ROTARY DRILLING FOR STRIPPABLE COAL IN THE JARVIS CREEK COALFIELD, ALASKA

By R. S. Warfield

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ROTARY DRILLING FOR STRIPPABLE COAL IN THE JARVIS CREEK COALFIELD, ALASKA

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ABSTRACT

During September 1970, 12 holes ranging in total depth from 26.4 to 138 feet were drilled using a CSR (center sample return) drilling system to test the applicability of the drilling system and to test coal continuity in the vicinity of the present mine workings of the Jarvis Creek coalfield. The drilling confirmed that some coal has been removed by glaciation and that, although only three drill holes intersected the mine coal seam, these intersections, plus geologic evidence from other holes, indicate depositional continuity over fairly large distances. The CSR drilling system appears to offer an excellent method for determining coal continuity and a system in which a fair (but not quite as good as core) sample may be obtained.

INTRODUCTION

The Jarvis Creek coalfield is located about 30 miles south of Delta Junction, or 125 miles southeast of Fairbanks on the north side of the Alaska Range. (Figure 1) A few hundred tons of subbituminous coal

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1/ Mining engineer, Alaska Field Operation Center, Bureau of Mines, Juneau, Alaska.

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FIGURE 1- Index map of Alaska

have been sporadically strip-mined for use as space-heating fuel in the Delta Junction area, and presently (1972) coal is being trucked to Fairbanks for space-heating use.

The coalfield, about 16 square miles in area, lies entirely within the Mount Hayes C-4 quadrangle as mapped by the U. S. Geological Survey. The coal deposits underlie a rolling plateau that slopes northwestward from a maximum altitude of about 4,400 feet at the southeast corner to a minimum altitude of 2,750 feet at the north end. The plateau is bounded on the east, south, and west by steep bluffs facing Jarvis Creek, Little Gold Creek, Ruby Creek, and the Delta River. The northwest-sloping surface of the plateau is drained by Ober Creek, a small stream that heads near the south-center of the coalfield, and flows northward about 14 miles to join Jarvis Creek. Current mining activity and the site of the Bureau of Mines drilling project is along Ober Creek.

Access to the mine area and project site is via a pioneer gravel road that leaves the Richardson Highway just north of mile post 242 and meanders, as nearly as possible, along a ridge top of glacial moraine 6 or 7 miles to the mine site. Figure 2 shows the approximate route of the road.

GEOLOGY

The geology of the Jarvis Creek coalfield has been studied by the U. S. Geological Survey. Results of their studies are published in Bulletin 989-G.(1) 2/ The following is a very brief summary taken almost

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2/ Underlined numbers in parentheses refer to items in the list of references at the end of this report.

Figure 2 Location Map, Jarvis Creek Coalfield
Mt. Hayes (C-4) Quadrangle Scale 1:63360
Limits of Jarvis Creek Coalfield as mapped by the USGS

in entirety from Bulletin 989-G:

The Jarvis Creek coalfield is Tertiary in age and the entire coal-bearing section is believed correlative with the lower coal-bearing member of the commercially important Nenana coalfield 100 miles to the west. The Tertiary sediments are underlain by Birch Creek Schist of Pre-Cambrian age. The schist, which is largely a quartz-sericite schist with many quartz veins, is a widespread prominent bedrock, outcropping at many localities in central Alaska.

The coal-bearing formation in the Jarvis Creek coalfield consists of a sequence of interbedded lenses of poorly consolidated sandstone, siltstone, claystone, conglomerate and lignitic to subbituminous coal. Thin discontinuous beds of coal are present throughout the entire thickness of the coal-bearing formation. In two measured sections near the south end of the field, 30 coal beds 1 to 7 feet thick were mapped, and in two other sections 14 beds were mapped. But coalbeds more than 2 1/2 feet thick are rare and most coalbeds are lenticular and grade laterally into sections containing bone and clay.

The coal-bearing formation has been warped into an oval shaped basin in which the major axis trends north-northwest. A subsidiary northward-trending anticline and syncline are indicated in the northern part of the coalfield. Dips in the coal-bearing formation are locally as high as 30°, but generally the beds dip 5 to 10 degrees inward toward the center of the basin.

Quaternary deposits include gravel, till, solifluctional debris, and windborne deposits. At least two major glacial stages have been recognized. The Plateau country lying west and north of Ober Creek is

covered by a thick glacial moraine of the younger glacial stage, on which the topography of the retreating glacier is almost perfectly preserved. This area contains a chaotic assemblage of low irregular ridges and mounds that separate numerous depressions, most of which are occupied by lakes. This is also the area through which the road to the mine along Ober Creek winds.

Older till mantles the southern part of the plateau of the coalfield and old till also caps hills in the northern and central parts. The original glacial topography of the old till has been completely destroyed and the presence of old till on the tops of high hills and interfluves indicates that downcutting erosion of several hundred feet by the present streams has taken place.

WORK BY THE BUREAU OF MINES

Results of Drilling

During September 1970, twelve holes ranging in depths from 26.4 feet to 138 feet were drilled in the Jarvis Creek coalfield to test coal continuity in the vicinity of the present mine workings and to test the applicability of a CSR (center sample return) drilling system. Figure 3, a topographic map, shows the location of drill holes and mine workings.

Glaciation made it possible that segments of the coal, especially at stripping depths, were gouged out, and that parts of the coalbed's original position are now occupied by glacial moraine. In addition, lateral depositional thickening, thinning or change of quality of coalbeds within short distances is a possibility.

The drilling confirmed that some coal on the south side of Ober Creek has been removed by glaciation (see logs of holes 10, 11, and 12 in the Appendix, Table 1). Only 3 drill holes, 3, 5, and 7 with certainty, intersected the mine coal seam (about a 10-foot seam). Projections of dips and strikes of the mine coal seam into drill hole 6 indicate that hole 6 should have intersected the mine seam: in one calculation at 48 feet, in the other at 62 feet. A coal interval from 69.5 to 78 feet in drill hole 6 (see Appendix, Table 2 for analyses) is not believed to be the mine seam because quality is much lower and correlation with other sections of the hole appears lacking. If this is so, the three drill hole intersections, plus geologic evidence from other holes, seems to indicate depositional continuity over fairly large distances, but then, structural deformation is greater than was apparent in the mine workings and from drill hole evidence. This, together with glaciation, would make necessary a fairly close order drilling program to enable transfer of inferred strippable reserves to a measured or indicated category. Figure 4 is a near north-south section through holes 9 and 12 and the mine workings; relevant drill hole data has been projected into the section.

Samples were sealed in plastic bags at the drill site. Later, splits of the samples, also sealed in plastic bags, were shipped to the Bureau of Mines Pittsburgh Energy Research Center for proximate analyses. On the basis of the proximate and sulfur analyses, splits of selected samples were forwarded to Pittsburgh for ultimate and fusibility of ash analyses (see Appendix, Table 2 for analyses).

Because of the current national concern about mercury pollution, selected samples were analyzed in the Bureau of Mines Juneau, Alaska, Laboratory for mercury; none was detected (see Appendix, Table 2 for analyses).

Drilling System

Drilling was with an all hydraulic top drive machine using the CSR drilling system. In this system of drilling, a dual wall drill pipe is used in which the circulating fluid enters the drill pipe and drill hole in the annulus between the two tubes of the drill pipe and returns to the surface through the center tube carrying the sample. Tri-cone rock bits were used to produce chip samples and compressed air was used as the circulating fluid. Sample separation from the returning air was accomplished in a cyclone separator. It had been intended that ordinary core drilling through the coal seam would be used to obtain a control sample. The core barrel available, however, was designed for liquid drilling fluids and proved almost a total failure using compressed air. Apparently, neither the core barrel nor diamond bit fluid passages were sufficiently large to pass the necessary air quantities at available pressures (approximately 100 p.s.i.) to clear the hole of cuttings.

Coal samples were collected as chips from a cyclone separator. This system proved generally very satisfactory. The main drawback of the system, as used, is the total dependence on the abilities of the sampler to obtain good results. During the drilling process, sample chips enter the cyclone separator continuously. The sampler must instantly recognize coal to start a saved sample and instantly recognize leaving coal to stop a saved sample, and of course, it is impossible to separate thin partings from the sample.

A number of stop and start times for determining penetration rates were recorded. These are shown in the Appendix, Table 3.

The CSR drilling system appears to offer an excellent method for determining coal continuity and a system with which a fair (if not quite as good as core) sample may be obtained.

RESERVES

Coal reserves have been calculated by the U. S. Geological Survey, Bulletin 989-G (1), according to standard proceedures, into indicated and inferred catagories and into thickness catagories of 2.5 to 5.0 feet and more than 5 feet. These are: in millions of short tons

Bed Thickness	Indicated	Inferred
2.5 - 5.0 feet	0.8	6.6
More than 5 feet	5.1	0.9
Total	5.9	7.5

At least, an additional 64 million tons of minable coal is believed, by the U. S. Geological Survey authors, to underlie the field. But these are resources that cannot be included in the inferred category because of the standard limits of projection for calculation of inferred reserves.

Most of the coalbeds considered minable outcrop near the base of steep bluffs into which they dip so that strip mining possibilities are considered very limited. However, 100 to 300 thousand tons are possibly available to strip mining along the outcrop of two beds near the southern end of the field (1), and a 10-foot bed that outcrops along Ober Creek on which strip mining is currently taking place has a conservatively estimated strip mining potential of 375,000 tons (2). These consist of measured reserves of 25,000 tons with a stripping ratio of 3 to 1,

determined from the pit face and drill holes; indicated reserves of 50,000 tons with a stripping ratio of 3 1/2 to 1, determined from drill holes and projected continuity of the "mine seam" and inferred reserves conservatively estimated to be 300,000 tons with a stripping ratio of 4 to 1 (2).

LIST OF REFERENCES

1. Wahrhaftig, Clyde, and C. A. Hickcox. Geology and Coal Deposits, Jarvis Creek Coal Field, Alaska. U. S. Geological Survey Bulletin 989-G, 1955, pp. 353-367.

2. Thomas, B. I. "Pre-Award Survey Delta Coal Company, Fairbanks, Alaska." U. S. Bureau of Mines Report to Defense Fuel Supply Center, Cameron Station, Alexandria, Virginia. March 1972. Copy of report on file at U. S. Bureau of Mines, Juneau, Alaska.

TABLE 1.--Logs of drill holes, Jarvis Creek Coalfield

Dip of hole: Vertical

Dates drilled: September 7, 1970

Hole No.: 1

Depth, feet		Material
From	To	
0.0	1.0	Tundra and soil overburden
1.0	14.0	Gravel
14.0	19.0	Medium grained sandstone
19.0	29.0	Siltstone
29.0	31.0	Conglomerate?
31.0	36.0	Siltstone
36.0	41.0	Fine grained sandstone
41.0	58.0	Siltstone, some carbonaceous from 53 feet
58.0	69.0	Claystone (feels like soapstone)
69.0	71.0	Interbedded clay and thin coal beds
71.0	73.0	Interbedded clay and thin coal beds
73.0	77.0	Interbedded clay and thin coal beds
77.0	80.0	Claystone, light gray color
80.0	86.0	Siltstone, light gray color
86.0	89.0	Coal with some bone--not sampled
89.0	91.0	Bone
91.0	91.5	Coal
91.5	102.0	Siltstone changing to medium sandstone
102.0	111.0	Clayey material--some carbonaceous, thin coal bed at 111 feet
111.0	114.0	Interbedded carbonaceous clayey material and thin coal beds
114.0	120.0	Clayey to silty material--red to light gray
120.0	123.0	Fine to medium sandstone--light gray, interbedded with siltstone and clayey material

TABLE 1.--Logs of drill holes, Jarvis Creek Coalfield--continued

Dip of hole: Vertical

Dates drilled: September 9, 1970

Hole No.: 2

Depth, feet		Material
From	To	
0.0	1.0	Tundra
1.0	15.0	Mud, silt and gravel--tough gravel drilling
15.0	16.0	Gravel
16.0	20.0	Clay and gravel--some large boulders
20.0	25.0	Clay; hit H_2O at 23 feet
25.0	25.5	Blue sandstone and clay
25.5	27.0	Dark sandstone and clay
27.0	37.5	Fluffy dark fine grained clay
37.5	37.8	Thin coal seam
37.8	39.0	Gray sandstone
39.0	42.0	Dark brown coal and sandstone
42.0	50.0	Gray sandstone
50.0	55.0	Gray sandstone and H_2O
55.0	71.0	Gray clay and sandstone
71.0	74.0	Coal--some clayey partings--sampled
74.0	78.0	Carbonaceous material
78.0	90.0	Gray clayey to silty material, some slightly carbonaceous
90.0	102.8	Gray clayey to silty material, some slightly carbonaceous
102.8	105.5	Clayey material with a few thin coal seams
105.5	106.9	Coal--not sampled
106.9	111.0	Highly carbonaceous material with a few thin coal seams
111.0	114.5	Gray clayey to silty material
114.5	118.5	Highly carbonaceous material with few thin coal seams
118.5	123.5	Gray clayey silty material
123.5	127.5	Sandstone, fine to medium grained, gray color, some carbonaceous lower 0.5 feet
127.5	131.0	Clayey highly carbonaceous material
131.0	138.0	Silty clayey material, some slightly carbonaceous

TABLE 1.--Logs of drill holes, Jarvis Creek Coalfield--continued

Dip of hole: Vertical

Dates drilled: September 11, 1970

Hole No.: 3

Depth, feet		Material
From	To	
0.0	1.0	Moss, vegetation
1.0	2.0	Frozen muck
2.0	11.0	Frozen dirt and gravel
11.0	19.0	Water, mud, ice, dark blue-gray sandstone
19.0	27.0	Fine gravel, gray clay
27.0	30.3	Dark gray clay
30.3	30.7	Carbonaceous material
30.7	33.3	Dark gray clay
33.3	33.6	Carbonaceous material, coal and clay
33.6	44.3	Gray clay
44.3	44.6	Coal--not sampled
44.6	51.0	Gray clay
51.0	52.0	Coal--not sampled
52.0	57.0	Gray clay
57.0	60.0	Coal--thin bedded and carbonaceous material
60.0	62.0	Gray clay
62.0	65.0	Coal--sampled--mine seam
65.0	70.0	Coal--sampled--mine seam
70.0	73.5	Coal--sampled--mine seam
73.5	80.0	Gray clay
80.0	81.5	Coal--sampled
81.5	90.0	Olive drab clay and fine grained sandstone

TABLE 1.--Logs of drill holes, Jarvis Creek Coalfield--continued

Dip of hole: Vertical

Dates drilled: September 14, 1970

Hole No.: 4

Depth, feet		Material
From	To	
0.0	1.0	Tundra
1.0	15.0	Frozen gravel
15.0	22.5	Clayey silty material, ice cuttings at about 20 feet
22.5	25.0	Interbedded clayey material and thin seams of coal
25.0	30.0	Clayey material, some carbonaceous
30.0	52.5	Clayey material--dark and light gray color, slightly carbonaceous at 47 feet
52.5	54.0	Dirty coal
54.0	55.5	Gray color clay, thin coal seams at 55 and 55.5 feet
55.5	75.0	Gray clayey to silty material, occassionaly very thin coal seam, some slightly carbonaceous
75.0	81.0	Clayey silty material, dark and light gray
81.0	82.5	Dirty coal
82.5	83.2	Clayey and carbonaceous material
83.2	84.5	Carbonaceous material and dirty coal
84.5	86.0	Carbonaceous material and dirty coal
86.0	90.2	Clayey silty material--gray, some carbonaceous
90.2	90.5	Coal
90.5	95.5	Clayey silty material, some carbonaceous, some dirty coal
95.5	98.0	Dirty coal
98.0	100.0	Clayey silty material, some carbonaceous
100.0	102.0	Interbedded thin coal seams and carbonaceous clayey material
102.0	108.5	Clayey silty material--dark to light gray color, some slightly carbonaceous
108.5	109.0	Dirty coal
109.0	114.0	Clayey silty material--dark gray color
114.0	115.5	Dirty coal
115.5	121.0	Carbonaceous material grading to clayey silty material

TABLE 1.--Logs of drill holes, Jarvis Creek Coalfield--continued

Dip of hole: Vertical

Dates drilled: September 15, 1970

Hole No.: 5

Depth, feet		Material
From	To	
0.0	1.0	Moss, vegetation
1.0	7.5	Frozen dirt and gravel
7.5	12.0	Gravel--some fairly large cobbles
12.0	27.0	Frozen dirt and gravel, some fairly large cobbles
27.0	34.6	Frozen gravel
34.6	37.5	Coal--sampled--mine seam
37.5	41.0	Coal--sampled--mine seam
41.0	43.8	Coal--sampled--mine seam
43.8	44.5	Clayey silty material, gray color
44.5	46.0	Clayey silty material, gray color
46.0	48.1	Coal--not sampled
48.1	55.0	Clayey material, gray color
55.0	57.0	Clayey material, gray color
57.0	57.2	Coal--not sampled
57.2	60.0	Clayey material--tan
60.0	61.5	Coal--not sampled
61.5	63.0	Clayey material--tan
63.0	63.5	Coal--not sampled
63.5	70.0	Clayey material--light gray, upper 1 foot highly carbonaceous
70.0	70.1	Coal--not sampled
70.1	74.0	Clayey material, light gray
74.0	75.0	Clayey material, light gray

TABLE 7.--Logs of drill holes, Jarvis Creek Coalfield--continued

Dip of hole: Vertical

Dates drilled: September 16, 1970

Hole No.: 6 1/

Depth, feet		Material
From	To	
0.0	1.0	Moss, vegetation
1.0	7.0	Frozen dirt, humus, water
7.0	10.5	Frozen clay
10.5	15.0	Frozen clay with some large gravel boulders
15.0	20.0	Frozen gray clay, thin coal seam at 20.0 feet
20.0	26.0	Gray clay
26.0	30.0	Dark gray clay
30.0	31.0	Dirty coal
31.0	33.0	Thin separation of clay
33.0	35.5	Dirty coal and clay
35.5	41.0	Gray dusty clay
41.0	43.5	Gray clay
43.5	44.5	Coal seam--not sampled
44.5	49.5	Gray clay
49.5	52.0	Coal--sampled
52.0	60.0	Gray clay
60.0	64.0	Sandy clayey material
64.0	64.5	Sandstone
64.5	69.2	Sandstone
69.2	69.5	Dark sandstone
69.5	74.5	Coaly material--sampled
74.5	78.0	Coaly material--sampled
78.0	80.5	Gray clay
80.5	83.5	Coaly material--sampled
83.5	86.0	Clayey coal
86.0	89.0	Sandstone and coal
89.0	91.0	Gray clay
91.0	123.0	Sandstone

1/ Hole 6 underlies mine seam.

TABLE 1.--Logs of drill holes, Jarvis Creek Coalfield--continued

Dip of hole: Vertical

Dates drilled: September 18, 1970

Hole No.: 7

Depth, feet		Material
From	To	
0.0	1.0	Tundra
1.0	8.0	Frozen dirt, humus
8.0	20.0	Frozen gravel, some silty material containing cobbles
20.0	29.7	Coal--sampled--mine seam
29.7	32.0	Clayey material, upper and lower part carbonaceous
32.0	35.0	Coal, upper part dirty--sampled
35.0	38.0	Clayey material, light gray, ice cuttings
38.0	40.0	Sandy material interbedded with clayey and silty material, tan color

TABLE 1.--Logs of drill holes, Jarvis Creek Coalfield--continued

Dip of hole: Vertical

Dates drilled: September 18, 1970

Hole No.: 8

Depth, feet		Material
From	To	
0.0	1.0	Tundra
1.0	9.0	Frozen mud, dirt, humus
9.0	21.0	Gravel, some large cobbles
21.0	21.8	Clayey silty material
21.8	22.0	Coal--cored to 26.4 feet (core not logged 9/29/70, but believe coring intersected thin seam 2 feet or 3 feet above mine seam)
		Core log 10/6/70
20.0	25.0	Medium sandstone grading to siltstone then claystone, lower 1.0 foot slightly coaly
25.0	26.0	Coal--high ash, thin seam 2 feet or 3 feet above mine seam, sampled (core crushed to 10 mesh then split)
26.0	26.4	Silty material grading to medium gray colored sandstone
		Bottom

NOTE: Core drilled part of hole apparently went off the side of CSR hole, hence core from above 22 feet.

TABLE 1.--Logs of drill holes, Jarvis Creek Coalfield--continued

Dip of hole: Vertical

Dates drilled: September 19, 1970

Hole No.: 9

Depth, feet		Material
From	To	
0.0	1.0	Tundra
1.0	8.0	Frozen dirt
8.0	13.0	Frozen gravel
13.0	29.0	Frozen gravel, chunks of ice, some large cobbles, fine gravel lower 8 feet
29.0	29.8	Frozen fine gravel
29.8	35.5	Coaly material--not sampled
35.5	41.0	Clayey material, slightly carbonaceous
41.0	44.5	Clayey silty material, dark gray
44.5	45.0	Dirty coal
45.0	47.0	Dirty coal
47.0	49.0	Clayey material, some coaly
49.0	61.0	Silty sandy material, light gray, thin coaly seam at 52 feet and 57.5 feet
61.0	65.0	Sandstone, light gray
65.0	76.5	Clayey silty material, coaly 67 feet-68 feet, coaly at 71 feet
76.5	77.0	Sandstone, light gray
77.0	79.0	Sandstone, light gray
79.0	80.0	Clayey silty material
80.0	81.0	Coaly material
81.0	85.0	Clayey silty material
85.0	86.5	Coaly material
86.5	88.0	Coal--not sampled
88.0	92.0	Clayey silty material, light gray

TABLE 1.--Logs of drill holes, Jarvis Creek Coalfield--continued

Dip of hole: Vertical

Dates drilled: September 21, 1970

Hole No.: 10

Depth, feet		Material
From	To	
0.0	12.0	Gravel, considerable amount fines and some large cobbles
12.0	28.0	Gravel, frozen, considerable fines, many cobbles--fairly tough drilling
28.0	44.0	Frozen gravel, some large boulders, also large amount fines
44.0	60.0	Frozen gravel, some large boulders, also dark gray fines
60.0	61.0	Frozen gravel, some large boulders, also dark gray fines
61.0	70.0	Sandy black material, appears coaly (appeared that it could be used as road paving)--sampled 66-67 feet, grades to dark gray material at 70 feet; zone produced gas which was ignitable at hole collar
70.0	71.0	Conglomerate
71.0	76.0	Sandy material, dark gray to black
76.0	77.0	Conglomerate
77.0	81.0	Sandy material, dark gray to black, some interbedded sticky clayey material
81.0	90.0	Coarse grain pebbly sandstone, dark gray, quartz pebbles

TABLE 1.--Logs of drill holes, Jarvis Creek Coalfield--continued

Dip of hole: Vertical

Dates drilled: September 22, 1970

Hole No.: 11

Depth, feet		Material
From	To	
0.0	1.0	Tundra
1.0	3.0	Dirt, soil
3.0	12.0	Gravel, thawed, large cobbles
12.0	28.0	Frozen gravel, large amount fines, some fairly large cobbles
28.0	44.0	Frozen gravel, large schist boulders, pieces up to 1 1/2 inches long by 1 inch around coming through bit, quartz pieces to 1 inch in size, fine clayey silty material lower 3 feet
44.0	59.0	Clayey silty material to 48 feet then more gravel, clayey silty material is probably glacial, fine silty material with lots of moisture (ice) 57 feet to 59 feet
59.0	76.0	Frozen gravel, some has lots of moisture (ice), mostly fine silty material with occasional pebbly sections
76.0	77.0	Frozen gravel, some has lots of moisture (ice), mostly fine silty material with occasional pebbly sections

TABLE 1.--Logs of drill holes, Jarvis Creek Coalfield--continued

Dip of hole: Vertical

Dates drilled: September 22, 1970

Hole No.: 12

Depth, feet		Material
From	To	
0.0	2.0	Tundra
2.0	12.5	Frozen dirt
12.5	28.0	Frozen dirt, humus, high moisture content
28.0	35.0	Frozen dirt, few rock pebbles starting at 30 feet grading to more true gravel with clayey sticky matrix
35.0	44.0	Silty elastic clay containing pebbles and cobbles--glacial
44.0	60.0	Frozen gravel, large amount fines, some large boulders (schist), very tough drilling lower 10 feet
60.0	71.4	Gravel, very high percentage hard siliceous rock, very tough drilling

TABLE 2.--Analyses of drill hole samples from Jarvis Creek Coalfield

Hole No.	2		3					
Depth	71.0 - 74.0 ft.		62.0 - 65.0 ft. 2/		65.0 - 70.0 ft. 2/		70.0 - 73.5 ft.	
Basis	As received	Maf	As received	Maf	As received	Maf	As received	Maf
Proximate analysis pct.								
Moisture	19.7		20.9		22.1		20.6	
Volatile Matter	28.1	51.4	30.6	51.1	33.7	49.5	33.0	52.1
Fixed carbon	26.6	48.6	29.3	48.9	34.5	50.5	30.3	47.9
Ash 1/	25.6		19.2		9.7		16.1	
Ultimate analysis pct.								
Hydrogen			5.6	5.5	6.2	5.4	6.0	5.6
Carbon			42.5	72.1	48.8	72.7	46.4	73.3
Nitrogen			0.7	1.2	0.8	1.2	0.7	1.1
Oxygen			31.0	19.8	33.3	19.6	30.6	18.0
Sulfur	0.6	1.1	0.8	1.4	0.8	1.1	1.3	2.0
Ash 1/			19.4		10.1		15.0	
Heating value Btu/lb.	6,640	12,140	7,340	12,240	8,450	12,390	8,010	12,650
Fusibility of ash °F								
Initial deformation temperature			2370		2050		2130	
Softening temperature			2420		2100		2180	
Fluid temperature			2480		2150		2240	
Mercury ppm	0.0							

1/ Proximate and ultimate analysis were run on different splits of the same sample. Thus, the reason for a slight discrepancy in results.
2/ Mine seam

TABLE 2.--Analyses of drill hole samples from Jarvis Creek Coalfield--continued

Hole No.	3		5					
Depth	80.0 - 81.5 ft.		34.6 - 37.5 ft. 2/		37.5 - 41.0 ft. 2/		41.0 - 43.8 ft. 2/	
Basis	As received	Maf	As received	Maf	As received	Maf	As received	Maf
Proximate analysis pct.								
Moisture	19.4		22.2		21.9			
Volatile Matter	33.6	55.1	32.5	51.8	33.1	48.9	20.7	
Fixed carbon	27.4	44.9	30.2	48.2	34.5	51.1	33.9	51.2
Ash 1/	19.6		15.1		10.5		32.3	48.8
							13.1	
Ultimate analysis pct.								
Hydrogen			6.0	5.6	6.0	5.3	6.0	5.5
Carbon			44.7	72.1	48.5	72.1	47.7	72.4
Nitrogen			0.8	1.2	0.8	1.2	0.7	1.1
Oxygen			32.3	20.1	32.8	19.8	31.0	18.7
Sulfur	1.3	2.1	0.6	1.0	1.1	1.6	1.5	2.3
Ash 1/			15.6		10.8		13.1	
Heating value Btu/lb.	7,850	12,860	7,830	12,480	8,420	12,460	8,310	12,550
Fusibility of ash °F								
Initial deformation temperature			2310		2070		2090	
Softening temperature			2360		2120		2140	
Fluid temperature			2410		2170		2190	
Mercury ppm	0.0							

1/ Proximate and ultimate analysis were run on different splits of the same sample. Thus, the reason for a slight discrepancy in results.
2/ Mine seam.

TABLE 2.--Analyses of drill hole samples from Jarvis Creek Coalfield--continued

Hole No.	6							
Depth	49.5 - 52.0 ft.		69.5 - 74.5 ft.		74.5 - 78.0 ft.		80.5 - 83.5 ft.	
Basis	As received	Maf	As received	Maf	As received	Maf	As received	Maf
Proximate analysis pct.								
Moisture	21.1		8.0		17.6		16.9	
Volatile Matter	32.5	53.5	30.5	62.3	24.9	53.7	28.6	57.7
Fixed carbon	28.3	46.5	18.5	37.7	21.6	46.3	21.0	42.3
Ash 1/	18.1		43.0		35.9		33.5	
Ultimate analysis pct.								
Hydrogen								
Carbon								
Nitrogen								
Oxygen								
Sulfur	1.4	2.4	0.7	1.4	1.0	2.2	0.9	1.8
Ash 1/								
Heating value Btu/lb.	7,640	12,550	4,850	9.900	5,720	12,320	6,220	12,540
Fusibility of ash °F								
Initial deformation temperature								
Softening temperature								
Fluid temperature								
Mercury ppm	0.0		0.0		0.0		0.0	

1/ Proximate and ultimate analysis were run on different splits of the same sample. Thus the reason for a slight discrepancy in results.

TABLE 2.--Analyses of drill hole samples from Jarvis Creek Coalfield--continued

Hole No.	7				8		10	
Depth	20.0 - 29.7 ft. 2/		32.0 - 35.0 ft.		25.0 - 26.0 ft.		66.0 - 67.0 ft.	
Basis	As received	Maf	As received	Maf	As received	Maf	As received	Maf
Proximate analysis pct.								
Moisture	22.8		22.3		17.1		9.6	
Volatile Matter	31.5	51.0	29.7	57.0	35.9	52.5	6.2	
Fixed carbon	30.1	49.0	22.4	43.0	32.4	47.5	--	
Ash 1/	15.6		25.6		14.6		84.8	
Ultimate analysis pct.								
Hydrogen	6.0	5.5						
Carbon	44.6	72.4						
Nitrogen	0.7	1.2						
Oxygen	33.0	19.4						
Sulfur	0.9	1.5	0.9	1.7	0.8	1.2	0.1	
Ash 1/	14.8							
Heating value Btu/lb.	7,660	12,420	6,410	12,300	8,450	12,370		
Fusibility of ash °F								
Initial deformation temperature	2140							
Softening temperature	2190							
Fluid temperature	2290							
Mercury ppm	0.0						0.0	

1/ Proximate and ultimate analysis were run on different splits of the same sample. Thus, the reason for a slight discrepancy in results.
2/ Mine seam.

TABLE 3.--Penetration rates, Jarvis Creek Coalfield drilling

Hole No. 5

Depth	Footage	Time	Elapsed time: minutes	Rate: ft./mi.
0.0 - 12.0	12.0	9:47 - 9:57	10	1.2
12.0 - 27.0	15.0	10:04 - 10:23	19	0.8
27.0 - 44.5	17.5	10:27 - 11:01	34	0.5
55.0 - 61.5	6.5	11:20 - 11:34	14	0.5

Hole No. 9

0.0 - 13.0	13.0	9:13 - 9:26	13	1.0
13.0 - 29.0	16.0	9:39 - 10:00	21	0.8
29.0 - 45.0	16.0	10:05 - 10:17	12	1.3
45.0 - 61.0	16.0	10:24 - 10:35	11	1.5
61.0 - 77.0	16.0	10:38 - 10:48	10	1.6
77.0 - 92.0	15.0	10:52 - 11:05	13	1.2

Hole No. 10

0.0 - 12.0	12.0	9:48 - 9:56	8	1.5
12.0 - 28.0	16.0	9:59 - 10:19	20	0.8
28.0 - 44.0	16.0	10:22 - 10:45	23	0.7
44.0 - 60.0	16.0	10:48 - 11:06	18	0.9
60.0 - 76.0	16.0	11:10 - 11:31	21	0.8
76.0 - 90.0	14.0	11:36 - 11:57	21	0.7

Hole No. 11

0.0 - 12.0	12.0	8:00 - 8:36	36 (bit & swivel plugged, so time not representative)	0.3
12.0 - 28.0	16.0	8:41 - 9:04	23	0.7
28.0 - 44.0	16.0	9:06 - 9:26	20	0.8
44.0 - 59.0	15.0	9:28 - 9:57	29	0.5
59.0 - 76.0	17.0	10:02 - 10:23	21	0.8

Hole No. 12

0.0 - 12.5	12.5	1:53 - 2:02	9	1.4
12.5 - 28.0	15.5	2:06 - 2:21	15	1.0
28.0 - 44.0	16.0	2:25 - 2:44	19	0.8
44.0 - 60.0	16.0	2:46 - 3:18	32	0.5
60.0 - 71.4	11.4	3:23 - 4:09	46	0.2