17	0.58 .60	8.0 .	1,195 1,275	1,250 1,275	1,275	---	1.11 W215877
R-8542	.6 ---	.03 .03	.16 .17	.55 .56	9.0 .59	1,180 1,275	1,275 1,325	1,325	---	.96 W217397
R-8553	.9 ---	.02 .02	.07 .07	.60 .61	8.0 .	1,240 1,245	1,345 1,455	1,455	---	.96 W217592
R-8558	.9 ---	.09 .09	.20 .20	.54 .55	7.5 .	1,245 1,325	1,325 1,440	1,440	---	1.17 W217597
R-8831	.9 ---	.06 .06	.18 .18	.70 .72	8.0 .	1,150 1,225	1,225 1,350	1,350	---	1.24 W213993

Table 11c.--Major- and minor-oxide concentrations in the laboratory ash of 14 bituminous coal samples from the Kennedy coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. L means less than the concentration shown; B not determined. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-6856	22.2	53	22	1.2	1.8	0.65	5.0	8.5	1.1	0.072	1.8	W192606
R-6885	2.9	36	24	4.5	1.8	.11	2.0	16	1.1	.069	6.9	W193932
R-6941	17.1	56	24	.52	2.2	.28	5.4	6.6	1.2	.041	.73	W196290
R-7362	24.5	70	19	.39	.88	.18	2.4	3.5	2.6	.041L	.82	W211168
R-7885	32.2	52	25	.34	1.8	.22	5.2	10	1.0	1.2	1.3	W211172
R-8488	2.8	42	26	3.2	1.2	.14	1.9	17	1.1	.36L	3.8	W215412
R-8503	3.0	40	26	2.7	1.1	.31	1.6	22	1.2	.50	3.5	W215448
R-8504	4.9	55	31	1.3	.32	.28	.56	6.1	2.2	.43	1.6	W215449
R-8518	5.0	42	28	2.6	1.3	.24	3.1	16	1.1	.40	3.2	W215876
R-8519	4.4	36	24	5.5	1.1	.22	2.0	20	1.0	.45	.58	W215877
R-8542	6.2	49	24	1.4	1.8	.43	4.0	16	1.0	.16	2.0	W217397
R-8553	5.0	45	25	2.6	1.2	.26	2.1	14	1.1	.40	B	W217592
R-8558	10.8	47	21	2.4	1.2	.30	2.8	9.3	1.3	.093	B	W217597
R-8831	5.0	37	20	7.3	2.0	.41	3.6	17	1.0	.20L	5.0	W213993

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Table 11d. - "Major", minor-, and trace-element composition of 14 bituminous coal samples from the Kennedy coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means less than the value shown; B, not determined; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-6856	5.5	2.5	0.19	0.24	0.11	0.92	1.3	0.15	0.027	18	W192606
R-6885	.49	.37	.093	.032	.002	.048	.31	.019	.010	1.6	W193932
R-6941	4.4	2.2	.063	.22	.036	.77	.79	.12	.034	6.9	W196290
R-7862	8.0	2.5	.069	.13	.032	.49	.60	.38	.044	7.2	W211168
R-7865	7.8	4.3	.077	.35	.052	1.4	2.3	.20	.045	64	W211172
R-8488	.55	.39	.064	.020	.003	.045	.34	.019	.022	2.8	W215412
R-8503	.55	.41	.057	.019	.007	.039	.46	.021	.024	16	W215448
R-8504	1.3	.79	.047	.009	.010	.023	.21	.064	.074	7.7	W215449
R-8518	.98	.75	.094	.040	.009	.13	.55	.034	.025	10	W215876
R-8519	.73	.55	.17	.030	.007	.073	.63	.027	.024	43	W215877
R-8542	1.4	.78	.064	.068	.020	.21	.69	.037	.068	36	W217397
R-8553	1.0	.65	.092	.036	.010	.089	.47	.032	.022	5.9	W217592
R-8558	2.4	1.2	.19	.080	.024	.25	.70	.082	.028	10	W217597
R-8831	.86	.53	.26	.060	.015	.15	.60	.031	.013	11	W213993

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-6856	27	120	1.7	28	0.080	22	B	7.8	20	3.4	W192606
R-6885	1.7	23	1.5	31	.004	11	B	4.6	4.9	.30	W193932
R-6941	19	100	5.5	45	.099	26	B	14	19	2.6	W196290
R-7862	23	130	1.6	20	.025L	47	480	5.5	31	2.2	W211168
R-7865	30	210	2.8	17	.032L	43	350	8.7	33	4.5	W211172
R-8488	1.9	21	1.7	27	.015	6.0	1,300	2.6	4.1	.20	W215412
R-8503	1.3	17	.69	17	.039	6.0	940	2.6	4.6	.20	W215448
R-8504	2.4	24	3.3	16	.12	27	820	3.8	12	.10	W215449
R-8518	3.8	44	.75	17	.021	8.0	800	3.0	.63	.50	W215876
R-8519	2.1	42	1.1	18	.016	7.0	700	3.1	5.6	.30	W215877
R-8542	4.9	34	.81	27	.021	9.0	1,200	3.5	8.3	.80	W217397
R-8553	3.0	30	1.2	14	.042	10	600	4.4	6.6	.40	W217592
R-8558	14	92	1.1	16	.045	19	800	3.6	12	1.3	W217597
R-8831	7.5	80	.95	19	.023	7.0	210	3.5	5.2	.85	W213993

Sample Number	Cu (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	La (ppm)	Li (ppm)	Lab Number
R-6856	22	0.37	190	11	1.5L	1.5	0.87	0.10	11	31	W192606
R-6885	9.9	.20	24	1.5	.41	4.6	.25	.010	5.0	6.1	W193932
R-6941	17	.47	220	8.7	1.2L	7.4	1.0	.065	14	34	W196290
R-7862	27	.71	150	8.1	3.7L	.37L	3.1	.50	27	25	W211168
R-7865	26	.73	230	11	4.8L	1.8	1.2	.37	24	28	W211172
R-8488	7.0	.13	30	1.6	.42L	2.6	.10	.14	3.0	5.0	W215412
R-8503	8.7	.20	40	.96	.45L	.69	.20	.19	3.0	5.4	W215448
R-8504	24	.55	30	1.8	.74L	3.2	.60	.22	12	14	W215449
R-8518	8.5	.18	10	1.7	.75L	.85	.20	.010L	5.0	6.5	W215876
R-8519	8.4	.18	110	1.3	.66L	2.0	.20	.015	4.0	4.4	W215877
R-8542	9.3	.15	280	2.3	.93L	.37	.20	.060	5.0	7.4	W217397
R-8553	8.0	.30	120	2.3	1.1	1.4	.30	.090	5.0	4.8	W217592
R-8558	9.8	.37	340	4.2	5.4	.68	.80	.15	10	8.5	W217597
R-8831	5.5	.17	10	2.0	.75L	1.3	.20	.27	4.0	3.5	W213993

Sample Number	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Pr-S (ppm)	Rb (ppm)	Lab Number
R-6856	0.14	71	1.3	2.9	14	13	70	8.2	15L	48	W192606
R-6885	.10	10	.55	.29	2.2	3.5	8.7	2.3	2.0L	7.0L	W193932
R-6941	.18	43	.62	2.2	8.6	14	31	7.5	12L	39	W196290
R-7862	.36	17	.37	6.1	22	12	44L	18	17L	22	W211168
R-7865	.25	42	1.3	4.8	22	22	1,700	19	22L	66	W211172
R-8488	.05	20	1.5	.42	1.8	4.8	44L	.78	1.9L	20L	W215412
R-8503	.04	5.7	1.9	.36	2.4	3.9	66	1.6	2.0L	20L	W215448
R-8504	.13	4.2	1.2	1.0	8.3	6.9	92	6.9	3.3L	20L	W215449
R-8518	.07	6.5	1.8	.31	5.5	4.7	87	4.4	3.4L	6.0	W215876
R-8519	.06	7.9	2.2	.48	3.2	4.8	87	4.1	3.0L	20L	W215877
R-8542	.07	23	1.1	.55	2.0L	4.1	44	2.4	4.2L	11	W217397
R-8553	.09	10	1.3	.80	5.5	6.5	87	2.0	5.0	6.0	W217592
R-8558	.09	25	1.5	1.7	16	9.4	44	4.6	9.5	15	W217597
R-8831	.06	16	3.1	.85	3.0	5.5	44L	1.1	3.7	30L	W213993

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Table 11d. --Major-, minor-, and trace-element composition of 14 bituminous coal samples from the Kennedy coal bed, Southwest Virginia,
reported on a whole-coal basis.--continued

Sample Number	Sb (ppm)	Sc (ppm)	Se (ppm)	Sm (ppm)	Sn-S (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	Tl-S (ppm)	Lab Number
R-6856	0.75	4.1	3.1	1.6	2.4	98	0.24	0.25	3.4	2.2L	W192606
R-6885	1.5	1.3	1.1	1.3	.32	25	.055	.24	.70	.29L	W19332
R-6941	1.6	4.3	1.3	2.3	1.7	38	.17	.34	3.2	1.7L	W196290
R-7862	3.2	6.3	4.5	3.5	2.5	81	.90	.97	8.7	1.1L	W211168
R-7865	2.0	8.0	2.6	3.5	.48L	100	.44	.99	6.2	2.7	W211172
R-8488	.50	.98	.90	.50	.04L	42	.040	.11	.60	.13L	W215412
R-8503	.50	1.1	1.7	.60	.05L	27	.070	.17	1.0	.14L	W215448
R-8504	.50	3.1	4.0	1.7	.39	69	.21	.42	2.7	.23L	W215449
R-8518	.80	1.5	1.5	.70	.08L	75	.050	.12	1.2	.23L	W215876
R-8519	1.2	1.3	1.5	.70	.07L	79	.070	.19	.90	.20L	W215877
R-8542	.30	1.5	1.1	.80	.29L	35	.090	.15	1.1	.62L	W217597
R-8553	.90	2.3	1.4	1.0	.23L	60	.090	.26	1.2	.50L	W217592
R-8558	.30	2.8	2.1	1.4	.82	210	.22	.28	2.6	.11L	W217597
R-8831	1.0L	1.3	1.3	.65	.08L	150	.10	.11	.90	.23L	W213993

Sample Number	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)			Lab Number
R-6856	1.5	29	0.54	5.8	0.80	49	20			W192606
R-6885	.66	3.8	.33	2.5	.60	2.3	2.2			W19332
R-6941	1.2	22	1.3	7.5	1.2	21	14			W196290
R-7862	2.9	34	1.2	12	2.2	11	56			W211168
R-7865	4.4	64	1.1	14	1.8	17	48			W211172
R-8488	.34L	6.2	.75	2.2	.35	4.5	4.2			W215412
R-8503	.21L	4.5	.30	2.0	.30	1.9	4.2			W215448
R-8504	.89	15	.60	5.4	1.0	2.9	8.8			W215449
R-8518	.65	9.5	.40	2.8	.40	2.1	7.5			W215876
R-8519	.65	7.5	.70	3.5	.40	2.2	7.5			W215877
R-8542	.58	6.8	.50	1.2	.40	4.0	2.9			W217597
R-8553	.58	11	.40	4.7	.75	3.7	6.0			W217592
R-8558	.65	17	.30	6.0	.90	5.0	14			W217597
R-8831	.27L	7.5	.70	4.2	.40	3.0	8.0			W213993

Table 11e.--Arithmetic mean, observed range and geometric mean of proximate and ultimate analyses, heat content, forms of sulfur, and ash-fusion temperatures for 14 bituminous coal samples from the Kennedy coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included.

[All values are in percent except Btu/lb, Kcal/kg, ash-fusion temperatures, and free-swelling index and are reported on an as-received basis. ${}^{\circ}\text{F} = \frac{9}{5} \text{ }^{\circ}\text{C} + 32$; Kcal/kg = 0.556 Btu/lb; (n) is number of samples per parameter.]

	Kennedy coal bed				Appalachian basin		
(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
Proximate and ultimate analyses							
Moisture	(14)	2.07	1.19	3.41	1.96	3.23	2.69
Volatile matter	(14)	25.61	19.10	33.28	25.35	32.46	31.72
Fixed carbon	(14)	62.72	48.84	72.60	62.24	52.48	51.76
Ash	(14)	9.60	2.75	29.55	6.92	11.83	9.83
Hydrogen	(14)	4.83	3.91	5.24	4.81	5.02	5.00
Carbon	(14)	77.57	58.28	86.13	77.08	70.69	70.17
Nitrogen	(14)	1.46	1.09	1.70	1.45	1.39	1.37
Oxygen	(14)	5.72	3.72	8.00	5.60	8.92	8.22
Sulfur	(14)	.80	.60	1.45	.78	2.15	1.63
Heat content							
KCal/kg	(14)	7,646	5,784	8,427	7,602	7,030	6,979
Btu/lb	(14)	13,751	10,403	15,156	13,673	12,644	12,553
Forms of sulfur							
Sulfate	(13)	0.05	0.01	0.24	0.04	0.08	0.04
Pyritic	(14)	.21	.05	.73	.16	1.36	.65
Organic	(14)	.54	.28	.70	.53	.82	.70
Ash-fusion temperature (°C)							
Initial deformation	(13)	1,257	1,149	1,404	1,255	1,255	1,246
Softening	(13)	1,339	1,227	1,499	1,337	1,287	1,280
Fluid	(11)	1,385	1,277	1,513	1,383	1,334	1,328
Free-swelling index	(14)	8.21	7.50	9.00	8.20	5.53	4.68
Air-dried loss	(13)	1.12	0.41	2.38	0.98	1.83	1.13

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Table 11f.--Arithmetic mean, observed range, and geometric mean of ash content and concentrations of 11 major- and minor-oxides in the laboratory ash of 14 bituminous coal samples from the Kennedy coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. (n) indicates the number of samples per oxide.

[All samples were ashed at 525°C; all data are in percent.]

	Kennedy coal bed				Appalachian basin			
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
			Min.	Max.				
(Ash)	(14)	10	2.8	32	7.3	13	10	(5,262)
SiO ₂	(14)	47	36	70	46	43	41	(5,229)
Al ₂ O ₃	(14)	24	19	31	24	24	23	(5,229)
CaO	(14)	2.6	.34	7.3	1.8	2.2	1.5	(5,227)
MgO	(14)	1.4	.32	2.2	1.3	.85	.75	(5,258)
Na ₂ O	(14)	.29	.11	.65	.26	.43	.34	(5,194)
K ₂ O	(14)	3.0	.56	5.4	2.6	2.0	1.7	(5,229)
Fe ₂ O ₃	(14)	13	3.5	22	12	19	13	(5,215)
MnO	(14)	.03	.009	.09	.03	.03	.02	(5,260)
TiO ₂	(14)	1.3	1.0	2.6	1.2	1.2	1.1	(5,203)
P ₂ O ₅	(11)	.35	.040	1.2	.22	.50	.22	(3,389)
SO ₃	(12)	2.6	.58	6.9	2.0	2.5	1.9	(5,063)

Table 11g.--Arithmetic mean, observed range, and geometric mean of concentrations of 54 trace elements in 14 bituminous coal samples from the Kennedy coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. Dashed values (---) represent less than five samples; (n) indicates the number of samples per element. [All data are in parts-per-million and are reported on a whole-coal basis.]

	Kennedy coal bed				Appalachian basin		
	(n)	Arith. mean	Observed range		Geom. mean	Arith. mean	Geom. mean
			Min.	Max.			(n)
Ag	(14)	0.03	0.010	0.07	0.03	0.07	0.05 (4,565)
As	(14)	17	1.6	64	11	35	13 (5,197)
B	(14)	10	1.3	30	5.7	30	20 (5,076)
Ba	(14)	70	17	210	52	90	63 (5,134)
Be	(14)	1.8	.69	5.5	1.4	2.5	2.0 (5,247)
Bi	---	---	---	---	---	1.5	1.1 (108)
Br	(14)	22	14	45	21	22	13 (4,892)
Cd	(12)	.04	.004	.12	.03	.10	.07 (4,978)
Ce	(14)	18	6.0	46	14	21	17 (5,075)
Cl	(11)	750	210	1,300	670	780	510 (3,646)
Co	(14)	5.1	2.6	14	4.4	7.4	5.7 (5,217)
Cr	(14)	12	4.2	33	9.5	18	15 (5,205)
Cs	(14)	1.3	.10	4.5	.69	1.3	.85 (4,831)
Cu	(14)	14	5.5	27	12	19	15 (5,239)
Dy	---	---	---	---	---	3.3	2.6 (759)
Er	---	---	---	---	---	1.5	1.2 (1,200)
Eu	(14)	.34	.13	.73	.28	.44	.37 (5,032)
F	(14)	130	10	340	74	99	71 (4,860)
Ga	(14)	4.2	.96	11	2.9	6.6	5.4 (5,046)
Gd	(3)	---	.41	5.4	---	2.6	1.9 (1,773)
Ge	(13)	2.2	.37	7.4	1.6	4.7	2.5 (4,608)
Hf	(14)	.66	.10	3.0	.41	.79	.62 (4,932)
Hg	(13)	.17	.010	.50	.11	.22	.15 (5,031)
Ho	---	---	---	---	---	.76	.61 (378)
La	(14)	9.4	3.0	26	7.2	11	8.9 (5,147)
Li	(14)	13	3.5	34	9.6	22	14 (5,243)
Lu	(14)	.12	.040	.35	.10	.16	.14 (4,885)
Mn	(14)	21	4.2	71	16	31	15 (5,260)
Mo	(14)	1.4	.37	3.0	1.2	3.7	2.3 (4,889)
Nb	(14)	1.6	.29	6.1	.99	2.6	1.9 (5,005)
Nd	(13)	8.8	1.8	22	6.2	13	9.9 (4,231)
Ni	(14)	8.3	3.5	22	7.0	17	14 (5,240)
Pb	(14)	5.9	.78	19	3.9	8.8	6.2 (5,172)
Pd	---	---	---	---	---	.17	.14 (18)
Pr	(3)	---	3.7	9.5	---	6.1	3.6 (960)
Rb	(8)	27	6.0	66	19	28	22 (2,232)
Sb	(13)	1.1	.30	3.2	.85	1.4	.91 (5,003)
Sc	(14)	2.9	.98	8.0	2.3	4.4	3.6 (5,218)
Se	(14)	2.0	.90	4.5	1.8	3.6	2.8 (5,052)
Sm	(14)	1.4	.50	3.5	1.2	2.0	1.6 (5,005)
Sn	(6)	1.4	.32	2.4	1.0	1.6	.86 (2,352)
Sr	(14)	78	25	210	65	110	79 (5,146)
Ta	(14)	.20	.040	.90	.13	.24	.19 (4,369)
Tb	(14)	.33	.11	.99	.25	.34	.29 (4,852)
Th	(14)	2.4	.60	8.7	1.7	3.0	2.3 (5,098)
Tl	(1)	---	2.7	2.7	---	3.4	2.1 (382)
Tm	---	---	---	---	---	1.7	.38 (46)
U	(11)	1.3	.58	4.4	1.0	1.8	1.3 (4,990)
V	(14)	17	3.8	64	12	24	19 (5,241)
W	(14)	.65	.30	1.3	.58	.94	.80 (4,421)
Y	(14)	5.2	1.2	14	4.2	8.5	7.2 (5,234)
Yb	(14)	.82	.30	2.2	.67	1.1	.92 (5,151)
Zn	(14)	9.2	1.9	49	5.2	22	14 (5,243)
Zr	(14)	15	2.2	56	9.1	24	17 (5,238)

BIG FORK COAL BED

This coal bed occurs in Buchanan, Russell and Tazewell Counties, and the 44,785 tons produced in 1989 came from Russell County (Virginia Division of Mines, 1990). The Big Fork coal bed was 2.4 feet thick at the surface mine in Russell County where one sample was collected (Figure 18 and Table 12a). This coal contains a total of 0.1 feet of bony material and displays a poorly-developed medium cleat. The roof rock is shale.

For the one sample collected from the Big Fork coal bed, Bi, Cl, Dy, Er, Gd, Ge, Ho, Pd, Pr, Sn, Tl, and Tm are found to be below the detection limits in addition to the eight elements found to be below detection limits for all 375 Virginia coal samples (Tables 12b, 12c, and 12d). The geometric means were not determined and will not be discussed.

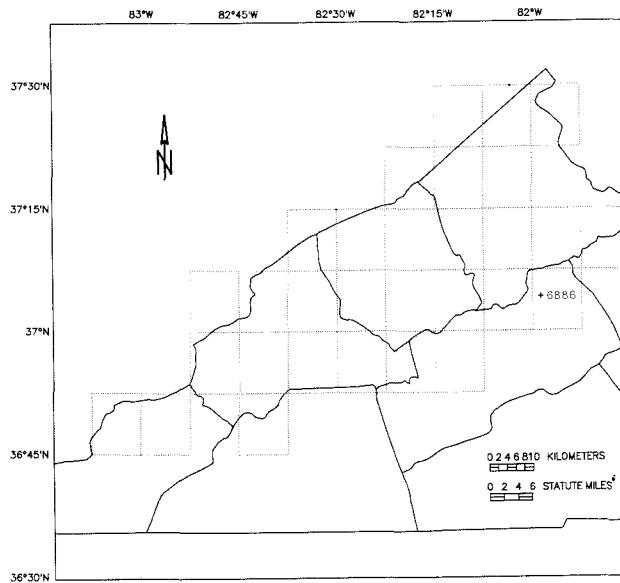


Figure 18. Location for sample from the Big Fork coal bed.

Table 12a.--Description and location for 1 bituminous coal sample from the Big Fork coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-6886	W193936	87C-1	370413N	815845W	Honaker (7.5')	Russell	28.80	Surface mine, s.l. weathered	Full Thickness

Table 12b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance number for 1 bituminous coal sample from the Big Fork coal bed, Southwest Virginia.

[All analyses except heat content, free-swelling index, ash-fusion temperatures, Hardgrove grindability index, and compliance number in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. Sample number is VDMR identification number. Lab number is the USGS Laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT			Lab Number
	Moisture	Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	
R-6886	3.3	28.0	53.6	15.1	4.7	70.4	1.0	7.2	1.6	6,880	12,380	W193936
---	29.0	55.4	15.6	4.5	72.8	1.0	4.4	1.7	7,110	12,800		
---	34.3	65.7	---	5.3	86.3	1.2	5.2	2.0	8,430	15,170		

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)				Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free- swelling index	Initial Deformation	Softening	Fluid			
R-6886	2.1	0.03	0.89	0.66	5.5	1,400	1,450	1,490	---	2.58	W193936
---	---	.03	.92	.68							
---	---	.04	1.09	.81							

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Table 12c.--Major- and minor-oxide concentrations in the laboratory ash of 1 bituminous coal sample from the Big Fork coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-6886	15.1	50	23	2.9	1.2	0.15	2.6	8.3	1.4	0.099	4.1	W193936

Table 12d.--Major-, minor-, and trace-element composition of 1 bituminous coal sample from the Big Fork coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. \$, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Cu (ppm)	Mo-S (ppm)	Lab Number
R-6886	3.5	1.8	0.31	0.11	0.017	0.33	0.88	0.13	0.026	16	W193936		

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Cu (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Lab Number
R-6886	18	120	1.4	7.0	0.030	24	5.3	22	2.4	15	W193936			

Sample Number	Eu (ppm)	F (ppm)	Ga-S (ppm)	Hf (ppm)	Hg (ppm)	La (ppm)	Li (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Lab Number
R-6886	0.38	110	4.4	1.2	0.078	13	21	0.16	33	0.79	W193936

Table 12d.--Major-, minor-, and trace-element composition of 1 bituminous coal sample from the Big Fork coal bed, Southwest Virginia, reported on a whole-coal basis. --continued

LOWER BANNER COAL BED

The Lower Banner coal bed, also known locally as the Gilbert, Upper Banner, Banner, Puncheon Camp No. 2, or the Cary coal bed, crops out in Buchanan, Dickenson, Russell, and Wise Counties. Dickenson County leads production of this coal with 1.2 million tons produced in 1989 (Virginia Division of Mines, 1990). Sampled thickness ranges from 2.1 to 4.7 feet (Figure 19). The Lower Banner coal bed is typically associated with a shale roof that grades into the top of the coal. There is usually a 0.5-foot thick shale parting. The coal below the parting is interbedded with shale partings which may be rathy coal and slickensided. In mines on Roaring Fork north of Trammel in Dickenson County, the coal has been severely deformed by folding and faulting. The Lower Banner typically has a poorly- to moderately-developed medium cleat and displays a moderate amount of thin banding. Pyrite is commonly present along bedding, especially where there are many thin partings.

Figure 20 is the sample distribution map and Table 13a contains the descriptive and location data for the Lower Banner coal bed. In addition to the eight elements below detection limits for all 375 Virginia coal samples, Bi, Ho, Pd, Pr, and Tm are also found to be below the detection limits for the 12 Lower Banner coal samples (Tables 13b, 13c, and 13d for the analytical results). The geometric means (Tables 13e, 13f, and 13g) for the Lower Banner coal samples are found to be substantially higher than those of the Appalachian basin samples for the following: P_2O_5 , MnO, Cs, Mn, and Sr. The geometric means for Ge, sulfate, and pyritic sulfur are found to be substantially lower. Dy and Er have less than five unqualified values and therefore consideration of geometric means was not possible.



Figure 19. Lower Banner coal bed, Dickenson County. Upper 2.5 feet is interbedded coal and shale, lower 3.2 feet is coal (sample R-7595).

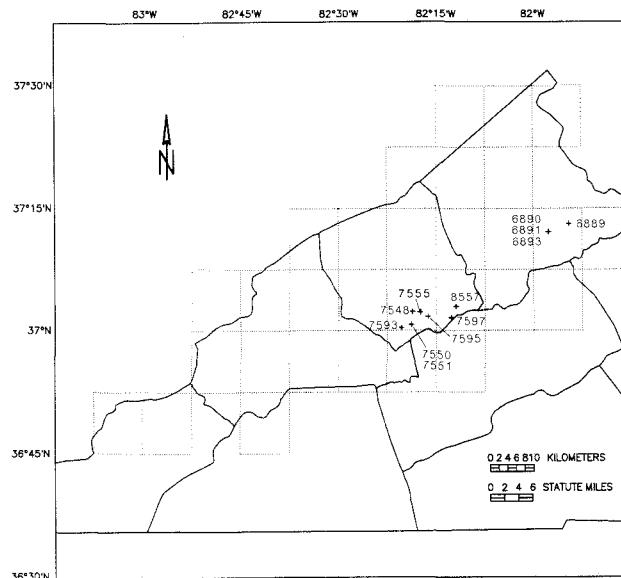


Figure 20. Locations for samples from the Lower Banner coal bed.

LOWER BANNER COAL BED

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Figure 20 is the sample distribution map and Table 13a contains the descriptive and location data for the Lower Banner coal bed. In addition to the eight elements below detection limits for all 375 Virginia coal samples, Bi, Ho, Pd, Pr, and Tm are also found to be below the detection limits for the 12 Lower Banner coal samples (Tables 13b, 13c, and 13d for the analytical results). The geometric means (Tables 13e, 13f, and 13g) for the Lower Banner coal samples are found to be substantially higher than those of the Appalachian basin samples for the following: P_2O_5 , MnO, Cs, Mn, and Sr. The geometric means for Ge, sulfate, and pyritic sulfur are found to be substantially lower. Dy and Er have less than five unqualified values and therefore consideration of geometric means was not possible.

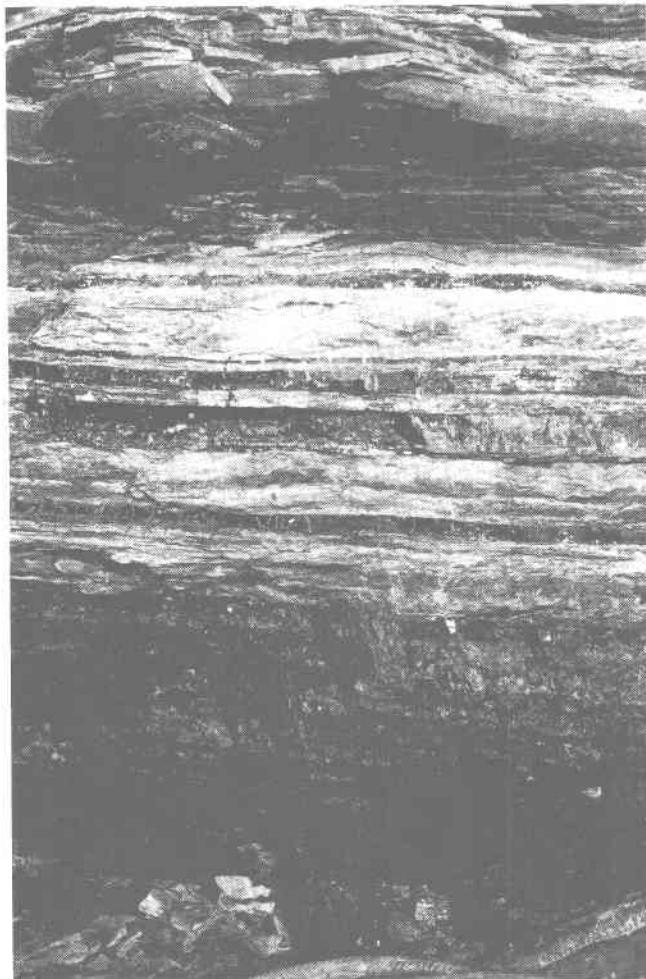


Figure 19. Lower Banner coal bed, Dickenson County. Upper 2.5 feet is interbedded coal and shale, lower 3.2 feet is coal (sample R-7595).

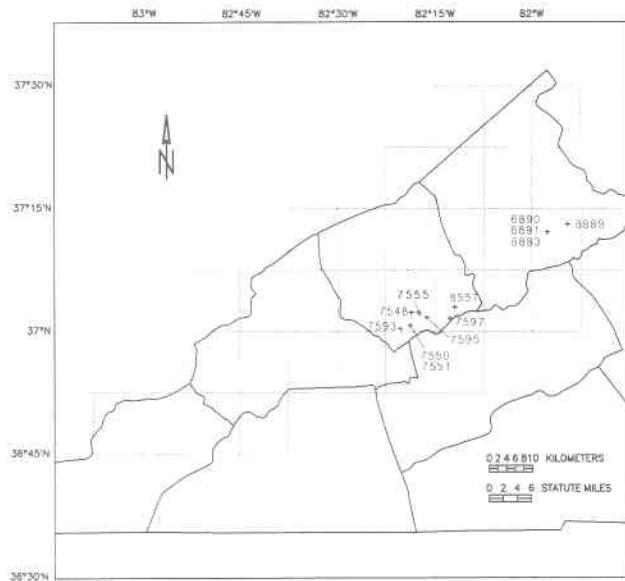


Figure 20. Locations for samples from the Lower Banner coal bed.

Table 13a.-Descriptions and locations for 12 bituminous coal samples from the Lower Banner coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-6889	W193947	87B-2	371305N	815429W	Keen Mountain (7.5')	Buchanan	20.76	Surface mine, sl. weathered	Full Thickness
R-6890	W193948	87B-3	371209N	815736W	Keen Mountain (7.5')	Buchanan	12.84	Surface mine, sl. weathered	Lower Split
R-6891	W193949	87B-4	371209N	815736W	Keen Mountain (7.5')	Buchanan	44.64	Surface mine, sl. weathered	Upper Split
R-6893	W193950	87B-6	371207N	815739W	Keen Mountain (7.5')	Buchanan	22.92	Surface mine, sl. weathered	Full Thickness
R-7548	W209962	89D-5	370220N	821834W	Nora (7.5')	Dickenson	39.60	Underground mine, sl. weathered	Full Thickness
R-7550	W210391	89D-7	370045N	821844W	Nora (7.5')	Dickenson	34.20	Underground mine	Bench Sample
R-7551	W210392	89D-8	370045N	821844W	Nora (7.5')	Dickenson	10.20	Underground mine	Bench Sample
R-7555	W210396	89D-12	370218N	821724W	Nora (7.5')	Dickenson	32.76	Underground mine, sl. weathered	Full Thickness
R-7593	W210398	89D-13	370022N	822017W	Nora (7.5')	Dickenson	56.40	Underground mine	Full Thickness
R-7595	W210400	89D-16	370144N	821613W	Nora (7.5')	Dickenson	38.40	Underground mine	Full Thickness
R-7597	W210402	88C-12	370136N	821240W	Duty (7.5')	Dickenson	43.20	Underground mine, weathered	Full Thickness
R-8557	W217596	88C-22	370258N	821156W	Duty (7.5')	Dickenson	37.32	Underground mine	Full Thickness

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Table 13b. -Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 12 bituminous coal samples from the Lower Banner coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. G for ash-fusion temperatures means greater than value shown. Sample number is VDMR identification number. Lab number is the USGS Laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	Moisture	PROXIMATE ANALYSIS			ULTIMATE ANALYSIS			HEAT CONTENT			Lab Number
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	
R-6889	4.6	23.1	66.1	6.2	5.1	79.0	1.4	7.5	0.7	7,740	13,930
	---	24.2	69.3	6.5	4.8	82.8	1.5	3.6	.7	8,110	14,600
	---	25.9	74.1	--	5.1	88.6	1.6	3.8	.8	8,680	15,620
R-6890	3.4	25.0	64.8	6.8	4.9	79.3	1.3	6.0	1.6	7,820	14,080
	---	25.9	67.1	7.0	4.7	82.1	1.3	3.1	1.7	8,100	14,570
	---	27.8	72.2	--	5.0	88.3	1.4	3.3	1.8	8,710	15,670
R-6891	3.6	23.5	63.5	9.4	4.8	77.5	1.4	6.3	.6	7,590	13,670
	---	24.4	65.9	9.8	4.6	80.4	1.5	3.2	.6	7,880	14,180
	---	27.0	73.0	--	5.1	89.1	1.6	3.6	.7	8,730	15,710
R-6893	7.0	23.3	58.4	11.3	4.9	71.4	1.2	10.0	1.2	7,000	12,610
	---	25.1	62.8	12.2	4.4	76.8	1.3	4.1	1.3	7,530	13,550
	---	28.5	71.5	--	5.0	87.4	1.5	4.6	1.5	8,570	15,430
R-7548	2.5	28.2	56.4	12.9	4.9	72.8	1.4	7.0	1.1	7,220	12,990
	---	28.9	57.8	13.2	4.7	74.7	1.4	4.9	1.1	7,400	13,330
	---	33.3	66.7	--	5.5	86.1	1.7	5.6	1.3	8,530	15,360
R-7550	1.3	44.5	47.3	6.9	5.2	80.0	1.6	5.5	.8	7,930	14,270
	---	45.1	47.9	7.0	5.1	81.1	1.6	4.4	.8	8,030	14,460
	---	48.5	51.5	--	5.5	87.1	1.7	4.7	.9	8,640	15,550
R-7551	1.5	19.7	28.5	50.3	3.0	39.2	.8	5.6	1.0	3,860	6,950
	---	20.0	28.9	51.1	2.9	39.8	.8	4.3	1.0	3,920	7,050
	---	40.9	59.1	--	5.9	81.3	1.7	8.9	2.1	8,010	14,410
R-7555	2.2	28.4	58.2	11.2	5.0	74.1	1.4	7.0	1.1	7,380	13,280
	---	29.0	59.5	11.5	4.9	75.8	1.4	5.2	1.1	7,550	13,580
	---	32.8	67.2	--	5.5	85.6	1.6	5.8	1.3	8,520	15,340
R-7593	1.6	30.0	53.1	15.3	4.8	72.0	1.4	5.6	.8	7,140	12,850
	---	30.5	54.0	15.5	4.7	73.2	1.4	4.2	.8	7,260	13,060
	---	36.1	63.9	--	5.6	86.6	1.7	5.0	1.0	8,590	15,470

Table 13b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 12 bituminous coal samples from the Lower Banner coal bed, Southwest Virginia. --continued

Sample Number	Air-dried Loss	FORMS OF SULFUR			Free-swelling index	ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number
		Sulfate	Pyritic	Organic		Initial deformation	Softening	Fluid			
R-6889	3.4	.01	.06	.68	9.0	1,540	1,540G	1,540G	---	1.01	W193947
	---	.01	.06	.71							
	---	.01	.07	.76							
R-6890	2.3	.02	.71	.91	9.0	1,270	1,325	1,390	---	2.27	W193948
	---	.02	.73	.94							
	---	.02	.79	1.01							
R-6891	2.7	.02	.17	.45	9.0	1,520	1,540	1,540G	---	.88	W193949
	---	.02	.18	.47							
	---	.02	.20	.52							
R-6893	5.8	.03	.40	.76	9.0	1,295	1,365	1,430	---	1.90	W193950
	---	.03	.43	.82							
	---	.04	.49	.93							
R-7548	1.8	.01	.65	.45	7.0	1,400	1,470	1,520	---	1.69	W209962
	---	.01	.67	.46							
	---	.01	.77	.53							
R-7550	.4	.01	.10	.65	8.0	1,165	1,215	1,300	---	1.12	W210391
	---	.01	.10	.66							
	---	.01	.11	.71							
R-7551	.6	.02	.54	.49	1.5	1,330	1,380	1,445	---	2.88	W210392
	---	.02	.55	.50							
	---	.04	1.12	1.02							
R-7555	1.0	.10	.23	.81	7.5	1,300	1,360	1,410	---	1.66	W210396
	---	.10	.24	.83							
	---	.12	.27	.94							
R-7593	.7	.01	.22	.61	7.5	1,245	1,305	1,355	56	1.25	W210398
	---	.01	.22	.62							
	---	.01	.26	.73							

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Table 13b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, grindability index, and compliance numbers for 12 bituminous coal samples from the Lower Banner coal bed, Southwest Virginia.--continued

Sample Number	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT			
	Moisture	Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	Lab Number
R-7595	2.4	30.5	60.0	7.1	5.4	78.8	1.5	6.3	0.8	7,820	14,080	W210400
	---	31.3	61.5	7.3	5.3	80.7	1.5	4.3	.8	8,010	14,420	
	---	33.7	66.3	---	5.7	87.1	1.7	4.6	.9	8,640	15,550	
R-7597	3.8	32.2	57.5	6.5	5.9	77.8	1.5	7.6	.8	7,740	13,920	W210402
	---	33.5	59.8	6.8	5.7	80.9	1.6	4.4	.8	8,040	14,470	
	---	35.9	64.1	---	6.1	86.7	1.7	4.7	.9	8,620	15,520	
R-8557	1.6	31.9	61.8	4.7	5.3	81.9	1.7	5.6	.8	8,090	14,560	W217596
	---	32.4	62.8	4.8	5.2	83.3	1.7	4.3	.8	8,220	14,790	
	---	34.1	65.9	---	5.5	87.4	1.8	4.5	.9	8,630	15,530	

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)				Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid			
R-7595	1.3	0.01	0.07	0.72	8.0	1,150	1,210	1,260	----	1.14	W210400
	---	.01	.07	.74					----		
	---	.01	.08	.80					----		
R-7597	2.6	.01	.09	.66	6.0	1,330	1,375	1,425	----	1.15	W210402
	---	.01	.09	.69					----		
	---	.01	.10	.74					----		
R-8557	.9	.05	.13	.62	7.0	1,300	1,325	1,460	----	1.10	W217596
	---	.05	.13	.63					----		
	---	.05	.14	.66					----		

Table 13c.--Major- and minor-oxide concentrations in the laboratory ash of 12 bituminous coal samples from the Lower Banner coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. L means less than the concentration shown; B not determined. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-6889	6.2	53	30	1.3	0.32	0.16	1.8	4.4	1.8	0.19	1.6	W193947
R-6890	8.3	29	19	1.0	.45	.34	2.5	37	.78	.084	1.9	W193948
R-6891	10.5	56	25	.89	1.1	.58	2.8	5.1	1.6	1.7	1.3	W193949
R-6893	10.1	43	25	2.3	.98	.50	3.6	13	.83	.11	3.8	W193950
R-7548	14.0	48	30	1.3	1.4	.34	4.2	7.1	1.3	.079	1.7	W209962
R-7550	7.1	50	25	4.3	1.0	.12	.89	9.2	1.9	1.4	2.9	W210391
R-7551	54.4	56	25	.32	2.0	.20	5.0	6.6	1.1	.018L	1.2	W210392
R-7555	13.3	49	27	1.3	1.6	.42	3.7	9.8	1.4	.075L	2.4	W210396
R-7593	18.5	51	26	2.1	1.6	.27	4.2	8.0	1.3	.054L	2.2	W210398
R-7595	7.5	46	25	5.2	1.7	.90	1.5	8.4	1.8	.60	3.1	W210400
R-7597	6.4	48	23	4.8	1.7	.81	.69	9.3	1.9	1.6	3.3	W210402
R-8557	5.8	50	23	1.9	1.2	.74	.46	11	2.2	.34	B	W217596

Table 13d.-Major-, minor-, and trace-element composition of 12 bituminous coal samples from the Lower Banner coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means less than the value shown; B, not determined; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-6889	1.5	0.97	0.058	0.012	0.007	0.19	0.067	0.030	8.4	W193947	
R-6890	1.1	.83	.059	.022	.021	.17	2.2	.039	.059	120	W193948
R-6891	2.7	1.4	.067	.071	.045	.24	.37	.10	.034	1.6	W193949
R-6893	2.0	1.3	.17	.060	.037	.30	.92	.050	.026	120	W193950
R-7548	3.1	2.2	.13	.12	.035	.49	.70	.11	.91	13	W209962
R-7550	1.7	.94	.22	.043	.006	.053	.46	.080	.021	7.6	W210391
R-7551	14	7.1	.13	.65	.081	2.3	2.5	.36	.060	.36	W210392
R-7555	3.0	1.9	.12	.12	.041	.41	.91	.11	.049	16	W210396
R-7593	4.4	2.6	.28	.18	.037	.64	1.0	.14	.024	23	W210398
R-7595	1.6	.99	.28	.075	.050	.096	.44	.079	.021	4.8	W210400
R-7597	1.4	.77	.22	.064	.038	.037	.42	.072	.010	3.8	W210402
R-8557	1.4	.70	.077	.041	.032	.022	.43	.075	.016	21	W217596

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-6889	3.9	32	0.87	21	0.006	15	B	3.2	9.5	0.40	W193947
R-6890	3.1	41	3.1	18	.15	17	B	16	9.8	.95	W193948
R-6891	13	77	1.4	11	.027	22	B	4.7	14	1.5	W193949
R-6893	8.7	64	2.5	15	.040	15	B	4.1	11	1.8	W193950
R-7548	18	170	1.0	9.2	.077	22	260	5.1	20	2.0	W209962
R-7550	9.2	55	.99	13	.055	18	720	4.5	12	.20	W210391
R-7551	82	460	3.7	9.5	.19	70	100L	13	57	7.0	W210392
R-7555	20	160	1.2	8.5	.12	18	200	3.3	14	1.7	W210396
R-7593	26	150	1.8	12	.11	26	300	5.2	21	3.0	W210398
R-7595	19	100	.69	6.8	.083	12	210	2.9	9.8	.40	W210400
R-7597	15	120	.90	6.5	.042	11	240	1.5	7.3	.30	W210402
R-8557	6.4	45	1.0	6.0	.032	13	400	1.7	8.5	.20	W217596

Sample Number	Cu (ppm)	Dy-S (ppm)	Er-S (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	Lab Number
R-6889	8.1	2.0L	0.62L	0.25	.39	2.5	0.42	0.40	0.60	0.13	W193947
R-6890	4.4	2.7L	1.2	.56	.44	3.4	1.5	.73	.40	.25	W193948
R-6891	20	3.4L	1.1L	.36	.74	4.4	.71L	.48L	.90	.021	W193949
R-6893	17	3.2L	1.0L	.26	.85	3.8	.69L	.46L	.40	.37	W193950
R-7548	20	3.4	2.2	.45	180	6.2	2.9	.21L	.80	.35	W209962
R-7550	14	1.6L	.71L	.37	.40	2.2	1.1	.33	.60	.065	W210391
R-7551	35	12L	5.4L	1.3	120	21	8.2L	.82L	2.8	.14	W210392
R-7555	20	2.9L	1.3L	.36	60	5.7	2.0L	.29	.70	.045	W210396
R-7593	22	4.1L	1.9L	.51	60	6.8	3.7	.56	1.0	.070	W210400
R-7595	12	1.7L	.75L	.23	40	3.2	1.1L	.12	.60	.045	W210400
R-7597	12	1.4L	.64L	.20	10	2.6	3.1	.24	.60	.070	W210402
R-8557	7.5	1.3L	.27L	.24	80	2.2	.87L	.45	.55	.16	W217596

Sample Number	La (ppm)	Li (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Lab Number
R-6889	8.0	16	0.09	11	0.99	1.1	5.5	6.8	52	4.7	W193947
R-6890	8.0	9.1	.34	17	2.8	.91	6.1	12	31	5.8	W193948
R-6891	12	20	.15	16	1.0	1.8	6.0	8.5	780	7.9	W193949
R-6893	7.0	14	.10	14	1.5	.84	5.4	4.8	48	3.0	W193950
R-7548	13	29	.16	22	1.8	2.0	15	12	48	8.4	W209962
R-7550	11	16	.10	22	1.5	2.6	8.5	11	420	4.4	W210391
R-7551	40	120	.41	120	.54L	8.2	22	38	44L	16	W210392
R-7555	11	29	.11	24	2.0	3.1	9.3	11	44L	7.7	W210396
R-7593	17	41	.18	50	1.1	3.1	5.9L	14	44L	8.1	W210398
R-7595	8.0	16	.08	52	1.2	1.3	2.7	18	200	4.4	W210400
R-7597	8.0	9.6	.08	58	.83	1.2	2.0L	4.7	450	2.9	W210402
R-8557	7.0	6.4	.08	12	1.5	2.2	8.7	5.2	87	2.3	W217596

VIRGINIA DIVISION OF MINERAL RESOURCES

Table 13d.--Major-, minor-, and trace-element composition of 12 bituminous coal samples from the Lower Banner coal bed, Southwest Virginia, reported on a whole-coal basis.

Sample Number	Rb (ppm)	Sb (ppm)	Sc (ppm)	Se (ppm)	Sm (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	Lab Number
R-6889	13L	0.45	2.2	2.4	1.3	0.81	.44	0.15	0.22	W193947
R-6890	16	2.2	3.2	2.3	2.4	.56L	.44	.53	1.6	W193948
R-6891	19	.61	3.4	3.1	1.9	1.4	.83	.24	.26	W193949
R-6893	19	1.5	2.6	4.1	1.4	.69L	.60	.11	.22	W193950
R-7548	50L	.60	4.2	3.0	2.1	.59	200	.29	.45	W209962
R-7550	20L	.60	2.7	2.4	1.4	.15	210	.27	.12	W210391
R-7551	120	1.7	13	1.7	5.5	1.1	180	1.0	1.0	W210392
R-7555	19	1.5	3.4	2.7	1.5	.25	190	.26	2.9	W210396
R-7593	35	2.4	4.9	2.8	2.2	1.0	170	.33	.43	W210398
R-7595	30L	.80	2.1	2.1	1.1	.54	180	.25	.19	W210400
R-7597	20L	1.1	2.0	1.7	1.0	.10L	140	.19	.24	W210402
R-8557	20L	.30	2.2	1.8	.80	.27L	140	.23	.17	W217596

Sample Number	Tl-S (ppm)	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)	Lab Number
R-6889	0.62L	0.91	12 ^a	0.69	2.9	0.55	5.1	5.8	W193947
R-6890	3.1	1.3	10	.70	10	2.0	38	4.6	W193948
R-6891	1.1L	1.6	15	.67	3.9	.90	12	9.5	W193949
R-6893	1.7	2.7	14	.77	3.7	.60	5.8	7.1	W193950
R-7548	.64L	1.9	29	.40	6.3	.95	17	15	W209962
R-7550	.33L	.59	13	.40	5.5	.80	7.8	22	W210391
R-7551	2.5L	4.0	87	1.3	17	3.1	92	50	W210392
R-7555	.61L	1.9	28	.60	5.7	.80	21	24	W210396
R-7593	.85L	1.9	30	.70	5.7	1.3	20	18	W210398
R-7595	.35L	1.0	11	.40	2.9	.60	7.5	16	W210400
R-7597	.29L	.85	9.0	.60	2.4	.60	2.1	12	W210402
R-8557	.58L	.67	10	.45	4.6	.60	2.1	16	W217596

Table 13e.--Arithmetic mean, observed range and geometric mean of proximate and ultimate analyses, heat content, forms of sulfur, and ash-fusion temperatures for 12 bituminous coal samples from the Lower Banner coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included.

[All values are in percent except Btu/lb, Kcal/kg, ash-fusion temperatures, and free-swelling index and are reported on an as-received basis. $^{\circ}\text{F} = 9/5 \, ^{\circ}\text{C} + 32$; Kcal/kg = 0.556 Btu/lb; (n) is number of samples per parameter.]

	Lower Banner coal bed				Appalachian basin		
(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
Proximate and ultimate analyses							
Moisture	(12)	2.96	1.30	7.00	2.61	3.23	2.69 (4,760)
Volatile matter	(12)	28.36	19.70	44.50	27.75	32.46	31.72 (4,760)
Fixed carbon	(12)	56.30	28.50	66.10	55.17	52.48	51.76 (4,760)
Ash	(12)	12.38	4.68	50.30	9.75	11.83	9.83 (4,760)
Hydrogen	(12)	4.93	3.00	5.90	4.88	5.02	5.00 (4,760)
Carbon	(12)	73.65	39.20	81.94	72.53	70.69	70.17 (4,760)
Nitrogen	(12)	1.38	.80	1.67	1.36	1.39	1.37 (4,757)
Oxygen	(12)	6.67	5.50	10.00	6.57	8.92	8.22 (4,756)
Sulfur	(12)	.94	.60	1.60	.91	2.15	1.63 (4,974)
Heat content							
KCal/kg Btu/lb	(12)	7,283	3,863	8,093	7,171	7,030	6,979 (4,759)
(12)	13,099	6,948	14,555	12,898	12,644	12,553	
Forms of sulfur							
Sulfate	(12)	0.03	0.01	0.10	0.02	0.08	0.04 (4,245)
Pyritic	(12)	.28	.06	.71	.20	1.36	.65 (4,392)
Organic	(12)	.65	.45	.91	.64	.82	.70 (4,393)
Ash-fusion temperature ($^{\circ}\text{C}$)							
Initial deformation	(12)	1,320	1,149	1,538	1,315	1,255	1,246 (4,063)
Softening	(11)	1,352	1,210	1,538	1,349	1,287	1,280 (3,722)
Fluid	(10)	1,257	1,260	1,521	1,398	1,334	1,328 (3,449)
Free-swelling index	(12)	7.37	1.50	9.00	6.84	5.53	4.68 (4,603)
Air-dried loss	(12)	1.96	0.40	5.80	1.49	1.83	1.13 (3,868)

Table 13f.--Arithmetic mean, observed range, and geometric mean of ash content and concentrations of 11 major- and minor-oxides in the laboratory ash of 12 bituminous coal samples from the Lower Banner coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. (n) indicates the number of samples per oxide.

[All samples were ashed at 525°C; all data are in percent.]

(n)	Arith. mean	Lower Banner bed			Appalachian basin		
		<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
		Min.	Max.				
(Ash)	(12)	14	5.8	54	11	13	10 (5,262)
SiO ₂	(12)	48	29	56	48	43	41 (5,229)
Al ₂ O ₃	(12)	25	19	30	25	24	23 (5,229)
CaO	(12)	2.2	.32	5.2	1.7	2.2	1.5 (5,227)
MgO	(12)	1.2	.31	2.0	1.1	.85	.75 (5,258)
Na ₂ O	(12)	.45	.12	.90	.38	.43	.34 (5,194)
K ₂ O	(12)	2.6	.46	5.0	2.1	2.0	1.7 (5,229)
Fe ₂ O ₃	(12)	11	4.4	37	9.1	19	13 (5,215)
MnO	(12)	.039	.018	.12	.032	.03	.02 (5,260)
TiO ₂	(12)	1.5	.78	2.2	1.4	1.2	1.1 (5,203)
P ₂ O ₅	(9)	.67	.079	1.7	.36	.50	.22 (3,389)
SO ₃	(11)	2.3	1.2	3.8	2.1	2.5	1.9 (5,063)

Table 13g.--Arithmetic mean, observed range, and geometric mean of concentrations of 54 trace elements in 12 bituminous coal samples from the Lower Banner coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. Dashed values (---) represent less than five samples; (n) indicates the number of samples per element. [All data are in parts-per-million and are reported on a whole-coal basis.]

	Lower Banner coal bed				Appalachian basin		
	Arith. mean (n)	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
		Min.	Max.				
Ag (12)	0.10	0.010	0.91	0.037	0.07	0.05	(4,565)
As (12)	31	1.6	120	15	35	13	(5,197)
B (12)	19	3.1	82	13	30	20	(5,076)
Ba (12)	120	32	460	92	90	63	(5,134)
Be (12)	1.6	.69	3.7	1.4	2.5	2.0	(5,247)
Bi ---	---	---	---	---	1.5	1.1	(108)
Br (12)	11	6.0	20	11	22	13	(4,892)
Cd (12)	.078	.006	.19	.057	.10	.07	(4,978)
Ce (12)	21	11	70	19	21	17	(5,075)
Cl (7)	330	200	720	300	780	510	(3,646)
Co (12)	5.4	1.5	16	5.4	7.4	5.7	(5,217)
Cr (12)	16	7.3	57	16	18	15	(5,205)
Cs (12)	1.6	.20	7.0	1.6	1.3	.85	(4,831)
Cu (12)	19	7.5	44	17	19	15	(5,239)
Dy (1)	---	3.4	3.4	---	3.3	2.6	(759)
Er (2)	---	1.2	2.2	---	1.5	1.2	(1,200)
Eu (12)	.42	.20	1.2	.36	.44	.37	(5,032)
F (12)	69	10	180	57	99	71	(4,860)
Ga (12)	5.3	2.2	21	4.2	6.6	5.4	(5,046)
Gd (6)	2.1	.42	3.7	1.7	2.6	1.9	(1,773)
Ge (8)	.39	.12	.73	.35	4.7	2.5	(4,608)
Hf (12)	.83	.40	2.8	.83	.79	.62	(4,932)
Hg (12)	.14	.021	.37	.10	.22	.15	(5,031)
Ho ---	---	---	---	---	.76	.61	(378)
La (12)	12	7.0	40	11	11	8.9	(5,147)
Li (12)	27	6.4	120	19	22	14	(5,243)
Lu (12)	.15	.075	.41	.13	.16	.14	(4,885)
Mn (12)	35	11	120	26	31	15	(5,260)
Mo (11)	1.5	.83	2.8	1.4	3.7	2.3	(4,889)
Nb (12)	2.4	.84	8.2	1.9	2.6	1.9	(5,005)
Nd (10)	9.0	2.7	22	7.6	13	9.9	(4,231)
Ni (12)	11	4.7	38	9.6	17	14	(5,240)
Pb (12)	6.3	2.3	16	5.5	8.8	6.2	(5,172)
Pd ---	---	---	---	---	.17	.14	(18)
Pr ---	---	---	---	---	6.1	3.6	(960)
Rb (6)	37	16	120	27	28	22	(2,232)
Sb (12)	1.1	.30	2.4	1.1	1.4	.91	(5,003)
Sc (12)	3.8	2.0	13	3.2	4.4	3.6	(5,218)
Se (12)	2.5	1.6	4.2	2.4	3.6	2.8	(5,052)
Sm (12)	1.9	.80	5.4	1.6	2.0	1.6	(5,005)
Sn (8)	.73	.15	1.4	.60	1.6	.86	(2,352)
Sr (12)	140	44	210	120	110	79	(5,146)
Ta (12)	.28	.085	1.0	.23	.24	.19	(4,369)
Tb (12)	.34	.12	1.0	.29	.34	.29	(4,852)
Th (12)	3.3	1.6	10	2.8	3.0	2.3	(5,098)
Tl (2)	---	1.7	3.1	---	3.4	2.1	(382)
Tm ---	---	---	---	---	1.7	.38	(46)
U (12)	1.6	.59	4.0	1.4	1.8	1.3	(4,990)
V (12)	22	9.0	87	17	24	19	(5,241)
W (12)	.63	.40	1.2	.60	.94	.80	(4,421)
Y (12)	5.9	2.4	17	5.0	8.5	7.2	(5,234)
Yb (12)	1.1	.55	3.0	.90	1.1	.92	(5,151)
Zn (12)	19	2.1	92	11	22	14	(5,243)
Zr (12)	17	4.6	50	14	24	17	(5,238)

UPPER BANNER COAL BED

This coal crops out in Buchanan, Dickenson, Russell and Wise Counties. The 1989 production of the Upper Banner was 1.9 million tons with 1.5 million tons being mined in Dickenson County (Virginia Division of Mines, 1990). Local names include the Lower Banner or the Lower Splash Dam coal bed. The Upper Banner coal bed can occur as a coal zone with up to three splits. The uppermost split has a one-inch sandstone parting which is laterally persistent and contains volcanic ash. Cannel coal occurs at the top of the Upper Banner at one sample location. The coal typically has a moderately-developed medium cleat and moderate amounts of thin and medium banding. The roof at most sample localities is shale with abundant plant fossils, however, sandstone roof occurs at two sample sites. Sampled thickness ranges from 1.3 to 10.6 feet.

In the 24 Upper Banner coal bed samples (Figure 21 and Table 14a), Pd and Tm are found to be below the detection limits in addition to the elements found below the detection limits for all 375 Virginia coal samples (Tables 14b, 14c, and 14d). Bi and Tl have only one unqualified value each, therefore geometric mean calculation was not possible. The geometric means (Tables 14e, 14f, and 14g) for Ba, U and the free-swelling index are substantially higher and the geometric means for P_2O_5 , As, B, Br, Cl, Ge, Hg, Pr, Zn, sulfur, sulfate, and pyritic sulfur are found to be substantially lower when comparing the geometric means of the Upper Banner coal samples with the samples from the Appalachian basin.

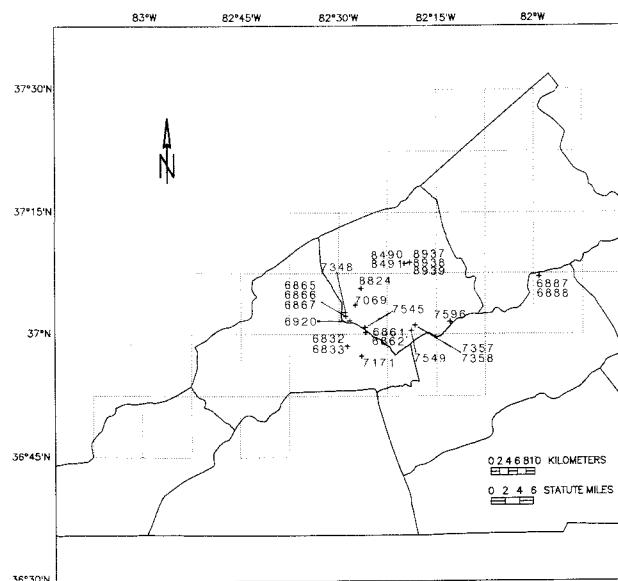


Table 14a.-Descriptions and locations for 24 bituminous coal samples from the Upper Banner coal bed, Southwest Virginia.

V/DMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-6832	W191329	59B-1	365835N	822840W	Coeburn (7.5')	Wise	29.40	Surface mine, weathered	Bench Sample
R-6833	W191328	59B-2	365835N	822840W	Coeburn (7.5')	Wise	15.96	Surface mine, weathered	Bench Sample
R-6861	W200128	89C-1	370015N	822550W	Caney Ridge (7.5')	Dickenson	51.96	Surface mine, sl. weathered	Bench Sample
R-6862	W200129	89C-2	370015N	822550W	Caney Ridge (7.5')	Dickenson	58.20	Surface mine, sl. weathered	Bench Sample
R-6865	W192700	89C-3	3700214N	822853W	Caney Ridge (7.5')	Dickenson	23.64	Surface mine, sl. weathered	Bench Sample
R-6866	W192699	89C-4	370214N	822853W	Caney Ridge (7.5')	Dickenson	9.36	Surface mine, sl. weathered	Bench Sample
R-6867	W192698	89C-5	370214N	822853W	Caney Ridge (7.5')	Dickenson	8.04	Surface mine, sl. weathered	Bench Sample
R-6887	W193945	87C-2	370704N	815912W	Honaker (7.5')	Russell	47.16	Surface mine, sl. weathered	Bench Sample
R-6888	W193946	87C-3	370704N	815912W	Honaker (7.5')	Russell	9.00	Surface mine, sl. weathered	Bench Sample
R-6920	W195444	89C-6	370141N	822816W	Caney Ridge (7.5')	Dickenson	17.16	Surface mine, sl. weathered	Full Thickness
R-7069	W198543	89C-7	370336N	822726W	Caney Ridge (7.5')	Dickenson	23.88	Surface mine, sl. weathered	Full Thickness
R-7171	W200486	59B-5	365722N	822629W	Coeburn (7.5')	Wise	16.20	Surface mine, weathered	Full Thickness
R-7348	W203390	89C-8	370244N	822858W	Caney Ridge (7.5')	Dickenson	30.00	Surface mine	Full Thickness
R-7357	W204160	89D-3	370109N	821814W	Nora (7.5')	Dickenson	34.80	Surface mine, sl. weathered	Lower Split
R-7358	W204161	89D-4	370109N	821814W	Nora (7.5')	Dickenson	26.28	Surface mine, sl. weathered	Upper Split
R-7545	W209959	89C-10	370050N	822554W	Caney Ridge (7.5')	Dickenson	39.00	Underground mine, sl. weathered	Full Thickness
R-7549	W209963	89D-6	370028N	821848W	Nora (7.5')	Dickenson	29.40	Underground mine	Lower Split
R-7596	W210401	88C-11	370134N	821253W	Duty (7.5')	Dickenson	29.40	Underground mine	Full Thickness
R-8490	W215414	89A-5	370844N	821949W	Haysi (7.5')	Dickenson	16.80	Underground mine, sl. weathered	Upper Split
R-8491	W215415	89A-6	370844N	821949W	Haysi (7.5')	Dickenson	26.40	Underground mine, sl. weathered	Lower Split
R-8824	W238943	89C-14	370538N	822632W	Caney Ridge (7.5')	Dickenson	12.00	Road cut, weathered	Full Thickness
R-8937	W246904	89A-14	370851N	821901W	Haysi (7.5')	Dickenson	34.80	Underground mine, sl. weathered	Bench Sample
R-8938	W246905	89A-15	370851N	821901W	Haysi (7.5')	Dickenson	25.20	Underground mine, sl. weathered	Bench Sample
R-8939	W246906	89A-16	370851N	821901W	Haysi (7.5')	Dickenson	12.00	Underground mine, sl. weathered	Bench Sample

Table 14b.-Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 24 bituminous coal samples from the Upper Banner coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. G for ash-fusion temperatures means greater than value shown. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT		
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	Lab Number
R-6832	1.7	35.2	58.0	5.1	5.4	80.4	1.3	7.3	0.5	8,010	14,410	W191329
	---	35.8	59.0	5.2	5.3	81.8	1.3	5.9	.5	8,140	14,660	
	---	37.8	62.2	---	5.6	86.3	1.4	6.2	.5	8,590	15,460	
R-6833	1.4	34.1	60.8	3.7	5.4	81.5	1.5	7.3	.6	8,110	14,600	W191328
	---	34.6	61.7	3.8	5.3	82.7	1.5	6.1	.6	8,230	14,810	
	---	35.9	64.1	---	5.5	85.9	1.6	6.4	.6	8,550	15,380	
R-6861	2.4	25.4	48.3	23.9	4.4	63.0	1.4	6.6	.7	6,190	11,150	W200128
	---	26.0	49.5	24.5	4.2	64.5	1.4	4.6	.7	6,350	11,420	
	---	34.5	65.5	---	5.6	85.5	1.9	6.1	.9	8,400	15,120	
R-6862	2.0	29.1	55.8	13.1	4.9	73.6	1.6	6.3	.6	7,280	13,100	W200129
	---	29.7	56.9	13.4	4.8	75.1	1.6	4.6	.6	7,420	13,360	
	---	34.3	65.7	---	5.5	86.7	1.9	5.3	.7	8,570	15,430	
R-6865	2.8	25.9	62.8	8.5	5.0	77.9	1.5	6.4	.8	7,670	13,810	W192700
	---	26.6	64.6	8.7	4.8	80.1	1.5	4.0	.8	7,890	14,210	
	---	29.2	70.8	---	5.3	87.8	1.7	4.4	.9	8,650	15,570	
R-6866	2.0	30.0	64.3	3.7	5.3	82.6	1.8	5.8	.9	8,210	14,770	W192699
	---	30.6	65.6	3.8	5.2	84.3	1.8	4.1	.9	8,370	15,070	
	---	31.8	68.2	---	5.4	87.6	1.9	4.3	1.0	8,700	15,560	
R-6867	2.6	28.0	61.8	7.6	5.2	78.2	1.6	6.2	1.2	7,770	13,980	W192698
	---	28.7	63.4	7.8	5.0	80.3	1.6	4.0	1.2	7,980	14,260	
	---	31.2	68.8	---	5.5	87.1	1.8	4.3	1.3	8,650	15,570	
R-6887	2.5	31.9	58.7	6.9	5.3	79.2	1.5	6.4	.7	7,840	14,100	W193945
	---	32.7	60.2	7.1	5.2	81.2	1.5	4.3	.7	8,040	14,660	
	---	35.2	64.8	---	5.5	87.4	1.7	4.6	.8	8,650	15,570	
R-6888	2.9	32.3	57.6	7.2	5.3	78.1	1.5	6.9	1.0	7,760	13,960	W193946
	---	33.3	59.3	7.4	5.1	80.4	1.5	4.5	1.0	7,990	14,780	
	---	35.9	64.1	---	5.5	86.9	1.7	4.8	1.1	8,630	15,530	

Table 14b.-Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 24 bituminous coal samples from the Upper Banner coal bed, Southwest Virginia.--continued

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Sample Number	Air-dried Loss	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number
		Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid			
R-6832	0.0	0.02	0.02	0.47	9.0	1,375	1,535	1,540	---	0.69	W191329
	---	.02	.02	.48							
	---	.02	.02	.50							
R-6833	.0	.02	.06	.55	8.5	1,375	1,425	1,475	---	.82	W191328
	---	.02	.06	.56							
	---	.02	.06	.58							
R-6861	1.2	.00	.10	.60	9.0	1,290	1,365	1,390	---	1.26	W200128
	---	.00	.10	.61							
	---	.00	.14	.81							
R-6862	1.0	.00	.10	.50	7.5	1,450	1,515	1,540	---	.92	W200129
	---	.00	.10	.51							
	---	.00	.12	.59							
R-6865	2.1	.00	.20	.50	7.5	1,540	1,540G	1,540G	---	1.16	W192700
	---	.00	.21	.51							
	---	.00	.23	.56							
R-6866	1.3	.00	.20	.70	9.0	1,345	1,395	1,435	---	1.22	W192699
	---	.00	.20	.71							
	---	.00	.21	.74							
R-6867	1.7	.00	.40	.70	9.0	1,385	1,460	1,525	---	1.72	W192298
	---	.00	.41	.72							
	---	.00	.45	.78							
R-6887	1.5	.02	.17	.53	8.5	1,420	1,480	1,540	---	.99	W193445
	---	.02	.17	.54							
	---	.02	.19	.58							
R-6888	1.6	.03	.33	.63	9.0	1,380	1,435	1,490	---	---	W193446
	---	.03	.34	.65							
	---	.03	.37	.70							

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Table 14b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 24 bituminous coal samples from the Upper Banner coal bed, Southwest Virginia. --continued

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT		
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	Lab Number
R-6920	4.3	30.4	60.9	4.4	5.6	79.8	1.7	7.5	1.0	7,920	14,260	W195444
	--	31.8	63.6	4.6	5.4	83.4	1.8	3.8	1.0	8,280	14,900	
	--	33.3	66.7	---	5.6	87.4	1.9	4.0	1.1	8,680	15,620	
R-7069	4.1	29.2	59.8	6.9	5.2	78.4	1.5	7.3	.7	7,680	13,830	W198543
	--	30.4	62.4	7.2	4.9	81.8	1.6	3.8	.7	8,010	14,420	
	--	32.8	67.2	---	5.3	88.1	1.7	4.1	.8	8,630	15,540	
R-7171	1.3	38.2	56.4	4.1	5.6	81.1	1.7	7.1	.5	8,070	14,520	W200486
	--	38.7	57.1	4.2	5.5	82.2	1.7	6.0	.5	8,170	14,710	
	--	40.4	59.6	---	5.8	85.7	1.8	6.3	.5	8,530	15,350	
R-7348	2.8	28.8	58.1	10.3	5.1	76.1	1.3	6.3	.9	7,520	13,540	W203390
	--	29.6	59.8	10.6	4.9	78.3	1.3	3.9	.9	7,740	13,920	
	--	33.1	66.9	---	5.5	87.6	1.5	4.4	1.0	8,650	15,580	
R-7357	3.3	32.6	60.5	3.6	5.4	81.8	1.5	7.1	.6	8,040	14,470	W204161
	--	33.7	62.6	3.7	5.2	84.6	1.6	4.3	.6	8,310	14,960	
	--	35.0	65.0	---	5.4	87.9	1.6	4.5	.6	8,630	15,540	
R-7358	3.4	28.8	52.0	15.8	4.9	69.2	1.4	8.0	.6	6,880	12,380	
	--	29.8	53.8	16.4	4.7	71.6	1.4	5.2	.6	7,120	12,820	
	--	35.6	64.4	---	5.6	85.6	1.7	6.2	.7	8,510	15,330	
R-7545	2.0	31.7	60.0	6.3	5.1	79.7	1.5	6.7	.6	7,910	14,240	W209959
	--	32.3	61.2	6.4	5.0	81.3	1.5	5.0	.6	8,070	14,530	
	--	34.6	65.4	---	5.3	86.9	1.6	5.4	.7	8,620	15,520	
R-7549	2.0	31.8	57.2	9.0	5.4	77.0	1.4	6.4	.7	7,570	13,620	W209963
	--	32.4	58.4	9.2	5.3	78.6	1.4	4.7	.7	7,720	13,900	
	--	35.7	64.3	---	5.8	86.5	1.6	5.2	.8	8,500	15,300	
R-7596	1.5	33.1	50.5	14.9	5.0	70.5	1.3	6.1	2.2	7,130	12,830	W210401
	--	33.6	51.3	15.1	4.9	71.6	1.3	4.8	2.2	7,240	13,030	
	--	39.6	60.4	---	5.8	84.3	1.6	5.7	2.6	8,550	15,350	
R-8490	.9	22.8	55.6	20.7	4.2	68.5	1.2	4.8	.6	6,640	11,960	W215414
	--	23.0	56.1	20.9	4.2	69.1	1.2	4.0	.6	6,710	12,070	
	--	29.1	70.9	---	5.2	87.4	1.5	5.1	.8	8,480	15,260	

Table 14b.-Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 24 bituminous coal samples from the Upper Banner coal bed, Southwest Virginia.--continued

Sample Number	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number
						Initial Deformation	Softening	Fluid			
R-6920	3.4 --- ---	0.01 .01 .01	0.30 .31 .33	0.71 .74 .78	9.0	1,180	1,235	1,290	---	---	W195444
R-7069	3.5 --- ---	.02 .02 .02	.11 .11 .12	.60 .63 .67	6.5	1,525	1,600	1,600G	72	1.01	W198543
R-7171	.1 --- ---	.02 .02 .02	.08 .08 .08	.45 .46 .48	6.5	1,125	1,155	1,265	---	.69	W200486
R-7348	2.0 --- ---	.01 .01 .01	.29 .30 .33	.59 .61 .68	8.0	1,600	1,600G	1,600G	---	1.33	W203390
R-7357	2.5 --- ---	.01 .01 .01	.13 .13 .14	.45 .47 .48	8.0	1,180	1,230	1,295	---	.83	W204160
R-7358	2.7 --- ---	.01 .01 .01	.16 .17 .20	.40 .41 .50	7.5	1,540	1,540G	1,540G	---	.97	W204161
R-7545	1.2 --- ---	.01 .01 .01	.10 .10 .11	.51 .52 .56	8.0	1,365	1,415	1,490	---	.84	W209959
R-7549	.9 --- ---	.01 .01 .01	.06 .06 .07	.58 .59 .65	8.0	1,210	1,290	1,350	---	1.03	W209963
R-7596	.5 --- ---	.01 .01 .01	1.91 1.94 2.28	.25 .25 .30	7.5	1,310	1,365	1,425	---	3.43	W210401
R-8490	.1 --- ---	.04 .04 .05	.10 .10 .13	.47 .47 .60	6.0	1,540	1,540G	1,540G	---	1.00	W215414

Table 14b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 24 bituminous coal samples from the Upper Banner coal bed, Southwest Virginia.--continued

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT		
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/kg	Btu/lb	Lab Number
R-8491	0.8	27.8	67.8	3.6	5.0	83.6	1.6	5.1	1.1	8,320	14,970	W215415
	---	28.0	68.3	3.7	4.9	84.2	1.6	4.5	1.1	8,380	15,090	
	---	29.1	70.9	---	5.1	87.4	1.7	4.6	1.1	8,700	15,660	
R-8824	13.4	24.8	55.6	6.2	5.3	67.9	1.3	18.8	.5	6,500	11,710	W238943
	---	28.7	64.1	7.2	4.4	78.4	1.5	7.9	.6	7,510	13,520	
	---	30.9	69.1	---	4.8	84.5	1.6	8.5	.6	8,090	14,560	
R-8937	2.4	28.2	65.1	4.3	5.1	82.5	1.4	6.1	.6	8,120	14,620	W246904
	---	28.9	66.7	4.4	5.0	84.5	1.4	4.1	.6	8,330	14,990	
	---	30.2	69.8	---	5.2	88.4	1.5	4.2	.7	8,710	15,670	
R-8938	1.5	27.8	62.4	8.4	4.9	78.7	1.4	5.9	.8	7,750	13,940	W246905
	---	28.2	63.3	8.5	4.8	79.9	1.4	4.7	.8	7,860	14,150	
	---	30.8	69.2	---	5.3	87.3	1.5	5.1	.9	8,590	15,460	
R-8939	1.5	24.9	59.8	13.8	4.6	73.9	1.2	5.8	.7	7,220	13,000	W246906
	---	25.3	60.7	14.0	4.5	75.0	1.2	4.4	.7	7,340	13,210	
	---	29.4	70.6	---	5.3	87.3	1.5	5.2	.9	8,530	15,360	

Table 14b.-Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 24 bituminous coal samples from the Upper Banner coal bed, Southwest Virginia. -continued

Sample Number	Air-dried Loss	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)				Hardgrove grindability index	Compliance Number	Lab Number
		Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid				
R-8491	0.1	0.01	0.45	0.62	7.5	1,205	1,280	1,360	---	1.47	W215415	
	---	.01	.45	.62								
	---	.01	.47	.65								
R-8824	8.6	.02	.01	.48	1.5	1,225	1,275	1,340	72	.85	W238943	
	---	.02	.01	.55								
	---	.02	.01	.60								
R-8937	1.8	.02	.02	.58	7.5	1,480	1,540	1,540G	79	.82	W246904	
	---	.02	.02	.59								
	---	.02	.02	.62								
R-8938	.7	.08	.04	.66	8.5	1,505	1,540	1,540G	80	1.15	W246905	
	---	.08	.04	.67								
	---	.09	.04	.73								
R-8939	.8	.11	.03	.59	7.5	1,540	1,540G	1,540G	72	1.08	W246906	
	---	.11	.03	.60								
	---	.13	.04	.70								

Table 14c.--Major- and minor-oxide concentrations in the laboratory ash of 24 bituminous coal samples from the Upper Banner coal bed,
Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. L means less than the concentration shown. Sample number is the VDMR identification number. Lab number is the USGS Laboratory number.]

Sample Number	Ash	SiO_2	Al_2O_3	CaO	MgO	Na_2O	K_2O	$\text{Fe}_{2\text{O}}_3$	TiO_2	$\text{P}_{2\text{O}}_5$	SO_3	Lab Number
R-6832	4.8	44	35	2.2	1.0	1.0	2.0	9.4	0.90	0.021	4.3	W191329
R-6833	4.3	46	29	1.9	1.3	1.1	1.7	9.4	1.1	.093	4.2	W191328
R-6861	22.9	52	29	1.4	1.3	.53	4.3	4.0	1.1	.048	1.4	W200128
R-6862	12.0	48	32	1.5	1.3	.82	1.8	4.7	.92	.042L	2.2	W200129
R-6885	8.3	52	31	1.4	.68	.27	1.3	7.7	1.5	.084	1.9	W192700
R-6886	3.0	41	29	3.6	.43	.12	.90	9.6	1.0	.27	5.2	W192699
R-6887	7.8	46	28	1.8	.90	.36	3.8	12	.96	.064	2.7	W192698
R-6887	7.0	49	24	2.3	1.2	.74	.48	8.1	2.0	.086	4.1	W193945
R-6888	7.4	46	23	2.8	1.1	.43	1.8	10	1.5	.11	4.4	W193946
R-6920	5.1	43	25	2.4	1.4	.53	2.4	12	1.1	.12	4.0	W195444
R-7069	27.7	62	25	.59	.80	.20	2.9	3.3	2.4	.25	.59	W198543
R-7171	4.3	31	20	6.3	2.0	1.9	1.2	13	1.1	.35	15	W200486
R-7348	11.8	54	31	.77	.88	.23	2.7	6.4	1.2	.042L	1.2	W203390
R-7357	4.5	39	25	3.9	1.5	.96	2.6	11	1.4	.49	.70	W204160
R-7358	12.0	50	28	1.8	1.0	.43	2.5	6.0	1.1	.13	2.8	W204161
R-7545	6.4	46	29	2.3	1.6	.89	1.8	8.1	1.1	.16L	2.1	W209959
R-7549	9.2	47	27	2.1	2.0	.63	3.9	7.7	1.3	.11L	2.1	W209963
R-7596	11.1	32	22	2.2	.75	.12	.63	34	.69	.090L	3.1	W210401
R-8490	20.6	56	33	.53	.86	.24	2.6	3.2	1.1	.049	.68	W215414
R-8491	3.7	36	26	2.0	1.1	.76	.79	26	1.7	.27L	2.3	W215415
R-8824	7.2	39	24	8.2	2.7	.42	2.2	5.7	.97	.14L	15	W238943
R-8937	4.4	48	29	1.2	.93	.89	1.1	8.8	1.5	.23L	2.3	W246904
R-8938	9.2	52	32	.80	1.2	.38	3.5	5.8	.79	.11L	2.0	W246905
R-8939	14.0	56	31	.50	.90	.31	2.8	4.3	1.2	.071L	1.6	W246906

Table 14d.--Major-, minor-, and trace-element composition of 24 bituminous coal samples from the Upper Banner coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means less than the value shown; B, not determined; H, interference for an element which cannot be resolved by any routine method; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS Laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-6832	.98	.88	.075	.030	.036	.080	.32	.026	.062	1.8	W191329
R-6833	.93	.65	.058	.034	.034	.061	.28	.028	.033	3.6	W191328
R-6861	5.6	3.5	.23	.19	.089	.82	.65	.16	.023L	3.9	W200128
R-6862	2.7	2.0	.13	.094	.073	.18	.40	.066	.026	5.6	W200129
R-6865	2.0	1.4	.083	.034	.017	.090	.45	.075	.041	4.1	W192700
R-6866	.57	.46	.077	.008	.003	.022	.20	.018	.021	6.9	W192699
R-6867	1.7	1.2	.10	.042	.021	.25	.67	.045	.026	9.6	W192698
R-6887	1.6	.90	.11	.050	.039	.028	.40	.084	.025	3.6	W193945
R-6888	1.6	.89	.15	.047	.024	.11	.52	.066	.043	5.2	W193946
R-6920	1.0	.67	.087	.042	.020	.10	.44	.034	.010	6.4	W195444
R-7069	8.0	3.7	.12	.13	.042	.67	.64	.40	.036	7.0	W198543
R-7171	.62	.47	.19	.052	.060	.043	.40	.027	.018	3.0	W200486
R-7348	2.9	1.9	.065	.063	.020	.26	.53	.085	.012	6.3	W203390
R-7357	.82	.60	.12	.041	.032	.099	.36	.038	.012	2.1	W204160
R-7358	2.8	1.8	.16	.072	.038	.25	.50	.078	.036	5.6	W204161
R-7545	1.4	.99	.11	.061	.042	.098	.36	.042	.012	1.6	W209959
R-7549	2.0	1.3	.14	.11	.043	.30	.50	.074	.022	3.5	W209963
R-7596	1.7	1.3	.17	.050	.010	.058	.2.7	.046	.044	59	W210401
R-8490	5.4	3.6	.078	.11	.037	.45	.46	.13	.043	6.6	W215414
R-8491	.63	.51	.052	.025	.021	.024	.67	.037	.024	45	W215415
R-8824	1.3	.90	.42	.12	.022	.13	.29	.042	.079	1.0	W238943
R-8937	.98	.67	.037	.025	.029	.041	.27	.039	.027	.93	W246904
R-8938	2.2	1.5	.053	.069	.026	.27	.37	.044	.052	6.1	W246905
R-8939	3.6	2.3	.050	.076	.032	.33	.42	.096	.057	5.0	W246906

Table 14d.--Major-, minor-, and trace-element composition of 24 bituminous coal samples from the Upper Banner coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Bi-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Lab Number
R-6832	19	86	2.6	2.1L	4.0	0.053	15	B	6.0	6.7	W191329
R-6833	17	86	2.3	1.9L	1.0	.024	11	B	1.6	4.9	W191328
R-6861	48	300	2.0	3.4L	2.4	.078	32	100	4.5	29	W200128
R-6862	36	110	2.3	1.8L	2.8	.028	22	110	3.2	9.9	W200129
R-6865	9.1	53	2.8	1.8L	5.0	.061	18	B	10	7.4	W192700
R-6866	4.8	24	1.2	.7L	6.0	.016	12	B	3.3	3.3	W192699
R-6867	12	61	2.3	1.7L	6.0	.076	18	B	9.8	14	W192698
R-6887	14	77	1.4	1.5L	5.0	.021	15	B	3.9	11	W193945
R-6888	10	89	1.8	1.6L	6.0	.030	15	B	10	11	W193946
R-6920	2.9	35	.82	.8L	6.6	.039	11	B	6.1	8.6	W195444
R-7069	17	130	3.0	4.2L	32	.053	49	630	10	45	W198543
R-7171	7.3	250	.69	.6L	2.4	.038	7.0	160	12	6.2	W200486
R-7348	9.4	73	2.2	1.8L	4.5	.091	24	240	4.6	11	W203390
R-7357	6.3	94	.95	.7L	4.7	.044	11	50L	6.5	7.4	W204160
R-7358	10	130	3.5	1.8L	4.9	.079	22	60	11	11	W204161
R-7545	14	110	1.5	.6L	2.3	.016	15	130	4.1	6.2	W209959
R-7549	17	140	1.1	.9L	2.8	.052	18	100L	7.1	13	W209963
R-7596	2.4	73	4.7	1.1L	5.1	.028	14	210	9.7	4.6	W210401
R-8490	18	250	4.1	2.1L	8.6	.20	39	250	6.1	17	W215414
R-8491	5.6	34	.93	.6	6.0	.027	10	380	2.1	5.8	W215415
R-8824	6.2	290	1.9	1.6L	8.1	.035	11	330	12	7.8	W238943
R-8937	4.8	62	1.1	1.0L	9.4	.023	9.4	510	2.9	6.7	W246904
R-8938	6.7	86	2.9	2.0L	9.7	.050	17	420	10	10	W246905
R-8939	9.9	240	3.8	3.1L	8.8	.043	30	330	8.6	17	W246906

Table 14d.--Major-, minor-, and trace-element composition of 24 bituminous coal samples from the Upper Banner coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Cs (ppm)	Cu (ppm)	Dy-S (ppm)	Er-S (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Lab Number
R-6832	0.30	15	3.1L	1.2	0.27	.28	3.0	1.2	0.44L	0.40	W191329
R-6833	.20	6.9	2.8L	.86L	.15	.46	2.6	.95	.40L	.60	W191328
R-6861	3.9	22	5.0L	2.3L	.53	.490	14	2.5	.34L	1.3	W200128
R-6862	.70	12	2.6	1.2L	.33	.140	6.7	2.2	.38	1.4	W200129
R-6865	.40	21	2.7L	.83L	.28	.36	5.1	.56L	.67	1.1	W192700
R-6866	.10	7.5	.99	.69	.25	20L	2.3	.93	.30	.60	W192699
R-6867	1.1	20	2.7	1.7	.57	.76	4.5	2.7	.55	.40	W192698
R-6887	.20	15	2.2L	.91	.29	.29	1.9	1.2	.32L	.75	W193945
R-6888	.45	19	2.4L	.74	.29	.39	3.8	.89	1.3	.60	W193946
R-6920	.40	13	1.1L	.51L	.27	.48	1.6	.61	.56	.30	W193444
R-7069	3.3	28	6.1L	2.8L	.61	170	10	3.0	1.3	3.5	W193543
R-7171	.40	7.3	.95L	.43L	.12	.27	2.6	.60	3.6	.25	W200486
R-7348	1.3	21	2.6L	1.2L	.34	.56	7.0	1.8L	.61	1.0	W203390
R-7357	.40	14	.99L	.45L	.22	.510	2.2	.68L	.29	.40	W204160
R-7358	1.0	17	2.6L	1.2L	.34	.210	6.6	1.8L	.41	1.7	W204161
R-7545	.30	9.6	1.4L	1.3	.28	60	3.2	1.3	.28	.70	W209959
R-7549	.85	18	2.0L	.92L	.37	70	4.1	1.4L	.25	.45	W209963
R-7596	.20	9.1	2.4L	1.1L	.24	10	6.8	1.7L	.83	1.1	W210401
R-8490	1.7	29	4.5L	2.1L	.58	210	9.3	3.1L	.33	1.5	W215414
R-8491	.10	16	.81L	.37L	.22	60	1.9	.56L	.37	.30	W215415
R-8824	.54	18	1.6	1.8	.27	100	5.0	1.9	3.7	.46	W238943
R-8937	.23	13	.44L	.20L	.25	20L	2.5	.97L	.28	.44	W246904
R-8938	1.4	17	.92L	.42L	.42	70	5.9	2.0L	.66	.66	W246905
R-8939	1.8	31	1.4L	.64L	.62	80	8.4	3.1L	.64	1.3	W246906

Table 14d.--Major-, minor-, and trace-element composition of 24 bituminous coal samples from the Upper Banner coal bed, Southwest Virginia, reported on a whole-coal basis. --continued

Sample Number	Hg (ppm)	Ho-S (ppm)	La (ppm)	Li (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Ni-S (ppm)	Lab Number
R-6832	0.010L	0.67L	7.0	8.6	0.13	4.7	2.1	1.1	13	8.2 W191329
R-6833	.29	.60L	5.0	5.6	.09	6.5	2.3	2.8	8.6	5.2 W191328
R-6861	.018	1.6L	18	53	.22	30	.89	4.4	11	15 W200128
R-6862	.030	1.8L	12	35	.18	12	1.2	9.7	16	8.9 W200129
R-6865	.083	.56L	9.5	22	.17	5.6	1.5	2.9	5.7	11 W192700
R-6866	.12	.30L	6.0	4.2	.11	3.6	1.8	1.8	4.5	4.5 W192699
R-6867	.18	.71	8.0	17	.24	14	4.1	1.3	14	12 W192698
R-6887	.042	.48L	9.0	13	.11	9.8	.98	2.7	9.8	5.5 W193945
R-6888	.018	.50L	8.5	9.6	.14	16	1.5	1.2	4.7	9.6 W193946
R-6920	.13	.35L	6.0	7.1	.11	16	.66	.28	3.4	4.9 W195444
R-7069	.020	1.9L	30	89	.32	17	.61L	6.4	18	18 W198543
R-7171	.010L	.29L	3.5	6.0	.05	11	.69	.56	2.1	7.7 W200486
R-7348	.070	.80L	13	32	.17	31	1.8	3.9	12	11 W203390
R-7357	.010L	.31L	6.0	6.3	.12	9.9	.86	.45	3.3	6.3 W204160
R-7358	.030	.82L	11	22	.24	14	1.0	2.8	6.5	14 W204161
R-7545	.080	.44L	8.0	13	.05	22	.90	2.4	9.0	9.6 W209959
R-7549	.16	.63L	9.5	12	.11	18	1.0	.81	2.9L	8.1 W209953
R-7596	.18	.75L	8.0	32	.11	36	2.6	5.2	3.6	18 W210401
R-8490	.12	1.4L	18	29	.27	17	.95	3.7	16	16 W215414
R-8491	.14	.25L	5.0	4.8	.06	7.8	2.0	1.0	4.8	6.3 W215415
R-8824	.005L	.37	6.1	8.6	.08	21	1.0	1.7	9.4	17 W238943
R-8937	.005L	.33	5.9	8.4	.08	4.8	1.2	.97	8.8	7.0 W246904
R-8938	.005L	.48	9.5	17	.18	11	3.0	2.0	16	15 W246905
R-8939	.005L	.57	18	25	.25	13	2.2	3.4	21	21 W246906

Table 14d.-Major-, minor-, and trace-element composition of 24 bituminous coal samples from the Upper Banner coal bed, Southwest Virginia, reported on a whole-coal basis.-continued

Sample Number	P (ppm)	Pb (ppm)	Pr-S (ppm)	Rb (ppm)	Sb (ppm)	Sc (ppm)	Se (ppm)	Sm (ppm)	Sn-S (ppm)	Sr-S (ppm)	Lab Number
R-6832	4.4	5.3	6.7L	13L	0.23	1.9	2.7	1.7	1.2	140	W191329
R-6833	17	4.7	6.0L	12L	.31	1.4	2.2	1.0	.73	190	W191328
R-6834	48	9.2	16L	63	.70	6.9	6.7	2.9	.34L	220	W200128
R-6832	22L	13	8.2L	15	.60	2.9	4.4	2.3	1.2	170	W200129
R-6835	31	17	5.6L	19L	.51	2.6	4.3	1.6	1.7	62	W192700
R-6866	35	5.4	2.0L	14L	2.1	1.5	2.2	1.4	.60	51	W192699
R-6867	22	5.8	5.3L	16	1.8	4.5	1.4	2.6	.53L	50	W192698
R-6887	26	2.9	4.8L	20L	.19	2.4	2.4	1.4	.64	110	W193945
R-6888	35	4.3	5.0L	9.0	1.1	3.2	2.3	1.5	.81	130	W193946
R-6920	26	2.6	3.5L	23L	.70	2.2	1.3	1.3	.08L	61	W195444
R-7069	300	18	19L	100L	.90	8.5	3.7	3.4	2.3	110	W198543
R-7171	66	.77	2.9L	60L	.90	1.3	1.3	.65	.06L	140	W200486
R-7348	22L	19	8.0L	17	1.2	3.5	4.2	2.1	1.8	68	W203390
R-7357	96	2.8	3.1L	20L	.40	1.9	5.2	.90	.07L	180	W204160
R-7358	70	17	8.2L	17	.60	3.2	2.6	2.3	.66	230	W204161
R-7545	44L	10	4.4L	50L	.40	1.9	3.4	1.5	.77	190	W209959
R-7549	44L	5.2	6.3L	50L	.55	2.9	5.6	1.8	.31	160	W209963
R-7596	44L	17	9.9	20L	.60	1.6	3.5	1.5	H	160	W210401
R-8490	44	23	14L	18	.80	4.5	3.3	2.9	2.5	93	W215414
R-8491	44L	2.2	2.5L	20L	.60	1.5	6.7	.90	.06L	67	W215415
R-8824	44L	3.7	1.3	18	.82	2.4	1.2	1.3	.94	43	W238943
R-8937	44L	2.5	.66	19L	.48	1.8	3.7	1.3	.57	79	W246904
R-8938	44L	9.1	.81	25	1.0	3.4	1.2	2.5	1.5	82	W246905
R-8939	44L	14	1.1	26	1.1	4.7	3.1	3.8	3.8	100	W246906

Table 14d.--Major-, minor-, and trace-element composition of 24 bituminous coal samples from the Upper Banner coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Ta (ppm)	Tb (ppm)	Th (ppm)	Tl-S (ppm)	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Lab Number
R-6832	0.29L	0.32	1.7	0.96L	1.3	12	0.77	8.6	0.80	3.1	W191329
R-6833	.17	.17	2.9	.86L	1.4	7.3	.80	7.3	.50	4.3	W191328
R-6861	.34	.44	5.6	.73L	B	55	.90	11	1.3	15	W200128
R-6862	.59	.20L	10	.38L	B	22	1.2	13	.97	6.2	W200129
R-6865	.43	.27	6.9	.83L	4.7	9.1	.92	4.2	.80	3.5	W192700
R-6866	.30	.25	3.3	.30L	2.0	3.9	.69	4.5	.60	1.5	W192699
R-6867	.12	.54	2.2	.78L	2.5	18	.72	12	1.4	20	W192698
R-6887	.19	.21	2.4	.70L	1.2	11	.54	8.4	.70	2.2	W193945
R-6888	.15	.25	2.5	.74L	1.2	14	1.1	5.6	.80	8.9	W193946
R-6920	.52L	.17	1.5	.18	1.2	6.1	.40	3.0	.70	6.6	W195444
R-7069	.88	.50	11	.89L	2.8	36	1.4	12	2.0	15	W198543
R-7171	.20L	.15	.75	.14L	.35L	4.3	.40	3.2	.35	3.3	W200486
R-7348	.54	.26	7.9	.38L	4.1	21	1.1	9.8	.90	9.4	W203390
R-7357	.080	.16	1.5	.14L	.52	8.1	.80L	4.2	.60	2.8	W204160
R-7358	.45	.36	7.1	.38L	3.6	16	.90	8.9	1.2	13	W204161
R-7545	.27	.36	5.3	.29L	3.9	9.0	.50	5.4	.70	3.1	W209959
R-7549	.20	.42	2.4	.42L	1.1	14	.40	2.9	1.0	5.2	W209963
R-7596	.75	.10L	7.5	.51L	4.3	7.7	1.2	6.4	.80	5.9	W210401
R-8490	.71	.67	9.5	.95L	5.4	29	2.7	10	2.0	21	W215414
R-8491	.10	.18	1.2	.17L	.38L	8.5	.40	4.1	.50	4.1	W215415
R-8824	.19	.17	1.8	.72L	.71	14	1.8	8.6	.66	7.9	W238943
R-8937	.11	.15	1.6	.44L	.88	11	.41	4.8	.56	1.2	W246904
R-8938	.30	.30	3.5	.92L	2.7	16	1.1	8.7	1.2	9.2	W246905
R-8939	.52	.44	7.4	1.4L	4.8	24	1.6	12	1.8	13	W246906

Table 14d.--Major-, minor-, and trace-element composition of 24 bituminous coal samples from the Upper Banner coal bed, Southwest Virginia, reported on a whole-coal basis. --continued

Sample Number	Zr-S (ppm)	Lab Number
R-6832	11	W191329
R-6833	17	W191328
R-6861	32	W200128
R-6862	130	W200129
R-6865	16	W192700
R-6866	6.0	W192699
R-6867	8.6	W192698
R-6887	36	W193945
R-6888	8.1	W193946
R-6920	4.0	W195444
R-7069	42	W198543
R-7171	6.9	W200486
R-7348	27	W203390
R-7357	4.1	W204160
R-7358	13	W204161
R-7545	15	W209959
R-7549	9.2	W209963
R-7596	24	W210401
R-8490	27	W215414
R-8491	8.9	W215415
R-8824	19	W238943
R-8937	10	W246904
R-8938	10	W246905
R-8939	22	W246906

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Table 14e.--Arithmetic mean, observed range and geometric mean of proximate and ultimate analyses, heat content, forms of sulfur, and ash-fusion temperatures for 24 bituminous coal samples from the Upper Banner coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included.

[All values are in percent except Btu/lb, Kcal/kg, ash-fusion temperatures, and free-swelling index and are reported on an as-received basis. ${}^{\circ}\text{F} = 9/5 {}^{\circ}\text{C} + 32$; Kcal/kg = 0.556 Btu/lb; (n) is number of samples per parameter.]

	Upper Banner coal bed				Appalachian basin		
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean
			Min.	Max.			(n)
Proximate and ultimate analyses							
Moisture	(24)	2.73	0.76	13.39	2.25	3.23	2.69 (4,760)
Volatile matter	(24)	29.70	22.81	38.20	29.49	32.46	31.72 (4,760)
Fixed carbon	(24)	58.74	48.30	67.80	58.57	52.48	51.76 (4,760)
Ash	(24)	8.83	3.60	23.90	7.50	11.83	9.83 (4,760)
Hydrogen	(24)	5.11	4.22	5.60	5.10	5.02	5.00 (4,760)
Carbon	(24)	76.80	63.00	83.59	76.60	70.69	70.17 (4,760)
Nitrogen	(24)	1.46	1.21	1.80	1.45	1.39	1.37 (4,757)
Oxygen	(24)	7.01	4.81	18.77	6.74	8.92	8.22 (4,756)
Sulfur	(24)	.80	.50	2.20	.75	2.15	1.63 (4,974)
Heat content							
KCal/kg Btu/lb	(24)	7,593	6,198	8,326	7,572	7,030	6,979 (4,759)
	(24)	13,657	11,147	14,974	13,618	12,644	12,553 (4,759)
Forms of sulfur							
Sulfate	(19)	0.03	0.01	0.11	0.02	0.08	0.04 (4,245)
Pyritic	(24)	.22	.01	1.91	.11	1.36	.65 (4,392)
Organic	(24)	.55	.25	.71	.53	.82	.70 (4,393)
Ash-fusion temperature (${}^{\circ}\text{C}$)							
Initial deformation	(19)	1,334	1,127	1,527	1,328	1,255	1,246 (4,063)
Softening	(16)	1,366	1,154	1,535	1,362	1,287	1,280 (3,722)
Fluid	(14)	1,405	1,266	1,538	1,402	1,334	1,328 (3,449)
Free-swelling index	(24)	7.69	1.50	9.00	7.38	5.53	4.68 (4,603)
Air-dried loss	(22)	1.79	0.06	8.57	1.10	1.83	1.13 (3,868)

Table 14f.--Arithmetic mean, observed range, and geometric mean of ash content and concentrations of 11 major- and minor-oxides in the laboratory ash of 24 bituminous coal samples from the Upper Banner coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. (n) indicates the number of samples per oxide.

[All samples were ashed at 525°C; all data are in percent.]

	Upper Banner bed				Appalachian basin			
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
(Ash)	(24)	9.5	3.0	28	8.0	13	10	(5,262)
SiO ₂	(24)	46	31	62	46	43	41	(5,229)
Al ₂ O ₃	(24)	28	20	35	27	24	23	(5,229)
CaO	(24)	2.3	.50	8.2	1.8	2.2	1.5	(5,227)
MgO	(24)	1.2	.43	2.7	1.1	.85	.75	(5,258)
Na ₂ O	(24)	.59	.12	1.9	.44	.43	.34	(5,194)
K ₂ O	(24)	2.2	.48	4.3	1.9	2.0	1.7	(5,229)
Fe ₂ O ₃	(24)	9.7	3.2	34	8.0	19	13	(5,215)
MnO	(24)	.023	.008	.044	.02	.03	.02	(5,260)
TiO ₂	(24)	1.2	.69	2.4	1.2	1.2	1.1	(5,203)
P ₂ O ₅	(14)	.15	.020	.49	.11	.50	.22	(3,389)
SO ₃	(24)	3.6	.59	15	2.4	2.5	1.9	(5,063)

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Table 14g.--Arithmetic mean, observed range, and geometric mean of concentrations of 54 trace elements in 24 bituminous coal samples from the Upper Banner coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. Dashed values (---) represent less than five samples; (n) indicates the number of samples per element. [All data are in parts-per-million and are reported on a whole-coal basis.]

	Upper Banner coal bed				Appalachian basin			
	(n)	Arith. mean	Observed range		Geom. mean	Arith. mean	Geom. mean	(n)
			Min.	Max.				
Ag (23)		0.033	0.010	0.079	0.029	0.07	0.05	(4,565)
As (24)		8.5	.93	59	4.8	35	13	(5,197)
B (24)		13	2.4	48	10	30	20	(5,076)
Ba (24)		120	24	300	97	90	63	(5,134)
Be (24)		2.2	.69	4.7	1.9	2.5	2.0	(5,247)
Bi (1)		---	.60	.60	---	1.5	1.1	(108)
Br (24)		6.4	1.0	32	5.1	22	13	(4,892)
Cd (24)		.050	.016	.20	.042	.10	.07	(4,978)
Ce (24)		18	7.0	49	16	21	17	(5,075)
Cl (14)		280	60	630	230	780	510	(3,646)
Co (24)		6.9	1.6	12	6.0	7.4	5.7	(5,217)
Cr (24)		11	3.3	45	9.4	18	15	(5,205)
Cs (24)		.88	.10	3.9	.54	1.3	.85	(4,831)
Cu (24)		17	6.9	31	15	19	15	(5,239)
Dy (4)		---	.99	2.7	---	3.3	2.6	(759)
Er (7)		1.2	.69	1.8	1.1	1.5	1.2	(1,200)
Eu (24)		.34	.12	.62	.31	.44	.37	(5,032)
F (22)		120	10	510	73	99	71	(4,860)
Ga (24)		5.0	1.6	14	4.2	6.6	5.4	(5,046)
Gd (13)		1.5	.60	3.0	1.3	2.6	1.9	(1,773)
Ge (20)		.86	.25	3.7	.60	4.7	2.5	(4,608)
Hf (24)		.88	.25	3.5	.71	.79	.62	(4,932)
Hg (17)		.10	.018	.29	.073	.22	.15	(5,031)
Ho (5)		.49	.33	.71	.47	.76	.61	(378)
La (24)		10	3.5	30	8.8	11	8.9	(5,147)
Li (24)		20	4.2	89	14	22	14	(5,243)
Lu (24)		.15	.050	.32	.13	.16	.14	(4,885)
Mn (24)		15	3.6	36	12	31	15	(5,260)
Mo (23)		1.6	.66	4.1	1.4	3.7	2.3	(4,889)
Nb (24)		2.6	.28	9.7	1.9	2.6	1.9	(5,005)
Nd (23)		9.6	2.1	21	8.1	13	9.9	(4,231)
Ni (24)		11	4.5	21	9.8	17	14	(5,240)
Pb (24)		8.9	.77	23	6.5	8.8	6.2	(5,172)
Pd ---		---	---	---	---	.17	.14	(18)
Pr (5)		2.8	.66	9.9	1.5	6.1	3.6	(960)
Rb (10)		22	9.0	63	19	28	22	(2,232)
Sb (24)		.77	.19	2.1	.66	1.4	.91	(5,003)
Sc (24)		3.0	1.3	8.5	2.6	4.4	3.6	(5,218)
Se (24)		3.3	1.2	6.7	2.9	3.6	2.8	(5,052)
Sm (24)		1.8	.65	3.8	1.7	2.0	1.6	(5,005)
Sn (17)		1.3	.31	3.8	1.0	1.6	.86	(2,352)
Sr (24)		120	43	230	110	110	79	(5,146)
Ta (21)		.35	.080	.88	.28	.24	.19	(4,369)
Tb (22)		.30	.15	.66	.28	.34	.29	(4,852)
Th (24)		4.5	.75	11	3.4	3.0	2.3	(5,098)
Tl (1)		---	.18	.18	---	3.4	2.1	(382)
Tm ---		---	---	---	---	1.7	.38	(46)
U (20)		2.5	.52	5.4	2.0	1.8	1.3	(4,990)
V (24)		16	3.9	55	13	24	19	(5,241)
W (23)		.95	.40	2.6	.82	.94	.80	(4,421)
Y (24)		7.5	2.9	13	6.8	8.5	7.2	(5,234)
Yb (24)		.95	.35	2.0	.86	1.1	.92	(5,151)
Zn (24)		7.7	1.2	21	5.9	22	14	(5,243)
Zr (24)		21	4.0	130	15	24	17	(5,238)

SPLASH DAM COAL BED

The Splash Dam coal bed crops out in Buchanan, Dickenson, Wise and Russell Counties. It is locally called the Upper Banner or Wilson coal bed in these counties, and is correlative with the Glenalum Tunnel coal bed in McDowell County, West Virginia. Total production of this coal in 1989 amounted to 3.1 million tons, the majority coming from Buchanan County (Virginia Division of Mines, 1990). Sampled thickness ranges from 0.9 to 4.8 feet. Roof rock is normally shale with abundant plant fossils. A 1.5 foot shale parting separates the "cleaner-looking" upper bench from the lower bench which contains three or more partings, some of which may be bony. The Splash Dam typically has moderate- to well-developed fine- or moderately-developed medium cleat with a moderate amount of thin banding.

The elements Bi, Pd, and Tm, in addition to the eight elements below the detection limits for all 375 Virginia coal samples, are also found to be below the detection limits for the 21 Splash Dam coal samples (Figure 22 and Table 15a are the descriptive and location information and Tables 15b, 15c, and 15d contain the analytical results). Tl has only one unqualified value and therefore geometric mean calculation was not possible. Na₂O, Cl, and the free-swelling index are found to have substantially higher geometric means (Tables 15e, 15f, and 15g) for the Splash Dam coal samples than for the Appalachian basin samples. MnO, As, Cd, Ge, Mn, Zn, and pyritic sulfur geometric means are found to be substantially lower.

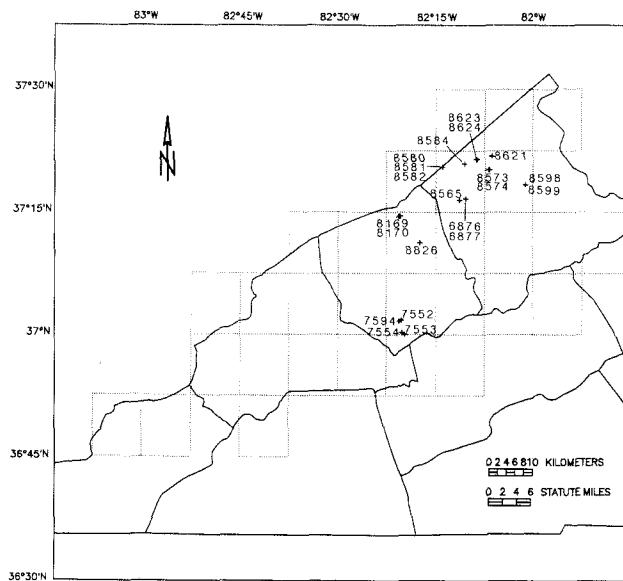


Figure 22. Locations for samples from the Splash Dam coal bed.

Table 15a. -Descriptions and locations for 21 bituminous coal samples from the Splash Dam coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-6876	W193671	118C-1	371638N	821024W	Harman (7.5')	Buchanan	36.12	Surface mine, sl. weathered	Bench Sample
R-6877	W193672	118C-2	371638N	821024W	Harman (7.5')	Buchanan	34.80	Surface mine, sl. weathered	Bench Sample
R-7552	W210393	89D-9	370149N	822008W	Nora (7.5')	Dickenson	47.40	Underground mine, sl. weathered	Full Thickness
R-7553	W210394	89D-10	370005N	821937W	Nora (7.5')	Dickenson	28.80	Underground mine, sl. weathered	Full Thickness
R-7554	W210395	89D-11	370016N	822003W	Nora (7.5')	Dickenson	37.80	Underground mine, sl. weathered	Full Thickness
R-7594	W210399	89D-14	370140N	822031W	Nora (7.5')	Dickenson	47.76	Underground mine, weathered	Full Thickness
R-8169	W211676	89A-3	371427N	822038W	Haysi (7.5')	Dickenson	52.80	Underground mine, sl. weathered	Full Thickness
R-8170	W211677	89A-4	371431N	822025W	Haysi (7.5')	Dickenson	51.60	Underground mine, sl. weathered	Full Thickness
R-8565	W217688	118C-13	371626N	821123W	Harman (7.5')	Buchanan	49.20	Underground mine, sl. weathered	Full Thickness
R-8573	W218772	118D-5	372011N	820564W	Grundy (7.5')	Buchanan	26.40	Underground mine, sl. weathered	Full Thickness
R-8574	W218773	118D-6	372010N	820555W	Grundy (7.5')	Buchanan	27.00	Underground mine	Full Thickness
R-8580	W218765	118C-15	372102N	821401W	Harman (7.5')	Buchanan	24.60	Underground mine	Partial Upper Split
R-8581	W218766	118C-16	372102N	821401W	Harman (7.5')	Buchanan	15.60	Underground mine	Partial Upper Split
R-8582	W218767	118C-17	372102N	821401W	Harman (7.5')	Buchanan	16.20	Underground mine	Lower Split
R-8584	W218769	118C-19	372055N	821060W	Harman (7.5')	Buchanan	27.00	Underground mine, sl. weathered	Full Thickness
R-8598	W218974	118D-10	371821N	820108W	Grundy (7.5')	Buchanan	10.20	Underground mine	Bench Sample
R-8599	W218975	118D-11	371821N	820108W	Grundy (7.5')	Buchanan	31.20	Underground mine	Bench Sample
R-8621	W223357	118D-18	372151N	820619W	Grundy (7.5')	Buchanan	31.20	Underground mine	Full Thickness
R-8623	W223359	118C-21	372127N	820849W	Harman (7.5')	Buchanan	27.60	Underground mine	Full Thickness
R-8624	W223360	118C-22	372130N	820359W	Harman (7.5')	Buchanan	37.20	Underground mine, sl. weathered	Full Thickness
R-8826	W238941	89A-12	371117N	821721W	Haysi (7.5')	Dickenson	16.80	Surface mine	Full Thickness

Table 15b.-Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 21 bituminous coal samples from the Splash Dam coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. G for ash-fusion temperatures means greater than value shown. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT		
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/KG	Btu/lb	Lab Number
R-6876	3.6	28.1	59.6	8.7	5.2	75.9	1.5	7.3	1.4	7,520	13,530	W193671
	---	29.1	61.8	9.0	5.0	78.7	1.6	4.3	1.5	7,800	14,040	
	---	32.0	68.0	---	5.5	86.5	1.7	4.7	1.6	8,570	15,430	
R-6877	1.8	25.7	58.7	13.8	4.6	73.8	1.5	5.4	.9	7,270	13,090	W193672
	---	26.2	59.8	14.1	4.5	75.2	1.5	3.9	.9	7,400	13,230	
	---	30.5	69.5	---	5.2	87.4	1.8	4.5	1.1	8,610	15,500	
R-7552	2.0	29.6	59.3	9.1	5.2	77.0	1.5	6.3	1.0	7,680	13,820	W210393
	---	30.2	60.5	9.3	5.1	78.6	1.5	4.6	1.0	7,840	14,100	
	---	33.3	66.7	---	5.6	86.6	1.7	5.1	1.1	8,640	15,550	
R-7553	1.9	33.5	55.0	9.6	5.3	75.4	1.4	6.5	1.8	7,560	13,600	W210394
	---	34.1	56.1	9.8	5.2	76.9	1.4	4.9	1.8	7,700	13,860	
	---	37.9	62.1	---	5.8	85.2	1.6	5.4	2.0	8,540	15,370	
R-7554	3.0	34.8	55.1	7.1	5.4	74.8	1.4	7.1	4.1	7,640	13,750	W210395
	---	35.9	56.8	7.3	5.2	77.1	1.4	4.6	4.2	7,880	14,180	
	---	38.7	61.3	---	5.6	83.2	1.6	4.9	4.6	8,500	15,300	
R-7594	3.3	42.9	32.1	21.7	4.5	64.6	1.2	4.5	.7	6,240	11,240	W210399
	---	44.4	33.2	22.4	4.3	66.8	1.2	4.5	.7	6,460	11,620	
	---	57.2	42.8	---	5.5	86.1	1.6	5.8	.9	8,320	14,980	
R-8169	2.8	31.1	56.0	10.1	5.1	74.8	1.5	7.8	.6	7,340	13,210	W211676
	---	32.0	57.6	10.4	4.9	77.0	1.5	5.5	.6	7,550	13,590	
	---	35.7	64.3	---	5.5	86.0	1.7	6.1	.7	8,430	15,180	
R-8170	2.3	28.9	52.8	16.0	4.9	70.0	1.5	6.8	.8	7,020	12,630	W211677
	---	29.6	54.0	16.4	4.7	71.6	1.6	4.9	.8	7,180	12,930	
	---	35.4	64.6	---	5.6	85.7	1.9	5.9	.9	8,590	15,460	
R-8565	1.6	27.5	66.0	4.9	5.0	81.6	1.6	6.3	.6	7,980	14,360	W217688
	---	27.9	67.1	5.0	4.9	83.0	1.7	4.9	.6	8,110	14,600	
	---	29.4	70.6	---	5.1	87.3	1.8	5.1	.6	8,540	15,370	

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Table 15b.-Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 21 bituminous coal samples from the Splash Dam coal bed, Southwest Virginia.--continued

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)				Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid			
R-6876	2.6	.22	0.53	0.62	8.5	1,350	1,420	1,480	---	2.07	W193671
	---	.23	.55	.64							
	---	.25	.60	.71							
R-6877	1.0	.07	.19	.59	9.0	1,430	1,490	1,540	---	1.38	W193672
	---	.07	.19	.60							
	---	.08	.23	.70							
R-7552	1.1	.01	.28	.73	8.5	1,280	1,355	1,420	---	1.45	W210393
	---	.01	.29	.74							
	---	.01	.31	.82							
R-7553	.7	.14	1.03	.66	8.5	1,040	1,145	1,225	---	2.65	W210394
	---	.14	1.05	.67							
	---	.16	1.16	.75							
R-7554	1.7	.23	2.77	1.15	8.5	1,070	1,120	1,170	---	5.96	W210395
	---	.24	2.86	1.19							
	---	.26	3.08	1.28							
R-7594	2.2	.01	.13	.57	7.0	1,410	1,480	1,530	---	1.25	W210399
	---	.01	.13	.59							
	---	.01	.17	.76							
R-8169	1.6	.04	.03	.56	7.5	1,400	1,540	1,540G	---	.91	W211676
	---	.04	.03	.58							
	---	.05	.03	.64							
R-8170	1.1	.11	.16	.48	7.5	1,370	1,455	1,500	---	1.27	W211677
	---	.11	.16	.49							
	---	.13	.20	.59							
R-8565	.8	.03	.01	.56	8.0	1,370	1,525	1,540	---	.84	W217688
	---	.03	.01	.57							
	---	.03	.01	.60							

Table 15b.-Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 21 bituminous coal samples from the Splash Dam coal bed, Southwest Virginia. -continued

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT		
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	Lab Number
R-8573	2.2	30.8	60.7	6.3	4.8	79.5	1.5	6.7	1.2	7,930	14,270	W218772
	---	31.5	62.1	6.4	4.6	81.3	1.6	4.9	1.2	8,100	14,590	
	---	33.7	66.3	---	5.0	86.9	1.7	5.2	1.3	8,660	15,590	
R-8574	2.4	31.1	62.2	4.3	5.2	81.8	1.6	6.3	.8	8,080	14,540	W218773
	---	31.8	63.7	4.4	5.1	83.8	1.6	4.2	.8	8,280	14,900	
	---	33.3	66.7	---	5.3	87.6	1.7	4.4	.9	8,660	15,590	
R-8580	3.2	28.0	61.4	7.3	5.0	78.5	1.5	7.0	.6	7,700	13,850	W218765
	---	29.0	63.5	7.6	4.8	81.0	1.6	4.4	.6	7,950	14,310	
	---	31.3	68.7	---	5.2	87.7	1.7	4.7	.7	8,600	15,480	
R-8581	4.1	28.6	62.1	5.3	5.2	79.6	1.6	7.6	.8	7,850	14,120	W218766
	---	29.8	64.7	5.5	4.9	83.0	1.6	4.1	.8	8,180	14,720	
	---	31.5	68.5	---	5.2	87.8	1.7	4.4	.8	8,660	15,580	
R-8582	3.3	29.3	58.5	8.9	4.9	76.0	1.5	6.3	2.3	7,560	13,610	W218767
	---	30.3	60.5	9.3	4.7	78.6	1.6	3.5	2.4	7,820	14,070	
	---	33.4	66.6	---	5.2	86.6	1.7	3.9	2.7	8,610	15,500	
R-8584	2.7	28.7	61.9	6.7	5.0	79.0	1.6	6.9	.7	7,780	14,010	W218769
	---	29.5	63.6	6.9	4.9	81.2	1.6	4.7	.7	8,000	14,400	
	---	31.7	68.3	---	5.2	87.2	1.7	5.0	.8	8,590	15,470	
R-8598	1.6	28.1	64.2	6.1	5.1	80.1	1.7	5.8	1.1	7,940	14,290	W218974
	---	28.5	65.2	6.2	5.1	81.4	1.7	4.4	1.1	8,070	14,530	
	---	30.4	69.6	---	5.4	86.9	1.8	4.7	1.2	8,610	15,490	
R-8599	2.8	27.0	65.9	4.4	5.2	80.8	1.7	7.3	.6	7,920	14,250	W218975
	---	27.7	67.7	4.5	5.0	83.1	1.7	5.0	.6	8,140	14,660	
	---	29.1	70.9	---	5.2	87.1	1.8	5.3	.6	8,530	15,350	
R-8621	1.9	29.7	63.1	5.4	5.1	80.8	1.6	6.5	.6	7,970	14,350	W223357
	---	30.3	64.3	5.5	5.0	82.4	1.6	4.9	.7	8,120	14,620	
	---	32.0	68.0	---	5.3	87.1	1.7	5.2	.7	8,590	15,470	
R-8623	1.4	29.1	62.1	7.4	5.0	79.7	1.6	5.8	.7	7,850	14,130	W223359
	---	29.6	62.9	7.5	4.9	80.8	1.6	4.6	.7	7,960	14,330	
	---	32.0	68.0	---	5.3	87.3	1.7	4.9	.7	8,600	15,490	

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Table 15b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 21 bituminous coal samples from the Splash Dam coal bed, Southwest Virginia.--continued

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening			
R-8573	1.2 --- --- ---	0.05 .05 .05 .03	0.55 .56 .60 .19	0.57 .58 .62 .61	7.0 .64 .20 .19	1,325 1,420 1,350	1,400 1,420 1,440	1,475 1,505 1,495	---	1.68 W218772
R-8574	1.4 --- --- ---	.03 .03 .03 .01	.19 .19 .20 .01	.60 .61 .64 .01	7.5 .58 .60 .65	1,370 1,440	1,440 1,495	---	1.10 W218773	
R-8580	2.2 --- --- ---	.01 .01 .01 .02	.01 .01 .01 .08	.01 .01 .09 .08	7.5 .58 .60 .66	1,370 1,440	1,440 1,495	---	.87 W218765	
R-8581	3.1 --- --- ---	.02 .02 .02 .02	.08 .08 .09 .09	.66 .69 .73	8.5 8.0 8.0 8.0	1,540 1,540G	1,540G 1,540G	---	1.13 W218766	
R-8582	2.3 --- --- ---	.15 .16 .17	1.53 1.58 1.74	.66 .68 .75	7.0 7.0 7.0	1,140 1,250	1,140 1,250	1,380 1,380	---	3.38 W218767
R-8584	1.7 --- --- ---	.07 .07 .08	.01 .01 .01	.62 .64 .68	7.0 7.0 7.0	1,540 1,540G	1,540G 1,540G	---	1.00 W218769	
R-8598	1.2 --- --- ---	.06 .06 .07	.22 .22 .24	.82 .83 .89	9.0 9.0 7.0	1,360 1,420	1,360 1,420	1,510 1,510	---	1.54 W218974
R-8599	1.7 --- --- ---	.06 .06 .06	.03 .03 .03	.51 .52 .55	7.0 7.0 7.5	1,325 1,430	1,325 1,430	1,540 1,540	---	.84 W218975
R-8621	1.1 --- --- ---	.02 .02 .02	.01 .01 .01	.62 .63 .67	7.5 7.5 7.5	1,540 1,540G	1,540G 1,540G	62 62	.84 W223357	
R-8623	.8 --- ---	.07 .07 .08	.03 .03 .03	.57 .58 .62	7.5 7.5 7.5	1,505 1,540	1,505 1,540	68 68	.99 W223359	

Table 15b.-Proximate and ultimate analyses, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 21 bituminous coal samples from the Splash Dam coal bed, Southwest Virginia.--continued

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT	
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/kg	Btu/lb
R-8624	3.2	27.9	62.4	6.5	5.1	78.8	1.6	7.4	0.6	7,760	13,980
	---	28.9	64.4	6.7	4.9	81.4	1.6	4.7	.7	8,020	14,440
	---	30.9	69.1	--	5.3	87.2	1.8	5.0	.7	8,600	15,480
R-8826	2.8	29.5	62.4	5.3	5.2	80.7	1.4	6.6	.8	7,970	14,340
	---	30.4	64.2	5.5	5.0	83.1	1.4	4.2	.8	8,200	14,750
	---	32.1	67.9	--	5.3	87.9	1.5	4.4	.8	8,670	15,610

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)				Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid			
R-8624	2.6	0.03	0.02	0.60	7.5	1,515	1,540	1,540G	68	0.86	W223360
	---	.03	.02	.62	.66						
	---	.03	.02	.62	.66						
R-8826	1.8	.00	.24	.53	7.0	1,415	1,470	1,540	66	1.12	W238941
	---	.00	.25	.55	.58						
	---	.00	.26	.58							

Table 15c. -Major- and minor-oxide concentrations in the laboratory ash of 21 bituminous coal samples from the Splash Dam coal bed,
Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. L means less than the concentration shown; B not determined. Sample number is the
VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-6876	4.8	41	28	0.71	0.73	0.66	3.3	12	1.3	0.042L	1.2	W193671
R-6877	11.1	71	17	.55	.40	.73	2.0	3.9	2.6	.090	.61	W193672
R-7552	12.3	49	26	2.0	1.2	.46	3.4	9.5	1.5	.081L	2.7	W210393
R-7553	11.9	44	20	2.8	1.4	.53	3.2	18	1.3	.084L	4.2	W210394
R-7554	14.5	46	38	2.6	1.5	.38	3.1	10	1.2	.13	3.8	W210395
R-7594	26.1	56	24	.80	1.6	.28	4.1	7.0	1.1	.14	1.3	W210399
R-8169	12.9	57	29	.70	.81	.57	3.4	3.1	1.5	.21	.50	W211676
R-8170	16.5	58	27	.56	1.0	.43	4.2	4.7	1.4	.067	.60	W211677
R-8565	5.3	56	28	1.3	.27	1.2	1.2	5.6	2.7	.38	1.6	W217588
R-8573	5.9	45	27	1.3	.53	1.0	.67	16	2.0	.17L	B	W218772
R-8574	4.7	44	28	1.8	.70	1.1	.69	13	1.9	.21L	B	W218773
R-8580	7.2	57	30	.69	.46	1.0	.84	2.7	2.4	.14L	B	W218765
R-8581	5.5	47	30	.88	1.0	1.2	3.1	8.4	1.0	.25	B	W218766
R-8582	9.1	39	24	.85	1.0	.76	2.7	26	.65	.11L	B	W218767
R-8584	6.7	48	32	1.1	.66	1.1	.51	3.3	2.0	.51	B	W218769
R-8598	5.7	49	27	1.2	.93	.45	2.7	9.4	1.0	.18L	B	W218974
R-8599	4.5	16	28	2.1	.85	.88	1.3	7.9	1.8	.22L	B	W218975
R-8621	5.6	54	32	1.1	.45	1.2	.61	3.0	2.3	.18L	1.4	W223357
R-8623	8.4	53	32	1.3	.70	1.1	.9	4.4	1.9	.36	1.3	W223359
R-8624	7.7	54	31	1.1	.58	1.2	2.4	3.0	2.3	.32	.88	W223360
R-8826	5.2	48	30	1.3	.90	.58	2.1	13	1.5	.19L	2.2	W238941

Table 15d. -Major-, minor-, and trace-element composition of 21 bituminous coal samples from the Splash Dam coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means less than the value shown; B, not determined; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VPMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-6876	1.1	0.72	0.024	0.021	0.024	0.13	0.41	0.037	0.010	23	W193671
R-6877	3.7	.97	.044	.027	.060	.18	.30	.17	.021	1.9	W193672
R-7552	2.8	1.7	.17	.090	.042	.35	.82	.11	.031	5.8	W210393
R-7553	2.5	1.3	.24	.099	.046	.31	1.5	.093	.044	12	W210394
R-7554	3.1	2.9	.27	.13	.041	.37	1.1	.11	.059	5.9	W210395
R-7594	6.8	3.4	.15	.26	.055	.89	1.3	.17	.026L	4.7	W210399
R-8169	3.4	2.0	.065	.063	.054	.36	.28	.12	.022	2.8	W211676
R-8170	4.4	2.4	.066	.10	.053	.58	.54	.14	.025	2.8	W211677
R-8365	1.4	.77	.048	.008	.049	.054	.21	.085	.026	7.1	W217688
R-8573	1.2	.84	.055	.019	.044	.033	.65	.070	.028	9.6	W218772
R-8574	.96	.70	.060	.020	.038	.027	.44	.054	.026	3.1	W218773
R-8380	1.9	1.1	.035	.020	.055	.050	.14	.10	.050	1.0	W218765
R-8581	1.2	.88	.035	.035	.051	.14	.32	.033	.055	4.5	W218766
R-8382	1.6	1.2	.055	.055	.051	.20	1.7	.036	.041	79	W218767
R-8384	1.5	1.1	.052	.027	.056	.028	.15	.080	.021	1.0	W218769
R-8598	1.3	.82	.050	.032	.019	.13	.38	.035	.036	13	W218974
R-8599	.34	.67	.067	.023	.029	.048	.25	.069	.029	3.3	W218975
R-8621	1.4	.95	.043	.015	.051	.029	.12	.077	.040	1.2	W223357
R-8623	2.1	1.4	.078	.035	.070	.13	.26	.098	.068	3.7	W223359
R-8624	1.9	1.3	.058	.027	.068	.15	.16	.10	.085	2.3	W223360
R-8826	1.2	.82	.048	.028	.022	.092	.49	.048	.041	7.6	W238941

Table 15d.--Major-, minor-, and trace-element composition of 21 bituminous coal samples from the Splash Dam coal bed, Southwest Virginia, reported on a whole-coal basis. --continued

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-6876	6.7	31	0.86	14	0.053	8.0	B	6.4	16	0.95	W193671
R-6877	20	68	2.0	12	.024	17	B	2.9	13	.55	W193672
R-7552	17	150	1.5	4.4	.098	17	100L	6.8	15	1.2	W210393
R-7553	19	130	.69	3.3	.060	15	100L	2.2	14	2.0	W210394
R-7554	26	160	1.2	18	.10	17	100L	5.2	19	1.5	W210395
R-7594	37	340	1.7	2.1	.11	37	100L	9.2	28	2.9	W210399
R-8169	23	120	1.3	15	.039	21	1,400	4.1	15	1.4	W211676
R-8170	26	140	1.4	14	.058	27	1,200	4.7	19	1.8	W211677
R-8565	21	64	1.2	8.4	.034	19	500	2.7	11	.40	W217688
R-8573	6.5	56	1.8	21	.024	18	1,300	8.2	11	.20	W218772
R-8574	4.6	47	1.2	19	.019	12	100L	6.1	7.6	.10	W218773
R-8580	9.4	46	.86	19	.026	17	1,100	4.6	13	.10	W218775
R-8581	8.3	45	2.3	20	.019	37	1,300	11	12	.40	W218766
R-8582	5.4	45	2.6	19	.051	16	1,100	14	10	.70	W218767
R-8584	8.7	42	1.2	17	.024	21	910	7.5	12	.10	W218769
R-8598	3.6	130	6.8	28	.034	13	1,500	3.4	8.7	1.3	W218974
R-8599	5.0	58	1.8	16	.032	15	870	5.7	9.2	.31	W218975
R-8621	12	78	4.4	25	.017	18	1,500	7.2	11	.13	W223357
R-8623	16	140	1.8	25	.017	18	1,200	3.3	13	.46	W223359
R-8624	18	150	1.8	26	.018	19	1,200	3.4	14	.55	W223360
R-88826	7.3	57	2.1	12	.021	13	970	5.1	7.5	.67	W238941

Table 15d.--Major-, minor-, and trace-element composition of 21 bituminous coal samples from the Splash Dam coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Cu (ppm)	Dy-S (ppm)	Er-S (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	Lab Number
R-6876	9.1	1.5L	0.48L	0.32	67	2.4	0.53	0.40	0.80	0.11	W193671
R-6877	11	3.6L	1.1L	.22	55	4.1	.98	4.1	1.3	.035	W193672
R-7552	17	2.7L	1.2L	.42	40	6.3	1.8L	.46	.80	.045	W210393
R-7553	9.3	2.6L	1.2L	.26	30	4.9	1.8L	.51	.90	.060	W210394
R-7554	22	3.2L	1.5L	.34	10	5.5	3.8	.22L	.80	.045	W210395
R-7594	19	5.7L	2.6L	.65	70	11	4.7	.57	1.7	.088	W210399
R-8169	19	2.8L	1.3L	.42	100	4.4	1.9L	1.5	.85	.14	W211676
R-8170	18	3.6L	1.7L	.48	90	5.6	2.5L	1.4	1.1	.058	W211677
R-8565	8.0	1.5	.74	.26	90	2.5	1.3	1.1	.80	.11	W217688
R-8573	7.7	1.3L	.27L	.37	60	2.5	1.9L	.44	.60	.36	W218772
R-8574	8.0	1.0L	.22L	.27	40	2.1	1.5L	.25	.30	.30	W218773
R-8580	17	1.6L	.33L	.33	160	3.5	2.3L	.33L	.90	.41	W218765
R-8581	14	3.5	1.8	1.0	260	5.0	2.2	1.5	.30	.40	W218766
R-8582	10	2.0L	.42L	.53	60	5.5	2.9L	1.0	.60	.41	W218767
R-8584	8.0	1.5L	.31L	.38	150	2.1	2.1L	.31L	.60	.25	W218769
R-8598	11	3.4	1.9	.44	100	8.0	3.5	9.1	.32	.14	W218974
R-8599	9.5	2.3	1.2	.35	80	2.7	1.9	.72	.45	.13	W218975
R-8621	17	2.7	1.5	.36	60	6.2	1.8L	.78	.57	.26	W223557
R-8623	14	3.6	.39L	.31	100	8.4	5.5	.62	.64	.19	W223559
R-8624	18	2.9	2.0	.33	180	7.1	4.2	.59	.72	.25	W223560
R-8826	11	1.2	1.1	.33	100	3.4	.83	1.2	.43	.005L	W238941

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Table 15d.--Major-, minor-, and trace-element composition of 21 bituminous coal samples from the Splash Dam coal bed, Southwest Virginia, reported on a whole-coal basis. --continued

Sample Number	Ho-S (ppm)	La (ppm)	Li (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Lab Number
R-6876	0.33L	4.0	8.6	0.14	11	1.1	0.48	2.2L	3.6	8.7	W193671
R-6877	.75L	12	5.4	.17	4.9	.85	5.0	7.7	4.7	44	W193672
R-7552	.84L	11	23	.16	48	2.6	2.0	3.9L	14	44L	W210393
R-7553	.81L	9.0	18	.11	21	.62	2.5	3.8L	6.7	44L	W210394
R-7554	.99L	10	41	.12	29	1.4	2.8	4.6L	6.1	83	W210395
R-7594	1.8L	23	39	.24	84	1.4	5.2	16	24	160	W210399
R-8169	.88L	13	53	.11	7.7	.86	3.0	9.8	9.8	120	W211676
R-8170	1.1L	16	48	.21	16	.41	2.3	8.3	9.2	48	W211677
R-8565	.36L	11	5.0	.07	4.6	.69	2.1	12	8.5	87	W217688
R-8573	.40L	11	6.5	.11	4.2	.83	1.4	8.9	12	44L	W218772
R-8574	.32L	7.0	5.2	.08	3.4	.56	1.3	8.0	8.0	44L	W218773
R-8580	.49L	10	10	.11	3.3	1.4	2.6	10	11	44L	W218765
R-8581	.77	16	3.7	.28	5.1	1.5	1.2	17	14	61	W218766
R-8582	.62L	8.0	4.4	.24	6.0	1.1	1.8	7.7	15	44L	W218767
R-8584	.46L	12	12	.09	1.9	.80	1.9	9.4	13	150	W218769
R-8598	.74	6.3	6.8	.20	4.8	4.1	.97	13	11	44L	W218974
R-8599	.50	8.6	7.2	.12	7.7	1.9	1.7	10	14	44L	W218975
R-8621	.62	11	13	.10	2.1	1.2	4.4	15	18	44L	W223557
R-8623	.66	10	13	.10	4.5	1.3	4.1	18	19	130	W223559
R-8624	.52L	11	10	.11	2.8	1.5	4.5	20	15	110	W223560
R-8826	.30	6.7	6.8	.09	6.2	2.2	2.0	12	6.8	44L	W238941

Table 15d.--Major-, minor-, and trace-element composition of 21 bituminous coal samples from the Splash Dam coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Pb (ppm)	Pr-S (ppm)	Rb (ppm)	Sb (ppm)	Sc (ppm)	Se (ppm)	Sm (ppm)	Sn-S (ppm)	Sr-S (ppm)	Ta (ppm)	Lab Number
R-6876	4.8	3.3L	17	.75	2.5	1.7	0.93	0.07L	24	0.20L	W193671
R-6877	4.4	7.5L	11	.94	2.4	1.7	1.6	.75L	56	.33	W193672
R-7552	7.4	8.4L	20	1.2	4.1	3.5	1.6	.60	200	.28	W210393
R-7553	3.1	8.1L	31	1.2	3.1	4.4	1.1	.18L	190	.28	W210394
R-7554	9.4	9.9L	27	2.9	3.6	2.8	1.5	.38	200	.37	W210395
R-7594	9.7	18L	74	.60	6.7	3.2	2.8	1.1	310	.50	W210399
R-8169	6.8	8.8L	60L	.90	3.9	2.6	1.7	.93	140	.26	W211676
R-8170	7.6	11L	60L	.80	5.1	2.5	1.6	.31	130	.50	W211677
R-8565	4.4	4.7	20L	.30	2.4	3.2	1.1	.49	130	.28	W217688
R-8573	2.3	5.9L	20L	.30	2.5	3.8	1.4	.51	83	.24	W218772
R-8574	2.8	4.7L	20L	.20	1.8	3.2	1.0	.25	75	.16	W218773
R-8580	6.0	7.2L	20L	.40	3.0	4.9	1.4	.79	86	.32	W218765
R-8581	4.0	6.1	20L	1.5	4.2	1.5	4.1	.28	82	.080	W218766
R-8582	6.2	9.1L	20L	2.1	3.8	2.6	2.1	.42L	59	.33	W218767
R-8584	3.3	6.7L	20L	.20	2.8	2.9	1.5	.80	130	.25	W218769
R-8598	3.0	5.7L	12	4.4	3.8	.90	1.5	.26L	74	.13	W218974
R-8599	3.4	4.5L	10L	.62	2.6	1.8	1.3	.26	99	.16	W218975
R-8621	3.6	7.8	10L	.43	2.7	3.1	1.4	1.0	160	.23	W223357
R-8623	9.2	8.4L	20L	.42	3.2	2.9	1.3	1.3	180	.24	W223359
R-8624	5.3	7.7	20L	.41	3.0	2.6	1.4	1.2	160	.29	W223360
R-8826	3.2	1.1	23L	.46	2.2	1.7	1.6	.83	38	.13	W238941

Table 15d. - Major-, minor-, and trace-element composition of 21 bituminous coal samples from the Splash Dam coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Tb (ppm)	Th (ppm)	Tl-S (ppm)	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)	Lab Number
R-6876	0.29	1.1	0.77	1.9	7.7	0.97	1.5	0.80	4.0	3.0	W193671
R-6877	.17	3.0	1.1L	1.1	16	.56	7.4	.90	4.5	4.1	W193672
R-7552	.41	3.1	.57L	1.3	21	.70	4.2	1.2	15	14	W210393
R-7553	.18	2.4	.55L	.86	12	.50	3.2	.80	9.8	14	W210394
R-7554	.21	2.9	.67L	1.5	20	.80	3.0	.80	12	14	W210395
R-7594	.60	5.6	1.2L	2.0	37	.80	7.6	1.7	26	26	W210399
R-8169	.25	3.3	.59L	1.4	21	.60	5.8	.90	4.5	21	W211676
R-8170	.31	4.4	.76L	1.6	23	.50	5.4	1.0	7.4	17	W211677
R-8565	.20	3.0	.53L	.73	9.0	.30	3.7	.60	1.9	12	W217688
R-8573	.32	2.6	.59L	.93	8.9	.50	5.1	.80	3.0	12	W218772
R-8574	.22	1.7	.47L	.86	8.5	.50	4.0	.60	2.4	9.4	W218773
R-8580	.29	3.5	.72L	1.0	12	.80	5.2	.90	5.3	14	W218765
R-8581	.74	2.2	.55L	2.1	18	.70	9.9	2.4	6.6	5.3	W218766
R-8582	.43	3.9	.91L	2.5	12	1.0	8.0	1.9	10	6.6	W218767
R-8584	.29	3.2	.67L	.76	11	.80	4.9	.80	3.8	13	W218769
R-8598	.54	1.7	.57L	2.7	21	1.8	13	1.6	6.8	8.6	W218974
R-8599	.32	2.1	.45L	.76	13	.58	7.7	.90	5.9	12	W218975
R-8621	.30	2.5	.56L	.85	15	.78	9.5	.83	3.7	27	W223357
R-8623	.24	2.9	.84L	1.1	25	.86	9.2	.79	4.7	29	W223359
R-8624	.23	2.9	.77L	1.1	24	.88	9.2	.84	3.7	23	W223360
R-8826	.20	1.4	.52L	.59	12	.88	7.8	.69	3.1	17	W238941

Table 15e.--Arithmetic mean, observed range and geometric mean of proximate and ultimate analyses, heat content, forms of sulfur, and ash-fusion temperatures for 21 bituminous coal samples from the Splash Dam coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included.

[All values are in percent except Btu/lb, Kcal/kg, ash-fusion temperatures, and free-swelling index and are reported on an as-received basis. $^{\circ}\text{F} = 9/5 \, ^{\circ}\text{C} + 32$; Kcal/kg = 0.556 Btu/lb; (n) is number of samples per parameter.]

(n)	Splash Dam coal bed				Appalachian basin		
	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	
		Min.	Max.				
Proximate and ultimate analyses							
Moisture	(21)	2.56	1.41	4.08	2.46	3.23	2.69 (4,760)
Volatile matter	(21)	29.99	25.70	42.90	29.81	32.46	31.72 (4,760)
Fixed carbon	(21)	59.11	32.10	65.98	58.57	52.48	51.76 (4,760)
Ash	(21)	8.34	4.31	21.70	7.59	11.83	9.83 (4,760)
Hydrogen	(21)	5.05	4.50	5.40	5.04	5.02	5.00 (4,760)
Carbon	(21)	77.29	64.60	81.76	77.18	70.69	70.17 (4,760)
Nitrogen	(21)	1.52	1.20	1.70	1.52	1.39	1.37 (4,757)
Oxygen	(21)	6.72	5.40	7.83	6.69	8.92	8.22 (4,756)
Sulfur	(21)	1.08	.60	4.10	.92	2.15	1.63 (4,974)
Heat content							
KCal/kg Btu/lb	(21)	7,651 13,760	6.247 11,236	8,085 14,541	7,639 13,739	7,030 12,644	6,979 12,553 (4,759)
Forms of sulfur							
Sulfate	(20)	0.07	0.01	0.23	0.05	0.08	0.04 (4,245)
Pyritic	(21)	.38	.01	2.77	.11	1.36	.65 (4,392)
Organic	(21)	.63	.48	1.15	.62	.82	.70 (4,393)
Ash-fusion temperature ($^{\circ}\text{C}$)							
Initial deformation	(18)	1,335	1,038	1,516	1,329	1,255	1,246 (4,063)
Softening	(15)	1,388	1,121	1,527	1,382	1,287	1,280 (3,722)
Fluid	(11)	1,427	1,171	1,532	1,422	1,334	1,328 (3,449)
Free-swelling index	(21)	7.81	7.00	9.00	7.78	5.53	4.68 (4,603)
Air-dried loss	(21)	1.61	0.70	3.08	1.48	1.83	1.13 (3,868)

Table 15f.--Arithmetic mean, observed range, and geometric mean of ash content and concentrations of 11 major- and minor-oxides in the laboratory ash of 21 bituminous coal samples from the Splash Dam coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. (n) indicates the number of samples per oxide.

[All samples were ashed at 525°C; all data are in percent.]

	Splash Dam coal bed				Appalachian basin			
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	
			Min.	Max.			(n)	
(Ash)	(21)	9.1	4.5	26	8.1	13	10	(5,262)
SiO ₂	(21)	49	16	71	48	43	41	(5,229)
Al ₂ O ₃	(21)	28	17	38	28	24	23	(5,229)
CaO	(21)	1.3	.55	2.8	1.1	2.2	1.5	(5,227)
MgO	(21)	.84	.27	1.6	.77	.85	.75	(5,258)
Na ₂ O	(21)	.81	.28	1.2	.74	.43	.34	(5,194)
K ₂ O	(21)	2.2	.50	4.2	1.9	2.0	1.7	(5,229)
Fe ₂ O ₃	(21)	8.8	2.7	26	7.1	19	13	(5,215)
MnO	(21)	.02	.004	.05	.01	.03	.02	(5,260)
TiO ₂	(21)	1.7	.65	2.7	1.6	1.2	1.1	(5,203)
P ₂ O ₅	(11)	.23	.05	.51	.18	.50	.22	(3,389)
SO ₃	(13)	1.7	.50	4.2	1.4	2.5	1.9	(5,063)

Table 15g.--Arithmetic mean, observed range, and geometric mean of concentrations of 54 trace elements in 21 bituminous coal samples from the Splash Dam coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. Dashed values (---) represent less than five samples; (n) indicates the number of samples per element. [All data are in parts-per-million and are reported on a whole-coal basis.]

	Splash Dam coal bed				Appalachian basin		
(n)	Arith. mean	Observed range		Geom. mean	Arith. mean	Geom. mean	(n)
		Min.	Max.				
Ag (20)	0.04	0.010	0.08	0.03	0.07	0.05	(4,565)
As (21)	9.3	1.0	79	4.8	35	13	(5,197)
B (21)	14	3.6	37	12	30	20	(5,076)
Ba (21)	100	31	340	82	90	63	(5,134)
Be (21)	1.9	.69	6.8	1.6	2.5	2.0	(5,247)
Bi ---	---	---	---	---	1.5	1.1	(108)
Br (21)	16	2.1	28	14	22	13	(4,892)
Cd (21)	.04	.017	.11	.03	.10	.07	(4,978)
Ce (21)	19	8.0	37	18	21	17	(5,075)
Cl (14)	1,200	500	1,500	1,100	780	510	(3,646)
Co (21)	5.9	2.2	14	5.3	7.4	5.7	(5,217)
Cr (21)	14	7.5	28	13	18	15	(5,205)
Cs (21)	.84	.10	2.9	.54	1.3	.85	(4,831)
Cu (21)	13	7.7	22	12	19	15	(5,239)
Dy (8)	2.6	1.2	3.6	2.5	3.3	2.6	(759)
Er (7)	1.5	.74	2.0	1.4	1.5	1.2	(1,200)
Eu (21)	.40	.22	1.0	.37	.44	.37	(5,032)
F (21)	91	10	260	74	99	71	(4,860)
Ga (21)	4.9	2.1	11	4.4	6.6	5.4	(5,046)
Gd (11)	2.7	.53	5.5	2.1	2.6	1.9	(1,773)
Ge (18)	1.5	.25	9.1	.91	4.7	2.5	(4,608)
Hf (21)	.74	.30	1.7	.67	.79	.62	(4,932)
Hg (20)	.19	.035	.41	.14	.22	.15	(5,031)
Ho (6)	.60	.30	.77	.57	.76	.61	(378)
La (21)	11	4.0	23	10	11	8.9	(5,147)
Li (21)	16	3.7	53	11	22	14	(5,243)
Lu (21)	.14	.070	.28	.13	.16	.14	(4,885)
Mn (21)	13	1.9	84	7.2	31	15	(5,260)
Mo (21)	1.4	.41	4.1	1.2	3.7	2.3	(4,889)
Nb (21)	2.5	.48	5.2	2.2	2.6	1.9	(5,005)
Nd (17)	12	7.7	20	11	13	9.9	(4,231)
Ni (21)	12	3.6	24	10	17	14	(5,240)
Pb (21)	5.2	2.3	9.7	4.8	8.8	6.2	(5,172)
Pd ---	---	---	---	---	.17	.14	(18)
Pr (5)	5.5	1.1	7.8	4.6	6.1	3.6	(960)
Rb (7)	27	10	74	22	28	22	(2,232)
Sb (21)	1.0	.20	4.4	.70	1.4	.91	(5,003)
Sc (21)	3.3	1.8	6.7	3.2	4.4	3.6	(5,218)
Se (21)	2.7	.90	4.8	2.5	3.6	2.8	(5,052)
Sm (21)	1.6	.93	4.1	1.5	2.0	1.6	(5,005)
Sn (16)	.70	.25	1.3	.60	1.6	.86	(2,352)
Sr (21)	120	24	310	110	110	79	(5,146)
Ta (20)	.27	.080	.50	.24	.24	.19	(4,369)
Tb (21)	.32	.17	.74	.30	.34	.29	(4,852)
Th (21)	2.8	1.1	5.6	2.6	3.0	2.3	(5,098)
Tl (1)	---	.77	.77	---	3.4	2.1	(382)
Tm ---	---	---	---	---	1.7	.38	(46)
U (21)	1.3	.59	2.7	1.2	1.8	1.3	(4,990)
V (21)	16	7.7	37	15	24	19	(5,241)
W (21)	.75	.30	1.8	.70	.94	.80	(4,421)
Y (21)	6.4	1.5	13	5.8	8.5	7.2	(5,234)
Yb (21)	1.0	.60	2.4	.96	1.1	.92	(5,151)
Zn (21)	6.8	1.9	26	5.5	22	14	(5,243)
Zr (21)	16	3.0	41	14	24	17	(5,238)

HAGY COAL BED

The Hagy coal bed crops out in Buchanan, Dickenson, and Wise Counties. In Buchanan County it is locally known as the Lower War Eagle, Edwards, or the Splash Dam coal bed. In 1989, 0.6 million tons were produced, all from Buchanan County (Virginia Division of Mines, 1990). The range of thicknesses at sample sites is from 1.9 to 3.6 feet. This coal normally has a shale roof but at one sample location the roof is sandstone. There is at least one bony coal parting. The Hagy is typified by a moderately-developed medium cleat with abundant thin banding.

In the 10 Hagy coal samples (Figure 23), Bi, Ho, Pd, Tl, and Tm are found to below the detection limits in addition to the eight elements found to be below the detection limits for all 375 Virginia samples. There were four or less unqualified values for Dy, Er, Pr, and Rb therefore geometric means were not reported for these. When comparing the geometric means of the Hagy coal samples with the geometric means of the Appalachian basin coal samples, As, Ba, and sulfate are substantially higher for the Hagy. The geometric means for CaO, B, and Mo of the Hagy coal samples are substantially lower. Table 16a describes the samples and provides location information about the samples. The analytical results are found in Tables 16b, 16c, and 16d. Tables 16e, 16f, and 16g contain statistical summaries for these samples.

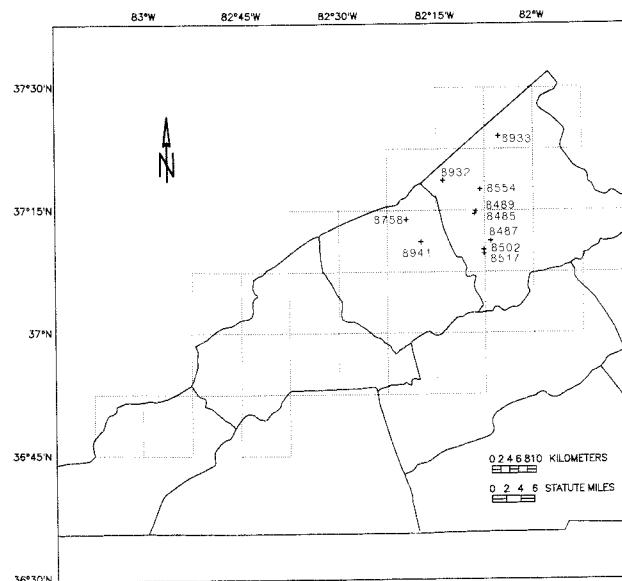


Figure 23. Locations for samples from the Hagy coal bed.

Table 16a.--Descriptions and locations for 10 bituminous coal samples from the Hagy coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-8485	W214771	88B-10	371435N	820905W	Prater (7.5')	Buchanan	39.00	Underground mine, sl. weathered	Full Thickness
R-8487	W214768	88A-12	371118N	820634W	Vansant (7.5')	Buchanan	37.20	Underground mine, sl. weathered	Full Thickness
R-8489	W215413	88B-11	371455N	820850W	Prater (7.5')	Buchanan	22.80	Underground mine, sl. weathered	Full Thickness
R-8502	W215447	88B-12	371014N	820739W	Prater (7.5')	Buchanan	27.60	Underground mine, sl. weathered	Full Thickness
R-8517	W215875	88B-13	370945N	820737W	Prater (7.5')	Buchanan	42.60	Underground mine, sl. weathered	Full Thickness
R-8554	W217593	118C-9	371732N	820809W	Harman (7.5')	Buchanan	31.20	Underground mine	Partial Seam
R-8758	W236240	89A-8	371355N	821932W	Haysi (7.5')	Dickenson	22.20	Surface mine	Full Thickness
R-8932	W246911	118C-23	371837N	821356W	Harman (7.5')	Buchanan	33.60	Underground mine	Full Thickness
R-8933	W246907	118A-2	372401N	820519W	Hurley (7.5')	Buchanan	28.80	Underground mine	Full Thickness
R-8941	W240452	89A-13	371112N	821721W	Haysi (7.5')	Dickenson	19.20	Surface mine, sl. weathered	Full Thickness

Table 16b. --Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 10 bituminous' coal samples from the Hagy coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa. and a commercial testing laboratory following ASTM standards. G for ash-fusion temperatures means greater than value shown. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT		
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	Lab Number
R-8485	2.8	27.3	60.1	9.8	4.9	75.5	1.4	6.4	2.1	7,470	13,450	W214771
	---	28.1	61.9	10.0	4.7	77.7	1.5	3.9	2.1	7,690	13,840	
	---	31.2	68.8	---	5.2	86.4	1.6	4.4	2.4	8,550	15,390	
R-8487	2.9	24.1	62.6	10.5	4.8	76.3	1.4	5.6	1.4	7,460	13,430	W214768
	---	24.8	64.4	10.8	4.6	78.6	1.4	3.2	1.4	7,680	13,830	
	---	27.8	72.2	---	5.2	88.1	1.6	3.6	1.6	8,610	15,500	
R-8489	1.6	27.0	65.7	5.7	4.8	80.9	1.5	6.0	1.2	7,880	14,180	W215413
	---	27.5	66.8	5.8	4.7	82.2	1.5	4.6	1.2	8,010	14,410	
	---	29.1	70.9	---	5.0	87.2	1.6	4.9	1.3	8,500	15,290	
R-8502	1.3	25.0	59.9	13.8	4.5	74.6	1.4	2.7	2.9	7,440	13,390	W215447
	---	25.3	60.7	14.0	4.5	75.6	1.4	1.6	3.0	7,540	13,570	
	---	29.4	70.6	---	5.2	87.9	1.7	1.8	3.5	8,760	15,780	
R-8517	2.6	25.9	64.3	7.2	5.0	80.0	1.5	5.4	.9	7,810	14,070	W215875
	---	26.6	66.0	7.4	4.8	82.2	1.5	3.2	.9	8,020	14,440	
	---	28.7	71.3	---	5.2	88.7	1.6	3.4	1.0	8,670	15,600	
R-8554	1.4	29.4	58.3	10.9	4.8	76.2	1.5	5.0	1.6	7,490	13,480	W217593
	---	29.8	59.2	11.1	4.8	77.3	1.5	3.8	1.6	7,590	13,670	
	---	33.5	66.5	---	5.4	86.9	1.7	4.2	1.8	8,540	15,370	
R-8758	1.6	31.7	54.9	11.8	4.9	73.0	1.4	5.3	3.6	7,320	13,180	W236240
	---	32.2	55.8	12.0	4.8	74.2	1.4	3.9	3.7	7,450	13,400	
	---	36.6	63.4	---	5.5	84.3	1.6	4.4	4.2	8,460	15,230	
R-8932	1.8	28.7	59.6	9.8	4.9	76.8	1.5	6.1	.8	7,520	13,540	W246911
	---	29.2	60.7	10.0	4.8	78.2	1.5	4.6	.8	7,660	13,790	
	---	32.5	67.5	---	5.3	86.9	1.7	5.1	.9	8,520	15,330	
R-8933	2.1	31.3	56.5	10.1	5.1	75.3	1.4	6.7	1.4	7,470	13,440	W246907
	---	31.9	57.7	10.3	4.9	76.9	1.4	4.9	1.5	7,630	13,730	
	---	35.6	64.4	---	5.5	85.8	1.6	5.5	1.6	8,510	15,310	

Table 16b.--Approximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 10 bituminous coal samples from the Hagy coal bed, Southwest Virginia. --continued

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Sample Number	FORMS OF SULFUR					ASH-FUSION TEMPERATURE (°C)				Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid				
R-8485	1.8 --- ---	0.22 .23 .25	1.13 1.16 1.29	0.71 .73 .81	6.5	1,210	1,350	1,425	----	3.12	W214771	
R-8487	1.9 --- ---	.14 .14 .16	.60 .62 .69	.65 .67 .75	8.0	1,355	1,430	1,495	----	2.08	W214768	
R-8489	.3 --- ---	.05 .05 .05	.23 .23 .25	.92 .94 .99	6.0	1,450	1,490	1,530	----	1.69	W215413	
R-8502	.6 --- ---	.08 .08 .09	2.07 2.10 2.44	.79 .80 .93	6.0	1,210	1,295	1,355	----	4.33	W215447	
R-8517	1.8 --- ---	.11 .11 .12	.21 .22 .23	.60 .62 .67	7.5	1,370	1,450	1,480	----	1.28	W215875	
R-8554	.5 --- ---	.11 .11 .13	.58 .59 .66	.88 .89 1.00	6.0	1,315	1,440	1,500	----	2.37	W217593	
R-8758	.8 --- ---	.07 .07 .08	2.80 2.85 3.24	.73 .74 .84	9.0	1,125	1,180	1,305	62	5.46	W236240	
R-8932	1.0 --- ---	.10 .10 .11	.06 .06 .07	.62 .63 .70	7.0	1,500	1,540	1,540G	63	1.18	W246911	
R-8933	1.0 --- ---	.21 .21 .24	.59 .60 .67	.63 .64 .72	7.0	1,345	1,440	1,540	59	2.08	W246907	

Table 16b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 10 bituminous coal samples from the Hagy coal bed, Southwest Virginia.--continued

Sample Number	PROXIMATE ANALYSIS					ULTIMATE ANALYSIS					HEAT CONTENT	
	Moisture	Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	Lab Number
R-8941	2.6	30.3	58.1	9.0	5.0	76.9	1.4	6.5	1.2	7,570	13,630	W240452
	---	31.1	59.7	9.2	4.9	79.0	1.4	4.2	1.3	7,780	14,000	
	---	34.3	65.7	---	5.4	87.0	1.5	4.7	1.4	8,570	15,420	

Sample Number	FORMS OF SULFUR					ASH-FUSION TEMPERATURE (°C)					Compliance Number	
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid	Hardgrove grindability index	Lab Number		
R-8941	2.1	0.09	0.58	0.57	7.5	1,460	1,495	1,540	76	1.76	W240452	
	---	.09	.60	.59								
	---	.10	.66	.64								

Table 16c.--Major- and minor-oxide concentrations in the laboratory ash of 10 bituminous coal samples from the Hagy coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. L means less than the concentration shown; B not determined. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-8685	12.1	49	26	0.70	0.91	0.57	3.2	14	1.3	0.083L	1.2	W214771
R-8687	20.4	51	25	.41	1.3	.31	3.7	11	1.2	.049L	.95	W214768
R-8689	6.1	47	28	2.1	.60	.32	.72	15	2.0	.16	2.5	W215413
R-8502	14.5	47	28	.92	.55	.24	2.4	24	1.5	.12	1.4	W215447
R-8517	7.0	48	28	1.1	.76	.59	1.7	13	2.0	.29	1.9	W215875
R-8554	14.4	52	27	.48	.93	.51	3.6	8.0	1.3	.069	B	W217593
R-8758	14.1	40	20	.59	.78	.34	2.4	32	.77	.078	1.2	W236240
R-8932	10.0	52	28	.52	.96	.54	3.0	4.3	1.7	.10L	2.0	W246911
R-8933	10.2	49	26	.55	.85	.42	2.4	13	1.2	.12	1.7	W246907
R-8941	9.5	50	29	.83	.80	.53	1.3	13	1.3	.11L	1.4	W240452

Table 16d.--Major-, minor-, and trace-element composition of 10 bituminous coal samples from the Hagy coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means less than the value shown; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDNR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-8485	2.8	1.7	0.061	0.067	0.051	0.32	1.2	0.096	0.045	.55	W214771
R-8487	4.9	2.7	.059	.16	.047	.63	1.6	.15	.031	.60	W214768
R-8489	1.3	.90	.092	.022	.015	.037	.65	.073	.012	.13	W215413
R-8502	3.2	1.6	.096	.048	.026	.29	2.4	.13	.039	.50	W215447
R-8517	1.6	1.0	.057	.032	.031	.099	.64	.085	.034	.20	W215875
R-8554	3.5	2.1	.049	.081	.055	.44	.80	.11	.036	.12	W217593
R-8758	2.6	1.5	.059	.066	.035	.28	3.2	.065	.048	.330	W236240
R-8932	2.4	1.5	.037	.058	.040	.25	.30	.099	.001L	4.2	W246911
R-8933	2.3	1.4	.040	.052	.032	.20	.91	.074	.045	.59	W246907
R-8941	2.2	1.4	.056	.046	.039	.10	.85	.073	.11	3.5	W240452

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-8485	9.1	79	1.9	15	0.017	19	720	2.3	15	1.3	W214771
R-8487	14	140	1.9	10	.078	25	480	4.4	20	2.5	W214768
R-8489	5.1	79	2.0	15	.024	13	800	1.2	8.3	.10	W215413
R-8502	4.4	78	1.9	9.9	.062	24	570	4.2	16	1.1	W215447
R-8517	6.2	70	.77	6.6	.022	14	300	4.5	12	.50	W215875
R-8554	14	120	2.2	14	.052	30	900	4.3	23	2.9	W217593
R-8758	8.7	65	2.0	19	.056	19	1,300	6.5	12	1.9	W236240
R-8932	7.8	77	2.2	14	.077	17	820	5.2	15	.84	W246911
R-8933	7.0	280	2.2	24	.054	14	1,100	7.0	11	1.3	W246907
R-8941	10	100	2.0	14	.061	21	810	7.1	15	.35	W240452

Table 16d.--Major-, minor-, and trace-element composition of 10 bituminous coal samples from the Hagy coal bed, Southwest Virginia, reported on a whole-coal basis.

Sample Number	Cu (ppm)	Dy-S (ppm)	Er-S (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	Lab Number
R-8485	16	3.6	1.2L	0.41	170	5.2	1.8L	4.8	0.70	0.10	W214771
R-8487	20	4.5L	2.0L	.42	120	7.8	3.1L	.80	.29	.13	W214768
R-8489	8.5	1.3L	.61L	.22	30	2.6	.92L	.73	.50	.13	W215413
R-8502	16	3.2L	1.5L	.46	100	3.9	2.2L	1.1	1.0	.13	W215447
R-8517	12	1.5L	.70L	.26	70	2.5	1.1L	.16	.50	.085	W215875
R-8554	10	3.2L	1.7	.53	210	7.9	12	1.1	1.1	.080	W217593
R-8758	25	3.1L	.65L	.40	20L	2.3	4.5L	.90	.53	.16	W236240
R-8932	18	1.0L	.46L	.35	50	5.6	2.2L	2.4	.74	.005L	W246911
R-8933	18	1.3L	.47L	.32	50	5.7	2.2L	2.8	.56	.060	W246907
R-8941	27	.95L	.44L	.38	470	5.8	2.1L	4.9	.76	.010	W240452

Sample Number	La (ppm)	Li (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Lab Number
R-8485	11	16	0.14	12	0.59	2.4	6.2	5.6	44L	8.3	W214771
R-8487	15	24	.14	27	.98	3.3	12	12	44L	12	W214768
R-8489	7.0	12	.07	14	.34	2.4	2.9	3.2	44	2.8	W215413
R-8502	12	26	.14	26	1.3	4.1	6.8	7.5	74	5.2	W215447
R-8517	8.0	7.7	.08	9.1	1.3	2.4	7.7	7.7	87	6.1	W215875
R-8554	15	19	.12	20	.45	3.0	14	11	44	4.5	W217593
R-8758	9.4	16	.08	12	3.8	2.7	9.9	14	48	9.2	W236240
R-8932	11	20	.10	120	.83	2.3	9.2	11	44L	6.8	W246911
R-8933	8.3	12	.10	6.3	1.3	.90	6.6	12	52	3.0	W246907
R-8941	12	24	.09	11	1.7	5.2	14	22	44L	5.1	W240452

Table 16d.--Major-, minor-, and trace-element composition of 10 bituminous coal samples from the Hagy coal bed, Southwest Virginia, reported on a whole-coal basis.

Sample Number	Pr-S (ppm)	Rb (ppm)	Sb (ppm)	Sc (ppm)	Se (ppm)	Sm (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Lab Number
R-8485	8.2L	13	1.7	4.1	3.0	1.7	0.18	.79	0.28	.34 W214771
R-8487	14L	35	.90	5.1	2.6	2.2	.31L	.94	.35	.33 W214768
R-8489	4.1L	20L	.30	2.1	3.6	1.0	.09L	100	.21	.18 W215413
R-8502	9.9L	15	.70	3.9	3.2	1.7	.22L	93	.39	.32 W215447
R-8517	4.8L	30L	.30	2.2	3.3	1.1	.20	91	.20	.34 W215875
R-8554	13	31	.50	5.2	2.6	2.0	1.1	120	.41	.43 W217593
R-8758	14L	60L	1.6	3.4	3.3	2.0	1.4	56	.20	.26 W236240
R-8932	.68	25L	.93	3.8	3.2	1.9	1.3	75	.29	.21 W246911
R-8933	.69L	24L	2.1	3.0	2.7	1.7	1.1	80	.21	.19 W246907
R-8941	1.5	16L	.32	3.5	3.5	2.0	1.7	90	.29	.25 W240452

Sample Number	Th (ppm)	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)	Lab Number
R-8485	2.8	1.0	21	0.90	5.1	1.0	7.9	19	W214771
R-8487	3.9	1.6	33	1.0	6.3	1.2	15	20	W214768
R-8489	1.8	.39L	10	.50	3.0	.50	4.3	16	W215413
R-8502	3.7	.77	16	.60	6.2	1.1	15	26	W215447
R-8517	2.2	.96	12	.50	3.8	.60	5.9	14	W215875
R-8554	4.2	1.2	26	.80	7.9	1.2	7.6	17	W217593
R-8758	2.2	1.9	18	.94	7.6	.72	13	20	W236240
R-8932	3.1	1.6	15	.80	5.4	.90	16	14	W246911
R-8933	1.8	1.4	14	.63	3.5	.76	6.1	8.4	W246907
R-8941	3.0	1.3	20	.78	9.5	.73	28	37	W240452

Table 16e.--Arithmetic mean, observed range and geometric mean of proximate and ultimate analyses, heat content, forms of sulfur, and ash-fusion temperatures for 10 bituminous coal samples from the Hagy coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included.

[All values are in percent except Btu/lb, Kcal/kg, ash-fusion temperatures, and free-swelling index and are reported on an as-received basis. $^{\circ}\text{F} = 9/5 \, ^{\circ}\text{C} + 32$; Kcal/kg = 0.556 Btu/lb; (n) is number of samples per parameter.]

	Hagy coal bed				Appalachian basin		
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean
			Min.	Max.			(n)
Proximate and ultimate analyses							
Moisture	(10)	2.08	1.33	2.87	2.00	3.23	2.69 (4,760)
Volatile matter	(10)	28.05	24.06	31.66	27.94	32.46	31.72 (4,760)
Fixed carbon	(10)	60.01	54.88	65.70	59.92	52.48	51.76 (4,760)
Ash	(10)	9.86	5.66	13.78	9.60	11.83	9.83 (4,760)
Hydrogen	(10)	4.88	4.55	5.06	4.88	5.02	5.00 (4,760)
Carbon	(10)	76.55	72.98	80.89	76.52	70.69	70.17 (4,760)
Nitrogen	(10)	1.44	1.37	1.52	1.44	1.39	1.37 (4,757)
Oxygen	(10)	5.56	2.72	6.66	5.42	8.92	8.22 (4,756)
Sulfur	(10)	1.71	.78	3.60	1.54	2.15	1.63 (4,974)
Heat content							
KCal/kg	(10)	7,550	7,330	7,884	7,548	7,030	6,979 (4,759)
Btu/lb	(10)	13,579	13,183	14,180	13,576	12,644	12,553 (4,759)
Forms of sulfur							
Sulfate	(10)	0.12	0.05	0.22	0.11	0.08	0.04 (4,245)
Pyritic	(10)	.88	.06	2.80	.54	1.36	.65 (4,392)
Organic	(10)	.71	.57	.92	.70	.82	.70 (4,393)
Ash-fusion temperature ($^{\circ}\text{C}$)							
Initial deformation	(10)	1,334	1,127	1,499	1,329	1,255	1,246 (4,063)
Softening	(9)	1,396	1,182	1,493	1,392	1,287	1,280 (3,722)
Fluid	(7)	1,442	1,304	1,532	1,440	1,334	1,328 (3,449)
Free-swelling index	(10)	7.05	6.00	9.00	6.99	5.53	4.68 (4,603)
Air-dried loss	(10)	1.18	0.25	2.11	0.98	1.83	1.13 (3,868)

Table 16f.--Arithmetic mean, observed range, and geometric mean of ash content and concentrations of 11 major- and minor-oxides in the laboratory ash of 10 bituminous coal samples from the Hagy coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. (n) indicates the number of samples per oxide.

[All samples were ashed at 525°C; all data are in percent.]

	Hagy coal bed				Appalachian basin			
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
			Min.	Max.				
(Ash)	(10)	12	6.1	20	11	13	10	(5,262)
SiO ₂	(10)	49	40	52	48	43	41	(5,229)
Al ₂ O ₃	(10)	26	20	28	26	24	23	(5,229)
CaO	(10)	.82	.41	2.1	.73	2.2	1.5	(5,227)
MgO	(10)	.84	.55	1.3	.82	.85	.75	(5,258)
Na ₂ O	(10)	.44	.24	.59	.42	.43	.34	(5,194)
K ₂ O	(10)	2.4	.72	3.7	2.2	2.0	1.7	(5,229)
Fe ₂ O ₃	(10)	15	4.3	32	13	19	13	(5,215)
MnO	(10)	.03	.008	.15	.02	.03	.02	(5,260)
TiO ₂	(10)	1.4	.77	2.0	1.4	1.2	1.1	(5,203)
P ₂ O ₅	(6)	.14	.069	.29	.12	.50	.22	(3,389)
SO ₃	(9)	1.6	.95	2.5	1.5	2.5	1.9	(5,063)

Table 16g.--Arithmetic mean, observed range, and geometric mean of concentrations of 54 trace elements in 10 bituminous coal samples from the Hagy coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. Dashed values (---) represent less than five samples; (n) indicates the number of samples per element. [All data are in parts-per-million and are reported on a whole-coal basis.]

	Hagy coal bed				Appalachian basin		
	(n)	Arith. mean	<u>Observed range</u>		Arith. mean	Geom. mean	(n)
			Min.	Max.			
Ag {9}		0.04	0.012	0.11	0.04	0.07	0.05 {4,565}
As {10}		60	3.5	330	26	35	13 {5,197}
B {10}		8.7	4.4	14	8.1	30	20 {5,076}
Ba {10}		110	65	280	98	90	63 {5,134}
Be {10}		1.9	.77	2.2	1.8	2.5	2.0 {5,247}
Bi ---		---	---	---	---	1.5	1.1 {108}
Br {10}		14	6.6	24	13	22	13 {4,892}
Cd {10}		.05	.017	.08	.04	.10	.07 {4,978}
Ce {10}		20	13	30	19	21	17 {5,075}
Cl {14}		780	300	1,300	720	780	510 {3,646}
Co {10}		4.7	1.2	7.1	4.2	7.4	5.7 {5,217}
Cr {10}		15	8.3	23	14	18	15 {5,205}
Cs {10}		1.3	.10	2.9	.91	1.3	.85 {4,831}
Cu {10}		17	8.5	27	16	19	15 {5,239}
Dy {1}		---	3.6	3.6	---	3.3	2.6 {759}
Er {1}		---	1.7	1.7	---	1.5	1.2 {1,200}
Eu {10}		.38	.22	.53	.36	.44	.37 {5,032}
F {9}		140	30	470	100	99	71 {4,860}
Ga {10}		4.9	2.3	7.9	4.5	6.6	5.4 {5,046}
Gd {1}		---	12	12	---	2.6	1.9 {1,773}
Ge {10}		2.2	.16	4.9	1.5	4.7	2.5 {4,608}
Hf {10}		.72	.50	1.1	.69	.79	.62 {4,932}
Hg {9}		.12	.010	.29	.09	.22	.15 {5,031}
Ho ---		---	---	---	---	.76	.61 {378}
La {10}		11	7.0	15	11	11	8.9 {5,147}
Li {10}		18	7.7	26	17	22	14 {5,243}
Lu {10}		.11	.070	.14	.10	.16	.14 {4,885}
Mn {10}		26	6.3	120	17.2	31	15 {5,260}
Mo {10}		1.3	.34	3.8	1.0	3.7	2.3 {4,889}
Nb {10}		2.9	.90	5.2	2.6	2.6	1.9 {5,005}
Nd {10}		8.9	2.9	14	8.2	13	9.9 {4,231}
Ni {10}		11	3.2	22	9.4	17	14 {5,240}
Pb {10}		6.3	2.8	12	5.7	8.8	6.2 {5,172}
Pd ---		---	---	---	---	.17	.14 {18}
Pr {3}		---	.68	13	---	6.1	3.6 {960}
Rb {4}		---	13	35	---	28	22 {2,232}
Sb {10}		.94	.30	2.1	.74	1.4	.91 {5,003}
Sc {10}		3.6	2.1	5.2	3.5	4.4	3.6 {5,218}
Se {10}		3.1	2.6	3.6	3.1	3.6	2.8 {5,052}
Sm {10}		1.7	1.0	2.2	1.7	2.0	1.6 {5,005}
Sn {7}		1.0	.18	1.7	.76	1.6	.86 {2,352}
Sr {10}		88	56	120	87	110	79 {5,146}
Ta {10}		.28	.20	.41	.27	.24	.19 {4,369}
Tb {10}		.29	.18	.43	.28	.34	.29 {4,852}
Th {10}		2.9	1.8	4.2	2.8	3.0	2.3 {5,098}
Tl ---		---	---	---	---	3.4	2.1 {382}
Tm ---		---	---	---	---	1.7	.38 {46}
U {9}		1.3	.77	1.9	1.3	1.8	1.3 {4,990}
V {10}		18	10	33	17	24	19 {5,241}
W {10}		.74	.50	1.0	.72	.94	.80 {4,421}
Y {10}		5.8	3.0	9.5	5.5	8.5	7.2 {5,234}
Yb {10}		.87	.50	1.2	.84	1.1	.92 {5,151}
Zn {10}		12	4.3	28	10	22	14 {5,243}
Zr {10}		19	8.4	37	18	24	17 {5,238}

NORTON COAL BED

This coal crops out in Dickenson and Wise Counties and all production is from these two counties. The top of the Norton coal bed marks the top of the Norton Formation. Local names for the Norton include the Middle Norton, Yellow Creek, Dorchester, Lyons, Hagy, Glamorgan, or Gladeville coal bed. Sampled thickness ranges from 1.7 to 3.2 feet and roof rock at sampled sites is shale and sandstone. There are usually two bone coal partings and traces of pyrite. The coal has a moderate- or well-developed medium cleat with moderate amounts of medium banding.

Twelve elements, Bi, Ho, Pd, and Tm in addition to the eight elements below the detection limits for all the Virginia coal samples, are found to be below the detection limits in the 15 samples analyzed from the Norton coal bed (Figure 24 and Table 17a have the descriptive and location data and Tables 17b, 17c, and 17d for the analytical results). Dy, Pr, and Tl do not have calculated geometric means due to an insufficient number of samples. The geometric means for MnO, B, Br, Ge, Mn, Tl, Zn, sulfate, and pyritic sulfur of the Norton coal samples are substantially lower than for the Appalachian basin coal samples. The geometric means are substantially higher for P₂O₅, Pr and the free-swelling index in the Norton coal samples than for the Appalachian basin samples. The statistical summaries are found in Tables 17e, 17f, and 17g.

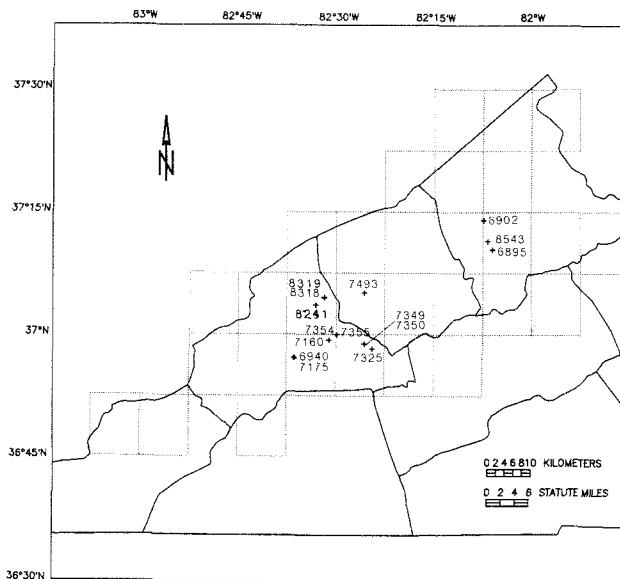


Figure 24. Locations for samples from the Norton coal bed.

Table 17a.-Descriptions and locations for 15 bituminous coal samples from the Norton coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-6895	W194301	88A-3	371025N	820557W	Vansant (7.5')	Buchanan	11.28	Surface mine, sl. weathered	Full Thickness
R-6902	W194292	88A-7	371401N	820720W	Vansant (7.5')	Buchanan	33.60	Surface mine, weathered	Full Thickness
R-6940	W196289	60A-24	365710N	823618W	Wise (7.5')	Wise	29.64	Surface mine, sl. weathered	Full Thickness
R-7160	W199466	60A-25	365919N	823104W	Wise (7.5')	Wise	17.64	Surface mine	Lower Split
R-7175	W200484	60A-28	365707N	823612W	Wise (7.5')	Wise	25.20	Surface mine	Full Thickness
R-7325	W202129	59B-6	365816N	822624W	Coeburn (7.5')	Wise	20.40	Surface mine, sl. weathered	Full Thickness
R-7349	W203388	59B-7	365853N	822541W	Coeburn (7.5')	Wise	18.72	Surface mine	Bench Sample
R-7350	W203391	59B-8	365853N	822541W	Coeburn (7.5')	Wise	5.40	Surface mine	Bench Sample
R-7354	W204157	59B-9	365959N	822951W	Coeburn (7.5')	Wise	23.40	Surface mine	Full Thickness
R-7355	W204158	59B-10	365959N	822951W	Coeburn (7.5')	Wise	23.40	Surface mine	Full Thickness
R-7493	W206889	89C-9	370506N	822538W	Caney Ridge (7.5')	Dickenson	24.60	Surface mine, sl. weathered	Full Thickness
R-8241	W212492	90D-17	370333N	822305W	Pound (7.5')	Wise	26.40	Underground mine, sl. weathered	Full Thickness
R-8318	W213994	90D-20	370427N	823146W	Pound (7.5')	Wise	29.40	Underground mine, sl. weathered	Full Thickness
R-8319	W213995	90D-21	370431N	823147W	Pound (7.5')	Wise	29.40	Underground mine, sl. weathered	Full Thickness
R-8543	W217398	88A-18	371126N	820642W	Vansant (7.5')	Buchanan	37.20	Surface mine, weathered	Full Thickness

Table 17b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 15 bituminous coal samples from the Norton coal bed, Southwest Virginia.

All analyses except heat contents, free-swelling indexes, ash-fusion temperatures, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. G for ash-fusion temperatures means greater than value shown. Sample number is VDMR identification number. Lab number following is USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT		
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	Lab Number
R-6895	1.7	25.1	56.2	17.0	4.6	71.4	1.3	4.7	1.0	7,050	12,690	W194301
	--	25.5	57.2	17.3	4.5	72.6	1.3	3.2	1.0	7,170	12,910	
	--	30.9	69.1	---	5.4	87.8	1.6	3.9	1.2	8,670	15,610	
R-6902	2.3	25.8	55.8	16.1	4.7	71.4	1.4	5.5	1.0	7,060	12,710	W194292
	--	26.4	57.1	16.5	4.5	73.1	1.4	3.5	1.0	7,230	13,010	
	--	31.6	68.4	---	5.4	87.5	1.7	4.2	1.2	8,650	15,580	
R-6940	2.4	34.2	58.5	4.9	5.5	80.0	1.7	7.3	.7	7,970	14,350	W196289
	--	35.0	59.9	5.0	5.4	82.0	1.7	5.3	.7	8,170	14,700	
	--	36.9	63.1	---	5.6	86.3	1.8	5.6	.8	8,600	15,480	
R-7160	2.8	31.6	63.4	2.2	5.5	82.4	1.5	7.0	1.3	8,140	14,650	W199466
	--	32.5	65.2	2.3	5.3	84.8	1.5	4.6	1.3	8,370	15,070	
	--	33.3	66.7	---	5.5	86.7	1.6	4.7	1.4	8,560	15,420	
R-7175	4.0	32.1	58.5	5.4	5.5	77.6	1.6	9.0	.8	7,680	13,820	W200484
	--	33.4	60.9	5.6	5.3	80.8	1.7	5.7	.8	8,000	14,400	
	--	35.4	64.6	---	5.6	85.7	1.8	6.0	.9	8,470	15,250	
R-7325	3.9	34.4	55.4	6.3	5.4	77.2	1.4	8.8	.9	7,630	13,730	W202129
	--	35.8	57.6	6.6	5.2	80.3	1.5	5.5	.9	7,940	14,290	
	--	38.3	61.7	---	5.5	86.0	1.6	5.9	1.0	8,500	15,290	
R-7349	3.5	31.4	50.1	15.0	5.2	69.6	1.5	7.8	1.1	6,890	12,390	W203388
	--	32.5	51.9	15.5	5.0	72.1	1.6	4.9	1.1	7,130	12,840	
	--	38.5	61.5	---	5.9	85.4	1.8	5.8	1.3	8,450	15,210	
R-7350	2.6	33.0	51.8	12.6	5.1	73.0	1.4	7.0	.8	7,240	13,030	W203391
	--	33.9	53.2	12.9	4.9	74.9	1.4	4.8	.8	7,430	13,380	
	--	38.9	61.1	---	5.7	86.1	1.7	5.5	.9	8,540	15,370	
R-7354	2.7	31.3	61.3	4.7	5.3	80.2	1.6	7.4	.8	7,940	14,280	W204157
	--	32.2	63.0	4.8	5.1	82.4	1.6	5.1	.8	8,160	14,680	
	--	33.8	66.2	---	5.4	86.6	1.7	5.4	.9	8,570	15,430	

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Table 17b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 15 bituminous coal samples from the Norton coal bed, Southwest Virginia.--continued

Sample Number	Air-dried Loss	FORMS OF SULFUR			ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number
		Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening			
R-6895	1.0 --- --- ---	0.02 .02 .02 .01	0.49 .50 .60 .38	0.50 .51 .62 .59	8.0 8.5 8.5 9.0	1,540 1,540 1,540 1,395	1,540G 1,540G 1,540G 1,455	1,540G 1,540G 1,540G 1,515	---	1.58 W194301
R-6902	1.4 --- --- ---	.01 .01 .01 .00	.38 .39 .47 .05	.58 .59 .71 .60	8.5 8.5 8.5 9.0	1,540 1,540 1,540 1,080	1,540G 1,540G 1,540G 1,110	1,540G 1,540G 1,540G 1,175	---	1.57 W194292
R-6940	1.1 --- --- ---	.00 .00 .00 .03	.05 .05 .05 .41	.60 .61 .65 .84	8.0 8.0 8.0 8.0	1,395 1,395 1,395 1,440	1,395 1,395 1,395 1,600	1,395 1,395 1,395 1,600G	---	.98 W196289
R-7160	1.0 --- --- ---	.03 .03 .03 .04	.42 .42 .43 .07	.86 .86 .88 .67	8.0 8.0 8.0 8.0	1,080 1,080 1,080 1,440	1,080 1,080 1,080 1,110	1,080 1,080 1,080 1,175	---	1.77 W199466
R-7175	2.4 --- --- ---	.04 .04 .04 .04	.07 .07 .08 .07	.70 .70 .74 .70	8.0 8.0 8.0 8.0	1,440 1,440 1,440 1,440	1,440 1,440 1,440 1,600	1,440 1,440 1,440 1,600G	---	1.16 W200484
R-7325	2.3 --- --- ---	.01 .01 .01 .01	.31 .32 .35 .43	.62 .65 .69 .74	8.5 8.5 8.5 8.5	1,165 1,165 1,165 1,320	1,165 1,165 1,165 1,380	1,165 1,165 1,165 1,380	---	1.31 W202129
R-7349	2.0 --- --- ---	.01 .01 .01 .01	.35 .36 .43 .43	.71 .74 .87 .87	8.5 8.5 8.5 8.5	1,320 1,320 1,320 1,440	1,320 1,320 1,320 1,440	1,320 1,320 1,320 1,440	---	1.78 W203388
R-7350	1.1 --- --- ---	.01 .01 .01 .01	.20 .21 .24 .24	.63 .65 .74 .74	8.5 8.5 8.5 8.5	1,405 1,405 1,405 1,455	1,405 1,405 1,405 1,515	1,405 1,405 1,405 1,515	---	1.23 W203391
R-7354	1.6 --- --- ---	.01 .01 .01 .01	.22 .23 .24 .24	.57 .59 .62 .62	9.0 9.0 9.0 9.0	1,455 1,455 1,455 1,515	1,455 1,455 1,455 1,540	1,455 1,455 1,455 1,540	---	1.12 W204157

Table 17b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 15 bituminous coal samples from the Norton coal bed, Southwest Virginia.--continued

Sample Number	Moisture	PROXIMATE ANALYSIS			ULTIMATE ANALYSIS			HEAT CONTENT			Lab Number	
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	kCal/kg		
R-7355	2.2	31.8	60.3	5.7	5.6	79.6	1.6	6.7	0.9	7,890	14,200	W204158
	---	32.5	61.7	5.8	5.5	81.4	1.6	4.9	.9	8,070	14,520	
R-7493	3.9	29.9	61.6	4.6	5.5	80.2	1.6	7.1	.9	7,890	14,200	W206889
	---	31.1	64.1	4.8	5.3	83.5	1.7	3.8	.9	8,210	14,780	
R-8241	2.4	30.3	63.1	4.3	5.2	80.8	1.6	7.4	.7	7,990	14,390	W212492
	---	31.0	64.6	4.4	5.0	82.7	1.7	5.4	.7	8,190	14,740	
R-8318	2.2	30.2	61.8	5.8	4.6	79.9	1.5	7.4	.8	7,850	14,140	W213994
	---	30.9	63.2	5.9	4.4	81.7	1.6	5.6	.8	8,030	14,450	
R-8319	2.0	31.1	61.4	5.6	5.0	79.3	1.6	7.7	.9	7,890	14,210	W213995
	---	31.7	62.6	5.7	4.8	80.9	1.6	6.0	.9	8,050	14,500	
R-8543	1.3	24.6	53.7	20.4	4.1	68.5	1.2	5.1	.6	6,690	12,040	W217398
	---	24.9	54.4	20.7	4.0	69.4	1.2	4.0	.6	6,780	12,200	
	---	31.4	68.6	--	5.1	87.5	1.6	5.0	.8	8,550	15,390	

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Table 17b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 15 bituminous coal samples from the Norton coal bed, Southwest Virginia. -continued

Sample Number	Air-dried Loss	FORMS OF SULFUR			ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number
		Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening			
R-7355	1.2 ---	0.01 .01	0.33 .34	0.55 .56	9.0 .60	1,290	1,350	1,405	---	1.27 W204158
R-7493	2.8 --- ---	.01 .01 .01	.43 .45 .47	.46 .48 .50	9.0 .48 .50	1,355	1,425	1,475	---	1.27 W206889
R-8241	1.2 --- ---	.03 .03 .03	.12 .12 .13	.57 .58 .61	8.5 .58	1,450	1,540	1,540G	---	.97 W212492
R-8318	1.0 --- ---	.06 .06 .07	.12 .12 .13	.60 .61 .65	8.5 .58	1,490	1,540	1,540G	---	1.13 W213994
R-8319	.9 --- ---	.08 .08 .09	.18 .18 .19	.66 .67 .71	9.0 .67 .71	1,425	1,500	1,540	---	1.27 W213995
R-8543	.6 --- ---	.01 .01 .01	.08 .08 .10	.54 .55 .69	5.0 .55 .69	1,540	1,540G	1,540G	---	1.00 W217398

[Concentrations in percent. Coal ashed at 525°C. L means less than the concentration shown. Sample number is the VDMR identification number. Lab number is the USGS [laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-6895	11.6	57	26	0.70	0.56	0.30	2.1	8.3	2.5	0.026	0.58	W194301
R-6902	16.5	56	28	.92	.66	.24	2.2	4.4	1.7	.47	.60	W194292
R-6940	5.1	48	27	4.3	.66	.80	1.2	3.9	1.7	3.5	3.1	W196289
R-7160	2.3	39	23	5.5	.76	.61	.80	19	1.0	.17	9.3	W199466
R-7175	4.9	51	27	2.6	.51	.39	1.4	6.6	1.5	2.9	2.0	W200484
R-7325	7.0	43	24	3.6	1.7	.38	2.1	14	1.3	.14	5.6	W202129
R-7349	14.4	56	25	1.0	1.4	.23	3.1	9.0	1.1	.13	1.9	W203388
R-7350	11.7	55	26	1.6	1.2	.35	4.1	7.8	1.2	.043L	2.8	W203391
R-7354	4.8	49	27	1.9	.83	.35	2.4	8.2	1.4	1.3	2.5	W204157
R-7355	5.5	52	26	1.6	.71	.39	2.5	6.6	1.7	.84	2.3	W204158
R-7493	5.8	52	29	1.2	.93	.69	2.8	8.3	1.6	.086L	.33	W206889
R-8241	5.2	54	29	.94	.60	.81	2.0	8.5	1.7	.19L	1.3	W212492
R-8318	5.3	49	33	1.1	.96	.92	2.8	7.2	1.4	.19L	1.6	W213994
R-8319	6.2	49	30	.92	.18	.86	3.1	9.6	1.5	.16L	1.3	W213995
R-8543	23.8	60	28	.87	.70	.23	2.0	2.3	1.9	.29	.78	W217398

Table 17d. --Major-, minor-, and trace-element composition of 15 bituminous coal samples from the Norton coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means Less than the value shown; B, not determined; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analysis. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-6895	3.1	1.6	0.058	0.039	0.026	0.20	0.67	0.17	0.038	55	W194301
R-6902	4.3	2.4	.11	.066	.030	.30	.51	.17	.056	15	W194292
R-6940	1.2	.72	.16	.020	.030	.051	.14	.052	.031	1.7	W196289
R-7160	.42	.28	.090	.011	.010	.015	.31	.014	.008	13	W199466
R-7175	1.2	.70	.090	.015	.014	.058	.22	.043	.021	3.6	W200484
R-7325	1.4	.90	.18	.070	.020	.12	.66	.053	.041	7.9	W202129
R-7349	3.8	1.9	.11	.12	.024	.37	.91	.094	.032	8.5	W203388
R-7350	3.0	1.6	.13	.082	.030	.40	.64	.081	.048	18	W203391
R-7354	1.1	.69	.066	.024	.012	.096	.27	.039	.026	4.3	W204157
R-7355	1.3	.77	.063	.024	.016	.11	.25	.055	.020	8.2	W204158
R-7493	1.4	.90	.049	.032	.030	.14	.34	.056	.026	9.0	W206889
R-8241	1.3	.80	.035	.019	.031	.087	.31	.053	.030	17	W212492
R-8318	1.2	.91	.041	.031	.036	.12	.27	.046	.029	8.5	W213994
R-8319	1.4	1.0	.041	.007	.040	.16	.42	.055	.033	17	W213995
R-8543	6.6	3.5	.15	.10	.040	.39	.38	.28	.062	1.7	W217398

Table 17d.--Major-, minor-, and trace-element composition of 15 bituminous coal samples from the Norton coal bed, southwest Virginia, reported on a whole-coal basis. --continued

Sample Number	B-S PPb	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-6895	8.5	.97	7.4	8.7	0.043	18	B	7.6	18	1.4	W194301
R-6902	10	110	2.6	5.7	.056	27	B	9.5	23	2.1	W194292
R-6940	16	140	.97	3.8	.14	13	B	16	9.3	.27	W196289
R-7160	6.0	16	.51	6.1	.028	2.0	B	6.6	5.0L	.10	W199466
R-7175	7.8	150	1.5	6.9	.064	12	390	9.9	7.5	.30	W200484
R-7325	11	84	1.7	8.1	.084	12	480	13	9.3	1.1	W202129
R-7349	16	100	2.2	9.4	.089	22	290	6.5	16	1.9	W203388
R-7350	13	110	3.5	8.7	.15	19	450	18	15	2.0	W203391
R-7354	7.2	36	1.5	12	.072	9.0	180	7.0	8.6	.60	W204157
R-7355	7.7	42	1.3	8.3	.077	11	80	7.7	8.7	.80	W204158
R-7493	6.4	45	3.7	8.5	.064	11	360	4.7	9.0	.75	W206889
R-8241	8.8	43	1.2	3.0	.17	9.0	340	3.3	7.5	.50	W212492
R-8318	9.5	53	.69	2.0	.032	10	220	3.8	9.1	.90	W213994
R-8319	9.9	68	1.6	4.0L	.037	12	1,100	4.5	10	1.1	W213995
R-8543	16	150	2.0	5.2	.033	32	200	7.7	32	2.5	W217398

Sample Number	Cu (ppm)	Dy-S (ppm)	Er-S (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	Lab Number
R-6895	28	3.7L	1.2L	0.39	64	6.7	1.3	2.6	1.4	0.16	W194301
R-6902	21	5.3L	1.7	.41	130	5.4	1.1L	1.3	1.2	.11	W194292
R-6940	11	1.6L	.61	.22	200	2.4	.87	1.4	.50	.095	W196289
R-7160	8.5	.51L	.23L	.08	68	.62	.41	.17	.40L	.057	W199466
R-7175	11	1.5	.54	.21	60	2.0	.88	2.4	.50	.010L	W200484
R-7325	22	1.5L	.70L	.25	45	3.2	1.4	.37	.50	.029	W202129
R-7349	24	3.2L	1.4L	.39	46	6.2	2.2	1.9	.80	.028	W203388
R-7350	40	2.6L	1.6	.47	84	6.1	2.1	1.4	.75	.077	W203391
R-7354	18	1.1L	.48L	.18	220	2.6	.72L	1.3	.35	.075	W204157
R-7355	15	1.2L	.55L	.19	350	2.4	.83L	.77	.50	.020	W204158
R-7493	16	1.3L	1.2	.20	70	1.9	.87L	.87	.50	.10	W206889
R-8241	8.8	1.1L	.52	.22	70	2.1	.78L	.14	.50	.16	W212492
R-8318	10	1.2L	.64	.24	30	2.5	.80L	1.2	.35	.17	W213994
R-8319	12	1.4L	.68	.27	30	3.0	.93L	3.0	.40	.24	W213995
R-8543	19	5.2L	1.1L	.52	420	11	3.6L	1.1L	1.5	.070	W217398

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Table 17d.--Major-, minor-, and trace-element composition of 15 bituminous coal samples from the Norton coal bed, Southwest Virginia, reported on a whole-coal basis. --continued

Sample Number	La (ppm)	Li (ppm)	Lu (ppm)	Mn (ppm)	No-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Lab Number
R-6895	10	21	0.17	11	1.4	4.3	5.3L	10	13	7.3	W194301
R-6902	16	41	.16	9.7	1.3	2.6	15	16	340	12	W194292
R-6940	8.0	5.6	.08	3.0	.77	2.0	4.0	19	780	2.9	W196289
R-7160	1.0	3.0	.06	6.4	.64	.22	1.2	4.4	17	1.3	W199466
R-7175	6.0	7.8	.09	2.9	1.3	1.8	5.4	17	610	4.1	W200484
R-7325	6.0	9.1	.11	11	3.2	1.8	7.7	18	44	3.0	W202129
R-7349	12	23	.15	23	1.3	2.2	14	16	83	7.9	W203388
R-7350	9.5	16	.27	18	2.0	1.9	14	18	22L	8.9	W203391
R-7354	5.0	7.7	.10	3.8	1.3	.62	5.3	9.1	260	3.4	W204157
R-7355	6.0	6.6	.09	2.9	1.1	.83	4.3	7.7	200	2.8	W204158
R-7493	6.0	8.7	.11	5.7	1.3	1.4	6.4	8.1	22L	3.0	W206889
R-8241	5.0	7.3	.07	2.0	2.2	2.5	6.8	7.8	44L	2.2	W212492
R-8318	5.0	8.0	.07	2.9	1.9	1.2	5.2	8.0	44L	3.3	W213994
R-8319	6.0	9.3	.11	3.7	2.0	1.8	8.7	9.9	44L	3.5	W213995
R-8543	19	38	.17	18	.24L	4.3	13	21	310	15	W217398

Sample Number	Pr-S (ppm)	Rb (ppm)	Sb (ppm)	Sc (ppm)	Se (ppm)	Sm (ppm)	Sn-S (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Lab Number
R-6895	7.9L	18	1.2	4.0	3.0	1.9	0.79L	44	0.43	0.34	W194301
R-6902	11L	27	.60	5.1	2.2	2.2	1.3	130	.37	.33	W194292
R-6940	3.5L	26L	1.3L	1.9	1.2	1.1	.35L	270	.79L	.28	W196289
R-7160	1.6L	24L	.55	1.1	2.8	.30	.03L	74	.26L	.31L	W199466
R-7175	3.3L	40L	.60	1.9	.92	1.1	2.4	210	.12	.15	W200484
R-7325	5.2	30L	.70	2.2	1.6	1.2	.11L	270	.090	.17	W202129
R-7349	9.8L	29	1.3	3.8	1.7	2.0	.22L	140	.20	.24	W203388
R-7350	8.0L	24	2.0	5.7	1.3	2.1	.41	150	.20	.37	W203391
R-7354	3.3L	8.5	.95	2.2	1.7	.95	.07L	82	.20L	.13	W204157
R-7355	3.7L	9.0	.60	2.0	.95	.90	.08L	82	.14	.16	W204158
R-7493	3.9L	10	.85	2.0	1.3	1.1	.11	70	.17	.15	W206889
R-8241	3.5L	30L	1.0L	1.6	2.2	.80	.22	68	.12	.23	W212492
R-8318	3.6L	14	2.0L	2.0	1.9	.90	.24	69	.13	.090	W213994
R-8319	4.2L	50L	1.0L	2.4	1.5	1.0	.35	59	.13	.12	W213995
R-8543	16	26	6.9	2.9	2.2	2.1	.21	230	.68	.36	W217398

Table 17d.--Major-, minor-, and trace-element composition of 15 bituminous coal samples from the Norton coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Th (ppm)	Tl-S (ppm)	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)	Lab Number
R-6895	4.1	3.4	2.5	20	.85	6.8	1.2	4.5	59	W194301
R-6902	4.4	1.7L	2.3	35	.55	9.2	1.0	8.7	20	W194292
R-6940	1.5	.51L	1.2	12	.20	5.6	.50	5.6	15	W196289
R-7160	.30	.074L	.17L	2.8	.35	1.9	.30	1.7	2.8	W199466
R-7175	1.5	.18	.71	12	.40	5.4	.45	6.9	20	W200484
R-7325	1.5	.22L	.77	18	.40	7.7	.60	28	18	W202129
R-7349	2.8	.46L	1.9	33	.60	10	.85	14	20	W203388
R-7350	2.8	.37L	1.8	32	1.3	16	1.7	26	14	W203391
R-7354	1.0	.15L	1.4	12	.50	3.9	.50	9.6	4.5	W204157
R-7355	1.4	.18L	.54	9.4	1.3	3.8	.50	5.0	5.5	W204158
R-7493	1.6	.27L	.47	12	.60	3.7	.60	4.5	8.7	W206889
R-8241	1.1	1.8	.32	11	.70	5.2	.50	2.3	22	W212492
R-8318	1.5	.24L	.31L	15	.65	3.3	.50	3.2	8.5	W213994
R-8319	1.7	.29L	.43	18	.80	4.3	.70	4.3	17	W213995
R-8543	6.5	2.4L	2.3	36	.70	6.7	1.3	6.2	20	W217398

Table 17e.--Arithmetic mean, observed range and geometric mean of proximate and ultimate analyses, heat content, forms of sulfur, and ash-fusion temperatures for 15 bituminous coal samples from the Norton coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included.

[All values are in percent except Btu/lb, Kcal/kg, ash-fusion temperatures, and free-swelling index and are reported on an as-received basis. $^{\circ}\text{F} = 9/5 \, ^{\circ}\text{C} + 32$; Kcal/kg = 0.556 Btu/lb; (n) is number of samples per parameter.]

		Norton coal bed			Appalachian basin		
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean
			Min.	Max.			(n)
Proximate and ultimate analyses							
Moisture	(15)	2.66	1.32	4.00	2.54	3.23	2.69
Volatile matter	(15)	30.45	24.56	34.40	30.30	32.46	31.72
Fixed carbon	(15)	58.19	50.10	63.40	58.04	52.48	51.76
Ash	(15)	8.71	2.20	20.43	7.16	11.83	9.83
Hydrogen	(15)	5.12	4.11	5.60	5.10	5.02	5.00
Carbon	(15)	76.73	68.48	82.40	76.60	70.69	70.17
Nitrogen	(15)	1.51	1.23	1.70	1.50	1.39	1.37
Oxygen	(15)	7.06	4.70	9.00	6.96	8.92	8.22
Sulfur	(15)	.88	.63	1.30	.87	2.15	1.63
Heat content							
KCal/kg	(15)	7,593	6,696	8,143	7,579	7,030	6,979
Btu/lb	(15)	13,656	12,043	14,645	13,631	12,644	12,553
Forms of sulfur							
Sulfate	(14)	0.02	0.01	0.08	0.02	0.08	0.04
Pyritic	(15)	.25	.05	.49	.20	1.36	.65
Organic	(15)	.61	.46	.84	.60	.82	.70
Ash-fusion temperature ($^{\circ}\text{C}$)							
Initial deformation	(12)	1,356	1,082	1,488	1,350	1,255	1,246
Softening	(9)	1,377	1,110	1,516	1,370	1,287	1,280
Fluid	(7)	1,404	1,177	1,513	1,399	1,334	1,328
Free-swelling index	(15)	8.33	5.00	9.00	8.26	5.53	4.68
Air-dried loss	(15)	1.44	0.56	2.80	1.32	1.83	1.13

Table 17f.--Arithmetic mean, observed range, and geometric mean of ash content and concentrations of 11 major- and minor-oxides in the laboratory ash of 15 bituminous coal samples from the Norton coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. (n) indicates the number of samples per oxide.

[All samples were ashed at 525°C; all data are in percent.]

	Norton coal bed				Appalachian basin			
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
(Ash)	(15)	8.7	2.3	24	7.2	13	10	(5,262)
SiO ₂	(15)	51	39	60	51	43	41	(5,229)
Al ₂ O ₃	(15)	27	23	33	27	24	23	(5,229)
CaO	(15)	1.9	.70	5.5	1.5	2.2	1.5	(5,227)
MgO	(15)	.82	.18	1.7	.74	.85	.75	(5,258)
Na ₂ O	(15)	.50	.23	.92	.45	.43	.34	(5,194)
K ₂ O	(15)	2.3	.80	4.1	2.2	2.0	1.7	(5,229)
Fe ₂ O ₃	(15)	8.2	2.3	19	7.4	19	13	(5,215)
MnO	(15)	.01	.005	.04	.01	.03	.02	(5,260)
TiO ₂	(15)	1.5	1.0	2.5	1.5	1.2	1.1	(5,203)
P ₂ O ₅	(10)	.97	.030	3.5	.41	.50	.22	(3,389)
SO ₃	(15)	2.4	.32	9.4	1.7	2.5	1.9	(5,063)

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Table 17g.--Arithmetic mean, observed range, and geometric mean of concentrations of 54 trace elements in 15 bituminous coal samples from the Norton coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. Dashed values (---) represent less than five samples; (n) indicates the number of samples per element. [All data are in parts-per-million and are reported on a whole-coal basis.]

	Norton coal bed				Appalachian basin		
	(n)	Arith. mean	Observed range		Geom. mean	Arith. mean	Geom. mean
			Min.	Max.			
Ag {15}		0.03	0.008	0.06	0.03	0.07	0.05 (4,565)
As {15}		13	1.7	55	8.6	35	13 (5,197)
B {15}		10	6.0	16	9.7	30	20 (5,076)
Ba {15}		83	16	150	70	90	63 (5,134)
Be {15}		2.2	.51	7.4	1.7	2.5	2.0 (5,247)
Bi ---		---	---	---	---	1.5	1.1 (108)
Br {14}		6.8	2.0	12	6.2	22	13 (4,892)
Cd {15}		.08	.028	.17	.07	.10	.07 (4,978)
Ce {15}		14	2.0	32	12	21	17 (5,075)
Cl {11}		370	80	1,100	300	780	510 (3,646)
Co {15}		8.4	3.3	18	7.5	7.4	5.7 (5,217)
Cr {14}		13	7.5	32	12	18	15 (5,205)
Cs {15}		1.1	.10	2.5	.81	1.3	.85 (4,831)
Cu {15}		18	8.5	40	16	19	15 (5,239)
Dy {1}		---	1.5	1.5	---	3.3	2.6 (759)
Er {8}		.94	.52	1.6	.84	1.5	1.2 (1,200)
Eu {15}		.28	.075	.52	.25	.44	.37 (5,032)
F {15}		130	30	420	89	99	71 (4,860)
Ga {15}		3.9	.62	11	3.1	6.6	5.4 (5,046)
Gd {7}		1.3	.41	2.2	1.1	2.6	1.9 (1,773)
Ge {14}		1.3	.14	3.0	.99	4.7	2.5 (4,608)
Hf {14}		.69	.35	1.5	.62	.79	.62 (4,932)
Hg {14}		.10	.020	.24	.08	.22	.15 (5,031)
Ho ---		---	---	---	---	.76	.61 (378)
La {15}		8.0	1.0	19	6.7	11	8.9 (5,147)
Li {15}		14	3.0	41	11	22	14 (5,243)
Lu {15}		.12	.055	.27	.11	.16	.14 (4,885)
Mn {15}		8.2	2.0	23	6.1	31	15 (5,260)
Mo {14}		1.6	.64	3.2	1.4	3.7	2.3 (4,889)
Nb {15}		2.0	.22	4.3	1.6	2.6	1.9 (5,005)
Nd {14}		7.9	1.2	15	6.7	13	9.9 (4,231)
Ni {15}		13	4.4	21	12	17	14 (5,240)
Pb {15}		5.4	1.3	15	4.3	8.8	6.2 (5,172)
Pd ---		---	---	---	---	.17	.14 (18)
Pr {2}		---	5.2	16	---	6.1	3.6 (960)
Rb {9}		18	8.5	29	17	28	22 (2,232)
Sb {11}		.90	.55	2.0	.82	1.4	.91 (5,003)
Sc {15}		3.0	1.1	6.9	2.6	4.4	3.6 (5,218)
Se {15}		1.8	.92	3.0	1.7	3.6	2.8 (5,052)
Sm {15}		1.3	.30	2.2	1.2	2.0	1.6 (5,005)
Sn {8}		.89	.11	2.4	.52	1.6	.86 (2,352)
Sr {15}		130	44	270	110	110	79 (5,146)
Ta {12}		.23	.090	.68	.19	.24	.19 (4,369)
Tb {14}		.22	.090	.37	.20	.34	.29 (4,852)
Th {15}		2.2	.30	6.5	1.8	3.0	2.3 (5,098)
Tl {3}		---	.18	3.4	---	3.4	2.1 (382)
Tm ---		---	---	---	---	1.7	.38 (46)
U {13}		1.3	.32	2.5	1.0	1.8	1.3 (4,990)
V {15}		18	2.8	36	16	24	19 (5,241)
W {15}		.66	.20	1.3	.59	.94	.80 (4,421)
Y {15}		6.3	1.9	16	5.5	8.5	7.2 (5,234)
Yb {15}		.74	.30	1.6	.67	1.1	.92 (5,151)
Zn {15}		.87	1.7	28	6.4	22	14 (5,243)
Zr {15}		17	2.8	59	13	24	17 (5,238)

WISE FORMATION

DORCHESTER COAL BED

Most production of the Dorchester coal bed is from Wise County, but production from Buchanan, Dickenson, and Lee Counties contributed to the total of 4.3 million tons produced in 1989 (Virginia Division of Mines, 1990). The Dorchester is the lowest coal in the Wise Formation and is known by many local names. In Lee County it is called the Marcee or Cornett coal bed. Wise and Dickenson County names include the Glamorgan, Norton No. 2, Eagle, Blair, Lyons, Gladeville, Esserville, or Big Dirt coal bed. Sampled thicknesses are from 2.1 to 6.1 feet. The Dorchester normally occurs as one coal with two or three partings totaling less than 0.5 foot. Bone coal is found as parting material. In some places, a well-defined shale parting ranges from 0.5- to 1-foot in thickness. In and east of the town of Wise, the coal is found in five splits within a 70-foot interval, numbered from top (No. 1) to bottom (No. 5). Pyrite is found disseminated through the coal, on cleats, and in the parting material. The roof rock is commonly shale, but sandstone roof occurs at several of the sample locations. The Dorchester typically has a moderate- to well-developed medium cleat with moderate amounts of thin and medium banding.

In addition to the elements below the detection limits for all 375 samples in this report, the elements Bi and Pd are found to be below the detection limits for the 57 Dorchester coal samples (Figure 25). Ho, Tl, and Tm have less than five unqualified values, therefore calculation of means was not possible. The geometric means for Na₂O and the free-swelling index are substantially higher and the geometric means for B, Dy, Gd, Ge, Li, Nb, Tl, Zr, and pyritic sulfur are substantially lower for the Dorchester coal bed samples than for the Appalachian basin samples. Table 18a displays the location and descriptive information for the Dorchester samples. The analytical results are presented in Tables 18b, 18c, and 18d. Summaries of the statistical data are shown in Tables 18e, 18f, and 18g.

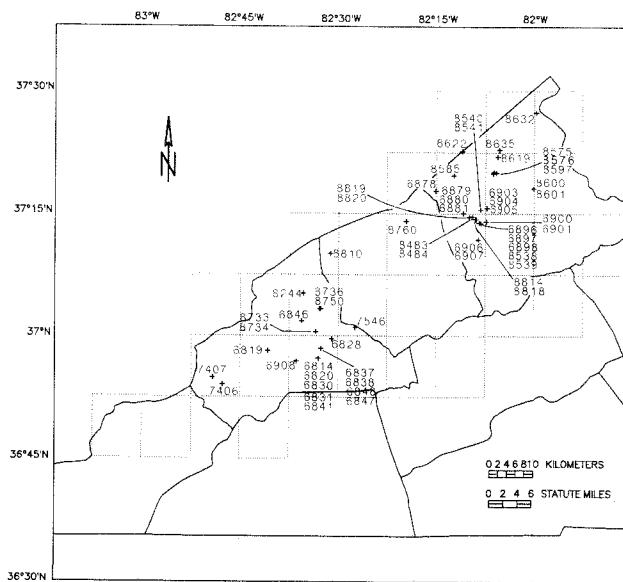


Figure 25. Locations for samples from the Dorchester coal bed.

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Table 18a.--Descriptions and Locations for 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-6814	W191067	60A-1	365717N	823253W	Wise (7.5')	Wise	25.44	Surface mine	Upper Split
R-6819	W191068	60B-4	365811N	820444W	Norton (7.5')	Wise	21.96	Surface mine	Full Thickness
R-6820	W191066	60A-3	365717N	823253W	Wise (7.5')	Wise	11.76	Surface mine	Lower Split
R-6828	W191337	60A-7	365937N	823056W	Wise (7.5')	Wise	20.76	Surface mine,	Full Thickness
R-6830	W191335	60A-8	365716N	823258W	Wise (7.5')	Wise	21.96	sl. weathered Surface mine,	Middle Split
R-6831	W191336	60A-9	365716N	823258W	Wise (7.5')	Wise	10.44	Surface mine,	Lower Split
R-6837	W200124	60A-10	365826N	823235W	Wise (7.5')	Wise	10.08	sl. weathered Surface mine,	Bench Sample
R-6838	W192200	60A-11	365826N	823235W	Wise (7.5')	Wise	11.04	sl. weathered Surface mine,	Bench Sample
R-6841	W192603	60A-14	365718N	823257W	Wise (7.5')	Wise	36.48	sl. weathered Surface mine,	Full Thickness
R-6846	W192592	90D-7	370148N	823337W	Pound (7.5')	Wise	33.48	sl. weathered Surface mine,	Full Thickness
R-6847	W200122	60A-16	365828N	823235W	Wise (7.5')	Wise	5.52	Surface mine,	Bench Sample
R-6848	W192587	60A-17	365828N	823235W	Elkhorn City (7.5')	Buchanan	15.96	sl. weathered Surface mine,	Bench Sample
R-6878	W193673	119D-1	371747N	821503W	Harman (7.5')	Buchanan	20.40	sl. weathered Surface mine,	Full Thickness
R-6879	W200131	118C-3	371502N	821052W	Harman (7.5')	Buchanan	12.24	sl. weathered Surface mine,	Bench Sample
R-6880	W193670	118C-4	371502N	821052W	Harman (7.5')	Buchanan	8.52	sl. weathered Surface mine,	Bench Sample
R-6881	W193669	118C-5	371502N	821052W	Harman (7.5')	Buchanan	7.92	Surface mine,	Bench Sample
R-6896	W194300	88B-2	371351N	820809W	Prater (7.5')	Buchanan	32.48	sl. weathered Surface mine,	Lower Split
R-6897	W194298	88B-3	371351N	820809W	Prater (7.5')	Buchanan	14.64	sl. weathered Surface mine,	Bench Sample of Upper Split
R-6898	W194299	88B-4	371351N	820809W	Prater (7.5')	Buchanan	21.20	sl. weathered Surface mine,	Bench Sample of Upper Split
R-6900	W194303	88A-4	371401N	820720W	Vansant (7.5')	Buchanan	16.56	sl. weathered Surface mine,	Bench Sample
R-6901	W194304	88A-5	371401N	820720W	Vansant (7.5')	Buchanan	16.80	Surface mine,	Bench Sample
R-6903	W194295	118D-1	371539N	820713W	Grundy (7.5')	Buchanan	21.12	sl. weathered Surface mine,	Lower Split
R-6904	W194296	118D-2	371539N	820713W	Grundy (7.5')	Buchanan	39.00	sl. weathered Surface mine,	Bench Sample of Lower Split
R-6905	W194297	118D-3	371537N	820713W	Grundy (7.5')	Buchanan	20.76	sl. weathered Surface mine,	Upper Split
R-6906	W194293	88B-5	371149N	820831W	Prater (7.5')	Buchanan	14.40	sl. weathered Surface mine,	Bench Sample
R-6907	W194294	88B-6	371149N	820831W	Prater (7.5')	Buchanan	10.68	Surface mine,	Bench Sample
R-6908	W194411	60A-19	365654N	823620W	Wise (7.5')	Wise	18.96	sl. weathered Surface mine,	Lower Split
R-7406	W205190	61A-4	365400N	824739W	Appalachia (7.5')	Wise	51.84	Underground mine,	Full Thickness
R-7407	W205191	61A-5	365451N	824913W	Appalachia (7.5')	Wise	49.92	sl. weathered Underground mine,	Full Thickness
R-7546	W209960	89C-11	370103N	822723W	Caney Ridge (7.5')	Dickenson	37.80	sl. weathered Surface mine,	Full Thickness

Table 18a.--Descriptions and locations for 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia.--continued

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-8244	W212494	90D-19	370511N	823519W	Pound (7.5')	Wise	34.20	Surface mine	Full Thickness
R-8483	W214770	88B-9	371437N	820926W	Prater (7.5')	Buchanan	16.80	Underground mine, sl. weathered	Bench Sample
R-8484	W214769	88B-8	371437N	820926W	Prater (7.5')	Buchanan	19.20	Underground mine, sl. weathered	Bench Sample
R-8538	W217399	88B-14	371353N	820826W	Prater (7.5')	Buchanan	37.20	Underground mine	Upper Split
R-8539	W217400	88B-15	371353N	820826W	Prater (7.5')	Buchanan	32.40	Underground mine	Lower Split
R-8540	W217401	118C-7	371529N	820812W	Harman (7.5')	Buchanan	37.20	Underground mine	Upper Split
R-8541	W217402	118C-8	371529N	820812W	Harman (7.5')	Buchanan	10.80	Underground mine	Lower Split
R-8575	W218774	118D-7	371956N	820617W	Grundy (7.5')	Buchanan	39.00	Underground mine	Lower Split
R-8576	W218775	118D-8	372006N	820608W	Grundy (7.5')	Buchanan	36.84	Underground mine	Full Thickness
R-8585	W218770	118C-20	371940N	821218W	Harman (7.5')	Buchanan	28.80	Surface mine, sl. weathered	Full Thickness
R-8597	W218973	118D-9	372001N	820549W	Grundy (7.5')	Buchanan	43.80	Surface mine, sl. weathered	Full Thickness
R-8600	W218976	118D-12	371805N	820002W	Grundy (7.5')	Buchanan	18.00	Underground mine	Bench Sample
R-8601	W218977	118D-13	371805N	820002W	Grundy (7.5')	Buchanan	25.80	Underground mine	Bench Sample
R-8619	W225107	118D-16,17	372159N	820535W	Grundy (7.5')	Buchanan	37.80	Underground mine	Composite
R-8622	W223358	118B-1	372238N	821141W	Jamboree (7.5')	Buchanan	18.00	Underground mine	Full Thickness
R-8632	W223353	117B-2	372272N	815940W	Panther (7.5')	Buchanan	34.80	Underground mine	Full Thickness
R-8635	W223352	118A-1	372250N	820519W	Hurley (7.5')	Buchanan	38.40	Surface mine	Full Thickness
R-8733	W231831	90D-29	370030N	823323W	Pound (7.5')	Wise	36.00	Underground mine	Bench Sample
R-8734	W231832	90D-30	370030N	823323W	Pound (7.5')	Wise	26.40	Underground mine	Bench Sample
R-8736	W231834	90D-32	370317N	823247W	Pound (7.5')	Wise	30.00	Surface mine	Full Thickness
R-8750	W235313	90D-37	370317N	823238W	Pound (7.5')	Wise	32.40	Surface mine	Full Thickness
R-8760	W236241	89A-10	371404N	821937W	Haysi (7.5')	Dickenson	24.00	Surface mine	Lower Split
R-8810	W238481	90A-4	371004N	823111W	Jenkins East (7.5')	Dickenson	33.60	Underground mine	Full Thickness
R-8814	W238474	88B-19	371419N	820859W	Prater (7.5')	Buchanan	44.40	Surface mine	Full Thickness
R-8818	W238475	88B-20	371419N	820853W	Prater (7.5')	Buchanan	32.40	Surface mine, weathered	Full Thickness
R-8819	W238476	88B-21	371434N	820956W	Prater (7.5')	Buchanan	15.60	Surface mine, sl. weathered	Lower Split
R-8820	W238477	88B-22	371434N	820956W	Prater (7.5')	Buchanan	34.80	Surface mine, sl. weathered	Upper Split

Table 18b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, ash-fusion temperatures, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. G for ash-fusion temperatures means greater than value shown. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT			Lab Number
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/KG	Btu/lb		
R-6814	1.3	31.1	53.1	14.5	5.0	71.6	1.5	6.8	0.6	7,120	12,820	W191067	
	---	31.5	53.8	14.7	4.9	72.5	1.5	5.7	.6	7,220	12,990		
	---	36.9	63.1	---	5.8	85.0	1.8	6.7	.7	8,460	15,250		
R-6819	1.9	36.5	56.1	5.5	5.4	77.4	1.4	7.2	3.1	7,840	14,120	W191068	
	---	37.2	57.2	5.6	5.3	78.9	1.4	5.6	3.2	8,000	14,390		
	---	39.4	60.6	---	5.6	83.6	1.5	6.0	3.3	8,470	15,250		
R-6820	2.3	33.0	56.3	8.4	5.3	75.8	1.5	8.1	.9	7,560	13,600	W191066	
	---	33.8	57.6	8.6	5.2	77.6	1.5	6.2	.9	7,730	13,920		
	---	37.0	63.0	---	5.6	84.9	1.7	6.8	1.0	8,460	15,230		
R-6828	3.5	34.4	58.5	3.6	5.6	79.0	1.2	9.5	1.1	7,830	14,100	W191337	
	---	35.6	60.6	3.7	5.4	81.9	1.2	6.6	1.1	8,120	14,610		
	---	37.0	63.0	---	5.6	85.0	1.3	6.9	1.2	8,430	15,180		
R-6830	3.4	35.0	59.1	2.5	5.7	80.3	1.2	9.2	1.1	7,920	14,260	W191335	
	---	36.2	61.2	2.6	5.5	83.1	1.2	6.4	1.1	8,200	14,760		
	---	37.2	62.8	---	5.7	85.3	1.3	6.6	1.2	8,420	15,150		
R-6831	2.5	36.1	59.2	2.2	5.6	80.7	1.2	9.1	1.2	8,060	14,500	W191336	
	---	37.0	60.7	2.3	5.5	82.8	1.2	7.1	1.2	8,260	14,870		
	---	37.9	62.1	---	5.6	84.7	1.3	7.2	1.3	8,450	15,220		
R-6837	2.4	30.2	55.0	12.4	5.1	71.5	1.4	7.3	2.3	7,130	12,830	W200124	
	---	30.9	56.4	12.7	5.0	73.3	1.4	5.3	2.4	7,300	13,150		
	---	35.4	64.6	---	5.7	83.9	1.6	6.1	2.7	8,370	15,060		
R-6838	1.2	32.2	57.3	9.3	5.3	76.7	1.5	6.5	.7	7,760	13,960	W192600	
	---	32.6	58.0	9.4	5.2	77.6	1.5	5.5	.7	7,850	14,130		
	---	36.0	64.0	---	5.8	85.7	1.7	6.1	.8	8,670	15,600		
R-6841	3.7	34.9	56.4	5.0	5.7	77.0	1.4	8.8	2.1	7,700	13,860	W192603	
	---	36.2	58.6	5.2	5.5	80.0	1.5	5.7	2.2	8,000	14,390		
	---	38.2	61.8	---	5.8	84.3	1.5	6.0	2.3	8,430	15,180		

Table 18b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia. -continued

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Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening			
R-6814	0.0 --- --- ---	0.02 .02 .02 .02	0.13 .13 .15 .15	0.44 .45 .52	9.0 1.07 1.09 1.16	1,540 1,100 1,150	1,540G 1,215	---	0.94	W191067
R-6819	.0 --- --- ---	.02 .02 .02 .02	2.03 2.07 2.19	1.07 1.09 1.16	9.0 ---	1,100 1,150	1,215	---	4.39	W191068
R-6820	.0 --- --- ---	.02 .02 .02 .02	.23 .24 .26 .28	.68 .70 .76 .88	9.0 --- --- ---	1,430 1,500	1,540 1,225	---	1.32	W191066
R-6828	.0 --- --- ---	.02 .02 .02 .02	.26 .27 .28 .28	.82 .85 .85 .88	9.0 --- --- ---	1,125 1,175	1,175 1,225	---	1.56	W191337
R-6830	.0 --- --- ---	.02 .02 .02 .02	.30 .31 .32 .32	.78 .81 .83	9.0 --- --- ---	1,100 1,100	1,165 1,205	---	1.54	W191335
R-6831	.0 --- --- ---	.07 .07 .07 .07	.52 .53 .55 .61	.59 .61 .62	9.0 --- --- ---	1,100 1,100	1,195 1,245	---	1.66	W191336
R-6837	.0 --- --- ---	.02 .02 .02 .02	1.93 1.98 2.27	.32 .33 .38	8.5 --- ---	1,305 1,370	1,370 1,440	---	3.59	W200124
R-6838	.0 --- --- ---	.02 .02 .02 .02	.50 .51 .56 .56	.17 .17 .19	8.0 --- --- ---	1,455 1,525	1,540 1,540	---	1.00	W192600
R-6841	.0 --- --- ---	.02 .02 .02 .02	.96 1.00 1.05	1.14 1.18 1.25	9.0 --- ---	1,095 1,155	1,180 1,180	---	3.03	W192603

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Table 18b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia.-continued

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT	
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/KG	Btu/lb
R-6846	4.4	27.5	59.5	8.6	5.1	74.9	1.7	8.7	1.0	7,440	13,400
	--	28.8	62.2	9.0	4.8	78.3	1.8	5.0	1.0	7,790	14,020
	--	31.6	68.4	--	5.3	86.1	2.0	5.5	1.1	8,560	15,400
R-6847	4.0	32.6	57.5	5.9	5.7	77.7	1.6	8.3	.8	7,720	13,900
	--	34.0	59.9	6.1	5.5	80.9	1.7	4.9	.8	8,040	14,480
	--	36.2	63.8	--	5.8	86.2	1.8	5.3	.9	8,570	15,430
R-6848	2.3	32.4	58.5	6.8	5.4	75.4	1.7	9.8	.9	7,760	13,970
	--	33.2	59.9	7.0	5.3	77.2	1.7	7.9	.9	7,940	14,300
	--	35.6	64.4	--	5.7	82.9	1.9	8.5	1.0	8,540	15,370
R-6878	1.9	35.2	50.6	12.3	5.0	72.2	1.4	5.4	3.9	7,290	13,120
	--	35.9	51.6	12.5	4.9	73.6	1.4	3.8	4.0	7,430	13,370
	--	41.0	59.0	--	5.6	84.1	1.6	4.3	4.5	8,490	15,290
R-6879	2.5	31.0	59.8	6.7	5.3	78.6	1.4	6.4	1.5	7,800	14,030
	--	31.8	61.3	6.9	5.2	80.6	1.4	4.3	1.5	7,990	14,390
	--	34.1	65.9	--	5.5	86.6	1.5	4.6	1.7	8,580	15,450
R-6880	1.7	32.0	61.4	4.9	5.1	79.7	1.4	5.4	3.4	7,990	14,380
	--	32.6	62.5	5.0	5.0	81.1	1.4	4.0	3.5	8,130	14,630
	--	34.3	65.7	--	5.3	85.3	1.5	4.2	3.6	8,550	15,400
R-6881	1.7	33.6	62.3	2.4	5.5	83.2	1.7	6.1	1.2	8,280	14,910
	--	34.2	63.4	2.4	5.4	84.6	1.7	4.7	1.2	8,430	15,170
	--	35.0	65.0	--	5.5	86.8	1.8	4.8	1.3	8,640	15,550
R-6896	2.5	25.3	52.9	19.3	4.5	68.1	1.3	6.1	.7	6,720	12,100
	--	25.9	54.3	19.8	4.3	69.8	1.3	4.0	.7	6,890	12,410
	--	33.4	66.6	--	5.6	87.1	1.7	5.0	.9	8,590	15,470
R-6897	2.8	29.7	59.3	8.2	5.3	77.4	1.5	6.3	1.2	7,710	13,870
	--	30.6	61.0	8.4	5.1	79.6	1.5	3.9	1.2	7,930	14,270
	--	33.4	66.6	--	5.6	87.0	1.7	4.3	1.3	8,660	15,590
R-6898	2.1	31.0	65.0	1.9	5.4	83.8	1.7	6.1	1.2	8,350	15,040
	--	31.7	66.4	1.9	5.3	85.6	1.7	4.3	1.2	8,530	15,360
	--	32.3	67.7	--	5.4	87.3	1.8	4.4	1.2	8,700	15,660

Table 18b.-Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia. -continued

Sample Number	Air-dried Loss	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)				Hardgrove grindability index	Compliance Number	Lab Number
		Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid				
R-6846	0.0	0.02	0.24	0.72	8.5	1,480	1,530	1,540	---	1.49	W192592	
	---	.02	.25	.75								
	---	.02	.28	.83								
R-6847	.0	.02	.06	.68	9.0	1,540	1,540G	1,540G	---	1.15	W200122	
	---	.02	.06	.71								
	---	.02	.07	.75								
R-6848	.0	.02	.25	.62	9.0	1,425	1,480	1,535	---	1.29	W192587	
	---	.02	.26	.63								
	---	.02	.28	.68								
R-6878	1.0	.01	2.59	1.26	8.5	1,125	1,170	1,230	---	5.95	W193673	
	---	.01	2.64	1.28								
	---	.01	3.02	1.47								
R-6879	1.5	.06	.68	.73	9.0	1,285	1,340	1,400	---	2.14	W200131	
	---	.06	.70	.75								
	---	.07	.75	.80								
R-6880	.8	.10	2.66	.66	.0	1,320	1,375	1,430	---	4.73	W193670	
	---	.10	2.71	.67								
	---	.11	2.85	.71								
R-6881	.8	.01	.31	.87	9.0	1,235	1,280	1,350	---	1.61	W193669	
	---	.01	.32	.89								
	---	.01	.32	.91								
R-6896	1.6	.02	.15	.56	6.5	1,540	1,540G	1,540G	---	1.16	W194300	
	---	.02	.15	.57								
	---	.03	.19	.72								
R-6897	1.7	.09	.41	.73	9.0	1,395	1,450	1,510	---	1.73	W194298	
	---	.09	.42	.75								
	---	.10	.46	.82								
R-6898	1.0	.02	.29	.87	9.0	1,175	1,225	1,290	---	1.60	W194299	
	---	.02	.30	.89								
	---	.02	.30	.91								

Table 18b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia.--continued

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT		
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	Lab Number
R-6900	4.1	21.5	42.7	31.7	3.9	54.4	1.0	7.5	1.3	5,390	9,700	W194303
	---	22.4	44.5	33.1	3.6	56.7	1.0	4.0	1.4	5,620	10,110	
	---	33.5	66.5	---	5.4	84.7	1.6	6.0	2.0	8,390	15,110	
R-6901	5.1	28.3	64.2	2.4	5.3	80.1	1.6	9.4	1.0	7,930	14,270	W194304
	---	29.8	67.7	2.5	5.0	84.4	1.7	5.1	1.1	8,350	15,040	
	---	30.6	69.4	---	5.1	86.6	1.7	5.3	1.1	8,570	15,430	
R-6903	2.4	25.9	51.5	20.2	4.5	66.8	1.2	6.7	.6	6,620	11,910	W194295
	---	26.5	52.8	20.7	4.3	68.4	1.2	4.7	.6	6,780	12,210	
	---	33.5	66.5	---	5.5	86.3	1.6	5.9	.8	8,550	15,390	
R-6904	3.3	29.8	60.6	6.3	5.2	78.6	1.5	7.0	1.3	7,820	14,080	W194296
	---	30.8	62.7	6.5	5.0	81.3	1.6	4.2	1.3	8,090	14,560	
	---	33.0	67.0	---	5.3	86.9	1.7	4.5	1.4	8,650	15,570	
R-6905	2.5	27.6	67.0	2.9	5.2	82.5	1.4	7.1	.9	8,180	14,720	W194297
	---	28.3	68.7	3.0	5.0	84.6	1.4	5.0	.9	8,390	15,100	
	---	29.2	70.8	---	5.2	87.2	1.5	5.2	1.0	8,640	15,560	
R-6906	4.5	28.5	59.1	7.9	5.2	77.1	1.5	7.3	1.0	7,650	13,780	W194293
	---	29.8	61.9	8.3	4.9	80.7	1.6	3.5	1.0	8,010	14,430	
	---	32.5	67.5	---	5.4	88.0	1.7	3.8	1.1	8,740	15,730	
R-6907	2.4	29.2	63.4	5.0	5.1	81.7	1.5	5.7	.9	8,100	14,570	W194294
	---	29.9	65.0	5.1	5.0	83.7	1.5	3.7	.9	8,290	14,920	
	---	31.5	68.5	---	5.2	88.2	1.6	3.9	1.0	8,740	15,740	
R-6908	3.8	33.7	60.2	2.3	5.3	80.6	1.6	9.4	.9	8,010	14,420	W194411
	---	35.0	62.6	2.4	5.1	83.8	1.7	6.4	1.0	8,330	14,990	
	---	35.9	64.1	---	5.2	85.8	1.7	6.4	1.0	8,530	15,550	
R-7406	2.0	32.3	49.6	16.1	4.9	69.3	1.5	7.4	.8	6,850	12,330	W205190
	---	33.0	50.6	16.4	4.8	70.7	1.5	5.7	.8	6,990	12,580	
	---	39.4	60.6	---	5.7	84.6	1.8	6.9	1.0	8,360	15,050	
R-7407	1.5	33.1	53.0	12.4	5.0	73.3	1.6	6.5	1.2	7,290	13,130	W205191
	---	33.6	53.8	12.6	4.9	74.4	1.6	5.2	1.2	7,400	13,330	
	---	38.4	61.6	---	5.6	85.1	1.9	6.0	1.4	8,470	15,250	

Table 18b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia. --continued

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)				Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyrritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid		
R-6900	2.8	0.02	0.76	0.53	8.5	1,375	1,435	1,500	---	2.68
	---	.02	.79	.55						W194303
	---	.03	1.18	.83						
R-6901	3.7	.02	.26	.76	9.0	1,050	1,100	1,165	---	1.40
	---	.02	.27	.80						W194304
	---	.02	.28	.82						
R-6903	1.5	.01	.12	.50	8.0	1,540	1,540G	1,540G	---	1.01
	---	.01	.12	.51						W194295
	---	.01	.16	.65						
R-6904	2.2	.01	.66	.65	8.5	1,130	1,180	1,245	---	1.85
	---	.01	.68	.67						W194296
	---	.01	.73	.72						
R-6905	1.0	.01	.19	.65	9.0	1,185	1,235	1,290	---	1.22
	---	.01	.19	.67						W194297
	---	.01	.20	.69						
R-6906	3.8	.01	.56	.48	8.0	1,540	1,540G	1,540G	---	1.45
	---	.01	.59	.50						W194293
	---	.01	.64	.55						
R-6907	1.5	.01	.28	.57	9.0	1,490	1,540	1,540G	---	1.24
	---	.01	.29	.58						W194294
	---	.01	.30	.62						
R-6908	2.1	.01	.16	.70	8.5	1,130	1,180	1,240	---	1.25
	---	.01	.17	.73						W194411
	---	.01	.17	.75						
R-7406	.8	.01	.20	.58	6.0	1,495	1,540	1,540G	---	1.30
	---	.01	.20	.59						W205190
	---	.01	.24	.71						
R-7407	.4	.02	.48	.74	6.0	1,455	1,515	1,540	---	1.83
	---	.02	.49	.75						W205191
	---	.02	.56	.86						

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Table 18b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, grindability index, and compliance numbers for 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia.--continued

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT		
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	Lab Number
R-7546	3.7	30.9	57.0	8.4	5.7	75.0	1.5	8.4	1.0	7,480	13,470	W209960
	---	32.1	59.2	8.7	5.5	77.9	1.6	5.3	1.0	7,770	13,990	
	---	35.2	64.8	---	6.0	85.3	1.7	5.8	1.1	8,510	15,320	
R-8244	1.8	30.2	53.5	14.4	4.8	70.4	1.7	5.3	3.4	7,060	12,710	W212494
	---	30.8	54.5	14.7	4.7	71.7	1.7	3.8	3.4	7,190	12,940	
	---	36.1	63.9	---	5.5	84.1	2.0	4.5	4.0	8,430	15,170	
R-8483	7.6	27.5	62.2	2.6	5.3	78.8	1.4	10.8	1.1	7,720	13,900	W214770
	---	29.8	67.4	2.8	4.8	85.3	1.5	4.3	1.2	8,360	15,050	
	---	30.7	69.3	---	5.0	87.7	1.6	4.5	1.3	8,600	15,480	
R-8484	3.1	31.1	63.5	2.3	4.9	82.0	1.7	7.7	1.4	8,160	14,690	W214769
	---	32.1	65.6	2.3	4.8	84.6	1.8	5.1	1.4	8,420	15,160	
	---	32.9	67.1	---	4.9	86.7	1.8	5.2	1.4	8,630	15,530	
R-8538	1.3	30.8	62.1	5.7	5.1	80.7	1.3	5.7	1.5	8,010	14,430	W217399
	---	31.2	63.0	5.8	5.1	81.8	1.3	4.5	1.5	8,120	14,620	
	---	33.2	66.8	---	5.4	86.9	1.4	4.8	1.6	8,620	15,520	
R-8539	1.4	29.0	62.4	7.1	5.1	80.0	1.3	5.6	.8	8,000	14,390	W217400
	---	29.5	63.3	7.2	5.0	81.2	1.4	4.4	.8	8,110	14,600	
	---	31.8	68.2	---	5.4	87.5	1.5	4.8	.9	8,740	15,740	
R-8540	2.6	29.2	59.8	8.4	5.1	77.3	1.6	6.5	1.1	7,630	13,740	W217401
	---	30.0	61.3	8.7	5.0	79.3	1.6	4.3	1.2	7,840	14,100	
	---	32.8	67.2	---	5.4	86.8	1.8	4.7	1.3	8,580	15,440	
R-8541	2.0	30.6	63.3	4.1	5.2	83.0	1.6	5.3	.7	8,150	14,660	W217402
	---	31.2	64.6	4.2	5.1	84.7	1.6	3.6	.7	8,310	14,960	
	---	32.6	67.4	---	5.3	88.4	1.7	3.8	.8	8,680	15,620	
R-8575	2.4	29.0	50.9	17.8	4.7	67.9	1.4	7.4	.8	6,790	12,220	W218774
	---	29.7	52.1	18.3	4.5	69.6	1.4	5.4	.8	6,950	12,520	
	---	36.3	63.7	---	5.5	85.1	1.7	6.7	1.0	8,510	15,310	
R-8576	2.5	32.2	59.9	5.3	5.2	79.5	1.6	6.8	1.7	7,930	14,280	W218775
	---	33.1	61.5	5.4	5.1	81.5	1.6	4.6	1.7	8,140	14,650	
	---	35.0	65.0	---	5.4	86.2	1.7	4.9	1.8	8,610	15,490	

Table 18b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia.--continued

Sample Number	Air-dried Loss	FORMS OF SULFUR			ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number
		Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid		
R-7546	2.2 ---	0.01 .01	0.15 .16	0.80 .83	8.5	1,190	1,255	1,325	---	1.48 W20990
R-8264	.8 ---	.25 .25	2.12 2.16	1.01 1.03	6.5	1,140	1,215	1,295	56	5.35 W212694
R-8483	6.3 ---	.17 .18	.29 .31	.67 .73	9.0	1,145	1,200	1,280	---	1.58 W214770
R-8484	1.7 ---	.09 .09	.49 .51	.78 .81	9.0	1,105	1,150	1,200	84	1.91 W214769
R-8538	.6 ---	.01 .01	.70 .71	.76 .77	8.5	1,060	1,110	1,125	---	2.08 W217399
R-8539	.6 ---	.10 .01	.06 .75	.67 .82	7.5	1,410	1,480	1,505	---	1.11 W217400
R-8540	1.7 ---	.07 .07	.37 .38	.71 .73	8.5	1,150	1,210	1,255	---	1.60 W217401
R-8541	1.4 ---	.03 .03	.04 .04	.65 .66	8.5	1,425	1,495	1,515	---	.95 W217402
R-8575	1.4 ---	.07 .07	.10 .13	.61 .62	6.5	1,540	1,540G	1,540G	---	1.31 W218774
R-8576	1.5 ---	.07 .07	.88 .90	.72 .74	8.0	1,130	1,200	1,280	---	2.38 W218775

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Table 18b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, grindability index, and compliance numbers for 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia.--continued

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT		
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	Lab Number
R-8585	2.9	33.0	62.0	2.0	5.3	82.8	1.6	7.2	1.0	8,230	14,810	W218770
	--	34.0	63.9	2.1	5.1	85.2	1.7	4.8	1.1	8,470	15,250	
	--	34.8	65.2	--	5.3	87.0	1.7	4.9	1.1	8,650	15,570	
R-8597	3.5	28.6	53.5	14.3	5.1	70.1	1.5	8.3	.7	6,910	12,440	W218973
	--	29.7	55.5	14.9	4.9	72.7	1.5	5.3	.7	7,170	12,900	
	--	34.8	65.2	--	5.7	85.4	1.8	6.3	.8	8,420	15,150	
R-8600	2.6	29.2	60.6	7.6	5.2	77.9	1.6	6.4	1.2	7,690	13,840	W218976
	--	29.9	62.2	7.8	5.0	80.0	1.7	4.2	1.2	7,890	14,210	
	--	32.5	67.5	--	5.5	86.8	1.8	4.6	1.3	8,560	15,410	
R-8601	3.4	28.3	66.3	2.0	5.4	83.0	1.6	7.2	.7	8,140	14,650	W218977
	--	29.3	68.6	2.1	5.2	86.0	1.7	4.4	.7	8,430	15,170	
	--	29.9	70.1	--	5.3	87.8	1.7	4.5	.8	8,610	15,490	
R-8619	1.1	33.1	58.1	7.7	5.3	78.1	1.7	6.4	.8	7,810	14,060	W225107
	--	33.4	58.7	7.8	5.2	79.0	1.7	5.5	.8	7,900	14,220	
	--	36.3	63.7	--	5.6	85.7	1.8	6.0	.9	8,570	15,420	
R-8622	2.4	34.2	57.5	5.9	5.3	76.4	1.6	6.9	4.0	7,680	13,830	W223358
	--	35.1	58.9	6.0	5.1	78.2	1.6	4.9	4.1	7,870	14,170	
	--	37.3	62.7	--	5.5	83.2	1.7	5.2	4.4	8,380	15,080	
R-8632	2.1	32.4	62.2	3.3	5.4	81.8	1.6	7.0	.8	8,070	14,520	W223353
	--	33.1	63.5	3.4	5.3	83.6	1.7	5.3	.8	8,240	14,830	
	--	34.3	65.7	--	5.5	86.5	1.7	5.5	.9	8,530	15,350	
R-8635	1.4	29.2	52.0	17.3	4.6	69.5	1.4	6.4	.8	6,880	12,380	W223352
	--	29.7	52.8	17.6	4.5	70.5	1.4	5.2	.8	6,970	12,550	
	--	36.0	64.0	--	5.5	85.5	1.7	6.3	.9	8,460	15,230	
R-8733	2.8	31.1	56.1	10.0	5.0	74.9	1.5	7.5	1.0	7,440	13,390	W231831
	--	32.0	57.8	10.3	4.9	77.1	1.6	5.2	1.0	7,650	13,770	
	--	35.6	64.4	--	5.4	85.9	1.8	5.8	1.1	8,530	15,350	
R-8734	5.2	30.9	58.8	5.1	5.6	76.9	1.5	9.5	1.4	7,610	13,690	W231832
	--	32.6	62.0	5.4	5.3	81.1	1.6	5.2	1.5	8,020	14,440	
	--	34.5	65.5	--	5.6	85.7	1.6	5.5	1.6	8,480	15,260	

Table 18b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia. --continued

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)				Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid			
R-8585	1.9	0.03	0.19	0.80	8.0	1,130	1,220	1,315	---	1.35	W218770
	---	.03	.20	.82							
	---	.03	.20	.84							
R-8597	2.5	.04	.01	.64	8.0	1,520	1,540	1,540G	---	1.13	W218973
	---	.04	.01	.66							
	---	.05	.01	.78							
R-8600	1.5	.14	.32	.72	8.5	1,250	1,360	1,460	---	1.73	W218976
	---	.14	.33	.74							
	---	.16	.36	.80							
R-8601	2.5	.09	.01	.62	9.0	1,240	1,270	1,390	---	.96	W218977
	---	.09	.01	.64							
	---	.10	.01	.66							
R-8619	.5	.05	.03	.75	7.5	1,540	1,540G	1,540G	58	1.14	W225107
	---	.05	.03	.76							
	---	.05	.03	.82							
R-8622	1.4	.69	1.61	1.70	8.0	1,090	1,110	1,130	76	5.78	W223358
	---	.71	1.65	1.74							
	---	.75	1.76	1.85							
R-8632	1.0	.06	.08	.69	8.5	1,320	1,380	1,470	59	1.10	W223353
	---	.06	.08	.70							
	---	.06	.08	.73							
R-8635	.6	.05	.09	.63	7.5	1,540	1,540G	1,540G	52	1.29	W223352
	---	.05	.09	.64							
	---	.06	.11	.78							
R-8733	1.7	.04	.37	.56	8.5	1,190	1,245	1,340	62	1.49	W231831
	---	.04	.38	.58							
	---	.05	.42	.64							
R-8734	4.0	.07	.71	.62	8.5	1,160	1,190	1,340	63	2.05	W231832
	---	.07	.75	.65							
	---	.08	.79	.69							

Table 18b.-Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia.--continued

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT	
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb
R-8736	3.4	31.6	59.6	5.4	5.3	78.1	1.4	8.2	1.6	7,850	14,120
---	32.7	61.7	5.6	5.1	80.9	1.4	5.4	1.6	8,120	14,620	
---	34.7	65.3	---	5.4	85.7	1.5	5.7	1.7	8,600	15,480	
R-8750	2.6	31.7	60.4	5.3	5.3	79.8	1.3	6.9	1.4	7,930	14,270
---	32.5	62.0	5.5	5.1	81.9	1.3	4.7	1.4	8,140	14,650	
---	34.4	65.6	---	5.4	86.6	1.4	5.0	1.5	8,610	15,500	
R-8760	1.8	33.1	62.3	2.8	5.3	82.2	1.5	7.4	.8	8,180	14,730
---	33.7	63.4	2.9	5.2	83.7	1.6	5.9	.8	8,350	15,000	
---	34.7	65.3	---	5.3	86.2	1.6	6.1	.8	8,580	15,440	
R-8810	2.1	38.0	54.9	4.9	5.5	78.8	1.9	7.5	1.3	7,930	14,270
---	38.8	56.1	5.0	5.4	80.5	1.9	5.8	1.3	8,100	14,580	
---	40.9	59.1	---	5.7	84.8	2.0	6.1	1.4	8,530	15,350	
R-8814	2.4	28.4	58.5	10.8	5.0	75.9	1.5	5.9	1.0	7,520	13,530
---	29.1	59.9	11.0	4.9	77.7	1.5	3.9	1.0	7,700	13,860	
---	32.7	67.3	---	5.5	87.3	1.7	4.4	1.2	8,650	15,570	
R-8818	8.2	27.5	60.9	3.4	5.4	75.1	1.5	13.6	.9	7,310	13,160
---	28.9	66.4	3.7	4.9	81.9	1.6	6.9	1.0	7,970	14,340	
---	31.1	68.9	---	5.1	85.0	1.7	7.2	1.1	8,270	14,890	
R-8819	13.2	22.7	52.2	11.9	5.0	60.0	1.3	21.4	.5	5,560	10,000
---	26.1	60.1	13.8	4.0	69.1	1.4	11.1	.6	6,400	11,520	
---	30.3	69.7	---	4.7	80.1	1.7	12.9	.7	7,420	13,350	
R-8820	3.4	36.3	57.0	3.3	5.5	81.3	1.6	7.1	1.3	8,080	14,540
---	37.6	59.1	3.4	5.3	84.1	1.6	4.2	1.3	8,370	15,060	
---	38.9	61.1	---	5.5	87.1	1.7	4.3	1.4	8,660	15,580	

Table 18b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia.--continued

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)				Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid			
R-8736	2.6	0.06	0.74	0.79	8.5	1,260	1,325	1,445	67	2.27	W231834
	---	.06	.77	.82							
	---	.07	.81	.87							
R-8750	2.1	.09	.49	.82	9.0	1,290	1,380	1,440	72	1.96	W235313
	---	.09	.50	.84							
	---	.10	.53	.89							
R-8760	.7	.01	.15	.64	8.0	1,350	1,425	1,495	60	1.09	W236241
	---	.01	.15	.65							
	---	.01	.16	.67							
R-8810	1.0	.03	.49	.80	7.0	1,125	1,255	1,365	57	1.82	W238481
	---	.03	.50	.82							
	---	.03	.53	.86							
R-8814	1.7	.02	.41	.57	8.0	1,425	1,530	1,540	72	1.48	W238474
	---	.02	.42	.58							
	---	.02	.47	.66							
R-8818	6.4	.01	.27	.66	2.5	1,120	1,140	1,295	74	1.37	W238475
	---	.01	.29	.72							
	---	.01	.31	.75							
R-8819	9.0	.01	.05	.44	.0	1,455	1,495	1,525	90	1.00	W238476
	---	.01	.06	.51							
	---	.01	.07	.59							
R-8820	2.6	.05	.58	.66	8.0	1,105	1,140	1,330	77	1.79	W238477
	---	.05	.60	.68							
	---	.05	.62	.71							

VIRGINIA DIVISION OF MINERAL RESOURCES

Table 18c.--Major- and minor-oxide concentrations in the laboratory ash of 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. L means less than the concentration shown; B not determined. Sample number is the VDMR identification number. Lab number is the USGS Laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	S ₀ 3	Lab Number
R-6814	15.4	59	29	1.1	1.0	0.73	2.2	2.3	1.4	0.80	1.5	W191067
R-6819	5.7	19	17	2.0	.61	1.2	.90	.54	.80	.11	4.3	W191068
R-6820	10.2	59	29	1.5	.90	.74	1.5	3.9	1.5	1.0	2.2	W191066
R-6828	3.8	31	15	2.9	3.0	1.2	1.9	.37	.50	.50	7.7	W191337
R-6830	3.0	34	21	2.4	1.0	1.9	2.5	.29	.70	.033	7.7	W191335
R-6831	2.4	28	14	3.4	.93	1.6	1.4	.41	.50	.083	8.2	W191336
R-6837	13.4	43	28	1.0	.76	.16	2.4	18	1.0	.68	.96	W200124
R-6838	9.4	60	24	2.4	.73	.92	1.3	3.4	1.6	1.5	1.8	W192600
R-6841	5.1	30	19	4.1	1.4	1.6	1.9	.28	1.0	.098	6.9	W192603
R-6846	9.6	56	25	1.2	.95	1.4	1.8	7.5	1.6	.38	1.5	W192592
R-6847	6.1	47	33	2.3	.70	.45	1.6	4.1	.96	1.5	1.7	W200122
R-6848	7.1	54	24	2.3	.58	1.2	.89	8.8	1.6	1.3	2.4	W192587
R-6878	12.1	44	17	.88	.65	.30	2.2	.27	.64	.16	2.2	W193673
R-6879	4.8	41	23	.96	1.2	1.0	3.3	.23	.74	.31	1.8	W200131
R-6880	4.7	16	11	1.1	.40	.59	.82	.57	.30	.085	2.3	W193670
R-6881	1.9	40	22	2.0	1.3	1.4	2.2	20	.67	.11	3.6	W193669
R-6896	6.7	52	32	1.1	.46	.55	.76	4.5	1.7	.045	.77	W194300
R-6897	7.0	46	24	.60	1.3	.68	4.2	12	.89	.071	1.4	W194298
R-6898	2.1	B	B	.76	1.8	B	B	B	B	B	.62	W194299
R-6900	23.4	54	25	.57	1.8	.35	4.8	8.4	1.0	.060	W194303	
R-6901	2.3	39	13	5.6	.98	1.1	1.5	20	.48	.26	8.8	W194304
R-6903	21.0	60	28	.58	.73	.27	2.3	2.9	2.2	.24	.30	W194295
R-6904	5.7	42	21	.95	1.3	.97	3.3	20	.72	.070	2.3	W194296
R-6905	2.7	43	22	1.7	.71	1.6	2.5	17	1.2	.15	2.4	W194297
R-6906	7.3	B	B	.46	.62	B	B	B	B	B	W194293	
R-6907	5.2	52	25	1.1	.58	.65	1.0	9.8	1.5	.077	1.8	W194294
R-6908	2.1	B	B	B	1.3	1.1	B	B	B	B	B	W194411
R-7406	15.3	56	26	1.8	.88	.31	1.9	4.4	1.8	.54	2.0	W205190
R-7407	13.7	53	24	2.2	.80	.38	1.9	9.6	1.7	.67	2.3	W205191
R-7546	7.4	42	25	1.6	.98	.47	2.6	18	1.1	.20	1.7	W209960
R-8244	14.2	45	22	.60	.75	.36	2.6	26	.99	.32	1.3	W212494
R-8483	3.1	35	20	1.6	1.0	.77	2.7	25	.65	.32L	2.7	W214770
R-8484	2.6	27	12	1.7	.45	1.5	1.3	41	.45	.38L	3.3	W214769
R-8538	5.1	30	11	1.8	1.0	.50	1.7	47	.43	.20	4.1	W217399
R-8539	8.4	57	27	.92	.47	.95	1.3	7.7	1.7	.12	1.4	W217400

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-8540	7.9	51	17	1.2	1.3	.78	.78	2.7	.22	.60	0.13	7.9
R-8541	4.3	57	29	1.3	.78	.68	.90	4.3	1.8	.23	.23	W217401
R-8575	18.9	55	29	.55	1.2	.57	2.5	3.2	1.5	.13	.13	W217402
R-8576	5.9	36	23	1.0	1.2	1.1	2.8	26	.90	.17L	.17L	W218774
R-8585	1.9	45	24	2.1	.55	2.3	.82	20	1.2	.53L	.53L	W218775
R-8597	15.2	54	29	.83	.86	.55	2.1	3.2	1.6	.24	.24	W218973
R-8600	7.4	48	26	1.1	1.1	.47	3.5	11	.84	.27	.27	W218976
R-8601	2.1	43	26	5.4	1.3	1.4	2.3	9.3	1.3	2.0	2.0	W218977
R-8619	7.5	50	34	1.4	.66	.70	1.8	3.4	1.6	.48	.48	W225107
R-8622	7.0	30	4.3	1.3	.27	.61	.35	59	.15	.14L	.14L	W223358
R-8632	3.5	45	30	2.1	1.0	1.5	2.4	7.6	1.3	.29L	.29L	W223353
R-8635	22.4	54	31	.60	1.1	.58	3.5	3.2	1.5	.28	.28	W223352
R-8733	10.3	44	22	1.9	1.0	.43	1.3	22	1.3	.93	.93	W231831
R-8734	6.0	43	19	1.8	1.2	.96	2.1	26	.50	.17L	.17L	W231832
R-8736	5.5	39	27	1.2	.60	.65	2.5	22	1.2	.20	.20	W231834
R-8750	6.8	43	30	1.2	.86	.76	3.1	15	1.2	.15L	.15L	W235313
R-8760	3.0	47	31	2.5	.96	.31	1.9	9.9	1.3	.33L	.33L	W236241
R-8810	4.8	48	26	1.3	.66	.27	2.6	17	1.2	.21L	.21L	W238481
R-8814	11.6	54	30	1.2	.52	.61	1.5	7.7	1.6	.55	.55	W238474
R-8818	3.8	30	20	3.7	1.3	.81	2.4	31	.54	.50	.50	W238475
R-8819	14.0	49	29	3.5	.71	.43	1.4	2.0	1.5	.36	.36	W238476
R-8820	3.6	37	20	1.3	.71	1.1	2.6	31	.67	.28L	.28L	W238477

Table 18d.--Major-, minor-, and trace-element composition of 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means less than the value shown; B, not determined; H, interference for an element which cannot be resolved by any routine method; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-6814	4.3	2.4	0.12	0.097	0.083	0.28	0.25	0.13	0.039	1.3	W191067
R-6819	.50	.51	.081	.021	.051	.043	2.1	.027	.042	35	W191068
R-6820	2.8	1.6	.11	.055	.056	.13	.28	.092	.072	3.7	W191066
R-6828	.55	.29	.079	.068	.035	.060	.99	.011	.008L	5.3	W191337
R-6830	.48	.33	.051	.019	.042	.062	.60	.013	.022	7.0	W191335
R-6831	.32	.18	.058	.013	.029	.028	.69	.007	.021	17	W191336
R-6837	2.7	2.0	.10	.062	.016	.27	1.6	.082	.10	34	W200124
R-6838	2.6	1.2	.16	.041	.064	.10	.22	.090	.014	1.1	W192600
R-6841	.72	.50	.15	.043	.061	.081	1.0	.031	.028	20	W192603
R-6846	2.5	1.3	.082	.055	.096	.14	.50	.092	.032	7.2	W192592
R-6847	1.3	1.1	.099	.026	.020	.080	.18	.035	.045	2.2	W200122
R-6848	1.8	.91	.12	.025	.061	.053	.44	.068	.034	16	W192587
R-6878	2.5	1.1	.076	.047	.027	.22	2.3	.046	.046	37	W193673
R-6879	.91	.59	.033	.035	.036	.13	.77	.021	.014	22	W200131
R-6880	.34	.28	.037	.011	.021	.032	1.9	.008	.029	88	W193670
R-6881	.35	.22	.027	.014	.019	.035	.26	.008	.016	6.0	W193669
R-6896	1.6	1.1	.053	.019	.027	.042	.21	.068	.031	1.1	W194300
R-6897	1.5	.90	.030	.057	.035	.24	.60	.037	.023	12	W194298
R-6898	B	B	B	.010	.027	B	B	B	.015	8.3	W194299
R-6900	5.9	3.1	.095	.26	.061	.94	1.4	.14	.023L	170	W194303
R-6901	.41	.16	.092	.014	.018	.029	.32	.007	.015	6.6	W194304
R-6903	5.9	3.1	.087	.092	.042	.40	.43	.28	.042	2.0	W194295
R-6904	1.1	.62	.039	.044	.041	.16	.78	.025	.006	14	W194296
R-6905	.54	.31	.033	.012	.032	.056	.32	.019	.014	16	W194297
R-6906	B	B	B	.020	.034	B	B	B	.030	1.1	W194293
R-6907	1.3	.70	.041	.018	.025	.043	.36	.047	.022	14	W194294
R-6908	B	B	B	.016	.016	B	B	B	.010	2.3	W194411
R-7406	4.0	2.1	.20	.081	.035	.25	.47	.16	.024	2.8	W205190
R-7407	3.4	1.7	.21	.066	.038	.21	.91	.14	.021	24	W205191
R-7546	1.4	.98	.087	.044	.026	.16	.91	.048	.011	29	W209960
R-8244	3.0	1.7	.061	.064	.038	.30	2.6	.084	.053	34	W212494
R-8483	.50	.33	.035	.019	.018	.069	.54	.012	.019	35	W214770
R-8484	.32	.16	.031	.007	.029	.75	.007	.023	.023	130	W214769
R-8538	.72	.30	.066	.031	.019	.071	1.7	.013	.026	14	W217399
R-8539	2.2	1.2	.055	.024	.059	.059	.45	.05	.012	11	W217400

Table 18d. --Major-, minor-, and trace-element composition of 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-8540	1.9	0.72	0.068	0.061	0.046	0.18	1.2	0.028	0.014	26	W217401
R-8541	1.2	.65	.039	.020	.022	.032	.13	.045	.024	1.6	W217402
R-8575	4.9	2.9	.074	.13	.079	.39	.42	.17	.030	4.7	W218774
R-8576	.99	.71	.043	.042	.047	.14	1.1	.032	.031	.89	W218775
R-8585	.39	.24	.029	.006	.032	.013	.26	.013	.019	29	W218770
R-8597	3.9	2.4	.090	.079	.062	.26	.33	.14	.040	3.2	W218973
R-8600	1.6	1.0	.060	.050	.026	.21	.56	.037	.034	13	W218976
R-8601	.42	.29	.080	.017	.021	.040	.14	.016	.015	1.4	W218977
R-8619	1.8	1.4	.074	.030	.039	.11	.18	.070	.062	1.7	W225107
R-8622	.99	.16	.067	.011	.032	.020	.2.9	.006	.11	130	W223358
R-8632	.73	.55	.054	.022	.039	.071	.19	.027	.027	12	W223353
R-8635	5.6	3.7	.096	.15	.096	.65	.49	.20	.12	3.6	W223352
R-8733	2.1	1.2	.14	.065	.033	.11	1.6	.080	.047	13	W231831
R-8734	1.2	.59	.077	.044	.043	.10	1.1	.018	.025	27	W231832
R-8736	1.0	.78	.048	.020	.026	.12	.85	.040	.018	22	W231834
R-8750	1.4	1.1	.059	.035	.038	.18	.71	.050	.049	12	W235313
R-8760	.65	.49	.054	.017	.007	.049	.21	.023	.017	2.7	W236241
R-8810	1.1	.67	.044	.019	.010	.11	.56	.033	.043	24	W238481
R-8814	2.9	1.9	.10	.036	.052	.15	.62	.11	.045	15	W238474
R-8818	.53	.40	.10	.031	.023	.075	.83	.012	.004L	30	W238475
R-8819	3.2	2.1	.35	.060	.045	.16	.19	.13	.042	3.8	W238476
R-8820	.62	.39	.033	.015	.030	.078	.79	.014	.025	41	W238477

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Table 18d.--Major-, minor-, and trace-element composition of 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-6814	28	180	2.3	9.0	0.077	24	B	8.7	22	1.6	W191067
R-6819	11	91	2.3	3.0	.063	6.0	B	2.3	5.0	.20	W191068
R-6820	16	150	4.4	21	.15	25	B	11	17	.50	W191066
R-6828	9.9	65	.91	3.0	.038	4.0	B	5.4	4.2	.30	W191337
R-6830	13	57	1.1	3.0	.045	5.0	B	4.1	4.7	.30	W191335
R-6831	8.2	38	1.3	8.0	.10	4.0	B	12	4.2	.10	W191336
R-6837	15	110	2.3	14	.47	37	650	6.7	21	1.3	W200124
R-6838	14	100	1.4	4.0	.094	24	B	6.5	18	.50	W192600
R-6841	28	82	.38	2.5	.087	7.0	B	2.2	6.6	.50	W192603
R-6846	14	61	1.7	3.0	.12	17	B	3.5	13	.80	W192592
R-6847	13	98	3.7	6.8	.10	21	400	8.8	12	.40	W200122
R-6848	15	110	1.5	1.0	.064	15	B	4.3	11	.20	W192587
R-6878	H	280	5.9	12	.099	27	B	16	12	1.3	W193673
R-6879	7.7	36	3.8	14	.19	8.0	760	9.4	6.3	.73	W200131
R-6880	H	21	1.3	11	.10	6.5	B	5.4	4.0	.20	W193670
R-6881	4.4	18	2.3	16	.051	5.0	B	5.6	3.2	.35	W193669
R-6896	5.0	44	1.7	4.5	.037	16	B	6.9	16	.40	W194300
R-6897	8.4	47	2.3	8.4	.091	11	B	5.7	8.8	1.6	W194298
R-6898	4.4	19	1.8	8.8	.036	3.0	B	3.0	3.2	.15	W194299
R-6900	26	140	3.5	9.1	.089	27	B	8.6	25	4.1	W194303
R-6901	3.2	23	1.6	9.1	.035	4.0	B	5.7	2.8	.20	W194304
R-6903	16	120	4.0	9.6	.050	30	B	13	33	2.1	W194295
R-6904	11	110	1.0	12	.063	8.0	B	4.1	6.4	.85	W194296
R-6905	7.3	26	1.9	17	.13	5.0	B	6.9	3.5	.35	W194297
R-6906	5.2	57	1.8	4.3	.016	16	B	9.0	15	.40	W194293
R-6907	5.0	41	1.9	5.7	.032	9.0	B	2.1	5.9	.20	W194294
R-6908	13	21	.50	1.3	.036	7.0	B	2.6	3.7	.30	W194411
R-7406	21	120	1.4	1.6	.066	27	70	5.1	22	1.3	W205190
R-7407	15	86	1.2	2.5	.067	24	100	3.7	18	1.1	W205191
R-7546	11	72	1.9	4.0	.068	14	190	5.8	10	1.0	W209960
R-8244	14	84	1.4	4.5	.054	16	280	3.2	14	1.1	W212494
R-8483	5.3	40	1.4	9.0	.059	4.0	510	3.9	3.1	.40	W214770
R-8484	3.6	34	1.1	8.7	.042	4.0	510	3.9	2.6	.20	W214769
R-8538	4.3	82	1.4	7.9	.043	4.0	500	4.6	3.2	.25	W217399
R-8539	5.9	52	1.3	3.9	.040	16	300	2.1	12	.80	W217400

Table 18d.--Major-, minor-, and trace-element composition of 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-8540	7.9	130	1.3	9.0	0.052	8.0	500	4.4	6.8	0.90	W217401
R-8541	6.5	35	1.7	9.3	.018	12	600	6.3	6.7	.20	W217402
R-8575	14	380	1.9	15	.057	39	640	6.1	32	2.8	W218774
R-8576	7.1	150	1.8	15	.030	9.0	900	3.5	6.6	.90	W218775
R-8585	3.0	21	1.0	13	.014	5.0	730	2.9	3.0	.10	W218770
R-8597	13	260	2.4	13	.027	33	660	6.1	27	2.5	W218973
R-8600	7.3	120	1.6	22	.044	11	1,300	4.5	11	1.5	W218976
R-8601	4.6	42	.99	15	.015	3.4	890	4.8	3.2	.28	W218977
R-8619	11	160	2.9	15	.030	17	1,400	8.0	16	.58	W225107
R-8622	5.0	45	1.5	17	.021	10	770	1.2	3.0L	.10L	W223358
R-8632	15	110	2.0	26	.026	8.0	2,000	2.2	5.0	.51	W223353
R-8635	25	380	4.0	15	.067	38	700	7.7	31	3.7	W223352
R-8733	10	110	1.0	2.9	.031	17	140	4.1	15	.97	W231831
R-8734	7.8	56	.59	2.3	.036	7.4	130	2.9	3.8	.42	W231832
R-8736	6.1	55	1.2	1.4	.011	8.8	100	2.9	7.6	.66	W231834
R-8750	13	120	2.4	1.2	.027	9.2	390	3.4	7.1	.83	W235313
R-8760	4.2	25	2.0	19	.014	9.6	1,900	2.5	4.0	.17	W236241
R-8810	19	32	2.6	9.2	.031	7.8	580	5.8	5.5	.58	W238481
R-8814	12	150	1.3	6.2	.028	21	290	4.7	16	1.2	W238474
R-8818	4.6	87	1.6	10	.038	6.4	540	3.8	3.5	.57	W238475
R-8819	15	200	1.8	5.1	.034	26	100L	5.2	19	1.2	W238476
R-8820	7.6	43	1.0	8.6	.14	4.1	600	5.6	4.2	.36	W238477

Table 18d.--Major-, minor-, and trace-element composition of 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia, reported on a whole-coal basis. --continued

Sample Number	Cu (ppm)	Dy-S (ppm)	Er-S (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	Lab Number
R-6814	18	8.9L	2.8L	0.40	20L	6.6	2.0	1.3L	1.0	0.017	W191067
R-6819	10	3.3L	1.0L	.13	160	2.6	.68L	1.5	.20	.15	W191068
R-6820	20	5.9L	2.8	.57	92	4.8	3.2	.85L	.80	.055	W191066
R-6828	11	2.4L	.76L	.12	150	2.0	.57	.68	.10	.030	W191337
R-6830	9.3	1.9L	.60L	.09	46	1.6	.42	.28L	.10	.048	W191335
R-6831	12	1.5L	.48L	.12	22	1.5	.62	1.2	.20	.048	W191336
R-6837	32	3.5	1.6	.73	320	6.4	2.8	.20L	.80	.18	W200124
R-6838	14	3.0L	.91	.30	140	4.5	.64L	1.3	1.1	.040	W192600
R-6841	9.7	1.6L	.51L	.15	37	2.1	.66	.29	.30	.15	W192603
R-6846	15	3.1L	.96L	.23	58	4.5	1.2	1.3	.70	.12	W192592
R-6847	18	2.1	1.1	.40	660	4.8	1.6	3.0	.43	.013	W200122
R-6848	11	2.3L	1.1	.25	63	4.0	.99	.71	.70	.10	W192587
R-6878	21	3.9L	1.2L	.40	63	5.0	2.8	8.5	.65	.063	W193673
R-6879	18	1.4	.72L	.20	56	4.8	1.0	3.8	.23	.025	W200131
R-6880	16	1.5L	.47L	.25	31	2.8	1.4	.42	.20	.13	W193670
R-6881	9.7	.70	.40	.21	21	2.1	.70	3.2	.25	.010L	W193669
R-6896	13	2.1L	.74	.27	34	2.9	.67	3.5	.65	.025	W194300
R-6897	17	2.2L	.70L	.24	66	4.4	.66	.70	.30	.073	W194298
R-6898	9.5	.67L	.40	.09	20L	1.7	.46	2.1	.10	.043	W194299
R-6900	26	7.5L	2.3L	.47	200	10	1.6L	1.1L	1.1	.13	W194303
R-6901	7.6	.74L	.23L	.11	30	1.3	.71	2.1	.10	.038	W194304
R-6903	21	6.7L	2.1L	.49	130	11	1.4L	12	1.8	.010L	W194295
R-6904	14	1.8L	.57L	.19	44	3.0	.57	.27	.20	.10	W194296
R-6905	17	.86L	.27L	.14	20	2.5	.62	.84	.20	.063	W194297
R-6906	14	2.3L	1.0	.28	39	3.6	.50L	3.9	.65	.043	W194293
R-6907	9.9	1.7L	.62	.15	30	3.4	.62	.73	.35	.020	W194294
R-6908	9.5	.46L	.21L	.17	20L	1.2	.34	.14	.30L	.010L	W194411
R-7406	21	3.4L	1.5L	.41	77	8.0	2.3L	.86	1.2	.062	W205190
R-7407	18	3.0L	1.4L	.39	72	6.9	2.1L	.62	1.0	.21	W205191
R-7546	17	1.6L	1.1	.36	60	3.3	1.2	.19	.40	.13	W209960
R-8244	13	3.1L	1.4L	.28	80	6.2	2.1L	3.3	.50	.26	W212494
R-8483	10	.68L	.31L	.11	20	1.7	.47L	.29	.10	.19	W214770
R-8484	6.8	.57L	.26L	.09	10L	1.2	.39L	2.6	.10	.25	W214769
R-8538	7.1	1.1L	.23L	.14	480	2.8	.77L	2.7	.30L	.070	W217399
R-8539	14	1.8L	.39L	.24	840	4.1	1.3L	.51	.60	.060	W217400

Table 18d.--Major-, minor-, and trace-element composition of 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Cu (ppm)	Dy-S (ppm)	Er-S (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	Lab Number
R-8540	8.7	1.7L	0.36L	0.20	50	2.8	1.2L	2.0	0.30	0.070	W217401
R-8541	4.7	.95L	.20L	.21	320	5.2	.65L	.65	.40	.060	W217402
R-8575	10	4.2L	.87L	.65	270	6.0	6.0L	.87L	1.3	.31	W218774
R-8576	7.1	1.3L	.27L	.23	160	2.7	1.9L	.36	.20	.39	W218775
R-8585	5.1	.42L	.09L	.10	30	1.3	.61L	2.3	.10	.29	W218770
R-8597	17	3.3L	.70L	.55	80	7.6	4.9L	2.4	1.1	.050	W218973
R-8600	13	1.6L	.34L	.30	100	5.5	2.4L	.57	.32	.15	W218976
R-8601	7.8	.95	.63	.10	20	1.8	.97	.42	.15	.11	W218977
R-8619	12	1.7L	.35L	.34	80	7.1	2.4L	3.5	.48	.16	W225107
R-8622	7.7	1.5L	.32L	.08	30	H	2.2L	.46	.20L	.36	W223358
R-8632	12	1.7	.95	.24	70	3.3	1.3	.46	.19	.20	W223353
R-8635	36	4.9L	1.0L	.67	100	14	7.2L	1.4	1.2	.21	W223352
R-8733	13	2.3L	.47L	.44	40	2.7	3.3L	.53	.76	.050	W231831
R-8734	13	1.3L	.28L	.21	20	1.3	1.9L	.54	.15	.050L	W231832
R-8736	9.4	1.2L	.25L	.21	70	1.2	1.8L	.25L	.36	.050L	W231834
R-8750	17	1.5L	.31L	.21	20L	4.3	2.2L	1.1	.30	.020	W235313
R-8760	14	.66L	.14L	.21	20L	1.5	.96L	2.5	.19	.005L	W236241
R-8810	12	.48L	.22L	.20	30	4.2	.48L	3.7	.26	.010	W238481
R-8814	15	1.2L	.53L	.39	90	8.6	1.2L	.56	.81	.060	W238474
R-8818	13	.38L	.17L	.18	30	2.1	.84L	1.4	.14	.060	W238475
R-8819	13	1.4L	.64L	.42	50	7.6	1.4L	1.1	.96	.080	W238476
R-8820	14	.90	.17L	.14	20L	2.5	.36L	.76	.10	.030	W238477

VIRGINIA DIVISION OF MINERAL RESOURCES

Table 18d.--Major-, minor-, and trace-element composition of 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Ho-S (ppm)	La (ppm)	Li (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Ni-S (ppm)	P (ppm)	Lab Number
R-6814	1.8L	14	.38	0.14	12	1.3	6.5	23	18	540 W191067
R-6819	.68L	3.0	5.5	.07	10	2.1	.74	4.7L	3.8	26 W191068
R-6820	1.2L	14	20	.22	8.2	2.4	3.9	35	22	450 W191066
R-6828	.53L	2.0	1.9	.06	28	2.0	.26	3.5L	6.1	83 W191337
R-6830	.42L	2.0	2.1	.07	3.6	2.8	.19L	2.8L	6.6	4.4 W191335
R-6831	.34L	2.0	.89	.07	6.0	2.4	.34	3.1	14	8.7 W191336
R-6837	.91L	22	.39	.24	8.3	3.8	1.7	20	21	400 W200124
R-6838	.64L	14	16	.15	17	.94	2.1	4.3L	6.2	620 W192600
R-6841	.35L	3.5	2.6	.07	23	.97	.51	2.3L	2.7	22 W192603
R-6846	.65L	9.0	26	.11	12	1.2	.31	9.0	8.8	160 W192592
R-6847	.48	12	12	.17	3.8	1.6	1.7	12	15	400 W200122
R-6848	.71L	8.0	7.1	.13	3.6	1.1	1.6	5.2	11	400 W192587
R-6878	.82L	17	8.1	.15	18	2.1	1.5	13	25	83 W193673
R-6879	.33L	4.0	6.2	.15	11	4.0	.72	4.8	16	66 W200131
R-6880	.32L	2.5	.99	.14	8.9	2.4	.52	2.8	8.9	17 W193670
R-6881	.13L	2.0	1.2	.10	3.6	1.3	.23	2.5	5.1	8.7 W193669
R-6896	.46L	9.0	17	.12	6.0	.54	1.3	6.4	15	13 W194300
R-6897	.48L	6.0	7.0	.12	12	2.9	.39	6.9	9.8	22 W194298
R-6898	.14L	1.5	1.6	.06	2.9	2.3	.17	2.5	5.7	B W194299
R-6900	1.6L	15	21	.17	54	2.6	1.1	14	16	61 W194303
R-6901	.16L	2.0	1.2	.05	30	3.0	.37	2.3	6.2	26 W194304
R-6903	1.4L	18	110	.22	9.7	.67L	3.8	15	23	220 W194295
R-6904	.39L	4.0	9.1	.08	43	2.5	.35	3.9	6.8	17 W194296
R-6905	.27L	2.0	2.2	.07	5.1	1.2	.27	3.5	7.6	17 W194297
R-6906	.50L	9.0	16	.12	5.2	.57	1.2	8.0	20	B W194293
R-6907	.35L	6.0	8.8	.08	3.5	2.4	1.2	7.3	10	17 W194294
R-6908	.14L	3.0	1.9	.09	19	.82	.17	1.0	2.5	B W194411
R-7406	1.0L	17	60	.15	13	.67	4.0	8.1	14	360 W205190
R-7407	.93L	14	52	.15	18	1.5	3.0	4.4L	9.3	400 W205191
R-7546	.50L	7.0	7.0	.09	120	2.7	1.6	12	10	66 W209960
R-8244	.97L	9.0	30	.11	24	.97L	1.6	6.0	10	200 W212494
R-8483	.21L	2.0	1.2	.04	8.4	6.5	.59	4.0	9.0	44L W214770
R-8484	.18L	2.0	.47	.03	2.6	3.4	.23	1.9	4.7	44L W214769
R-8538	.35L	2.0	2.0	.06	170	4.0	.56	1.6L	12	44 W217399
R-8539	.57L	8.0	8.4	.06	7.0	.92	1.4	6.4	8.4	44 W217400

Table 18d.--Major-, minor-, and trace-element composition of 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Ho-S (ppm)	La (ppm)	Li (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Lab Number
R-8540	.54L	4.0	6.1	0.04	120	2.6	0.95	6.2	9.5	44	W217401
R-8541	.29L	6.0	6.0	.09	6.9	1.2	.73	2.9	13	44	W217402
R-8575	1.3L	22	18	.06	7.4	.30	3.4	16	14	110	W218774
R-8576	.40L	5.0	2.1	.08	3.6	1.8	1.1	5.2	7.1	44L	W218775
R-8585	.13L	3.0	1.2	.01	1.2	1.1	.40	2.5	4.6	44L	W218770
R-8597	1.0L	18	21	.15	9.9	.47	3.3	15	14	160	W218973
R-8600	.50L	5.9	5.1	.12	8.1	5.2	1.1	12	15	87	W218976
R-8601	.14L	1.9	1.1	.04	12	2.7	.55	1.8	8.4	180	W218977
R-8619	.51L	11	11	.10	3.7	.98	1.6	12	19	160	W225107
R-8622	.48L	1.2	1.3	.02	8.4	H	1.3	2.2L	7.7	44L	W223358
R-8632	.39	4.0	2.5	.07	2.9	1.4	1.7	8.8	7.4	44L	W223353
R-8635	1.5L	21	27	.17	15	.85	6.9	36	29	270	W223352
R-8733	.70L	8.8	20	.15	200	1.5	1.1	8.5	7.3	420	W231831
R-8734	.41L	3.8	5.4	.08	14	.90	.41L	3.7	4.4	44L	W231832
R-8736	.37L	4.5	6.6	.05	5.5	.72	.47	5.0	4.0	48	W231834
R-8750	.46L	5.0	11	.07	8.8	2.0	1.6	11	12	44L	W235313
R-8760	.20L	4.9	5.4	.05	6.0	.93	.90	6.3	3.9	44L	W236241
R-8810	.07L	4.0	5.8	.08	5.3	1.6	.48	2.9	12	44L	W238481
R-8814	.17L	12	27	.14	7.8	1.3	.46	11	15	280	W238474
R-8818	.06L	3.1	2.6	.05	57	2.1	.31	3.7	8.0	83	W238475
R-8819	.21L	15	20	.16	35	1.3	.87	10	15	220	W238476
R-8820	.05L	2.4	2.6	.07	27	2.5	.31	2.0	8.6	44L	W238477

Table 18d.--Major-, minor-, and trace-element composition of 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Pb (ppm)	Pr-S (ppm)	Rb (ppm)	Sb (ppm)	Sc (ppm)	Se (ppm)	Sm (ppm)	Sn-S (ppm)	Sr-S (ppm)	Ta (ppm)	Lab Number
R-6814	6.8	18L	22	0.34	4.3	1.5	2.2	1.8L	340	0.32	W191067
R-6819	1.3	10L	11L	.37	1.5	7.0	.60	.68L	97	.060	W191068
R-6820	5.9	12L	14L	.37	3.6	1.7	2.9	1.2L	280	.40	W191066
R-6828	.87	5.3L	11L	.70	1.8	2.1	.50	.53L	49	.21L	W191337
R-6830	1.7	4.2L	12L	.62	1.3	2.5	.50	.57	57	.23L	W191335
R-6831	1.1	3.4L	11L	.77	1.3	1.7	.60	.48	41	.22L	W191336
R-6837	9.1	20L	21	1.0	4.2	2.4	3.5	.20L	310	.17	W200124
R-6838	4.6	6.4L	24L	.42	3.5	1.5	1.9	.64L	150	.24	W192600
R-6841	61	3.5L	15L	19	1.4	6.8	7.0	14	61	.13	W192603
R-6846	5.1	6.5L	27L	.36	2.9	2.5	1.5	.65L	110	.19	W192592
R-6847	4.4	9.2L	20L	.73	3.5	1.3	1.9	.09L	220	.11	W200122
R-6848	3.2	4.8L	28L	.40	2.8	1.1	1.2	.48L	160	.23	W192587
R-6878	2.7	9.4	14	2.3	3.0	2.3	2.1	.82L	93	.060	W193673
R-6879	2.8	7.2L	11	2.3	2.5	1.7	.93	.07L	82	.20L	W200131
R-6880	.85	3.2L	9.0L	.90	2.1	3.7	1.1	.32L	36	.21L	W193670
R-6881	1.5	1.3L	7.0L	2.7	2.1	2.0	.85	.13L	30	.19L	W193669
R-6896	5.1	4.6L	21L	1.1	2.4	1.4	1.5	.46L	60	.16	W194300
R-6897	4.7	4.8L	19	1.7	3.0	1.1	1.2	.48L	43	.090	W194298
R-6898	1.6	1.4L	18L	1.5	.82	1.3	.40	.14L	34	.53L	W194299
R-6900	9.4	16L	59	2.4	5.9	3.2	2.5	1.6L	56	.29	W194303
R-6901	1.3	1.6L	14L	1.5	1.1	2.2	.40	.20	37	.41L	W194304
R-6903	14	14L	21	1.3	7.1	2.7	2.4	1.4L	130	.57	W194295
R-6904	3.0	3.9L	23L	.95	2.0	1.8	.80	.39L	46	.070	W194296
R-6905	1.6	1.8L	20L	.95	1.3	2.8	.55	.35	38	.085	W194297
R-6906	9.5	5.0L	25L	.95	3.2	1.4	1.4	.50L	71	.15	W194293
R-6907	3.4	3.5L	21L	.90	1.6	.79	.90	.35L	50	.10	W194294
R-6908	1.6	1.4L	13L	.30	1.5	1.3	.80	.05	25	.27L	W194411
R-7406	11	10L	21	.45	4.6	1.4	2.1	.66	240	.39	W205190
R-7707	9.0	9.3L	19	.70	4.1	1.5	1.9	.55	220	.36	W205191
R-7546	2.7	5.8	50L	.70	2.4	1.8	1.2	.11L	150	.14	W209960
R-8244	4.3	11	13	1.0L	3.0	2.9	1.2	.21L	140	.18	W212494
R-8483	2.2	2.1L	20L	1.1	1.4	1.4	.50	.05L	53	.040	W214770
R-8484	1.6	1.8L	20L	1.6	.93	3.0	.30	H	42	.060L	W214769
R-8538	1.6	8.2	20L	1.1	1.3	1.8	.40	1.3	44	.20L	W217399
R-8539	6.6	5.7L	20L	.30	2.5	1.9	1.1	.49	81	.25	W217400

Table 18d.--Major-, minor-, and trace-element composition of 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Pb (ppm)	Pr-S (ppm)	Rb (ppm)	Sb (ppm)	Sc (ppm)	Se (ppm)	Sr (ppm)	Sr-S (ppm)	Ta (ppm)	Lab Number
R-8540	3.1	7.6	20L	1.0	1.7	2.2	0.70	0.36L	.66	W217401
R-8541	2.8	3.5	8.0	.60	2.1	.84	.90	.47	.69	W217402
R-8575	4.7	19L	27	.40	6.4	3.2	2.7	1.8	140	W218774
R-8576	.94	5.9L	4.0	.90	1.8	6.9	.80	.42	71	W218775
R-8585	.30	1.9L	20L	.40	.55	2.4	.30	.10	.38	W218770
R-8597	7.4	15L	19	.71	6.0	3.3	2.2	1.5	180	W218973
R-8600	3.5	7.4L	14	1.8	3.1	2.4	1.1	.34L	.67	W218976
R-8601	.80	2.1L	10L	.50	.94	1.5	.35	.12	.55	W218977
R-8619	4.4	7.5L	20L	.85	3.5	1.7	1.4	.83	.190	W225107
R-8622	3.2	7.0L	10L	1.0	.39	.90L	.27	H	.70	W223358
R-8632	2.8	3.5L	20L	.56	1.4	3.2	.84	.29	.130	W223353
R-8635	19	22L	40	.56	7.0	3.7	2.8	2.1	.250	W223352
R-8733	6.5	10L	13	.39	4.2	1.6	2.0	2.1	.120	W231831
R-8734	4.0	6.0L	30L	.71	1.6	2.9	1.0	.28L	.60	W231832
R-8736	3.1	5.5L	25L	.33	1.9	6.2	.99	.99	.49	W231834
R-8750	3.8	6.8L	11	.47	2.1	5.2	1.1	.95	.120	.12
R-8760	2.6	3.0L	30L	.65	1.3	4.0	1.0	.36	.84	W236241
R-8810	1.8	.33L	20L	1.9	1.7	1.7	1.0	.48	.34	W238481
R-8814	5.8	.79L	40L	.28	3.9	2.3	2.0	1.5	.220	W238474
R-8818	1.7	.49	26L	1.2	1.2	3.3	.85	.99	.27	W238475
R-8819	3.9	1.4	30L	.38	4.6	2.3	2.3	1.2	.98	W238476
R-8820	1.6	.32	29L	1.2	.63	1.6	1.6	.54	.24	W238477

Table 18d.--Major-, minor-, and trace-element composition of 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Tb (ppm)	Th (ppm)	Tl-S (ppm)	Tm-S (ppm)	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Lab Number
R-6814	0.27	3.6	2.8L	1.3L	1.2	38	0.44	15	0.90	10	W191067
R-6819	.080	.70	1.0L	.47L	.66	5.4	.46	3.9	.40	3.0	W191068
R-6820	.50	3.1	1.8L	.85L	.90	34	.61	26	1.5	26	W191066
R-6828	.10	.50	.76L	.35L	.53	5.3	.55	2.3	.30	5.3	W191337
R-6830	.10	.50	.60L	.28L	.42	7.2	.39	3.3	.40	5.7	W191335
R-6831	.12	.30	.48L	.22L	.46	4.1	.48	3.8	.40	34	W191336
R-6837	.53	4.2	.43L	.62L	B	33	.67	16	1.5	44	W200124
R-6838	.28	3.1	.94L	.43L	1.6	17	.64	2.5	.70	3.8	W192800
R-6841	.46L	.90	.51L	.23L	1.3	4.9	.26	1.8	.30	7.1	W192603
R-6846	.78L	2.1	.96L	.44L	1.5	17	.38	6.7	.50	8.8	W192592
R-6847	.28	1.7	.20L	.28L	B	31	.40	13	1.1	3.8	W200122
R-6848	.80L	2.0	.78	.50	1.2	16	.33	6.1	.70	2.6	W192587
R-6878	.27	2.2	1.2L	.56L	1.7	22	.51	11	.90	18	W192673
R-6879	.21	1.1	.15L	.22L	B	15	.97	9.1	.87	16	W200131
R-6880	.25	.50	.47L	.22L	1.8	7.5	.38	5.6	.80	56	W192670
R-6881	.22	.50	.19L	.09L	.99	6.1	.77	4.6	.60	16	W193669
R-6896	.20	2.4	.67L	.31L	3.3	15	.50	6.4	.70	4.8	W194300
R-6897	.20	1.7	.70L	.32L	2.5	18	.60	6.9	.70	24	W194298
R-6898	.10	.30	.48	.10L	1.6	7.1	.25	3.8	.30	7.4	W194299
R-6900	.38	4.6	2.3L	1.1L	3.8	42	.60	8.9	1.1	28	W194303
R-6901	.13	.30	.23L	.11L	2.2	7.1	.40	4.6	.30	8.7	W194304
R-6903	.37	5.7	2.1L	.97L	3.0	52	.95	11	1.4	12	W194295
R-6904	.14	1.2	1.5	.26L	1.7	11	.30	4.0	.45	17	W194296
R-6905	.13	.55	.27L	.12L	1.1	4.9	.35	3.8	.40	3.5	W194297
R-6906	.22	2.3	.73L	.34L	3.3	18	.40	6.5	.70	5.1	W194293
R-6907	.13	1.1	.52L	.24L	2.1	13	.60	6.8	.50	3.7	W194294
R-6908	.31L	.50	.067L	.10L	1.0	4.2	.60	2.3	.50	5.7	W194411
R-7406	.31	4.6	.70L	.70L	1.7	26	B	5.7	.80	7.5	W205190
R-7407	.33	3.9	.63L	.63L	1.5	22	B	4.0	.90	6.4	W205191
R-7546	.25	1.7	.34L	.34L	.88	15	.40	6.4	.70	10	W209960
R-8244	.22	2.5	.65L	.65L	1.8	21	.70	2.7	.60	13	W212494
R-8483	.10	.60	2.0	.14L	.36L	14	.60	3.7	.40	16	W214770
R-8484	.080	.30	.12L	.12L	.32L	4.9	.40	1.7	.20	13	W214769
R-8538	.11	.45	.51L	.23L	.45	7.1	.30	3.9	.40	13	W217399
R-8539	.21	2.5	.84L	.39L	1.3	12	.50	2.6	.60	5.5	W217400

Table 18d.--Major-, minor-, and trace-element composition of 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Tb (ppm)	Th (ppm)	Tl-S (ppm)	Tm-S (ppm)	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Lab Number
R-8540	.30L	1.4	0.79L	0.36L	0.59	13	0.30	3.4	0.40	12	W217401
R-8541	.19	1.5	.43L	.20L	.68	7.7	.70	3.7	.70	2.0	W217402
R-8575	.47	6.0	1.9L	.87L	1.7	32	.80	7.7	1.3	6.2	W218774
R-8576	.14	1.1	.59L	.27L	.92	9.4	2.0L	4.2	.60	5.3	W218775
R-8585	.040	.50	.19L	.09L	.28	3.4	.50	1.2	.20	2.7	W218770
R-8597	.63	4.8	1.5L	.70L	1.8	35	.76	9.9	1.2	4.0	W218973
R-8600	.25	1.9	.74L	.34L	2.5	27	.87	7.1	.91	8.9	W218976
R-8601	.088	.43	.21L	.10L	.22L	5.5	.35	3.2	.29	2.7	W218977
R-8619	.31	2.2	.75L	.35L	1.2	23	.92	7.2	.89	5.3	W225107
R-8622	.070	.20L	.70L	.32L	.30	4.1	.71	4.0	.15	4.9	W223358
R-8632	.22	.80	.35L	.16L	1.0	12	.92	5.6	.52	9.5	W223353
R-8635	.57	6.0	2.2L	1.0L	1.9	52	.84	15	1.4	15	W223352
R-8733	.32	2.7	1.0L	.47L	1.0	9.6	.61	4.7	1.1	13	W231831
R-8734	.13	1.0	.60L	.28L	.70	6.0	.47	2.4	.44	13	W231832
R-8736	.12	1.1	.55L	.25L	.67	5.3	.30	2.6	.52	4.0	W231834
R-8750	.14	1.2	.68L	.31L	.49	15	.37	5.1	.54	6.1	W235313
R-8760	.14	.75	.30L	.14L	.30L	5.1	.51	3.3	.48	3.9	W236241
R-8810	.13	.86	.48L	.15L	.82	8.6	.77	1.7	.53	7.7	W238481
R-8814	.24	3.1	1.2L	.37L	1.2	22	.45	4.1	.84	4.6	W238474
R-8818	.11	.66	.38L	.12L	.53	5.7	.35	3.6	.45	11	W238475
R-8819	.26	3.6	1.4L	.45L	1.6	25	.47	5.9	.94	4.5	W238476
R-8820	.10	.66	.36L	.12L	.79	6.8	.47	2.3	.41	18	W238477

Table 18d.--Major-, minor-, and trace-element composition of 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia, reported on a whole-coal basis. --continued

Sample Number	Zr-S (ppm)	Lab Number	Sample Number	Zr-S (ppm)	Lab Number
R-6814	89	W191067	R-8540	5.8	W217401
R-6819	8.0	W191068	R-8541	7.3	W217402
R-6820	46	W191066	R-8575	21	W218774
R-6828	2.1	W191337	R-8576	6.5	W218775
R-6830	2.3	W191335	R-8585	3.0	W218770
R-6831	1.7	W191336	R-8597	27	W218973
R-6837	20	W200124	R-8600	10	W218976
R-6838	10	W192600	R-8601	5.0	W218977
R-6841	3.7	W192603	R-8619	12	W225107
R-6846	21	W192592	R-8622	2.8	W223358
R-6847	15	W200122	R-8632	8.8	W223353
R-6848	9.9	W192587	R-8635	45	W223352
R-6878	19	W193673	R-8733	8.2	W231831
R-6879	7.7	W200131	R-8734	2.6	W231832
R-6880	2.4	W193670	R-8736	6.1	W231834
R-6881	1.6	W193669	R-8750	10	W235313
R-6896	12	W194300	R-8760	6.0	W236241
R-6897	6.5	W194298	R-8810	7.2	W238481
R-6898	2.0	W194299	R-8814	13	W238474
R-6900	17	W194303	R-8818	2.9	W238475
R-6901	3.0	W194304	R-8819	20	W238476
R-6903	27	W194295	R-8820	2.4	W238477
R-6904	4.4	W194296			
R-6905	3.0	W194297			
R-6906	12	W194293			
R-6907	14	W194294			
R-6908	1.4	W194411			
R-7406	26	W205190			
R-7407	15	W205191			
R-7546	13	W209960			
R-8244	12	W212494			
R-8483	4.0	W214770			
R-8484	1.5	W214769			
R-8538	2.8	W217399			
R-8539	6.8	W217400			

Table 18e.--Arithmetic mean, observed range and geometric mean of proximate and ultimate analyses, heat content, forms of sulfur, and ash-fusion temperatures for 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included.

[All values are in percent except Btu/lb, Kcal/kg, ash-fusion temperatures, and free-swelling index and are reported on an as-received basis. °F = 9/5 °C + 32; Kcal/kg = 0.356 Btu/lb; (n) is number of samples per parameter.]

	Dorchester coal bed				Appalachian basin		
	Arith. mean (n)	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
		Min.	Max.				
Proximate and ultimate analyses							
Moisture	(57)	3.03	1.12	13.17	2.67	3.23	2.69 (4,760)
Volatile matter	(57)	30.94	21.50	38.01	30.77	32.46	31.72 (4,760)
Fixed carbon	(57)	58.19	42.70	67.00	58.00	52.48	51.76 (4,760)
Ash	(57)	7.84	1.90	31.70	6.18	11.83	9.83 (4,760)
Hydrogen	(57)	5.20	3.90	5.70	5.19	5.02	5.00 (4,760)
Carbon	(57)	76.54	54.40	83.80	76.31	70.69	70.17 (4,760)
Nitrogen	(57)	1.48	1.00	1.86	1.48	1.39	1.37 (4,757)
Oxygen	(57)	7.64	5.35	21.38	7.40	8.92	8.22 (4,756)
Sulfur	(57)	1.29	.50	4.00	1.14	2.15	1.63 (4,974)
Heat content							
KCal/kg	(57)	7,612	5,393	8,361	7,587	7,030	6,979 (4,759)
Btu/lb	(57)	13,691	9,699	15,038	13,645	12,644	12,553 (4,759)
Forms of sulfur							
Sulfate	(57)	0.06	0.01	0.69	0.03	0.08	0.04 (4,245)
Pyritic	(57)	.53	.01	2.66	.29	1.36	.65 (4,392)
Organic	(57)	.71	.17	1.70	.68	.82	.70 (4,393)
Ash-fusion temperature (°C)							
Initial deformation	(49)	1,250	1,052	1,521	1,242	1,255	1,246 (4,063)
Softening	(46)	1,294	1,102	1,532	1,287	1,287	1,280 (3,722)
Fluid	(42)	1,342	1,127	1,538	1,336	1,334	1,328 (3,449)
Free-swelling index	(55)	8.20	2.50	9.00	8.08	5.53	4.68 (4,603)
Air-dried loss	(45)	2.00	0.40	9.02	1.57	1.83	1.13 (3,868)

Table 18f.--Arithmetie mean, observed range, and geometric mean of ash content and concentrations of 11 major- and minor-oxides in the laboratory ash of 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. (n) indicates the number of samples per oxide.

[All samples were ashed at 525°C; all data are in percent.]

	Dorchester coal bed				Appalachian basin			
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	
			Min.	Max.			(n)	
(Ash)	(57)	7.8	1.9	23	6.2	13	10	(5,262)
SiO ₂	(54)	44	16	60	43	43	41	(5,229)
Al ₂ O ₃	(54)	23	4.3	34	22	24	23	(5,229)
CaO	(54)	1.8	.55	5.6	1.5	2.2	1.5	(5,227)
MgO	(57)	.93	.27	3.0	.85	.85	.75	(5,258)
Na ₂ O	(57)	.85	.16	2.3	.73	.43	.34	(5,194)
K ₂ O	(54)	2.1	.35	4.8	1.9	2.0	1.7	(5,229)
Fe ₂ O ₃	(54)	18	2.0	59	13	19	13	(5,215)
MnO	(57)	.048	.005	.44	.023	.03	.02	(5,260)
TiO ₂	(54)	1.1	.15	2.2	.97	1.2	1.1	(5,203)
P ₂ O ₅	(43)	.42	.020	2.0	.25	.50	.22	(3,389)
SO ₃	(48)	2.9	.30	8.8	2.3	2.5	1.9	(5,063)

Table 18g.--Arithmetic mean, observed range, and geometric mean of concentrations of 54 trace elements in 57 bituminous coal samples from the Dorchester coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. Dashed values (---) represent less than five samples; (n) indicates the number of samples per element. [All data are in parts-per-million and are reported on a whole-coal basis.]

	Dorchester coal bed				Appalachian basin		
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean
			Min.	Max.			(n)
Ag (55)		0.033	0.006	0.12	0.027	0.07	0.05 (4,565)
As (57)		23	1.1	170	11	35	13 (5,197)
B (55)		11	3.0	28	9.3	30	20 (5,076)
Ba (57)		96	18	380	72	90	63 (5,134)
Be (57)		1.9	.38	5.9	1.6	2.5	2.0 (5,247)
Bi ---		---	---	---	---	1.5	1.1 (108)
Br (57)		9.0	1.0	26	6.9	22	13 (4,892)
Cd (57)		.065	.011	.47	.049	.10	.07 (4,978)
Ce (57)		14	3.0	39	11	21	17 (5,075)
Cl (32)		630	70	2,000	470	780	510 (3,646)
Co (57)		5.4	1.2	16	4.8	7.4	5.7 (5,217)
Cr (56)		11	2.6	33	8.2	18	15 (5,205)
Cs (56)		.84	.10	4.1	.57	1.3	.85 (4,831)
Cu (57)		14	4.7	36	13	19	15 (5,239)
Dy (6)		1.5	.70	3.5	1.3	3.3	2.6 (759)
Er (14)		1.0	.40	2.8	.88	1.5	1.2 (1,200)
Eu (57)		.27	.080	.73	.23	.44	.37 (5,032)
F (50)		120	20	840	69	99	71 (4,860)
Ga (56)		4.1	1.2	14	3.4	6.6	5.4 (5,046)
Gd (25)		1.1	.34	3.2	.93	2.6	1.9 (1,773)
Ge (50)		1.8	.14	12	1.1	4.7	2.5 (4,608)
Hf (54)		.50	.10	1.8	.36	.79	.62 (4,932)
Hg (51)		.11	.010	.39	.077	.22	.15 (5,031)
Ho (2)		---	.39	.48	---	.76	.61 (378)
La (57)		7.6	1.2	22	5.5	11	8.9 (5,147)
Li (57)		13	.47	110	6.4	22	14 (5,243)
Lu (57)		.10	.010	.24	.09	.16	.14 (4,885)
Mn (57)		23	1.2	200	11	31	15 (5,260)
Mo (54)		1.9	.30	6.5	1.6	3.7	2.3 (4,889)
Nb (55)		1.4	.17	6.9	.93	2.6	1.9 (5,005)
Nd (49)		8.6	1.0	36	6.2	13	9.9 (4,231)
Ni (57)		11	2.5	29	9.6	17	14 (5,240)
Pb (57)		5.2	.30	61	3.2	8.8	6.2 (5,172)
Pd ---		---	---	---	---	.17	.14 (18)
Pr (9)		5.4	.32	11	3.1	6.1	3.6 (960)
Rb (18)		20	4.0	59	17	28	22 (2,232)
Sb (56)		1.2	.28	19	.81	1.4	.91 (5,003)
Sc (57)		2.6	.39	7.1	2.2	4.4	3.6 (5,218)
Se (56)		2.5	.79	7.0	2.2	3.6	2.8 (5,052)
Sm (57)		1.3	.27	3.5	1.0	2.0	1.6 (5,005)
Sn (28)		1.3	.050	14	.66	1.6	.86 (2,352)
Sr (57)		100	24	340	80	110	79 (5,146)
Ta (43)		.19	.040	.57	.15	.24	.19 (4,369)
Tb (52)		.22	.040	.63	.19	.34	.29 (4,852)
Th (56)		1.9	.30	6.0	1.3	3.0	2.3 (5,098)
Tl (4)		---	.48	2.0	---	3.4	2.1 (382)
Tm (1)		---	.50	.50	---	1.7	.38 (46)
U (49)		1.4	.28	3.8	1.1	1.8	1.3 (4,990)
V (56)		16	3.4	52	12	24	19 (5,241)
W (53)		.54	.25	.97	.51	.94	.80 (4,421)
Y (56)		5.8	1.2	26	4.8	8.5	7.2 (5,234)
Yb (56)		.67	.15	1.5	.59	1.1	.92 (5,151)
Zn (56)		11	2.0	56	8.2	22	14 (5,243)
Zr (56)		12	1.4	89	7.5	24	17 (5,238)

LYONS COAL BED

This coal crops out in Dickenson, Lee, and Wise Counties. In 1989, 0.4 million tons were produced from Dickenson and Wise Counties (Virginia Division of Mines, 1990). In Lee County, the Lyons is known as the Thompson coal bed. In Wise and Dickenson Counties it has been called the Eagle, Blair, Bald Eagle, or the Upper Eagle coal bed. Sampled thickness ranges from 1.2 to 3.2 feet. The Lyons typically has a well-developed medium cleat with moderate- and abundant-medium banding. Pyrite occurs on the cleats and roof rock is generally shale.

The 32 samples from the Lyons coal bed (Figure 26 and Table 19a are the descriptive and location information and Tables 19b, 19c, and 19d for the analytical results) have substantially lower geometric means (Tables 19e, 19f, and 19g) than those of the Appalachian basin for Br, Er, Ge, Li, Pb, Pr, Zr, and pyritic sulfur. Only the geometric means for Na₂O, and the free-swelling index are substantially higher than those of the Appalachian basin samples. The elements Bi, Ho, Pd, and Tm in addition to the eight elements previously listed are below their detection limits. Dy has no calculated means because of having only two unqualified values.

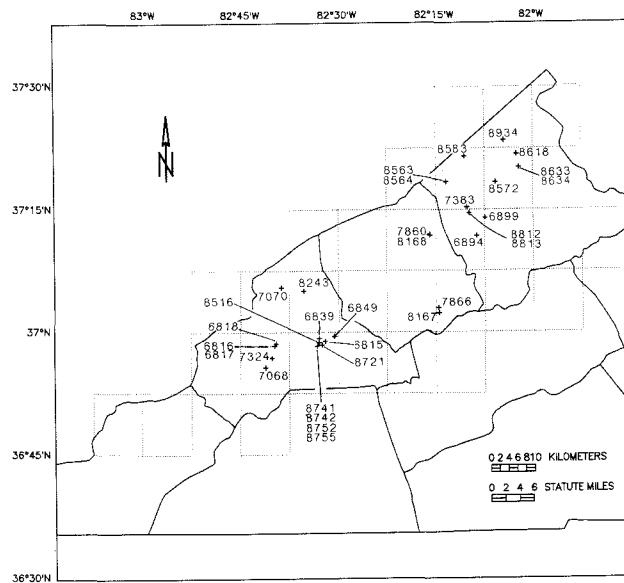


Figure 26. Locations for samples from the Lyons coal bed.

Table 19a.--Descriptions and locations for 32 bituminous coal samples from the Lyons coal bed, Southwest Virginia.

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VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-6815	W191064	60A-2	365829N	823227W	Wise (7.5')	Wise	13.08	Surface mine	Upper Split
R-6816	W191069	60B-1	365822N	823942W	Norton (7.5')	Wise	24.36	Surface mine	Upper Split
R-6817	W191065	60B-2	365822N	823942W	Norton (7.5')	Wise	15.72	Surface mine	Lower Split
R-6818	W191063	60B-3	365838N	823927W	Norton (7.5')	Wise	27.96	Surface mine	Full Thickness
R-6839	W192601	60A-12	365917N	823252W	Wise (7.5')	Wise	39.12	Surface mine, sl.	weathered Full Thickness
R-6849	W192588	60A-18	365930N	823034W	Wise (7.5')	Wise	22.56	Surface mine, sl.	weathered Full Thickness
R-6894	W194305	88B-1	371147N	820843W	Prater (7.5')	Buchanan	41.52	Surface mine, sl.	weathered Full Thickness
R-6899	W194302	88A-6	371359N	820723W	Vansant (7.5')	Buchanan	31.92	Surface mine, sl.	weathered Upper Split
R-7068	W198542	60B-12	365542N	824108W	Norton (7.5')	Wise	38.64	Surface mine, sl.	weathered Full Thickness
R-7070	W197299	90C-7	370530N	823844W	Flat Gap (7.5')	Wise	22.68	Surface mine, sl.	weathered Full Thickness
R-7324	W202130	60B-13	365653N	824007W	Norton (7.5')	Wise	28.80	Surface mine	Full Thickness
R-7383	W204620	118C-6	371519N	821009W	Harman (7.5')	Buchanan	38.40	Surface mine	Full Thickness
R-7860	W211174	89A-1	371154N	821555W	Haysi (7.5')	Dickenson	46.80	Surface mine	Full Thickness
R-7866	W211173	88C-17	370300N	821437W	Duty (7.5')	Dickenson	66.00	Surface mine, sl.	weathered Full Thickness
R-8167	W211674	88C-18	370222N	821432W	Duty (7.5')	Dickenson	37.20	Surface mine	Full Thickness
R-8168	W211675	89A-2	371148N	821555W	Haysi (7.5')	Dickenson	10.20	Surface mine	Lower Split
R-8243	W212463	90D-18	370505N	823519W	Pound (7.5')	Wise	30.60	Surface mine	Full Thickness
R-8516	W215874	60A-29	365846N	823557W	Wise (7.5')	Wise	38.40	Surface mine	Full Thickness
R-8563	W217686	118C-11	371825N	821321W	Harman (7.5')	Buchanan	18.00	Underground mine, sl.	weathered Bench Sample
R-8564	W217687	118C-12	371825N	821321W	Harman (7.5')	Buchanan	38.40	Underground mine, sl.	weathered Bench Sample
R-8572	W218771	118D-4	371822N	820550W	Grundy (7.5')	Buchanan	33.60	Underground mine	Composite
R-8583	W218768	118C-18	372130N	821033W	Harman (7.5')	Buchanan	34.20	Underground mine	Partial Seam
R-8618	W223361	118D-15	372146N	820230W	Grundy (7.5')	Buchanan	51.60	Surface mine	Composite
R-8633	W225106	118D-20, 21	372009N	820210W	Grundy (7.5')	Buchanan	54.60	Underground mine	Partial Seam
R-8721	W229078	60A-31	365854N	823158W	Wise (7.5')	Wise	39.60	Surface mine	Composite
R-8741	W231828	60A-36	365826N	823309W	Wise (7.5')	Wise	37.20	Surface mine, sl.	weathered Full Thickness
R-8742	W231829	60A-37	365829N	823308W	Wise (7.5')	Wise	34.80	Surface mine, sl.	weathered Full Thickness
R-8752	W235317	60A-38	365821N	823312W	Wise (7.5')	Wise	21.60	Surface mine	Upper Split
R-8755	W235318	60A-39	365821N	823312W	Wise (7.5')	Wise	12.60	Surface mine	Lower Split
R-8812	W238472	88B-17	371435N	820949W	Prater (7.5')	Buchanan	32.40	Surface mine	Bench Sample
R-8813	W238473	88B-18	371435N	820949W	Prater (7.5')	Buchanan	19.20	Surface mine	Bench Sample
R-8934	W246908	118A-3	372326N	820428W	Hurley (7.5')	Buchanan	25.20	Auger	Full Thickness

Table 19b.-Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 32 bituminous coal samples from the Lyons coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. G for ash-fusion temperatures means greater than value shown. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	Moisture	PROXIMATE ANALYSIS			ULTIMATE ANALYSIS			HEAT CONTENT			Lab Number
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	
R-6815	2.0	32.6	58.7	6.7	5.3	77.5	1.5	7.5	1.5	7,720	13,900
	---	33.3	59.9	6.8	5.2	79.1	1.5	5.8	1.5	7,880	14,180
	---	35.7	64.3	---	5.6	84.9	1.6	6.3	1.6	8,460	15,220
R-6816	3.6	32.9	58.0	5.5	5.4	74.8	1.5	9.9	2.9	7,670	13,810
	---	34.1	60.2	5.7	5.2	77.6	1.6	7.0	3.0	7,960	14,330
	---	36.2	63.8	---	5.5	82.3	1.7	7.4	3.2	8,440	15,190
R-6817	1.3	35.2	57.2	6.3	5.7	79.2	1.7	6.5	.6	7,910	14,230
	---	35.7	58.0	6.4	5.6	80.2	1.7	5.4	.6	8,010	14,420
	---	38.1	61.9	---	6.0	85.7	1.8	5.8	.6	8,560	15,400
R-6818	2.6	34.8	56.3	6.3	5.3	76.1	1.4	7.8	3.1	7,650	13,770
	---	35.7	57.8	6.5	5.1	78.1	1.4	5.6	3.2	7,850	14,140
	---	38.2	61.8	---	5.5	83.5	1.5	6.0	3.4	8,400	15,120
R-6839	3.9	32.2	61.9	2.1	5.8	81.3	1.6	8.8	.5	8,050	14,490
	---	33.5	64.4	2.2	5.6	84.6	1.7	5.5	.5	8,380	15,080
	---	34.3	65.9	---	5.7	86.5	1.7	5.7	.5	8,560	15,410
R-6849	2.6	31.5	62.1	3.8	5.4	80.3	1.6	7.7	1.2	7,980	14,370
	---	32.3	63.8	3.9	5.2	82.4	1.6	5.5	1.2	8,200	14,750
	---	33.7	66.3	---	5.5	85.8	1.7	5.8	1.3	8,530	15,350
R-6894	5.9	27.7	51.5	14.9	4.9	68.1	1.3	9.4	1.5	6,790	12,230
	---	29.4	54.7	15.8	4.5	72.4	1.4	4.4	1.6	7,220	13,000
	---	35.0	65.0	---	5.4	86.0	1.6	5.2	1.9	8,580	15,440
R-6899	5.1	25.6	49.3	20.0	4.6	64.3	1.2	8.6	1.2	6,360	11,450
	---	27.0	51.9	21.1	4.3	67.8	1.3	4.3	1.3	6,700	12,060
	---	34.2	65.8	---	5.4	85.8	1.6	5.4	1.6	8,490	15,290
R-7068	1.9	37.6	54.8	5.7	5.4	78.3	1.6	7.5	1.6	7,760	13,970
	---	38.3	55.9	5.8	5.3	79.8	1.6	5.9	1.6	7,910	14,240
	---	40.7	59.3	---	5.6	84.7	1.7	6.3	1.7	8,400	15,120

Table 19b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 32 bituminous coal samples from the Lyons coal bed, Southwest Virginia.--continued

Sample Number	Air-dried Loss	FORMS OF SULFUR			ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number
		Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening			
R-6815	0.0	0.04	0.67	0.81	9.0	1,055	1,110	1,215	----	2.16
	---	.04	.68	.83						W191064
	---	.04	.73	.89						
R-6816	.0	.02	1.94	.91	9.0	1,090	1,140	1,180	----	4.20
	---	.02	2.01	.94						W191069
	---	.02	2.13	1.00						
R-6817	.0	.02	.06	.49	9.0	1,315	1,390	1,455	----	.84
	---	.02	.06	.50						W191065
	---	.02	.06	.53						
R-6818	.0	.02	1.83	1.26	9.0	1,120	1,175	1,220	----	4.50
	---	.02	1.88	1.29						W191063
	---	.02	2.01	1.38						
R-6839	.0	.02	.18	.34	9.0	1,320	1,390	1,445	----	.69
	---	.02	.19	.35						W192601
	---	.02	.19	.36						
R-6849	.0	.02	.50	.67	9.0	1,110	1,155	1,225	----	1.67
	---	.02	.51	.69						W192588
	---	.02	.53	.72						
R-6894	4.9	.24	.65	.57	8.5	1,300	1,345	1,400	----	2.45
	---	.26	.69	.61						W194305
	---	.30	.82	.72						
R-6899	3.4	.15	.49	.52	9.0	1,520	1,540	1,540G	----	2.10
	---	.16	.52	.55						W194302
	---	.20	.65	.69						
R-7068	.6	.04	.91	.62	6.5	1,140	1,195	1,315	----	2.29
	---	.04	.93	.63						W198542
	---	.04	.98	.67						

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Table 19b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 32 bituminous coal samples from the Lyons coal bed, Southwest Virginia.--continued

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT		
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	Lab Number
R-7070	3.1	34.7	55.8	6.4	5.4	76.8	1.4	7.6	2.4	7,740	13,920	W197299
	--	35.8	57.6	6.6	5.2	79.3	1.4	5.0	2.5	7,980	14,370	
	--	38.3	61.7	---	5.6	84.9	1.5	5.4	2.7	8,550	15,390	
R-7324	3.0	34.2	53.9	8.9	5.2	73.8	1.3	8.0	2.8	7,440	13,390	W202130
	--	35.3	55.6	9.2	5.0	76.1	1.3	5.5	2.9	7,670	13,800	
	--	38.8	61.2	---	5.5	83.8	1.5	6.1	3.2	8,440	15,200	
R-7383	3.6	23.3	44.9	28.2	4.1	58.5	1.1	7.4	.6	5,720	10,300	W204620
	--	24.2	46.6	29.3	3.8	60.7	1.1	4.4	.6	5,940	10,690	
	--	34.2	65.8	---	5.4	85.8	1.6	6.2	.9	8,390	15,110	
R-7860	2.7	30.3	55.9	11.0	5.0	73.3	1.4	6.5	2.8	7,290	13,120	W211174
	--	31.2	57.5	11.3	4.8	75.3	1.4	4.2	2.9	7,490	13,490	
	--	35.2	64.8	---	5.4	84.9	1.6	4.7	3.3	8,450	15,210	
R-7866	2.2	28.9	53.2	15.7	4.8	70.8	1.4	6.7	.6	6,980	12,560	W211173
	--	29.6	54.4	16.0	4.7	72.4	1.4	4.8	.6	7,140	12,840	
	--	35.2	64.8	---	5.6	86.2	1.7	5.8	.7	8,500	15,290	
R-8167	2.1	33.3	61.2	3.4	5.4	81.4	1.5	7.5	.8	8,020	14,430	W211674
	--	34.0	62.5	3.5	5.3	83.2	1.6	5.7	.8	8,190	14,730	
	--	35.2	64.8	---	5.5	86.2	1.6	5.9	.8	8,480	15,260	
R-8168	2.7	29.5	55.8	12.0	4.9	72.9	1.5	6.5	2.2	7,240	13,030	W211675
	--	30.3	57.4	12.3	4.7	74.9	1.5	4.2	2.3	7,440	13,390	
	--	34.5	65.5	---	5.4	85.5	1.7	4.8	2.6	8,490	15,280	
R-8243	2.6	31.4	53.5	12.5	4.9	72.2	1.7	6.1	2.5	7,160	12,890	W212493
	--	32.2	54.9	12.9	4.8	74.1	1.8	3.9	2.5	7,350	13,230	
	--	35.4	64.6	---	5.5	85.1	2.0	4.5	2.9	8,430	15,180	
R-8516	3.8	32.8	59.8	3.7	5.5	79.8	1.6	8.8	.6	7,890	14,210	W215874
	--	34.1	62.1	3.8	5.2	83.0	1.7	5.6	.7	8,210	14,770	
	--	35.4	64.6	---	5.5	86.3	1.7	5.8	.7	8,530	15,360	
R-8563	1.7	31.7	58.9	7.7	5.1	78.2	1.6	6.4	1.0	7,740	13,940	W217686
	--	32.3	59.9	7.8	5.0	79.6	1.6	5.0	1.0	7,880	14,180	
	--	35.0	65.0	---	5.4	86.3	1.8	5.4	1.1	8,550	15,380	

Table 19b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 32 bituminous coal samples from the Lyons coal bed, Southwest Virginia.--continued

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Sample Number	FORMS OF SULFUR					ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid			
R-7070	1.5 --- ---	0.11 .11 .12	0.98 1.01 1.08	1.31 1.35 1.45	9.0	1,140	1,240	1,350	---	3.45	W197299
R-7324	1.5 --- ---	.02 .02 .02	1.65 1.70 1.87	1.15 1.19 1.31	8.5	1,140	1,260	1,305	---	4.18	W202130
R-7383	2.7 --- ---	.01 .01	.19 .20 .28	.44 .46 .65	4.5	1,540	1,540G	1,540G	---	1.17	W204620
R-7860	1.5 --- ---	.42 .43 .49	1.29 1.33 1.49	1.14 1.17 1.32	9.0	1,225	1,295	1,405	---	4.27	W211174
R-7866	.9 --- ---	.03 .03 .04	.04 .04 .05	.54 .55 .66	7.5	1,475	1,540	1,540G	---	.96	W211173
R-8167	.6 --- ---	.07 .07 .07	.17 .17 .18	.55 .56 .58	8.5	1,275	1,330	1,470	---	1.11	W211674
R-8168	1.5 --- ---	.26 .27 .30	1.16 1.19 1.36	.78 .80 .91	9.0	1,190	1,280	1,370	---	3.38	W211675
R-8243	1.3 --- ---	.20 .21 .24	1.35 1.39 1.59	.92 .94 1.08	8.0	1,220	1,300	1,425	---	3.88	W212493
R-8516	2.4 --- ---	.03 .03 .03	.04 .04 .04	.58 .60 .63	8.5	1,320	1,470	1,540	---	.84	W215874
R-8563	.8 --- ---	.06 .06 .07	.13 .13 .14	.79 .80 .87	9.0	1,315	1,460	1,540	---	1.43	W217686

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Table 19b.-Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 32 bituminous coal samples from the Lyons coal bed, Southwest Virginia.--continued

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT			Lab Number
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb		
R-8564	1.5	31.3	58.7	8.5	5.0	77.3	1.6	6.6	0.9	7,680	13,820		W217687
	---	31.7	59.6	8.7	4.9	78.5	1.6	5.4	1.9	7,800	14,030		
	---	34.7	65.3	--	5.4	86.0	1.8	5.9	1.0	8,530	15,360		
R-8572	2.7	30.9	59.9	6.5	5.0	78.0	1.6	7.6	1.2	7,840	14,100		W218771
	---	31.8	61.6	6.7	4.9	80.2	1.7	5.4	1.2	8,050	14,500		
	---	34.1	65.9	--	5.2	85.9	1.8	5.7	1.3	8,630	15,530		
R-8583	2.7	32.0	60.9	4.4	5.0	81.0	1.6	6.9	1.1	7,940	14,290		W218788
	---	32.9	62.6	4.6	4.8	83.3	1.6	4.6	1.1	8,160	14,680		
	---	34.4	65.6	--	5.1	87.2	1.7	4.8	1.2	8,550	15,380		
R-8618	1.9	32.7	60.3	5.0	5.1	80.7	1.6	6.4	1.1	7,970	14,350		W223361
	---	33.4	61.5	5.1	5.0	82.3	1.6	4.9	1.1	8,130	14,630		
	---	35.2	64.8	--	5.3	86.7	1.7	5.1	1.2	8,570	15,430		
R-8633	1.5	29.5	60.5	8.4	5.0	77.8	1.5	6.5	.7	7,680	13,820		W225106
	---	30.0	61.4	8.6	4.9	79.0	1.6	5.2	.7	7,800	14,040		
	---	32.8	67.2	--	5.4	86.4	1.7	5.7	.8	8,530	15,350		
R-8721	3.1	32.5	56.3	8.1	5.3	76.5	1.5	7.9	.6	7,570	13,630		W229078
	---	33.5	58.1	8.3	5.2	79.0	1.6	5.3	.6	7,820	14,070		
	---	36.6	63.4	--	5.6	86.2	1.7	5.8	.7	8,530	15,350		
R-8741	16.5	26.2	53.6	3.8	5.5	62.0	1.3	26.8	.6	5,900	10,620		W231829
	---	31.3	64.1	4.5	4.4	74.3	1.5	14.6	.7	7,060	12,710		
	---	32.8	67.2	--	4.6	77.8	1.6	15.3	.8	7,400	13,520		
R-8742	15.7	27.3	53.4	3.5	5.4	63.5	1.1	26.0	.5	5,960	10,730		
	---	32.4	63.4	4.2	4.4	75.4	1.3	14.2	.5	7,080	12,740		
	---	33.8	66.2	--	4.6	78.7	1.4	14.8	.6	7,590	13,290		
R-8752	2.2	33.5	62.6	1.7	5.4	82.3	1.7	8.0	1.0	8,220	14,790		W235317
	---	34.3	64.0	1.7	5.3	84.1	1.7	6.2	1.0	8,400	15,120		
	---	34.8	65.2	--	5.3	85.6	1.7	6.3	1.0	8,550	15,380		
R-8755	2.9	35.8	57.5	3.9	5.4	79.6	1.5	8.3	1.3	8,010	14,410		W235318
	---	36.8	59.2	4.0	5.3	82.0	1.5	5.9	1.3	8,240	14,840		
	---	38.4	61.6	--	5.5	85.4	1.6	6.2	1.4	8,590	15,450		

Table 19b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 32 bituminous coal samples from the Lyons coal bed, Southwest Virginia.--continued

Sample Number	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT			
	Moisture	Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	Lab Number
R-8812	2.2	30.7	64.1	2.9	5.4	82.7	1.6	6.1	1.2	8,200	14,760	W238472
---	31.4	65.6	3.0	5.3	84.6	1.6	4.3	1.2	8,380	15,090		
---	32.4	67.6	---	5.4	87.2	1.6	4.4	1.3	8,640	15,560		
R-8813	2.5	29.5	62.9	5.1	5.2	80.6	1.4	6.7	1.0	7,970	14,350	W238473
---	30.3	64.5	5.2	5.1	82.6	1.4	4.6	1.0	8,170	14,710		
---	32.0	68.0	---	5.3	87.2	1.5	4.9	1.0	8,620	15,520		
R-8934	1.7	30.1	57.2	11.0	4.9	75.3	1.3	6.3	1.2	7,450	13,410	W246908
---	30.6	58.2	11.2	4.8	76.7	1.3	4.8	1.2	7,580	13,650		
---	34.5	65.5	---	5.4	86.3	1.5	5.5	1.4	8,530	15,360		

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index			Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid				
R-8812	1.3	0.02	0.58	0.61	8.0	1,145	1,205	1,330	68	1.63	W238472	
---	---	.02	.59	.62								
---	---	.02	.61	.64								
R-8813	1.4	.02	.29	.65	8.0	1,370	1,430	1,465	64	1.39	W238473	
---	---	.02	.30	.67								
---	---	.02	.31	.70								
R-8934	.9	.07	.63	.49	8.0	1,365	1,445	1,540	58	1.79	W246908	
---	---	.07	.64	.50								
---	---	.08	.72	.56								

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Table 19c.--Major- and minor-oxide concentrations in the laboratory ash of 32 bituminous coal samples from the Lyons coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. L means less than the concentration shown; B, not determined. Sample number is the VDMR identification number. Lab number is the USGS Laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-6815	6.0	53	28	2.0	1.3	0.78	1.5	8.7	1.5	1.0	3.3	W191064
R-6816	6.9	25	10	1.1	1.2	.85	1.5	53	.40	.10	3.9	W191069
R-6817	6.8	43	14	2.1	1.5	1.3	1.7	32	.50	.21	5.0	W191065
R-6818	6.8	27	19	1.6	.70	.92	1.7	43	.80	.044	3.6	W191063
R-6839	2.5	45	30	2.2	.85	3.1	1.4	6.0	1.7	.20	4.4	W192601
R-6849	3.4	41	16	1.9	.95	1.9	2.5	23	.56	.15	4.0	W192588
R-6894	25.9	47	22	.77	1.7	.54	3.9	14	1.2	.031	1.2	W194305
R-6899	12.3	46	29	.64	1.2	.70	5.0	10	.91	.033	.78	W194302
R-7068	6.4	39	23	2.2	.68	.24	1.1	28	1.3	.70	2.9	W198542
R-7070	5.4	42	22	1.5	.68	.32	1.8	27	1.1	.20	2.7	W197299
R-7324	8.4	32	22	1.7	.90	.41	2.7	31	.89	.23	3.4	W202130
R-7383	26.4	59	26	.74	.78	.20	1.8	3.1	2.0	.38	.25	W204620
R-7860	15.3	41	23	.67	1.1	.45	4.2	23	.95	.065L	2.0	W211174
R-7866	17.1	60	26	.87	1.0	.45	2.7	3.2	1.7	.058L	1.3	W211173
R-8167	3.1	40	29	3.5	1.1	.76	2.5	14	1.4	.32L	3.8	W211674
R-8168	12.5	53	19	.49	1.2	.30	3.1	19	.64	.080L	1.1	W211675
R-8243	10.3	39	25	.63	1.0	.53	4.0	26	.92	.097L	1.4	W212493
R-8516	3.4	43	32	2.7	.70	1.6	2.8	7.0	1.7	.29	3.7	W215874
R-8563	8.9	53	29	.76	1.1	.89	4.8	6.6	.95	.11	1.8	W217686
R-8564	9.0	54	29	.77	1.1	.92	4.5	6.0	1.1	.22	1.6	W217687
R-8572	6.5	44	30	1.8	.71	.96	.96	12	1.3	.71	B	W218771
R-8583	4.1	44	26	.91	1.2	1.1	3.0	13	1.1	.24L	B	W218768
R-8618	5.3	45	28	.95	.61	1.4	1.6	17	1.4	.19L	1.6	W223361
R-8633	8.0	41	22	.81	1.5	.78	2.8	4.6	.87	.25	1.4	W225106
R-8721	8.8	50	30	.97	1.5	.65	4.2	5.3	1.3	.11L	1.6	W229078
R-8741	4.1	20	18	10	1.8	.73	1.3	21	.62	.37	17	W231828
R-8742	3.9	37	21	3.1	2.5	1.1	1.6	14	1.3	.28	8.8	W231829
R-8752	1.7	B	B	1.1	2.3	B	B	B	B	.59L	B	W235317
R-8755	3.9	26	11	3.8	.75	.72	1.4	43	.47	.26L	3.5	W235318
R-8812	2.9	33	25	1.4	.60	1.5	2.3	30	.90	.34L	3.2	W238472
R-8813	5.1	49	32	.84	.75	1.0	3.1	8.0	1.4	.20L	1.7	W238473
R-8934	10.7	57	23	.61	.53	.49	2.1	12	1.5	.093L	.87	W246908

Table 19d. Major-, minor-, and trace-element composition of 32 bituminous coal samples from the Lyons coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means less than the value shown; B, not determined; H, interference for an element which cannot be resolved by any routine method; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-6815	1.5	0.88	0.086	0.048	0.035	0.075	0.36	0.054	0.012	.68	W191064
R-6816	.81	.38	.054	.049	.043	.086	2.5	.017	.031	.98	W191069
R-6817	1.4	.50	.10	.060	.065	.096	1.5	.020	.032	1.9	W191065
R-6818	.85	.70	.078	.029	.046	.096	2.0	.033	.035	.97	W191063
R-6839	.52	.39	.039	.013	.058	.029	.10	.025	.021	1.8	W192601
R-6849	.64	.29	.046	.019	.048	.071	.54	.011	.016	.18	W192588
R-6894	5.7	3.1	.14	.26	.10	.84	2.5	.19	.057	.35	W194305
R-6899	2.6	1.9	.056	.086	.064	.51	.86	.067	.030	.38	W194302
R-7068	1.2	.79	.10	.026	.012	.056	1.3	.049	.028	.47	W198542
R-7070	1.1	.63	.057	.022	.013	.080	1.0	.037	.012	.29	W197299
R-7324	1.3	.98	.10	.045	.025	.19	1.8	.045	.034	.55	W202130
R-7383	7.3	3.6	.14	.12	.040	.40	.57	.32	.026L	.3.9	W204620
R-7860	2.9	1.8	.073	.099	.050	.53	2.5	.087	.031	.20	W211174
R-7866	4.8	2.4	.11	.11	.056	.38	.39	.18	.019	1.5	W211173
R-8167	.59	.47	.078	.021	.017	.063	.29	.025	.019	5.6	W211674
R-8168	3.1	1.2	.044	.089	.028	.32	1.7	.048	.020	.40	W211675
R-8243	1.9	1.4	.046	.063	.040	.34	1.9	.057	.037	.63	W212493
R-8516	.69	.57	.065	.014	.041	.080	.17	.035	.016	4.8	W215874
R-8563	2.2	1.4	.048	.058	.059	.35	.41	.051	.034	8.1	W217686
R-8564	2.3	1.4	.050	.058	.061	.34	.38	.061	.036	7.3	W217687
R-8572	1.3	1.0	.084	.028	.046	.052	.54	.049	.022	.90	W218771
R-8583	.84	.57	.027	.029	.035	.10	.36	.027	.019	.19	W218768
R-8618	1.1	.78	.036	.020	.053	.072	.63	.046	.044	18	W223361
R-8633	1.5	.94	.046	.074	.046	.19	.26	.042	.042	2.4	W225106
R-8721	2.0	1.4	.061	.081	.042	.31	.33	.071	.044	1.9	W229078
R-8741	.38	.30	.045	.022	.043	.59	.015	.041	.041	2.9	W231828
R-8742	.67	.44	.087	.058	.033	.053	.39	.031	.034	1.1	W231829
R-8752	B	B	B	.011	.029	B	B	B	.029	10	W235317
R-8755	.48	.22	.11	.018	.021	.045	1.2	.011	.066	.34	W235318
R-8812	.44	.38	.029	.010	.032	.055	.60	.016	.028	.27	W238472
R-8813	1.2	.86	.031	.023	.038	.13	.29	.041	.049	15	W238473
R-8934	2.9	1.3	.047	.034	.039	.18	.89	.096	.064	24	W246908

Table 19d.--Major-, minor-, and trace-element composition of 32 bituminous coal samples from the Lyons coal bed, Southwest Virginia,
reported on a whole-coal basis.--continued

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-6815	11	78	2.3	7.0	0.096	6.0	B	7.8	5.5	0.30	W191064
R-6816	12	41	1.5	4.0	.063	4.0	B	1.9	4.2	.30	W191069
R-6817	22	95	1.5	3.0	.049	14	B	3.2	11	.40	W191065
R-6818	12	82	1.7	5.0	.068	8.0	B	3.1	7.8	.40	W191063
R-6839	10	55	.90	1.0	.055	10	B	7.1	16	.50	W192601
R-6849	10	44	1.2	2.0	.054	3.5	B	2.9	3.0	.25	W192588
R-6894	28	210	8.0	6.1	.13	15	B	6.9	12	1.6	W194305
R-6899	16	81	1.7	13	.065	17	B	3.9	16	2.9	W194302
R-7068	19	30	.58	1.1	.083	10	110	4.6	9.0	.20	W198542
R-7070	6.5	22	.81	13	.012	9.0	B	1.2	8.1	.30	W197299
R-7324	9.2	84	.92	3.0	.074	10	140	5.4	9.8	1.3	W202130
R-7383	22	210	1.5	5.3	.074	43	150	9.8	42	2.3	W204620
R-7860	17	150	1.5	4.4	.089	16	290	3.2	14	2.6	W211174
R-7866	21	150	1.7	5.6	.024	27	100L	4.8	22	2.6	W211173
R-8167	7.4	59	.74	3.7	.031	6.5	510	4.6	5.3	.60	W211674
R-8168	8.6	240	2.5	6.3	.089	14	550	7.8	12	2.0	W211675
R-8243	14	110	1.2	4.0L	.068	13	160	2.8	13	1.5	W212493
R-8516	12	75	.75	1.3	.012	7.0	100	3.7	6.1	.50	W215874
R-8553	15	130	2.0	14	.071	14	900	3.8	12	2.2	W217686
R-8564	15	140	1.8	14	.083	15	900	3.2	11	1.6	W217687
R-8572	6.2	97	1.4	15	.023	17	870	4.6	10	.30	W218771
R-8553	4.9	78	1.3	22	.016	8.0	1,400	3.5	6.5	.80	W218768
R-8618	15	90	3.4	17	.016	11	1,100	3.7	6.7	.36	W223361
R-8633	12	88	1.4	18	.042	14	1,100	4.5	12	1.1	W225106
R-8721	18	180	1.2	4.1	.035	18	150	3.7	12	1.2	W229078
R-8741	4.5	210	1.0	25	.041	5.5	100L	5.1	7.8	.38	W231828
R-8742	5.9	74	.47	17	.039	9.8	100L	9.3	6.2	.32	W231829
R-8752	7.3	80	.71	1.4	.020	3.4	520	5.1	1.9	.13	W235317
R-8755	8.6	97	2.2	4.6	.059	3.7	590	8.3	4.1	.25	W235318
R-8812	8.1	72	.58	12	.018	6.4	960	2.5	3.4	.29	W238472
R-8813	12	290	2.8	14	.051	13	980	7.1	8.4	1.6	W238473
R-8934	8.5	92	2.2	23	.042	19	1,300	5.5	11	.97	W246908

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Table 19d.--Major-, minor-, and trace-element composition of 32 bituminous coal samples from the Lyons coal bed, Southwest Virginia,
reported on a whole-coal basis.--continued

Sample Number	Cu (ppm)	Dy-S (ppm)	Er-S (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	Lab Number
R-6815	16	3.5L	1.1L	0.17	.46	2.2	1.2	0.72	0.30	0.045	W191064
R-6816	12	4.0L	1.2L	.10	.42	2.0	1.4	.57L	.20	.16	W191069
R-6817	12	3.9L	1.2L	.23	.47	3.5	.82L	.56L	.60	.018	W191065
R-6818	11	3.9L	1.2L	.17	170	3.3	.82L	3.1	.30	.24	W191063
R-6839	10	.80L	.33	.28	20L	1.6	.43	.78	.40	.020	W192601
R-6849	13	1.1L	.37	.15	20L	1.8	.71	.95	.55	.093	W192588
R-6894	31	8.3L	2.6L	.28	94	12	2.1	2.6	.60	.17	W194305
R-6899	20	3.9L	1.2L	.30	120	6.8	.84L	1.4	.55	.070	W194302
R-7068	13	1.4L	.64L	.19	120	2.0	.44L	.42	.50	.21	W198542
R-7070	5.9	1.2L	.54L	.16	28	2.2	.70	2.5	.40	.29	W197299
R-7324	14	1.8L	.84L	.22	76	3.9	1.3L	2.5	.40	.17	W202130
R-7353	20	5.8L	2.6L	.55	120	12	4.0L	.71	2.4	.023	W204620
R-7860	11	3.4L	1.5L	.27	260	4.3	2.3L	.23L	.50	.37	W211174
R-7866	14	3.8L	1.7L	.41	150	5.0	2.6L	.43	1.2	.18	W211173
R-8167	7.4	.68L	.31L	.18	100	.96	.47L	.37	.20	.058	W211674
R-8168	20	2.8L	1.3L	.35	90	3.8	1.9L	2.9	.40	.068	W211675
R-8243	13	2.3L	1.0L	.26	60	5.0	1.9	5.9	.70L	.15	W212493
R-8516	7.5	.75L	.58	.15	120	1.3	.51L	.06	.30	.010L	W215874
R-8563	8.9	2.6	.98	.32	150	6.1	2.2	.49	.40	.090	W217686
R-8564	9.9	2.3	1.1	.29	270	5.4	6.0	.49	.45	.090	W217687
R-8572	5.6	1.4L	.30L	.31	250	3.6	2.1L	2.1	.45	.40	W218771
R-8583	5.7	.90L	.19L	.20	110	2.6	1.3L	1.2	.30	.31	W218768
R-8618	13	1.2L	.24L	.26	30	3.4	1.7L	.45	.44	.23	W223361
R-8633	9.6	1.8L	.37L	.31	100	4.2	2.6L	.48	.39	.14	W225106
R-8721	18	1.9L	.40L	.38	50	5.0	2.8L	.48	.59	.050L	W229078
R-8741	8.2	.90L	.19L	.15	100	.53	1.3L	.19L	.27	.050L	W231828
R-8742	11	.86L	.18L	.29	20L	.78	1.2L	.18L	.39	.050L	W251829
R-8752	12	.37L	.08L	.10	100	1.1	.54L	.31	.06	.010	W235317
R-8755	18	.86L	.18L	.13	20L	H	1.2L	1.9	.11	.050	W235318
R-8812	8.1	.29L	.13L	.18	20L	1.8	.29L	.14	.15	.070	W238472
R-8813	22	.51L	.23L	.31	20	4.7	.51L	9.2	.41	.005L	W238473
R-8974	20	1.1L	.49L	.37	100	5.4	2.4L	.52	1.1	.005L	W246908

Table 19d.--Major-, minor-, and trace-element composition of 32 bituminous coal samples from the Lyons coal bed, Southwest Virginia,
reported on a whole-coal basis.--continued

Sample Number	La (ppm)	Li (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Lab Number
R-6815	3.0	3.4	0.09	78	2.0	0.53	5.0L	9.0	260	1.4
R-6816	2.0	3.2	.06	19	2.5	.40L	5.7L	4.0	31	.83
R-6817	8.0	8.2	.09	.75	1.2	1.2	10	8.2	61	3.0
R-6818	4.0	8.2	.08	20	1.8	.95	5.9	6.4	13	1.6
R-6839	3.0	6.3	.06	8.0	.80	.50	1.2L	7.5	22	1.9
R-6849	2.0	2.4	.07	7.1	2.2	.41	2.6	4.4	22	1.6
R-6894	8.0	19	.13	57	3.4	2.6	22	26	35	W192588
R-6899	9.0	9.7	.15	9.0	2.5	.75	8.0	8.6	17	W194305
R-7068	5.0	7.7	.07	5.3	1.5	1.3	5.2	6.1	200	W194302
R-7070	5.0	11	.05	11	1.5	1.1	3.9	3.7	48	W198542
R-7324	6.0	13	.11	15	1.8	1.0	5.5	7.6	83	2.8
R-7383	25	180	.29	13	1.2	8.7	13	19	440	W202130
R-7860	9.0	9.5	.10	18	1.1	1.0	5.5	7.2	44L	W204620
R-7866	16	16	.15	7.9	.48	5.6	12	11	44L	W211174
R-8167	4.0	4.3	.05	5.3	1.3	1.1	3.4	5.0	44L	W211173
R-8168	7.5	11	.17	21	2.0	.66	4.0L	16	44L	W211674
R-8243	7.0	13	.09	11	.42	.84	3.3	6.4	3.3	W211675
R-8516	3.5	2.3	.06	1.7	1.1	.95	3.1	5.1	44	W212493
R-8563	7.0	7.1	.11	11	1.5	1.2	8.5	11	44	W215874
R-8564	8.0	8.5	.08	12	1.5	1.2	13	9.9	87	W217686
R-8572	9.5	6.3	.07	2.2	1.1	1.5	7.8	10	200	W217687
R-8583	4.0	2.0	.07	2.1	.66	.94	5.3	5.7	44L	W218771
R-8618	6.1	5.2	.07	2.4	1.1	2.0	8.5	12	44L	W218768
R-8633	7.4	6.6	.08	12	1.4	1.2	11	14	87	W223361
R-8721	10	15	.13	16	1.3	1.2	14	12	44L	W225106
R-8741	2.7	2.3	.04	78	1.2	.34	4.5	12	66	W231828
R-8742	4.9	2.7	.08	100	.47	.27L	5.5	9.4	48	W231829
R-8752	1.3	.95	.04	2.2	2.2	.19	2.4	6.3	44L	W235317
R-8755	2.0	1.2	.08	51	H	.90	2.7L	19	44L	W235318
R-8812	3.2	2.4	.06	2.6	1.6	.25	3.8	5.5	44L	W238472
R-8813	6.7	4.9	.13	4.5	1.4	.42	5.6	11	44L	W238473
R-8934	12	15	.11	3.3	1.5	2.4	12	9.2	44L	W246908

Table 19d. --Major-, minor-, and trace-element composition of 32 bituminous coal samples from the Lyons coal bed, Southwest Virginia,
reported on a whole-coal basis.--continued

Sample Number	Pr-S (ppm)	Rb (ppm)	Sb (ppm)	Sc (ppm)	Se (ppm)	Sm (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Lab Number
R-6815	7.2L	13L	.86	1.5	2.4	.70	.72L	.60	.040	.10 W191064
R-6816	8.3L	10L	.82	1.3	4.4	.50	.83L	.52	.24L	.22 W191069
R-6817	8.2L	15L	.37	2.1	1.3	1.3	.82L	.180	.13	.20 W191065
R-6818	12L	8.0	.91	2.1	7.6	.80	.82L	.68	.070	.13 W191063
R-6839	1.7L	23L	.26	1.9	3.1	.60	.17L	.40	.19	.37 W192601
R-6849	2.3L	26L	.81	1.5	2.1	.50	.23L	.44	.67L	.69L W192588
R-6894	18L	22	.90	3.0	6.1	1.3	1.8L	.170	.18	.20 W194305
R-6899	8.4L	28	2.2	3.8	4.9	1.6	.84L	.70	.16	.23 W194302
R-7068	4.4L	50L	.80	1.7	3.2	1.0	.10L	.96	.20L	.60L W198542
R-7070	3.7L	18L	.30	2.0	2.6	.70	.08L	.37	.070	.11 W197299
R-7324	7.3	16	.80	3.0	6.0	1.0	.33	.83	.10	.10 W202130
R-7383	18L	28	.70	8.5	B	3.0	3.4	.340	.72	.51 W204620
R-7860	10L	20	.50L	3.2	7.1	1.2	.23L	.130	.20	.040 W211174
R-7866	12L	26	1.0	4.7	2.0	1.9	1.1	.210	.44	.54 W211173
R-8167	4.7L	40L	.80	1.4	3.1	.55	.05L	.120	.070	.13 W211674
R-8168	8.5L	40L	1.8	3.9	1.8	1.2	.19L	.70	.16	.28 W211675
R-8243	7.0L	15	2.0L	3.3	6.0	1.0	.15L	.47	.15	.19 W212493
R-8516	2.3L	40L	.20	1.5	3.2	.55	.13	.110	.085	.13 W212874
R-8563	6.3	19	.70	3.0	3.7	1.2	.45	.110	.15	.27 W217686
R-8564	6.1L	17	.55	2.5	3.2	1.2	.41L	.150	.16	.25 W217687
R-8572	6.5L	20L	.95	2.3	3.0	1.2	.43	.140	.14	.17 W218771
R-8583	4.1L	20L	.90	1.7	5.8	.70	.19L	.45	.10	.13 W218768
R-8618	5.3L	20L	.37	1.5	5.4	.96	.38	.110	.11	.19 W223361
R-8633	8.0L	14	.41	2.8	3.5	1.3	.62	.140	.15	.25 W225106
R-8721	8.8L	20	.27	3.3	4.9	2.1	1.1	.120	.13	.23 W229078
R-8741	4.1L	27L	.21	1.1	1.7	.68	.90	.98	.070	.10 W231828
R-8742	3.9L	29L	.13	1.6	2.7	1.4	.74	.47	.13	.19 W231829
R-8752	1.7L	14L	.60	.94	1.8	.45	.44	.66	.050L	.081 W235317
R-8755	3.9L	15L	1.2	2.0	2.3	.63	H	.82	.088	.12 W235318
R-8812	.38	30L	.49	1.0	4.3	.88	.49	.49	.042	.11 W238472
R-8813	.45	30L	2.1	2.6	5.9	1.6	.66	.35	.16	.20 W238473
R-8934	.89	20L	.75	3.0	5.0	2.0	1.6	.70	.31	.23 W246908

Table 19d.--Major-, minor-, and trace-element composition of 32 bituminous coal samples from the Lyons coal bed, Southwest Virginia,
reported on a whole-coal basis.--continued

Sample Number	Th (ppm)	Tl-S (ppm)	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)	Lab Number
R-6815	0.70	2.8	0.77	8.4	0.43	5.3	0.50	.72	4.1	W191064
R-6816	.50	1.2L	1.1	9.0	.50	3.4	.30	.28	4.3	W191069
R-6817	1.9	1.2L	1.3	17	.54	6.1	.60	5.8	15	W191065
R-6818	1.0	1.2L	.72	9.5	.50	3.7	.50	4.2	8.8	W191063
R-6839	1.5	.30	.39	3.3	.22	1.9	.45	2.5	2.8	W192601
R-6849	.50	.88	.69	6.1	.38	3.4	.40	9.2	2.0	W192588
R-6894	2.0	2.6L	1.8	39	.40	11	.70	.36	.26	W194305
R-6899	2.7	1.2L	3.6	27	.70	4.6	.75	.18	6.2	W194302
R-7068	1.2	.20L	.70	9.6	.20	3.6	.40	5.1	12	W198542
R-7070	1.1	1.9	1.4	9.2	.50	2.8	.40	4.6	8.1	W197299
R-7324	1.5	.27L	.63	9.2	.50	3.8	.60	8.4	6.7	W202130
R-7383	7.9	1.2L	2.8	40	.90	7.7	1.6	9.0	.42	W204620
R-7860	2.3	.70L	.89	18	.30	3.8	.60	.13	15	W211174
R-7866	4.3	.79L	1.6	29	.50	8.9	1.0	.17	44	W211173
R-8167	.85	.14L	.46	6.2	.25	3.1	.45	1.6	10	W211674
R-8168	2.2	.58L	2.3	21	.65	5.1	1.0	.43	9.8	W211675
R-8243	2.1	.47L	1.4	14	.50	2.5	.70	6.7	7.6	W212493
R-8516	.90	.44	.39	6.8	.40	2.4	.40	2.0	8.5	W215874
R-8563	2.2	.89L	1.0	18	.50	5.4	.70	8.3	6.3	W217686
R-8564	2.1	.90L	1.1	17	.45	5.2	.65	7.7	6.9	W217687
R-8572	1.8	2.2	.97	12	.70	4.0	.55	2.6	9.8	W218771
R-8583	1.0	.41L	.78	7.0	.50	3.2	.50	3.0	4.5	W218768
R-8618	1.6	.53L	.72	13	.31	4.9	.53	3.8	13	W223361
R-8653	2.1	.80L	1.2	20	.46	6.2	.77	8.8	12	W225106
R-8721	2.4	.88L	.92	18	.72	6.5	.87	.11	9.7	W229078
R-8741	.77	.41L	.29L	2.6	.25	2.0	.33	.45	3.5	W231828
R-8742	1.2	.39L	.43	3.1	.50L	2.0	.62	.39	2.8	W231829
R-8752	.25	.17L	.44	3.4	.33	2.0	.32	5.4	1.3	W235317
R-8755	.60	.39L	.47	8.6	.66	4.3	.60	.25	3.7	W235318
R-8812	.58	1.5	.67	4.1	.40L	2.3	.46	4.6	2.3	W238472
R-8813	1.5	1.1	1.3	15	.42	4.2	.82	.14	6.6	W238473
R-8934	3.2	1.1L	1.2	13	.62	7.2	1.0	2.5	22	W246908

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Table 19e.--Arithmetic mean, observed range and geometric mean of proximate and ultimate analyses, heat content, forms of sulfur, and ash-fusion temperatures for 32 bituminous coal samples from the Lyons coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included.

[All values are in percent except Btu/lb, Kcal/kg, ash-fusion temperatures, and free-swelling index and are reported on an as-received basis. ${}^{\circ}\text{F} = 9/5 \, {}^{\circ}\text{C} + 32$; $\text{Kcal/kg} = 0.556 \, \text{Btu/lb}$; (n) is number of samples per parameter.]

		Lyons coal bed				Appalachian basin		
	(n)	Arith. mean	Observed range		Geom. mean	Arith. mean	Geom. mean	(n)
Proximate and ultimate analyses								
Moisture	(32)	3.55	1.30	16.46	2.86	3.23	2.69	(4,760)
Volatile matter	(32)	31.32	23.30	37.60	31.16	32.46	31.72	(4,760)
Fixed carbon	(32)	57.21	44.90	64.13	57.05	52.48	51.76	(4,760)
Ash	(32)	7.92	1.66	28.20	6.48	11.83	9.83	(4,760)
Hydrogen	(32)	5.19	4.10	5.80	5.17	5.02	5.00	(4,760)
Carbon	(32)	75.48	58.50	82.72	75.21	70.69	70.17	(4,760)
Nitrogen	(32)	1.47	1.10	1.74	1.46	1.39	1.37	(4,757)
Oxygen	(32)	8.61	6.11	26.80	7.97	8.92	8.22	(4,756)
Sulfur	(32)	1.33	.46	3.10	1.14	2.15	1.63	(4,974)
Heat content								
KCal/kg	(32)	7,490	5,728	8,225	7,459	7,030	6,979	(4,759)
Btu/lb	(32)	13,472	10,302	14,793	13,415	12,644	12,553	(4,759)
Forms of sulfur								
Sulfate	(32)	0.07	0.01	0.42	0.05	0.08	0.04	(4,245)
Pyritic	(32)	.56	.02	1.94	.30	1.36	.65	(4,392)
Organic	(32)	.69	.34	1.31	.66	.82	.70	(4,393)
Ash-fusion temperature (${}^{\circ}\text{C}$)								
Initial deformation	(31)	1,175	1,054	1,518	1,245	1,255	1,246	(4,063)
Softening	(29)	1,311	1,110	1,516	1,305	1,287	1,280	(3,722)
Fluid	(23)	1,356	1,182	1,499	1,353	1,334	1,328	(3,449)
Free-swelling index	(30)	8.30	4.50	9.00	8.24	5.53	4.68	(4,603)
Air-dried loss	(26)	2.40	0.60	11.87	1.65	1.83	1.13	(3,868)

Table 19f.--Arithmetic mean, observed range, and geometric mean of ash content and concentrations of 11 major- and minor-oxides in the laboratory ash of 32 bituminous coal samples from the Lyons coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. (n) indicates the number of samples per oxide.

[All samples were ashed at 525°C; all data are in percent.]

(n)	Lyons coal bed				Appalachian basin		
	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
		Min.	Max.				
(Ash) (32)	8.2	1.7	26	6.6	13	10	(5,262)
SiO ₂ (31)	43	20	60	42	43	41	(5,229)
Al ₂ O ₃ (31)	24	10	32	23	24	23	(5,229)
CaO (31)	1.8	.49	10	1.3	2.2	1.5	(5,227)
MgO (32)	1.1	.53	2.5	1.0	.85	.75	(5,258)
Na ₂ O (32)	.93	.20	3.1	.77	.43	.34	(5,194)
K ₂ O (31)	2.6	.96	5.0	2.3	2.0	1.7	(5,229)
Fe ₂ O ₃ (31)	18	3.1	53	14	19	13	(5,215)
MnO (32)	.043	.001	.34	.02	.03	.02	(5,260)
TiO ₂ (31)	1.1	.40	2.0	1.0	1.2	1.1	(5,203)
P ₂ O ₅ (19)	.29	.030	1.0	.20	.50	.22	(3,389)
SO ₃ (29)	3.2	.25	17	2.3	2.5	1.9	(5,063)

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Table 19g.--Arithmetic mean, observed range, and geometric mean of concentrations of 54 trace elements in 32 bituminous coal samples from the Lyons coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. Dashed values (---) represent less than five samples; (n) indicates the number of samples per element. [All data are in parts-per-million and are reported on a whole-coal basis.]

	Lyons coal bed				Appalachian basin			
	(n)	Arith. mean	Observed range		Geom. mean	Arith. mean	Geom. mean	(n)
			Min.	Max.				
Ag {31}		0.032	0.012	0.066	0.030	0.07	0.05	(4,565)
As {32}		31	1.1	120	15	35	13	(5,197)
B {32}		12	4.5	28	11	30	20	(5,076)
Ba {32}		110	22	290	94	90	63	(5,134)
Be {32}		1.7	.47	8.0	1.4	2.5	2.0	(5,247)
Bi ---		---	---	---	---	1.5	1.1	(108)
Br {31}		9.2	1.0	24	6.4	22	13	(4,892)
Cd {32}		.053	.012	.13	.040	.10	.07	(4,978)
Ce {32}		12	3.4	43	10	21	17	(5,075)
Cl {20}		630	100	1,400	460	780	510	(3,646)
Co {32}		4.8	1.2	9.8	4.4	7.4	5.7	(5,217)
Cr {32}		10	1.9	42	8.6	18	15	(5,205)
Cs {32}		1.0	.13	2.9	.69	1.3	.85	(4,831)
Cu {32}		13	5.6	31	12	19	15	(5,239)
Dy {2}		---	2.2	2.6	---	3.3	2.6	(759)
Er {5}		.67	.33	1.1	.60	1.5	1.2	(1,200)
Eu {32}		.25	.098	.55	.23	.44	.37	(5,032)
F {27}		110	20	270	89	99	71	(4,860)
Ga {31}		3.8	.53	12	3.0	6.6	5.4	(5,046)
Gd {10}		1.9	.42	6.0	1.5	2.6	1.9	(1,773)
Ge {27}		1.6	.060	9.2	.89	4.7	2.5	(4,608)
Hf {31}		.49	.064	2.4	.39	.79	.62	(4,932)
Hg {26}		.14	.010	.40	.099	.22	.15	(5,031)
Ho ---		---	---	---	---	.76	.61	(378)
La {32}		6.6	1.3	25	5.4	11	8.9	(5,147)
Li {32}		13	.95	180	6.3	22	14	(5,243)
Lu {32}		.09	.040	.29	.080	.16	.14	(4,885)
Mn {32}		19	.75	100	9.5	31	15	(5,260)
Mo {31}		1.5	.42	3.4	1.3	3.7	2.3	(4,889)
Nb {30}		1.4	.19	8.7	.99	2.6	1.9	(5,005)
Nd {27}		7.6	2.4	22	6.5	13	9.9	(4,231)
Ni {32}		9.6	3.7	26	8.6	17	14	(5,240)
Pb {32}		3.9	.83	16	3.0	8.8	6.2	(5,172)
Pd ---		---	---	---	---	.17	.14	(18)
Pr {5}		3.1	.38	7.3	1.5	6.1	3.6	(960)
Rb {12}		19	8.0	28	18	28	22	(2,232)
Sb {30}		.88	.25	2.2	.77	1.4	.91	(5,003)
Sc {32}		2.5	.94	8.5	2.2	4.4	3.6	(5,218)
Se {31}		3.9	1.3	7.6	3.5	3.6	2.8	(5,052)
Sm {32}		1.1	.45	3.0	.99	2.0	1.6	(5,005)
Sn {15}		.85	.13	3.4	.64	1.6	.86	(2,352)
Sr {32}		100	35	340	85	110	79	(5,146)
Ta {28}		.16	.040	.72	.13	.24	.19	(4,369)
Tb {30}		.20	.040	.54	.17	.34	.29	(4,852)
Th {32}		1.8	.25	7.9	1.4	3.0	2.3	(5,098)
Tl {8}		1.4	.30	2.8	1.1	3.4	2.1	(382)
Tm ---		---	---	---	---	1.7	.38	(46)
U {31}		1.1	.39	3.6	.93	1.8	1.3	(4,990)
V {32}		14	2.6	40	11	24	19	(5,241)
W {30}		.48	.20	.90	.45	.94	.80	(4,421)
Y {32}		4.4	1.9	11	4.0	8.5	7.2	(5,234)
Yb {32}		.63	.30	1.6	.58	1.1	.92	(5,151)
Zn {32}		15	1.6	72	8.8	22	14	(5,243)
Zr {32}		11	1.3	44	7.5	24	17	(5,238)

BLAIR MARKER AND BLAIR COAL BEDS

The Blair coal zone consists of several splits, of which the Blair Marker and the Blair were sampled for this report. The Blair coal zone crops out in Buchanan, Dickenson, Lee, and Wise Counties. Production in 1989 was 1.8 million tons (Virginia Division of Mines, 1990). Due to the great number of coal beds in a small stratigraphic interval, the Blair coal bed is most often confused with the Clintwood coal bed. Sampled thickness, including partings, is from 1.7 to 6.6 feet. The Blair commonly has a shale or siltstone roof in sharp contact with the coal. There are two or three shale, bone coal, or rathy coal partings, each less than one inch thick. Bone coal commonly occurs in the lower portion of the coal and cannel coal was observed in one sampled exposure southeast of Pound (R-8817). The Blair typically has a well-developed medium- or fine-cleat and thin and medium banding. Pyrite occurs disseminated through the coal and associated with the parting material. In Wise County, the Blair splits into at least three beds which are all locally minable.

Three samples were collected for the Blair Marker coal bed (Figure 27 and Table 20a are the descriptive and location information). Bi, Dy, Ho, Pd, Pr, and Tm are found to be below the detection limits for these samples in addition to the eight elements below the detection limits for all 375 Virginia samples (Tables 20b, 20c, and 20d). The geometric means for these analyses will not be discussed since there are only 3 samples.

The elements Bi and Pd, in addition to the eight elements below the detection limit for all 375 Virginia coal samples, are below the detection limits for the 17 Blair coal bed samples (Figure 28). The geometric means for As, B, Br, Cs, Dy, Gd, Ge, Mn, Pr, Rb, Sn, Sr, Th, V, Zn, Zr, and pyritic sulfur are substantially higher and Na₂O and the free-swelling index are substantially lower for the Appalachian basin coal samples than for the Blair coal samples. Tm has only one unqualified value and therefore an analysis of means is not possible. The descriptive and location information are found in Table 21a, the analytical results are found in Tables 21b, 21c, and 21d, and the statistical summaries are found in Tables 21e, 21f, and 21g.

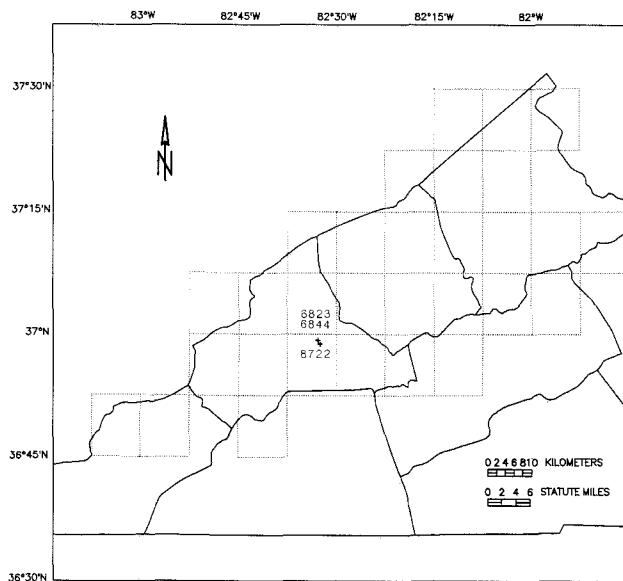


Figure 27. Locations for samples from the Blair Marker coal bed.

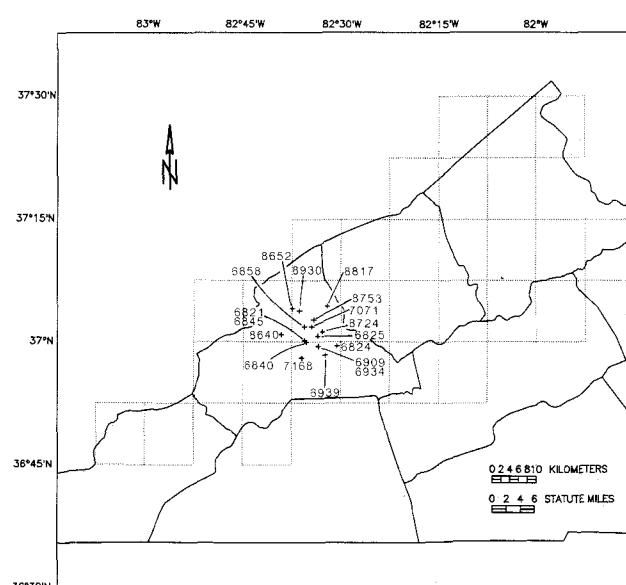


Figure 28. Locations for samples from the Blair coal bed.

Table 20a.--Descriptions and locations for 3 bituminous coal samples from the Blair Marker coal bed, Southwest Virginia.

VDMR Ic. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-6823	W191134	60A-5	365917N	823250W	Wise (7.5')	Wise	7.68	Surface mine, sl.	Lower Split
R-6844	W192586	60A-15	365917N	823250W	Wise (7.5')	Wise	10.56	Surface mine, sl.	Upper Split
R-8722	W229079	60A-32	365849N	823229W	Wise (7.5')	Wise	10.80	Surface mine	Full Thickness

Table 20b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 3 bituminous coal samples from the Blair Marker coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, ash-fusion temperatures, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT		
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/kg	Btu/lb	Lab Number
R-6823	6.2	32.2	54.0	7.6	5.6	74.4	1.4	10.3	0.7	7,410	13,330	W191134
	--	34.3	57.6	8.1	5.2	79.3	1.5	5.1	.7	7,900	14,210	
	--	37.4	62.6	--	5.7	86.3	1.6	5.6	.8	8,590	15,460	
R-6844	4.5	29.3	50.0	16.2	4.9	65.9	1.4	8.9	2.7	6,590	11,870	W192586
	--	30.7	52.4	17.0	4.6	69.0	1.5	5.1	2.8	6,910	12,430	
	--	36.9	63.1	--	5.5	83.1	1.8	6.2	3.4	8,320	14,970	
R-8722	1.8	32.8	53.1	12.3	5.0	74.3	1.4	5.1	1.9	7,420	13,350	W229079
	--	33.4	54.1	12.5	4.9	75.6	1.5	3.5	2.0	7,550	13,600	
	--	38.2	61.8	--	5.6	86.4	1.7	4.0	2.2	8,630	15,540	

Table 20b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 3 bituminous coal samples from the Blair Marker coal bed, Southwest Virginia.--continued

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C.)				Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid			
R-6823	0.0	0.04	0.07	0.60	8.0	1,405	1,455	1,600	---	1.05	W191134
	---	.04	.07	.64							
	---	.05	.08	.70							
R-6844	.0	.02	1.37	1.27	9.0	1,170	1,235	1,320	---	4.55	W192586
	---	.02	1.43	1.33							
	---	.03	1.73	1.60							
R-8722	1.1	.09	1.22	.61	7.0	1,255	1,330	1,430	49	2.85	W229079
	---	.09	1.24	.62							
	---	.10	1.42	.71							

Table 20c.--Major- and minor-oxide concentrations in the laboratory ash of 3 bituminous coal samples from the Blair Marker coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. L means less than the concentration shown. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-6823	5.7	58	25	1.4	1.3	0.90	2.6	6.3	1.1	0.89	2.9	W191134
R-6844	18.8	47	22	.65	1.2	.88	3.8	17	.98	.048	1.1	W192586
R-8722	12.8	49	23	.67	.85	.11	2.1	18	1.2	.078L	.93	W229079

Table 20d.--Major-, minor-, and trace-element composition of 3 bituminous coal samples from the Blair Marker coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means less than the value shown; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-6823	1.5	0.76	0.057	0.044	0.038	0.12	0.25	0.038	0.080	2.6	W191134
R-6844	4.1	2.2	.087	.14	.12	.60	2.3	.11	.053	.78	W192586
R-8722	2.9	1.5	.061	.065	.010	.23	1.6	.088	.10	.35	W229079

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cf (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-6823	14	74	5.2	4.0	0.11	16	B	21	12	0.40	W191134
R-6844	28	92	2.4	4.0	.23	27	B	11	24	1.7	W192586
R-8722	11	68	2.4	7.7	.13	18	400	15	11	.47	W229079

Sample Number	Cu (ppm)	Er-S (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	La (ppm)	Lab Number
R-6823	22	1.9	0.46	110	4.8	1.7	5.7	0.40	0.030	7.0	W191134
R-6844	28	1.9L	.45	120	8.6	1.3L	1.2	.80	.33	17	W192586
R-8722	26	.59L	.48	30	4.5	4.1L	1.4	.62	.26	9.2	W229079

Sample Number	Li (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Rb (ppm)	Lab Number
R-6823	6.3	0.25	7.4	2.1	1.0	21	21	220	4.3	15L	W191134
R-6844	39	.22	19	3.6	.94	8.6L	21	39	8.8	30	W192586
R-8722	17	.18	11	1.8	1.8	14	32	44L	10	.9.2	W229079

Table 20d. --Major-, minor-, and trace-element composition of 3 bituminous coal samples from the Blair Marker coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Sb (ppm)	Sc (ppm)	Se (ppm)	Sm (ppm)	Sr-S (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	Tl-S (ppm)	Lab Number
R-6823	0.78	3.9	1.5	2.1	0.68L	39	0.18	0.36	1.6	1.0L	W191134
R-6844	1.4	5.6	2.7	2.5	1.3L	39	.18	.66L	4.1	3.9	W192586
R-8722	.44	3.6	2.9	2.6	.86	46	.22	.36	2.5	1.3L	W229079

Sample Number	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)	Lab Number
R-6823	0.73	24	0.86L	18	1.4	13	10	W191134
R-6844	2.6	28	.53	5.1	1.2	41	8.6	W192586
R-8722	.85	18	.47	9.3	1.3	31	19	W229079

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Table 21a.--Descriptions and locations for 17 bituminous coal samples from the Blair coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-6821	W191136	90D-1	370010N	822531W	Pound (7.5')	Wise	21.48	Surface mine, sl. weathered	Full Thickness
R-6824	W191332	60A-6	365930N	823034W	Wise (7.5')	Wise	28.08	Surface mine, sl. weathered	Full Thickness
R-6825	W200132	90D-2	370150N	822533W	Pound (7.5')	Wise	27.00	Surface mine, sl. weathered	Full Thickness
R-6840	W192602	60A-13	365956N	822516W	Wise (7.5')	Wise	17.88	Surface mine, sl. weathered	Full Thickness
R-6845	W200123	90D-8	370007N	822531W	Pound (7.5')	Wise	35.52	Surface mine, sl. weathered	Full Thickness
R-6858	W192703	90D-13	370043N	8223331W	Pound (7.5')	Wise	18.00	Surface mine, sl. weathered	Full Thickness
R-6909	W194412	60A-20	365934N	822325W	Wise (7.5')	Wise	32.40	Surface mine, sl. weathered	Full Thickness
R-6934	W195287	60A-22	365927N	822325W	Wise (7.5')	Wise	13.80	Surface mine, sl. weathered	Full Thickness
R-6939	W195288	60A-23	365822N	8223220W	Wise (7.5')	Wise	43.80	Surface mine, sl. weathered	Full Thickness
R-7071	W197500	90D-16	370149N	8223426W	Pound (7.5')	Wise	32.40	Surface mine, sl. weathered	Full Thickness
R-7168	W199467	60A-26	365800N	8223556W	Wise (7.5')	Wise	31.20	Surface mine, sl. weathered	Full Thickness
R-8640	W223356	90C-18	370052N	823906W	Flat Gap (7.5')	Wise	25.20	Surface mine	Full Thickness
R-8652	W226977	90D-23	370405N	8223725W	Pound (7.5')	Wise	19.20	Surface mine	Full Thickness
R-8724	W229075	90D-26	370116N	8223246W	Pound (7.5')	Wise	44.40	Surface mine	Full Thickness
R-8753	W233315	90D-39	370243N	8223408W	Pound (7.5')	Wise	32.40	Surface mine, sl. weathered	Full Thickness
R-8817	W238682	90D-42	370421N	8223206W	Pound (7.5')	Wise	18.00	Surface mine	Full Thickness
R-8930	W246902	90D-46	370349N	8223621W	Pound (7.5')	Wise	33.60	Surface mine, sl. weathered	Full Thickness

Table 21b.-Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 17 bituminous coal samples from the Blair coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, ash-fusion temperatures, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. G for ash-fusion temperatures means greater than value shown. Sample number is VDMR identification number. Lab number is the USGS Laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT		
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	Lab Number
R-6821	6.4	31.2	59.6	2.8	5.7	78.4	1.5	10.9	0.7	7,760	13,970	W191136
	--	33.3	63.7	3.0	5.3	83.8	1.6	5.6	.7	8,290	14,930	
	--	34.4	65.6	--	5.5	86.3	1.7	5.7	.8	8,550	15,390	
R-6824	3.9	35.0	55.0	6.1	5.4	76.3	1.0	8.2	3.0	7,650	13,770	W191332
	--	36.4	57.2	6.3	5.2	79.4	1.0	4.9	3.1	7,960	14,330	
	--	38.9	61.1	--	5.5	84.8	1.1	5.3	3.3	8,500	15,300	
R-6825	4.9	32.3	57.5	5.3	5.6	76.5	1.1	9.9	1.6	7,620	13,710	W200132
	--	34.0	60.5	5.6	5.3	80.4	1.2	5.8	1.7	8,010	14,420	
	--	36.0	64.0	--	5.6	85.2	1.2	6.2	1.8	8,480	15,270	
R-6840	2.9	29.9	58.2	9.0	5.4	75.5	1.5	7.6	.8	7,510	13,510	W192602
	--	30.8	59.9	9.3	5.2	77.8	1.5	5.2	.8	7,750	13,910	
	--	33.9	66.1	--	5.8	85.7	1.7	5.7	.9	8,520	15,350	
R-6845	11.0	28.2	54.1	6.7	5.5	68.9	1.4	16.6	.9	6,670	12,010	W200123
	--	31.7	60.8	7.5	4.8	77.4	1.6	7.7	1.0	7,500	13,490	
	--	34.3	65.7	--	5.2	83.7	1.7	8.3	1.1	8,110	14,590	
R-6858	3.9	30.3	60.7	5.1	5.5	78.8	1.7	8.1	.9	7,810	14,060	W192703
	--	31.5	63.2	5.3	5.3	82.0	1.8	4.8	.9	8,130	14,630	
	--	33.3	66.7	--	5.6	86.6	1.9	5.1	1.0	8,590	15,450	
R-6909	5.5	31.0	58.0	5.5	5.5	77.2	1.6	9.7	.6	7,670	13,810	W194412
	--	32.8	61.4	5.8	5.2	81.7	1.7	5.1	.6	8,120	14,620	
	--	34.8	65.2	--	5.5	86.7	1.8	5.4	.7	8,620	15,520	
R-6934	1.7	33.8	53.3	11.2	5.0	72.8	1.6	4.2	5.2	7,400	13,330	W196287
	--	34.4	54.2	11.4	4.9	74.1	1.6	2.7	5.3	7,530	13,560	
	--	38.8	61.2	--	5.5	83.6	1.8	3.1	6.0	8,500	15,300	
R-6939	2.9	33.2	55.7	8.2	5.3	75.9	1.5	8.5	.6	7,550	13,600	W196288
	--	34.2	57.4	8.4	5.1	78.2	1.5	6.1	.6	7,780	14,000	
	--	37.3	62.7	--	5.6	85.4	1.7	6.7	.7	8,500	15,290	

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Table 21b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 17 bituminous coal samples from the Blair coal bed, Southwest Virginia.--continued

Sample Number	Air-dried Loss	FORMS OF SULFUR			ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number
		Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening			
R-6821	0.0 --- ---	0.02 .02 .02	0.03 .03 .03	0.64 .68 .70	9.0	1,600	1,600G	---	1.00	W19136
R-6824	.0 --- ---	.02 .02 .02	2.12 2.21 2.36	.91 .95 1.01	9.0	1,150	1,210	1,245	4.36	W191332
R-6825	.0 --- ---	.25 .26 .28	1.00 1.05 1.11	.38 .40 .42	9.0	1,200	1,315	1,365	2.33	W200132
R-6840	.0 --- ---	.31 .32 .35	.28 .29 .32	.26 .27 .30	8.0	1,520	1,540	1,540G	---	1.18
R-6845	.0 --- ---	.02 .02 .02	.23 .26 .28	.65 .73 .79	2.0	1,265	1,315	1,355	---	1.50
R-6858	2.9 --- ---	.00 .00 .00	.00 .00 .00	.80 .83 .88	9.0	1,540	1,540G	1,540G	---	1.28
R-6909	4.4 --- ---	.01 .01 .01	.08 .08 .09	.54 .57 .61	8.5	1,410	1,460	1,515	---	.87
R-6934	.6 --- ---	.05 .05 .06	4.20 4.27 4.82	.97 .99 1.11	9.0	1,145	1,205	1,270	---	7.80
R-6939	1.3 --- ---	.05 .05 .06	.12 .12 .13	.45 .46 .51	9.0	1,490	1,540	1,540G	---	.88

Table 21b.-Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 17 bituminous coal samples from the Blair coal bed, Southwest Virginia.--continued

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT		
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	Lab Number
R-7071	2.3	30.4	61.1	6.2	4.9	79.3	1.5	7.2	.8	7,870	14,160	
	---	31.1	62.5	6.3	4.8	81.2	1.5	5.3	.8	8,050	14,490	
	---	33.2	66.8	---	5.1	86.7	1.6	5.6	.9	8,600	15,480	W197300
R-7168	2.9	35.1	59.2	2.8	5.5	81.7	1.5	7.6	0.9	8,050	14,490	
	---	36.1	61.0	2.9	5.3	84.1	1.5	5.2	.9	8,290	14,920	
	---	37.2	62.8	---	5.5	86.6	1.6	5.3	1.0	8,540	15,370	W199467
R-8640	1.9	33.1	61.5	3.5	5.3	82.1	1.7	6.6	.8	8,120	14,620	
	---	33.8	62.7	3.5	5.2	83.6	1.7	5.1	.8	8,280	14,900	
	---	35.0	65.0	---	5.4	86.7	1.8	5.3	.9	8,580	15,450	
R-8652	1.8	31.9	57.4	8.8	5.2	76.9	1.6	6.6	.8	7,620	13,720	
	---	32.5	58.5	9.0	5.1	78.4	1.7	5.0	.9	7,760	13,980	
	---	35.8	64.2	---	5.6	86.1	1.8	5.5	1.0	8,530	15,360	
R-8724	6.9	30.4	59.1	3.5	5.6	78.4	1.5	10.4	.5	7,710	13,880	
	---	32.7	63.5	3.8	5.2	84.2	1.6	4.6	.6	8,280	14,910	
	---	34.0	66.0	---	5.5	87.5	1.7	4.7	.6	8,610	15,500	
R-8573	3.3	31.4	60.3	5.0	5.3	78.5	1.4	7.4	2.4	7,940	14,280	
	---	32.5	62.4	5.2	5.1	81.2	1.5	4.6	2.5	8,200	14,770	
	---	34.2	65.8	---	5.3	85.6	1.5	4.9	2.6	8,650	15,570	
R-8817	2.3	31.7	63.5	2.4	5.5	83.3	1.6	6.6	.6	8,260	14,870	
	---	32.5	65.1	2.5	5.3	85.3	1.6	4.6	.6	8,460	15,230	
	---	33.3	66.7	---	5.5	87.5	1.7	4.7	.6	8,670	15,610	
R-8930	1.8	30.1	57.6	10.5	4.9	75.7	1.5	6.4	1.0	7,480	13,470	
	---	30.6	58.7	10.7	4.7	77.0	1.5	4.9	1.0	7,620	13,710	
	---	34.3	65.7	---	5.3	86.3	1.7	5.5	1.2	8,530	15,350	W246902

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Table 21b.--Approximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 17 bituminous coal samples from the Blair coal bed, Southwest Virginia. --continued

Table 21c.--Major- and minor-oxide concentrations in the laboratory ash of 17 bituminous coal samples from the Blair coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. L means less than the concentration shown. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-6821	3.6	48	36	1.7	0.90	1.1	0.86	5.6	1.4	0.083	2.7	W191136
R-6824	5.6	25	19	2.9	.68	1.2	.42	1.0	.30	6.0	W191332	
R-6825	5.3	38	30	1.0	.65	.36	3.0	.21	.91	.25	1.5	W200132
R-6840	9.9	56	27	1.0	.68	.77	4.6	5.9	1.9	.27	1.2	W192602
R-6845	8.4	36	27	6.9	1.3	.47	2.7	8.4	1.1	.18	.99	W200123
R-6858	5.1	49	28	2.9	.51	.50	2.2	6.4	1.2	.059	5.0	W192703
R-6909	3.4	46	29	1.9	.98	1.5	1.6	8.9	1.7	.059	3.9	W194412
R-6934	10.7	26	15	1.2	.66	.34	1.4	.41	.86	.056	2.1	W196287
R-6939	7.7	56	26	1.4	.95	.72	2.5	3.8	1.5	.065	2.1	W196288
R-7071	4.7	54	30	1.3	.45	.45	.88	6.3	1.8	.36	1.7	W197300
R-7168	3.5	35	28	3.5	.88	1.5	1.1	21	1.5	.31	6.6	W199467
R-8640	4.0	50	33	1.0	.43	.68	1.1	8.6	1.8	.25L	1.4	W223356
R-8652	10.6	55	31	.71	.90	.31	1.7	4.9	1.6	.57	.73	W226977
R-8724	4.1	47	32	2.5	.50	1.1	1.4	3.3	1.8	.14	1.8	W229075
R-8753	4.8	28	18	1.5	.47	.42	1.4	.45	1.1	.21L	1.3	W235315
R-8817	1.9	48	35	1.8	.28	1.0	.91	7.1	1.2	.53L	3.1	W238482
R-8930	10.5	52	30	.80	.91	.19	2.8	5.9	1.6	.45	1.4	W246902

Table 21d.--Major-, minor-, and trace-element composition of 17 bituminous coal samples from the Blair coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means Less than the value shown; B, not determined; H, interference for an element which cannot be resolved by any routine method; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-6821	0.81	0.68	0.043	0.019	0.029	0.026	0.14	0.030	0.027	1.6	W191136
R-6824	.65	.55	.12	.023	.045	.056	1.6	.034	.034	140	W191132
R-6825	.94	.85	.039	.021	.014	.13	.78	.029	.020	15	W200152
R-6840	2.6	1.4	.071	.041	.056	.38	.41	.11	.037	3.4	W192602
R-6845	1.4	1.2	.41	.065	.029	.19	.49	.054	.035	14	W200123
R-6858	1.2	.76	.11	.016	.019	.093	.23	.037	.030	.93	W192703
R-6909	.73	.52	.046	.020	.037	.045	.21	.035	.024	1.7	W194412
R-6934	1.3	.84	.092	.043	.027	.12	3.1	.055	.064	16	W196287
R-6939	2.0	1.1	.077	.044	.041	.16	.20	.069	.051	1.7	W196288
R-7071	1.2	.75	.044	.013	.016	.034	.21	.052	.016	2.9	W197300
R-7168	.58	.52	.088	.019	.039	.033	.51	.031	.029	7.1	W199467
R-8640	.94	.70	.030	.010	.020	.037	.24	.043	.056	9.8	W223556
R-8652	2.7	1.7	.054	.057	.024	.15	.36	.099	.038	4.8	W226977
R-8724	.91	.69	.075	.012	.033	.047	.094	.044	.040	1.7	W229075
R-8753	.63	.45	.052	.013	.015	.055	1.5	.030	.042	32	W235315
R-8817	.43	.35	.024	.003	.014	.014	.094	.013	.027	.95	W238482
R-8930	2.5	1.7	.060	.058	.015	.24	.44	.10	.064	5.6	W246902

Table 21d.--Major-, minor-, and trace-element composition of 17 bituminous coal samples from the Blair coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-6821	11	58	3.5	11	0.068	9.0	B	9.5	5.7	0.10	W191136
R-6824	13	130	1.5	2.0	.067	6.0	B	4.1	6.8	.40	W191332
R-6825	9.0	43	2.0	3.7	.069	9.3	250	1.8	7.8	.73	W200132
R-6840	12	41	1.8	2.0	.11	22	B	7.8	18	.50	W192602
R-6845	17	84	1.6	6.4	.29	23	210	6.1	13	.80	W200123
R-6858	13	42	1.1	2.0	.037	15	B	3.9	7.3	.38	W192703
R-6909	8.8	48	1.1	1.6	.037	8.0	B	6.6	4.4	.30	W194412
R-6934	19	79	1.0	7.3	.30	12	B	2.2	12	.75	W196287
R-6939	18	100	1.2	3.5	.069	18	B	2.3	9.7	1.2	W196288
R-7071	5.2	24	2.5	5.4	.056	14	B	7.8	7.4	.10	W197300
R-7168	13	38	.60	3.5	.091	9.5	B	8.5	6.4	.40	W199467
R-8640	7.2	29	3.2	3.4	.022	9.6	240	7.1	6.9	.30L	W223356
R-8652	8.7	67	3.1	6.0	.072	24	280	7.4	13	.52	W226977
R-8724	13	90	.82	1.9	.016	15	100L	3.6	6.5	.35	W229075
R-8753	4.8	58	1.1	3.0	.017	6.3	430	4.8	5.5	.25	W235315
R-8817	6.8	18	3.8	3.5	.074	6.6	220	3.6	3.0	.08	W238482
R-8930	9.3	72	2.3	11	.10	25	510	4.7	13	1.1	W246902

Table 21d.--Major-, minor-, and trace-element composition of 17 bituminous coal samples from the Blair coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Cu (ppm)	Dy-S (ppm)	Er-S (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	Lab Number
R-6821	15	2.1L	0.79	0.25	140	3.0	0.72	3.6	0.30	0.020	W191136
R-6824	11	3.6L	1.1L	.15	54	3.0	1.1	1.3	.30	.23	W191332
R-6825	12	1.5	.53	.20	20	3.5	1.2	.35	.30	.096	W200132
R-6840	17	3.2L	.99	.41	75	4.2	.67L	1.2	.95	.11	W192602
R-6845	17	1.8L	1.0	.52	610	3.4	2.1	.41	.50	.11	W200123
R-6858	9.2	1.6L	.87	.35	38	1.8	.97	.27	.68	.11	W192703
R-6909	12	.78	.41	.15	20L	2.3	.54	.65	.40	.010L	W194412
R-6934	16	3.4L	1.1L	.23	68	3.3	.73L	.74	.50	.24	W196287
R-6939	18	2.5L	.77L	.37	220	4.0	.52L	.38	.80	.060	W196288
R-7071	15	1.0L	.56	.26	29	2.6	.99	1.5	.60	.020	W197500
R-7168	13	.81	.39	.24	140	1.5	.60	1.1	.35	.17	W199467
R-8640	18	2.2	.88	.22	50	4.0	1.4	6.4	.30	.21	W223336
R-8652	21	2.3L	.49L	.55	120	5.0	3.4L	5.0	.97	.22	W226977
R-8724	14	1.8	.90	.28	40	2.4	1.3L	.19	.56	.050L	W229075
R-8753	13	1.1L	.22L	.14	60	H	1.5L	.67	.29	.040	W235315
R-8817	10	.80	.57	.21	20L	1.9	.55	2.3	.15	.005L	W238482
R-8930	19	1.1L	.48L	.53	80	6.1	2.3L	2.4	1.0	.005L	W246902

Table 21d.--Major-, minor-, and trace-element composition of 17 bituminous coal samples from the Blair coal bed, Southwest Virginia, reported on a whole-coal basis. --continued

Sample Number	Ho-S (ppm)	La (ppm)	Li (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Ni-S (ppm)	P (ppm)	Lab Number
R-6821	0.43L	5.0	3.2	0.10	7.9	1.2	0.86	9.0	10	13
R-6824	.78L	4.0	3.4	.08	15	1.5	.78	5.3	5.4	74
R-6825	.36L	5.0	11	.11	5.8	1.6	1.5	6.9	4.1	57
R-6840	.67L	12	15	.20	14	1.5	3.1	4.6L	9.9	120
R-6845	.57L	12	15	.20	36	.92	1.3	11	20	66
R-6858	.35L	7.5	8.2	.11	5.0	.97	.82	11	6.1	13
R-6909	.23L	5.0	4.4	.09	9.2	1.1	.95	2.8	7.5	8.7
R-6934	.73L	6.0	8.7	.08	18	12	2.9	7.4	6.8	26
R-6939	.52L	10	15	.12	5.1	.69	1.2	4.2	5.2	22
R-7071	.32L	7.0	12	.13	2.4	1.2	1.6	5.2	13	74
R-7168	.24L	5.0	4.2	.08	5.6	1.3	.56	4.6	10	48
R-8640	.27L	5.7	4.8	.08	1.4	1.3	2.4	9.6	14	44L
R-8652	.72L	13	15	.21	5.3	.88	3.8	18	14	260
R-8724	.36	8.0	9.0	.08	3.9	1.2	2.1	7.8	8.6	250
R-8753	.33L	3.5	.06	11	H	1.9	5.8	9.1	44L	W2353315
R-8817	.19	2.9	3.0	.11	2.7	.67	.30	3.6	7.2	W238482
R-8930	.45	16	21	.11	12	1.3	2.7	16	11	W246902

Table 21d.--Major-, minor-, and trace-element composition of 17 bituminous coal samples from the Blair coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Pb (ppm)	Pr-S (ppm)	Rb (ppm)	Sb (ppm)	Sc (ppm)	Se (ppm)	Sm (ppm)	Sn-S (ppm)	Sr-S (ppm)	Ta (ppm)	Lab Number
R-6821	2.6	4.3L	11L	0.50	1.7	3.3	1.1	0.43L	.58	0.070	W191136
R-6824	1.0	7.8L	14L	.96	1.9	6.0	.60	.78L	.130	.080	W191332
R-6825	3.1	8.0L	10	.40	2.4	4.6	.97	.08L	.69	.075	W200132
R-6840	7.9	6.7L	22L	.70	4.3	2.9	2.1	.67L	.43	.25	W192602
R-6845	4.5	5.7L	15	.30	3.1	3.3	2.6	.13L	.84	.12	W200123
R-6858	2.9	3.5L	8.0	.18	1.7	1.6	1.7	.35L	.40	.095	W192703
R-6909	3.4	2.3L	15L	.30	1.7	4.4	.80	.12	.54	.12	W194412
R-6934	2.6	7.3L	29L	.80	1.9	2.3	1.0	.73L	.42	-.80L	W196287
R-6939	6.2	5.2L	12	.30	2.6	7.2	1.7	.52L	.85	.21	W196288
R-7071	4.4	3.2L	15L	2.0	2.7	4.1	1.3	.21	.61	.13	W197300
R-7168	2.9	2.4L	38L	.45	2.3	2.4	1.0	.05L	.80	.10	W199467
R-8640	4.8	4.0L	10L	.83	2.1	4.2	.87	.27	.48	.14	W223356
R-8652	5.5	11L	14L	.72	4.8	3.8	2.9	.99	.190	.32	W226977
R-8724	3.4	4.1L	11	.19	2.1	4.0	1.6	.86	.160	.21	W229075
R-8753	2.3	4.8L	18L	.49	1.6	6.4	.75	H	.53	.13	W235315
R-8817	.76	.32	18L	.37	1.8	1.5	.98	.29	.30	.048	W238482
R-8930	6.4	1.2	23L	.71	4.1	4.4	3.0	1.3	.230	.28	W246902

Table 21d.--Major-, minor-, and trace-element composition of 17 bituminous coal samples from the Blair coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Tb (ppm)	Th (ppm)	Tl-S (ppm)	Tm-S (ppm)	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Lab Number
R-6821	0.22	1.1	0.65L	0.30L	1.0L	11	0.74L	7.2	0.70	2.0	W191136
R-6824	.080	.80	3.2	.52L	.60	6.2	.37	3.2	.40	3.6	W191332
R-6825	.15	1.5	.17L	.24L	B	17	.55	8.0	.60	5.8	W200132
R-6840	.29	3.2	.99L	.46L	3.3	18	.58	4.6	1.0	16	W192602
R-6845	.40	2.7	.27L	.39L	B	13	2.0L	11	1.2	32	W200123
R-6858	.29	1.7	.51L	.23L	.83	10	.24	7.1	.68	6.6	W192703
R-6909	.12	1.4	.11L	.16L	1.4	5.1	.60	3.2	.50	3.7	W194412
R-6934	.18	1.5	1.1L	.49L	1.9	12	.50	5.0	.50	32	W196287
R-6939	.31	2.4	.77L	.35L	1.6	11	.40	2.9	.70	9.2	W196288
R-7071	.21	1.8	.15L	.22L	1.6	11	.85	5.6	.75	12	W197300
R-7168	.19	1.2	.95	.16L	.19	7.4	.60L	3.9	.50	9.1	W199467
R-8640	.21	1.8	.40L	.18L	.98	14	.33	5.2	.60	6.0	W223356
R-8652	.36	3.6	1.1L	.49L	1.9	21	.60	13	1.5	15	W226977
R-8724	.18	2.3	.41L	.19L	.65	9.0	.31	4.5	.58	4.5	W229075
R-8753	.091	.84	.48L	.22L	.28L	6.2	.46	3.2	.43	3.6	W235315
R-8817	.16	.46	.19L	.08	.28L	6.3	.35	5.1	.71	9.1	W238482
R-8930	.29	3.6	1.1L	.34L	1.5	19	.75	7.1	1.2	13	W246902

Table 21d. --Major-, minor-, and trace-element composition of 17 bituminous coal samples from the Blair coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Zr-S (ppm)	Lab Number
R-6821	8.6	W191136
R-6824	7.3	W191332
R-6825	16	W200132
R-6840	17	W192602
R-6845	20	W200123
R-6858	9.7	W192703
R-6909	9.2	W194412
R-6934	21	W196287
R-6939	6.2	W196288
R-7071	11	W197300
R-7168	7.4	W199467
R-8640	13	W223356
R-8652	36	W226977
R-8724	14	W229075
R-8753	9.6	W233315
R-8817	3.2	W236482
R-8930	16	W246902

Table 21e.--Arithmetic mean, observed range and geometric mean of proximate and ultimate analyses, heat content, forms of sulfur, and ash-fusion temperatures for 17 bituminous coal samples from the Blair coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included.

[All values are in percent except Btu/lb, Kcal/kg, ash-fusion temperatures, and free-swelling index and are reported on an as-received basis. $^{\circ}\text{F} = 9/5 \, ^{\circ}\text{C} + 32$; Kcal/kg = 0.556 Btu/lb; (n) is number of samples per parameter.]

	Blair coal bed				Appalachian basin		
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean
			Min.	Max.			(n)
Proximate and ultimate analyses							
Moisture	(17)	3.90	1.70	11.00	3.36	3.23	2.69
Volatile matter	(17)	31.72	28.20	35.10	31.67	32.46	31.72
Fixed carbon	(17)	58.34	53.30	63.54	58.28	52.48	51.76
Ash	(17)	6.04	2.40	11.20	5.46	11.83	9.83
Hydrogen	(17)	5.36	4.86	5.70	5.35	5.02	5.00
Carbon	(17)	77.42	68.90	83.34	77.35	70.69	70.17
Nitrogen	(17)	1.48	1.00	1.70	1.47	1.39	1.37
Oxygen	(17)	8.38	4.20	16.60	8.03	8.92	8.22
Sulfur	(17)	1.31	.55	5.20	1.03	2.15	1.63
Heat content							
KCal/kg	(17)	7,694	6,678	8,269	7,686	7,030	6,979
Btu/lb	(17)	13,839	12,010	14,872	13,825	12,644	12,553
Forms of sulfur							
Sulfate	(16)	0.07	0.01	0.31	0.04	0.08	0.04
Pyritic	(16)	.65	.03	4.20	.22	1.36	.65
Organic	(17)	.64	.26	.97	.61	.82	.70
Ash-fusion temperature ($^{\circ}\text{C}$)							
Initial deformation	(13)	1,344	1,116	1,527	1,334	1,255	1,246
Softening	(8)	1,304	1,182	1,521	1,299	1,287	1,280
Fluid	(7)	1,343	1,246	1,513	1,340	1,334	1,328
Free-swelling index	(17)	7.94	2.00	9.00	7.59	5.53	4.68
Air-dried loss	(12)	2.08	0.60	6.31	1.61	1.83	1.13

Table 21f.--Arithmetic mean, observed range, and geometric mean of ash content and concentrations of 11 major- and minor-oxides in the laboratory ash of 17 bituminous coal samples from the Blair coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. (n) indicates the number of samples per oxide.

[All samples were ashed at 525°C; all data are in percent.]

	Blair coal bed				Appalachian basin			
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
(Ash)	(17)	6.1	1.9	11	5.5	13	10	(5,262)
SiO ₂	(17)	44	25	56	43	43	41	(5,229)
Al ₂ O ₃	(17)	28	15	36	27	24	23	(5,229)
CaO	(17)	2.0	.71	6.9	1.7	2.2	1.5	(5,227)
MgO	(17)	.71	.28	1.3	.67	.85	.75	(5,258)
Na ₂ O	(17)	.73	.19	1.5	.62	.43	.34	(5,194)
K ₂ O	(17)	1.8	.86	4.6	1.6	2.0	1.7	(5,229)
Fe ₂ O ₃	(17)	14	3.3	45	9.8	19	13	(5,215)
MnO	(17)	.02	.004	.06	.02	.03	.02	(5,260)
TiO ₂	(17)	1.4	.86	1.9	1.4	1.2	1.1	(5,203)
P ₂ O ₅	(14)	.32	.050	1.4	.20	.50	.22	(3,389)
SO ₃	(17)	2.5	.72	6.6	2.1	2.5	1.9	(5,063)

Table 21g.--Arithmetic mean, observed range, and geometric mean of concentrations of 54 trace elements in 17 bituminous coal samples from the Blair coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. Dashed values (---) represent less than five samples; (n) indicates the number of samples per element. [All data are in parts-per-million and are reported on a whole-coal basis.]

	Blair coal bed				Appalachian basin		
	(n)	Arith. mean	<u>Observed range</u>		Arith. mean	Geom. mean	(n)
			Min.	Max.			
Ag	(17)	0.04	0.016	0.06	0.03	0.07	0.05 (4,565)
As	(17)	15	.93	140	5.2	35	13 (5,197)
B	(17)	11	4.8	19	10	30	20 (5,076)
Ba	(17)	60	18	130	53	90	63 (5,134)
Be	(17)	1.9	.60	3.8	1.6	2.5	2.0 (5,247)
Bi	--	---	---	---	---	1.5	1.1 (108)
Br	(17)	4.6	1.6	11	3.8	22	13 (4,892)
Cd	(17)	.09	.016	.30	.06	.10	.07 (4,978)
Ce	(17)	14	6.0	25	12	21	17 (5,075)
Cl	(7)	310	210	510	290	780	510 (3,646)
Co	(17)	5.4	1.8	9.5	4.8	7.4	5.7 (5,217)
Cr	(17)	8.7	3.0	18	7.9	18	15 (5,205)
Cs	(16)	.49	.078	1.2	.38	1.3	.85 (4,831)
Cu	(17)	15	9.2	21	14	19	15 (5,239)
Dy	(6)	1.3	.78	2.2	1.2	3.3	2.6 (759)
Er	(11)	.72	.38	1.0	.68	1.5	1.2 (1,200)
Eu	(17)	.30	.14	.55	.27	.44	.37 (5,032)
F	(15)	120	20	610	77	99	71 (4,860)
Ga	(16)	3.2	1.5	6.1	3.0	6.6	5.4 (5,046)
Gd	(10)	1.0	.54	2.1	.93	2.6	1.9 (1,773)
Ge	(17)	1.7	.19	6.4	1.0	4.7	2.5 (4,608)
Hf	(17)	.53	.14	1.0	.46	.79	.62 (4,932)
Hg	(13)	.13	.020	.24	.10	.22	.15 (5,031)
Ho	(3)	---	.19	.45	---	.76	.61 (378)
La	(17)	7.5	2.9	16	6.7	11	8.9 (5,147)
Li	(17)	9.2	3.0	21	7.6	22	14 (5,243)
Lu	(17)	.11	.060	.21	.11	.16	.14 (4,885)
Mn	(17)	9.4	1.4	36	6.9	31	15 (5,260)
Mo	(16)	1.8	.66	12	1.3	3.7	2.3 (4,889)
Nb	(17)	1.7	.30	3.8	1.4	2.6	1.9 (5,005)
Nd	(16)	8.0	2.8	18	7.0	13	9.9 (4,231)
Ni	(17)	9.5	4.1	20	8.8	17	14 (5,240)
Pb	(17)	3.8	.76	7.9	3.3	8.8	6.2 (5,172)
Pd	--	---	---	---	---	.17	.14 (18)
Pr	(2)	---	.32	1.2	---	6.1	3.6 (960)
Rb	(5)	11	8.0	15	11	28	22 (2,232)
Sb	(17)	.60	.18	2.0	.50	1.4	.91 (5,003)
Sc	(17)	2.5	1.6	4.8	2.4	4.4	3.6 (5,218)
Se	(17)	3.9	1.5	7.2	3.6	3.6	2.8 (5,052)
Sm	(17)	1.5	.60	3.0	1.3	2.0	1.6 (5,005)
Sn	(7)	.57	.12	1.3	.42	1.6	.86 (2,352)
Sr	(17)	86	30	230	72	110	79 (5,146)
Ta	(16)	.15	.048	.32	.13	.24	.19 (4,369)
Tb	(17)	.22	.080	.40	.20	.34	.29 (4,852)
Th	(17)	1.9	.46	3.6	1.6	3.0	2.3 (5,098)
Tl	(2)	---	.95	3.2	---	3.4	2.1 (382)
Tm	(1)	---	.08	.08	---	1.7	.38 (46)
U	(12)	1.4	.19	3.3	1.1	1.8	1.3 (4,990)
V	(17)	12	5.1	21	11	24	19 (5,241)
W	(14)	.49	.24	.85	.46	.94	.80 (4,421)
Y	(17)	5.9	2.9	13	5.3	8.5	7.2 (5,234)
Yb	(17)	.74	.40	1.5	.69	1.1	.92 (5,151)
Zn	(17)	11	2.0	32	8.1	22	14 (5,243)
Zr	(17)	13	3.2	36	11	24	17 (5,238)

CLINTWOOD MARKER, CLINTWOOD, AND CLINTWOOD RIDER COAL BEDS

The Clintwood coal zone, consisting of the Clintwood Marker, Clintwood, and Clintwood Rider coal beds, occurs in Buchanan, Dickenson, Lee and Wise Counties. Wise County produced 1.9 of the 2.3 million tons total production in 1989 (Virginia Division of Mines, 1990). Other names for the Clintwood coal bed include: North Fork coal bed (Lee County); Norton No. 8 or Big Dorchester coal bed (Wise County); Matewan or Feds Creek coal bed (Buchanan County). A 10-foot thick Clintwood coal was sampled near the town of Clintwood; this was the thickest coal sampled in this study. Away from the town of Clintwood, the coal is typically found in benches and splits. Where four splits occur, the uppermost Clintwood Rider coal bed may be the Addington coal bed.

The elements B, F, Pd, Rb are below the detection limits for the Clintwood Marker samples. In addition to the elements below the detection limits for all the Virginia coal samples, the element Tm is below the detection limit for the 59 Clintwood samples. The elements, Bi, Cl, Dy, Er, Gd, Ho, Nd, Pd, Pr, Sn, Tl, and Tm are below the detection limits for the Clintwood Rider sample. The descriptive and location information are presented for the Clintwood Marker samples in Table 22a and Figure 29, for the Clintwood samples in Table 23a and Figure 30, and for the Clintwood Rider sample in Table 24a and Figure 31. The analytical results for the Clintwood Marker are displayed in Tables 22b, 22c, and 22d. The Clintwood analytical results are presented in Tables 23b, 23c, and 23d. The Clintwood Rider analytical data are shown in Tables 24b, 24c, and 24d.

Geometric means in the Clintwood coal samples (Tables 23e, 23f, and 23g) indicated P_2O_5 , the air-dried loss, and the free-swelling index are substantially higher than those for the samples from the Appalachian basin. Bi, Br, Cs, Sn, and W geometric means are substantially higher in the Appalachian basin coal samples than in the Clintwood samples. Pd, with only one unqualified value, has no means calculated. Because there is only one sample of the Clintwood Rider coal bed and only two samples for the Clintwood Marker, the geometric means will not be discussed for these two beds.

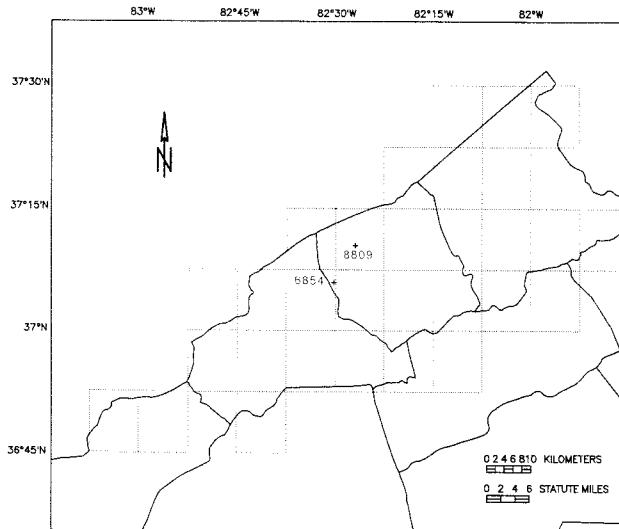


Figure 29. Locations for samples from the Clintwood Marker coal bed.

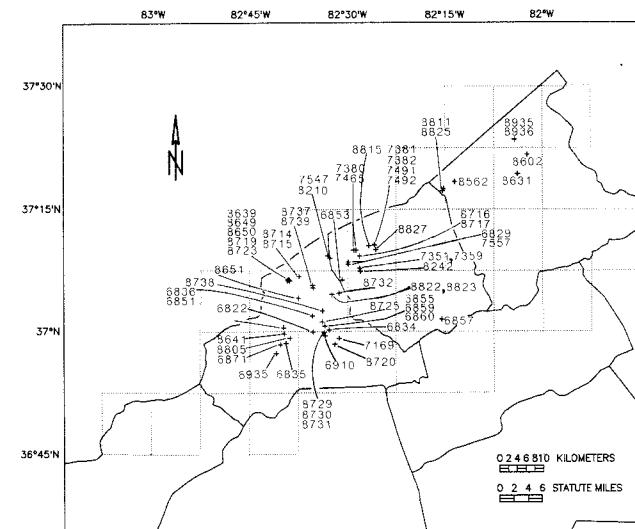


Table 22a.-Descriptions and locations for 2 bituminous coal samples from the Clintwood Marker coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-6854	W192610	90D-10	370555N	823012W	Pound (7.5') Clintwood (7.5')	Dickenson	18.48	Surface mine, s.l. weathered	Full Thickness
R-8809	W238478	89B-14	371029N	822654W	Dickenson	13.20	Surface mine		Full Thickness

Table 22b.-Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 2 bituminous coal samples from the Clintwood Marker coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, Hardgrove grindability indexes, and compliance numbers in percent.

For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT			
	Moisture	Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	Lab Number
R-6854	3.0	31.6	63.1	2.3	5.5	81.8	1.6	7.8	1.0	8,110	14,590	W192610
	---	32.6	65.1	2.4	5.3	84.3	1.6	5.3	1.0	8,360	15,040	
	---	33.4	66.6	---	5.5	86.4	1.7	5.4	1.1	8,560	15,410	
R-8809	3.8	34.5	59.9	1.8	5.6	82.3	1.5	8.1	.7	8,140	14,660	W238478
	---	35.9	62.3	1.9	5.4	85.5	1.6	4.9	.7	8,470	15,240	
	---	36.5	63.5	---	5.5	87.2	1.6	5.0	.7	8,630	15,530	

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Table 22b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 2 bituminous coal samples from the Clintwood Marker coal bed, Southwest Virginia.-continued

Sample Number	FORMS OF SULFUR					ASH-FUSION TEMPERATURE (°C)				Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid				
R-6854	0.0	0.02	0.26	0.76	9.0	1,350	1,415	1,480	---	1.37	W192610	
	--	.02	.27	.78								
R-8809	3.0	.03	.04	.59	7.5	1,250	1,310	1,470	59	.95	W238478	
	--	.03	.04	.61								

Table 22c.--Major- and minor-oxide concentrations in the laboratory ash of 2 bituminous coal samples from the Clintwood Marker coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. L means less than the concentration shown. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-6854	2.0	41	34	1.9	0.63	1.9	1.3	8.8	1.4	0.15	3.4	W192610
R-8809	1.6	36	31	3.1	.60	1.1	.87	7.6	.92	.62L	7.9	W238478

Table 22d. - Major-, minor-, and trace-element composition of 2 bituminous coal samples from the Clintwood Marker coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means less than the value shown; G means greater than the value shown; B, not determined; H, interference for an element which cannot be resolved by any routine method; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-6854	0.39	0.36	0.027	0.008	0.028	0.022	0.12	0.017	0.036	6.0	W192610
R-8809	.27	.26	.035	.006	.013	.012	.085	.009	.011	2.0	W238478

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-6854	6.4	15	3.6	2.0	0.056	5.7	B	12	5.6	0.30	W192610
R-8809	8.0	350G	2.4	5.9	.062	11	520	14	4.9	.20L	W238478

Sample Number	Cu (ppm)	Dy-S (ppm)	Er-S (ppm)	Eu (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	Ho-S (ppm)	Lab Number
R-6854	12	0.84	0.52	0.18	2.4	0.70	6.0	0.17	0.035	0.22	W192610
R-8809	16	.90	.80	.40	3.2	.88	4.3	.14	.005L	.21	W238478

Sample Number	La (ppm)	Li (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Lab Number
R-6854	2.7	3.0	0.09	4.0	0.82	0.68	3.4	10	13	44L	W192610
R-8809	4.5	1.6	.16	3.7	1.8	.14	H	13	.93	.26	W238478

Table 22d.--Major-, minor-, and trace-element composition of 2 bituminous coal samples from the Clintwood Marker coal bed,
Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Pr-S (ppm)	Sb (ppm)	Sc (ppm)	Se (ppm)	Sm (ppm)	Sn-S (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	Lab Number
R-6854	1.4L	1.4	2.0	3.9	0.67	0.28	22	0.24L	0.14	0.63	W192610
R-8809	.51	.78	2.0	1.1	1.8	.29	.38	.057	.26	.59	W238478

Sample Number	Tl-S (ppm)	Tm-S (ppm)	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)	Lab Number
R-6854	0.30	0.09L	0.45	9.8	0.26	4.8	0.50	3.6	4.4	W192610
R-8809	.16L	.10	.31	8.6	.68	5.0	.97	6.9	2.1	W238478

Table 23a.-Descriptions and locations for 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-6822	W191135	60A-4	365956N	823516W	Wise (7.5')	Wise	14.04	Surface mine, sl. weathered	Full Thickness
R-6834	W191334	90D-4	370012N	823246W	Pound (7.5')	Wise	37.44	Surface mine, sl. weathered	Lower Split
R-6835	W192604	60B-5	365834N	823926W	Norton (7.5')	Wise	27.24	Surface mine, sl. weathered	Partial Lower Split
R-6836	W192605	90D-5	370157N	823519W	Pound (7.5')	Wise	18.36	Surface mine, sl. weathered	Upper Split
R-6851	W192608	90D-9	370157N	823320W	Pound (7.5')	Wise	16.56	Surface mine, sl. weathered	Full Thickness
R-6853	W192611	90D-11	370622N	823050W	Pound (7.5')	Dickenson	33.24	Surface mine, sl. weathered	Full Thickness
R-6855	W192613	90D-12	370043N	823326W	Pound (7.5')	Wise	10.92	Surface mine, sl. weathered	Partial Lower Split
R-6857	W200125	89D-1	370131N	821528W	Nora (7.5')	Dickenson	27.36	Surface mine, sl. weathered	Lower Split
R-6859	W200127	90D-14	370043N	823326W	Pound (7.5')	Wise	10.32	Surface mine, sl. weathered	Bench Sample of Lower Split
R-6860	W192701	90D-15	370043N	823326W	Pound (7.5')	Wise	20.28	Surface mine, sl. weathered	Bench Sample of Lower Split
R-6871	W193663	60B-6	365823N	824015W	Norton (7.5')	Wise	20.16	Surface mine, sl. weathered	Full Thickness
R-6910	W194852	60A-21	365929N	823324W	Wise (7.5')	Wise	20.64	Surface mine, sl. weathered	Lower Split
R-6935	W196283	60B-8	365721N	824055W	Norton (7.5')	Wise	26.40	Surface mine, sl. weathered	Full Thickness
R-7169	W199468	60A-27	365912N	823116W	Wise (7.5')	Wise	15.12	Surface mine, sl. weathered	Full Thickness
R-7351	W203392	89B-1	370748N	822806W	Clintwood (7.5')	Dickenson	87.24	Surface mine	Middle Split
R-7359	W204162	89B-2	370748N	822806W	Clintwood (7.5')	Dickenson	28.20	Surface mine	Lower Split
R-7380	W204617	89B-3	371003N	822841W	Clintwood (7.5')	Dickenson	15.36	Surface mine, sl. weathered	Lower Split
R-7381	W204618	89B-4	371036N	822538W	Clintwood (7.5')	Dickenson	11.64	Surface mine, sl. weathered	Bench Sample of Lower Split
R-7382	W204619	89B-5	371036N	822538W	Clintwood (7.5')	Dickenson	12.00	Surface mine, sl. weathered	Bench Sample of Lower Split
R-7465	W206886	89B-6	371003N	822903W	Clintwood (7.5')	Dickenson	17.76	Surface mine	Lower Split
R-7491	W206887	89B-7	371040N	822548W	Clintwood (7.5')	Dickenson	31.80	Surface mine, sl. weathered	Lower Split
R-7492	W206888	89B-8	371043N	822550W	Clintwood (7.5')	Dickenson	21.60	Surface mine, sl. weathered	Lower Split
R-7547	W209961	90A-1	370904N	823229W	Jenkins East (7.5')	Dickenson	13.20	Surface mine, sl. weathered	Lower split
R-7557	W210397	89B-9	370819N	822952W	Clintwood (7.5')	Dickenson	25.20	Surface mine	Upper Split
R-8206	W212486	89B-10	370836N	822953W	Clintwood (7.5')	Dickenson	43.80	Surface mine, sl. weathered	Lower Split
R-8210	W212490	90A-3	370919N	823300W	Jenkins East (7.5')	Wise	33.00	Surface mine	Partial Lower Split
R-8242	W212487	89C-12	370726N	822759W	Caney Ridge (7.5')	Dickenson	82.80	Surface mine, weathered	Partial Seam
R-8562	W217685	118C-10	371824N	821329W	Harman (7.5')	Buchanan	45.60	Underground mine, sl. weathered	Full Thickness
R-8602	W218978	118D-14	372140N	820223W	Grundy (7.5')	Buchanan	37.80	Surface mine	Full Thickness
R-8631	W223355	118D-19	371919N	820349W	Grundy (7.5')	Buchanan	45.60	Surface mine	Full Thickness

Table 23a.--Descriptions and locations for 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia.--continued

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-8639	W225108	90C-16',17'	370029N	823948W	Flat Gap (7.5')	Wise	46.80	Surface mine, sl. weathered	Composite
R-8641	W225109	60B-23',24'	365944N	823942W	Norton (7.5')	Wise	50.40	Underground mine	Composite
R-8649	W226974	90C-21'	370614N	823911W	Flat Gap (7.5')	Wise	24.00	Surface mine	Upper split
R-8650	W226975	90C-22'	370613N	823853W	Flat Gap (7.5')	Wise	24.00	Surface mine	Upper split
R-8651	W226976	90D-22'	370406N	823729W	Pound (7.5')	Wise	24.00	Surface mine, sl. weathered	Lower split
R-8714	W229073	90D-24'	370645N	823724W	Pound (7.5')	Wise	14.40	Surface mine, sl. weathered	Lower split
R-8715	W229074	90D-25'	370645N	823724W	Pound (7.5')	Wise	10.80	Surface mine, sl. weathered	Upper split
R-8716	W229083	89B-11'	370919N	822808W	Clintwood (7.5')	Dickenson	49.20	Surface mine, sl. weathered	Lower split
R-8717	W229084	89B-12'	370912N	822804W	Clintwood (7.5')	Dickenson	43.20	Surface mine, sl. weathered	Upper split
R-8719	W229082	90C-24'	370621N	823857W	Flat Gap (7.5')	Wise	16.80	Surface mine	Lower split
R-8720	W229077	60A-30'	365828N	823155W	Wise (7.5')	Wise	20.40	Surface mine	Partial seam
R-8723	W229081	90C-25'	370625N	822906W	Flat Gap (7.5')	Wise	20.40	Surface mine	Upper split
R-8725	W229076	90D-27'	370113N	823350W	Pound (7.5')	Wise	24.00	Surface mine	Full thickness
R-8729	W229550	60A-33'	365953N	823333W	Wise (7.5')	Wise	37.20	Surface mine, sl. weathered	Lower split
R-8730	W229551	60A-34'	365953N	823333W	Wise (7.5')	Wise	9.60	Surface mine, sl. weathered	Middle split
R-8731	W229552	60A-35'	365953N	823333W	Wise (7.5')	Wise	20.40	Surface mine, sl. weathered	Upper split
R-8732	W229549	90D-28'	370444N	823118W	Pound (7.5')	Wise	20.40	Surface mine	Partial seam
R-8737	W231835	90D-33'	370540N	823519W	Pound (7.5')	Wise	28.80	Surface mine, sl. weathered	Lower split
R-8738	W231836	90D-34'	370234N	823348W	Pound (7.5')	Wise	30.00	Surface mine, sl. weathered	Upper split
R-8739	W231838	90D-35'	370521N	823516W	Pound (7.5')	Wise	28.80	Surface mine	Lower split
R-8805	W236237	60B-25'	365911N	823848W	Norton (7.5')	Wise	33.60	Surface mine	Full thickness
R-8811	W238483	119D-2'	371716N	821521W	Elkhorn City (7.5')	Buchanan	40.80	Surface mine	Full thickness
R-8815	W238479	89B-15'	371035N	822641W	Clintwood (7.5')	Dickenson	39.60	Surface mine	Partial lower split
R-8822	W238945	90D-44'	370434N	823321W	Pound (7.5')	Wise	30.00	Surface mine, sl. weathered	Lower split
R-8823	W238944	90D-45'	370434N	823321W	Pound (7.5')	Wise	19.20	Surface mine, sl. weathered	Upper split
R-8825	W238946	119D-3'	371731N	821512W	Elkhorn City (7.5')	Buchanan	43.20	Surface mine, sl. weathered	Full thickness
R-8827	W238942	89B-17'	371007N	822536W	Clintwood (7.5')	Dickenson	31.20	Surface mine	Lower split
R-8935	W246909	118A-4'	372329N	820416W	Hurley (7.5')	Buchanan	8.40	Auger	Upper split
R-8936	W246910	118A-5'	372329N	820416W	Hurley (7.5')	Buchanan	10.80	Auger	Lower split

Table 23b.-Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, Hardgrove grindability indexes, and compliance numbers in percent.
 For each sample number, the analyses are reported three ways: first, as received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. G for ash-fusion temperatures means greater than value shown. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT		
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	Lab Number
R-6822	2.9	32.2	53.5	11.4	5.0	72.2	1.5	7.1	2.8	7,240	13,030	W191135
---	---	33.2	55.1	11.7	4.8	74.4	1.5	4.7	2.9	7,460	13,420	
---	---	37.6	62.4	---	5.5	84.2	1.8	5.3	3.3	8,450	15,200	
R-6834	1.5	33.5	54.6	10.4	5.0	73.5	1.2	5.5	4.4	7,380	13,290	W191334
---	---	34.0	55.4	10.6	4.9	74.6	1.2	4.2	4.5	7,500	13,490	
---	---	38.0	62.0	---	5.5	83.4	1.4	4.7	5.0	8,380	15,090	
R-6835	4.3	32.3	58.5	4.9	5.6	77.8	1.6	9.0	1.1	7,720	13,890	W192604
---	---	33.8	61.1	5.1	5.4	81.3	1.7	5.4	1.1	8,060	14,510	
---	---	35.6	64.4	---	5.6	85.7	1.8	5.7	1.2	8,500	15,300	
R-6836	4.1	30.2	58.1	7.6	5.5	76.2	1.6	8.2	.9	7,550	13,590	W192605
---	---	31.5	60.6	7.9	5.3	79.5	1.7	4.8	.9	7,870	14,170	
---	---	34.2	65.8	---	5.7	86.3	1.8	5.2	1.0	8,550	15,390	
R-6851	3.1	30.1	63.0	3.8	5.5	80.7	1.6	7.8	.6	8,020	14,430	W192608
---	---	31.1	65.0	3.9	5.3	83.3	1.7	5.2	.6	8,270	14,890	
---	---	32.3	67.7	---	5.5	86.7	1.7	5.4	.6	8,610	15,500	
R-6853	2.3	33.4	59.6	4.7	5.5	79.1	1.5	6.4	2.8	7,930	14,270	W192611
---	---	34.2	61.0	4.8	5.4	81.0	1.5	4.5	2.9	8,110	14,610	
---	---	35.9	64.1	---	5.6	85.1	1.6	4.7	3.0	8,520	15,340	
R-6855	6.0	28.2	57.1	8.7	5.2	71.8	1.5	9.5	3.3	7,120	12,810	W192613
---	---	30.0	60.7	9.3	4.8	76.4	1.6	4.4	3.5	7,570	13,630	
---	---	33.1	66.9	---	5.3	84.2	1.8	4.9	3.9	8,340	15,020	
R-6857	2.7	32.8	* 61.3	3.2	5.6	79.9	1.5	8.7	1.1	7,950	14,310	W200125
---	---	33.7	63.0	3.3	5.4	82.1	1.5	6.5	1.1	8,170	14,710	
---	---	34.9	65.1	---	5.6	84.9	1.6	6.7	1.2	8,450	15,210	
R-6859	4.0	22.6	36.8	36.6	3.9	49.2	1.1	8.3	.8	4,880	8,790	
---	---	23.5	38.3	38.1	3.6	51.2	1.1	4.9	.8	5,080	9,150	
---	---	38.0	62.0	---	5.8	82.8	1.9	8.0	1.3	8,220	14,790	

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Table 23b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia.--continued

Sample Number	Air-dried Loss	FORMS OF SULFUR			ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number
		Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening			
R-6822	0.0	.22	1.77	.77	7.5	1,145	1,240	1,320	---	4.30
	--	.23	1.82	.79	.90					W191135
	--	.26	2.07							
R-6834	.0	.02	3.30	1.09	9.0	1,140	1,205	1,225	---	6.62
	--	.02	3.35	1.11						W191334
	--	.02	3.75	1.24						
R-6835	.0	.02	.64	.48	9.0	1,360	1,430	1,480	---	1.58
	--	.02	.67	.50	.53					W192604
	--	.02	.70							
R-6836	.0	.17	.28	.47	8.5	1,355	1,420	1,455	---	1.32
	--	.18	.29	.49						W192605
	--	.19	.32	.53						
R-6851	.0	.02	.15	.40	9.0	1,090	1,175	1,215	---	.83
	--	.02	.15	.41	.43					W192608
	--	.02	.16							
R-6853	.0	.02	2.02	.71	9.0	1,095	1,155	1,190	---	3.92
	--	.02	2.07	.73						W192611
	--	.02	2.17	.76						
R-6855	.0	.02	2.20	1.12	9.0	1,075	1,140	1,215	---	5.15
	--	.02	2.34	1.19						W192613
	--	.02	2.58	1.31						
R-6857	.0	.02	.67	.42	8.5	1,100	1,230	1,325	---	1.54
	--	.02	.69	.43						W200125
	--	.02	.71	.45						
R-6859	2.7	.10	.30	.40	5.5	1,540	1,540G	1,540G	---	1.82
	--	.10	.31	.42	.51					W200127
	--	.17		.67						

Table 23b.-Proximate and ultimate analyses, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia.--continued

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT	
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/kg	Btu/lb
R-6860	2.1	31.9	60.0	6.0	5.3	79.0	1.8	7.1	0.8	7,880	14,180
	---	32.6	61.3	6.1	5.2	80.7	1.8	5.3	.8	8,040	14,480
	---	34.7	65.3	---	5.5	86.0	2.0	5.7	.9	8,570	15,420
R-6871	1.5	33.5	53.3	11.7	5.1	74.3	1.4	6.3	1.2	7,380	13,280
	---	34.0	54.1	11.9	5.0	75.4	1.4	5.0	1.2	7,490	13,480
	---	38.6	61.4	---	5.7	85.6	1.6	5.7	1.4	8,500	15,300
R-6910	2.3	33.0	58.5	6.2	5.3	78.4	1.8	5.9	2.5	7,840	14,120
	---	33.8	59.9	6.3	5.2	80.2	1.8	3.9	2.6	8,030	14,450
	---	36.1	63.9	---	5.5	85.7	2.0	4.2	2.7	8,570	15,350
R-6935	3.9	37.1	53.0	6.0	5.8	75.8	1.4	8.4	2.6	7,640	13,760
	---	38.6	55.2	6.2	5.6	78.9	1.5	5.1	2.7	7,950	14,310
	---	41.2	58.8	---	6.0	84.1	1.6	5.5	2.9	8,480	15,270
R-7169	3.0	31.5	59.9	5.6	5.3	78.8	1.5	7.7	1.1	7,790	14,020
	---	32.5	61.8	5.8	5.1	81.2	1.5	5.2	1.1	8,030	14,660
	---	34.5	65.5	---	5.4	86.2	1.6	5.5	1.2	8,520	15,340
R-7351	3.9	33.7	57.7	4.7	5.5	79.0	1.8	8.2	.8	7,850	14,140
	---	35.1	60.0	4.9	5.3	82.2	1.9	4.9	.8	8,170	14,710
	---	36.9	63.1	---	5.5	86.4	2.0	5.2	.9	8,590	15,470
R-7359	2.2	30.8	55.9	11.1	5.0	74.4	1.5	7.1	.9	7,440	13,400
	---	31.5	57.2	11.3	4.9	76.1	1.5	5.3	.9	7,610	13,700
	---	35.5	64.5	---	5.5	85.8	1.7	5.9	1.0	8,580	15,450
R-7380	4.0	34.6	57.8	3.6	5.8	79.7	1.7	8.3	.9	7,920	14,260
	---	36.0	60.2	3.7	5.6	83.0	1.8	4.9	.9	8,250	14,860
	---	37.4	62.6	---	5.8	86.3	1.8	5.1	1.0	8,580	15,440
R-7381	3.9	31.6	57.5	7.0	5.3	76.3	1.5	9.0	.8	7,550	13,590
	---	32.9	59.8	7.3	5.1	79.4	1.6	5.8	.8	7,860	14,150
	---	35.5	64.5	---	5.5	85.6	1.7	6.2	.9	8,480	15,260
R-7382	3.4	30.8	54.2	11.6	4.9	72.6	1.4	8.5	.9	7,180	12,930
	---	31.9	56.1	12.0	4.7	75.2	1.4	5.7	.9	7,430	13,380
	---	36.2	63.8	---	5.3	85.4	1.6	6.4	1.1	8,450	15,210

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Table 23b.-Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia.--continued

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number	
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening				
R-6860	1.0	0.00	0.10	0.70	9.0	1,540	1,540G	---	1.13	W192701	
	---	.00	.10	.72							
	---	.00	.11	.76							
R-6871	.6	.04	.45	.67	5.5	1,425	1,465	1,500	---	1.81	W193663
	---	.04	.46	.68							
	---	.05	.52	.77							
R-6910	1.1	.01	1.89	.56	9.0	1,100	1,160	1,225	---	3.54	W194852
	---	.01	1.93	.57							
	---	.01	2.07	.61							
R-6935	2.6	.08	1.47	1.07	9.0	1,150	1,215	1,265	---	3.78	W196283
	---	.08	1.53	1.11							
	---	.09	1.63	1.19							
R-7169	1.3	.03	.25	.79	7.5	1,380	1,395	1,395G	---	1.57	W199468
	---	.03	.26	.81							
	---	.03	.27	.86							
R-7351	2.7	.02	.19	.62	8.0	1,390	1,445	1,505	---	1.13	W203392
	---	.02	.20	.65							
	---	.02	.21	.68							
R-7359	1.3	.01	.36	.52	7.5	1,540	1,540G	1,540G	---	1.34	W204162
	---	.01	.37	.53							
	---	.01	.42	.60							
R-7380	2.8	.01	.24	.62	7.0	1,245	1,295	1,365	---	1.26	W204617
	---	.01	.25	.65							
	---	.01	.26	.67							
R-7381	2.9	.01	.17	.65	9.0	1,540	1,540G	1,540G	---	1.18	W204618
	---	.01	.18	.68							
	---	.01	.19	.73							
R-7382	2.3	.01	.19	.72	9.0	1,540	1,540G	1,540G	---	1.39	W204619
	---	.01	.20	.75							
	---	.01	.22	.85							

Table 23b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia.--continued

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT		
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	Lab Number
R-7465	3.7	34.5	55.4	6.4	5.9	76.5	1.7	7.9	1.6	7,630	13,740	W206886
	---	35.8	57.5	6.6	5.7	79.4	1.8	4.8	1.7	7,930	14,270	
	---	38.4	61.6	---	6.1	85.1	1.9	5.1	1.8	8,490	15,280	
R-7491	4.0	33.2	56.5	6.3	5.6	77.0	1.8	8.1	1.3	7,670	13,800	W206887
	---	34.6	58.9	6.6	5.4	80.2	1.9	4.7	1.4	7,990	14,370	
	---	37.0	63.0	---	5.7	85.8	2.0	5.1	1.4	8,550	15,380	
R-7492	3.4	33.7	59.0	3.9	5.8	79.5	1.8	7.4	1.6	7,960	14,330	W206888
	---	34.9	61.1	4.0	5.6	82.3	1.9	4.5	1.7	8,240	14,830	
	---	36.4	63.6	---	5.8	85.8	1.9	4.7	1.7	8,590	15,460	
R-7547	8.9	34.1	49.2	7.8	5.9	69.8	1.5	12.3	2.6	7,050	12,690	W209961
	---	37.4	54.0	8.6	5.4	76.6	1.6	4.8	2.9	7,740	13,930	
	---	40.9	59.1	---	5.9	83.8	1.8	5.3	3.1	8,460	15,230	
R-7557	3.9	30.8	52.1	13.2	5.3	71.0	1.4	8.0	1.1	7,090	12,760	W210397
	---	32.0	54.2	13.7	5.1	73.9	1.5	4.7	1.1	7,370	13,270	
	---	37.2	62.8	---	5.9	85.6	1.7	5.5	1.3	8,550	15,390	
R-8206	2.1	30.9	61.8	5.2	5.0	79.9	1.6	7.5	.7	7,820	14,080	W212486
	---	31.6	63.2	5.3	4.9	81.7	1.7	5.7	.7	7,990	14,380	
	---	33.3	66.7	---	5.2	86.2	1.8	6.0	.8	8,440	15,190	
R-8210	1.8	31.6	52.6	13.9	4.7	71.8	1.6	7.3	.7	7,090	12,770	W212490
	---	32.2	53.6	14.2	4.6	73.2	1.6	5.8	.7	7,230	13,010	
	---	37.6	62.4	---	5.3	85.2	1.9	6.7	.8	8,420	15,150	
R-8242	4.0	31.7	59.6	4.7	5.2	77.3	1.8	10.1	.8	7,540	13,580	W212487
	---	33.0	62.1	4.9	4.9	80.6	1.9	6.8	.9	7,860	14,150	
	---	34.7	65.3	---	5.2	84.7	2.0	7.2	.9	8,270	14,880	
R-8562	1.5	33.6	58.8	6.0	5.2	79.8	1.7	6.0	1.3	7,900	14,220	W217685
	---	34.2	59.7	6.1	5.1	81.1	1.7	4.7	1.3	8,020	14,440	
	---	36.4	63.6	---	5.5	86.3	1.8	5.0	1.4	8,540	15,380	
R-8602	2.2	30.2	61.2	6.4	5.2	79.4	1.7	6.2	1.0	7,820	14,070	W218978
	---	30.9	62.6	6.6	5.1	81.2	1.7	4.4	1.0	7,990	14,390	
	---	33.0	67.0	---	5.5	86.9	1.9	4.7	1.1	8,560	15,400	

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Table 23b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia.--continued

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)				Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid			
R-7465	2.3 --- ---	0.01 .01 .01	1.20 1.25 1.33	0.38 .39 .42	8.0 9.0	1,330 1,395	1,395 1,440	1,440	---	2.33	W206886
R-7491	2.8 --- ---	.02 .02 .02	.84 .87 .94	.46 .48 .51	9.0	1,395	1,440	1,490	---	1.88	W206887
R-7492	1.9 --- ---	.02 .02 .02	1.18 1.22 1.27	.39 .40 .42	9.0	1,215	1,265	1,320	---	2.23	W206888
R-7547	7.5 --- ---	.01 .01 .01	2.20 2.41 2.64	.43 .47 .52	8.0	1,095	1,160	1,220	---	4.10	W20961
R-7557	2.8 --- ---	.19 .20 .23	.32 .33 .39	.62 .65 .75	8.5	1,170	1,240	1,330	---	1.72	W210397
R-8206	.6 --- ---	.01 .01 .01	.10 .10 .11	.61 .62 .66	3.5	1,540	1,540G	1,540G	---	.99	W212486
R-8210	.4 --- ---	.04 .04 .05	.14 .14 .17	.53 .54 .63	6.5	1,510	1,540	1,540G	---	1.10	W212490
R-8242	1.9 --- ---	.09 .09 .10	.15 .16 .16	.60 .63 .66	7.5	1,225	1,375	1,445	---	1.18	W212487
R-8562	.6 --- ---	.09 .09 .10	.61 .62 .66	.61 .62 .66	7.0	1,295	1,370	1,450	---	1.83	W217685
R-8602	1.3 --- ---	.05 .05 .05	.32 .33 .35	.63 .64 .69	8.0	1,370	1,475	1,540	---	1.42	W218978

Table 23b.-Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia.--continued

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Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT		
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	Lab Number
R-8631	1.6	31.3	64.1	3.1	5.3	83.2	1.7	6.1	0.7	8,220	14,800	W223355
	--	31.8	65.1	3.1	5.2	84.5	1.7	4.8	.7	8,350	15,040	
	--	32.8	67.2	--	5.4	87.2	1.8	5.0	.7	8,620	15,520	
R-8639	1.2	34.2	60.2	4.4	5.1	81.0	1.8	6.8	.8	8,090	14,570	W225108
	--	34.6	60.9	4.5	5.1	82.0	1.8	5.8	.8	8,190	14,740	
	--	36.2	63.8	--	5.3	85.8	1.9	6.1	.8	8,570	15,430	
R-8641	1.5	33.7	60.9	3.9	5.2	81.5	1.8	7.0	.7	8,070	14,530	W225109
	--	34.2	61.9	3.9	5.1	82.7	1.8	5.7	.8	8,290	14,760	
	--	35.6	64.4	--	5.3	86.1	1.9	5.9	.8	8,530	15,360	
R-8649	2.1	35.5	55.1	7.3	5.2	76.7	1.7	7.9	1.2	7,650	13,780	W226974
	--	36.2	56.3	7.5	5.1	78.4	1.7	6.2	1.2	7,820	14,070	
	--	39.1	60.9	--	5.5	84.7	1.9	6.6	1.3	8,450	15,200	
R-8650	2.1	34.8	56.1	7.0	5.3	76.5	1.7	6.1	3.3	7,680	13,830	W226975
	--	35.5	57.3	7.1	5.2	78.1	1.8	4.3	3.4	7,840	14,120	
	--	38.3	61.7	--	5.6	84.1	1.9	4.7	3.7	8,450	15,210	
R-8651	17.7	27.6	49.9	4.8	5.4	61.7	1.4	26.1	.5	5,750	10,340	W226976
	--	33.5	60.6	5.9	4.2	75.0	1.7	12.5	.7	6,980	12,570	
	--	35.6	64.4	--	4.5	79.7	1.8	13.3	.7	7,420	13,360	
R-8714	2.7	34.1	55.8	7.4	5.3	76.8	2.4	7.3	.8	7,620	13,720	W229073
	--	35.0	57.3	7.6	5.1	78.9	2.4	5.1	.9	7,840	14,100	
	--	37.9	62.1	--	5.5	85.4	2.6	5.5	.9	8,480	15,270	
R-8715	2.4	36.0	52.6	9.0	5.3	73.9	2.1	6.2	3.6	7,510	13,520	W229074
	--	36.9	53.9	9.2	5.2	75.7	2.1	4.2	3.7	7,690	13,850	
	--	40.6	59.4	--	5.7	83.3	2.4	4.6	4.0	8,470	15,250	
R-8716	4.5	32.5	56.1	6.9	5.4	76.2	1.5	8.5	1.5	7,580	13,640	W229083
	--	34.1	58.7	7.2	5.1	79.8	1.6	4.7	1.5	7,930	14,270	
	--	36.7	63.3	--	5.5	86.0	1.7	5.1	1.7	8,550	15,390	
R-8717	9.4	28.6	56.3	5.7	5.1	68.9	1.4	18.1	.7	6,630	11,940	W229084
	--	31.6	62.1	6.3	4.5	76.1	1.6	10.8	.8	7,320	13,180	
	--	33.7	66.3	--	4.8	81.2	1.7	11.5	.8	7,810	14,070	

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Table 23b.--Approximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia. --continued

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)				Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid			
R-8651	.8	.01	.05	.62	8.5	1,415	1,490	63	0.95	W223555	
	---	.01	.05	.63							
	---	.01	.05	.65							
R-8639	.5	.05	.09	.64	7.5	1,495	1,540	55	1.10	W225108	
	---	.05	.09	.65							
	---	.05	.10	.68							
R-8641	.7	.08	.06	.60	8.5	1,365	1,440	60	.96	W225109	
	---	.08	.06	.61							
	---	.08	.06	.63							
R-8649	1.0	.08	.42	.67	7.0	1,360	1,440	52	1.74	W226974	
	---	.08	.43	.68							
	---	.09	.46	.74							
R-8650	.9	.11	2.20	1.03	7.5	1,140	1,150	53	4.77	W226975	
	---	.11	2.25	1.05							
	---	.12	2.42	1.13							
R-8651	12.6	.02	.02	.50	.0	1,195	1,270	91	.97	W226976	
	---	.02	.02	.61							
	---	.03	.03	.65							
R-8714	1.7	.05	.21	.58	8.0	1,370	1,430	51	1.17	W229073	
	---	.05	.22	.60							
	---	.06	.23	.65							
R-8715	1.4	.13	2.51	.93	8.0	1,105	1,125	54	5.33	W229074	
	---	.13	2.57	.95							
	---	.15	2.83	1.05							
R-8716	3.7	.11	.71	.66	7.5	1,320	1,380	59	2.20	W229083	
	---	.12	.74	.69							
	---	.12	.80	.74							
R-8717	7.4	.01	.04	.63	.50	1,300	1,360	63	1.17	W229084	
	---	.01	.04	.70							
	---	.01	.05	.74							

Table 23b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-shelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia.--continued

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT	
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb
R-8719	1.8	34.8	51.7	11.6	5.3	73.4	1.6	6.8	1.3	7,340	13,220
	---	35.5	52.7	11.9	5.2	74.7	1.6	5.3	1.3	7,430	13,460
	---	40.3	59.7	---	5.9	84.8	1.8	6.0	1.5	8,490	15,280
R-8720	2.6	32.0	62.0	3.4	5.4	81.2	1.5	7.8	.7	8,050	14,490
	---	32.8	63.6	3.5	5.3	83.3	1.5	5.6	.7	8,260	14,870
	---	34.0	66.0	---	5.5	86.4	1.6	5.8	.7	8,560	15,410
R-8723	2.0	34.2	54.2	9.6	5.2	75.2	1.6	7.2	1.2	7,490	13,480
	---	34.9	55.3	9.8	5.1	76.7	1.6	5.5	1.2	7,640	13,760
	---	38.7	61.3	---	5.7	85.1	1.8	6.1	1.4	8,480	15,260
R-8725	3.2	33.0	60.6	3.2	5.3	81.0	1.7	8.0	.8	8,030	14,450
	---	34.1	62.6	3.3	5.2	83.7	1.7	5.3	.8	8,290	14,930
	---	35.3	64.7	---	5.3	86.5	1.8	5.5	.9	8,580	15,440
R-8729	4.2	30.9	58.4	6.4	5.3	77.4	1.6	8.4	.9	7,670	13,800
	---	32.2	61.0	6.7	5.0	80.9	1.6	4.8	.9	8,010	14,410
	---	34.6	65.4	---	5.4	86.7	1.8	5.2	1.0	8,580	15,450
R-8730	4.4	31.3	53.0	11.4	5.1	69.4	1.4	6.1	6.6	7,110	12,800
	---	32.7	55.4	11.9	4.9	72.6	1.4	2.3	6.9	7,440	13,390
	---	37.1	62.9	---	5.5	82.4	1.6	2.6	7.8	8,440	15,190
R-8731	5.2	30.9	53.0	10.9	5.1	70.5	1.4	7.6	4.4	7,150	12,880
	---	32.6	56.0	11.5	4.8	74.4	1.5	3.2	4.7	7,550	13,590
	---	36.8	63.2	---	5.4	84.1	1.7	3.6	5.3	8,520	15,340
R-8732	6.0	31.8	61.0	1.3	5.7	81.2	1.5	9.5	.8	8,010	14,420
	---	33.8	64.9	1.3	5.4	86.4	1.6	4.4	.9	8,520	15,340
	---	34.2	65.8	---	5.4	87.5	1.6	4.5	.9	8,640	15,550
R-8737	3.4	32.0	62.0	2.6	5.4	80.9	1.5	8.9	.7	8,100	14,580
	---	33.1	64.2	2.7	5.2	83.7	1.6	6.1	.7	8,380	15,080
	---	34.0	66.0	---	5.4	86.0	1.6	6.2	.7	8,610	15,500
R-8738	3.8	30.4	58.1	7.7	5.1	75.9	1.6	7.4	2.3	7,580	13,640
	---	31.6	60.4	8.0	4.9	78.9	1.7	4.2	2.3	7,880	14,180
	---	34.4	65.6	---	5.3	85.8	1.8	4.5	2.5	8,570	15,420

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Table 23b.—Approximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia. --continued

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening			
R-8719	1.1	0.02	0.52	0.78	7.0	1,515	1,540	1,540G	46	1.97
	---	.02	.53	.79						W229082
	---	.02	.60	.90						
R-8720	1.7	.01	.07	.60		1,305	1,450	1,530	---	.97
	---	.01	.07	.62						W229077
	---	.01	.07	.64						
R-8723	1.2	.05	.42	.75	7.5	1,425	1,450	1,530	50	1.78
	---	.05	.43	.77						W229081
	---	.06	.48	.85						
R-8725	2.4	.01	.16	.65	8.5	1,355	1,395	1,510	56	1.11
	---	.01	.17	.67						W229076
	---	.01	.17	.69						
R-8729	3.7	.05	.12	.72	8.5	1,350	1,445	1,470	61	1.30
	---	.05	.13	.75						W229550
	---	.06	.13	.81						
R-8730	3.9	.22	5.22	1.17	9.0	1,110	1,160	1,180	68	10.31
	---	.23	5.46	1.22						W229551
	---	.26	6.20	1.39						
R-8731	4.6	.27	2.97	1.17	9.0	1,095	1,145	1,205	63	6.83
	---	.28	3.13	1.23						W229552
	---	.32	3.54	1.39						
R-8732	5.4	.02	.07	.73	9.0	1,260	1,325	1,450	70	1.11
	---	.02	.07	.78						W229549
	---	.02	.08	.79						
R-8737	2.6	.03	.09	.54	8.5	1,455	1,500	1,540	66	.96
	---	.03	.09	.56						W231835
	---	.03	.10	.57						
R-8738	3.1	.14	1.53	.58	8.0	1,380	1,395	1,440	74	3.37
	---	.15	1.59	.60						W231836
	---	.16	1.73	.66						

Table 23b.-Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, grindability index, and compliance numbers for 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia. -continued

Sample Number	Moisture	PROXIMATE ANALYSIS					ULTIMATE ANALYSIS					HEAT CONTENT	
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal./KG	Btu/lb	Lab Number	
R-8739	4.1	31.4	61.1	3.5	5.5	80.5	1.6	8.2	0.7	8,010	14,410	W231838	
	--	32.7	63.7	3.6	5.2	84.0	1.7	4.7	.7	8,350	15,020		
	--	33.9	66.1	--	5.4	87.1	1.8	4.9	.7	8,660	15,590		
R-8805	3.3	34.2	57.1	5.4	5.4	78.9	1.5	8.0	.7	7,830	14,090	W236237	
	--	35.3	59.0	5.6	5.2	81.6	1.6	5.2	.7	8,090	14,570		
	--	37.5	62.5	--	5.5	86.5	1.7	5.6	.8	8,580	15,440		
R-8811	2.0	35.6	55.5	6.9	5.4	77.7	1.5	5.7	2.7	7,840	14,110	W238483	
	--	36.3	56.6	7.1	5.3	79.3	1.6	4.0	2.7	8,000	14,400		
	--	39.1	60.9	--	5.7	85.4	1.7	4.3	3.0	8,610	15,500		
R-8815	2.0	35.1	59.3	3.7	5.4	81.2	1.7	7.0	--	1.0	8,090	14,560	
	--	35.8	60.5	3.7	5.3	82.9	1.8	5.3	1.0	8,250	14,850	W238479	
	--	37.2	62.8	--	5.5	86.1	1.8	5.5	1.1	8,570	15,420		
R-8822	2.9	33.2	60.8	3.2	5.5	81.0	1.8	7.9	.6	8,110	14,610	W238945	
	--	34.2	62.6	3.3	5.4	83.4	1.8	5.5	.6	8,360	15,040		
	--	35.3	64.7	--	5.6	86.2	1.9	5.7	.7	8,640	15,550		
R-8823	3.0	32.5	60.8	3.7	5.4	81.2	1.6	7.0	.9	8,060	14,510	W238944	
	--	33.5	62.7	3.9	5.3	83.7	1.7	4.5	1.0	8,300	14,950		
	--	34.8	65.2	--	5.5	87.0	1.7	4.7	1.0	8,640	15,550		
R-8825	3.2	34.6	56.2	5.9	5.5	78.1	1.6	7.0	1.9	7,850	14,130	W238946	
	--	35.8	58.1	6.1	5.3	80.7	1.6	4.3	2.0	8,110	14,600		
	--	38.1	61.9	--	5.6	85.9	1.7	4.5	2.1	8,640	15,550		
R-8827	3.3	32.8	60.2	3.7	5.5	80.5	1.5	7.7	1.0	8,010	14,410	W238942	
	--	33.9	62.3	3.8	5.3	83.3	1.6	4.9	1.1	8,280	14,910		
	--	35.2	64.8	--	5.5	86.6	1.7	5.1	1.1	8,610	15,500		
R-8935	2.3	35.9	54.9	6.9	5.4	76.1	1.6	6.5	3.4	7,700	13,850	W246909	
	--	36.7	56.2	7.1	5.3	77.9	1.7	4.6	3.5	7,880	14,180		
	--	39.5	60.5	--	5.7	83.9	1.8	4.9	3.8	8,480	15,260		
R-8936	1.8	31.7	61.7	4.8	5.3	81.4	1.4	6.4	.8	7,980	14,370	W246910	
	--	32.3	62.8	4.8	5.2	82.9	1.4	4.8	.8	8,130	14,640		
	--	34.0	66.0	--	5.4	87.2	1.5	5.1	.8	8,550	15,380		

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Table 23b.- Approximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia.--continued

Sample Number	Air-dried Loss	FORMS OF SULFUR			ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number
		Sulfate	Pyritic	Organic	Free-swelling index	Initiation Deformation	Softening			
R-8739	3.4	0.03	0.08	0.58	8.5	1,480	1,525	1,540	67	0.97
	---	.03	.08	.60	.63					W231838
R-8805	2.4	.01	.04	.64	7.0	1,540	1,540G	1,540G	54	.99
	---	.01	.04	.66	.70					W236237
R-8811	1.5	.09	1.67	.93	6.0	1,050	1,105	1,300	64	3.83
	---	.09	1.70	.95	1.02					W238483
R-8815	1.1	.02	.32	.66	7.0	1,310	1,430	1,500	57	1.37
	---	.02	.33	.67	.70					W238479
R-8822	1.7	.02	.15	.45	8.0	1,540	1,540G	1,540G	60	.82
	---	.02	.15	.46						W238945
R-8823	1.6	.11	.15	.68	8.0	1,475	1,505	1,540	60	1.24
	---	.11	.15	.70	.73					W238944
R-8825	2.1	.05	1.00	.90	6.5	1,070	1,125	1,180	61	2.69
	---	.05	1.03	.93						W238946
R-8827	2.0	.01	.36	.67	8.0	1,405	1,450	1,510	57	1.39
	---	.01	.37	.69						W238942
R-8935	1.1	.42	1.85	1.14	8.0	1,100	1,115	1,230	73	4.91
	---	.43	1.89	1.17						W246909
R-8936	1.1	.07	.04	.68	6.0	1,510	1,540	1,540G	56	1.11
	---	.07	.04	.69	.73					W246910

Table 23c.--Major- and minor-oxide concentrations in the laboratory ash of 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. L means less than the concentration shown; B not determined. Sample number is the VDMR identification number. Lab number is the USGS Laboratory number.]

Sample Number	Ash	S ₁₀₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	S ₀₃	Lab Number
R-6822	11.2	44	24	1.4	1.1	0.95	2.1	.22	1.2	1.4	2.2	W191135
R-6834	10.8	30	17	1.3	.32	.81	.70	.46	1.5	.40	2.4	W191334
R-6835	4.3	42	27	2.3	.33	.66	1.1	.13	1.1	.047	3.1	W192604
R-6836	7.7	49	25	3.0	.43	.76	1.5	.91	2.3	1.6	2.9	W192605
R-6851	4.2	53	30	1.5	.50	.63	1.8	4.1	1.4	.14	2.7	W192608
R-6853	4.5	25	16	1.6	.60	.57	1.5	.39	1.0	.11	2.6	W192611
R-6855	10.6	32	18	1.2	.80	.54	1.8	.38	.69	.27	1.6	W192613
R-6857	3.2	29	23	3.2	.80	1.8	1.4	.29	.89	.16L	5.2	W200125
R-6859	32.6	57	28	.21	1.2	.23	4.2	4.1	1.2	.086	.01L	W200127
R-6860	6.1	52	31	1.6	.81	.35	2.5	7.3	2.1	.43	1.6	W192701
R-6871	10.7	52	29	.85	.71	.18	2.1	.90	1.5	.12	1.3	W193663
R-6910	5.8	31	22	1.7	.55	.59	1.0	.29	1.4	.66	2.3	W194852
R-6935	7.8	53	30	.69	.68	.32	2.7	5.6	1.8	.064	.79	W196283
R-7169	6.1	48	26	1.2	.91	.53	3.3	12	1.1	.11	2.1	W199468
R-7351	4.7	47	30	2.3	.51	1.3	.94	11	2.6	1.4	2.4	W203392
R-7359	8.7	54	26	.85	.98	.54	1.4	8.5	1.9	.17	1.0	W204162
R-7380	3.3	43	29	2.7	.83	.81	1.9	9.9	1.6	1.0	3.5	W204617
R-7381	7.4	54	34	.83	.50	.16	1.8	2.7	1.1	.068L	.75	W204618
R-7382	12.1	51	35	.53	.95	.32	4.1	3.0	1.0	.041L	.50	W204619
R-7465	6.8	45	27	1.0	.50	.19	1.1	20	1.7	.074L	.28	W206886
R-7491	8.8	62	22	.88	.33	.27	.78	10	3.5	.22	.05L	W206887
R-7492	3.7	36	24	1.8	.60	.93	1.3	.27	1.2	.54	1.3	W206888
R-7547	7.6	29	20	1.4	.38	.14	1.2	.40	1.1	1.1	1.6	W209961
R-7557	6.7	22	14	1.5	.40	.08	1.0	.51	.89	.15L	2.4	W210397
R-8206	4.5	49	31	2.3	.56	.45	1.0	6.1	2.6	4.0	2.5	W212486
R-8210	17.6	56	30	.34	1.2	.43	4.2	4.1	1.2	.057	.85	W212490
R-8242	4.8	44	26	1.9	.83	1.1	1.5	15	2.2	3.3	2.2	W212487
R-8562	6.8	47	25	1.3	.20	1.0	.69	17	2.4	.29	2.2	W217685
R-8602	6.3	53	26	.78	.37	1.1	.61	.9	3.1	.16L	B	W218978
R-8631	3.4	51	30	1.9	.51	1.6	1.1	4.0	2.1	2.3	2.1	W223355
R-8639	4.8	50	33	1.2	.63	.41	1.9	6.3	1.5	.27	1.6	W225108
R-8641	3.6	93	6.4	.15	.66	.45	.13	.3	.70	1.6	.50	W225109
R-8649	7.8	49	27	.83	.96	.32	2.6	12	1.6	.27	1.1	W226974
R-8650	6.9	33	17	.77	.32	.18	1.1	44	1.1	.14L	1.1	W226975
R-8651	4.8	26	12	.77	3.7	.59	1.7	7.6	.72	.21L	16	W226976

Table 23c. -Major- and minor-oxide concentrations in the laboratory ash of 59 bituminous coal samples from the Clintwood coal bed,
Southwest Virginia.--continued

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-8714	7.7	47	28	1.9	0.50	0.22	0.90	10	2.7	2.2	1.4	W229073
R-8715	9.6	31	18	1.1	.50	.12	1.5	40	1.0	.64	1.4	W229074
R-8716	7.3	45	27	.87	.61	.43	1.6	16	1.7	.14L	1.3	W229083
R-8717	5.9	39	28	3.9	1.2	.43	1.6	13	1.9	.17L	4.8	W229084
R-8719	12.8	52	28	.45	.91	.16	2.5	7.7	1.8	.10	.73	W229082
R-8720	3.8	43	31	1.9	1.0	1.6	2.5	8.1	1.9	.26L	2.8	W229077
R-8723	8.9	49	30	.64	1.1	.35	3.5	9.9	1.3	.11L	.90	W229081
R-8725	3.0	40	31	2.5	.73	.89	.97	13	1.3	.33L	2.4	W229076
R-8729	7.6	54	27	2.3	.55	.65	1.2	4.4	2.2	1.5	2.3	W229550
R-8730	12.2	18	13	1.7	.50	.11	.59	.59	.32	.082L	2.4	W229551
R-8731	11.7	33	17	1.3	.50	.27	1.7	38	.90	.10	1.9	W229552
R-8732	1.3	34	30	3.2	.78	1.1	.75	18	1.2	.77L	4.8	W229549
R-8737	2.6	37	37	2.9	.55	.51	.90	13	1.0	2.0	3.1	W231835
R-8738	7.7	37	23	1.8	.40	.32	.75	29	2.1	.99	2.4	W231836
R-8739	3.7	43	31	2.5	.86	.39	1.2	14	1.4	.97	3.4	W231838
R-8805	5.2	52	37	1.0	.48	.27	1.5	3.1	1.5	.33	1.2	W236237
R-8811	6.8	35	24	2.7	.33	.51	.60	29	1.7	.66	4.2	W238483
R-8815	3.5	42	31	1.7	.20	.74	.49	14	2.8	.31	2.4	W238479
R-8822	3.2	45	39	1.8	.55	1.3	1.1	4.9	2.2	.31L	3.5	W238944
R-8823	3.6	45	33	1.3	.73	1.1	1.3	12	1.6	.28L	2.6	W238945
R-8825	6.4	36	23	2.6	.66	.90	.60	28	2.0	.42	4.6	W238946
R-8827	3.8	43	31	1.4	.65	1.2	1.9	15	1.4	.26L	2.6	W238942
R-8935	7.0	27	13	1.5	.93	.54	1.8	45	.59	.14L	3.5	W246909
R-8936	4.9	49	32	2.0	.63	.61	1.3	5.1	1.8	.20L	3.2	W246910

[Concentrations in percent or parts-per-million. L means less than the value shown; H, interference for an element which cannot be resolved by any routine method; B, not determined; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-68322	2.3	1.4	0.11	0.076	0.078	0.20	1.8	0.081	0.063	.21	W191135
R-6834	1.5	.97	.10	.021	.065	3.5	.097	.058	.047	.42	W191334
R-6835	.84	.61	.071	.009	.021	.39	.028	.047	.047	.12	W192604
R-6836	1.7	1.0	.16	.020	.043	.96	.49	.11	.025	.3.6	W192605
R-6851	1.0	.67	.045	.013	.020	.063	.12	.035	.040	.60	W192608
R-6853	.52	.39	.051	.016	.019	.056	1.2	.027	.023	.82	W192611
R-6855	1.6	1.0	.091	.051	.042	.16	2.8	.044	.041	.37	W192613
R-6857	.44	.40	.072	.015	.042	.038	.65	.017	.019	.24	W200125
R-6859	8.7	4.7	.049	.24	.055	1.1	.94	.23	.033L	.6-.4	W200127
R-6860	1.5	.98	.070	.030	.016	.13	.31	.077	.029	.3.0	W192701
R-6871	2.6	1.6	.065	.046	.014	.19	.67	.096	.022	.10	W193663
R-6910	.84	.69	.070	.019	.026	.048	1.2	.049	.019	.15	W194852
R-6935	1.9	1.3	.038	.032	.019	.18	.31	.084	.043	.78	W196283
R-7169	1.4	.83	.054	.034	.024	.17	.50	.059	.041	.12	W199468
R-7351	1.0	.75	.077	.015	.046	.037	.35	.073	.027	.3.4	W203392
R-7359	2.2	1.2	.053	.051	.035	.10	.52	.098	.053	.3-.8	W204162
R-7380	.66	.51	.063	.016	.020	.052	.23	.032	.040	.6.0	W204617
R-7381	1.9	1.3	.044	.022	.009	.11	.14	.050	.055	.80	W204618
R-7382	2.9	2.2	.046	.069	.029	.42	.26	.075	.045	1.6	W204619
R-7465	1.4	.97	.049	.020	.010	.065	.95	.070	.031	.17	W206886
R-7491	2.5	1.0	.055	.018	.018	.057	.63	.18	.031	.6.3	W206887
R-7492	.62	.47	.048	.013	.026	.040	.70	.027	.024	.13	W206888
R-7547	1.0	.82	.074	.017	.008	.074	2.1	.048	.070	.68	W209961
R-7557	.68	.50	.070	.016	.004	.057	2.4	.036	.056	.110	W210397
R-8206	1.0	.73	.073	.015	.015	.037	.19	.069	.023	.1.5	W212486
R-8210	4.6	2.8	.042	.12	.056	.62	.50	.13	.026	.4.1	W212490
R-8242	.98	.66	.065	.024	.037	.059	.50	.063	.022	.9.1	W212487
R-8362	1.5	.91	.062	.008	.051	.039	.82	.099	.024	.12	W217685
R-8502	1.5	.87	.035	.014	.050	.032	.038	.12	.035	.27	W218978
R-8631	.81	.53	.047	.011	.041	.031	.095	.042	.037	1.8	W223355
R-8639	1.1	.84	.041	.018	.014	.074	.21	.042	.042	.6.5	W225108
R-8641	1.6	.12	.004	.014	.012	.004	.007	.015	.043	.7.9	W225109
R-8649	1.8	1.1	.046	.045	.019	.17	.63	.073	.066	.8.5	W226974
R-8650	1.1	.61	.038	.013	.009	.062	2.1	.046	.064	100	W226975
R-8651	.58	.42	.047	.011	.021	.070	.25	.021	.041	.89	W226976

Table 23d. -Major-, minor-, and trace-element composition of 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-8714	1.7	1.2	0.11	0.023	0.012	0.058	0.55	0.12	0.065	4.2	W229073
R-8715	1.4	.93	.073	.029	.009	.12	2.7	.059	.054	180	W229074
R-8716	1.5	1.1	.045	.027	.023	.097	.82	.073	.049	27	W229083
R-8717	1.1	.87	.16	.042	.019	.079	.54	.068	.053	3.0	W229084
R-8719	3.1	1.9	.041	.070	.015	.27	.69	.14	.11	4.7	W229082
R-8720	.76	.63	.052	.024	.046	.078	.22	.043	.031	5.0	W229077
R-8723	2.0	1.4	.041	.060	.023	.26	.61	.068	.063	9.9	W229081
R-8725	.56	.50	.055	.013	.020	.024	.27	.024	.042	5.9	W229076
R-8729	1.9	1.1	.12	.025	.036	.077	.24	.10	.045	4.3	W229550
R-8730	1.0	.81	.15	.037	.010	.060	5.0	.023	.11	39	W229551
R-8731	1.8	1.0	.11	.035	.023	.17	3.1	.063	.064	6.3	W229552
R-8732	.20	.21	.030	.006	.011	.008	.17	.009	.030	5.5	W229549
R-8737	.45	.51	.054	.009	.010	.020	.24	.016	.020	2.2	W231835
R-8738	1.3	.92	.097	.018	.018	.048	1.6	.097	.031	21	W231836
R-8739	.75	.60	.066	.019	.011	.038	.37	.031	.023	1.4	W231838
R-8805	1.3	1.0	.039	.015	.010	.064	.11	.048	.026	1.2	W236237
R-8811	1.1	.87	.13	.014	.026	.034	1.4	.070	.031	15	W238483
R-8815	.69	.58	.043	.004	.019	.014	.34	.058	.031	5.4	W238479
R-8822	.67	.66	.041	.011	.032	.030	.11	.043	.027	3.1	W238944
R-8823	.75	.63	.035	.016	.031	.039	.31	.034	.040	4.8	W238945
R-8825	1.1	.77	.12	.026	.043	.032	1.3	.077	.048	37	W238946
R-8827	.77	.62	.038	.015	.033	.060	.41	.032	.029	7.6	W238942
R-8935	.87	.49	.072	.039	.028	.11	2.2	.025	.048	54	W246909
R-8936	1.1	.83	.071	.019	.022	.054	.18	.053	.042	2.7	W246910

Table 23d.--Major-, minor-, and trace-element composition of 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Bi-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	ppm)	Lab Number
R-6822	13	160	2.7	4.5L	5.0	0.15	17	B	6.5	14	W191135	
R-6834	14	120	.93	4.8L	4.0	.067	14	B	4.3	13	W191334	
R-6835	10	42	1.8	.9L	3.0	.16	17	B	4.5	6.5	W192604	
R-6836	12	160	1.6	1.7L	3.0	.092	19	B	11	17	W192605	
R-6851	7.1	210	2.3	.9L	4.0	.024	8.0	B	13	6.1	W192608	
R-6853	6.8	23	1.6	1.0L	1.7	.036	4.7	B	2.7	5.5	W192611	
R-6855	9.6	36	1.9	2.3L	10	.10	13	B	13	11	W192613	
R-6857	10	20	.38	.5L	6.4	.064	6.5	340	8.0	4.5	W200125	
R-6859	36	200	3.6	4.9L	9.1	.25	60	220	15	42	W200127	
R-6860	13	54	1.0	1.3L	4.5	.054	14	B	5.8	9.8	W192701	
R-6871	10	42	2.7	2.4L	2.5	.075	30	B	14	16	W193663	
R-6910	9.3	37	.81	1.3L	2.6	.12	9.7	B	12	8.8	W194852	
R-6935	12	50	1.6	1.7L	2.2	.078	5.0	B	2.2	5.7	W196283	
R-7169	8.5	50	1.7	.9L	8.0	.21	12	B	11	11	W199468	
R-7351	23	52	.71	.7L	3.1	.052	16	280	2.7	8.8	W203392	
R-7359	12	96	3.3	1.3L	2.5	.096	30	350	14	18	W204162	
R-7380	9.6	40	1.7	.3L	7.3	.10	12	430	6.0	7.0	W204617	
R-7381	13	42	2.5	.7L	4.3	.058	14	230	15	12	W204618	
R-7382	18	85	5.4	1.2L	5.4	.15	23	200	9.4	22	W204619	
R-7465	8.8	95	2.2	.7L	3.2	.057	19	200	17	12	W206886	
R-7491	13	52	2.9	.9L	6.7	.069	23	350	7.9	15	W206887	
R-7492	7.4	37	2.1	.4L	11	.059	11	650	13	6.0	W206888	
R-7547	9.9	69	3.5	.8L	9.0	.17	22	520	15	14	W209961	
R-7557	13	53	2.3	.7L	8.2	.054	5.0	100L	2.2	5.0	W210397	
R-8206	9.5	72	2.3	.5L	7.6	.023	15	520	8.3	10	W212486	
R-8210	42	150	1.4	1.8L	6.3	.056	30	360	2.8	24	W212490	
R-8242	11	72	.96	.5L	3.0	.077	12	170	4.9	11	W212487	
R-8562	13	60	2.1	.7L	11	.067	14	600	4.8	12	W211685	
R-8602	8.2	51	1.9	.6L	16	.058	21	1,100	6.3	15	W218978	
R-8631	15	140	1.5	.3L	13	.010	12	750	2.5	5.6	W223355	
R-8639	9.6	31	.91	.5L	2.5	.020	11	660	4.4	8.8	W225108	
R-8641	9.0	54	.72	.4	2.4	.019	9.7	640	2.9	7.1	W225109	
R-8649	12	61	1.7	.8L	5.4	.053	18	410	6.8	13	W226974	
R-8650	9.0	21	1.7	.7L	5.4	.047	11	490	6.8	10	W226975	
R-8651	3.5	170	.62	.5L	8.6	.048	8.9	120	3.7	5.6	W226976	

Table 23d. Major-, minor-, and trace-element composition of 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia, reported on a whole-coal basis. --continued

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Bi-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	La (ppm)	Lab Number
R-8714	12	150	2.8	0.8L	7.1	0.065	.25	490	.21	.20		V229073
R-8715	13	59	1.6	1.0L	5.4	.072	.14	360	5.9	11		W229074
R-8716	11	61	2.5	.9	2.7	.029	.20	120	11	10		W229083
R-8717	8.9	77	1.1	.6L	2.1	.033	.12	100L	7.5	8.2		W229084
R-8719	18	91	2.3	1.3L	6.7	.13	.27	340	11	16		W229082
R-8720	16	190	.35	.4L	1.3	.008	5.9	100L	1.9	5.5		V229077
R-8723	13	57	2.4	.9L	3.5	.050	.25	380	8.5	17		V229081
R-8725	6.9	33	1.1	.4	4.8	.007	8.4	360	6.6	4.0		V229076
R-8729	19	120	1.4	.8L	3.1	.015	.20	180	6.6	13		W229550
R-8730	17	59	2.0	1.2L	4.5	.049	9.3	230	6.2	11		W229551
R-8731	16	53	1.1	1.2L	8.6	.088	13	430	1.9	13		V229552
R-8732	4.4	16	.88	.1L	3.0	.007	3.2	140	6.1	2.2		W229549
R-8737	5.5	20	.39	.3L	2.3	.015	14	160	1.8	5.2		V231835
R-8738	6.7	40	.42	.8L	2.9	.015	.12	140	7.3	9.9		W231836
R-8739	5.2	21	.63	.4L	2.0	.010	.12	130	2.6	5.6		V231838
R-8805	6.2	29	2.2	.5L	2.7	.010	.15	350	9.4	8.5		V236237
R-8811	16	82	3.5	1.5L	8.5	.068	.11	570	6.0	8.3		W238483
R-8815	16	38	.91	.8L	2.9	.018	.11	250	4.3	6.7		V238479
R-8822	17	42	.58	.7L	4.6	.007	.7.9	410	4.4	8.4		V238944
R-8823	9.7	35	1.7	.8L	6.0	.032	8.5	520	11	6.7		W238945
R-8825	19	140	3.0	1.4L	9.5	.031	.11	530	3.4	8.9		V238946
R-8827	20	61	1.7	.8L	4.5	.019	6.5	300	1.9	5.2		W238942
R-8935	2.6	39	3.4	1.5L	27	.068	7.0	1,300	11	7.6		W246909
R-8936	3.5	78	2.6	1.1L	26	.059	.11	1,700	9.7	8.0		W246910

Table 23d.--Major-, minor-, and trace-element composition of 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Cs (ppm)	Cu (ppm)	Dy-S (ppm)	Er-S (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Lab Number
R-6822	1.0	.22	6.5L	2.0L	.39	140	5.7	1.3L	1.5	0.60	W191135
R-6834	.30	15	6.9L	2.2L	.26	78	5.2	1.5L	1.0	.90	W191334
R-6835	.20	18	1.4L	.69	.34	60	2.5	.33	1.3	.40	W192604
R-6836	.40	15	2.5L	.92	.34	130	4.4	.52L	2.5	.90	W192605
R-6851	.20	10	1.3L	.67	.19	22	3.7	.80	3.3	.37	W192608
R-6853	.27	8.6	1.4L	.45L	.10	28	2.3	.31L	5.4	.27	W192611
R-6855	.30	19	3.4L	1.1L	.31	63	3.8	.72L	1.3	.30	W192613
R-6857	.15	11	1.1	.58	.17	880	1.4	1.1	.28	.20	W200125
R-6859	3.1	28	7.2L	3.3L	.99	360	13	5.2	4.9L	2.0	W192701
R-6860	.40	16	2.0L	.98	.22	62	3.1	.73	.47	.60	
R-6871	.55	27	3.4L	1.1L	.37	70	4.0	.74	1.6	.95	W193663
R-6910	.30	8.1	1.9L	.58L	.20	60	3.0	.87	1.2	.40	W194852
R-6935	.35	21	2.5L	.78L	.11	68	6.0	.53L	2.1	.35	W196283
R-7169	.60	26	1.6	.92	.31	130	3.0	1.2	.98	.35	W199468
R-7351	.20	15	1.0L	.71	.26	48	2.5	.80	.15	.70	W203392
R-7359	.30	31	1.9L	.87L	.53	560	4.2	1.3L	2.0	1.1	W204162
R-7380	.30	17	.73L	.50	.22	57	1.9	.66	2.2	.30	W204617
R-7381	.47	23	2.4	1.0	.31	35	5.0	1.1L	3.6	.50	W204618
R-7382	1.8	27	2.7L	1.9	.43	95	7.0	1.8L	9.4	.63	W204619
R-7465	.55	24	1.5L	.82	.29	60	2.7	2.7	1.5	.70	W206886
R-7491	.25	24	1.9L	1.5	.46	90	3.0	2.6	1.2	1.5	W206887
R-7492	.40	16	.81L	1.1	.25	50	1.7	1.2	1.8	.25	W206888
R-7547	.30	17	1.7L	.76L	.43	70	6.0	1.1L	9.9	.40	W209961
R-7557	.20	8.7	1.5L	.67L	.13	10L	4.0	1.1	13	.30	W21397
R-8206	.20	14	.99L	.45L	.26	30	2.3	.68L	2.7	.60	W212486
R-8210	2.3	14	3.9L	1.9	.53	140	8.6	2.6L	.74	.90	W212490
R-8242	.30	11	1.1L	.48L	.27	30	2.8	.72L	.48	.70L	W212487
R-8562	.30	8.2	1.5L	.31L	.28	520	3.0	2.6	.68	.70	W217685
R-8631	.11	11	2.0	1.1	.26	30	2.9	1.8	.41	.43	W223355
R-8602	.18	14	1.4L	.29L	.43	40	3.4	3.0	.60	.88	W218978
R-8639	.23	7.2	1.1L	.22L	.26	120	3.0	1.5L	.34	.35	W225108
R-8641	.08	6.5	.79L	.17L	.23	90	2.6	1.2L	.33	.26	W225109
R-8649	.71	18	2.7	1.3	.39	100	4.4	2.8	2.4	.67	W226974
R-8650	.25	14	1.5L	.32L	.32	70	H	2.2L	2.8	.49	W226975
R-8651	.22	7.7	1.1L	.22L	.25	150	1.2	1.5L	.25	.26	W226976

Table 23d. --Major-, minor-, and trace-element composition of 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Cs (ppm)	Cu (ppm)	Dy-S (ppm)	Er-S (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Lab Number
R-8714	.024	22	5.0	1.8	.45	60	7.2	2.5L	6.1	0.92	W229073
R-8715	.86	18	2.1L	.50	.27	20L	H	3.1L	1.5	.47	W229074
R-8716	.60	21	3.9	1.6	.42	20	3.0	2.3L	1.5	.52	W229083
R-8717	.24	15	1.3L	.27L	.28	30	3.2	1.9L	1.0	.56	W229084
R-8719	.78	44	2.8L	1.5	.56	70	7.8	4.1L	1.2	.87	W229082
R-8720	.63	7.2	.84L	.17L	.12	60	2.3	1.2L	.17L	.27	W229077
R-8723	1.3	22	2.0L	1.5	.52	50	6.3	2.8L	2.8	.65	W229081
R-8725	.13	11	.66L	.51	.24	20L	1.7	.96L	.51	.25	W229076
R-8729	.28	18	1.7L	.35L	.36	60	3.9	2.4L	.91	.75	W229550
R-8730	.25	17	8.1	.56L	.39	20L	H	3.9L	2.0	.28	W229551
R-8731	.90	14	6.9	.54L	.30	20	H	3.7L	.81	.47	W229552
R-8732	.06	8.6	.74	.06L	.11	20L	.73	.42L	.36	.11	W229549
R-8737	.09	7.5	.57L	.12L	.38	20	.83	.83L	.26	.19	W231835
R-8738	.20	14	1.7L	.35L	.23	20	1.8	2.5L	1.0	.62	W231836
R-8739	.11	8.9	.81L	.17L	.31	20L	.96	1.2L	.27	.29	W231838
R-8805	.39	20	1.1L	.24L	.34	20L	2.6	1.7L	3.2	.46	W236237
R-8811	.18	18	.68L	.31L	.20	30	3.7	1.5L	.88	.47	W238483
R-8815	.20L	15	.35L	.33	.21	20L	2.5	.42	1.3	.52	W238479
R-8822	.14	7.7	.58	.45	.16	80	2.9	.70	.67	.31	W238944
R-8823	.25	12	1.0	1.0	.21	80	2.6	.94	1.3	.26	W238945
R-8825	.24	12	.64L	.29L	.20	130	4.2	.64L	1.5	.60	W238946
R-8827	.28	9.5	.38L	.17L	.16	30	2.7	.38L	1.7	.24	W238942
R-8935	.57	14	.70L	.32L	.34	40	6.7	1.5L	3.9	.26	W246909
R-8936	.33	2.7	.49L	.23L	.24	100	4.3	1.1L	1.1	.42	W246910

Table 23d.--Major-, minor-, and trace-element composition of 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Hg (ppm)	Ho-S (ppm)	La (ppm)	Li (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Ni-S (ppm)	Lab Number
R-6822	0.073	1.3L	9.0	1.1	0.15	7.2	4.3	1.5	9.7	20 W191135
R-6834	.27	1.5L	8.0	8.7	.11	13	2.8	2.6	9.9L	7 W191334
R-6835	.21	.29L	8.0	8.2	.14	12	1.5	.95	2.1	6.5 W192604
R-6836	.082	.52L	10	11	.16	25	2.4	2.2	3.9	15 W192605
R-6851	.010	.42L	3.7	4.6	.09	3.8	1.6	.92	6.3	14 W192608
R-6853	.14	.31L	2.7	3.9	.06	9.0	1.4	.72	2.1L	3.5 W192611
R-6855	.24	.72L	7.0	17	.16	20	3.2	1.2	6.4	19 W192613
R-6857	.15	.42	3.5	3.5	.08	5.4	1.8	.93	4.5	21 W200125
R-6859	.018	2.2L	33	75	.37	46	.72L	7.8	36	39 W200127
R-6860	.073	.41L	8.0	9.8	.12	4.9	1.2	1.8	7.9	9.2 W192701
R-6871	.11	.73L	16	22	.18	52	.93	1.2	4.9L	15 W193663
R-6910	.24	.39L	5.0	4.7	.10	8.7	.87	1.2	2.7L	10 W194852
R-6935	.20	.53L	3.0	24	.07	5.7	1.4	1.2	4.8	12 W196283
R-7169	.012	.46	7.0	9.8	.17	5.9	2.1	.67	6.7	11 W199468
R-7351	.028	.71L	9.0	9.4	.11	3.8	1.3	2.3	8.0	6.6 W203392
R-7359	.12	.59L	17	18	.20	2.6	.96	1.9	8.7	20 W204162
R-7380	.010L	.22L	6.0	5.6	.10	2.7	2.2	1.1	5.0	9.9 W204617
R-7381	.010L	.50L	7.0	17	.13	3.8	1.7	2.7	10	17 W204618
R-7382	.023	.82L	11	35	.20	9.1	1.2	2.5	13	17 W204619
R-7465	.17	1.0L	11	13	.13	4.4	2.2	3.1	12	22 W206886
R-7491	.20	1.3L	12	12	.26	3.4	2.5	6.4	18	14 W206887
R-7492	.11	.25L	5.5	3.4	.12	6.7	1.3	.70	7.8	14 W206888
R-7547	.25	.52L	11	5.4	.15	7.0	3.1	1.4	14	21 W209961
R-7557	.15	.46L	3.0	4.8	.08	11	1.4	1.4	2.7	6.7 W210397
R-8206	.10	.31L	8.5	9.5	.09	7.2	.50	2.3	3.4	20 W212486
R-8210	.20	1.2L	18	35	.15	17	.44	2.1	17	11 W212490
R-8242	.17	.33L	7.0	7.2	.08	48	1.8	2.6	6.2	16 W212487
R-8562	.11	.68	8.0	11	.08	8.8	.88	3.3	8.8	11 W217685
R-8602	.23	.43L	11	9.5	.16	3.8	1.4	3.3	13	17 W218978
R-8631	.20	.41	6.5	3.2	.08	1.1	1.4	1.8	11	9.5 W223355
R-8639	.13	.33L	6.0	5.3	.08	2.4	.91	.86	5.8	12 W225108
R-8641	.15	.28	5.3	2.8	.07	1.9	1.2	.86	6.1	7.9 W225109
R-8649	.27	.69	11	9.4	.13	6.1	1.2	2.3	19	18 W226974
R-8650	.38	.47L	6.1	3.6	.12	3.7	H	3.3	9.0	16 W226975
R-8651	.23	.33L	4.2	1.7	.07	.67	.82	.53	6.7	9.6 W226976

Table 23d.--Major-, minor-, and trace-element composition of 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Hg (ppm)	Ho-S (ppm)	La (ppm)	Li (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Ni-S (ppm)	Lab Number
R-8714	0.070	0.85	14	11	0.16	6.7	1.8	4.5	20	30
R-8715	.24	.65L	6.5	9.2	.12	12	H	1.9	7.5	W229073
R-8716	.13	.50L	11	10	.11	8.0	1.8	2.8	14	W229074
R-8717	.050L	.40L	6.8	10	.10	150	1.0	2.1	14	W229083
R-8719	.010	.87L	14	29	.18	9.0	1.2	4.1	19	W229084
R-8720	.050L	.26L	3.4	3.2	.04	4.9	.84	1.6	5.3	W229077
R-8723	.050L	.61L	16	19	.17	12	.98	1.9	15	W229081
R-8725	.050L	.20L	4.0	3.9	.08	3.9	.99	.69	5.7	W229076
R-8729	.050L	.52L	11	12	.11	6.9	1.1	4.0	16	W229550
R-8730	.050L	.83L	3.8	13	.16	27	H	2.6	7.7	W229551
R-8731	.14	.80L	7.2	11	.14	23	H	2.1	3.7L	7.7
R-8732	.050L	.09L	1.6	1.7	.05	7.3	.69	.25	1.7	W229552
R-8737	.050L	.18L	6.6	3.4	.08	3.9	.78	.18L	7.3	W229449
R-8738	.070	.52L	6.8	7.2	.09	12	.35	.92	4.5	W231835
R-8739	.050L	.25L	6.5	3.7	.09	52	.59	.37	6.7	W231836
R-8805	.005L	.35L	8.2	9.9	.10	3.7	1.3	2.0	7.8	W236237
R-8811	.050	.10L	6.6	15	.08	26	2.2	1.8	8.2	W236483
R-8815	.040	.05L	6.5	3.9	.08	1.6	1.5	1.2	4.9	W238479
R-8822	.005L	.16	4.5	4.8	.04	2.0	1.9	2.0	6.4	W228944
R-8823	.005L	.40	4.8	4.0	.08	6.8	1.7	1.3	7.6	W238945
R-8825	.005L	.10L	6.8	13	.08	20	2.6	2.9	8.3	W228946
R-8827	.005L	.06L	3.8	3.6	.07	3.8	1.6	1.1	6.1	W228942
R-8935	.070	.11L	4.1	3.9	.19	9.8	3.4	.91	4.8	W246909
R-8936	.005L	.30	6.2	3.4	.07	4.1	.78	1.3	6.4	W246910

Table 23d.--Major-, minor-, and trace-element composition of 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	P (ppm)	Pb (ppm)	Pd-S (ppm)	Pr-S (ppm)	Rb (ppm)	Sb (ppm)	Sc (ppm)	Se (ppm)	Sm (ppm)	Sn-S (ppm)	Lab Number
R-6822	690	4.9	0.30L	13L	15	2.5	3.4	1.8	1.6	1.3L	W191135
R-6834	190	2.6	.32L	15L	.55	2.7	3.2	1.2	1.2	1.5L	W191334
R-6835	8.7	3.7	.06L	2.9L	.46	2.1	3.6	1.9	.65	.65	W192604
R-6836	540	11	.12L	5.2L	.94	3.8	1.2	1.7	3.2	3.2	W192605
R-6851	26	1.2	.06L	2.9L	.60	2.3	1.4	.83	.71	.71	W192608
R-6853	22	2.2	.07L	3.1L	4.0	1.5	2.1	6.2	.37	.54	W192611
R-6855	130	6.3	.16L	7.2L	9.0	1.6	2.9	2.8	1.5	1.3	W192613
R-6857	22L	1.6	.05L	4.8L	20L	.30	1.0	2.6	.85	.05L	W200125
R-6859	120	12	.49L	22L	76	.75	9.5	3.1	5.4	.49L	W200127
R-6860	110	4.7	.09L	4.1L	16L	.31	2.8	1.7	1.2	.79	W192701
R-6871	57	9.6	.16L	7.3L	13	.65	2.8	4.0	2.7	.73L	W193663
R-6910	170	2.0	.09L	3.9L	43L	.37	2.5	1.0	.93	.39L	W194832
R-6935	22	9.4	.12L	5.3L	22L	.55	1.9	6.4	.50	.53L	W196283
R-7169	31	5.4	.09L	4.1L	35L	.65	3.5	1.5	1.5	.26	W199468
R-7351	290	4.1	.07L	3.2L	20L	.30	2.0	2.0	1.4	.16	W2033392
R-7359	66	10	.13L	5.9L	30L	.80	5.5	7.4	2.7	.13L	W204162
R-7380	150	4.0	.03L	2.2L	5.0	.70	1.9	1.5	1.0	.22	W204617
R-7381	22L	12	.07L	5.0L	6.0	.87	3.3	5.2	1.4	.71	W204618
R-7382	22L	12	.12L	8.2L	23	1.7	5.6	4.2	2.2	1.2	W204619
R-7465	22L	4.6	.07L	8.2	20L	1.1	2.3	5.3	1.5	.10L	W206886
R-7491	83	6.3	.09L	6.8	30L	.85	3.6	2.5	2.3	1.2	W206887
R-7492	87	2.3	.05	4.4	30L	.70	1.6	1.3	1.3	.06	W206888
R-7547	370	4.6	.08L	5.2L	40L	1.8	3.7	1.9	1.9	H	W209961
R-7557	44L	6.0	.07L	4.6L	20L	5.9	2.2	7.0	.50	H	W210397
R-8206	790	4.0	.05L	3.6	30L	1.0L	2.5	3.0	1.1	.44	W212486
R-8210	44	5.8	.18L	12L	31	2.0L	4.8	2.1	2.2	.58	W212490
R-8242	700	3.6	.05L	3.3L	40L	1.0L	2.4	3.1	1.0	.07L	W212487
R-8562	87	3.7	.07L	7.5	20L	.40	2.5	2.7	1.0	.31L	W217685
R-8602	44L	4.9	.06L	6.3L	20L	.65	3.5	3.8	1.6	.55	W218978
R-8631	340	2.8	.03L	3.4L	20L	.29	1.7	3.4	1.0	.61	W223355
R-8639	57	2.6	.05L	4.8L	6.0	.20	1.7	1.6	1.1	.42	W225108
R-8641	250	2.2	.04L	3.6L	10L	.21	1.4	2.0	.96	.40	W225109
R-8649	92	4.1	.08L	10	15	.63	3.2	2.4	2.3	1.2	W226974
R-8650	44L	2.4	.07L	6.9L	16L	1.1	3.3	8.0	1.6	H	W226975
R-8651	44L	.91	.05L	4.8L	15L	.19	1.6	1.8	1.3	1.3	W226976

Table 23d. -Major-, minor-, and trace-element composition of 59 bituminous coal samples from the Clinchwood coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	P (ppm)	Pb (ppm)	Pd-S (ppm)	Pr-S (ppm)	Rb (ppm)	Sb (ppm)	Sc (ppm)	Se (ppm)	Sm (ppm)	Sn-S (ppm)	Lab Number
R-8714	730	7.6	.08L	9.2	8.4	1.2	6.1	3.1	2.5	1.5	W229073
R-8715	270	2.9	.10L	9.6L	15	.88	3.4	2.7	1.4	H	W229074
R-8716	44L	5.8	.07L	8.0	12	.68	2.9	3.7	2.3	.66	W229083
R-8717	44L	4.3	.06L	5.9	9.8	.37	2.8	3.0	1.4	.59	W229084
R-8719	57	13	.13L	13L	16	.64	4.6	3.8	3.2	1.4	W229082
R-8720	44L	2.2	.04L	4.9	8.1	.086	1.3	2.9	.64	.61	W229077
R-8723	44L	7.8	.09L	8.9	23	.56	4.4	2.4	3.0	.89	W229081
R-8725	44L	2.0	.03L	3.6	10L	.20	1.4	2.1	1.2	.33	W229076
R-8729	490	6.1	.08L	8.4	25L	.33	3.1	2.1	2.1	1.1	W229550
R-8730	44L	6.0	.12L	12L	18L	.69	3.1	2.7	1.9	H	W229551
R-8731	52	3.5	.12L	12L	12	.17	2.8	2.1	1.6	H	W229552
R-8732	44L	.88	.01L	1.3L	15L	.10	.59	2.7	.56	.16	W229549
R-8737	230	2.0	.03L	2.6L	17L	.12	1.3	1.3	1.9	.55	W231835
R-8738	330	5.1	.08L	7.7L	23L	.34	2.4	2.9	1.2	1.5	W231836
R-8739	160	2.7	.04L	3.7L	18L	.17	1.4	1.5	1.6	.89	W231838
R-8805	74	5.7	.05L	5.2L	30L	.78	2.9	3.2	1.8	.37	W236237
R-8811	200	2.9	.05L	.88	24L	.34	2.0	2.3	1.1	1.4	W238483
R-8815	48	2.5	.02L	.49	23L	.38	1.8	3.4	1.1	.74	W238479
R-8822	44L	2.8	.02L	.64	21L	.21	1.6	1.1	.79	.42	W238944
R-8823	44L	2.7	.02L	.72	19L	.43	1.6	.90	1.1	.50	W238945
R-8825	120	4.1	.04L	.96	22L	.47	2.2	2.8	1.1	1.9	W238946
R-8827	44L	1.7	.03L	.61	23L	.49	1.7	4.1	.87	.57	W238942
R-8935	44L	1.5	.05L	.56	19L	3.1	3.0	1.6	1.4	2.7	W246909
R-8936	44L	4.0	.03L	.59	15L	1.1	2.2	1.1	1.1	2.6	W246910

Table 23d.--Major-, minor-, and trace-element composition of 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia, reported on a Whole-coal basis.--continued

Sample Number	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	Tl-S (ppm)	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Lab Number
R-6822	200	0.15	0.25	2.1	2.0L	2.2	25	0.94L	6.9	0.90	W191135
R-6834	160	.19	.22	2.8	2.2L	1.6	15	.41	5.6	.70	W191334
R-6835	77	.070	.35	1.5	1.4	.77	6.5	.70	3.2	.75	W192604
R-6836	77	.28	.33	3.1	.77	2.5	17	.38	4.8	1.0	W192605
R-6851	21	.10	.14	1.2	.42L	.87	12	.22	6.3	.53	W192608
R-6853	21	.083	.090	.67	1.9	.45	6.3	.28	1.8	.37	W192611
R-6855	50	.040	.24	1.6	1.1L	2.6	18	.21	8.1	.90	W192613
R-6857	200	.060	.13	.80	1.2	B	6.4	.80L	6.4	.40	W200125
R-6859	150	.57	.82	8.5	1.0L	B	85	.75	28	2.2	W200127
R-6860	67	.17	.18	2.1	.61L	1.2	13	.39	5.6	.65	W192701
R-6871	43	.57	.38	4.1	1.1L	2.2	19	.55	4.8	1.0	W193663
R-6910	49	.13	.16	1.3	1.2	.97	7.5	.27	3.8	.70	W194852
R-6935	41	.66L	.50L	.70	1.2	.81	16	.35	3.0	.40	W196283
R-7169	47	.10	.25	1.7	.20L	.62	27	.70L	9.2	1.1	W199468
R-7351	150	.19	.18	2.3	.15L	.99	11	.40	6.1	.60	W203392
R-7359	130	.28	.36	4.1	.28L	1.8	21	.40	7.5	1.2	W204162
R-7380	110	.20L	.19	1.2	.15L	.59	10	.37	4.6	.60	W204617
R-7381	58	.18	.27	2.3	.34L	1.7	24	.43	8.1	.80	W204618
R-7382	52	.16	.35	4.0	.56L	3.1	41	.40	9.0	1.1	W204619
R-7465	95	.22	.24	2.5	.31L	.81	12	.40	5.8	.70	W206886
R-7491	130	.48	.39	3.6	.97	1.4	18	.80	11	1.6	W206887
R-7492	100	.30L	.21	.95	.17L	.48	7.4	.40	5.9	.70	W206888
R-7547	220	.050	.55	1.7	.35L	.68	13	.30	6.8	1.2	W209961
R-7557	60	.12	.11	.80	.31L	.34	7.4	.30	2.9	.50	W210397
R-8206	85	.20	.19	2.3	.21L	1.2	13	.40	3.7	.60	W212486
R-8210	120	.33	.39	4.4	1.1	1.7	39	.40	7.4	1.1	W212490
R-8242	110	.19	.23	1.8	.22L	.84	12	.20	5.8	.60	W212487
R-8562	130	.20	.22	2.6	.68L	.84	10	.40	3.8	.70	W217685
R-8602	110	.38	.51	3.6	2.0	1.5	15	.81	8.2	1.2	W218978
R-8631	440	.16	.20	1.6	.34L	.69	8.8	.44	5.8	.64	W223355
R-8639	58	.13	.23	1.5	.48L	.78	10	.27	2.4	.56	W225108
R-8641	110	.11	.22	1.3	.36L	.82	7.9	.12	3.1	.47	W225109
R-8649	78	.21	.25	2.8	.78L	1.9	23	.46	8.6	1.0	W226974
R-8650	35	.15	.22	1.8	.69L	2.2	14	.40	8.3	.94	W226975
R-8651	58	.075	.17	1.3	.48L	.56	6.2	.33	4.6	.54	W226976

Table 23d.--Major-, minor-, and trace-element composition of 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	Tl-S (ppm)	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Lab Number
R-8714	300	0.31	0.24	3.3	0.77L	2.9	.39	0.70	9.2	1.1	W229073
R-8715	96	.14	.18	1.6	.96L	.97	.11	.55	6.0	.88	W229074
R-8716	80	.22	.25	2.5	.73L	1.4	.15	.53	7.2	.78	W229083
R-8717	59	.21	.19	2.0	.59L	1.0	.11	.39	4.3	.67	W229084
R-8719	72	.28	.34	4.3	1.3L	3.7	.27	.70	9.5	1.4	W229082
R-8720	150	.12	.066	.90	.38L	.23	8.0	.18	2.9	.25	W229077
R-8723	65	.21	.31	3.7	.89L	2.1	.21	.61	8.5	1.2	W229081
R-8725	36	.10L	.16	1.3	.30L	1.1	6.6	.40L	4.2	.56	W229076
R-8729	270	.27	.27	3.1	.76L	1.3	.15	.30	8.4	.81	W229550
R-8730	88	.11	.32	1.3	1.2L	2.7	.16	.41	10	1.4	W229551
R-8731	73	.12	.20	1.9	1.2L	1.2	13	.29	6.0	.82	W229552
R-8732	20	.070L	.083	.29	.13L	.28L	2.2	.23	2.0	.29	W229549
R-8737	83	.073	.23	1.1	.26L	.52	3.4	.50L	2.1	.60	W231835
R-8738	150	.22	.14	1.9	.77L	.79	5.1	.38	2.5	.53	W231836
R-8739	63	.088	.21	1.1	.37L	.43	3.7	.23	2.4	.70	W231838
R-8805	45	.16	.22	2.1	.52L	1.1	9.9	.41	5.2	.77	W236237
R-8811	330	.17	.14	1.6	.68L	.98	12	.71	5.4	.47	W238483
R-8815	73	.18	.14	1.5	.35L	.81	8.8	.27	2.8	.57	W238479
R-8822	77	.096	.10	1.0	.67	.47	9.6	.25	3.5	.34	W238944
R-8823	47	.043	.14	.92	.36L	.26L	7.9	.28	5.8	.63	W238945
R-8825	250	.25	.14	1.8	.64L	.83	9.6	.91	5.9	.66	W238946
R-8827	76	.078	.12	.86	.38L	.35	.11	.59	4.9	.54	W238942
R-8935	65	.089	.27	.98	.70L	1.9	.11	1.7	8.4	1.5	W246909
R-8936	88	.13	.18	1.4	.49L	.45	9.8	1.0	4.9	.78	W246910

Table 23d.--Major-, minor-, and trace-element composition of 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Zn (ppm)	Zr-S (ppm)	Lab Number	Sample Number	Zn (ppm)	Zr-S (ppm)	Lab Number
R-6822	29	15	W191135	R-8714	23	35	W229073
R-6834	5.5	24	W191334	R-8715	20	14	W229074
R-6835	4.7	4.3	W192604	R-8716	10	17	W229083
R-6836	9.2	8.5	W192605	R-8717	10	12	W229084
R-6851	12	9.2	W192608	R-8719	42	23	W229082
R-6853	3.8	5.0	W192611	R-8720	1.9	11	W229077
R-6855	9.8	13	W192613	R-8723	15	16	W229081
R-6857	2.8	12	W200125	R-8725	2.6	6.6	W229076
R-6859	49	95	W200127	R-8729	4.2	27	W229550
R-6860	4.8	12	W192701	R-8730	16	7.8	W229551
R-6871	13	11	W193663	R-8731	25	13	W229552
R-6910	6.4	11	W194832	R-8732	2.2	1.8	W229549
R-6935	10	7.0	W196283	R-8737	4.2	2.3	W231835
R-7169	20	7.9	W199468	R-8738	7.5	6.2	W231836
R-7351	3.2	15	W203392	R-8739	4.1	3.2	W231838
R-7359	9.6	13	W204162	R-8805	4.9	11	W236237
R-7380	5.3	8.6	W204617	R-8811	16	16	W238483
R-7381	8.9	21	W204618	R-8815	3.9	10	W238479
R-7382	21	21	W204619	R-8822	2.3	19	W238944
R-7465	12	25	W206886	R-8823	7.6	14	W238945
R-7491	6.0	46	W206887	R-8825	7.0	26	W238946
R-7492	8.1	8.5	W206888	R-8827	4.9	11	W238942
R-7547	14	14	W209961	R-8935	22	5.1	W246919
R-7557	4.4	8.0	W210397	R-8936	2.9	8.3	W246910
R-8206	2.4	17	W212486				
R-8210	16	19	W212490				
R-8242	8.6	19	W212487				
R-8562	7.5	15	W217685				
R-8602	11	21	W218978				
R-8631	2.2	13	W223355				
R-8639	4.3	4.8	W225108				
R-8641	4.0	6.5	W225109				
R-8649	12	23	W226974				
R-8650	9.0	29	W226975				
R-8651	15	7.7	W226976				

Table 23e.--Arithmetic mean, observed range and geometric mean of proximate and ultimate analyses, heat content, forms of sulfur, and ash-fusion temperatures for 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included.

[All values are in percent except Btu/lb, Kcal/kg, ash-fusion temperatures, and free-swelling index and are reported on an as-received basis. $^{\circ}\text{F} = 9/5 \, ^{\circ}\text{C} + 32$; Kcal/kg = 0.556 Btu/lb; (n) is number of samples per parameter.]

		Clintwood coal bed				Appalachian basin		
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
Proximate and ultimate analyses								
Moisture	(59)	3.50	1.18	17.74	3.05	3.23	2.69	(4,760)
Volatile matter	(59)	32.45	22.60	37.10	32.36	32.46	31.72	(4,760)
Fixed carbon	(59)	57.03	36.80	64.09	56.85	52.48	51.76	(4,760)
Ash	(59)	7.02	1.25	36.60	6.05	11.83	9.83	(4,760)
Hydrogen	(59)	5.33	3.90	5.90	5.32	5.02	5.00	(4,760)
Carbon	(59)	76.44	49.20	83.16	76.22	70.69	70.17	(4,760)
Nitrogen	(59)	1.60	1.10	2.38	1.59	1.39	1.37	(4,757)
Oxygen	(59)	8.08	5.50	26.06	7.78	8.92	8.22	(4,756)
Sulfur	(59)	1.53	.54	6.61	1.24	2.15	1.63	(4,974)
Heat content								
KCal/kg	(59)	7,610	4,885	8,228	7,586	7,030	6,979	(4,759)
Btu/lb	(59)	13,687	8,786	14,799	13,645	12,644	12,553	(4,759)
Forms of sulfur								
Sulfate	(58)	0.06	0.01	0.42	0.04	0.08	0.04	(4,245)
Pyritic	(59)	.79	.02	5.22	.35	1.36	.65	(4,392)
Organic	(59)	.68	.38	1.17	.65	.82	.70	(4,393)
Ash-fusion temperature ($^{\circ}\text{C}$)								
Initial deformation	(51)	1,282	1,049	1,516	1,274	1,255	1,246	(4,063)
Softening	(47)	1,325	1,104	1,527	1,318	1,287	1,280	(3,722)
Fluid	(40)	1,373	1,182	1,532	1,368	1,334	1,328	(3,449)
Free-swelling index	(58)	7.75	.50	9.00	7.42	5.53	4.68	(4,603)
Air-dried loss	(51)	2.39	0.37	12.58	1.83	1.83	1.13	(3,868)

Table 23f.--Arithmetic mean, observed range, and geometric mean of ash content and concentrations of 11 major- and minor-oxides in the laboratory ash of 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. (n) indicates the number of samples per oxide.

[All samples were ashed at 525°C; all data are in percent.]

	Clintwood coal bed				Appalachian basin			
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
			Min.	Max.				
(Ash)	(59)	7.0	1.3	33	6.1	13	10	(5,262)
SiO ₂	(59)	43	18	93	42	43	41	(5,229)
Al ₂ O ₃	(59)	26	6.4	39	25	24	23	(5,229)
CaO	(59)	1.8	.15	12	1.4	2.2	1.5	(5,227)
MgO	(59)	.71	.20	3.7	.62	.85	.75	(5,258)
Na ₂ O	(59)	.61	.081	1.8	.48	.43	.34	(5,194)
K ₂ O	(59)	1.6	.13	4.2	1.3	2.0	1.7	(5,229)
Fe ₂ O ₃	(59)	17	.29	59	12	19	13	(5,215)
MnO	(59)	.03	.004	.34	.02	.03	.02	(5,260)
TiO ₂	(59)	1.6	.32	3.5	1.4	1.2	1.1	(5,203)
P ₂ O ₅	(39)	.83	.040	4.0	.44	.50	.22	(3,389)
SO ₃	(56)	2.5	.28	16	2.0	2.5	1.9	(5,063)

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Table 23g.--Arithmetic mean, observed range, and geometric mean of concentrations of 54 trace elements in 59 bituminous coal samples from the Clintwood coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. Dashed values (---) represent less than five samples; (n) indicates the number of samples per element. [All data are in parts-per-million and are reported on a whole-coal basis.]

	Clintwood coal bed				Appalachian basin		
(n)	Arith. mean	Observed range		Geom. mean	Arith. mean	Geom. mean	(n)
		Min.	Max.				
Ag (58)	0.04	0.019	0.11	0.04	0.07	0.05	(4,565)
As (59)	20	.60	180	8.6	35	13	(5,197)
B (59)	12	2.6	42	11	30	20	(5,076)
Ba (59)	73	16	210	59	90	63	(5,134)
Be (59)	1.8	.35	5.4	1.6	2.5	2.0	(5,247)
Bi (3)	---	.36	.88	---	1.5	1.1	(108)
Br (59)	6.1	1.3	27	4.8	2.2	13	(4,892)
Cd (59)	.06	.007	.25	.04	.10	.07	(4,978)
Ce (59)	15	3.2	60	13	21	17	(5,075)
Cl (44)	430	120	1,700	350	780	510	(3,646)
Co (59)	7.6	1.8	21	6.2	7.4	5.7	(5,217)
Cr (59)	11	2.2	42	9.4	18	15	(5,205)
Cs (58)	.46	.062	3.1	.32	1.3	.85	(4,831)
Cu (59)	16	2.7	44	14	19	15	(5,239)
Dy (12)	3.0	.58	8.0	2.2	3.3	2.6	(759)
Er (25)	1.0	.32	1.9	.92	1.5	1.2	(1,200)
Eu (59)	.31	.10	.99	.28	.44	.37	(5,032)
F (51)	110	20	880	68	99	71	(4,860)
Ga (55)	3.7	.73	13	3.2	6.6	5.4	(5,046)
Gd (21)	1.5	.33	5.2	1.2	2.6	1.9	(1,773)
Ge (57)	2.0	.15	13	1.3	4.7	2.5	(4,608)
Hf (58)	.54	.11	2.0	.46	.79	.62	(4,932)
Hg (42)	.14	.010	.38	.10	.22	.15	(5,031)
Ho (10)	.46	.16	.85	.42	.76	.61	(378)
La (59)	8.1	1.6	33	7.0	11	8.9	(5,147)
Li (59)	11	1.7	75	7.9	22	14	(5,243)
Lu (59)	.12	.038	.37	.11	.16	.14	(4,885)
Mn (59)	15	1.1	150	8.1	31	15	(5,260)
Mo (54)	1.5	.35	4.3	1.4	3.7	2.3	(4,889)
Nb (58)	2.0	.25	7.8	1.6	2.6	1.9	(5,005)
Nd (54)	9.1	1.7	36	7.7	13	9.9	(4,231)
Ni (59)	14	2.9	39	12	17	14	(5,240)
Pb (59)	4.7	.88	13	3.9	8.8	6.2	(5,172)
Pd (1)	---	.05	.05	---	.17	.14	(18)
Pr (21)	4.5	.49	10	2.7	6.1	3.6	(960)
Rb (20)	16	4.0	76	12	28	22	(2,232)
Sb (56)	.78	.086	5.9	.54	1.4	.91	(5,003)
Sc (59)	2.8	.59	9.5	2.5	4.4	3.6	(5,218)
Se (59)	2.9	.90	8.0	2.6	3.6	2.8	(5,052)
Sm (59)	1.5	.37	5.4	1.4	2.0	1.6	(5,005)
Sn (42)	.90	.059	3.2	.68	1.6	.86	(2,352)
Sr (59)	110	20	440	86	110	79	(5,146)
Ta (54)	.18	.040	.82	.15	.24	.19	(4,369)
Tb (58)	.24	.066	.32	.21	.34	.29	(4,852)
Th (59)	2.1	.29	8.5	1.8	3.0	2.3	(5,098)
Tl (10)	1.2	.67	2.0	1.2	3.4	2.1	(382)
Tm (---)	---	---	---	---	1.7	.38	(46)
U (55)	1.2	.23	3.7	1.0	1.8	1.3	(4,990)
V (59)	15	2.2	85	12	24	19	(5,241)
W (54)	.46	.12	1.7	.40	.94	.80	(4,421)
Y (59)	6.1	1.8	28	5.4	8.5	7.2	(5,234)
Yb (59)	.80	.25	2.2	.73	1.1	.92	(5,151)
Zn (59)	11	1.9	49	7.8	22	14	(5,243)
Zr (59)	15	1.8	95	12	24	17	(5,238)

Table 24a.--Description and location for 1 bituminous coal sample from the Clintwood Rider coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-6829	W191338	90D-3	370156N	823519W	Pound (7.5')	Wise	17.04	Surface mine, sl. weathered	Full Thickness

Table 24b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance number for 1 bituminous coal sample from the Clintwood Rider coal bed, Southwest Virginia.

[All analyses except heat content, free-swelling index, ash-fusion temperatures, Hardgrove grindability index, and compliance number in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	Moisture	PROXIMATE ANALYSIS			ULTIMATE ANALYSIS			HEAT CONTENT			Lab Number
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	
R-6829	3.9	34.3	51.3	10.5	5.2	71.8	1.2	8.0	3.3	7,210	12,980
---	35.7	53.4	10.9	5.0	74.7	1.2	4.7	3.4	7,500	13,510	W191338
---	40.1	59.9	---	5.6	83.9	1.4	5.3	3.9	8,420	15,160	

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)				Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free- swelling index	Initial Deformation	Softening	Fluid			
R-6829	0.0	0.02	2.32	0.99	8.5	1,150	1,245	1,265	----	5.08	W191338
---	---	.02	2.41	1.03							
---	---	.02	2.71	1.16							

Table 24c. Major- and minor-oxide concentrations in the laboratory ash of 1 bituminous coal sample from the Clintwood Rider coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-6829	13.8	37	19	1.3	0.37	0.65	2.0	35	1.0	0.60	2.3	W191338

Table 24d.--Major-, minor-, and trace-element composition of 1 bituminous coal sample from the Clintwood Rider coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-6829	2.4	1.4	0.13	0.030	0.066	0.23	3.4	0.083	0.091	43	W191338
Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Cu (ppm)	Lab Number
R-6829	9.1	80	3.0	3.0	0.17	19	5.3	15	0.90	21	W191338
Sample Number	Eu (ppm)	F (ppm)	Ga-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	La (ppm)	Li (ppm)	Lu (ppm)	Mn (ppm)	Lab Number
R-6829	0.36	100	6.3	2.1	0.70	0.26	10	15	0.19	30	W191338

Table 24d.--Major-, minor-, and trace-element composition of 1 bituminous coal sample from the Clintwood Rider coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Mo-S (ppm)	Nb-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Rb (ppm)	Sb (ppm)	Sc (ppm)	Se (ppm)	Sn (ppm)	Lab Number
R-6829	4.1	1.2	17	360	6.3	19	1.1	4.1	2.7	1.7	W191338
Sample Number	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Lab Number
R-6829	110	0.17	0.35	2.3	1.5	23	0.52	8.8	1.1	18	W191338

Sample Number	Zr-S (ppm)	Lab Number
R-6829	13	W191338

ADDINGTON COAL BED

Cropping out in Wise and Dickenson Counties, the Addington coal bed is the uppermost identifiable coal bed in the Blair-to-Clintwood package. Total tonnages mined from the Addington coal bed are included with the Clintwood production figures (Virginia Division of Mines, 1990). The Addington coal bed is about 60-feet above the upper Clintwood coal bed and immediately above a sandstone bed which may be from 5- to 45-feet thick and below a distinctive siltstone unit which is about 150-feet thick. Thickness of the Addington may be up to 17-inches but the coal bed grades laterally to hard, black shale up to 12-inches thick (Diffenbach, 1988, Whitlock and others, 1988, and Nolde and others, 1988a & b). At the sampling location in the Flat Gap quadrangle (Figure 32), the fifteen inches of Addington coal bed displayed a well-developed medium cleat, moderate amounts of thin- to medium-banding, with limonite and pyrite on bedding surfaces.

There are only two Addington samples, therefore the geometric means will not be discussed. The descriptive and location data can be found in Table 25a, the analytical results in Tables 25b, 25c, and 25d. Statistical summaries are not included because there are less than five samples. In addition to the 8 elements below the detection limit for all 375 Southwest Virginia samples, the following elements were also found to be below the detection limits for these samples: Bi, Dy, Er, Ho, Pd, Pr, Tl, and Tm.

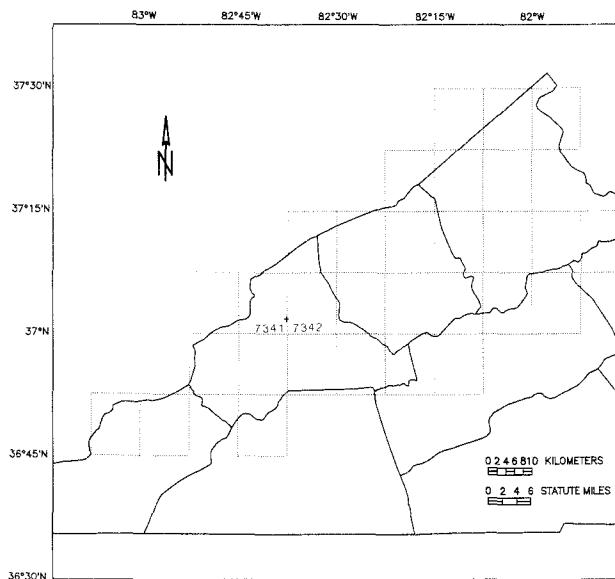


Figure 32. Locations for samples from the Addington coal bed.

Table 25a.--Descriptions and locations for 2 bituminous coal samples from the Addington coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-7341	W203394	90C-10	370150N	823742W	Flat Gap (7.5')	Wise	16.00	Surface mine	Full Thickness
R-7342	W203393	90C-9	370150N	823742W	Flat Gap (7.5')	Wise	13.92	Surface mine	Full Thickness

Table 25b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 2 bituminous coal samples from the Addington coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, ash-fusion temperatures, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. Sample number is VDMR identification number. Lab number is the USGS Laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT		Lab Number	
	Moisture	Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	
R-7341	2.5	33.1	53.8	10.6	5.2	73.3	1.5	5.3	4.2	7,410	13,330	W203394
	--	33.9	55.2	10.9	5.0	75.2	1.5	3.2	4.3	7,600	13,670	
	--	38.1	61.9	--	5.7	84.3	1.7	3.5	4.8	8,520	15,340	
R-7342	2.2	32.8	52.3	12.7	5.0	71.5	1.4	4.8	4.5	7,240	13,040	W203393
	--	33.5	53.5	13.0	4.9	73.1	1.4	2.9	4.6	7,410	13,330	
	--	38.5	61.5	--	5.6	84.0	1.6	3.3	5.3	8,510	15,320	

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Table 25b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 2 bituminous coal samples from the Addington coal bed, Southwest Virginia.--continued

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening			
R-7341	1.6	0.01	2.54	1.62	8.5	1,075	1,145	1,180	----	6.30
---	---	.01	2.61	1.66						W203394
---	---	.01	2.92	1.86						
R-7342	1.2	.01	3.02	1.50	8.0	1,110	1,175	1,270	----	6.90
---	---	.01	3.09	1.53						W203393
---	---	.01	3.55	1.76						

Table 25c.--Major- and minor-oxide concentrations in the laboratory ash of 2 bituminous coal samples from the Addington coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. Sample number is the VDMR identification number. Lab number is the USGS Laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-7341	9.9	31	18	1.0	0.38	0.10	1.4	49	1.0	0.66	1.7	W203394
R-7342	12.9	36	18	.59	.58	.11	1.9	42	.94	.52	1.1	W203393

Table 25d. --Major-, minor-, and trace-element composition of 2 bituminous coal samples from the Addington coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means less than the value shown; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-7341	1.4	0.92	0.071	0.023	0.008	0.11	3.4	0.059	0.046	62	W203394
R-7342	2.2	1.2	.054	.045	.010	.20	3.8	.072	.053	95	W203393

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-7341	4.4	48	1.9	4.0	0.13	15	260	9.3	11	0.70	W203394
R-7342	4.8	54	2.5	4.3	.17	20	240	12	14	.95	W203393

Sample Number	Cu (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	La (ppm)	Li (ppm)	Lab Number
R-7341	23	0.30	24	4.6	2.2	3.5	0.45	0.39	8.0	13	W203394
R-7342	27	.39	43	5.4	2.7	6.1	.60	.39	11	17	W203393

Sample Number	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Rb (ppm)	Sb (ppm)	Lab Number
R-7341	0.13	12	4.4	1.9	8.0	17	280	3.1	15	1.6	W203394
R-7342	.17	12	4.3	2.3	10	21	290	5.0	13	2.1	W203393

Table 25d.--Major-, minor-, and trace-element composition of 2 bituminous coal samples from the Addington coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Sc (ppm)	Se (ppm)	Sm (ppm)	Sr-S (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	U (ppm)	V-S (ppm)	Lab Number
R-7341	2.8	2.3	1.5	0.32	140	0.14	0.17	1.8	1.3	15	W203394
R-7342	3.4	2.7	2.0	.19L	120	.17	.33	2.2	1.9	19	W203393

Sample Number	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)						Lab Number
R-7341	0.40	8.2	0.80	17	19						
R-7342	.55	8.9	1.0	25	18						

IMBODEN MARKER, IMBODEN, AND CAMPBELL CREEK COAL BEDS

The Imboden coal bed crops out in Buchanan, Dickenson, Lee, and Wise Counties. Production in 1989 was 0.6 million tons, mainly from Wise County (Virginia Division of Mines, 1990). Other names for the Imboden include: the No. 1 coal bed (Lee County); Upper Bolling coal bed (Wise County); and the Campbell Creek coal bed (Buchanan County). The Imboden has five splits in the Norton area but elsewhere it is found as one bed with two or three shale partings. Bone coal and rashy coal can occur as parting material. Cannel coal occurs at the top one-inch of the bed at one sample location. Sampled thicknesses are 2.1 to 6.4 feet. The coal typically has a well-developed medium cleat with moderate amounts of medium and thin banding. Pyrite occurs as nodules and as a film on cleat surfaces.

The descriptive and location information for the Imboden Marker coal bed is available in Figure 33 and Table 26a and the analytical results are available in Tables 26b, 26c, and 26d. For the Imboden coal bed, location and descriptive information are in Figure 34 and Table 27a and the analytical results are available in Tables 27b, 27c, and 27d. As, Br, Cl, Ge, Mo, Sb, Sn, Y, Zn, sulfur, sulfate, and pyritic sulfur geometric means (Tables 27e, 27f, and 27g) are substantially lower in the Imboden coal samples than in the Appalachian basin coal samples. The free-swelling index geometric means are substantially lower in the Appalachian basin samples than in the Imboden coal samples. In addition to Au, In, Ir, Os, Pt, Re, Rh, and Ru, the 8 elements found below their detection limits for the rest of the Southwest Virginia samples, Bi, Ho, Pd, and Tm are found to be below the detection limits for the 15 Imboden samples; Bi, Dy, Er, Ho, Pd, Rb, Tl, and Tm for the 4 Imboden Marker samples; and Bi, Ho, Pd, Pr, Tl, and Tm for the 2 Campbell Creek samples. The geometric means will not be discussed for the two Campbell Creek samples and the 4 Imboden Marker samples due to lack of data. Figure 35 and Table 28a contains the descriptive and location information for the Campbell Creek samples, Tables 28b, 28c, and 28d contain the analytical results.

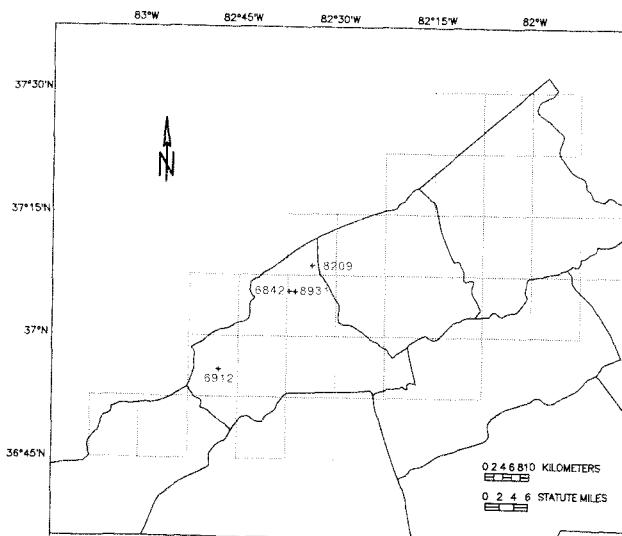


Figure 33. Locations for samples from the Imboden Marker coal bed.

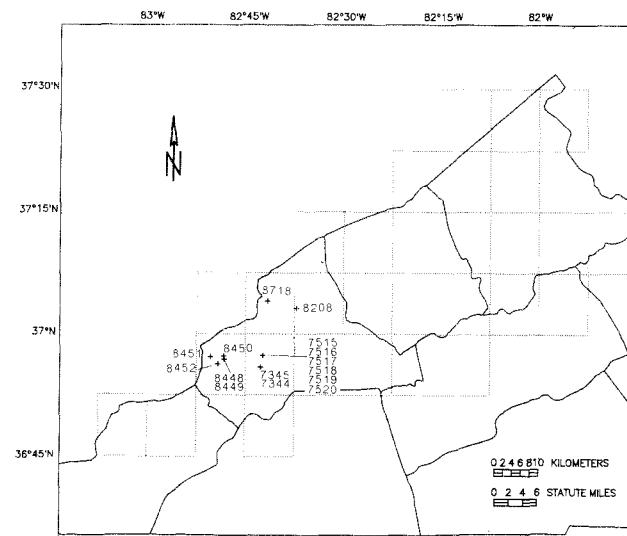


Figure 34. Locations for samples from the Imboden coal bed.

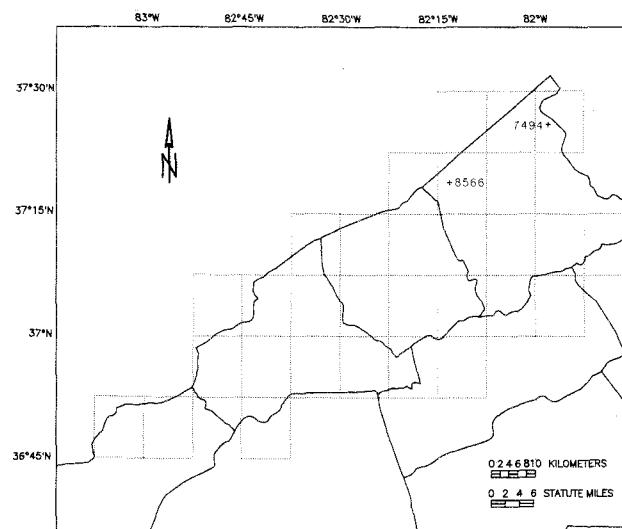


Figure 35. Locations for samples from the Campbell Creek coal bed.

Table 26a.-Descriptions and locations for 4 bituminous coal samples from the Imboden Marker coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample thickness (inches)	Type of Sample	Part of Bed Represented
R-6842	W192609	90D-6	370529N	823711W	Pound (7.5')	Wise	27.84	Surface mine, sl. weathered	Full Thickness
R-6912	W194855	61A-2	365551N	824754W	Appalachia (7.5')	Wise	39.00	Surface mine, sl. weathered	Full Thickness
R-8209	W212489	90A-2	370842N	823337W	Jenkins East (7.5')	Wise	36.24	Surface mine, sl. weathered	Full Thickness
R-8931	W246903	90D-47	370527N	823617W	Pound (7.5')	Wise	44.40	Surface mine, sl. weathered	Full Thickness

--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 4 bituminous coal samples from the Imboden Marker coal bed, Southwest Virginia.

ALL analyses except heat contents, free-swelling indexes, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. Sample number is VDMR identification number. Lab number is the USGS Laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

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Table 26c.--Major- and minor-oxide concentrations in the laboratory ash of 4 bituminous coal samples from the Imboden Marker coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-6842	7.5	32	14	1.9	0.48	0.47	1.1	.42	1.1	0.77	1.8	W192609
R-6912	2.5	49	24	2.8	.88	1.2	.38	8.3	2.0	.040	4.2	W194855
R-8209	5.6	40	21	3.0	.43	.49	.85	.26	1.5	1.8	1.9	W212489
R-8931	6.2	47	28	1.0	.61	.32	2.2	14	1.7	.47	2.0	W246903

Table 26d.--Major-, minor-, and trace-element composition of 4 bituminous coal samples from the Imboden Marker coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means less than the value shown; B, not determined; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS Laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-6842	1.1	0.54	0.10	0.022	0.026	2.2	0.049	0.039	15	.60	W192609
R-6912	.58	.32	.050	.013	.022	.15	.030	.017			W194855
R-8209	1.0	.63	.12	.015	.020	1.0	.051	.046		7.2	W212489
R-8931	1.3	.92	.046	.023	.015	.11	.60	.063		3.0	W246903

Sample Number	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Pr-S (ppm)	Sb (ppm)	Lab Number
R-6842	0.07	19	1.5	1.2	3.8	6.5	250	5.4	5.1L	0.83	W192609
R-6912	.05	13	.38	1.0	2.8	11	4.4	1.8	1.7L	.20	W194855
R-8209	.06	6.7	.38L	1.1	4.2	7.8	440	3.0	5.3	.50L	W212489
R-8931	.08	23	1.1	.99	5.1	8.7	130	3.8	.51	.61	W246903

Table 26d.--Major-, minor-, and trace-element composition of 4 bituminous coal samples from the Imboden Marker coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Sc (ppm)	Se (ppm)	Sm (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	U (ppm)	V-S (ppm)	Lab Number
R-6842	1.8	3.4	0.60	0.83	45	0.10	0.18	1.2	0.79	W192609
R-6912	.88	1.6	.57	.171	57	.073	.090	.87	.89	W194855
R-8209	1.8	3.1	.70	.081	150	.12	.14	1.5	.89	W212489
R-8931	2.5	2.5	1.1	1.3	150	.15	.11	2.0	1.6	W246903

Sample Number	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)					Lab Number
R-6842	0.53	2.3	0.33	14	6.7					W192609
R-6912	.10	2.8	.30	2.3	8.8					W194855
R-8209	.30	3.3	.40	5.4	11					W212489
R-8931	.60	3.3	.53	7.4	8.1					W246903

Table 27a.--Descriptions and locations for 15 bituminous coal samples from the Imboden coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-7344	W203386	60B-15	365556N	824239W	Norton (7.5')	Wise	30.60	Surface mine	Upper Split
R-7345	W203385	60B-14	365556N	824239W	Norton (7.5')	Wise	36.00	Surface mine	Lower Split
R-7515	W208044	60B-17	365720N	824220W	Norton (7.5')	Wise	6.00	Surface mine, sl.	Partial Lower Split
R-7516	W208045	60B-18	365720N	824220W	Norton (7.5')	Wise	26.40	Surface mine, sl.	Partial Lower Split
R-7517	W208046	60B-19	365720N	824220W	Norton (7.5')	Wise	22.20	Surface mine, sl.	Partial Lower Split
R-7518	W208047	60B-20	365720N	824220W	Norton (7.5')	Wise	34.20	Surface mine, sl.	Weathered
R-7519	W208048	60B-21	365720N	824220W	Norton (7.5')	Wise	56.40	Surface mine, sl.	Weathered
R-7520	W208049	60B-22	365720N	824220W	Norton (7.5')	Wise	19.80	Surface mine, sl.	Weathered
R-8208	W212491	90D-16A	370309N	823712W	Pound (7.5')	Wise	37.20	Underground mine	Full Thickness
R-8448	W214244	61A-11	365651N	824816W	Appalachia (7.5')	Wise	37.20	Underground mine	Bench Sample
R-8449	W214245	61A-12	365651N	824816W	Appalachia (7.5')	Wise	37.20	Underground mine	Bench Sample
R-8450	W214246	61A-13	365715N	824821W	Appalachia (7.5')	Wise	45.00	Underground mine	Full Thickness
R-8451	W214247	61A-14	365710N	825023W	Appalachia (7.5')	Wise	76.80	Underground mine	Full Thickness
R-8452	W214248	61A-15	365617N	824913W	Appalachia (7.5')	Wise	69.00	Underground mine	Full Thickness
R-8718	W229080	90C-23	370400N	824139W	Flat Gap (7.5')	Wise	31.20	Surface mine, sl.	Weathered

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Table 27b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 15 bituminous coal samples from the Imboden coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, ash-fusion temperatures, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. G for ash-fusion temperatures means greater than value shown. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	Moisture	Volatile Matter	PROXIMATE ANALYSIS			ULTIMATE ANALYSIS					HEAT CONTENT		
			Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	Lab Number	
R-7344	2.7	36.9	57.4	3.0	5.7	80.1	1.5	8.7	1.0	7,990	14,390	W203386	
---	37.9	59.0	59.0	3.1	5.5	82.3	1.5	6.5	1.0	8,220	14,790		
---	39.1	60.9	60.9	---	5.7	84.9	1.6	6.7	1.1	8,480	15,260		
R-7345	3.3	31.8	48.9	16.0	4.9	68.2	1.3	8.8	.8	6,740	12,130	W203385	
---	32.9	50.6	50.6	16.5	4.7	70.5	1.3	6.1	.8	6,970	12,540		
---	39.4	60.6	60.6	---	5.6	84.5	1.6	7.3	1.0	8,350	15,030		
R-7515	3.9	34.8	55.8	5.5	5.5	77.0	1.5	9.5	1.1	7,640	13,760	W208044	
---	36.2	58.1	58.1	5.7	5.3	80.1	1.6	6.3	1.1	7,950	14,320		
---	38.4	61.6	61.6	---	5.6	85.0	1.7	6.7	1.2	8,440	15,190		
R-7516	3.0	33.8	57.3	5.9	5.3	75.5	1.5	11.2	.6	7,740	13,940	W208045	
---	34.8	59.1	6.1	5.1	5.1	77.8	1.5	8.8	.6	7,980	14,370		
---	37.1	62.9	62.9	---	5.5	82.9	1.6	9.4	.7	8,500	15,300		
R-7517	4.2	28.0	47.9	19.9	4.7	64.0	1.2	9.4	.8	6,300	11,350	W208046	
---	29.2	50.0	50.0	20.8	4.4	66.8	1.3	5.9	.8	6,580	11,840		
---	36.9	63.1	63.1	---	5.6	84.3	1.6	7.5	1.1	8,300	14,950		
R-7518	2.5	35.2	55.0	7.3	5.4	76.9	1.5	8.2	.7	7,670	13,800	W208047	
---	36.1	56.4	7.5	5.3	5.3	78.9	1.5	6.1	.7	7,860	14,150		
---	39.0	61.0	61.0	---	5.7	85.3	1.7	6.6	.8	8,500	15,300		
R-7519	2.4	33.4	58.1	6.1	5.3	78.7	1.6	7.7	.6	7,750	13,960	W208048	
---	34.2	59.5	6.2	5.2	5.2	80.6	1.6	5.7	.6	7,940	14,300		
---	36.5	63.5	63.5	---	5.5	86.0	1.7	6.1	.7	8,470	15,250		
R-7520	3.3	35.0	57.2	4.5	5.5	78.3	1.5	9.2	1.0	7,850	14,130	W208049	
---	36.2	59.2	4.7	5.3	5.3	81.0	1.6	6.5	1.0	8,120	14,610		
---	38.0	62.0	62.0	---	5.6	84.9	1.6	6.8	1.1	8,510	15,320		
R-8208	2.2	28.5	53.5	15.7	4.6	70.1	1.2	7.7	.7	6,910	12,430	W212491	
---	29.2	54.8	16.1	4.4	4.4	71.7	1.2	5.9	.7	7,060	12,710		
---	34.7	65.3	65.3	---	5.3	85.4	1.5	7.0	.8	8,420	15,150		

Table 27b.-Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, grindability index, and compliance numbers for 15 bituminous coal samples from the Imboden coal bed, Southwest Virginia.--continued

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT		
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	Lab Number
R-8448	1.7	32.0	57.3	9.0	5.0	76.4	1.5	7.6	0.5	7,520	13,540	W214244
	--	32.6	58.3	9.2	4.9	77.7	1.5	6.2	.5	7,650	13,780	
	--	35.9	64.1	--	5.4	85.5	1.7	6.8	.6	8,430	15,170	
R-8449	1.5	36.0	55.3	7.2	5.1	78.3	1.6	7.1	.6	7,720	13,890	W214245
	--	36.6	56.1	7.3	5.0	79.5	1.6	5.9	.6	7,830	14,100	
	--	39.4	60.6	--	5.4	85.8	1.8	6.3	.7	8,450	15,210	
R-8450	1.2	35.1	59.3	4.3	5.3	81.4	1.6	6.7	.7	8,060	14,520	W214246
	--	35.6	60.1	4.4	5.3	82.4	1.6	5.7	.7	8,160	14,690	
	--	37.2	62.8	--	5.5	86.2	1.7	5.9	.7	8,540	15,360	
R-8451	1.6	32.7	57.8	8.0	5.1	77.2	1.6	7.4	.8	7,600	13,680	W214247
	--	33.2	58.7	8.1	5.0	78.4	1.6	6.1	.8	7,720	13,900	
	--	36.1	63.9	--	5.4	85.3	1.7	6.6	.9	8,410	15,130	
R-8452	1.4	33.7	59.2	5.7	5.3	79.9	1.6	7.0	.6	7,900	14,210	W214248
	--	34.2	60.1	5.7	5.2	81.0	1.6	5.9	.6	8,010	14,410	
	--	36.3	63.7	--	5.5	85.9	1.7	6.2	.7	8,500	15,290	
R-8718	1.7	37.6	54.8	5.9	5.4	78.4	1.5	6.3	2.5	7,860	14,150	W229080
	--	38.3	55.7	6.0	5.3	79.8	1.5	4.9	2.5	8,000	14,390	
	--	40.7	59.3	--	5.6	84.9	1.6	5.2	2.7	8,510	15,310	

Table 27b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, Hardgrove grindability index, and compliance numbers for 15 bituminous coal samples from the Imboden coal bed, Southwest Virginia.--continued

Sample Number	Air-dried Loss	FORMS OF SULFUR			ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number
		Sulfate	Pyritic	Organic	Free-swelling index	Initial deformation	Softening	Fluid		
R-8448	.5	.01	.05	.46	8.0	1,255	1,415	1,475	---	0.74
	--	.01	.05	.47						W214244
	--	.01	.06	.52						
R-8449	.4	.02	.04	.58	8.5	1,325	1,480	1,520	---	.86
	--	.02	.04	.59						W214245
	--	.02	.04	.64						
R-8450	.2	.01	.11	.56	8.0	1,340	1,495	1,540	---	.96
	--	.01	.11	.57						W214246
	--	.01	.12	.59						
R-8451	.2	.06	.09	.62	8.0	1,360	1,525	1,540	---	1.17
	--	.06	.09	.63						W214247
	--	.07	.10	.69						
R-8452	.3	.01	.03	.58	8.5	1,395	1,540	1,540	---	.84
	--	.01	.03	.59						W214248
	--	.01	.03	.62						
R-8718	1.0	.07	1.39	1.03	6.5	1,095	1,110	1,310	52	3.53
	--	.07	1.41	1.05						W229080
	--	.08	1.50	1.11						

Table 27c.--Major- and minor-oxide concentrations in the laboratory ash of 15 bituminous coal samples from the Imboden coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. L means less than the concentration shown. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO_2	Al_2O_3	CaO	MgO	Na_2O	K_2O	Fe_2O_3	TiO_2	P_2O_5	SO_3	Lab Number
R-7344	3.0	33	32	3.9	1.2	0.35	1.8	20	1.3	0.17L	7.0	W203386
R-7345	9.3	52	29	.85	1.2	.15	3.3	6.8	1.2	.054L	1.5	W203385
R-7515	5.4	44	32	1.0	1.1	.43	4.1	13	1.0	.19L	1.4	W208044
R-7516	5.3	49	32	1.3	1.5	.65	3.9	6.9	1.2	.19L	2.1	W208045
R-7517	22.6	55	28	.60	1.5	.19	3.1	8.1	1.4	.044L	1.3	W208046
R-7518	7.8	47	36	.84	.78	.58	3.5	4.8	1.6	.13L	1.0	W208047
R-7519	11.0	67	21	.95	.53	.84	1.0	3.4	2.0	.091L	.88	W208048
R-7520	4.2	47	29	2.0	.90	.95	2.2	9.4	1.5	.24L	2.6	W208049
R-8208	11.1	56	28	1.1	.91	.36	3.5	5.0	1.4	.14	1.7	W212491
R-8448	10.1	44	25	1.3	2.5	.26	2.8	17	1.3	.099L	2.9	W214244
R-8449	7.9	47	30	1.2	2.0	.36	2.8	11	1.5	.13L	2.1	W214245
R-8450	4.0	48	29	1.8	1.1	.27	2.3	11	1.4	.25L	2.4	W214246
R-8451	7.1	49	33	1.4	1.0	.30	3.4	6.3	1.6	.14L	1.6	W214247
R-8452	5.3	49	33	1.2	1.0	.26	2.5	6.7	1.8	.23	1.2	W214248
R-8718	6.2	35	21	2.0	.45	.30	.85	33	1.5	1.0	1.9	W229080

Table 27d. -Major-, minor-, and trace-element composition of 15 bituminous coal samples from the Imboden coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means less than the value shown; B, not determined; S, after element title indicates determinations by automatic plate reading computer assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-7344	0.47	0.51	0.083	0.022	0.008	0.044	0.42	0.024	0.023	8.4	W203386
R-7345	2.3	1.4	.057	.065	.010	.25	.44	.067	.020	3.8	W203385
R-7515	1.1	.91	.039	.036	.017	.18	.48	.034	.018	33	W208044
R-7516	1.2	.88	.048	.048	.025	.17	.26	.037	.014	1.1	W208045
R-7517	5.8	3.4	.097	.20	.032	.59	1.3	.19	.023L	3.7	W208046
R-7518	1.7	1.5	.047	.037	.034	.23	.26	.073	.026	4.4	W208047
R-7519	3.4	1.2	.075	.035	.068	.093	.26	.13	.012	2.0	W208048
R-7520	.93	.64	.060	.023	.029	.076	.28	.039	.016	37	W208049
R-8208	2.9	1.7	.085	.061	.030	.32	.39	.091	.011L	5.4	W212491
R-8448	2.1	1.3	.097	.15	.019	.24	1.2	.078	.010L	1.8	W214244
R-8449	1.7	1.3	.070	.095	.021	.18	.60	.070	.24	1.0	W214245
R-8450	.89	.62	.052	.026	.008	.077	.31	.033	.038	5.4	W214246
R-8451	1.6	1.3	.071	.044	.016	.20	.31	.068	.023	4.0	W214247
R-8452	1.2	.93	.047	.032	.010	.11	.25	.056	.025	2.0	W214248
R-8718	1.0	.69	.089	.017	.014	.044	1.4	.056	.043	22	W229080

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-7344	15	63	1.4	1.1	0.063	11	150	4.0	6.1	0.10	W203386
R-7345	18	67	1.0	1.4	.050	16	110	4.5	12	1.3	W203385
R-7515	12	38	4.7	2.7	.13	11	170	15	9.5	1.2	W208044
R-7516	15	58	.46	3.2	.045	11	180	4.4	6.1	.90	W208045
R-7517	25	160	1.4	3.4	.057	32	100	3.7	30	3.8	W208046
R-7518	21	94	.38	1.5	.055	19	200	2.3	15	.60	W208047
R-7519	31	120	.72	1.6	.064	20	120	1.6	13	.40	W208048
R-7520	14	67	.88	2.4	.025	13	190	4.2	7.4	.50	W208049
R-8208	19	110	3.3	9.1	.034	20	570	4.1	17	2.1	W212491
R-8448	21	94	.93	1.8	.044	14	240	3.8	12	1.7	W214244
R-8449	18	100	.78	1.3	.044	14	210	3.7	12	1.4	W214245
R-8450	13	34	1.7	1.2	.038	7.0	220	3.0	5.3	.50	W214246
R-8451	13	50	1.1	1.1	.11	12	230	3.9	11	1.0	W214247
R-8452	14	53	1.8	1.5	.045	10	230	4.1	9.4	.50	W214248
R-8718	8.1	46	2.7	4.5	.015	8.8	270	4.9	7.0	.12	W229080

Table 27d.--Major-, minor-, and trace-element composition of 15 bituminous coal samples from the Imboden coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Cu (ppm)	Dy-S (ppm)	Er-S (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	Lab Number
R-7344	15	0.66L	0.66	0.22	20L	2.8	0.99	0.72	0.40	0.10	W203386
R-7345	10	2.0L	.93L	.28	88	3.8	1.4	.15	.55	.034	W203385
R-7515	18	1.2L	.70	.28	10	3.6	.81L	1.2	.30	.33	W208044
R-7516	10	1.2L	.53L	.20	10	1.7	.80L	.08L	.20	.10	W208045
R-7517	14	5.0L	2.3L	.47	130	6.8	3.4L	.34L	1.4	.23	W208046
R-7518	20	1.7L	.78L	.29	20	3.4	1.2L	.12L	.50	.48	W208047
R-7519	15	2.4L	1.1L	.30	10	2.9	2.8	.17L	1.1	.27	W208048
R-7520	10	.92L	.42L	.23	40	1.8	.63L	.39	.30	.20	W208049
R-8208	9.8	2.4L	1.1L	.43	100	5.6	1.7L	.44	.70	.045	W212491
R-8448	8.0	2.2L	1.0L	.36	360	3.8	1.5L	.43	.55	.11	W214244
R-8649	8.7	1.7L	.79L	.28	70	4.3	1.2L	1.3	.50	.078	W214245
R-8650	9.2	.88L	.40L	.15	50	2.0	.60L	.92	.30	.15	W214246
R-8651	9.2	1.6L	.71L	.24	60	2.9	1.1L	1.3	.40	.078	W214247
R-8652	9.0	1.2L	1.0	.20	50	2.6	.80L	.95	.40	.052	W214248
R-8718	15	2.8	.29L	.17	30	2.1	2.0L	1.3	.37	.10	W229080

Sample Number	La (ppm)	Li (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Lab Number
R-7344	5.5	7.5	0.09	6.6	1.9	0.60	5.1	9.9	22L	2.6	W203386
R-7345	8.0	18	.10	14	1.2	1.9	10	8.7	22L	3.3	W203385
R-7515	4.5	5.4	.22	5.9	1.6	.48	3.5	11	44L	4.8	W208044
R-7516	5.0	5.2	.07	12	.95	.29	3.6	5.1	44L	2.5	W208045
R-7517	16	22	.18	440	1.2	4.3	12	10	44L	6.3	W208046
R-7518	10	16	.07	2.9	1.6	.78	5.2	6.2	44L	5.9	W208047
R-7519	12	15	.14	3.5	.62	3.1	12	6.8	44L	5.8	W208048
R-7520	7.0	5.9	.12	2.5	1.1	.80	3.6	5.5	44L	2.0	W212491
R-8208	10	13	.11	43	1.0	2.4	11	8.8	70	3.8	W214244
R-8448	7.0	11	.08	75	.22	2.1	4.9	6.8	44L	2.3	W214244
R-8649	8.0	12	.09	21	1.2	1.5	3.6	7.9	44L	3.3	W214245
R-8450	4.0	6.0	.06	5.6	1.2	1.1	3.4	7.2	44L	2.0	W214246
R-8451	7.0	11	.08	6.2	.69	1.6	5.5	6.6	44L	3.4	W214247
R-8452	6.0	11	.07	6.4	1.3	1.9	8.5	9.0	52	2.9	W214248
R-8718	5.0	8.1	.07	9.3	.74	1.3	6.8	8.1	270	3.7	W229080

Table 27d.--Major-, minor-, and trace-element composition of 15 bituminous coal samples from the Imboden coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Pr-S (ppm)	Rb (ppm)	Sb (ppm)	Sc (ppm)	Se (ppm)	Sm (ppm)	Sn-S (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Lab Number
R-7344	2.0L	20L	0.50	1.4	3.6	1.0	0.11	210	0.060	0.15	W203386
R-7345	6.3L	22	.30	2.5	2.5	1.3	.21	78	.16	.17	W203385
R-7515	3.7L	20	1.5	3.7	5.6	1.3	.17	40	.070	.24	W208044
R-7516	3.6L	40L	.40	1.5	2.9	1.0	.13	79	.060	.14	W208045
R-7517	15L	61	.80	5.7	4.8	2.3	.70	97	.37	.28	W208046
R-7518	5.3L	20	.50	2.8	4.7	1.6	.38	100	.15	.23	W208047
R-7519	7.5L	50L	.20	2.8	3.1	1.7	1.2	160	.31	.21	W208048
R-7520	2.9L	40L	.50	2.1	1.7	1.2	.21	150	.11	.20	W208049
R-8208	7.5L	19	1.0L	3.4	4.6	1.6	.42	110	.23	.32	W212491
R-8448	6.9L	20	.30	2.7	2.3	1.0	.15L	92	B	.11	W214244
R-8449	5.4L	13	.40	2.5	3.3	1.1	.24	110	.19	.080	W214245
R-8450	2.7L	20L	.40	1.4	3.3	.60	.06L	68	.11	.10	W214246
R-8451	4.8L	9.0	.40	2.3	3.7	.90	.22	53	.16	.090	W214247
R-8452	3.6L	8.0	.30	1.8	3.2	.80	.40	85	.14	.070	W214248
R-8718	8.1	11L	.38	1.9	2.3	.92	.29L	150	.070	.095	W229080

Sample Number	Th (ppm)	Tl-S (ppm)	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)	Lab Number
R-7344	1.4	0.096L	0.77	15	0.30	5.4	0.50	3.9	5.7	W203386
R-7345	1.9	.30L	.46	20	.40	7.1	.60	7.9	18	W203385
R-7515	1.6	2.8	1.4	11	1.4	3.8	1.3	3.9	2.6	W208044
R-7516	1.0	.24L	.60	8.0	.30	1.3	.40	3.3	2.5	W208045
R-7517	4.4	1.0L	1.2	29	.60	6.3	1.2	23	38	W208046
R-7518	2.8	.36L	1.4	16	.40	2.0	.60	4.7	5.7	W208047
R-7519	3.4	.51L	.48	13	.80L	5.4	.80	3.3	24	W208048
R-7520	1.5	.19L	.46	8.0	.70L	3.1	.60	2.9	6.7	W208049
R-8208	2.5	.51L	.87	23	.50	5.6	.80	7.3	23	W212491
R-8448	2.0	.46L	.67	11	.30	2.9	.60	3.3	15	W214244
R-8449	2.0	.36L	.85	14	.30	2.9	.60	5.6	9.5	W214245
R-8450	.90	.18L	.32	7.6	.40	2.5	.40	1.6	5.6	W214246
R-8451	1.7	.33L	.70	13	.30	3.4	.60	2.5	13	W214247
R-8452	1.5	.24L	.66	13	.30	3.7	.50	2.1	15	W214248
R-8718	1.4	.62L	.43	6.8	.51	3.7	.47	5.7	11	W229080

Table 27e.--Arithmetic mean, observed range and geometric mean of proximate and ultimate analyses, heat content, forms of sulfur, and ash-fusion temperatures for 15 bituminous coal samples from the Imboden coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included.

[All values are in percent except Btu/lb, Kcal/kg, ash-fusion temperatures, and free-swelling index and are reported on an as-received basis. $^{\circ}\text{F} = 9/5 \, ^{\circ}\text{C} + 32$; $\text{Kcal}/\text{kg} = 0.556 \, \text{Btu}/\text{lb}$; (n) is number of samples per parameter.]

		Imboden coal bed			Appalachian basin		
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean
			Min.	Max.			(n)
Proximate and ultimate analyses							
Moisture	(15)	2.44	1.21	4.20	2.27	3.23	2.69
Volatile matter	(15)	33.64	28.00	37.62	33.53	32.46	31.72
Fixed carbon	(15)	55.65	47.90	59.33	55.55	52.48	51.76
Ash	(15)	8.27	3.00	19.90	7.20	11.83	9.83
Hydrogen	(15)	5.21	4.59	5.70	5.20	5.02	5.00
Carbon	(15)	76.02	64.00	81.42	75.87	70.69	70.17
Nitrogen	(15)	1.47	1.20	1.62	1.47	1.39	1.37
Oxygen	(15)	8.17	6.31	11.20	8.08	8.92	8.22
Sulfur	(15)	.87	.52	2.49	.79	2.15	1.63
Heat content							
KCal/kg	(15)	7,556	6,308	8,070	7,540	7,030	6,979
Btu/lb	(15)	13,591	11,346	14,515	13,561	12,644	12,553
Forms of sulfur							
Sulfate	(15)	0.02	0.01	0.07	0.02	0.08	0.04
Pyritic	(15)	.30	.03	1.39	.18	1.36	.65
Organic	(15)	.55	.35	1.03	.53	.82	.70
Ash-fusion temperature ($^{\circ}\text{C}$)							
Initial deformation	(12)	1,354	1,093	1,527	1,349	1,255	1,246
Softening	(8)	1,399	1,110	1,527	1,393	1,287	1,280
Fluid	(6)	1,438	1,310	1,521	1,436	1,334	1,328
Free-swelling index	(15)	7.83	5.50	9.00	7.77	5.53	4.68
Air-dried loss	(15)	1.08	0.18	2.80	.82	1.83	1.13

Table 27f.--Arithmetic mean, observed range, and geometric mean of ash content and concentrations of 11 major- and minor-oxides in the laboratory ash of 15 bituminous coal samples from the Imboden coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. Dashed values (---) represent less than five samples; (n) indicates the number of samples per oxide.

[All samples were ashed at 525°C; all data are in percent.]

	Imboden coal bed				Appalachian basin			
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
			Min.	Max.				
(Ash)	(15)	8.0	3.0	23	7.1	13	10	(5,262)
SiO ₂	(15)	48	33	67	48	43	41	(5,229)
Al ₂ O ₃	(15)	29	21	36	29	24	23	(5,229)
CaO	(15)	1.4	.60	3.9	1.3	2.2	1.5	(5,227)
MgO	(15)	1.2	.45	2.5	1.1	.85	.75	(5,258)
Na ₂ O	(15)	.42	.15	.94	.36	.43	.34	(5,194)
K ₂ O	(15)	2.7	.85	4.1	2.5	2.0	1.7	(5,229)
Fe ₂ O ₃	(15)	11	3.4	33	9.0	19	13	(5,215)
MnO	(15)	.04	.004	.25	.02	.03	.02	(5,260)
TiO ₂	(15)	1.4	1.0	2.0	1.4	1.2	1.1	(5,203)
P ₂ O ₅	(3)	---	.14	1.0	---	.50	.22	(3,389)
SO ₃	(15)	2.1	.88	7.0	1.8	2.5	1.9	(5,063)

Table 27g.--Arithmetic mean, observed range, and geometric mean of concentrations of 54 trace elements in 15 bituminous coal samples from the Imboden coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. Dashed values (---) represent less than five samples; (n) indicates the number of samples per element. [All data are in parts-per-million and are reported on a whole-coal basis.]

	Imboden coal bed				Appalachian basin			
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
			Min.	Max.				
Ag (12)		0.04	0.012	0.24	0.03	0.07	0.05	(4,565)
As (15)		9.0	1.0	37	4.7	35	13	(5,197)
B (15)		17	8.1	31	16	30	20	(5,076)
Ba (15)		77	34	160	70	90	63	(5,134)
Be (15)		1.6	.38	4.7	1.2	2.5	2.0	(5,247)
Bi ---		---	---	---	---	1.5	1.1	(108)
Br (15)		2.5	1.0	9.1	2.0	22	13	(4,892)
Cd (15)		.05	.015	.13	.05	.10	.07	(4,978)
Ce (15)		15	7.0	32	14	21	17	(5,075)
Cl (15)		210	100	570	190	780	510	(3,646)
Co (15)		4.5	1.6	15	4.0	7.4	5.7	(5,217)
Cr (15)		11	5.3	30	10	18	15	(5,205)
Cs (15)		1.1	.10	3.8	.73	1.3	.85	(4,831)
Cu (15)		12	8.0	20	12	19	15	(5,239)
Dy (1)		---	2.8	2.8	---	3.3	2.6	(759)
Er (3)		---	.66	1.0	---	1.5	1.2	(1,200)
Eu (15)		.27	.15	.47	.26	.44	.37	(5,032)
F (14)		73	10	360	44	99	71	(4,860)
Ga (15)		3.3	1.7	6.8	3.1	6.6	5.4	(5,046)
Gd (3)		---	.99	2.8	---	2.6	1.9	(1,773)
Ge (11)		.83	.15	1.4	.70	4.7	2.5	(4,608)
Hf (15)		.53	.20	1.4	.47	.79	.62	(4,932)
Hg (15)		.16	.034	.48	.12	.22	.15	(5,031)
Ho ---		---	---	---	---	.76	.61	(378)
La (15)		7.7	4.0	16	7.1	11	8.9	(5,147)
Li (15)		11	5.2	22	10	22	14	(5,243)
Lu (15)		.10	.060	.21	.10	.16	.14	(4,885)
Mn (15)		44	2.5	440	12	31	15	(5,260)
Mo (15)		1.1	.22	1.9	1.0	3.7	2.3	(4,889)
Nb (15)		1.6	.29	4.3	1.3	2.6	1.9	(5,005)
Nd (15)		6.6	3.4	12	5.9	13	9.9	(4,231)
Ni (15)		7.9	5.1	11	7.7	17	14	(5,240)
Pb (15)		3.6	2.0	6.3	3.4	8.8	6.2	(5,172)
Pd ---		---	---	---	---	.17	.14	(18)
Pr (1)		---	8.1	8.1	---	6.1	3.6	(960)
Rb (9)		21	8.0	61	18	28	22	(2,232)
Sb (14)		.49	.20	1.5	.43	1.4	.91	(5,003)
Sc (15)		2.6	1.4	5.7	2.4	4.4	3.6	(5,218)
Se (15)		3.4	1.7	5.6	3.3	3.6	2.8	(5,052)
Sm (15)		1.2	.60	2.3	1.2	2.0	1.6	(5,005)
Sn (12)		.37	.11	1.2	.29	1.6	.86	(2,352)
Sr (15)		110	40	210	97	110	79	(5,146)
Ta (14)		.16	.060	.37	.13	.24	.19	(4,369)
Tb (15)		.17	.070	.32	.15	.34	.29	(4,852)
Th (15)		2.0	.90	4.4	1.8	3.0	2.3	(5,098)
Tl (1)		---	2.8	2.8	---	3.4	2.1	(382)
Tm ---		---	---	---	---	1.7	.38	(46)
U (15)		.75	.32	1.4	.69	1.8	1.3	(4,990)
V (15)		14	6.8	29	13	24	19	(5,241)
W (13)		.46	.30	1.40	.41	.94	.80	(4,421)
Y (15)		3.9	1.3	7.1	3.6	8.5	7.2	(5,234)
Yb (15)		.66	.40	1.3	.63	1.1	.92	(5,151)
Zn (15)		5.4	1.6	23	4.2	22	14	(5,243)
Zr (15)		13	2.5	38	10	24	17	(5,238)

Table 28a.—Descriptions and locations for 2 bituminous coal samples from the Campbell Creek coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
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R-7494	W206890	117B-1	372554N	815759W	Panther (7.5')	Buchanan	28.80
R-8566	W217689	118C-14	371847N	821309W	Harman (7.5')	Buchanan	46.80

Table 28b.—Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 2 bituminous coal samples from the Campbell Creek coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, Hardgrove grindability indexes, and compliance numbers in percent for each sample number, the analyses are reported three ways: first, as received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa., and a commercial testing laboratory following ASTM standards. G for ash-combustion, + for carbon, and minus sign for sulfur. Sample number is USGS laboratory number. Lab number is the USGS laboratory number. The

accuracy of rank calculated from these parameters:

Sample Number	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT			
	Moisture	Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	Lab Number
R-7494	3.3	33.2	57.1	6.4	5.6	78.5	1.6	7.2	0.8	7,740	13,940	W206890
	---	34.3	59.0	6.6	5.4	81.2	1.7	4.4	.8	8,010	14,410	
	---	36.8	63.2	---	5.8	86.9	1.8	4.7	.9	8,570	15,430	
R-8566	2.0	32.3	59.1	6.6	5.2	78.7	1.5	7.4	.6	7,810	14,060	W217689
	---	32.9	60.3	6.8	5.1	80.4	1.5	5.7	.6	7,970	14,350	
	---	25.2	64.7	---	5.4	86.2	1.6	6.1	.7	8,550	15,400	

Table 28b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 2 bituminous coal samples from the Campbell Creek coal bed, Southwest Virginia. -continued

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening			
R-7494	2.1 ---	0.01 .01	0.23 .24	0.53 .55	9.0 .59	1,540 1,540G	1,540G	1,540G	---	1.15 W206890
R-8566	1.1 --- --- ---	.03 .03 .03	.02 .02 .02	.56 .57 .61	8.5 .57	1,415 1,540	1,540G	1,540G	---	.85 W217689

Table 28c.--Major- and minor-oxide concentrations in the laboratory ash of 2 bituminous coal samples from the Campbell Creek coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. L means less than the concentration shown. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-7494	6.9	51	36	0.98	0.68	0.85	2.2	3.7	2.0	0.072L	0.03L	W206890
R-8566	8.8	56	28	.73	1.1	.62	4.4	4.1	1.3	.11	1.3	W217689

Table 28d.-Major-, minor-, and trace-element composition of 2 bituminous coal samples from the Campbell Creek coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts per-million. L means less than the value shown; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 33%. Sample number is the VDMR identification number. Lab number is the USGS Laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-7494	1.6	1.3	0.048	0.028	0.043	0.12	0.18	0.084	0.021	0.90	W206890
R-8566	2.3	1.3	.046	.056	.040	.32	.26	.071	.017	.90	W217689

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-7494	9.7	61	3.5	21	0.040	18	1,100	5.3	14	0.95	W206890
R-8566	11	63	2.0	14	.074	13	700	5.9	12	2.0	W217689

Sample Number	Cu (ppm)	Dy-S (ppm)	Er-S (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	Lab Number
R-7494	19	1.5L	0.69	0.31	70	3.6	1.0L	1.4	0.65	0.19	W206890
R-8566	9.7	2.4	1.1	.27	270	4.0	2.0	1.4	.40	.15	W217689

Sample Number	La (ppm)	Li (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Lab Number
R-7494	10	16	0.10	3.9	0.30	2.5	9.7	9.0	22L	6.1	W206890
R-8566	7.0	6.0	.08	11	.28	1.4	8.4	11	44	4.0	W217689

Table 28d. --Major-, minor-, and trace-element composition of 2 bituminous coal samples from the Campbell Creek coal bed,
Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Rb (ppm)	Sb (ppm)	Sc (ppm)	Se (ppm)	Sm (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	Lab Number
R-7494	.30L	0.75	2.8	3.1	1.5	0.76	110	0.20	0.21	W206890
R-8566	.19	.80	2.7	1.9	1.1	.67	82	.14	.20	W217689

Sample Number	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)			Lab Number
R-7494	0.70	15	0.60	4.4	0.60	1.9	16			W206890
R-8566	.59	17	.50	4.8	.70	7.6	11			W217689

KELLY COAL BED

This coal occurs in Dickenson, Lee, and Wise Counties. In Dickenson county it may be confused with the Pinhook coal bed. Production in 1989 was 1.2 million tons, all from Wise County (Virginia Division of Mines, 1990). Sampled thickness ranges from 3.4 to 4.7 feet. The Kelly has a moderately-developed medium cleat with moderate amounts of thin and medium banding. Pyrite occurs along bedding and as a film on some cleat surfaces.

Bi, Dy, Er, Ho, Pd, Pr, and Tm as well as Au, In, Ir, Os, Pt, Re, Rh, and Ru are found to be below the detection limits for the 5 Kelly samples. The geometric means for K₂O, MnO, Ba, Co, Se, Sr, and air-dried loss are substantially higher in the Kelly coal bed samples than in the Appalachian basin samples. As, Br, Mo, sulfur, sulfate, and pyritic sulfur geometric means are substantially higher for the Appalachian basin coal samples than for the Kelly samples (Figure 36). The analytical data are available in Tables 29b, 29c, and 29d. The statistical summaries can be found in Tables 29e, 29f, and 29g. Table 29a presents the descriptive and location information for the samples.

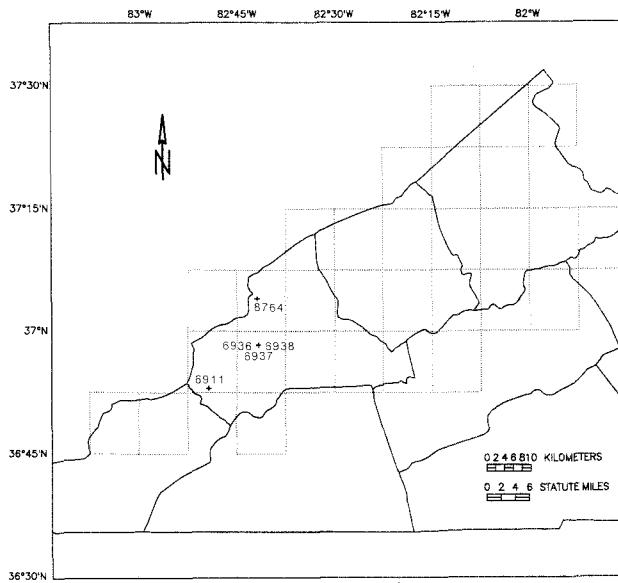


Figure 36. Locations for samples from the Kelly coal bed.

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Table 29a.-Descriptions and locations for 5 bituminous coal samples from the Kelly coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-6911	W194854	61A-1	365301N	824917W	Appalachia (7.5')	Wise	36.84	Surface mine, weathered	Full Thickness
R-6936	W196284	60B-9	365819N	824139W	Norton (7.5')	Wise	20.88	Surface mine, sl. weathered	Bench Sample
R-6937	W196285	60B-10	365819N	824139W	Norton (7.5')	Wise	10.32	Surface mine, sl. weathered	Bench Sample
R-6938	W196286	60B-11	365819N	824139W	Norton (7.5')	Wise	10.20	Surface mine, sl. weathered	Bench Sample
R-8764	W231830	90C-26	370400N	824150W	Flat Gap (7.5')	Wise	37.12	Surface mine	Full Thickness

Table 29b.-Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 5 bituminous coal samples from the Kelly coal bed, Southwest Virginia.

All analyses except heat contents, free swelling indexes, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. G for ash-fusion temperatures means greater than value shown. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT		Lab Number	
	Moisture	Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	BTu/lb	
R-6911	3.6	33.3	53.8	9.3	5.1	73.7	1.4	9.6	0.8	7,270	13,090	W194854
	---	34.5	55.8	9.6	4.9	76.5	1.5	6.6	.8	7,540	13,580	
	---	38.2	61.8	---	5.4	84.6	1.6	7.3	.9	8,350	15,030	
R-6936	3.6	31.4	52.5	12.5	5.1	71.7	1.3	8.4	.9	7,130	12,840	W196284
	---	32.6	54.5	13.0	4.9	74.4	1.3	5.4	.9	7,400	13,320	
	---	37.4	62.6	---	5.6	85.5	1.5	6.2	1.1	8,580	15,310	
R-6937	2.4	39.5	50.0	8.1	6.0	77.0	1.3	7.2	.5	7,810	14,060	W196285
	---	40.5	51.2	8.3	5.9	78.9	1.3	5.2	.5	8,000	14,400	
	---	44.1	55.9	---	6.4	86.0	1.5	5.7	.6	8,750	15,710	
R-6938	2.9	28.7	44.7	23.7	4.6	61.8	1.2	8.3	.5	6,120	11,020	W196286
	---	29.6	46.0	24.4	4.4	63.6	1.2	5.9	.5	6,300	11,350	
	---	39.1	60.9	---	5.8	84.2	1.6	7.8	.7	8,340	15,010	
R-8764	4.5	32.0	53.9	9.6	5.3	73.7	1.3	9.1	1.0	7,310	13,160	W231830
	---	33.5	56.4	10.1	5.0	77.1	1.4	5.4	1.0	7,660	13,780	
	---	37.3	62.7	---	5.6	85.8	1.5	6.0	1.1	8,520	15,330	

Table 29b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 5 bituminous coal samples from the Kelly coal bed, Southwest Virginia.--continued

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)				Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid			
R-6911	1.7	0.01	0.19	0.64	5.5	1,540	1,540G	1,540G	---	1.22	W194854
	---	.01	.20	.66							
	---	.01	.22	.73							
R-6936	2.6	.04	.33	.57	7.5	1,540	1,540G	1,540G	---	1.40	W196284
	---	.04	.34	.59							
	---	.05	.39	.68							
R-6937	.9	.00	.00	.00	1.0	1,290	1,345	1,405	---	.71	W196285
	---	.00	.00	.00							
	---	.00	.00	.00							
R-6938	1.4	.01	.06	.45	2.0	1,540	1,540G	1,540G	---	.91	W196286
	---	.01	.06	.46							
	---	.01	.08	.61							
R-8764	3.4	.04	.31	.61	8.0	1,510	1,540	1,540G	54	1.52	W231830
	---	.04	.32	.64							
	---	.05	.36	.71							

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Table 29c.--Major- and minor-oxide concentrations in the laboratory ash of 5 bituminous coal samples from the Kelly coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-6911	8.4	42	33	2.8	0.81	0.45	3.2	5.8	1.5	2.2	3.2	W194854
R-6936	6.4	21	18	2.8	.83	.43	1.7	37	.82	.063	5.1	W196284
R-6937	7.9	50	25	3.8	1.0	.81	2.2	6.6	1.4	.063	5.4	W196285
R-6938	21.8	55	33	.56	.91	.41	4.6	2.6	1.3	.069	.72	W196286
R-8764	10.4	52	31	1.0	.88	.42	2.7	6.9			1.1	W231830

Table 20d.-Major-, minor-, and trace-element composition of 5 bituminous coal samples from the Kelly coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means less than the value shown; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-6911	1.6	1.5	0.17	0.041	0.028	0.22	0.34	0.075	0.037	3.5	W194854
R-6936	.64	.61	.13	.032	.020	.091	1.7	.031	.026	7.6	W196284
R-6937	1.8	1.0	.21	.047	.047	.14	.36	.066	.20	1.1	W196285
R-6938	5.6	3.7	.087	.12	.065	.84	.40	.17	.087	.95	W196286
R-8764	2.5	1.7	.077	.055	.032	.24	.50	.089	.035	3.8	W231830

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-6911	14	180	0.92	0.7	0.13	22	B	7.2	15	0.93	W194854
R-6936	24	96	1.7	2.5	.10	26	B	15	21	.55	W196284
R-6937	16	190	.79	3.7	.27	18	B	11	11	.60	W196285
R-6938	28	190	3.3	3.7	.10	36	B	13	35	2.0	W196286
R-8764	12	140	1.4	4.7	.021	18	280	4.8	15	1.3	W231830

Sample Number	Cu (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	La (ppm)	Li (ppm)	Lab Number
R-6911	26	0.39	.76	4.5	0.69	2.0	0.70	0.28	12	15	W194854
R-6936	14	.53	160	3.8	.44L	7.0	.95	.26	15	7.7	W196284
R-6937	28	.38	72	4.2	1.0	.36L	.65	.085	10	10	W196285
R-6938	37	.65	300	12	1.8	1.0L	1.5	.030	20	50	W196286
R-8764	15	.39	20	4.2	3.3L	1.5	.68	.050L	9.2	11	W231830

Table 29d.--Major-, minor-, and trace-element composition of 5 bituminous coal samples from the Kelly coal bed, Southwest Virginia, reported on a whole-coal basis.

Sample Number	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Rb (ppm)	Sb (ppm)	Lab Number
R-6911	0.12	12	0.81	1.0	7.6	10	810	8.4	49L	0.67	W194854
R-6936	.14	24	1.5	.83	2.9L	5.0	17	2.0	29L	.90	W196284
R-6937	.13	43	.87	.79	3.6L	26	22	7.3	31L	1.5L	W196285
R-6938	.25	31	1.3	4.6	28	15	66	18	43	.90	W196286
R-8764	.11	9.3	.64	1.0	4.8	9.8	320	5.9	14	.58	W231830

Sample Number	Sc (ppm)	Se (ppm)	Sm (ppm)	Sn-S (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	Tl-S (ppm)	U (ppm)	Lab Number
R-6911	3.4	4.0	2.0	1.1	240	0.17	0.28	3.2	1.0	1.9	W194854
R-6936	4.1	7.7	2.4	.52	83	.26	.35	3.7	.64L	2.4	W196284
R-6937	2.3	4.3	1.8	.54L	110	.20	.25	1.9	.79L	1.2	W196285
R-6938	7.4	4.6	3.3	1.5L	54	.41	.50	6.9	2.2L	2.9	W196286
R-8764	3.7	3.6	1.9	1.9	290	.22	.22	2.2	1.0L	.67	W231830

Sample Number	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)	Lab Number
R-6911	18	0.40	4.5	0.87	7.4	7.6	W194854
R-6936	6.4	.55	3.1	.90	7.7	6.3	W196284
R-6937	7.4	.25	2.9	.80	58	8.7	W196285
R-6938	44	.70	14	1.6	14	35	W196286
R-8764	10	.71	2.9	.74	7.5	6.2	W231830

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Table 29e.--Arithmetic mean, observed range and geometric mean of proximate and ultimate analyses, heat content, forms of sulfur, and ash-fusion temperatures for 5 bituminous coal samples from the Kelly coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included.

[All values are in percent except Btu/lb, Kcal/kg, ash-fusion temperatures, and Kcal/kg = 0.556 Btu/lb; dashed values (---) represent less than five samples; (n) is number of samples per parameter.]

	Kelly coal bed				Appalachian basin		
	Arith. mean (n)	Observed range		Geom. mean	Arith. mean	Geom. mean	(n)
Proximate and ultimate analyses							
Moisture	(5)	3.40	2.40	4.49	3.32	3.23	2.69
Volatile matter	(5)	32.98	28.70	39.50	32.79	32.46	31.72
Fixed carbon	(5)	50.98	44.70	53.88	50.85	52.48	51.76
Ash	(5)	12.65	8.10	23.70	11.65	11.83	9.83
Hydrogen	(5)	5.22	4.60	6.00	5.20	5.02	5.00
Carbon	(5)	71.57	61.80	77.00	71.38	70.69	70.17
Nitrogen	(5)	1.30	1.20	1.40	1.30	1.39	1.37
Oxygen	(5)	8.53	7.20	9.60	8.49	8.92	8.22
Sulfur	(5)	.73	.50	.96	.70	2.15	1.63
Heat content							
KCal/kg Btu/lb	(5)	7,135	6,125	7,816	7,113	7,030	6,979
	(5)	12,833	11,016	14,058	12,793	12,644	12,553
Forms of sulfur							
Sulfate	(4)	---	0.01	0.04	---	0.08	0.04
Pyritic	(4)	---	.06	.33	---	1.36	.65
Organic	(4)	---	.45	.64	---	.82	.70
Ash-fusion temperature (°C)							
Initial deformation	(2)	---	1,290	1,510	---	1,255	1,246
Softening	---	---	---	---	---	1,287	1,280
Fluid	---	---	---	---	---	1,334	1,328
Free-swelling index	(5)	4.80	1.00	8.00	3.66	5.53	4.68
Air-dried loss	(5)	2.01	0.90	3.45	1.81	1.83	1.13

Table 29f.--Arithmetic mean, observed range, and geometric mean of ash content and concentrations of 11 major- and minor-oxides in the laboratory ash of 5 bituminous coal samples from the Kelly coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. (n) indicates the number of samples per oxide.

[All samples were ashed at 525°C; all data are in percent.]

	Kelly coal bed				Appalachian basin			
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
			Min.	Max.				
(Ash)	(5)	11	6.4	22	9.9	13	10	(5,262)
SiO ₂	(5)	44	21	55	42	43	41	(5,229)
Al ₂ O ₃	(5)	28	18	33	27	24	23	(5,229)
CaO	(5)	2.2	.56	3.8	1.8	2.2	1.5	(5,227)
MgO	(5)	.89	.81	1.0	.88	.85	.75	(5,258)
Na ₂ O	(5)	.50	.40	.81	.48	.43	.34	(5,194)
K ₂ O	(5)	2.9	1.8	4.6	2.7	2.0	1.7	(5,229)
Fe ₂ O ₃	(5)	12	2.6	37	7.6	19	13	(5,215)
MnO	(5)	.03	.011	.07	.03	.03	.02	(5,260)
TiO ₂	(5)	1.3	.82	1.5	1.3	1.2	1.1	(5,203)
P ₂ O ₅	(5)	.62	.060	2.2	.21	.50	.22	(3,389)
SO ₃	(5)	3.1	.72	5.4	2.4	2.5	1.9	(5,063)

Table 29g.--Arithmetic mean, observed range, and geometric mean of concentrations of 54 trace elements in 5 bituminous coal samples from the Kelly coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. Dashed values (---) represent less than five samples; (n) indicates the number of samples per element. [All data are in parts-per-million and are reported on a whole-coal basis.]

(n)	Arith. mean	Kelly coal bed			Appalachian basin		
		<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
		Min.	Max.				
Ag (5)	0.08	0.026	0.20	0.06	0.07	0.05	(4,565)
As (5)	3.4	.95	7.6	2.5	35	13	(5,197)
B (5)	19	12	28	18	30	20	(5,076)
Ba (5)	160	96	190	150	90	63	(5,134)
Be (5)	1.6	.79	3.3	1.4	2.5	2.0	(5,247)
Bi ---	---	---	---	---	1.5	1.1	(108)
Br (5)	3.1	.72	4.7	2.6	22	13	(4,892)
Cd (5)	.12	.021	.27	.09	.10	.07	(4,978)
Ce (5)	24	18	36	23	21	17	(5,075)
Cl (1)	---	280	280	---	780	510	(3,646)
Co (5)	10	4.8	15	9.4	7.4	5.7	(5,217)
Cr (5)	19	11	35	18	18	15	(5,205)
Cs (5)	1.1	.55	2.0	.96	1.3	.85	(4,831)
Cu (5)	24	14	37	22	19	15	(5,239)
Dy ---	---	---	---	---	3.3	2.6	(759)
Er ---	---	---	---	---	1.5	1.2	(1,200)
Eu (5)	.47	.38	.65	.45	.44	.37	(5,032)
F (5)	130	20	300	88	99	71	(4,860)
Ga (5)	5.7	3.8	12	5.1	6.6	5.4	(5,046)
Gd (3)	---	.69	1.8	---	2.6	1.9	(1,773)
Ge (3)	---	1.5	7.0	---	4.7	2.5	(4,608)
Hf (5)	.89	.65	1.4	.84	.79	.62	(4,932)
Hg (4)	---	.030	.28	---	.22	.15	(5,031)
Ho ---	---	---	---	---	.76	.61	(378)
La (5)	13	9.2	20	13	11	8.9	(5,147)
Li (5)	19	7.7	50	15	22	14	(5,243)
Lu (5)	.15	.11	.24	.14	.16	.14	(4,885)
Mn (5)	24	9.3	43	20	31	15	(5,260)
Mo (5)	1.0	.64	1.5	.98	3.7	2.3	(4,889)
Nb (5)	1.6	.79	4.6	1.2	2.6	1.9	(5,005)
Nd (3)	---	4.8	28	---	13	9.9	(4,231)
Ni (5)	13	5.0	26	11	17	14	(5,240)
Pb (5)	8.4	2.0	18	6.7	8.8	6.2	(5,172)
Pd ---	---	---	---	---	.17	.14	(18)
Pr ---	---	---	---	---	6.1	3.6	(960)
Rb (2)	---	14	43	---	28	22	(2,232)
Sb (4)	---	.58	.90	---	1.4	.91	(5,003)
Sc (5)	4.2	2.3	7.4	3.9	4.4	3.6	(5,218)
Se (5)	4.8	3.6	7.7	4.6	3.6	2.8	(5,052)
Sm (5)	2.3	1.8	3.3	2.2	2.0	1.6	(5,005)
Sn (3)	---	.52	1.9	---	1.6	.86	(2,352)
Sr (5)	160	54	290	130	110	79	(5,146)
Ta (5)	.25	.17	.40	.24	.24	.19	(4,369)
Tb (5)	.32	.22	.50	.30	.34	.29	(4,852)
Th (5)	3.5	1.8	6.8	3.2	3.0	2.3	(5,098)
Tl (1)	---	1.0	1.0	---	3.4	2.1	(382)
Tm ---	---	---	---	---	1.7	.38	(46)
U (5)	1.8	.67	2.9	1.6	1.8	1.3	(4,990)
V (5)	17	6.4	44	13	24	19	(5,241)
W (5)	.52	.25	.71	.49	.94	.80	(4,421)
Y (5)	5.6	2.9	14	4.4	8.5	7.2	(5,234)
Yb (5)	.98	.74	1.6	.94	1.1	.92	(5,151)
Zn (5)	19	7.4	58	13	22	14	(5,243)
Zr (5)	13	6.2	35	9.8	24	17	(5,238)

UPPER ST. CHARLES COAL BED

The Upper St. Charles coal bed occurs in Lee and Wise Counties and about 4,000 tons were produced from Lee County in 1987 (Virginia Division of Mines, 1988). One sample was collected from a distorted coal bed 2.7 feet thick.

The elements Bi, Dy, Gd, Hg, Ho, P, Pd, Pr, Tl, and Tm are found to below their detection limits for this coal bed (in addition to the 8 elements found to be below their detection limits for the remaining Virginia samples). There is only one sample (Figure 37), therefore the geometric means are not meaningful. Table 30a presents the location and descriptive data for the Upper St. Charles sample, and Tables 30b, 30c, and 30d present the analytical data for this sample.

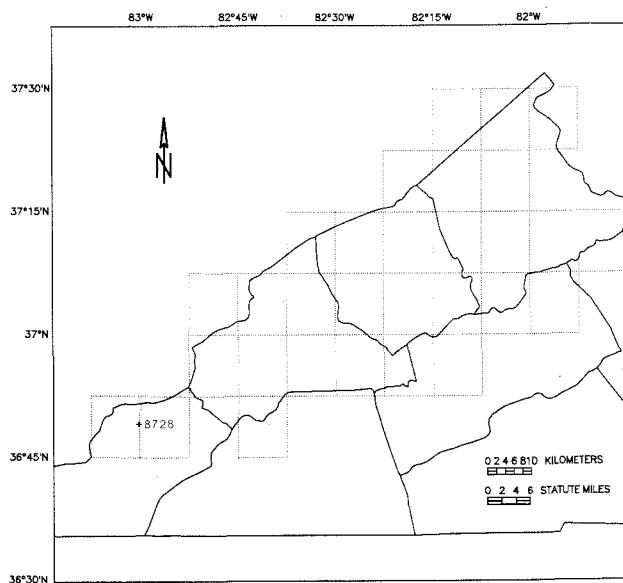


Figure 37. Location for sample from the Upper St. Charles coal bed.

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Table 30a.--Description and location for 1 bituminous coal sample from the Upper St. Charles coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-8728	W229548	62D-2	364906N	830010W	Pennington Gap (7.5')	Lee	32.40	Underground mine, sl. weathered	Full Thickness

Table 30b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance number for 1 bituminous coal sample from the Upper St. Charles coal bed, Southwest Virginia.

[All analyses except heat content, free-swelling index, ash-fusion temperatures, Hardgrove grindability index, and compliance number in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa. and a commercial testing laboratory following ASTM standards. G for ash-fusion temperatures means greater than value shown. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT			Lab Number
	Moisture	Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	
R-8728	5.1	32.9	53.6	8.3	5.3	72.6	1.4	11.7	0.7	7,160	12,890	W229548
	--	34.7	56.5	8.8	5.0	76.5	1.5	7.5	.7	7,540	13,580	
	--	38.0	62.0	--	5.5	83.8	1.6	8.2	.8	8,270	14,880	

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)				Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free- swelling index	Initial Deformation	Softening	Fluid			
R-8728	3.7	0.06	0.03	0.58	4.0	1,540	1,540	45	45	1.09	W229548
	--	.06	.03	.61							
	--	.07	.03	.67							

Table 30c.--Major- and minor-oxide concentrations in the laboratory ash of 1 bituminous coal sample from the Upper St. Charles coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO_2	Al_2O_3	CaO	MgO	Na_2O	K_2O	Fe_2O_3	TiO_2	SO_3	Lab Number
R-8728	9.0	53	31	1.1	0.85	0.20	2.5	3.4	2.2	1.1	W229548

Table 30d.--Major-, minor-, and trace-element composition of 1 bituminous coal sample from the Upper St. Charles coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-8728	2.2	1.5	0.069	0.046	0.014	0.19	0.22	0.12	0.040	1.7	W229548

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-8728	24	90	1.8	1.9	0.018	18	150	5.8	16	0.94	W229548

Sample Number	Cu (ppm)	Er-S (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Ge-S (ppm)	Hf (ppm)	La (ppm)	Li (ppm)	Lu (ppm)	Lab Number
R-8728	12	1.3	0.33	40	5.0	2.7	0.77	9.9	16	0.12	W229548

Table 30d.--Major-, minor-, and trace-element composition of 1 bituminous coal sample from the Upper St. Charles coal bed, Southwest Virginia, reported on a whole-coal basis.

Sample Number	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	Pb (ppm)	Rb (ppm)	Sb (ppm)	Se (ppm)	Lab Number	
R-8728	7.5	0.50	2.3	12	12	6.1	15	0.39	3.7	4.7	W229548

Sample Number	Sm (ppm)	Sn-S (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Lab Number
R-8728	1.9	1.2	130	0.25	0.22	2.4	0.81	18	0.59	6.0	W229548

Sample Number	Yb (ppm)	Zn (ppm)	Zr-S (ppm)	Lab Number
R-8728	0.81	4.7	18	W229548

WILSON COAL BED

The Wilson coal bed is found in Lee and Wise Counties and is also called the Upper Standiford, No. 4, Jackrock, or Mason coal bed. The Wilson may be correlative with the Harlan coal bed of Harlan County, Kentucky. A sampled interval from the Flat Gap area of Wise County has a thickness of 3.4 feet (R-8207, Figure 38). This sample of the Wilson is characterized by a well-developed medium cleat with moderate amounts of thin banding and sparse amounts of medium banding. Where sampled, there are two partings, the upper being four inches of shale; the lower, one inch of rashy coal.

Five samples of the Wilson coal bed were analyzed. Table 31a shows the location and descriptive information for these samples. The analytical results are presented in Tables 31b, 31c, and 31d. Bi, Dy, Er, Ho, Pd, Pr, Tl, and Tm, in addition to the eight elements below the detection limits for all the Virginia samples discussed in this paper, are found to be below the detection limits. The geometric means (Tables 31e, 31f, and 31g present the statistical summaries for these samples) for P_2O_5 , Ba, Gd, Nb, Sr, and sulfate are substantially higher for the Wilson coal samples than for the samples from the Appalachian basin. The geometric means for MnO, Br, Mo, and Sb are substantially lower for the Wilson than the Appalachian coal samples.

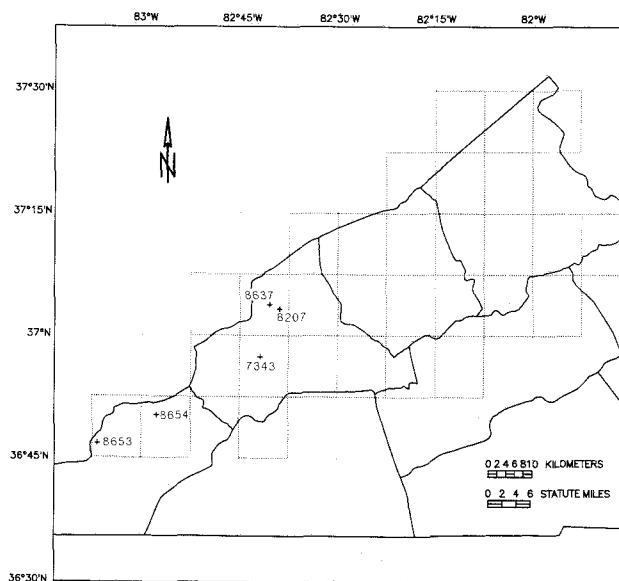


Figure 38. Locations for samples from the Wilson coal bed.

Table 31a.-Descriptions and locations for 5 bituminous coal samples from the Wilson coal bed, Southwest Virginia.

VDMR Icl. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-7343	W203387	60B-16	365724N	824148W	Norton (7.5')	Wise	40-80	Surface mine	Full Thickness
R-8207	W212488	90C-14	370314N	823856W	Flat Gap (7.5')	Wise	36-00	Surface mine, sl. weathered	Full Thickness
R-8637	W223354	90C-15	370345N	824028W	Flat Gap (7.5')	Wise	26-40	Underground mine	Full Thickness
R-8653	W226970	62D-1	364644N	830639W	Pennington Gap (7.5')	Lee	37-20	Underground mine	Full Thickness
R-8654	W226971	61C-2	365011N	825739W	Keokee (7.5')	Lee	32-88	Underground mine	Full Thickness

Table 31b.-Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 5 bituminous coal samples from the Wilson coal bed, Southwest Virginia.

All analyses except heat contents, free-swelling indexes, ash-fusion temperatures, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. G for ash-fusion temperatures means greater than value shown. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT			
	Moisture	Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	Lab Number
R-7343	3.8	33.4	51.8	11.0	5.4	72.5	1.4	8.8	0.8	7,220	12,990	W203387
	---	34.7	53.8	11.4	5.2	75.4	1.5	5.6	.8	7,500	13,500	
	---	39.2	60.8	--	5.8	85.1	1.6	6.4	.9	8,470	15,240	
R-8207	1.7	33.8	55.4	9.2	5.1	76.4	1.4	6.8	1.1	7,570	13,620	W212488
	---	34.3	56.3	9.3	5.0	77.7	1.4	5.4	1.1	7,700	13,860	
	---	37.9	62.1	--	5.6	85.7	1.5	5.9	1.3	8,490	15,280	
R-8637	1.9	33.6	58.2	6.3	5.3	78.9	1.4	7.0	1.1	7,790	14,030	W223354
	---	34.2	59.3	6.4	5.2	80.4	1.4	5.4	1.1	7,940	14,300	
	---	36.6	63.4	--	5.6	86.0	1.5	5.8	1.2	8,490	15,280	
R-8653	2.2	38.3	50.2	9.2	5.2	72.6	1.4	7.6	4.1	7,260	13,070	W226970
	---	39.2	51.4	9.4	5.0	74.3	1.4	5.7	4.2	7,430	13,370	
	---	43.3	56.7	--	5.5	82.0	1.5	6.3	4.6	8,200	14,760	
R-8654	4.7	38.6	47.0	9.7	5.4	69.1	1.3	10.8	3.7	6,990	12,590	W226971
	---	40.6	49.3	10.2	5.1	72.5	1.4	6.9	3.9	7,340	13,200	
	---	45.1	54.9	--	5.7	80.7	1.6	7.7	4.3	8,160	14,700	

Table 31b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 5 bituminous coal samples from the Wilson coal bed, Southwest Virginia. --continued

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number	
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid			
R-7343	2.2	0.01	0.16	0.64	8.0	1,600	1,600G	---	1.23	W203387	
	--	.01	.17	.67							
	--	.01	.19	.75							
R-8207	.5	.05	.26	.81	8.0	1,540	1,540G	---	1.62	W212488	
	--	.05	.26	.82							
	--	.06	.29	.91							
R-8637	.8	.16	.24	.70	8.0	1,415	1,440	49	1.57	W223354	
	--	.16	.24	.71							
	--	.17	.26	.76							
R-8653	.8	.19	2.04	1.84	3.5	1,080	1,090	1,145	39	6.27	W226970
	--	.19	2.09	1.88							
	--	.21	2.30	2.03							
R-8654	3.2	.49	1.58	1.62	4.0	1,095	1,110	1,160	45	5.88	W226971
	--	.51	1.66	1.70							
	--	.57	1.85	1.89							

Table 31c.--Major- and minor-oxide concentrations in the laboratory ash of 5 bituminous coal samples from the Wilson coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. L means less than the concentration shown. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-7343	16.0	57	29	0.45	1.3	0.19	3.9	4.8	1.4	0.031L	0.90	W203387
R-8207	13.8	55	29	.45	.95	.46	3.8	6.0	1.3	1.5	.88	W212488
R-8637	6.5	50	29	1.1	.78	.61	2.0	11	1.5	.15L	.15L	W223354
R-8653	8.0	34	20	3.0	.70	.71	.85	31	1.6	.79	3.1	W226970
R-8654	10.4	32	21	2.3	.76	.28	1.2	36	.97	.66	3.3	W226971

Table 31d.- Major-, minor-, and trace-element composition of 5 bituminous coal samples from the Wilson coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means less than the value shown; H, interference for an element which cannot be resolved by any routine method; S, after element title indicates determinations by automatic plate reading computer assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-7343	4.3	2.4	0.051	0.13	0.022	0.52	0.53	0.13	0.026	3.2	W203387
R-8207	3.6	2.1	.044	.079	.047	.44	.58	.11	.036	9.9	W212488
R-8637	1.5	1.0	.051	.031	.029	.11	.51	.057	.044	4.7	W223354
R-8653	1.3	.86	.17	.034	.042	.057	1.7	.075	.054	.23	W226970
R-8654	1.6	1.1	.17	.048	.022	.10	2.6	.060	.081	.22	W226971

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-7343	16	110	1.2	1.7	0.058	22	50L	3.4	20	2.6	W203387
R-8207	23	130	2.6	9.0	.10	20	340	5.6	20	2.0	W212488
R-8637	10	64	3.0	6.4	.020	11	460	3.0	9.6	.72	W223354
R-8653	28	140	.79	1.1	.032	14	100L	1.7	10	.13	W226970
R-8654	37	100	.99	.9	.052	18	100L	3.5	12	.63	W226971

Sample Number	Cu (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	La (ppm)	Li (ppm)	Lab Number
R-7343	13	0.38	120	6.2	2.4L	0.24L	1.0	0.020	12	.26	W203387
R-8207	19	.45	120	6.5	2.1L	1.5	.60	.11	11	.21	W212488
R-8637	9.1	.27	50	4.9	2.1L	2.5	.43	.15	6.1	6.2	W223354
R-8653	14	.24	120	2.2	2.6	1.3	.53	.31	7.5	9.6	W226970
R-8654	18	.37	50	H	3.8	.99	.53	.30	11	14	W226971

Table 31d.--Major-, minor-, and trace-element composition of 5 bituminous coal samples from the Wilson coal bed, Southwest Virginia,
reported on a whole-coal basis.--continued

Sample Number	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Rb (ppm)	Sb (ppm)	Lab Number
R-7343	0.13	19	1.2	3.4	16	9.3	22L	6.6	39	0.40	W203387
R-8207	.12	11	.48	3.7	11	12	920	8.0	27	1.0L	W212488
R-8637	.08	5.3	.40	2.5	7.8	9.8	44L	5.1	7.0	.33	W223354
R-8653	.07	9.6	3.2	2.8	14	4.8	280	2.4	22L	.24	W226970
R-8654	.11	17	H	3.0	16	8.7	300	4.6	19L	.52	W26971

Sample Number	Sc (ppm)	Se (ppm)	Sm (ppm)	Sn-S (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	U (ppm)	V-S (ppm)	Lab Number
R-7343	4.2	3.3	1.8	1.2	74	0.26	0.25	3.0	1.1	29	W203387
R-8207	4.6	5.7	1.7	.22	150	.22	.28	3.0	1.1	34	W212488
R-8637	2.5	4.1	.95	.33	91	.16	.19	1.6	.66	16	W223354
R-8653	2.5	3.3	1.4	1.5	380	.18	.18	2.1	.83	13	W226970
R-8654	3.2	3.7	2.1	H	280	.17	.28	2.8	1.2	18	W226971

Sample Number	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)						Lab Number
R-7343	0.45	8.3	0.85	15	30						W203387
R-8207	.90	6.5	1.0	11	25						W212488
R-8637	.42	4.4	.65	5.9	11						W223354
R-8653	.55	5.7	.62	3.2	22						W226970
R-8654	.52	7.4	.75	8.9	24						W226971

Table 31e.--Arithmetic mean, observed range and geometric mean of proximate and ultimate analyses, heat content, forms of sulfur, and ash-fusion temperatures for 5 bituminous coal samples from the Wilson coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included.

[All values are in percent except Btu/lb, Kcal/kg, ash-fusion temperatures, and Kcal/kg = 0.556 Btu/lb; dashed values (---) represent less than five samples; (n) is number of samples per parameter.]

	Wilson coal bed				Appalachian basin		
	Arith. mean (n)	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
Proximate and ultimate analyses							
Moisture	(5)	2.87	1.70	4.69	2.64	3.23	2.69 (4,760)
Volatile matter	(5)	35.54	33.40	38.65	35.46	32.46	31.72 (4,760)
Fixed carbon	(5)	52.52	46.98	58.21	52.37	52.48	51.76 (4,760)
Ash	{5}	9.08	6.31	11.00	8.93	11.83	9.83 (4,760)
Hydrogen	(5)	5.28	5.14	5.41	5.28	5.02	5.00 (4,760)
Carbon	(5)	73.90	69.09	78.90	73.82	70.69	70.17 (4,760)
Nitrogen	(5)	1.37	1.35	1.40	1.37	1.39	1.37 (4,757)
Oxygen	(5)	8.19	6.80	10.78	8.07	8.92	8.22 (4,756)
Sulfur	(5)	2.16	.80	4.07	1.71	2.15	1.63 (4,974)
Heat content							
KCal/kg Btu/lb	{5}	7,372	6,997	7,798	7,366	7,030	6,979 (4,759)
	(5)	13,258	12,585	14,026	13,249	12,644	12,553 (4,759)
Forms of sulfur							
Sulfate	(5)	0.18	0.01	0.49	0.09	0.08	0.04 (4,245)
Pyritic	{5}	.86	.16	2.04	.50	1.36	.65 (4,392)
Organic	(5)	1.12	.64	1.84	1.02	.82	.70 (4,393)
Ash-fusion temperature (°C)							
Initial deformation	{3}	---	1,082	1,416	---	1,255	1,246 (4,063)
Softening	{3}	---	1,088	1,438	---	1,287	1,280 (3,722)
Fluid	(3)	---	1,143	1,477	---	1,334	1,328 (3,449)
Free-swelling index	(5)	6.30	3.50	8.00	5.90	5.53	4.68 (4,603)
Air-dried loss	(5)	1.50	0.47	3.22	1.17	1.83	1.13 (3,868)

Table 31f.--Arithmetic mean, observed range, and geometric mean of ash content and concentrations of 11 major- and minor-oxides in the laboratory ash of 5 bituminous coal samples from the Wilson coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. Dashed values (---) represent less than five samples; (n) indicates the number of samples per oxide.

[All samples were ashed at 525°C; all data are in percent.]

	Wilson coal bed				Appalachian basin		
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean
			Min.	Max.			(n)
(Ash)	(5)	11	6.5	16	10	13	10 (5,262)
SiO ₂	(5)	46	32	57	45	43	41 (5,229)
Al ₂ O ₃	(5)	26	20	29	25	24	23 (5,229)
CaO	(5)	1.5	.45	3.0	1.1	2.2	1.5 (5,227)
MgO	(5)	.90	.70	1.3	.88	.85	.75 (5,258)
Na ₂ O	(5)	.45	.19	.72	.40	.43	.34 (5,194)
K ₂ O	(5)	2.3	.85	3.9	2.0	2.0	1.7 (5,229)
Fe ₂ O ₃	(5)	18	4.8	36	13	19	13 (5,215)
MnO	(5)	.01	.010	.02	.01	.03	.02 (5,260)
TiO ₂	(5)	1.3	.97	1.6	1.3	1.2	1.1 (5,203)
P ₂ O ₅	(3)	---	.66	1.5	---	.50	.22 (3,389)
SO ₃	(5)	1.9	.88	3.2	1.6	2.5	1.9 (5,063)

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Table 31g.--Arithmetic mean, observed range, and geometric mean of concentrations of 54 trace elements in 5 bituminous coal samples from the Wilson coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. Dashed values (---) represent less than five samples; (n) indicates the number of samples per element. [All data are in parts-per-million and are reported on a whole-coal basis.]

	Wilson coal bed				Appalachian basin		
	(n)	Arith. mean	Observed range		Geom. mean	Arith. mean	Geom. mean
			Min.	Max.			(n)
Ag (5)		0.05	0.026	0.08	0.04	0.07	0.05 (4,565)
As (5)		12	3.2	23	9.4	35	13 (5,197)
B (5)		23	10	37	21	30	20 (5,076)
Ba (5)		110	64	140	100	90	63 (5,134)
Be (5)		1.7	.79	3.0	1.5	2.5	2.0 (5,247)
Bi ---		---	---	---	---	1.5	1.1 (108)
Br (5)		3.8	.87	9.0	2.5	22	13 (4,892)
Cd (5)		.05	.019	.10	.05	.10	.07 (4,978)
Ce (5)		17	11	22	16	21	17 (5,075)
Cl (2)		---	340	460	---	80	510 (3,646)
Co (5)		3.4	1.6	5.6	3.2	7.4	5.7 (5,217)
Cr (5)		14	9.6	20	14	18	15 (5,205)
Cs (5)		1.2	.13	.26	.79	1.3	.85 (4,831)
Cu (5)		15	9.1	19	14	19	15 (5,239)
Dy ---		---	---	---	---	3.3	2.6 (759)
Er ---		---	---	---	---	1.5	1.2 (1,200)
Eu (5)		.34	.24	.45	.33	.44	.37 (5,032)
F (5)		92	50	120	85	99	71 (4,860)
Ga (4)		---	2.2	6.5	---	6.6	5.4 (5,046)
Gd (2)		---	2.6	3.8	---	2.6	1.9 (1,773)
Ge (4)		---	.99	2.5	---	4.7	2.5 (4,608)
Hf (5)		.62	.43	1.0	.59	.79	.62 (4,932)
Hg (5)		.18	.020	.31	.13	.22	.15 (5,031)
Ho ---		---	---	---	---	.76	.61 (378)
La (5)		9.5	6.1	12	9.2	11	8.9 (5,147)
Li (5)		15	6.2	26	13	22	14 (5,243)
Lu (5)		.10	.072	.13	.10	.16	.14 (4,885)
Mn (5)		12	5.3	19	11	31	15 (5,260)
Mo (4)		---	.40	3.2	---	3.7	2.3 (4,889)
Nb (5)		3.1	2.5	3.7	3.0	2.6	1.9 (5,005)
Nd (5)		13	7.8	16	12	13	9.9 (4,231)
Ni (5)		9.0	4.8	12	8.6	17	14 (5,240)
Pb (5)		5.3	2.4	8.0	5.0	8.8	6.2 (5,172)
Pd ---		---	---	---	---	.17	.14 (18)
Pr ---		---	---	---	---	6.1	3.6 (960)
Rb (3)		---	7.0	39	---	28	22 (2,232)
Sb (4)		---	.24	.40	---	1.4	.91 (5,003)
Sc (5)		3.4	2.5	4.6	3.3	4.4	3.6 (5,218)
Se (5)		4.0	3.3	5.7	3.9	3.6	2.8 (5,052)
Sm (5)		1.6	.95	2.1	1.5	2.0	1.6 (5,005)
Sn (4)		---	.22	1.5	---	1.6	.86 (2,352)
Sr (5)		190	74	380	160	110	79 (5,146)
Ta (5)		.20	.16	.26	.20	.24	.19 (4,369)
Tb (5)		.24	.18	.28	.23	.34	.29 (4,852)
Th (5)		2.5	1.6	3.0	2.4	3.0	2.3 (5,098)
Tl ---		---	---	---	---	3.4	2.1 (382)
Tm ---		---	---	---	---	1.7	.38 (46)
U (5)		.99	.66	1.2	.96	1.8	1.3 (4,990)
V (5)		22	13	34	20	24	19 (5,241)
W (5)		.57	.42	.90	.55	.94	.80 (4,421)
Y (5)		6.4	4.4	8.3	6.3	8.5	7.2 (5,234)
Yb (5)		.77	.62	1.0	.76	1.1	.92 (5,151)
Zn (5)		8.7	3.2	15	7.7	22	14 (5,243)
Zr (5)		22	1	30	21	24	17 (5,238)

TAGGART MARKER AND TAGGART COAL BEDS

The Taggart coal bed occurs in Lee and Wise Counties and is separated from the underlying Taggart Marker coal bed by 20 to 75 feet of sandstone and siltstone. In both counties, the Taggart Marker may be called the "B" coal. In 1989, 2.2 million tons were produced from these coals (Virginia Division of Mines, 1990). The Taggart typically has a poorly- to moderately-developed medium cleat with sparse amounts of medium banding and moderate amounts of thin banding. There can be several partings, each less than 2 inches thick which are composed of shale or bone coal.

Two samples were analyzed from the Taggart Marker coal bed (Figure 39 and Table 32a) and 10 samples are analyzed from the Taggart coal bed (Figure 40 and Table 33a). In the Taggart Marker coal samples, Bi, Cl, Dy, Ho, Pd, Pr, Tl, and Tm are found to be below the detection limits. The geometric means for the Taggart Marker will not be discussed because there are only two samples. With the Taggart coal samples, in addition to Au, In, Ir, Os, Pt, Re, Rh, and Ru, which are below the detection limits for all 375 Virginia samples in this report, Bi, Ho, Pd, Pr, and Tm are below the detection limits. Tables 32b, 32c, and 32d display the analytical results for the Taggart Marker samples. The analytical results for the Taggart samples are presented in Tables 33b, 33c and 33d while statistical summaries are found in Tables 33e, 33f, and 33g.

In the Taggart coal samples, K₂O, Na₂O, Y, and the free-swelling index are found to have substantially higher geometric means than for the Appalachian basin samples. The geometric means of MnO, As, Br, Cl, Gd, Ge, Mn, Mo, Sn, Tl, Zn, sulfur, sulfate, pyritic sulfur, and air-dried loss are found to be substantially lower for the Taggart samples than for the Appalachian basin samples. For the Taggart coal bed, P₂O₅, Dy, Er, and Tl have less than five unqualified values and therefore means are not reported.

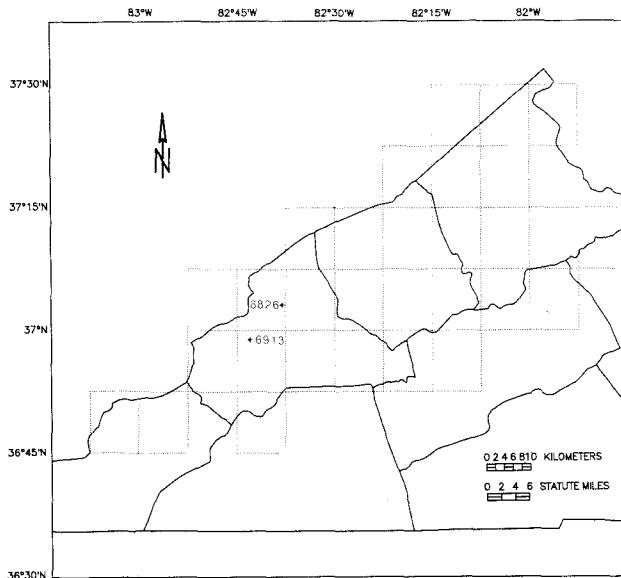


Figure 39. Location for samples from the Taggart Marker coal bed.

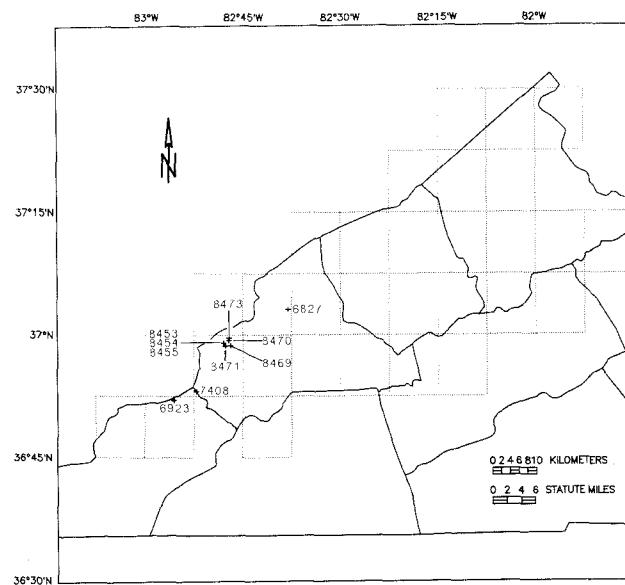


Figure 40. Location for samples from the Taggart coal bed.

Table 32a.--Descriptions and locations for 2 bituminous coal samples from the Taggart Marker coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-6826	W191333	90C-1	370308N	823800W	Flat Gap (7.5')	Wise	32.52	Surface mine, s.l. weathered	Full Thickness
R-6913	W194853	60B-7	365853N	824301W	Norton (7.5')	Wise	50.76	Surface mine, s.l. weathered	Full Thickness

Table 32b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 2 bituminous coal samples from the Taggart Marker coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. Analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. G for ash-fusion temperatures means greater than value shown. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	Moisture	PROXIMATE ANALYSIS			ULTIMATE ANALYSIS			HEAT CONTENT			Lab Number	
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	BTU/lb	
R-6826	4.3	35.8	57.0	2.9	5.7	79.7	1.1	9.7	0.9	7,940	14,290	W191333
	---	37.4	59.6	3.0	5.5	83.3	1.1	6.1	.9	8,300	14,350	
	---	38.6	61.4	---	5.6	85.9	1.2	6.3	1.0	8,550	15,400	
R-6913	2.1	34.5	52.9	10.5	5.2	75.0	1.4	7.2	.7	7,470	13,440	W194853
	---	35.2	54.0	10.7	5.1	76.6	1.4	5.4	.7	7,630	13,730	
	---	39.5	60.5	---	5.7	85.8	1.6	6.1	.8	8,540	15,370	

Table 32b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 2 bituminous coal samples from the Taggart Marker coal bed, Southwest Virginia. --continued

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid		
R-6826	0.0	0.02	0.22	0.62	9.0	1,370	1,420	1,480	---	1.26
	--	.02	.23	.65						W191333
	--	.02	.24	.67						
R-6913	.7	.01	.21	.53	8.0	1,540	1,5406	1,5406	---	1.04
	--	.01	.21	.54						W194853
	--	.01	.24	.61						

Table 32c.--Major- and minor-oxide concentrations in the laboratory ash of 2 bituminous coal samples from the Taggart Marker coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-6826	2.7	43	29	2.1	0.30	1.0	0.50	18	1.6	0.41	3.4	W191333
R-6913	17.4	53	30	.67	1.0	.47	4.3	4.5	1.2	.057	1.0	W194853

Table 32d. --Major-, minor-, and trace-element composition of 2 bituminous coal samples from the Taggart Marker coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means less than the value shown; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-6826	0.54	0.42	0.040	0.005	0.021	0.011	0.35	0.026	0.032	3.2	W191333
R-6913	4.3	2.8	.083	.11	.061	.62	.55	.13	.064	4.1	W194853

Sample Number	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Rb (ppm)	Sb (ppm)	Lab Number
R-6826	0.05	4.9	0.92	0.92	5.4	4.1	48	2.3	10L	0.15	W191333
R-6913	.20	28	.85	2.8	19	13	44	10	43	.70	W194853

Table 32d.--Major-, minor-, and trace-element composition of 2 bituminous coal samples from the Taggart Marker coal bed, Southwest Virginia, reported on a whole-coal basis. --continued

Sample Number	Sc (ppm)	Se (ppm)	Sr (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	U (ppm)	V-S (ppm)	Lab Number
R-6826	0.90	2.5	0.70	1.6	86	0.060	0.10	0.90	0.37	W191333
R-6913	5.3	2.7	2.7	2.4	90	.31	.37	5.5	1.7	W194853

Sample Number	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)					Lab Number
R-6826	0.55	3.2	0.30	2.7	12					W191333
R-6913	.67	10	1.3	19	23					W194853

Table 33a.-Descriptions and locations for 10 bituminous coal samples from the Taggart coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-6827	W200133	90C-2	370307N	823802W	Flat Gap (7.5')	Wise	33.12	Surface mine, sl. weathered	Full Thickness
R-6923	W195439	61C-1	365159N	825553W	Keokee (7.5')	Lee	38.40	Underground mine	Full Thickness
R-7408	W205192	61A-6	365307N	825205W	Appalachia (7.5')	Wise	55.08	Underground mine, sl. weathered	Full Thickness
R-8433	W214249	61A-16	365858N	824757W	Appalachia (7.5')	Wise	15.00	Underground mine	Upper Split
R-8454	W214250	61A-17	365858N	824757W	Appalachia (7.5')	Wise	22.20	Underground mine	Middle Split
R-8455	W214251	61A-18	365858N	824757W	Appalachia (7.5')	Wise	36.00	Underground mine	Lower Split
R-8459	W214252	61A-19	365841N	824655W	Appalachia (7.5')	Wise	68.40	Underground mine	Full Thickness
R-8470	W214253	61A-20	365937N	824706W	Appalachia (7.5')	Wise	42.00	Underground mine	Full Thickness
R-8471	W214254	61A-21	365839N	824741W	Appalachia (7.5')	Wise	41.88	Underground mine	Full Thickness
R-8473	W214256	61A-23	365919N	824708W	Appalachia (7.5')	Wise	28.80	Underground mine	Full Thickness

Table 33b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 10 bituminous coal samples from the Taggart coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. G for ash-fusion temperatures means greater than value shown. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT Lab Number
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	
R-6827	2.7	32.0	53.7	11.6	5.0	72.5	0.9	7.6	2.4	W200133
---	32.9	55.2	11.9	4.8	74.5	.9	5.3	2.5	7,240 7,440	13,390
---	37.3	62.7	--	5.5	84.6	1.1	6.1	2.8	8,450	15,200
R-6923	3.4	36.0	56.0	4.6	5.6	77.8	1.5	10.0	.6	W195439
---	37.3	58.0	4.8	5.4	80.5	1.6	7.2	.6	8,220 8,630	14,800 15,540
---	39.1	60.9	--	5.7	84.6	1.6	7.6	.7	8,400	15,120
R-7408	3.4	34.3	53.1	9.2	5.4	74.1	1.4	9.3	.7	W205192
---	35.5	55.0	9.5	5.2	76.7	1.4	6.5	.7	7,600 8,400	13,680 15,420
---	39.2	60.8	--	5.7	84.8	1.6	7.2	.8		
R-8453	1.1	34.0	53.3	11.5	4.8	74.6	1.4	6.8	.8	W214249
---	34.4	53.9	11.7	4.8	75.5	1.4	5.9	.8	7,390 7,470	13,290 13,440
---	38.9	61.1	--	5.4	85.5	1.6	6.6	1.0	8,450	15,220
R-8454	1.3	35.7	54.9	8.0	5.2	77.9	1.5	6.7	.7	W214250
---	36.2	55.7	8.1	5.1	79.0	1.5	5.6	.7	7,730 7,830	13,910 14,100
---	39.4	60.6	--	5.6	85.9	1.6	6.1	.8	8,520	15,340
R-8455	1.7	32.8	58.2	7.3	5.1	78.3	1.3	7.3	.7	W214251
---	33.4	59.2	7.4	5.0	79.7	1.4	5.9	.7	7,690 7,820	13,850 14,080
---	36.1	63.9	--	5.4	86.0	1.5	6.3	.7	8,450	15,200
R-8469	1.8	33.1	60.2	4.8	5.3	80.3	1.4	7.5	.7	W214252
---	33.7	61.3	4.9	5.2	81.8	1.5	6.0	.7	8,010 8,430	14,120 15,170
---	35.5	64.5	--	5.4	86.0	1.5	6.3	.7		
R-8470	1.5	34.7	60.3	3.6	5.4	81.7	1.5	7.4	.5	W214253
---	35.2	61.2	3.6	5.3	82.9	1.5	6.2	.5	8,030 8,450	14,450 14,860
---	36.5	63.5	--	5.5	86.0	1.6	6.4	.5		
R-8471	1.6	32.5	57.9	7.9	5.1	77.5	1.4	7.4	.8	W214254
---	33.1	58.9	8.1	5.0	78.8	1.4	6.0	.8	7,620 8,420	13,710 15,160
---	36.0	64.0	--	5.4	85.7	1.5	6.5	.9		

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Table 33b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 10 bituminous coal samples from the Taggart coal bed, Southwest Virginia.--continued

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)				Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid			
R-6827	0.0 --- ---	0.04 .04 .05	1.99 2.05 2.32	0.33 .34 .39	8.5	1,255	1,370	1,410	---	3.68	W200133
R-6923	1.2 --- ---	.00 .00 .00	.04 .04 .04	.54 .56 .59	5.5	1,395	1,455	1,515	---	.84	W195439
R-7408	1.8 --- ---	.01 .01 .01	.10 .10 .11	.57 .59 .65	5.5	1,505	1,540	1,540G	---	1.06	W205192
R-8453	.1 --- ---	.01 .01 .01	.09 .09 .10	.73 .74 .84	6.5	1,445	1,540	1,540G	---	1.20	W214249
R-8454	.2 --- ---	.01 .01 .01	.06 .06 .07	.64 .65 .71	7.5	1,540	1,540G	1,540G	---	1.01	W214250
R-8455	.4 --- ---	.02 .02 .02	.06 .06 .07	.60 .61 .66	8.0	1,415	1,540	1,540G	---	1.01	W214251
R-8469	.4 --- ---	.05 .05 .05	.07 .07 .07	.57 .58 .61	7.5	1,315	1,450	1,515	---	.99	W214252
R-8470	.3 --- ---	.03 .03 .03	.05 .05 .05	.43 .44 .45	8.5	1,260	1,395	1,495	---	.69	W214253
R-8471	.4 --- ---	.03 .03 .03	.15 .15 .17	.60 .61 .66	8.5	1,415	1,540	1,540G	---	1.17	W214254

Table 33b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 10 bituminous coal samples from the Taggart coal bed, Southwest Virginia.--continued

Sample Number	Moisture	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT		
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	Lab Number
R-8473	1.5	34.4	59.9	4.2	5.3	81.4	1.5	6.9	0.7	8,020	14,430	W214256
	---	34.9	60.8	4.3	5.3	82.6	1.5	5.6	.7	8,140	14,640	
	---	36.4	63.6	---	5.5	86.3	1.6	5.9	.7	8,500	15,300	

Sample Number	Air-dried Loss	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)				GRINDABILITY INDEX		
		Sulfate	Pyritic	Organic	Free-swelling index	Initial deformation	Softening	Fluid	Hardgrove grindability index	Compliance Number	Lab Number	
R-8473	0.3	0.01	0.15	0.54	7.5	1,310	1,445	1,515	---	0.97	W214256	
	---	.01	.15	.55								
	---	.01	.16	.57								

Table 33c.--Major- and minor-oxide concentrations in the laboratory ash of 10 bituminous coal samples from the Taggart coal bed, Southwest Virginia.											
[Concentrations in percent. Coal ashed at 525°C. L means less than the concentration shown. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]											

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-6827	11.0	48	27	0.53	0.63	0.22	2.6	15	1.2	0.17	0.84	W200133
R-6923	5.2	46	29	1.8	1.6	.36	3.2	9.2	1.1	.077	3.1	W195439
R-7408	11.9	51	30	.97	1.4	.39	4.4	5.3	1.1	.042L	1.5	W205192
R-8453	10.5	54	33	.87	.48	.26	1.4	3.1	1.7	.55	.70	W214249
R-8454	8.7	54	33	.87	.85	.22	1.7	4.4	1.7	.18	.93	W214250
R-8455	7.1	48	.34	.85	.98	.32	3.7	4.2	1.4	.14L	1.0	W214251
R-8469	4.7	49	28	1.9	1.6	.36	3.3	7.5	1.2	.21L	2.1	W214252
R-8470	3.2	44	30	1.5	1.3	2.2	3.0	11	1.3	.31L	2.6	W214253
R-8471	7.5	49	33	.76	1.0	.28	4.5	6.2	1.7	.13L	1.1	W214254
R-8473	3.1	44	29	1.5	.86	.53	2.5	14	1.3	.32L	1.8	W214256

Table 33d.-Major-, minor-, and trace-element composition of 10 bituminous coal samples from the Taggart coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means less than the value shown; B, not determined; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDNR identification number. Lab number is laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-6827	2.4	1.6	0.042	0.042	0.018	0.24	1.2	0.057	0.037	.85	W200133
R-6923	1.1	.78	.067	.049	.014	.14	.33	.034	.009	2.0	W195439
R-7408	2.8	1.9	.082	.10	.034	.44	.44	.078	.037	1.7	W205192
R-8453	2.7	1.8	.065	.030	.020	.12	.23	.10	.028	3.3	W214249
R-8454	2.2	1.5	.054	.044	.014	.12	.27	.086	.040	1.7	W214250
R-8455	1.6	1.3	.043	.042	.017	.22	.21	.058	.041	1.9	W214251
R-8469	1.1	.70	.063	.046	.013	.13	.25	.034	.026	8.0	W214252
R-8470	.66	.51	.035	.025	.051	.079	.25	.024	.027	3.6	W214253
R-8471	1.7	1.3	.041	.046	.016	.28	.33	.076	.040	1.3	W214254
R-8473	.64	.47	.053	.016	.012	.064	.31	.024	.022	.23	W214256

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-6827	9.8	64	4.4	8.1	0.088	21	360	5.9	16	2.1	W200133
R-6923	8.3	45	1.1	.8	.057	9.0	B	7.3	8.7	.80	W195439
R-7408	19	140	.83	.5	.070	21	50	5.7	15	1.9	W205192
R-8453	10	97	4.5	.9	.061	24	170	3.1	18	.70	W214249
R-8454	13	70	1.5	.8	.087	25	190	4.3	12	1.1	W214250
R-8455	13	78	1.8	.7	.061	15	190	6.8	12	.90	W214251
R-8469	11	47	1.6	.7	.043	10	200	4.2	6.7	.60	W214252
R-8470	9.6	58	1.1	.7	.029	7.0	190	3.9	4.4	.30	W214253
R-8471	9.8	90	2.0	.4	.047	15	180	4.5	13	1.0	W214254
R-8473	6.5	40	2.4	.9	.043	8.0	230	5.0	4.5	.90L	W214256

Table 33d.--Major-, minor-, and trace-element composition of 10 bituminous coal samples from the Taggart coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Cu (ppm)	Dy-S (ppm)	Er-S (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	Lab Number
R-6827	18	2.8	1.1L	0.42	.32	5.3	2.1	1.3	0.80	0.096	W200133
R-6923	14	1.1L	.52L	.19	.76	1.3	.52	.73	.20	.16	W195439
R-7408	25	2.6L	1.2L	.38	.80	6.3	1.8L	.21	.60	.040	W205192
R-8453	17	2.3L	1.3	.48	100	4.5	1.6L	.22	.80	.15	W214249
R-8454	16	1.9L	.87L	.40	.60	6.5	1.3L	.65	1.1	.067	W214250
R-8455	23	1.6L	.78	.33	.70	4.5	1.1L	.42	.40	.15	W214251
R-8469	13	1.0L	.47L	.27	.70	2.3	.71	.52	.20	.067	W214252
R-8470	9.9	.70L	.48	.16	.50	1.8	.48L	1.3	.20	.052	W214253
R-8471	21	1.7L	1.1	.32	.70	4.2	1.1L	.52	.50	.078	W214254
R-8473	11	.68L	.31L	.80L	.50	2.1	.47L	2.9	.20	.12	W214256

Sample Number	La (ppm)	Li (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Lab Number
R-6827	11	19	0.19	8.8	1.2	4.0	13	12	83	5.2	W200133
R-6923	5.0	6.8	.09	17	.32	.32	5.7	5.7	17	3.3	W195439
R-7408	11	15	.14	20	1.9	1.8	11	12	22L	11	W205192
R-8453	14	29	.13	4.3	.97	3.6	13	9.8	250	7.5	W214249
R-8454	14	21	.16	8.7	1.5	2.3	9.6	10	70	11	W214250
R-8455	8.0	16	.12	4.9	2.3	1.5	9.2	14	44L	9.2	W214251
R-8469	5.0	5.2	.10	7.5	1.3	1.0	5.2	8.5	44L	4.4	W214252
R-8470	4.0	3.1	.04	7.4	.83	.48	3.1	5.4	44L	2.7	W214253
R-8471	8.0	11	.12	3.5	.83	1.1	9.0	7.5	44L	7.4	W214254
R-8473	4.0	3.4	.08	2.5	.74	.37	3.1	7.4	44L	3.4	W214256

Table 33d. --Major-, minor-, and trace-element composition of 10 bituminous coal samples from the Taggart coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Rb (ppm)	Sb (ppm)	Sc (ppm)	Se (ppm)	Sm (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	Lab Number
R-6827	.28	1.2	3.9	4.9	2.0	0.17	.130	0.23	0.37	2.7
R-6923	.11	.50	1.7	4.2	1.0	.08L	.110	.56L	.20	1.2
R-7408	.34	.60	4.0	4.8	1.9	.49	.150	.18	.25	3.4
R-8453	.30L	1.0	5.0	2.9	1.9	.83	.180	.30	.27	3.2
R-8454	.30L	.60	3.1	3.7	1.9	.96	.100	.41	.30	5.8
R-8455	.12	.80	2.9	5.1	1.4	.35	.78	.17	.23	2.9
R-8469	.20L	.50	1.9	2.4	1.0	.12	.75	.090	.15	1.5
R-8470	.30L	.40	1.1	3.4	.70	.17	.77	.070	.11	1.0
R-8471	.10	.80	3.0	5.7	1.3	.47	.90	.21	.24	2.8
R-8473	.20L	1.1	1.8	3.4	.70	.05L	.59	B	.15	1.0

Sample Number	Tl-S (ppm)	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)	Lab Number
R-6827	2.3	B	28	0.90	14	1.1	7.8	40	W200133
R-6923	.27	1.2	3.9	B	1.9	.50	12	2.7	W195439
R-7408	.55L	2.2	25	B	6.1	.80	11	13	W205192
R-8453	.48L	1.8	26	.80	6.7	1.0	4.3	24	W214249
R-8454	.40L	2.5	17	.70	5.7	1.2	4.4	17	W214250
R-8455	.33L	2.0	23	.50	4.9	.80	4.2	12	W214251
R-8469	.22L	.70	12	.50	5.6	.70	2.4	8.9	W214252
R-8470	.15L	.62	6.4	.20	1.9	.40	2.0	5.1	W214253
R-8471	1.2	1.5	19	.50	4.6	.80	2.5	9.0	W214254
R-8473	1.4	.54	7.8	.50	2.5	.60	1.7	2.4	W214256

Table 33e.--Arithmetic mean, observed range and geometric mean of proximate and ultimate analyses, heat content, forms of sulfur, and ash-fusion temperatures for 10 bituminous coal samples from the Taggart coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included.

[All values are in percent except Btu/lb, Kcal/kg, ash-fusion temperatures, and free-swelling index and are reported on an as-received basis. $^{\circ}\text{F} = \frac{9}{5}^{\circ}\text{C} + 32$; Kcal/kg = 0.556 Btu/lb; (n) is number of samples per parameter.]

	Taggart coal bed				Appalachian basin		
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean
			Min.	Max.			(n)
Proximate and ultimate analyses							
Moisture	(10)	2.00	1.10	3.40	1.86	3.23	2.69
Volatile matter	(10)	33.96	32.00	36.00	33.94	32.46	31.72
Fixed carbon	(10)	56.76	53.10	60.26	56.69	52.48	51.76
Ash	(10)	7.27	3.57	11.60	6.73	11.83	9.83
Hydrogen	(10)	5.22	4.82	5.60	5.22	5.02	5.00
Carbon	(10)	77.61	72.50	81.66	77.55	70.69	70.17
Nitrogen	(10)	1.38	.90	1.50	1.37	1.39	1.37
Oxygen	(10)	7.67	6.72	10.00	7.61	8.92	8.22
Sulfur	(10)	.86	.51	2.40	.77	2.15	1.63
Heat content							
KCal/kg	(10)	7,691	7,245	8,033	7,686	7,030	6,979
Btu/lb	(10)	13,833	13,030	14,447	13,824	12,644	12,553
Forms of sulfur							
Sulfate	(9)	0.02	0.01	0.05	0.02	0.08	0.04
Pyritic	(10)	.28	.04	1.99	.11	1.36	.65
Organic	(10)	.55	.33	.73	.54	.82	.70
Ash-fusion temperature ($^{\circ}\text{C}$)							
Initial deformation	(9)	1,368	1,254	1,504	1,366	1,255	1,246
Softening	(5)	1,422	1,368	1,457	1,422	1,287	1,280
Fluid	(5)	1,489	1,410	1,516	1,489	1,334	1,328
Free-swelling index	(10)	7.35	5.50	8.50	7.26	5.53	4.68
Air-dried loss	(9)	.56	.14	1.80	.40	1.83	1.13

Table 33f.--Arithmetic mean, observed range, and geometric mean of ash content and concentrations of 11 major- and minor-oxides in the laboratory ash of 10 bituminous coal samples from the Taggart coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. Dashed values (---) represent less than five samples; (n) indicates the number of samples per oxide.

[All samples were ashed at 525°C; all data are in percent.]

Table 33g.--Arithmetic mean, observed range, and geometric mean of concentrations of 54 trace elements in 10 bituminous coal samples from the Taggart coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. Dashed values (---) represent less than five samples; (n) indicates the number of samples per element. [All data are in parts-per-million and are reported on a whole-coal basis.]

	Taggart coal bed				Appalachian basin			
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
			Min.	Max.				
Ag (10)		0.03	0.009	0.04	0.03	0.07	0.05	(4,565)
As (10)		14	1.7	85	5.5	35	13	(5,197)
B (10)		11	6.5	19	11	30	20	(5,076)
Ba (10)		73	40	140	68	90	63	(5,134)
Be (10)		2.1	.83	4.5	1.8	2.5	2.0	(5,247)
Bi ---		---	---	---	---	1.5	1.1	(108)
Br (10)		1.5	.42	8.1	.89	22	13	(4,892)
Cd (10)		.06	.029	.09	.06	.10	.07	(4,978)
Ce (10)		15	7.0	25	14	21	17	(5,075)
Cl (9)		200	50	360	180	780	510	(3,646)
Co (10)		5.1	3.1	7.3	4.9	7.4	5.7	(5,217)
Cr (10)		11	4.4	18	9.9	18	15	(5,205)
Cs (9)		1.0	.30	2.1	.90	1.3	.85	(4,831)
Cu (10)		17	9.9	25	16	19	15	(5,239)
Dy (1)		---	2.8	2.8	---	3.3	2.6	(759)
Er (4)		.91	.48	1.3	.85	1.5	1.2	(1,200)
Eu (9)		.33	.16	.48	.31	.44	.37	(5,032)
F (10)		66	32	100	63	99	71	(4,860)
Ga (10)		3.9	1.3	6.5	3.4	6.6	5.4	(5,046)
Gd (3)		---	.52	2.1	---	2.6	1.9	(1,773)
Ge (10)		.88	.21	2.9	.65	4.7	2.5	(4,608)
Hf (10)		.50	.20	1.1	.41	.79	.62	(4,932)
Hg (10)		.10	.040	.16	.09	.22	.15	(5,031)
Ho ---		---	---	---	---	.76	.61	(378)
La (10)		8.4	4.0	14	7.5	11	8.9	(5,147)
Li (10)		13	3.1	29	10	22	14	(5,243)
Lu (10)		.12	.040	.19	.11	.16	.14	(4,885)
Mn (10)		8.4	2.5	20	6.9	31	15	(5,260)
Mo (10)		1.2	.32	2.3	1.0	3.7	2.3	(4,889)
Nb (10)		1.6	.32	4.0	1.2	2.6	1.9	(5,005)
Nd (10)		7.9	3.1	13	6.9	13	9.9	(4,231)
Ni (10)		9.3	5.4	14	8.9	17	14	(5,240)
Pb (10)		6.5	2.7	11	5.8	8.8	6.2	(5,172)
Pd ---		---	---	---	---	.17	.14	(18)
Pr ---		---	---	---	---	6.1	3.6	(960)
Rb (5)		19	10	34	17	28	22	(2,232)
Sb (10)		.75	.40	1.2	.70	1.4	.91	(5,003)
Sc (10)		2.8	1.1	5.0	2.6	4.4	3.6	(5,218)
Se (10)		4.0	2.4	5.7	3.9	3.6	2.8	(5,052)
Sm (10)		1.4	.70	2.0	1.3	2.0	1.6	(5,005)
Sn (7)		.48	.12	.96	.39	1.6	.86	(2,352)
Sr (10)		110	59	180	100	110	79	(5,146)
Ta (8)		.21	.07	.41	.18	.24	.19	(4,369)
Tb (10)		.23	.11	.37	.21	.34	.29	(4,852)
Th (10)		2.6	1.0	5.8	2.2	3.0	2.3	(5,098)
Tl (4)		---	.27	2.3	---	3.4	2.1	(382)
Tm ---		---	---	---	---	1.7	.38	(46)
U (9)		1.5	.54	2.5	1.3	1.8	1.3	(4,990)
V (10)		17	3.9	28	14	24	19	(5,241)
W (8)		.57	.20	.90	.53	.94	.80	(4,421)
Y (10)		5.4	1.9	14	12	8.5	7.2	(5,234)
Yb (10)		.79	.40	1.2	.75	1.1	.92	(5,151)
Zn (10)		5.2	1.7	12	4.2	22	14	(5,243)
Zr (10)		13	2.4	40	9.7	24	17	(5,238)

34-INCH COAL BED

This coal, also known locally as the Cedar Grove or Low Splint E coal bed, is found in Lee and Wise Counties. At the one sample site (Figure 41), the coal is 2.0 feet thick and has a well-developed medium cleat with one 3-inch parting.

Bi, Dy, Er, P, Pd, Pr, Rb, Ta, Tl, and Tm (in addition to the 8 elements found to be below the detection limits for all 375 Virginia samples) are below the detection limits for this sample of the 34-inch coal bed. There is only one sample of the 34-inch coal bed, therefore the geometric means are not comparable. Table 34a contains the location and descriptive information for this sample, and Tables 34b, 34c, and 34d contain the analytical results.

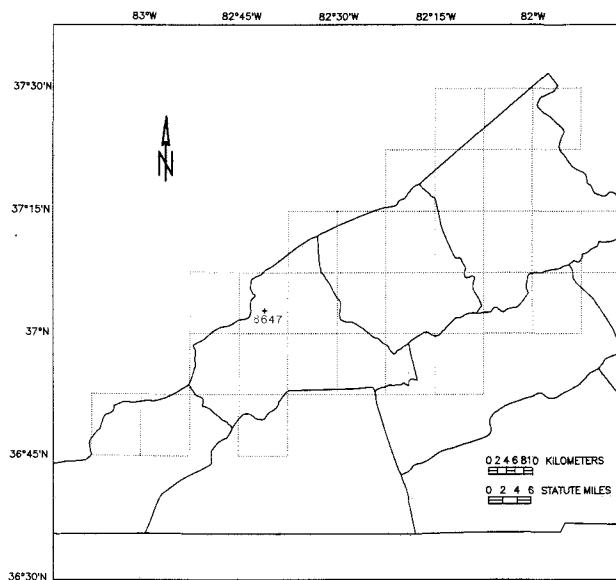


Figure 41. Location for sample from the 34-inch coal bed.

Table 34a.-Description and location for 1 bituminous coal sample from the 34-inch coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-8647	W226972	90C-19	370247N	824105W	Flat Gap (7.5')	Wise	20.40	Surface mine	Full Thickness

Table 34b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance number for 1 bituminous coal sample from the 34-inch coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, ash-fusion temperatures, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT			Lab Number
	Moisture	Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal./KG	Btu/lb	
R-8647	5.6	33.0	57.2	4.1	5.5	75.9	1.2	11.4	1.8	7,530	13,550	W226972
---	35.0	60.6	4.4	5.2	80.5	1.3	6.8	1.9	7,980	14,360		
---	36.6	63.4	---	5.4	84.1	1.4	7.1	2.0	8,340	15,020		

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)				Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free- swelling index	Initial Deformation	Softening	Fluid			
R-8647	4.3	0.30	0.49	1.01	8.0	1,105	1,140	1,380	60	2.66	W226972
---	---	.32	.52	1.07							
---	---	.33	.54	1.12							

Table 34c.--Major- and minor-oxide concentrations in the laboratory ash of 1 bituminous coal sample from the 34-inch coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO_2	Al_2O_3	CaO	MgO	Na_2O	K_2O	Fe_2O_3	TiO_2	SO_3	Lab Number
R-8647	4.1	34	23	1.6	0.61	0.41	2.1	34	1.3	1.3	W226972

Table 34d.--Major-, minor-, and trace-element composition of 1 bituminous coal sample from the 34-inch coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analysis. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-8647	0.66	0.49	0.046	0.015	0.012	0.071	0.99	0.032	0.030	32	W226972
Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	La (ppm)
R-8647	4.9	53	2.2	2.9	0.018	5.3	180	2.6	5.2	0.50	W226972

Sample Number	Cu (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	Ho-S (ppm)	La (ppm)	Lab Number
R-8647	9.8	0.16	40	2.1	1.6	2.3	0.27	0.30	0.62	2.9	W226972

Table 34d.—Major-, minor-, and trace-element composition of 1 bituminous coal sample from the 34-inch coal bed, Southwest Virginia, reported on a whole-coal basis.—continued

LOW SPLINT COAL BED

In Lee and Wise Counties the Low Splint coal bed is also known as the Buck Knob, No. 6, or Creveling coal bed. In 1989, 0.6 million tons were produced, mainly from Lee County (Virginia Division of Mines, 1990). The Low Splint typically has a moderately- to poorly-developed medium cleat. Near the town of Appalachia in Wise County, the coal is mined in two benches, separated by an 8-inch parting. Elsewhere, up to five splits make up the Low Splint coal zone. Two sample locations contain splint coal (R-7347 and R-7409).

Fifteen elements are below the detection limits for the 3 samples from the Low Splint coal bed: Au, Bi, Dy, Gd, Ho, In, Ir, Os, Pd, Pr, Pt, Re, Rh, Ru, and Tm. The geometric means for these samples will not be discussed. Figure 42 and Table 35a contains the location and descriptive information for these 3 samples. The analytical results are presented in Tables 35b, 35c, and 35d.

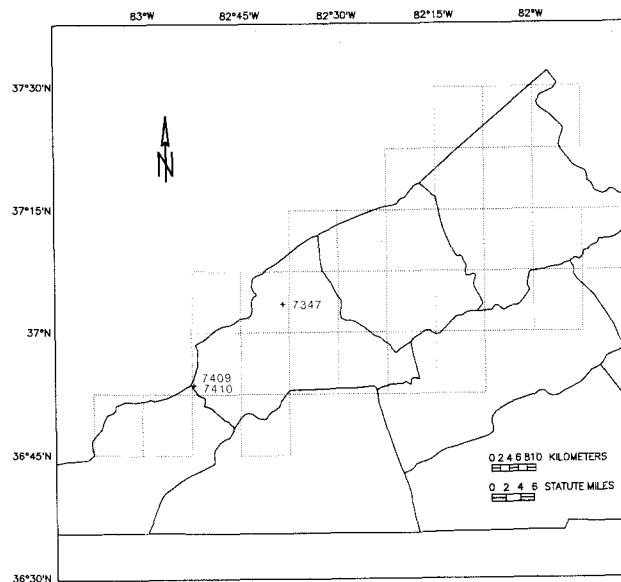


Figure 42. Locations for samples from the Low Splint coal bed.

Table 35a.--Descriptions and locations for 3 bituminous coal samples from the Low Splint coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-7347	W203389	90C-11	370328N	823831W	Flat Gap (7.5')	Wise	24.84	Surface mine	Full Thickness
R-7409	W205193	61A-7	365333N	825213W	Appalachia (7.5')	Wise	38.88	Underground mine, sl.	Lower Split
R-7410	W205194	61A-8	365333N	825213W	Appalachia (7.5')	Wise	24.24	Underground mine, sl.	Upper Split

Table 35b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 3 bituminous coal samples from the Low Splint coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa. and a commercial testing laboratory following ASTM standards. G for ash-fusion temperatures means greater than value shown. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT		Lab Number	
	Moisture	Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	
R-7347	3.1	32.6	53.6	10.7	5.3	73.5	0.4	8.2	2.0	7,330	13,200	W203389
---	33.6	55.3	11.0	5.1	75.9	.4	5.6	2.1	7,570	13,620		
---	37.8	62.2	--	5.7	85.3	.5	6.3	2.3	8,510	15,310		
R-7409	2.3	37.9	55.3	4.5	5.1	79.2	1.6	9.1	.6	7,880	14,190	W205193
---	38.8	56.6	4.6	5.0	81.1	1.6	7.2	.6	8,070	14,530		
---	40.7	59.3	--	5.2	85.0	1.7	7.6	.6	8,460	15,230		
R-7410	2.3	36.3	51.4	10.0	5.0	73.6	1.5	9.1	.8	7,320	13,180	W205194
---	37.2	52.6	10.2	4.9	75.3	1.5	7.2	.8	7,500	13,490		
---	41.4	58.6	--	5.4	83.9	1.7	8.0	.9	8,350	15,030		

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Table 35b. --Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 3 bituminous coal samples from the Low splint coal bed, Southwest Virginia.--continued

Sample Number	FORMS OF SULFUR					ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid			
R-7347	1.9	0.01	1.09	0.90	8.5	1,350	1,400	1,450	---	3.03	W203389
	---	.01	1.12	.93	1.04						
R-7409	.6	.05	.06	.50	6.0	1,490	1,540	1,540	---	.85	W205193
	---	.05	.06	.51	.54						
R-7410	.7	.02	.08	.66	4.5	1,510	1,540	1,540	---	1.21	W205194
	---	.02	.08	.68	.75						
R-7410	10.1	55	26	.09					---	.32	W205194

Table 35c. --Major- and minor-oxide concentrations in the laboratory ash of 3 bituminous coal samples from the Low splint coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. L means less than the concentration shown. Sample number is the VDMR identification number. Lab number is the USGS Laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-7347	11.7	50	27	0.50	0.78	0.23	2.8	15	1.5	0.051	0.90	W203389
R-7409	4.5	52	27	2.3	.90	.66	.82	5.8	2.6	.11L	3.0	W205193
R-7410	10.1	55	26	2.8	.91	.27	2.2	3.8	1.7	.32	2.3	W205194

Table 35d.--Major-, minor-, and trace-element composition of 3 bituminous coal samples from the Low Splint coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means less than the value shown; B, not determined; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-7347	2.7	1.7	0.042	0.055	0.020	0.27	1.2	0.10	0.023	31	W203389
R-7409	1.1	.64	.073	.024	.022	.031	.18	.071	.018	.90	W205193
R-7410	2.6	1.4	.20	.056	.020	.19	.27	.10	.043	.90	W205194

Sample Number	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Rb (ppm)	Sb (ppm)	Lab Number
R-7347	0.13	12	0.43	2.7	9.6	6.9	26	5.7	23	0.45	W203389
R-7409	.13	3.2	.90	3.2	8.1	9.0	22L	4.2	20L	.20	W205193
R-7410	.18	19	1.0	3.9	12	11	140	8.1	17	.50	W205194

Table 35d.--Major-, minor-, and trace-element composition of 3 bituminous coal samples from the Low Splint coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Sc (ppm)	Se (ppm)	Sr (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	Tl-S (ppm)	U (ppm)	Lab Number
R-7347	3.5	7.4	1.4	0.18L	67	0.21	0.19	2.4	0.37L	0.95
R-7409	1.8	1.8	1.3	.26	140	.17	.15	2.3	.21L	.98
R-7410	4.0	1.0	2.1	.58	150	.22	.27	3.6	.54	1.2

Sample Number	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)	Lab Number
R-7347	19	0.70	7.0	0.70	5.4	26	W203389
R-7409	8.1	B	6.3	.70	3.4	25	W205193
R-7410	25	B	11	1.0	20	35	W205194

HOUSE COAL BED

This coal is mined in Wise County but production estimates are not available. The coal is aptly named because it breaks into large blocks that transport well and is quite suitable for home heat. In the Flat Gap area, the coal has a very well-developed large cleat and moderate- to sparse-thin banding. Thickness at sample sites varies from 1.6 to 2.2 feet. Pyrite is commonly found as a film on cleat surfaces.

Two samples were collected from the House coal bed (Figure 43) and therefore the geometric means will not be discussed. Table 36a shows the descriptive and location data. The analytical data is presented in Tables 36b, 36c, and 36d. Statistical summaries are not shown due to only two samples in the data set. In addition to the 8 elements found to be below their detection limits for the Southwest Virginia coal samples, Bi, P, Pd, Rb, Tl, and Tm were found to be below their detection limits for these samples.

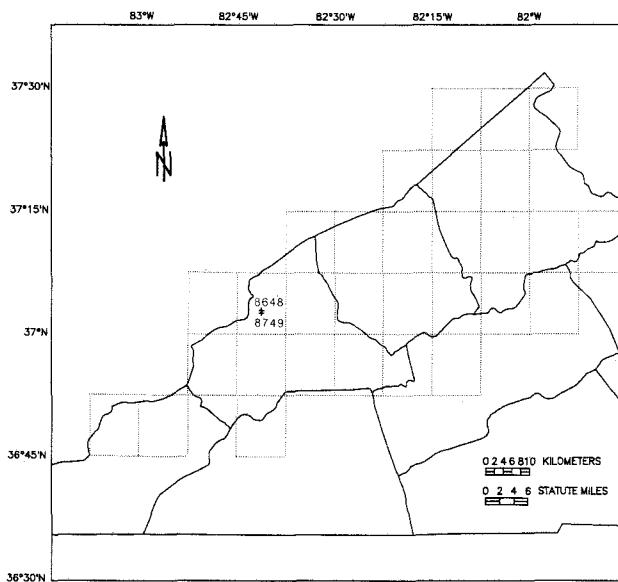


Figure 43. Locations for samples from the House coal bed.

Table 36a.--Descriptions and locations for 2 bituminous coal samples from the House coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-8648	W226973	90C-20	370254N	824114W	Flat Gap (7.5')	Wise	23.40	Surface mine	Lower Split
R-8749	W236243	90C-27	370234N	824114W	Flat Gap (7.5')	Wise	30.00	Surface mine	Lower Split

Table 36b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 2 bituminous coal samples from the House coal bed, Southwest Virginia.

All analyses except heat contents, free-swelling indexes, Hardgrove grindability indexes, and compliance numbers in percent for each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT		Lab Number	
	Moisture	Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	
R-8648	1.1	37.3	58.3	3.3	5.4	82.5	1.5	6.6	0.8	8,190	14,740	W226973
---	37.7	58.9	3.4	5.3	83.4	1.5	5.6	.8	.8	8,280	14,910	
---	39.0	61.0	---	5.5	86.3	1.5	5.8	.8	.8	8,570	15,430	
R-8749	1.4	37.8	58.3	2.5	5.5	83.4	1.5	6.3	.8	8,290	14,920	W236243
---	38.4	59.1	2.5	5.4	84.6	1.5	5.2	.8	.8	8,400	15,120	
---	39.4	60.6	---	5.6	86.8	1.5	5.3	.9	.9	8,620	15,510	

Table 36b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 2 bituminous coal samples from the House coal bed, Southwest Virginia.--continued

Sample Number	FORMS OF SULFUR					ASH-FUSION TEMPERATURE (°C)			Hardgrove grindability index	Compliance Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial deformation	Softening	Fluid			
R-8648	0.4	0.03	0.09	0.64	4.5	1,450	1,505	1,540	43	1.09	W226973
	---	.03	.09	.65							
	---	.03	.09	.67							
R-8749	.3	.02	.02	.79	5.0	1,330	1,390	1,475	47	1.07	W236243
	---	.02	.02	.80							
	---	.02	.02	.82							

Table 36c.--Major- and minor-oxide concentrations in the laboratory ash of 2 bituminous coal samples from the House coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	SO ₃	Lab Number
R-8648	3.3	52	30	1.6	0.45	1.3	1.0	7.9	2.1	1.9	W226973
R-8749	2.3	49	29	2.9	.81	.93	.59	7.2	1.8	3.9	W236243

Table 36d. --Major-, minor-, and trace-element composition of 2 bituminous coal samples from the House coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. L means less than the value shown; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-8648	0.80	0.52	0.037	0.009	0.032	0.027	0.18	0.041	0.046	3.8	W226973
R-8749	.52	.36	.048	.011	.016	.011	.12	.024	.020	.75	W236243

Sample Number	Cu (ppm)	Dy-S (ppm)	Er-S (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	Lab Number
R-8648	4.0	25	3.2	1.9	0.019	9.3	140	6.2	5.7	0.11	W226973
R-8749	3.7	21	1.8	1.5	.005	8.2	310	7.7	3.6	.04	W236243

Sample Number	Ho-S (ppm)	La (ppm)	Li (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	Pb (ppm)	Lab Number
R-8648	15	1.4	0.73	0.23	70	2.3	1.7	1.6	0.34	0.25	W226973
R-8749	11	.51L	.11L	.15	20L	1.5	.74L	.55	.23	.005L	W236243

Table 36d.--Major-, minor-, and trace-element composition of 2 bituminous coal samples from the House coal bed, Southwest Virginia,
reported on a whole-coal basis.--continued

Sample Number	Pr-S (ppm)	Sb (ppm)	Sc (ppm)	Se (ppm)	Sm (ppm)	Sn-S (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	Lab Number
R-8648	5.0	0.75	1.5	3.8	1.2	0.40	46	0.12	0.15	1.3	W226973
R-8749	2.3L	.46	1.0	2.3	.76	.37	60	.079	.10	.79	W236243

Sample Number	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)				Lab Number
R-8648	0.40	6.9	0.55	5.3	0.51	3.3	13				W226973
R-8749	.28L	3.5	.48	2.8	.28	1.6	8.7				W236243

PHILLIPS COAL BED

Occurring in Wise and Dickenson Counties, the Phillips coal bed has also been called the No. 7, Fire Clay, or the Lower Phillips coal bed. As many as four splits occur with maximum thickness less than 24-inches. Any one of the splits may be typified as displaying poorly developed cleats with thin- to medium-banding. Production from the Phillips in 1989 was about 428 thousand tons (Virginia Division of Mines, 1990).

There was only one coal sample for the Phillips coal bed (Figure 44), thus the geometric means will not be discussed. Table 37a displays the descriptive and location data and Tables 37b, 37c, and 37d display the analytical results. The following elements, in addition to the eight elements found to be below their detection limits for the other Southwest Virginia samples, were found to be below their detection limits: Bi, Er, Ho, Pd, Pr, Rb, Sn, Tl, and Tm.

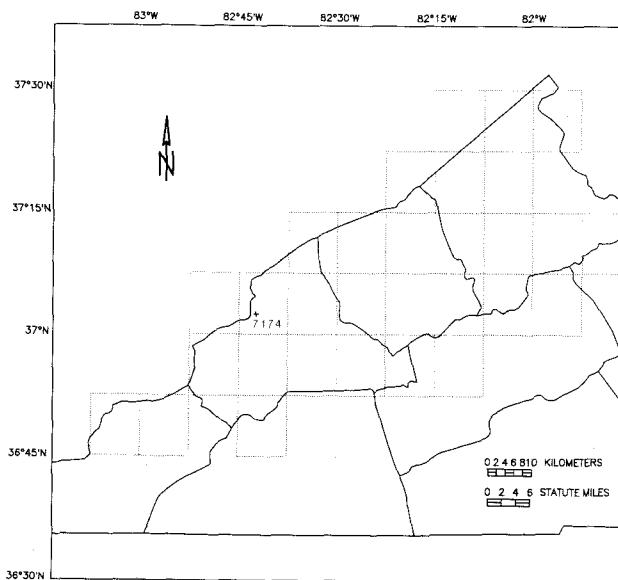


Figure 44. Location for sample from the Phillips coal bed.

Table 37a.--Description and location for 1 bituminous coal sample from the Phillips coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-7174	W200485	90C-8	370225N	824224W	Flat Gap (7.5')	Wise	18.96	Surface mine, weathered	Full Thickness

Table 37b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 1 bituminous coal sample from the Phillips coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, ash-fusion temperatures, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT			Lab Number
	Moisture	Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb	
R-7174	5.5	33.7	54.6	6.2	5.5	75.0	1.4	10.6	1.2	7,350	13,240	W200485
---	35.7	57.8	6.6	5.2	79.4	1.5	6.0	1.3	7,780	14,010		
---	38.2	61.8	---	5.5	84.9	1.6	6.5	1.4	8,350	14,990		

Sample Number	FORMS OF SULFUR					ASH-FUSION TEMPERATURE (°C)					Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free- swelling index	Initial deformation	Softening	Fluid	Hardgrove grindability index	Number	
R-7174	3.2	0.06	0.44	0.65	4.5	1,165	1,325	1,415	---	1.81	W200485
---	.06	.47	.69	.50	.74						
---	.07										

Table 37c.--Major- and minor-oxide concentrations in the laboratory ash of 1 bituminous coal sample from the Phillips coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-7174	5.6	52	21	2.6	0.78	0.41	1.2	10	1.7	0.59	4.6	W200485

Table 37d.--Major-, minor-, and trace-element composition of 1 bituminous coal sample from the Phillips coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analysis. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-7174	1.4	0.62	0.10	0.026	0.017	0.055	0.40	0.057	0.008	10	W200485

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	La (ppm)	Lab Number
R-7174	7.3	73	2.5	1.7	0.055	16	.130	4.5	9.8	0.25	W200485	

Sample Number	Cu (ppm)	Dy-S (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	La (ppm)	Lab Number
R-7174	13	1.7	0.31	23	2.4	0.90	0.17	0.65	0.018	9.0	W200485

Table 37d.--Major-, minor-, and trace-element composition of 1 bituminous coal sample from the Phillips coal bed, Southwest Virginia, reported on a whole-coal basis. --continued

PARDEE COAL BED

The Pardee coal bed, also known as the No. 10, Parsons, or Top Parsons coal bed, is found in Lee and Wise Counties. Most of the 0.8 million tons mined in 1989 was from Wise County (Virginia Division of Mines, 1990). Where sampled, the coal is 1.3 to 5.2 feet thick and is characterized by moderate- to well-developed medium cleat with medium and thin banding. Several partings are found in the coal, commonly shale and bone coal. Pyrite is commonly associated with the parting material but is also found disseminated within the coal.

Table 38a present the location and descriptive data for the six samples from the Pardee coal bed (Figure 45). The analytical results are found in Tables 38b, 38c, and 38d. The following elements, in addition to those below the detection limits for all 375 Virginia samples, are below the detection limits: Bi, Dy, Er, Ho, Pd, Pr, Tl, and Tm. Li and U have substantially higher geometric means (Tables 38e, 38f, and 38g) and Fe₂O₃, MnO, SO₃, As, Br, Ge, Mn, Mo, Zn, sulfate, and pyritic sulfur have substantially lower geometric means for the Pardee samples than for the Appalachian basin samples.

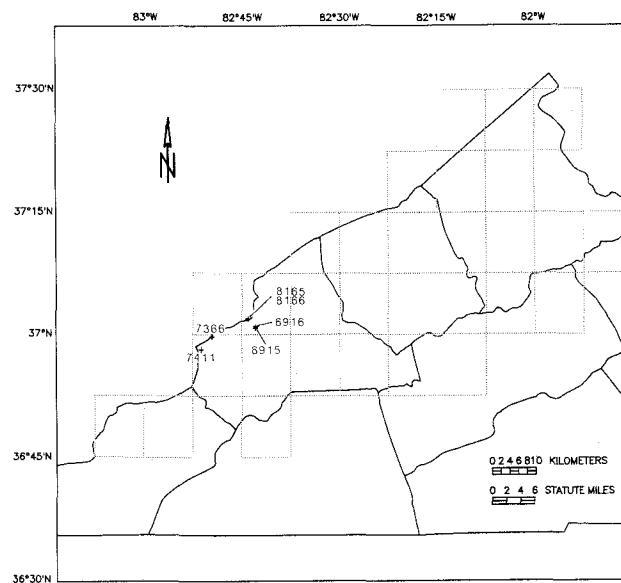


Figure 45. Locations for samples from the Pardee coal bed.

Table 38a.--Descriptions and locations for 6 bituminous coal samples from the Pandee coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-6915	W195441	90C-4	370046N	824251W	Flat Gap (7.5')	Wise	15.60	Surface mine, sl. weathered	Full Thickness
R-6916	W195443	90C-6	370058N	824248W	Flat Gap (7.5')	Wise	46.08	Surface mine, sl. weathered	Full Thickness
R-7366	W204163	61A-3	365941N	824931W	Appalachia (7.5')	Wise	29.64	Underground mine, sl. weathered	Full Thickness
R-7411	W205195	61A-9	365736N	825122W	Appalachia (7.5')	Wise	62.52	Underground mine, sl. weathered	Full Thickness
R-8165	W211679	90C-12	370155N	824400W	Flat Gap (7.5')	Wise	39.60	Underground mine	Bench Sample
R-8166	W211678	90C-13	370155N	824400W	Flat Gap (7.5')	Wise	45.60	Underground mine	Bench Sample

Table 38b.-Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 6 bituminous coal samples from the Pardee coal bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa. and a commercial testing laboratory following ASTM standards. G for ash-fusion temperatures means greater than value shown. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	Moisture	PROXIMATE ANALYSIS			ULTIMATE ANALYSIS			HEAT CONTENT			
		Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	KCal/KG	Btu/lb
R-6915	3.6	36.8	53.9	5.7	5.7	77.2	1.6	9.0	0.8	7,710	13,880
	---	38.2	55.9	5.9	5.5	80.1	1.7	6.0	.8	8,000	14,400
	---	40.6	59.4	---	5.8	85.1	1.8	6.4	.9	8,500	15,300
R-6916	3.4	32.7	49.9	14.0	5.2	69.9	1.4	8.2	1.2	6,950	12,510
	---	33.9	51.7	14.5	5.0	72.4	1.4	5.4	1.2	7,190	12,250
	---	39.6	60.4	---	5.8	84.6	1.7	6.3	1.5	8,410	15,140
R-7366	3.5	33.5	56.2	6.8	5.2	76.3	1.6	9.5	.6	7,460	13,430
	---	34.7	58.2	7.0	5.0	79.1	1.7	6.6	.6	7,730	13,910
	---	37.3	62.7	---	5.4	85.1	1.8	7.1	.7	8,310	14,970
R-7411	2.2	35.9	53.2	8.7	5.4	75.0	1.7	8.3	.9	7,520	13,530
	---	36.7	54.4	8.9	5.3	76.7	1.7	6.5	.9	7,690	13,330
	---	40.3	59.7	---	5.8	84.2	1.9	7.1	1.0	8,440	15,180
R-8165	1.9	31.5	54.5	12.1	4.9	73.1	1.6	7.3	.9	7,200	12,970
	---	32.1	55.6	12.3	4.8	74.5	1.7	5.7	.9	7,340	13,220
	---	36.6	63.4	---	5.5	85.0	1.9	6.5	1.0	8,370	15,070
R-8166	2.1	34.2	51.8	11.8	5.1	72.7	1.7	7.3	1.3	7,200	12,970
	---	35.0	52.9	12.1	5.0	74.3	1.7	5.6	1.3	7,360	13,240
	---	39.8	60.2	---	5.7	84.5	2.0	6.3	1.5	8,370	15,070

Table 38b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 6 bituminous coal samples from the Pardee coal bed, Southwest Virginia.--continued

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)				Hardgrove grindability index	Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid			
R-6915	2.1	0.00	0.07	0.74	8.5	1,540	1,540G	1,540G	---	1.15	W195441
	---	.00	.07	.77							
	---	.00	.08	.82							
R-6916	1.8	.01	.33	.81	8.5	1,540	1,540G	1,540G	---	1.92	W195443
	---	.01	.34	.84							
	---	.01	.40	.98							
R-7366	1.8	.01	.13	.43	4.5	1,430	1,495	1,540	---	.89	W204163
	---	.01	.13	.45							
	---	.01	.14	.48							
R-7411	.6	.01	.14	.76	5.5	1,540	1,540G	1,540G	---	1.33	W205195
	---	.01	.14	.78							
	---	.01	.16	.85							
R-8165	.5	.04	.14	.72	5.0	1,480	1,540	1,540G	---	1.39	W211679
	---	.04	.14	.73							
	---	.05	.16	.84							
R-8166	.8	.11	.60	.60	7.0	1,425	1,480	1,520	---	2.00	W211678
	---	.11	.61	.61							
	---	.13	.70	.70							

Table 38c. - Major- and minor-oxide concentrations in the laboratory ash of 6 bituminous coal samples from the Pardue coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. L means less than the concentration shown. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-6915	5.9	52	31	1.3	0.60	0.45	2.4	4.0	1.5	0.034	2.1	W195441
R-6916	13.3	58	27	.67	.96	.47	3.4	5.2	1.2	.060	.97	W195443
R-7366	8.3	50	33	2.7	.66	.19	1.4	2.7	1.4	.084	1.3	W204163
R-7411	9.2	51	33	1.4	.76	.32	2.1	4.1	2.0	.49	1.0	W205195
R-8165	12.2	53	32	2.9	.40	.26	.89	3.5	2.1	1.9	.60	W211679
R-8166	12.3	52	31	.49	.83	.43	3.3	7.9	1.6	.081L	.48	W211678

Table 38d. -Major-, minor-, and trace-element composition of 6 bituminous coal samples from the Pardie coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts per-million. L means less than the value shown; B, not determined; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-6915	1.4	0.97	0.055	0.021	0.019	0.12	0.16	0.053	0.015	2.4	W195441
R-6916	3.6	1.9	.064	.077	.047	.38	.48	.096	.023	2.1	W195443
R-7366	1.9	1.5	.16	.033	.012	.097	.16	.068	.021	1.5	W204163
R-7411	2.2	1.6	.090	.042	.022	.16	.27	.11	.038	2.6	W205195
R-8165	3.0	2.1	.25	.029	.023	.090	.30	.15	.020	2.5	W211679
R-8166	3.0	2.0	.043	.061	.039	.34	.68	.12	.046	12	W211678

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-6915	5.0	36	2.2	0.8	0.024	14	B	14	9.8	0.50	W195441
R-6916	12	84	1.6	.5	.072	13	B	1.9	7.8	.90	W195443
R-7366	12	48	1.7	1.0	.075	20	1,700	4.6	9.6	.30	W204163
R-7411	13	61	1.7	.9	.082	19	70	4.0	16	1.3	W205195
R-8165	17	77	1.6	1.3	.078	37	270	2.1	19	.40	W211679
R-8166	22	95	2.2	1.1	.057	20	290	8.2	15	1.3	W211678

Sample Number	Cu (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	La (ppm)	Li (ppm)	Lab Number
R-6915	16	0.35	.59	1.8	0.71	1.3	0.40	0.090	7.0	10	W195441
R-6916	19	.17	.96	3.6	1.5	.32	.40	.16	8.0	10	W195443
R-7366	16	.27	14.0	5.3	1.2L	1.0	.90	.070	11	23	W204163
R-7411	19	.34	4.7	5.7	1.4L	.56	.80	.043	12	37	W205195
R-8165	20	.47	16.0	3.9	1.8L	1.0	1.1	.16	16	55	W211679
R-8166	25	.37	120	4.2	1.8L	.80	.80	.19	12	23	W211678

Table 38d.--Major-, minor-, and trace-element composition of 6 bituminous coal samples from the Pardee coal bed, Southwest Virginia,
reported on a whole-coal basis.--continued

Sample Number	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Rb (ppm)	Sb (ppm)	Lab Number
R-6915	.0.14	3.3	0.13L	0.59	4.5	7.7	8.7	5.9	27L	1.6	W195441
R-6916	.09	10	.76	1.3	9.7	8.6	35	7.8	18	.40	W195443
R-7366	.14	3.0	.38	1.8	5.6	12	31	8.3	8.0	.50	W204163
R-7411	.14	9.2	.45	3.1	10	9.0	200	9.1	10	.60	W205195
R-8165	.14	8.3	1.2	6.6	9.3	7.7	1,000	10	40L	.80	W211679
R-8166	.14	7.5	.54	3.2	14	12	44L	7.7	40L	.70	W211678

Sample Number	Sc (ppm)	Se (ppm)	Sm (ppm)	Sn-S (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	U (ppm)	V-S (ppm)	Lab Number
R-6915	2.7	2.0	1.7	0.15	40	0.16	0.32	1.7	1.4	6.5	W195441
R-6916	2.0	.86	1.2	.65	61	.13	.17	2.4	3.3	16	W195443
R-7366	3.0	3.0	1.7	.72	91	.21	.27	3.4	1.3	14	W204163
R-7411	3.8	.73	1.7	.75	86	.25	.30	3.6	1.7	22	W205195
R-8165	5.0	2.9	2.2	1.3	200	.41	.34	3.9	2.2	21	W211679
R-8166	4.0	3.9	1.6	.47	98	.23	.25	3.2	1.6	26	W211678

Sample Number	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)						Lab Number
R-6915	0.60	4.9	0.90	4.1	5.4						W195441
R-6916	.40	6.0	.60	12	15						W195443
R-7366	.90L	7.1	.80	4.6	16						W204163
R-7411	B	6.0	.90	8.4	19						W205195
R-8165	.60	9.2	1.0	3.7	50						W211679
R-8166	.40	8.2	1.0	11	30						W211678

Table 38e.--Arithmetic mean, observed range and geometric mean of proximate and ultimate analyses, heat content, forms of sulfur, and ash-fusion temperatures for 6 bituminous coal samples from the Pardee coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included.

[All values are in percent except Btu/lb, Kcal/kg, ash-fusion temperatures, and free-swelling index and are reported on an as-received basis. $^{\circ}\text{F} = 9/5 \, ^{\circ}\text{C} + 32$; Kcal/kg = 0.556 Btu/lb; dashed values (---) represent less than five samples; (n) is number of samples per parameter.]

	Pardee coal bed				Appalachian basin		
	Arith. mean (n)	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
Proximate and ultimate analyses							
Moisture	(6)	2.78	1.88	3.60	2.68	3.23	2.69 (4,760)
Volatile matter	(6)	34.10	31.49	36.80	34.06	32.46	31.72 (4,760)
Fixed carbon	(6)	53.26	49.90	56.20	53.22	52.48	51.76 (4,760)
Ash	{6}	9.86	5.70	14.00	9.37	11.83	9.83 (4,760)
Hydrogen	{6}	5.27	4.95	5.70	5.26	5.02	5.00 (4,760)
Carbon	{6}	74.04	69.90	77.20	74.00	70.69	70.17 (4,760)
Nitrogen	{6}	1.60	1.40	1.70	1.60	1.39	1.37 (4,757)
Oxygen	{6}	8.26	7.28	9.50	8.23	8.92	8.22 (4,756)
Sulfur	(6)	.95	.60	1.31	.92	2.15	1.63 (4,974)
Heat content							
KCal/kg Btu/lb	{6}	7,346 13,212	6,954 12,508	7,716 13,877	7,318 13,204	7,030 12,644	6,979 12,553 (4,759)
Forms of sulfur							
Sulfate	(5)	0.04	0.01	0.11	0.02	0.08	0.04 (4,245)
Pyritic	{6}	.23	.07	.60	.18	1.36	.65 (4,392)
Organic	{6}	.68	.43	.81	.66	.82	.70 (4,393)
Ash-fusion temperature ($^{\circ}\text{C}$)							
Initial deformation	(3)	---	1,427	1,482	---	1,255	1,246 (4,063)
Softening	(2)	---	1,482	1,493	---	1,287	1,280 (3,722)
Fluid	---	---	---	---	---	1,334	1,328 (3,449)
Free-swelling index	(6)	6.50	4.50	8.50	6.30	5.53	4.68 (4,603)
Air-dried loss	(6)	1.26	0.51	2.10	1.08	1.83	1.13 (3,868)

Table 38f.--Arithmetic mean, observed range, and geometric mean of ash content and concentrations of 11 major- and minor-oxides in the laboratory ash of 6 bituminous coal samples from the Pardee coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. (n) indicates the number of samples per oxide.

[All samples were ashed at 525°C; all data are in percent.]

	Pardee coal bed					Appalachian basin		
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
			Min.	Max.				
(Ash)	(6)	10	5.9	13	9.8	13	10	(5,262)
SiO ₂	(6)	53	50	58	52	43	41	(5,229)
Al ₂ O ₃	(6)	31	26	33	31	24	23	(5,229)
CaO	(6)	1.6	.49	2.9	1.3	2.2	1.5	(5,227)
MgO	(6)	.70	.40	.96	.68	.85	.75	(5,258)
Na ₂ O	(6)	.35	.19	.47	.34	.43	.34	(5,194)
K ₂ O	(6)	2.2	.89	3.4	2.0	2.0	1.7	(5,229)
Fe ₂ O ₃	(6)	4.6	2.7	7.9	4.3	19	13	(5,215)
MnO	(6)	.01	.005	.01	.01	.03	.02	(5,260)
TiO ₂	(6)	1.6	1.2	2.1	1.6	1.2	1.1	(5,203)
P ₂ O ₅	(5)	.52	.040	1.9	.18	.50	.22	(3,389)
SO ₃	(6)	1.1	.48	2.1	.95	2.5	1.9	(5,063)

Table 38g.--Arithmetic mean, observed range, and geometric mean of concentrations of 54 trace elements in 6 bituminous coal samples from the Pardee coal bed, Southwest Virginia. For comparison the arithmetic and geometric means of channel and drill core samples of bituminous coal from the Appalachian basin are included. Dashed values (---) represent less than five samples; (n) indicates the number of samples per element. [All data are in parts-per-million and are reported on a whole-coal basis.]

	Pardee coal bed				Appalachian basin			
	(n)	Arith. mean	<u>Observed range</u>		Geom. mean	Arith. mean	Geom. mean	(n)
			Min.	Max.				
Ag	(6)	0.03	0.015	0.05	0.02	0.07	0.05	{4,565}
As	(6)	3.9	1.5	12	2.9	35	13	{5,197}
B	(6)	13	5.0	22	12	30	20	{5,076}
Ba	(6)	67	36	95	63	90	63	{5,134}
Be	(6)	1.8	1.6	2.2	1.8	2.5	2.0	{5,247}
Bi	---	---	---	---	---	1.5	1.1	(108)
Br	(6)	.95	.51	1.3	.91	22	13	{4,892}
Cd	(6)	.06	.024	.08	.06	.10	.07	{4,978}
Ce	(6)	20	13	37	19	21	17	{5,075}
Cl	(4)	---	70	1,700	---	780	510	{3,646}
Co	(6)	5.8	1.9	14	4.5	7.4	5.7	{5,217}
Cr	(6)	13	7.8	19	12	18	15	{5,205}
Cs	(6)	.78	.30	1.3	.67	1.3	.85	{4,831}
Cu	(6)	19	16	25	19	19	15	{5,239}
Dy	---	---	---	---	---	3.3	2.6	(759)
Er	---	---	---	---	---	1.5	1.2	(1,200)
Eu	(6)	.33	.17	.47	.31	.44	.37	{5,032}
F	(6)	100	47	160	95	99	71	{4,860}
Ga	(6)	4.1	1.8	5.7	3.8	6.6	5.4	{5,046}
Gd	(2)	---	.71	1.5	---	2.6	1.9	{1,773}
Ge	(6)	.83	.32	1.3	.76	4.7	2.5	{4,608}
Hf	(6)	.73	.40	1.1	.68	.79	.62	{4,932}
Hg	(6)	.12	.043	.19	.10	.22	.15	{5,031}
Ho	---	---	---	---	---	.76	.61	(378)
La	(6)	11	7.0	16	11	11	8.9	{5,147}
Li	(6)	26	10	55	22	22	14	{5,243}
Lu	(6)	.13	.090	.14	.13	.16	.14	{4,885}
Mn	(6)	6.9	3.0	10	6.2	31	15	{5,260}
Mo	(5)	.67	.38	1.2	.61	3.7	2.3	{4,889}
Nb	(6)	2.8	.59	6.6	2.1	2.6	1.9	{5,005}
Nd	(6)	8.8	4.5	14	8.2	13	9.9	{4,231}
Ni	(6)	9.6	7.7	12	9.4	17	14	{5,240}
Pb	(6)	8.2	5.9	10	8.1	8.8	6.2	{5,172}
Pd	---	---	---	---	---	.17	.14	(18)
Pr	---	---	---	---	---	6.1	3.6	(960)
Rb	(3)	---	8.0	18	---	28	22	{2,232}
Sb	(6)	.77	.40	1.6	.69	1.4	.91	{5,003}
Sc	(6)	3.4	2.0	5.0	3.3	4.4	3.6	{5,218}
Se	(6)	2.2	.73	3.9	1.9	3.6	2.8	{5,052}
Sm	(6)	1.7	1.2	2.2	1.7	2.0	1.6	{5,005}
Sn	(6)	.68	.15	1.3	.57	1.6	.86	{2,352}
Sr	(6)	95	40	200	85	110	79	{5,146}
Ta	(6)	.23	.13	.41	.22	.24	.19	{4,369}
Tb	(6)	.27	.17	.34	.27	.34	.29	{4,852}
Th	(6)	3.0	1.7	3.9	2.9	3.0	2.3	{5,098}
Tl	---	---	---	---	---	3.4	2.1	(382)
Tm	---	---	---	---	---	1.7	.38	(46)
U	(6)	1.9	1.3	3.3	1.8	1.8	1.3	{4,990}
V	(6)	18	6.5	26	16	24	19	{5,241}
W	(4)	---	.40	.60	---	.94	.80	{4,421}
Y	(6)	6.9	4.9	9.2	6.7	8.5	7.2	{5,234}
Yb	(6)	.87	.60	1.0	.85	1.1	.92	{5,151}
Zn	(6)	7.4	3.7	12	6.6	22	14	{5,243}
Zr	(6)	22	5.4	50	18	24	17	{5,238}

MORRIS COAL BED

The Morris coal bed crops out in Lee and Wise Counties and locally is known as the No. 11 coal bed. Production in 1989 was 0.7 million tons, all from Wise County (Virginia Division of Mines, 1990). Where sampled, the coal varies from 2.5 to 6.1 feet thick and is typically hard with a poorly-developed medium cleat. There are one or two siltstone partings totaling less than 3 inches in thickness.

Au, Bi, Dy, Ho, In, Ir, Os, Pd, Pr, Pt, Rb, Re, Rh, Ru, Tl, and Tm are below the detection limits for the 3 Morris samples. The descriptive and location data are presented in Table 39a and Figure 46 with the analytical results reported in Tables 39b, 39c, and 39d. The geometric means for the 3 samples from this bed are not discussed because there are less than five samples.

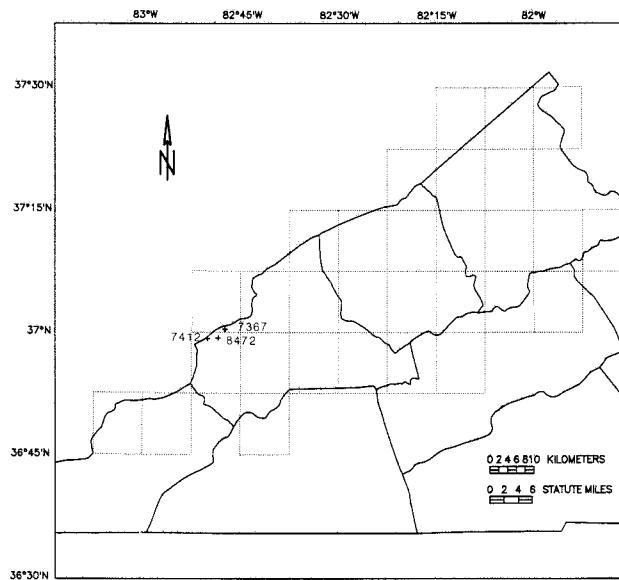


Figure 46. Locations for samples from the Morris coal bed.

Table 39a.-Descriptions and locations for 3 bituminous coal samples from the Morris coal bed, Southwest Virginia.

VDMR Ic. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-7367	W204164	91D-1	370022N	824720W	Whitesburg (7.5') Appalachia (7.5') Appalachia (7.5')	Wise	45.60	Underground mine, st.	weathered
R-7412	W205196	61A-10	365912N	825004W	Wise	73.20	Underground mine, st.	weathered	Full Thickness
R-8472	W214255	61A-22	365918N	824825W	Wise	43.56	Underground mine		Full Thickness

Table 39b.-Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 3 bituminous coal samples from the Morris coal bed, Southwest Virginia.

All analyses except heat contents, free-swelling indexes, ash fusion temperatures, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. G for ash-fusion temperatures means greater than value shown. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT			Lab Number
	Moisture	Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/KG	Btu/lb	
R-7367	2.2	34.5	56.5	6.8	5.3	77.6	1.6	8.0	.7	7,600	13,690	W204164
	---	35.3	57.8	7.0	5.2	79.3	1.6	6.2	.7	7,770	13,990	
	---	37.9	62.1	---	5.6	85.3	1.8	6.6	.8	8,360	15,040	
R-7412	2.9	34.6	57.5	5.0	5.4	78.9	1.6	8.5	.6	7,760	13,970	W205196
	---	35.6	59.2	5.1	5.2	81.3	1.6	6.1	.6	7,990	14,390	
	---	37.6	62.4	---	5.5	85.7	1.7	6.4	.7	8,430	15,170	
R-8472	1.8	36.7	57.3	4.1	5.4	80.0	1.6	8.2	.7	7,880	14,190	W214255
	---	37.4	58.4	4.2	5.3	81.5	1.7	6.7	.7	8,030	14,450	
	---	39.1	60.9	---	5.5	85.1	1.7	7.0	.7	8,380	15,090	

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Table 39b.--Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance numbers for 3 bituminous coal samples from the Morris coal bed, Southwest Virginia.--continued

Sample Number	FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)				Hardgrove grindability index	Number	Lab Number
	Air-dried Loss	Sulfate	Pyritic	Organic	Free-swelling index	Initial Deformation	Softening	Fluid			
R-7367	.7	.01	.16	.50	5.0	1,540	1,540G	1,540G	---	1.02	W204164
---	.01	.16	.51	.51							
---	.01	.18	.55	.55							
R-7412	.9	.01	.12	.52	5.0	1,540	1,540G	1,540G	---	.86	W205196
---	.01	.12	.54	.54							
---	.01	.13	.56	.56							
R-8472	.3	.03	.09	.54	5.0	1,405	1,470	1,540	---	.99	W214255
---	.03	.09	.55	.55							
---	.03	.10	.57	.57							

Table 39c.--Major- and minor-oxide concentrations in the laboratory ash of 3 bituminous coal samples from the Morris coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. L means less than the concentration shown. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO ₂	Al ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	Fe ₂ O ₃	TiO ₂	P ₂ O ₅	SO ₃	Lab Number
R-7367	7.5	52	32	1.3	1.1	0.28	1.6	4.8	1.6	0.15	1.3	W204164
R-7412	5.1	48	31	2.7	.78	.19	1.4	6.7	1.5	1.4	2.0	W205196
R-8472	4.1	51	28	2.3	1.0	.20	1.1	8.6	1.9	.24L	2.2	W214255

Table 39d.-Major-, minor-, and trace-element composition of 3 bituminous coal samples from the Morris coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts per-million. L means less than the value shown; B, not determined; S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrographic analyses. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-7367	1.8	1.3	0.070	0.048	0.016	0.10	0.25	0.072	0.023	2.4	W204164
R-7412	1.1	.85	.10	.024	.007	.058	.24	.047	.017	3.0	W205196
R-8472	.98	.62	.066	.025	.006	.039	.25	.048	.045	.30	W214255

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cl (ppm)	Co (ppm)	Cr (ppm)	Cs (ppm)	Lab Number
R-7367	9.0	34	1.3	1.1	0.098	20	370	10	10	0.30	W204164
R-7412	7.7	28	1.1	.9	.046	15	110	1.8	6.9	.20	W205196
R-8472	9.0	21	1.5	.9	.053	11	210	3.4	6.4	.70L	W214255

Sample Number	Cu (ppm)	Er-S (ppm)	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Ge-S (ppm)	Hf (ppm)	Hg (ppm)	La (ppm)	Lab Number
R-7367	16	0.75L	0.27	48	4.0	1.1L	2.0	0.70	0.030	12	W204164
R-7412	16	.82	.23	84	2.3	.77L	.40	.50	.040	8.0	W205196
R-8472	12	.41L	.23	50	2.0	.90	.74	.30	.12	6.0	W214255

Sample Number	Li (ppm)	Lu (ppm)	Mn (ppm)	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Sb (ppm)	Lab Number
R-7367	17	0.14	5.7	0.19	1.2	7.2	17	.48	7.0	0.50	W204164
R-7412	15	.11	3.6	.66	2.3	8.7	4.9	310	5.6	.30	W205196
R-8472	4.5	.07	6.6	.78	1.7	6.6	10	44L	3.9	.30	W214255

Table 39d.--Major-, minor-, and trace-element composition of 3 bituminous coal samples from the Morris coal bed, Southwest Virginia,
reported on a whole-coal basis.--continued

Sample Number	Sc (ppm)	Se (ppm)	Sr (ppm)	Sn-S (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	U (ppm)	V-S (ppm)	Lab Number
R-7367	2.4	3.5	1.7	0.26	69	0.20	0.25	2.5	1.1	12	W204164
R-7412	1.6	3.1	1.4	.34	51	.14	.20	2.1	.88	9.2	W205196
R-8472	1.7	4.4	1.0	.30	30	B	.13	1.5	.64	10	W214255

Sample Number	W (ppm)	Y-S (ppm)	Yb (ppm)	Zn (ppm)	Zr-S (ppm)	Lab Number
R-7367	0.90L	5.6	0.70	8.3	11	W204164
R-7412	B	7.1	.60	2.6	28	W205196
R-8472	.20	4.5	.50	2.5	12	W214255

HIGH SPLINT COAL BED

This coal crops out in Lee and Wise Counties, and production in 1989 was 0.3 million tons (Virginia Division of Mines, 1990). In Lee County, the High Splint coal bed is locally known as the No. 12 coal bed. At the single sample location (Figure 47), the High Splint is 3.6 feet thick and displays a poorly-developed medium cleat with sparse thin banding. The coal is commonly hard and bony.

With only one coal sample for the High Splint coal bed, the geometric means are not discussed (see Table 40a for the descriptive and location data and Tables 40b, 40c, and 40d for the analytical results). However, in addition to the 8 elements found below the detection limits in the rest of the Virginia samples, the following elements, Bi, Cl, Dy, Er, Ge, Ho, Pd, Pr, Tl, and Tm are found below the detection limits for the High Splint sample.

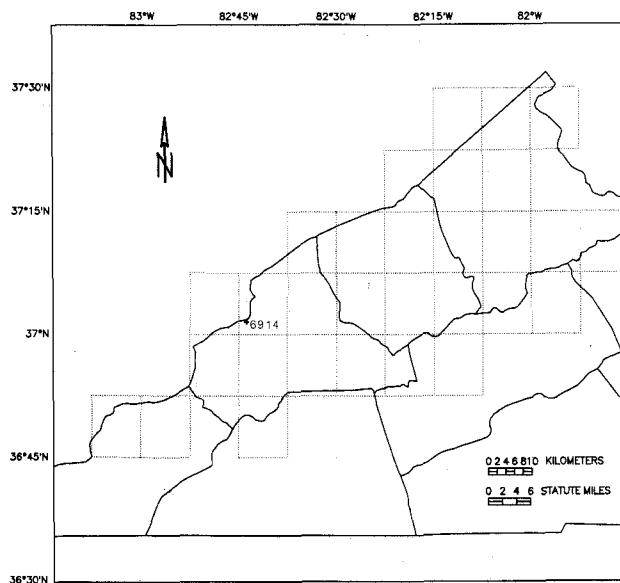


Figure 47. Location for sample from the High Splint coal bed.

Table 40a.—Description and location for 1 bituminous coal sample from the High Splint coal bed, Southwest Virginia.

VDMR Id. No.	USGS Lab No.	Field Id. No.	Latitude	Longitude	Quadrangle Map Name	County	Sample Thickness (inches)	Type of Sample	Part of Bed Represented
R-6914	W195442	90C-5	370204N	82346W	Flat Gap (7.5')	Wise	45.00	Surface mine, sl. weathered	Full Thickness

Table 40b.—Proximate and ultimate analyses, heat content, forms of sulfur, free-swelling index, ash-fusion temperature determinations, Hardgrove grindability index, and compliance number for 1 bituminous coal sample from the High Splint bed, Southwest Virginia.

[All analyses except heat contents, free-swelling indexes, Hardgrove grindability indexes, and compliance numbers in percent. For each sample number, the analyses are reported three ways: first, as-received; second, moisture free; and third, moisture and ash free. All analyses by Coal Analysis Section, Department of Energy, Pittsburgh, Pa and a commercial testing laboratory following ASTM standards. G for ash-fusion temperatures means greater than value shown. Sample number is VDMR identification number. Lab number is the USGS laboratory number. The USGS makes no claims as to the accuracy of rank calculated from these parameters.]

Sample Number	PROXIMATE ANALYSIS				ULTIMATE ANALYSIS				HEAT CONTENT			Lab Number
	Moisture	Volatile Matter	Fixed Carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Kcal/KG	Btu/lb	
R-6914	3.6 --- ---	30.8 32.0 38.8	48.6 50.4 61.2	17.0 17.6 ---	4.8 4.6 5.5	66.8 69.3 84.1	1.4 1.5 1.8	9.1 6.1 7.4	0.8 .8 1.0	6,590 6,830 8,290	11,850 12,300 14,930	W195442
FORMS OF SULFUR				ASH-FUSION TEMPERATURE (°C)				Hardgrove Compliance Number			Lab Number	
Sample	Air-dried	Initial	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900

Table 40c.--Major- and minor-oxide concentrations in the laboratory ash of 1 bituminous coal sample from the High Splint coal bed, Southwest Virginia.

[Concentrations in percent. Coal ashed at 525°C. Sample number is the VDMR identification number. Lab number is the USGS laboratory number.]

Sample Number	Ash	SiO_2	Al_2O_3	CaO	MgO	Na_2O	K_2O	Fe_2O_3	TiO_2	P_2O_5	SO_3	Lab Number
R-6914	14.2	55	30	0.65	1.3	0.22	4.0	4.3	1.2	0.099	0.76	W195442

Table 40d.--Major-, minor-, and trace-element composition of 1 bituminous coal sample from the High Splint coal bed, Southwest Virginia, reported on a whole-coal basis.

[Concentrations in percent or parts-per-million. S, after element title indicates determinations by automatic plate reading computer-assisted, emission spectrography analysis. For elements by emission spectrographic analysis, the standard deviation of any answer should be taken as plus 50% and minus 35%. Sample number is VDMR identification number. Lab number is USGS laboratory number.]

Sample Number	Si (percent)	Al (percent)	Ca (percent)	Mg (percent)	Na (percent)	K (percent)	Fe (percent)	Ti (percent)	Ag-S (ppm)	As (ppm)	Lab Number
R-6914	3.7	2.3	0.066	0.11	0.023	0.47	0.43	0.10	0.018	2.6	W195442

Sample Number	B-S (ppm)	Ba-S (ppm)	Be-S (ppm)	Br (ppm)	Cd (ppm)	Ce (ppm)	Cr (ppm)	Cs (ppm)	Cu (ppm)	Lu (ppm)	Mn (ppm)	Lab Number
R-6914	10	82	1.3	1.7	0.095	23	5.4	23	1.5	20	W195442	

Sample Number	Eu (ppm)	F (ppm)	Ga-S (ppm)	Gd-S (ppm)	Hf (ppm)	Hg (ppm)	La (ppm)	Li (ppm)	Lu (ppm)	Mn (ppm)	Lab Number
R-6914	0.38	150	3.6	1.3	0.80	0.090	14	23	0.15	14	W195442

Table 40d.--Major-, minor-, and trace-element composition of 1 bituminous coal sample from the High Splint coal bed, Southwest Virginia, reported on a whole-coal basis.--continued

Sample Number	Mo-S (ppm)	Nb-S (ppm)	Nd-S (ppm)	Ni-S (ppm)	P (ppm)	Pb (ppm)	Rb (ppm)	Sb (ppm)	Sc (ppm)	Se (ppm)	Lab Number
R-6914	0.74	0.92	8.0	9.2	61	9.5	4.9	0.60	4.2	2.9	W195442

Sample Number	Sm (ppm)	Sn-S (ppm)	Sr-S (ppm)	Ta (ppm)	Tb (ppm)	Th (ppm)	U (ppm)	V-S (ppm)	W (ppm)	Y-S (ppm)	Lab Number
R-6914	2.2	0.47	40	0.23	0.29	3.6	2.1	20	0.10	5.8	W195442

Sample Number	Yb (ppm)	Zn (ppm)	Zr-S (ppm)	Lab Number
R-6914	0.80	31	14	W195442

REFERENCES CITED

- American Society for Testing Materials (ASTM), 1982, Annual book of ASTM standards: Philadelphia, Pennsylvania, ASTM, 828 p.
- Biggs, T. H., 1974, Geographic and cultural names in Virginia: Virginia Division of Mineral Resources Report of Investigation 20, 374 p.
- Cavallaro, J. A., Johnston, M. T., and Deurbrouck, A. W., 1976, Sulfur reduction potential of the United States: U.S. Bureau of Mines Report of Investigations 8118, 323 p.
- Cavallaro, J. A. and Deurbrouck, A. W., 1965, Froth flotation and washability data of various Appalachian coals using time release analysis technique: U. S. Bureau of Mines Report of Investigations 6652, 48 p.
- Cobb, J. C., Currens, J. C., and Enoch, H. G., 1982, Compliance coal resources in Kentucky: Kentucky Geological Survey Information Circular 9, series XI, 52 p.
- Cobb, J. C., Steele, J. D., Treworgy, C. G., and Ashby, J. F., 1980, The abundance of zinc and cadmium in sphalerite-bearing coals in Illinois: Illinois Geological Survey, Illinois Mineral Notes 74, 24 p.
- Connor, J. J., Keith, J. R., and Anderson, B. M., 1976, Trace-metal variation in soils and sagebrush in the Powder River basin, Wyoming and Montana: U.S. Geological Survey Journal of Research, v. 4, n. 1, p. 49-59.
- Currens, J. C., Bragg, L. J., and Hower, J. C., 1986, Analysis of coal samples from the Princess district, Kentucky: Kentucky Geological Survey Information Circular 18, Series XI, 128 p.
- Diffenbach, R. N., 1988, Geology of the Virginia portions of the Clintwood and Jenkins East quadrangles: Virginia Division of Mineral Resources Publication 86, 1:24,000 map with text.
- Dutcher, R. R. (ed), 1976, Field description of coal: American Society for Testing Materials Special Technical Publication 661, 71 p.
- Environmental Protection Agency (EPA), 1989, 40 CFR Part 60, Standards of performance for new stationary sources: Federal Register, June 9, 1989, Superintendant of Documents, Washington, D.C., p. 24792-24820.
- Erwin, R. B., Smith, C. J., McColloch, G. H., and Ashton, K. C., 1986, Coal-fired power plants: the geological survey's role: Mountain State Geology, p. 1-8.
- Glass, G. B., 1975, Analyses and measured sections of 54 Wyoming coal samples (collected in 1974): The Geological Survey of Wyoming Report of Investigations No. 11, 219 p.
- Golightly, D. W., and Simon, F. O., eds., 1989, Methods for sampling and inorganic analysis of coal: U.S. Geological Survey Bulletin 1823, 72 p.
- Harvey, R. D., and Ruch, R. R., 1986, Mineral matter in Illinois and other U. S. coals: ACS Symposium Series 301, American Chemical Society, Washington, D. C., p 10-40.
- Henderson, J. A., Jr., 1979, Summary of coal resources in Virginia: Virginia Division of Mineral Resources, Virginia Minerals, v. 25, n. 1, p. 1-7.
- Henderson, J. A., Jr., Oman, C. L., and Coleman, S. L., 1981, Analyses of coal samples collected 1975-1977: Virginia Division of Mineral Resources Publication 33, 135 p.
- Henderson, J. A., Jr., Wilkes, G. P., Bragg, L. J., and Oman, C. L., 1985, Analyses of Virginia coal samples collected 1978-1980: Virginia Division of Mineral Resources Publication 63, 56 p.
- Lasaga, A. C., 1981, The sulfur cycle: The Pennsylvania State University, Earth and Mineral Sciences, v. 51, n. 1, p. 6-11.
- Milici, R. C. and Gathright, T. M., II, 1985, Geologic features related to coal mine roof falls- a guide for miner training: Virginia Division of Mineral Resources Publication 55, 13 p.
- Miller, M. S., 1974, Stratigraphy and coal beds of Upper Mississippian and Lower Pennsylvanian rocks in Southwestern Virginia: Virginia Division of Mineral Resources Bulletin 84, 211 p.
- Nolde, J. E., Whitlock, W. W., and Lovett, J. A., 1988a, Geology of the Flat Gap quadrangle: Virginia Division of Mineral Resources Publication 71, 1:24,000 map with text.
- Nolde, J. E., Whitlock, W. W., and Lovett, J. A., 1988b, Geology of the Pound and Caney Ridge quadrangles, Virginia: Virginia Division of Mineral Resources Publication 84, 8 p., 1:24,000 map.
- Oman, C. L., Bragg, L. J., Nock, H. M., Schwartz, L. J., Harris, J. L., Rega, N. H., and Crowley, S. S., 1981, Chemical analysis of 45 Maryland coal samples: U. S. Geological Survey Open-file Report 81-1099, 56 p.
- Schopf, J. M., 1960, Field description and sampling of coal beds: U. S. Geological Survey Bulletin 1111-B, 70 p., 24 plates.
- Swanson, V. E., and Huffman, C., Jr., 1976, Guidelines for sample collecting and analytical methods used in the U. S. Geological Survey for determining chemical composition of coal: U. S. Geological Survey Circular 735, 11 p.
- Sweet, P. C., Fordham, O. M. Jr., and Giannini, W. F., 1987, Carbonate materials suitable for desulfurization of flue gas: Virginia Division of Mineral Resources, Virginia Minerals, v. 33, n. 4, p. 33-36.

Tewalt, S. J., Bragg, L. J., and C. L. Oman, 1989, Guidelines for verifying data stored in the NCRDS USCHEM database: U. S. Geological Survey, Branch of Coal Resources files, 44 p.

Virginia Division of Mines, 1990, Summary of coal mining in Virginia, 1989: Big Stone Gap, Virginia Division of Mines, 8 p.

Whitlock, W. W., Lovett, J. A., and Diffenbach, R. N., 1988, Geology of the Wise quadrangle and the coal-bearing portion of the Fort Blackmore quadrangle, Virginia: Virginia Division of Mineral Resources Publication 80, 1:24,000 map with text.

APPENDIX I

7.5-MINUTE TOPOGRAPHIC MAPS SHOWING SAMPLE LOCATIONS

The following 7.5-minute maps contain all sample locations found in this report and are at a scale of approximately 1:50,000. They are arranged in alphabetical order and some have been divided into northern and southern halves. The symbol "X" denotes a surface sample point, the symbol "X" is an underground sample location. Although located on a topographic base, the elevation of the sampled coal bed will not usually match that shown on the map; they are geographic locations only. Highwalls and modified land change the sample elevation in surface mines, and obviously, elevations in underground mines are different than the indicated surface elevation. The sample number is the same four digit number listed in the first column of every table, although for sake of brevity, the "R" prefix is not used on these location maps. Also shown with the sample location and sample number is an abbreviation of the coal bed that was sampled. The following lists the abbreviations used on the maps:

ad = Addington coal bed
 a = Aily coal bed
 bf = Big Fork coal bed
 bl = Blair coal bed
 blm = Blair Marker coal bed
 c = Campbell Creek coal bed
 cl = Clintwood coal bed
 clm = Clintwood Marker coal bed
 clr = Clintwood Rider coal bed
 cc = Cove Creek coal bed
 d = Dorchester coal bed
 h = Hagy coal bed
 hs = High Splint coal bed

ho = House coal bed
 I = Imboden coal bed
 IM = Imboden Marker coal bed
 J = Jawbone coal bed
 JR = Jawbone Rider coal bed
 JT = Jawbone-Tiller coal bed
 ky = Kelly coal bed
 k = Kennedy coal bed
 lb = Lower Banner coal bed
 ls = Low Splint coal bed
 L = Lyons coal bed
 mo = Morris coal bed
 n = Norton coal bed

pd = Pardee coal bed
 ph = Phillips coal bed
 p3 = Pocahontas No. 3 coal bed
 r = Raven coal bed
 sd = Splash Dam coal bed
 tg = Taggart coal bed
 tm = Taggart Marker coal bed
 T = Tiller coal bed
 ub = Upper Banner coal bed
 usc = Upper St. Charles coal
 w = Wilson coal bed
 34 = 34-inch coal bed

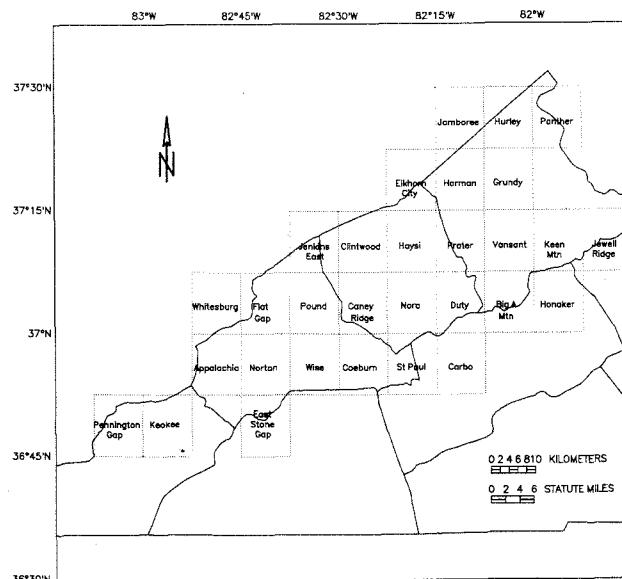
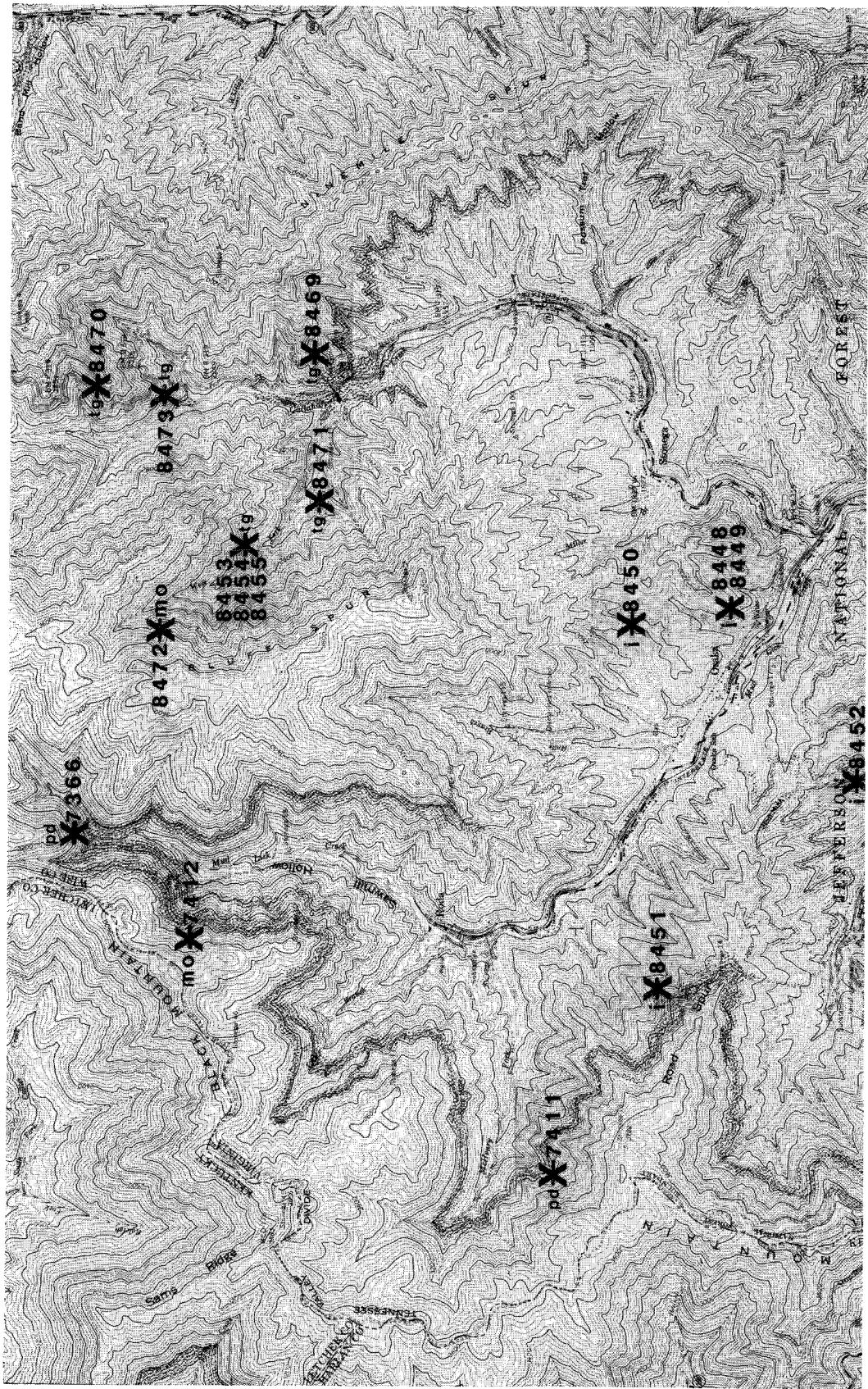
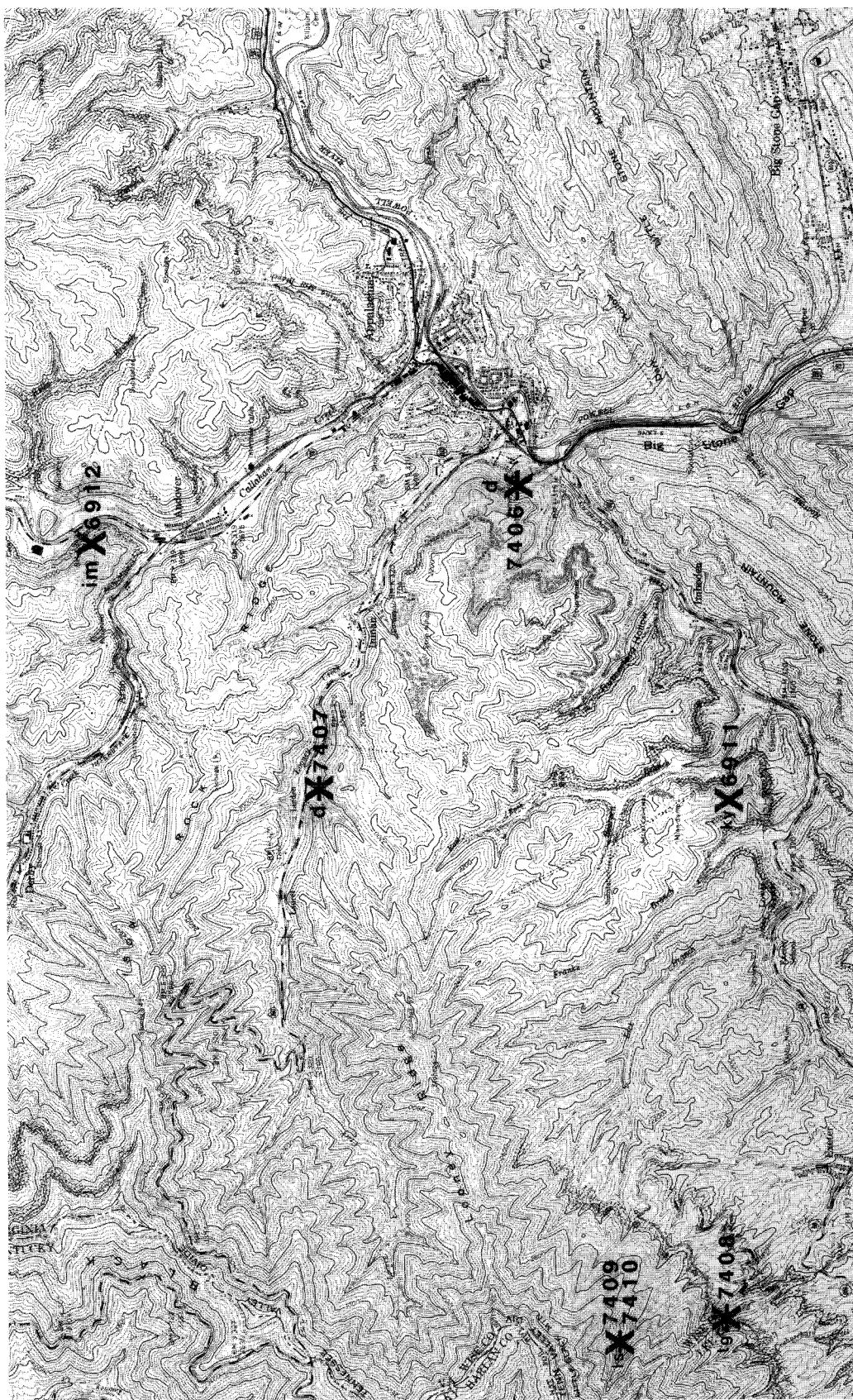


Figure 48. Topographic quadrangle index map of the Southwest Virginia coalfield (7.5-minute).



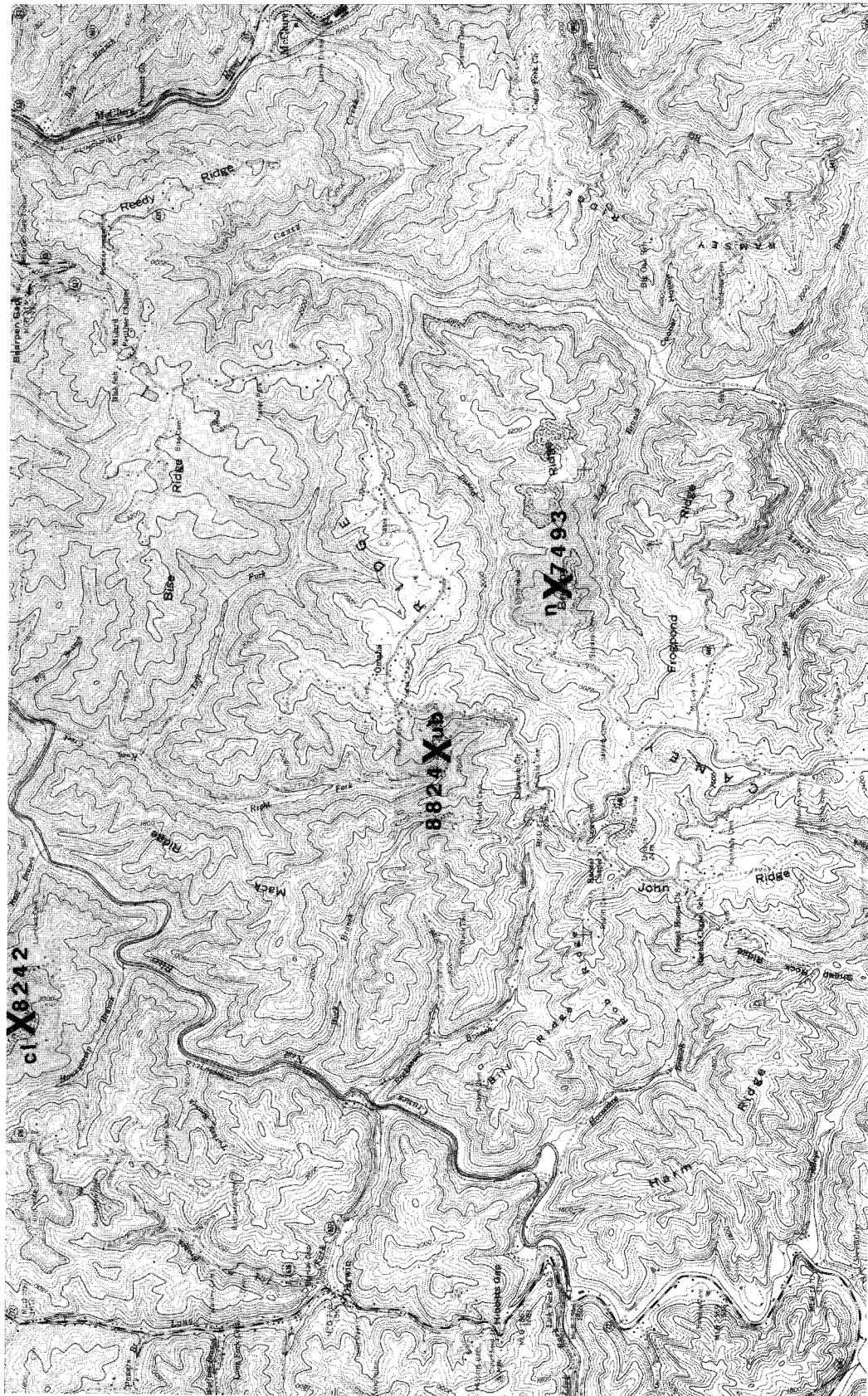
APPALACHIA, NORTHERN HALF



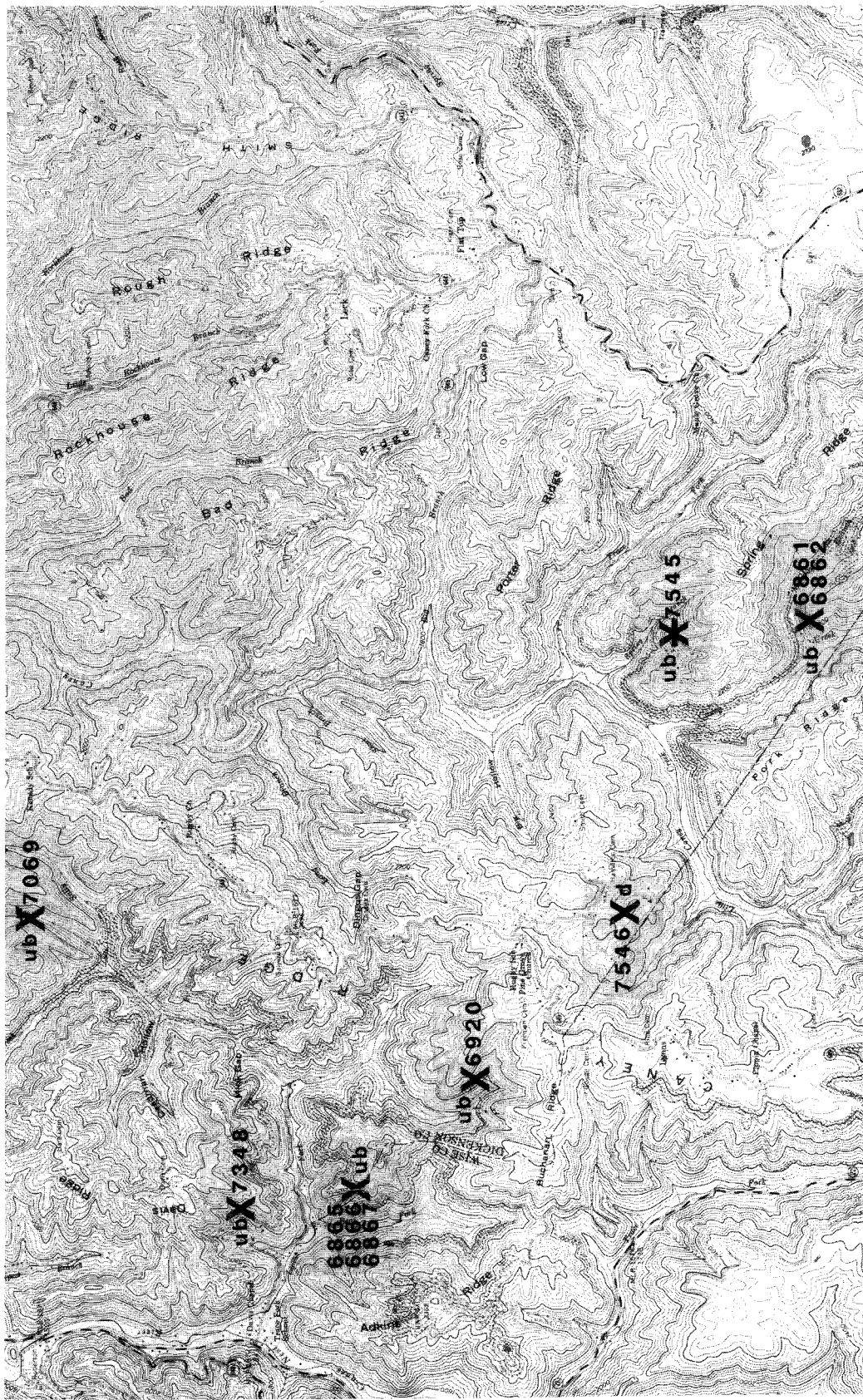
APPALACHIA, SOUTHERN HALF



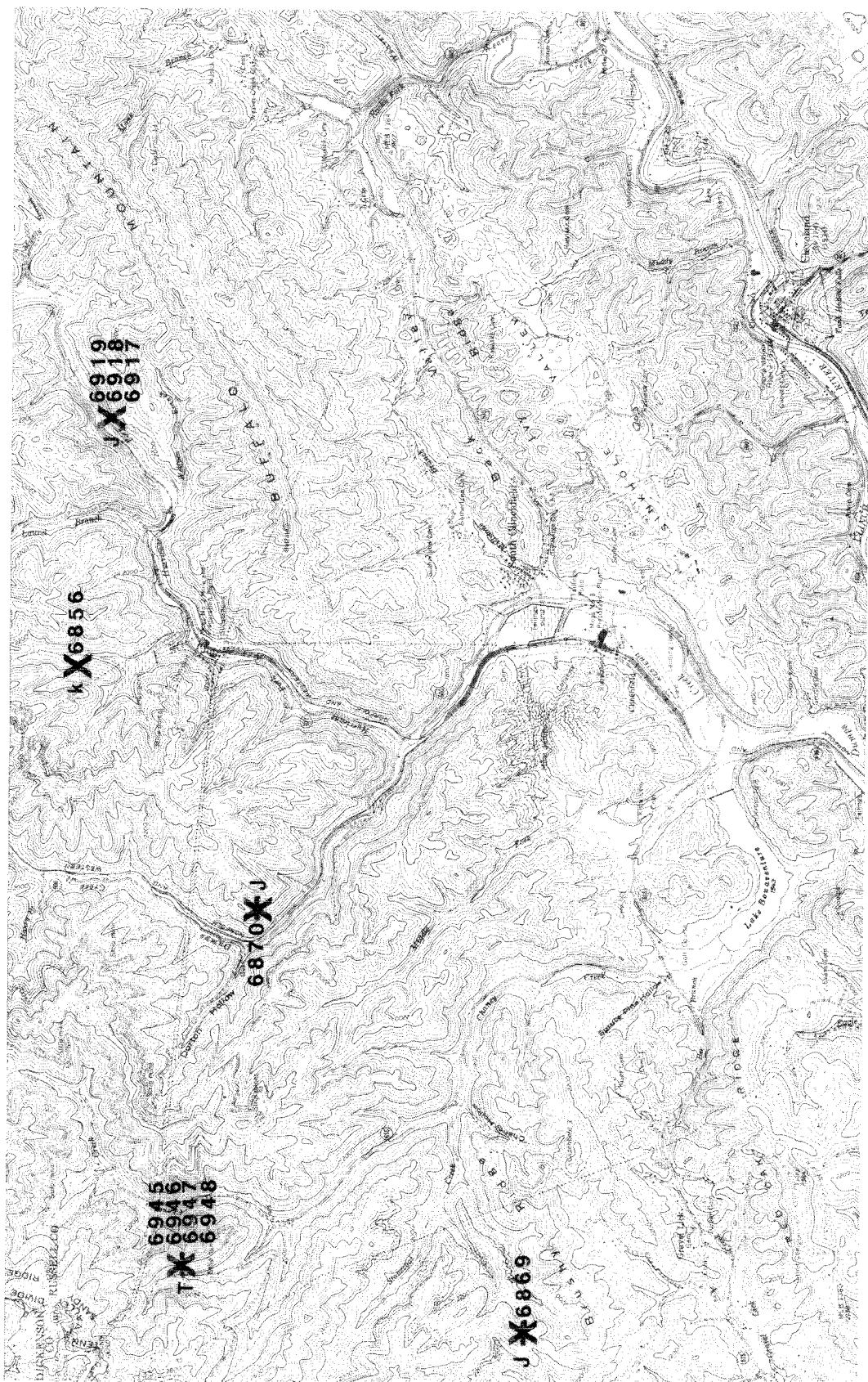
BIG A MOUNTAIN, NORTHERN HALF



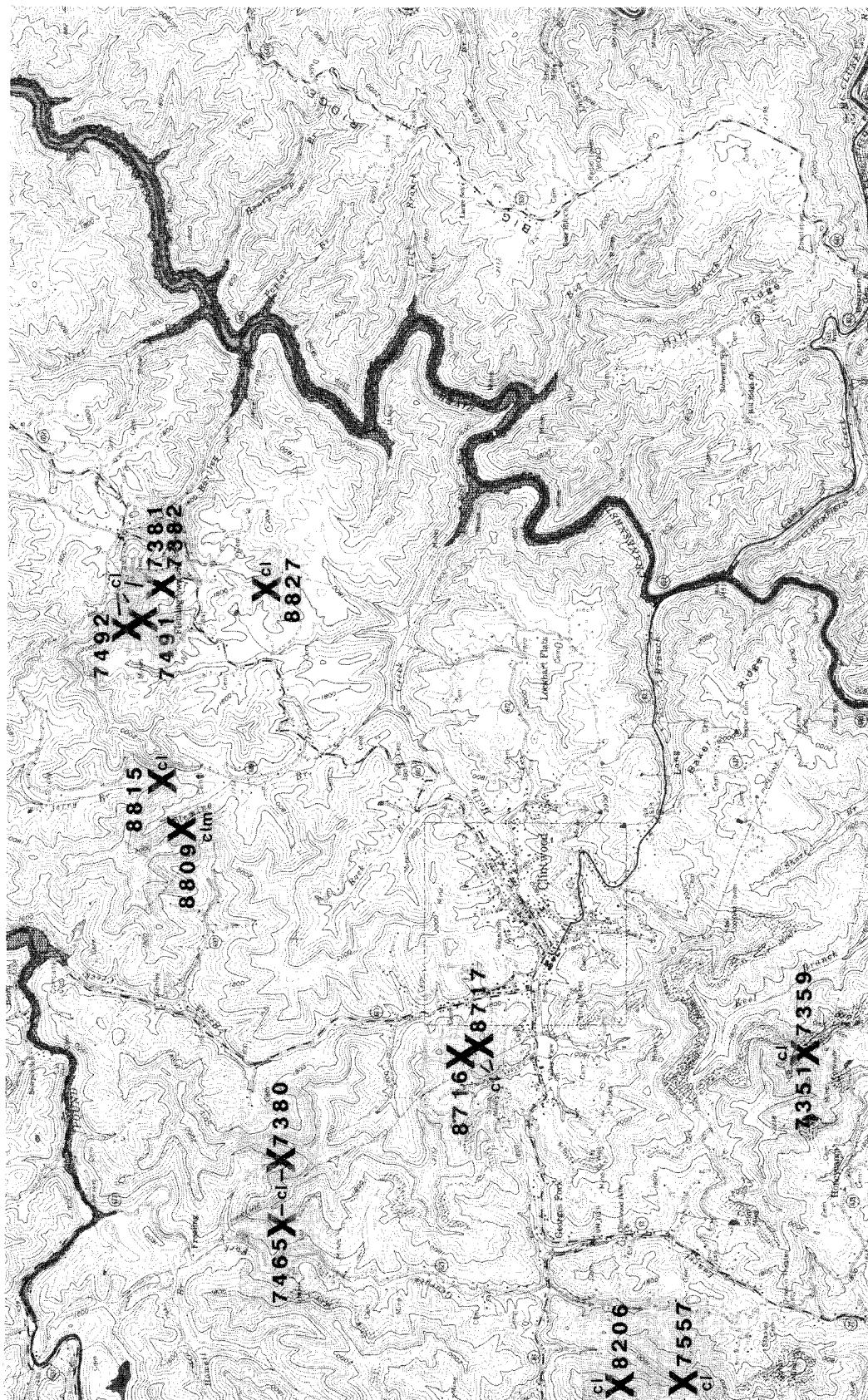
CANEY RIDGE, NORTHERN HALF



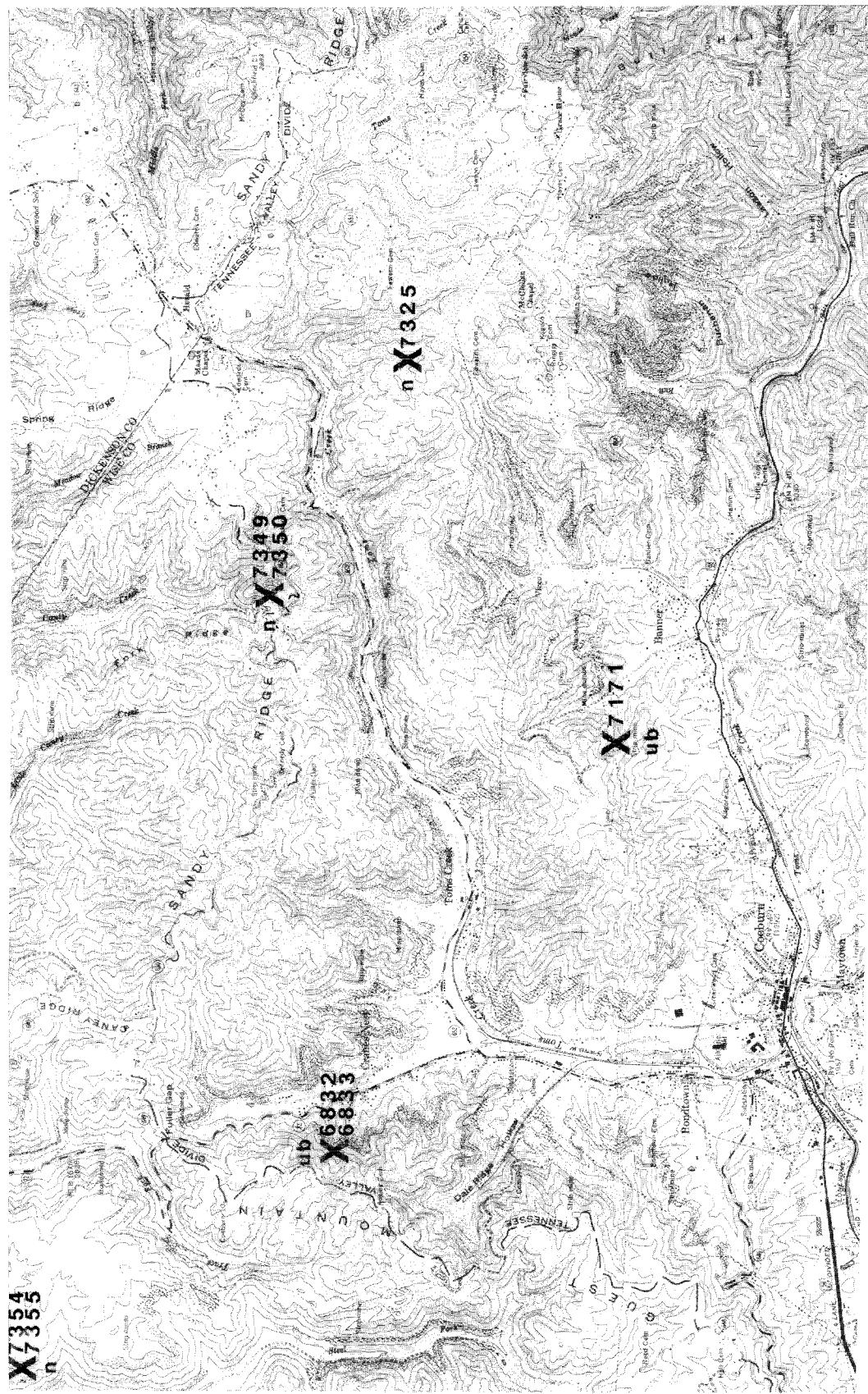
CANEY RIDGE, SOUTHERN HALF



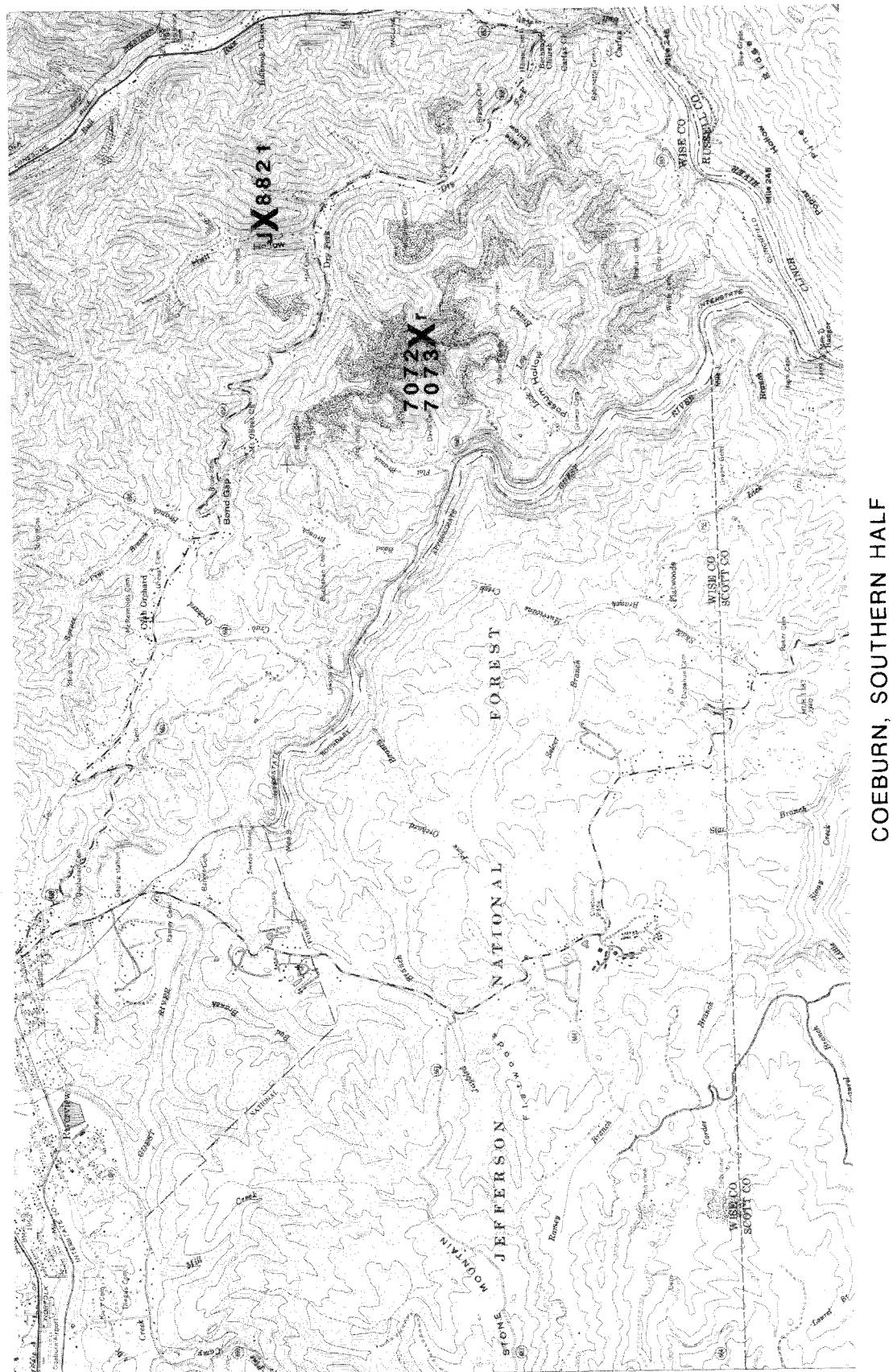
CARBO, NORTHERN HALF



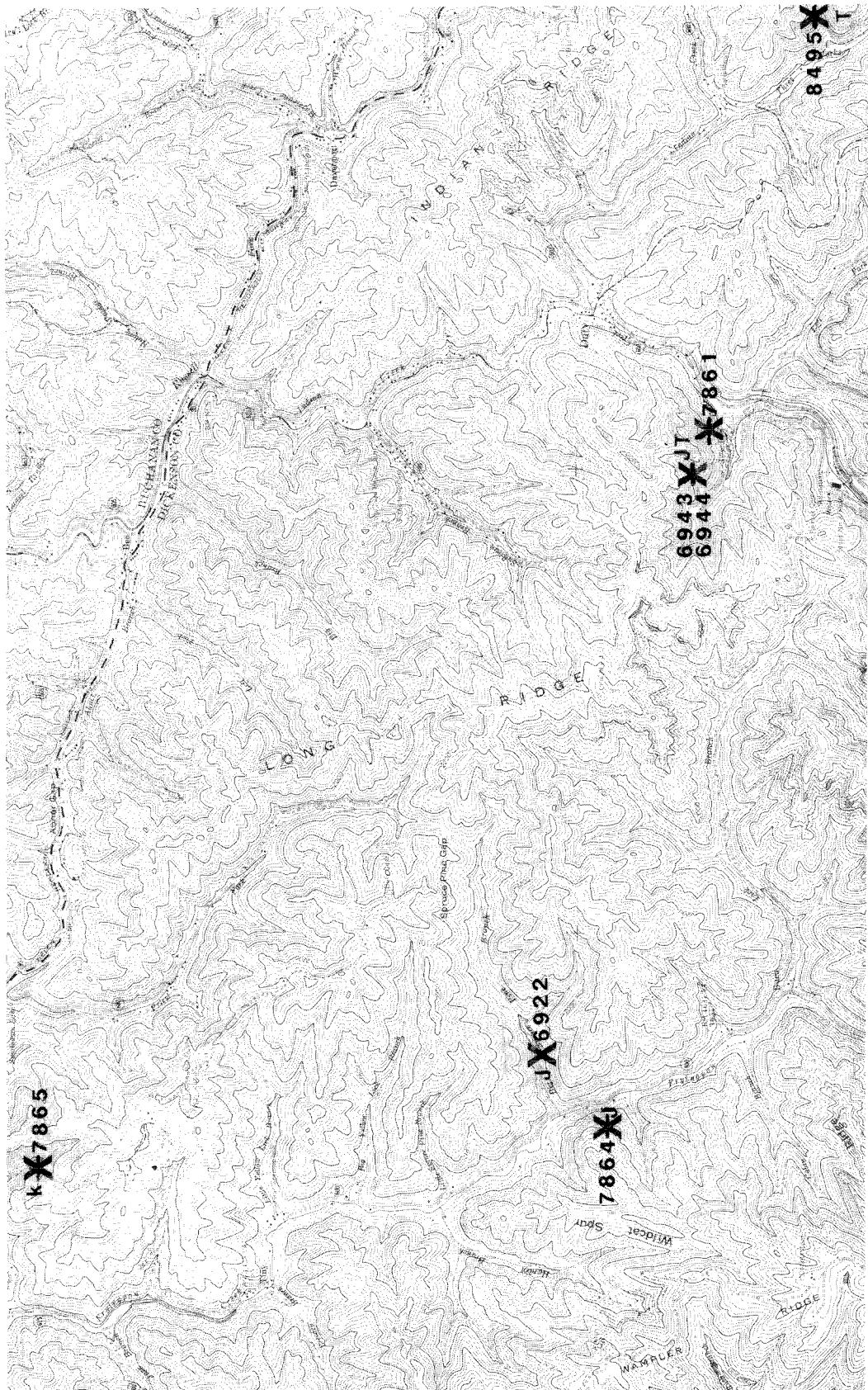
CLINTWOOD, SOUTHERN HALF



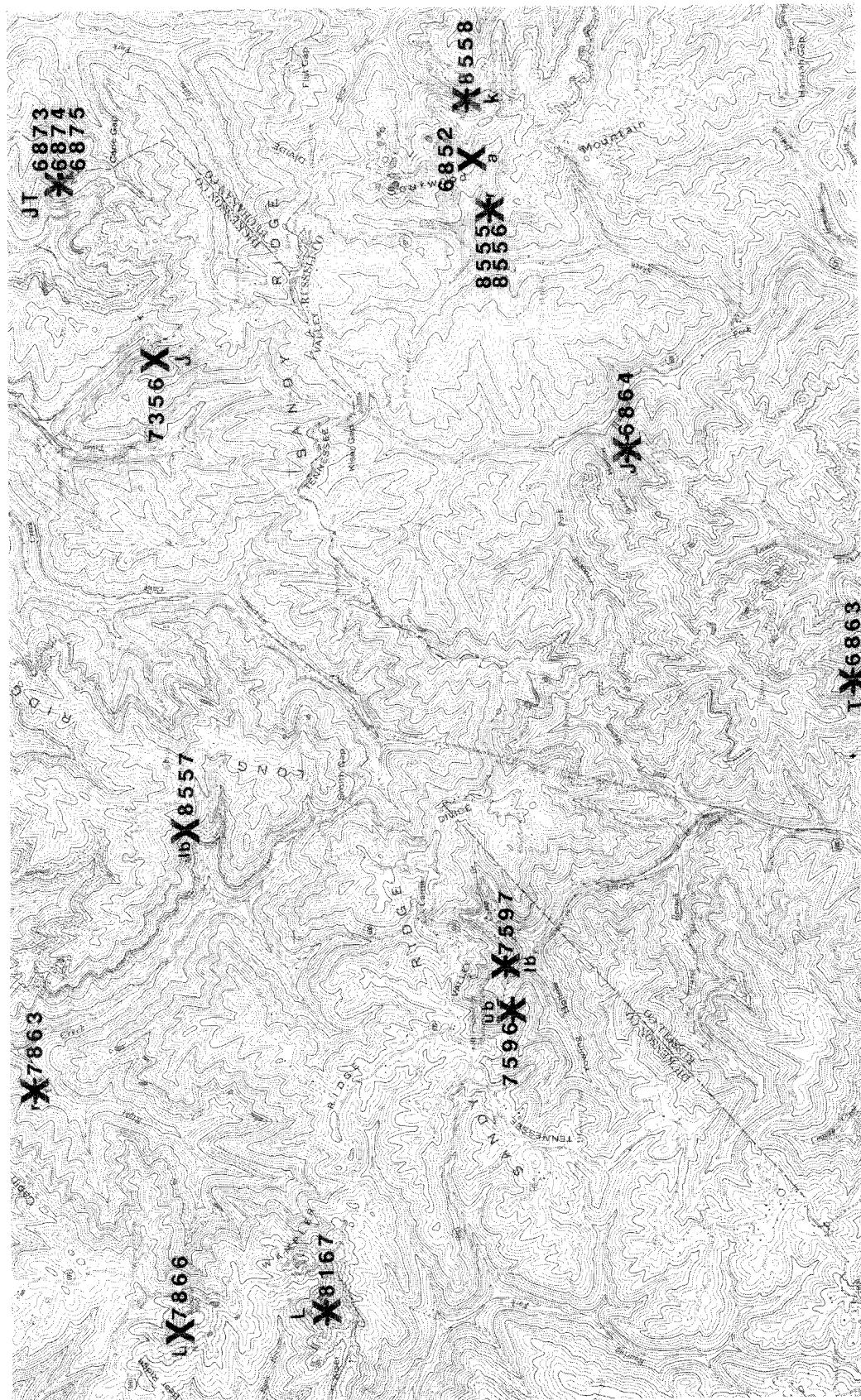
COEBURN, NORTHERN HALF



COEBURN, SOUTHERN HALF



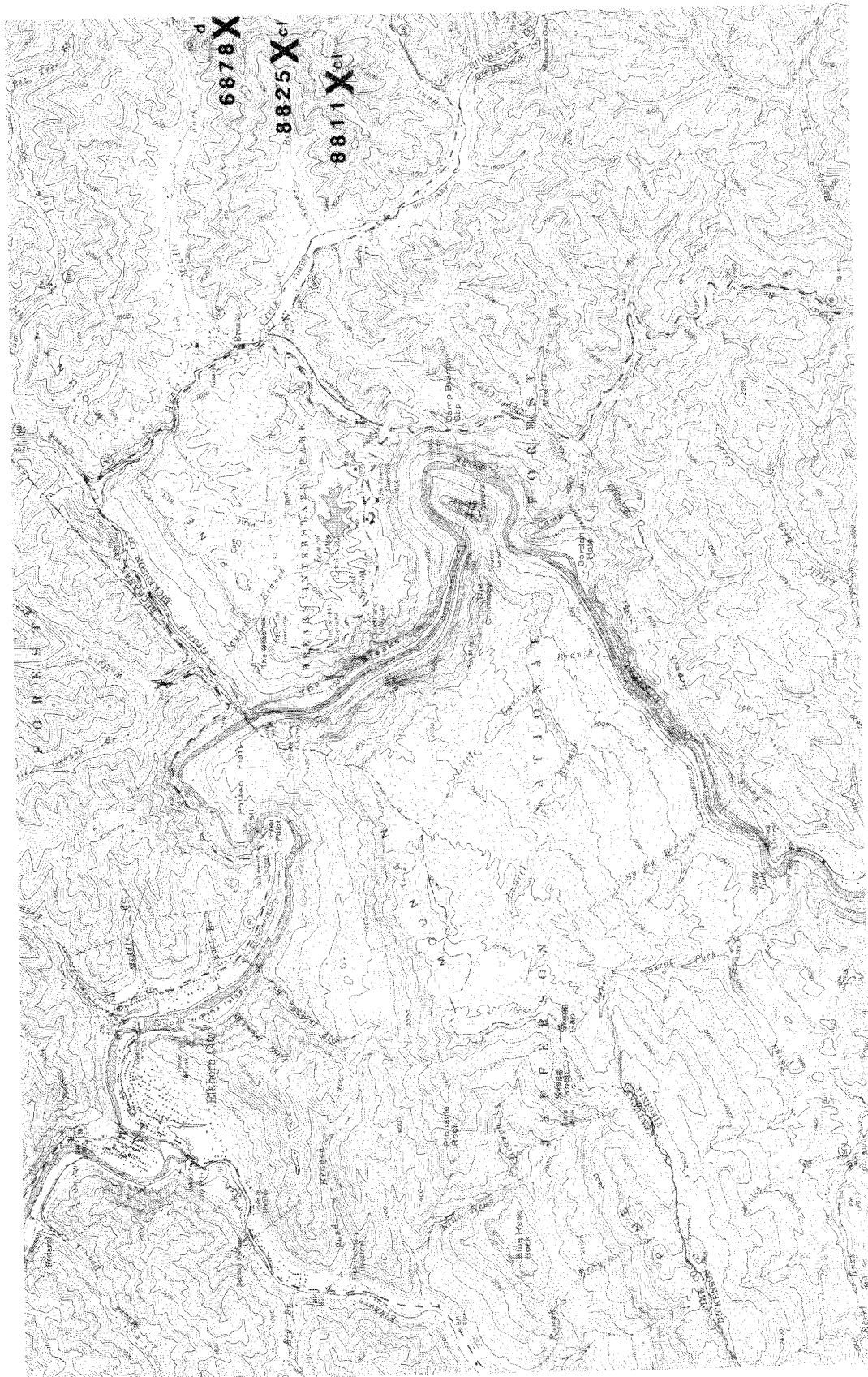
DUTY, NORTHERN HALF



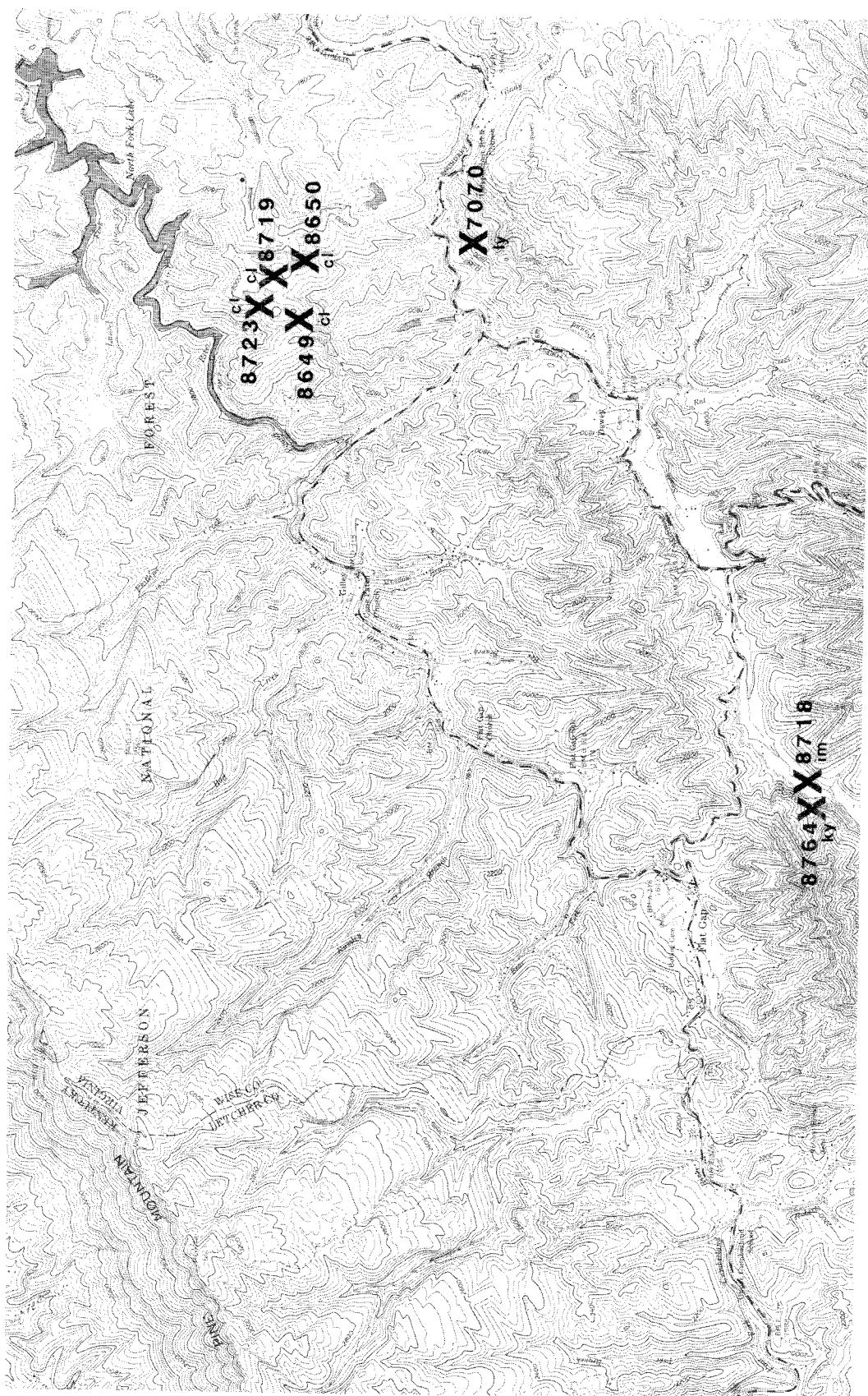
DUTY, SOUTHERN HALF



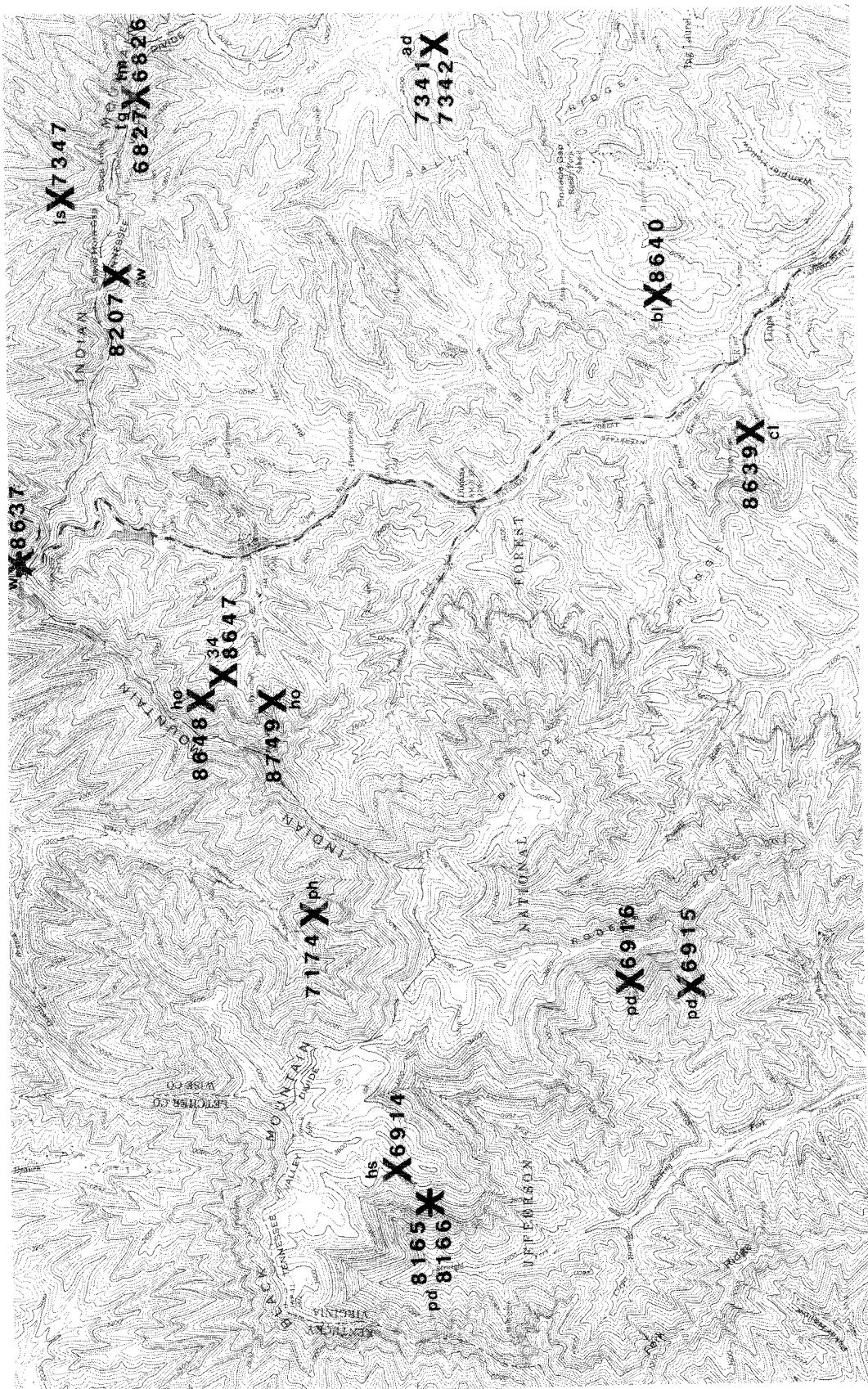
EAST STONE GAP, SOUTHERN HALF



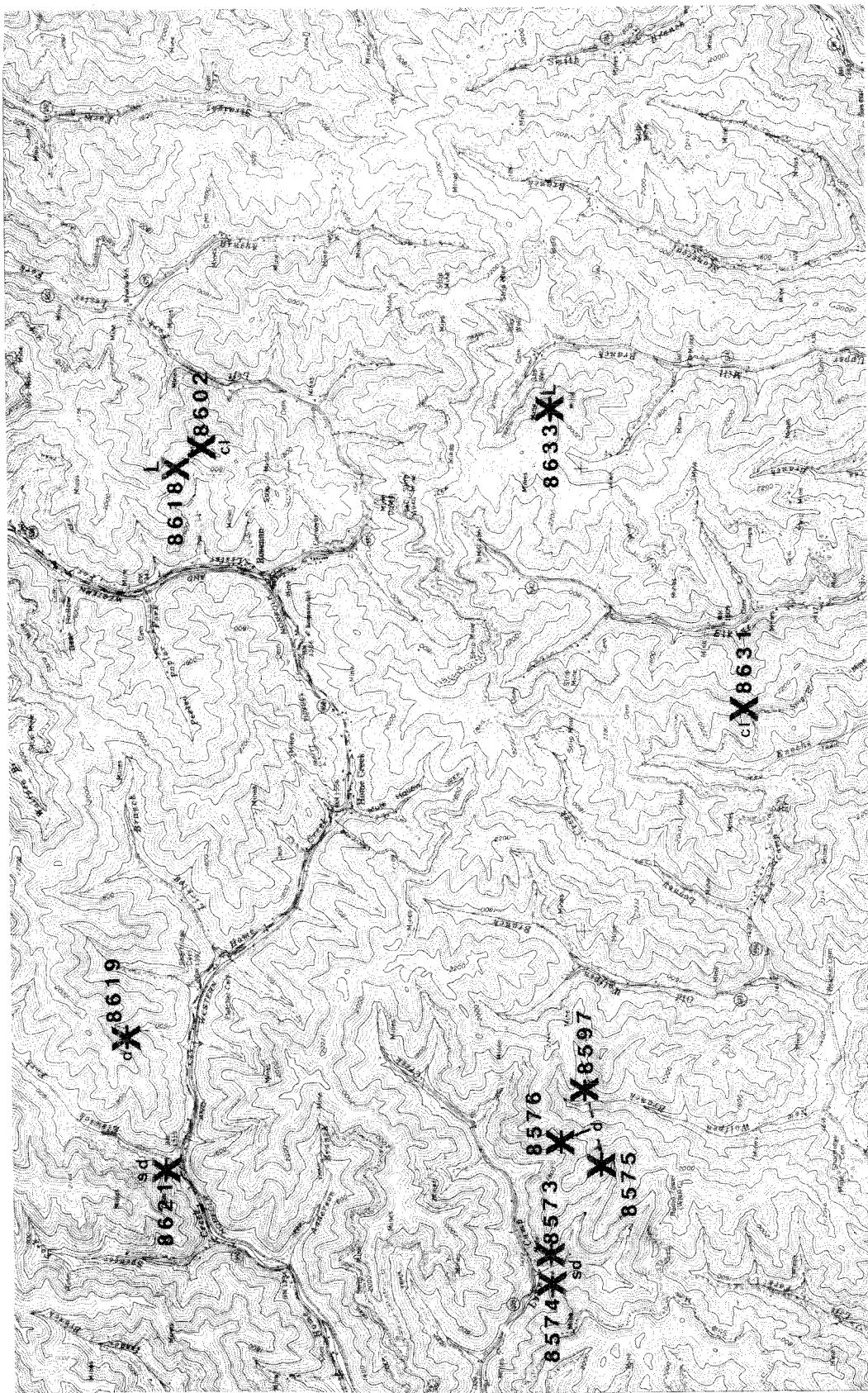
ELKHORN CITY, SOUTHERN HALF



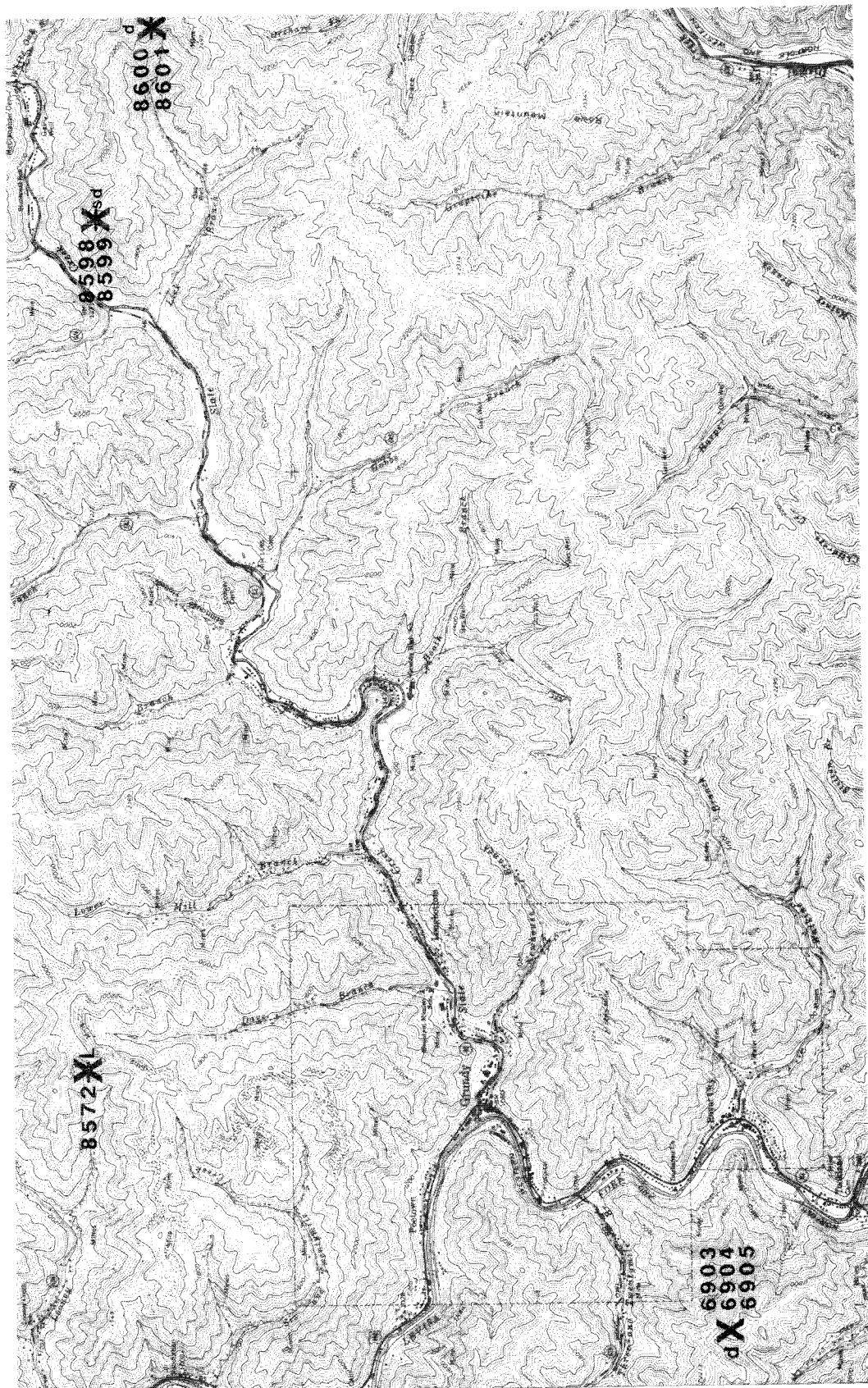
FLAT GAP, NORTHERN HALF

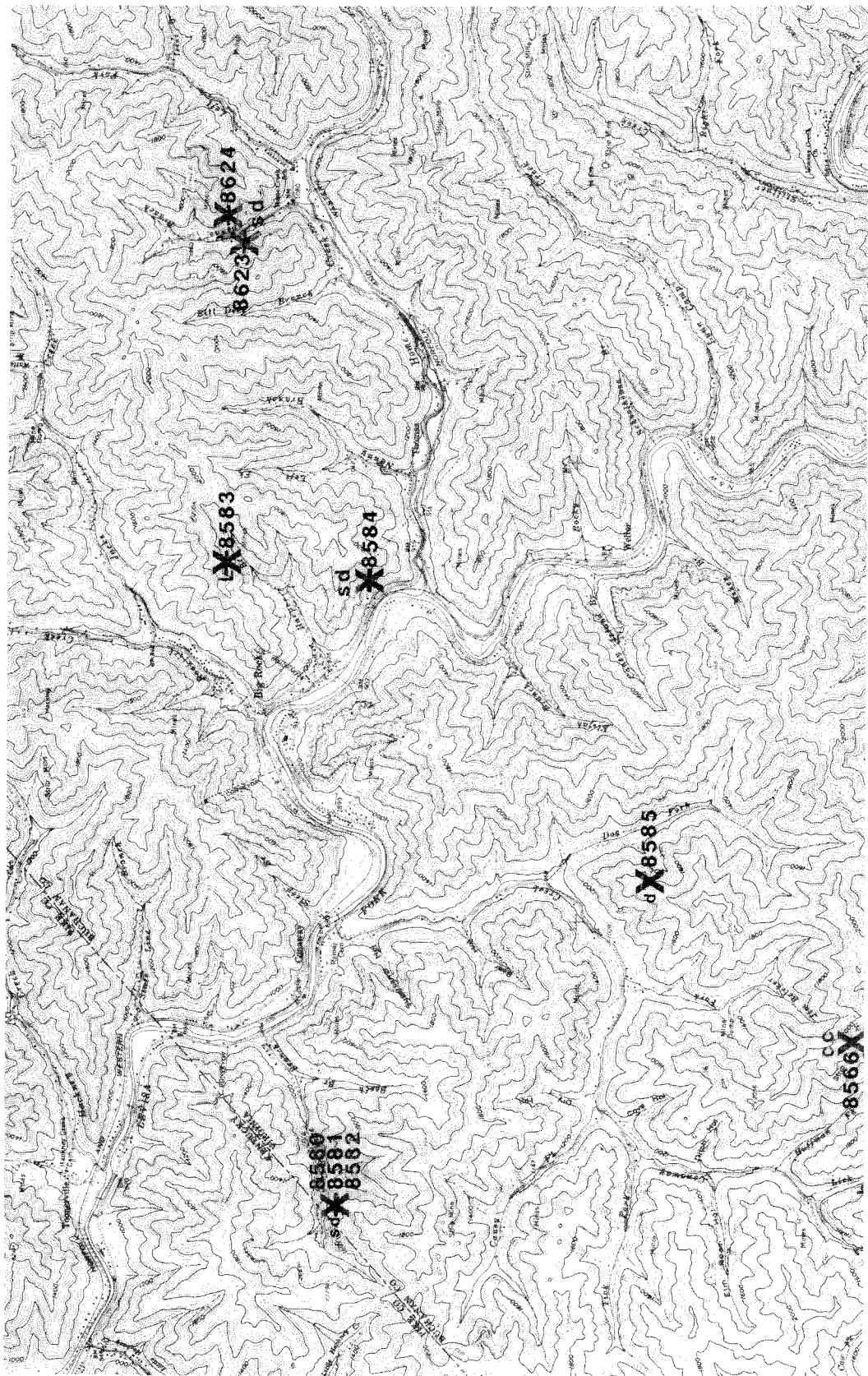


FLAT GAP, SOUTHERN HALF

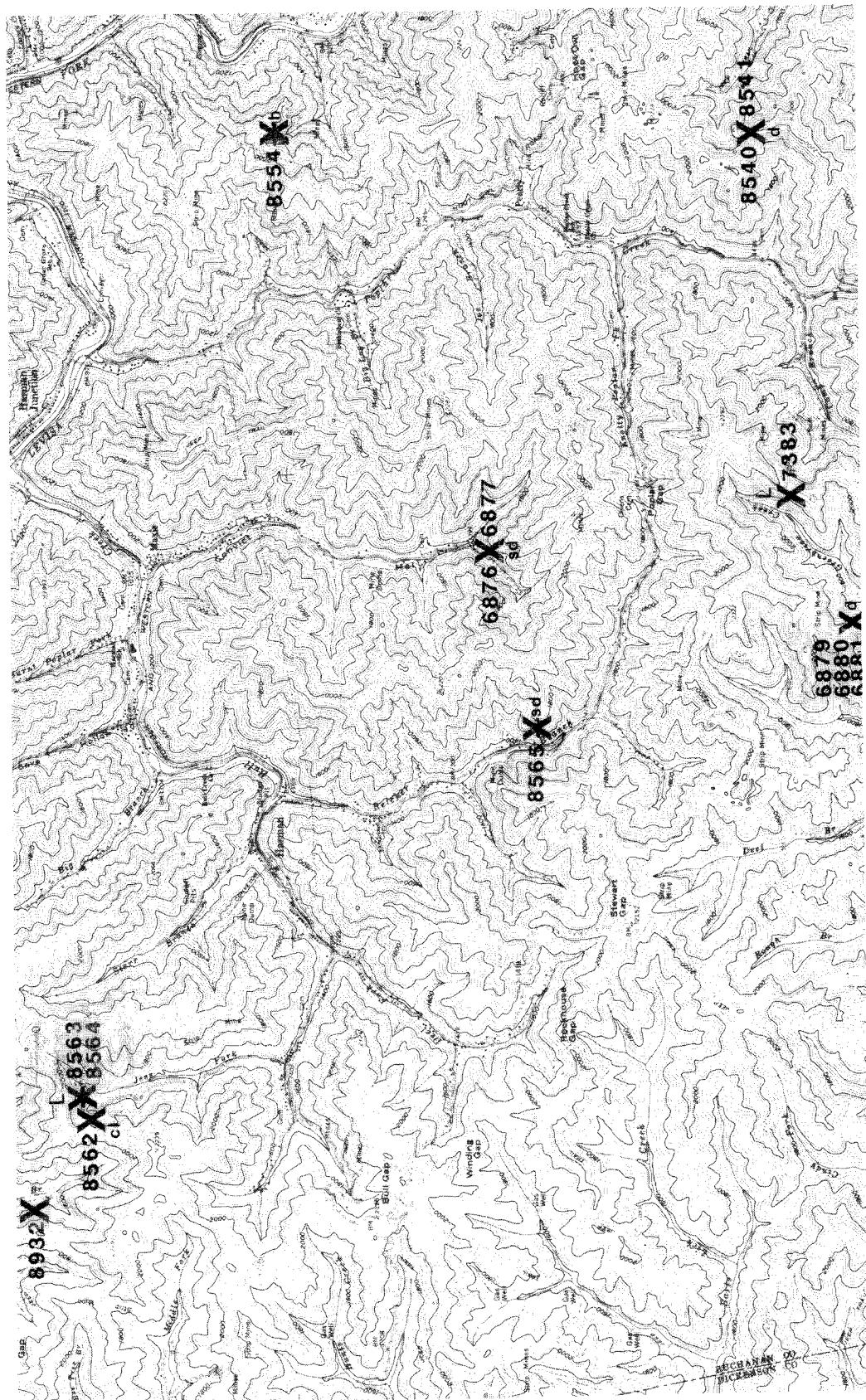


GRUNDY, NORTHERN HALF

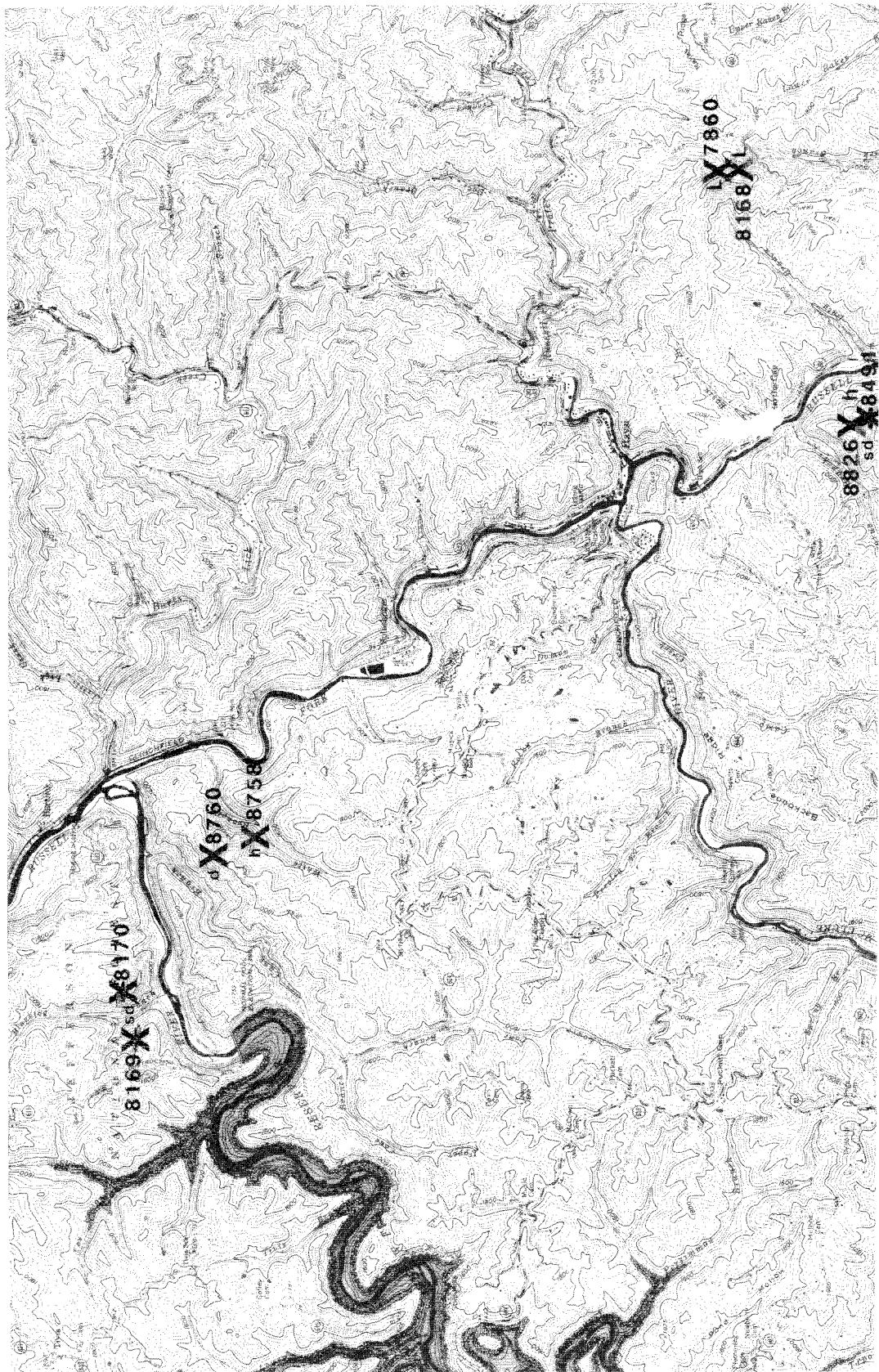




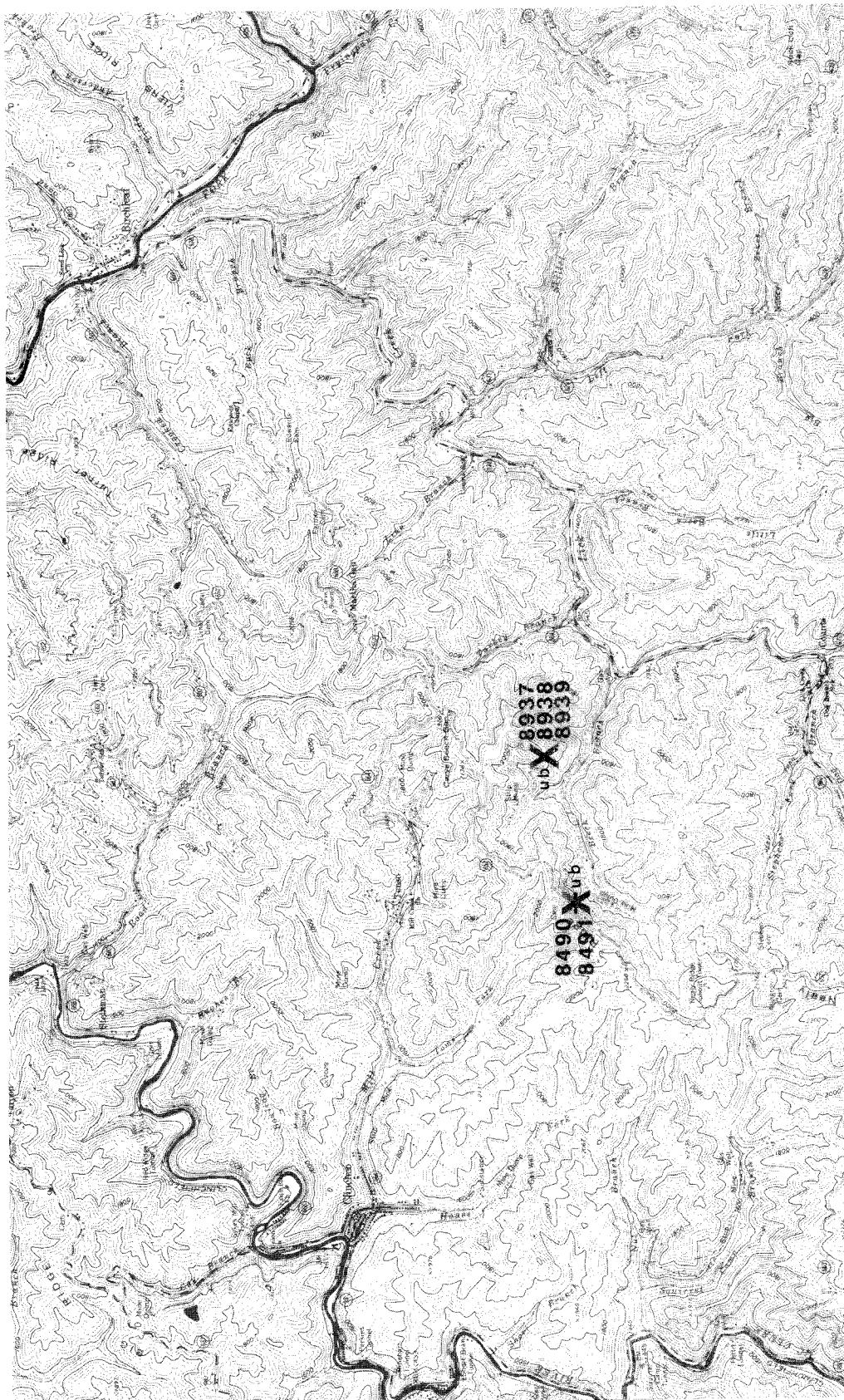
HARMAN, NORTHERN HALF

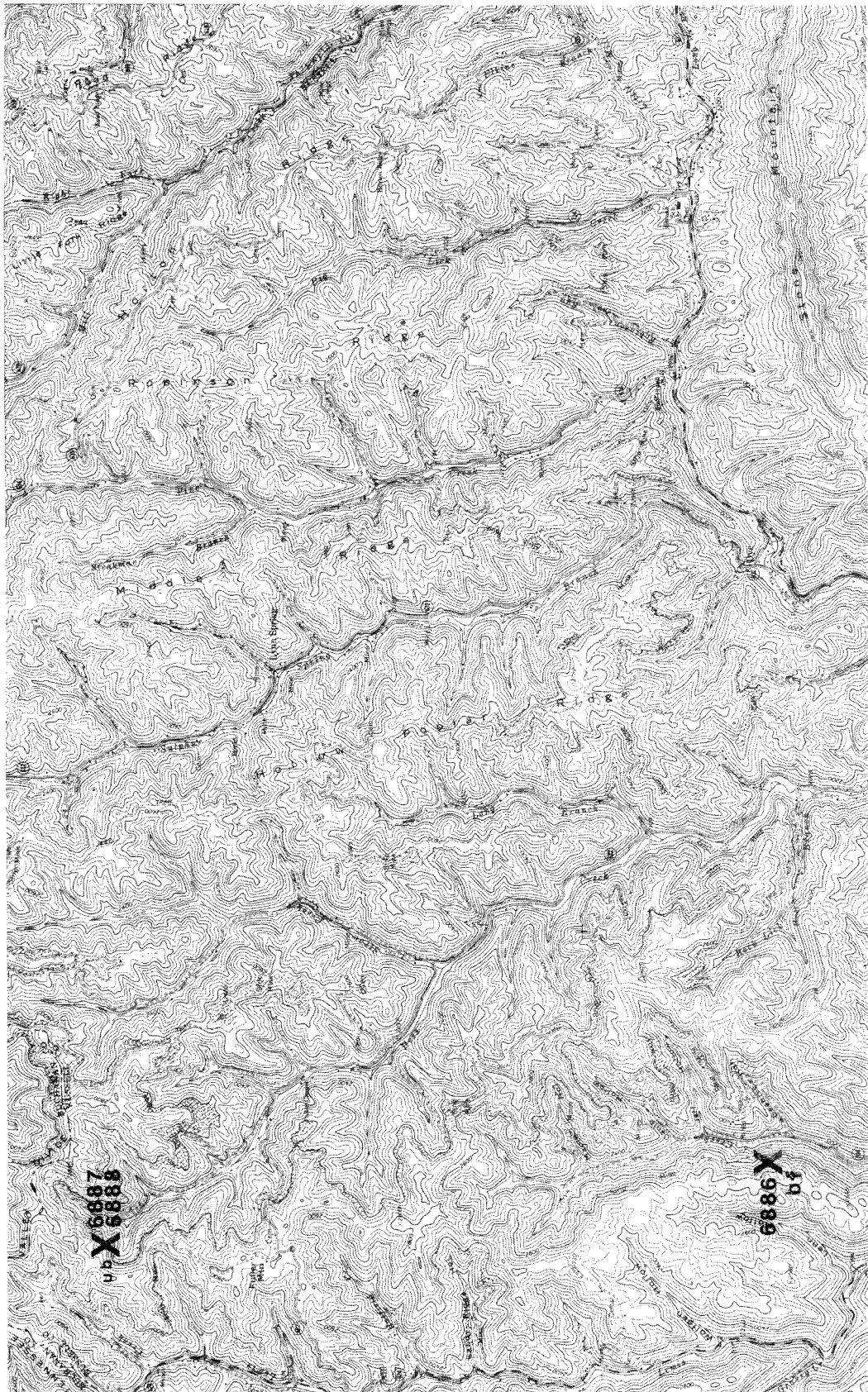


HARMAN, SOUTHERN HALF

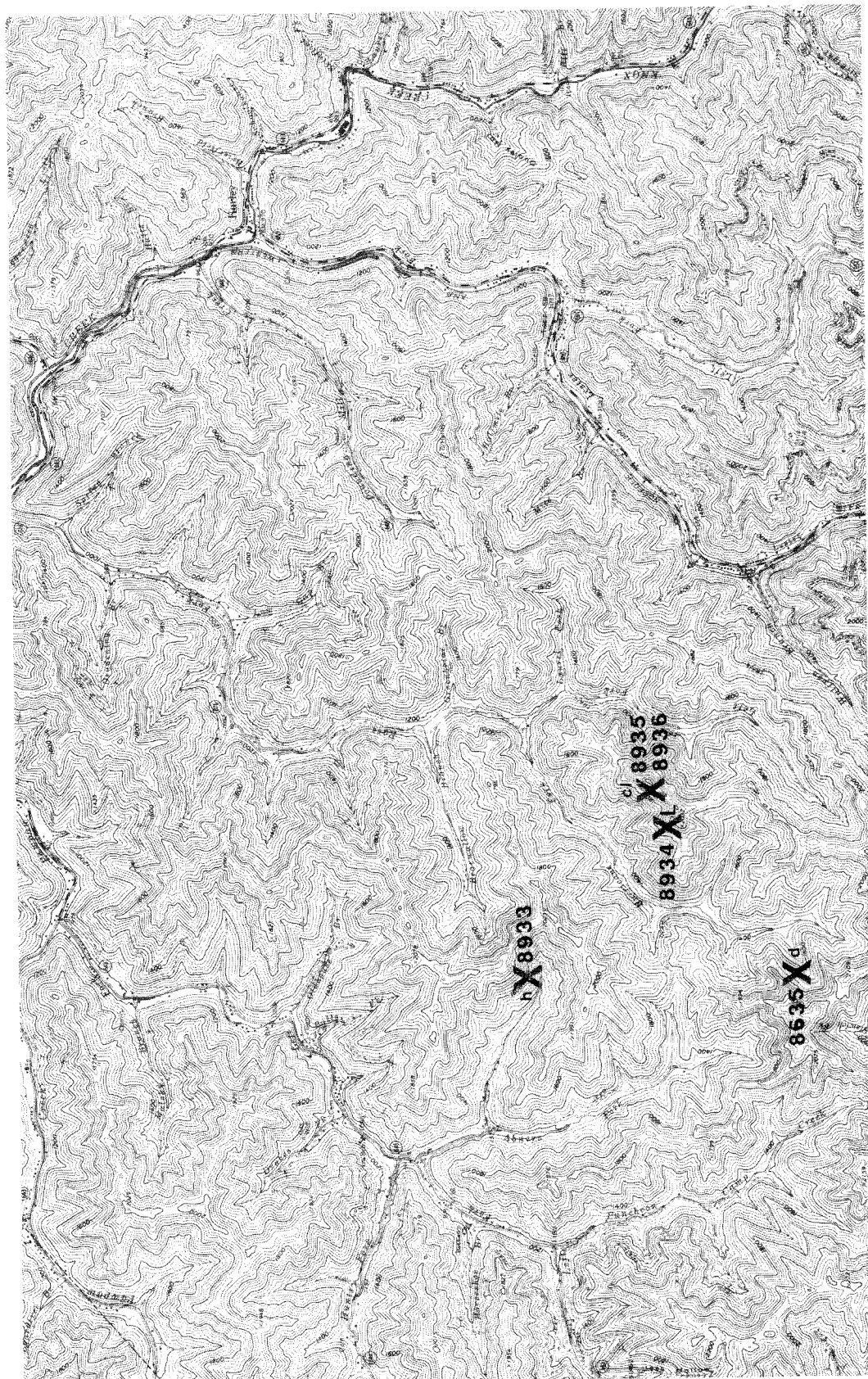


HAYSI, NORTHERN HALF

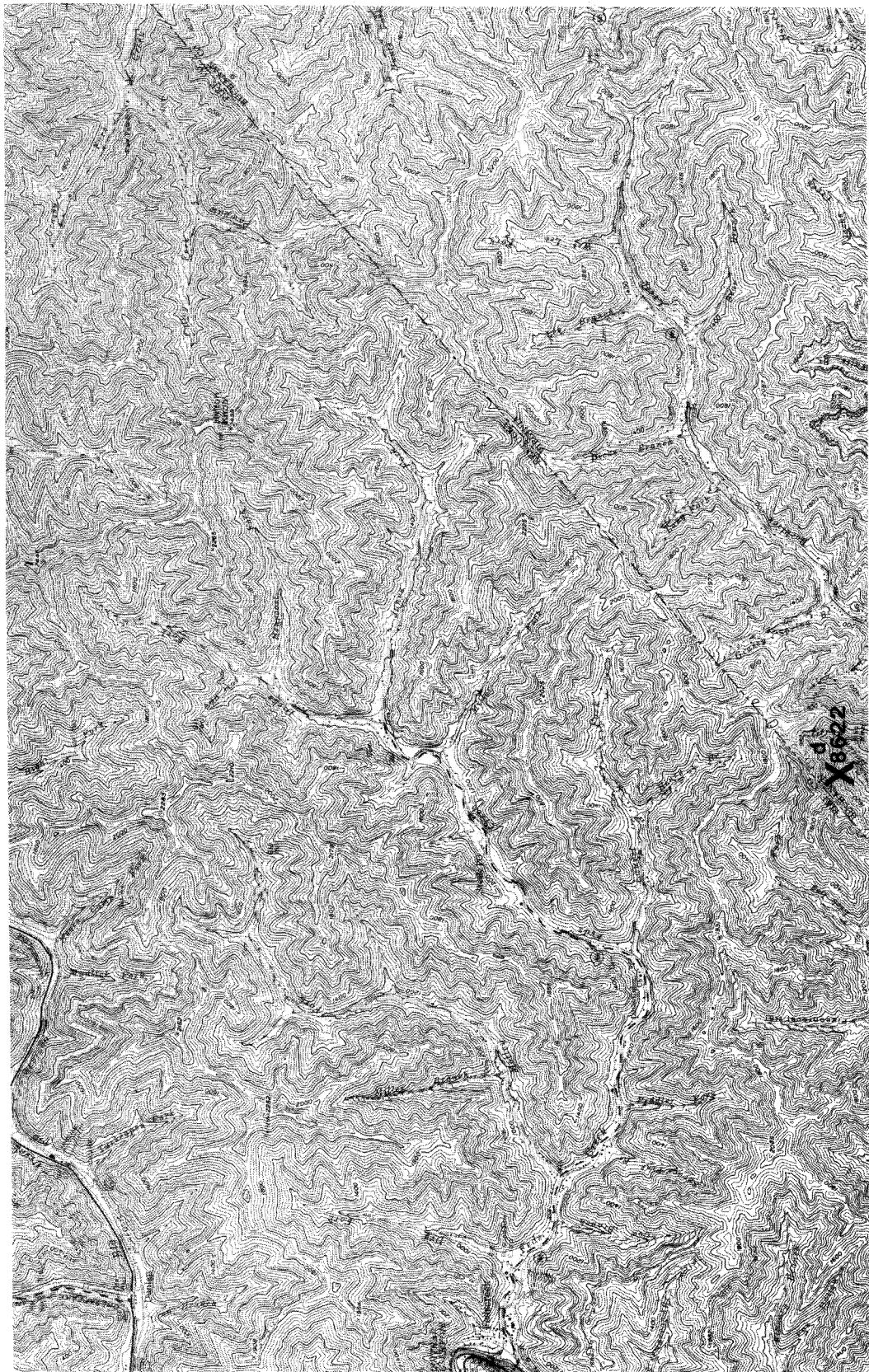




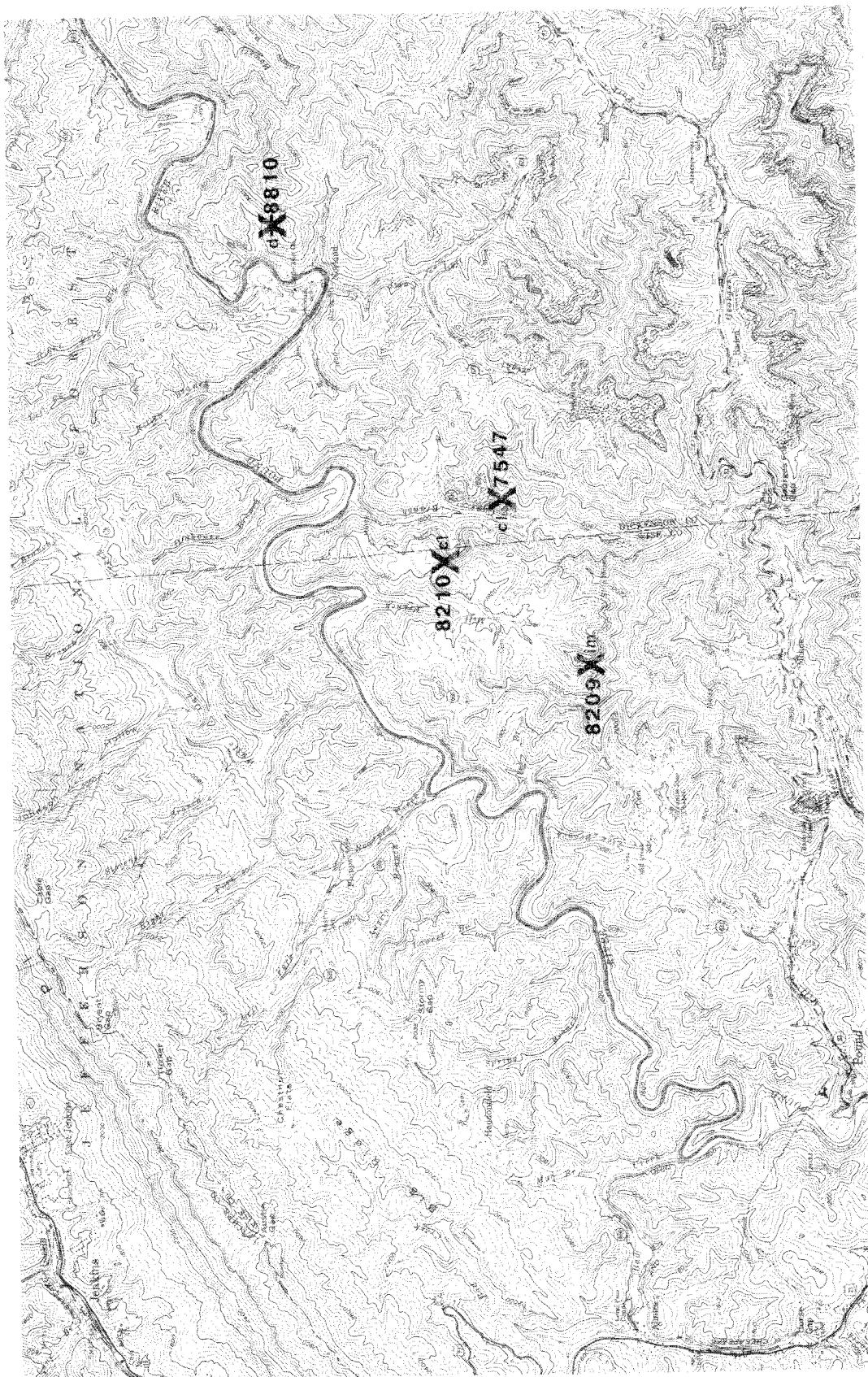
HONAKER, NORTHERN HALF



HURLEY, SOUTHERN HALF



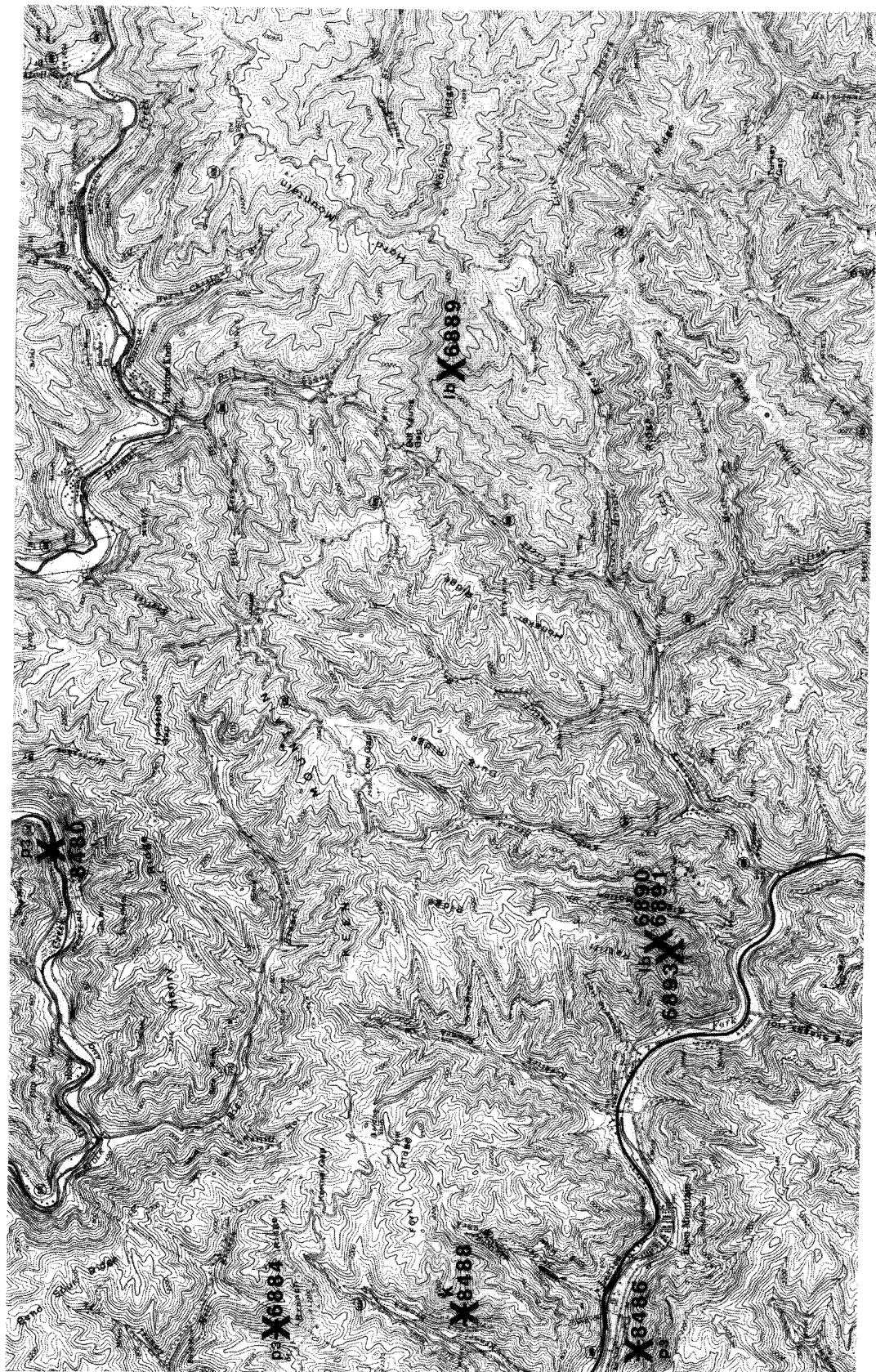
JAMBOREE, SOUTHERN HALF



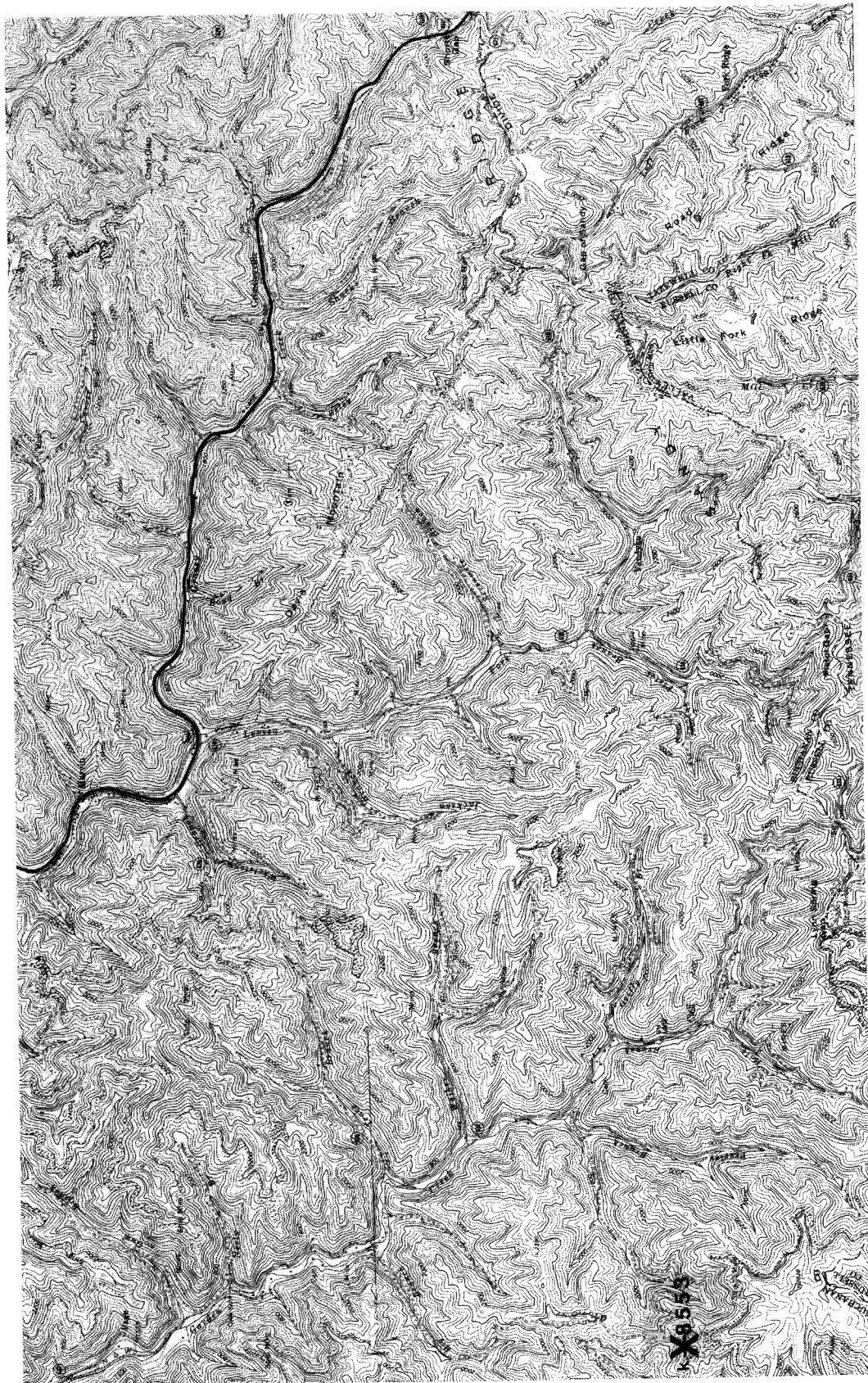
JENKINS EAST, SOUTHERN HALF



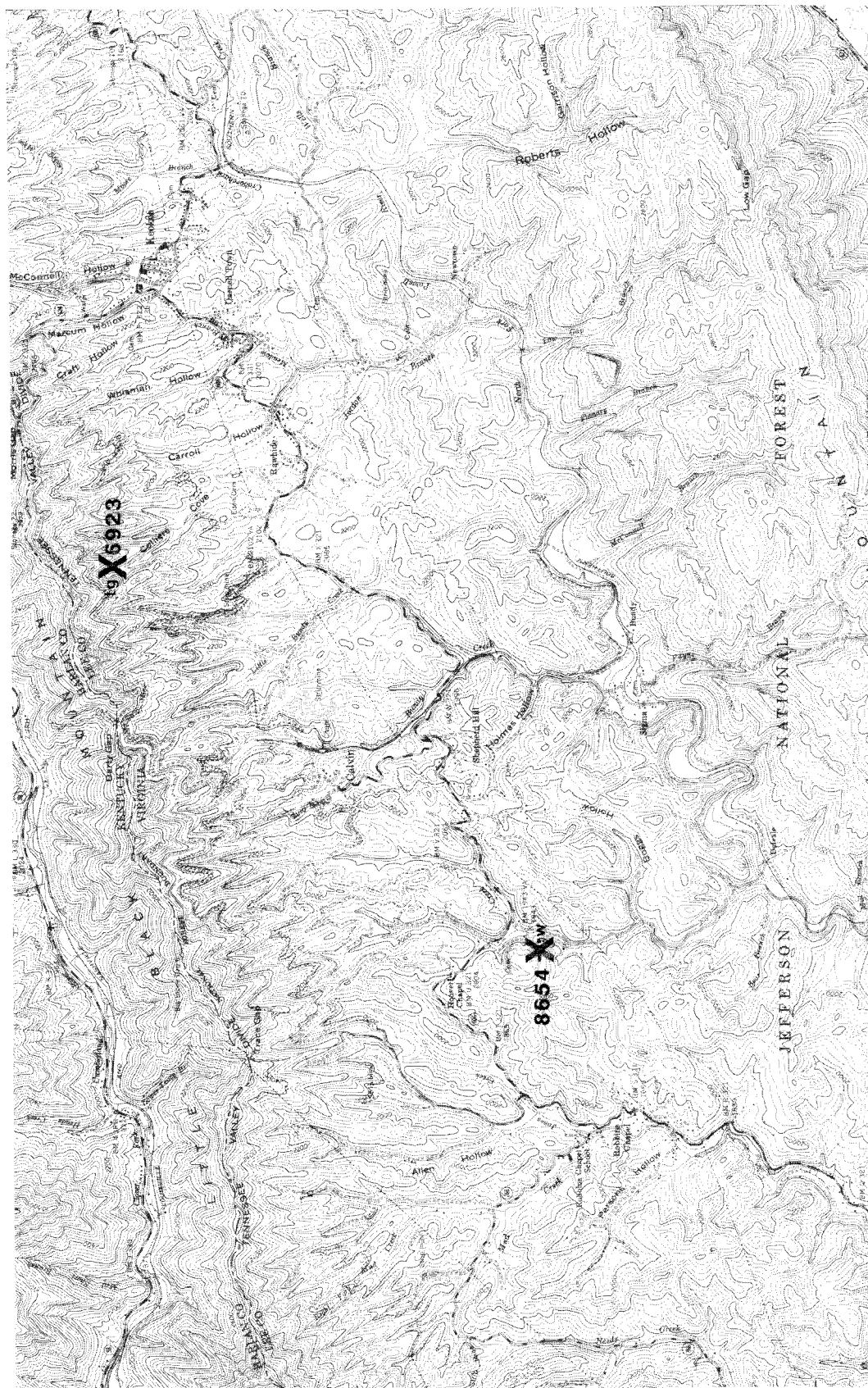
JEWELL RIDGE, NORTHERN HALF



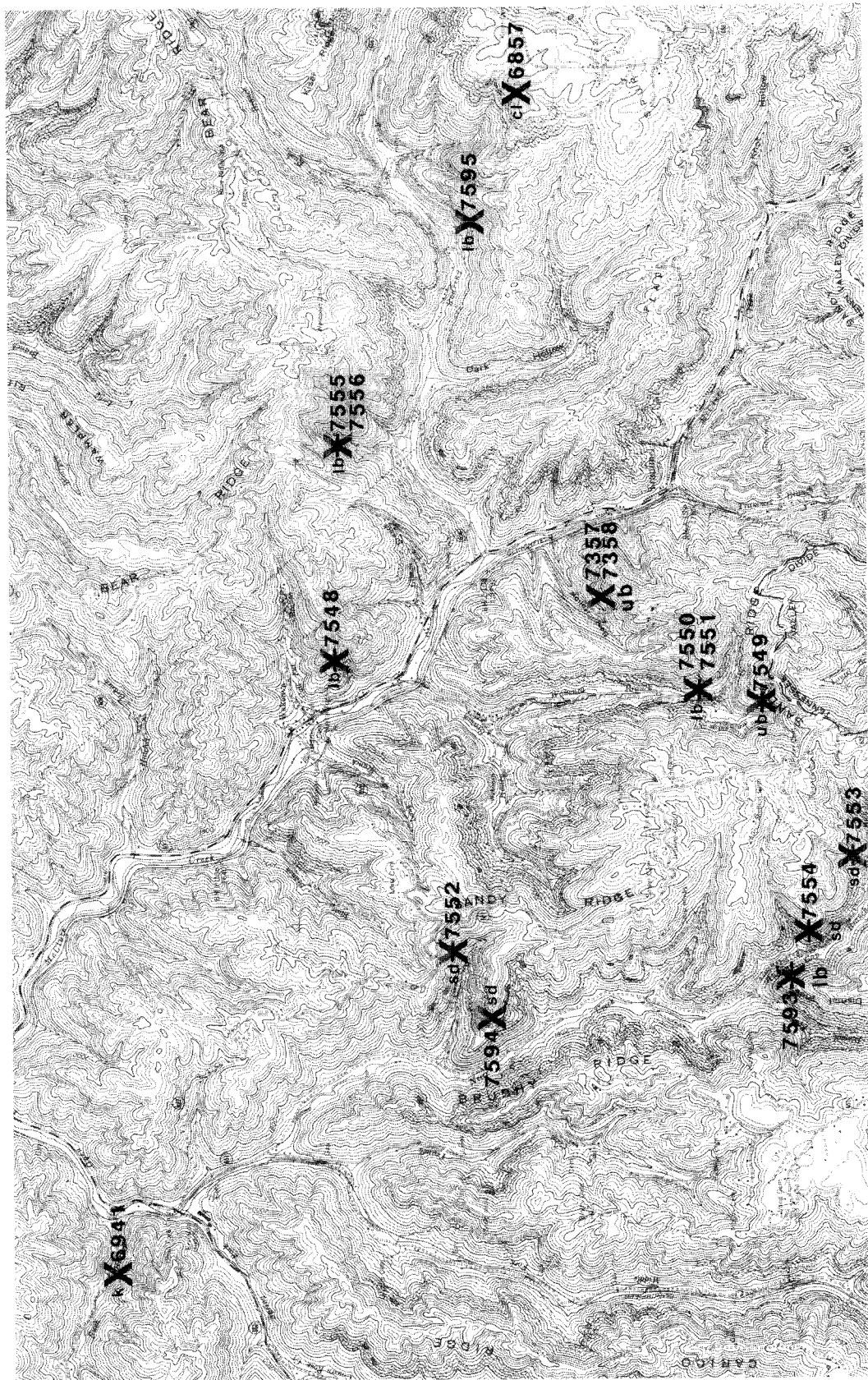
KEEN MOUNTAIN, NORTHERN HALF



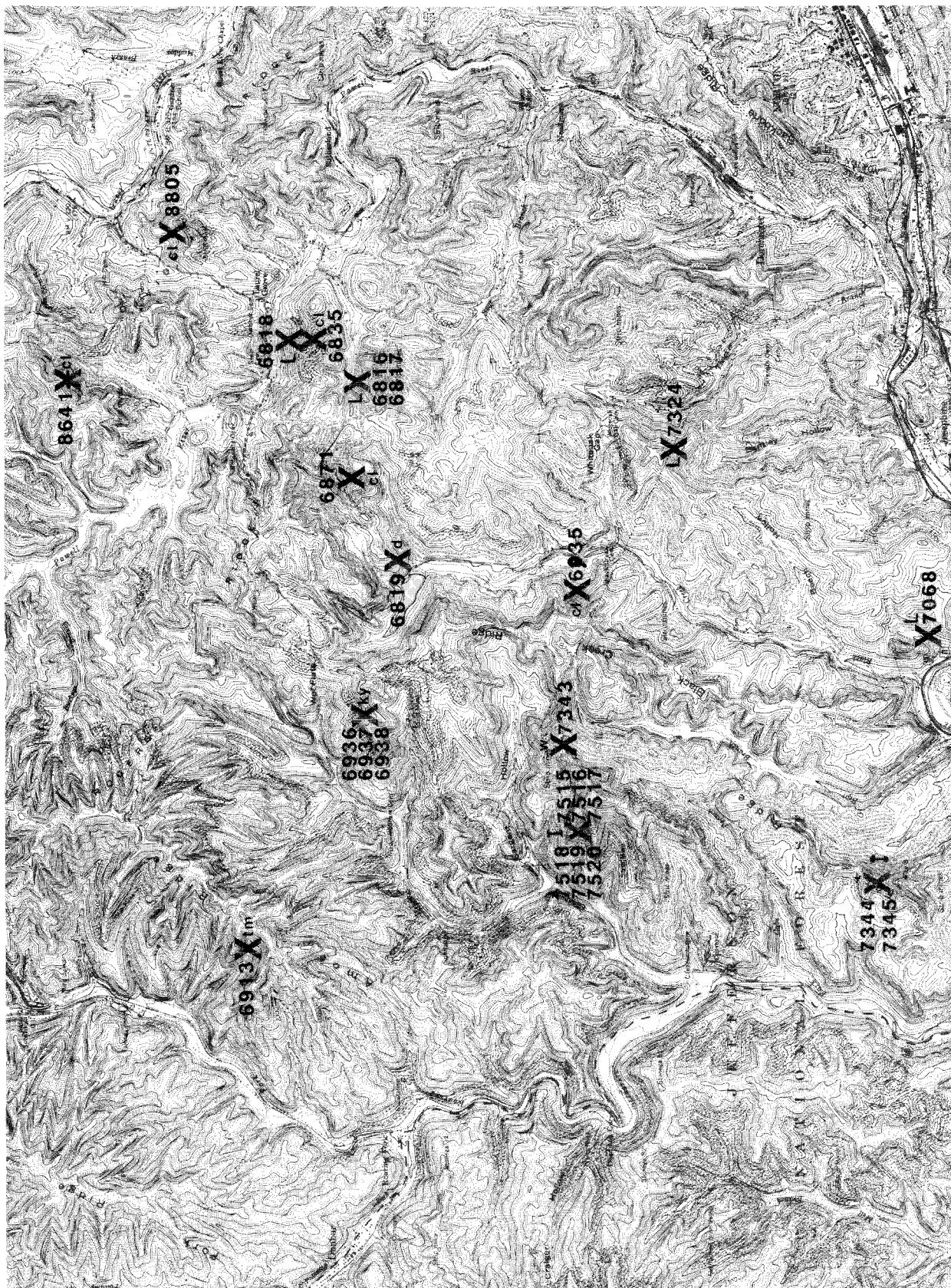
KEEN MOUNTAIN, SOUTHERN HALF



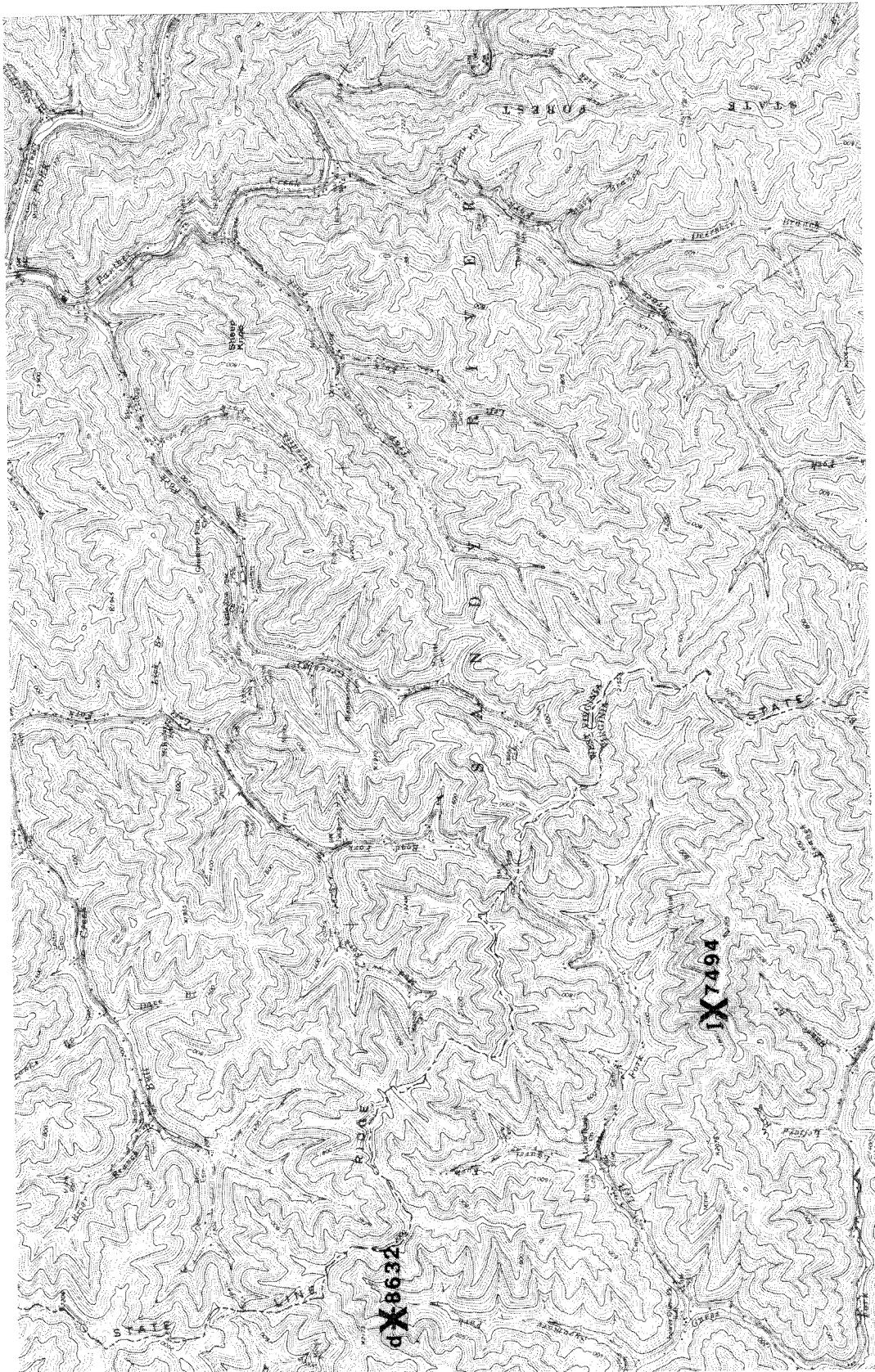
KEOKEE, NORTHERN HALF



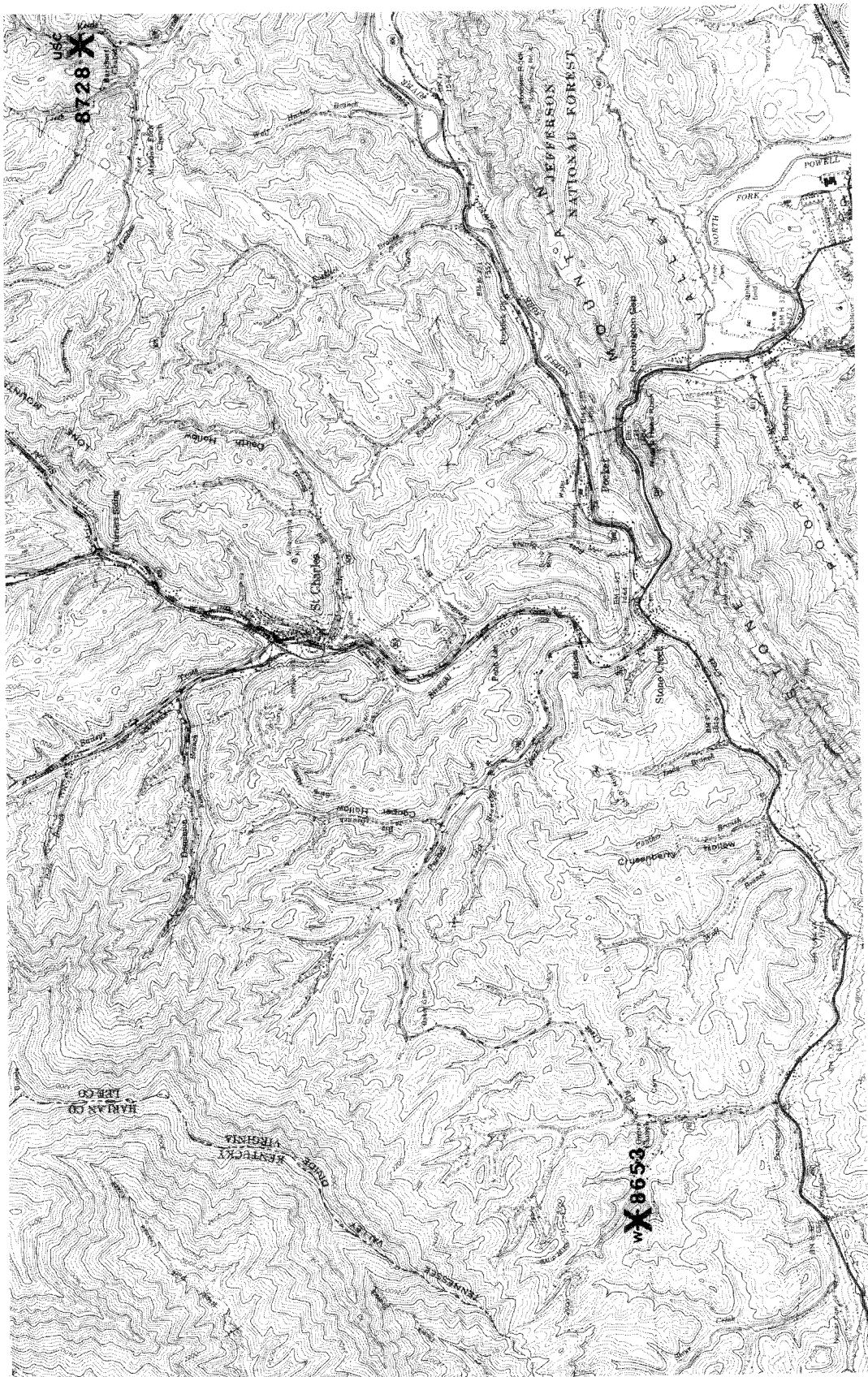
NORA, SOUTHERN HALF



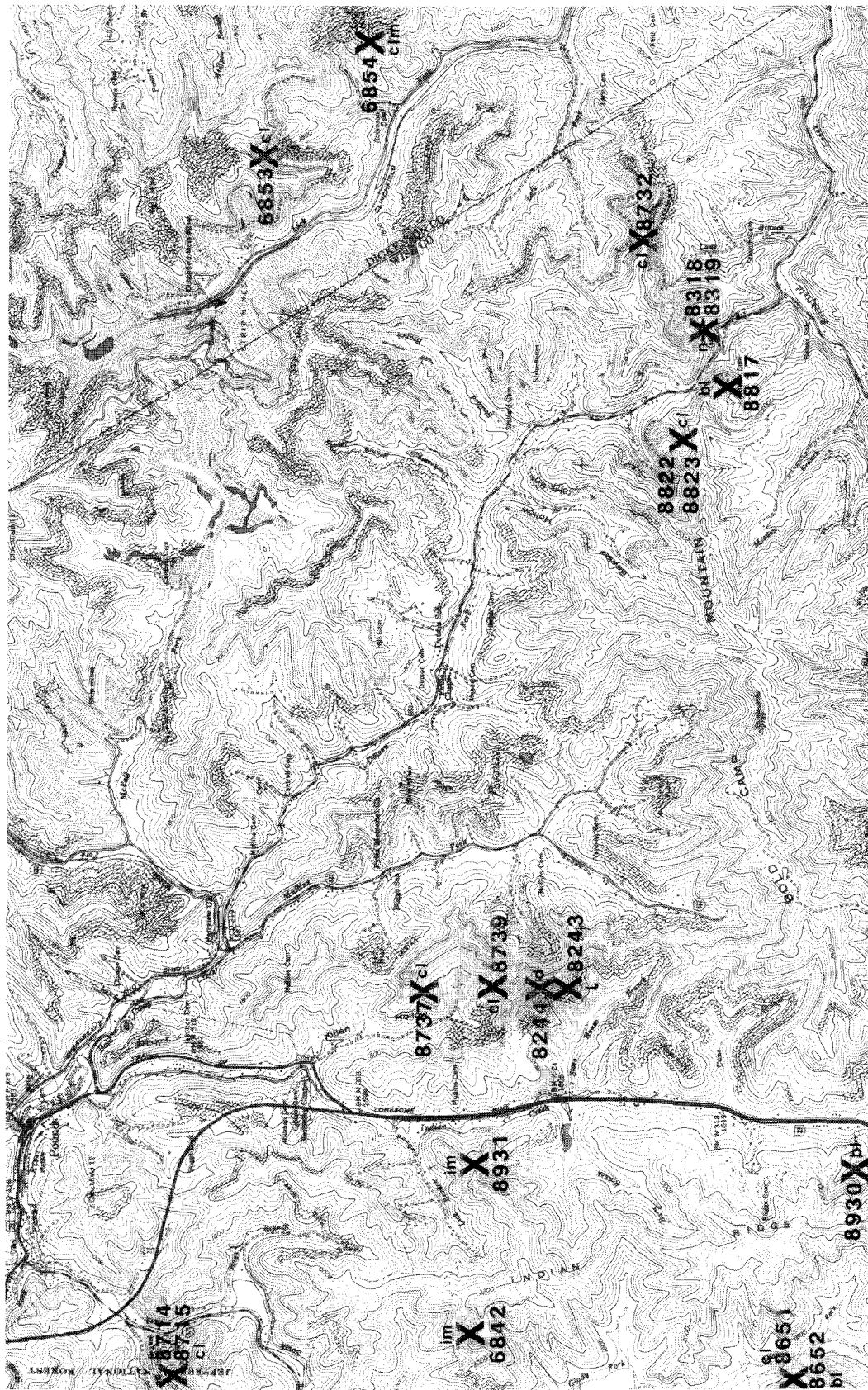
NORTON, NORTHERN HALF



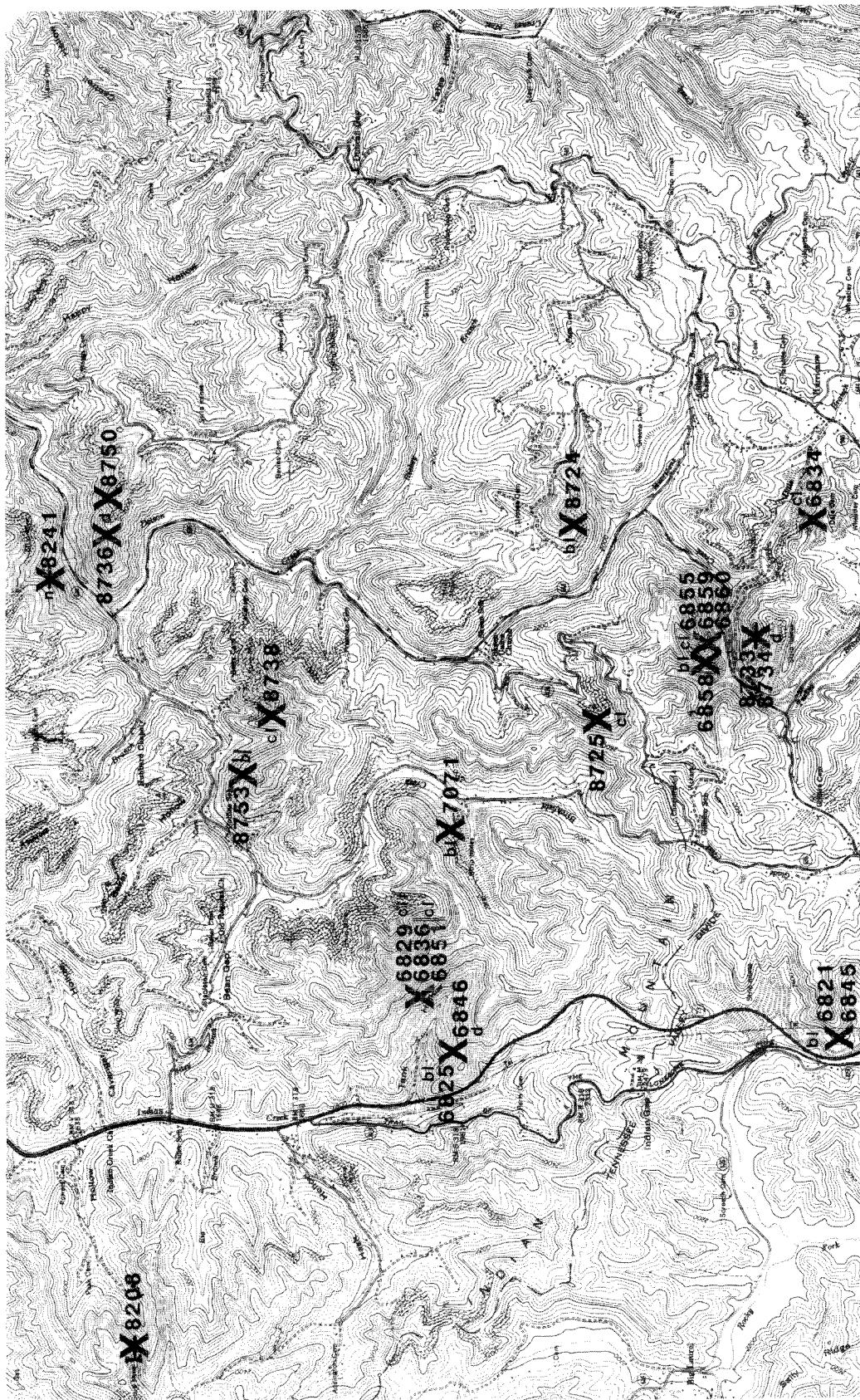
PANTHER, CENTRAL PORTION



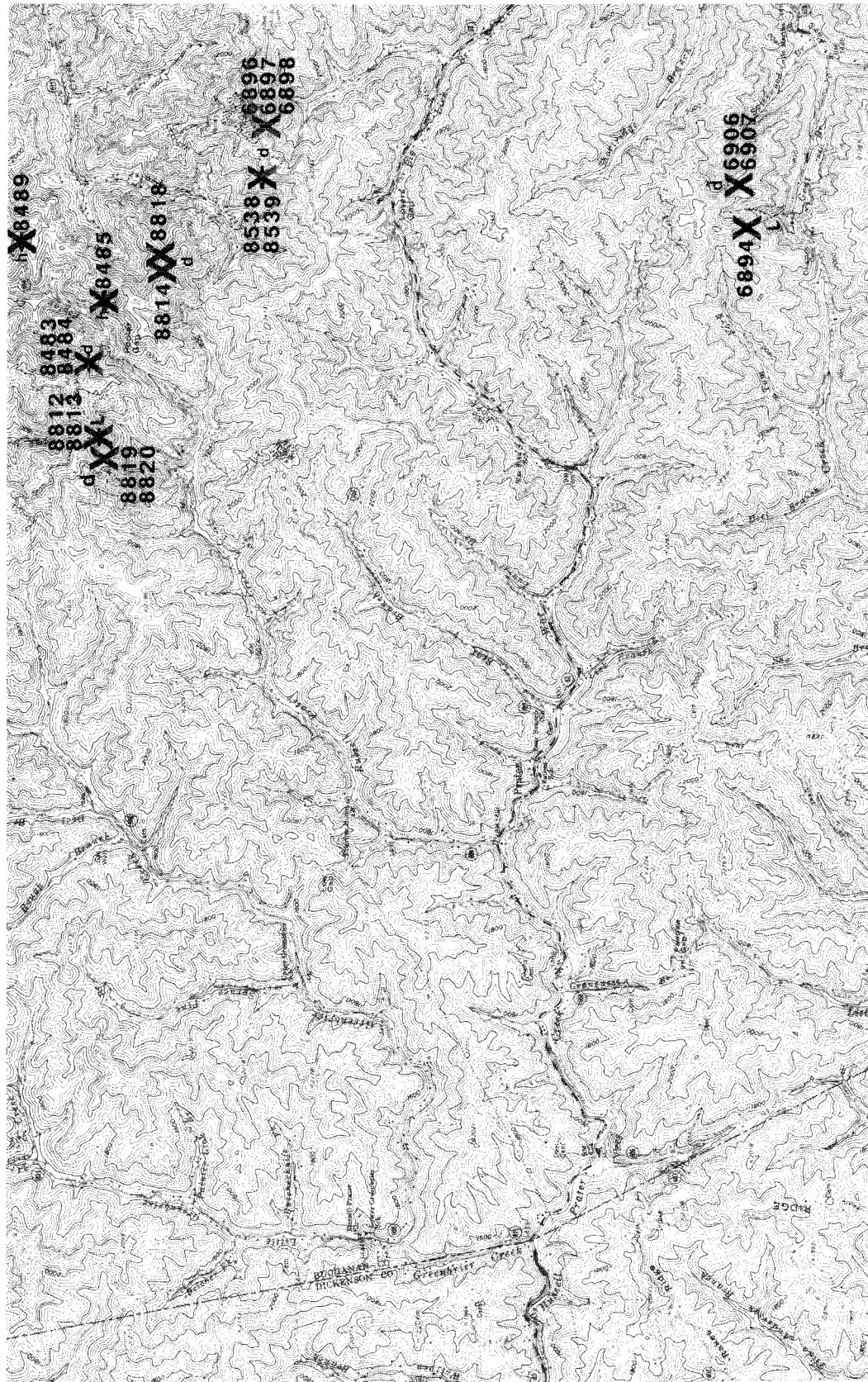
PENNINGTON GAP, CENTRAL PORTION



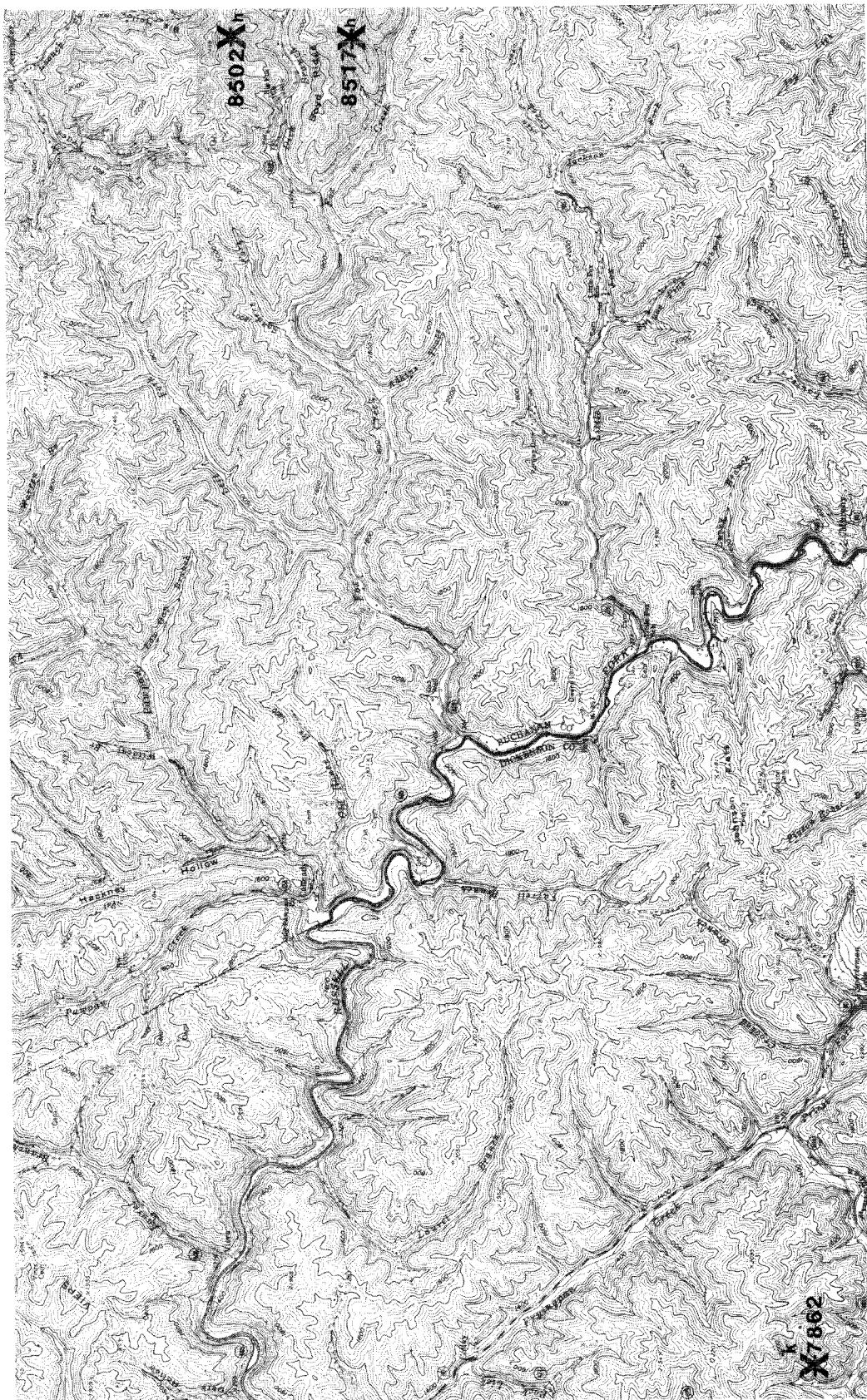
POUND, NORTHERN HALF



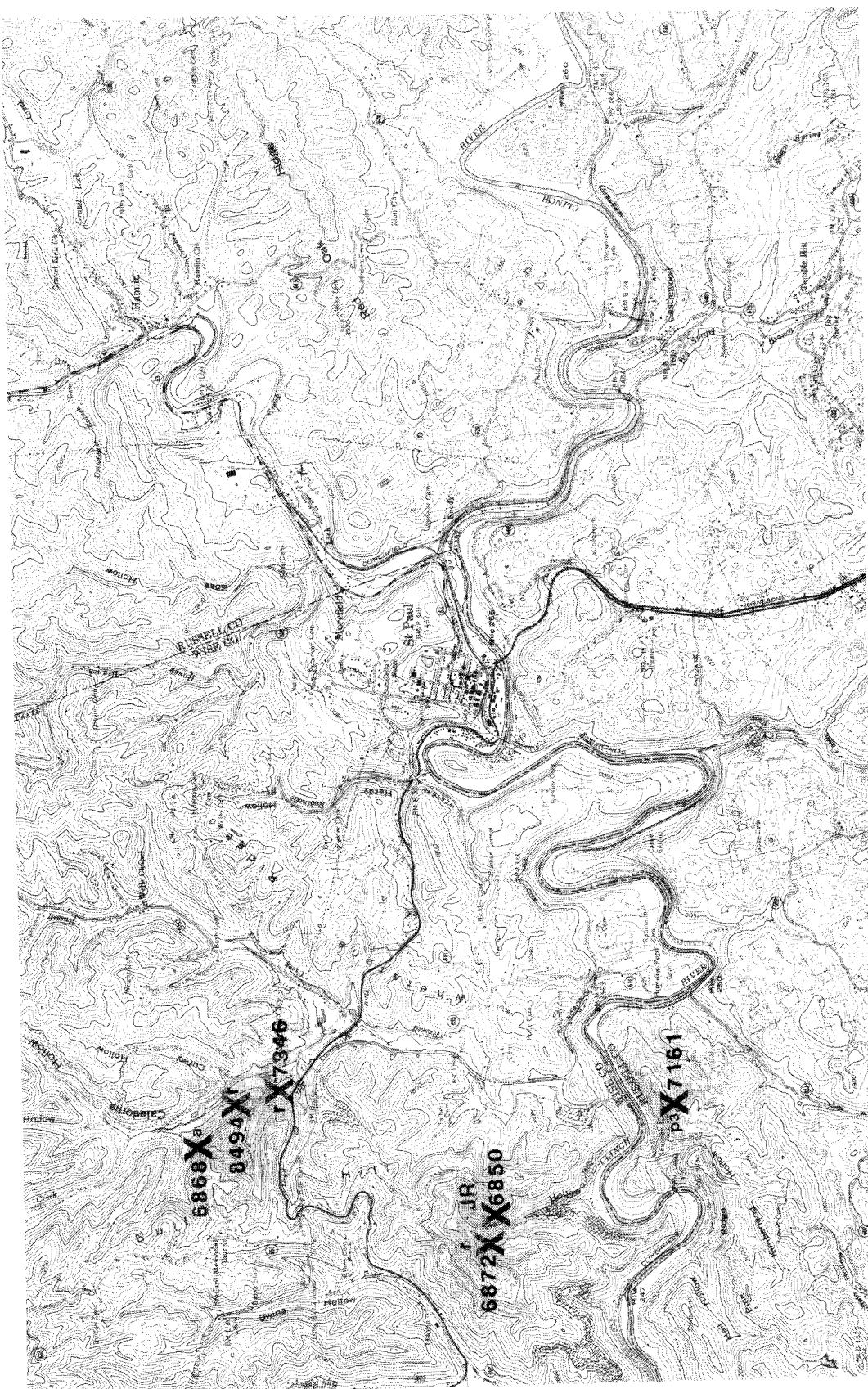
POUND, SOUTHERN HALF



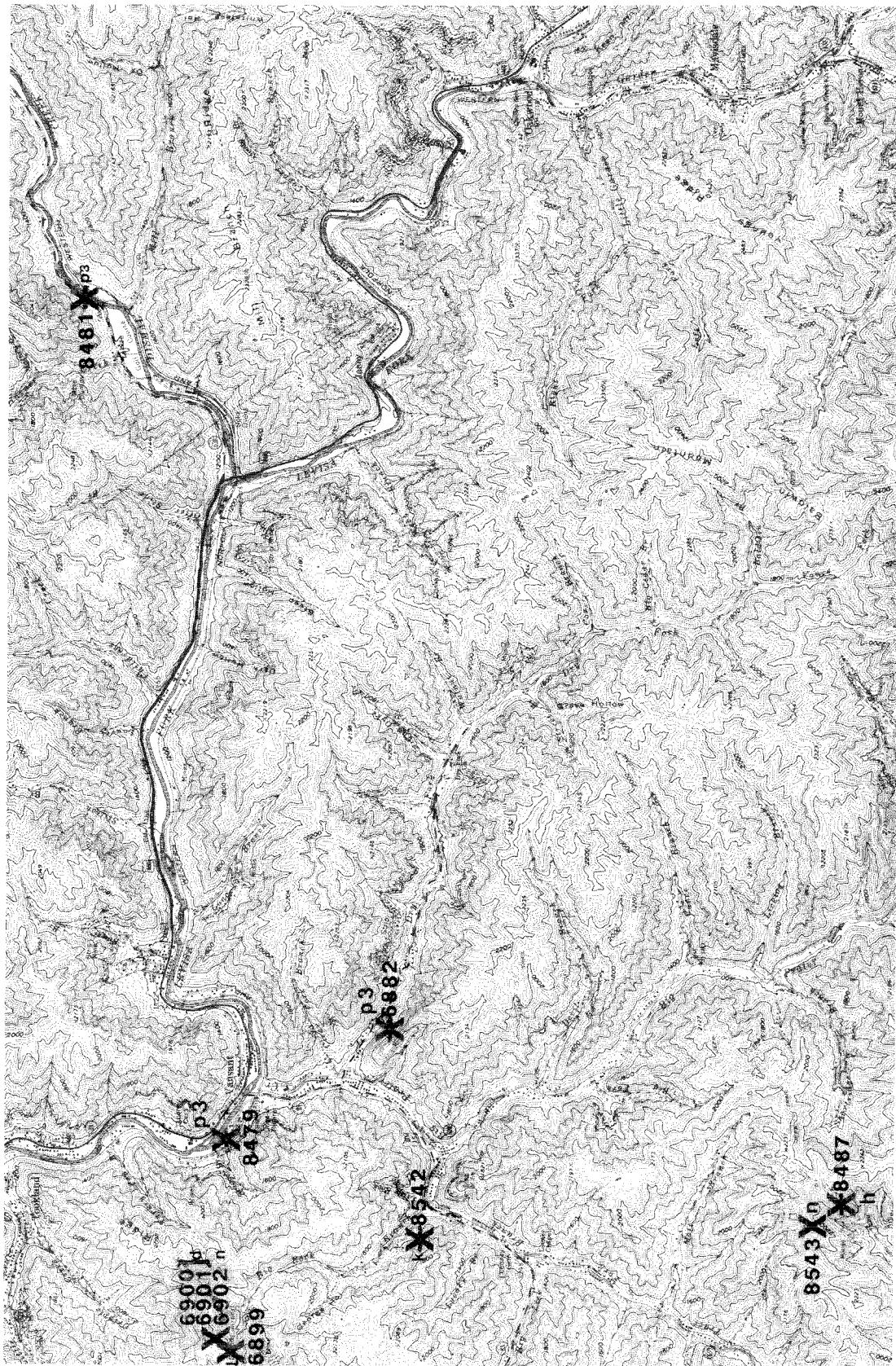
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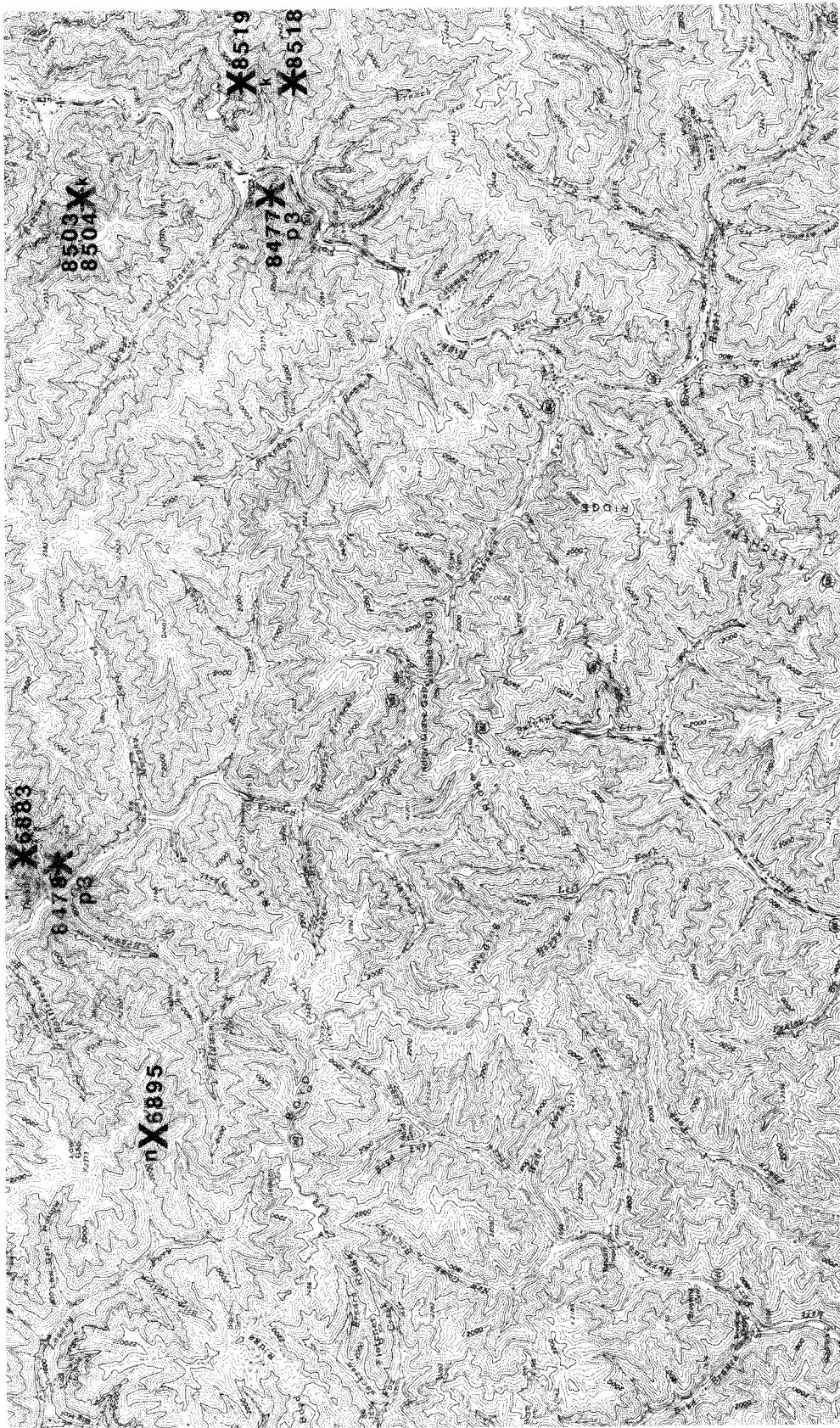
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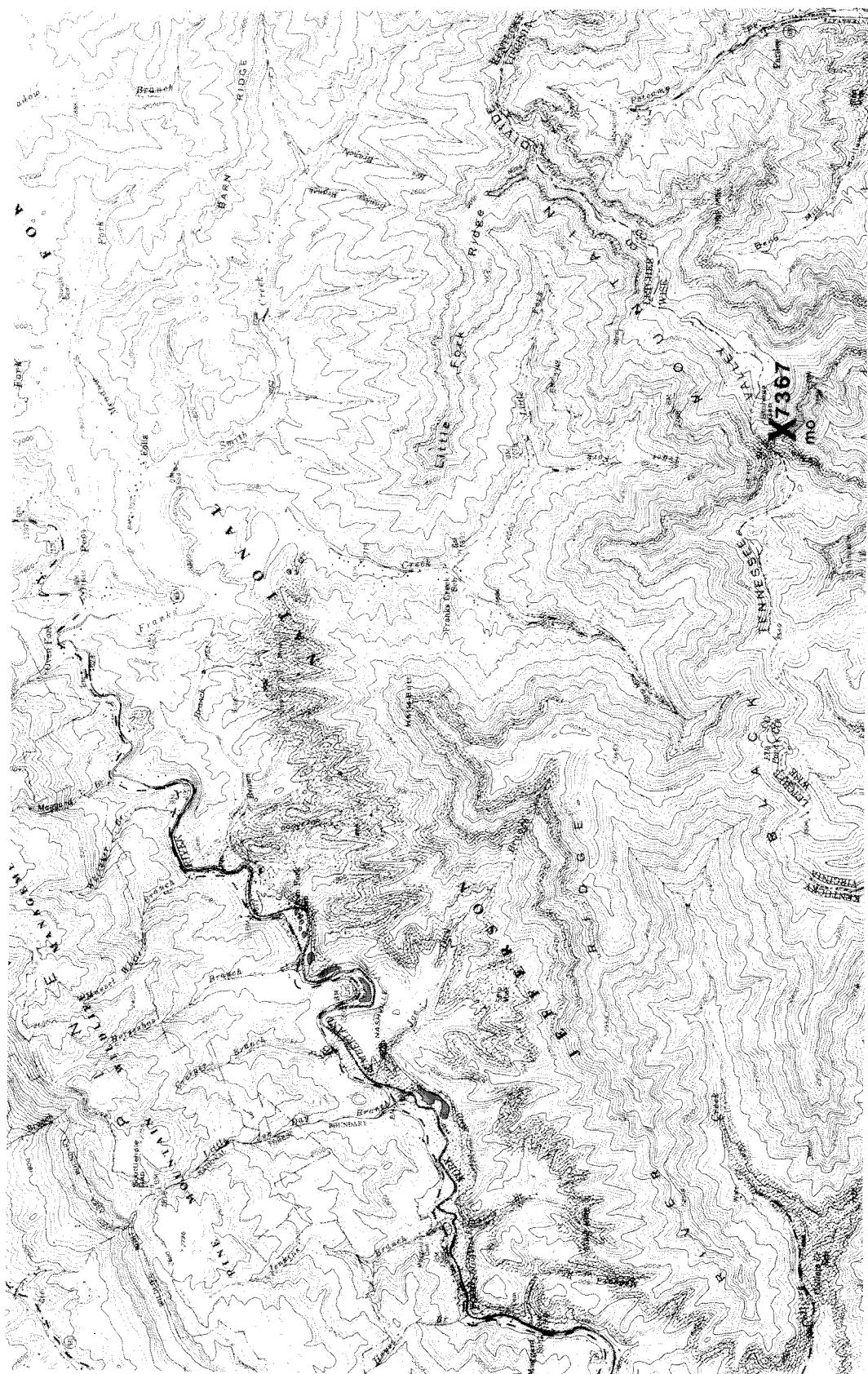
ST. PAUL, SOUTHERN HALF



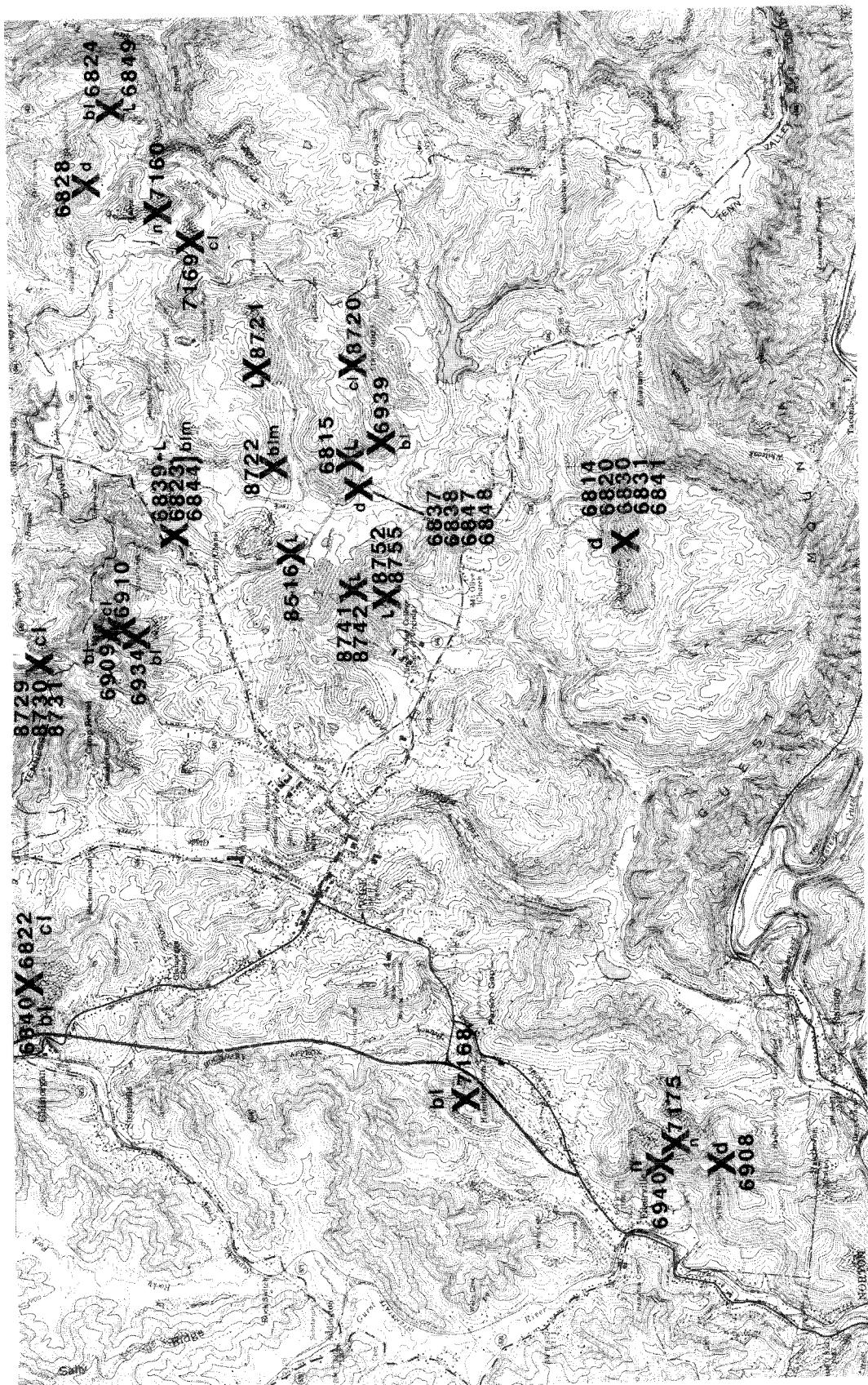
VANSANT, NORTHERN HALF



VANSANT, SOUTHERN HALF



WHITESBURG, SOUTHERN HALF



WISE, NORTHERN HALF

APPENDIX II

SAMPLE NUMBER CROSS-REFERENCE

Associated with each coal sample are four identification numbers. The Virginia Division of Mineral Resources had maintained a rock repository where representative splits of coal samples were stored. A repository number (VDMR ID NUMBER) was assigned to the sample at the time of entry. The U.S. Geological Survey assigned an identifying number to their split of the sample (USGS LAB NUMBER). The VA FIELD NUMBER was applied in the field at the time of sampling and was based upon the topographic map index number (Biggs, 1974). The fourth number was derived from the laboratory which performed the routine analysis (CLASSICAL ANALYSIS LAB NUMBER).

VDMR ID	USGS LAB	VA FIELD	CLASSICAL ANALYSIS LAB NUMBER
NUMBER	NUMBER	NUMBER	
R-6814	W191067	60A1	Z822
R-6815	W191064	60A2	Z821
R-6816	W191069	60B1	Z819
R-6817	W191065	60B2	Z823
R-6818	W191063	60B3	Z827
R-6819	W191068	60B4	Z818
R-6820	W191066	60A3	Z820
R-6821	W191136	90D1	K64699
R-6822	W191135	60A4	K64701
R-6823	W191134	60A5	K64700
R-6824	W191332	60A6	Z564
R-6825	W191331	90D2	Z565
R-6826	W191333	90C1	Z563
R-6827	W191330	90C2	Z566
R-6828	W191337	60A7	Z559
R-6829	W191338	90D3	Z558
R-6830	W191335	60A8	Z556
R-6831	W191336	60A9	Z560
R-6832	W191329	59B1	Z561
R-6833	W191328	59B2	Z562
R-6834	W191334	90D4	Z557
R-6835	W192604	60B5	Z645
R-6836	W192605	90D5	Z644
R-6837	W192599	60A10	Z646
R-6838	W192600	60A11	Z647
R-6839	W192601	60A12	Z642
R-6840	W192602	60A13	Z643
R-6841	W192603	60A14	Z641
R-6842	W192609	90D6	Z634
R-6844	W192586	60A15	Z869
R-6845	W192591	90D8	Z871
R-6846	W192592	90D7	Z870
R-6847	W192589	60A16	Z866
R-6848	W192587	60A17	Z868
R-6849	W192588	60A18	Z865
R-6850	W192590	59A1	Z867
R-6851	W192608	90D9	Z633
R-6852	W192607	88C1	Z636
R-6853	W192611	90D11	Z640
R-6854	W192610	90D10	Z635
R-6855	W192613	90D12	Z638

APPENDIX II—continued

VDMR ID	USGS LAB	VA FIELD	CLASSICAL ANALYSIS LAB NUMBER
NUMBER	NUMBER	NUMBER	
R-6856	W192606	58B1	Z637
R-6857	W192612	89D1	Z639
R-6858	W192703	90D13	K67881
R-6859	W192702	90D14	K67871
R-6860	W192701	90D15	K67870
R-6861	W192704	89C1	K67878
R-6862	W192705	89C2	K67873
R-6863	W192709	88C2	K67877
R-6864	W192707	88C3	K67879
R-6865	W192700	89C3	K67874
R-6866	W192699	89C4	K67872
R-6867	W192698	89C5	K67875
R-6868	W192697	59A2	K67869
R-6869	W192708	58B2	K67876
R-6870	W192706	58B3	K67880
R-6871	W193663	60B6	K69357
R-6872	W193664	59A3	K68364
R-6873	W193665	88C4	K68361
R-6874	W193666	88C5	K68358
R-6875	W193667	88C6	K68362
R-6876	W193671	118C1	K68363
R-6877	W193672	118C2	K68359
R-6878	W193673	119D1	K68360
R-6879	W193668	118C3	K68354
R-6880	W193670	118C4	K68356
R-6881	W193669	118C5	K68355
R-6882	W193935	88A1	K68623
R-6883	W193934	88A2	K68622
R-6884	W193933	87B1	K68621
R-6885	W193932	87A1	K68620
R-6886	W193936	87C1	K68624
R-6887	W193945	87C2	K69658
R-6888	W193946	87C3	K69659
R-6889	W193947	87B2	K69657
R-6890	W193948	87B3	K69662
R-6891	W193949	87B4	K69660
R-6893	W193950	87B6	K69661
R-6894	W194305	88B1	K69855
R-6895	W194301	88A3	K69851
R-6896	W194300	88B2	K69849
R-6897	W194298	88B3	K69856
R-6898	W194299	88B4	K69850
R-6899	W194302	88A6	K69852
R-6900	W194303	88A4	K69854
R-6901	W194304	88A5	K69853
R-6902	W194292	88A7	K70350
R-6903	W194295	118D1	K70345
R-6904	W194296	118D2	K70348
R-6905	W194297	118D3	K70349
R-6906	W194293	88B5	K70346
R-6907	W194294	88B6	K70347
R-6908	W194411	60A19	K70535
R-6909	W194412	60A20	K70533
R-6910	W194852	60A21	K70920
R-6911	W194854	61A1	K70922
R-6912	W194855	61A2	K70921
R-6913	W194853	60B7	K70923

APPENDIX II—continued
 VDMR ID USGS LAB VA FIELD

CLASSICAL
 ANALYSIS
 LAB NUMBER

NUMBER	NUMBER	NUMBER	LAB NUMBER
R-6914	W195442	90C5	K72729
R-6915	W195441	90C4	K72728
R-6916	W195443	90C6	K72730
R-6917	W195445	58B4	K72722
R-6918	W195446	58B5	K72723
R-6919	W195447	58B6	K72724
R-6920	W195444	89C6	K72727
R-6922	W195440	88C7	K72726
R-6923	W195439	61C1	K72725
R-6934	W196287	60A22	K73189
R-6935	W196283	60B8	K73185
R-6936	W196284	60B9	K73186
R-6937	W196285	60B10	K73187
R-6938	W196286	60B11	K73188
R-6939	W196288	60A23	K73190
R-6940	W196289	60A24	K73191
R-6941	W196290	89D2	K73192
R-6943	W197307	88C8	K78507
R-6944	W197308	88C9	K78508
R-6945	W197303	58B7	K78503
R-6946	W197304	58B8	K78504
R-6947	W197305	58B9	K78505
R-6948	W197306	58B10	K78506
R-7068	W198542	60B12	K79172
R-7069	W198543	89C7	K79173
R-7070	W197299	90C7	K78499
R-7071	W197300	90D16	K78500
R-7072	W197301	59B3	K78501
R-7073	W197302	59B4	K78502
R-7160	W199466	60A25	K78694
R-7161	W199465	59A4	K78693
R-7168	W199467	60A26	K78695
R-7169	W199468	60A27	K78696
R-7171	W200486	59B5	K84860
R-7174	W200485	90C8	K84856
R-7175	W200484	60A28	K84859
R-7324	W202130	60B13	K84984
R-7325	W202129	59B6	K84983
R-7341	W203394	90C10	K86728
R-7342	W203393	90C9	K86727
R-7343	W203387	60B16	K86421
R-7344	W203386	60B15	K86420
R-7345	W203385	60B14	K86419
R-7346	W203384	59A5	K86416
R-7347	W203389	90C11	K86423
R-7348	W203390	89C8	K86422
R-7349	W203388	59B7	K86417
R-7350	W203391	59B8	K86418
R-7351	W203392	89B1	K86726
R-7354	W204157	59B9	K89584
R-7355	W204158	59B10	K89585
R-7356	W204159	88C10	K89588
R-7357	W204160	89D3	K89586
R-7358	W204161	89D4	K89587
R-7359	W204162	89B2	K89589
R-7366	W204163	61A3	K89590
R-7367	W204164	91D1	K89591

APPENDIX II—continued
 VDMR ID USGS LAB VA FIELD

NUMBER	NUMBER	NUMBER	LAB NUMBER
R-7380	W204617	89B3	K89328
R-7381	W204618	89B4	K89330
R-7382	W204619	89B5	K89329
R-7383	W204620	118C6	K89331
R-7406	W205190	61A4	K90623
R-7407	W205191	61A5	K90624
R-7408	W205192	61A6	K90625
R-7409	W205193	61A7	K90626
R-7410	W205194	61A8	K90627
R-7411	W205195	61A9	K90628
R-7412	W205196	61A10	K90629
R-7465	W206886	89B6	K94187
R-7491	W206887	89B7	K94188
R-7492	W206888	89B8	K94189
R-7493	W206889	89C9	K94190
R-7494	W206890	117B1	K94191
R-7515	W208044	60B17	K96811
R-7516	W208045	60B18	K96812
R-7517	W208046	60B19	K96813
R-7518	W208047	60B20	K96814
R-7519	W208048	60B21	K96815
R-7520	W208049	60B22	K96816
R-7545	W209959	89C10	L05049
R-7546	W209960	89C11	L03955
R-7547	W209961	90A1	L03960
R-7548	W209962	89D5	L05053
R-7549	W209963	89D6	L03956
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R-7551	W210392	89D8	L03950
R-7552	W210393	89D9	L03948
R-7553	W210394	89D10	L03949
R-7554	W210395	89D11	L03953
R-7555	W210396	89D12	L03957
R-7556	W210403	89D15	L03958
R-7557	W210397	89B9	L03947
R-7593	W210398	89D13	L03961
R-7594	W210399	89D14	L03952
R-7595	W210400	89D16	L03962
R-7596	W210401	88C11	L03959
R-7597	W210402	88C12	L03954
R-7860	W211174	89A1	U10079
R-7861	W211169	88C13	U10075
R-7862	W211168	88B7	U10074
R-7863	W211170	88C14	U10076
R-7864	W211171	88C15	U10077
R-7865	W211172	88C16	U10073
R-7866	W211173	88C17	U10078
R-8165	W211679	90C12	U10085
R-8166	W211678	90C13	U10084
R-8167	W211674	88C18	U10080
R-8168	W211675	89A2	U10081
R-8169	W211676	89A3	U10082
R-8170	W211677	89A4	U10083
R-8206	W212486	89B10	U10167
R-8207	W212488	90C14	U10168
R-8208	W212491	90D16	U10184
R-8209	W212489	90A2	U10183

APPENDIX II—continued

VDMR ID USGS LAB VA FIELD

CLASSICAL ANALYSIS

NUMBER	NUMBER	NUMBER
R-8210	W212490	90A3
R-8241	W212492	90D17
R-8242	W212487	89C12
R-8243	W212493	90D18
R-8244	W212494	90D19
R-8318	W213994	90D20
R-8319	W213995	90D21
R-8448	W214244	61A11
R-8449	W214245	61A12
R-8450	W214246	61A13
R-8451	W214247	61A14
R-8452	W214248	61A15
R-8453	W214249	61A16
R-8454	W214250	61A17
R-8455	W214251	61A18
R-8469	W214252	61A19
R-8470	W214253	61A20
R-8471	W214254	61A21
R-8472	W214255	61A22
R-8473	W214256	61A23
R-8477	W214764	88A8
R-8478	W214765	88A9
R-8479	W214766	88A10
R-8480	W214762	87B7
R-8481	W214767	88A11
R-8483	W214770	88B9
R-8484	W214769	88B8
R-8485	W214771	88B10
R-8486	W214763	87B9
R-8487	W214768	88A12
R-8488	W215412	87B8
R-8489	W215413	88B11
R-8490	W215414	89A5
R-8491	W215415	89A6
R-8492	W240451	89A7
R-8494	W215446	59A6
R-8495	W215450	88C19
R-8502	W215447	88B12
R-8503	W215448	88A13
R-8504	W215449	88A14
R-8508	W215451	83A1
R-8516	W215874	60A29
R-8517	W215875	88B13
R-8518	W215876	88A15
R-8519	W215877	88A16
R-8538	W217399	88B14
R-8539	W217400	88B15
R-8540	W217401	118C7
R-8541	W217402	118C8
R-8542	W217397	88A17
R-8543	W217398	88A18
R-8553	W217592	87B10
R-8554	W217593	118C9
R-8555	W217595	88C21
R-8556	W217594	88C20
R-8557	W217596	88C22
R-8558	W217597	88C23

APPENDIX II—continued

VDMR ID USGS LAB VA FIELD

CLASSICAL ANALYSIS

NUMBER	NUMBER	NUMBER
R-8637	W223354	90C15
R-8639	W225108	90C-16,17
R-8640	W223356	90C18
R-8641	W225109	60B-23,24
R-8647	W226972	90C19
R-8648	W226973	90C20
R-8649	W226974	90C21
R-8650	W226975	90C22
R-8651	W226976	90D22
R-8652	W226977	90D23
R-8653	W226970	62D1
R-8654	W226971	62C2
R-8714	W229073	90D24
R-8715	W229074	90D25
R-8716	W229083	89B11
R-8562	W217685	118C10
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R-8565	W217688	118C13
R-8566	W217689	118C14
R-8572	W218771	118D4
R-8573	W218772	118D5
R-8574	W218773	118D6
R-8575	W218774	118D7
R-8576	W218775	118D8
R-8580	W218765	118C15
R-8581	W218766	118C16
R-8582	W218767	118C17
R-8583	W218768	118C18
R-8584	W218769	118C19
R-8585	W218770	118C20
R-8597	W218973	118D9
R-8598	W218974	118D10
R-8599	W218976	118D11
R-8600	W218976	118D12
R-8601	W218977	118D13
R-8602	W218978	118D14
R-8618	W223361	118D15
R-8619	W225107	118D-16,17
R-8621	W223357	118D18
R-8622	W223358	118B1
R-8623	W223359	118C21
R-8624	W223360	118C22
R-8631	W223355	118D19
R-8632	W223353	117B2
R-8633	W225106	118D-20,21
R-8635	W223352	118A1
R-8717	W229084	89B12
R-8718	W229080	90C23
R-8719	W229082	90C24
R-8720	W229077	60A30
R-8721	W229078	60A31
R-8722	W229079	60A32
R-8723	W229081	90C25
R-8724	W229075	90D26
R-8725	W229076	90D27
R-8728	W229548	62D2

APPENDIX II—continued

VDMR ID	USGS LAB	VA FIELD	CLASSICAL ANALYSIS LAB NUMBER
NUMBER	NUMBER	NUMBER	
R-8820	W238477	88B22	U13208
R-8821	W238940	59B11	U13259
R-8822	W238945	90D44	U13263
R-8823	W238944	90D45	U13264
R-8824	W238943	89C14	U13262
R-8825	W238946	119D3	U13265
R-8826	W238941	89A12	U13260
R-8827	W238942	89B17	U13261
R-8830	W239224	127C1	U13281
R-8831	W213993	88D1	U10198
R-8940	W240450	87B5	U13582
R-8941	W240452	89A13	U13584
R-8949	W236245	88B16	U12961
R-8950	W236247	89C13	U12963
R-8951	W236246	89D17	U12962
R-8729	W229550	60A33	U12445
R-8730	W229551	60A34	U12446
R-8731	W229552	60A35	U12447
R-8732	W229549	90D28	U12444
R-8733	W231831	90D29	U12498
R-8734	W231832	90D30	U12499
R-8735	W231833	90D31	U12500
R-8736	W231834	90D32	U12501
R-8737	W231835	90D33	U12502
R-8738	W231830	90C26	U12497
R-8739	W231838	90D35	U12504
R-8740	W231837	90D36	U12505
R-8741	W231828	60A36	U12495
R-8742	W231829	60A37	U12496
R-8749	W236243	90C27	U12959
R-8750	W235313	90D37	U12891
R-8751	W235314	90D38	U12892
R-8752	W235317	60A38	U12895
R-8753	W235315	90D39	U12893
R-8755	W235318	60A39	U12896
R-8756	W235316	90D40	U12894
R-8758	W236240	89A8	U12956
R-8760	W236241	89A10	U12957
R-8761	W236242	89A11	U12958
R-8764	W231836	90D34	U12503
R-8805	W236237	60B25	U12953
R-8806	W236238	60B26	U12954
R-8807	W236239	60B27	U12955
R-8808	W238471	60C1	U13202
R-8809	W238478	89B14	U13209
R-8810	W238481	90A4	U13212
R-8811	W238483	119D2	U13214
R-8812	W238472	88B17	U13203
R-8813	W238473	88B18	U13204
R-8814	W238474	88B19	U13205
R-8815	W238479	89B15	U13210
R-8816	W238480	89B16	U13211
R-8817	W238482	90D42	U13213
R-8818	W238475	88B20	U13206
R-8819	W238476	88B21	U13207

APPENDIX III

COAL SAMPLING PROCEDURE

In order to reduce outside variables and produce coal analyses that relate to one another, consistency in the sampling procedure at every site is necessary. The Virginia Division of Mineral Resources personnel follow as closely as possible the sampling procedures outlined and described in publications by ASTM (Dutcher, 1976) and the U. S. Geological Survey (Schopf, 1960). Procedures described by Glass (1975) and Currens and others (1986) are also used as a guide.

Best analytical results are derived from fresh coal exposures, and with the exception of rare fresh road cut exposures, all samples are collected from active mines. Type of surface mining and reclamation techniques often limit the availability of potential sample sites. With the exception of an augering operation (Figure 49), surface mine exposures more than two weeks old are generally not considered for sampling (Figure 50). Samples from underground mines are collected either at the working face or another section of the mine where the coal is fresh (Figure 51).

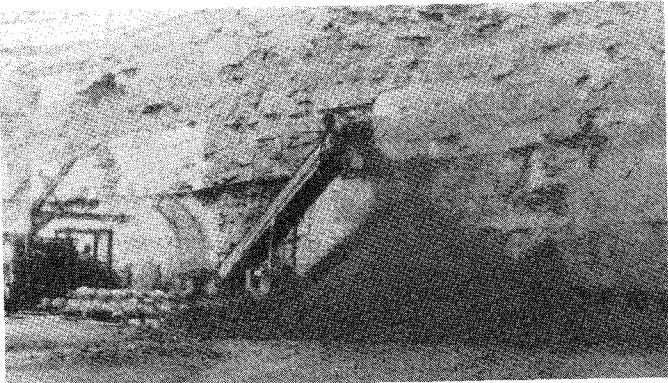


Figure 49. Auger operation on surface mine bench, Buchanan County.

To facilitate location of potential sampling sites, local residents, coal operators, the Virginia Division of Mines, the Virginia Division of Mined Land Reclamation, Virginia Department of Forestry personnel, and legal notices in local newspapers are consulted. The foreman of the mine is contacted to gain permission to sample. Poor working conditions or other problems will be pointed out by the foreman at this time. When a potential sample site is located, several factors must be addressed to insure a successful sample. Of foremost consideration is the safety of the personnel directly or indirectly involved with the actual sampling. Safety considerations in underground mines include roof conditions, blasting schedule, and the proximity of the potential sampling sites to active mining and electrical equipment. In surface mines, the condition of the highwall is of eminent consideration; sections of highwall that are making water, are coated with ice, or have large amounts of talus indicate a weak wall and are avoided. Additionally, blasting, haul traffic, and the proximity of mining equipment within the pit must be considered.

APPENDIX II—continued

VDMR ID	USGS LAB	VA FIELD	CLASSICAL ANALYSIS LAB NUMBER
NUMBER	NUMBER	NUMBER	
R-8820	W238477	88B22	U13208
R-8821	W238940	59B11	U13259
R-8822	W238945	90D44	U13263
R-8823	W238944	90D45	U13264
R-8824	W238943	89C14	U13262
R-8825	W238946	119D3	U13265
R-8826	W238941	89A12	U13260
R-8827	W238942	89B17	U13261
R-8830	W239224	127C1	U13281
R-8831	W213993	88D1	U10198
R-8940	W240450	87B5	U13582
R-8941	W240452	89A13	U13584
R-8949	W236245	88B16	U12961
R-8950	W236247	89C13	U12963
R-8951	W236246	89D17	U12962
R-8729	W229550	60A33	U12445
R-8730	W229551	60A34	U12446
R-8731	W229552	60A35	U12447
R-8732	W229549	90D28	U12444
R-8733	W231831	90D29	U12498
R-8734	W231832	90D30	U12499
R-8735	W231833	90D31	U12500
R-8736	W231834	90D32	U12501
R-8737	W231835	90D33	U12502
R-8738	W231830	90C26	U12497
R-8739	W231838	90D35	U12504
R-8740	W231837	90D36	U12505
R-8741	W231828	60A36	U12495
R-8742	W231829	60A37	U12496
R-8749	W236243	90C27	U12959
R-8750	W235313	90D37	U12891
R-8751	W235314	90D38	U12892
R-8752	W235317	60A38	U12895
R-8753	W235315	90D39	U12893
R-8755	W235318	60A39	U12896
R-8756	W235316	90D40	U12894
R-8758	W236240	89A8	U12956
R-8760	W236241	89A10	U12957
R-8761	W236242	89A11	U12958
R-8764	W231836	90D34	U12503
R-8805	W236237	60B25	U12953
R-8806	W236238	60B26	U12954
R-8807	W236239	60B27	U12955
R-8808	W238471	60C1	U13202
R-8809	W238478	89B14	U13209
R-8810	W238481	90A4	U13212
R-8811	W238483	119D2	U13214
R-8812	W238472	88B17	U13203
R-8813	W238473	88B18	U13204
R-8814	W238474	88B19	U13205
R-8815	W238479	89B15	U13210
R-8816	W238480	89B16	U13211
R-8817	W238482	90D42	U13213
R-8818	W238475	88B20	U13206
R-8819	W238476	88B21	U13207

APPENDIX III

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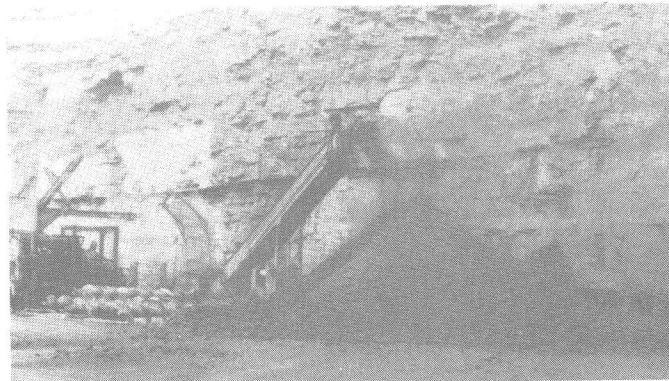


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Figure 50. Surface mine, Wise County.

After finding a safe site, the coal bed should be entirely visible. In some cases, loose debris may need to be removed to expose the entire coal bed. The suitability for sampling is assessed by hammering on the coal bed to test the overall cohesiveness of the unit and by visual inspection for excessive amounts of mud, blooms, or coatings. Parting material that is not mined or is screened out is noted so that it may be excluded from the sample. If a coal is found to be suitable to sample, the roof and wall rock above the sample point is cleared of loose debris that could contaminate the sample. A stiff-bristle whisk-broom works nicely to remove small rocks and dust. To maintain the integrity of the highwall or roof, removal of large blocks of rock is avoided. The area to be cleaned should be sufficient to eliminate contamination of the sample, generally not less than five feet wide. When the rock above the coal is secure, the accumulated talus is shoveled away, thus exposing the floor. Using a hammer or mattock, the coal face is chipped to a depth of two inches or more to expose a clean surface. The coal face and floor are then swept with the broom until all debris is removed. From this point, care must be taken that material outside the channel is excluded from the sample. A piece of 4-mil plastic sheeting is folded several times to a size of at least two feet square, and placed on the floor adjacent to the cleaned coal face. Making sure protective eyewear and gloves are on and the tools are clean, two parallel grooves, normal to bedding, are dug about six inches apart using a pick-end hammer or chisel and sledge hammer. The placement of the grooves is often dictated by

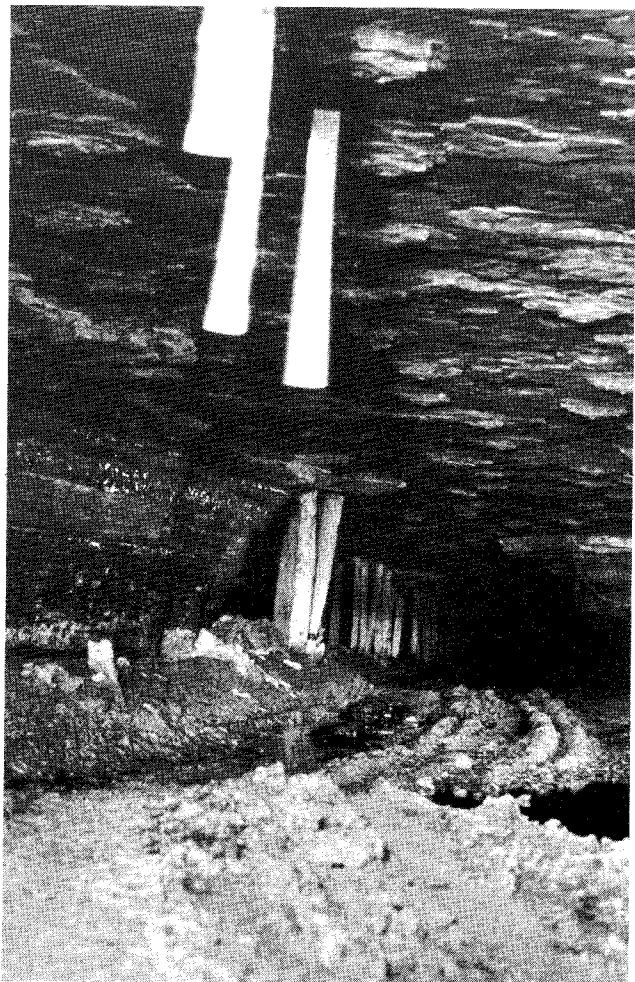


Figure 51. Underground mine, Dickenson County.

the direction and development of the cleat. Beginning at the floor contact and using a hammer or chisel and sledge, the coal between the grooves is removed to a depth of four to six inches. Material that is not to be sampled is carefully removed and tossed aside as the channel reaches it. Laterally consistent partings greater than 0.25 inch thick are generally excluded from the sample. Coal broken outside the grooved parameters is likewise discarded. Undercutting the coal within the channel works well and most coal will fall onto the plastic sheet. To keep coal pieces contained, the sheet may be nailed to the wall on either side of the channel and/or tucked into the sampler's belt. The actual dimensions of the channel will depend on the thickness of the coal bed but at least six pounds per foot of coal are collected. After completing the channel sample, the corners of the plastic are folded over the top of the collected coal and the sheet is moved away from the highwall, or in the case of underground mines, to a place that has a flat floor and reasonable working conditions. The coal is then crushed to at least 1/2-inch mesh by light hammering. Thorough mixing of the sample by hand shows up any contamination or oversized coal pieces. The sample is shaped into a



Figure 50. Surface mine, Wise County.

After finding a safe site, the coal bed should be entirely visible. In some cases, loose debris may need to be removed to expose the entire coal bed. The suitability for sampling is assessed by hammering on the coal bed to test the overall cohesiveness of the unit and by visual inspection for excessive amounts of mud, blooms, or coatings. Parting material that is not mined or is screened out is noted so that it may be excluded from the sample. If a coal is found to be suitable to sample, the roof and wall rock above the sample point is cleared of loose debris that could contaminate the sample. A stiff-bristle whisk-broom works nicely to remove small rocks and dust. To maintain the integrity of the highwall or roof, removal of large blocks of rock is avoided. The area to be cleaned should be sufficient to eliminate contamination of the sample, generally not less than five feet wide. When the rock above the coal is secure, the accumulated talus is shoveled away, thus exposing the floor. Using a hammer or mattock, the coal face is chipped to a depth of two inches or more to expose a clean surface. The coal face and floor are then swept with the broom until all debris is removed. From this point, care must be taken that material outside the channel is excluded from the sample. A piece of 4-mil plastic sheeting is folded several times to a size of at least two feet square, and placed on the floor adjacent to the cleaned coal face. Making sure protective eyewear and gloves are on and the tools are clean, two parallel grooves, normal to bedding, are dug about six inches apart using a pick-end hammer or chisel and sledge hammer. The placement of the grooves is often dictated by

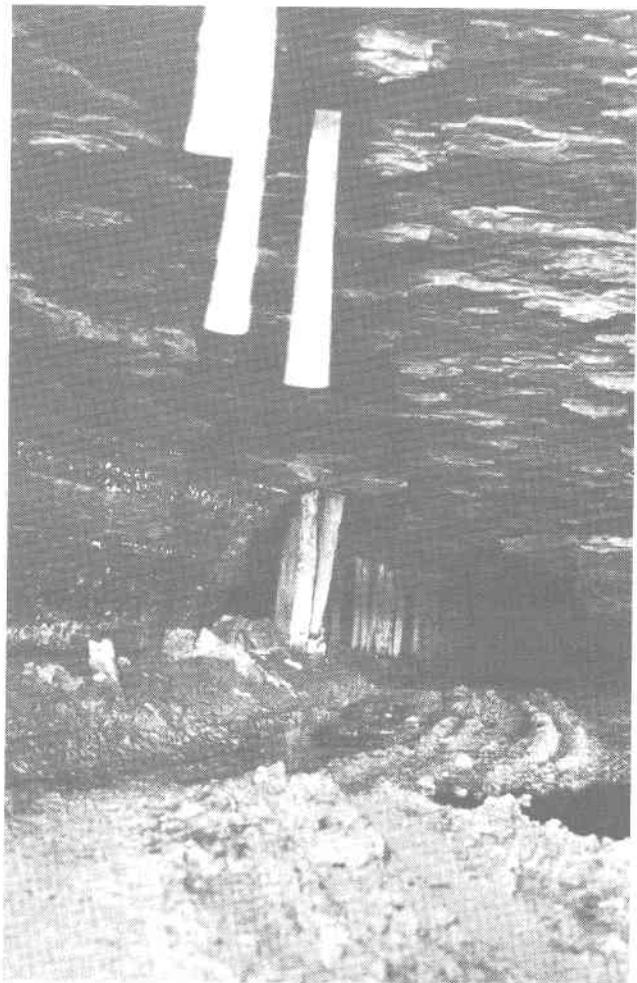


Figure 51. Underground mine, Dickenson County.

the direction and development of the cleat. Beginning at the floor contact and using a hammer or chisel and sledge, the coal between the grooves is removed to a depth of four to six inches. Material that is not to be sampled is carefully removed and tossed aside as the channel reaches it. Laterally consistent partings greater than 0.25 inch thick are generally excluded from the sample. Coal broken outside the grooved parameters is likewise discarded. Undercutting the coal within the channel works well and most coal will fall onto the plastic sheet. To keep coal pieces contained, the sheet may be nailed to the wall on either side of the channel and/or tucked into the sampler's belt. The actual dimensions of the channel will depend on the thickness of the coal bed but at least six pounds per foot of coal are collected. After completing the channel sample, the corners of the plastic are folded over the top of the collected coal and the sheet is moved away from the highwall, or in the case of underground mines, to a place that has a flat floor and reasonable working conditions. The coal is then crushed to at least 1/2-inch mesh by light hammering. Thorough mixing of the sample by hand shows up any contamination or oversized coal pieces. The sample is shaped into a

conical pile by alternately lifting the edges of the plastic sheet and then is evenly quartered. One quarter is discarded and the remaining piles are individually placed into doubled-up, 4-mil thick, polyurethane bags which are identified with a unique sample number and sealed with twist-ties (Figure 52). One quarter is placed in the Virginia Division of Mineral Resources coal repository, one is sent to the testing laboratory for routine analyses, and one quarter is reserved for the U.S. Geological Survey for ash and trace-element analyses. Hand samples are also obtained from the roof, floor, and significant parting material at or near the sample site. These samples are placed in the Virginia Division of Mineral Resources coal repository.



Figure 52. Field preparation of a coal sample. Each bag is a representative sample of the entire coal bed.

Upon completion of the actual sampling, a description of the coal and highwall is prepared (Figure 53). Field notations are written concerning the sampled and unsampled units, thickness of the total coal and partings, and variations of the physical character of the coal, partings, roof and floor rock over the area covered by the mine. Other data collected include coal bed elevation and contacts, cleat development and direction, banding, impurities, regional strike and dip, mine name and identification number, map location, and weather conditions. Often it is possible to construct a good stratigraphic section by observing the rocks exposed in the mine and talking to mine personnel about what they have seen during mining and shot hole drilling.

After leaving the mine, the map location of the sample is double checked and the altimeter is recalibrated against a known elevation as soon as possible.



Figure 53. Measuring a coal bed. Note cleaned coal face, channel, and sample on plastic sheet.

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