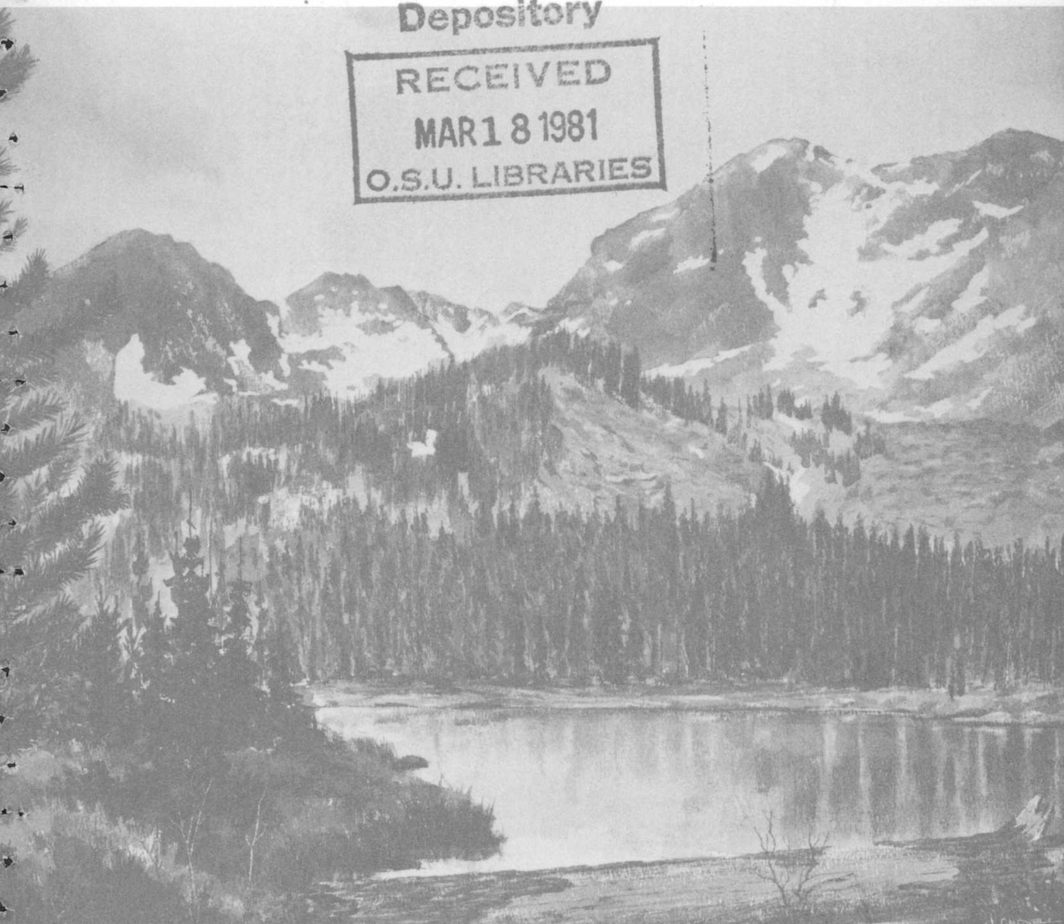
STUDIES RELATED TO WILDERNESS



MINERAL RESOURCES OF THE CRANBERRY WILDERNESS STUDY AREA, WEBSTER AND POCAHONTAS COUNTIES, WEST VIRGINIA

GEOLOGICAL SURVEY BULLETIN 1494

Mineral Resources of the Cranberry Wilderness Study Area, Webster and Pocahontas Counties, West Virginia

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Geochemical Survey

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STUDIES RELATED TO WILDERNESS—WILDERNESS AREAS

GEOLOGICAL SURVEY BULLETIN 1494

An evaluation of the mineral potential of the area

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STUDIES RELATED TO WILDERNESS STUDY AREAS

In accordance with the provisions of the Wilderness Act (Public Law 88–577, September 3, 1964) and the Joint Conference Report on Senate Bill 4, 88th Congress, and as specifically designated by PL93–622, January 3, 1975, the U.S. Geological Survey and U.S. Bureau of Mines have been conducting mineral surveys of wilderness and primitive areas. Studies and reports of all primitive areas have been completed. Areas officially designated as "wilderness," "wild," or "canoe" when the act was passed were incorporated into the National Wilderness Preservation System, and some of them are presently being studied. The act provided that areas under consideration for wilderness designation should be studied for suitability for incorporation into the Wilderness System. The mineral surveys constitute one aspect of the suitability studies. This report discusses the results of a mineral survey of national forest land in the Cranberry Study Area, West Virginia, that is being considered for wilderness designation (Public Law 93–622, January 3, 1975). The area studied is in the Monongahela National Forest in Webster and Pocahontas Counties.

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CONVERSION FACTORS

Metric unit		Inch-Pound equivalent	
Length			
millimeter (mm)	=	0.03937	inch (in)
meter (m)	=	3.28	feet (ft)
kilometer (km)	=	.62	mile (mi)
Area			
square meter (m^2)	=	10.76	square feet (ft^2)
square kilometer (km^2)	=	.386	square mile (mi^2)
hectare (ha)	=	2.47	acres
Volume			
cubic centimeter (cm^3)	=	0.061	cubic inch (in^3)
liter (L)	=	61.03	cubic inches
cubic meter (m^3)	=	35.31	cubic feet (ft^3)
cubic meter	=	.00081	acre-foot (acre-ft)
cubic hectometer (hm^3)	=	810.7	acre-feet
liter	=	2.113	pints (pt)
liter	=	1.06	quarts (qt)
liter	=	.26	gallon (gal)
cubic meter	=	.00026	million gallons (Mgal or 10^6 gal)
cubic meter	=	6.290	barrels (bbl) (1 bbl=42 gal)
Weight			
gram (g)	=	0.035	ounce, avoirdupois (oz avdp)
gram	=	.0022	pound, avoirdupois (lb avdp)
metric tons (t)	=	1.102	tons, short (2,000 lb)
metric tons	=	0.9842	ton, long (2,240 lb)
Specific combinations			
kilogram per square centimeter (kg/cm^2)	=	0.96	atmosphere (atm)
kilogram per square centimeter	=	.98	bar (0.9869 atm)
cubic meter per second (m^3/s)	=	35.3	cubic feet per second (ft^3/s)

Metric unit		Inch-Pound equivalent	
Specific combinations—Continued			
liter per second (L/s)	=	.0353	cubic foot per second
cubic meter per second per square kilometer [$(m^3/s)/km^2$]	=	91.47	cubic feet per second per square mile [$(ft^3/s)/mi^2$]
meter per day (m/d)	=	3.28	feet per day (hydraulic conductivity) (ft/d)
meter per kilometer (m/km)	=	5.28	feet per mile (ft/mi)
kilometer per hour (km/h)	=	.9113	foot per second (ft/s)
meter per second (m/s)	=	3.28	feet per second
meter squared per day (m^2/d)	=	10.764	feet squared per day (ft^2/d) (transmissivity)
cubic meter per second (m^3/s)	=	22.826	million gallons per day (Mgal/d)
cubic meter per minute (m^3/min)	=	264.2	gallons per minute (gal/min)
liter per second (L/s)	=	15.85	gallons per minute
liter per second per meter [(L/s)/m]	=	4.83	gallons per minute per foot [(gal/min)/ft]
kilometer per hour (km/h)	=	.62	mile per hour (mi/h)
meter per second (m/s)	=	2.237	miles per hour
gram per cubic centimeter (g/cm^3)	=	62.43	pounds per cubic foot (lb/ft^3)
gram per square centimeter (g/cm^2)	=	2.048	pounds per square foot (lb/ft^2)
gram per square centimeter	=	.0142	pound per square inch (lb/in^2)
Temperature			
degree Celsius (°C)	=	1.8	degrees Fahrenheit (°F)
degrees Celsius (temperature)	=	[(1.8×°C)+32]	degrees Fahrenheit

MINERAL RESOURCES OF THE CRANBERRY WILDERNESS STUDY AREA, WEBSTER AND POCAHONTAS COUNTIES, WEST VIRGINIA

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and
PETER C. MORY and DONALD K. HARRISON,
U.S. BUREAU OF MINES

SUMMARY

The Cranberry Wilderness Study Area comprises 14,702 ha in the Monongahela National Forest, Webster and Pocahontas Counties, east-central West Virginia. The area is in the Yew Mountains of the Appalachian Plateaus and is at the eastern edge of the central Appalachian coal fields. Cranberry Glades, a peatland of botanical interest, lies at the southern end of the study area. All surface rights in the area are held by the U.S. Forest Service; nearly 90 percent of the mineral rights are privately owned or subordinate to the surface rights.

Sedimentary rocks of Mississippian and Pennsylvanian age are exposed in the area and have a gentle regional dip to the northwest. The oldest rocks are of Late Mississippian age and are composed predominantly of red shale and siltstone, and sandstone, containing a few lenticular coal beds. They crop out in the southern part of the area and along the deeper river valleys to the north. Overlying Lower Pennsylvanian rocks of the Pocahontas and New River Formations have a higher ratio of sandstone to shale than the Mississippian units and contain economically important coal beds. The Pennsylvanian rocks crop out in all but the southernmost part of the area, where they have been removed by erosion.

Bituminous coal of coking quality is the most economically important mineral resource in the Cranberry Wilderness Study Area. Estimated resources in beds 35 cm thick or more are about 100 million metric tons in nine coal beds. Most measured-indicated coal, 70 cm thick or more (reserve base), is in a 7-km-wide east-west trending belt extending across the center of the study area. The estimated reserve base is 34,179 thousand metric tons. Estimated reserves in seven of the coal beds total 16,830 thousand metric tons and are recoverable by underground mining methods.

Other mineral resources, all of which have a low potential for development in the study area, include peat, shale, and clay suitable for building brick and lightweight aggregate, sandstone for low-quality glass sand, and sandstone suitable for construction material.

Evidence derived from drilling indicates little possibility for oil and gas in the study area. No evidence of economic metallic deposits was found during this investigation.

INTRODUCTION

Cranberry Wilderness Study Area comprises 14,702 ha in the Monongahela National Forest, east-central West Virginia. The area is in parts of Webster and Pocahontas Counties, about 13 km west of Marlinton, W. Va. (fig. 1). The study area can be reached by several improved roads. Access to the northeastern corner is by State Highway 17 to U.S. Forest Route 86. Route 86, a graded gravel road, parallels the Williams River and forms the northern and northeastern boundary of the area (fig. 2). State Highway 39 abuts the southern end of the area and State Highway 150 follows the mountain crest along the southern and eastern boundaries of the study area. U.S. Forest Route 102, which extends from State Highway 39, parallels the Cranberry River and provides access for restricted vehicular traffic along the southwestern boundary. U.S. Forest Service roads, old logging railroad grades, and a few primitive trails provide access by foot or horseback to the interior. All motor-vehicle traffic or motorized equipment is prohibited inside the Cranberry Wilderness Study Area.

The area, dominated topographically by the Yew Mountains of the Appalachian Plateaus, is at the eastern edge of the central Appalachian coal fields. Elevations range from about 730 m (2,080 ft) above sea level in the Middle Fork valley to 1,390 m (4,559 ft) above sea level on Black Mountain. Principal streams are the Williams, Middle Fork of the Williams, Cranberry, and the North Fork of the Cranberry River.

The lower mountain slopes are covered by a variety of second growth northern hardwood trees including yellow birch, maple, black ash, and oak. Large groves of red spruce dominate the mountain crests and are underlain by a thick carpet of moss. The area was heavily logged between 1910 and 1926, and little virgin forest remains. Small selected tracts totaling 245 ha were also logged in the early 1950's.

A major tourist attraction is the Cranberry Glades Botanical Area, which covers about 304 ha at the southern end of the study area. These glades are likened to the tundra country of Alaska, containing peat, reindeer moss, sedges, high bush cranberry (vibernum) and other shrubs, as well as birds and animals native to more northern areas of the United States.

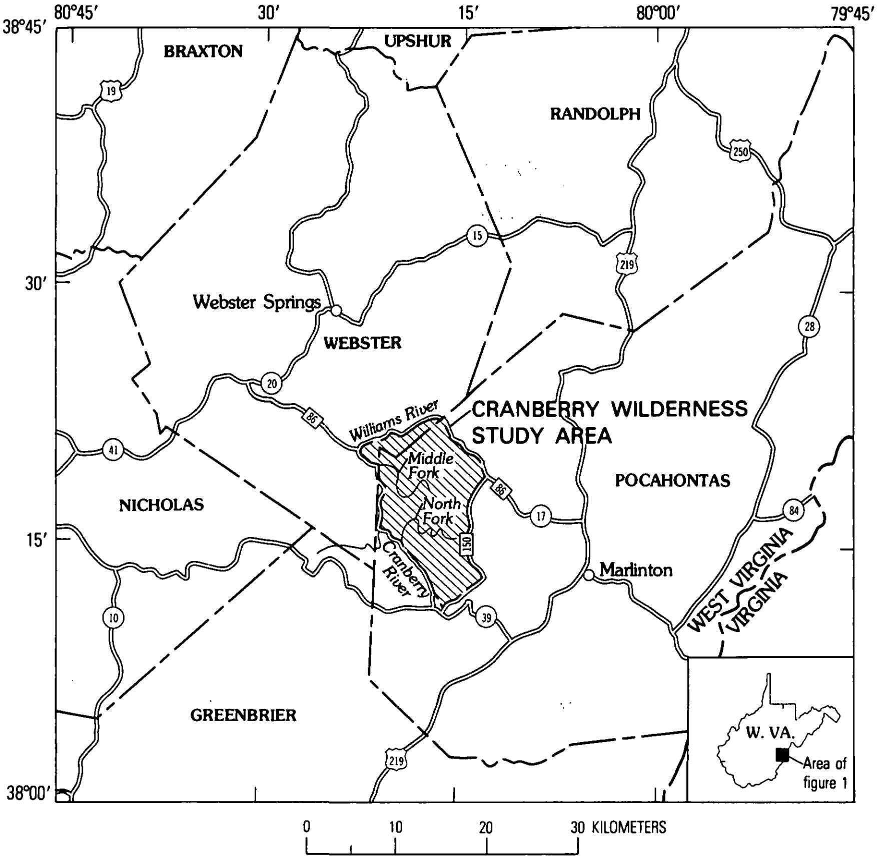


FIGURE 1.—Index map showing the location of the Cranberry Wilderness Study Area in east-central West Virginia.

SURFACE AND MINERAL OWNERSHIP

All surface-land rights were purchased by the Federal Government in the 1930's under the authority of the Weeks Act of 1911 and are held by the U.S. Forest Service. Nearly 86 percent of the mineral rights are owned by Mid Allegheny Corp. The remainder of the mineral rights either are owned outright (10 percent) by the U.S. Forest Service or are subordinate (4 percent) to the surface-land rights (fig. 3). The owner of the mineral rights reserved the privilege to cross the subordinated area by underground openings or mine headings.

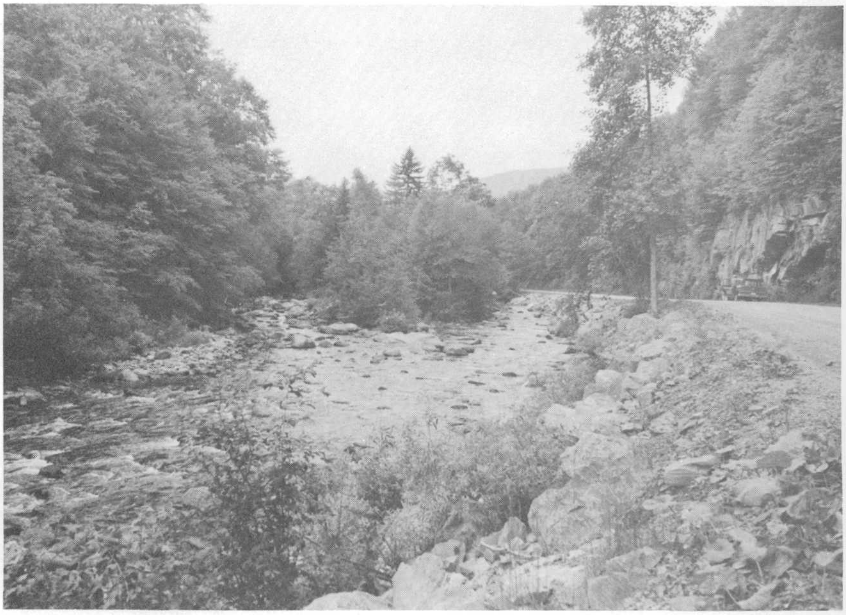


FIGURE 2.—View of Williams River, looking east along U.S. Forest Route 86. The cliff at the roadside is in the Princeton (?) Sandstone.

PREVIOUS INVESTIGATIONS

Descriptions of the geology and coal resources of the Cranberry Wilderness Study Area may be found in the West Virginia Geological Survey reports on Webster County by Reger, Tucker, and Buchanan (1920), and on Pocahontas County by Price and Reger (1929). Both reports include a county geologic map at a scale of 1:62,500.

A generalized informative report on coal and coal mining in West Virginia and regional characteristics of the coal in the study area was prepared by Barlow (1974).

An unpublished report prepared by the U.S. Forest Service (1975) describes the geology and evaluates the coal resources of three areas within the Monongahela National Forest. These areas are the Cranberry Back Country and its environs, the Shavers Fork Area, and the Otter Creek Area. The Cranberry Wilderness Study Area covers about one-fourth of the Cranberry Back Country and its environs. Estimates of coal reserves, 70 cm thick or more, were made for the larger Cranberry Back Country by

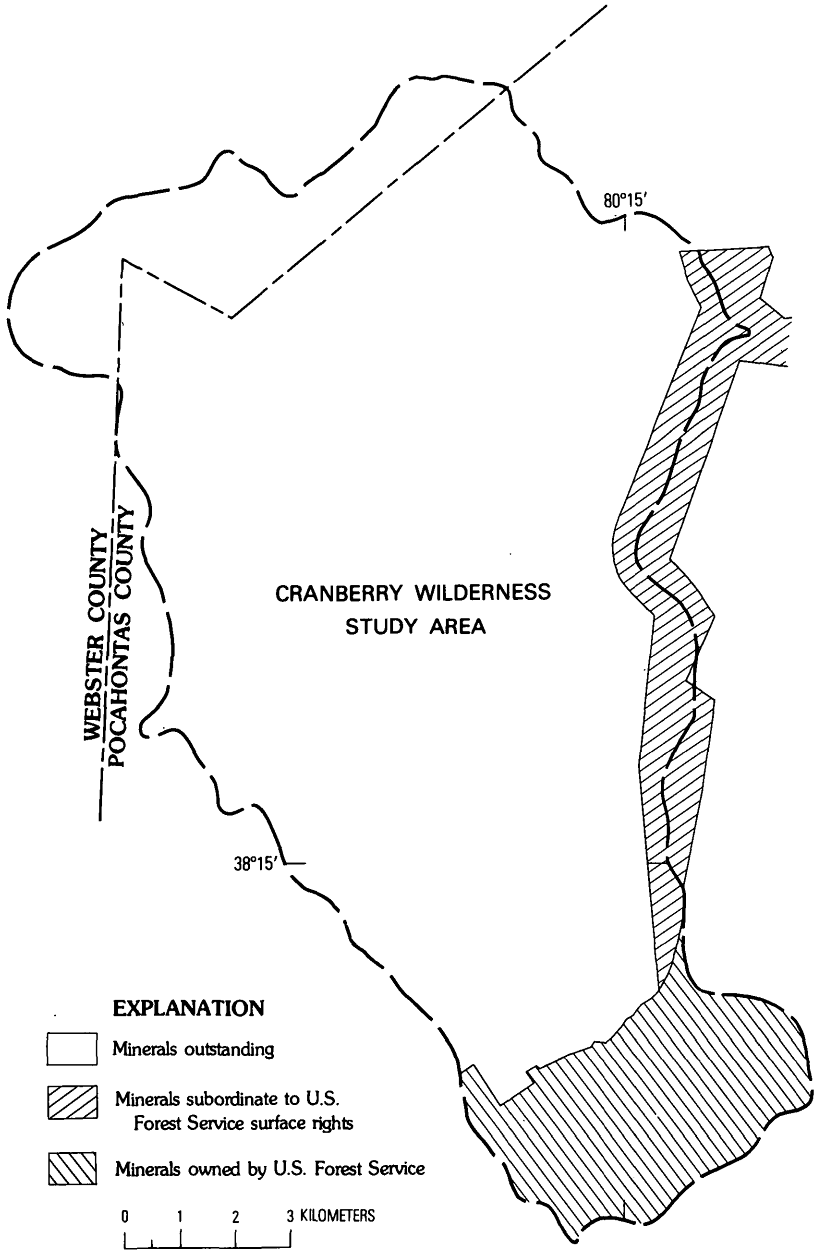


FIGURE 3.—Status of mineral ownership, Cranberry Wilderness Study Area.

the Forest Service; tonnage estimates currently made for the smaller wilderness study area could not be directly compared with those of larger areas.

Several reports have been published concerning the peat deposits of the Cranberry Glades at the south end of the study area (Darlington, 1943, Core, 1955, and Cameron, 1970, 1972).

PRESENT INVESTIGATIONS

U.S. Geological Survey fieldwork and collection of data were done by C. R. Meissner, Jr., and J. F. Windolph, Jr., during April 1977. This work consisted of reconnaissance geologic mapping, measuring sections, and describing diamond drill cores. Coal beds were mapped and correlated by relating them to mappable resistant sandstone units throughout the study area. Field mapping within the study area was supplemented by lithologic data obtained from more than 60 coal company drill-core logs, augmented by 20 U.S. Forest Service drill logs, and maps of inactive mines. Geochemical survey sampling was done by F. G. Lesure, C. E. Brown, A. E. Grosz, and J. W. Whitlow during 6 days in April 1977. Stream sediment and rock samples were analyzed in the U.S. Geological Survey laboratories, Denver, Colo. W. J. Perry, Jr., examined oil and gas records and studied available publications for information on oil and gas potential. C. C. Cameron and A. E. Grosz evaluated peat resources during a 1-week field study in May 1977.

U.S. Bureau of Mines field reconnaissance was conducted by P. C. Mory and D. K. Harrison; they were assisted by M. L. Dunn, Jr., and P. T. Behum in the spring and summer of 1977. Prospects, mines, exposures, and drill sites in and near the area were examined with primary emphasis on evaluating coal beds. Fifty-four coal-prospect trenches and adits in the area were examined and nine localities were sampled. Mine maps from the Bureau's Eastern Field Operations Center Mine Map Repository, Pittsburgh, Pa., were examined to determine the extent of coal mining in or near the study area, and to aid in coal-bed correlation. Thirty-one rock samples of sandstone, underclay, and shale, and, six peat samples from four bogs in Cranberry Glades were collected for analysis.

Coal and peat samples were tested by the Department of Energy, Division of Solid Fuel Mining and Preparation, Coal Analysis (formerly the U.S. Bureau of Mines, Coal Preparation and Analysis Group), Pittsburgh, Pa. The Bureau's Reno Metallurgy Research Center, Reno, Nev., conducted spectrographic, chemical, atomic absorption, and radiometric analyses on rock and coal-ash samples. Ceramic and lightweight aggregate evaluations of shale and clay samples were made by the U.S. Bureau of Mines, Tuscaloosa Metallurgy Research Center, Tuscaloosa, Ala.

ACKNOWLEDGMENTS

We are grateful to David T. Morrison, executive vice president, and Forrest Jones, geologist, of Mid Allegheny Corp., Summerville, W. Va., for supplying copies of drill logs and coal washability data. The West Virginia Geological Survey, Oil and Gas Division, made available oil and gas drill-hole information. Appreciation is extended to U.S. Forest Service personnel in the Eastern Region Office, Milwaukee, Wis.; Roger Johnson and Thomas R. Manley, Monongahela National Forest Headquarters Office, Elkins, W. Va.; and Ronald E. Scott, Gauley Ranger Station, Richwood, W. Va., for providing surface- and mineral-ownership information, drill-hole information, and access privileges to the study area.

GEOLOGY

GEOLOGIC SETTING

The Cranberry Wilderness Study Area is west of the northeast-trending Deer Creek anticline in the erosional Yew Mountains of the Appalachian Plateaus. It is underlain by gently northwest dipping sedimentary rocks of Pennsylvanian and Mississippian age (pl. 1, geologic map and cross section). The oldest exposed rocks of Late Mississippian age crop out in the lower slopes of the more deeply incised valleys and underlie flat lowlands along the headwaters of the Cranberry River where the peat-bearing Cranberry Glades are found. Overlying Pennsylvanian rocks cap the higher slopes and ridges in the central and northern part of the area. Surficial colluvial deposits mantle much of the mountainsides and, with alluvium, are found in the valley floors. Bedrock exposures are limited to a few localities along major stream beds and ridge crests.

MISSISSIPPIAN ROCKS

Upper Mississippian sedimentary rocks in or near the study area include, from oldest to youngest, the Greenbrier Limestone, Bluefield Formation, Hinton Formation, Princeton(?) Sandstone, and Bluestone Formation (pl. 1). Total thickness of these rocks is about 770 m. They consist of sandstone, siltstone, shale, limestone, minor amounts of underclay, and two or more lenticular beds of impure coal. These rocks represent deltaic near-shore, swamp, intertidal, and marine deposits.

GREENBRIER LIMESTONE

Outcrops of Greenbrier Limestone of Late Mississippian age just south of the study area were selected as the starting point for examining the stratigraphic sequence, because of the easy recognition and widespread occurrence of the formation. An oil and gas test well near the west-central edge of the study area penetrated a total thickness of 138 m of Greenbrier. The upper 55 m of the formation are well exposed 1.5 km south of the study area on State Route 39. The Taggard Red(?) Member, a castellated grayish-red shaly siltstone, is exposed about 10 m above the base of the outcrop, and is considered a key bed for correlation (pl. 1, stratigraphic column). The Greenbrier consists of medium- to dark-gray, very finely to coarsely crystalline limestone, containing oolites, calcareous pellets, fossil fragments, quartz grains, and chert nodules. Interbeds of greenish-gray to grayish-red shale and siltstone are dominant near the top. The limestone units are mostly thick bedded to massive and contain some crossbedded detrital sandy zones. The contact between the Greenbrier and the overlying Bluefield Formation is transitional from mostly limestone in the Greenbrier to calcareous shale and argillaceous limestone in the Bluefield.

BLUEFIELD FORMATION

The Bluefield is the oldest formation exposed in the study area. The upper part of the formation, approximately 50 m thick, crops out on the south side of Cranberry Glades. The underlying part of the formation, approximately 267 m thick, was examined where it is exposed above the Greenbrier Limestone along State Route 39 just south of the area. The formation consists of partly calcareous grayish-red and greenish-gray shale, and interbeds of lenticular sandstone and siltstone. Dark-gray to black clayey limestone is interbedded with shale at the base of the formation. Root zones overlain by thin, bony lenticular coal beds occur in the lower part of the unit. The formation is conformably overlain by the Stony Gap(?) Sandstone Member of the Hinton Formation.

HINTON FORMATION

The Hinton Formation crops out in the southern part of the study area along the lower slopes of the mountains and in adjacent valleys. It is composed of grayish-red shale and a few thin beds of gray to grayish-red sandstone and conglomerate lenses containing rounded to angular limestone pebbles. Thickness of the Hinton Formation is about 155 m. The Stoney Gap(?) Sandstone Member at the base of the formation is exposed in the lower slopes of the mountains surrounding Cranberry Glades. There, it consists of light-greenish-gray thin-bedded sandstone that is distinguishable from the sandstone of the underlying Bluefield Formation by less carbonaceous material and dark minerals. The contact between the Bluefield and the overlying Princeton(?) Sandstone is irregular because of channelling.

PRINCETON(?) SANDSTONE

The Princeton(?) Sandstone is exposed in the upper slopes of the mountains at the south part of the study area. It descends gradually northwestward because of the regional dip to lower elevations along the mountainsides, and locally forms resistant outcrops in the creek and river beds of the central and northern areas (pl. 1, geologic map). It dips below the stream valleys along the western side of the area. The Princeton(?) ranges in thickness from 12 to 24 m and is composed of medium-gray to light-greenish-gray thick-bedded to massive lenses of sandstone and conglomerate, containing rounded quartz and limestone pebbles as much as 2 cm long (pl. 1, stratigraphic column). The formation is resistant to weathering and forms ledges or prominent benches. The Princeton(?) Sandstone appears to be conformably overlain by the Pride(?) Shale Member of the Bluestone Formation.

BLUESTONE FORMATION

The Bluestone Formation ranges in thickness from less than 60 m to 100 m or more and consists, in ascending stratigraphic order, of the Pride(?) Shale and Glady Fork(?) Sandstone Members, and one unnamed upper member. The formation is exposed at the crests of the mountains in the south part of the area but, because of regional dip, descends gradually below the valley bottoms in the western and northern part (pl. 1, geologic map).

The Pride(?) Shale Member occupies most of the lower half of the formation and has an average thickness of about 40 m. It consists of medium- to dark-gray and some grayish-red and greenish-gray shale, which locally grades to silty shale. The shale is evenly bedded and contains marine pelecypod and ostracode fossils. A lenticular impure coal bed, locally as much as 61 cm thick, is the uppermost unit of the member and is directly overlain by the Glady Fork(?) Sandstone Member.

The Glady Fork(?) Sandstone Member crops out near the south end of State Highway 150 and near the junction of the Cranberry River and the North Fork where it paves the streambed. This member, near the middle of the Bluestone Formation, has an average thickness of 10 m and probably underlies most of the area. It consists of thick-bedded to massive lenses of sandstone and conglomerate containing rounded quartz and limestone pebbles.

The upper member of the formation averages 45 m in thickness and is composed of grayish-red shale and sandstone and a few lenticular conglomerate beds. The uppermost part of the member intertongues and grades laterally into the lower beds of the Pocahontas Formation of Pennsylvanian age. Where intertonguing has occurred, both formations are classified as Pennsylvanian in age. However, in those localities where the Pocahontas Formation has been removed by erosion, an unconformable contact separates the Bluestone from the New River Formation of Pennsylvanian age.

PENNSYLVANIAN ROCKS

Lower Pennsylvanian coal-bearing rocks of the Pocahontas and New River Formation crop out in all but the southernmost part of the study area. Where these rocks are present, they form the upper parts of the mountains in the south and, as a result of the northwesterly regional dip, constitute most of the exposed rocks in the mountains of the central and northern parts of the area. The Lower Pennsylvanian rocks are mostly of continental origin, consist of sandstone, shale, underclay, siltstone, and conglomerate, and contain six major coal beds as well as several thinner and less extensive beds of economic importance. The thickness of the two formations is about 326 m.

POCAHONTAS FORMATION

The Pocahontas Formation, a relatively thin unit in the area that has a maximum thickness of about 21 m, is economically significant because it contains the Pocahontas No. 3(?) coal bed. In the southern part of the area, exposures occur high in the mountains; northwestward, they are much lower, and the formation is exposed along the sides of the deeper stream valleys. This formation, previously unknown in the study area, has been extended 25 km northeastward of previously mapped occurrences and pinches out along an east-west trend in the northern part of the study area. The formation is composed of gray to very dark gray shale and siltstone, coal, and underclay. Abundant plant material, including leaf pinules of the *Neuropteris Pocahontas* (W. H. Gillespie, oral comm., 1978), was found in the roof rock above the Pocahontas No. 3(?) coal bed.

NEW RIVER FORMATION

Most rocks exposed in the study area are assigned to the New River Formation, which has a total thickness of more than 300 m. Several important coal beds occur in this formation, including the Sewell, Little Raleigh(?), Beckley(?), and Fire Creek(?). Four sandstone and conglomerate members were mapped to aid correlation of the coal beds: (1) basal sandstone and conglomerate probably correlative with the Pineville Sandstone Member; (2) sandstone and conglomerate below the Little Raleigh(?) coal bed; (3) sandstone and conglomerate above the Sewell coal bed; and (4) ortho-quartzite above the Hughes Ferry(?) coal bed.

The basal sandstone and conglomerate member occurs in all but the northern quarter of the study area where it pinches out (pl. 1, geologic map). The member is light gray, and in many places contains white rounded quartz pebbles as much as 3 cm in diameter. It forms a bench or ledge and has a maximum thickness of about 49 m in the central part of the study area.

The sandstone and conglomerate below the Little Raleigh(?) coal bed is light gray, locally contains pebbles, is thick to very thick bedded and forms resistant benches. Maximum thickness is about 36 m, but the unit grades laterally into shale northwestward and pinches out in the northwestern corner of the study area. Erosional fragments from the unit commonly accumulate as boulder colluvium at the base of slopes.

The sandstone and conglomerate unit above the Sewell coal bed crops out extensively in the mountains in the northern part of the study area. It underlies all the highest knobs in the central part and has been eroded away in the southern part of the study area. Maximum thickness is about 30 m, and the sandstone locally contains two or more lenticular shale beds as much as 4 m thick. The unit is commonly conglomeratic and contains lenses of quartz pebbles as much as 1 cm in diameter. It forms resistant ledges, cliffs, and benches, which weather into boulders and rock debris.

The ortho-quartzite unit is preserved only on the crest of the mountain west of Laurelly Branch at the western border of the study area. It contains 80–90 percent quartz sand at the top and becomes less quartzose toward the base. This unit may be correlative with the basal part of the Nuttall Sandstone Member that elsewhere is the uppermost member of the New River Formation.

QUATERNARY DEPOSITS

Colluvim mantles most mountainsides and covers all but a few good bed-rock exposures. The colluvium deposits were not mapped, because time was not available to delineate their boundaries. Most of the stream valleys are strewn with sandstone boulders, but deposits of sand, silt, mud, and some coarse rock material are present in the headwaters of Cranberry River, of the North Fork of the Cranberry, and along much of the Middle Fork of the Williams River (pl. 1, geologic map). A large landslide was mapped in the Bluestone Formation on the east side of the Middle Fork, north of its junction with Laurelly Branch. Other less extensive landslides have occurred throughout the study area but have not been mapped.

The peat bogs of the Cranberry Glades in the south end of the study area are a unique feature because they contain fauna and flora usually found much farther north. Their origin and characteristics are described in the chapter on "Mineral Resources."

STRUCTURE

The structure contours for plate 2 were drawn on the base of the Beckley(?) coal bed in the study area. In the southern part of the area where the Beckley(?) is absent, elevations were projected by an average interval from points on older or younger coal beds. The resulting structure map, which generally reflects the structure for the area, reveals a northwesterly dipping homocline. The average strike is N. 38° E., and the dip ranges from 1° to 4° and averages slightly less than 2° NW. This average dip results in a northwestward drop in the elevation of the Beckley(?) coal bed of 185 feet per mile (35m/km). The strike of cleats in the coal beds ranges from N. 35° W. to N. 10° W. for the face cleat and N. 35° E. to N. 60° E. for the butt cleat. The dips range from 82° to vertical wavering from northeast to southwest for the face cleat and northwest to southeast for the butt cleat.

MINERAL RESOURCES

SETTING

Potential mineral resources in the Cranberry Wilderness Study Area consist of coal, peat, shale and clay, high-silica sandstone, and stone. The area has a low potential for gas and practically no potential for oil. A geochemical survey indicates no potential for metallic minerals.

Coal has been prospected extensively and constitutes the most economically important mineral resource in the study area. The locations of at least 65 drill holes, 54 prospect trenches, and 10 adits shown on figure 4 are known in the study area.

Several surface and underground coal mines that are currently inactive have operated within 2 km of the northern border of the area. There is no record of commercial production within the study area, although several small openings may have furnished coal for locomotives used in logging operations.

Minerals, other than coal, have not been mined in or near the study area. However, rock units similar to those within the study area have the potential for economic mineral production in other parts of the State. McCue and others (1948) reported that shales and clays suitable for brick and tile are abundant throughout the State. Seventeen West Virginia clay beds are possible sources of alumina (Tallon and Hunter, 1959). In addition, high-silica sandstones have been identified at various localities in the State in rocks of Early Pennsylvanian and Mississippian age (Arkle and Hunter, 1957, p. 36). Uneconomic quarrying of building stone has been reported in southeastern Webster County (Reger and others, 1920).

COAL

Coal beds tentatively identified within the study area are the Pocahontas No. 3(?), Pocahontas No. 3(?) rider, Little Fire Creek(?), Fire Creek(?), Beckley(?), Little Raleigh(?), Little Raleigh(?) rider, Sewell, and Hughes Ferry(?).

The names assigned to these coal beds do not agree with those assigned in earlier reports or with those in common local usage. All names were assigned after the Sewell coal bed was successfully correlated into the area from known Sewell outcrops and mines west and south of the area. All the identified beds except the Sewell and Hughes Ferry(?) contain coal of economically minable thickness. Areally, the most extensive beds are the

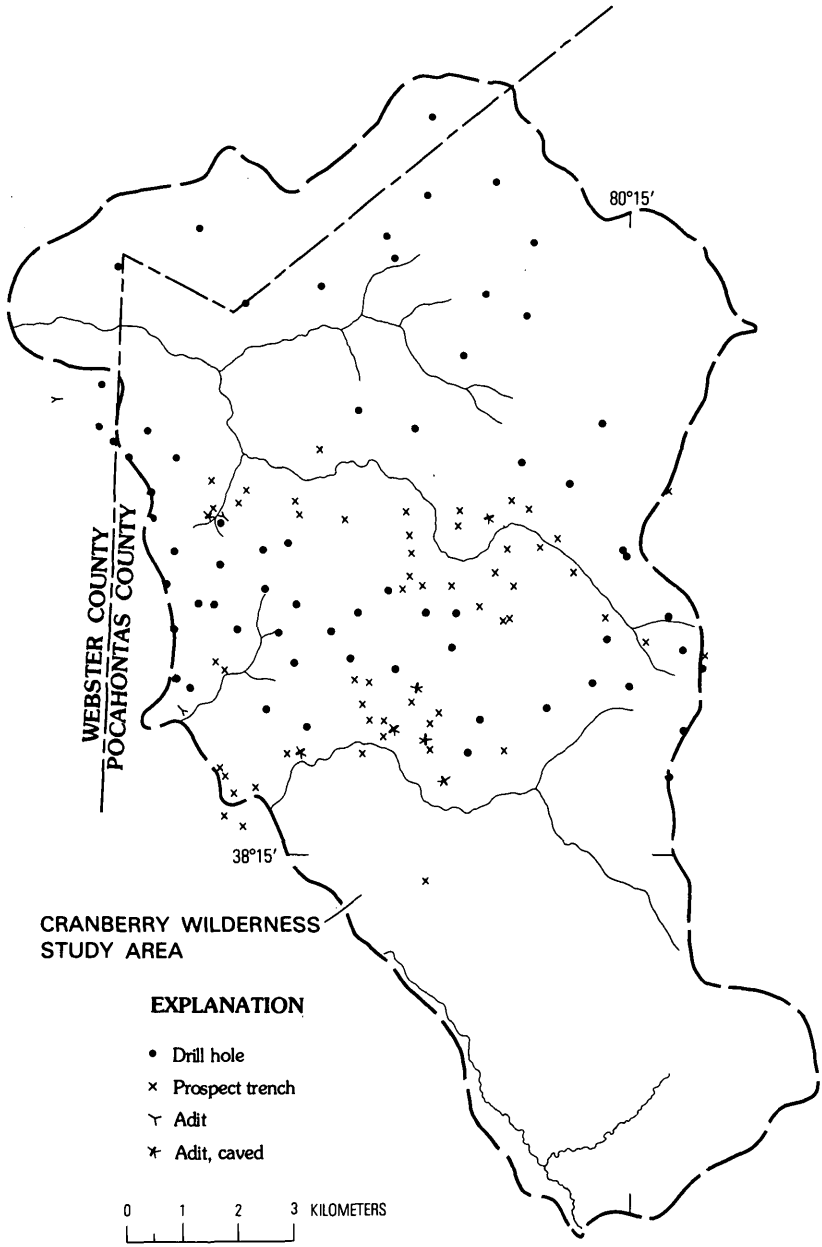


FIGURE 4.—Extent of coal exploration, Cranberry Wilderness Study Area.

Pocahontas No. 3(?), Fire Creek(?), Beckley(?), Little Raleigh(?), and Sewell.

Estimated coal resources are about 100 million metric tons (pl. 3). The reserve base (demonstrated reserve base) is

TABLE 1.—*Summary of estimated coal reserves, Cranberry Wilderness Study Area, W. Va.*

[By P. C. Mory and D. K. Harrison, U.S. Bureau of Mines, Nov. 15, 1977]

Coal bed	Hectares of coal 70 cm or more thick	Reserve base (thousand metric tons)			Reserves [1] (thousand metric tons)
		Measured	Indicated	Total	
Little Raleigh(?) rider	102	470	604	1,074	537
Little Raleigh(?)	724	6,631	1,818	8,449	4,225
Beckley(?)	641	4,648	2,199	6,847	3,424
Fire Creek(?)	174	1,639	440	2,079	1,040
Little Fire Creek(?)	150	875	744	1,619	810
Pocahontas No. 3(?) rider	42	375	150	525	263
Pocahontas No. 3(?)	820	5,229	8,357	13,586	[2] 6,531
Total tonnages		19,867	14,312	34,179	16,830

[1] Based on 50 percent recovery factor.
[2] Excludes isolated economically unrecoverable parts of coal bed.

34,179,000 metric tons and reserves are 16,830,000 metric tons (table 1). Coal resources underlie most of the northern three-quarters of the study area (fig. 5); the reserve base underlies the central part (fig. 6).

Coal resources include all coal beds 35 cm thick or more, whereas reserves are limited, as classified herein, to coal 70 cm thick or more in the measured and indicated categories explained in "Procedure." The reserves would be recoverable by underground mining methods. Adverse environmental impacts could be minimized by use of appropriate mining techniques. All surface disturbance caused by mining would be temporary and limited to small areas. The drainage area and the water table of the Cranberry Glades are isolated from the coal reserve area. The bogs are upstream from the coal reserves, are updip on older rocks that are not related to aquifers of the coal-bearing areas, and would, therefore, not be harmed by mining.

PROCEDURE

Coal bed investigations and evaluations consisted of surface geologic mapping, subsurface correlation of drill-core logs, and collection and analysis of coal samples. Correlation and identification of coal beds and rock formations in the core holes were made by the U.S. Geological Survey. Surface mapping included locating all prospect trenches and adits on the geologic map and determining which coal beds the trenches and adits were testing. U.S. Bureau of Mines personnel located 54 prospect trenches and adits within the study area; 32 were reopened and examined. Six inactive mines and 2 adits outside the area were also examined.

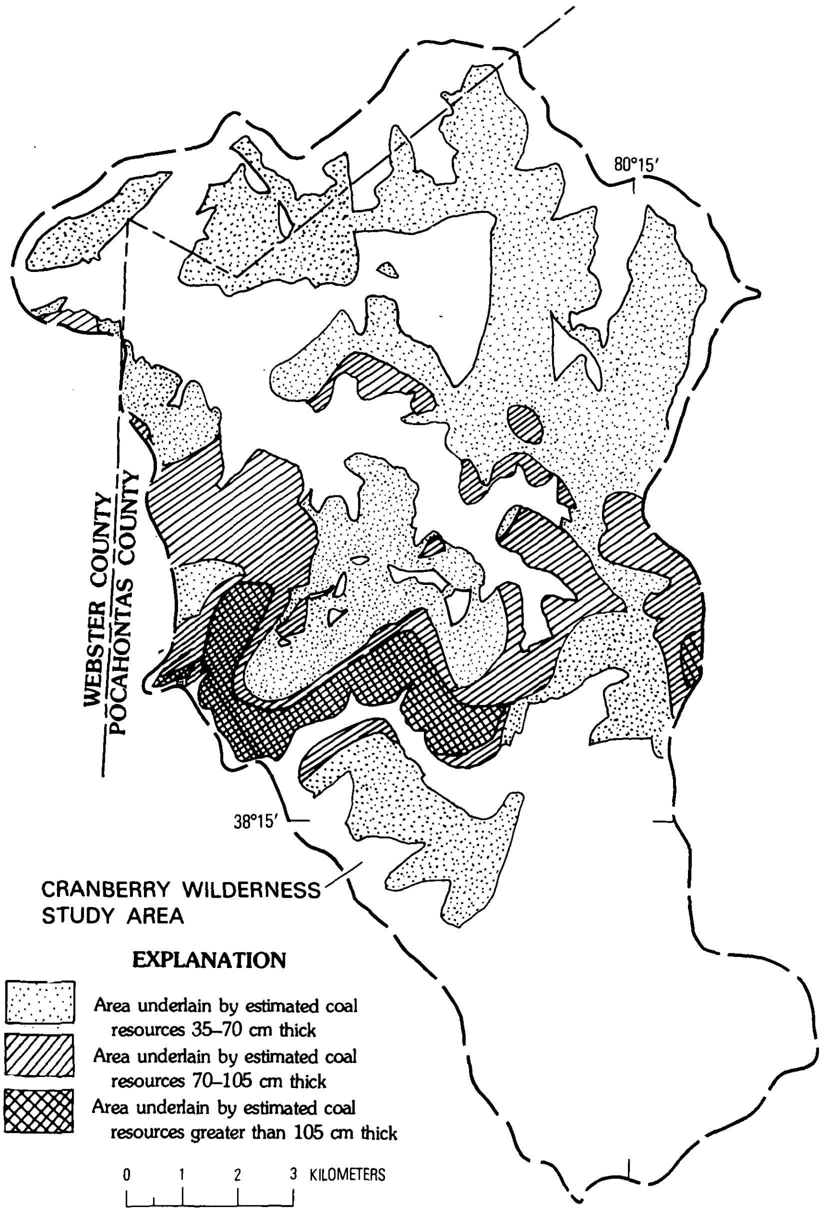


FIGURE 5.—Coal resource distribution of all beds in the Cranberry Wilderness Study Area.

A "bed map" prepared for each of the coal beds by the U.S. Geological Survey (pl. 3) shows: (1) coal thickness contours for 35, 70, and 105 cm, and (2) the coal bed outcrop and distribution.

FIGURE 6.—Composite reserve base area of all coal beds.

The estimate of coal resources is divided into categories based on reliability of data (distance from a point of measurement) and thickness of a coal bed (exclusive of partings and bony coal) for each coal bed. The reliability categories are measured, indicated, and inferred. Measured coal is projected to extend 0.4 km from a point of surface or subsurface measurement; indicated coal extends in a belt from more than 0.4 to 1.2 km from a measurement point; and inferred coal is projected to extend in a belt that is more than 1.2 to 4.8 km from a measurement point (U.S. Bureau of Mines and U.S. Geological Survey, 1976). Each area of coal categorized as measured, indicated, and inferred is divided into subareas that are based on coal thicknesses of 35, 70, and 105 cm or greater. No resources were estimated for coal beds less than 35 cm thick.

The reserve base is an estimate of the quantity of coal 70 cm thick or more in those parts of beds that are assigned to the measured and indicated reliability categories. Coal beds of this thickness generally are considered recoverable by underground-mining methods. Coal that could be strip mined is included in the reserve base and was not calculated separately. A 50-percent recovery factor was used to estimate the reserves (the quantity of recoverable coal) from the reserve base. Reserve base maps were modified from the individual bed maps. Past mining is negligible in the study area.

Analyses (table 2) indicate that coal in the study area can be tentatively ranked as medium-volatile to high-volatile A bituminous. All samples are low in sulfur and most are low in ash. Most of the raw coal is of premium-grade coking-coal quality and contains not more than 1.0 percent sulfur and 8.0 percent ash. Washability tests (table 3) performed on drill-core samples and on bulk samples from three adits indicate that any coal not of premium quality can be cleaned to reduce sulfur and ash content.

Spectrographic analyses of coal ash for 39 elements and radiometric determination of U_3O_8 (table 4) indicate no abnormal concentrations.

Trace-element contents of coal ash from the study area compare favorably with the averages for trace elements in coal ash of West Virginia as reported by Abernethy and others (1969) and Swanson and others (1976).

POCAHONTAS NO. 3(?) COAL BED

The Pocahontas No. 3(?) coal bed (fig. 7) ranges in thickness from 0 to 170 cm. In most places the bed is free of partings, but locally may have several bony coal layers 2 to 5 cm thick. This coal bed crops out and is thickest along the north bank of the North Fork near its junction with the Cranberry River. Resources

FIGURE 7.—Pocahontas No. 3(?) coal bed, sample locality WVC–623. Coal extends from base of shovel to about 30 cm above top of handle.

in this bed underlie the central part of the study area, although two small blocks were identified north of this central band (pl. 3). One block is northeast of the headwaters of the Middle Fork of the Williams River; the other underlies a high ridge west of

TABLE 2.—*Analyses of coal, Cranberry*

[Analyses by Department of Energy, Division of Solid Fuel Mining and Preparation, Coal Pa. All samples are of weathered coal and were collected from adits, prospect trenches, or effects of weathering on analytical results]

Sample number	Coalbed	Sample interval (centi-meters)	Specific gravity	Condition of sample1/	Proximate (percent) Moisture	Volatile matter	Fixed carbon
WVC-626	Little Raleigh (?)	106.7	1.37	AR	6.3	27.0	60.9
				MF	--	28.9	64.9
				MAF	--	30.8	69.2
WVC-627	do.	105.4	1.36	AR	6.7	27.9	60.3
				MF	--	29.9	64.6
				MAF	--	31.6	68.4
WVC-659	do.	106.7	1.37	AR	3.1	29.6	60.8
				MF	--	30.6	62.7
				MAF	--	32.8	67.2
WVC-608	Beckley (?)	71.4	1.35	AR	4.5	28.5	61.4
				MF	--	29.8	64.3
				MAF	--	31.7	68.3
WVC-634	do.	71.1	1.35	AR	8.1	26.4	58.8
				MF	--	28.7	64.1
				MAF	--	30.9	69.1
WVC-651	do.	78.7	1.39	AR	10.3	26.0	58.8
				MF	--	29.0	65.6
				MAF	--	30.7	69.3
WVC-613	Fire Creek (?)	147.3	1.34	AR	2.7	29.6	62.3
				MF	--	30.5	63.9
				MAF	--	32.5	67.7
WVC-614	do.	144.8	1.34	AR	2.4	29.8	61.7
				MF	--	30.5	63.3
				MAF	--	32.6	67.4
WVC-616	do.	35.63/	1.39	AR	5.4	25.7	61.3
				MF	--	27.2	64.8
				MAF	--	29.6	70.4
WVC-617	do.	50.84/	1.39	AR	4.3	25.8	59.9
				MF	--	26.9	62.6
				MAF	--	30.1	69.9
WVC-623	Pocahontas No. 3 (?)	157.5	1.44	AR	6.0	25.3	53.9
				MF	--	26.9	57.4
				MAF	--	31.9	68.1
WVC-624	do.	153.7	1.40	AR	3.5	15.5	66.7
				MF	--	16.1	69.1
				MAF	--	18.9	81.1

1/ AR = As received; MF = Moisture free; MAF = Moisture and ash free.
2/ By atomic absorption analyses.
3/ Upper bench of coalbed at sample locality WVC-616 and 617.
4/ Lower bench of coalbed at sample locality WVC-616 and 617.

Wilderness Study Area, W. Va.

Analysis (formerly U.S. Bureau of Mines, Coal Preparation and Analysis Group), Pittsburgh, outcrops. An attempt was made to penetrate the coal bed at least 0.3 meter to lessen the

Ultimate (percent)							Sulfur forms (percent)[2/]				
Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	Calorific value Btu/lb	Sulfate	Pyritic	Organic	Ash softening temperature (°F)	Free-swelling index
5.8	5.3	75.2	1.5	11.5	0.8	13,213	0.01	0.19	0.56		
6.2	4.9	80.2	1.6	6.3	.8	14,098	.01	.21	.60	2,510	3.5
--	5.2	85.5	1.7	6.7	.9	15,027	.01	.22	.64		
5.1	5.3	75.1	1.5	12.1	.8	13,187	.01	.19	.57		
5.5	4.9	80.5	1.6	6.6	.8	14,136	.01	.21	.61	2,460	2.5
--	5.2	85.2	1.7	7.0	.9	14,955	.01	.22	.64		
6.5	5.2	78.0	1.5	7.9	.9	13,873	.00	.23	.62		
6.7	5.0	80.5	1.5	5.3	.9	14,317	.00	.24	.64	2,910	8.0
--	5.4	86.4	1.6	5.7	.9	15,352	.00	.26	.69		
5.6	5.5	78.8	1.3	7.8	.9	13,974	.01	.33	.53		
5.9	5.3	82.5	1.4	4.0	.9	14,628	.01	.35	.56	2,800+	9.0
--	5.6	87.6	1.5	4.3	1.0	15,539	.01	.37	.59		
6.7	5.3	74.6	1.3	11.6	.6	13,111	.01	.10	.50		
7.2	4.8	81.2	1.4	4.8	.7	14,264	.01	.11	.54	2,910	8.5
--	5.2	87.5	1.5	5.1	.7	15,379	.01	.12	.58		
4.9	5.2	71.4	1.1	16.9	.5	12,312	.02	.04	.47		
5.4	4.6	79.6	1.2	8.7	.6	13,721	.02	.04	.53	2,910	.5
--	4.8	84.1	1.3	9.2	.6	14,507	.02	.04	.56		
5.4	5.4	80.5	1.4	6.6	.7	14,383	.01	.17	.54		
5.6	5.2	82.7	1.4	4.3	.7	14,777	.01	.17	.56	2,800+	9.0
--	5.5	87.6	1.5	4.6	.8	15,650	.01	.18	.59		
6.1	5.4	80.3	1.4	6.2	.6	14,284	.01	.17	.46		
6.2	5.2	82.3	1.4	4.2	.7	14,628	.01	.17	.48	2,800+	9.0
--	5.6	87.7	1.5	4.5	.7	15,597	.01	.18	.51		
7.6	5.0	74.8	1.4	10.3	.9	13,141	.01	.16	.68		
8.0	4.6	79.1	1.5	5.8	.9	13,891	.01	.17	.72	2,800+	3.5
--	5.0	86.0	1.7	6.3	1.0	15,106	.01	.19	.78		
10.0	5.0	74.4	1.4	8.6	.6	13,135	.01	.17	.46		
10.5	4.7	77.7	1.5	5.0	.7	13,722	.01	.17	.48	2,800+	7.0
--	5.2	86.8	1.6	5.6	.7	15,331	.01	.19	.53		
14.8	4.8	68.4	1.0	10.4	.7	12,043	.01	.16	.48		
15.7	4.4	72.8	1.0	5.3	.7	12,815	.01	.17	.52	2,800+	7.5
--	5.2	86.4	1.2	6.3	.8	15,209	.01	.20	.61		
14.3	4.9	71.4	1.0	7.6	.8	12,572	.01	.29	.47		
14.8	4.6	74.0	1.1	4.7	.8	13,022	.01	.30	.49	2,800+	9.0
--	5.4	86.8	1.3	5.5	.9	15,288	.01	.36	.57		

TABLE 3.—*Coal washability characteristics,*

Sample locality number	Coalbed	Specific gravity fractions		Dry basis (percent)		
		Sink	Float	Weight	Ash	Sulfur
Laurelly Branch adit, same locality as WVC-626 and 627[2/]	Little Raleigh (?)					
		--	1.35	72.83	3.19	0.87
		1.35	1.40	6.81	12.48	.81
		1.40	1.45	10.05	17.58	.85
		1.45	1.50	2.47	20.85	.83
		1.50	1.55	.68	24.81	1.39
		1.55	--	7.16	37.49	1.60
Do.[2/]	do.					
		--	1.35	83.86	2.21	.87
		1.35	1.40	5.89	10.05	.80
		1.40	1.45	4.21	14.45	.80
		1.45	1.50	1.47	17.59	.80
		1.50	1.55	.98	19.30	.82
		1.55	--	3.59	40.19	4.00
Do.[2/]	do.					
		--	1.35	79.46	2.57	.87
		1.35	1.40	6.26	11.10	.80
		1.40	1.45	6.54	16.37	.83
		1.45	1.50	1.87	19.31	.82
		1.50	1.55	.86	21.04	1.00
		1.55	--	5.01	38.65	2.63
Drill hole CW-104[3/]	do.	--	1.30	77.2	2.01	.85
		1.30	1.35	9.0	6.74	.92
		1.35	1.40	2.8	9.43	.94
		1.40	1.45	1.3	13.02	.91
		1.45	1.50	1.7	21.93	1.02
		1.50	1.55	1.5	27.86	.59
		1.55	1.60	1.0	30.67	.59
		1.60	--	5.5	54.58	.49
Drill hole CW-110[3/]	do.	--	1.30	61.4	1.78	.78
		1.30	1.35	11.6	5.77	.79
		1.35	1.40	7.6	10.87	.76
		1.40	1.45	4.1	13.03	.65
		1.45	1.50	2.2	14.16	.59
		1.50	1.55	1.1	16.25	.40
		1.55	1.60	1.0	24.31	.35
		1.60	--	11.0	56.71	.41

Cranberry Wilderness Study Area, W. Va.[1]

Cumulative data (percent)						
Float			Sink			
Weight	Ash	Sulfur	Weight	Ash	Sulfur	Remarks
			100.00	8.31	0.92	Plus 1/4 inch round =
72.83	3.19	0.87	27.17	22.03	1.05	39.88% of total sample
79.64	3.98	.86	20.36	25.22	1.13	
89.69	5.51	.86	10.31	32.67	1.40	
92.16	5.92	.86	7.84	36.39	1.58	
92.84	6.06	.87	7.16	37.49	1.60	
100.00	8.31	.92				
			100.00	4.94	.97	1/4 inch round by 0 =
83.86	2.21	.87	16.14	19.15	1.51	60.12% of total sample
89.75	2.72	.87	10.25	24.38	1.92	
93.96	3.25	.86	6.04	31.30	2.71	
95.43	3.47	.86	4.57	35.71	3.32	
96.41	3.63	.86	3.59	40.19	4.00	
100.00	4.94	.97				
			100.00	6.29	.95	Calculated composite =
79.46	2.57	.87	20.54	20.66	1.27	100% of total sample
85.72	3.19	.86	14.28	24.85	1.47	
92.26	4.13	.86	7.74	32.02	2.01	
94.13	4.43	.86	5.87	36.07	2.39	
94.99	4.58	.86	5.01	38.65	2.63	
100.00	6.29	.95				
77.2	2.01	.85	100.0	6.69	.84	Composite 3/4 inch round
86.2	2.50	.86	22.8	22.54	.79	by 0 = 100% of core
89.0	2.72	.86	13.8	32.85	.70	crushed to 3/4 inch
90.3	2.87	.86	11.0	38.81	.64	round
92.0	3.22	.86	9.7	42.26	.61	
93.5	3.62	.86	8.0	46.58	.52	
94.5	3.90	.86	6.5	50.90	.51	
100.0	6.69	.84	5.5	54.58	.49	
61.4	1.78	.78	100.0	10.09	.72	Composite 3/4 inch round
73.0	2.41	.78	38.6	23.32	.63	by 0 = 100% of core
80.6	3.21	.78	27.0	30.86	.56	crushed to 3/4 inch
84.7	3.69	.77	19.4	38.69	.48	round
86.9	3.95	.77	15.3	45.57	.43	
88.0	4.11	.76	13.1	50.84	.40	
89.0	4.33	.76	12.0	54.01	.41	
100.0	10.09	.72	11.0	56.71	.41	

TABLE 3.—*Coal washability characteristics, Cranberry*

Sample locality number	Coalbed	Specific gravity fractions		Dry basis (percent)		
		Sink	Float	Weight	Ash	Sulfur
Drill hole CW-116 3/	Little Raleigh (?)	--	1.30	37.4	3.06	0.76
		1.30	1.35	17.0	6.90	.77
		1.35	1.40	8.9	12.22	.72
		1.40	1.45	4.0	16.78	.69
		1.45	1.50	2.3	22.58	.78
		1.50	1.55	1.7	26.81	.73
		1.55	1.60	1.3	32.34	.78
		1.60	--	27.4	66.20	.34
Tumbling Rock Run adit, same locality as WVC-613 and 614 4/	Fire Creek (?)	--	1.40			
		1.40	1.45	92.57	5.00	.80
		1.45	1.50	1.95	16.32	1.36
		1.50	1.55	.62	24.93	1.31
		1.55	--	4.86	62.10	3.02
Drill hole CW-117 3/	Pocahontas No. 3 (?)	--	1.30	30.2	2.44	.66
		1.30	1.35	27.6	6.13	.61
		1.35	1.40	8.9	10.51	.51
		1.40	1.45	5.7	15.17	.47
		1.45	1.50	3.7	19.95	.47
		1.50	1.55	4.0	26.29	.55
		1.55	1.60	5.3	31.59	.46
		1.60	--	14.6	40.87	.35
Drill hole CW-118 3/	do.	--	1.30	17.7	2.42	.74
		1.30	1.35	34.3	6.86	.66
		1.35	1.40	18.8	11.29	.58
		1.40	1.45	9.7	14.94	.50
		1.45	1.50	4.6	18.77	.48
		1.50	1.55	2.2	22.97	.44
		1.55	1.60	1.3	24.93	.40
		1.60	--	11.4	74.70	.36
Hunting Run adit, same locality as WVC-624 4/	do.	--	1.35			
		1.35	1.40	72.49	7.99	.91
		1.40	1.45	1.86	18.11	.94
		1.45	1.50	4.36	24.49	.96
		1.50	1.55	2.74	26.73	.85
		1.55	--	18.55	49.81	.74

1/ All washability data provided by Mid Allegheny Corporation, Summersville, W. Va.
2/ Analyses performed by Standard Laboratories, Inc., Charleston, W. Va.
3/ Analyses performed by Commercial Testing and Engineering Co., Charleston, W. Va.
4/ Analyses performed by the Powellton Company, Mallory, W. Va.

Wilderness Study Area, W. Va.[1]—Continued

Cumulative data (percent)						
Float			Sink			
Weight	Ash	Sulfur	Weight	Ash	Sulfur	Remarks
37.4	3.06	0.76	100.0	23.61	0.64	Composite 3/4 inch round by 0 = 100% of core crushed to 3/4 inch round
54.4	4.26	.76	62.6	35.89	.57	
63.3	5.38	.76	45.6	46.70	.49	
67.3	6.06	.75	36.7	55.06	.44	
69.6	6.60	.75	32.7	59.74	.41	
71.3	7.08	.75	30.4	62.55	.38	
72.6	7.54	.75	28.7	64.67	.36	
100.0	23.61	.64	27.4	66.20	.34	
			100.00	8.04	.92	3/4 inch by 0 = total bulk sample
92.57	5.00	.80	7.43	45.94	2.37	
94.52	5.24	.81	5.48	57.35	2.78	
95.14	5.35	.82	4.86	62.10	3.02	
100.00	8.04	.92				
30.2	2.44	.66	100.0	13.66	.55	Composite 3/4 inch round by 0 = 100% of core crushed to 1 inch round
57.8	4.20	.64	69.8	18.51	.51	
66.7	5.04	.62	42.2	26.61	.44	
72.4	5.84	.61	33.3	30.92	.43	
76.1	6.53	.60	27.6	34.17	.42	
80.1	7.51	.60	23.9	36.37	.41	
85.4	9.01	.59	19.9	38.40	.38	
100.0	13.66	.55	14.6	40.87	.35	
17.7	2.42	.74	100.0	16.56	.59	Composite 3/4 inch round by 0 = 100% of core crushed to 3/4 inch round
52.0	5.35	.69	82.3	19.60	.56	
70.8	6.93	.66	48.0	28.71	.49	
80.5	7.89	.64	29.2	39.92	.43	
85.1	8.48	.63	19.5	52.35	.40	
87.3	8.85	.63	14.9	62.72	.38	
88.6	9.08	.62	12.7	69.61	.36	
100.0	16.56	.59	11.4	74.70	.36	
			100.00	17.17	--	3/4 inch by 0 = total bulk sample
72.49	7.99	.91	27.51	41.36	--	
74.35	8.24	.91	25.65	43.04	--	
78.71	9.14	.91	21.29	46.84	--	
81.45	9.73	.91	18.55	49.81	--	
100.00	17.17	.88				

Data as reported with no independent rounding by the Bureau of Mines.

TABLE 4.—*Analyses of coal ash, Cranberry*

[Analyses performed by U.S. Bureau of Mines, Reno Metallurgy Research Center, Reno, Nev. include: As(.009), Bi(.08), Cd(.002), Ga(.001), La(.02), Mo.(.004), Na(2), Nb(.05), P(.2), Si occurs in all samples in amounts greater than 29 percent. A possible error of plus 100 than; <, less than].

Sample number	Coalbed	Sample interval (centimeters)	General		
			Al	B	Ba
WVC-626	Little Raleigh (?)	106.7	21	0.02	0.2
WVC-627	do.	105.4	24	.02	.2
WVC-659	do.	106.7	26	.02	.2
WVC-608	Beckley (?)	71.4	18	<.02	.4
WVC-634	do.	78.7	27	<.02	.4
WVC-651	do.	71.1	24	<.02	.4
WVC-613	Fire Creek (?)	147.3	21	.02	.1
WVC-614	do.	144.8	24	.02	.1
WVC-616	do.	35.6 1/	27	<.02	.09
WVC-617	do.	50.8 2/	22	<.03	.08
WVC-623	Pocahontas No. 3 (?)	157.5	> 27	<.02	.2
WVC-624	do.	153.7	24	.02	.04

Sample number	Coalbed	Sample interval (centimeters)
WVC-626	Little Raleigh (?)	106.7
WVC-627	do.	105.4
WVC-659	do.	106.7
WVC-608	Beckley (?)	71.4
WVC-634	do.	78.7
WVC-651	do.	71.1
WVC-613	Fire Creek (?)	147.3
WVC-614	do.	144.8
WVC-616	do.	35.6 1/
WVC-617	do.	50.8 2/
WVC-623	Pocahontas No. 3 (?)	157.5
WVC-624	do.	153.7

1/ Upper bench of coalbed at sample locality WVC-616 and 617.
2/ Lower bench of coalbed at sample locality WVC-616 and 617.

Wilderness Study Area, W. Va.

Elements tested for but occurring in amounts below the lower detection limit (in parentheses) Pd(.001), Pt(.004), Sb(.05), Sc(.001), Sn(.007), Ta(.05), Te(.1), W(.06), Y(.007), Zr(.005). percent to minus 50 percent of reported concentration is assumed. Symbols used; >, greater

spectrographic analyses (percent)								
Be	Ca	Co	Cr	Cu	K	Li	Mg	Mn
0.002	1.0	<0.001	0.02	0.03	3	<0.005	2.0	0.2
.002	1.0	<.001	.02	.02	9	<.005	1.0	.06
.002	.7	.007	.03	.03	5	.03	1.0	<.001
.003	.9	.009	.02	.02	3	.02	1.0	.03
.002	1.0	.006	.04	<.001	5	<.005	1.0	.04
.002	2.0	.01	.02	.006	5	.01	2.0	.03
.002	.6	.001	.03	.09	4	.06	1.0	.007
.002	.5	<.001	.02	.06	5	.04	.9	.004
.002	.8	<.001	.02	<.001	11	.02	1.0	.07
.002	.4	<.003	.02	<.001	3	<.005	1.0	<.001
.001	.5	<.001	.02	<.001	5	.03	1.0	.004
<.001	.3	<.001	.02	.008	4	.07	1.0	.009

General spectrographic analyses (percent)						Spectrographic Ge (ppm)	Radiometric U_3O_8 (percent)
Ni	Pb	Sr	Ti	V	Zn		
0.009	<0.03	0.04	2	0.08	0.04	<10	0.003
.01	<.03	.04	2	.08	.02	12	.003
.01	<.01	.07	2	.08	<.001	14	.003
.01	.01	.2	1	.03	.04	45	.003
.01	<.01	.2	2	.07	<.001	43	.004
.02	<.01	.2	2	.02	.01	20	.002
.004	.02	.05	2	.05	.003	15	.004
.004	.02	.05	2	.05	<.001	17	.004
.008	<.01	.04	3	.05	<.001	<10	.003
.009	<.03	.03	2	.03	<.001	10	.003
.006	<.01	.08	3	.02	.001	10	.003
.005	<.01	.04	3	.02	<.001	<10	.003

Laurelly Branch. Areas underlain by coal assigned to the reserve base are shown in figure 8.

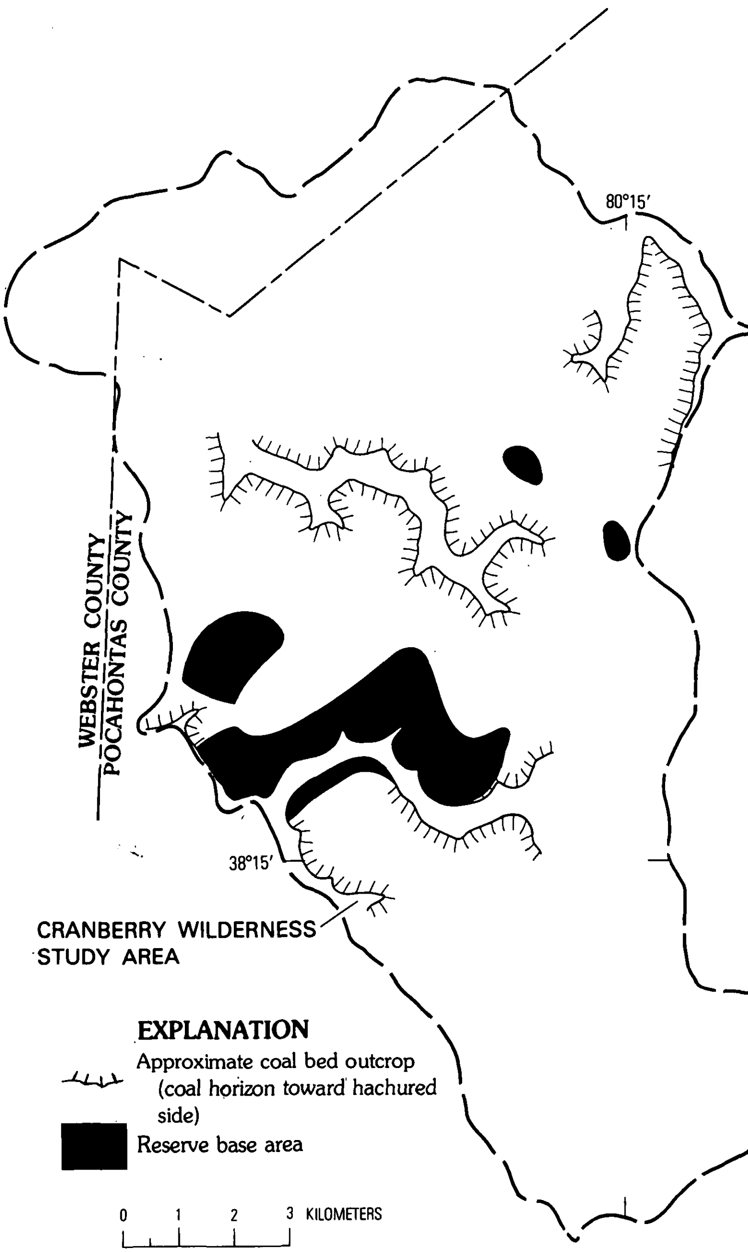


FIGURE 8.—Reserve base area, Pocahontas No. 3(?) coal bed.

The estimates for the coal resources, reserve base, and reserves for the Pocahontas No. 3 coal bed are as follows:

	Metric tons
Coal resources	20,490,000
Reserve base	13,586,000
Reserves	[1] 6,531,000

[1] The estimate for reserves excludes the two small northernmost blocks because they are considered too small to be economically minable.

The potential for mining this coal bed is high because of the large estimated reserve tonnages and good surface access. The reserves would be accessible to mining only from mine entries within the study boundary.

Pocahontas No. 3 (?) coal bed samples WVC–623 and WVC–624 (table 2) were collected adjacent to caved adits. Coal from the bed is tentatively ranked as medium-volatile bituminous; however, fixed carbon values show a large variation that may be due to the weathered condition of the samples. The analytical data indicate that the coal has a low sulfur content and a high ash content. The washability tests (table 3) show that the coal can be cleaned to meet marginal- to premium-grade coking coal standards.

POCAHONTAS NO. 3(?) RIDER COAL BED

The Pocahontas No. 3 (?) rider generally lies about 5 m above the Pocahontas No. 3(?). The bed thickness ranges from 0 to 107 cm and locally includes a shale parting 5–8 cm thick. A pod of thin coal identified as the Pocahontas No. 3 (?) rider underlies mountainsides near the east-central boundary of the area (pl. 3). Coal of minable thickness is located only along the Cranberry River in the west-central part of the area (fig. 9).

The estimates for the coal resources, reserve base, and reserves for the Pocahontas No. 3 (?) rider coal bed are as follows:

	Metric tons
Coal resources	1,034,000
Reserve base	525,000
Reserves	263,000

The reserves identified during this study are confined to a small block accessible to mining only from entries within the study area. Recovery could be possible in conjunction with deep mining of the underlying Pocahontas No. 3 (?) coal bed.

LITTLE FIRE CREEK(?) COAL BED

Little Fire Creek (?) coal bed lies from 3 to 49 m above the base of the New River Formation. The bed ranges in thickness

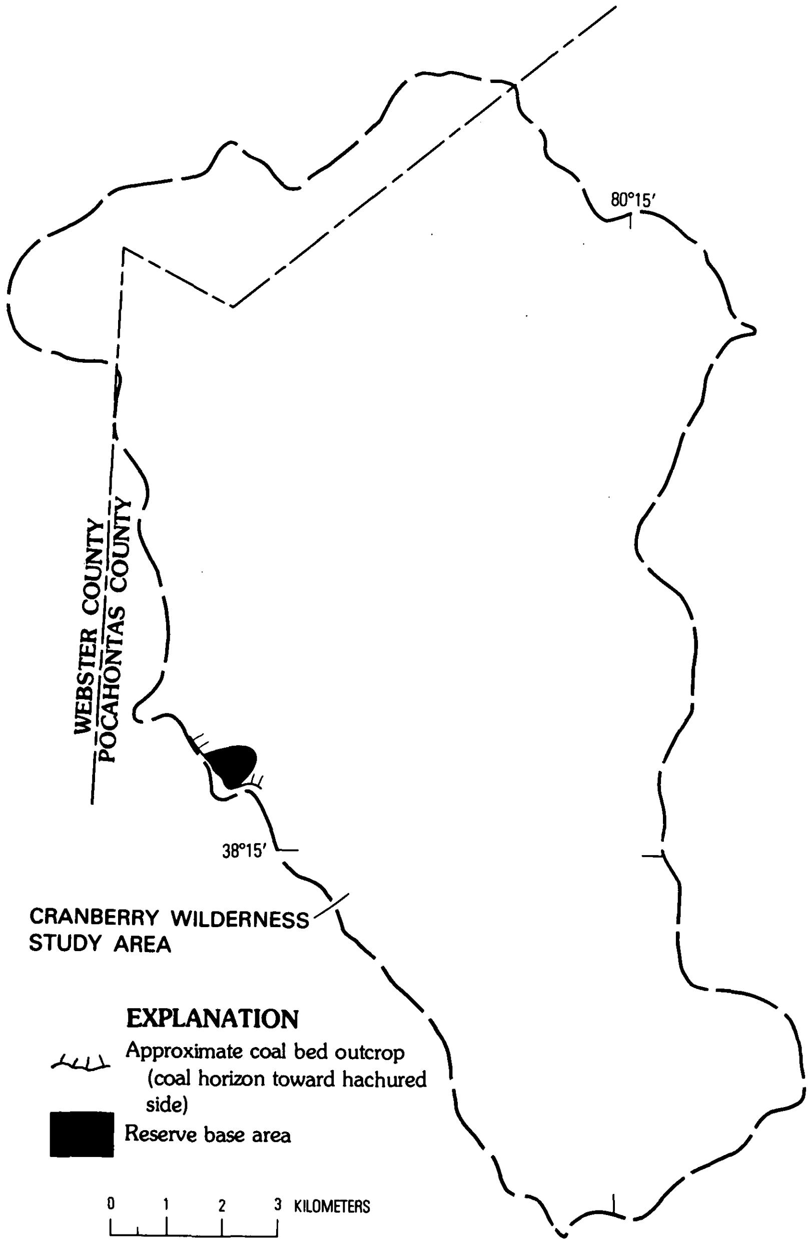


FIGURE 9.—Reserve base area, Pocahontas No. 3(?) rider coal bed.

from 0 to 97 cm and locally contains thin bony coal and shale partings. The bed underlies an area along the North Fork east of Cashcamp Run and at the head of the Middle Fork of the Williams

River (pl. 3). Coal of minable thickness lies along the east-central boundary of the study area (fig. 10).

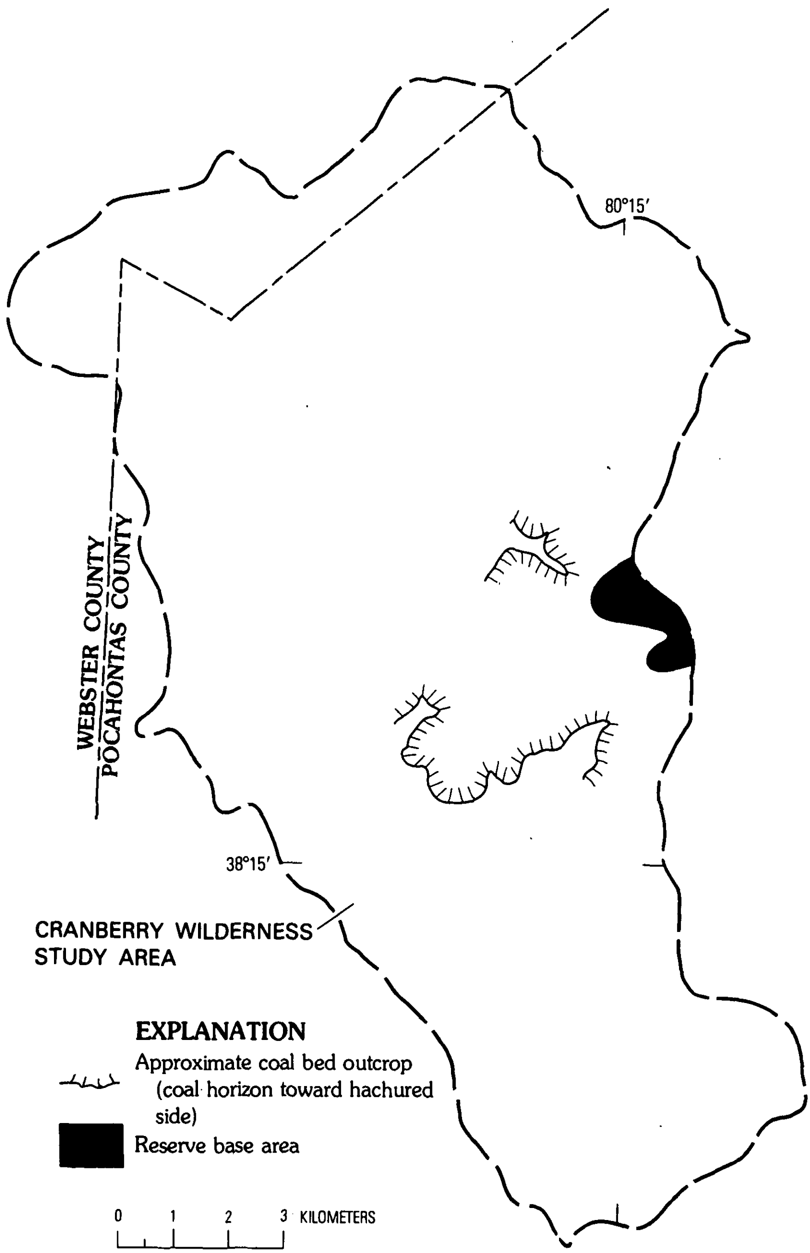


FIGURE 10.—Reserve base area, Little Fire Creek(?) coal bed.

The estimates for coal resources, reserve base, and reserves of the Little Fire Creek(?) coal bed are as follows:

	Metric tons
Coal resources	3,865,000
Reserve base	1,619,000
Reserves	810,000

This coal bed would be accessible by drift mining from entries outside the boundary of the study area. Mining from within the area would require the sinking of a vertical or inclined shaft.

FIRE CREEK(?) COAL BED

The Fire Creek(?) coal bed occurs about 60 m above the Pocahontas No. 3(?) coal bed. Where present as a single bed, the coal thickness varies from 0 to 147 cm, but locally the coal splits into two or more beds. Although most of the study area is underlain by the Fire Creek(?), blocks containing coal 35 cm thick or more are widely separated (pl. 3). The bed crops out on the mountainsides along the North Fork, Tumbling Rock Run, Cranberry, Williams, and Middle Fork of the Williams Rivers. Reserve blocks occur mainly along Tumbling Rock Run, but two small blocks have been identified in the central and eastern parts of the area (fig. 11). The lateral extent of this coal bed has been defined by core drilling, except in the mountains east of the Cranberry River and south of the North Fork where there has been no drilling. A prospect pit in this part of the study area suggests that the Fire Creek(?) coal underlies these mountains. Isopachs projected southward from areas of both surface and subsurface control also suggest coal in this area.

The estimates for the coal resources, reserves base, and reserves of the Fire Creek(?) coal bed are as follows:

	Metric tons
Coal resources	22,243,000
Reserve base	2,079,000
Reserves	1,040,000

Coal reserves along Tumbling Rock Run would be accessible to mining only from entries within the area. The central reserve block has a small tonnage that lessens the potential for mining of this coal. The easternmost reserve block would be accessible to underground mining from entries outside the study boundary.

Four samples of the Fire Creek(?) coal bed were collected and their analyses are shown in table 2. Tentatively, the raw coal is ranked as high-volatile A to medium-volatile bituminous. Samples

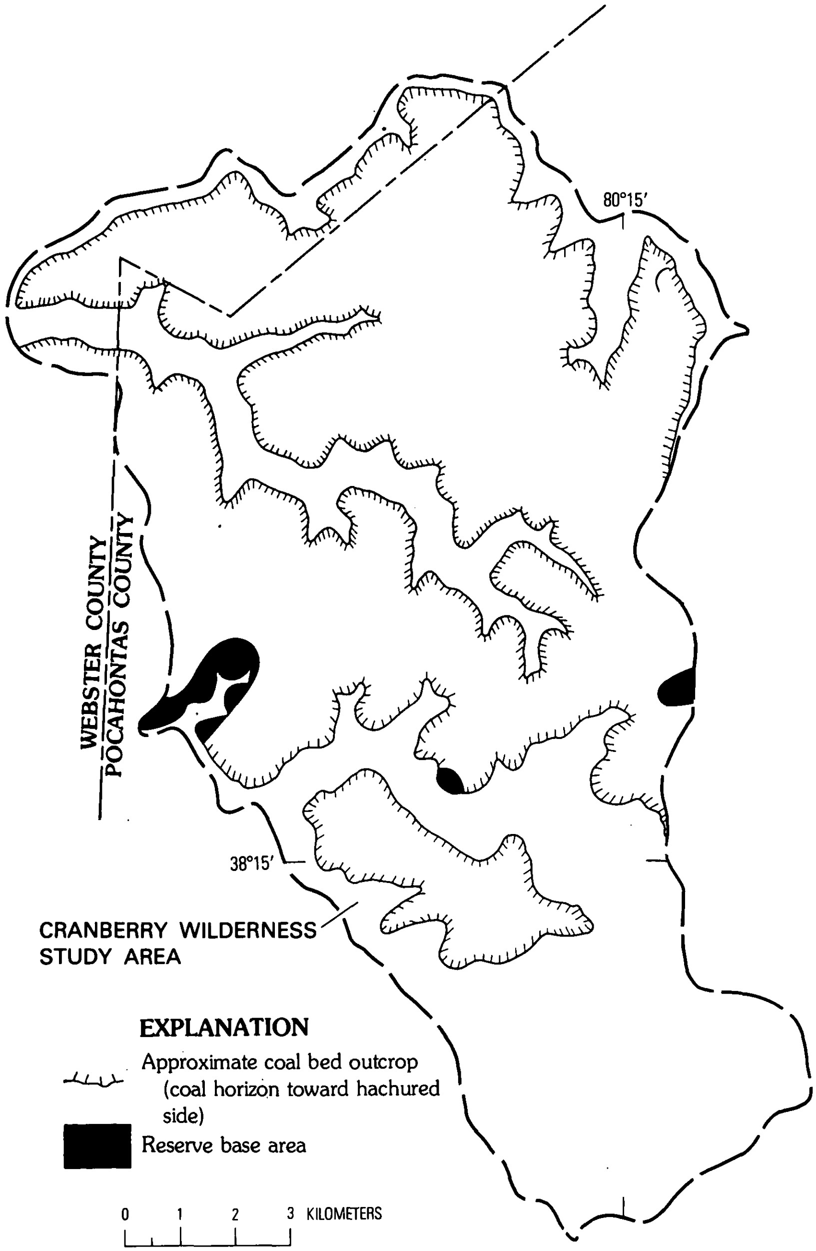


FIGURE 11.—Reserve base area, Fire Creek(?) coal bed.

WVC–613 and 614 were taken from opposite ribs at the face of the adit on Tumbling Rock Run (fig. 12). The coal has low sulfur and ash contents and is of premium coking-coal quality. Samples

FIGURE 12.—Adit along Tumbling Rock Run.

WVC–616 and 617 were taken from outside a caved adit on the north side of North Fork; WVC–616 is from the upper coal bench, WVC–617, the lower coal bench. These benches are separated by 11 cm of underclay. Both samples are low in sulfur, but have a moderate ash content, which may in part be due to weathering.

BECKLEY(?) COAL BED

The Beckley(?) coal bed is about 18 to 24 m above the Fire Creek(?) and underlies most of the northern half of the area (pl. 3). Thickness ranges from 0 to 145 cm; thin shale partings are locally present. The thickest part of the bed lies in the east-central part of the study area, where it is of minable thickness (fig. 13).

In much of the northern quarter of the area, the bed is less than 35 cm thick and locally may be absent. At least 30 prospect trenches are known in the Beckley(?) along the mountainsides north of North Fork and the upper tributaries of Middle Fork. South of North Fork are no known drill holes or prospects, but isopachs projected in this area suggest that the bed is thin or absent.

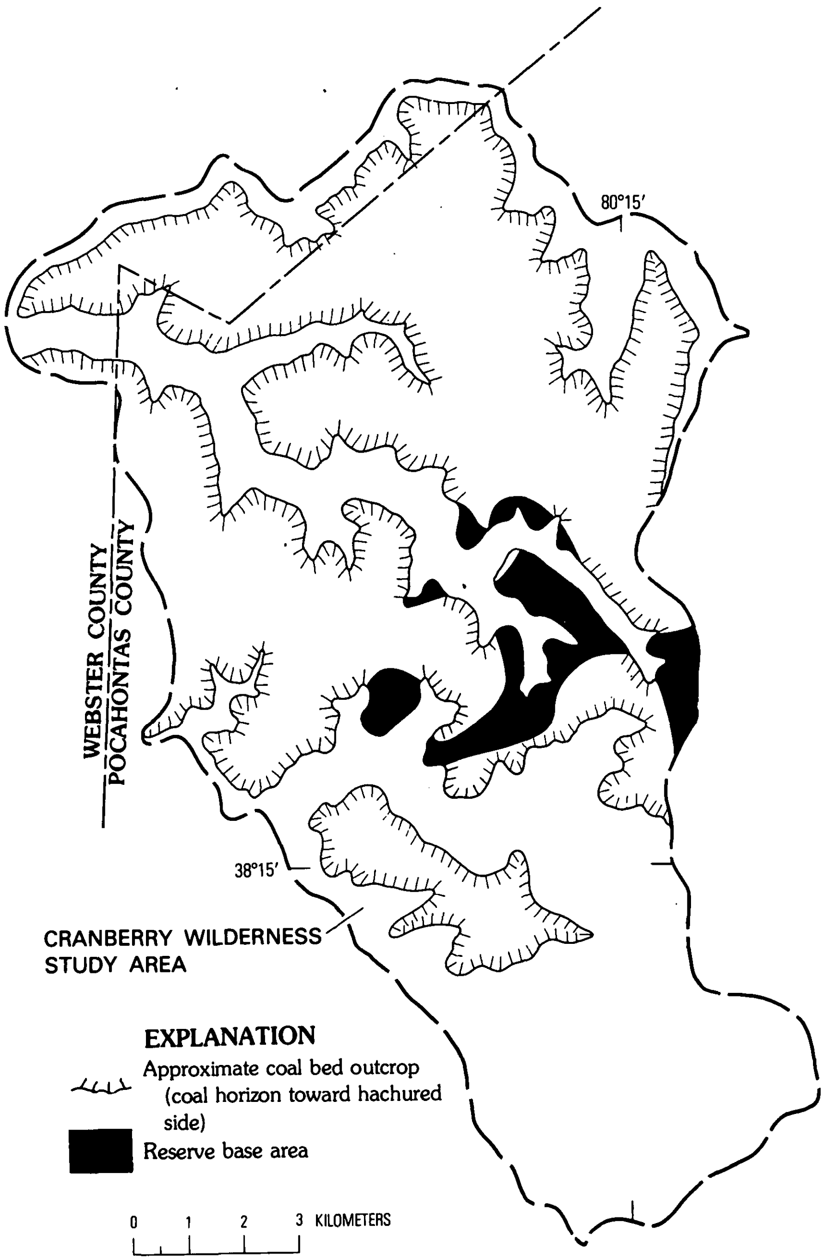


FIGURE 13.—Reserve base area, Beckley(?) coal bed.

The estimates for coal resources, reserve base, and reserves are:

	Metric tons
Coal resources	22,553,000
Reserve base	6,847,000
Reserves	3,424,000

Reserves would be easily accessible to underground mining from entries within the study boundary. The easternmost block of coal could also be mined from entries outside the area.

Three sample analyses, WVC–608, 634, and 651 (table 2), indicate that the raw coal can be ranked tentatively as medium-volatile bituminous. The coal bed has a low sulfur and ash content and is of premium coking-coal quality.

LITTLE RALEIGH(?) COAL BED

The Little Raleigh(?) coal bed lies about 55 m above the Beckley(?). The bed ranges in thickness from 0 to 107 cm, and contains sporadic thin partings of shale and bony coal. A bony coal layer, 5 to 30 cm thick, occurs in several areas below and, in some places, above the bed. The coal is split locally into three or more beds separated by as much as 5 m of intervening strata. Most of the resource and reserve base lies between the Middle Fork of the Williams River and Tumbling Rock Run (pl. 3 and fig. 14). Portions of the bed have been partly or entirely removed as a result of channel washouts that occurred during or shortly after the coal deposition.

The estimates for the coal resources, reserve base, and reserves of the Little Raleigh(?) coal bed are:

	Metric tons
Coal resources	17,193,000
Reserve base	8,449,000
Reserves	4,225,000

Areas having a bony coal layer at the top or bottom of the coal bed were excluded from these reserve base tonnages where the exclusion of the bony layer made the bed less than 70 cm thick.

A high potential exists for mining this coal bed. Underground-mining plans have been developed by Mid Allegheny Corp. for the large reserve base block between Laurelly Branch and Tumbling Rock Run and for the northwesternmost block. Coal in the northwesternmost and southwesternmost blocks would be accessible to mining from entries outside the study boundary; the remaining coal could be mined only from entries within the area.

Three samples, WVC–626, 627, and 659 (table 2), from inside adits indicate that the raw coal can be ranked tentatively as high-volatile A to medium-volatile bituminous. Sulfur and ash contents are low and the coal is of premium coking-coal quality. Washability tests for a bulk sample from an adit and three drill holes are shown in table 3.

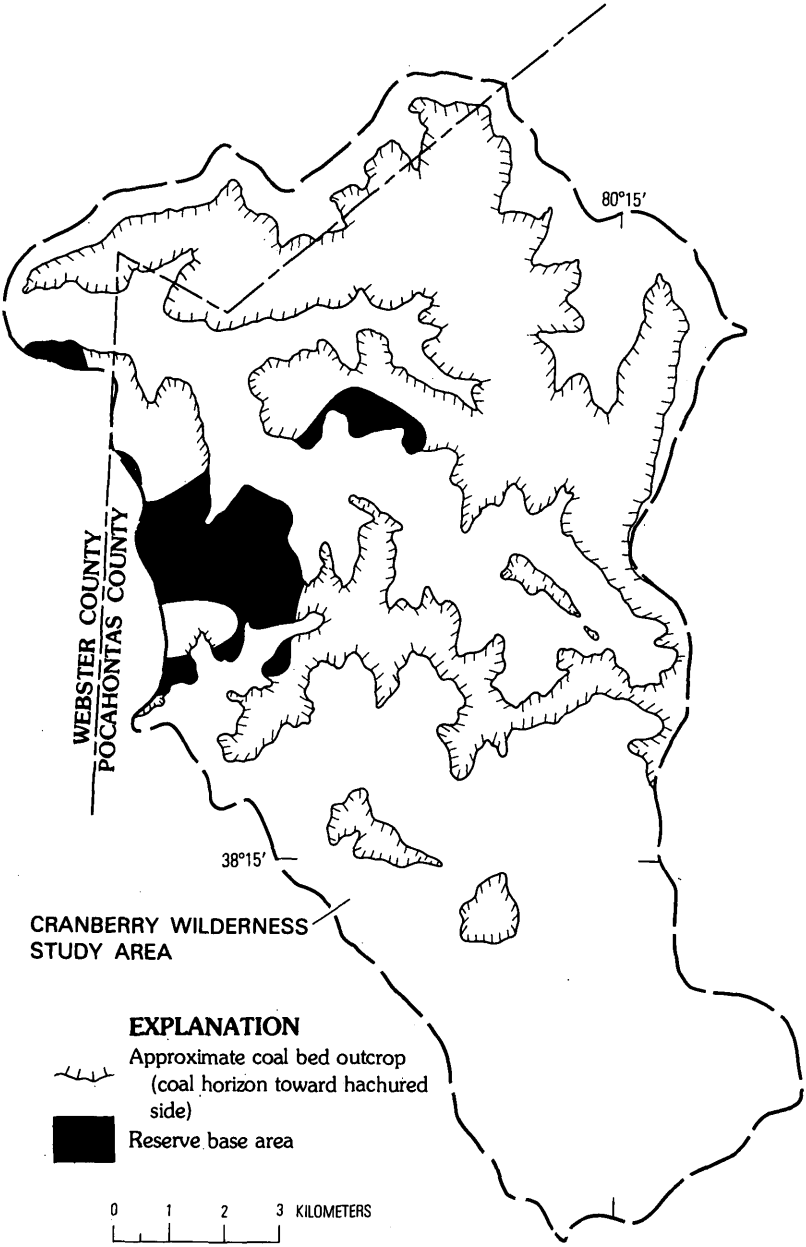


FIGURE 14.—Reserve base area, Little Raleigh (?) coal bed.

LITTLE RALEIGH (?) RIDER COAL BED

The Little Raleigh (?) rider coal bed is generally from 6 to 12 m above the Little Raleigh (?). The bed ranges in thickness from

0 to 81 cm and in some areas consists of two or more splits separated by as much as 5 m. The coal generally is impure, and scattered thin shale and bony coal partings are present. Channel washouts have partly or completely removed the coal in some places. The thickest coal is along the east-central edge of the study area where the bed is free of partings and is as much as 81 cm thick (pl. 3). A small resource block occurs northwest of Hateful Run in the east-central part of the area. The area underlain by the coal reserve base is shown in figure 15.

The estimates for the coal resources, reserve base, and reserves of the Little Raleigh (?) rider are:

	Metric tons
Coal resources	2,638,000
Reserve base	1,074,000
Reserves	537,000

The limited reserve tonnage lessens the potential for mining of the Little Raleigh (?) rider. Mining would have to be from entries within the study boundary because of restrictions on mining at shallow depths below State Scenic Highway 150.

SEWELL COAL BED

The Sewell coal bed occurs about 55 m above the Little Raleigh (?). The bed ranges in thickness from 0 to 69 cm, and locally contains thin bony coal and shale partings. Thickest coal occurs in two small pods, one in the northeast part of the study area and the other in the west-central part (pl. 3). None of the coal is considered to be of minable thickness.

The coal resources of the Sewell coal bed are 10,044,000 metric tons.

This bed was correlated into the area from known Sewell coal in mines and drill holes to the southwest. A marker bed of conglomeratic sandstone, which lies 0 to 15 m above the coal, aided in the correlation.

HUGHES FERRY(?) COAL BED

The Hughes Ferry (?) coal bed occurs from 104 to 113 m above the Sewell. The bed ranges in thickness from 48 to 61 cm, and locally contains shale partings. This coal bed occurs only in a small area near the top of a ridge between Little Fork and Laurelly Branch (pl. 3). None of the coal is considered to be of minable thickness.

Coal resources of the Hughes Ferry (?) coal bed are 930,000 metric tons.

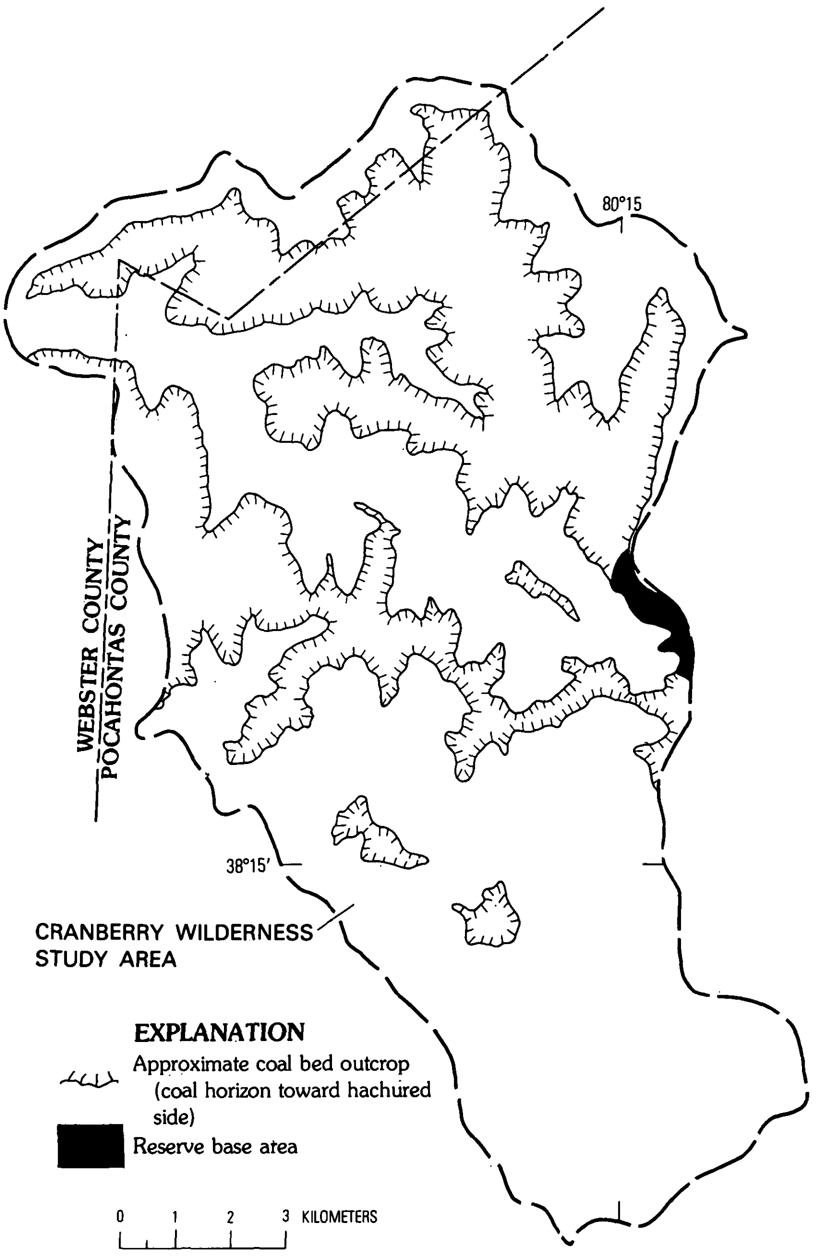


FIGURE 15.—Reserve base area, Little Raleigh (?) rider coal bed.

PEAT RESOURCES

By CORNELIA C. CAMERON and ANDREW E. GROSZ
U.S. GEOLOGICAL SURVEY

Peat, which is partly decomposed vegetable matter that accumulated under water or in a water-saturated environment, has a wide range of physical and chemical properties. For statistical purposes, the U.S. Bureau of Mines classifies peat into three general types. Material from decomposed *Sphagnum, Hypnum,* or other moss groups is classified as moss peat; that from reed-sedge, shrub, and tree groups is classified as reed-sedge peat; and material so decomposed that its botanical identity is obscured and further oxidation of the material has been impeded is classified as humus peat. The American Society for Testing and Materials restricts the classification of commercial quality peat to that having an ash content not exceeding 25 percent. Ash content consists of solids remaining after dry peat has been heated at 550°C.

The peat deposits in the Cranberry Wilderness Study Area are restricted to an area of approximately 304 ha, called the Cranberry Glades, on the valley floor of Cranberry River and its principal tributary, Charles Creek. This valley floor is about 7 km long and from 0.5 to a little more than 1.0 km wide. It lies at an elevation between 1,037 m at its upper or eastern end and 1,021 m at the lower end.

Cranberry Glades includes several peat bogs that total about 46 ha—(1) Big Glade (fig. 16), (2) Long Glade, (3) Round Glade, and (4) Flag Glade.

A forest consisting of red spruce, hemlock, yellow birch, and black ash borders these glades. Shrubs in the forest include winterberry, wild raisin, rhododendron, and yew. Sphagnum and other mosses grow over much of the forest floor. The principal deposits of commercial quality reed-sedge and moss peat occur in the form of open bogs. Their dominant floral cover is sedge, grass, moss, high bush cranberry (vibernum), low shrubs, and dwarf trees.

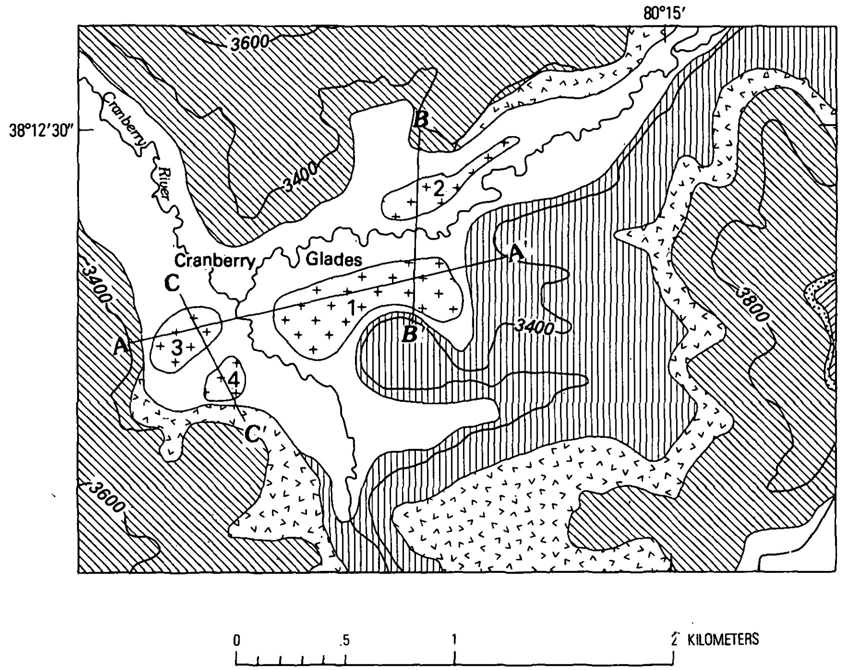
The uniqueness of Cranberry Glades in the Southern Appalachians has stimulated study since 1898 (Core, 1955). The most extensive study was made by Darlington (1943), who conducted observations over a period of 12 years and made pace and compass traverses. He obtained his profile data from 100 holes by using a Hiller peat sampler. Cameron (1970, 1972) also made subsurface studies of the Glades using a Davis peat sampler and a Macaulay peat auger. This summary of peat resources in the Cranberry

FIGURE 16.—View of Big Glade.

Wilderness Study Area is based on previous studies, together with current sampling and mapping during the spring of 1977.

The steep-sided, flat-floored valley containing Cranberry Glades is incised in sandstone and shale. Peat appears to have accumulated on a northwest-dipping homocline. Darlington (1943) suggested lateral erosion as a cause of widening of the Cranberry River system in shale and siltstone of the Bluefield Formation (fig. 17). This lateral erosion was caused by natural damming of the Cranberry River headwaters where they come to grade on the more resistant Stony Gap (?) Sandstone Member.

Noticeable encroachment of the forest has taken place within the past 25 years and is associated with a drop of water table. Cores of the peat deposits taken during the present study show the following sequence from the bottom upward: alluvial silt, light blue-gray pond clay, peaty clay (at least 50 percent ash content), clayey peat (25 to 50 percent ash content), reed-sedge peat containing wood, and finally sphagnum-moss peat. The first peat began to form an estimated 10,000 years ago (Darlington, 1943). It formed in marshes on filled-in ponds and in depressions behind natural levees. The moss peat produced raised bogs over the marsh surfaces. Note the location of the sphagnum and reed-sedge peat deposits in the interfluves on the geologic map (fig. 17).



EXPLANATION

QUARTERNARY
- Alluvium clay, silt, sand and gravel, covered by reed-sedge and humus peat 0–1 meter thick; ash content generally greater than 25 percent
- Sphagnum and reed-sedge peat 1–2 meters thick; ash content less than 25 percent

PENNSYLVANIAN
- Bluestone Formation

MISSISSIPPIAN
- Princeton(?) Sandstone
- Hinton Formation
- Stony Gap(?) Sandstone Member of the Hinton Formation
- Bluefield Formation

1 Big Glade
2 Long Glade
3 Round Glade
4 Flag Glade

FIGURE 17.—Geologic map of the Cranberry Glades, and vicinity, Cranberry Wilderness Study Area. Points *A–A′*, *B–B′*, and *C–C′* mark locations of profiles of peat deposits shown in figure 18.

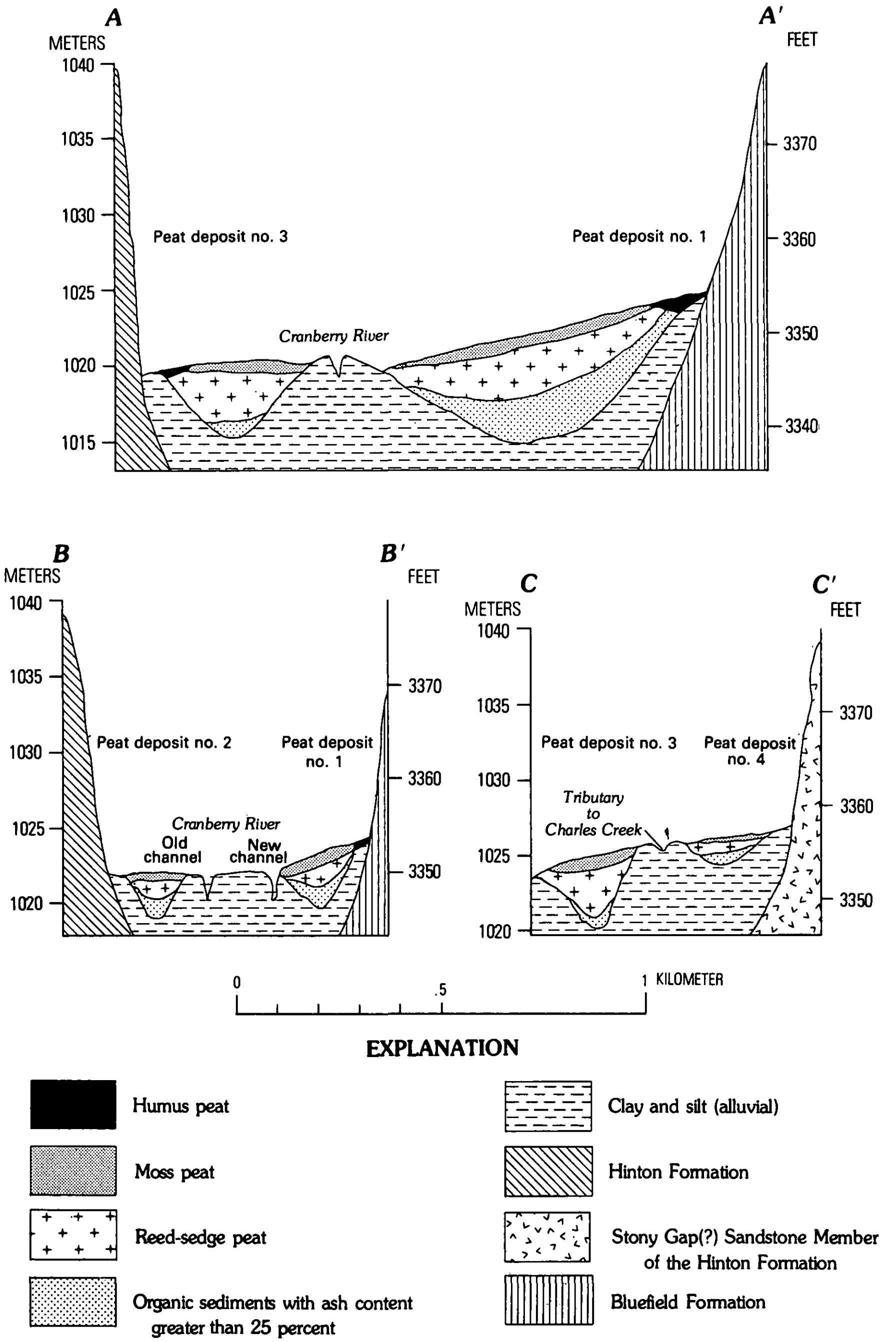


FIGURE 18.—Generalized profiles of peat deposits showing relation to drainage. Locations are shown on map (fig. 17). Deposits occupy abandoned stream channels behind natural levees in which present streams are entrenched.

TABLE 5.—*Size, thickness, and tonnages of four major peat bogs in the Cranberry Glades*

Deposit number (see fig. 17)	Size (hectares)	Average thickness (m)	Metric tons (air-dried peat)
1. Big Glade	24	1.2	43,500
2. Long Glade	8	.6	7,500
3. Round Glade	11	1.2	20,300
4. Flag Glade	3	.6	2,900
Total			74,200

The three profiles on figure 18 show the stratigraphy of the peat deposits and their positions relative to the modern stream system.

Although the reed-sedge and sphagnum peat reach maximum depths of 1 to 2.5 m in the four major bogs, average thicknesses are 0.6-1.2 m (table 5). The amount of peat in these bogs ranges from 2,900 to 43,500 metric tons and totals 74,200 metric tons of air-dried peat. One or two thousand additional tons may lie in small scattered basins in Cranberry Valley Alluvium mapped (fig. 17) as reed-sedge and humus peat 0 to 1.2 m thick, containing ash content generally greater than 25 percent. Peat deposits in the Cranberry Wilderness Study Area are too small and thin to consider exploiting commercially, at present.

Using a soil probe, the U.S. Bureau of Mines collected 6 peat samples to achieve a balanced distribution of material through the profile. Proximate analyses of these samples (table 6) show that the peat is of fuel quality and has low ash and sulfur contents and adequate heating value.

SHALE AND CLAY

Sixteen shale and underclay samples from the Bluefield, Hinton, Bluestone, and New River Formations, and from Quaternary deposits in the study area were subjected to standard preliminary ceramic tests (table 7, pl. 2B). Tests indicate that all samples except WVC–604 and 641 are suitable for building brick. Sample WVC–606 is also considered marginally suitable for structural tile and sample 609 for floor brick. Two samples (WVC–609 and 643) expanded during the quick-firing bloating test, but only sample WVC–643 is considered suitable for lightweight aggregate in the short-firing range.

Underclay samples were analyzed for aluminum by atomic absorption (table 8). None of the tested samples showed a content high enough to be considered a source of alumina.

TABLE 6.—*Proximate analyses of peat samples, Cranberry Wilderness Study Area, W. Va.*

[Prepared by: Maynard L. Dunn, Jr., U.S. Bureau of Mines. Analyses by Department of Energy, Division of Solid Fuel Mining and Preparation, Coal Analysis (formerly U.S. Bureau of Mines, Coal Preparation and Analysis Group), Pittsburgh, Pa. Symbols used: AR, as received; MF, Moisture free; MAF, Moisture and ash free. Samples were oven dried; consequently, heating values may be high]

Bog name and sample number	Condition of sample	Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Calorific value (Btu/lb)
Flag Glade ----	AR	7.8	51.4	20.9	19.9	0.4	7,153
WVC–661	MF	---	55.7	22.7	21.6	.5	7,755
	MAF	---	71.1	28.9	---	.6	9,894
Round Glade --	AR	7.8	63.9	20.1	8.2	.2	8,518
WVC–662	MF	---	69.4	21.7	8.9	.2	9,242
	MAF	---	76.1	23.9	---	.3	10,141
Big Glade -----	AR	7.5	61.4	21.1	10.0	.3	8,224
WVC–642	MF	---	66.4	22.8	10.8	.4	8,892
	MAF	---	74.4	25.6	---	.4	9,974
WVC–644 ---	AR	9.7	63.1	23.6	4.6	.3	8,212
	MF	---	69.1	25.8	5.1	.3	8,994
	MAF	---	72.8	27.2	---	.3	9,475
WVC–666 ---	AR	8.2	62.6	23.0	6.2	.3	8,250
	MF	---	68.2	25.1	6.7	.4	8,983
	MAF	---	73.1	26.9	---	.4	9,633
Long Glade ---	AR	7.2	53.1	18.6	21.1	.2	7,377
WVC–667	MF	---	57.2	20.1	22.7	.2	7,945
	MAF	---	74.0	26.0	---	.3	10,275

Because of the abundance of shale and clay in the State, these deposits could not compete economically with more readily available material outside the study area.

HIGH-SILICA SANDSTONE

Twelve sandstone and conglomeratic sandstone samples were taken from exposures and drill cores in the study area (pl. 2B). Analyses show that three samples have a silica (SiO_2) content greater than 90 percent, but all have higher percentages of aluminum (Al), iron (Fe), magnesium (Mg), and titanium (Ti) than are considered suitable for high-silica sand (table 8). Locally, some sandstones may qualify for low-quality glass sand; the great distance from markets reduces their economic potential.

STONE

Sandstone and conglomeratic sandstone suitable for construction purposes are present in the study area. According to Reger and others (1920, p. 540), attempts to quarry the Princeton(?) Sandstone in the southeastern quarter of Webster County for building blocks were not economically successful, but they believed that the material seemed well adapted for concrete aggregate.

TABLE 7.—*Evaluation of shale and clay samples,*

[Analyses by the U.S. Bureau of Mines, Tuscaloosa Metallurgy Research Center, Tuscaloosa, or process design]

Sample number	Sample interval (meters)	Formation 2/	Raw properties	Temp. 3/ °C
WVC-602	0.7	Pnr	Water of plasticity: 12.7%	1000
			Working properties: short	1050
			Drying shrinkage: 2.5%	1100
			Dry strength: fair	1150
			pH: 7.5	1200
			HCl effervescence: none	1250
WVC-604	1.7	Pnr	Water of plasticity: 17.4%	1000
			Working properties: short	1050
			Drying shrinkage: 2.5%	1100
			Dry strength: poor	1150
			pH: 7.8	1200
			HCl effervescence: none	1250*
WVC-605	1.5	Pnr	Water of plasticity: 13.4%	1000
			Working properties: short	1050
			Drying shrinkage: 2.5%	1100
			Dry strength: fair	1150
			pH: 7.6	1200
			HCl effervescence: none	1250*
WVC-606	2.1	Pnr	Water of plasticity: 16.2%	1000
			Working properties: plastic	1050
			Drying shrinkage: 2.5%	1100
			Dry strength: fair	1150
			pH: 7.5	1200
			HCl effervescence: none	1250
WVC-609	2.1	Pnr	Water of plasticity: 14.5%	1000
			Working properties: plastic	1050
			Drying shrinkage: 2.5%	1100
			Dry strength: fair	1150
			pH: 7.5	1200
			HCl effervescence: none	1250
WVC-612	9.1	Mh	Water of plasticity: 18.6%	1000
			Working properties: plastic	1050
			Drying shrinkage: 5.0%	1100
			Dry strength: good	1150
			pH: 5.2	1200
			HCl effervescence: none	1250
WVC-615	7.6	PMb	Water of plasticity: 16.8%	1000
			Working properties: plastic	1050
			Drying shrinkage: 5.0%	1100
			Dry strength: good	1150
			pH: 5.5	1200
			HCl effervescence: none	1250

Cranberry Wilderness Study Area, W. Va.[1]

Ala. All data presented are based on preliminary laboratory tests and will not suffice for plant

Slow firing test						
Munsell color	Mohs' hardness	Linear shrinkage (percent)	Absorption (percent)	Apparent porosity (percent)	Bulk density (gm/cc)	Potential use
7.5 YR 8/4	3	2.5	13.4	26.3	1.94	Building brick
7.5 YR 8/4	3	2.5	13.4	26.1	1.96	
7.5 YR 7/6	3	2.5	11.3	22.9	2.03	
7.5 YR 7/6	4	2.5	9.9	20.1	2.03	
7.5 YR 7/[illegible]	4	5.0	9.2	19.1	2.07	
2.5 Y 7/2	6	5.0	3.5	7.9	2.27	
7.5 YR 8/4	2	2.5	16.9	30.4	1.80	None, too soft below 1250°C
5 YR 8/4	2	2.5	16.5	29.7	1.80	
5 YR 7/6	3	2.5	14.5	26.9	1.86	
5 YR 6/6	3	2.5	13.2	24.8	1.87	
5 YR 6/4	3	5.0	12.2	23.2	1.91	
10 YR 5/2	6	7.5	3.0	6.6	2.24	
5 YR 8/4	3	2.5	15.8	29.7	1.88	Building brick
5 YR 7/4	3	2.5	15.5	29.1	1.88	
5 YR 7/6	3	5.0	12.6	24.6	1.96	
5 YR 6/6	4	5.0	10.8	21.7	2.01	
5 YR 6/4	4	5.0	10.1	20.6	2.05	
2.5 YR 6/2	6	5.0	3.3	7.0	2.14	
7.5 YR 9/2	3	5.0	15.4	29.1	1.82	Building brick
7.5 YR 9/2	3	5.0	15.0	27.4	1.89	Structural tile
7.5 YR 8/4	3	5.0	12.6	25.0	1.98	
7.5 YR 8/4	4	5.0	10.4	21.4	2.06	
10 YR 7/4	4	5.0	7.0	14.7	2.09	
2.5 YR 7/2	5	5.0	4.8	10.9	2.24	
2.5 YR 6/4	3	5.0	29.0	49.0	1.69	Building brick
2.5 YR 5/4	4	5.0	13.7	27.6	2.01	Floor brick
2.5 YR 4/4	5	7.5	9.7	21.2	2.18	
2.5 YR 3/4	5	7.5	7.5	16.7	2.23	
10 R 4/2	6	10.0	5.5	12.7	2.33	
10 R 3/1	7	10.0	1.4	3.4	2.38	
2.5 YR 6/8	3	5.0	19.7	37.0	1.88	Building brick
2.5 YR 5/8	4	7.5	8.2	17.6	2.16	
2.5 YR 5/6	5	10.0	3.9	9.2	2.37	
2.5 YR 4/6	5	10.0	2.4	5.7	2.42	
-	-	Melted	-	-	-	
-	-	-	-	-	-	
2.5 YR 6/8	3	5.0	15.8	26.2	1.66	Do.
2.5 YR 6/8	3	5.0	11.4	23.4	2.06	
2.5 YR 5/8	4	7.5	7.7	17.1	2.22	
2.5 YR 4/8	5	7.5	5.4	12.4	2.29	
2.5 YR 4/6	6	10.0	4.0	9.4	2.33	
2.5 YR 3/2	7	10.0	2.1	5.0	2.33	

TABLE 7.—*Evaluation of shale and clay samples,*

Sample number	Sample interval (meters)	Formation[2/]	Raw properties	Temp.[3/] °C
WVC-618	0.1	Pnr	Water of plasticity: 17.8%	1000
			Working properties: plastic	1050
			Drying shrinkage: 2.5%	1100
			Dry strength: good	1150
			pH: 5.6	1200
			HCl effervescence: none	1250
WVC-636	3.0	PMb	Water of plasticity: 15.1%	1000
			Working properties: plastic	1050
			Drying shrinkage: 2.5%	1100
			Dry strength: good	1150
			pH: 6.2	1200
			HCl effervescence: slight	1250
WVC-639	6.1	PMb	Water of plasticity: 14.0%	1000
			Working properties: plastic	1050
			Drying shrinkage: 2.5%	1100
			Dry strength: good	1150
			pH: 6.7	1200
			HCl effervescence: slight	1250
WVC-641	6.1	PMb	Water of plasticity: 13.0%	1000
			Working properties: plastic	1050
			Drying shrinkage: 2.5%	1100
			Dry strength: good	1150
			pH: 7.7	1200
			HCl effervescence: high	1250
WVC-643	0.3	Q	Water of plasticity: 23.8%	1000
			Working properties: plastic	1050
			Drying shrinkage: 2.5%	1100
			Dry strength: good	1150
			pH: 4.9	1200
			HCl effervescence: none	1250
WVC-645	2.4	PMb	Water of plasticity: 13.6%	1000
			Working properties: plastic	1050
			Drying shrinkage: 0%	1100
			Dry strength: fair	1150
			pH: 6.6	1200*
			HCl effervescence: slight	1250
WVC-654	0.8	Pnr	Water of plasticity: 15.7	1000
			Working properties: short	1050
			Drying shrinkage: 2.5%	1100
			Dry strength: poor	1150
			pH: 5.7	1200
			HCl effervescence: none	1250

Cranberry Wilderness Study Area, W. Va.[1]—Continued

Slow firing test						
Munsell color	Mohs' hardness	Linear shrinkage (percent)	Absorption (percent)	Apparent porosity (percent)	Bulk density (gm/cc)	Potential use
5 YR 8/4	3	2.5	13.4	25.8	1.93	Building brick
5 YR 8/4	3	5.0	11.9	24.7	2.08	
5 YR 7/6	5	5.0	7.2	15.5	2.15	
5 YR 6/6	6	7.5	4.9	10.9	2.22	
2.5 YR 5/4	6.5	10.0	2.4	5.5	2.28	
-	-	Melted	-	-	-	
2.5 YR 6/8	3	2.5	16.6	30.5	1.83	Do.
2.5 YR 5/8	3	5.0	11.9	24.2	2.03	
2.5 YR 5/6	4	5.0	7.7	16.7	2.18	
2.5 YR 4/6	5	7.5	5.0	11.2	2.26	
2.5 YR 3/4	6	10.0	2.7	6.3	2.31	
-	-	Melted	-	-	-	
2.5 YR 6/8	3	2.5	16.6	30.5	1.83	Do.
2.5 YR 5/8	4	5.0	11.9	24.2	2.03	
2.5 YR 4/6	4	5.0	7.7	16.7	2.18	
2.5 YR 4/4	5	5.0	5.0	11.2	2.26	
10 R 4/2	6	5.0	2.7	6.3	2.31	
-	-	Melted	-	-	-	
2.5 YR 5/8	3	2.5	10.7	22.1	2.06	None, short firing range
2.5 YR 5/8	3	2.5	10.1	21.6	2.13	
2.5 YR 4/6	4	5.0	5.0	11.2	2.26	
2.5 YR 3/4	6	5.0	1.8	4.2	2.34	
-	-	Melted	-	-	-	
-	-	-	-	-	-	
7.5 YR 8/6	3	5.0	18.7	33.1	1.77	Building brick
7.5 YR 8/6	3	5.0	18.1	32.2	1.78	
5 YR 6/8	4	7.5	7.4	15.8	2.12	
5 YR 5/6	5	7.5	4.7	10.3	2.19	
5 YR 5/4	6	10.0	2.6	5.8	2.26	
-	-	Expanded	-	-	-	
2.5 YR 6/8	3	2.5	15.6	29.5	1.89	Do.
2.5 YR 6/8	3	5.0	15.3	29.2	1.91	
2.5 YR 5/6	4	5.0	11.3	22.7	2.01	
2.5 YR 4/4	5	5.0	6.6	14.1	2.15	
2.5 YR 3/2	6	7.5	1.1	2.6	2.29	
-	-	Melted	-	-	-	
5 YR 7/6	3	2.5	14.2	27.4	1.93	Do.
5 YR 7/6	3	2.5	13.7	26.6	1.95	
2.5 YR 6/8	4	5.0	7.3	15.8	2.17	
2.5 YR 5/8	5	5.0	6.2	13.6	2.21	
2.5 YR 5/4	6	7.5	4.3	9.8	2.26	
-	-	Melted	-	-	-	

TABLE 7.—*Evaluation of shale and clay samples,*

Sample number	Sample interval (meters)	Formation2/	Raw properties	Temp.3/ °C
WVC-664	2.4	PMb	Water of plasticity: 17.0%	1000
			Working properties: plastic	1050
			Drying shrinkage: 5.0%	1100
			Dry strength: fair	1150
			pH: 7.0	1200
			HCl effervescence: slight	1250
WVC-668	1.8	Q	Water of plasticity: 24.9%	1000
			Working properties: plastic	1050
			Drying shrinkage: 2.5%	1100
			Dry strength: good	1150
			pH: 4.9	1200
			HCl effervescence: none	1250*

Preliminary

Sample number	Temp. °C	Absorption (percent)	Bulk density (gm/cc)	Bulk density (lb/ft³)
WVC-609	1000	10.4	1.75	109.4
	1050	10.5	1.65	103.2
	1100	10.2	1.59	99.2
	1150	24.9	0.75	46.6
WVC-643	1100	7.8	1.85	115.3
	1150	7.3	1.79	111.4
	1200	6.1	1.56	97.2
	1250	7.1	0.86	53.7

1/ Analyses by the U.S. Bureau of Mines, Tuscaloosa Metallurgy Research Center, laboratory tests and will not suffice for plant or process design.
2/ Pnr--New River Formation; PMb--Bluestone Formation; Mh--Hinton Formation;
3/ Asterisk denotes abrupt vitrification prior to temperature noted.
4/ All samples except WVC-609 and 643 showed negative preliminary bloating

602 - Drill core, medium gray underclay, about 228 meters below surface.
604 - Drill core, medium dark gray flinty underclay, about 92 meters below surface.
605 - Drill core, medium gray underclay, about 208 meters below surface.
606 - Drill core, light gray underclay, about 194 meters below surface.
609 - Outcrop, black carbonaceous shale.
612 - Roadcut, grayish-red shale.
615 - Outcrop, grayish-red shale.
618 - Outcrop, dark gray underclay.

Cranberry Wilderness Study Area, W. Va.[1]—Continued

Slow firing test						
Munsell color	Mohs' hardness	Linear shrinkage (percent)	Absorption (percent)	Apparent porosity (percent)	Bulk density (gm/cc)	Potential use
2.5 YR 6/8	3	5.0	12.2	24.7	2.02	Building brick
2.5 YR 6/8	3	5.0	11.6	23.7	2.04	
2.5 YR 5/6	4	7.5	6.3	14.0	2.21	
2.5 YR 4/6	5	10.0	5.8	12.7	2.21	
10 R 4/4	6	10.0	4.0	9.0	2.25	
-	-	Melted	-	-	-	
5 YR 7/8	3	5.0	29.3	43.6	1.49	Do.
5 YR 7/8	3	5.0	20.5	34.8	1.70	
2.5 YR 6/8	4	7.5	18.7	32.0	1.71	
2.5 YR 5/8	4	7.5	11.6	22.4	1.94	
2.5 YR 5/6	4	10.0	8.6	17.2	2.00	
10 YR 4/2	6	10.0	1.3	2.7	2.10	

bloating test[4/]

Remarks	Potential use
Slight expansion	Not suitable for lightweight aggregate
Slight expansion	
Good pore structure (sticky)	
Some large pores (sticky)	
Slight expansion	Marginal for lightweight aggregate
Good pore structure	
Good pore structure	
Some large pores	

Tuscaloosa, Alabama. All data presented are based on preliminary

Q--Quaternary.

test results.

636 - Outcrop, grayish-red shale.
639 - Roadcut, grayish-red and greenish-gray shale.
641 - Roadcut, grayish-red silty shale.
643 - Auger core, light gray underclay, below peat.
645 - Outcrop, medium gray shale.
654 - Roadcut, dark gray underclay.
664 - Roadcut, grayish-red and greenish-gray shale.
668 - Outcrop, light reddish-gray to light gray underclay, below peat.

TABLE 8.—*Analyses of rock samples from*

[Analyses performed by U.S. Bureau of Mines, Reno Metallurgy Research Center, Reno, Nev. spectrographically and detected but less than the lower limit(s) of determination (unless B (0.01–0.03), Be (0.001), Bi (0.06–0.5), Cd (0.001–0.004), Co (0.001–0.003), Cu (0.001), (0.001–0.003), P (0.2–0.5), Pb (0.03–0.1), Pd (0.001), Pt (0.003–0.009), Sb (0.03– V (0.001–0.004), W (0.04–0.1), Y (0.005–0.01), Zr (0.002–0.009). All numbers given in possible error of plus or minus 100 percent of reported concentration is assumed. Symbols and lower limits of determination may vary because of interference corrections]

Sample number	General spectrographic analyses (percent)										
	Al	Ba	Ca	Cr	Fe	K	Li	Mg	Mn	Sr	Ti
WVC-601	2	<0.002	<0.1	<0.001	3	<2	<0.001	0.1	0.02	<0.001	0.5
WVC-602	12	.04	<.1	.005	3	3	.007	1	.01	.001	2
WVC-603	.8	<.002	<.1	<.002	4	<3	<.001	.04	.01	<.001	.2
WVC-604	7	.01	<.1	.003	3	4	.006	2	.03	<.001	1
WVC-605	8	.02	<.1	.005	3	4	.006	2	.04	.001	.9
WVC-606	14	.03	<.1	.004	4	<3	.01	1	.04	.001	2
WVC-609	9	.03	<.1	<.004	13	4	<.004	.9	.3	<.001	1
WVC-612	11	.03	<.2	<.002	6	3	<.002	3	.03	.004	2
WVC-615	14	.02	.2	.005	7	3	.008	2	.06	.002	1
WVC-618	13	.03	<.1	.002	3	6	.008	2	.02	.002	1
WVC-628	6	.008	3	<.002	4	<2	<.002	1	.2	.002	.7
WVC-629	3	<.002	<.1	<.001	3	<2	<.001	.2	.01	<.001	.6
WVC-632	8	.01	<.1	<.001	5	<2	<.001	1	.03	<.001	1
WVC-633[2]	6	.004	<.1	<.001	4	<2	<.001	1	.03	<.001	.7
WVC-636	8	.02	.3	<.001	5	3	.003	3	.05	<.001	1
WVC-638	1	<.002	3	<.001	5	<2	<.001	.9	.1	<.001	.3
WVC-639	9	.02	1	<.004	7	<6	<.004	2	.07	<.001	2
WVC-640	8	.02	1	<.001	4	<2	<.001	1	.06	.001	.9
WVC-641	13	.02	2	<.004	7	<6	<.004	2	.07	.005	3
WVC-643	7	.02	<.1	.003	3	3	.001	2	.02	.004	.9
WVC-645	9	.02	2	.002	5	3	.002	2	.09	.002	1
WVC-646	1	<.002	<.1	<.001	5	2	<.002	.02	.02	<.001	.4
WVC-647	.6	<.002	<.1	<.001	1	<2	<.001	<.002	.004	<.001	<.3
WVC-654	12	.06	<.3	<.004	8	6	<.004	2	.07	.002	4
WVC-655[3]	.7	<.004	<.2	<.002	4	3	<.002	.04	.06	<.001	<.3
WVC-664	6	.02	.4	.004	4	3	.007	2	.05	.002	1
WVC-668	5	.02	<.1	.003	3	2	.004	2	.02	.002	.9
WVC-671[4]	.3	<.007	<.3	<.004	3	<6	<.004	.02	.04	<.001	<.5
WVC-673	1	<.002	3	<.001	3	<2	<.001	.7	.1	.007	<.2
WVC-674	<.2	<.002	<.1	.001	2	<2	.002	<.002	.01	<.001	<.2
WVC-675	8	.01	<.1	.003	4	<2	<.001	1	.07	.003	.7

1/ Calculated value from elemental determination.
2/ Contains .02 percent Zr by spectrographic analysis.
3/ Contains .006 percent Ag by spectrographic analysis.
4/ Contains .006 percent Cu by spectrographic analysis.

the Cranberry Wilderness Study Area, W. Va.

Samples are random chips every 2-10 cm through interval noted. Elements tested for otherwise noted in footnote) include: Ag (0.002–0.005), As (0.006–0.02), Au (0.001–0.004), Ga (0.001–0.002), La (0.01–0.03), Mo (0.002–0.007), Na (1–6), Nb (0.002–0.005), Ni 0.1), Sc (0.001–0.002), Se (0.9–3), Sn (0.002–0.01), Ta (0.03–0.1), Te (0.01–0.2), percent. Si occurs in all samples greater than the upper detection limit (20–40 percent). A used: <, detected but less than lower limit of determination; —, not looked for. The upper

	Atomic absorption 1/ (percent)		Neutron activation 1/ (percent)	Radiometric 1/ (percent)	Sample interval (meters)	
Zn	Al_2O_3	Fe_2O_3	SiO_2	U_3O_8		Sample description
<0.001	--	--	89	0.001	11.7	Sandstone
<.001	17	2.8	70.4	--	.7	Underclay
<.001	1.2	1.4	96.2	.001	3.4	Sandstone
<.001	12.4	3.2	72.9	--	1.6	Underclay
<.001	18	4.3	63.5	--	1.5	Do.
<.001	19.8	4.7	57.6	--	2.1	Underclay
<.001	--	--	--	.002	2.1	Shale-carbonaceous
.001	18	7.7	--	--	9.1	Shale
<.001	18.7	7.7	--	--	7.6	Do.
<.001	--	--	--	--	.1	Underclay
<.001	--	--	--	.001	3.6	Sandstone
.001	--	--	--	.001	4.2	Do.
<.001	--	--	--	--	3.6	Do.
<.001	--	--	--	--	7.6	Do.
<.001	16.1	5.6	--	--	3	Shale
<.001	3.7	5.8	--	.001	4.2	Conglomerate
<.001	16.7	8.4	--	--	7.6	Shale
<.001	--	--	--	--	8.8	Sandstone
<.001	--	--	--	--	6.1	Shale
.01	16.1	3.7	--	--	.3	Underclay
.003	--	--	--	--	2.4	Shale
<.001	--	--	--	--	4.6	Sandstone
<.001	1	.95	--	.001	7.9	Sandstone/conglomerate
<.001	21.8	5.3	60.6	.001	.8	Underclay
<.001	--	--	--	.001	1.5	Sandstone/conglomerate
.005	16.6	7.7	--	--	2.4	Shale
.003	12.4	3.7	76.3	--	1.8	Underclay
<.001	.74	2.3	96.2	.001	1.2	Sandstone/conglomerate
.008	2.7	2.3	81.1	.001	1.2	Conglomerate
.002	.42	1	97.6	--	1.5	Sandstone/conglomerate
.004	11.3	4.7	85.6	--	.4	Underclay

The possibility of commercial development of any of the sandstone units in the study area is low because stone is abundant throughout the State (Price, 1952, p. 10) and the study area is not readily accessible.

The Greenbrier Limestone of Mississippian age crops out southeast of the study area and is mined about 7 km to the southeast. This unit is not exposed in the study area, but was found in an oil and gas test well at a depth of 451 m in the western part of the study area. Because of this depth below the surface and abundance of limestone to the south and southeast, the Greenbrier Limestone is not considered an economic mineral resource in the study area.

OIL AND GAS POTENTIAL

By WILLIAM J. PERRY, JR.
U.S. GEOLOGICAL SURVEY

Exploration drilling (table 9) suggests a remote chance for gas, but virtually no chance for oil in and near the Cranberry Wilderness Study Area.

Only one exploratory well, Pocahontas No. 8 (table 9), has been drilled within the study area (fig. 19). This well was drilled to a depth of 1,389 m and bottomed in Upper Devonian beds. No shows of oil or gas were reported. In a second exploratory well (Webster No. 2), drilled 7 km west of the western tip of the study area, shows of gas in Lower Mississippian sandstones were found, as well as a show in the overlying Greenbrier Limestone. This well lies on the crest of the north-northeast trending Webster Springs anticline, which does not cross the wilderness area (fig. 19). The gas on the anticline was probably structurally trapped, but was not present in sufficient quantities to warrant production. The closest current gas production is in western Webster County, approximately 19 km to the northwest. A very old well, Pocahontas Land Company No. 1 (Poca-'O', fig. 19 and table 9), was drilled 2 km east of the study area. Price and Reger (1929, p. 103–104) questioned the show of oil reported in the lower part of the Pocono Sandstone, in this hole. No shows of oil have been subsequently reported in wells in the area during the succeeding 40 years of oil and gas exploration, and furthermore, no oil discovery is expected in this area because of the high thermal maturity of the rock.

Shows of gas have been found in the Huntersville Chert (Middle Devonian) and underlying Oriskany Sandstone (Lower Devonian)

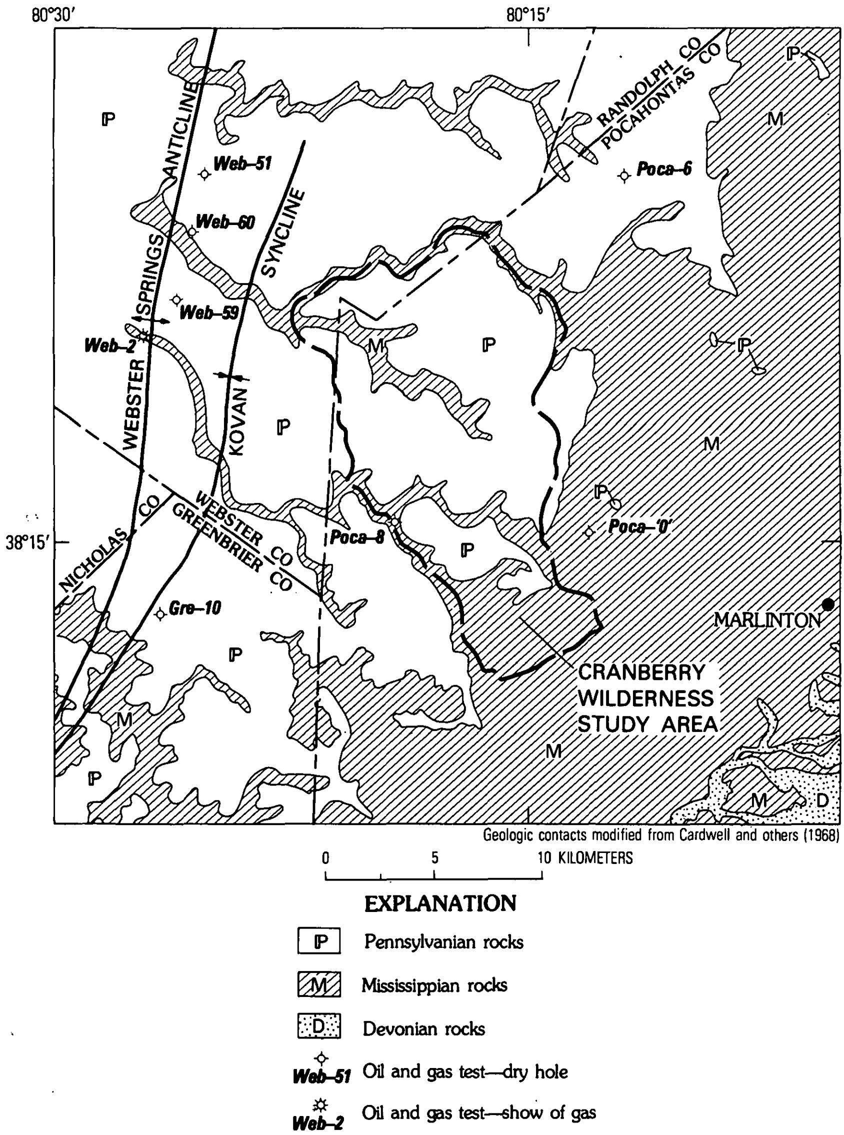


FIGURE 19.—Generalized geologic map of the Cranberry Wilderness Study Area and surrounding area.

in only two deeper wells west of the study area, Webster No. 59 and No. 60. Natural gas may be present in the "Benson" or other Upper Devonian sands, but none has been found to date. These formations are unexplored under the study area, but, on the basis of nearby dry holes, probably lack sufficient porosity to warrant

TABLE 9.—*Test wells drilled for oil and*

County and permit no.	Operator—lease	Elevation (m)	Total Depth (m)
Greenbrier 10	Columbian Carbon-Cherry River Boom and Lumber Co. No. 1 (GW–1247)	879	1423
Pocahontas 0 (No permit number) Source: Price (1929, p. 103–104)	Pocahontas Coal and Land Co. No. 1	1033	924
Pocahontas 6	Logan Gas Development Co.-Cherry Boom and Lumber Co. No. 1	1046	1373
Pocahontas 8	Columbian Carbon-Gauley Co. No. 4 (GW–1269)	978	1389
Webster 2	Hope Natural Gas Co.-W. Va. & Pittsburgh R. R. Co. No. 9227	768	1946
Webster 51	Columbian Carbon-Gauley Co. No. 3 (GW–1267)	823	1274
Webster 59	Consolidated Gas Supply—Mid-Allegheny & W. Va. and Pittsburgh R. R. Co. No. 11,300	1095	2542
Webster 60	Consolidated Gas-W. Va. and Pittsburgh R. R. Co. No. 11,431	828	2221

gas near Cranberry Wilderness Study Area, W. Va.

Lithologic zones or formations (depths in meters)		Remarks
"Big Lime" (Greenbrier Limestone)	492–626	Dry, slight show of gas at 514 m.
Sandstone	633–638	
"Broken" sandstone (with shale)	638–639	Show gas at 1383.5 m in Benson.
Red beds	774–775	
Benson sandstone	1,373–1,385	
Greenbrier Limestone	185–351	Dry, oil show (?) in sandstones of lower part of Pocono.
Pocono Sandstone	351–446	
Hampshire Formation	446–712	
"Chemung Series"	712–924 Total Depth	
"Big Lime" (Greenbrier Limestone)	367–444	Dry, saltwater.
Red beds	444–446	
Sandstone	461–469	
Red beds	675–767	
Sandstone	1,117–1,177	
Red beds	365–369	Dry, saltwater at 501 m.
"Big Lime"	451–589	
Red sandstone	589–592	
Red beds	592–595	
Chiefly red beds	13–232	Show gas at 291 m.
"Big Lime"	239–419	Saltwater at 299 m.
Red beds	419–423	Saltwater at 341.4 m.
Hard sandstone	438–450	Show gas at 444.4 m.
Sandstone	636–649	Show gas at 645 m.
Hard sandstone	701–711	Show gas at 728 m.
Sandstone	722–728	Gas 773 m.
"Big Lime"	371–457	Dry, gas show at 457 m.
Sandstone	457–474	Saltwater at 595.6 m.
"Broken" sandstone	474–492	Saltwater at 969 m in "gritty lime".
Sand	523–537	
Sand	566–613	
Sand	629–692	
"Big Lime"		
Tully equivalent	2,422–2,426	Dry, shows of gas in chert and Oriskany.
Huntersville Chert	2,447–2,495	
Oriskany Sandstone	2,495–2,527	
Helderberg Group	2,527–2,542	
"Lime and shells"	386–459	Dry, show of gas in chert.
"Big Lime" (?)	459–492	
Red beds	492–634	
Sandstone and shale	1,215–2,153	
Huntersville Chert and Onondaga Limestone	2,171–2,215	
Oriskany Sandstone	2,215–2,221	

deeper exploration. Natural gas has been found in Lower Mississippian rocks to the west, but probably does not extend as far east as the Cranberry Wilderness Study Area on the basis of results of Pocahontas No. 8.

GEOCHEMICAL SURVEY

By FRANK G. LESURE
U.S. GEOLOGICAL SURVEY

Reconnaissance geochemical sampling of the Cranberry Wilderness Study Area was done to find indistinct or unexposed mineral deposits that might be recognized by their geochemical halos. No metallic deposits have been reported in the study area, and none were found during the reconnaissance geologic mapping. The geochemical samples consist of 104 stream-sediment and 100 rock and mineral samples (pl. 2*C*).

Most small drainage basins within the study area and some adjacent to it were sampled by collecting the finest sediment possible. The samples were dried and sieved in the laboratory; the minus 80-mesh (0.177 mm) fraction was used for analyses.

The rock samples are representative of the major rock types exposed in the area. The freshest samples are from cores from four diamond-drill holes in the northwestern part of the area (pl. 2*C*). Other rock samples are from road cuts, coal prospects, and natural outcrops. Samples are mostly composites of small chips taken from a single rock unit.

All stream-sediment and rock samples were analyzed by semiquantitative emission spectrographic methods for 30 elements and chemically for zinc. Equivalent uranium (eU) was determined instrumentally by total gamma count. The analytical data are summarized in table 10, and the complete data are given in Motooka and others, 1978.

Only normal background values of elements tested were found in most of the rock and stream-sediment samples. No metallic mineral deposits of economic importance are known in rocks of these formations in the surrounding area. An extensive sampling of similar rocks in the same general stratigraphic sequence along the New River from Hinton to Gauley Bridge, W. Va., produced similar analytical results (Lesure and Whitlow, 1977).

A few samples of rock contain high values for some elements. One sample of green mudstone (WVC–139), from a layer 0.3 m thick enclosed in a thicker unit of red mudstone, contains 300 ppm copper and 2 ppm silver. The combination of Ag and Cu is a

TABLE 10.—*Range and median values for 25 elements in rock and stream sediment samples from the Cranberry Wilderness Study Area, Webster and Pocahontas Counties, W. Va.*

[All analyses are by J. M. Motooka using semiquantitative spectrographic methods except zinc, which is by J. D. Sharkey and J. R. Groves using atomic absorption methods and equivalent uranium (eU), which is by J. C. Negri using instrumental methods. Spectrographic analyses are reported to the nearest number in the series 1, 1.5, 2, 3, 5, 7, and 10, which represent approximate midpoints of group data on a geometric scale. The assigned groups for the series will include the quantitative value about 30 percent of the time. Letter symbols: L, detected but below limit of determination (value shown in parenthesis after element symbol); N, not detected; G, greater than. Elements looked for but not found and their lower limits of determination: As(200), Au(20), Bi(10), Cd(20), Sb(100), and W(50)]

Elements		Sandstone (59 samples)				Shale (39 samples)				Stream sediments (104 samples)		
		Low	High	Median	Average in sandstone [1,2]	Low	High	Median	Average in shale [2]	Low	High	Median
Percent												
Ca	(0.05)	N	10	0.05	3.9	L	15	0.2	2.21	L	0.3	L
Fe	(0.05)	0.05	20	2	.98	1.5	10	3	4.72	1	10	3
Mg	(0.02)	.02	1.5	.3	.7	.5	1.5	1.0	1.5	.1	1.0	.2
Ti	(0.002)	.07	1.0	.3	.15	.5	.7	.5	.46	.2	.7	.5
Parts per million												
Ag	(0.5)	N	N	N	[3] 0.0X	N	2	N	0.07	N	N	N
B	(10)	10	150	30	20–30	70	150	100	100	50	150	100
Ba	(20)	70	1,500	200	300	150	G 5,000	300	500	150	700	200
Be	(1)	N	3	1	2	1	3	3	3	L	7	2
Co	(5)	N	30	10	.3	7	30	20	19	N	70	15
Cr	(10)	L	150	20	10–20	50	100	70	90	15	100	50
Cu	(5)	N	50	5	10–20	5	300	30	45	L	30	15
La	(20)	N	100	N	30	N	50	30	92	N	150	20
Mn	(10)	10	3,000	500	500	150	5,000	700	850	70	G 5,000	1,000
Mo	(5)	N	15	N	.2	N	N	N	2.6	N	N	N
Nb	(20)	N	20	N	[3] .0X	L	L	L	11	L	20	L
Ni	(5)	N	70	15	2	20	70	50	68	N	70	15
Pb	(10)	N	70	N	9	N	50	20	20	N	30	10
Sc	(5)	N	15	5	1	7	15	15	13	N	15	10
Sn	(10)	N	N	N	[3] .X	N	N	N	6	N	15	N
Sr	(100)	N	150	N	20	N	300	L	300	N	200	N
V	(10)	15	200	50	10–20	50	200	150	130	30	150	100
Y	(10)	L	70	20	40	20	50	30	26	15	50	20
Zn	(5)	5	150	45	16	25	130	85	95	20	230	70
Zr	(10)	50	G 1,000	200	200–250	150	1,000	200	160	200	G 1,000	300
eU	(20)	L	30	L	—	L	20	L	—	L	20	L

[1] Pettijohn, F. J. (1963, p. S11).
[2] Turekian, K. K., and Wedepohl, K. H. (1961).
[3] Order of magnitude estimated by Turekian and Wedepohl (1961).

common association in some red-bed sequences (Lesure and others, 1977, p. 613). Another sample of mottled green and red mudstone (WVC–161) from a layer 5 cm thick contains more than 5,000 ppm barium. These samples suggest the possibility of stratabound metallic deposits in this red-bed sequence, but none have been found. Only a small part of the red-bed sequence is exposed along the northeastern edge of the study area and along the southern margin.

A few rocks contained minor amounts of iron sulfides, but only two samples were collected. WVC–149 is a composite of thin pyrite concretions and seams along a bedding plane in gray shale; WVC–167 is a composite of pyrite concretions and replacement of crinoid(?) fossils in micaceous sandstone. WVC–149 contains 5 ppm Ag, 1,000 ppm As, 1,000 ppm Ba, 500 ppm Co, 150 ppm Cu, 20 ppm Mo, 300 ppm Ni, and 100 ppm Pb. All are higher values than are normal in sedimentary rocks, but are not unusual for sedimentary sulfide concretions. WVC–167 has 1,500 ppm Ba and only background values for other elements. The pyrite concretions are scattered along certain bedding planes or in certain beds and do not represent enough material to be considered economically important.

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