UNITED STATES DEPARTMENT OF THE INTERIOR

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TEST DRILLING FOR COAL IN 1982-83 IN THE JEFFERSON NATIONAL FOREST, VIRGINIA

Part 2: Analyses of coal cores from the southwestern Virginia coal field

by

Frederick O. Simon and Kenneth J. Englund
U. S. Geological Survey

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This report is preliminary and has not been reviewed for conformity with U. S. Geological Survey editorial standards or stratigraphic nomenclature.

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Introduction

In 1982-83 the U.S. Geological Survey (USGS), in cooperation with the Bureau of Land Management, drilled 13 coreholes in Dickenson, Lee, Scott and Wise counties of the southwestern Virginia coal field (figs. 1-3). These coreholes penetrated in descending order, the Wise Formation, Gladeville (?) Sandstone, and Norton, Lee, Pocahontas, and Bluestone Formations. The detailed stratigraphic analysis of the cores and geophysical logs of the coreholes are presented in Part 1 of this series of reports (Englund and others, 1983). Samples were analyzed by Geochemical Testing, Inc., Somerset, Pennsylvania, under contract to the USGS and include proximate and ultimate analyses, calorific value, forms of sulfur, ash fusion temperatures, and free swelling index.

Additional data for the southwestern Virginia coal field are available in USGS open-file reports and coal maps (Englund and Teaford, 1980; Meissner, 1979; Meissner and Heerman, 1982; Zubovic and others, 1979, 1980), a report by Virginia Division of Mineral Resources (Henderson and others, 1981), and U. S. Bureau of Mines Technical Papers (Fieldner and others, 1926; Snyder, 1926).

The assistance of J. M. Back, T. M. Kehn, R. E. Thomas, J. C. Weber, and J. F. Windolph, Jr. with the collection of coal samples during drilling is gratefully acknowledged.

Sampling and analysis procedures

All analyses presented in this report are of drillcore samples and, except for samples w219798-800, represent the entire thickness of coal for each bed at that locality.

Coal cores were sealed in polyethylene for transportation to the laboratory. Continuous and discontinuous partings 3/8-inch or greater in thickness were discarded prior to crushing. Crushed samples (-1/4-inch) were divided into four splits. One split was sent to Geochemical Testing, Inc. for the determinations presented in this report. A second split was sent to the USGS Branch of Analytical Chemistry for major, minor and trace element analysis. The third and fourth splits were retained for petrological analysis and for storage respectively. All analytical procedures used by Geochemical Testing, Inc. are described in part 26 of the Annual Book of ASTM Standards (ASTM, 1981); these procedures will not be repeated here. The petrological and major, minor, and trace analysis results are not a part of this report.

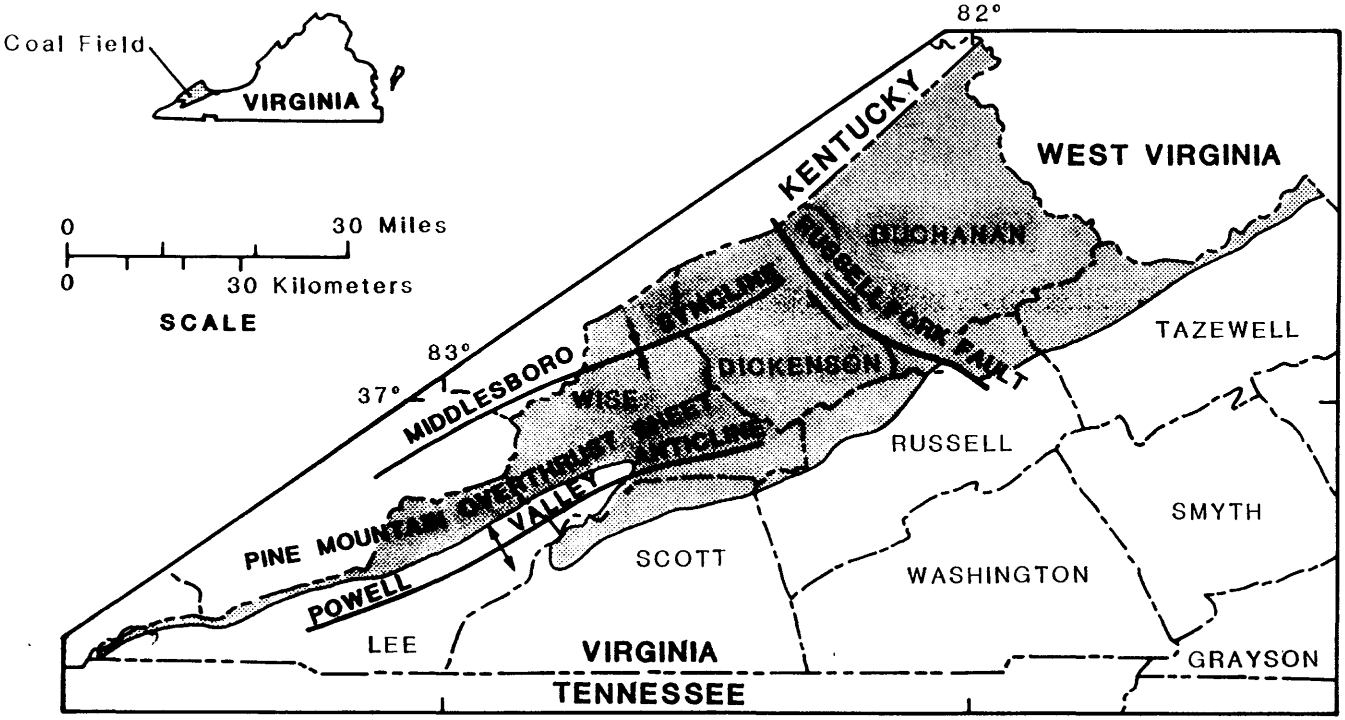

Figure 1. Index map of southwestern Virginia coal field (shaded).

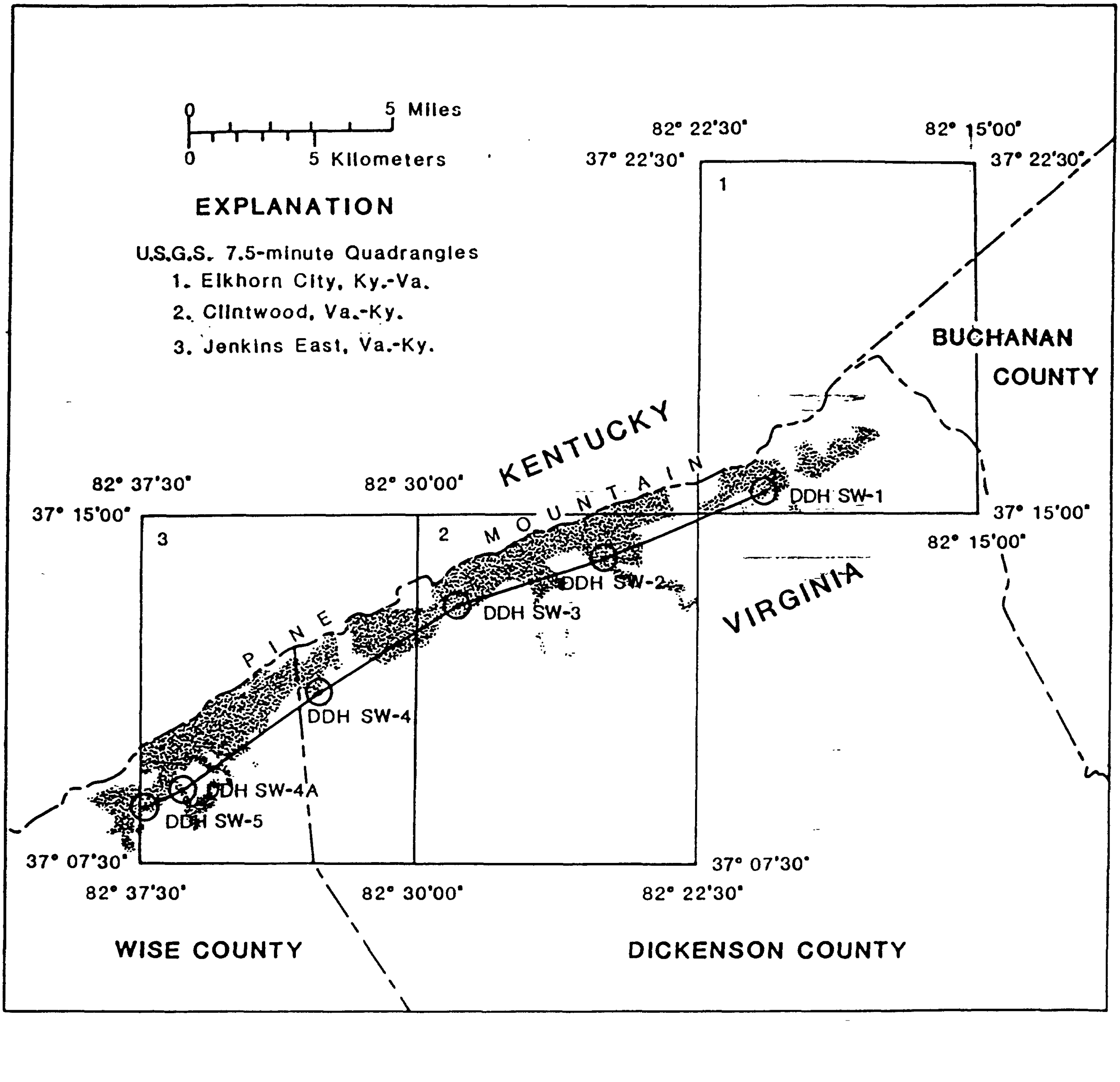

Figure 2. Location of coreholes in the Pine Mountain area, Jefferson National Forest, Virginia. Stippled pattern indicates approximate areas of Federal mineral ownership.

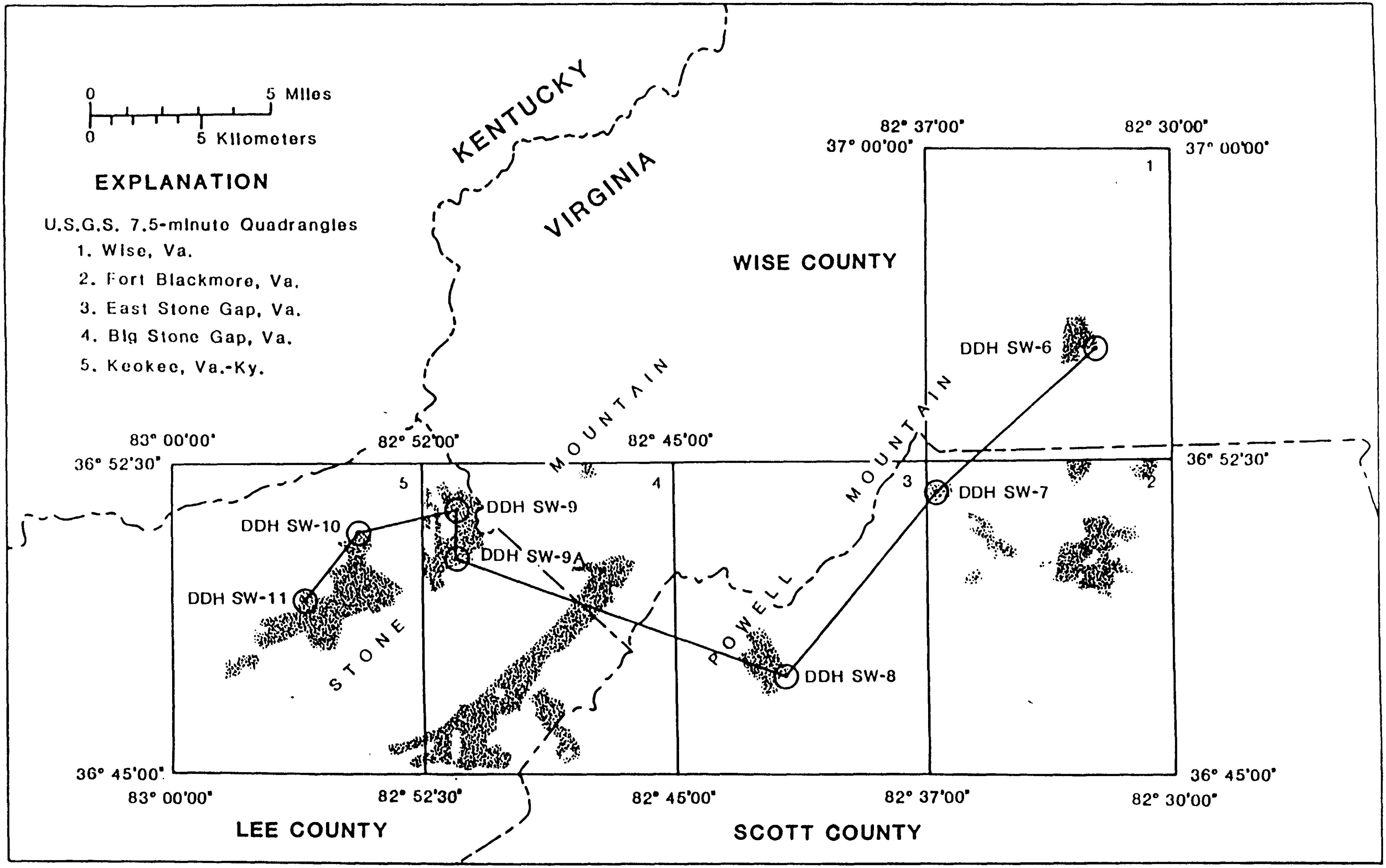

Figure 3. Location of coreholes in the Stone and Powell Mountain areas, Jefferson National Forest, Virginia Stippled pattern indicates approximate areas of Federal mineral ownership.

Explanation of tables

Table 1 briefly describes the 53 samples from the southwestern Virginia coal field. All samples, except for No. W219799 which was too small, were analyzed. Apparent ranks were calculated using the data in Table 2 and the Parr equations (ASTM D388-77) and are listed in Table 1. All coal samples are classified as high-volatile A bituminous coal. Proximate and ultimate analyses and calorific value for each sample are listed in Table 2a. Data are presented three ways: as received, moisture-free, and moisture- and ash-free. Air-dried loss, forms of sulfur, free swelling index and ash fusion temperatures for each sample are listed in Table 2b. A statistical summary of the chemical data of the 52 analyzed samples from the southwestern Virginia coal field is given in Table 3; the geometric means for 369 bituminous coal samples from Virginia were calculated using the National Coal Resources Data System (U. S. Geological Survey, Reston, VA) and are given for comparision.

Discussion

The coal beds sampled in this drilling program in the southwestern Virginia coal field are similar to the high-volatile bituminous coal beds sampled previously in Virginia. That is, on an as-received basis, they are greater than 13,000 Btu/lb., contain less than 1.0 percent sulfur and contain less than 10 percent ash. Two samples contained greater than 5 percent sulfur: one of these (w219349) is from a thin (14 inches) split of the Little Fire Creek (?) coal bed; the other (w219798) is a 6-inch bench sample of the top part of the Upper Banner coal bed which was separated on physical differences. The bottom three inches (w219799) of this latter coal, also separated because of physical differences, was not analyzed. If the sulfur content of samples w219798 and w219800 are averaged, the mean sulfur content of the Upper Banner coal bed at this location is 3.2 percent. The ash content of w219795, a canneloid shale, is greater than 50 percent and is classified as a shale; three other samples have ash contents greater than 20 percent (w219402, w219404 and w219590). All coal samples analyzed from this drilling project are classified as high-volatile A bituminous (hvAb) coal. Four samples have free swelling indices less than 4.0.

Table 1.--Descriptions for 53 drill core samples from the southwestern Virginia coal field, Virginia.
[nde = no data entered; sample No. w219799 not analyzed. Apparent rank calculated using ASTM D388.]

Sample No.	Field No.	County	Latitude	Longnitude	Formation	Coal bed	Apparent rank	Depth of coal bed (inches)	Sampled thickness (inches)
w218688	sw8-cl	Scott	364730n	824143w	Lee	Cove Creek lsp	hvAb	692.	17.0
w219343	sw4-c3	Dickenson	371115n	823241w	Lee	Lee usp	hvAb	5477.	7.0
w219345	sw11-cl	Lee	364918n	825604w	Lee	Lee	hvAb	2175.	22.5
w219346	sw4-c6	Dickenson	371115n	823241w	Lee	Sewell (?)	hvAb	8022.	19.2
w219347	sw4-cl	Dickenson	371115n	823241w	Lee	Jawbone rider	hvAb	1832.	9.5
w219348	sw9-c4	Lee	365113n	825134w	Norton	Splash Dam (?)	hvAb	4856.	11.0
w219349	sw7-c3	Scott	365117n	823629w	Lee	L. Fire Cr. (?) usp	hvAb	2719.	14.0
w219350	sw7-cl	Scott	365117n	823629w	Lee	Cove Creek usp	hvAb	1526.	17.2
w219351	sw9-c6	Lee	365113n	825134w	Norton	Lower Banner	hvAb	7395.	19.0
w219352	sw4-c5	Dickenson	371115n	823241w	Lee	Castle (?)	hvAb	6639.	16.0
w219353	sw4-c4	Dickenson	371115n	823241w	Lee	Lee lsp	hvAb	5497.	7.0
w219354	sw9-cl	Lee	365113n	825134w	Norton	Norton	hvAb	1321.	26.0
w219355	swl-cl	Dickenson	371523n	828055w	Lee	Sewell (?)	hvAb	2760.	20.0
w219356	sw2-c3	Dickenson	371403n	821958w	Lee	Castle (?)	hvAb	7756.	17.5
w219357	sw9-c8	Lee	365134n	825134w	Lee	Jawbone	hvAb	13659.	25.0
w219358	sw3-c3	Dickenson	371302n	822858w	Lee	Welch (?)	hvAb	4849.	11.0
w219359	sw2-cl	Dickenson	371403n	821958w	Norton	Kennedy	hvAb	420.	34.0
w219360	sw10-c2	Lee	365051n	825425w	Wise	Clintwood	hvAb	1890.	40.0
w219361	sw10-c4	Lee	365051n	825425w	Wise	Dorchester	hvAb	3731.	42.0
w219362	sw10-c6	Lee	365051n	825425w	Norton	unnamed	hvAb	5525.	16.0
w219363	sw10-c10	Lee	365051n	825425w	Norton	Kennedy	hvAb	12790.	18.0
w219364	sw10-c11	Lee	365051n	825425w	Lee	Jawbone	hvAb	16785.	20.8
w219391	sw4a-c3	Wise	370904n	823625w	Lee	Lee	hvAb	4791.	11.2
w219392	sw4a-c4	Wise	370904n	823625w	Lee	Fire Creek rider	hvAb	10160.	18.0
w219393	sw4a-c5	Wise	370904n	823625w	Lee	Cove Creek (?)	hvAb	10799.	14.0

Table 1.--Descriptions for 53 drill core samples from the southwestern Virginia coal field (continued).

Sample No.	Field No.	County	Latitude	Longnitude	Formation	Coal bed	Apparent rank	Depth of coal bed (inches)	Sampled thickness (inches)
w219394	sw3-c1	Dickenson	371302n	822858w	Lee	Castle rider (?)	hvAb	2486.	13.0
w219395	sw3-c2	Dickenson	371302n	822858w	Lee	Sewell (?)	hvAb	4318.	12.5
w219396	sw6-c1	Wise	365506n	823214w	Pocahontas	Pocahontas No. 1	hvAb	3036.	12.0
w219397	sw11-c3	Lee	364918n	825604w	Pocahontas	Pocahontas No. 1	hvAb	13579.	12.0
w219398	sw7-c2	Scott	365117n	823629w	Lee	Cove Creek lsp	hvAb	1674.	10.5
w219399	sw7-c5	Scott	365117n	823629w	Pocahontas	Pocahontas No 1	hvAb	5840.	9.2
w219400	sw9-c7	Lee	365113n	825134w	Norton	Kennedy	hvAb	9376.	26.5
w219401	sw9-c9	Lee	365113n	825134w	Lee	Tiller	hvAb	15848.	13.0
w219402	sw9a-c1	Lee	365011n	825138w	Lee	Little Raleigh (?)	hvAb	4582.	17.0
w219403	sw9a-c2	Lee	365011n	825138w	Lee	Beckley	hvAb	5551.	27.8
w219404	sw9a-c3	Lee	365011n	825138w	Lee	Cove Creek	hvAb	7472.	23.0
w219405	sw4a-c2	Wise	370904n	823625w	Lee	Jawbone	hvAb	2334.	27.0
w219406	sw3-c4	Dickenson	371302n	822858w	Lee	Beckley	hvAb	5843.	54.0
w219788	sw2-c2	Dickenson	371403n	822501w	Lee	Jawbone	hvAb	3357.	25.0
w219789	sw3-c5	Dickenson	371302n	822858w	Lee	Fire Creek rider	hvAb	6557.	17.0
w219790	sw4-c2	Dickenson	371115n	823241w	Lee	Jawbone	hvAb	2884.	34.0
w219791	sw7-c4	Scott	365117n	823629w	Lee	L. Fire Cr. (?) lsp	hvAb	3015.	21.5
w219792	sw7-c6	Scott	365117n	823629w	Pocahontas	Squire Jim	hvAb	6249.	18.0
w219793	sw9-c5	Lee	365113n	825134w	Norton	Upper Banner	hvAb	5408.	40.0
w219794	sw9-c10	Lee	365113n	825134w	Lee	Lee	hvAb	17567.	27.0
w219795	sw10-c7	Lee	365052n	825423w	Norton	Splash Dam (?)	shale	8005.	19.0
w219796	sw10-c5	Lee	365052n	825423w	Norton	Norton	hvAb	4825.	35.5
w219797	sw10-c9	Lee	365052n	825423w	Norton	Lower Banner	hvAb	10623.	14.5
w219798	sw10-c8-1.1	Lee	365052n	825423w	Norton	Upper Banner	hvAb	8752.	6.0
w219799	sw10-c8-1.3	Lee	365052n	825423w	Norton	Upper Banner	nde	8782.	3.0
w219800	sw10-c8-1.2	Lee	365052n	825423w	Norton	Upper Banner	hvAb	8758.	24.0
w219265	sw5-c1	Wise	370845n	823740w	Lee	Castle (?)	hvAb	3641.	36.0
w219590	sw11-c2	Lee	364918n	825604w	Lee	Little Fire Creek	hvAb	12038.	48.0

Table 2a.--Proximate and ultimate analyses and calorific value determinations for 52 bituminous coal samples from the southwestern Virginia coal field, Virginia.

[All analyses except calorific value are in percent. The analyses are reported: a) as received, b) moisture-free, and c) moisture- and ash-free. All analyses by Geochemical Testing, Inc., Somerset, PA.]

Sample number		Proximate analysis				Ultimate analysis					Calorific value
		Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Btu/lb
w218688	a)	1.1	35.8	47.0	16.1	4.9	70.4	1.3	6.7	0.6	12,510
	b)	---	36.2	47.5	16.3	4.8	71.2	1.3	5.8	.6	12,640
	c)	---	43.2	56.8	---	5.7	85.0	1.6	7.0	.7	15,100
w219343		2.4	39.0	52.6	6.0	5.5	76.0	1.8	7.9	2.8	13,740
		---	39.9	54.0	6.1	5.3	77.8	1.9	6.1	2.8	14,070
		---	42.5	57.5	---	5.7	82.9	2.0	6.4	3.0	14,990
w219345		2.1	32.8	52.9	12.2	5.1	71.6	1.5	8.2	1.4	12,680
		---	33.6	53.9	12.5	4.9	73.1	1.6	6.5	1.4	12,950
		---	38.3	61.7	---	5.6	83.5	1.8	7.5	1.6	14,800
w219346		3.8	33.0	53.8	9.4	5.2	73.6	1.5	9.2	1.1	13,060
		---	34.3	55.9	9.8	4.9	76.5	1.5	6.1	1.2	13,580
		---	38.1	61.9	---	5.5	84.8	1.7	6.7	1.3	15,050
w219347		1.7	43.9	43.1	11.3	5.5	71.4	1.4	7.2	3.2	13,090
		---	44.7	43.8	11.5	5.4	72.6	1.4	5.8	3.3	13,310
		---	50.5	49.5	---	6.1	82.1	1.6	6.5	3.7	15,050
w219348		2.5	37.7	56.8	3.0	5.6	81.1	1.7	7.9	.7	14,490
		---	38.6	58.3	3.1	5.5	83.2	1.8	5.7	.7	14,850
		---	39.9	60.1	---	5.6	85.9	1.8	6.0	.7	15,330
w219349		1.4	40.9	48.2	9.5	5.0	72.4	1.3	6.2	5.6	13,470
		---	41.5	48.9	9.6	4.9	73.5	1.3	5.0	5.7	13,360
		---	45.9	54.1	---	5.4	81.3	1.4	5.6	6.3	15,120

Table 2a.--Proximate and ultimate analyses and calorific value determinations (continued).

Sample number	Proximate analysis: Moisture	Proximate analysis: Volatile matter	Proximate analysis: Fixed carbon	Proximate analysis: Ash	Ultimate Analysis: Hydrogen	Ultimate Analysis: Carbon	Ultimate Analysis: Nitrogen	Ultimate Analysis: Oxygen	Ultimate Analysis: Sulfur	Calorific value Btu/lb
w219350	2.7	33.1	55.9	8.3	5.1	75.2	1.6	8.7	1.1	13,340
	---	34.0	57.4	8.6	4.9	77.3	1.6	6.4	1.2	13,710
	---	37.2	62.8	---	5.4	84.5	1.8	7.0	1.3	15,000
w219351	1.7	39.3	52.7	6.3	5.4	77.3	2.0	6.8	2.2	14,040
	---	40.0	53.5	6.5	5.3	78.6	2.0	5.4	2.2	14,280
	---	42.7	57.3	---	5.7	84.1	2.1	5.7	2.4	15,260
w219352	2.4	36.5	49.5	11.6	5.0	71.5	1.6	7.8	2.5	12,800
	---	37.4	50.7	11.9	4.8	73.2	1.6	5.9	2.6	13,120
	---	42.4	57.6	---	5.5	83.1	1.8	6.6	3.0	14,890
w219353	3.0	38.6	47.4	11.0	5.4	70.9	1.6	8.8	2.3	12,940
	---	39.8	48.8	11.4	5.2	73.2	1.6	6.3	2.3	13,340
	---	44.9	55.1	---	5.8	82.5	1.9	7.2	2.6	15,050
w219354	2.8	38.4	54.5	4.3	5.6	78.9	1.9	7.8	1.5	14,070
	---	39.5	56.1	4.4	5.4	81.2	1.9	5.6	1.5	14,470
	---	41.3	58.7	---	5.6	84.9	2.0	5.9	1.6	15,130
w219355	2.5	35.4	54.2	7.9	5.2	76.8	1.6	6.8	1.7	13,680
	---	36.3	55.6	8.1	5.1	78.8	1.7	4.5	1.8	14,030
	---	39.5	60.5	---	5.5	85.7	1.8	5.1	1.9	15,260
w219356	2.1	32.7	46.1	19.1	4.8	66.5	1.3	7.2	1.1	11,870
	---	33.4	47.1	19.5	4.6	67.9	1.4	5.4	1.2	12,120
	---	41.5	58.5	---	5.8	84.4	1.7	6.7	1.4	15,060
w219357	1.5	39.2	56.2	3.1	5.5	82.3	1.7	6.5	.9	14,650
	---	39.8	57.0	3.2	5.4	83.6	1.7	5.2	.9	14,880
	---	41.1	58.9	---	5.6	86.3	1.8	5.4	.9	15,360

Table 2a.--Proximate and ultimate analyses and calorific value determinations (continued).

Sample number	Proximate analysis: Moisture	Volatile matter	Fixed carbon	Ash	Ultimate analysis: Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Calorific value Btu/lb
w219358	2.4	37.3	52.3	8.0	5.3	75.6	1.4	8.4	1.3	13,530
	---	38.2	53.6	8.2	5.2	77.4	1.5	6.4	1.3	13,860
	---	41.6	58.4	---	5.7	84.4	1.6	6.8	1.5	15,100
w219359	3.5	35.5	56.6	4.4	5.4	77.7	1.6	9.3	1.6	13,930
	---	36.8	58.6	4.6	5.2	80.5	1.7	6.3	1.7	14,440
	---	38.6	61.4	---	5.5	84.4	1.8	6.5	1.8	15,130
w219360	2.7	36.2	56.1	5.0	5.4	77.9	1.8	8.6	1.3	13,920
	---	37.2	57.6	5.2	5.2	80.1	1.8	6.3	1.4	14,300
	---	39.2	60.8	---	5.5	84.4	1.9	6.7	1.5	15,090
w219361	1.9	37.0	54.5	6.6	5.4	77.8	1.8	7.5	.9	13,780
	---	37.7	55.6	6.7	5.2	79.3	1.8	6.1	.9	14,050
	---	40.4	59.6	---	5.6	85.0	1.9	6.6	.9	15,060
w219362	2.7	38.2	56.2	2.9	5.6	80.5	1.7	8.6	.7	14,320
	---	39.2	57.8	3.0	5.4	82.8	1.8	6.2	.8	14,710
	---	40.4	59.6	---	5.6	85.3	1.8	6.5	.8	15,160
w219363	1.4	39.1	52.1	7.4	5.3	76.6	1.7	6.1	2.9	13,810
	---	39.7	52.8	7.5	5.2	77.7	1.7	4.9	3.0	14,010
	---	42.9	57.1	---	5.6	84.0	1.9	5.3	3.2	15,150
w219364	1.3	39.4	49.4	9.9	5.1	74.1	1.4	5.3	4.2	13,570
	---	39.9	50.1	10.0	5.0	75.0	1.4	4.3	4.3	13,740
	---	44.4	55.6	---	5.5	83.4	1.6	4.7	4.8	15,280
w219391	1.9	37.2	55.0	5.9	5.6	78.3	1.8	7.0	1.4	14,100
	---	37.9	56.1	6.0	5.5	79.8	1.8	5.5	1.4	14,360
	---	40.3	59.7	---	5.8	84.9	1.9	5.9	1.5	15,280

Table 2a.--Proximate and ultimate analyses and calorific value determinations (continued).

Sample number	Proximate Analysis: Moisture	Volatile matter	Fixed carbon	Ash	Ultimate Analysis: Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Calorific value Btu/lb
w219392	2.4	33.5	58.2	5.9	5.3	79.3	1.4	7.5	0.6	14,000
	---	34.3	59.7	6.0	5.1	81.3	1.4	5.6	.6	14,350
	---	36.5	63.5	---	5.5	86.5	1.5	5.9	.6	15,270
w219393	1.8	34.7	58.7	4.8	5.3	79.8	1.6	7.3	1.2	14,240
	---	35.3	59.8	4.9	5.2	81.2	1.6	5.8	1.3	14,490
	---	37.1	62.9	---	5.4	85.4	1.7	6.2	1.3	15,240
w219394	3.3	38.1	51.1	7.5	5.3	74.0	1.6	9.6	2.0	13,310
	---	39.4	52.9	7.7	5.2	76.6	1.6	6.9	2.0	13,770
	---	42.7	57.3	---	5.6	83.0	1.7	7.5	2.2	14,920
w219395	2.2	35.0	53.5	9.3	5.1	73.8	1.5	7.7	2.6	13,220
	---	35.8	54.7	9.5	5.0	75.5	1.6	5.8	2.6	13,520
	---	39.6	60.4	---	5.5	83.5	1.7	6.4	2.9	14,940
w219396	2.0	34.4	59.4	4.2	5.3	81.2	1.4	7.0	.9	14,440
	---	35.1	60.6	4.3	5.2	82.8	1.4	5.4	.9	14,730
	---	36.6	63.4	---	5.4	86.6	1.5	5.6	.9	15,400
w219397	2.5	32.1	46.4	19.0	4.7	64.3	1.4	7.3	3.3	11,720
	---	32.9	47.6	19.5	4.5	66.0	1.4	5.2	3.4	12,030
	---	40.9	59.1	---	5.6	82.0	1.7	6.5	4.2	14,950
w219398	1.9	38.1	51.1	8.9	5.3	75.8	1.4	8.0	.6	13,510
	---	38.8	52.1	9.1	5.2	77.3	1.4	6.4	.6	13,770
	---	42.7	57.3	---	5.7	85.0	1.6	7.1	.6	15,150
w219399	3.0	32.4	59.0	5.6	5.3	78.1	1.4	9.0	.6	13,380
	---	33.4	60.8	5.8	5.1	80.5	1.4	6.6	.6	14,250
	---	35.5	64.5	---	5.5	85.5	1.5	6.8	.7	15,130

Table 2a.--Proximate and ultimate analyses and calorific value determinations (continued).

Sample number	Proximate Analysis				Ultimate Analysis					Calorific value
	Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Btu/lb
w219400	1.8	35.2	55.1	7.9	5.3	76.4	1.7	7.4	1.3	13,680
	---	35.8	56.1	8.1	5.2	77.7	1.8	5.9	1.3	13,920
	---	39.0	61.0	---	5.6	84.5	1.9	6.5	1.5	15,140
w219401	1.4	37.6	50.0	11.0	5.3	73.8	1.5	6.8	1.6	13,330
	---	38.1	50.7	11.2	5.2	74.8	1.5	5.7	1.6	13,520
	---	42.9	57.1	---	5.8	84.2	1.7	6.5	1.8	15,230
w219402	2.7	27.8	41.6	27.9	4.2	57.4	1.1	8.9	.5	10,180
	---	28.6	42.8	28.6	4.0	59.0	1.1	6.8	.5	10,460
	---	40.1	59.9	---	5.6	82.7	1.5	9.5	.7	14,660
w219403	2.9	35.3	56.9	4.9	5.4	78.6	1.6	8.9	.7	13,980
	---	36.3	58.6	5.1	5.2	80.9	1.6	6.5	.7	14,400
	---	38.3	61.7	---	5.5	85.2	1.7	6.9	.7	15,160
w219404	2.5	26.9	41.3	29.3	4.0	55.9	1.1	8.4	1.3	9,880
	---	27.6	42.4	30.0	3.8	57.3	1.1	6.5	1.3	10,130
	---	39.4	60.6	---	5.4	81.9	1.6	9.2	1.9	14,480
w219405	3.0	34.3	58.1	4.6	5.3	79.4	1.6	8.5	.6	14,120
	---	35.3	59.9	4.8	5.1	81.8	1.6	6.1	.6	14,550
	---	37.1	62.9	---	5.4	85.9	1.7	6.4	.6	15,270
w219406	2.9	36.3	56.5	4.3	5.4	78.9	1.6	9.0	.8	14,030
	---	37.4	58.2	4.4	5.2	81.2	1.6	6.8	.8	14,440
	---	39.1	60.9	---	5.5	85.0	1.7	6.9	.9	15,110
w219788	2.7	35.5	59.7	2.1	5.4	82.4	1.5	8.0	.6	14,670
	---	36.4	61.4	2.2	5.3	84.7	1.6	5.6	.6	15,070
	---	37.2	62.8	---	5.4	86.5	1.6	5.9	.6	15,400

Table 2a.--Proximate and ultimate analyses and calorific value determinations (continued).

Sample number	Proximate Analysis				Ultimate Analysis					Calorific value
	Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Btu/lb
w219789	2.8	35.2	59.3	2.7	5.3	80.9	1.4	8.9	.8	14,330
	---	36.2	61.0	2.8	5.2	83.2	1.4	6.6	.8	14,730
	---	37.2	62.8	---	5.3	85.6	1.5	6.8	.8	15,150
w219790	3.3	34.5	59.8	2.4	5.5	80.5	1.6	9.5	.5	14,220
	---	35.7	61.8	2.5	5.3	83.2	1.6	6.9	.5	14,710
	---	36.6	63.4	---	5.4	85.4	1.7	7.0	.5	15,090
w219791	2.1	34.6	49.1	14.2	4.9	69.3	1.4	7.6	2.6	12,420
	---	35.4	50.1	14.5	4.8	70.8	1.4	5.9	2.6	12,690
	---	41.4	58.6	---	5.6	82.8	1.6	6.9	3.1	14,840
w219792	2.6	35.2	53.3	8.9	5.1	75.7	1.2	8.4	.7	13,370
	---	36.1	54.8	9.1	5.0	77.7	1.2	6.2	.7	13,730
	---	39.7	60.3	---	5.5	85.5	1.3	6.9	.8	15,100
w219793	1.9	36.5	55.3	6.3	5.4	77.8	1.7	7.5	1.3	13,970
	---	37.2	56.3	6.5	5.3	79.3	1.8	5.8	1.3	14,230
	---	39.8	60.2	---	5.6	84.7	1.9	6.4	1.4	15,220
w219794	1.6	32.8	53.7	11.9	5.0	73.9	1.4	6.5	1.3	13,140
	---	33.3	54.6	12.1	4.9	75.1	1.4	5.1	1.4	13,360
	---	37.9	62.1	---	5.6	85.4	1.6	5.9	1.5	15,190
w219795	1.1	19.3	18.1	61.5	2.6	28.2	.7	5.7	1.3	5,020
	---	19.5	18.2	62.3	2.5	28.6	.7	4.6	1.3	5,080
	---	51.7	48.3	---	6.7	75.7	1.9	12.3	3.4	13,450
w219796	1.5	37.4	57.1	4.0	5.5	80.3	1.5	7.8	.9	14,300
	---	37.9	58.0	4.1	5.4	81.6	1.6	6.4	.9	14,520
	---	39.6	60.4	---	5.6	85.0	1.6	6.8	1.0	15,140

Table 2a.--Proximate and ultimate analyses and calorific value determinations (continued).

Sample number	Proximate Analysis				Ultimate Analysis					Calorific value
	Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Btu/lb
w219797	1.7	37.9	56.4	4.0	5.5	80.5	2.0	7.0	1.0	14,450
	---	38.5	57.4	4.1	5.4	81.9	2.0	5.6	1.0	14,700
	---	40.2	59.8	---	5.7	85.4	2.1	5.7	1.1	15,330
w219798	1.4	38.4	46.2	14.0	5.0	67.9	1.5	2.8	8.8	12,790
	---	38.9	46.9	14.2	4.9	68.9	1.5	1.6	8.9	12,980
	---	45.4	54.6	---	5.7	80.3	1.8	1.8	10.4	15,120
w219800	1.5	40.5	54.0	4.0	5.6	80.1	1.8	6.7	1.8	14,530
	---	41.1	54.8	4.1	5.5	81.3	1.8	5.5	1.8	14,740
	---	42.9	57.1	---	5.8	84.8	1.9	5.6	1.9	15,370
w219265	3.7	34.3	51.7	10.3	5.3	72.3	1.5	9.2	1.4	12,970
	---	35.6	53.7	10.7	5.1	75.1	1.6	6.1	1.4	13,470
	---	39.9	60.1	---	5.7	84.1	1.8	6.8	1.6	15,090
w219590	2.1	28.4	45.1	24.4	4.3	60.7	1.1	8.8	.7	10,790
	---	29.0	46.1	24.9	4.2	62.0	1.2	7.0	.7	11,020
	---	38.6	61.4	---	5.6	82.6	1.5	9.3	1.0	14,670

Table 2b.--Air-dried loss, forms of sulfur, free-swelling index, and ash-fusion temperatures for 52 bituminous coal samples from the southwestern Virginia coal field, Virginia.

[All analyses except free swelling index and ash fusion temperatures are in percent. Data are reported: a) as received, b) moisture-free, and c) moisture- and ash-free. All analyses by Geochemical Testing, Inc., Somerset, PA.]

Sample number		Air-dried loss	Forms of sulfur: Sulfate	Forms of sulfur: Pyritic	Forms of sulfur: Organic	Free swelling index	Ash fusion temperature (°C): Initial deformation	Ash fusion temperature (°C): Softening	Ash fusion temperature (°C): Fluid
w218688	a)	0.2	0.02	0.03	0.52	5.0	1,395	1,470	1,495
	b)	---	.02	.03	.53				
	c)	---	.02	.04	.63				
w219343		2.4	.02	1.55	1.19	5.0	1,080	1,115	1,175
		---	.02	1.59	1.22				
		---	.02	1.69	1.30				
w219345		.7	.02	.53	.84	4.0	1,415	1,480	1,520
		---	.02	.54	.86				
		---	.02	.62	.98				
w219346		2.3	.02	.42	.68	6.0	1,155	1,195	1,305
		---	.02	.44	.71				
		---	.02	.48	.78				
w219347		.5	.03	2.14	1.06	4.0	1,120	1,170	1,240
		---	.03	2.18	1.08				
		---	.03	2.46	1.22				
w219348		1.1	.01	.07	.59	7.0	1,395	1,430	1,495
		---	.01	.07	.61				
		---	.01	.07	.62				
w219349		.4	.01	3.70	1.86	4.5	1,050	1,070	1,140
		---	.01	3.75	1.89				
		---	.01	4.15	2.09				

Table 2b.--Air-dried loss, forms of sulfur, free-swelling index, and ash-fusion temperature determinations (continued).

Sample number	Air-dried loss	Forms of sulfur			Free swelling index	Ash fusion temperature (°C)		
		Sulfate	Pyritic	Organic		Initial deformation	Softening	Fluid
w219350	1.1	0.00	0.32	0.80	4.5	1,415	1,460	1,515
	---	.00	.33	.82				
	---	.00	.36	.90				
w219351	.7	.01	1.36	.82	4.0	1,045	1,100	1,190
	---	.01	1.38	.83				
	---	.01	1.48	.89				
w219352	1.0	.02	1.49	1.03	4.5	1,175	1,270	1,330
	---	.02	1.53	1.06				
	---	.02	1.73	1.20				
w219353	1.4	.03	1.31	.92	4.0	1,215	1,355	1,405
	---	.03	1.35	.95				
	---	.03	1.52	1.07				
w219354	1.1	.04	.59	.83	6.5	1,165	1,215	1,345
	---	.04	.61	.85				
	---	.04	.63	.89				
w219355	1.2	.01	.88	.82	6.5	1,350	1,405	1,420
	---	.01	.90	.84				
	---	.01	.98	.91				
w219356	.9	.01	.48	.64	5.5	1,540	1,540	1,540
	---	.01	.49	.65				
	---	.01	.61	.81				
w219357	.5	.02	.26	.62	4.5	1,275	1,370	1,395
	---	.02	.26	.63				
	---	.02	.27	.65				

Table 2b.--Air-dried loss, forms of sulfur, free-swelling index, and ash fusion temperature determinations (continued).

Sample number	Air-dried loss	Forms of sulfur: Sulfate	Pyrite	Organic	Free swelling index	Ash-fusion temperature (°C): Initial deformation	Softening	Fluid
w219358	1.0	0.01	0.46	0.84	4.0	1,540	1,540	1,540
	---	.01	.47	.86				
	---	.01	.51	.94				
w219359	2.1	.01	.55	1.06	7.0	1,390	1,440	1,455
	---	.01	.57	1.10				
	---	.01	.60	1.15				
w219360	1.3	.01	.63	.70	6.5	1,290	1,370	1,395
	---	.01	.65	.72				
	---	.01	.68	.76				
w219361	.6	.01	.21	.64	6.5	1,390	1,430	1,455
	---	.01	.21	.65				
	---	.01	.23	.70				
w219362	1.3	.01	.03	.69	4.5	1,540	1,540	1,540
	---	.01	.03	.71				
	---	.01	.03	.73				
w219363	.5	.00	2.07	.86	4.5	1,080	1,115	1,150
	---	.00	2.10	.87				
	---	.00	2.27	.94				
w219364	.4	.03	2.54	1.65	6.0	1,130	1,220	1,270
	---	.03	2.57	1.67				
	---	.03	2.86	1.86				
w219391	.5	.02	.43	.97	6.5	1,375	1,420	1,455
	---	.02	.44	.99				
	---	.02	.47	1.05				

Table 2b.--Air-dried loss, forms of sulfur, free-swelling index, and ash-fusion temperature determinations (continued).

Sample number	Air-dried loss	Forms of sulfur: Sulfate	Pyritic	Organic	Free swelling index	Ash fusion temperature (°C): Initial deformation	Softening	Fluid
w219392	1.1	0.00	0.02	0.55	7.0	1,440	1,500	1,515
	---	.00	.02	.56				
	---	.00	.02	.60				
w219393	.7	.03	.39	.81	7.0	1,400	1,425	1,450
	---	.03	.40	.82				
	---	.03	.42	.87				
w219394	2.0	.02	.91	1.03	4.5	1,160	1,250	1,325
	---	.02	.94	1.07				
	---	.02	1.02	1.15				
w219395	.8	.00	1.79	.79	5.5	1,095	1,145	1,255
	---	.00	1.83	.81				
	---	.00	2.02	.89				
w219396	.5	.01	.40	.47	6.5	1,110	1,150	1,205
	---	.01	.41	.48				
	---	.01	.43	.50				
w219397	1.1	.00	2.19	1.10	5.0	1,140	1,230	1,315
	---	.00	2.25	1.13				
	---	.00	2.79	1.40				
w219398	.5	.00	.02	.54	5.5	1,440	1,500	1,540
	---	.00	.02	.55				
	---	.00	.02	.61				
w219399	1.7	.01	.11	.50	4.0	1,240	1,305	1,365
	---	.01	.11	.52				
	---	.01	.12	.55				

Table 2b.--Air-dried loss, forms of sulfur, free-swelling index, and ash-fusion temperature determinations (continued).

Sample number	Air-dried loss	Forms of sulfur: Sulfate	Forms of sulfur: Pyritic	Forms of sulfur: Organic	Free swelling index	Ash fusion temperature (°C): Initial deformation	Ash fusion temperature (°C): Softening	Ash fusion temperature (°C): Fluid
w219400	.6	0.00	0.47	0.85	5.0	1,345	1,405	1,440
	---	.00	.48	.87				
	---	.00	.52	.94				
w219401	.6	.01	.86	.72	5.0	1,400	1,460	1,530
	---	.01	.87	.73				
	---	.01	.98	.82				
w219402	1.5	.03	.02	.45	1.5	1,500	1,540	1,540
	---	.03	.02	.46				
	---	.04	.03	.65				
w219403	1.9	.02	.15	.52	5.0	1,195	1,315	1,370
	---	.02	.15	.54				
	---	.02	.16	.56				
w219404	1.6	0.01	0.62	0.64	1.5	1,415	1,505	1,540
	---	.01	.64	.66				
	---	.01	.91	.94				
w219405	2.2	.02	.07	.48	7.0	1,480	1,540	1,540
	---	.02	.07	.49				
	---	.02	.08	.52				
w219406	2.0	.00	.09	.70	5.5	1,540	1,540	1,540
	---	.00	.09	.72				
	---	.00	.10	.75				
w219788	1.7	.01	.07	.50	7.0	1,390	1,445	1,540
	---	.01	.07	.51				
	---	.01	.07	.52				

Table 2b.--Air-dried loss, forms of sulfur, free-swelling index, and ash-fusion temperature determinations (continued).

Sample number	Air-dried loss	Forms of sulfur			Free swelling index	Ash fusion temperature (°C)		
		Sulfate	Pyritic	Organic		Initial deformation	Softening	Fluid
w219789	1.6	0.03	0.14	0.59	6.0	1,340	1,420	1,480
	---	.03	.14	.61				
	---	.03	.15	.62				
w219790	2.2	.01	.02	.48	5.0	1,540	1,540	1,540
	---	.01	.02	.50				
	---	.01	.02	.51				
w219791	1.1	.01	1.71	.85	6.5	1,175	1,295	1,440
	---	.01	1.75	.87				
	---	.01	2.04	1.02				
w219792	1.6	.01	.23	.49	5.0	1,340	1,375	1,410
	---	.01	.24	.50				
	---	.01	.26	.55				
w219793	1.0	.01	.69	.62	5.5	1,305	1,390	1,455
	---	.01	.70	.63				
	---	.01	.75	.68				
w219794	.8	.00	.56	.77	4.5	1,345	1,475	1,540
	---	.00	.57	.78				
	---	.00	.65	.89				
w219795	.5	.01	1.22	.04	.50	1,440	1,470	1,505
	---	.01	1.23	.04				
	---	.03	3.27	.11				
w219796	.6	.02	.20	.71	7.0	1,245	1,280	1,405
	---	.02	.20	.72				
	---	.02	.21	.75				

Table 2b.--Air-dried loss, forms of sulfur, free-swelling index, and ash-fusion temperature determinations (continued).

Sample number	Air-dried loss	Forms of sulfur: Sulfate	Pyritic	Organic	Free swelling index	Ash fusion temperature (°C): Initial deformation	Softening	Fluid
w219797	0.8	0.01	0.30	0.71	5.5	1,155	1,240	1,360
	---	.01	.31	.72				
	---	.01	.32	.75				
w219798	.6	.01	5.38	3.39	4.5	1,110	1,160	1,215
	---	.01	5.46	3.44				
	---	.01	6.36	4.01				
w219800	.7	.01	.92	.84	6.5	1,180	1,250	1,315
	---	.01	.93	.85				
	---	.01	.97	.89				
w219265	2.5	.04	.57	.78	6.5	1,370	1,450	1,525
	---	.04	.59	.81				
	---	.05	.66	.91				
w219590	.9	.05	.10	.56	2.5	1,500	1,540	1,540
	---	.05	.10	.57				
	---	.07	.14	.76				

Table 3.--Arithmetic mean, observed range, geometric mean, and geometric deviation, of proximate and ultimate analyses, heat of combustion, forms of sulfur, and ash-fusion temperatures of 52 coal samples from the southwestern Virginia coal field, Virginia.

[All values are in percent except calorific value, ash-fusion temperatures, and free-swelling index and are reported on the as-received basis. °F = 9/5°C + 32; Kcal/kg = 0.556 Btu/lb.]

	Arithmetic mean	Observed range		Geometric mean	Geometric deviation	Geometric mean (369 samples from Virginia)
		Minimum	Maximum			
Proximate and ultimate analyses (%)						
Moisture	2.26	1.07	3.79	2.16	1.36	2.41
Volatile matter	35.54	19.29	43.90	35.29	1.13	28.49
Fixed carbon	52.29	18.02	59.79	51.66	1.19	55.88
Ash	9.91	2.10	61.55	7.62	1.97	8.41
Hydrogen	5.16	2.64	5.63	5.13	1.12	4.87
Carbon	74.07	28.24	82.43	73.33	1.17	73.35
Nitrogen	1.52	.71	1.97	1.50	1.19	1.33
Oxygen	7.70	2.81	9.67	7.58	1.21	6.91
Sulfur	1.64	.50	8.78	1.29	1.90	0.93
Heat of combustion (Btu/lb)						
Calorific value	13265.	5020.	14670.	13133.	1.17	12994.
Forms of sulfur (%S)						
Sulfate	0.02	.01	0.05	0.02	1.66	0.02
Pyritic	0.81	.02	5.38	0.37	4.20	0.24
Organic	0.81	.04	3.39	0.72	1.73	0.56
Ash-fusion temperature (°C)						
Initial deformation	1304.	1045.	1540.	1296.	1.12	1298.
Softening temperature	1362.	1070.	1540.	1355.	1.11	1341.
Fluid temperature	1413.	1140.	1540.	1407.	1.09	1389.
Free-swelling index	5.2	.50	7.0	4.8	1.6	6.5

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