UNITED STATES DEPARTMENT OF THE INTERIOR

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

Part 4: Analyses of coal cores from the Valley coal fields

by

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

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

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Introduction

In 1982-83 the U.S. Geological Survey (USGS), in cooperation with the Bureau of Land Management, drilled 8 coreholes in the Valley coal fields, Bland, Botetourt, Montgomery, Pulaski, Smyth, and Wythe Counties, Virginia (Figure 1). These coreholes penetrated the Elbrook (?), Price Formation and Maccrady Shale; coal samples were obtained from four the eight coreholes. The detailed stratigraphic analysis of the cores and geophysical logs of the coreholes are presented in Part 3 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 analyses for the Valley coal fields are available in reports by the Virginia Geological Survey (Campbell and others, 1925) and the Virginia Division of Mineral Resources (Stanley and Schultz, 1983).

The assistance of J. M. Back, P. C. Lyons, J. O. Mayberry, R. E. Thomas, J. C. Weber and J. F. Windolph, Jr. with the collection of the coal cores during drilling is gratefully acknowledged.

Sampling and analysis procedures

The analyses presented in this report are of drillcore samples and represent the entire coal bed, excluding partings, except for samples w218548-551.

Coal cores were sealed in polyethylene for transportation to the laboratory.

Partings of impure coal or shale 3/8-inch or greater in thickness were discarded prior to crushing. In some coal cores, such as samples W218548-551, the intensely sheared condition of the core resulted in the intermingling of flakes of coal and partings, so that the parting could not be effectively removed. 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. to produce the data in this report are described in part 26 of the Annual Book of ASTM Standards (ASTM, 1981) and the details will not be repeated here. Petrological results and major, minor, and trace analysis results are not a part of this report.

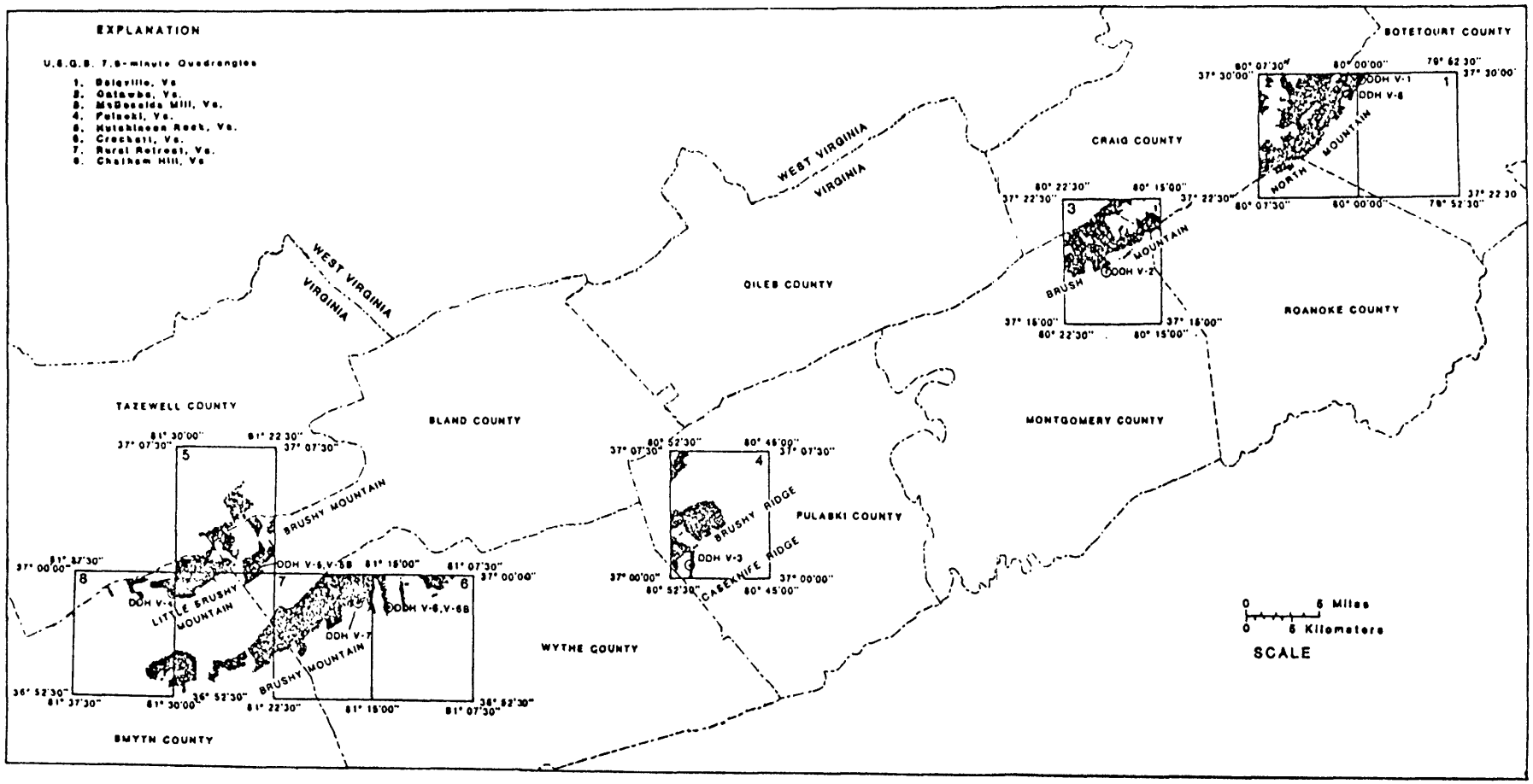

Figure 1. Location of coreholes in the Valley coal fields. Stippled pattern indicates approximate areas of Federal mineral ownership in proximity of drill sites.

Explanation of tables

Table 1 briefly describes the 20 samples from the Valley coal fields; all samples 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. The coal samples ranged from medium-volatile bituminous to semi-anthracite; four samples had ash contents greater than 50%.

Proximate and ultimate analyses and calorific value for each sample are listed in Table 2a. Data are presented three ways: a) as received, b) moisture-free, and c) 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 20 samples from the Valley coal fields is given in Table 3; the geometric means for 85 anthracite samples from the United States were calculated using the National Coal Resources Data System (U.S. Geological Survey, Reston, Virginia) and are given for comparision. Statistical summaries of the 10 semianthracite samples (Table 4) and the 6 bituminous samples (Table 5) also were calculated.

Discussion

The coal beds sampled in this drilling program in the Valley coal fields are, on an as-received basis, high ash (approximately 30%), low sulfur (<0.5%) and moderate calorific value (<12,000 Btu/lb.). Two samples contained less than 20 percent ash and only one sample contained greater than 1.0 percent sulfur; more than half the samples (11) contain greater than 30 percent ash. Ten of the samples are classified as semi-anthracite, three as low-volatile bituminous, three as medium-volatile bituminous and three as carbonaceous shale. Five samples have free swelling indices greater than 1.0.

Table 1. Descriptions for 20 drill core samples from the Valley coal fields, Virginia
[Apparent rank calculated using ASTM D388.]

Sample No.	Field No.	County	Latitude	Longnitude	Formation	Coal zone	Apparent rank	Depth of coal bed (inches)	Sampled thickness (inches)
w218548	ddhv-6	Wythe	365803n	811345w	Price	Merrimac lsp	lvb	3108.	36.0
w218549	ddhv-7c	Wythe	365817n	811605w	Price	Langhorne (?) lsp	mvb	4016.	19.0
w218550	ddhv-7a	Wythe	365817n	811605w	Price	Merrimac (?) msp	mvb	3809.	14.0
w218551	ddhv-7b	Wythe	365819n	811605w	Price	Merrimac (?) lsp	mvb	3855.	32.0
w218683	v1-1a	Botetourt	372933n	795952w	Price	unnamed	shale	360.	21.0
w218684	v1-1b	Botetourt	372933n	795952w	Price	Langhorne (?) lsp	sa	381.	15.0
w218685	v1-1c	Botetourt	372933n	795952w	Price	unnamed	shale	615.	22.0
w218686	v1-1d	Botetourt	372933n	795952w	Price	unnamed	shale	713.	12.0
w218687	v1-1e	Botetourt	372933n	795952w	Price	Merrimac	mvb	2586.	26.0
w219206	v1-c1	Botetourt	372933n	795952w	Price	Merrimac usp	sa	6532.	32.5
w219207	v1-c2	Botetourt	372933n	795952w	Price	Langhorne usp	sa	6845.	20.0
w219208	v1-c3	Botetourt	372933n	795952w	Price	Langhorne msp	sa	6880.	13.0
w219209	v1-c4	Botetourt	372933n	795952w	Price	unnamed	sa	9947.	20.0
w219210	v2-c2	Montgomery	371817n	801930w	Price	Merrimac usp	sa	1549.	13.0
w219211	v2-c3	Montgomery	371817n	801930w	Price	Merrimac msp	sa	1573.	17.0
w219212	v2-c4	Montgomery	371817n	801930w	Price	Merrimac lsp	sa	1667.	8.0
w219213	v2-c5	Montgomery	371817n	801930w	Price	Langhorne usp	sa	1917.	30.0
w219214	v2-c6	Montgomery	371817n	801930w	Price	Langhorne lsp	sa	2022.	14.0
w219344	v6b-c1	Wythe	365803n	811345w	Price	Merrimac usp	lvb	3071.	10.0
w219365	v6b-c2	Wythe	365803n	811345w	Price	Merrimac lsp	lvb	3106.	70.0

Table 2a.--Proximate and ultimate analyses and calorific value for 20 coal samples from the Valley coal fields, 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
w218548	a)	1.4	17.3	57.6	23.7	3.7	67.0	1.0	3.6	1.0	11,480
	b)	---	17.6	58.4	24.0	3.6	67.9	1.1	2.4	1.0	11,640
	c)	---	23.1	76.9	---	4.7	89.3	1.4	3.3	1.3	15,310
w218549		1.0	20.3	50.7	28.0	3.7	62.6	.8	3.9	1.0	10,860
		---	20.4	51.4	28.2	3.6	63.2	.8	3.2	1.0	10,960
		---	28.5	71.5	---	5.0	88.0	1.1	4.4	1.5	15,270
w218550		1.0	21.2	44.3	33.5	3.5	56.3	.8	4.3	1.6	9,790
		---	21.4	44.8	33.8	3.4	56.9	.8	3.5	1.6	9,890
		---	32.4	67.6	---	5.1	86.0	1.3	5.2	2.4	14,950
w218551		.9	25.1	53.2	20.8	4.1	68.9	1.0	4.3	.9	12,030
		---	25.3	53.7	21.0	4.0	69.6	1.0	3.5	.9	12,140
		---	32.1	67.9	---	5.1	88.1	1.3	4.4	1.1	15,380
w218683		.6	7.3	13.9	78.2	1.3	16.4	.2	3.7	.2	2,470
		---	7.4	14.0	78.6	1.2	16.5	.2	3.3	.2	2,480
		---	34.6	65.4	---	5.6	77.2	.8	15.5	.9	11,600
w218684		.9	10.8	48.6	39.7	2.6	53.7	.4	3.1	.5	8,970
		---	10.9	49.1	40.0	2.5	54.1	.4	2.5	.5	9,050
		---	18.2	81.8	---	4.2	90.2	.7	4.0	.9	15,080
w218685		.9	7.3	17.8	74.0	1.4	20.1	.2	4.1	.2	3,150
		---	7.4	17.9	74.7	1.3	20.2	.2	3.4	.2	3,170
		---	29.2	70.8	---	5.0	79.9	.9	13.3	.9	12,530

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

Sample number	Proximate Analysis				Ultimate Analysis					Calorific value
	Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Btu/lb
w218686	.7	7.0	13.9	78.4	1.2	16.1	.2	3.9	.2	2,380
	---	7.0	14.1	78.9	1.1	16.2	.2	3.4	.2	2,400
	---	33.3	66.7	---	5.3	76.9	.9	15.8	1.1	11,370
w218687	.8	17.4	46.4	35.4	2.7	55.7	.6	5.0	.6	9,120
	---	17.5	46.8	35.7	2.6	56.1	.6	4.4	.6	9,190
	---	27.2	72.8	---	4.1	87.2	.9	6.9	.9	14,290
w219206	4.3	10.2	63.5	22.0	3.5	67.0	.8	6.0	.7	11,310
	---	10.7	66.3	23.0	3.2	70.0	.8	2.3	.7	11,820
	---	13.9	86.1	---	4.1	91.0	1.0	3.0	.9	15,350
w219207	1.4	8.8	75.1	14.7	3.3	78.3	.8	2.6	.3	13,080
	---	8.9	76.2	14.9	3.2	79.4	.8	1.4	.3	13,270
	---	10.5	89.5	---	3.7	93.3	.9	1.7	.4	15,590
w219208	1.2	9.2	48.1	41.5	2.3	49.8	0.5	5.7	0.2	8,350
	---	9.3	48.7	42.0	2.2	50.4	.5	4.7	.2	8,450
	---	16.1	83.9	---	3.8	87.0	.9	7.9	.4	14,570
w219209	.9	11.0	62.9	25.2	3.2	67.3	.7	3.3	.3	11,270
	---	11.1	63.4	25.5	3.1	67.9	.7	2.5	.3	11,370
	---	14.8	85.2	---	4.2	91.0	1.0	3.4	.4	15,250
w219210	4.9	9.7	48.6	36.8	3.0	50.2	.6	9.1	.3	8,310
	---	10.2	51.0	38.8	2.6	52.8	.6	4.9	.3	8,750
	---	16.7	83.3	---	4.3	86.2	1.0	8.1	.4	14,280
w219211	5.6	10.9	65.7	17.8	3.7	70.3	.8	6.9	.5	11,700
	---	11.5	69.7	18.8	3.2	74.4	.8	2.3	.5	12,390
	---	14.2	85.8	---	4.0	91.7	1.0	2.7	.6	15,260

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

Sample number	Proximate Analysis				Ultimate Analysis					Calorific value
	Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Btu/lb
w219212	4.2	9.2	60.0	26.6	2.8	62.9	.6	6.8	.3	10,400
	---	9.6	62.6	27.8	2.5	65.6	.7	3.1	.3	10,850
	---	13.3	86.7	---	3.4	90.8	.9	4.4	.5	15,030
w219213	5.6	8.1	37.1	49.2	2.8	38.1	.4	9.3	.2	6,470
	---	8.5	39.4	52.1	2.3	40.4	.5	4.5	.2	6,850
	---	17.8	82.2	---	4.8	84.3	.9	9.5	.5	14,290
w219214	6.7	9.9	38.7	44.7	2.9	41.9	.4	9.9	.2	6,980
	---	10.6	41.5	47.9	2.3	44.9	.5	4.2	.2	7,480
	---	20.3	79.7	---	4.4	86.2	.9	8.0	.5	14,340
w219344	1.5	12.4	35.5	50.6	2.5	40.2	.5	5.3	.9	6,810
	---	12.6	36.0	51.4	2.3	40.8	.5	4.1	.9	6,910
	---	25.9	74.1	---	4.8	84.0	1.0	8.3	1.9	14,220
w219365	3.7	15.9	52.2	28.2	3.6	61.0	.9	5.4	.9	10,480
	---	16.5	54.2	29.3	3.3	63.3	.9	2.3	.9	10,880
	---	23.4	76.6	---	4.7	89.6	1.2	3.2	1.3	15,390

Table 2b.--Air-dried loss, forms of sulfur, free swelling index, and ash-fusion temperatures for 20 coal samples from the Valley coal fields, 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			Free swelling index	Ash fusion temperature (°C)		
			Sulfate	Pyritic	Organic		Initial deformation	Softening	Fluid
w218548	a)	0.8	0.03	0.63	0.29	2.0	1,270	1,325	1,450
	b)	---	.03	.64	.29				
	c)	---	.04	.84	.39				
w218549		.4	.01	.67	.36	1.5	1,460	1,510	1,540
		---	.01	.68	.36				
		---	.01	.94	.51				
w218550		.4	.02	1.24	.31	1.5	1,325	1,405	1,500
		---	.02	1.25	.31				
		---	.03	1.89	.47				
w218551		.4	.01	.42	.43	6.5	1,265	1,315	1,470
		---	.01	.42	.43				
		---	.01	.54	.55				
w218683		.1	.02	.13	.05	.0	1,475	1,515	1,540
		---	.02	.13	.05				
		---	.09	.61	.24				
w218684		.1	.02	.23	.27	.5	1,455	1,515	1,530
		---	.02	.23	.27				
		---	.03	.39	.45				
w218685		.1	.02	.08	.13	.0	1,395	1,470	1,495
		---	.02	.08	.13				
		---	.08	.32	.52				

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

Sample number	Air-dried loss	Forms of sulfur			Free swelling index	Ash fusion temperature (°C)		
		Sulfate	Pyritic	Organic		Initial deformation	Softening	Fluid
w218686	.1	.02	.21	.00	.0	1,465	1,510	1,540
	---	.02	.21	.00				
	---	.10	1.00	.00				
w218687	.2	.01	.30	.25	.5	1,155	1,205	1,255
	---	.01	.30	.25				
	---	.02	.47	.39				
w219206	3.6	.01	.38	.29	.5	1,325	1,400	1,470
	---	.01	.40	.30				
	---	.01	.52	.39				
w219207	.6	.01	.02	.31	.5	1,470	1,525	1,540
	---	.01	.02	.31				
	---	.01	.02	.37				
w219208	.5	.01	.02	.19	.0	1,425	1,495	1,540
	---	.01	.02	.19				
	---	.02	.03	.33				
w219209	.4	.02	.01	.27	1.0	1,515	1,540	1,540
	---	.02	.01	.27				
	---	.03	.01	.37				
w219210	4.5	.02	.06	.18	.0	1,540	1,540	1,540
	---	.02	.06	.19				
	---	.03	.10	.31				
w219211	5.0	.02	.10	.34	.0	1,440	1,515	1,540
	---	.02	.11	.36				
	---	.03	.13	.44				

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

Sample number	Air-dried loss	Forms of sulfur			Free swelling index	Ash fusion temperature (°C)		
		Sulfate	Pyritic	Organic		Initial deformation	Softening	Fluid
w219212	3.7	.02	.02	.29	.0	1,540	1,540	1,540
	---	.02	.02	.30				
	---	.03	.03	.42				
w219213	5.1	.04	.02	.16	.0	1,540	1,540	1,540
	---	.04	.02	.17				
	---	.09	.04	.35				
w219214	6.3	.02	.01	.19	.0	1,540	1,540	1,540
	---	.02	.01	.20				
	---	.04	.02	.39				
w219344	.7	.01	.75	.16	1.0	1,470	1,540	1,540
	---	.01	.76	.16				
	---	.02	1.57	.33				
w219365	3.1	.01	.56	.33	1.5	1,345	1,410	1,450
	---	.01	.58	.34				
	---	.01	.82	.48				

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 20 samples from the Valley coal fields, 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 (85 anthracite samples from the United States)
		Minimum	Maximum			
Proximate and ultimate analyses (%)						
Moisture	2.40	.56	6.67	1.71	2.25	1.63
Volatile matter	12.45	6.97	25.10	11.56	1.45	6.64
Fixed carbon	46.71	13.92	75.09	42.66	1.61	75.43
Ash	38.44	14.68	78.36	34.42	1.59	12.41
Hydrogen	2.88	1.19	4.08	2.73	1.43	2.26
Carbon	52.18	16.12	78.26	47.84	1.59	76.47
Nitrogen	0.61	.17	1.05	0.55	1.67	0.80
Oxygen	5.33	2.65	9.87	4.98	1.44	3.68
Sulfur	0.55	.20	1.57	0.45	1.90	0.66
Heat of combustion (Btu/lb)						
Calorific value	8769.	2380.	13080.	7946.	1.65	12178.
Forms of sulfur (%)						
Sulfate	0.02	.01	0.04	0.02	1.52	0.01
Pyritic	0.29	.01	1.24	0.12	4.65	0.14
Organic	0.25	.05	0.43	0.23	1.61	0.46
Ash-fusion temperature (°C)						
Initial deformation	1421.	1155.	1540.	1417.	1.08	----
Softening temperature	1467.	1205.	1540.	1464.	1.07	----
Fluid temperature	1502.	1255.	1540.	1500.	1.05	----
Free-swelling index	1.6	.50	6.5	1.1	2.1	----

Table 4.--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 10 semi-anthracite samples from the Valley coal fields, Virginia.

[All values are in percent except Btu/lb, 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 (85 anthracite samples from the United States)
		Minimum	Maximum			
Proximate and ultimate analyses (%)						
Moisture	3.57	.86	6.67	2.75	2.20	1.63
Volatile matter	9.77	8.05	10.96	9.73	1.10	6.64
Fixed carbon	54.85	37.22	75.09	53.55	1.25	75.43
Ash	31.81	14.68	49.17	29.58	1.48	12.41
Hydrogen	3.02	2.31	3.68	3.00	1.14	2.26
Carbon	57.93	38.14	78.26	56.54	1.25	76.47
Nitrogen	0.61	.43	0.79	0.59	1.26	0.80
Oxygen	6.27	2.65	9.87	5.70	1.58	3.68
Sulfur	0.36	.22	0.68	0.33	1.45	0.66
Heat of combustion (Btu/lb)						
Calorific value	9682.	6470.	13078.	9452.	1.25	12178.
Forms of sulfur (%)						
Sulfate	0.02	.01	0.04	0.02	1.52	0.01
Pyritic	0.09	.01	0.38	0.04	3.39	0.14
Organic	0.25	.16	0.34	0.24	1.29	0.46
Ash-fusion temperature (°C)						
Initial deformation	1478.	1325.	1540.	1477.	1.05	----
Softening temperature	1514.	1400.	1540.	2756.	1.03	----
Fluid temperature	1531.	1470.	1540.	1531.	1.01	----
Free-Swelling index	.63	.50	1.0	.59	1.4	----

Table 5.--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 6 bituminous coal samples from the Valley coal fields, Virginia.

[All values are in percent except Btu/lb, 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	1.45	.77	3.67	1.23	1.68	2.41
Volatile matter	19.53	15.94	25.10	19.30	1.16	28.49
Fixed carbon	50.76	44.29	57.65	50.57	1.09	55.88
Ash	28.27	20.83	35.42	27.80	1.20	8.41
Hydrogen	3.52	2.67	4.08	3.49	1.14	4.87
Carbon	61.91	55.65	68.94	61.72	1.08	73.35
Nitrogen	0.85	.59	1.05	0.84	1.21	1.33
Oxygen	4.46	3.70	5.42	4.42	1.14	6.91
Sulfur	0.98	.56	1.57	0.94	1.35	0.93
Heat of combustion (Btu/lb)						
Calorific value	10626.	9117.	12029.	10580.	1.10	12994.
Forms of sulfur (%)						
Sulfate	0.02	.01	0.03	0.01	1.55	0.02
Pyritic	0.64	.30	1.24	0.58	1.55	0.24
Organic	0.33	.25	0.43	0.32	1.19	0.56
Ash-fusion temperature (°C)						
Initial deformation	1303.	1155.	1460.	1301.	1.07	1298.
Softening temperature	1362.	1205.	1510.	1358.	1.07	1341.
Fluid temperature	1424.	1255.	1500.	1422.	1.06	1389.
Free-Swelling index	2.3	.50	6.5	1.7	2.1	6.5

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