Geophysical Logs and Sample Analysis for 10 Holes Drilled during 1981 in the Western Part of the Yampa Coal Field, Moffat County, Colorado

By

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

¹USGS, Denver, Colo.
²Bureau of Land Management

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INTRODUCTION

During the summer of 1981, 10 drill holes (six rotary holes with diameters of approximately 5 inches and four 3-inch core holes) were drilled in the western part of the Yampa coal field southwest of Craig, Colo. (figs. 1-3, table 1). All of the 16,200 cumulative feet were drilled with truck-mounted drill rigs. The core holes were drilled by personnel and equipment of the Branch of Coal Resources of the U.S. Geological Survey and the rotary holes were drilled under U.S. Geological Survey Contract No. 14-08-0001-18814 awarded to A. E. Bennett.

The purpose of the drilling was to obtain information on the depth, thickness, continuity, and quality of the Federal coal in the Williams Fork Formation of Late Cretaceous age (fig. 4) as described by Hancock (1925) in this area of the Yampa coal field. Drill-hole sites were positioned within areas known to be of interest to industry for future leasing, and drilling operations were limited to areas adjacent to existing roads. For stratigraphic control, wells were drilled to reach either the Twentymile Sandstone Member of the Williams Fork Formation or the Trout Creek Sandstone Member of the Upper Cretaceous Iles Formation. However, in several instances the target unit was not reached or could not be identified with certainty.

Permission for access and to drill on private surface was obtained by Janet Hook, who also coordinated the drilling, geophysical logging, and coring operations and was present during some of the Bureau of Land Management's drill-site inspections. Other U.S. Geological Survey geologists who assisted with various phases of the drilling program were Bill Bowers, Cletus King, and Tom Piccirilli.

Geophysical logs were run in each of the 10 drill holes. Those run in the rotary holes were by Savage Scientific, Craig, Colo., under contract to A. E. Bennett, and those run in the core holes were by the U.S. Geological Survey. Natural-gamma (NG), density (gamma-gamma) (D), and single-point resistance (R) logs were run in all 10 holes. Coal is represented on the natural-gamma log by a sharp reduction in the radioactivity (deflection to the left) and on the density log by a sharp reduction in the density (deflection to the left except on log R-2-81c). Using the density log, coal thickness can be estimated as the vertical distance between the halfway point on the upper deflection and the halfway point on the lower deflection. In addition to these logs, caliper (C) and spontaneous potential (SP) logs were run in the core holes. Owing to various lost circulation problems, liquid (drilling mud or water) could not always be maintained in the upper parts of some drill holes during logging. Because the electric logs (SP and R) require a liquid in the hole, the logging operation was halted and an attempt was made to fill the holes to the top. This procedure was not always successful and, thus,
Figure 1.—General location map showing the boundaries of figures 2 and 3.
Figure 2.--Detailed location map of drill-holes JHS-1-81c, R-15-HG, R-16-HG, HG-1-81, HG-2-81, HG-3-81c, and HG-4-81c.
Figure 3.—Detailed location map of drill-holes RB-1-81, RB-2-81c, and RB-3-81.
Table 1.—Drill-hole locations, ground elevations, and drilled and logged total depths

[Locations shown on figures 2 and 3. All depths are in feet; to convert to meters, multiply by 0.3048]

<table>
<thead>
<tr>
<th>Hole No.</th>
<th>Location</th>
<th>Ground elevation</th>
<th>Total depth drilled</th>
<th>Depth logged</th>
</tr>
</thead>
<tbody>
<tr>
<td>JHS-1-81c₁</td>
<td>T. 6 N., R. 93 W., sec. 7</td>
<td>6,450</td>
<td>635</td>
<td>632</td>
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<td></td>
<td>600 ft FWL, 2,600 ft FNL</td>
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<tr>
<td>R-15-HG</td>
<td>T. 6 N., R. 93 W., sec. 8</td>
<td>6,630</td>
<td>1,525</td>
<td>1,520.5</td>
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<tr>
<td></td>
<td>550 ft FEL, 750 ft FSL</td>
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<tr>
<td>R-16-HG</td>
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<td>1,947</td>
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<tr>
<td></td>
<td>1,150 ft FWL, 1,150 ft FSL</td>
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<td>HG-1-81</td>
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<td>HG-2-81</td>
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<td>2,600 ft FWL, 2,800 ft FNL</td>
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**Figure 2**

**Figure 3**

<table>
<thead>
<tr>
<th>Hole No.</th>
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<th>Total depth drilled</th>
<th>Depth logged</th>
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</thead>
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<td></td>
<td>2,000 ft FWL, 700 ft FNL</td>
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<td>RB-3-81</td>
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</table>

₁The letter c indicates a core hole. All of the core holes were selectively sampled for coal and the analyses are listed in this report.
Figure 4.--Generalized columnar section of the Williams Fork Formation in the western Yampa coal field showing coal beds and zones. Most of these beds and zones were sampled in one or more of the core holes.
electric logs were not recorded in the top portion of some drill holes. The logs were originally run at a vertical scale of 1 inch equal to 10 feet, but for convenience of reproducing this report, the logs were reduced in scale to 1 inch equal to 50 feet. To convert feet to meters, multiply by 0.3048. All of the log scales listed in this report on the individual log headings are the values reported by the logger in reference to the original scale of 1 inch equal to 10 feet.

A total of 806 feet of core was recovered from holes JHS-1-81c, HG-3-81c, HG-4-81c, and RB-2-81c of which 256 feet of the core were coal. Each core hole was a twin of a rotary hole previously drilled at the same location. From the cored coal, 40 samples (one sample, D239537 from JHS-1-81c, was later lost) were ground and put in plastic bags by the U.S. Geological Survey during the fall of 1981 and placed in storage. The noncoal part of the core was later placed in the U.S. Geological Survey core library. In the spring of 1984, the Bureau of Land Management contracted the Denver office of Commercial Testing and Engineering Company (C.T.&E.) to conduct proximate analysis on the 39 available samples and the results are given in tables 3 and 4 and summarized in table 2.¹

REFERENCES CITED


¹These samples were in storage for 2 1/2 years. Thus, the values obtained by proximate analysis may not be truly representative of the coal as originally sampled.
Table 2.—Arithmetic mean, observed range, geometric mean, and geometric deviation of proximate analysis, sulfur, and heat-of-combustion of 39 coal samples from the Williams Fork Formation, Yampa coal field, Moffat County, Colorado

[All values are in percent except Kcal/kg, Btu/lb, and geometric deviation and are reported on an as-received basis. Kcal/kg = 0.556 (Btu/lb)]

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<th></th>
<th>Arithmetic mean</th>
<th>Observed range</th>
<th>Geometric mean</th>
<th>Geometric deviation</th>
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<td>Minimum</td>
<td>Maximum</td>
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<td>Proximate analysis</td>
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<td></td>
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<td>36.54</td>
<td>33.51</td>
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<td>Fixed carbon</td>
<td>47.5</td>
<td>38.84</td>
<td>51.79</td>
<td>47.42</td>
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| Sulfur              |                 |                |                |                     |                    |
| Sulfur              | 0.59            | 0.26           | 1.31           | 0.55                | 1.5                |

Heat-of-combustion

|                     | Btu/lb          | Kcal/kg        |                |                     |                    |
|                     | 10,690          | 5,944          | 9,073          | 6,380               | 10,672             | 5,045             | 5,934             | 1.1                | 1.1                |
Table 3.—Proximate analysis of coal samples from drill holes JHS-1-81c, HG-3-81c, HG-4-81c, and RB-2-81c, Moffat County, Colorado

[The first line of entry for each analysis represents as-received values, the second line represents moisture-free values and the third line represents moisture- and ash-free values. All analyses were conducted in accordance with ASTM D-3172 and, except Btu/lb, are reported in percent. NC = not calculated by C.T.&E. Leaders (---) indicate no data]

<table>
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<tr>
<th>Sample No.</th>
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<th>Moisture</th>
<th>Ash</th>
<th>Volatile matter</th>
<th>Fixed carbon</th>
<th>Btu/lb</th>
<th>Sulfur</th>
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<td>46.4</td>
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<td>39.3</td>
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<td>.87</td>
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<td>Sample lost</td>
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<td>Interval (ft)</td>
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<td>Volatile matter</td>
<td>Fixed carbon</td>
<td>Btu/lb</td>
<td>Sulfur</td>
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<td>JHS-1-81c</td>
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**Table 3—Proximate analysis of coal samples from drill holes JHS-1-81c, HG-3-81c, HG-4-81c, and RB-2-81c.**

Moffat County, Colorado—Continued.
<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Bed name</th>
<th>Interval (ft)</th>
<th>Moisture</th>
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<th>Volatile matter</th>
<th>Fixed carbon</th>
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Table 3.--Proximate analysis of coal samples from drill holes JHS-1-81c, HG-3-81c, HG-4-81c, and RB-2-81c, Moffat County, Colorado--Continued

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Table 3.--Proximate analysis of coal samples from drill holes JHS-1-81c, HG-3-81c, HG-4-81c, and RB-2-81c, Moffat County, Colorado—Continued

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Table 3.—Proximate analysis of coal samples from drill holes JHS-1-81c, HG-3-81c, HG-4-81c, and RB-2-81c, Moffat County, Colorado—Continued

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Table 4. Calculated values based on proximate analysis results for coal samples from drill holes JHS-1-81c, HG-3-81c, HG-4-81c, and RB-2-81c, Moffat County, Colorado

[Volatile matter and fixed carbon values are in percent]

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JHS-1-81c

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HG-3-81c
Table 4. Calculated values based on proximate analysis results for coal samples from drill holes JHS-1-81c, HG-3-81c, HG-4-81c, and RB-2-81c, Moffat County, Colorado—Continued

<table>
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<tr>
<th>Sample No.</th>
<th>Dry mineral(^1) matter free</th>
<th>Dry mineral(^1) matter free</th>
<th>Moist mineral(^1) matter free</th>
<th>Lbs sulfur(^2) million Btu</th>
<th>Lbs sulfur dioxide(^3) million Btu</th>
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<td>fixed carbon</td>
<td>Btu</td>
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\(^1\) Calculated according to ASTM D-388 Parr Formula.

\(^2\) \[
\frac{1,000,000}{\text{Btu (as-received)}} \times \text{percent sulfur (as-received)} = \text{lbs sulfur/million Btu.}
\]

\(^3\) \[
\frac{1,000,000}{\text{Btu (as-received)}} \times \text{percent sulfur (as-received) } \times 2 = \text{lbs sulfur dioxide/million Btu.}
\]
U.S. GEOLOGICAL SURVEY
GEOPHYSICAL LOG, MOFFAT COUNTY, COLORADO

Hole no. JHS-1-81c Date logged 7/22/81
Ground elevation 6450 ft
T. 6 N., R. 93 W., Sec. 7 : 600 ft W. 1, 2600 ft N. 1
Drilling medium mud
Drilled depth 635 ft Fluid level 39 ft
Logging company USGS Logging speed 20 ft/min. Logged depth 632 ft

Natural gamma (NG) Scale 13.26 CPS/in. T.C. 4
Caliper (C) Scale ?
Density (gamma-gamma) (D) Scale ? T.C. 3
Spontaneous potential (SP) Scale 40 mv/log div.
Single point resistance (R) Scale variable

Remarks: Density and caliper log run on 7/23/81. Hole filled with fresh water at time of logging. Note: This hole cored coal intervals and was a twin of R-1-JHS drilled in 1980.
Hole no. JHS-1-81c (continued)

NG

Depth

m ft

190

200 650

210 700

220

230 750

240

250

260

270

280

290 900

300

310

Coal

D239539
Hole no. JHS-1-81c (continued)

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H

ELLGEN

e-F-G

E

D239631
D239632
D239633
D239634
U.S. GEOLOGICAL SURVEY
GEOPHYSICAL LOG, MOFFAT COUNTY, COLORADO

Hole no. R-15-HG Date logged 6/8/81 Ground elevation 6630 ft

T. 6 N., R. 93 W., Sec. 8: 550 ft E., 750 ft S.

Drilling medium mud Drilled depth 1525 ft Fluid level 322 ft

Logging company 1 Logging speed 25 ft/min. Logged depth 1520.5 ft

Natural gamma (NG) Scale 50 CPS/in. T.C. 1

Density (gamma-gamma) (D) Scale 500 CPS/in. T.C. 1

Single point resistance (R) Scale variable

Remarks: 1 Savage Scientific. Lost circulation associated with clinker and fractured rock prevented the Trout Creek Sandstone target horizon from being reached.
Hole no. **R-15-HG** (continued)

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<table>
<thead>
<tr>
<th>NG</th>
<th>D</th>
<th>R</th>
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**Coal**

![Graphical representation of the hole data with depth intervals and intervals for NG, D, and R, along with coal layers indicated as S and R₁-R.](image-url)
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NG | D | R

Coal

L-Q
Hole no. R-16-HG  Date logged 6/12/81  Ground elevation 6300 ft

T. 6 N., R. 93 W., Sec. 14 : 1150 ft W. 1, 1150 ft S. 1

Drilling medium mud  Drilled depth 1947 ft  Fluid level 156 ft

Logging company 1  Logging speed 25 ft/min.  Logged depth 1947 ft

Natural gamma (NG)  Scale 50 CPS/in.  T.C. 1
Density (gamma-gamma) (D)  Scale 1000 CPS/in.  T.C. 1
Single point resistance (R)  Scale variable

Remarks: 1 Savage Scientific
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Hole no. R-16-HG (continued)
Hole no. R-16-HG (continued)

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Hole no. R-16-HG (continued)

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ELLGEN
Hole no. HG-1-81  Date logged 6/4/81  Ground elevation 6371 ft

T. 6 N., R. 93 W., Sec. 10  :  925 ft f W.  1, 1900 ft f S.  1

Drilling medium mud  Drilled depth 2300 ft  Fluid level 18 ft

Logging company  1  Logging speed 25 ft/min. Logged depth 2296 ft

Natural gamma (NG)  Scale 50 CPS/in.  T.C.  1

Density (gamma-gamma) (D)  Scale 500 CPS/in.  T.C.  1

Single point resistance (R)  Scale variable

Remarks:  1Savage Scientific. This hole penetrated the entire Williams Fork Formation. Coal beds and zones between the Twentymile Trout Creek Sandstones could not be identified by name.

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Hole no. HG-1-81 (continued)

Depth

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NGD R

Top TM

Coal
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NG  D  R

Coal

Top TC
Hole no. HG-2-81  Date logged  6/17/81  Ground elevation  6195 ft

T. 6 N., R. 92 W., Sec. 19  Drilled depth  ?
: 950 ft f W. 1, 1750 ft f N. 1

Drilling medium  mud  Fluid level  16 ft

Logging company  1  Logging speed  25 ft/min. Logged depth  2247 ft

Natural gamma (NG)  Scale  50 CPS/in.  T.C.  1

Density (gamma-gamma) (D)  Scale  1000 CPS/in.  T.C.  1

Single point resistance (R)  Scale  variable

Remarks:  1Savage Scientific. Some of the coal beds and zones between the

Twentymile and Trout Creek Sandstones could not be identified by name.
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NG D R Coal

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Hole no. HG-2-81 (continued)

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Top TC
U.S. GEOLOGICAL SURVEY
GEOPHYSICAL LOG, MOFFAT COUNTY, COLORADO

Hole no. HG-3-81c  Date logged 8/1/81  Ground elevation 6355 ft
T. 6 N., R. 92 W., Sec. 31  Drilling medium mud
2700 ft f W., 1, 1550 ft f N.
Drilled depth 1217 ft  Fluid level 10 ft
Logging company USGS  Logging speed 20 ft/min. Logged depth 1200 ft

Natural gamma (NG)  Scale 9.39 CPS/in.  T.C. 4
Caliper (C)  Scale 1 in./log div.
Density (gamma-gamma) (D)  Scale ?  T.C. 3
Spontaneous potential (SP)  Scale 2
Single point resistance (R)  Scale variable

Remarks: 1 Hole filled with fresh water when logged. 2 100 mv/log div. from 1200 ft to 180 ft; 200 mv/log div. from 180 ft to 0 ft. Note: This hole cored coal intervals and was a twin of R-11-HG drilled in 1977 (Meyer, 1978).
Hole no. HG-3-81c (continued)

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| SP | R |

Coal:
- R1
- D239540
- D239541

L-Q
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- 0239663
- D239664
- D239649
- D239650
- D239651
- D239652
- D239653
- D239654
Hole no. HG-4-81c Date logged 8/18/81
Ground elevation 6410 ft

T. 6 N., R. 92 W., Sec. 30 : 2600 ft W. 1, 2800 ft N. 1

Drilling medium mud
Drilled depth 460 ft Fluid level 19 ft

Logging company USGS Logging speed 20 ft/min. Logged depth 459 ft

Natural gamma (NG) Scale 8.16 CPS/in. T.C. 4
Caliper (C) Scale .7 in./log div.
Density (gamma-gamma) (D) Scale ? T.C. 3
Spontaneous potential (SP) Scale 20 mv/log div.
Single point resistance (R) Scale variable

Remarks: 1 Natural gamma run 8/17/81. 2 Hole filled with fresh water when logged.

Note: This hole cored coal intervals and was a twin of R-10-HG drilled in 1977 (Meyer, 1978).
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Hole no. HG-4-81c (continued)

- **SP**
- **R**

**Coal**

Q

D239530
U.S. GEOLOGICAL SURVEY
GEOPHYSICAL LOG, MOFFAT COUNTY, COLORADO

Hole no. RB-1-81  Date logged 6/29/81  Ground elevation 6382 ft

T. 6 N., R. 92 W., Sec. 13 : 2550 ft W. 1, 1400 ft N. 1

Drilling medium mud  Drilled depth 2070 ft(?)  Fluid level 81 ft

Logging company  Logging speed 25 ft/min.  Logged depth 2070 ft

1

Natural gamma (NG) Scale 50 CPS/in.  T.C. 1

Density (gamma-gamma) (D) Scale 500 CPS/in.  T.C. 1

Single point resistance (R) Scale variable

Remarks: Savage Scientific.

Depth

m  ft

0  0

NG  D  R

Coal

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Hole no. RB-3-81 Date logged 6/24/81 Ground elevation 6190 ft
T. 6 N., R. 92 W., Sec. 21 : 1750 ft f W. 1, 575 ft f S. 1
Drilling medium mud Drilled depth 2318 ft Fluid level 1 ft
Logging company 2 Logging speed 15 ft/min. Logged depth 2300 ft
Natural gamma (NG) Scale 30 CPS/in. T.C. 2
Density (gamma-gamma) (D) Scale 100 CPS/in. T.C. 1
Single point resistance (R) Scale variable
Remarks: 1Hole filled with fresh water when logged. 2Savage Scientific.
Hole no. RB-3-81 (continued)

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NG | D | R

Coal
Hole no. RB-1-81 (continued)

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NG D R

Coal

fault ?
TC ?
### Geophysical Log, Moffat County, Colorado

**Hole no. RB-2-81c**  
**Date logged:** 8/16/81  
**Ground elevation:** 6600 ft

**T. 6 N., R. 92 W., Sec. 25:** 2000 ft W. 1, 700 ft N.

**Drilling medium:** mud  
**Drilled depth:** 1485 ft  
**Fluid level:** 170 ft

**Logging company:** USGS  
**Logging speed:** 25 ft/min.  
**Logged depth:** 1480 ft

| Spontaneous potential (SP) | Scale 20 mv/log div. |  |
|----------------------------|----------------------|--
| Single point resistance (R) | Scale variable |  |
| Caliper (C) | Scale 1 in./log div. |  |
| Density (gamma-gamma) (D) | Scale | T.C. |
| Natural gamma (NG) | Scale | T.C. |

**Remarks:**  
1. Electric log run on 8/17/81.  
2. Some fresh water added.  
3. Caliper-density-natural gamma log run at 17 ft/min. Note: This hole cored coal intervals and was a twin of E-12-RdB drilled in 1977 (Johnson, 1978).

#### Log Table

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<th>SP</th>
<th>R</th>
<th>Depth (m ft)</th>
<th>C</th>
<th>D</th>
<th>NG</th>
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**Coal**

![Graph of the geophysical log data](image-url)
Hole no. RB-2-81c (continued)
### Hole no. RB-2-81c (continued)

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TC