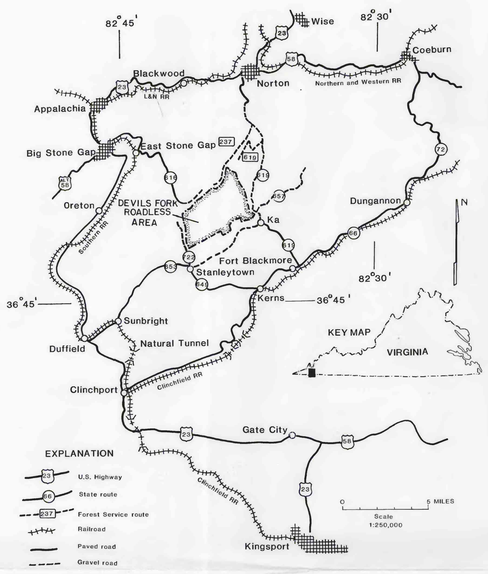

Figure 1.—Index map showing the location of the Devils Fork Roadless Area, Scott County, Va.

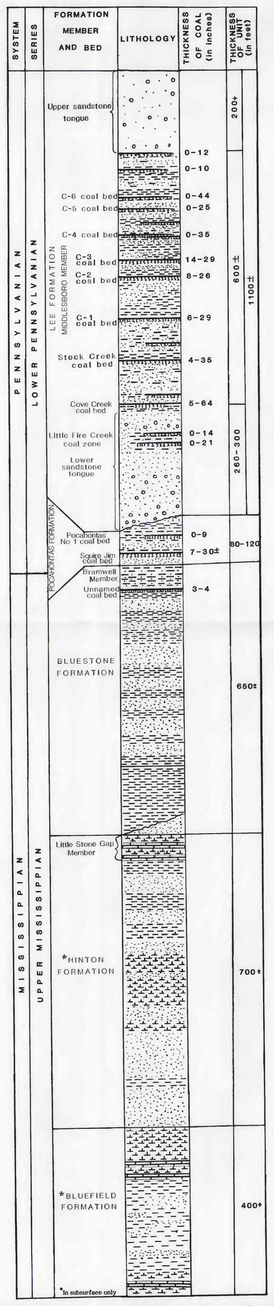

Figure 2.—Generalized stratigraphic section of rock formations in the Devils Fork Roadless Area (from Englund and others, in press).

EXPLANATION FOR FIGURES 3-9

- Demonstrated reserve-base area
- Inferred reserve-base area
- Mined-out area
- Strip-minable area
- Auger-minable area
- Strip-mined area
- Fault
- CC Coal outcrop
- 14 Coal-thickness isopach
- X Coal prospect
- Diamond-drill hole

Base for figures 3-9 from U.S. Geological Survey 1:24,000 East Stone Gap, 1957 (photorevised 1969)

Figure 3.—Composite coal reserve base area.

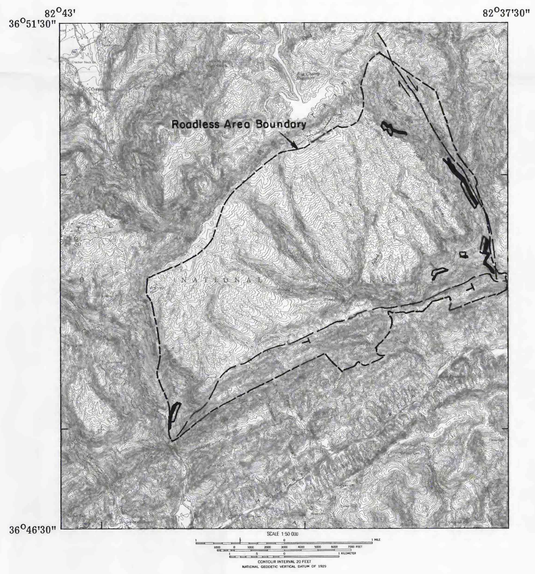

Figure 4.—Composite restricted (surface minable) reserve base area.

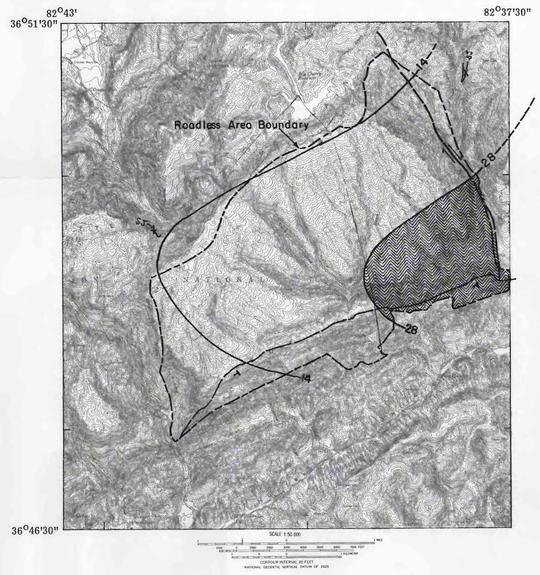

Figure 5.—Squire Jim coal bed inferred reserve base area.

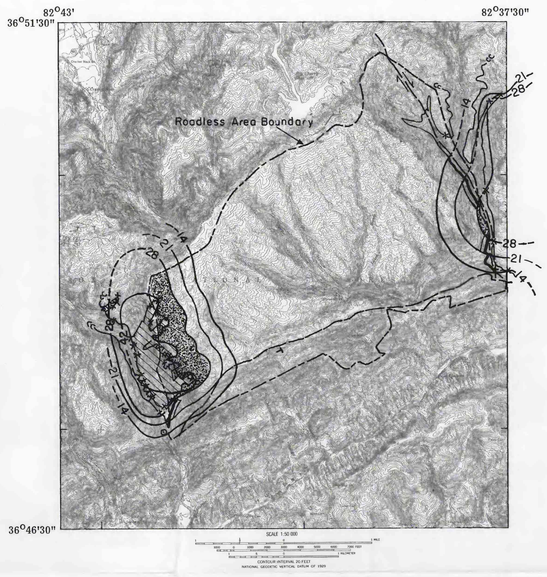

Figure 6.—Cove Creek coal bed reserve base area.

Figure 7.—Stock Creek coal bed reserve base area.

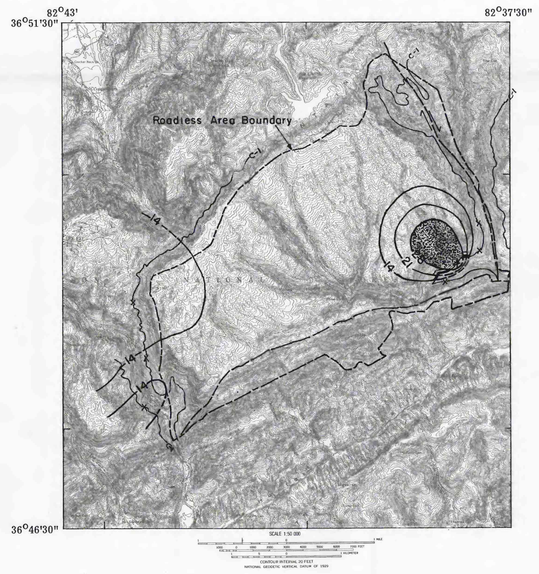

Figure 8.—C-1 coal bed reserve base area.

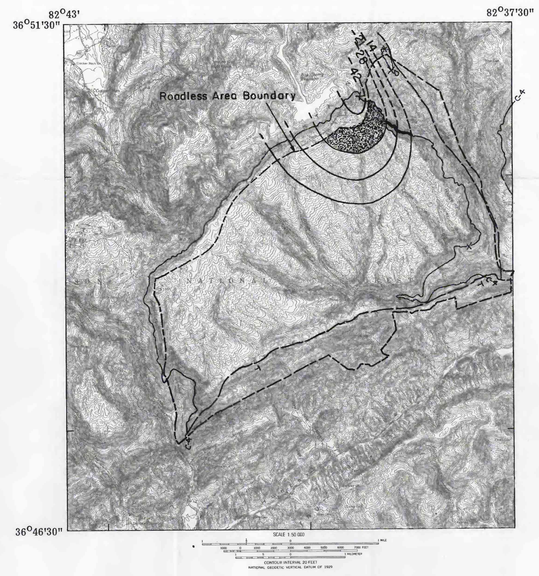

Figure 9.—C-4 coal bed reserve base area.

COAL RESERVE BASE

Coal is the mineral resource of highest economic value in the Devils Fork Roadless Area (fig. 1). High-volatile A bituminous coal has been prospected in the area and mined near the eastern and western boundaries of the study area.

Three coal beds have been regionally correlated in the study area. These include the Cove Creek and Stock Creek coal beds of the Lee Formation and the Squire Jim coal bed of the Pocahontas Formation. Coal bed names correspond approximately to those formerly used in the Powell Mountain coalfield (Eby, 1923; Campbell and Woodruff, 1909; Brown and others, 1952; Virginia Dept. of Labor and Industry, 1970-1980; and Englund and others, 1983). Three other Lee Formation coal beds, termed the C-1, C-2, and C-4, have been locally correlated in the area. All beds except the C-2 contain coal of sufficient thickness for underground mining. Demonstrated or inferred surface-minable reserves are present for all coal beds except the Squire Jim and C-2. Other minor Lee and Pocahontas Formation coal beds were identified during the investigation (fig. 2) but are either too thin and variable or inadequately exposed to calculate reserves. One or two thin coal beds are also reported in the upper part of the Bluestone Formation (Campbell, 1893; Campbell and Woodruff, 1909; Eby, 1923; and Englund and others, 1983) but are too thin to be considered minable.

The demonstrated reserve base for coal within the study area is 4.57 million short tons (table 1). A composite reserve base area for all coal beds is shown in figure 3. If mining is permitted, an additional 125 thousand short tons is accessible by contour strip mining and 74 thousand short tons by auger mining. Figure 4 illustrates the portion of the study area underlain by coal recoverable by surface mining.

Coal Evaluation Procedures

To evaluate the coal resources and reserves of Devils Fork Roadless Area, an attempt was made to locate and reopen all known mines and prospects in and near the study area. Interviews were conducted with mineral-rights owners, prospectors, and local residents. Many of the prospects reported by Eby (1923) and Campbell and Woodruff (1909) are caved and their locations uncertain. U.S. Bureau of Mines personnel located and examined two mines, three prospects, and 12 coal exposures within the study area (Behum, in press). In addition, 20 mines, 33 propects, and 12 exposures outside the study area were investigated.

The degree of geologic control dictates the category into which coal resources and reserves are placed. Published information and data points established during this investigation were utilized where detailed coal bed data could be verified. The measured coal extends 0.25 mi from a point of measurement, indicated coal extends in a belt from 0.25 to 0.75 mi from a measured point, and inferred coal extends in a belt from 0.75 to 3 mi from a measured point (U.S. Bureau of Mines and U.S. Geological Survey, 1976). Measured, indicated, and inferred coal areas were then divided into thickness categories of 14 to 28 in., 28 to 42 in., and greater than 42 in. No resources were determined for coal less than 14 in. thick. A map was prepared for each coal bed using these criteria.

The reserve base constitutes that portion of resources in the measured and the indicated (demonstrated) categories 28 in. or more in thickness which is considered minable by present underground methods. Only coal measurements were considered for this thickness. In cases where two benches of coal are separated by a parting, and provided the parting is not thicker than either bench, the thickness is taken to be the cumulative thickness of the two benches of coal. Reserve base maps were prepared for each coal bed.

The portion of the underground minable reserve base that could also be surface mined was not calculated separately. Additional reserve base was estimated for surface-minable resources between 14 and 28 in. thick, which are too thin to recover by underground mining. These resources are classified as restricted reserve base (U.S. Bureau of Mines and U.S. Geological Survey, 1980) because of the prohibition of surface mining in National Forests east of the 100th meridian by the Surface Mining Control and Reclamation Act of 1977 (SMCRA, 30 U.S.C. 1201). Both contour strip and auger minable reserves are estimated (table 1). The contour strip minable area is delineated using the outcrop trace of the coal bed between the 14- and 28-inch isopachous lines and a 20:1 overburden-to-coal ratio. A 25 to 30 ft highwall would be developed; this is comparable to abandoned surface mines near the study area (Behum, in press). The auger-minable area is based on a 150-foot average auger penetration from the strip mine highwall (Secor and others, 1977). The minimum coal bed thickness recoverable by current auger mining technology is 21 in. Restricted surface-minable coal reserves were estimated using an 85 percent recovery factor for contour strip mining and 35 percent for auger mining (Secor and others, 1977).

A small amount of additional coal may possibly be recovered in the previously mined part of the Cove Creek coal bed beneath the roadless area because pillar recovery was not practiced in early mines. The amount of coal remaining in the abandoned mine pillars was not calculated because the condition of these workings is unknown.

An inferred reserve base is estimated for coal beds in which geologic character indicates the bed to be continuous and the area is 0.75 to 3 mi from a measured data point. This tonnage is a separate part of the identified resources and not part of the demonstrated reserve base from which reserves are estimated (U.S. Bureau of Mines and U.S. Geological Survey, 1980). Because of the varying depths of the coal beds, an inferred reserve base was estimated for that coal less than and greater than 1,000 ft below the surface.

Coal analyses for this investigation (Behum, in press) are on weathered coal from outcrops, prospect trenches, and adit entrances. The samples were of oxidized coal that contained considerable moisture adhering to coal surfaces. Weathering drastically lowers free-swelling indexes and heating values and increases oxygen content in ultimate analyses (Yohe, 1958; Rees, 1966). These analytical results are only an indication of coal quality. Coal analyses reported by others are of fresh or less-weathered samples from surface mines, prospect trenches, adits, and drill core (Eby, 1923; Maple Gap Land Corp., written commun., 1979; Cardinal Mining, Ltd., written commun., 1979; Simon and Englund, 1983; Behum, 1984). Based on reported analyses, all study area coal can be tentatively ranked as high-volatile A bituminous.

Pocahontas and Lee Formation coal beds in this region are generally suitable for the manufacture of metallurgical coke (Campbell, 1914; Eby, 1923; Sanner and Benson, 1979). Analyses indicate that some of the raw coal within the study area has an ash and sulfur content within marginal grade coking-coal quality, containing not more than 12 percent ash and 1.0 percent sulfur; most is of lower quality, latent coking-coal grade. Some raw coal would be suitable for compliance steam coal; raw coal heating values average 12,800 Btu for less-weathered samples. Cleaning would be beneficial to upgrade most study area coal.

Spectrographic analyses of coal-ash samples (Behum, 1984) indicate that lithium is the only anomalously high minor element in the study area coal beds. Slightly enriched lithium values (greater than 0.2 percent) were noted in samples from several mappable coal beds (Behum, 1984). An anomalously high amount of U_3O_8 (40-56 ppm) was detected by radiometric analysis of two coal-ash samples of a thin coal bed within the underclay of the Cove Creek coal bed (Behum, in press). Lithium and uranium are not presently recovered from coal ash.

Pocahontas Formation Coal Beds

The Burtons Ford coal bed is usually the uppermost and thickest Pocahontas Formation coal in the region, but the bed is inferred to be thin or absent in the study area. The Squire Jim coal bed has been reported lower in the formation by recent core drilling (Englund and others, 1983) and two outcrops were located outside the study area during the field reconnaissance.

Squire Jim coal bed—The Squire Jim coal bed lies a short distance below the base of the Lee Formation and has been locally eroded prior to deposition of the basal Lee conglomeratic sandstone. Occurrences of this coal bed in drill holes SW-7 and SW-8, (Englund and others, 1983) were correlated with exposures near the study area. An isopach map indicates that the bed thins to the northwest (fig. 5).

Analyses of samples from these coal beds (sheet 1, table 1; Behum, 1984) indicate that the coal is of good quality in the northern part of the roadless area and east of the Hagen mine (Behum, in press). However, a high ash, mixed humic and cannel coal is reported in the Burtons Ford coal bed at the Hagen mine, and the description of the IC and IC-1 drill core indicates a similar impure coal interval (Eby, 1923). Therefore, the Burton Ford coal bed in the study area could be high in ash. Drilling is necessary to verify the thickness and quality of these coal beds in the study area.

Lee Formation Coal Beds

Cove Creek coal bed—The Cove Creek coal bed is economically the most important coal bed in the roadless area. Geologic data indicate this bed to be correlative with the Tacus coal bed to the west and possibly the Milner coal bed to the east. In mines west of the area the bed is overlain by 1 to 21 in. of hard slaty shale or "draw rock" that was extracted prior to the use of roof bolting. A split was observed in the southernmost exposures east of the study area (DDH-4, Behum, in press). The lower bench is up to 10 in. thick and is separated from the main bench by as much as 10 in. of underclay or rash. The bed is predominantly dull-banded attritus or semisplint coal that is hard and blocky.

A gradual thinning occurs from west to east, but the coal bed appears to maintain a thickness suitable for underground mining in the western part of the roadless area (fig. 6).

Analyses indicate the sulfur content is normally low, averaging 0.98 percent as received (Behum, in press). A small area east of the study area in which nodular pyrite was noted contains higher-sulfur coal. Ash content is highly variable, averaging 11 percent, as received. Raw-coal heating values average 13,000 Btu and the free swelling index ranges from 2.5 to 7.5 and averages 4.5. Initial tests reported that coal from the Powell Mountain field was unsuitable for the manufacture of coke (Campbell, 1893), but subsequent tests from the Milner coal bed (Milner mine, Behum, in press) produced excellent quality coke (Campbell, 1914). Because the Milner coal bed is tentatively correlated with the Cove Creek coal bed, similar results may be attainable. The study area interior has not been explored adequately for this coal bed.

Stock Creek coal bed—Extensive, small-scale mining has occurred in the Stock Creek coal bed west of the study area (Stock Creek mines, Behum, in press). Mine maps could not be located to verify the extent of these underground mines. The Stock Creek coal bed, which is also known as the Egan coal bed and may be correlative with the Duncan coalbed to the east (Eby, 1923), occurs about 45 to 90 ft above the Cove Creek coal bed in a thick shale zone. The coalbed appears to be continuous throughout most of the area (fig. 7) but varies in thickness from 9 to 48 in. Thicker pods of coal commonly contain interlaminated bone coal both to the east and west of the study area.

Analyses indicate a low ash and low to moderate sulfur content, averaging 8.1 and 1.3 percent, respectively (Behum, 1984). Sulfur content decreases from east to west from about 1.6 to 0.6 percent. Coal from this bed is suitable for steam generation and may possibly be utilized for coke manufacture; heating values average 13,000 Btu, and the free swelling index was 4.5, as received. Geologic data indicate that the bed may be of underground-minable thickness along most of the western study area boundary, but core drilling to evaluate the inferred reserve-base area is necessary.

C-1 coal bed—The C-1 coal bed occurs 90 to 110 ft above the Stock Creek coal bed in the eastern part of the study area in a thick shale interval; to the west the shale interval thins, and the C-1 occurs about 20 to 40 ft above the Stock Creek. A prospect trench was developed in this coal zone near the northwest corner of the study area and underground mining has occurred along Shupes Branch (Stock Creek mines, Behum, in press) and Devil Fork. Surface-minable restricted reserves are indicated in the Church Rock Branch drainage basin (fig. 8). Reserves were estimated for surface minable coal 14 to 21 in. thick because two operations have demonstrated that recovery of thin coal from some coal beds in the Lee Formation is economically possible (Behum, in press).

Analyses, as received, indicate that the C-1 coal bed is generally low in sulfur and has a moderate ash content.

C-4 coal bed—The C-4 coal bed occurs approximately 150 ft above the base of the C-2 coal zone near the top of the upper shale interval. Limited data are available for the coal bed near the study area (Behum, in press); figure 9 illustrates the coal reserve base.

Analyses indicate that the bed has a low to moderate sulfur content and a moderate to high ash content. Cleaning of this coal would probably be required to reduce the ash content prior to use as steam coal. More data are required to properly evaluate the potential of this coal bed to the south and west of the reserve area.

Little Fire Creek coal zone—A small underground mine in a Little Fire Creek coal zone on Church Rock Branch supplied coal for a timbering operation in the early 1920's (Behum, in press; Eby, 1923). Erosion of the coal bed prior to deposition of the overlying conglomeratic sandstone units removed the upper part of the coal bed at some localities. The coal bed along Church Rock Branch is too thin for modern underground mining.

An upper coal bed is found only where the lower shale interval of the Lee Formation thickens east of the area. This bed is 25 to 35 ft above the lower coal bed (fig. 2) with a maximum known thickness of 16.5 in. east of the study area (Behum, in press and 1984).

Analyses indicate that the beds have a low sulfur and low to moderate ash content (sheet 1; Behum, 1984). More detailed exploration and sampling is necessary to determine the extent and quality of the coal in the roadless area. Because of the lack of coal bed data, no coal resources or reserve base was estimated for coal beds in the Little Fire Creek zone.

Other coal beds—Other thin or discontinuous coal beds are present in the area (fig. 2). One, a persistent coal bed 4 to 12 in. thick, occurs in the lower shale interval 30 to 35 ft above the Little Fire Creek coal zone. A discontinuous coal bed 0 to 17 in. thick was observed below the Stock Creek coal bed southwest of the study area. Another thin rider coal above the Stock Creek coal bed is 6 to 14 in. thick in the southeast corner of the study area and was stripped in a small surface mine just east of the study area (Behum, in press). A persistent rider coal bed occurs 6 to 17 ft above the C-1 coal bed but is thin (7 to 12 in. thick). Another unnamed coal bed occurs persistently 85 to 95 ft above the C-1 coal bed east of the area but is less than 13 in. thick. Numerous coal beds occur near the top of the upper shale interval but are discontinuous due, in part, to erosion prior to deposition of the overlying upper conglomerate (fig. 2). The most notable of these coal beds, termed the C-6, occurs 25 to 40 ft above the C-5 bed. Although this bed is 42 in. thick east of the study area, the coal is much thinner at other localities. The C-5 coalbed (fig. 2) is also more than 25 in. thick east of the study area, indicating that there is probably a local pod there. There is no indication that resoures in any of these coal beds exist in the study area, but core drilling may indicate additional coal reserves in the Lee Formation.

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Table 1.— *Summary of estimated coal reserve base and reserves, Devils Fork Roadless Area, December, 1983*

Coal Recoverable by Underground Mining Methods

Coalbed	Acreage	Demonstrated Reserve Base (short tons)			Demonstrated Reserves [2] (short tons)	Inferred Reserve Base (short tons) Overburden	
		Measured	Indicated	Total [1]		<1000 ft.	>1000 ft.
C-4	119	44,000	515,000	559,000	335,000	--	--
C-1	145	211,000	395,000	606,000	363,000	--	--
Stock Creek	382 (127) [3]	214,000	1,710,000	1,920,000	1,150,000	593,000	--
Cove Creek	275	1,340,000	142,000	1,480,000	849,000	--	--
Squire Jim	-- (1,018) [3]	--	--	--	--	2,840,000	1,680,000
TOTAL [1]	--	1,810,000	2,760,000	4,570,000	2,700,000	3,430,000	1,680,000

Coal Recoverable by Surface Mining Methods

Coalbed	Acreage	Restricted Reserve base (short tons)			Restricted Reserves [4] (short tons)		
		Strip	Auger	Total [1]	Strip	Auger	Total [1]
C-4	8	14,000	16,000	30,000	12,000	6,000	17,000
C-1	5	8,000	9,000	18,000	7,000	3,000	10,000
Stock Creek	6	15,000	--	15,000	13,000	--	13,000
Cove Creek	42	88,000	49,000	137,000	75,000	17,000	92,000
TOTAL [1]	--	125,000	74,000	199,000	107,000	26,000	132,000

[1] Numbers shown may not total due to independent rounding.
[2] Using a 60 pct. recovery factor.
[3] Number in parentheses is the area of the inferred reserve base coal.
[4] Using an 85 pct. recovery factor for strip and 35 pct. factor for auger.

COAL RESERVE MAPS

By
Paul T. Behum

MINERAL RESOURCE POTENTIAL MAP OF THE DEVILS FORK ROADLESS AREA, SCOTT COUNTY, VIRGINIA

By
Kenneth J. Englund and Wayne R. Sigleo, U.S. Geological Survey
and
Paul T. Behum, U.S. Bureau of Mines

1983

INTERIOR—GEOLOGICAL SURVEY, RESTON, VA.—1984