UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

A Detailed Stratigraphic and Quality Analysis of the Anderson Coal Deposit, Johnson County, Wyoming

By

Robert G. Hobbs[1], J. Daniel Cathcart[1],

Stephen B. Roberts[1], and Richard N. Babcock[1]

Open-File Report 86-436

[1]USGS, Denver, Colo.

1986

CONTENTS

ILLUSTRATIONS

TABLES

A Detailed Stratigraphic and Quality Analysis of the Anderson Coal Deposit, Johnson County, Wyoming

By

Robert G. Hobbs, J. Daniel Cathcart, Stephen B. Roberts,

and Richard N. Babcock

ABSTRACT

In 1983, the U.S. Geological Survey drilled and sampled a thick Anderson coal deposit reported by previous U.S. Geological Survey investigation (Pierce and others, 1982).

At the sampling location, central Johnson County, Wyoming, the total gross coal thickness including partings is 201.85 ft; the net coal thickness is 197.99 ft.

The coal is characterized by low ash and sulfur contents, and a rather uniform Btu/lb (dry, mineral-matter-free basis). Its overall indicated apparent rank is subbituminous B with some probable zones of subbituminous A.

A total of six depositional zones within the overall coal bed have been identified: very thin lower and upper transition zones (floor and roof coals), three major coal zones, and one major rock parting. The three coal zones each have distinct depositional characteristics and reflect major changes in the coal swamp environment.

A rock parting, about 140 ft from the top of the coal, may have been caused by a major flooding--a result of a regional geologic event. The coal deposit above this parting shows significant differences from the coal below.

A correlation between coal zone 1 of this report and the thick Anderson-Canyon coal bed of the Arvada-Spotted Horse area of Sheridan and Campbell Counties, Wyoming, is probable.

INTRODUCTION

In 1983, the U.S. Geological Survey, in cooperation with the Bureau of Land Management, conducted a coal and water resource exploratory drilling project in central Johnson County, Wyoming. The objective was to evaluate the thick Big George coal bed reported by Pierce and others (1982).

This report includes a detailed stratigraphic evaluation of the coal bed, evaluation and interpretation of the coal proximate and ultimate analytical data, apparent specific gravities, the relationship of the ash content to the apparent specific gravities and Btu/lb, and the possible coal depositional environment. Comparisons and possible correlations have been made to the Anderson coal bed at other locations near Arvada, Wyo.

The sampling location, drill hole No. B32-BG1C, is located in the SE1/4SE1/4 sec. 7, T. 48 N., R. 77 W., Johnson County, Wyoming. It is about midway between Buffalo and Gillette (see fig. 1).

Unless otherwise specified, the data and interpretations contained in this report are restricted to this sampling location and are not to be construed as applicable to the entire Big George coal deposit or the Anderson Canyon coal beds of the Powder River Basin except where noted.

COAL CORE DESCRIPTION

The roof rock, coal, and floor rock core description are shown in appendix A. This was done concurrently with the apparent specific gravity determinations and after the X-ray radiographic investigation.

The core description includes the entire cored interval from a depth of 1,028.0 to 1,265.45 ft. The roof rock, coal, and floor rock intervals are:

Roof rock	1,028.00 - 1,051.00 ft
Coal	1,051.00 - 1,252.85 ft
Floor rock	1,252.85 - 1,265.45 ft

The 201.85-ft-thick coal deposit, examined megascopically, is characterized by thin transition zones from floor rock to coal and from coal to roof rock, as well as an overall increase in the vitrain content and a gradual decrease in apparent specific gravity from the top downward to the base. Also important is the sparse to absent occurrence of sulfur in the pyritic and sulfate forms throughout the coal deposit, the extensive bleeding of methane gas from the coal core, and the oil-stained floor rocks at the depth of 1,255.95-1,256.20 ft.

SAMPLING

The Anderson coal core was sampled for several ongoing research investigations. The methods and procedures used were designed to maximize data available from the core while maintaining representative sample data.

The first sampling was for the methane in coal investigations. The intervals chosen for methane content and composition determinations are shown in table 1, and were reported by Boreck (1984) and Boreck and Weaver (1984).

Table 1.--Coal samples for coal bed methane investigations

Sample number	Footage (ft depth)	Core interval (ft)	Length (ft)
MRBG-1	1,052.25-1,053.10	1.25- 2.15	0.85
MRBG-2	1,085.20-1,085.85	34.20- 34.85	.65
MRBG-3	1,124.35-1,125.15	73.35- 74.15	.80
MRBG-4	1,166.15-1,166.95	115.15-115.95	.80
MRBG-5	1,178.40-1,179.40	127.40-128.40	1.00
MRBG-6	195.25-1,196.05	144.25-145.05	.80
MRBG-7	1,225.25-1,226.05	174.25-175.05	.80

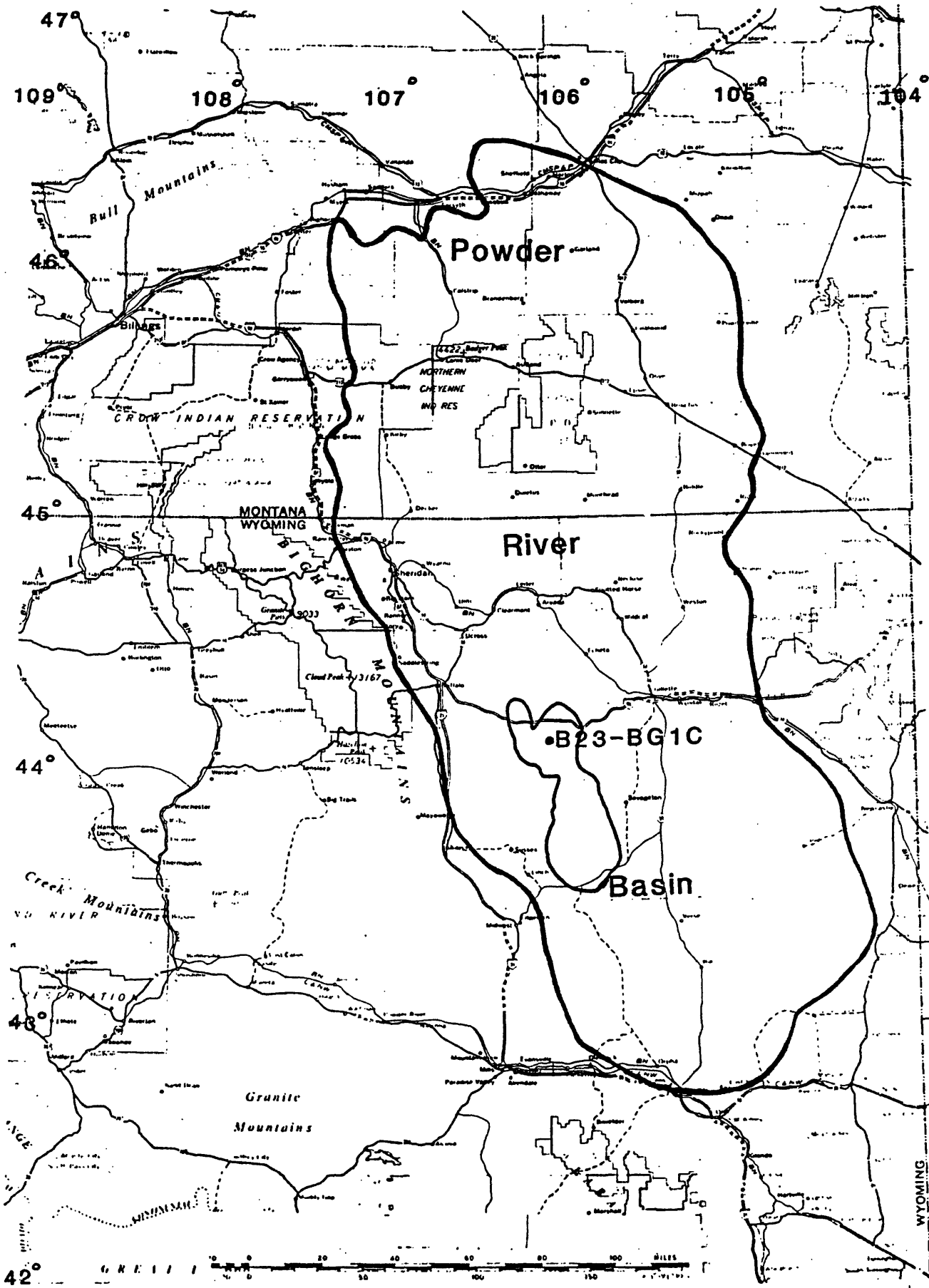

Figure 1.--Index map of the Powder River Basin showing the outline of the Anderson coal deposit and the location of the sampling site, USGS drill hole B23-BG1C. (Modified from Cathcart, 1984).

The remaining solid unbroken coal core was packaged and sealed in 2-ft plastic tubing for X-ray radiographic examination. The broken coal was packaged and sealed in plastic bags. The rock parting, with minor coal at a depth of 1,188.15-1,192.25 ft, was boxed.

With completion of the X-ray examination of the tubed samples, the entire remaining core was megascopically examined and described, and the apparent specific gravities determined. The rock and coal core samples were described, handled, and packaged following the guidelines in Hobbs (1979). The core description is shown in appendix A; the apparent specific gravity determinations are shown on table 2.

The sample intervals selected for the proximate and ultimate analyses, Btu/lb, and other determinations are shown on table 3. The sample interval for other investigations, though not part of this study but included to show the completeness of the samples selected, is shown in appendix B, tables B-1 and B-2. The rock parting at 1,187.87-1,191.95-ft depth was removed and excluded from any of the foregoing samples.

The roof rock samples at 1,028.00-1,051.00-ft depth and floor rock samples at 1,252.85-1,265.45-ft depth were investigated by the South Dakota School of Mines and Technology for various rock mechanic properties (Hladysz, 1983 and 1984).

COAL QUALITY

General

The sample intervals for the proximate and ultimate analysis, Btu/lb, forms-of-sulfur, and ash-fusion temperatures are shown on table 3. The analytical results by sample interval, as well as the weighted average for overall coal bed, are shown on table 4. Table 5 shows the AFT (ash-fusion temperatures °F). The sample intervals and the analytical results included in this report total net coal intervals at this sample location.

Free-swelling index (FSI) determinations were made for each sample; all were 0.0.

Calorific value

Overall, the calorific values of this coal bed are relatively uniform. The statistical values for the Btu/lb on a dry, mineral-matter-free (dmmf) basis are:

	Btu/lb
Mean	13,193
Standard deviation	173
Median	13,195
Range	867
Lowest value	12,558
Highest value	13,425

Only two samples, BG3A and BG6, had a Btu/lb, dmmf value of less than 13,000.

TABLE 2 Sample intervals for apparent specific gravity determinations(ASG) in grams per cubic centimeter(g/cc). N.D.=not determined

SAMPLE NUMBER	COAL CORE FROM TO (FEET)	THICKNESS (FEET)	LOG DEPTH FROM TO (FEET)	ASG (g/cc)
TUBE 1	0.00- 2.00	2.00	1051.00-1053.00	N.D.
TUBE 2	2.00- 3.35	1.35	1053.00-1054.35	N.D.
LOST	3.35- 14.85	11.50	1054.34-1065.85	----
TUBE 3	14.85- 16.85	2.00	1065.85-1067.85	N.D.
TUBE 4	16.85- 18.85	2.00	1067.85-1069.85	N.D.
TUBE 5	18.85- 20.85	2.00	1069.85-1071.85	N.D.
BAG 1	20.85- 22.85	2.00	1071.85-1073.85	1.26
TUBE 6	22.85- 24.85	2.00	1073.85-1075.85	N.D.
TUBE 7	24.85- 26.85	2.00	1075.85-1077.85	1.28
TUBE 8	26.85- 28.85	2.00	1077.85-1079.85	N.D.
TUBE 9	28.85- 30.85	2.00	1079.85-1081.85	1.37
TUBE 10	30.85- 32.85	2.00	1081.85-1083.85	1.44
TUBE 11	32.85- 34.85	2.00	1083.85-1085.85	1.31
TUBE 12	34.85- 36.85	2.00	1085.85-1087.85	1.42
TUBE 13	36.85- 38.85	2.00	1087.85-1089.85	1.37
TUBE 14	38.85- 40.85	2.00	1089.85-1091.85	1.35
TUBE 15	40.85- 42.85	2.00	1091.85-1093.85	1.33
TUBE 16	42.85- 44.85	2.00	1093.85-1095.85	1.29
BAG 2	44.85- 46.85	2.00	1095.85-1097.85	1.38
TUBE 17	46.85- 48.85	2.00	1097.85-1099.85	1.38
TUBE 18	48.85- 50.85	2.00	1099.85-1101.85	1.36
BAG 3	50.85- 52.85	2.00	1101.85-1103.85	1.41
BAG 4	52.85- 54.65	1.80	1103.85-1105.65	1.43
BAG 5	54.65- 56.65	2.00	1105.65-1107.65	1.19
BAG 6	56.65- 58.65	2.00	1107.65-1109.65	1.37
BAG 7	58.65- 60.65	2.00	1109.65-1111.65	1.32
TUBE 19	60.65- 62.65	2.00	1111.65-1113.65	1.42
TUBE 20	62.65- 64.65	2.00	1113.65-1115.65	1.26
TUBE 21	64.65- 66.65	2.00	1115.65-1117.65	1.27
TUBE 22	66.65- 68.65	2.00	1117.65-1119.65	1.40
TUBE 23	68.65- 70.65	2.00	1119.65-1121.65	1.32
BAG 8	70.65- 72.65	2.00	1121.65-1123.65	1.39
BAG 9	72.65- 74.65	2.00	1123.65-1125.65	1.42
TUBE 24	74.65- 76.65	2.00	1125.65-1127.65	1.34
TUBE 25	76.65- 78.65	2.00	1127.65-1129.65	1.32
TUBE 26	78.65- 80.65	2.00	1127.65-1131.65	1.30
TUBE 27	80.65- 82.65	2.00	1131.65-1133.65	1.33
TUBE 28	82.65- 84.65	2.00	1133.65-1135.65	1.33
TUBE 29	84.65- 86.65	2.00	1135.65-1137.65	1.28
TUBE 30	86.65- 88.65	2.00	1137.65-1139.65	1.31
TUBE 31	88.65- 90.65	2.00	1139.65-1141.65	1.28
TUBE 32	90.65- 92.65	2.00	1141.65-1143.65	1.30
BAG 10	92.65- 94.65	2.00	1143.65-1145.65	1.48

TABLE 2 Con't.

SAMPLE NUMBER	COAL CORE FROM TO (FEET)	THICKNESS (FEET)	LOG DEPTH FROM TO (FEET)	ASG (g/cc)
TUBE 33	94.65- 96.65	2.00	1145.65-1147.65	1.35
TUBE 34	96.65- 99.65	3.00	1147.65-1150.65	1.32
TUBE 35	99.65-101.65	2.00	1150.65-1152.65	1.40
BAG 11	101.65-103.65	2.00	1152.65-1154.65	1.38
BAG 12	103.65-106.65	3.00	1154.65-1157.65	1.40
TUBE 36	106.65-108.65	2.00	1157.65-1159.65	1.32
TUBE 37	108.65-110.65	2.00	1159.65-1161.65	1.31
TUBE 38	110.65-112.65	2.00	1161.65-1163.65	1.39
TUBE 39	112.65-114.65	2.00	1163.65-1165.65	1.23
BAG 13	114.65-116.65	2.00	1165.65-1167.65	1.48
BAG 14	116.65-118.65	2.00	1167.65-1169.65	1.31
BAG 15	118.65-120.65	2.00	1169.65-1171.65	1.37
BAG 16	120.65-122.65	2.00	1171.65-1173.65	1.34
TUBE 40	122.65-124.65	2.00	1173.65-1175.65	1.36
TUBE 41	124.65-126.65	2.00	1175.65-1177.65	1.31
BAG 17	126.65-128.65	2.00	1177.65-1179.65	1.39
TUBE 42	128.65-130.65	2.00	1179.65-1181.65	1.36
TUBE 43	130.65-132.65	2.00	1181.65-1183.65	1.32
BAG 18	132.65-135.15	2.50	1183.65-1186.15	1.40
TUBE 44	135.15-137.15	2.00	1186.15-1188.15	1.37
BOX 1-A	137.15-138.75	1.60	1188.15-1189.75	2.17
BOX 1-B	138.75-141.25	2.50	1189.75-1192.25	2.29
TUBE 45	141.25-143.25	2.00	1192.25-1194.25	1.25
TUBE 46	143.25-145.25	2.00	1194.25-1196.25	1.37
TUBE 47	145.25-147.25	2.00	1196.25-1198.25	1.21
TUBE 48	147.25-149.25	2.00	1198.25-1200.25	1.31
TUBE 49	149.25-151.25	2.00	1200.25-1202.25	1.30
TUBE 50	151.25-153.25	2.00	1202.25-1204.25	1.31
TUBE 51	153.25-155.25	2.00	1204.25-1206.25	1.30
TUBE 52	155.25-157.25	2.00	1206.25-1208.25	1.15
TUBE 53	157.25-159.25	2.00	1208.25-1210.25	1.30
TUBE 54	159.25-161.25	2.00	1210.25-1212.25	1.31
TUBE 55	161.25-163.25	2.00	1212.25-1214.25	1.34
TUBE 56	163.25-165.25	2.00	1214.25-1216.25	1.31
TUBE 57	165.25-167.25	2.00	1216.25-1218.25	1.33
TUBE 58	167.25-169.25	2.00	1218.25-1220.25	1.29
TUBE 59	169.25-171.25	2.00	1220.25-1222.25	1.31
TUBE 60	171.25-173.25	2.00	1222.25-1224.25	1.37
BAG 19	173.25-175.25	2.00	1224.25-1226.25	1.25
TUBE 61	175.25-177.25	2.00	1226.25-1228.25	1.29
TUBE 62	177.25-179.25	2.00	1228.25-1230.25	1.31
TUBE 63	179.25-181.25	2.00	1230.25-1232.25	1.28
TUBE 64	181.25-183.25	2.00	1232.25-1234.25	1.27
TUBE 65	183.25-185.25	2.00	1234.25-1236.25	1.24
TUBE 66	185.25-187.25	2.00	1236.25-1238.25	1.28
TUBE 67	187.25-189.25	2.00	1238.25-1240.25	1.29

TABLE 2 Con't.

SAMPLE NUMBER	COAL CORE FROM TO (FEET)	THICKNESS (FEET)	LOG DEPTH FROM TO (FEET)	ASG (g/cc)
BAG 20	189.25-191.25	2.00	1240.25-1242.25	1.25
TUBE 68	191.25-193.25	2.00	1242.25-1244.25	1.30
BAG 21	193.25-195.25	2.00	1244.25-1246.25	N.D.
TUBE 69A	195.25-195.85	0.60	1246.25-1246.85	1.09
TUBE 69B	195.85-197.25	1.40	1246.85-1248.25	2.33
TUBE 70	197.25-199.25	2.00	1248.25-1250.25	1.23
TUBE 71	199.25-201.25	2.00	1250.25-1252.25	1.25
BAG 22	201.25-201.85	0.60	1252.25-1252.85	1.62

TABLE 3 Coal sample intervals for proximate and ultimate analysis, BTU/lb., forms of sulfur, FSI(free swelling index), and ash fusion temperatures.

SAMPLE NUMBER	FOOTAGE INT. (FEET)	CORE INT. (FEET)	LENGTH (FEET)
BG-1	1051.00-1052.25	0.00- 1.25	1.25
	1053.10-1054.35	2.15- 3.35	1.20
NONE	1054.35-1065.85	3.35- 14.85	11.50
BG-2	1065.85-1068.85	14.85- 17.85	3.00
BG-3	1068.85-1069.85	17.85- 18.85	1.00
	1070.35-1081.85	19.35- 30.85	11.50
	1082.60-1084.45	31.60- 33.45	1.85
BG-3A	1086.55-1087.15	35.55- 36.15	0.60
BG-3B	1087.30-1087.85	36.30- 36.85	0.55
BG-4	1087.85-1099.85	36.85- 48.85	12.00
BG-5	1099.85-1111.65	48.85- 60.65	11.80
BG-5A	1111.65-1112.45	60.65- 61.45	0.80
	1113.31-1114.51	62.31- 63.51	1.20
	1115.04-1115.75	64.04- 64.75	0.71
	1116.35-1117.65	65.35- 66.65	1.30
BG-6	1117.65-1119.65	66.65- 68.25	2.00
BG-7	1119.65-1121.65	68.65- 70.65	2.00
BG-8	1121.65-1124.35	70.65- 73.35	2.70
	1125.15-1127.65	74.15- 76.65	2.50
BG-9	1127.65-1128.55	76.65- 77.55	0.90
	1129.42-1130.12	78.42- 79.12	0.60
	1130.94-1133.72	79.94- 82.72	0.80
	1134.31-1141.65	83.31- 90.65	11.62
BG-10	1141.65-1150.65	90.65- 99.65	9.00
BG-11	1150.65-1157.65	99.65-106.65	7.00
BG-12	1157.65-1158.65	106.65-107.65	1.00
	1159.16-1160.19	108.16-109.19	1.03
	1160.86-1163.36	109.86-112.36	2.50
	1163.86-1164.40	112.86-113.40	0.54
	1164.65-1165.65	113.65-114.65	1.00
BG-13	1164.65-1166.15	114.65-115.15	0.50
	1166.95-1173.65	115.95-122.65	6.70
BG-14	1174.45-1175.45	123.45-124.45	1.00
BG-15	1176.40-1178.40	125.40-127.40	2.00
	1179.40-1179.65	128.40-128.65	0.25
BG-16	1179.65-1183.65	128.65-132.65	4.00
BG-17	1183.65-1187.87	132.65-136.87	4.22
BG-18	1191.95-1193.45	140.95-142.45	1.50
BG-19	1194.25-1195.25	143.25-144.25	1.00
	1196.05-1210.25	145.05-159.25	14.20
BG-20	1210.25-1216.25	159.25-165.25	6.00
BG-21	1216.25-1219.25	165.25-168.25	3.00
	1220.60-1221.20	169.10-170.20	0.60
	1221.86-1223.60	170.86-172.60	1.74
BG-22	1224.25-1225.25	173.25-174.25	1.00
	1226.05-1230.25	175.05-179.25	4.20

TABLE 3 Con't.

SAMPLE	FOOTAGE INT. (FEET)	CORE INT (FEET)	LENGTH (FEET)
BG-23	1230.25-1234.25	179.25-183.25	4.00
BG-24	1234.25-1240.25	183.25-189.25	6.00
BG-25	1240.25-1246.60	189.25-195.60	6.35
BG-26	1247.45-1252.25	196.45-201.25	4.80
BG-27	1252.25-1252.85	201.25-201.85	0.60

TABLE 4 Proximate and ultimate analysis, BTU/lb.,forms of sulfur, and average apparent specific gravity(ASG) in grams per cubic centimeter(g/cc)

[THK.,Thickness; Ft.,Feet; ANAL.,Analysis; H2Ø,Water; VM,Volatile Matter; FC,Fixed Carbon; BTU/lb.,British Thermal Unit per pound; H2,Hydrogen; C,Carbon; N,Nitrogen; O2,Oxygen; S,Sulfur; ORG.,Organic; 1=As Recieved; 2=Dry; 3=Dry, Mineral Matter Free.]

	TOTAL INTERVAL FEET	THK. Ft.	PROXIMATE ANALYSIS ANAL	H2O	ASH	VM	FC	ULTIMATE ANALYSIS BTU /lb.	H2	C	N	O2	TOT. S	FORMS OF SULFUR SUL-FATE	SUL-FIDE	ORG.	ASG
BG-1	1051.ØØ-1054.35	3.35	1	21.15	2.59	34.92	41.34	10041	6.3Ø	58.29	Ø.85	31.75	Ø.22	Ø.Ø2	Ø.Ø1	Ø.19	N.D.
			2		3.29	44.29	52.42	12734	4.99	73.92	1.Ø8	16.44	Ø.28	Ø.Ø2	Ø.Ø1	Ø.25	
			3			45.79	54.21	13167	5.16	76.43	1.12	17.ØØ	Ø.29	Ø.Ø2	Ø.Ø1	Ø.26	
BG-2	1065.85-1068.85	3.ØØ	1	25.41	3.88	31.86	38.85	9399	6.54	54.4Ø	Ø.72	34.3Ø	Ø.16	Ø.Ø1	Ø.Ø1	Ø.14	N.D.
			2		5.21	42.71	38.85	12601	4.96	72.93	Ø.96	15.72	Ø.22	Ø.Ø1	Ø.Ø1	Ø.2Ø	
			3			45.Ø6	54.94	13293	5.23	76.94	1.Ø1	16.59	Ø.23	Ø.Ø1	Ø.Ø1	Ø.21	
BG-3	1068.85-1085.85	17.ØØ	1	22.48	2.38	32.39	42.75	9889	6.28	57.79	Ø.71	32.7Ø	Ø.14	Ø.Ø1	Ø.ØØ	Ø.13	N.D.
			2		3.Ø7	41.78	55.15	12757	4.86	74.55	Ø.91	16.43	Ø.18	Ø.Ø1	Ø.ØØ	Ø.17	
			3			43.1Ø	56.9Ø	13161	5.Ø1	76.91	Ø.94	16.95	Ø.19	Ø.Ø1	Ø.ØØ	Ø.18	
BG-3A	1086.55-1087.15	Ø.6Ø	1	21.78	5.98	31.51	4Ø.73	9420	6.18	54.43	Ø.82	31.43	1.16	Ø.Ø4	Ø.35	Ø.77	1.42
			2		7.65	4Ø.28	52.Ø7	12Ø43	4.78	69.59	1.Ø5	15.45	1.48	Ø.Ø5	Ø.45	Ø.98	
			3			43.62	56.38	13Ø4Ø	5.18	75.35	1.14	16.73	1.6Ø	Ø.Ø5	Ø.49	1.Ø6	
BG-3B	1087.3Ø-1087.85	Ø.55	1	21.Ø9	6.Ø1	29.93	42.97	9412	6.Ø7	55.13	Ø.67	3Ø.64	1.48	Ø.Ø7	Ø.83	Ø.58	1.42
			2		7.62	37.92	54.46	11928	4.71	69.86	Ø.84	15.Ø9	1.88	Ø.Ø8	1.Ø5	Ø.75	
			3			41.Ø5	58.95	12912	5.1Ø	75.62	Ø.91	16.33	2.Ø4	Ø.Ø9	1.14	Ø.81	
BG-4	1087.85-1099.85	12.ØØ	1	23.81	2.36	31.87	41.96	9691	6.31	56.32	Ø.66	34.Ø9	Ø.26	Ø.Ø2	Ø.Ø2	Ø.22	1.35
			2		3.Ø9	41.83	55.Ø8	12719	4.79	73.92	Ø.86	17.ØØ	Ø.34	Ø.Ø2	Ø.Ø3	Ø.29	
			3			43.16	56.84	13125	4.94	76.28	Ø.89	17.54	Ø.35	Ø.Ø2	Ø.Ø3	Ø.3Ø	
BG-5	1099.85-1111.65	11.8Ø	1	22.Ø1	2.Ø3	34.27	41.69	10127	6.39	58.47	Ø.7Ø	32.26	Ø.15	Ø.Ø1	Ø.ØØ	Ø.14	1.35
			2		2.6Ø	43.94	53.46	12985	5.Ø3	74.97	Ø.89	16.32	Ø.19	Ø.Ø1	Ø.ØØ	Ø.18	
			3			45.11	54.89	13331	5.16	79.97	Ø.91	16.76	Ø.2Ø	Ø.Ø1	Ø.ØØ	Ø.19	
BG-5A	1111.65-1117.65	6.ØØ	1	24.65	1.99	3Ø.37	42.99	9583	6.38	56.42	Ø.59	34.5Ø	Ø.12	Ø.6Ø	Ø.ØØ	Ø.12	1.32
			2		2.64	4Ø.31	57.Ø5	12718	4.81	74.87	Ø.78	16.74	Ø.16	Ø.ØØ	Ø.ØØ	Ø.16	
			3			41.4Ø	58.6Ø	13Ø63	4.94	76.9Ø	Ø.8Ø	17.2Ø	Ø.16	Ø.ØØ	Ø.ØØ	Ø.16	
BG-6	1117.65-1119.65	2.ØØ	1	25.32	5.9Ø	28.77	4Ø.Ø1	8637	5.91	51.96	Ø.52	35.59	Ø.12	Ø.ØØ	Ø.Ø1	Ø.11	1.4Ø
			2		7.91	38.52	53.57	11565	4.12	69.57	Ø.69	17.55	Ø.16	Ø.Ø1	Ø.Ø1	Ø.14	
			3			41.83	58.17	12558	4.47	75.54	Ø.75	19.Ø7	Ø.17	Ø.Ø1	Ø.Ø1	Ø.15	
BG-7	1119.65-1121.65	2.ØØ	1	26.84	1.86	28.24	43.Ø6	9332	6.38	55.28	Ø.61	35.71	Ø.16	Ø.ØØ	Ø.ØØ	Ø.16	1.32
			2		2.54	38.61	58.85	12756	4.62	75.56	Ø.83	16.23	Ø.22	Ø.Ø1	Ø.ØØ	Ø.21	
			3			39.62	6Ø.38	13Ø88	4.74	77.53	Ø.85	16.65	Ø.23	Ø.Ø1	Ø.ØØ	Ø.22	

TABLE 4 con't.

	TOTAL INTERVAL FEET	THK. Ft.	ANAL	PROXIMATE ANALYSIS H2O	ASH	VM	FC	BTU /lb.	ULTIMATE ANALYSIS H2	C	N	O2	TOT. S	FORMS OF SULFUR SUL-FATE	SUL-FIDE	ORG.	ASG
BG-8	1121.65-1127.65	6.00	1	25.20	2.03	28.36	44.41	9536	6.23	56.66	0.64	34.33	0.11	0.01	0.01	0.09	1.38
			2		2.72	37.92	59.36	12749	4.56	75.75	0.85	15.97	0.15	0.01	0.01	0.13	
			3			38.98	61.02	13105	4.69	77.86	0.87	16.43	0.15	0.01	0.01	0.13	
BG-9	1127.65-1141.65	14.00	1	23.75	2.03	28.24	45.98	9777	6.11	57.62	0.67	33.48	0.09	0.02	0.01	0.06	1.31
			2		2.66	37.04	60.30	12822	4.53	75.57	0.87	16.26	0.11	0.03	0.01	0.07	
			3			38.05	61.95	13172	4.65	77.63	0.89	16.72	0.11	0.03	0.01	0.07	
BG-10	1141.65-1150.65	9.00	1	25.48	2.83	27.44	44.33	9426	6.19	55.78	0.69	34.44	0.07	0.01	0.00	0.06	1.36
			2		3.79	36.78	59.43	12636	4.48	74.78	0.92	15.94	0.09	0.01	0.00	0.08	
			3			38.23	61.77	13133	4.66	77.72	0.96	16.57	0.09	0.01	0.00	0.08	
BG-11	1150.65-1157.65	7.00	1	21.95	4.17	30.42	43.46	9780	6.01	57.70	0.83	31.18	0.11	0.01	0.01	0.09	1.39
			2		5.35	38.97	55.68	12531	4.55	73.93	1.06	14.97	0.14	0.01	0.01	0.12	
			3			41.17	58.83	13239	4.81	78.11	1.12	15.81	0.15	0.01	0.01	0.13	
BG-12	1157.65-1165.65	8.00	1	22.00	1.80	32.92	43.28	10174	6.43	58.80	0.89	31.96	0.12	0.02	0.00	0.10	1.31
			2		2.30	45.20	55.50	13043	5.09	75.38	1.14	15.93	0.16	0.03	0.00	0.13	
			3			43.19	56.81	13350	5.21	77.16	1.17	16.30	0.16	0.03	0.00	0.13	
BG-13	1165.65-1173.65	8.00	1	22.86	1.69	32.30	43.15	10071	6.47	58.31	0.86	32.55	0.12	0.01	0.00	0.11	1.38
			2		2.19	41.87	55.94	13056	5.07	75.59	1.12	15.87	0.16	0.01	0.00	0.15	
			3			42.81	57.19	13348	5.18	77.28	1.15	16.23	0.16	0.01	0.00	0.15	
BG-14	1173.85-1175.45	1.60	1	21.44	2.56	30.57	45.43	10089	6.27	58.91	0.92	31.26	0.08	0.02	0.00	0.06	1.36
			2		3.26	38.92	57.82	12843	4.93	74.98	1.17	15.55	0.11	0.03	0.00	0.08	
			3			40.23	59.77	13276	5.10	77.51	1.21	16.07	0.11	0.03	0.00	0.08	
BG-15	1176.40-1179.65	3.25	1	21.32	3.36	31.78	43.54	10068	6.08	58.74	0.95	30.79	0.08	0.01	0.00	0.07	1.35
			2		4.27	40.39	55.34	12796	4.69	74.65	1.28	15.08	0.11	0.01	0.00	0.10	
			3			42.19	57.81	13366	4.98	77.98	1.25	15.76	0.11	0.01	0.00	0.10	
BG-16	1179.65-1183.65	4.00	1	23.17	2.62	31.29	42.92	9829	6.31	57.69	0.82	32.45	0.11	0.02	0.00	0.09	1.34
			2		3.41	40.73	55.86	12793	4.84	75.08	1.07	15.46	0.14	0.02	0.00	0.12	
			3			42.17	57.83	13245	5.01	77.73	1.11	16.01	0.14	0.02	0.00	0.12	
BG-17	1183.65-1188.45	4.80	1	24.47	1.84	28.19	45.50	9693	6.18	57.43	0.87	33.58	0.16	0.02	0.00	0.08	1.39
			2		2.44	37.32	60.24	12833	4.55	76.04	1.15	15.69	0.13	0.03	0.01	0.09	
			3			38.25	61.75	13154	4.66	77.94	1.18	16.09	0.13	0.03	0.01	0.09	
BG-18	1191.85-1193.45	1.60	1	21.26	1.82	29.64	47.28	10088	6.02	59.29	0.90	31.83	0.14	0.01	0.00	0.13	1.28
			2		2.32	37.64	60.04	12812	4.63	75.30	1.14	16.44	0.17	0.01	0.00	0.16	
			3			38.53	61.47	13116	4.74	77.08	1.17	16.84	0.17	0.01	0.00	0.16	
BG-19	1194.25-1210.25	16.00	1	23.36	1.90	28.13	46.61	9821	6.08	57.75	0.88	33.27	0.12	0.01	0.01	0.10	1.27
			2		2.47	36.71	60.82	12815	4.52	75.35	1.15	16.35	0.16	0.01	0.01	0.14	
			3			37.64	62.36	13140	4.63	77.26	1.18	16.77	0.16	0.01	0.01	0.14	

TABLE 4 con't.

	TOTAL INTERVAL FEET	THK. Ft.	ANAL	PROXIMATE ANALYSIS H2O	ASH	VM	FC	ULTIMATE ANALYSIS BTU /lb.	H2	C	N	O2	FORMS OF SULFUR TOT. S	SUL- FATE	SUL- FIDE	ORG.	ASG
BG-20	1210.25-1216.25	6.00	1	21.18	2.06	31.14	45.62	10232	6.04	59.73	0.99	31.07	0.11	0.02	0.00	0.09	1.32
			2		2.62	39.51	57.87	12982	4.66	75.78	1.26	15.54	0.14	0.02	0.00	0.12	
			3			40.57	59.43	13331	4.79	77.82	1.29	15.96	0.14	0.02	0.00	0.12	
BG-21	1216.25-1224.25	8.00	1	21.32	2.51	29.56	46.61	10195	6.10	59.12	1.00	31.15	0.12	0.01	0.00	0.11	1.31
			2		3.19	37.57	59.24	12958	4.72	75.14	1.27	15.53	0.15	0.02	0.01	0.12	
			3			38.81	61.19	13385	4.88	77.62	1.31	16.04	0.15	0.02	0.01	0.12	
BG-22	1224.25-1230.25	6.00	1	22.85	1.78	31.10	44.27	10118	6.34	58.55	0.96	32.26	0.11	0.01	0.00	0.10	1.28
			2		2.31	40.31	57.38	13115	4.90	75.89	1.24	15.52	0.14	0.01	0.01	0.12	
			3			41.26	58.74	13425	5.02	77.68	1.27	15.89	0.14	0.01	0.01	0.12	
BG-23	1230.25-1234.25	4.00	1	21.93	2.03	29.46	46.58	10145	6.19	59.13	1.01	31.56	0.08	0.00	0.00	0.08	1.27
			2		2.60	37.74	59.66	12995	4.78	75.74	1.29	15.48	0.11	0.00	0.00	0.11	
			3			38.75	61.25	13342	4.91	77.76	1.32	15.90	0.11	0.00	0.00	0.11	
BG-24	1234.25-1240.25	6.00	1	21.79	1.56	31.77	44.88	10215	6.30	59.59	1.03	31.38	0.14	0.00	0.00	0.14	1.27
			2		2.00	40.62	57.38	13061	4.94	76.20	1.32	15.37	0.17	0.00	0.00	0.17	
			3			41.45	58.55	13328	5.04	77.75	1.35	15.69	0.17	0.00	0.00	0.17	
BG-25	1240.25-1246.60	6.35	1	20.77	6.98	29.47	42.78	9550	5.70	56.12	0.93	30.05	0.22	0.00	0.00	0.22	1.28
			2		8.81	37.19	54.00	12053	4.26	70.83	1.18	14.65	0.27	0.00	0.00	0.27	
			3			40.78	59.22	13217	4.67	77.67	1.29	16.07	0.30	0.00	0.00	0.30	
BG-26	1247.45-1252.25	4.80	1	20.21	2.79	31.81	45.19	10300	6.16	59.19	1.09	30.55	0.22	0.01	0.00	0.21	1.24
			2		3.49	39.86	56.65	12908	4.89	74.18	1.37	15.79	0.28	0.01	0.01	0.26	
			3			41.30	58.70	13375	5.07	76.86	1.42	16.36	0.29	0.01	0.01	0.27	
BG-27	1252.25-1252.85	0.60	1	17.20	22.22	28.64	31.94	7883	5.40	44.82	0.83	25.36	1.37	0.03	0.55	0.79	1.62
			2		26.84	34.59	38.57	9521	4.20	54.13	1.00	12.17	1.66	0.04	0.66	0.96	
			3			47.28	52.72	13013	5.74	73.99	1.37	16.63	2.27	0.05	0.90	1.32	

Weighted average samples BG-1 to BG-26(floor coal sample BG-27 excluded)

AVG 2	1051.00-1252.25	201.25	1	22.91	2.50	30.66	43.93	9862	6.22	57.66	0.88	32.68	0.14	0.01	0.01	0.12	1.33
			2		3.24	39.88	56.78	12793	4.74	74.79	1.03	16.01	0.18	0.01	0.01	0.16	
			3			41.09	58.91	13219	4.89	77.50	1.07	16.56	0.19	0.01	0.01	0.17	

Weighted average samples BG-1 to BG-27(full coalbed)

AVG	1051.00-1252.85	201.85	1	22.86	2.56	30.63	43.94	9862	6.21	57.65	0.81	32.62	0.14	0.01	0.01	0.12	1.33
			2		3.31	39.83	56.78	12785	4.73	74.74	1.04	15.98	0.19	0.01	0.01	0.17	
			3			41.06	58.94	13222	4.89	77.49	1.08	16.54	0.19	0.01	0.01	0.17	

TABLE 5. Ash Fusion Temperatures(°F) for samples shown on Table 3 and 4.

SAMPLE NUMBER	INITIAL DEFORMATION TEMPERATURE	SOFTENING TEMPERATURE	FLUID TEMPERATURE
BG-1	2120	2180	2240
BG-2	2100	2220	2310
BG-3	2130	2240	2290
BG-3A	2260	2340	2370
BG-3B	2270	2340	2370
BG-4	2130	2210	2280
BG-5	2050	2180	2230
BG-5A	2210	2350	2390
BG-6	2240	2280	2330
BG-7	2200	2320	2400
BG-8	2140	2280	2310
BG-9	2130	2250	2290
BG-10	2040	2120	2180
BG-11	2050	2200	2250
BG-12	2090	2200	2240
BG-13	2110	2240	2270
BG-14	2060	2170	2220
BG-15	2130	2230	2280
BG-16	2120	2160	2210
BG-17	2090	2150	2170
BG-18	2090	2150	2180
BG-19	2140	2180	2220
BG-20	2090	2140	2170
BG-21	2100	2170	2240
BG-22	2150	2210	2240
BG-23	2060	2160	2230
BG-24	2000	2080	2140
BG-25	2350	2440	2470
BG-26	1990	2230	2360
BG-27	2680	2790	2800+

In 1983, the U.S. Geological Survey conducted a study of the coal deterioration between time of acquisition (coring) and proximate and ultimate analysis (Hobbs, 1983). In that study the Anderson-Canyon coal sample, 80AU15, showed an approximate loss of 1 Btu/lb per day from the time of core sampling to analysis. As the time interval from the Big George coal core acquisition to the coal analyses (table 4) was approximately 6 months, application of these data to data from samples of the Big George coal bed would suggest that the Btu/lb values of table 4 are about 180 Btu/lb lower than the original Btu/lb values at the time of sample acquisition.

Moisture

The moisture content range is:

	All samples (percent)	Less sample B-27 (percent)
Mean	22.60	22.79
Standard deviation	1.94	1.69
Median	22.01	22.01
Range	9.64	6.63
Lowest value	17.20	20.21
Highest value	26.84	26.84

Equilibrium moisture values for these samples were not determined. However, equilibrium moisture values of the Anderson-Canyon coal were 26.6 percent at 80AU15 and 25.52 percent at 80AU16 (Hobbs, 1983). A decrease in the moisture with an increase in the rank would be expected (Stach, 1982, p. 40), and, together with an increased depth of burial, a moisture value of less than 25 percent would be reasonable for the Big George coal bed of this report. Table 4 displays an average (on a weighted basis) moisture value of 22.91 percent and is considered to be less than the equilibrium or the inherent bed moisture of this coal bed at this sampling location. The true moisture is probably greater than the 22.91 percent of this study, and less than the 25.52 and 26.6 percent of the 80AU15 and 80AU16 samples.

Based on a 1 percent decrease of inherent coal-bed moisture per 150 m depth of burial (Stach, 1982), a reasonable estimate of the inherent moisture of the Anderson coal deposit at this sample location, which is about 150 m deeper than at the 80AU15 and 80AU16 localities, would be 24.5 percent.

Sulfur

The total sulfur content of the Big George coal bed samples is anomalously low throughout the analyzed intervals. Only three samples showed appreciable total sulfur contents: BG-3A, BG-3B, and BG-27. BG-3A and BG-3B are associated with a rock parting. BG27 is a 0.60-ft coal floor sample.

One possible explanation for the low percentage of the sulfide minerals within the coal bed may be their alteration and partial redeposition by ground water. Evidences for this are the occasional gypsum rosettes and other gypsiferous fillings and coatings found in the coal-bed cleat systems, assuming that these secondary minerals originated from sulfides in the coal bed and were not introduced subsequent to coalification.

Ash

For the most part, the ash content is very low with about 91 percent of the analyzed footage showing a 3.00 percent or less ash content on an as-received basis. These data are:

	Ash (percent)					
Range	0.00-2.00	2.01-3.00	3.01-4.00	5.00-6.00	6.00-7.00	>7.00
Feet	56.40	102.53	6.25	2.6	6.90	.60
Percent of total	32.16	58.50	3.51	1.48	3.93	.33

The statistical ranges for these data are:

	All samples (percent)	Less sample B27 (percent)
Mean	3.52	2.87
Standard deviation	3.76	1.48
Median	2.37	2.36
Range	20.66	5.42
Low value	1.56	1.56
High value	22.22	6.98

Overall, the ash content on the dry basis is quite uniform. This, however, is contradictory and anomalous to the apparent specific gravities. This will be discussed in detail in the interpretation section.

RANK

The questionable moisture content of these samples prevents their ranking on a moist basis according to the American Society for Testing and Materials Standards (ASTM Stds., 1983, D388-82, sec. 7.1.4, p. 241). However, an approximation of the rank, using the ASTM Parr Formula 3, can be made by using the average estimated inherent moisture of 24.5 percent.

Based on these data, the overall moist, mineral-matter-free Btu/lb is 9923 and the calculated apparent rank is subbituminous B. The estimated Btu/lb loss between sample acquisition and analysis is about 180 Btu/lb. The estimated heat content at the time of sample collection is 10,100 Btu/lb, moist, mineral-matter-free basis. In view of the above, the overall coal bed

rank at the time of sampling was subbituminous B; in some zones, particularly in the lower 60 ft, the coal rank may be subbituminous A.

HARDGROVE GRINDABILITY INDEX

The Hardgrove Grindability Index (HGI) determinations were not made of coal from this core. However, the coal of this deposit resembles, in megascopic appearance and physical characteristics such as the ease of breaking both vertically and laterally, the coals of samples 80AU15 and 80AU16. The HGI of these coals was 54.2 at 22.04 percent moisture and 59.2 at 23.90 percent moisture, respectively (Hobbs, 1983). An approximation of the overall HGI of the Big George coal deposit at this location would be a minimum of 55-60 at a moisture content of 23 percent.

APPARENT SPECIFIC GRAVITY

The apparent specific gravity (ASG) determinations using the weight in air/weight in water method were performed on the samples. Moisture levels of the samples were not individually determined at the time of the ASG measurements. However, the samples had been kept moist and for the most part sealed since acquisition; thus, any coal desiccation and possible oxidation were believed minimal. It is assumed that the samples were at equilibrium moisture conditions.

The ASG values for 2-ft sample intervals (table 2) were plotted against depth and are shown on figure 2. The average ASG values for the intervals shown on table 3 were likewise plotted with depth and are shown on figure 3.

These plots show the varied range of ASG values from the coal-bed top to the base. Among other things, the banded characteristics can be interpreted from figure 2. Also, the plots show the overall decrease of the ASG values from the top to the base of the coal bed.

INTERPRETATIONS

1. Apparent specific gravity versus the coal ash (mineral matter) composition.

If the coal ash were of the same composition throughout the coal bed, a direct correlation between the ash content (percent) of the coal and its ASG should be possible. This correlation is not possible. The coal ASG values (table 2 and fig. 2) and the average coal ASG of these values for the analysis shown on table 3 and figure 3 show a considerable ASG range throughout the coal bed while the ash content (percent) remains rather uniform. To illustrate this, the ash content of each sample (as-received basis) was against its corresponding ASG and is shown on figure 4. This plot illustrates the varied range of the ASG compared to the ash content (percent).

The data points shown on figure 4 were grouped according to their best logical fit and a linear regression analysis was made of each group; the groups and the results of the linear regression analysis are presented on table 6.

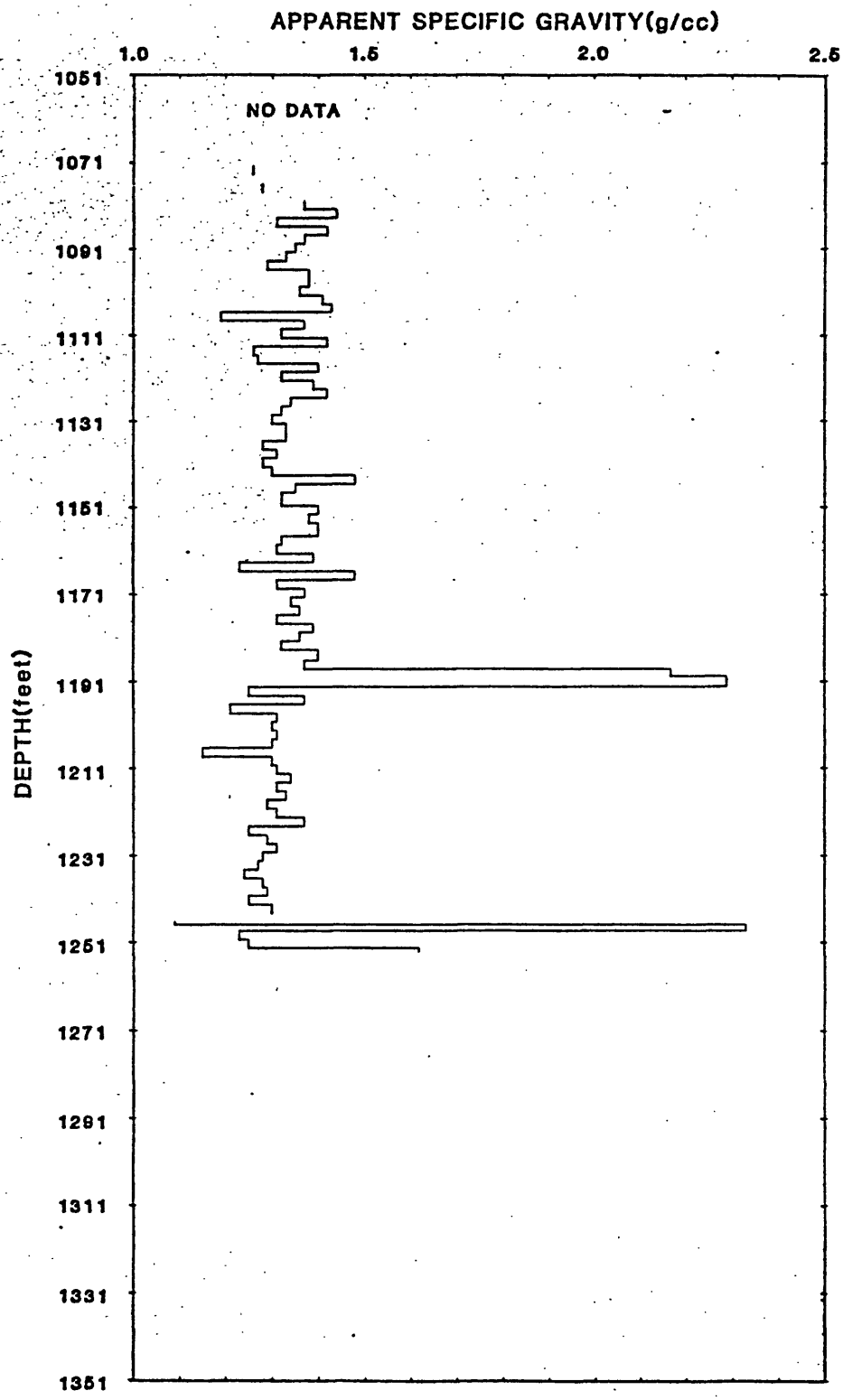

FIGURE 2.--Apparent specific gravity determinations (2-ft intervals) plotted with depth.

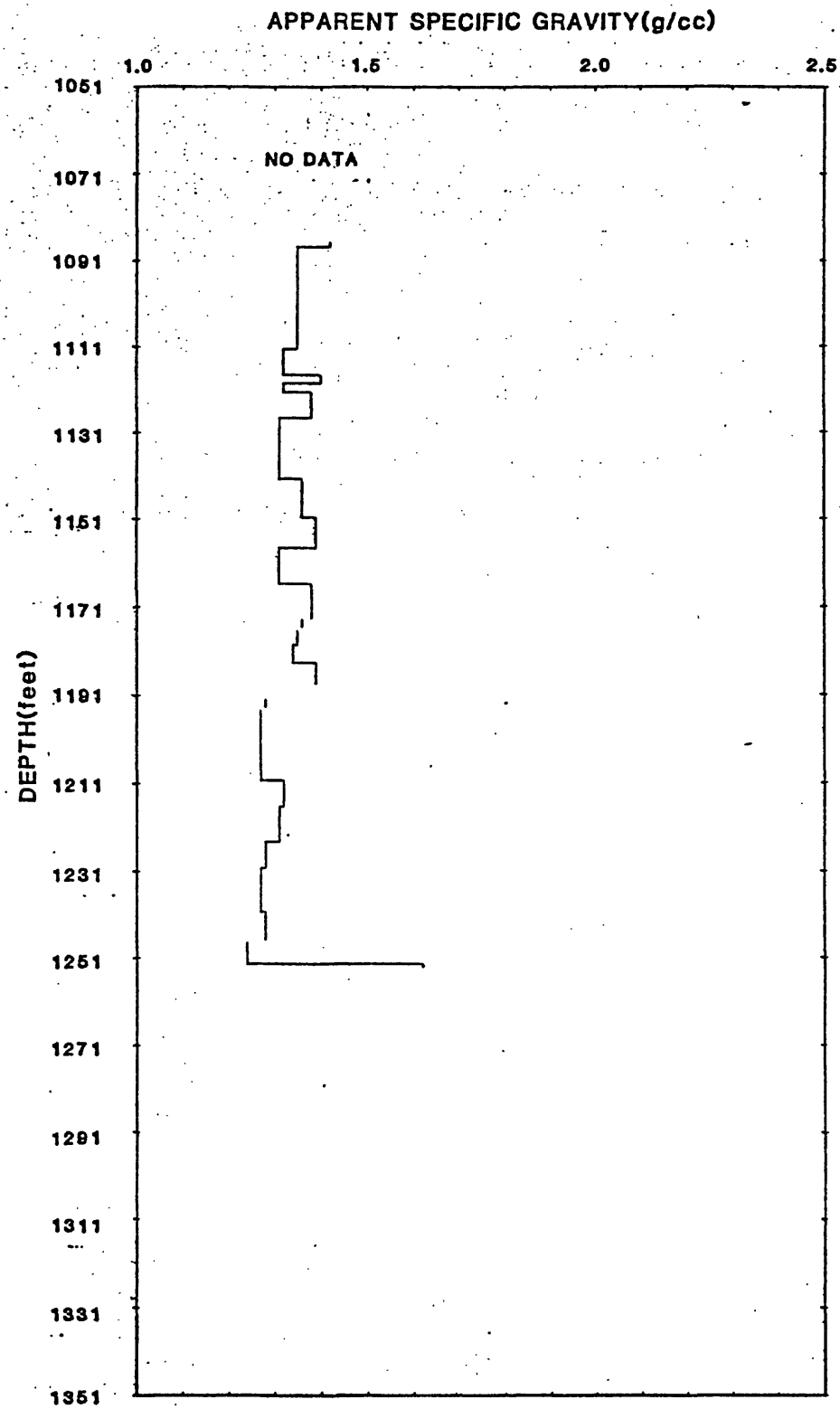

FIGURE 3.--Average apparent specific gravity values of sample analysis shown on tables 3 and 4 plotted with depth.

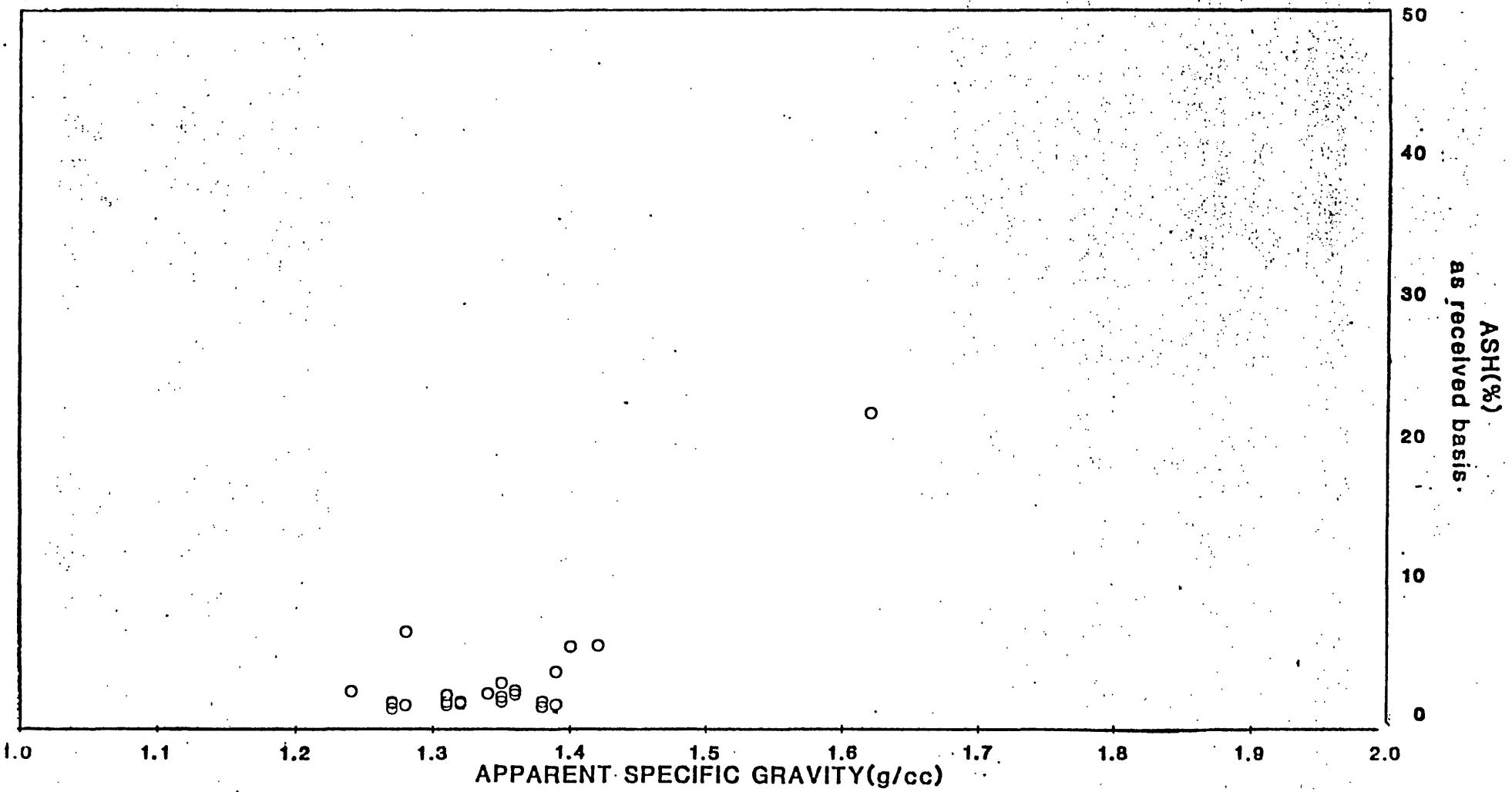

FIGURE 4.--Apparent specific gravity values of sample intervals cross plotted with the ash values (percent), as-received basis, from table 4.

TABLE 6 Apparent Specific Gravities(ASG) of coal at 0% and at 100% ash(mineral matter) of samples shown on Tables 3 and 4.

ASG CURVE	SAMPLE NUMBER	ASG 0% ASH (g/cc)	100% ASH (g/cc)
A	BG-25,&26	1.22	2.14
B	BG-18,19,22, 23,&24	1.26	2.23
C	BG-9,12,&21	1.29	2.49
D	BG-5A,7,&20	1.30	2.32
E	BG-15,&16	1.30	2.66
F	BG-4,5,10,11, 14,&6	1.32	2.68
G	BG-8,13,17, 27,34,&3B	1.37	2.46

These data show the ASG of the coal at 0 percent ash ranges from 1.22 to 1.37 g/cm^3 (grams per cubic centimeter). The ash or contained mineral matter at 100 percent ranges from 2.14 to 2.68 g/cm^3. These data plots are shown on figure 5.

The ASG of the coal at 0 percent ash (ash free) is a function of the type of organic input and resultant maceral type of the coal. The ash ASG is a function of the chemical composition of the ash.

The ASG values range with corresponding probable input material or basic ash composition are interpreted as:

Coal at 0 percent ash (mineral-matter-free)

ASG g/cm^3	Organic material input and resulting maceral types
1.22-1.29	Mostly woody material, trees, large branches, organic material; maceral types would be predominant vitrain with minor attritus and fusain.
1.29-1.32	Predominant woody material, some input of non-woody organic material; vitrain would still be dominant but the attritus and (or) fusain content is increasing.
1.37	Non-woody material becomes the important organic material with lesser amounts of woody material intermixed; vitrain content is 50 percent or less, and attritus becomes important with increasing fusain.

Ash (mineral-matter)

ASG (g/cm^3)	Material, composition
2.14-2.23	Silica base possibly fixed by growing plants from sandstone parting at 1,246.85-1,247.40 ft and floor at 1,253.25 ft downward. Rootlets in sandstone at 1,254.70-1,257.00 ft may be in part from plants in the coal zone.
2.32	Mixed silica and clay minerals.
2.46-2.49	Clay minerals, calcium oxide base.
2.62	Clay minerals, heavier alumina base (kaolinite?), possibly some iron minerals.

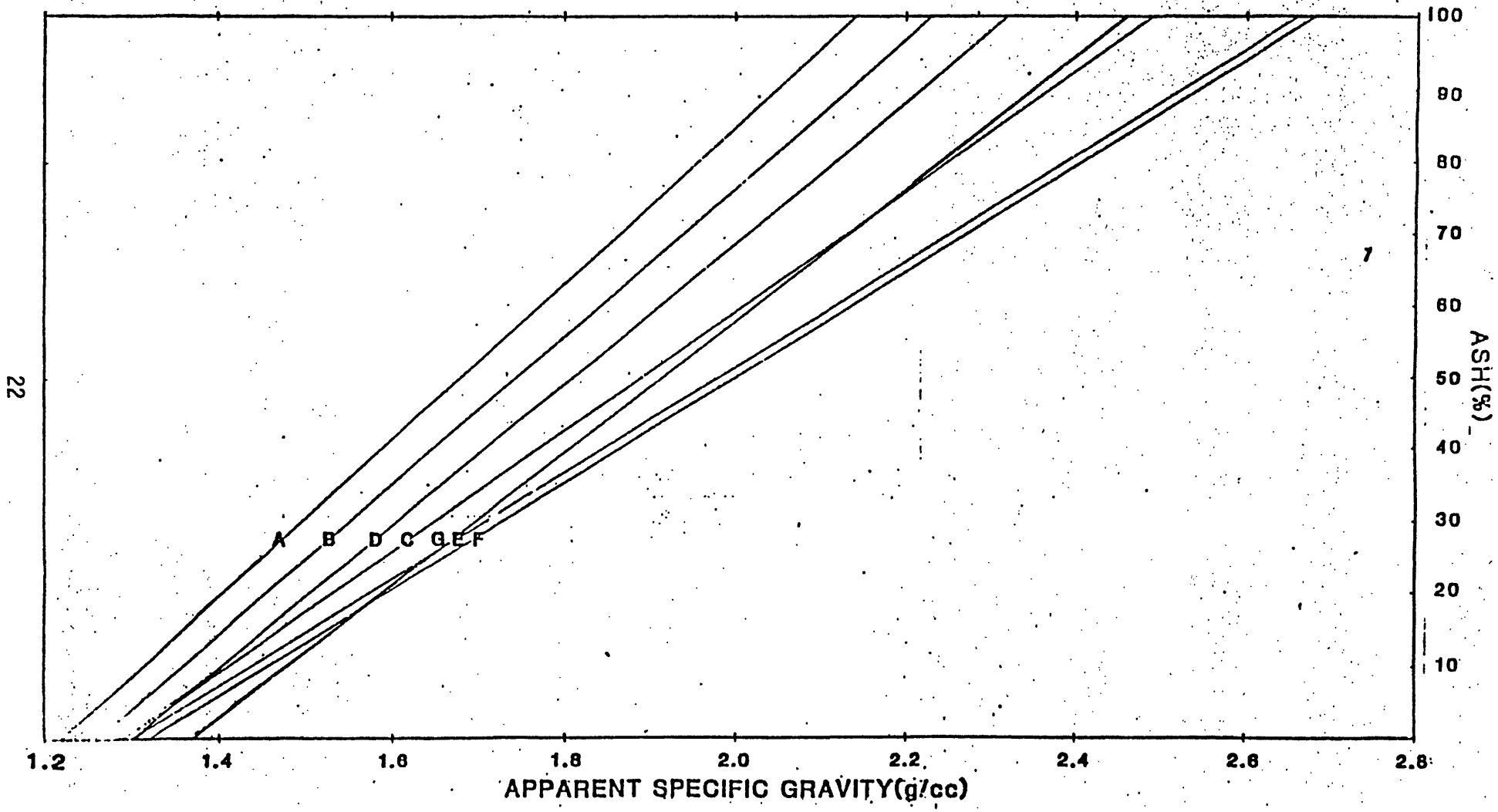

FIGURE 5.--Apparent specific gravity values from table 4 cross plotted with the ash values (percent), as-received basis.

The low ash percent (91 percent of analyzed coal being 3 percent or less) indicates the ash content is predominantly mineral matter fixed by the growing plants.

The coal and ash ASG from table 6 and the Btu/lb-dmmf basis from table 4 were plotted with depth (sample interval) and are shown on figure 6.

In general, the overall average ASG values of the coal at 0 percent mineral matter increase slightly from the coal base upward while the Btu/lb values remain somewhat uniform. The average ash ASG values are varied but overall increase upward.

Several coal zones are worth noting, such as the lower ASG values of samples BG-25 and BG-26. The lower values are related to the enclosed sandstone parting at a depth from 1,246.45 to 1,247.00 ft. The high ASG values are at depths of 1,175.45 and 1,216.00 ft. The high ASG value and the low Btu/lb zone, at about 1,118.00 ft depth (sample BG-6), are macerated plant debris. The effect of the abundant plant debris and macerated plant material within the interval 1,111.65-1,127.65-ft depth (samples BG-5A to BG-8) is shown in all three plots.

2. Depositional characteristics

The Big George coal bed of this sampling location has been divided into six distinct units or zones (fig. 6) based on the ASG, the coal core description (appendix A), and the analytical data.

The analytical data for coal zones 1, 2, and 3 are shown on table 7; the lower transition zone is represented by sample BG-27 (table 4). The rock parting is not included in the analysis and the upper transition zone analysis is included in sample BG-1 (table 4). Table 8 shows the combined analysis (weighed) of the lower transition zone and coal zone 1.

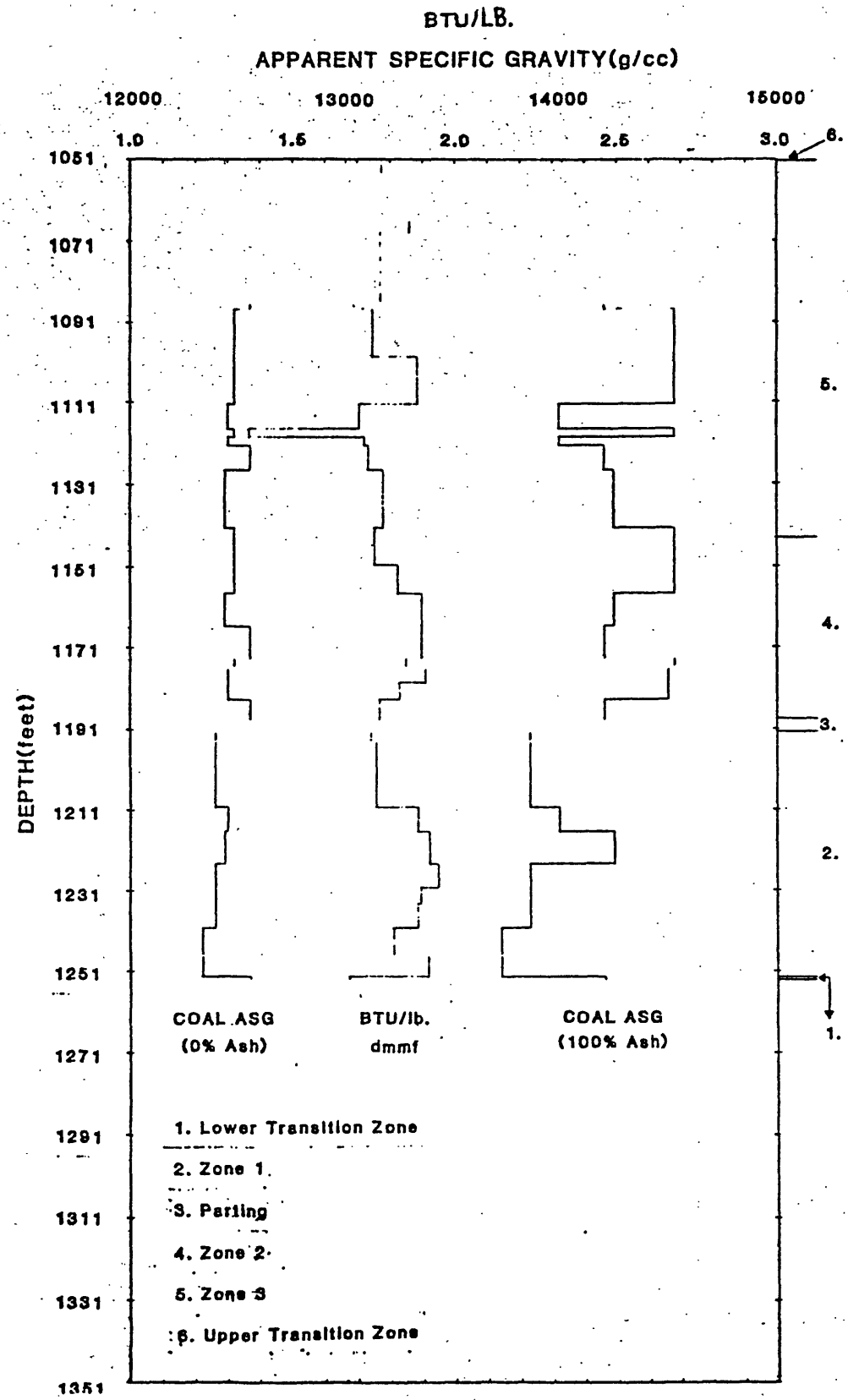

FIGURE 6.--Plot of coal apparent specific gravity at 0 percent ash, Btu/lb-dry, mineral-matter-free basis, and apparent specific gravity at 100 percent coal ash (mineral matter), plotted with depth. Also shows depositional zones.

TABLE 7 Weighted average of the proximate and ultimate analysis, BTU/lb., forms of sulfur, and apparent specific gravity for zones 3, 2, and 1, without the floor transition zone.

	TOTAL INTERVAL FEET	THK. Ft.		PROXIMATE ANALYSIS H2O	ASH	VM	FC	ULTIMATE ANALYSIS BTU /lb.	H2	C	N	O2	TOT. S	FORMS OF SULFUR SUL-FATE	SUL-FIDE	ORG.	ASG
ZONE 3	1051.00-1144.65	93.65	1	23.51	2.42	31.11	42.96	9746	6.27	57.03	0.68	33.43	0.16	0.01	0.02	0.13	1.34
			2		3.17	40.65	55.70	12741	4.76	74.56	0.88	16.42	0.21	0.01	0.02	0.18	
			3			41.98	58.02	13156	4.91	77.43	0.91	16.97	0.22	0.01	0.02	0.19	
ZONE 2	1144.65-1188.45	43.8	1	22.95	2.54	30.76	43.75	9887	6.26	57.84	0.84	32.40	0.10	0.01	0.00	0.09	1.36
			2		3.30	40.46	56.81	12831	4.79	75.07	1.09	15.61	0.14	0.02	0.00	0.12	
			3			41.25	58.75	13267	4.95	77.63	1.13	16.14	0.14	0.02	0.00	0.12	
ZONE 1	1191.85-1252.25	60.4	1	21.96	2.58	29.88	45.58	10024	6.10	58.49	0.96	31.73	0.14	0.01	0.00	0.13	1.28
			2		3.29	38.28	58.42	12845	4.67	74.95	1.23	15.68	0.17	0.01	0.00	0.16	
			3			39.60	60.40	13282	4.82	77.50	1.28	16.22	0.18	0.01	0.00	0.17	

TABLE 8 Weighted average of the proximate and ultimate analysis, BTU/lb., forms of sulfur, and apparent specific gravity for zone 1 with floor transition zone.

	TOTAL INTERVAL FEET	THK. Ft.		PROXIMATE ANALYSIS H2O	ASH	VM	FC	ULTIMATE ANALYSIS BTU /lb.	H2	C	N	O2	TOT. S	FORMS OF SULFUR SUL-FATE	SUL-FIDE	ORG.	ASG
ZONE 1	1191.85-1252.85	61.0	1	21.91	2.78	29.87	45.44	10002	6.09	58.35	0.96	31.67	0.15	0.01	0.01	0.13	1.28
			2		3.53	38.25	58.22	12811	4.66	74.74	1.23	15.65	0.19	0.01	0.01	0.17	
			3			39.68	60.33	13279	4.83	77.46	1.28	16.23	0.20	0.01	0.02	0.17	

Coal zone 1: 1,251.25-1,191.85 ft

This coal is characteristically a very low ash, low ASG, (both coal and ash), high Btu/lb, and high vitrain (80+ percent).

The 0.55-ft sandstone at 1,247.40-1,246.85 ft influences the coal ash composition of the enclosing coal samples BG-25 and BG-26. The coal ash ASG on either side of this parting is much lower than the average for zone 1, indicating the major source of the ash in samples BG-25 and BG-26 was this parting. The sand of the parting intermixed with the peat material both above and below the sand parting prior to coalification.

The source of the higher ASG at a depth of 1,223.60-1,210.25 ft (samples BG-20 and BG-21) is indicated to be two thin partings(?) at depths of 1,210.25± and 1,216.25 ft. These partings are interpreted as a volcanic ash fall and the higher ASG of the coal on either side of the parting at 1,216.25 ft and below 1,216.25 ft reflects the input from these partings. It shows an input of mineral matter of a higher ASG into an otherwise uniform coal of low ASG.

This coal zone represents a very stable coal environment of a protected area. The organic humic material was derived from predominantly thick woody material, and surface ground water was relatively clean and free of contaminants. The dominant constituent of the ash was probably fixed by the growing vegetation.

Parting: 1,191.95-1,188.60 ft

This rock parting represents the end of the stable swamp environment of coal zone 1. The deposition of the sandstone parting indicates a sudden or massive influx of a high energy depositional system as shown by the sharp contact of the rock parting with respect to the underlying coal. The parting probably represents the effects of a major regional tectonic event such as a sudden basin or area subsidence, or an uplift causing an increased stream gradient with a higher suspended load and massive flooding. This sandstone parting also represents a change in the coal-forming environment from coal zone 1. Also, the influx of rock effectively terminated the coal-forming swamp at the time of its deposition at this location.

Coal zone 2: 1,188.05-1,143.85 ft

The re-emergence or re-establishment of the coal swamp at this location is shown by the coal transitional zone at the base of coal zone 2, or at the top of the parting at depths of 1,188.60-1,188.05 ft. This thin 0.55 ft of coal is allochthonous and is the beginning of coal zone 2.

Analytically (table 4), the coals within this zone are very similar to coal zone 1. The coal ASG at 0 percent ash is slightly higher than in coal zone 1, reflecting the lower vitrain content--about 70 percent as compared to greater than 80 percent of coal zone 1. This may be the result of a reduction in the density of woody material, such as a less dense forest. The significant difference of this zone from coal zone 1 is the ASG of the coal ash.

In coal zone 2, the ash ASG is indicated to be midrange to high-density calcium oxide to aluminum oxide base in contrast to the low density of coal zone 1. A thin parting is present at a depth of 1,160.50 ft and is probably a volcanic ash fall. The ASG plot (fig. 2) showing the higher ASG zones alternating with the lower ASG zones indicates alternating periods of medium and higher density ash (mineral matter) input. This may be due to fluctuating water composition and (or) depth and (or) suspended load, occasional light dust storms, or light falls of a material such as volcanic ash.

Coal zone 3: 1,143.85-1,051.10 ft

Beginning at a depth of about 1,143.85 ft, the coal depositional pattern changes significantly from predominant vitrain to less than 50 percent vitrain with an increase in attrital and fusain coals becoming important to dominant. The ASG plot (fig. 2) is interpreted as cyclic deposition with alternating zones of macerated and other plant debris. One zone, as represented by sample BG-6 at a depth of 1,117.65-1,119.65 ft, shows the effects of this macerated plant humic material; lower Btu, higher ash content, and higher coal ash density.

The interpretation of the detailed ASG of this zone (fig. 2) shows a possible cyclic-type deposition: low ASG with predominantly woody material increasing to a higher ASG with nonwoody plant material debris becoming more important. The cycle is then repeated.

Moreover, the overall dmmf Btu/lb is slightly lower than the underlying coals of coal zones 2 and 1, reflecting the decreasing amount of vitrain or woody material present.

The coal swamp environment at this sampling location appears to have changed and is influenced, more than coal zones 1 and 2, by an outside source such as a fluvial and (or) lacustrine system nearby or within the swamp environment.

Upper transition zone: 1,051.10-1,051.00 ft

The termination of the coal-forming swamp and environment at this location appears to be abrupt. It is not a gradual transition as shown by the very thin upper transition debris zone and abrupt contact with the overlying carbonaceous shale.

This coal bed is primarily autochthonous, especially below a depth of about 1,143.85 ft. This is evidenced by the exceptional thickness, overall uniformity of the calorific value (Btu/lb), low sulfur content, and generally very low ash content of the coals. The coal ash source is apparently dominantly mineral matter fixed by the growing plants. The contribution of ash from other sources such as contaminated surface water with a high suspended or colloidal load appears to be minimal. The zone from 1,143.85 to 1,051.00 ft may be mixed, the intervals of abundant plant debris representing an allochthonous contribution of drift material into, and intermixed with, the autochthonous peat material.

CORRELATION TO ANOTHER AREA

The Big George coal bed at this sampling location is considered to be, in part at least, the Anderson-Canyon coal bed of the Arvada-Spotted Horse-Recluse area of eastern Sheridan and northern Campbell Counties, and the Wyodak coal bed of central Campbell County, Wyoming. This is based on stratigraphic and coal correlations (Pierce, 1982). At this sample site the lower part of the Big George coal bed from 1,191.95- to 1,251.85-ft depth is very similar in respect to the Anderson-Canyon coal bed of the Arvada-Spotted Horse area of eastern Sheridan and northern Campbell Counties, Wyoming (Hobbs, 1982, 1983).

The quality similarities are:

Quality - uniform high Btu/lb value
Rank - apparent subbituminous B, drill hole 80AU15
Ash - low, uniform
Sulphur - low, uniform
Maceral - predominately over 80 percent vitrain

The coals of both areas represent similar coal-swamp conditions and conditions that were stable throughout their respective coal-forming periods. Finally, the inception and termination of each coal-swamp environment were similar--both rather rapid.

These data, together with the stratigraphic interpretations, support a correlation of the Arvada-Spotted Horse, Anderson-Canyon coal bed to the lower part of the Big George coal deposit.

REFERENCES CITED

American Society for Testing and Materials (ASTM), 1983, 1983 Annual Book of Standards, gaseous fuels; coal and coke: 1616 Race Street, Philadelphia, Pa. 19103, v. 05.05, sec. 5.

Boreck, D. L., 1984, Origin and control of methane in a coal bed of the Paleocene Fort Union Formation, Johnson County, Wyoming [abs.], in Proceedings, 1984 Symposium on the geology of Rocky Mountain coal: North Dakota Geological Survey, Bismarck, N. Dak., p. 77-80.

Boreck, D. L., and Weaver, J. N., 1984, Coal-bed methane study of the "Anderson" coal deposit, Johnson County, Wyoming--a preliminary report: U.S. Geological Survey Open-File Report 84-831, p. 18.

Cathcart, J. D., 1984, Bibliography of U.S. Geological Survey reports on coal drilling and geophysical logging projects and related reports on geologic uses, Powder River Basin, Montana and Wyoming, 1973-1983: U.S. Geological Survey Open-File Report 84-518, 15 p.

Hladysz, Zbigniew, 1983, Report No. 1, Coal Exploratory Drilling Cooperative Report: U.S. Geological Survey, Denver, Colo., and South Dakota School of Mining and Technology, Department of Mining Engineering, Rapid City, S. Dak., December 1983, 6 p.

Hladysz, Zbigniew, and Erickson, J. D., 1984, Portable rock strength tester and economic benefits of rapid testing: Society of Mining Engineers of AIME, preprint number 84-86 presented at the SME-AIME Annual Meeting, Los Angeles, Calif., Feb. 26-Mar. 1, 1984, 7 p.

Hobbs, R. G., 1979, Guidelines for logging, describing, and sampling cores and cuttings of coal and associated rocks of the drill site: U.S. Geological Survey Open-File Report 1522, 23 p.

_____1982, Coal exploratory drilling 1980 Recluse and Sheridan 1/2° x 1° quadrangle, Campbell, Johnson, and Sheridan Counties, Wyoming: U.S. Geological Survey Open-File Report 82-799, 158 p.

Hobbs, R. G., Cathcart, J. D., and Correia, G. A., 1983, Coal quality loss from acquisition to analysis--A preliminary time study: U.S. Geological Survey Open-File Report 83-167, 57 p.

Pierce, F. W., Kent, B. H., and Grundy, W. D., 1982, Geostatistical analysis of a 113 billion ton coal deposit, central part of the Powder River Basin, northeastern Wyoming, in Klaus, D. Q., ed., Proceedings--Fifth Symposium on the geology of the Rocky Mountain coal: Utah Geological and Mineralogical Survey Bulletin 118, p. 262-272.

Stach, E., MacKowsky, M.-Th, Teichmuller, M., Taylor, G. H., Chandra, D., Teichmuller, R., 1982, Stach's textbook of coal petrology, third edition, Gedruder Borntraeger, Berlin-Stuttgart, 6 pls., 204 figs., 49 tables, 535 p.

APPENDIX A

CORE DESCRIPTION

U.S. Geological Survey
Branch of Coal Resources

Project Anderson Coal Deposit Evaluation "Big George"

Hole No. B23-BG1C(83) Geologist R. G. Hobbs, S. B. Roberts and D. L. Boreck

Type log Core description Elev. 4,095 ft Total depth 1,265 ft

Location SE1/4SE1/4SE1/4 Sec. 7 T. 48 N. R. 77 W.

Nearest town Buffalo County Johnson State Wyo. Quad. Juniper Draw 7.5'

Drilled by: USGS, Branch of Coal Resources, Arthur C. Clark, Supervisor

Driller(s): Larry Kozak (driller), Mike Dahlin and Matt Washut (helpers)

Drill: GD17W Date start 6/6/83 Complete 6/26/83

Non-core intervals and size hole: 0-1,028 ft, 9-inch diameter

Cored intervals and size: 1,028-1,265 ft, 4 5/8-inch O.D., 3-inch diameter core

Remarks: Completed as research monitor water well, steel casing, 6" I.D. wall, 0-1,028 ft. Research geophysical logging by R. N. Babcock and J. D. Cathcart, USGS/BCR. Research and experimental logging by J. Daniels, F. Clutson and C. Starter, USGS, Branch of Geophysics. Core description by R. G. Hobbs, modified in part from description by S. B. Roberts and D. L. Boreck. Coal cored June 22-26, 1983.

LOG

Depth (ft) From	To	Length	Description
			Core description 1,028-1,051 ft based on natural gamma/density log aided by core and sample description
1,028.0	1,028.8	0.8	Sandstone, gray, fine-grained
1,028.8	1,030.0	1.2	Shale, black, carbonaceous
1,030.0	1,032.5	2.5	Mudstone, gray massive
1,032.5	1,037.0	4.5	Sandstone, white, fine-grained
1,037.0	1,039.5	2.5	Shale
1,039.5	1,040.2	.7	Mudstone, gray
1,040.2	1,041.0	.8	Sandstone, white to gray, fine-grained
1,041.0	1,042.3	1.3	Shale
1,042.3	1,043.3	1.0	Sandstone, white, fine-grained

Log Continuation
Page 2 of 7

Hole No. B23-BG1C
Project: Anderson

LOG

Depth (ft) From	To	Length	Description
1,043.3	1,044.0	0.7	Shale
1,044.0	1,045.3	1.3	Coal, mostly fusain, minor streaks of vitrain, "dirty"
1,045.3	1,048.0	2.7	Mudstone, shale interbedded, minor streaks of vitrain
1,048.0	1,051.0	3.0	Mudstone, black carbonaceous
			Core description--coal
1,051.00	1,051.10	.10	Coal, fusain and attrital; transition zone main coal bed to roof rock; sharp contact coal to rock at 1,051.00 ft
1,051.10	1,054.35	3.25	Coal, hard, vitrain 40 percent, banded 0.01-0.02 ft width irregular with 60 percent attrital coal. Primary vertical break splint parallel to cleat, lateral break conchoidal in vitrain, irregular along bedding surfaces in attrital coal. Minor clay or gypsum on cleat surfaces
1,054.35	1,065.85	11.50	Lost in coring
1,065.85	1,085.85	10.00	Coal as 1,051.10-1,054.35 to 1,067± ft where vitrain increases to 60 percent vitrain increasing to 70 percent at 1,075±; vitrain bands increase in width to 0.03 ft; 10 percent fusain at 1,077±; balance of coal attrital. Thin zone plant fragments at 1,079±0.1 ft thick, mottled plant fragments at ±1,082 ft, 0.05-0.07 width; fragments consist of stems, twigs, and leaves. High angle, 60°, compression fractures at 1,069.85 and 1,071.85 ft cut across cleats
1,085.85	1,085.95	.10	Coal, 50 percent vitrain, 50 percent fusain, interbedded, bony, shaly; fracture friable--small cubes; minor gypsum(?) on cleat fractures, pyritic crystals on bedding surfaces
1,085.95	1,086.05	.10	Sandstone, black, very fine grained, hard bedded with streaks of vitrain and fusain starting at one-third core diameter to 0.08 ft thick at opposite diameter side

Log Continuation
Page 3 of 7

Hole No. B23-BG1C
Project: Anderson

LOG

Depth (ft) From	To	Length	Description
1,086.05	1,087.15	1.10	Coal, hard, face and butt cleat, vertical fracture blocky to cubic; lateral fracture, conchoidal (vitrain) to irregular along bedding surface (attrital coal), minor pyrite lower 0.05 ft; two bony bands 0.02 ft thick and 0.08 ft apart in upper 0.50 ft
1,087.15	1,087.19	.04	Sandstone, black, fine to very fine grained, hard, flecks of carbonaceous material (leaves, stems, etc.), no discernible bedding gypsum or pyrite
1,087.19	1,087.25	.06	Coal, vitrain, very friable, cubic (very small) fracture, contains tree branch structure, no discernible gypsum and/or pyrite
1,087.25	1,087.30	.05	Sandstone as in 1,087.15-1,087.19-ft interval
1,087.30	1,087.45	.15	Coal, fusain and attrital, "dirty" minor pyrite crystals
1,087.45	1,087.85	.40	Coal, hard, banded, 30 percent vitrain, 70 percent attrital, face and butt cleat developed, fractures conchoidal laterally
1,087.85	1,091.85	4.00	Coal, hard, 50 percent/50 percent, vitrain and attrital coal, attritus dull to silky bright upper 1.5-2.0 ft; lower 2.5-2.0 ft vitrain increases to 60± percent; face and butt cleat, vertical break parallel face cleat, blocky to splint; lateral break conchoidal. Plant material (leaf, stem, and twig) at 1,091.75-1,091.85 ft
1,091.85	1,099.85	8.00	Coal, hard, vitrain 60± percent, attritus 35± percent (bright). Minor fusain 15 percent scattered. Amber (resin) 1,093.55-1,093.85 ft. High angle (60°), compression fractures at 1,091.65-1,092.65 ft; coal highly fractured at 1,095.85-1,097.85 ft induced by coring or natural--not determinable. Plant debris and granular material (bone?) attritus at 1,099.55-1,099.85 ft; clay and (or) gypsum on cleats lower 2.0 ft

Log Continuation
Page 4 of 7

Hole No. B23-BG1C
Project: Anderson

LOG

Depth (ft) From	To	Length	Description
1,099.85	1,143.85	44.00	Coal, hard, vitrain dominant 70± percent, medium to thick bands 0.10-0.15 ft, attrital coal mostly bright, minor scattered fusain, face and butt cleat developed, vertical fracture parallel to cleats blocky; lateral fracture conchoidal; internal wood (tree) structures such as tree rings, bark, etc., abundant at various angles from horizontal to vertical in zones 1,100-1,104, 1,106-1,110, and 1,118-1,120 ft; fractures conform to wood (tree) structures at 1,108-1,110 ft; minor to no deformations of wood structure due to compaction (compression); plant material and debris (leaves, stems, and twigs) at 1,102-1,111-ft zone at 1,114-1,115 ft; grainy macerated plant material at 1,118±, 0.08 ft thick; fragmented plant material 0.50 ft thick at 1,120 ft; 0.02-0.04 ft thick at 1,126 and 1,131.5 ft; plant material on bedding surfaces at 1,132-1,134 ft and thin zone at 1,135 ft; coal extremely friable at 1,103.00-1,103.50 ft, abundant plant material. High-angle fracture (60° compressive) at 1,106-1,108 ft; scattered clay and (or) gypsum on cleats; irridescent mineralization at 1,118 ft ("peacock coal")
1,143.85	1,173.65	29.80	Coal, hard, vitrain dominant 70-80 percent; balance attrital coal mostly bright to silky, face and butt cleat well developed; vertical breaks parallel to cleat mostly blocky with some splint; lateral breaks conchoidal in vitrain, irregular along bedding surfaces in attritus. Internal wood structure as 1,199.85-1,143.85-ft interval at 1,152-1,160 and 1,166-1,171 ft. Vitrain banding distorted at top of thin sandstone at 1,162.50 ft. Thin sandstone at 1,162.50, 0.05 ft thick, brown, no discernible bedding contains quartz shards and zircon (B. Bohor, personal commun., 1983), no reaction to HCl--volcanic ash fall?
1,173.65	1,173.85	.20±	Sandstone, very light gray, very hard, very fine grained, irregular thickness, contact with overlying coal sharp, intertongues with underlying coal; no discernible bedding; contains scattered minute, bright, shiny specks; no reaction with HCl; vertical break jagged and irregular--volcanic ash(?)

Log Continuation
Page 5 of 7

Hole No. B23-BG1C
Project: Anderson

LOG

Depth (ft) From	To	Length	Description
1,173.85	1,175.45	1.60	Coal, hard, vitrain dominant 70-80 percent, balance attritus; vertical break parallel to cleat, blocky; lateral break conchoidal in vitrain, uneven and irregular along bedding surfaces in attrital coal. Shows internal wood (tree) structure--tree rings, limbs, branches, and trunks(?); no discernible gypsum and (or) pyrite
1,175.45	1,175.65	.20	Sandstone as in 1,173.65-1,173.85-ft interval; interbedded 50 percent with coal, 50 percent with carbonaceous material; vertical break jagged, lateral break irregular to wavy; no discernible gypsum or pyrite; no reaction with HCl; volcanic ash(?)
1,175.65	1,188.05	12.40	Coal, hard, vitrain dominant 80 percent, thick bands; attritus mostly bright to silky, face and butt cleat developed; lense of plant material at 1,182 ft; shows internal wood structure at 1,175.65-1,176.00 ft
1,188.05	1,188.60	.55	Coal, fusain dominant, minor attritus and vitrain; vitrain in lenses showing internal wood structure (branches) at various attitudes horizontal to vertical
1,188.60	1,188.67	.07	Sandstone, black to gray, extremely fine grained 0.04-0.07 ft thick, upper and lower contact with coal very sharp but wavy
1,188.67	1,188.75	.08	Coal, attrital, dull, abundant plant debris; allochthonous(?)
1,188.75	1,189.15	.40	Claystone, gray, upper contact with coal, very sharp, wavy with coal, lower contact intertongues with overlying coal
1,189.15	1,189.70	.55	Coal, very hard, mostly fusain scattered plant material--leaves, twigs, and stems; occasional minor vitrain streak (wood fragment--branch?); lower part bony, upper and lower contacts with rock very irregular; allochthonous(?)
1,189.70	1,191.65	1.95	Sandstone, gray, very fine grained, massive, no discernible bedding, very hard, scattered carbonaceous material--leaves, stems, twigs throughout. Full leaf at 1,190.25 ft (removed for identification); no reaction to HCl

Log Continuation
Page 6 of 7

Hole No. B23-BG1C
Project: Anderson

LOG

Depth (ft) From	To	Length	Description
1,191.65	1,191.75	0.10	Sandstone, gray, very fine grained, minor bedding contains scattered carbonaceous material as 1,189.75-1,191.65 ft
1,191.75	1,191.80	.05	Shale, gray, scattered carbonaceous material--leaf, stem, twig
1,191.80	1,191.95	.15	Sandstone, as in 1,189.70-1,191.65-ft interval contact with underlying coal (thick vitrain band) very sharp; no transition zone coal to rock
1,191.95	1,246.85	54.90	Coal, hard, +80 percent vitrain, balance mostly bright attritus with fusain zone at 1,244.50-1,246.50-ft face and butt cleat; internal wood structures (tree rings, bark, etc.) at 1,202-1,204 ft, 1,208.50-1,210.50 ft, 1,212-1,214 ft, and 1,232-1,240 ft not deformed or compressed; plant material 0.03 ft thick at 1,228 ft. Scattered gypsum(?) on cleat surfaces. Breaks blocky parallel to cleats, vertical; lateral break is conchoidal. Thin sandstone(?) very fine grained at 1,216.25-1,216.30 ft and 1,210.25 ft volcanic ash(?)
1,246.85	1,247.40	.55	Sandstone, white upper and lower one-third, yellow cast middle one-third, very fine grained; very hard, massive--no discernible bedding. Upper and lower contacts with coal very sharp--no transition zone either coal to rock (lower) or rock to coal (upper)
1,247.40	1,252.25	4.85	Coal, hard, vitrain dominant 80 percent upper 4.00 ft; lower 0.85 ft attritus with some fusain becomes dominant; vertical break, blocky parallel to cleat, lateral break--conchoidal
1,252.25	1,252.85	.60	Coal, mostly fusain, dirty, contains macerated plant debris--leaf, stem, twig material contact with underlying shale sharp, no gradual transition zone--rock to coal Base of coal 1,252.85 ft
1,252.85	1,253.25	.40	Shale, brownish-black with vitrain streaks and scattered carbonaceous material; slickensides present

Log Continuation
Page 7 of 7

Hole No. B23-BG1C
Project: Anderson

LOG

Depth (ft) From	To	Length	Description
1,253.25	1,254.70	1.45	Sandstone, fine-grained, poorly sorted, subrounded, contains carbonaceous material
1,254.70	1,257.00	2.30	Sandstone, orange-pink, fine-grained, moderately sorted, subrounded to round, major vitrain stringers at 1,255.95 and 1,256.85 ft tree branches(?); scattered minor vitrain stringers throughout, rootlets and carbonaceous material important upper portion; amount decreases downward, oil stain at 1,255.95-1,256.20 ft
1,257.00	1,259.00	2.00	Sandstone, gray, fine grained, cross bedded--low angle; erosional surface at 1,258.25 ft
1,259.00	1,262.85	3.85	Sandstone, fine-grained, interbedded with siltstone, cross bedded at 30°-45° shows evidence of faulting (minor growth) during deposition
1,262.85	1,263.15	.30	Shale, olive-black, slickensides
1,263.15	1,263.45	.30	Chert, microcrystalline, yellow (concretion?), hard, ropy surface
1,263.45	1,263.85	.40	Coal, dirty, impure, fusain
1,263.85	1,264.30	.45	Chert as in 1,263.15-1,263.45-ft interval
1,264.30	1,264.85	.55	Shale, brownish-black
1,264.85	1,265.45	.60	Shale, olive-green, carbonaceous, slickensides

APPENDIX B

TABLE B-1 Coal and rock samples for petrographic and other interpretations.

SAMPLE NUMBER	FOOTAGE INTERVAL (FEET)	CORE INTERVAL (FEET)	LENGTH (FEET)
BGP-4	1085.85-1086.05	34.85- 35.05	0.20
BGP-5	1087.15-1087.30	36.15- 36.30	0.15
BGP-1	1173.65-1173.85	122.65-122.85	0.20
BGP-2	1175.45-1175.65	124.45-124.65	0.20
BGP-3	1246.85-1247.40	195.90-196.45	0.55

TABLE B-2 Samples for geophysical investigations.

SAMPLE NUMBER	FOOTAGE INTERVAL (FEET)	CORE INTERVAL (FEET)	LENGTH (FEET)
D5/20	1069.85-1070.35	18.85- 19.35	0.50
D10/33	1081.85-1082.60	30.85- 31.60	0.75
D11/35	1084.45-1085.20	33.45- 34.20	0.75
D12/36	1086.05-1086.55	35.05- 35.55	0.50
D19/62	1112.45-1113.31	60.65- 61.31	0.69
D20/65	1114.51-1115.04	62.51- 63.04	0.53
D21/67	1115.75-1116.35	63.75- 64.35	0.60
D25/78	1128.55-1129.42	77.55- 78.42	0.87
D26/80	1130.12-1130.94	79.12- 79.94	0.82
D27/83	1133.72-1134.31	82.72- 83.31	0.69
D36/106	1158.65-1159.16	107.65-108.16	0.51
D37/109	1160.19-1160.86	109.19-109.86	0.67
D38/110	1163.36-1163.86	112.36-112.86	0.50
D39/112	1164.40-1164.65	114.40-114.65	0.25
D40/122	1173.85-1174.45	122.85-123.45	0.60
D41/123	1175.65-1176.40	124.65-125.40	0.75
D44/135	1187.87-1188.25	136.87-137.25	0.38
D1A	1188.25-1188.85	137.25-137.85	0.60
D45/141	1193.45-1194.25	142.45-143.25	0.80
D58/167	1219.25-1220.60	168.25-169.10	0.85
D59/168	1221.20-1221.86	172.20-172.86	0.66
D60/171	1223.60-1224.25	172.60-173.25	0.65
D69/124	1246.60-1246.90	195.60-195.90	0.30
D70/	1249.00-1249.60	198.00-198.60	0.60
D71/199	1251.89-1252.25	200.89-201.25	0.36