COMMONWEALTH OF VIRGINIA
DEPARTMENT OF CONSERVATION
AND ECONOMIC DEVELOPMENT
DIVISION OF MINERAL RESOURCES

STRATIGRAPHY AND COAL BEDS OF UPPER MISSISSIPPIAN AND LOWER PENNSYLVANIAN ROCKS IN SOUTHWESTERN VIRGINIA

MARSHALL S. MILLER

BULLETIN 84

VIRGINIA DIVISION OF MINERAL RESOURCES
James L. Calver
Commissioner of Mineral Resources and State Geologist

CHARLOTTESVILLE, VIRGINIA
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STRATIGRAPHY AND COAL BEDS OF UPPER MISSISSIPPIAN AND LOWER PENNSYLVANIAN ROCKS IN SOUTHWESTERN VIRGINIA

By

MARSHALL S. MILLER

ABSTRACT

The stratigraphy and coal beds of Upper Mississippian and Lower Pennsylvanian rocks in Buchanan, Dickenson, Russell, Scott, Tazewell, and Wise counties in southwestern Virginia were studied primarily by examining cuttings from oil and gas tests and core samples from coal exploration tests. The rocks that were studied range from the base of the Greenbrier Limestone (Upper Mississippian) to the top of the Norton Formation (Lower Pennsylvanian), with detailed work concentrated on the stratigraphic sequence between the Little Stone Gap Member of the Hinton Formation (Mississippian) and the top of the Kennedy coal bed of the Lee and Norton formations (Pennsylvanian).

The Lee Formation unconformably overlies and successively truncates older rock units including the Pocahontas Formation to the northwest, and is composed of three quartz arenite members that tongue out successively from top to bottom into finer-textured rocks generally to the southeast. Where the Pocahontas Formation is present, the Mississippian-Pennsylvanian boundary is intertonguing; where the Pocahontas Formation is truncated or absent, the Mississippian-Pennsylvanian boundary is unconformable.

The stratigraphic sequence can be divided into five depositional periods: a northwestward progradational system during which the Greenbrier, Bluefield, and lower Hinton formations were deposited; a southeastward transgression; a northwestward regression resulting in the deposition of the Little Stone Gap Member, the Princeton interval, and Bluestone and Pocahontas formations; onlap of the Lee Formation and erosion of previously deposited lagoonal-deltaic sediments; and a regional offlap, but oscillations of the sea level establishing offlap-onlap tongues of the Lee quartz arenites. Recognition of these periods is essential in evaluating the coal resources. The occurrence of the highly regarded Pocahontas coals can be predicted by recognizing the stratigraphic position of the unconformity at the base

of the Lee Formation, whereas the predictability of Lee coals is best made by establishing paleoenvironmental patterns. Of the coals studied, the Pocahontas No. 3 and War Creek coals have the greatest economic potential.

INTRODUCTION

The area of this report lies between 36°50′ and 37°30′ north latitudes and 81°30′ and 82°50′ west longitudes encompassing about 1442 square miles (Figure 1). It includes all of Buchanan and Dickenson counties and portions of Wise, Tazewell, Russell, and Scott counties in southwestern Virginia. It comprises most

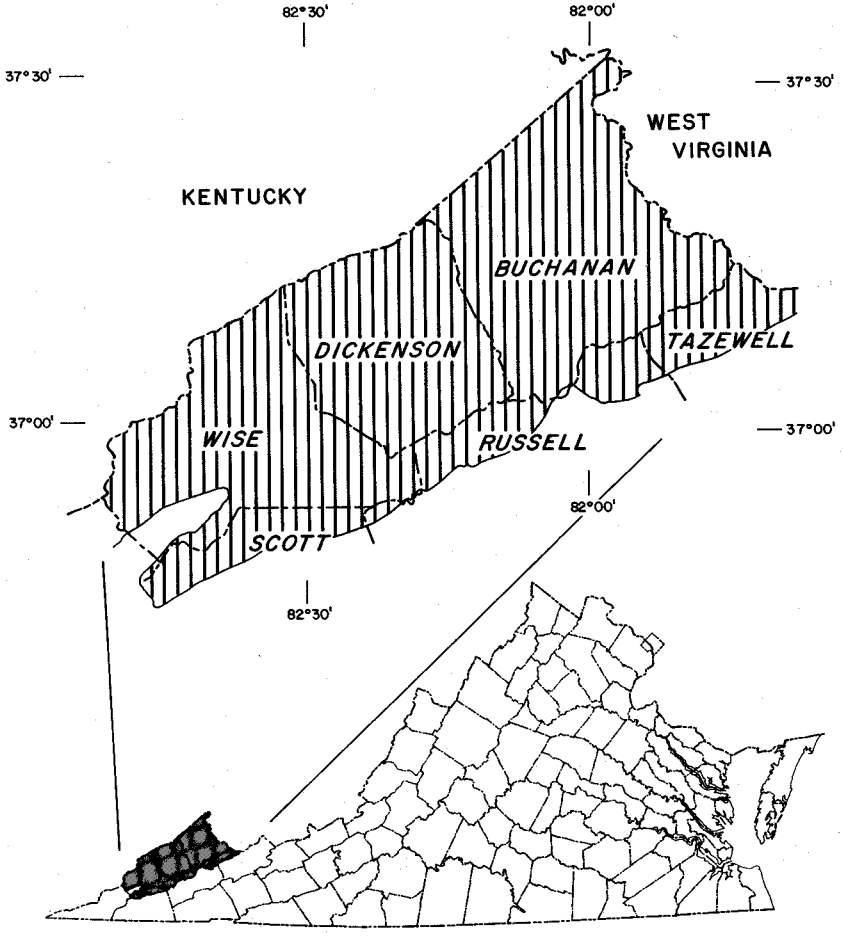

Figure 1. Index map showing location of area of study.

of the Appalachian Plateaus physiographic province in Virginia. It is bounded on the northeast by McDowell, Mercer, and Mingo counties, West Virginia; on the northwest by Pike and Letcher counties, Kentucky; on the southwest by Harlan County, Kentucky, Lee County, Virginia, and the Powell Valley anticline; and on the southeast by the St. Paul and St. Clair thrust faults.

The surface is rugged and highly dissected by narrow, winding streams (Figure 2). The drainage is ultimately to the west to

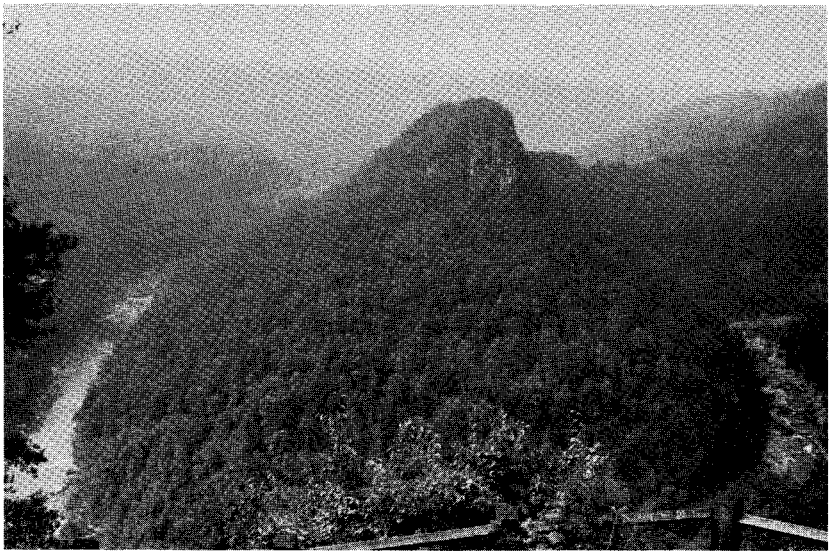

Figure 2. The "Towers" at Breaks Interstate Park, Dickenson County, is capped by the massive upper quartz arenite (Bee Rock Sandstone) member of the Lee Formation. Note deeply trenched youthful valleys and rugged topography typical of areas underlain by Pennsylvanian rocks.

the Gulf of Mexico. The elevation ranges from less than 1000 feet to more than 3500 feet above sea level. The area is well traversed by highways and railroads and produced over 34 million tons of coal in 1972 which accounted for more than 70 per cent of the mineral production value in Virginia during that year.

The rising demand for low-sulfur coal and natural gas has greatly increased exploration activities in southwestern Virginia during recent years. The purpose of this report is to present a comprehensive geologic review and study of the subsurface data in the area. The report presents subsurface maps, diagrams, il-

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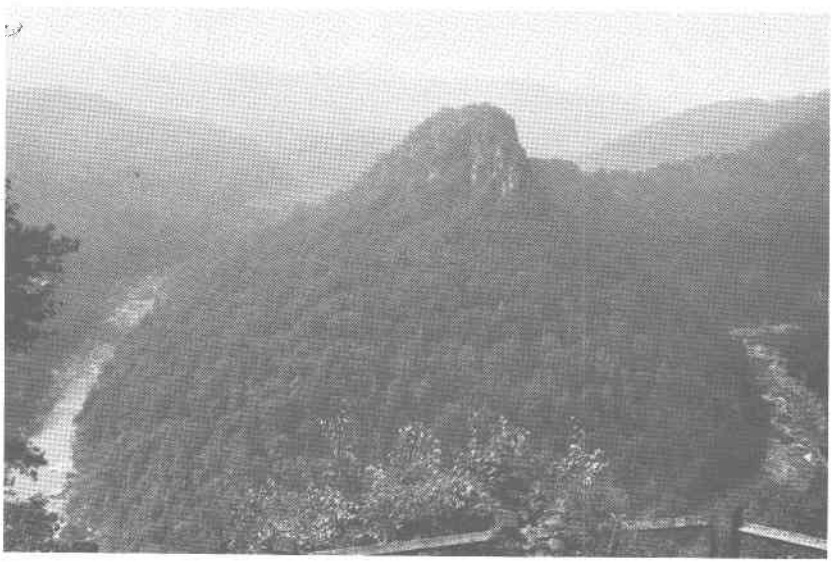

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METHOD OF STUDY

This report is based largely on information obtained from the miscroscopic study of cuttings from oil and gas tests, cores from coal exploration holes, and field examination of outcrops. The cuttings examined are chiefly from oil and gas tests drilled by cable-tool rigs. In recent years, however, nearly all oil and gas tests in southwestern Virginia have been drilled by air-rotary tools (Figure 3). Electrical and radioactivity logs, which were

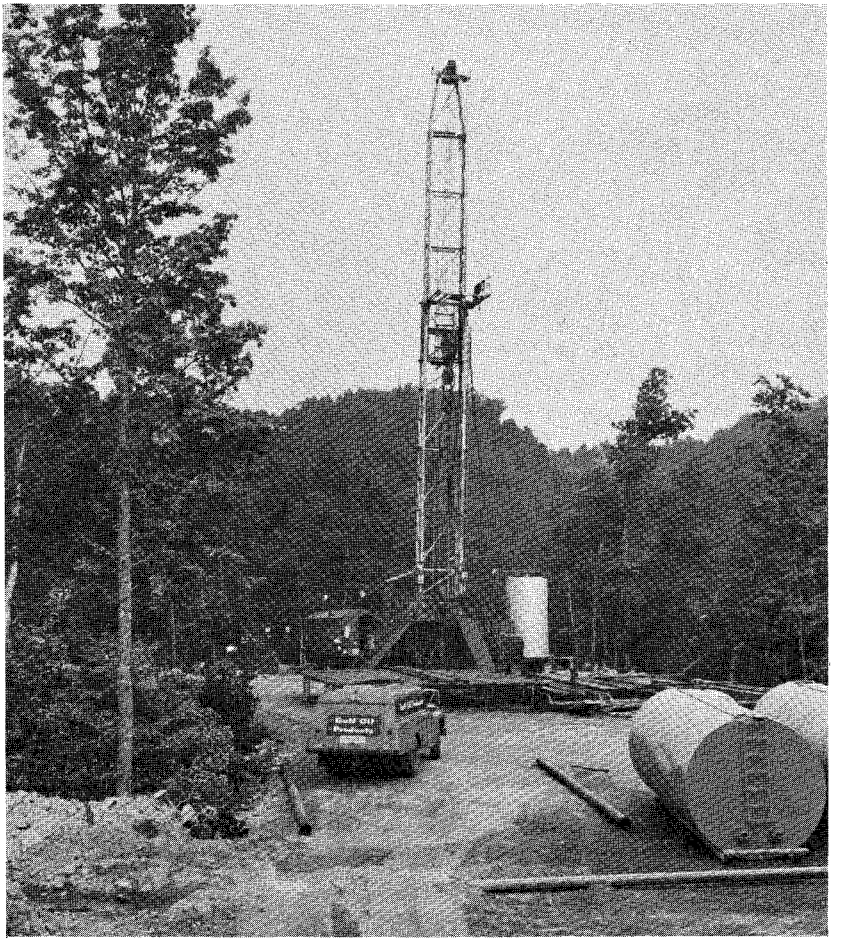

Figure 3. Portable air-rotary drilling rig used for subsurface exploration for gas.

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commonly run in these recent tests, were used extensively to supplement subsurface data in this report. Driller's logs of oil and gas tests, because of their very general descriptive terminology, were used sparingly, and then only for reference. Driller's logs for cores from exploratory tests by coal companies (Figures 4, 5) were more accurate and descriptive, and were

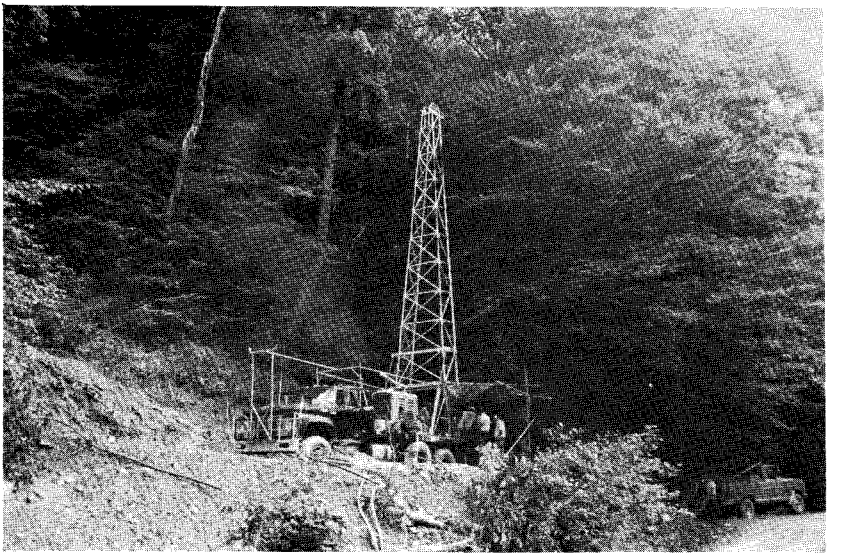

Figure 4. Truck-mounted diamond-drill coring rig for exploring subsurface coal reserves.

useful for subsurface mapping and correlations, particularly when used with well cuttings and core descriptions from nearby sections. Subsurface data from 99 oil and gas tests and 49 coal exploration tests are used in this report (Plate 1). The more detailed coal correlations were established in Buchanan County and projected into Wise and Dickenson counties. The subsurface sections which were used in this report are summarized in the Appendix. A repository number is noted for those oil and gas tests for which samples are in the repository at the Virginia Division of Mineral Resources in Charlottesville.

The cuttings were examined under a binocular microscope with magnification from 6 to 30 power. Most routine examination was made on dry samples; samples were immersed in water and examined wet as necessary to facilitate recognition of size and shape of grains, color, accessory minerals, and other diagnostic features. Grain size was determined by comparison with

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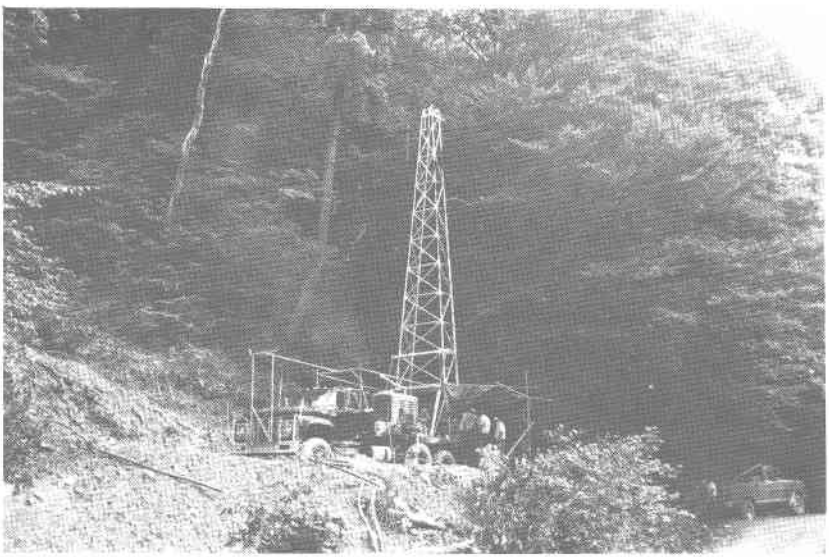

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prepared charts based on the Wentworth grade scale. Occasionally x-ray diffraction methods were used to supplement visual examinations. Special effort was made to examine cuttings from all isolated exploratory tests.

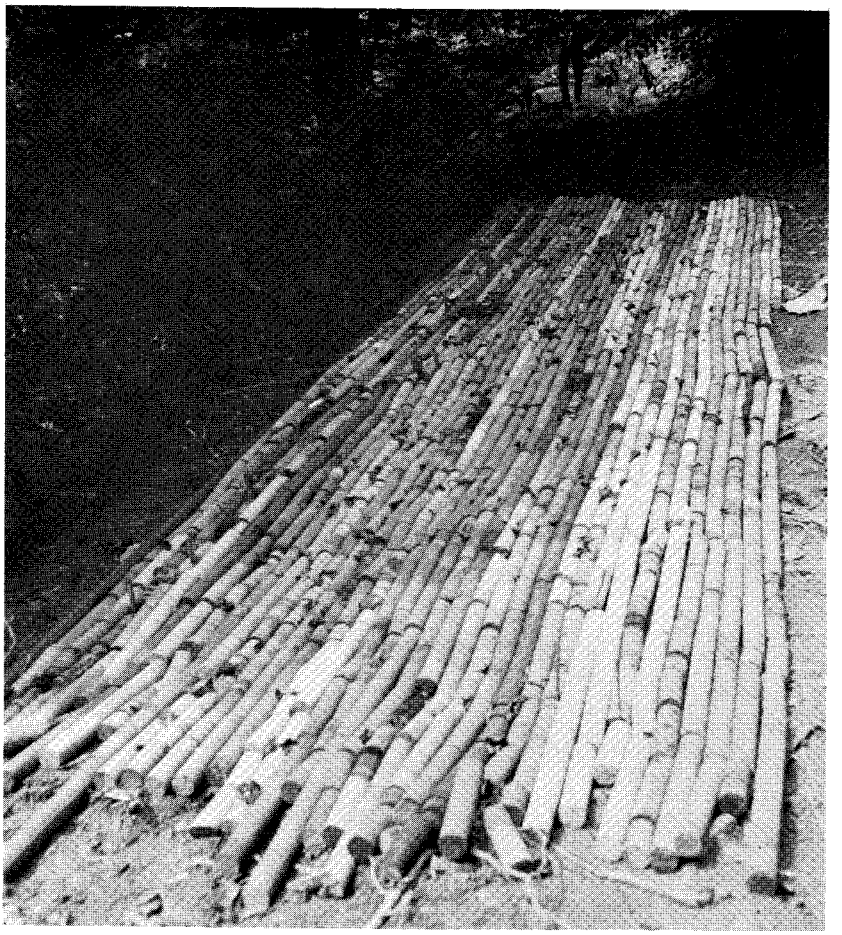

Figure 5. Coal companies in the Virginia area normally core-drill through coal-bearing strata. The core sections provide invaluable stratigraphic data.

Most of the descriptions of cuttings used for this report were done by the writer. Descriptions in the Division of Mineral Resources files prepared by other geologsts of its staff and by the U. S. and Kentucky geological surveys were utilized according to the complexity of the stratigraphic sequence. The Mississippian rocks generally are distinctive by their gross lithology so that differentiation of the sequence into units which are easy to recog-

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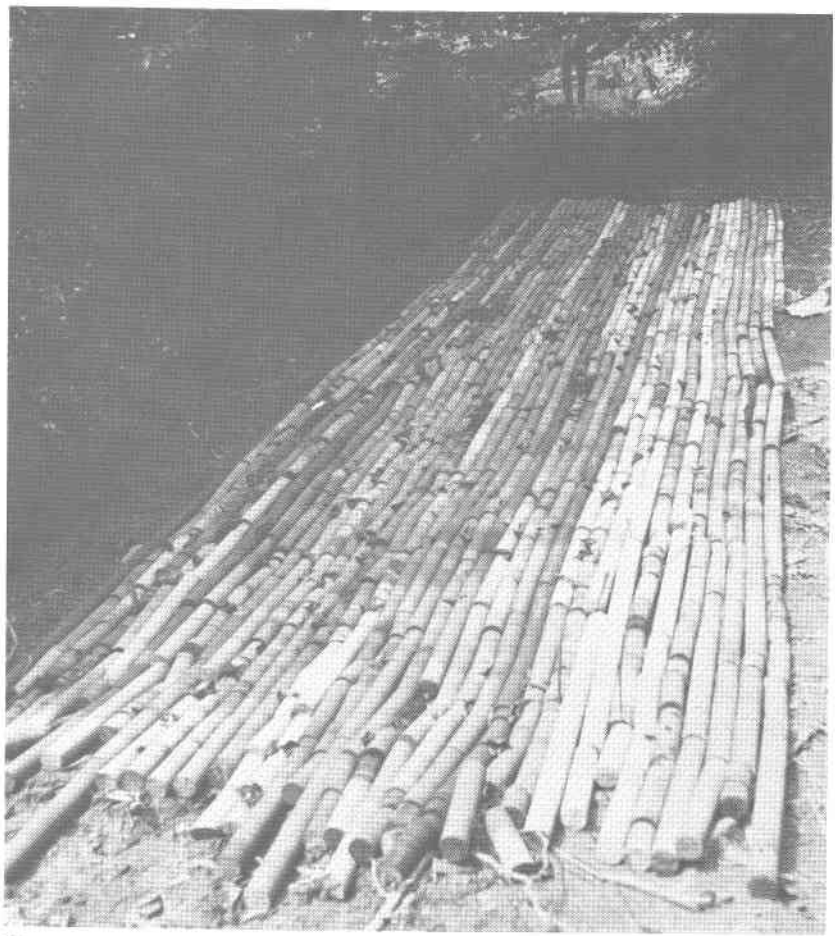

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nize by various workers is possible. The descriptions of these units by previous workers were thus used considerably because of their reliability.

A limited palynological study of principal coal beds was used to supplement correlations and interpretations. Thin sections of sandstone units were prepared from selected cores and used for additional information.

Recent publications concerning the subsurface of the area are Huddle, Jacobsen, and Williamson (1955, 1956), Le Van (1962), Martens (1943), Wilpolt and Marden (1949, 1959), Bowen (1963), Mitchum (1954), Englund and DeLaney (1966), and Englund (1971). These reports were used considerably in the preparation of this work. The comprehensive studies of Campbell (1893, 1894, 1896), Butts (1940-41), Eby (1923), Giles (1921), Hinds (1918), Wentworth (1922), Harnsberger (1919), and Miller (1969) were also utilized, particularly for their descriptions of Mississipian and Pennsylvanian stratigraphy and the structural geology of the area. A correlation chart showing the classification of stratigraphic nomenclature used in this report and the nomenclature which has been in use for Upper Mississippian and Lower Pennsylvanian rocks in southwestern Virginia is given in Figure 12.

ACKNOWLEDGMENTS

The author wishes to thank the following companies and individuals who permitted study of samples and data from wells and cores: David M. Young, Clinchfield Coal Company; William F. Shupe, Virginia Coal and Iron Company; William C. Turley and R. W. Brown, Island Creek Coal Company; Nick M. Spanos, Consolidation Coal Company; Robert L. Raines, Pocahontas Land Corporation; and Porter J. Brown and William M. Ryan, Columbia Gas Transmission Corporation. R. L. Miller and T. M. Gathright served as guides on field conferences in southwestern Virginia. Alan C. Donaldson, Geology Department, West Virginia University provided helpful comments and review on portions of the report.

REGIONAL STRUCTURE

The dip of the surface rocks and those at shallow depths (Figures 6, 7, and 8) is to the northwest with slight variations caused by broad, open gentle folds. Structure contours on se-

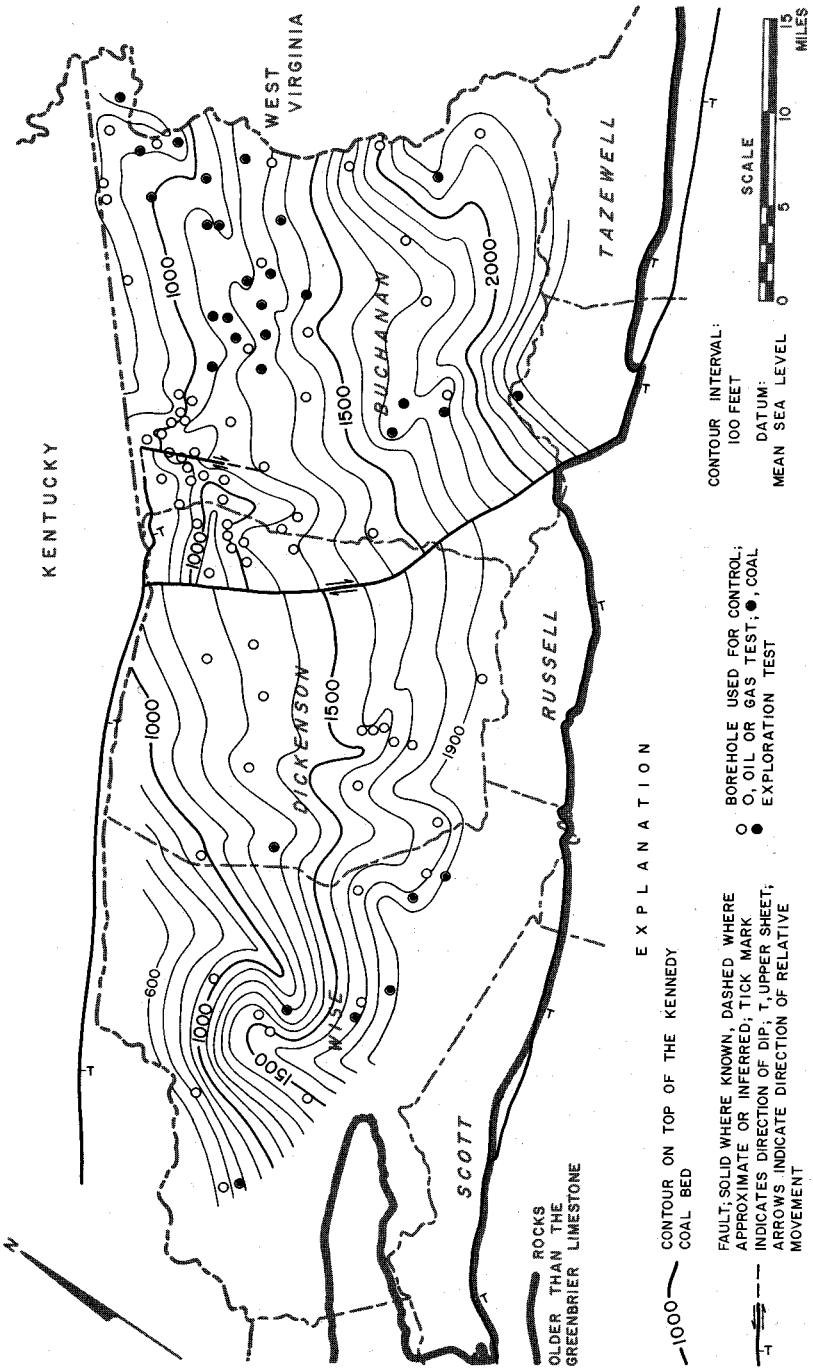


Figure 6. Structure-contour map of the top of the Kennedy coal bed.

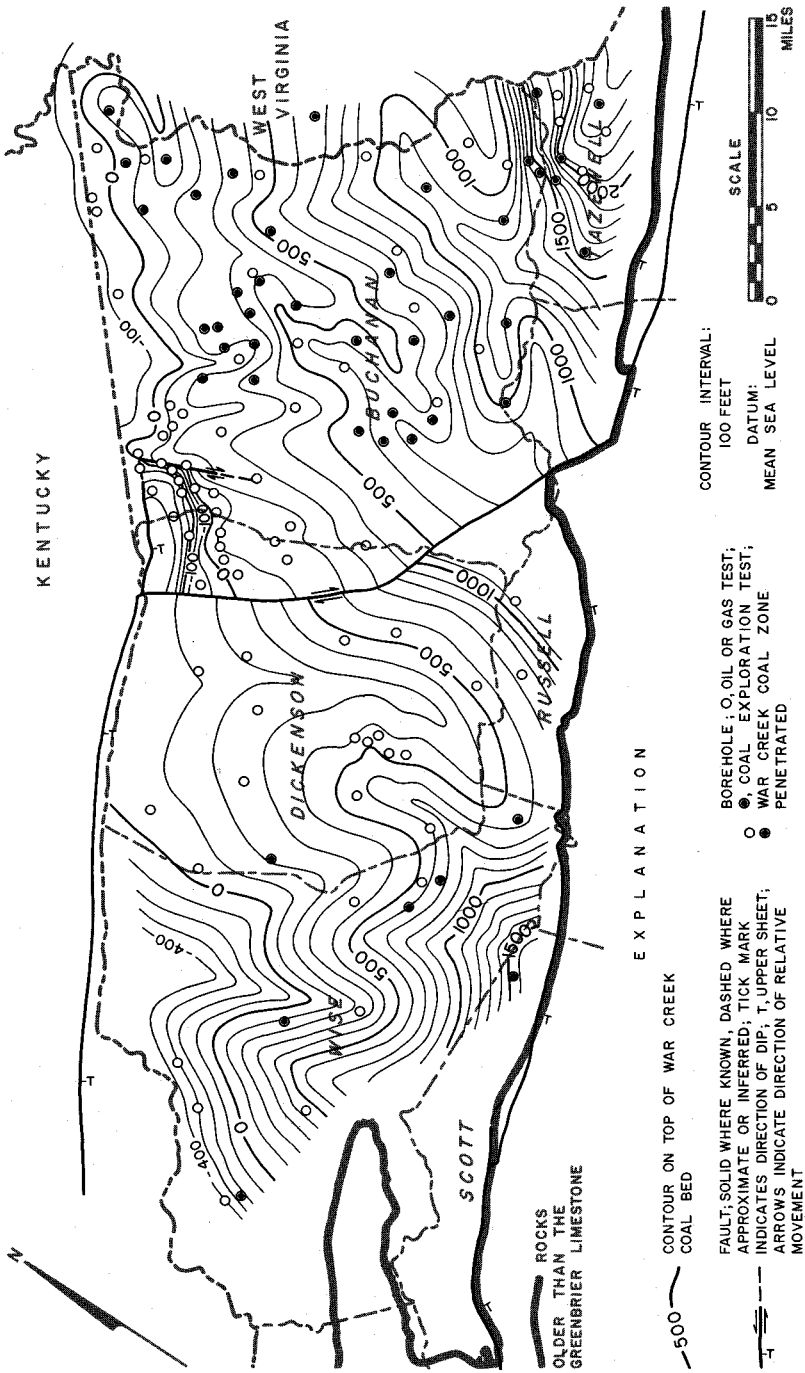


Figure 7. Structure-contour map of the top of the War Creek coal bed.

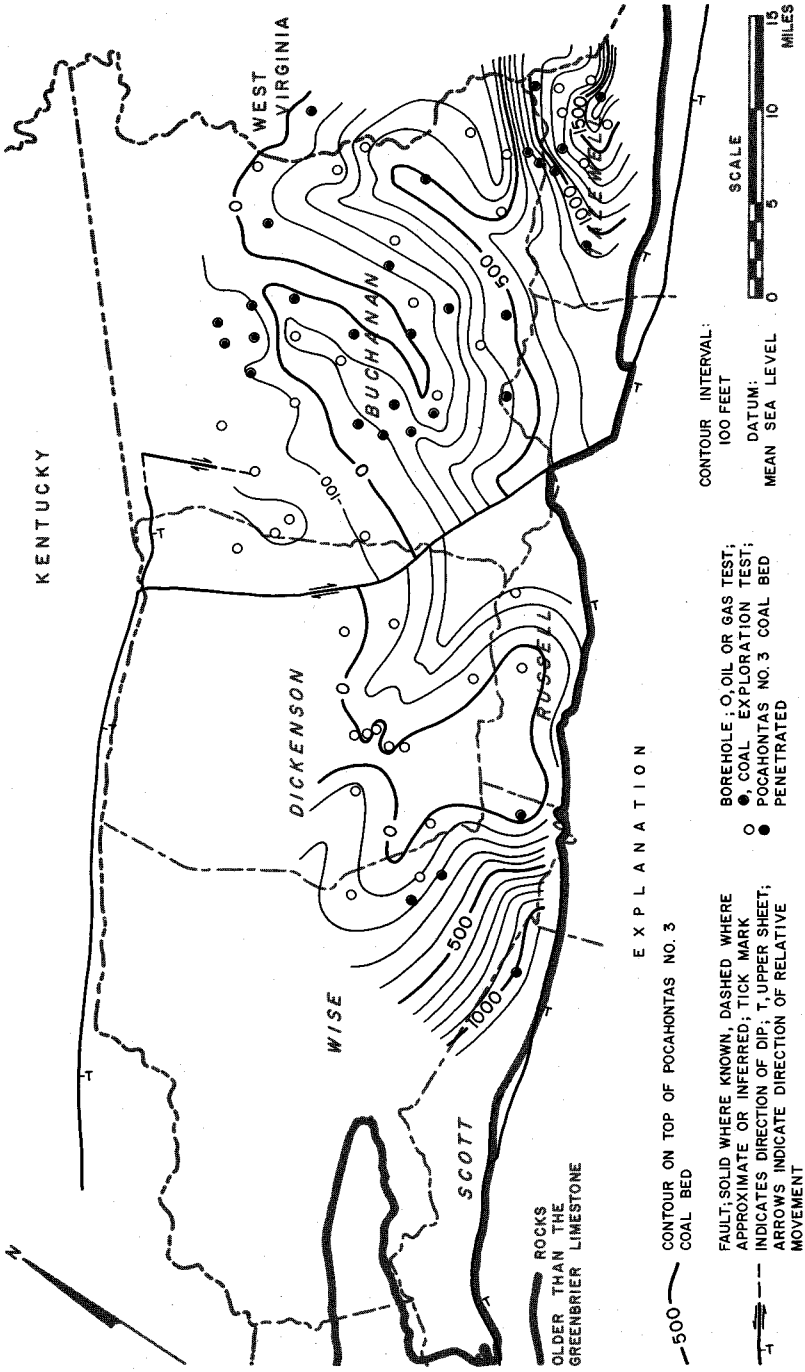


Figure 8. Structure-contour map of the top of the Pocahontas No. 3 coal bed.

lected coal beds of Pennsylvanian age illustrate that the overall dip to the northwest is 70 to 80 feet per mile. The regional dip of the deeper formations is to the southeast (Figure 9). The reversal in dip is due principally to the general southeastward divergence of the Mississippian stratigraphic sequence (Figure 10).

Complex structural features are limited mainly to faulted zones associated with the Cumberland thrust sheet, which is a large quadrilateral structural feature approximately 25 miles wide and 125 miles long and trends northeasterly-southwesterly parallel with Appalachian folding. Part of Buchanan County, most of Dickenson County, all of Wise County, and parts of Scott and Russell counties lie within the boundaries of the Cumberland thrust sheet. It has been established that the sheet was thrust from southeast to northwest (Bates, 1936; Englund, 1971; Giles, 1921; Wentworth *in* Giles, 1921, p. 53-67; Wentworth, 1922). The Pine Mountain fault limits the sheet on the northwest, the Russell Fork fault on the northeast, and the St. Paul or Hunter Valley fault on the southeast (Figure 11). To the southwest in Tennessee the Cumberland thrust sheet is limited by the Jacksboro fault. The Pine Mountain and St. Paul faults are essentially low-angle thrusts along which the beds are overturned, twisted, and crushed. The trace of the Pine Mountain fault everywhere southwest of the Russell Fork fault, which for the most part is located in Kentucky just north of the Virginia-Kentucky boundary, is stratigraphically located in Upper Devonian shales. This fault in these areas is thus located below the rock units of this report. However, the Pine Mountain fault northeast of the Russell Fork fault is much shallower stratigraphically and involves rock units as young as the Lee Formation of Pennsylvanian age (Alvord and Miller, 1972). Along the St. Paul fault, rocks as old as Cambrian extend over and against overturned Mississippian and Pennsylvanian rocks. Southeast of the St. Paul fault strongly folded and thrust-faulted Paleozoic sedimentary rocks of the Valley and Ridge province are present.

The Russell Fork fault, along which a number of thickness and lithic variations occur, is the most significant structural feature in the subsurface. It is essentially a high-angle strike-slip fault. The amount of lateral movement along it as evidenced by the subsurface data in this report is approximately 4 miles. This

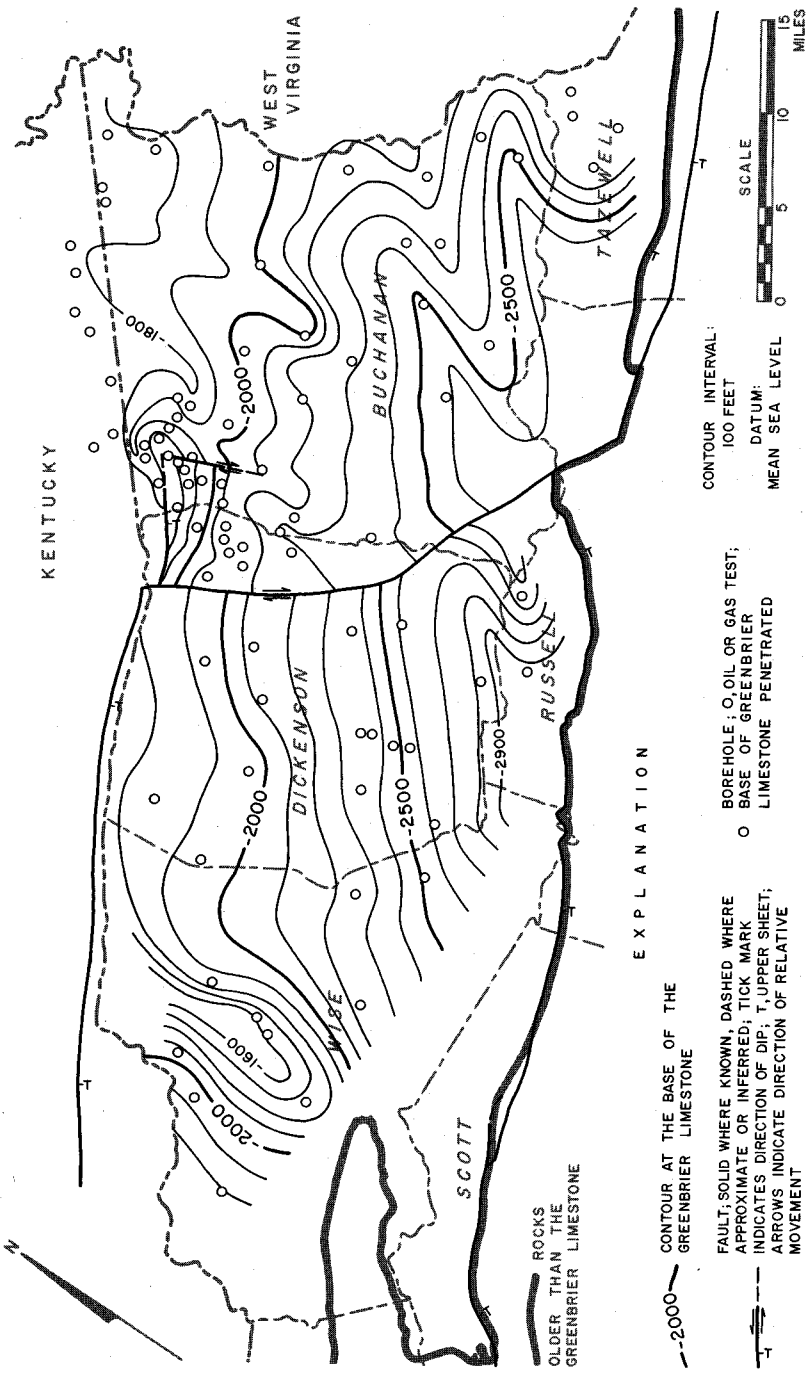


Figure 9. Structure-contour map of the base of the Greenbrier Limestone.

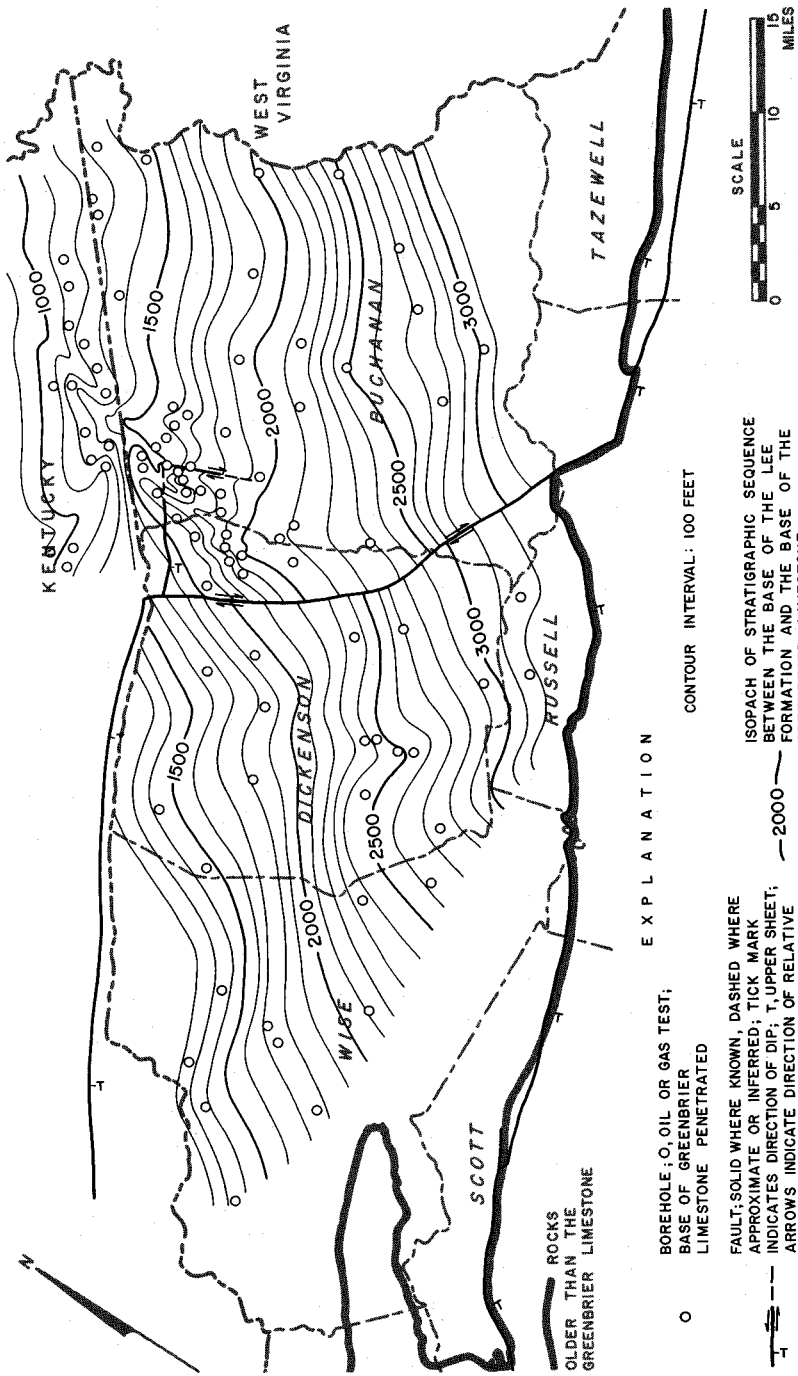


Figure 10. Thickness map of the stratigraphic sequence between the base of the Greenbrier Limestone and the base of the Lee Formation.

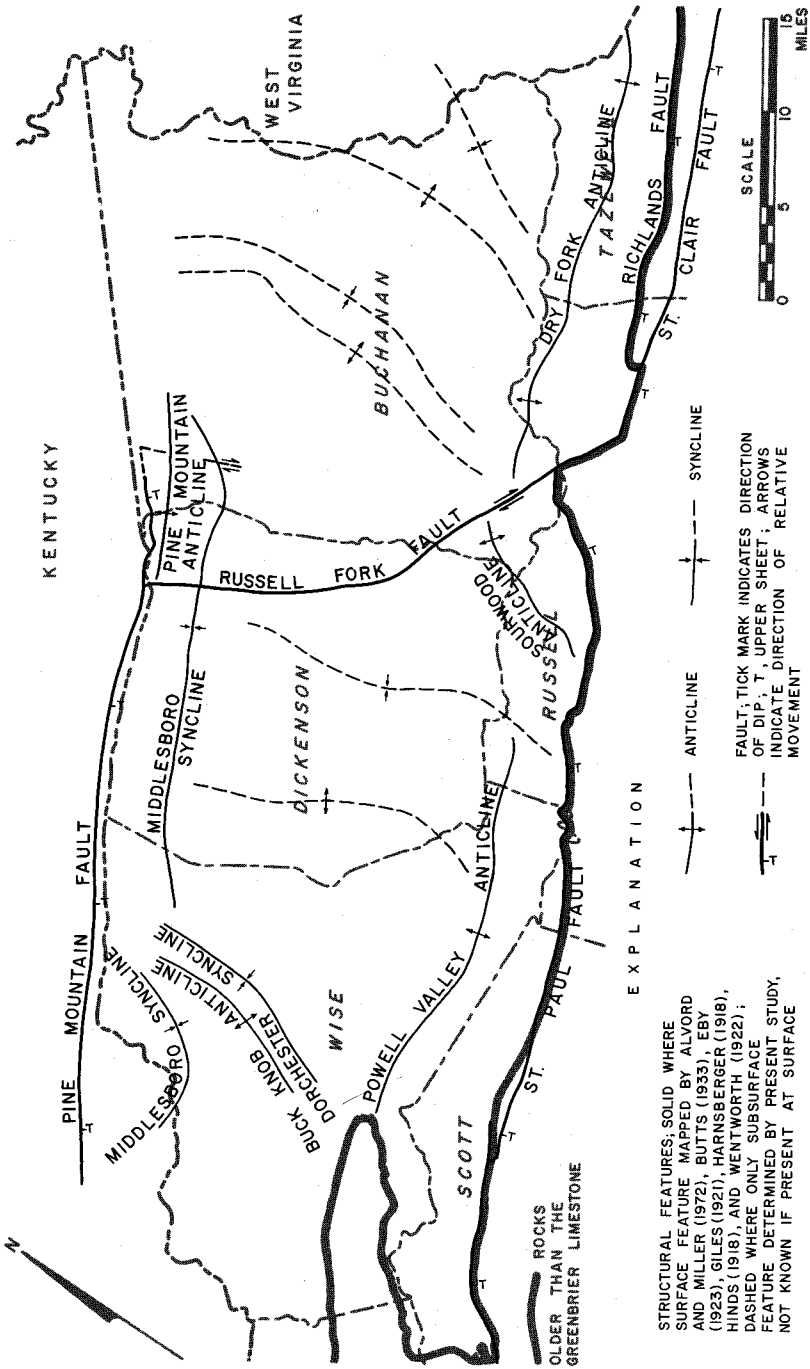


Figure 11. Map showing structural features in the area of study.

agrees with a recent estimate made by Englund (1971). The Russell Fork fault causes significant offsets to economically important coal beds of the Pocahontas Formation. As shown in Figure 24, the Pocahontas No. 3 coal bed southwest of the Russell Fork fault has been displaced about 4 miles to the northwest relative to its position in the block to the northeast.

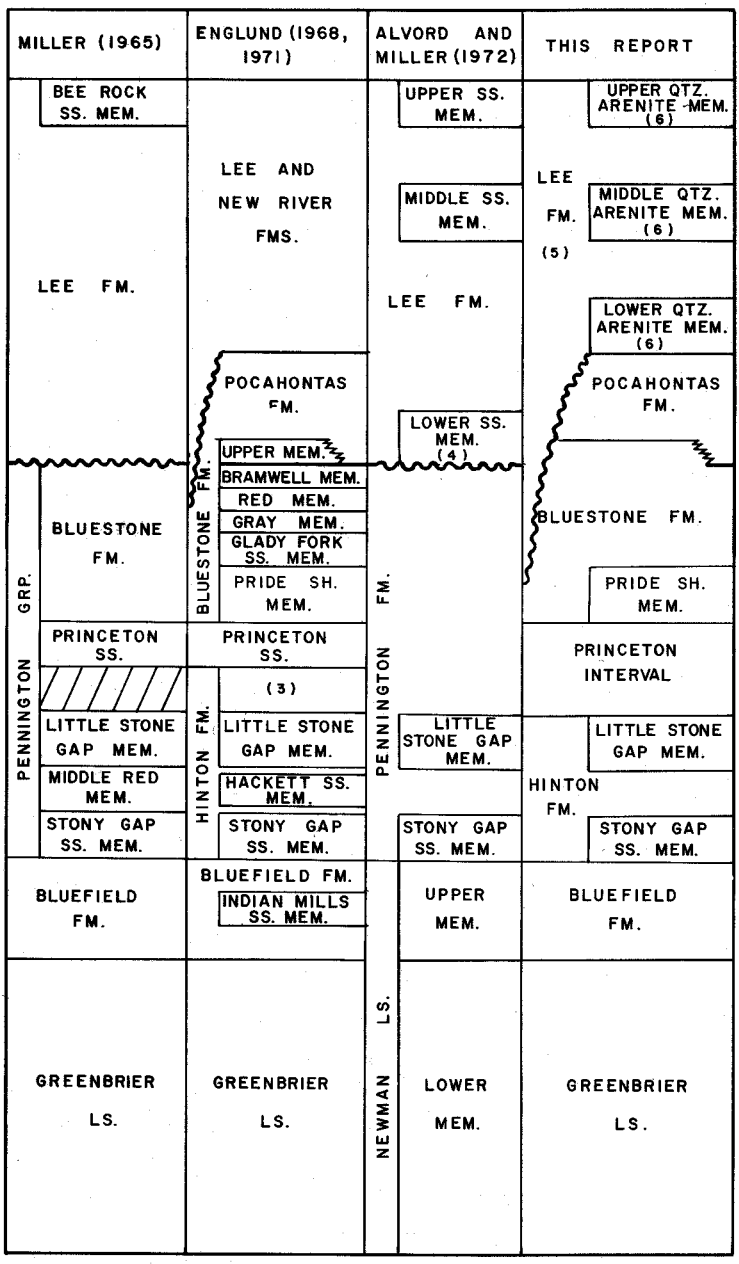
Another strike-slip fault is located northeast of the Russell Fork fault more or less paralleling Jess Fork (Figure 11). It has approximately the same strike direction and is of the same nature as the Russell Fork fault. The amount of horizontal displacement appears to be about 1 mile and can be traced for 6 miles to the southeast of the northeastward extension of the Pine Mountain fault. The location, trend, and nature of the fault along Jess Fork suggest that the Pine Mountain thrust fault to the north extends at least far enough northeastward in the subsurface to connect with this northwestward-trending strike-slip fault. Alvord and Miller (1972) recently illustrated that the Pine Mountain thrust fault extends northeastward past the Russell Fork fault for about 5.5 miles. If the Pine Mountain fault were extended for another 1.5 miles, it would connect with the fault along Jess Fork. This northeastward extension would represent the site of horizontal northwestward thrusting which resulted during the lateral displacement of the fault along Jess Fork. (The fault along Jess Fork was established in the subsurface with closely spaced borehole control. No efforts were made to establish the fault trace on the surface.)

Thus, a thrust sheet northeast of the larger Cumberland sheet that is roughly 7 miles wide and extends southeastward for an undetermined distance is suggested by the subsurface data. The same tectonic forces that produced the Cumberland thrust sheet were apparently responsible for the smaller sheet to the northeast. The relative displacements along the northeastern edges of the two sheets indicate that the larger one moved about 4 miles to the northwest, and the smaller one moved about 1 mile in the same direction (Figures 23, 24).

The southeastern limit of the northeastern sheet could not be determined. All isopach and structure maps indicate that northwestward movement along the edge of the sheet becomes less significant to the south. It is possible that the fault along Jess Fork extends farther south and eventually connects with the Russell Fork fault in extreme southern Buchanan County. The

	HARNSBERGER (1919), WENTWORTH (1922), EBY (1923)	BUTTS (1933, 1940)	HUDDLE (1956)	WILPOLT AND MARDEN (1949, 1959)
PENNSYLVANIAN SYSTEM	LEE FM.: BEE ROCK SS. MEM.; BALD ROCK CONGL.; (1)	LEE FM. (1)	LEE FM.	(NOT STUDIED)
	?			
MISSISSIPPIAN SYSTEM	PENNINGTON SH., FM., OR GRP.: BLUESTONE AND PRINCETON SS.	BLUESTONE FM.	BLUESTONE FM.	PENNINGTON GRP.: BLUESTONE FM.: UPPER MEM. (2); RED MEM.; GRAY SH. MEM.
		PRINCETON SS.	PRINCETON SS.	PRINCETON SS.
	HINTON FM.	PENNINGTON FM. (IN SOUTHWEST); HINTON FM. (IN BLUEFIELD REGION)	HINTON FM.	HINTON FM.: UPPER RED MEM.; LIMESTONE MEM.; MIDDLE RED MEM.; STONY GAP SS. MEM.
	BLUEFIELD SH.	BLUEFIELD SH.	BLUEFIELD FM.	BLUEFIELD FM.
	NEWMAN FM. OR LS.	GASPER	GREENBRIER LS.	GREENBRIER LS.
		STE. GENEVIEVE LS.		
		ST. LOUIS LS.		
		LIMESTONE OF WARSAW AGE		

Figure 12. Correlation chart showing stratigraphic nomenclature of various workers in the Upper Mississippian and Lower Pennsylvanian rocks in southwestern Virginia.



(1) Pocahontas equivalents were included by Harnsberger (1919), Eby (1923), and Butts (1933, 1940) in the basal part of the Lee Formation; Wentworth (1922) included Pocahontas equivalents in the upper part of the Bluestone Formation. (2) Pocahontas equivalents were included in this member. (3) Upper shale, Falls Mills Sandstone, Prater Shale, Tallery Sandstone, Middle shale, and Neal Sandstone members included in this sequence. (4) Pocahontas equivalents not present in area of mapping. (5) Lee Formation approximately equivalent to the New River Formation. (6) Quartz arenite members of Lee Formation tongue out successively from top to bottom and generally from northwest to southeast into finer textured sediments.

connection may be with the Little Paw Paw fault, a branching fault off the Russell Fork fault, which extends for a short distance northwestward almost directly along the same trace as the Buchanan-Dickenson boundary (Wentworth, *in* Giles 1921). The remoteness of the Little Paw Paw fault in relation to the subsurface data included in this report, however, restricted the study of the relationship between the fault along Jess Fork and the Little Paw Paw fault.

Recent structural studies (Jeran, 1968; Elder, Jeran, and Keck, 1974; and Ryan, 1974) in Buchanan County and nearby areas suggest that the fault along Jess Fork may actually be one of a series of subparallel strike-slip faults aligned about N.30°W. to N.60°W. A strike-slip fault that has a strike of N.30° W. near Keen Mountain has been traced for about 9 miles in Buchanan County (Jeran, 1968, p. 108-109); as with the other strike-slip faults, the southwest sheet was "thought to have moved northwest" past "the relatively stable northeast block along the fault strike." The amount of horizontal displacement for this fault was not determined by Jeran (1968), although he established that coal beds have been vertically displaced as much as 18 feet. In a more recent study the Keen Mountain fault is traced for a distance of 14 miles by Elder, Jeran, and Keck (1974, p. 15), who state that "the horizontal movement is evidenced by slickensides on the fault plane exposed in coal mines." However, the total horizontal and vertical displacement associated with the fault is apparently small, and is not evident on the subsurface maps constructed in this report. The Bishop-Bradshaw fault, occurring in the adjacent area of McDowell County, West Virginia, has also been recently established (Elder, Jeran, and Keck, 1974, p. 20). This fault is traced for 22 miles, has a surface trend of approximately N.60°W., and "the southern block has moved westward relative to the northern block." In the same study, based on the interpretation of airborne side-looking radar. imagery it was suggested that the Little Paw Paw fault may extend for a total distance of 16 miles and trend in the same northwesterly direction as the Russell Fork fault. However, the exact location of the extension of the Little Paw Paw fault has not been established as of the writing of this report nor has it been identified by field measurement. The fault, therefore, was not included during the construction of the subsurface maps although abrupt changes in some of the subsurface contouring is apparent along the postulated trace of the fault.

Other than the strike-slip faulting, the regional structure is relatively uncomplicated—principally broad, gentle folds, the dips of which are so slight that in most parts of the study area the beds are essentially horizontal. These folds include: the Middlesboro syncline, the Buck Knob anticline, the Dorchester syncline, the Powell Valley anticline, the Sourwood anticline, the Pine Mountain anticline, and the Dry Fork anticline (Figure 11). Of these folds, the Dry Fork anticline, the Dorchester syncline, and the Buck Knob anticline appear to be particularly well represented in the subsurface (Figures 7 and 8). Other folds, also very distinctive in the subsurface, are located in Buchanan and Dickenson counties. In central Buchanan County two anticlinal folds, separated by a syncline, trend north and appear to become more distinctive with increase in depth (Figures 6, 7, 8). Another syncline trending to the northeast in the extreme eastern portion of Buchanan County is just north of the Dry Fork anticline. In the southern portion of Dickenson County a broad and gently dipping syncline, trending generally to the north, is indicated by structure maps of the Pocahontas No. 3 and War Creek coal beds (Figures 7, 8).

STRATIGRAPHY

The Upper Mississippian and Lower Pennsylvanian units discussed in this report are in ascending order: Greenbrier Limestone, Bluefield Formation, Hinton Formation, Princeton interval, Bluestone Formation, Pocahontas Formation, Lee Formation, and Norton Formation (Table 1, Figure 12). An outcrop section from the top of the Greenbrier to the base of the Lee is shown in Figure 13. Detailed work is concentrated on the stratigraphic sequence between the base of the Little Stone Gap Member of the Hinton Formation (Mississippian) and the top of the Kennedy coal bed of the Norton Formation (Pennsylvanian). The stratigraphic sequence above the Kennedy coal is mostly above drainage and was thus not studied in as much detail as the older Pennsylvanian units because this report is basically a subsurface study. The Mississippian stratigraphic sequence below the Little Stone Gap Member through the Greenbrier Limestone was not studied in as much detail as the younger rocks and is included principally to illustrate the regional stratigraphic relationship with the younger coal-bearing units. The descriptions of the stratigraphic units included in this report are listed in Table 1.

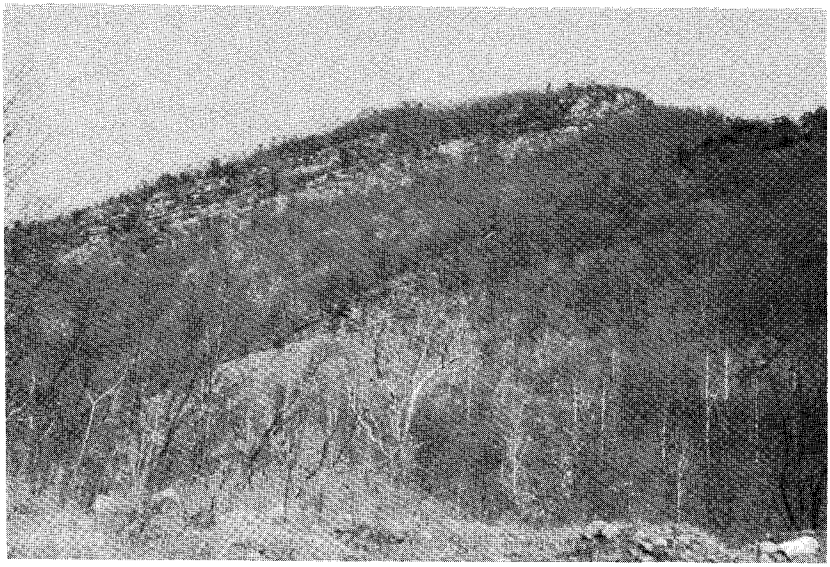
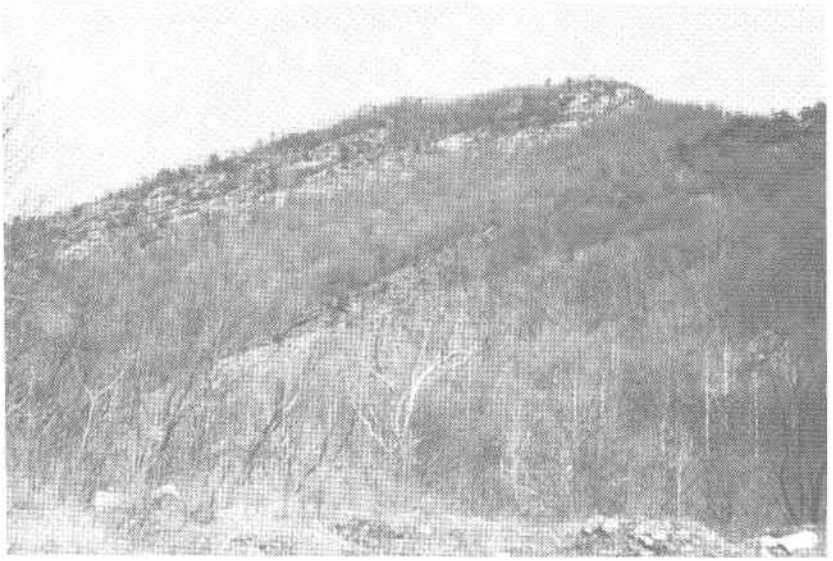


Figure 13. Upper Mississippian and Lower Pennsylvanian rocks at Big Stone Gap, Wise County, Virginia. In the extreme right is Greenbrier Limestone which is presently being quarried. The middle ridge is capped by the massive quartzose Stony Gap Sandstone Member of the Hinton Formation. The smaller, less prominent ridge above the Stony Gap Sandstone is held up by the quartzose Princeton sandstone. The massive ridge in the background is the lower quartz arenite member of the Lee Formation.

Table 1.—Geologic formations of Upper Mississippian and Lower Pennsylvanian age of southwestern Virginia included in this report.

Age	Name		Character	Approximate thickness in feet
Pennsylvanian	Norton Formation		Impure, fine-grained sandstone, dark shale and siltstone, and coal beds; includes the Norton, Hagy, Splash Dam, Upper Banner, Lower Banner, and Kennedy coal beds in the northwestern areas, and with the tonguing out of the Bee Rock Sandstone to the southeast includes the Aily, Raven, Jawbone, and Tiller coal beds.	
	Lee Fm.	Upper quartz arenite mem.	Referred to as Bee Rock Sandstone Member in some areas; a massive quartzose sandstone,	0-250



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	Lee Fm.	Upper quartz arenite mem.	Referred to as Bee Rock Sandstone Member in some areas; a massive quartzose sandstone,	0-250

Age	Name		Character	Approximate thickness in feet
Pennsylvanian	Lee Formation		more than 90 percent quartz, strongly consolidated with lenses of well-rounded quartz pebbles; a few interbeds of silty sandstone and shale.	
			Shale, sandstone, and coal: shale is gray, silty, and commonly carbonaceous; sandstone is gray, fine to coarse grained, and micaceous; includes the Aily, Raven, Jawbone, and Tiller coal beds.	180-550
		Middle quartz arenite member	Predominantly quartzose sandstone; over 90 percent quartz; fine to coarse grained, locally conglomeratic; strongly consolidated; thin interbeds of silty sandstone and sandy shale; tongues out to the southeast into finer textured sediments; includes the Upper, Middle, and Lower Seaboard coal beds.	0-600
			Shale, sandstone, and coal: shale is dark, silty, and interbedded with siltstone; sandstone is gray, fine to medium grained, micaceous, and silty; includes all the Horsepen, War Creek, Pocahontas No. 9 and No. 8 coal beds; includes the Seaboard coal beds in southeastern areas with the tonguing out of the middle quartz arenite member.	80-800
		Lower quartz arenite member	Almost all quartzose sandstone with over 90 percent quartz; fine to coarse grained; basal intervals commonly conglomeratic; includes a few thin lenticular coals and shales.	0-500
	Pocahontas Formation		Sandstone, shale, and coal: sandstone is gray, fine to medium grained, commonly feldspathic, micaceous and silty, quartz per-	0-700

Age	Name		Character	Approximate thickness in feet
Pennsylvanian ?			centage generally about 60 percent; shale is gray, silty, micaceous; includes the low-sulfur Pocahontas coals.	
Mississippian	Bluestone Formation		Consists principally of red, green, and gray shale and siltstone with minor beds of limestone and sandstone.	0-420
	Bluestone Formation	Pride Shale Member	Almost entirely dark-gray to black shale; locally silty, carbonaceous; interlaminated with siltstone.	70-320
	Princeton interval		Principally fine to coarse grained, commonly quartzose, occasionally conglomeratic sandstone, containing lenticular beds of gray, green, and red shales and siltstones, and rarely limestones.	0-300
	Hinton Formation	Little Stone Gap Member	Gray, argillaceous limestone and highly calcareous, pyritic shale; abundantly fossiliferous with brachiopods, pelecypods, bryozoans, and crinoids.	10-220
	Hinton Formation		A widely variable sequence of shale, siltstone, sandstone, limestone, coal, and underclay; shales are red, green, gray, calcareous, often clayey, but occasionally hard and carbonaceous; siltstones are varicolored and argillaceous to siliceous. Sandstones are usually fine grained and silty; limestones are thin and impure; coals are thin with underclays and may contain fragmented plant fossils.	200-1000
	Hinton Formation	Stony Gap Sandstone Member	Sandstone; white, quartzose, fine to medium grained; over 90 percent quartz.	10-200
	Bluefield Formation		Principally gray calcareous shale with lesser amounts of red and green shale; gray fossiliferous	150-750

Age	Name	Character	Approximate thickness in feet
Mississippian		limestone; light-gray to greenish-gray sandstone and siltstone; and a few thin beds of carbonaceous shale and coal.	
	Greenbrier Limestone	Limestone; gray to dark gray to black and greenish gray to olive to white; very finely to coarsely crystalline; partly oolitic and dolomitic; abundantly fossiliferous.	300-850

GREENBRIER LIMESTONE

The term Greenbrier Limestone is here applied to the sequence of rocks between the calcareous shales of the overlying Bluefield Formation and the red siltstone and shale of the underlying Maccrady Shale (Table 1, Figure 12). It is composed chiefly of very fossiliferous limestone and minor shale. The limestone is generally gray to dark gray, but is locally light gray and white, red, green, greenish gray, olive, light tan to brown, brownish gray to black and oolitic, cherty, and dolomitic. The shales are gray to reddish gray, silty and generally calcareous. Fragments of crinoids, corals, brachiopods, gastropods, and bryozoans are commonly visible in the well cuttings.

The Greenbrier Limestone appears to have an unconformable contact with the underlying Maccrady Shale. The contact between the units can usually be well identified on a gamma ray-density log, as illustrated in Figure 14. The contact between the Greenbrier Limestone and the overlying Bluefield Formation, however, is gradational and can be approximately determined by use of a gamma ray-density log.

The Greenbrier Limestone occurs throughout the area; it is 700 to 850 feet thick in Tazewell and Russell counties and thins to the northwest to about 200 to 500 feet near the Virginia-Kentucky boundary.

BLUEFIELD FORMATION

The Bluefield Formation consists principally of calcareous shale, shale, siltstone, and limestone, with lesser amounts of sand-

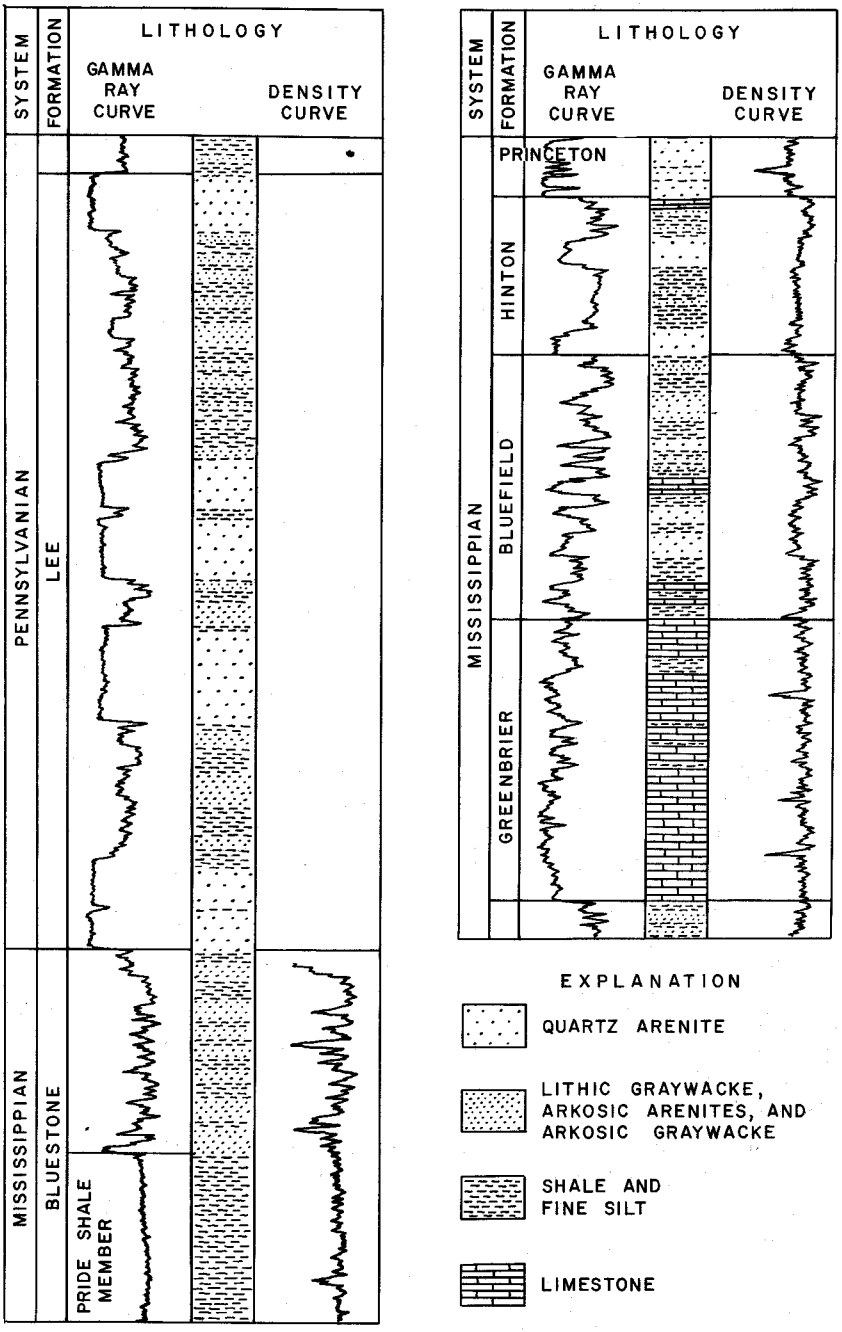

Figure 14. Composite lithologic, gamma-ray, and density log of Upper Mississippian and Lower Pennsylvanian rocks.

stone. The calcareous shale is predominant and is gray, grayish-red, red, greenish-gray, and green. The limestones are gray to brown, fine to medium crystalline, argillaceous, fossiliferous, and occur principally in the lower portions of the formation. The sandstones are light gray to white, fine to very fine grained, silty, calcareous, and nonpersistent. In the subsurface these sandstone units are often referred to by drillers as "lower Maxon sands." A few thin beds of black carbonaceous shale and coal may occasionally be present in the upper portions of the Bluefield. An abundance of pelecypods, brachiopods, gastropods, bryozoans, crinoids, corals, blastoids, and a few annelids and plant fossils are present (Reger, 1926; Butts, 1940-41; and Cooper, 1944).

The Stony Gap Sandstone Member of the Hinton Formation overlies the Bluefield Formation with apparent conformity. The Bluefield reaches a maximum thickness of about 600 to 750 feet in the southeast and thins to the northwest and west to 150 to 250 feet along the Virginia-Kentucky boundary.

HINTON FORMATION

The Hinton Formation was named for exposures along the New River near Hinton, Summers County, West Virginia (Campbell and Mendenhall, 1896). The formation has often been referred to in Virginia as the Pennington Formation (Butts, 1940-41; Cooper, 1944) as well as the Hinton Formation, but the confusion was eliminated by the formal identification of the Pennington as a group to include the Hinton, Princeton, and Bluestone units as formations (Harris and Miller, 1958).

The Hinton Formation has been divided into four members (Wilpolt and Marden, 1959; Englund, 1968), which are in ascending order, the Stony Gap Sandstone Member, the middle red member, the Little Stone Gap Member, and the upper red member (Figure 12). In many outcrop areas the upper red member is missing (Miller, 1965; Alvord and Miller, 1972) and in the subsurface the sequence appears to be absent throughout the area of study. This widespread absence was attributed to a possible hiatus by Wilpolt and Marden (1959, p. 601), although they stated that "... in any individual exposure the strata appear to represent an uninterrupted sequence of deposition." An alternate explanation preferred by the writer would attribute the deposition of the upper red member to environmental conditions similar to those that formed the quartzose sandstone of the over-

lying Princeton unit in the northwest; more rapid subsidence in the southeastern areas produced a thicker and more variable lithologic sequence. Although Wilpolt and Marden (1959) named the sequence the upper red member, the lithology is composed of a large percentage of quartzose sandstones, indicating the continued presence of basically a high-energy environment. With the rapid disappearance to the northwest of the red shales and siltstones from which the upper red member is named, the Little Stone Gap Member becomes the uppermost distinguishable unit of the Hinton Formation. Because the upper red member is composed of a large percentage of quartzose sandstones, and does not maintain any laterally consistent red clastics by which it can be mapped separately, the writer prefers to refer to the stratigraphic sequence between the Little Stone Gap Member and the Bluestone Formation as the Princeton interval.

The Hinton Formation below the Little Stone Gap Member contains many varied and generally lenticular interbeds of shale, siltstone, sandstone, limestone, and occasionally coal and underclay. The shale is gray, grayish-red, green, and greenish-gray, partly calcareous, and partly soft and clayey. The siltstones are varicolored, argillaceous to siliceous, and usually calcareous. The sandstones occur in shades of white, gray, green, red, and brown, and are fine to coarse grained, micaceous, silty, and occasionally quartzose. The Stony Gap Sandstone Member, occurring at the base of the Hinton Formation, is the most persistent and massive of the quartzose sandstone units. The sandstone is white, fine to medium grained, well to moderately sorted, sometimes silty, and consistently high in quartz percentage. Small amounts of mica and pyrite occur as accessory minerals. Drillers usually refer to the Stony Gap Sandstone as the "Maxon sand." Limestones within the Hinton Formation are generally gray, argillaceous, thin, and abundantly fossiliferous. The coal beds are thin, lenticular, shaly, and contain fragmented plant fossils.

The Hinton Formation appears to be gradational with the formations above and below. Where the Stony Gap Sandstone remains persistent, the lower boundary of the Hinton can usually be determined. The Little Stone Gap Member, which marks the upper boundary of the Hinton Formation in the subsurface, is usually distinctive and easily identified.

In the study area the Hinton Formation ranges in thickness from about 250 to 450 feet in the northwest to about 700 to 1100 feet in the southeast.

Little Stone Gap Member

Because of the stratigraphic importance, the Little Stone Gap Member is reviewed separately in this report. Several informal names have been applied to this highly fossiliferous unit of the Hinton Formation. The name Little Stone Gap Member, which is recognized in this report, was formalized by Miller (1964).

The member is generally a gray to brown, abundantly fossiliferous, argillaceous, highly calcareous shale and finely crystalline limestone with pyrite and calcite as common accessory minerals. On the surface the calcareous content is at places leached out and the unit weathers to a yellowish-gray clay residuum. In the subsurface the abundant fauna are readily observable in the coarser cuttings. In the finer rotary cuttings the zone is usually identified by the high effervescence in dilute hydrochloric acid.

The member is at all places fossiliferous, with many brachiopods, bryozoans, pelecypods, and crinoids (Figure 15). The fossils are sometimes small or dwarfed and have been attributed to a shallow restricted sea (Wilpolt and Marden, 1959, p. 610).

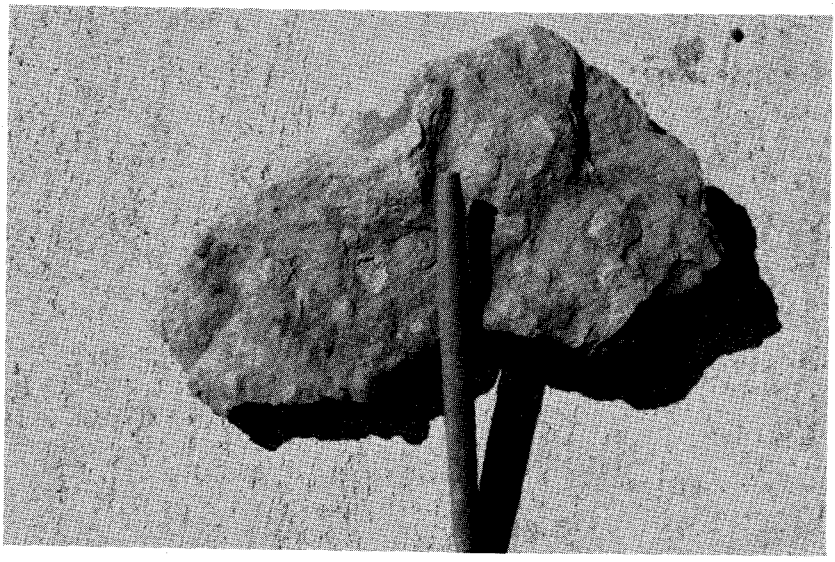

Figure 15. Sample of Little Stone Gap Member from exposures along State Highway 67, just east of Honaker, Russell County, Virginia, showing the abundant fossiliferous content. The unit normally contains abundant brachiopods, pelecypods, bryozoans, and crinoids.

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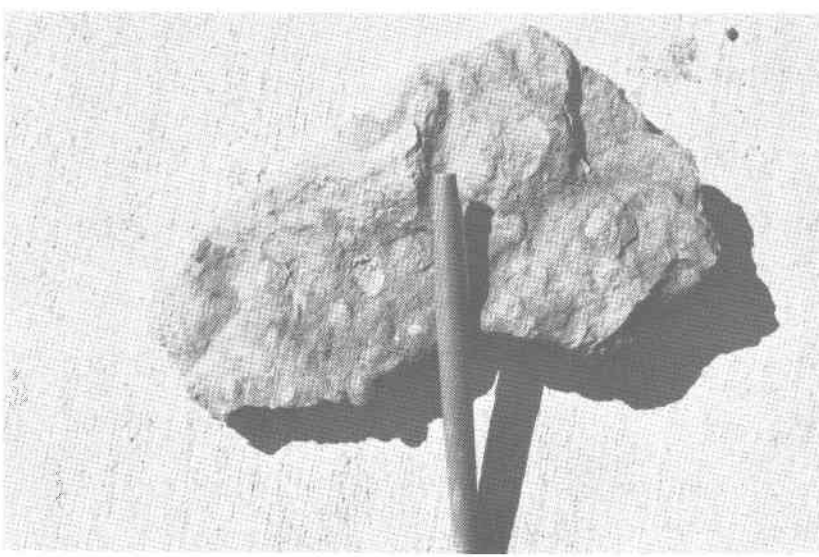

Figure 15. Sample of Little Stone Gap Member from exposures along State Highway 67, just east of Honaker, Russell County, Virginia, showing the abundant fossiliferous content. The unit normally contains abundant brachiopods, pelecypods, bryozoans, and crinoids.

The Little Stone Gap Member normally overlies a red, silty, calcareous shale that makes a distinguishable lower boundary. It is generally gradational above with the white quartzose Princeton interval. In surface exposures in Tazewell and Russell counties, the member is overlain by a series of sandstones with interbedded and varicolored shales. The Little Stone Gap generally averages about 50 to 60 feet in thickness, reaching a maximum thickness of around 200 feet in Tazewell County and thinning to less than 20 feet in the northwestern portions of Buchanan, Dickenson, and Wise counties.

PRINCETON INTERVAL

The stratigraphic sequence between the Little Stone Gap Member and the Bluestone Formation is referred to in this report as the Princeton interval. The term Princeton conglomerate was originally applied to the uppermost unit of this interval (Campbell and Mendenhall, 1896, p. 487) from exposures along a deep cut of the Norfolk and Western Railway just north of the station at Princeton, West Virginia. Later workers referred to this unit as the Princeton Sandstone (Cooper, 1944; Wilpolt and Marden, 1949, 1959; and Huddle, Jacobsen, and Williamson, 1956). The Princeton Sandstone was formally identified as a formation by Harris and Miller (1958).

At its type section and in exposures in Tazewell County, the Princeton Sandstone is a gray, hard, very coarse-grained to granular, poorly sorted, polymitic conglomerate and sandstone that underlies the Pride Shale Member of the Bluestone Formation and overlies a series of generally well-sorted, fine-grained, quartzose sandstone units, which are split locally by varicolored shale and siltstone beds. Underlying these units is the Little Stone Gap Member. However, in exposures at Big Stone Gap in Wise County (Miller, 1965), Pennington Gap in Lee County (Miller and Roen, 1973), and in areas of the Duffield quadrangle in Scott County (Harris and Miller, 1958) the Princeton Sandstone is white, fine- to coarse-grained, quartzose, moderately to well-sorted sandstone with occasional rounded quartz pebbles, and is overlain by the Pride Shale Member of the Bluestone Formation and directly overlies the Little Stone Gap Member of the Hinton Formation; the upper red member of the Hinton Formation is not recognized in these areas. Throughout most of the subsurface, a white, fine- to coarse-grained and locally conglomeratic quartzose sandstone separates the basal dark-gray shale

unit (Pride Shale Member) of the Bluestone Formation from the Little Stone Gap Member of the Hinton Formation. Although a few thin interbeds of limestone, shale, and coal occur locally with the quartzose sandstone, no separation or division of units is possible in the subsurface. Thus, for regional mapping purposes and interpretations offered previously by the writer (see discussion of the Hinton Formation) this stratigraphic sequence is referred to collectively and informally as the Princeton interval.

The Princeton interval is present throughout most of the area but is generally thicker in the southeast. Some of the thickening is due in part to additional thin shale and siltstone units. The interval reaches a thickness of 300 feet in Tazewell County and thins to the northwest and west. In extreme northwestern Buchanan, Dickenson, and Wise counties the thickness is generally between 50 and 150 feet. Locally, the interval increases to over 250 feet of almost all quartzose sandstone or abruptly thins to less than 20 feet.

BLUESTONE FORMATION

Cooper (1944), Englund (1968), and Wilpolt and Marden (1959) divided the Bluestone Formation into several members. The lowermost unit, the Pride Shale Member, is recognized and mapped throughout the subsurface in this report. However, the remainder of the Bluestone above the Pride Shale Member, because of either the ambiguity of the nomenclature or the inconsistency of the member units, is undifferentiated. The Pride Shale Member, having one of the more distinct lithologies, is composed almost entirely of dark-gray to black, evenly bedded shale with thin beds and laminations of dark-gray, argillaceous siltstone and sandstone. The shale is sometimes carbonaceous, calcareous, and locally rich in pyrite.

On the surface the Pride Shale Member may be recognized by the large, rounded, castellated-weathering forms (Figure 16). The member, wherever observed on the surface is uniform, dark-gray shale.

In the subsurface, the consistent nature of the Pride Shale Member is shown by the gamma ray-density curves (Figure 14). The gamma ray curve indicates relatively low radioactivity in the underlying Princeton interval. As the log enters the Pride Shale Member, the curve advances abruptly to the right, indi-

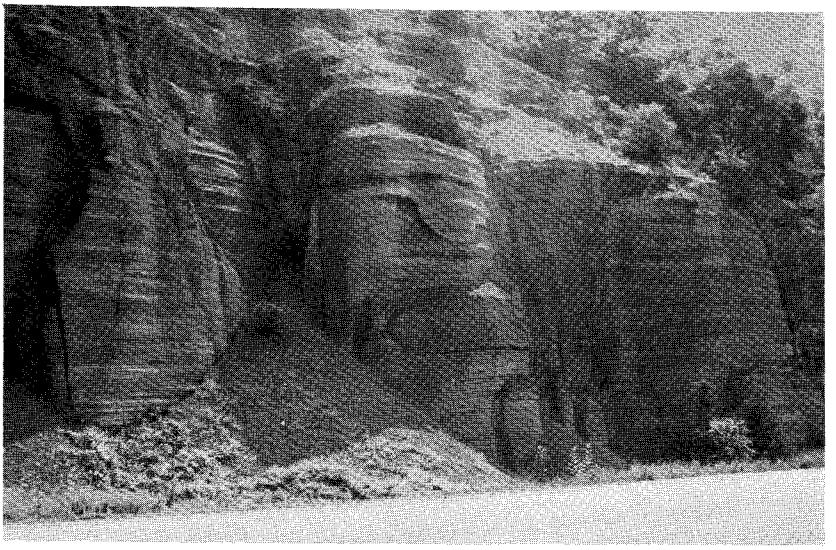

Figure 16. Pride Shale Member along the West Virginia Turnpike. Note the uniform lithology and unusual castellated-weathering features.

cating higher natural radioactivity, and maintains a consistent and high response throughout the member. The density curve also maintains an unusually consistent response throughout the Pride Shale Member. Rarely does any other lithologic unit within the Mississippian and Pennsylvanian rocks included in this report exhibit this degree of homogeneity. Fossils are rare and generally absent in the Pride Shale Member in the mapped area.

Although the lower boundary of the Pride Shale Member is distinctive and sometimes abrupt (Figure 14), the member lies in apparent conformity with the Princeton interval. The member grades upward into gray, argillaceous siltstone, which may in places contain a thin coal bed.

The Pride averages about 200 feet thick in the subsurface. The unit is present in all subsurface sections examined, and reaches a maximum thickness of slightly more than 325 feet. In only three oil and gas tests in the Virginia area (Plate 1, numbers 3, 4, 48) was the thickness less than 100 feet. In tests in extreme northwestern Wise County (Plate 1, numbers 116, 117, 122, 123) and Dickenson County (Plate 1, number 96) and in northeastern Pike County, Kentucky (Plate 1, numbers 137, 143, 145, 146, 147) the Pride Shale Member is uncomformably overlain by quartz arenites of the Lee Formation (Figure 17).

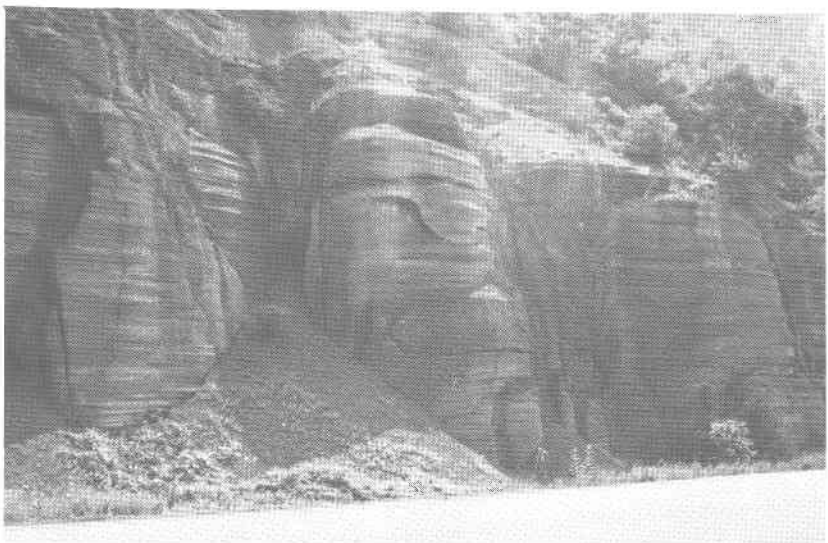

Figure 16. Pride Shale Member along the West Virginia Turnpike. Note the uniform lithology and unusual castellated-weathering features.

cating higher natural radioactivity, and maintains a consistent and high response throughout the member. The density curve also maintains an unusually consistent response throughout the Pride Shale Member. Rarely does any other lithologic unit within the Mississippian and Pennsylvanian rocks included in this report exhibit this degree of homogeneity. Fossils are rare and generally absent in the Pride Shale Member in the mapped area.

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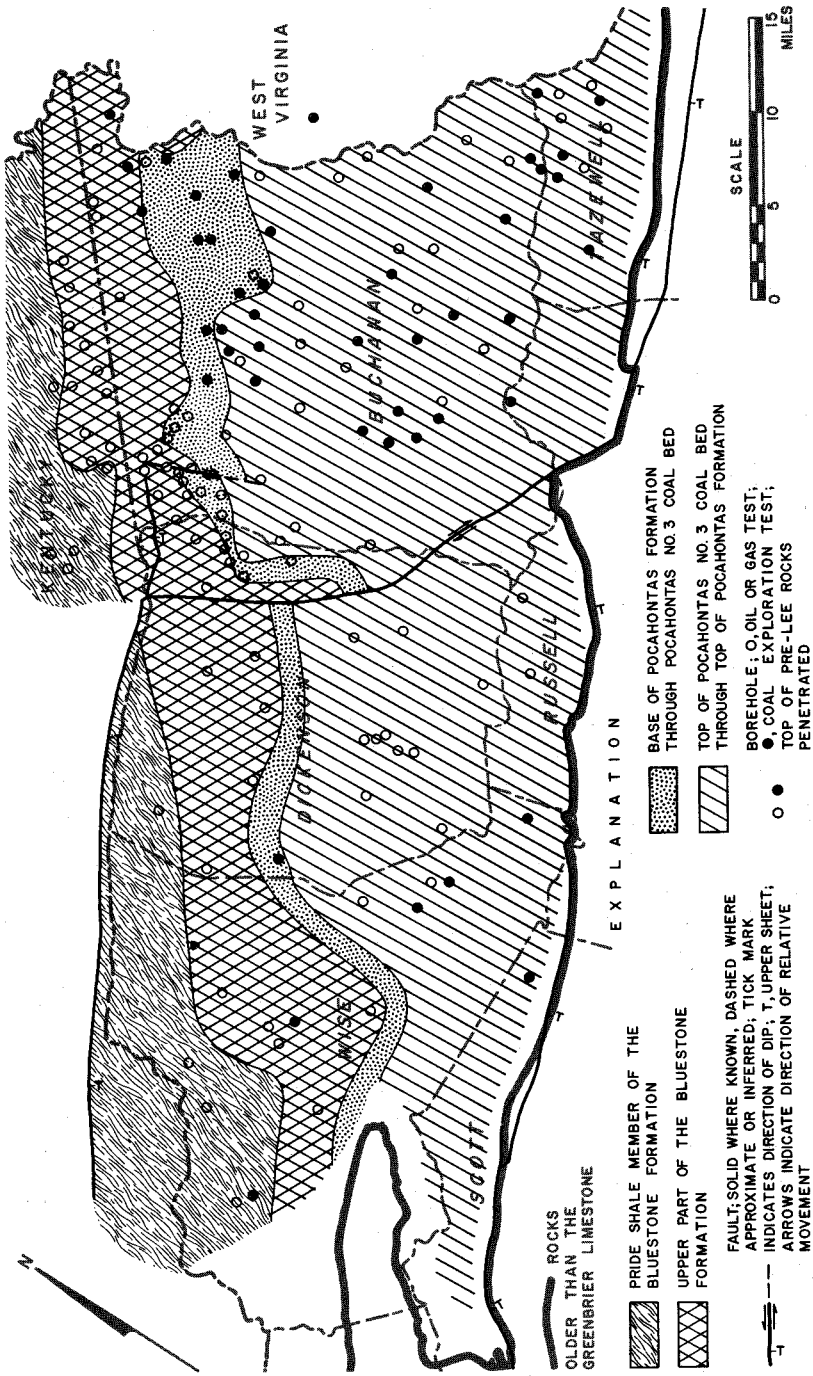

Figure 17. Map showing pre-Lee geology.

In areas where the Pride Shale Member is not in contact with the Lee quartz arenites the lithology above the Pride is dominated by varicolored shale (Figure 18) with lesser amounts of sandstone, siltstone, and limestone and a few coal beds. The

Figure 18. Mottled red and green shale of the upper portion of the Bluestone Formation from core in Buchanan County, Virginia. Diameter of core is 2 inches. Drillers normally identify the base of the Pennsylvanian strata at the first occurrence of these distinctive bright shales.

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shales are predominantly red and green but occasionally gray, grayish green, and grayish red, and are partly calcareous, locally carbonaceous, and may contain either plant or shell fragments. Small spherulitic siderite nodules often occur within these shales. The siltstones are red or green to gray, mottled in places, and may be argillaceous and calcareous. The sandstones, normally thin and discontinuous and commonly ripple marked, are brown, green, and gray, fine grained, silty, and micaceous with abundant clay matrix. The limestones are gray, thin and lenticular, argillaceous, and may contain marine fossils including brachiopods and pelecypods. The coals are thin, impure, and lenticular, but more abundant than in the Hinton Formation or Princeton interval. Six coal beds within this series of rocks in the Bramwell area, Mercer County, West Virginia, with thin beds of underclay containing fossil rootlets, have been noted by Englund (1968).

The lower boundary is at the top of the Pride Shale Member, a distinctive and consistent unit throughout the subsurface, and always apears to be gradational; the upper boundary between the Mississippian and Pennsylvanian systems has been determined to be much more complex (Miller, M. S., 1973, p. 39-42). Only recently, with increasing subsurface and surface geological data, has the stratigraphic relationship of the Bluestone Formation with overlaying units been understood. Red clastics of the Bluestone Formation actually intertongue with some of the Lower Pennsylvanian sandstones in some areas (Englund, 1969); but at other places the Bluestone Formation is uncomformably overlain by the Lee Formation (Englund, 1971, p. B14).

Figure 19 illustrates areas where the Mississippian and Pennsylvanian rocks intertongue and areas where an unconformity divides the two systems. The upper boundary of the Bluestone Formation is sharp and unconformable in northwestern Buchanan, Dickenson and Wise counties, but it is intertonguing to the southeast.

The Bluestone Formation is generally 400 to 500 feet thick with a maximum observed thickness of 730 feet in Tazewell County (Plate 1, number 80). The unconformity at the base of the Lee truncates the formation to the northwest. The undifferentiated portion of the Bluestone above the Pride Shale Member is not present in extreme northwestern Wise and Dickenson

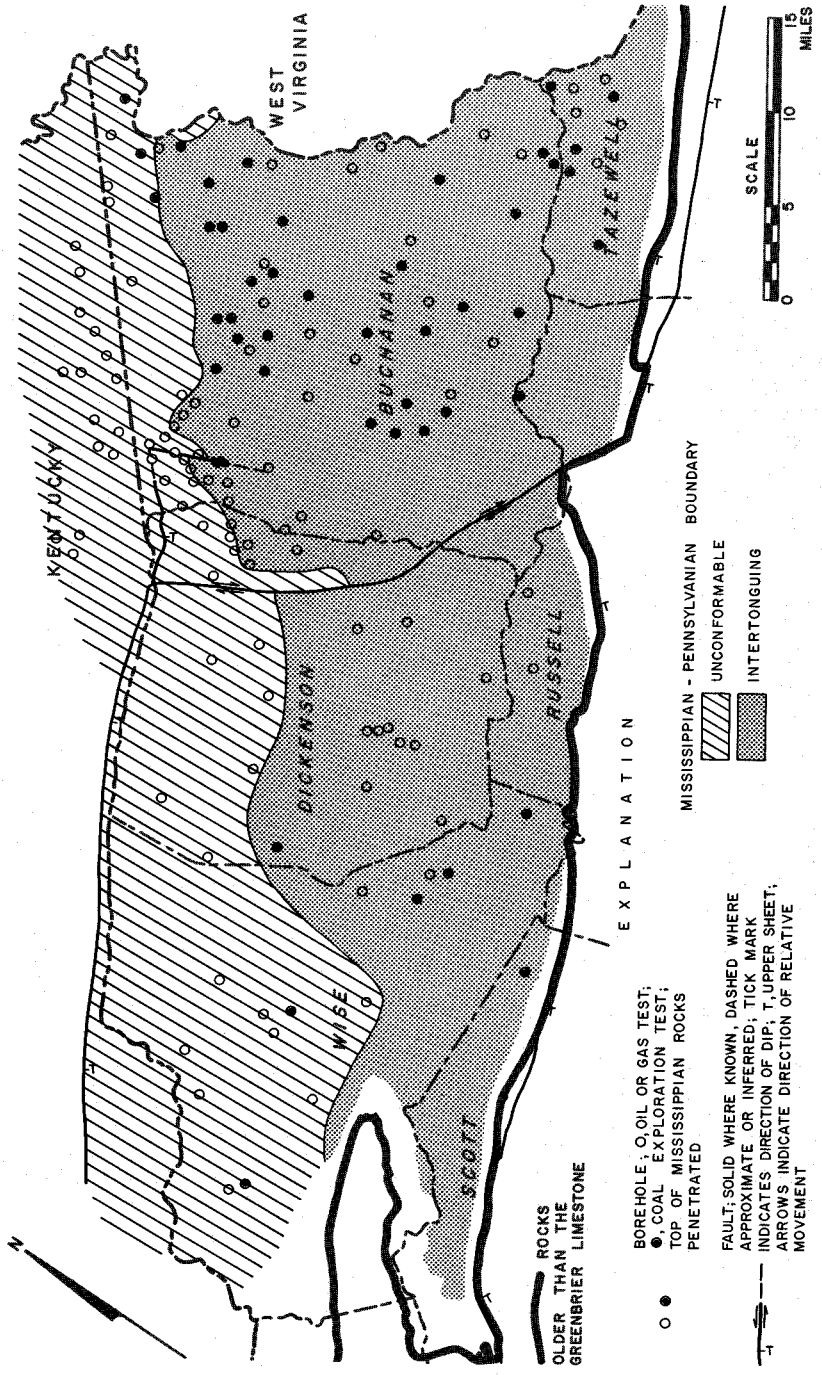


Figure 19. Map showing areas where the Mississippian-Pennsylvanian contact is unconformable or intertongues.

counties, and in northeastern Pike County, Kentucky. The formation is only 78 feet thick in a borehole in Pike County (Plate 1, number 144) and consists only of the Pride Shale Member.

POCAHONTAS FORMATION

The term Pocahontas Formation was originally used for exposures near Pocahontas, Virginia by Campbell (1896, p. 3) who limited the Pocahontas Formation to "all the rocks, from the top of the red shales up as far as the roof of the Pocahontas (No. 3) seam." The Pennsylvanian rocks in West Virginia were later grouped into lower, middle, and upper groups with the lower group termed the Pocahontas group including the Pocahontas coals, Nos. 1, 2, 3, 4, 5, 6, 7, and the Flat Top Mountain Sandstone as the uppermost member (White, 1908, p. 12-13; Hennen and Gawthrop, 1915, p. 215-240). In Virginia the Lee and Norton formations rather than the Pocahontas and New River formations have commonly been used (Harnsberger, 1919; Giles, 1921, 1925; Wentworth, 1922; Eby, 1923; Wanless, 1939, 1946; Moore, 1944; Branson, 1962; Virginia Division of Mineral Resources, 1963). As illustrated in recent studies Englund (1966, 1971a), Miller, M. S. (1972, 1973); Miller and Meissner (1973) and detailed geologic mapping on a scale of 1:24,000 in local areas of Virginia by the U.S. Geological Survey, the Pocahontas Formation is unconformably overlain by the Lee Formation. Thus, the original Pennsylvanian nomenclature of Campbell (1893) needs to be revised and the Pocahontas Formation established as a stratigraphic term that should be applied to certain rocks in Virginia as well as West Virginia. In the present report the Pocahontas Formation is considered to be separate from and older than the Lee Formation, and it is mapped separately.

The Pocahontas Formation is composed of sandstone, siltstone, shale, coal, and underclay. The sandstones are generally gray to light gray, very fine to medium grained, poorly sorted, micaceous, commonly feldspathic, and generally low in quartz content (Figure 20). A few quartzose sandstones (Figure 21) occur near the distal ends of the Pocahontas Formation in the subsurface in Buchanan, Dickenson, and Wise counties. Unlike those in the Lee Formation, however, the Pocahontas quartzose sandstones are very fine to fine grained, commonly silty, generally less than 20 feet thick, and commonly interbedded with thin, dark-gray shales and siltstones. The siltstones within the Pocahontas

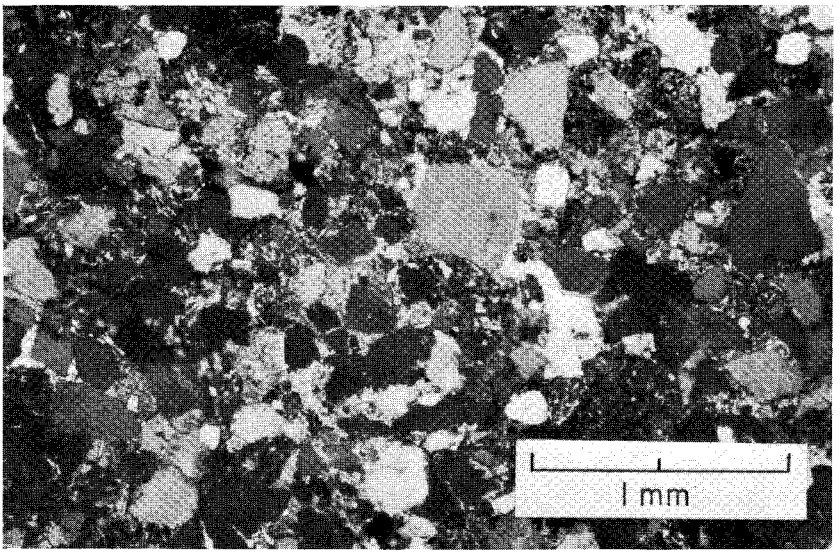


Figure 20. Photomicrograph of Pocahontas graywacke from core in Buchanan County. Shows typical nature of the Pocahontas sandstones. A lithic graywacke consisting of poorly sorted, subrounded to subangular grains of quartz, rock fragments, and feldspar in a fine matrix. Quartz is about 60-65 percent. Crossed nicols.

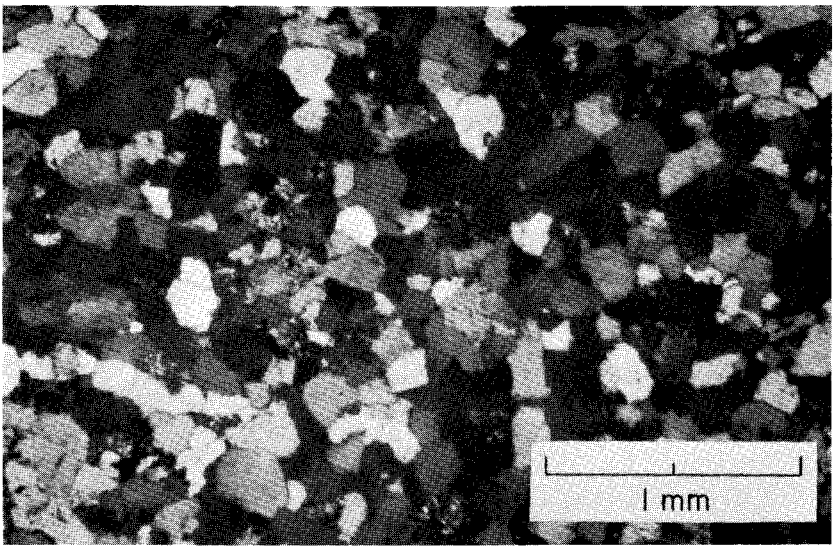
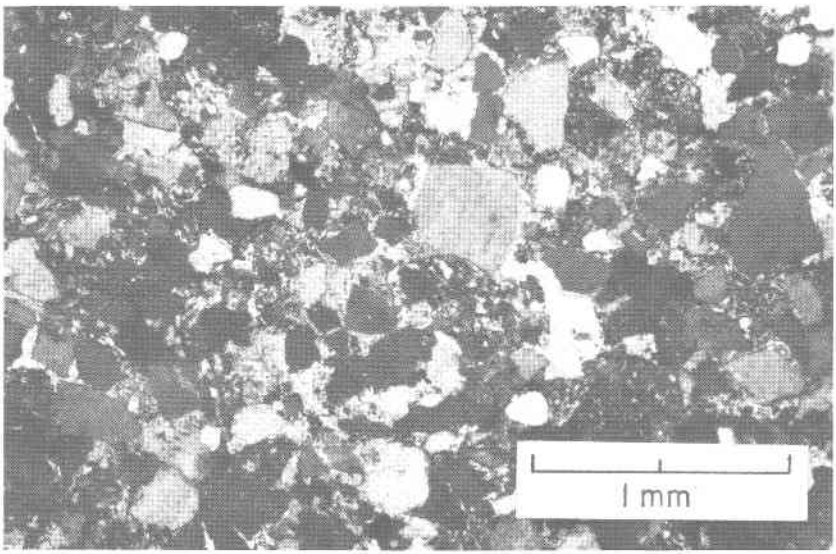


Figure 21. Photomicrograph of fine-grained, well-sorted, lithic arenite within the basal portion of the Pocahontas Formation from core from Buchanan County. Although high in quartz content, the fine-grained nature, the increase in rock particles, and matrix is atypical of the Lee quartz arenites. These sandstones have occasionally been mistaken as belonging to the Lee Formation. Crossed nicols.



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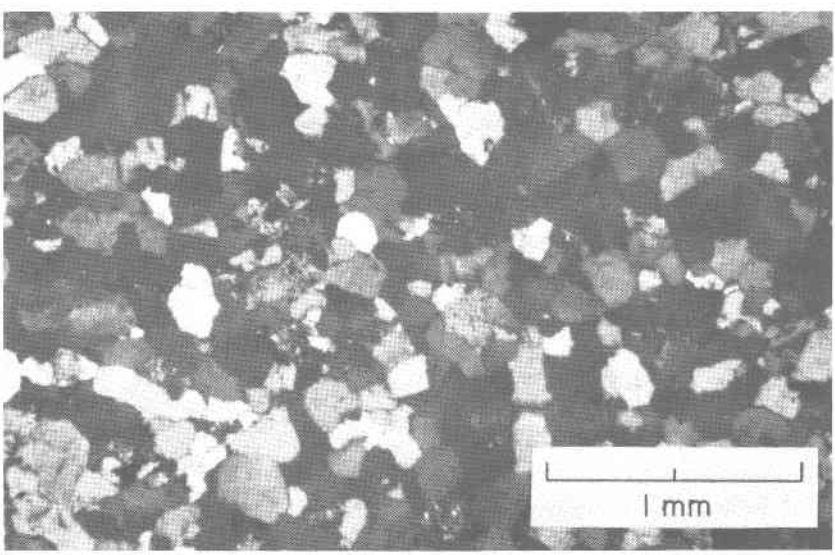

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Formation are gray to light gray, usually thin, and in many places contain plant fossils. The shales are gray to dark gray, partly carbonaceous, locally silty and calcareous, and rarely contain small ironstone concretions. Plant fossils are generally abundant within the shales, the most distinctive being *Neuropteris pocahontas*. Coals within the Pocahontas Formation are generally low sulfur, medium to low volatile bituminous and are among the most highly regarded in the United States.

The intertonguing of the Pocahontas and Bluestone formations is difficult to trace in detail in the subsurface. The intertonguing takes place only within the basal portions of the Pocahontas Formation and does not appear to involve any prominent coal beds such as the Pocahontas No. 3. In the subsurface an arbitrary boundary is placed at the first red or green shale (Figure 18), or at gray, calcareous shales that contain marine fossils.

The upper boundary is generally much more distinctive, particularly in the northwestern areas where the basal white, quartzose, conglomeratic sandstone of the Lee Formation lies unconformably upon the dark-gray shales and siltstones, and the light-gray, fine-grained, feldspathic sandstones of the Pocahontas Formation (Figure 22). The basal sandstone of the Lee Formation is nonidentifiable only in extreme southeastern Bu-

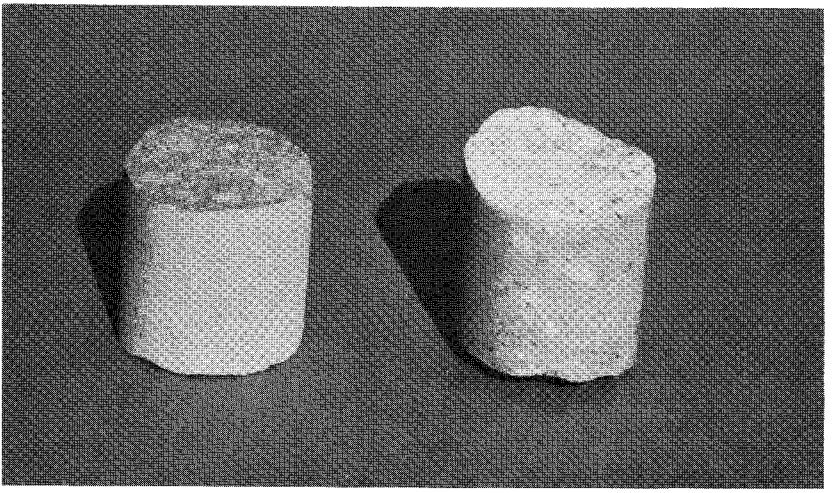

Figure 22. Sandstones from the Lee and Pocahontas formations are usually distinguishable in core sections. The basal conglomeratic quartz arenite of the Lee shown on the right unconformably overlies finer grained graywackes of the Pocahontas Formation shown on the left. Cores are 2 inches in diameter.

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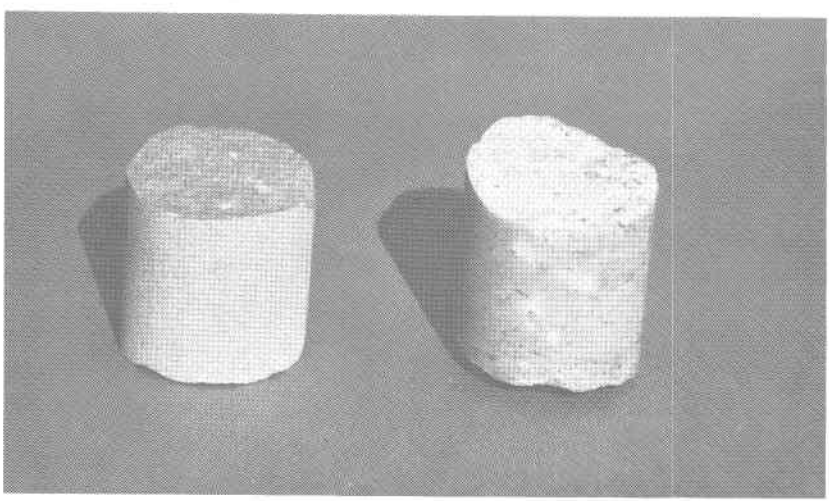

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chanan County and in Tazewell County (Figure 25). In these areas the top of the Pocahontas Formation is determined by the Flat Top Mountain Sandstone or the estimation of the Pocahontas No. 7 and No. 8 coal beds, which occur below and above the Flat Top Mountain Sandstone Member. The unconformity becomes obscure with the termination of the basal Lee sandstone to the southeast, but projection of the unconformity illustrates the base of the Lee Formation is roughly equivalent to the base of the New River Formation (Plates 2, 4).

The Pocahontas Formation is thickest in southeastern Buchanan County and in Tazewell County, where it is 600 to more than 750 feet thick (Figure 23). The formation thins to the west and northwest, principally by truncation, and is absent in northwestern Wise, Dickenson, and Buchanan counties. This coal-bearing formation extends over most of Buchanan County, about half of Dickenson and Wise counties, and all the coal-field areas of Russell, Scott, and Tazewell counties.

The isopach map (Figure 23) shows that the Pocahontas has been laterally displaced along the Russell Fork fault and the fault along Jess Fork. In these areas, northwestward movement of the southwestern sheet has brought a thicker sequence of Pocahontas beds opposite a thinner succession to the northeast. South of the Russell Fork fault, along the southeastern fringes of the coal fields in Wise, Russell, and Scott counties, the Pocahontas Formation thins generally to the west. The Pocahontas Formation is about 500 feet thick where Russell, Buchanan, and Dickenson counties meet, and about half that thickness 12 miles to the southwest near the Russell-Wise county boundary. The Pocahontas thickens to about 350 feet in eastern Wise County, and thins farther to the west and northwest. At Little Stone Gap in Wise County, on the north limb of the Powell Valley anticline, the formation appears to be over 100 feet thick. About 8 miles farther west, at Big Stone Gap, it is less than 30 feet, and in a gas test and a deep coal exploration test 5 miles northwest of Big Stone Gap, the formation is totally absent (Plate 1, numbers 122 and 123).

In the exposures in southeastern Wise County and parts of Russell and Scott counties the Pocahontas Formation and its coal beds have never been well established. Incorrect correlations have been made in these areas because there are few outcrops of the formation, and most of these are where the rocks are highly

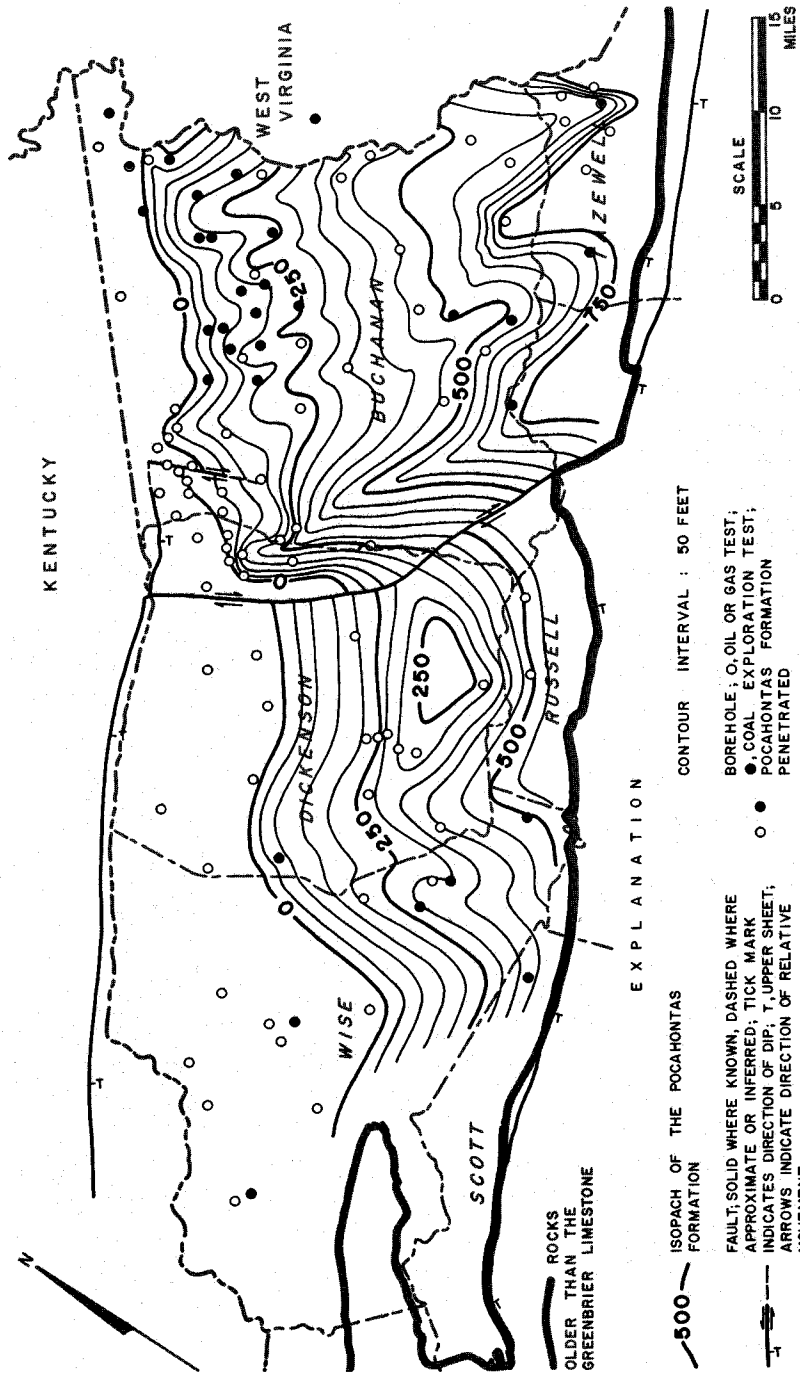

Figure 23. Thickness map of the Pocahontas Formation.

folded. Additionally, names other than Pocahontas have long been established in geologic mapping in the area because the Pocahontas Formation was not recognized as a stratigraphic unit separate from and truncated by the Lee Formation.

An enigmatic stratigraphic sequence noted by earlier workers in Lower Pennsylvanian rocks in the areas where this report shows that the Pocahontas Formation is present (Figures 23, 24), indirectly supports the interpretations of this study. Comparison of the earlier studies with the map of the Pocahontas Formation (Figure 23) illustrates that where the Pocahontas Formation is of considerable thickness the tendency has been to include the Pocahontas sequence within the Pennington (Wentworth, 1922; Wilpolt and Marden, 1959), whereas in areas where the coal-bearing sequence is thinner and of less significance, the Pocahontas was often included in the Lee Formation (Eby, 1923; Butts, 1940-41).

Pocahontas No. 1 and No. 2 Coal Beds

The data from cores taken during coal exploratory tests show that coals below the Pocahontas No. 3 coal bed are generally thin, inconsistent, and of little economic potential. Subsurface data, however, are somewhat limited, because coal companies often discontinue exploratory drilling below the Pocahontas No. 3. The Pocahontas No. 2 coal bed is usually thicker than the Pocahontas No. 1 coal bed, but nowhere appears to be of economically mineable thickness.

Pocahontas No. 3 Coal Bed

The Pocahontas No. 3 coal bed is the most important coal in southwestern Virgina, and is one of the most important in the Appalachian coal fields. It is of medium- to low-volatile bituminous rank, possesses excellent combustion qualities, burns with little smoke, and is very low in sulfur content. Because of these distinct qualities the coal is widely used as a blending coal in the manufacture of metallurgical coke. The coal has been mined extensively where exposed in northeastern Tazewell County and nearby areas in West Virginia, and is presently produced from several large, deep, shaft mines in Buchanan County, each of which is about 1300 feet deep, and produces about 1.5 million tons annually. Due to the development of these large shaft mines

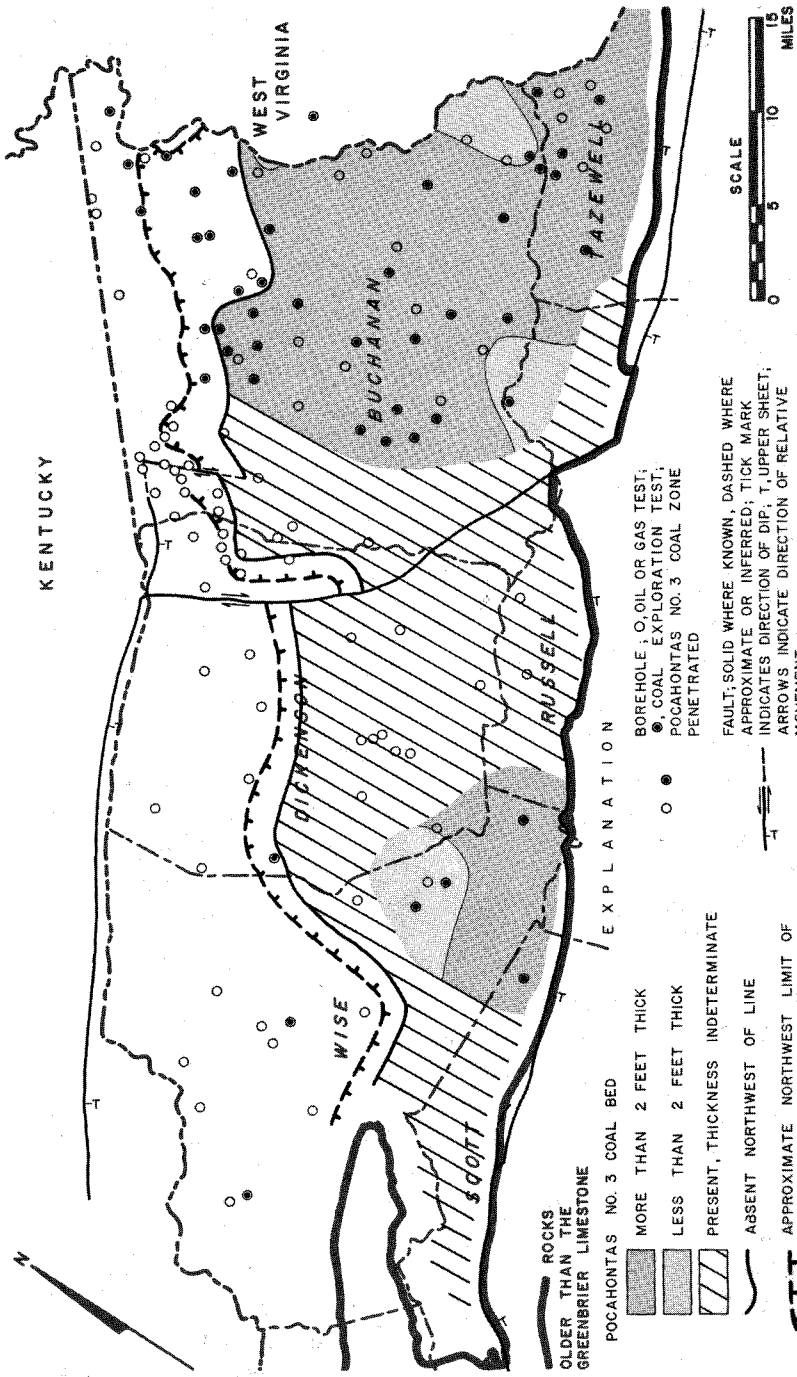

Figure 24. Map showing approximate extent and thickness of the Pocahontas No. 3 coal bed. (Some data from Harnsberger, 1919.)

during the late 1960's and early 1970's, the Pocahontas No. 3 coal has recently become the most produced coal in Virginia (Virginia Department of Labor and Industry, 1973).

The range in composition of the Pocahontas No. 3 coal from mine samples on the "as received" basis from mines in Tazewell County (U.S. Bureau of Mines, 1944, p. 72-75; Deurbrouck, 1963, p. 27; and Birge, Wolfson, and Lynch, 1964, p. 9) is as follows:

	Percent
Moisture	1.4–2.3
Volatile matter	21.0–22.8
Fixed carbon	68.9–72.8
Ash	3.3–6.9
Sulfur	0.5–0.6

The Pocahontas No. 3 bed has a maximum thickness of about 11 feet in outcrops in extreme northeastern Tazewell County, ranges from 97 to 100 inches in mines in that vicinity, and decreases in thickness to 30 inches near the Tazewell-Russell county boundary (Harnsberger, 1919; Brown and others, 1952).

The subsurface data (Figure 24) indicate that the Pocahontas No. 3 bed has a thickness of over 4 feet throughout south-central Buchanan County and thins to minimums of about 31 inches to the north and about 20 inches to the south. To the northwest in Buchanan County the Pocahontas No. 3 coal is terminaed by an unconformity which marks the base of the overlying Lee Formation. In boreholes in the northwest portion of Buchanan County (Plate 1, numbers 20, 21, 22), the thick, basal conglomeratic quartz arenite of the Lee Formation lies directly upon the Pocahontas No. 3 coal. In these boreholes the thickness of the Pocahontas coal is 3 to 4 feet. In subsurface sections short distances to the northwest and north (Plate 1, numbers 16, 17, 19, 23) the Pocahontas No. 3 coal is absent and older sediments of the Pocahontas Formation are in turn overlain by the same massive Lee sandstone. The entire Pocahontas Formation is eventually removed to the northwest.

South of the Russell Fork fault the Pocahontas No. 3 coal has not been mined or developed, but does occur in the subsurface over an area that is as extensive as that in Buchanan County. The coal occurs in the southern half of Dickenson County, the southeastern third of Wise County, and the coal-bearing portions

of Scott and Russell counties. Although core data is scarce in these areas, the well cuttings from oil and gas tests and the limited amount of data from cores of coal exploration tests illustrate for the most part that the coal continues to be of mineable thickness. In north and northwestern Dickenson and Wise counties, the Pocahontas No. 3 bed is absent, again apparently through truncation by the basal Lee quartz arenite member. The total area of Pocahontas No. 3 coal in southwest Virginia is approximately 750 square miles, which agrees with a previous estimate made by the writer (Miller, 1972).

The elevation of the Pocahontas No. 3 coal bed is from sea level in central Buchanan County to over 1700 feet some 21 miles to the southeast where exposed in western Tazewell County (Figure 8). In central Buchanan County, the coal exhibits two northward-plunging anticlines and one syncline which trend essentially to the north. Another syncline trending to the northeast is located in eastern Buchanan County just north of the Dry Fork anticline. A gently dipping, northward-trending syncline appears to be present in the western corner of Buchanan County near the Dickenson-Buchanan County boundary. In southern Dickenson County the coal occurs in a broad syncline which trends and plunges to the north. In central Buchanan County, where the coal is mined, changes in structural relief around the folds are slight, averaging about 1 foot per 100 feet. In eastern Buchanan County and Tazewell County, as indicated on the map, the dip of the Pocahontas No. 3 coal bed becomes much steeper, particularly near the north limb of the Dry Fork anticline.

The structure and thickness maps (Figures 8, 24) show that the Pocahontas No. 3 coal has been displaced by the Russell Fork fault and the fault along Jess Fork (Figure 8). Along the Russell Fork fault the Pocahontas No. 3 has been laterally displaced about 4 miles and along the smaller fault along Jess Fork about 1 mile.

Pocahontas No. 3 Coal Bed, Burtons Ford Coal Bed, and Low-Grade Metamorphism

The Pocahontas No. 3 coal bed and Burtons Ford coal bed are probably the same coal bed. The apparent stratigraphic consistency of the Burtons Ford coal along the south side of Powell Mountain in Scott County and the thickness of the seam, re-

portedly 4 to 9 feet (Eby, 1923, p. 465), lend support to correlation with the Pocahontas No. 3 coal, which is also known for consistency and thickness within the same stratigraphic interval in the subsurface farther to the northeast. Subsurface and surface studies by this writer and comparative review of previous publications (Wilpolt and Marden, 1959; Englund and DeLaney, 1966) illustrate that the Burtons Ford coal bed at its type locality is in the Pocahontas Formation. Examinations of outcrop areas show that the deformed and crushed nature of these exposures (Figure 25) limits the accuracy of any surface

Figure 25. In the northern part of Scott County near Hanging Rock. Outcrop shows vertical spine of basal Lee quartz arenite member, which is typical of the Lower Pennsylvanian exposures along the southeastern fringes of the Virginia coal fields. Less resistant units equivalent to the Pocahontas Formation underlie the more resistant lower quartz arenite member.

measurements. Palynological studies of several samples taken from the Burtons Ford and Pocahontas No. 3 coals were also inconclusive. There is apparently no question, however, that the Burtons Ford and the Pocahontas No. 3 beds occur below the basal Lee conglomerate and are both of the Pocahontas sequence.

The recognition of the approximate stratigraphic position of the Burtons Ford coal bed and its close relationship with the Pocahontas No. 3 coal bed, aids in understanding the regional tectonic relationships in the area, and evaluating the total eco-

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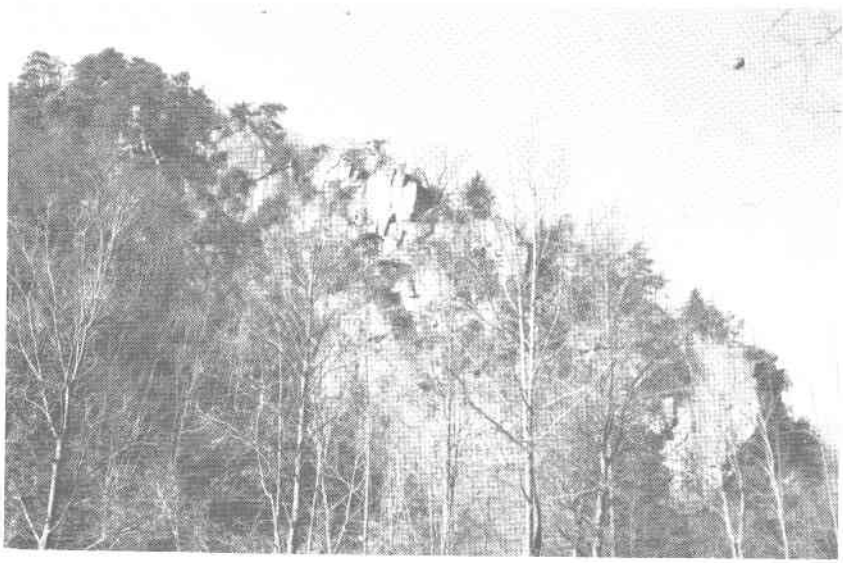

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The recognition of the approximate stratigraphic position of the Burtons Ford coal bed and its close relationship with the Pocahontas No. 3 coal bed, aids in understanding the regional tectonic relationships in the area, and evaluating the total eco-

nomic potential of the Pocahontas No. 3 coal. The range in compositional analyses of the Pocahontas No. 3 coal along the relatively flat-lying exposures in Tazewell County has been noted earlier. Chemical analysis of Pocahontas No. 3 coal of raw coal samples from the Beatrice-Pocahontas mine in Buchanan County on the "as received" basis is as follows (Deurbrouck, 1966, p. 42):

	Percent
Moisture	0.4
Ash, moisture free	7.6
Sulfur, moisture free	0.6
Volatile matter, moisture free	17.3
Fixed carbon, moisture free	75.1

The chemical analysis of the Burtons Ford coal of channel samples taken from the Russell Fork mine at Burtons Ford, Russell County, on the "as received" basis is as follows (Wentworth, 1922, p. 105):

	Percent
Moisture	3.6
Ash, moisture free	3.96
Sulfur, moisture free	0.49
Volatile matter, moisture free	33.2
Fixed carbon, moisture free	62.8

The following range of composition of the Burtons Ford coal of channel samples from mines near Little Stony Creek in Scott County on the "as received" basis was reported by Eby (1923, p. 525):

	Percent
Moisture	2.6–2.9
Ash, moisture free	6.8–7.4
Sulfur, moisture free	0.88–0.98
Volatile matter, moisture free	31.7–32.3
Fixed carbon, moisture free	60.3–61.4

The analyses illustrate a consistently low sulfur and ash content for both coals, a feature which is typical of all the Pocahontas coals. The difference in volatile matter and fixed carbon is striking, however. The Pocahontas No. 3 coal samples from horizontal strata northeast of the Cumberland thrust sheet

exhibit a high amount of fixed carbon and low amount of volatile matter, whereas the samples of Burtons Ford coal have a smaller amount of fixed carbon and a much larger amount of volatile matter. One would normally expect the volatile constituents of the Burtons Ford to be lower because of the degree of associated folding and faulting, and to have undergone considerably more low-grade metamorphism than coals in the flat-lying beds, particularly outside the Cumberland thrust sheet. The opposite, however, appears to have taken place from the comparison of chemical analyses.

A palynological study of the coals also supports the increase in low-grade metamorphism in horizontal beds that appear to be less disturbed. Coal samples collected from the Pocahontas No. 3 coal bed at its type section in Pocahontas, Tazewell County, and from the Beatrice Pocahontas mine in Buchanan County, were so metamorphosed that the spores could not be separated by maceration. Spores were obtained, however, from the Burtons Ford coal from vertical and overturned sections near Miller Yard in Scott County. It should be noted that near the top of the younger Lee Formation an excellent assemblage of spores (Table 2, Plates 5-7) was found in samples of Kennedy coal from vertical exposures along the northern limb of the Powell Valley anticline near Norton in Wise County. Samples of the same coal about 8 miles northeast near Tacoma in horizontal beds yielded only rare fragmental and poorly preserved spores. Samples of the Kennedy coal from horizontal strata near McClure, Dickenson County, within the Cumberland thrust sheet and from flat-lying coal measures along U. S. Highway 460 near Big Rock, Buchanan County, north of the Cumberland thrust sheet, were too metamorphosed to yield any spore assemblage. Coals in Wise and Lee counties, stratigraphically higher than the Kennedy coal, also were determined by Robert Kosanke as being "so metamorphosed that spores could not be separated by conventional maceration methods" (Miller, 1969, p. 24). The preservation of spores and volatile matter, and the low amount of fixed carbon in the coal measures which have been displaced, moved upward, and overturned, suggests the probability that the compressive forces responsible for the movement of the Cumberland thrust sheet had a greater effect on coal that remained relatively stationary and horizontal, and less of an effect on coal in strata that were displaced and overturned. The Burtons Ford coal bed, by moving upward with the initial horizontal thrusts, was not

subjected to the effects of heat and pressure, as was the probable laterally equivalent Pocahontas No. 3 coal bed which was unable to move with the stresses. This theory was actually proposed for the southwest Virginia coal fields by White (1913), but was apparently dismissed with the later criticisms of Reeves (1928, p. 805) and Heck (1943).

It appears evident that the Pocahontas No. 3 bed, which is being mined in Buchanan and Tazewell counties, has been subjected to low-grade metamorphism, the effects of which should be less in areas of displacement, folding or faulting, where an increase in volatile matter and a decrease in fixed carbon should be expected. Therefore the Pocahontas No. 3 coal in the subsurface in Dickenson and Wise counties, within the Cumberland thrust sheet, should approach medium volatile, with a decrease in fixed carbon. The sulfur and ash content should remain relatively consistent throughout the area.

It is also possible that the amount of fixed carbon will vary with the presence of synclines and anticlines. A recent study concerning low-grade metamorphism of the Arkoma basin coals in eastern Oklahoma illustrated that the percentage of fixed-carbon of coals in anticlines was higher than in synclines (Wilson, 1961, p. 135).

Pocahontas No. 4 Coal Bed

The Pocahontas No. 4 coal bed, a low-sulfur, low-volatile coal, normally occurs about 80 to 120 feet above the Pocahontas No. 3 coal bed, and is reported to be 15 to 84 inches thick in surface exposures in Tazewell County (Harnsberger, 1919). In the subsurface the interval between the Pocahontas No. 3 and No. 4 coals is thinner. In western Buchanan County and farther southwest in Wise, Dickenson, and Scott counties the interval is about 30 to 50 feet; in southeastern and south-central Buchanan County it ranges from 40 to 80 feet. The coal in south-central Buchanan County is generally less than 2 feet thick (Figure 26) with local thickening in southwestern Buchanan County and Tazewell County. In a small area in eastern Buchanan County the coal is absent. The thickness is greatest in southwestern Buchanan County, where it is locally over 6 feet.

In eastern Wise, southern Dickenson, and Russell counties the Pocahontas No. 4 coal bed appears to be consistently present in cuttings from oil and gas tests. Lack of core data in these

areas, however, prevented the accurate evaluation of thickness. The thicker occurrences are probably in the extreme southern areas, as based on projection of the thick Pocahontas No. 4 coal in Buchanan County into the areas southwest of the Russell Fork fault and core data in eastern Wise County.

The Pocahontas No. 4 coal does not extend into the northern parts of Wise, Dickenson, and Buchanan counties. The unconformity at the base of the Lee Formation truncates it in these areas.

Pocahontas No. 5 Coal Bed

The Pocahontas No. 5 coal bed, a medium-volatile, low-sulfur coal, is generally about 35 to 45 feet above the Pocahontas No. 4 coal bed, and is reported to be 15 to 78 inches thick in outcrop in Tazewell County. In the subsurface, the interval between the Pocahontas No. 4 and No. 5 beds is variable. In extreme southern Buchanan County the Pocahontas No. 5 is 50 to 60 feet above the No. 4, whereas in eastern Buchanan County the interval appears to increase to about 100 feet. A massive sandstone normally separates the coal beds. An increase in thickness of this sandstone unit appears to be responsible for the absence of the Pocahontas No. 5 coal in south-central Buchanan County.

The approximate extent and thickness of the Pocahontas No. 5 coal bed are shown in Figure 27. The coal is more limited in extent than the No. 3 and No. 4 coals. This is principally due to the stratigraphic position of the basal Lee unconformity, which truncates successively older strata to the northwest. As shown, the coal is limited in occurrence to south and southeastern Buchanan County, northern Tazewell County, two separate areas in northern Russell County, and small areas in the southeastern parts of Dickenson and Wise counties. The coal is normally thin in the subsurface. Only in a few isolated areas in Buchanan and Tazewell counties is the thickness over 2 feet.

Pocahontas No. 6 Coal Bed

The Pocahontas No. 6 coal bed, considered a good quality coal, is limited in southwestern Virginia to southeastern Buchanan County, and the northern parts of Tazewell and Russell counties and probably a very small part of southeastern Dickenson County (Figure 28). This coal is known to occur about 200 feet above the Pocahontas No. 3 coal at the surface in Tazewell

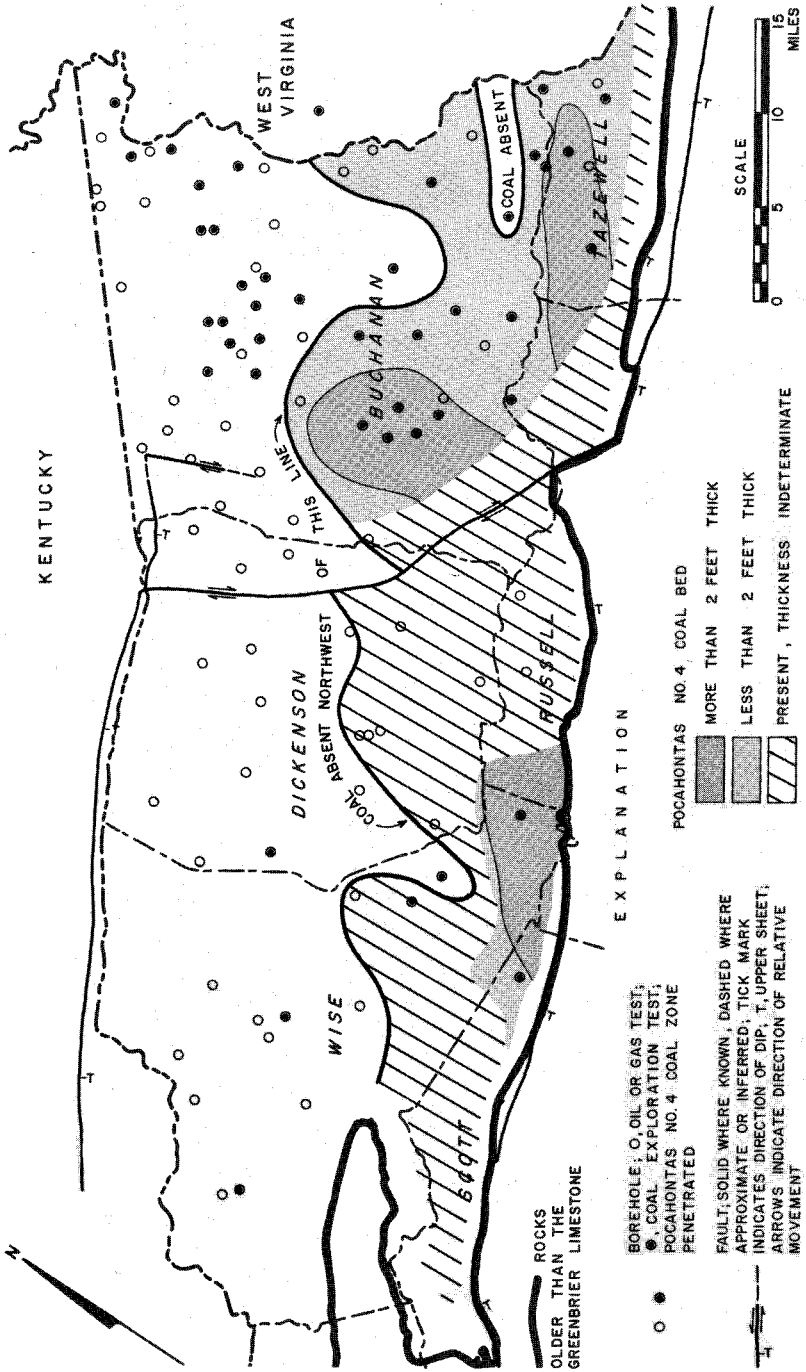


Figure 26. Map showing approximate extent and thickness of the Pocahontas No. 4 coal bed. (Some data from Harnsberger, 1919.)

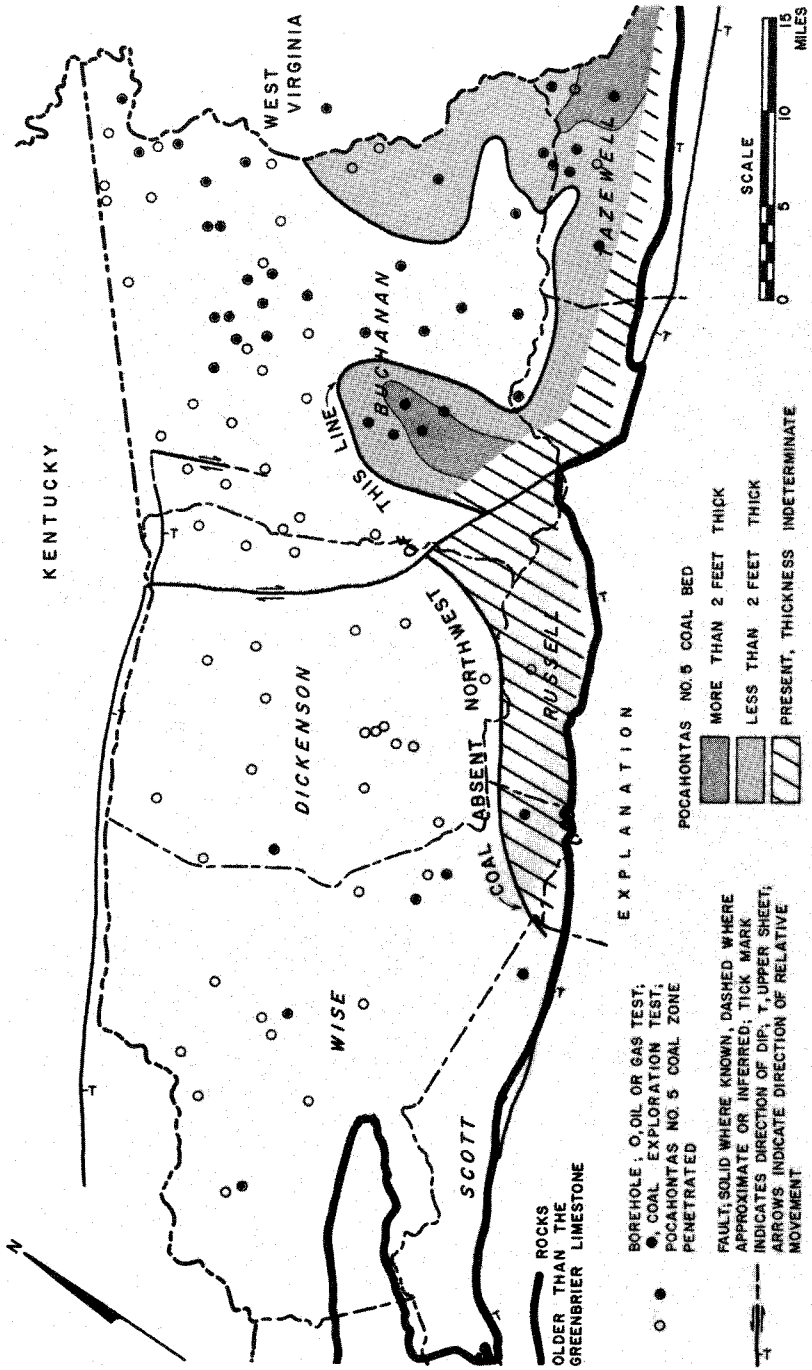


Figure 27. Map showing the approximate extent and thickness of the Pocahontas No. 5 coal bed. (Some data from Harnsberger, 1919.)

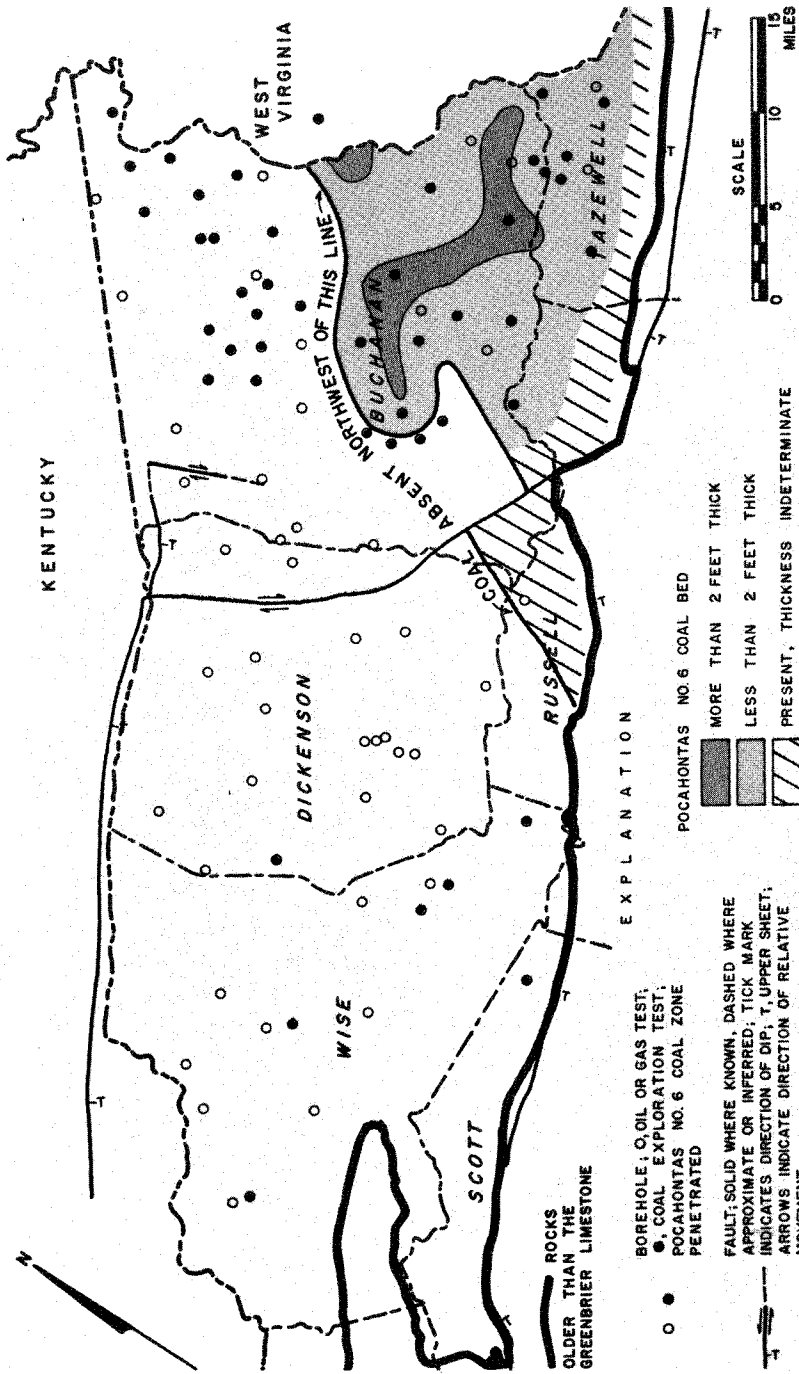


Figure 28. Map showing approximate extent and thickness of the Pocahontas No. 6 coal bed. (Some data from Harnsberger, 1919.)

County (Harnsberger, 1919, p. 77). The interval between the Pocahontas No. 3 and No. 6 coal beds gradually decreases eastward into the subsurface to about 130 feet in south-central Buchanan County. The Pocahontas No. 6 bed, except for small areas in southeastern Buchanan County, is less than 2 feet in thickness. The No. 6 coal, similar to the other Pocahontas coals, is truncated to the northwest by the basal Lee unconformity.

Pocahontas No. 7 Coal Bed

The Pocahontas No. 7 coal bed, containing only small indicated and inferred reserves of less than 2 feet in outcrop areas in Tazewell County (Brown and others, 1952), also appears to have very little economic potential in the subsurface to the north and west. The coal is limited to extreme southeastern Buchanan County and small portions of Tazewell and Russell counties. The extent and thickness of Pocahontas No. 7 coal bed is shown in Figure 29.

LEE FORMATION

The Lee conglomerate was named for a series of exposures along the northwest boundary of Lee County, Virginia (Campbell, 1893). His published section of the unit and the area where he considered the Lee to be best exposed, however, was at Big Stone Gap in Wise County. This section has since been established as the type section by Eby (1923) and Miller (1969). Later workers (Eby, 1923; Giles, 1921; Hinds, 1918; Harnsberger, 1919; Wentworth, 1922) normally referred to the Lee conglomerate as the Lee Formation.

The occurrence or absence of the Upper Mississippian rock units and many of the economically important Lower Pennsylvanian coals, the interpretation of the geologic history, and the depositional environments of the Mississippian and Pennsylvanian systems can be best interpreted with an accurate understanding of the Lee Formation.

The Lee Formation, although a prominent ridge maker at the surface, is actually best studied in the subsurface. Where the Lee is exposed, the terrain is usually rugged with steep cliffs and hogbacks formed by quartz arenites (Figures 2 and 25). The less resistant units separating the quartz arenites are normally covered and cannot be observed at the surface. Even at Big

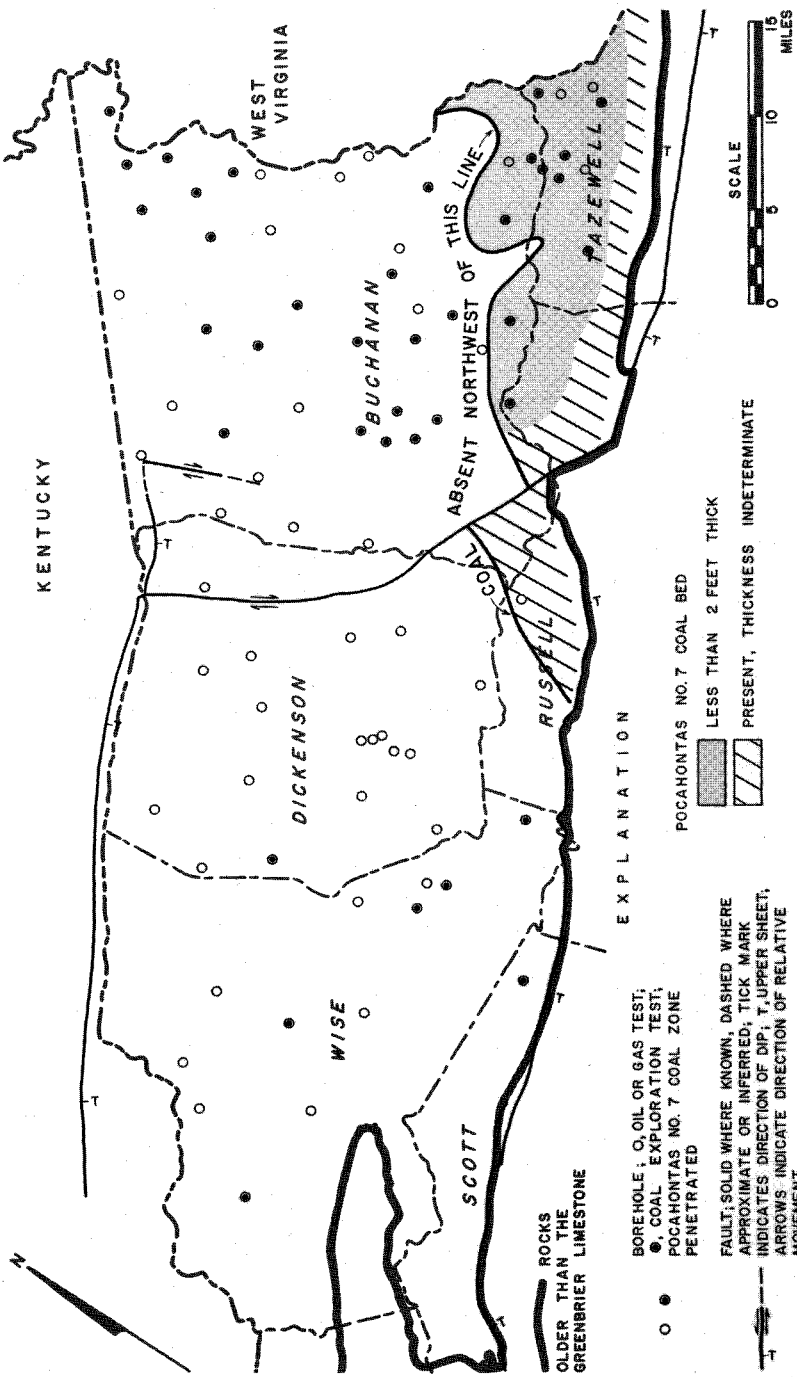


Figure 29. Map showing approximate extent and thickness of the Pocahontas No. 7 coal bed. (Some data from Harnsberger, 1919.)

Stone Gap, where the Lee is considered to be best exposed, only portions of the formation can be seen. Here the Lee is steeply folded and crushed, and shearing and slippage features can be observed along the section. Here, at least a third of the Lee is not exposed and measured sections prepared by different geologists vary by as much as 300 feet. In the subsurface, however, the Lee Formation is usually flat-lying and relatively undisturbed. Exploratory drilling and coring operations for oil, gas, and coal have penetrated the Lee Formation at numerous places throughout the study area providing considerable data upon which more accurate stratigraphic determinations can be made. From this subsurface data, the writer found that continuous vertical subsurface sections and close lateral control were essential for accurate correlations and interpretations of the Lee. The limited outcrop exposures of the Lee were examined for diagnostic surface features, but were found to be restricted in their use for correlation purposes.

As established by Campbell (1894, p. 3) the Lee at Big Stone Gap "is composed of three beds of massive sandstone or conglomerate, separated by intervals of shale, the whole carrying from two to six seams of coal." The massive sandstones are quartz arenites using the sandstone classification of Pettijohn, Potter, and Siever (1972). It is these resistant quartz arenites that identify the Lee Formation as such a prominent ridge maker. Microscopic study of well cuttings, thin-section analysis of selected cores, and field study of outcrop sections illustrate that the quartz arenite units are composed of more than 90 percent quartz; less than 5 percent rock fragments; less than 1 percent feldspars; less than 1 percent accessory minerals; and less than 5 percent matrix. In the detrital quartz fraction, the ratio of monocrystalline to polycrystalline quartz is about 10 to 1. The grains are fine to granule size, but mostly medium to coarse grained, rounded to subangular, medium to well sorted, but poorly sorted where the sand is conglomeratic (Figure 30). The grains are usually cemented by silica as secondary enlargements (Figure 31). The contacts between the quartz are often joined with a straight boundary that gives the rock an interlocking texture (Figure 32).

The matrix makes up only a small portion of quartz arenites and is usually composed of mica, calcite, sericite, and quartz of

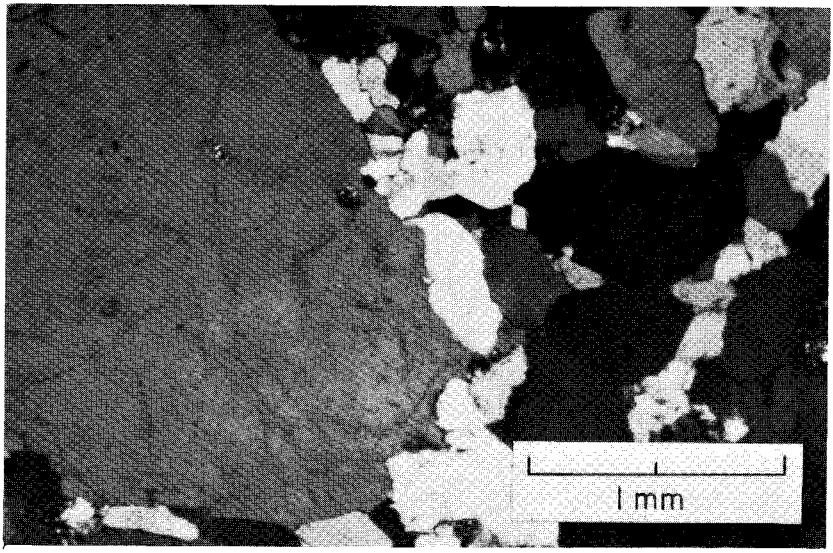


Figure 30. Photomicrograph from core in Buchanan County showing the poorly sorted nature of the conglomeratic zones in the Lee quartz arenites. Some pebbles have reconstructed crystal form and show crystal faces which are the result of secondary quartz overgrowths in crystallographic continuity with the original pebbles and coarse grains. Contains over 95 percent quartz. Crossed nicols.

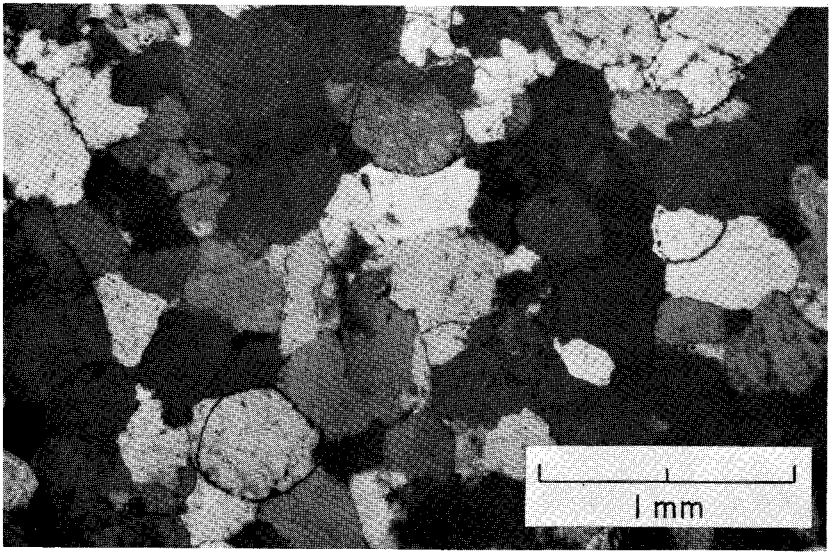
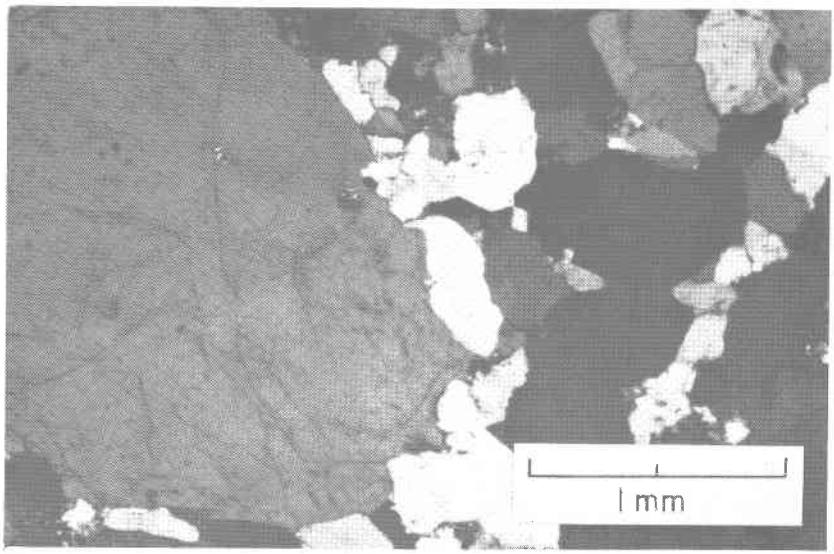


Figure 31. Photomicrograph of Lee quartz arenite from core in Buchanan County. Good example of secondary enlargement of well-rounded quartz, which is characteristic of the Lee quartz arenites. The boundaries between detrital grain and overgrowth made very distinct by preservation of dust rings on the original detrital core. Crossed nicols.



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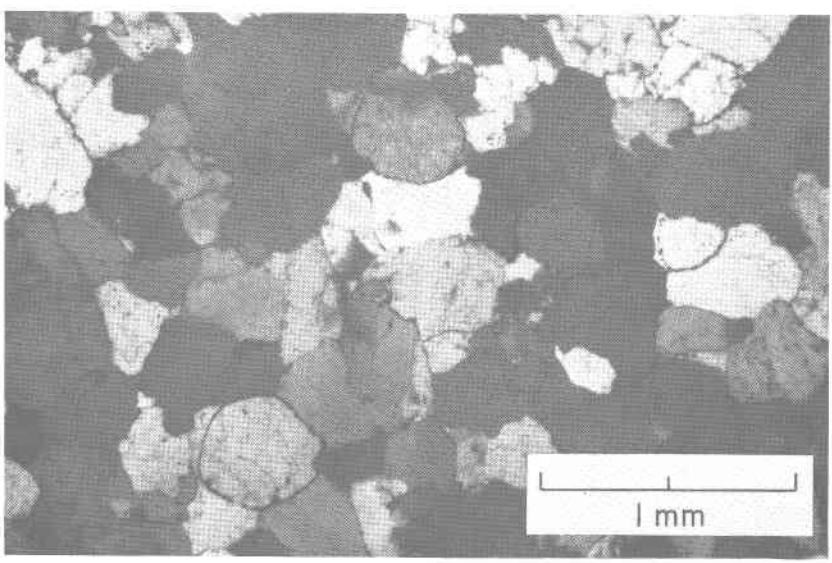

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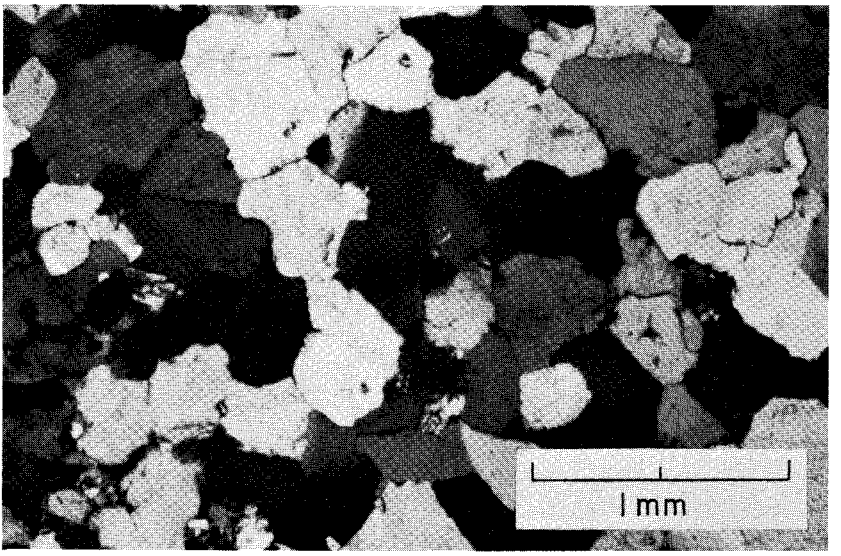

Figure 32. Photomicrograph of medium- to coarse-grained Lee quartz arenite from core in Buchanan County. Original outlines in quartz are difficult to see; the secondary quartz results in interlocking sutured grain boundaries, which accounts for the hard, resistant nature and low amount of porosity that are characteristic of the Lee quartz arenites. Crossed nicols.

silt size and smaller. Where the matrix occurs between quartz grains, the secondary enlargement of the grains is limited. Very rarely, chert or chalcedony are present between grains.

The rock fragments are of sedimentary and metamorphic origin, consisting of sandstone, slate, phyllite, schist, shale, siltstone, and quartzite. They are usually well-rounded and range from equidimensional to elongate. Tourmaline and zircon, with lesser amounts of ilmenite and leuxocene, compose the heavy mineral suite. Microcline and plagioclase make up the small amount of feldspar, and muscovite is the dominant mica.

The pebbles in the Lee quartz arenites are mostly milky, white to rose vein quartz with minor quartzite, sandstone, shale, and siltstone pebbles. Most pebbles are spherical and well-rounded and average from 1 to 2 cm in diameter, but some are as much as 4 to 5 cm (Figure 33). The pebbles are usually concentrated along bedding and cross-bedding planes (Figure 34), but may occur sporadically throughout the units (Figure 35).

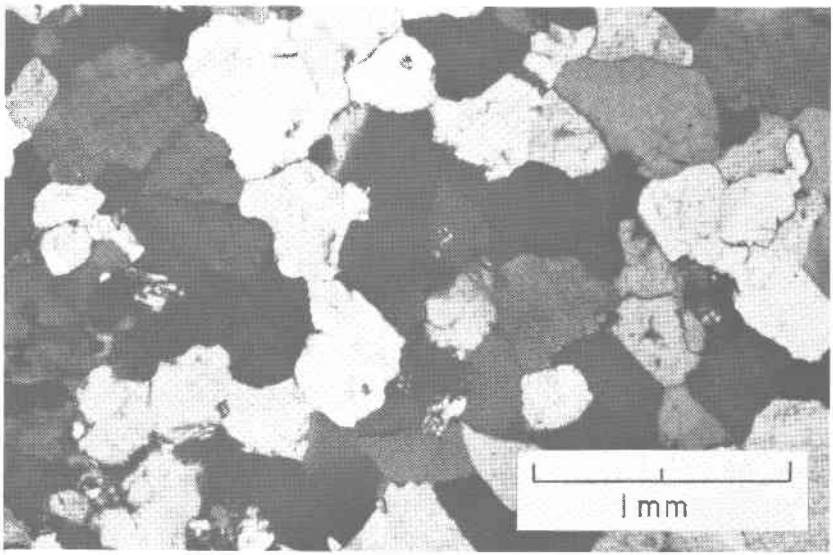

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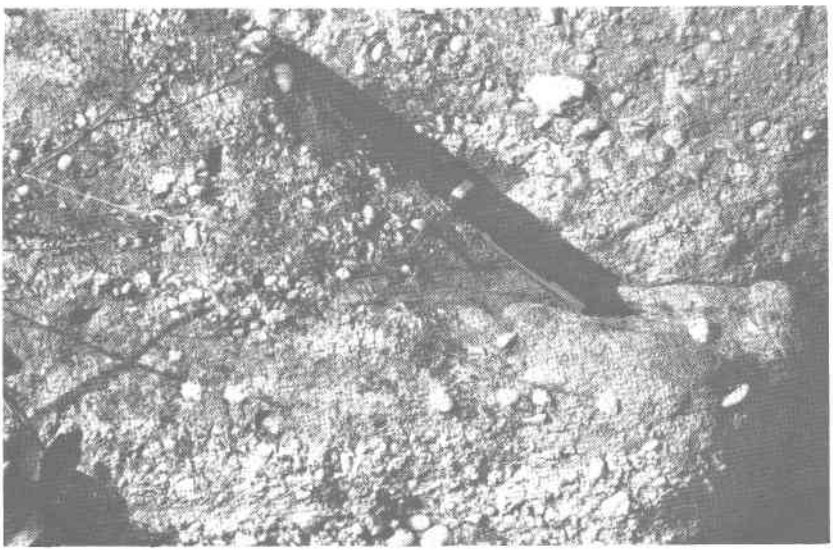
Figure 33. Conglomeratic bed in quartz arenite of the Lee Formation. Note the large, round, white quartz pebbles, which are normally 1 to 2 cm. in diameter, but may occur up to 10 cm. The conglomeratic zones are normally less than 2 feet in thickness and generally lack significant lateral continuity.

Figure 34. Lower quartz arenite member of the Lee Formation along State Highway 72 east of Baker Branch about 2.5 miles northeast of Dungannon, Scott County, Virginia showing the distribution of quartz pebbles along a 6-inch lens along the bedding planes.



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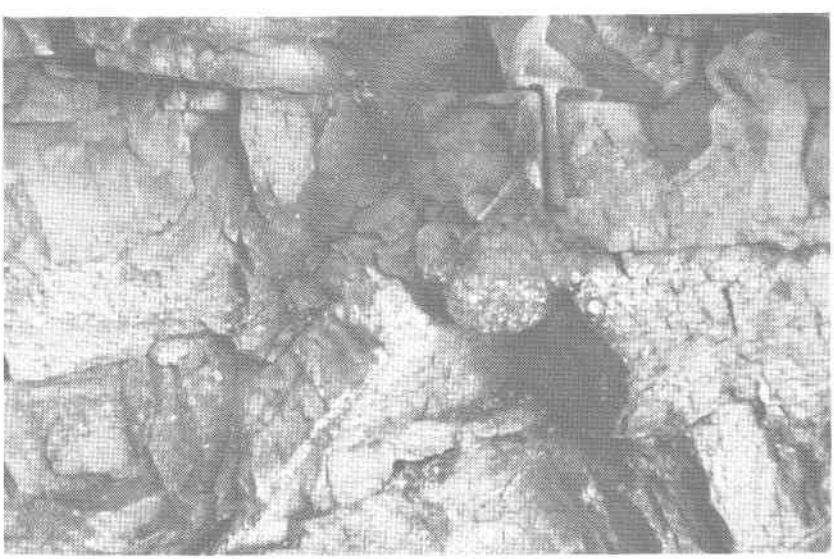

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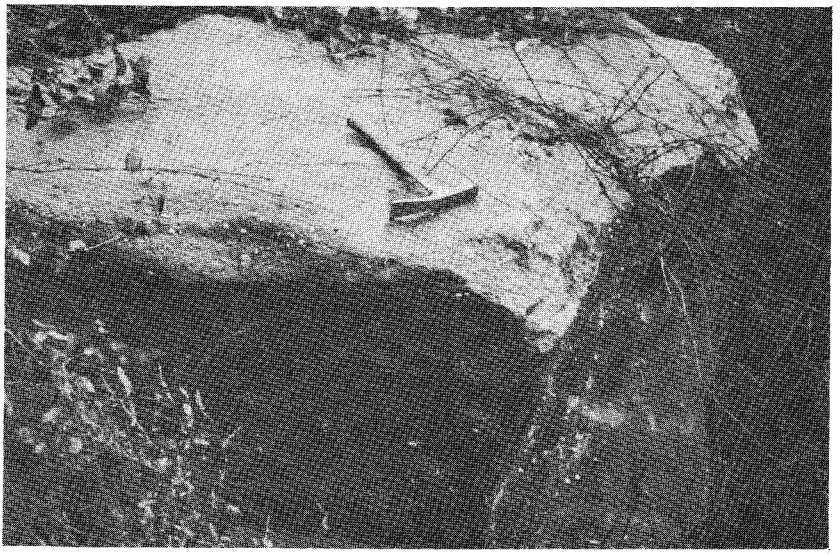

Figure 35. Coarse conglomeratic Lee quartz arenite along U. S. Highway 23 on the south slope of Pine Mountain north of Pound in Wise County, showing the sporadic distribution of rounded quartz pebbles.

In outcrop the quartz arenites are usually massive bedded, but are at a few places medium to thin bedded. The units are characterized by an abundance of cross-stratification features, such as low- to high-angle planar cross-laminations (Figures 36 and 37) large-scale, low-angle cross-stratification (Figure 38) and festoon cross-bedding (Figure 39). Some sandstones have very regular, platy, smooth-surfaced bedding, whereas others are massive and structureless, showing very poorly developed bedding. The latter units appear to be more commonly developed near the basal intervals in large channel fills. The cross-bedding features of the Lee sandstones mostly have a southerly and southwesterly dip, but a significant number of others have northwesterly and southeasterly directions. Limited exposures did not allow for a sufficient number of measurements to outline the trend or direction of the paleocurrent system.

The basal contacts of the Lee quartz arenites are usually sharp, undulating and disconformable (Figure 40) and the upper contacts are more gradational. The base is often marked by a basal conglomerate up to a few feet in thickness, whereas the upper intervals are usually finer grained. These massive units are

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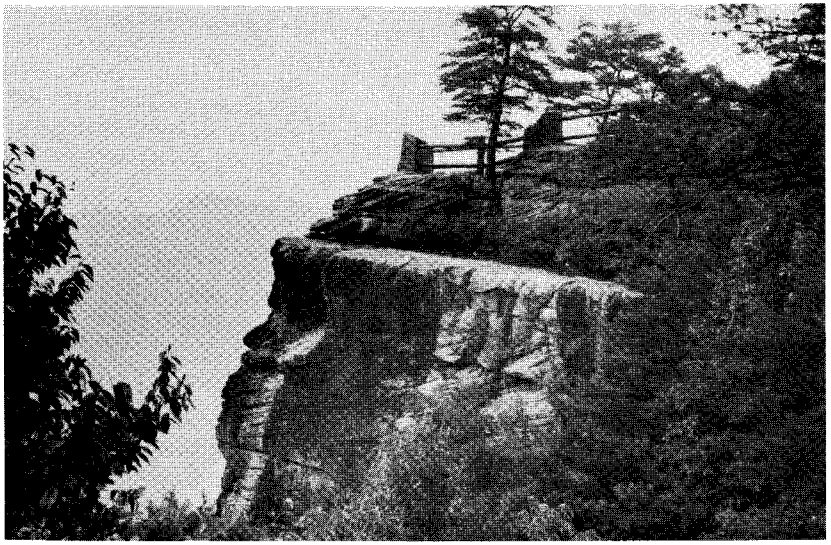
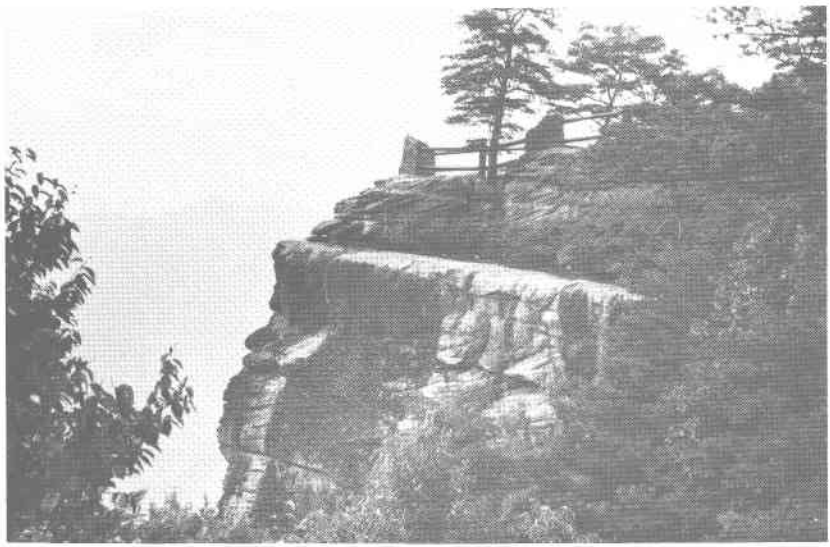


Figure 36. Upper quartz arenite (Bee Rock Sandstone) member of the Lee Formation (previously mapped as McClure sandstone of the Norton Formation) in Breaks Interstate Park, Dickenson County, showing well-defined and uniform planar cross-laminations. Facing north. Dip of the cross-laminations is to the southwest.

Figure 37. One of the upper quartz arenite units within the Lee Formation in Flag Rock Park near Norton, Virginia, with abundant low-angle cross-stratification. These sweeping sets are typical of high-energy near-shore beach sands.



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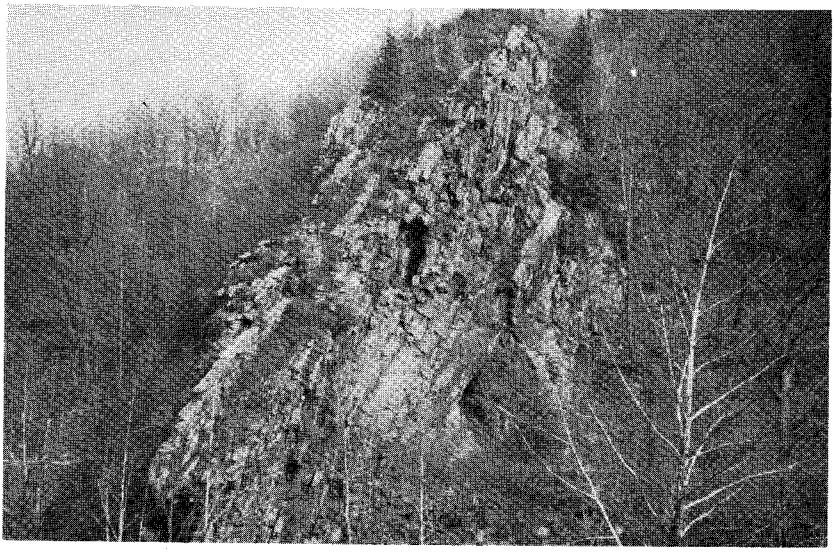
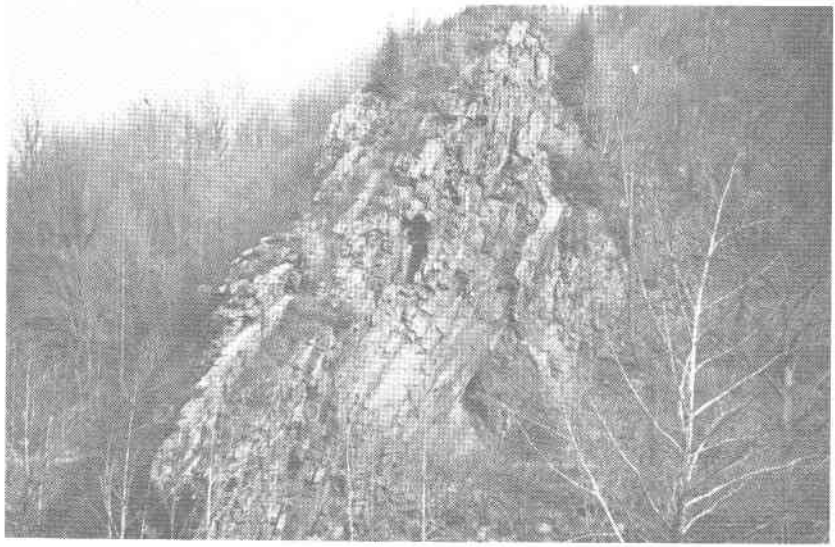


Figure 38. Upper quartz arenite (Bee Rock Sandstone) member of the Lee Formation at Big Stone Gap, Wise County, Virginia showing the large-scale low-dipping cross-stratification commonly found in the Lee units.

Figure 39. Lee quartz arenite along State Highway 72 in Wise County just north of the Wise-Scott County boundary. Unit exhibits festoon cross-bedding characteristic of many of the Lee sandstones.



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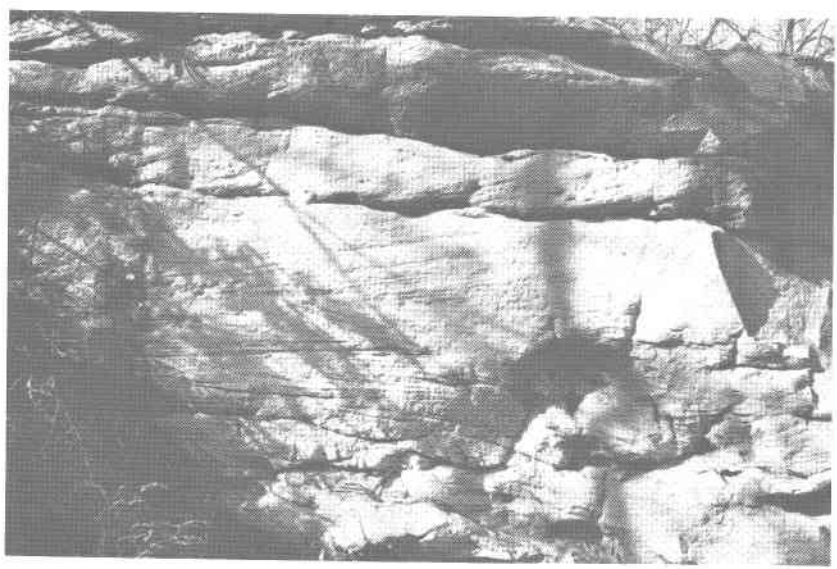

Figure 39. Lee quartz arenite along State Highway 72 in Wise County just north of the Wise-Scott County boundary. Unit exhibits festoon cross-bedding characteristic of many of the Lee sandstones.

Figure 40. Quartz arenite of the Lee Formation exhibiting sharp, undulating, unconformable basal contact. Quarry along the east side of U. S. Highway 23 north of Pound, Wise County, Virginia. Characteristic of unconformities beneath the massive quartz arenites of the Lee Formation.

normally coarse at the base and fine grained at the top, but no distinct graded bedding exists from bottom to top as pebbles and coarser grains occur sporadically throughout.

Thin beds of dark shale and siltstone and lenses of coal occur within the white, massive Lee quartz arenites. These beds are usually less than a foot thick and lack significant lateral continuity. Impressions of plant fragments occur sparsely within these units. The only other breaks within the compositionally mature quartz arenites are stylolitic seams that are particularly evident in the cores (Figure 41).

Nonresistant and generally nondistinct intervals of shale, siltstone, sandstone, coal, and underclay (Figure 42) separate the three massive quartz arenites. In the northwestern portions of the study area these finer textured sediments constitute about a third of the total thickness of the Lee Formation. To the south, southeast, and east, as the quartz arenites tongue out, these weaker units gradually make up a much larger portion of the Lee. The shales and siltstones of these units are gray to dark gray, generally micaceous, and rarely carbonaceous. The sandstones are gray to light gray, fine to coarse grained, poorly sorted, and

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Thin beds of dark shale and siltstone and lenses of coal occur within the white, massive Lee quartz arenites. These beds are usually less than a foot thick and lack significant lateral continuity. Impressions of plant fragments occur sparsely within these units. The only other breaks within the compositionally mature quartz arenites are stylolitic seams that are particularly evident in the cores (Figure 41).

Nonresistant and generally nondistinct intervals of shale, siltstone, sandstone, coal, and underclay (Figure 42) separate the three massive quartz arenites. In the northwestern portions of the study area these finer textured sediments constitute about a third of the total thickness of the Lee Formation. To the south, southeast, and east, as the quartz arenites tongue out, these weaker units gradually make up a much larger portion of the Lee. The shales and siltstones of these units are gray to dark gray, generally micaceous, and rarely carbonaceous. The sandstones are gray to light gray, fine to coarse grained, poorly sorted, and

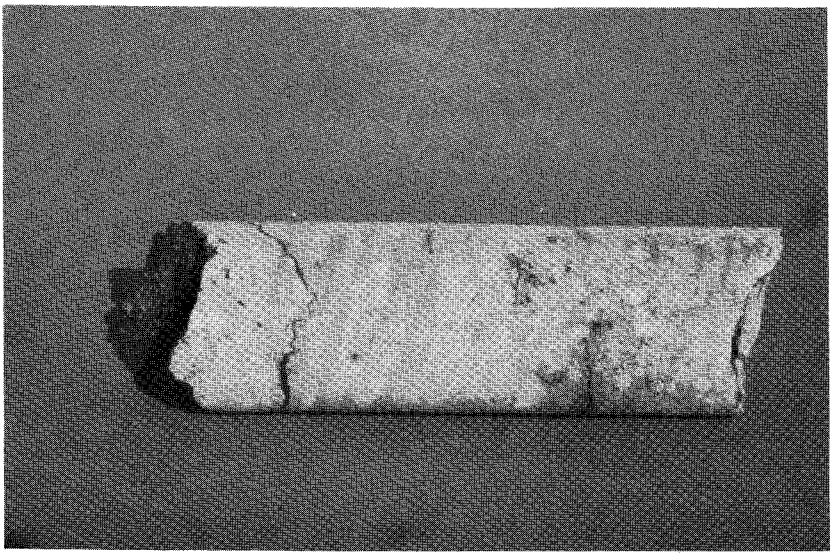
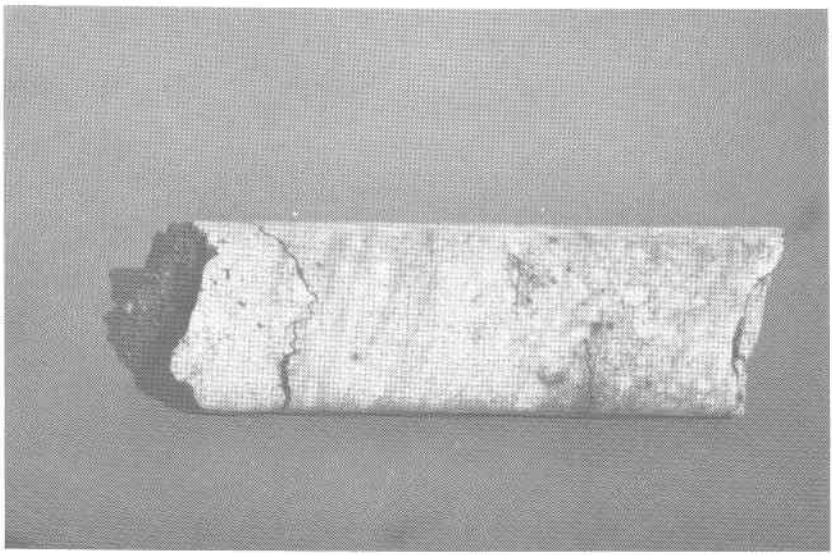


Figure 41. Core from Buchanan County, Virginia showing the coarse conglomeratic nature distinctive of the Lee quartz arenites. Note the stylolitic seams. Core is 2 inches in diameter.

Figure 42. Shale and siltstone sequence between the middle quartz arenite and lower quartz arenite members of the Lee Formation; from core in Buchanan County, Virginia. Bedding characteristic of zone of intermittent turbulence. Diameter of core is 2 inches.



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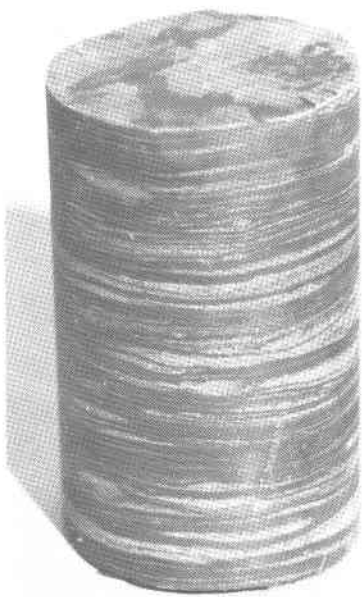

Figure 42. Shale and siltstone sequence between the middle quartz arenite and lower quartz arenite members of the Lee Formation; from core in Buchanan County, Virginia. Bedding characteristic of zone of intermittent turbulence. Diameter of core is 2 inches.

contain a lower percentage of quartz than the quartz arenites. The coals are thin and impure in the northwest, but appear to be thicker and better developed to the southeast. The relatively less quartzose units are typical continental beds that have no perceptible order of recurrence, or characteristics that are persistent over a large area.

The three massive sandstone units which Campbell (1894) recognized within the Lee Formation are reviewed separately in this report, and will be referred to as the upper, middle, and lower quartz arenite members.

Lower Quartz Arenite Member

The lower quartz arenite member is the most extensive unit of the Lee Formation. As shown in Figure 43 these basal sandstones occur throughout most of the area and are absent only in Tazewell County, extreme southeastern Buchanan County, northern Russell County, and probably along a narrow area in southern Dickenson and western Russell counties. The quartz arenites are distributed in fan or delta shapes and are concentrated along paleochannels that undoubtedly were areas of major transport. This is particularly evident in north-central Buchanan County, where the quartz arenites appear to be distributed outward from a central inlet that extends into that county from Pike County, Kentucky. Two other pronounced large areas of accumulation extend into central Wise County and central Dickenson County from the northwest. In the centers of these channels the total accumulation of quartz arenite is 350 to 450 feet. From these centers the quartz arenites thin generally to the southeast, eventually terminating in that directon by tonguing out into less quartzose and finer textured sediments.

In wells in northwestern Wise, Dickenson, and Buchanan counties, cuttings from the basal 200 to 300 feet of Pennsylvanian section overlying Upper Mississippian shales and siltstones are almost all quartz. Only rare shale or coal fragments interrupt the large, continuous intervals of quartz. To the east, south, and west, intervening shales, siltstones, and poorly sorted sandstones separate the lower quartz arenite member into two or three beds of quartz arenite. In these directions the lower quartz arenite member thins to one basal quartz arenite bed that ranges in thickness from less than 20 feet to more than 200 feet. With the termination of this bed, the lower quartz arenite member

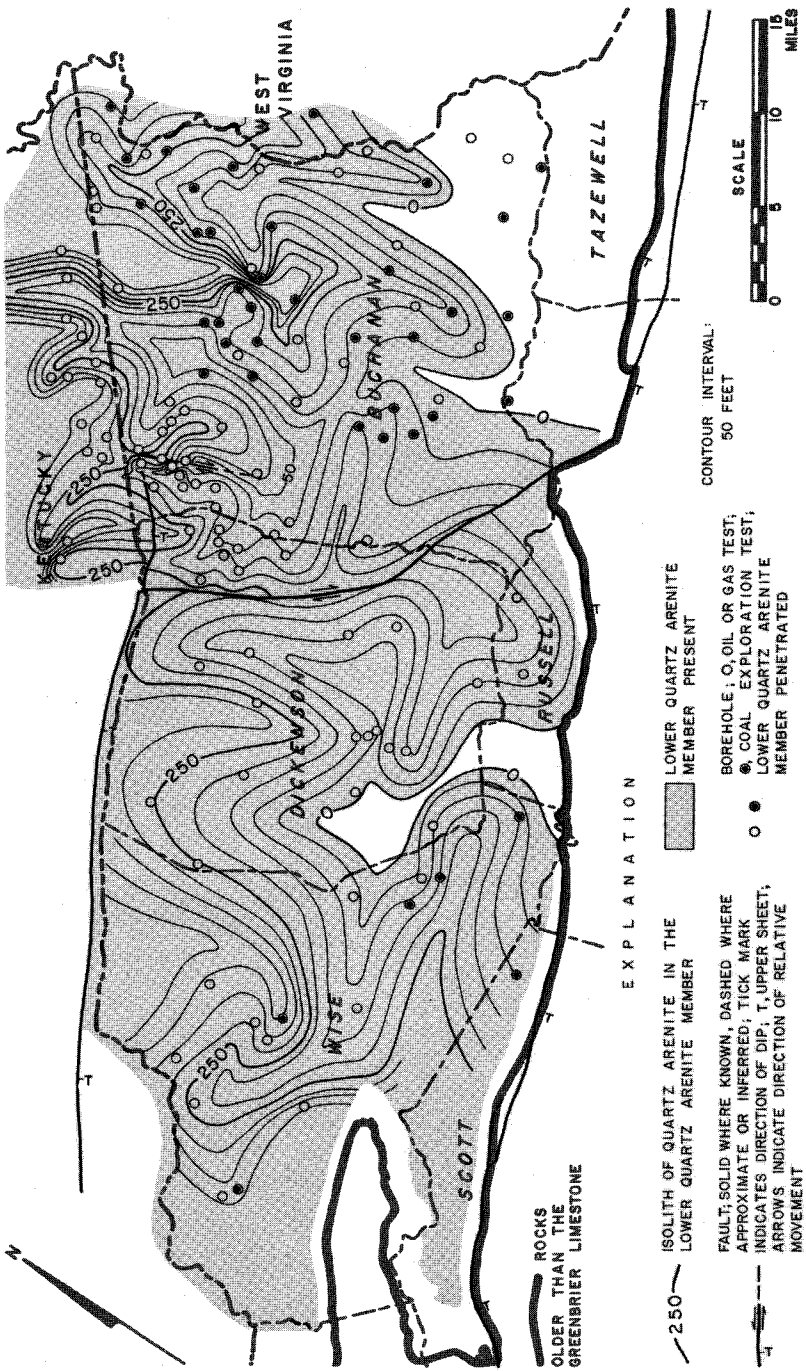

Figure 43. Isolith map of the lower quartz arenite member of the Lee Formation.

loses its last distinguishing bed and cannot be mapped in the subsurface. The loss of the lower quartz arenite member marks the limit of the Lee Formation.

The basal portions of the lower quartz arenite member are almost always conglomeratic in the subsurface, as the cuttings contain large fragments of quartz, which are broken portions of larger quartz pebbles. It is concluded that the lower half of this member is usually more conglomeratic than the upper half. Although the high percentage of quartz is consistent, the degree of sorting, the grain size, and the angularity are variable. Secondary quartz overgrowths often obscure these characteristics in cuttings. Very little matrix and cementing material other than secondary quartz are visible, and no fossils other than a few plant fragments can be seen in the cuttings.

The contact of the lower quartz arenite member with underlying units is always abrupt and easily identified. As illustrated on Plates 2, 3, and 4, the lithology below the basal conglomeratic quartz arenite is variable. Figure 17 illustrates the lithologic units that occur just below the Lee Formation. In most of the southeastern portion of the area the basal Lee quartz arenite overlies the coal-bearing Pocahontas sequence. To the northwest the same basal Lee unit overlies red and green shales of the Bluestone Formation and farther to the northwest it is in contact with the gray shale of the Pride Shale Member.

The upper contacts of this lower member are much like those of all the quartz arenites in the Lee Formation, the lithology passing upward from a quartz arenite to a quartz wacke, to a lithic graywacke, and finally to shales, siltstones, and coal beds.

Middle Quartz Arenite Member

The middle quartz arenite member has all the characteristics noted for the lower quartz arenite member: the basal portions usually contain more conglomeratic zones than the upper portions; the grain size and roundness are variable; matrix, rock fragments, and accessory minerals are rare; and the units are occasionally separated by thin beds of shale, siltstone, coal, and less quartzose sandstone. The middle quartz arenite member consists of several separate beds of quartz arenite that coalesce to the northwest and tongue out to the southeast. In most areas the middle member is composed of a single unit of quartz arenite about 100 to 150 feet thick, and normally occurs about 400 to 500

feet above the top of the lower quartz arenite member. In the northwestern part of the study area, with the addition of several more quartz arenite units, the interval between the middle and lower quartz arenite members decreases to less than 100 feet (Plates 2, 3, 4).

The isolith map of the middle quartz arenite member is shown on Figure 44. The quartz arenites are concentrated in delta- and fan-shaped bodies that extend from the northeast, northwest, and west. Four principal areas of accumulation are indicated: one trending north and northwest along the boundary of Buchanan and Dickenson counties; another extending into central Wise County from the west; a third extending into extreme northern Buchanan County from the northeast; and a fourth trending northwest and extending into central Dickenson County. From these four areas of thicker accumulation, the quartz arenites thin out and converge generally towards the Wise-Russell boundary.

In the centers of the four principal areas of accumulation the total thickness of quartz arenite is about 350 feet. The units tongue out into finer-textured sediments to the southeast, east, and southwest. Overall, the middle member does not extend to the southeast as far as the lower member. In the areas where the middle member cannot be identified and the lower remains, the Lee Formation is restricted to the one basal member.

Upper Quartz Arenite Member

In southwestern Virginia the uppermost quartz arenite member of the Lee Formation has normally been mapped and referred to as the Bee Rock Sandstone Member (Stevenson, 1881; Campbell, 1893). The Bee Rock Sandstone Member, however, has not been consistently mapped and identified by previous workers. In some areas, the middle quartz arenite member has been mistakenly identified as the Bee Rock Sandstone Member. In this report, unless otherwise pointed out, the upper quartz arenite member and the Bee Rock Sandstone Member are synonymous. This report will continue to acknowledge the Bee Rock name, but will point out the areas where the name has been misapplied.

The upper quartz arenite member has the same characteristics that distinguish the lower and middle quartz arenite members. The unit is a hard, massive, fine- to coarse-grained, conspicuously

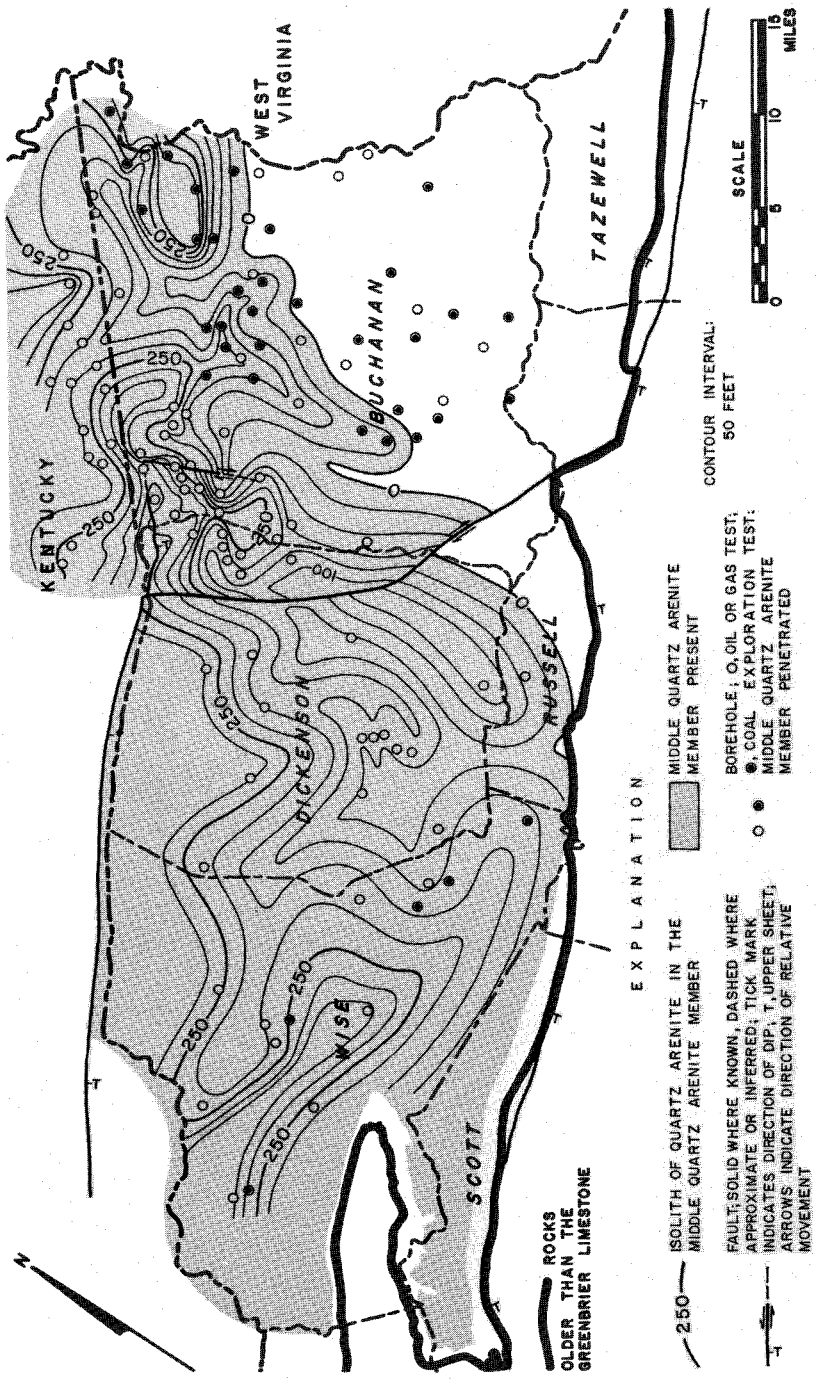

Figure 44. Isolith map of the middle quartz arenite member of the Lee Formation.

cross-bedded, locally conglomeratic sandstone, which contains more than 90 percent quartz. The contact with underlying sediments is abrupt and disconformable. At the top, the unit grades upward into finer-textured sediments.

The upper quartz arenite member is limited chiefly to the one unit described above, which is normally about 100 feet thick. In the northwest, west, and southwest areas the member increases to over 200 feet in thickness by the addition of another quartz arenite that occurs stratigraphically just above the original unit. Where this upper unit is first recognizable, it is about 20 to 25 feet thick and about 50 feet above the lower unit. Farther westward, the unit is over 100 feet thick and coalesces with the original Bee Rock Sandstone Member. This same phenomenon was observed on the surface by Miller (1969, p. 7).

The isolith map of the upper quartz arenite member (Bee Rock Sandstone Member) is shown on Figure 45. The unit occurs only in the extreme northwestern part of Buchanan and Dickenson counties and in the western half of Wise Couuty. Similar to the middle and lower members, the upper member thickens to the northwest and thins and terminates to the southeast; it has a pronounced area of quartz arenite accumulation extending into central Wise County from the west-northwest.

Regional Geologic Mapping of the Lee Formation

As reestablished by Englund and DeLaney (1966), the Lee Formation is regionally defined as a rock stratigraphic unit with lower and upper contacts marked by quartz arenites. Regional mapping by Englund in southeastern Kentucky and Tennessee has shown that the upper boundary of the Lee Formation has commonly been placed at the top of the uppermost quartz arenite, although the uppermost unit at that place may be stratigraphically several hundred feet below another quartz arenite previously designated as the top of the Lee in a nearby area (Englund, 1962, p. 72).

In the subsurface of Virginia, the Lee Formation exhibits similar stratigraphic relationships to those illustrated by Englund in Kentucky and Tennessee. The three quartz arenite members in southwestern Virginia terminate to the south, southeast, and east by intertonguing and lateral gradation with finer clastics that are lower in quartz content. Each successive underlying quartz arenite member extends farther eastward than that

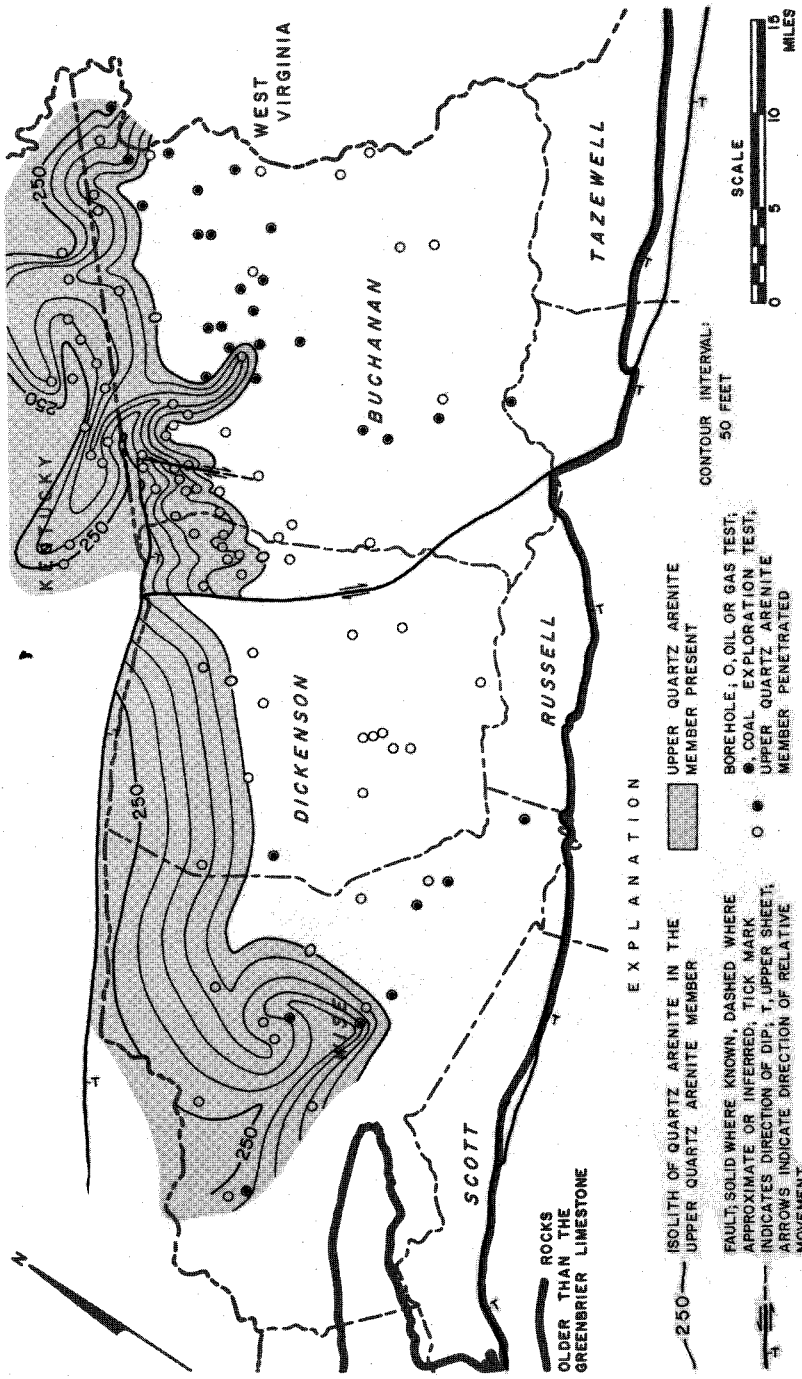

Figure 45. Isolith map of the upper quartz arenite (Bee Rock Sandstone) member of the Lee Formation.

above, each eventually becoming the uppermost rock unit of the Lee Formation (Figure 47). In this report, wherever the uppermost quartz arenite becomes thin and loses its distinguishing characteristics, the upper boundary is moved downward to the next quartz arenite in conformance with the Code of Stratigraphic Nomenclature, Article 5, Remark (e) (American Association of Petroleum Geologists, 1970).

Redefinition of the Lee Formation in Virginia

The Lower Pennsylvanian stratigraphy in southwestern Virginia is best illustrated by establishing the location and lateral extent of the three quartz arenite members of the Lee Formation, as in this report (Figures 43, 44, 45). In most instances the naming and mapping of coals by earlier workers appear to be accurate and well defined. In some areas, however, it is necessary to reestablish the stratigraphic relation of the coals with the quartz arenite members of the Lee Formation. Figure 46 illustrates the generalized stratigraphic columns of the lower Pennsylvanian rocks as used by Butts (1914), Eby (1923), Giles (1921), Wentworth (1922), Hinds (1918), and Harnsberger (1919) during their respective mapping projects in the area. Figure 47 illustrates the generalized stratigraphic columns for the Lower Pennsylvanian rocks as determined in this report. The coal intervals in Figure 47 remain much the same as those in Figure 46. The principal differences between the generalized stratigraphic columns is the determination of the upper and lower boundaries of the Lee Formation.

Each of the early workers was confronted with the changing and intertonguing nature of the quartz arenites of the Lee Formation in their respective areas of study and each attempted to maintain the nomenclature established by Campbell (1893). Campbell (1893) established the stratigraphic relations for the quartz arenites of the Lee Formation from his study of the vertical exposures along the northwest limb of the Powell Valley anticline. The coal stratigraphy above what he considered to be the Lee Formation was established, however, in relatively flat-lying and better exposed beds in the eastern portion of Wise County along the gently-dipping nose of the Powell Valley anticline. This created the principal stratigraphic problem. Figure 45 illustrates that the upper quartz arenite member (Bee Rock Sandstone Member), loses its distinguishing characteristics to

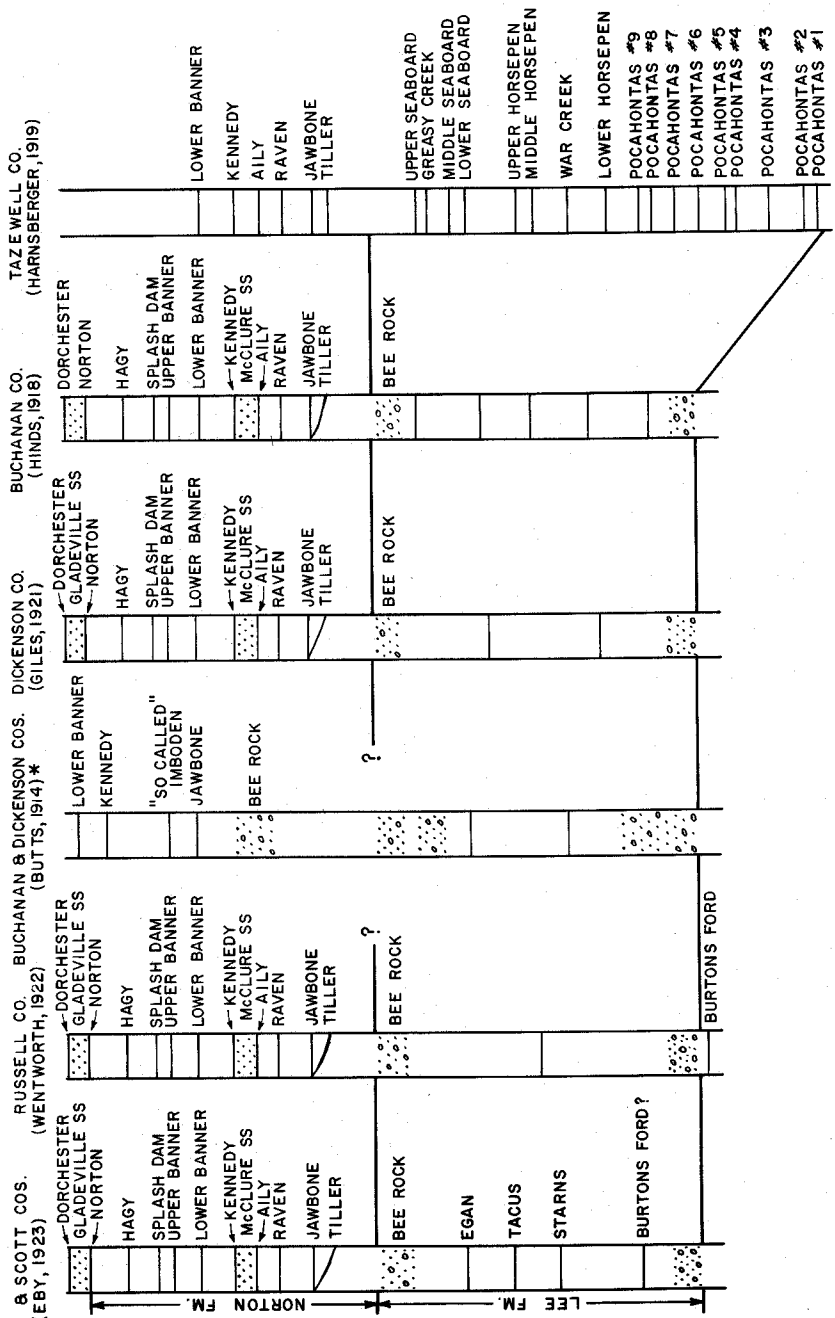

Figure 46. Generalized geologic column of Lower Pennsylvanian rocks as used by previous workers in area of this report.

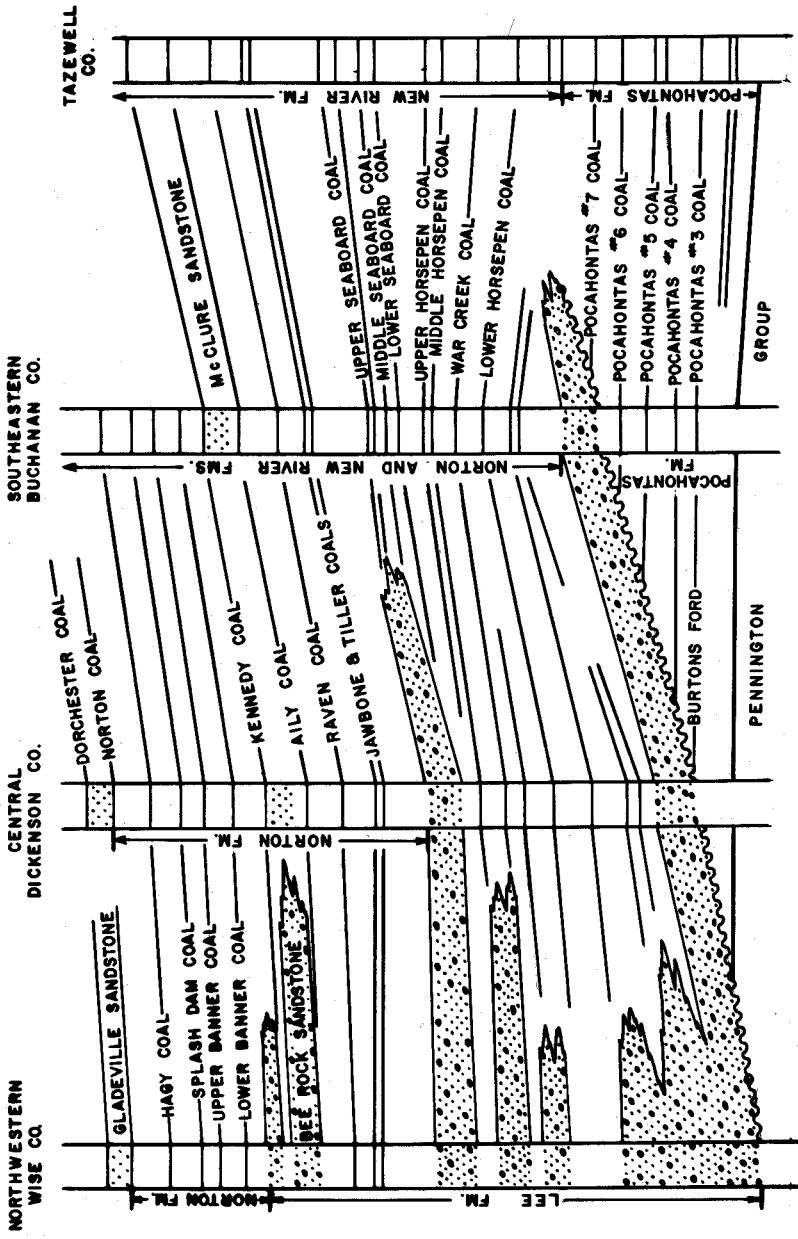

Figure 47. Geologic column of Lower Pennsylvanian rocks as determined in this report.

the southeast and east along the nose of the Powell Valley anticline and is not present in eastern Wise County and other areas to the east where Campbell (1893), Eby (1923), Giles (1921), and Hinds (1918) established the stratigraphic position of the coals. Thus, the uppermost quartz arenite unit of the Lee Formation in eastern Wise County is not the Bee Rock Sandstone Member as mapped by Campbell and others, but is the middle quartz arenite member; their middle quartz arenite is the lower quartz arenite member. Consequently, the coal beds established by Campbell (1893) and Eby (1923) in eastern Wise County did not readily fit into the equivalent stratigraphic sequence in western Wise County. The geologic map of Wise County, as prepared by Eby (1923) under the direction of Campbell, shows that the stratigraphic sequence above the Bee Rock Sandstone Member along the north limb of the Powell Valley anticline west of Tacoma was enigmatic in their mapping. In the area just west of Tacoma and near the vicinity of Ramsey, the Raven and Kennedy coal beds are abruptly dashed out and terminated. The Lower Banner coal bed is mapped directly into the Upper Banner coal bed, which in this area is normally considered to be about 150 feet above the Lower Banner coal. Farther westward along the north limb of the Powell Valley anticline, Eby (1923) and Campbell, who wrote a section on geologic work and coal correlation in Eby's report, established the Pigeon Creek fault, the existence of which has been disproven by Miller (1969, p. 13).

Additional significant doubts concerning some of the coal stratigraphy as established by Campbell were discussed by Gathright (1964), who noted that the top of the Lee Formation had been placed about 500 feet lower stratigraphically near the area of Ramsey. In less than a mile between Ramsey and Tacoma, along the road and railway cuts of U. S. Highway 58 Alternate and the Norfolk and Western Railway, the hard, massive, and steeply dipping Bee Rock Sandstone Member grades laterally into several beds of gray, slightly micaceous, and locally coarse-grained, quartz wacke, lithic arenite, and lithic graywacke atypical of the Bee Rock (Figures 48, 49, 50).

Subsurface data (Figure 45) support the surface findings of Gathright (1964). In a shallow core from a coal exploration test (Plate 1, number 125) about 1.2 miles north-northeast of Ramsey, 210 feet of "hard sandstone" is noted by the driller within the Bee Rock interval. Based on cuttings from a gas test

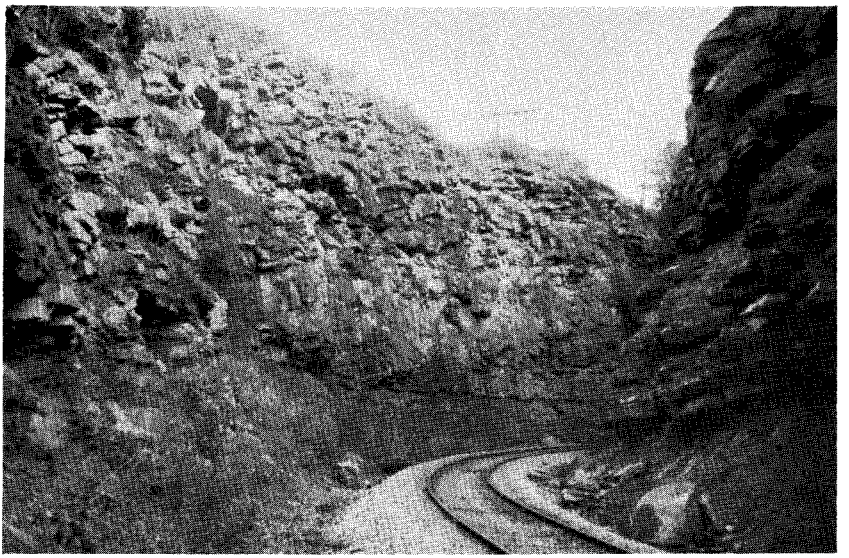

Figure 48. The upper arenite (Bee Rock Sandstone) member of the Lee Formation 0.5 mile east of Ramsey on Interstate Railway. The sandstone is fine grained, micaceous, thin and wavy bedded and commonly ripple marked (see Figure 49) with numerous shale partings. Less than 300 yards east, the upper boundary of the Lee Formation was placed stratigraphically downward about 500 feet to the next lower quartz arenite by Eby (1923).

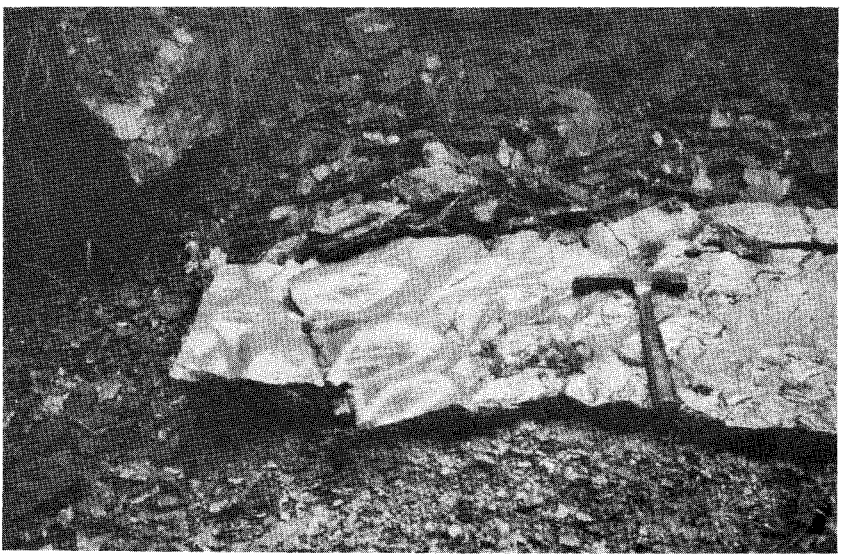

Figure 49. Asymmetrical ripple-marks in the upper quartz arenite (Bee Rock Sandstone) member of the Lee Formation 0.5 mile east of Ramsey.

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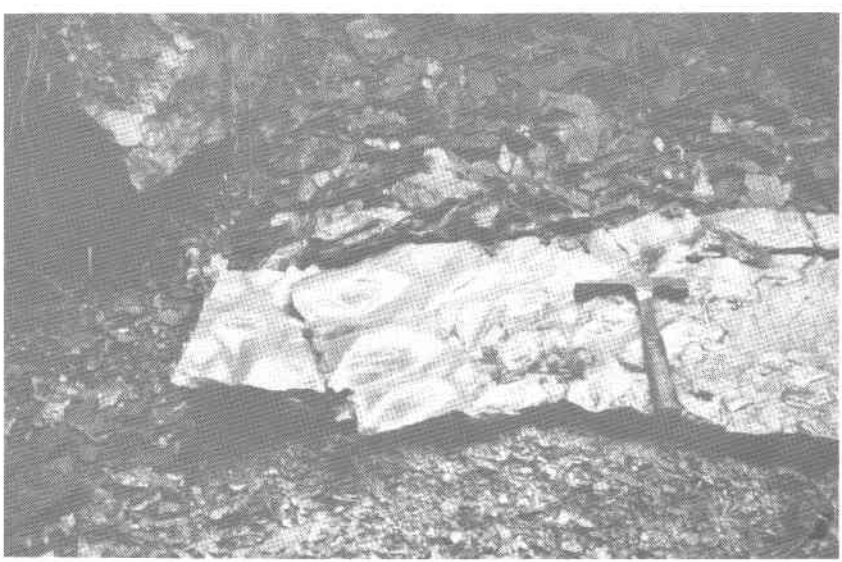

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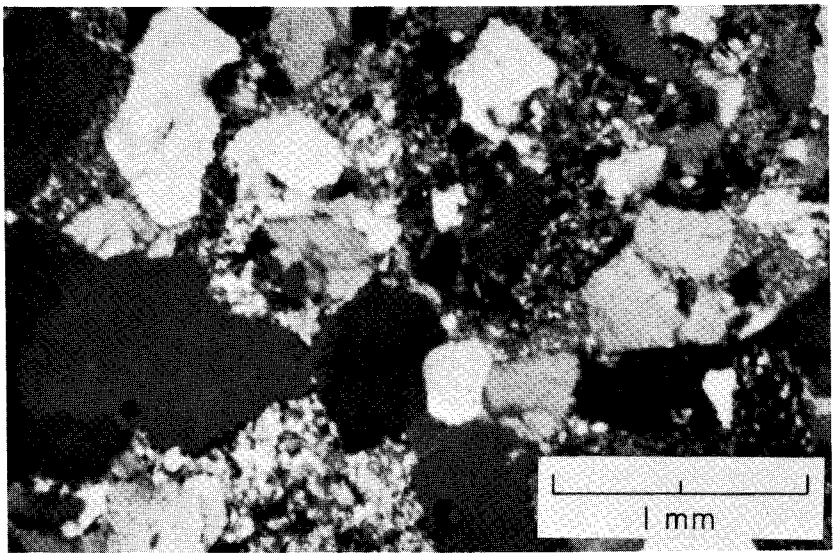
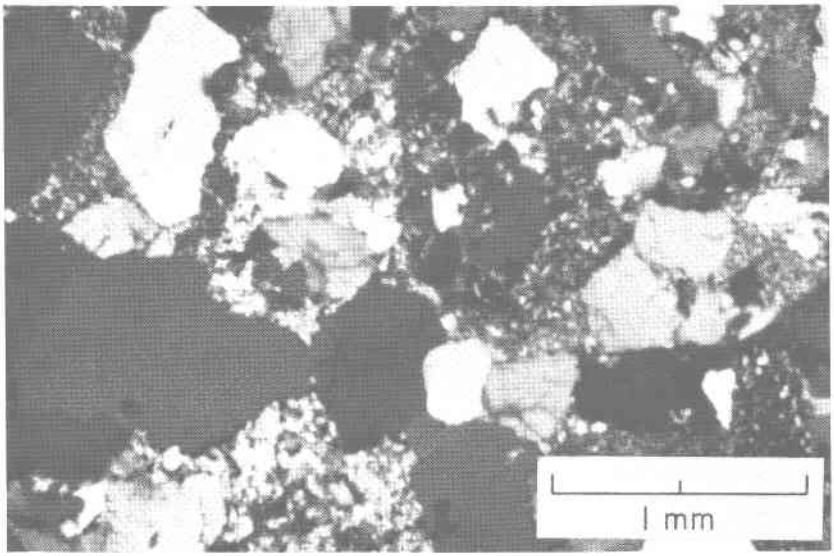


Figure 50. Photomicrograph of McClure sandstone of the Norton Formation from core in Buchanan County. The unit consists of 65 to 80 percent medium to very coarse, monocrystalline quartz, about 5 percent shale and siltstone fragments, rare feldspar and chert, and about 20 to 25 percent clay and silt matrix. In the northwestern portions of the study area, this interval is occupied by the upper quartz arenite (Bee Rock Sandstone) member of the Lee Formation. Crossed nicols.

(Plate 1, number 126), about 71 feet of quartz arenite are present within the Bee Rock interval 1.7 miles northeast of Ramsey. In another shallow core from a coal exploration test (Plate 1, number 127) about 1.7 miles east of this well and about 0.5 mile north of Tacoma, only dark shales and gray sandstones are noted by the driller within the laterally equivalent Bee Rock interval.

The downward displacement of the Lee at Ramsey by the earlier workers actually conforms with the strict definition of the Lee Formation as having upper and lower boundaries marked by quartz arenites. The stratigraphic problems, therefore, did not result from the downward displacement but rather from the unawareness that the upper member tongues out.

Figure 47 is a generalized correlation chart of the Lower Pennsylvanian rocks in southwestern Virginia that incorporates most of the stratigraphic conclusions determined in this study. Comparison of this chart with geologic sections used by the



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earlier workers (Figure 46) illustrates the stratigraphic discrepancies that have taken place. The more important stratigraphic conclusions developed during this study are:

(1) The Pocahontas Formation and its coal beds are truncated and overlain by the lower quartz arenite member of the Lee Formation.

(2) The Mississippian-Pennsylvanian boundary is unconformable where the base of the Lee is in contact with the upper beds of the Bluestone Formation, but intertonguing where the Pocahontas Formation is present (Figure 19).

(3) The coal beds from the Pocahontas No. 8 coal bed upward to the Upper Seaboard coal bed are mostly between the middle and lower quartz arenite members of the Lee Formation.

(4) The Aily, Raven, Jawbone, and Tiller coal beds, which occur above the uppermost quartz arenite (middle quartz arenite member of the Lee Formation) in eastern Wise County, south and central Dickenson County and most of Buchanan, Russell, and Scott counties, actually occur below the upper quartz arenite member (Bee Rock Sandstone Member) of the Lee Formation in western Wise County and northwestern Dickenson and Buchanan counties.

(5) The Kennedy coal bed occurs only a few feet above the upper quartz arenite member (Bee Rock Sandstone Member), and eventually the bed terminates northwestward and westward with the addition of another quartz arenite, stratigraphically just above the Bee Rock.

(6) The Bee Rock Sandstone Member (the upper quartz arenite member of the Lee Formation) grades laterally into the McClure sandstone member of Eby (1923) (Plates 2, 3).

(7) The Norton Formation, in northwestern Buchanan, Dickenson, and Wise counties or wherever the Bee Rock Sandstone Member maintains a quartzose nature, is about 600 to 800 feet thick and contains the Norton, Hagy, Splash Dam, Upper Banner and Lower Banner coal beds. To the southeast in these same counties where the Bee Rock Sandstone Member tongues out, the thickness increases to 1100 to 1300 feet, with the addition of the Kennedy, Aily, Raven, Jawbone, and Tiller coals.

The seventh statement is very important to the understanding of the Pennsylvanian stratigraphy in southwestern Virginia. The problem of what to include within the Norton Formation has generally always confronted geologists working in the area and was recently reiterated by Miller (1969, p. 23) : "The thickness of the Norton is difficult to determine accurately in most places. Some of the thicknesses cited in the earlier literature are in error because of misidentification of the Gladeville Sandstone, which overlies the Norton. Others seem to have been considerably in error because they were estimates rather than measurements." Miller (1969) concluded that although his figures suggested there was a rapid thickening of the formation east of Norton, the thicknesses of the Norton Formation recorded by Eby (1923) in Wise County and Giles (1925) in Lee County appeared to be too great for both areas. Study and correlation of over 100 subsurface sections in the present report, however, illustrate that the apparent rapid thickness changes of the formation are due principally to the tonguing out of the upper quartz arenite member of the Lee Formation.

The stratigraphic significance of the relationship between the Bee Rock Sandstone Member and the McClure sandstone (sixth statement) should also be pointed out. The Bee Rock Sandstone (upper quartz arenite member) in northwestern Wise, Dickenson and Buchanan counties and along Pine Mountain is a thick, massive, hard, and conspicuously resistant quartzose sandstone. The subsurface isolith map (Figure 45) shows that the quartz arenite facies is well defined in these areas. Butts (1914) recognized this unit as the uppermost quartzose sandstone of the Lee Formation (Figure 46). However, Hinds (1918), Harnsberger (1919), Giles (1921), Wentworth (1922), and Eby (1923) all disagreed with this "apparent" upward placement of the upper boundary of the Lee Formation, contending that Butts had mistaken the McClure sandstone of the Norton Formation for the Bee Rock Sandstone of the Lee Formation (Figure 46). This downward placement of the upper boundary of the Lee Formation along Pine Mountain by Eby and the others established a Lee Formation in Virginia that is thinner than the Lee Formation in Kentucky. Modern correlation charts continue to show an abrupt change in thickness of the Lee Formation at the Virginia-Kentucky boundary. This report recognizes the presence of the upper quartz arenite member in northwestern Buchanan, Dickenson, and Wise counties, and relegates the downward placement

of the top of the Lee Formation farther to the southeast in Virginia where the upper quartz arenite (Bee Rock Sandstone Member) eventually tongues out. The Lee Formation in Kentucky and the Lee Formation in Virginia thus may be mapped and correlated with the same upper boundary.

Pocahontas No. 8 and No. 9 Coal Beds

Subsurface correlations in this report illustrate that the Pocahontas No. 8 and No. 9 coal beds occur near the base of the Lee Formation. The basal quartz arenite of the Lee, which progresses upward in the section from northwest to southeast, appears to tongue out into a stratigraphic interval just below the Pocahontas No. 8 coal. Neither the Pocahontas No. 8 nor No. 9 coal beds, however, appear to have any consistency to the northwest where the lower quartz arenite member is well developed. The initial presence of the basal Lee quartz arenite member usually marks the absence of these overlying coals.

To the southeast in the subsurface the Pocahontas No. 8 and No. 9 coals normally occur about 10 to 20 feet apart, with gradual thickening of the interval to about 40 feet in the areas of outcrop in Tazewell County (Harnsberger, 1919).

In the subsurface the Pocahontas No. 8 and No. 9 coal beds are normally less than a foot thick and nowhere appear to have economic potential. Both coals are limited to the extreme southeastern portion of Buchanan County and western portion of Tazewell County.

Lower Horsepen Coal Bed

The Lower Horsepen coal bed is normally about 100 to 150 feet above the top of the lower quartz arenite member of the Lee Formation, and about 120 to 170 feet below the War Creek coal bed. The general extent and thickness of the coal in Buchanan County are shown on Figure 51. The coal is usually less than 2 feet in thickness and is locally absent in eastern Buchanan County. In western Buchanan County the Lower Horsepen appears to be more consistent and slightly thicker. Another coal, usually about a foot thick and about 20 feet below the Lower Horsepen, also occurs in these western areas; this may be a split of the Lower Horsepen coal, as the bed is too high in the stratigraphic section to be the Pocahontas No. 9 coal.

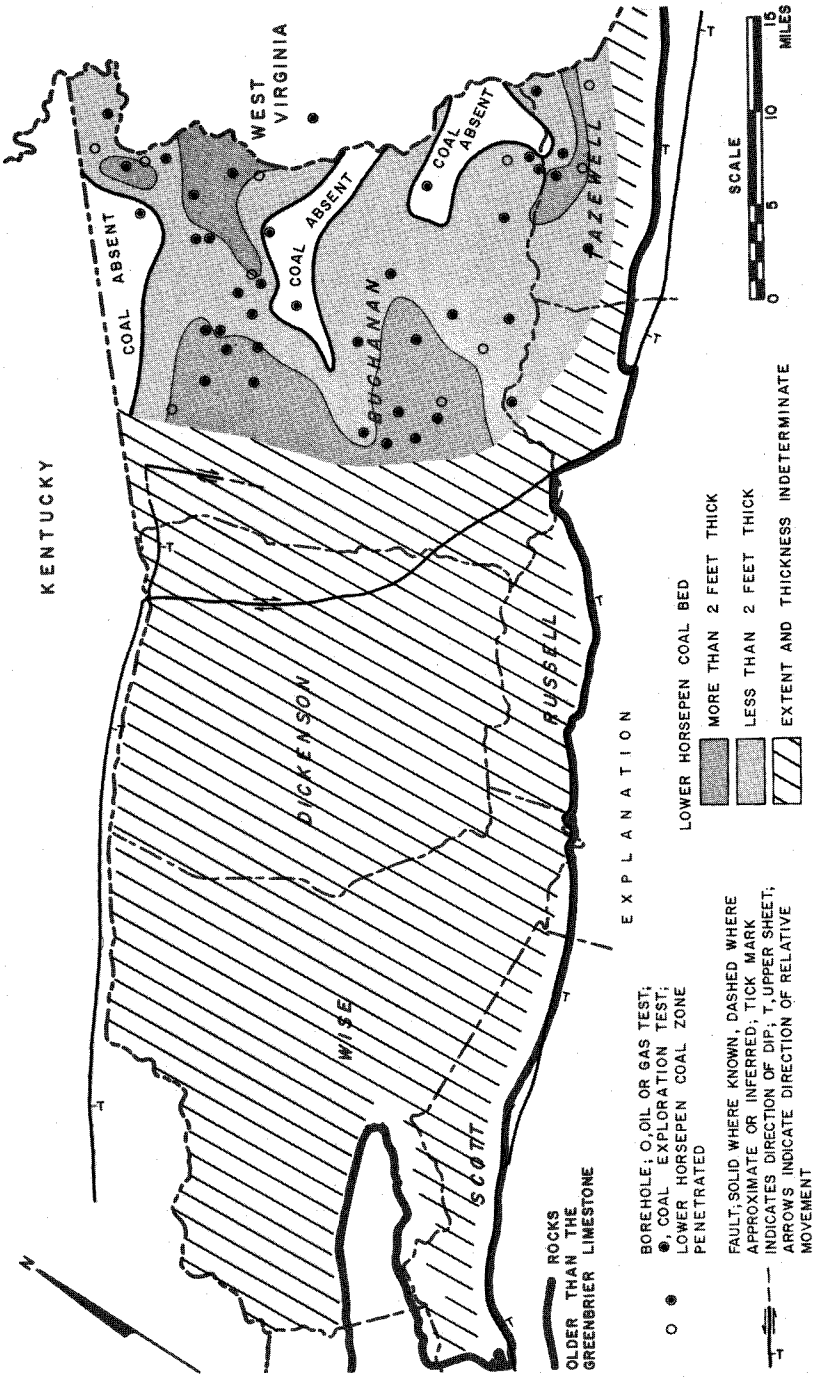


Figure 51. Map showing approximate extent and thickness of the Lower Horsepen coal bed. (Some data from Harnsberger, 1919.)

In most of Buchanan County the Lower Horsepen overlies about 100 to 150 feet of shale, siltstone, and fine-grained sandstone, which in turn overlie about 100 feet of coarse-grained quartz arenite. To the northwest, near the Virginia-Kentucky boundary, the lower quartz arenite member is as much as 300 feet thick, replacing the finer-textured sediments and eventually the Lower Horsepen coal.

In Buchanan County the Lower Horsepen coal does not appear to have significant economic potential in the subsurface. The coal thickens westward, but the increase is very gradual and only slight—from about 18 inches in the east to about 30 inches in the west. If the increase continues in that direction, the coal may have subsurface economic potential in Dickenson and Wise counties.

War Creek Coal Bed

The War Creek coal bed is one of the thicker and more extensive coals within the Lee Formation. It normally occurs near the middle of the interval which separates the middle and lower quartz arenite members. In western Tazewell County and along the southeastern areas of Buchanan, Dickenson and Wise counties the War Creek coal is about 600 to 700 feet above the Pocahontas No. 3 coal; in the central part of the study area it is about 500 feet above the Pocahontas No. 3. The interval containing the War Creek coal becomes thinner northwestward as the middle and lower quartz arenites become thicker. In northern Buchanan County the interval between the middle and lower quartz arenite members is about 400 feet and the War Creek is very near the middle of this sequence. In extreme northern areas near the Virginia-Kentucky boundary the interval between the middle and lower quartz arenite members is only 50 to 150 feet, and the War Creek coal continues to be present near the middle of this interval. The War Creek is found in almost every subsurface section. Only in a narrow area in north-central Buchanan County (Plate 1, numbers 12, 13, 17) and an area in central Wise County (Plate 1, numbers 115, 118, 119, 124) is the War Creek absent. In these boreholes the War Creek coal is replaced in the stratigraphic section by the northwestward-thickening and coalescing quartz arenite units of the Lee Formation. The coal is also absent in a small area of Tazewell County (Plate 1, number 77).

The thickness map of the War Creek bed is shown in Figure 52. The coal is over 2 feet thick throughout much of Buchanan County with local thickening to more than 6 feet in central and eastern areas of the county. The coal has lateral persistence in Dickenson and Wise counties, as coal fragments are consistently present in the cuttings within the War Creek zone; core data were insufficient to establish the extent and thickness of the War Creek into these areas.

Middle Horsepen and Upper Horsepen Coal Beds

The Middle and Upper Horsepen coal beds normally occur about 50 feet apart and about 100 and 150 feet respectively above the War Creek coal bed. In southeastern Buchanan County both coals are usually over 100 feet below the bottom of the middle quartz arenite member and about 300 to 400 feet above the top of the lower quartz arenite member. Both of these intervals, however, decrease to the northwest with the increase in thickness of both quartz arenite members in that direction. The Middle and Upper Horsepen coals are truncated to the northwest by the middle quartz arenite member.

In Buchanan County both coal beds are relatively thin in the subsurface and neither appears to have economic potential. In southeastern Buchanan County and western Tazewell and Russell counties the Upper Horsepen coal is usually thicker than the Middle Horsepen, but is normally less than 2 feet thick. From these areas both coal beds appear to become thin to the north, northwest, and west. In Wise and Dickenson counties the coals were not consistently evident in the well cuttings. The approximate extent and thickness of the Upper Horsepen coal bed is shown in Figure 53.

Seaboard Coal Beds

The Lower, Middle, and Upper Seaboard coal beds constitute what are here collectively referred to as the Seaboard coal beds. These coals are grouped together because of their close stratigraphic proximity and because they have many of the same stratigraphic characteristics.

In the subsurface the Lower Seaboard coal is normally about 300 feet above the War Creek coal. To the northwest it is replaced in the stratigraphic section by the middle quartz arenite member. The Lower Seaboard is about 2 feet thick in south-

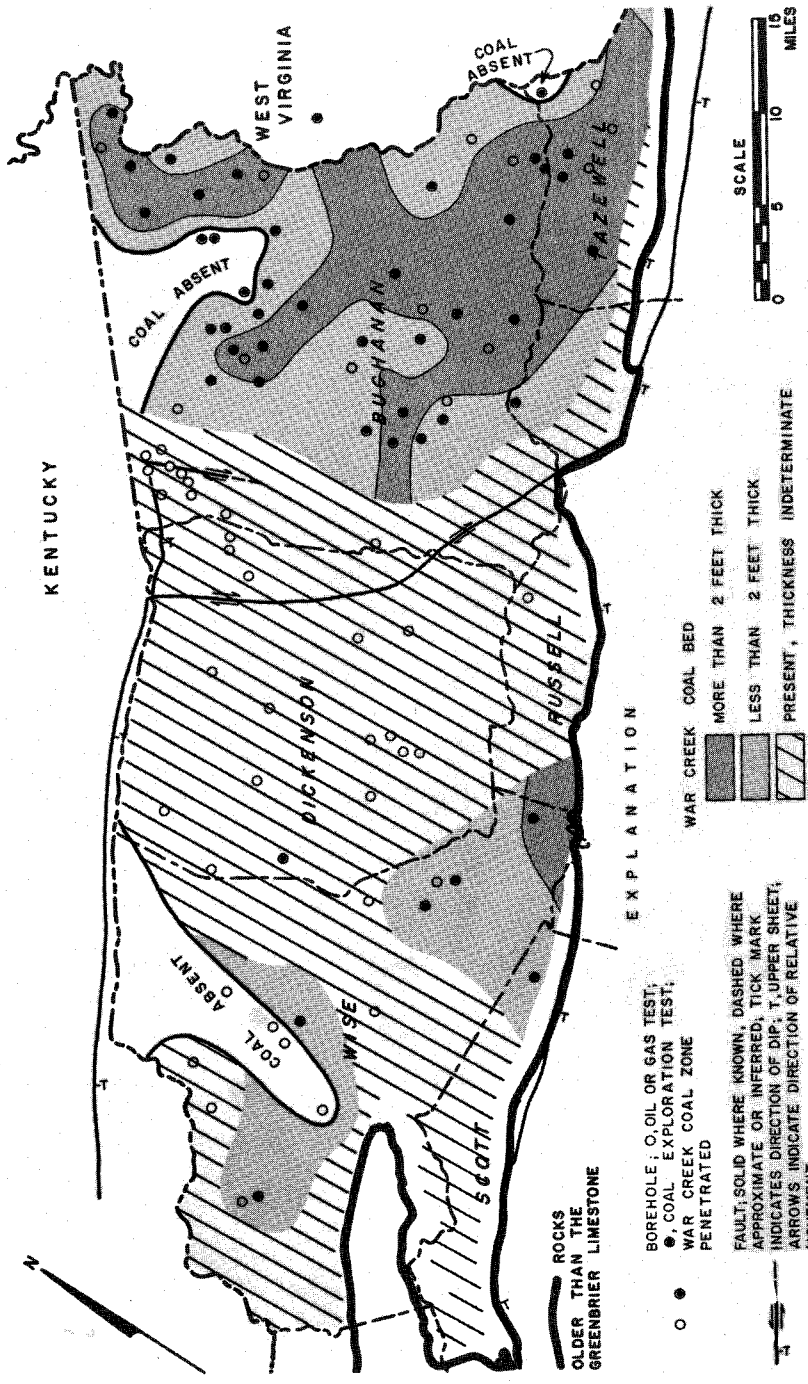


Figure 52. Map showing approximate extent and thickness of the War Creek coal bed. (Some data from Harnsberger, 1919.)

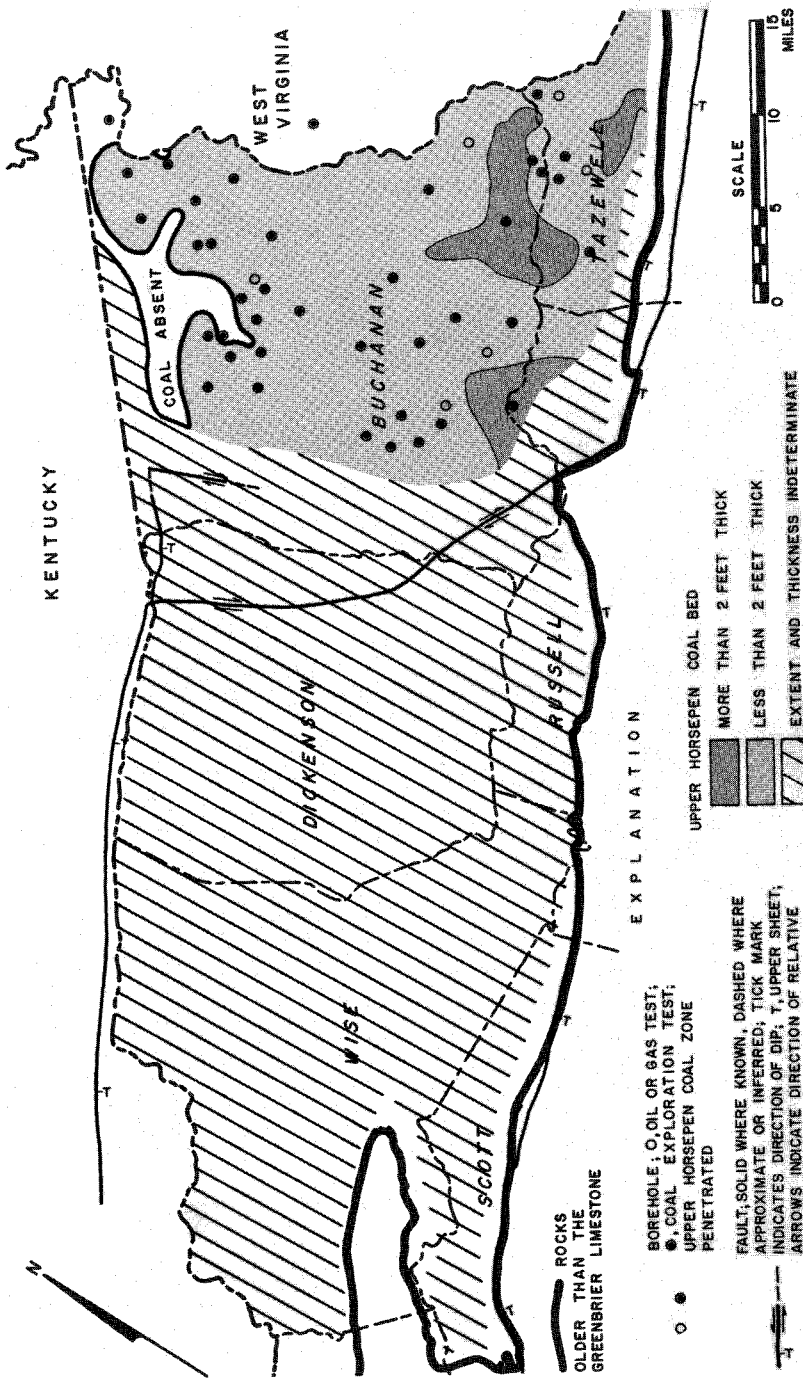


Figure 53. Map showing approximate extent and thickness of the Upper Horsepen coal bed. (Some data from Harnsberger, 1919.)

eastern Buchanan County, but is less than 1 foot thick over most of its extent. The trace of the southeastern limit of the middle quartz arenite in Buchanan County (Figure 44) is about the same as that of the northwestern limit of the Lower Seaboard coal.

The Middle Seaboard coal bed is about 30 feet above the Lower Seaboard coal bed and is replaced stratigraphically to the northwest by the middle quartz arenite member. The coal is usually less than a foot in thickness, but is consistently present.

Just above the Middle Seaboard coal bed, correlations are somewhat uncertain in the subsurface. On the surface in Tazewell County a coal bed referred to as the Greasy Creek occurs about 70 to 90 feet above the Lower Seaboard, and about 50 feet above the Greasy Creek coal the Upper Seaboard coal is present. It is difficult to determine which of these coals extends northwestward into the subsurface where a coal bed is normally present 95 to 100 feet above the Middle Seaboard coal. Because most of the Pennsylvanian rocks become thinner to the northwest, the writer believes that the coal is probably the Upper Seaboard coal bed, and that the Greasy Creek coal bed is probably absent. The coal is normally 1 to 2 feet thick and terminates laterally into the upper part of the middle quartz arenite member.

None of the Seaboard coals appear to have economic potential in the subsurface of Buchanan County, and all are limited in the northwest by the middle quartz arenite member of the Lee Formation. It is doubtful that any of the Seaboard coal beds extend very far westward into Wise or Dickenson counties.

Tiller Coal Bed

In Tazewell and Russell counties, where the middle quartz arenite is absent (Figure 44), the Tiller coal bed is about 300 to 325 feet above the uppermost Seaboard coal bed. The interval between these coals contains only a few rare, thin, lenticular coal beds. To the northwest in Buchanan County, southeast of the northwest limit of the middle quartz arenite the interval thins to about 250 feet. The middle quartz arenite member, which marks the termination of the Seaboard coal beds, is stratigraphically about 200 feet below the Tiller coal. Further northwest near the Virginia-Kentucky boundary, the interval between the Tiller and the top of the middle quartz arenite member decreases

to about 150 feet. In Wise and Dickenson counties a similar relationship is observed. In the southeastern part of those counties the Tiller coal is about 250 to 300 feet above the middle quartz arenite; the interval decreases to about 225 to 250 feet in the central part, and to about 150 feet in the northwest.

In northwestern Buchanan and Dickenson counties and the western half of Wise County, the Tiller coal is well below the upper quartz arenite member (Bee Rock Sandstone Member). Prior to this report the Tiller coal has been considered to occur about 200 to 300 feet above the top of the Lee Formation. As illustrated in this report, the sandstone member which Campbell considered to be located below the Tiller coal is actually the middle quartz arenite member of the Lee Formation.

In surface exposures in Russell County and in the subsurface in southeastern Dickenson and southern Buchanan counties the Tiller coal bed and the overlying Jawbone coal bed coalesce to form one coal bed with a combined thickness of from 7 to 18 feet. In areas to the northwest and west, where the coal is at greater subsurface depths, however, the writer could find no evidence to indicate that the two beds coalesce. Throughout the subsurface of Buchanan County the Tiller coal is separated from the overlying Jawbone coal by about 50 to 100 feet of sandstone. In Dickenson and Wise counties, although core data are more limited and the sandstone unit is locally thinner, the two coal beds appear to separate everywhere.

The general extent and thickness of Tiller coal is shown in Figure 54, which illustrates that the thickest beds are generally in the southeast. Those are areas where the coal is now being mined. To the north, northwest, west, and southwest where it is more deeply buried the coal is generally thinner and locally splits into two to three coal beds, each less than a foot thick, which are separated by about 5 to 10 feet of shale. In part of northeastern Buchanan County the coal is locally absent. Farther to the northwest in Buchanan County near the Virginia-Kentucky boundary, the Tiller is represented by two beds each less than 6 inches thick. The coal is also absent in two deep coal exploration tests (Plate 1, numbers 120, 128) in eastern Wise County.

In northern and northwestern Wise and Dickenson counties the Tiller coal bed was normally not evident in the cuttings from the gas tests. Unless there is an area where the Tiller rejoins

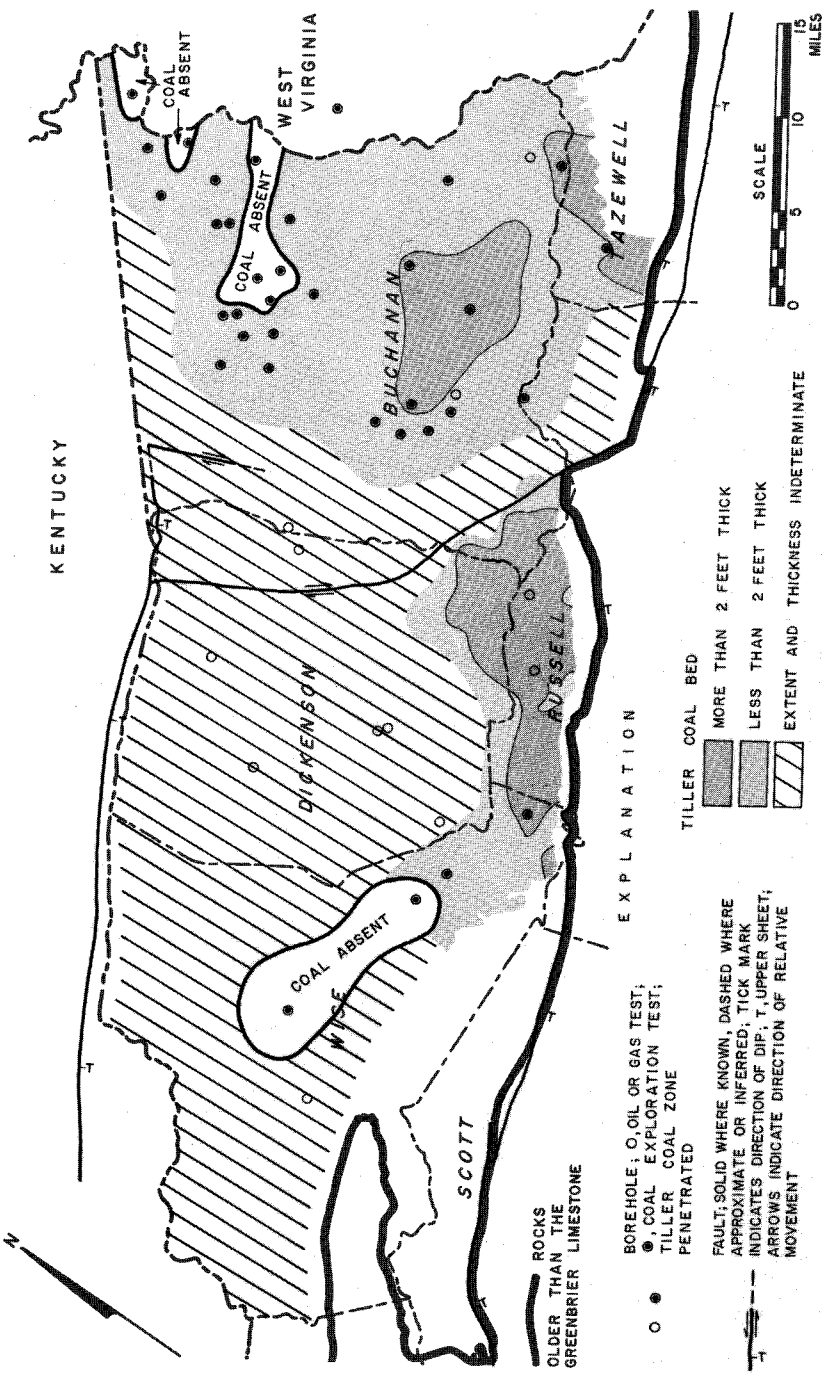


Figure 54. Map showing approximate extent and thickness of the Tiller coal bed. (Some data from Harnsberger, 1919; Hinds, 1918; Giles, 1921; Wentworth, 1922; Eby, 1928; Brown and others, 1952.)

the overlying Jawbone coal, the Tiller coal is probably of little economic importance in the below-drainage areas in northwestern Buchanan, Dickenson and Wise counties.

Jawbone Coal Bed

The Jawbone coal bed, which ranges in rank from high-volatile A to low-volatile bituminous, is one of the more extensive and correlatable coal beds associated with the Lee Formation. A persistent, locally conglomeratic sandstone, 50 to 100 feet thick, occurs directly below the Jawbone, which makes the coal bed easy to identify. The thickness of this sandstone usually determines the interval between the Jawbone and the stratigraphically lower Tiller coal bed.

Comparison of Figure 45 with geologic maps showing the outcrops of the Jawbone coal bed in Tazewell (Harnsberger, 1919), Russell (Wentworth, 1922), Buchanan (Hinds, 1918), Dickenson (Giles, 1921), and Wise (Eby, 1923) counties shows that where the Jawbone bed is well exposed and mined extensively, the upper quartz arenite (Bee Rock) member of the Lee Formation has tongued out and is not present. In these southeastern outcrops, the Jawbone coal occurs about 350 feet above the middle quartz arenite member of the Lee Formation, which throughout most of these areas is the "uppermost" quartz arenite of the Lee. To the northwest, in central Buchanan, Dickenson, and Wise counties, the interval between the middle quartz arenite member and the Jawbone coal bed decreases to 250 to 300 feet. The interval further decreases gradually northwestward and near the Virginia-Kentucky boundary is about 200 feet. In western Wise County and northwestern Buchanan and Dickenson counties the Jawbone coal extends below the upper quartz arenite member (Bee Rock Sandstone Member), occurring about 150 to 200 feet below the base of that unit. This interval also decreases farther to the northwest.

The general extent and thickness of the Jawbone coal bed is shown in Figure 55. The coal is present throughout most of the study area; only in a small part in northeastern Buchanan County and in extreme western Wise County does it appear to be absent. The absence in Buchanan County appears to be due to local thinning of the coal bed, whereas in Wise County the coal appears to have been replaced in the stratigraphic section by the northwestward-thickening upper quartz arenite member

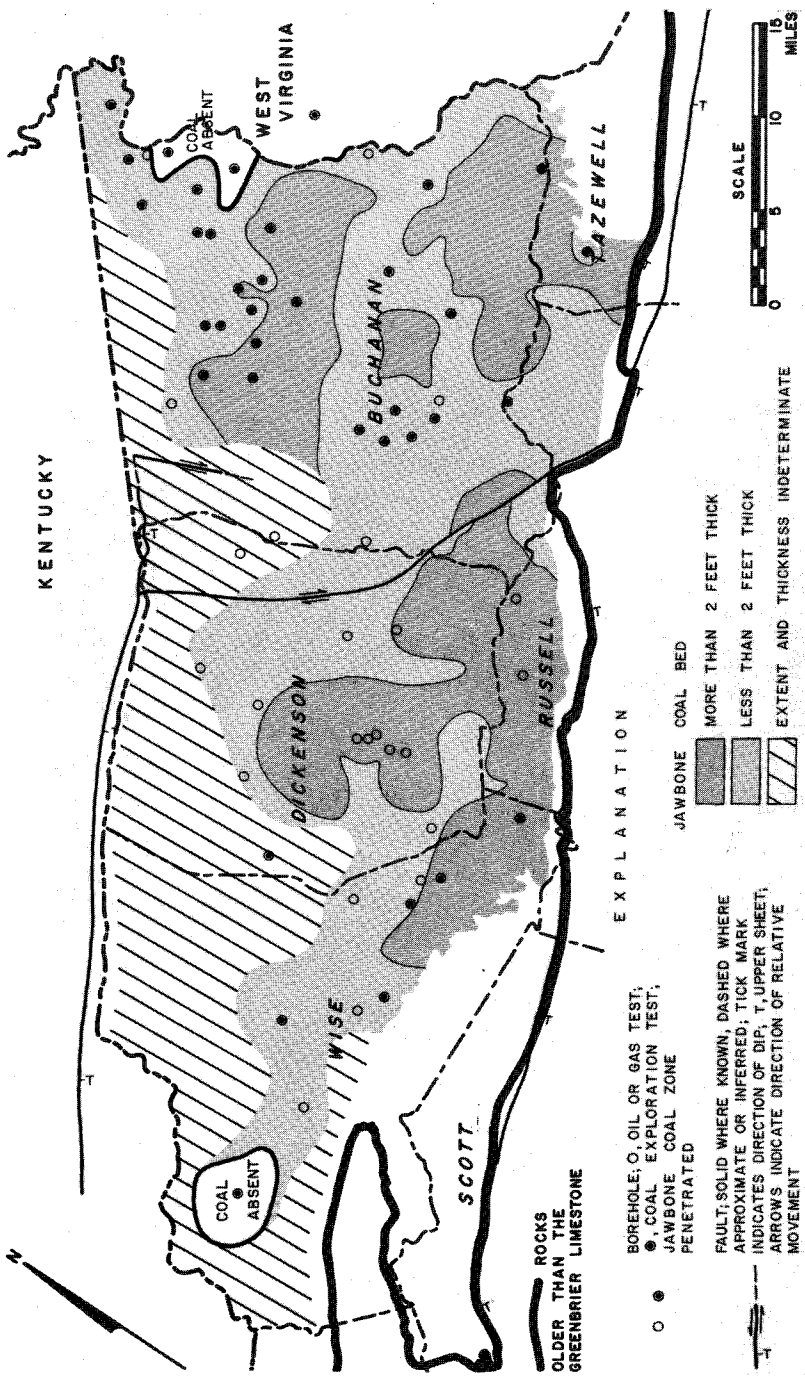


Figure 55. Map showing approximate extent and thickness of the Jawbone coal bed. (Some data from Harnsberger, 1919; Hinds, 1918; Giles, 1921; Wentworth, 1922; Eby, 1923; Brown and others, 1952.)

(Bee Rock). The latter stratigraphic change appears to limit the occurrence of the Jawbone coal along the Virginia-Kentucky boundary and farther northwestward into Kentucky.

In the subsurface of Buchanan County the Jawbone coal bed does not appear to be as thick as in some outcrop sections, nor does it appear to coalesce with the underlying Tiller coal bed as it does locally in outcrop. The thickest known Jawbone coal in the subsurface of Buchanan County is 30 to 42 inches in the central portion of the county. In all other areas of the county the coal is less than 2 feet. Along the exposures at Breaks in extreme northwestern Buchanan County the thickness may only by a few inches (Alvord and Miller, 1972). In Dickenson and Wise counties, the oil- and gas-test cuttings almost always indicate a good thickness of coal within the Jawbone zone.

Raven Coal Bed

In Tazewell and southeastern Buchanan counties, where it is well exposed and has been extensively mined, the Raven coal bed is about 200 feet above the Jawbone coal and 400 feet above the base of the Norton Formation. Subsurface correlations indicate that these intervals decrease northwestward. The interval between the Raven coal bed and the base of the Norton Formation, which is determined by the uppermost quartz arenite of the Lee Formation, also decreases to the northwest. In central Buchanan County the Raven coal is about 400 to 500 feet above the top of the middle quartz arenite member of the Lee Formation (the upper quartz arenite member is absent). Farther northwest the Raven coal occurs from 0 to 100 feet below the upper quartz arenite member and in these areas the coal is included within the Lee Formation.

A similar relationship exists in Wise and Dickenson counties. In Russell, southeastern Dickenson, and eastern Wise counties the Raven coal bed is 175 to 200 feet above the Jawbone coal bed and 400 to 500 feet above the middle quartz arenite member (the upper quartz arenite member is absent). These intervals decrease northwestward, and the Raven coal extends below the upper quartz arenite member (Bee Rock Sandstone Member). In northwestern Dickenson County and in western Wise County the Raven is about 120 to 150 feet above the Jawbone coal bed, about 350 to 400 feet above the middle quartz arenite member, and from 0 to 100 feet below the upper quartz arenite member.

The Raven coal in the subsurface of Buchanan County is normally less than 1 foot thick. The coal bed is commonly separated into two thin beds by a shale sequence a few feet thick. In extreme northern Buchanan County the coal is locally absent, apparently being replaced in the stratigraphic section as the upper quartz arenite member thickens. Near the Virginia-Kentucky boundary in the vicinity of Breaks Interstate Park the Raven directly underlies the upper quartz arenite member.

In Wise and Dickenson counties, well cuttings indicate that the Raven is laterally persistent, and is probably thicker than in Buchanan County. The limited amount of core data did not allow for a detailed evaluation of the coal in these areas.

The Raven coal ranges in rank from high-volatile A to medium-volatile bituminous (Brown and others, 1952). The coal is low-sulfur, low-ash, and has a good reputation as a domestic fuel. The Raven appears generally to be thinner to the northwest, however, and does not appear to be of commercial importance in the subsurface, particularly in Buchanan County. Areas in Wise and Dickenson counties may show more economic potential with more detailed exploration.

Aily Coal Bed

The Aily coal bed in the subsurface normally occurs about 100 feet below the Kennedy coal and about 100 to 150 feet above the Raven coal. Although generally thin, the Aily coal is consistently present in south and central Buchanan and Dickenson counties and in eastern Wise County. In these areas the coal underlies a persistent, coarse-grained, locally conglomeratic, slightly micaceous, lithic arenite or graywacke, which is referred to as the McClure sandstone (Eby, 1923; Hinds, 1918; Giles, 1921). In northwestern Buchanan and Dickenson counties and western Wise County, however, the McClure sandstone zone is occupied by the upper quartz arenite member of the Lee Formation which appears to cut out the Aily coal bed locally. It is doubtful that the coal extends into Kentucky. The Aily coal, although a good stratigraphic marker in some areas, does not appear to have commercial value anywhere in the subsurface.

Kennedy Coal Bed

The Kennedy coal bed occurs throughout much of the area, just above drainage, and is typically well exposed where the flat-lying strata are cut by rivers, roads, and railways. The coal bed

has been well mapped by Hinds (1918), Harnsberger (1919), Giles (1921), Wentworth (1922), and Eby (1923), and its stratigraphic position accurately established. Most of the oil and gas and coal exploration tests have been located at the heads of hollows and ravines about 100 to 200 feet above the Kennedy coal. Great care was taken to use accurate surface elevations of both the exploratory test sites and the Kennedy coal bed. Wherever applicable, measured sections of the Kennedy, as published in detail in Hinds (1918), Harnsberger (1919), Giles (1921), Wentworth (1922), and Eby (1923), were used to determine even more closely the stratigraphic position of the Kennedy coal in relation to the subsurface tests.

The sandstone sequence underlying the Kennedy coal is a resistant, massive, coarse-grained, locally conglomeratic, lithic graywacke or lithic arenite generally referred to as the McClure sandstone member (Figure 50). Along the extreme northwestern part of Buchanan and Dickenson counties and in western Wise County a coarse, locally conglomeratic, quartz arenite, generally referred to as the Bee Rock Sandstone Member, underlies the Kennedy coal bed. In either case, the Kennedy coal is always underlain by a conspicuous massive sandstone.

In Tazewell County and in extreme southeastern Buchanan County where the Lee Formation is absent, the Kennedy coal bed occurs about 250 feet above the Raven coal bed and from 1700 to 1900 feet above the Pocahontas No. 3 coal bed. In south-central Buchanan County, the top of the basal quartz arenite member of the Lee Formation is about 1400 to 1450 feet below the Kennedy. In central Buchanan County where the middle quartz arenite member is present, the Kennedy coal occurs about 200 feet above the Raven coal, 550 to 650 feet above the top of the middle quartz arenite member, and about 1300 to 1450 feet above the Pocahontas No. 3 coal. Farther northwestward, in north-central Buchanan County, the Kennedy is from a few feet to 75 feet above the upper quartz arenite member of the Lee Formation. The interval between the Raven and Kennedy coals is about 180 feet, and the Pocahontas No. 3 coal bed, if not truncated by the lower quartz arenite member, may be present about 1200 feet below the Kennedy. Near the Virginia-Kentucky boundary the upper quartz arenite member merges with a younger, overlying quartz arenite bed, which is as much as 100 feet thick, into which the Kennedy coal eventually terminates.

From Russell County northwestward and westward across Dickenson and Wise counties the Kennedy coal bed exhibits much the same relationships as in Buchanan County. In Russell County the Kennedy overlies the McClure sandstone member, rather than the upper quartz arenite (Bee Rock) member; it is 650 to 750 feet above the middle quartz arenite member and about 1800 to 2000 feet above the Pocahontas No. 3 coal. In southern and eastern Dickenson County and eastern Wise County the Kennedy coal is 600 to 650 feet above the middle quartz arenite member and about 1550 to 1700 feet above the Pocahontas No. 3 coal. In western Wise County and northwestern Dickenson County the Kennedy is about 15 to 25 feet above the upper quartz arenite (Bee Rock) member. To the northwest near the Virginia-Kentucky boundary, as in Buchanan County, the Kennedy eventually terminates with the appearance of an overlying quartz arenite unit that coalesces to the northwest with the Bee Rock member.

Subsurface correlations of the Kennedy coal indicate that the previous mapping of the bed has been largely consistent and correct throughout most of southwestern Virginia. An exception, the reason for which was outlined in the discussion of the Lee Formation, is along the north flank of the Powell Valley anticline everywhere southwest of Ramsey in Wise County, where Eby (1923) indicated that the Kennedy was absent.

The writer found the Kennedy coal along the north limb of the Powell Valley anticline in exposures just north of Little Stone Gap, Wise County, along State Road 610, south of its intersection with old U. S. Highway 58 Alternate. Along this road several hundred feet of strata can be observed above the upper quartz arenite (Bee Rock) member. The Kennedy coal, 31 inches thick including a 4-inch shale parting, was found 29 feet above the upper quartz arenite (Bee Rock) member. Prior to this study, no coal bed had been reported at this location. A palynological study of this coal bed yielded an abundance of spores (Plates 5-7). Many of the species were similar to those identified in Pennsylvania, strata in nearby areas (Kosanke, 1950, 1971; Guennel, 1958; and Peppers, 1970). A comparison of the distribution of the spore assemblages for the Kennedy coal is shown in Table 2. *Lycospora* was found to be the dominant genus, with *Granulati-sporites* and *Triquitrites* making up the second and third most abundant genera.

Table 2.—Spore assemblage in Kennedy coal bed.

Genus	Percent
Lycospora	37.8
Reticulati-sporites	1.2
Triquitrites	10.6
Raistrika	4.2
*Granulati-sporites	25.9
Punctati-sporites	3.1
Laevigato-sporites	6.9
Florinites	trace
Cirratriradites	trace
Densosporites	5.0
Calamospora	trace
Endosporites	trace
Unidentified sp. A	trace
Unidentified sp. B	trace
Unidentified sp. C	trace
Unidentified sp. D	trace
Unidentified sp. E	1.4
Unidentified sp. F	trace

*Identification of spores was made according to the criteria set forth by Schopf, Wilson, and Bentall, 1944. Of the triangular miospores of the genus Granulati-sporites about 22 percent were smooth-coated forms, assignable to the emended genus Leiotriletes (Potonie and Kremp, 1954).

Because of its widespread and accessible distribution, the Kennedy coal bed has been estimated to contain more indicated and inferred reserves than any other coal in Virginia (Brown and others, 1952). The thickness of the Kennedy coal averages about 30 inches, which is considered a "border-line" thickness by most coal operators.

NORTON FORMATION

The Norton Formation was named for a series of flat-lying beds near the town of Norton in Wise County (Campbell, 1893, p. 34); the formation was defined as including all beds between the top of the Lee Formation and the base of the Gladeville Sandstone. Miller (1969, p. 23) illustrated that Campbell had misidentified the Gladeville Sandstone in the Norton area and that the Norton Formation was not exposed in the flat-lying beds in the hills of Norton, but instead was poorly exposed in steeply dipping beds south of the town. Miller (1969) established the closest practicable reference section to the town of Norton in the Graham No. 1 gas test, 2.5 miles northwest of Norton. Ac-

PLATE 5—SPORES FROM THE KENNEDY COAL BED

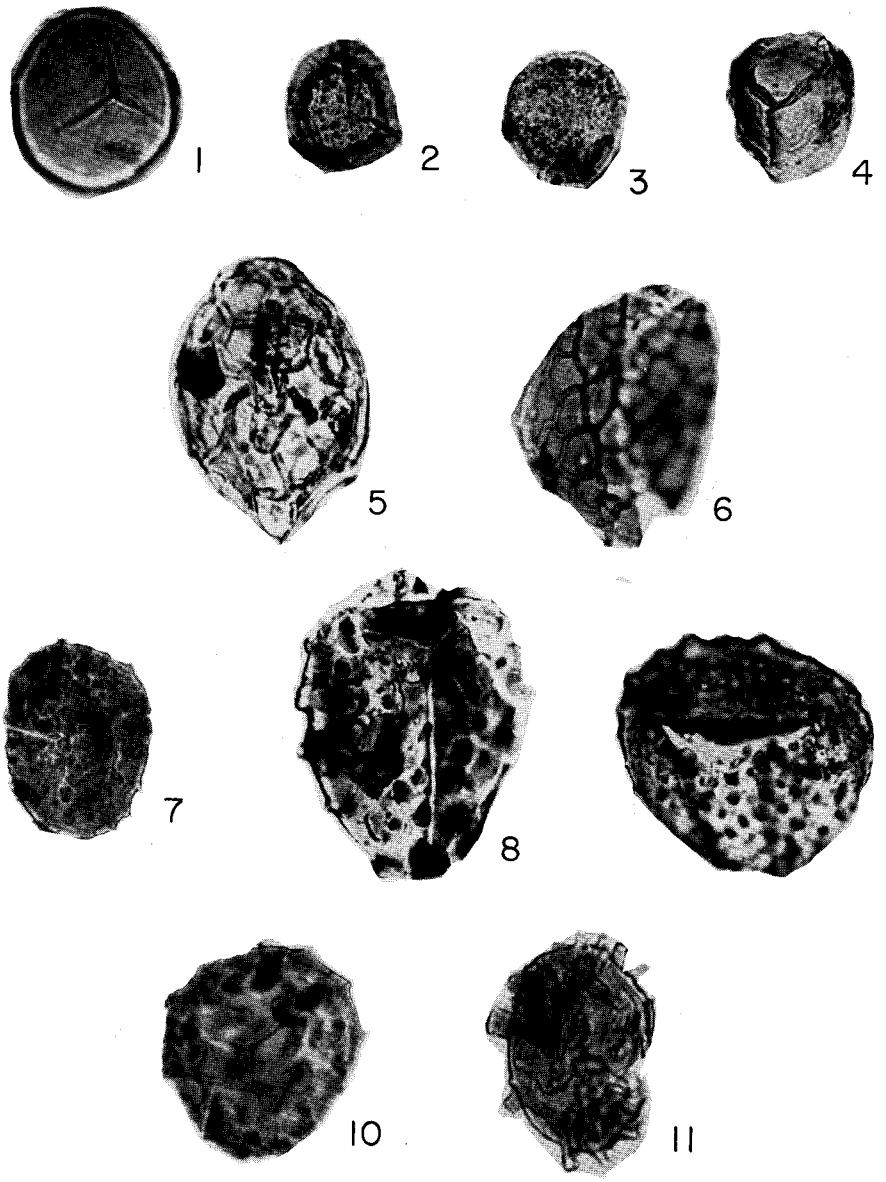


PLATE 5—SPORES FROM THE KENNEDY COAL BED

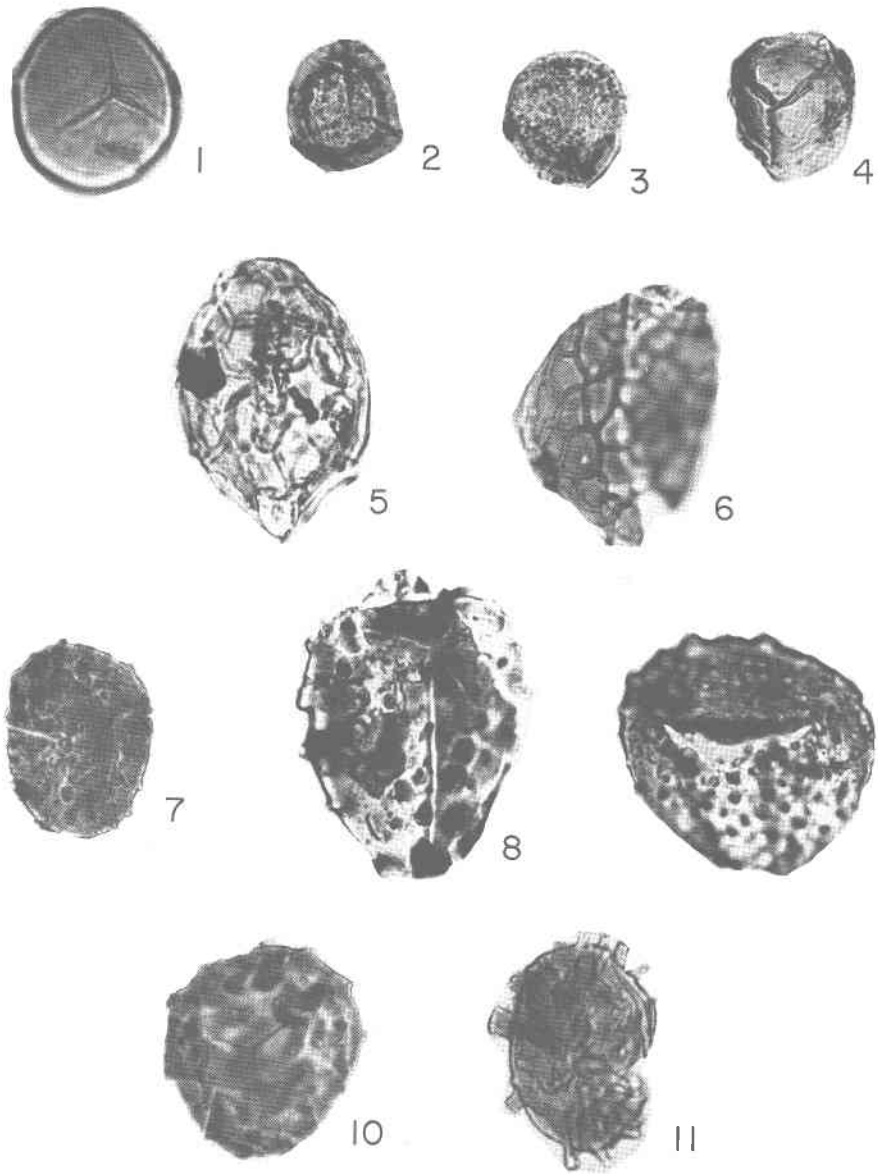


Fig. 1—*Lycospora* sp., (Schopf, Wilson, and Bentall, 1944), maceration 1, slide 2, overall dimensions 52.5 x 47.9 microns.

Fig. 2—*L.* sp., maceration 1, slide 2, overall dimensions 39.0 x 31.5 microns.

Fig. 3—*L.* sp., maceration 1, slide 5, overall dimensions 38.5 x 35.0 microns.

Fig. 4—*L.* sp., maceration 1, slide 4, overall dimensions 42.0 x 33.8 microns.

Fig. 5—*Reticulati-sporites* sp., (Ibrahim, 1933, emend., Schopf, Wilson, and Bentall, 1944), maceration 1, slide 4, overall dimensions 79.7 x 52.5 microns.

Fig. 6—*R.* sp., maceration 1, slide 1, overall dimensions 70.0 x 53.1 microns.

Fig. 7—*Raistricka* sp., (Schopf, Wilson, and Bentall, 1944) maceration 1, slide 2, overall dimensions 57.0 x 42.2 microns.

Fig. 8—*R.* sp., maceration 1, slide 5, overall dimensions 73.5 x 63.0 microns.

Fig. 9—*R.* sp., maceration 1, slide 5, overall dimensions 70.0 x 64.2 microns.

Fig. 10—*R.* sp., maceration 1, slide 3, overall dimensions 57.2 x 54.7 microns.

Fig. 11—*R.* sp., maceration 1, slide 2, overall dimensions 58.3 x 38.5 microns.

PLATE 6—SPORES FROM THE KENNEDY COAL BED

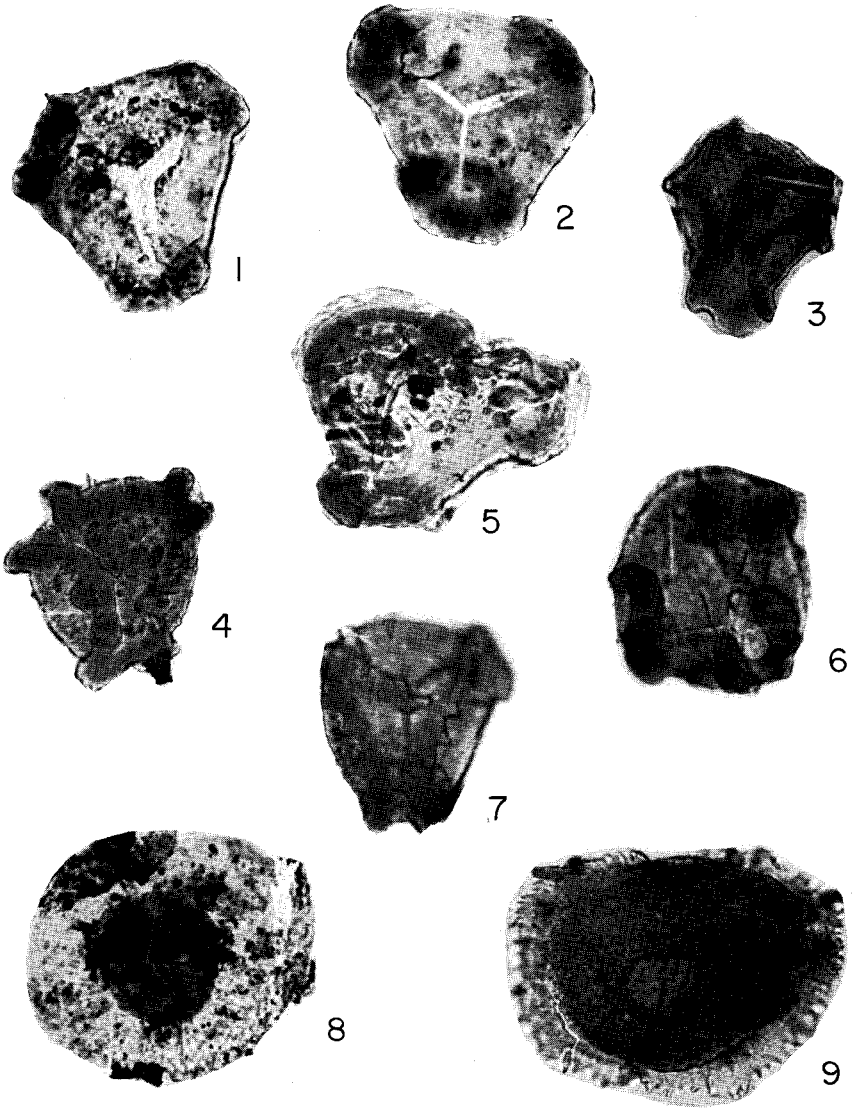


PLATE 6—SPORES FROM THE KENNEDY COAL BED

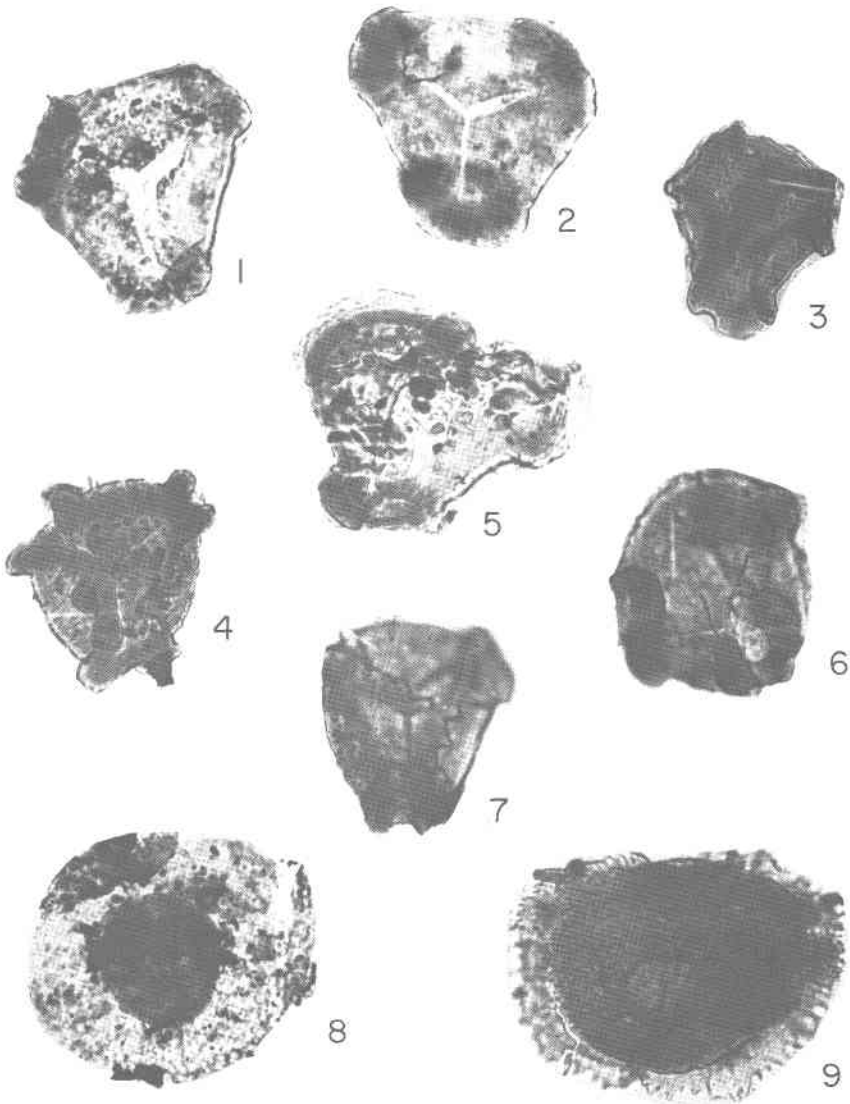


Fig. 1—*Triquitrites* sp., (Wilson and Coe, 1940) maceration 1, slide 4, overall dimensions 63.0 x 56.5 microns.

Fig. 2—*T.* sp., maceration 1, slide 4, overall dimensions 67.7 x 58.5 microns.

Fig. 3—*T.* sp., maceration 1, slide 2, overall dimensions 60.5 x 50.3 microns.

Fig. 4—*T.* sp., maceration 1, slide 2, overall dimensions 64.5 x 53.2 microns.

Fig. 5—*T.* sp., maceration 1, slide 2, overall dimensions 78.0 x 70.0 microns.

Fig. 6—*T.* sp., maceration 1, slide 1, overall dimensions 68.8 x 57.2 microns.

Fig. 7—*T.* sp., maceration 1, slide 3, overall dimensions 59.5 x 51.0 microns.

Fig. 8—*Florinites* sp., (Schopf, Wilson, and Bentall, 1944), maceration 1, slide 5, overall dimensions 82.5 x 67.5 microns.

Fig. 9—*Cirratriradites* sp., (Wilson and Coe, 1940), maceration 1, slide 2, overall dimensions 84.7 x 65.3 microns.

PLATE 7—SPORES FROM THE KENNEDY COAL BED

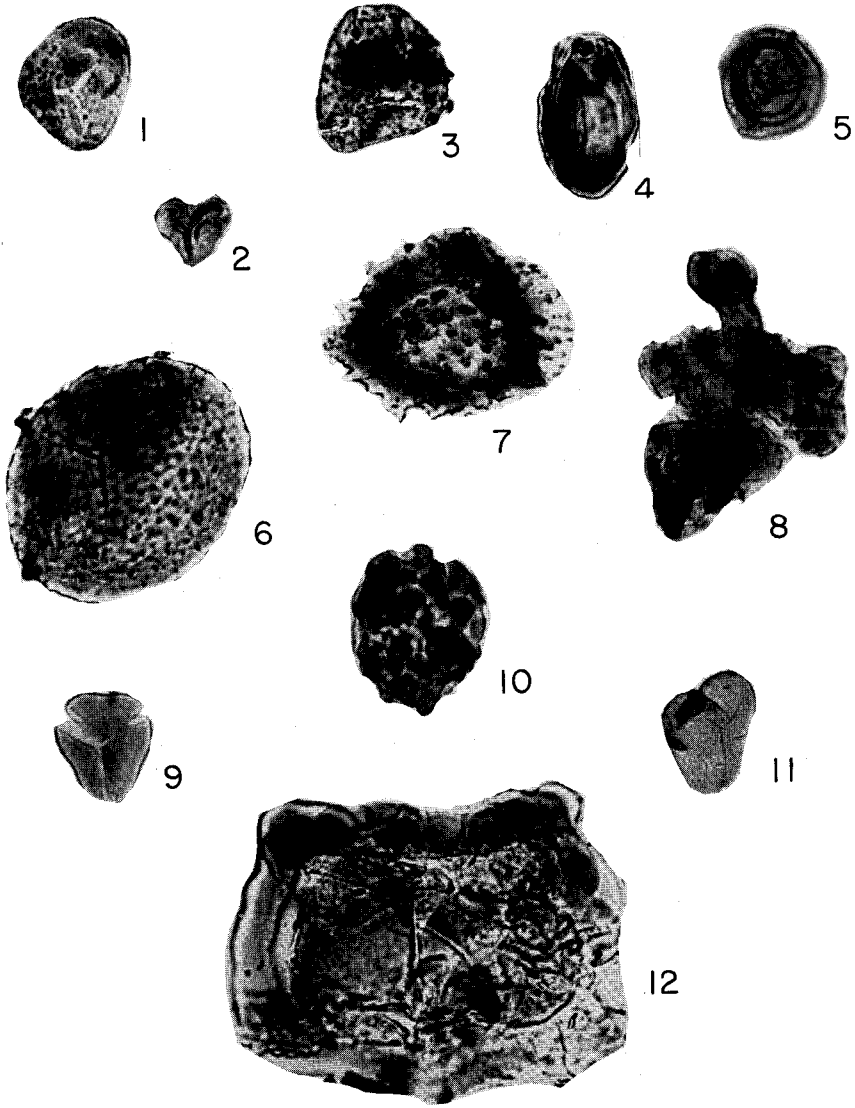


PLATE 7—SPORES FROM THE KENNEDY COAL BED

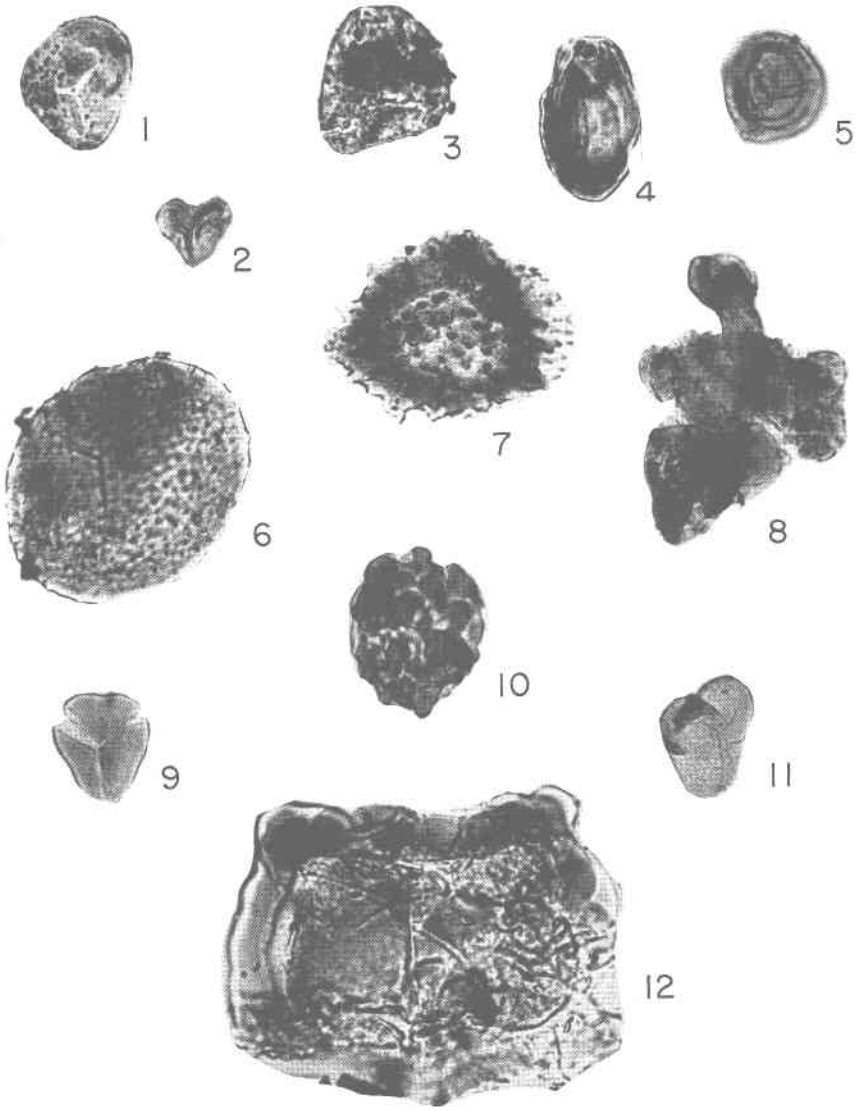


Fig. 1—*Granulati-sporites* sp., (Ibrahim, 1833, emend., Schopf, Wilson, and Bentall, 1944), maceration 1, slide 4, overall dimensions 33.8 x 30.3 microns.

Fig. 2—*G.* sp., maceration 1, slide 2, overall dimensions 22.1 x 18.6 microns.

Fig. 3—*G.* sp., maceration 1, slide 4, overall dimensions 39.6 x 37.3 microns.

Fig. 4—*Laevigato-sporites* sp., (Ibrahim, 1933, emend., Schopf, Wilson, and Bentall, 1944), maceration 1, slide 1, overall dimensions 46.7 x 29.2 microns.

Fig. 5—*Denso-sporites* sp., (Berry, 1937, emend., Schopf, Wilson, and Bentall, 1944), maceration 1, slide 3, overall dimensions 31.4 x 29.1 microns.

Fig. 6—*Punctati-sporites* sp., (Ibrahim, 1933, emend., Schopf, Wilson, and Bentall, 1944), maceration 1, slide 5, overall dimensions 75.6 x 61.7 microns.

Fig. 7—Unidentified sp. A, maceration 1, slide 5, overall dimensions 67.5 x 52.5 microns.

Fig. 8—Unidentified sp. B, maceration 1, slide 2, overall dimensions 81.4 x 58.2 microns.

Fig. 9—Unidentified sp. C, maceration 1, slide 2, overall dimensions 30.2 x 26.8 microns.

Fig. 10—Unidentified sp. D, maceration 1, slide 1, overall dimensions 46.5 x 37.2 microns.

Fig. 11—Unidentified sp. E, maceration 1, slide 1, overall dimensions 32.6 x 26.8 microns.

Fig. 12—Unidentified sp. F, maceration 1, slide 5, overall dimensions 115.5 x 79.5 microns.

cording to Miller the well spudded about 90 feet below the Gladeville Sandstone and penetrated the Bee Rock Sandstone Member of the Lee Formation at a depth of 701 feet. Study for the present report of the cuttings of the entire Pennsylvanian section in this well and correlations with nearby wells confirmed the identification of the Bee Rock Sandstone Member and the approximate position of the Gladeville Sandstone as interpreted by Miller (1969). Thus, this report recognizes the reference section which he established from the Graham No. 1 test, and the definition of the Norton Formation as established by Campbell (1893).

The Norton Formation consists chiefly of shale and siltstone, with lesser amounts of standstone, coal, and underclay. The shales and siltstones are gray to dark gray, locally carbonaceous, locally sideritic, thinly laminated, and commonly contain carbonaceous plant fossils. The sandstones are gray to light gray, fine to medium grained, commonly clayey, silty, and micaceous, locally feldspathic, and weakly cemeted; they are usually discontinuous units less than 25 feet thick.

The Norton Formation by definition includes all beds between the base of the Gladeville Sandstone and the top of the Lee Formation. Because the top of the Lee is stratigraphically lowered by the successive eastward and southeastward tonguing out of quartz arenite members of the Lee Formation, the Norton Formation includes considerably more section in these directions. In western Wise County and northwestern Dickenson and Buchanan counties, the Norton Formation is limited to beds between the Gladeville Sandstone and the upper quartz arenite member (Bee Rock Sandstone Member). These coal beds include the Norton, Hagy, Splash Dam, Upper and Lower Banner, and Kennedy. Of these, only the Kennedy bed does not always occur within the Norton Formation. As shown in this report, the Kennedy in the extreme western and northwestern parts of the study area eventually extends below an upper quartz arenite unit that coalesces and is included with the upper quartz arenite (Bee Rock Sandstone Member) of the Lee Formation. Where the base of the Norton is limited by the presence of the Bee Rock Sandstone the Norton is 750 to 800 feet thick in western Wise County, 600 to 650 feet in northwestern Dickenson County, and 550 to 600 feet in northwestern Buchanan County. Southeast and east of these areas, where the base of the Norton is limited

by the middle quartz arenite member of the Lee, the Norton Formation is considerably thicker and additionally includes the Kennedy, Aily, Raven, Jawbone, and Tiller coals. In eastern Wise County the Norton is 1200 to 1300 feet thick, and in central Dickenson and Buchanan counties 1100 to 1200 feet thick.

With the tonguing out of the middle quartz arenite member of the Lee, the Norton Formation includes all strata between the top of the lower quartz arenite member of the Lee Formation and the base of the Gladeville Sandstone. The resulting extremely thick section and placing of additional coal seams in the Norton Formation occurs only in a small area and largely in the subsurface where surface mapping is not affected. The only area on the surface where the middle quartz arenite member is absent, leaving only the lower quartz arenite member to represent the Lee Formation, is the narrow, upturned section along the extreme southeastern part of the coal fields in Russell County, south of the Russell Fork fault, as shown approximately by Englund and DeLaney (1966, p. 48). In Tazewell County where the lateral equivalents of the Lee Formation are at the surface, no quartz arenites typical of the Lee Formation are present. In this area, where no units are available to map the Lee Formation, the New River-Pocahontas nomenclature is much more applicable and should be used, as in the Bramwell quadrangle (Englund, 1968).

The coal beds in the upper part of the Norton Formation, from the Lower Banner to the Norton coal, are mostly above drainage and are not reviewed individually in this report, which is basically a subsurface study. Wherever possible, however, control was maintained for these coal beds in order to aid in subsurface correlations of stratigraphically lower coals.

NEW RIVER FORMATION

The New River Formation, as recently redefined by Read and Mamay (1964) in West Virginia, extends from the top of the Flattop Mountain Sandstone of the Pocahontas Formation to the top of the Upper Nutall Sandstone of the New River Formation and includes in ascending order the Pocahontas No. 8 and 9 coals, and the Fire Creek, Beckley, Raleigh, Welch, Sewell, and Iaeger coals. The New River Formation overlies the Pocahontas Formation and underlies the Kanawha Formation. The name New River has usually been limited to a large area in south-

eastern West Virginia where the sequence of rocks is well exposed. In Virginia, the New River crops out only in a small area in northwestern Tazewell County. As in West Virginia, the New River interval in Virginia extends northwestward into the subsurface. No attempt is made in this report to correlate with sections in West Virginia and or to evaluate reported regional coal correlations. Based on subsurface correlations, however, the base of the Lee Formation and the base of the New River Formation appear to be roughly the same. Furthermore, the general description of the New River Formation as grading northwestward in the subsurface to mostly sandstone closely resembles the Lee Formation. Descriptions of several of the more persistent and mappable sandstone units within the New River Formation in various West Virginia Geological Survey publications show that some of the units in the northwestern part of that state are as thick, massive, and conglomeratic as those within the Lee Formation. The Kennedy coal in Virginia occurs just above the upper quartz arenite member (Bee Rock Sandstone), the uppermost unit in the Lee Formation. In West Virginia, the Douglas coal, which is considered to be the Kennedy equivalent, is less than 200 feet above the top of the New River Formation. The Lee and New River formations thus appear to have upper and lower boundaries that are very closely related. If the two formations are equivalent, geologic mapping along the West Virginia-Virginia boundary and regional correlations of Pennsylvanian strata would be greatly facilitated. More detailed subsurface correlations and paleobotanical studies are needed to establish the exact stratigraphic relationship between the Lee and New River formations.

The New River Formation in Tazewell County, Virginia, consists of interbedded sandstone, siltstone, shale, coal, and underclay. The sandstones in this area are gray to light gray, fine to coarse grained, silty, micaceous, mostly thin bedded, and relatively low in quartz content. The siltstones and shales are gray to dark gray, micaceous, locally carbonaceous, thinly laminated, and commonly contain plant fragments. The coals and associated underclay are fairly thick and usually persistent.

To the northwest and west in the subsurface of Buchanan County, the lower and middle quartz arenite members of the Lee Formation become clearly recognizable within the New River sequence. As this occurs, the Lee nomenclature, which is more

widely used and accepted in Virginia, is used throughout the remainder of the area. Thus, the New River terminology is used in this report only in those areas where the Lee Formation cannot be distinguished.

Similar to other Pennsylvanian rocks, the units within the New River become thinner to the northwest and west. No thickness maps were prepared for the New River Formation because of the lack of stratigraphic control of the upper boundary. Several of the coal beds belonging to the New River sequence have been mapped throughout the southwestern Virginia area (Figures 51-55) and have been reviewed under the discussion of the Lee Formation.

GEOLOGIC HISTORY AND DEPOSITIONAL ENVIRONMENTS

Because of the acceleration of exploration for fossil fuels in the subsurface and increased highway building, the Mississippian and Pennsylvanian rocks in the Appalachians have been intensively studied in recent years. As a result, an entirely new concept has been generated concerning the depositional history of the Mississippian and Pennsylvanian systems. The changes in thinking are so great that even the use of the names Mississippian and Pennsylvanian as systems are now questioned by some geologists. Many workers, convinced that no systemic boundary exists between Mississippian and Pennsylvanian rocks, now prefer to refer to these strata collectively as Carboniferous (Hobday, 1969; Ferm and others, 1971; Smith and others, 1971; Ferm, 1972; Ferm, Milici, and Eason, 1972; and Galloway, 1972).

Most of the changes involve new depositional models that are created by treating rock bodies as facies reflecting depositional environments, rather than tabular, laterally continuous rock units. Comparison of modern areas of active deposition with ancient environments that are preserved in older rocks has rendered some of the inferred, long-established stratigraphic concepts questionable.

One concept is that rocks containing abundant marine fossils and overlying rocks containing plant fossils are considered to been interpreted to be present between two such rock units. Commonly, erosional breaks or periods of nondeposition have been interpreted to be present between two such rock units.

Present areas of active deposition illustrate that marine invertebrate animals are living and being deposited contemporaneously with plants in nearby swamp and lagoonal areas.

Another older concept is that rock units are essentially tabular rock bodies that extend over widespread areas and represent distinct, isolated periods of time. As highway cuts and other man-made exposures become more numerous, it is found that many rock units previously considered to be widespread and continuous actually wedge out, intertongue, and grade laterally into other units previously considered to be younger or older. In many instances the depositional environments of such rock units are so closely related that it becomes apparent that the units formed at the same time.

The Pennsylvanian and Mississippian stratigraphic units in the subsurface in southwestern Virginia have long been interpreted by tabular or layer-cake concepts, whereby the thick and fossiliferous limestone units are attributed to a period during which the area was completely inundated by marine seas; the sandstone units and coarser clastics are generally thought to be a result of uplift and tectonic activity of the source areas; and siltstones and shales are attributed to periods of quiescence (Huddle, Jacobsen, and Williamson, 1956; Wilpolt and Marden, 1959; Bowen, 1963). The application of the tabular models and concepts, however, left many questions unanswered and much of the stratigraphy unresolved. The writer found that the grouping of units by environmental association as has been applied recently to equivalent units in Kentucky, Tennessee, Alabama, and West Virginia (Hobday, 1969; Ferm and others, 1971; Smith and others, 1971; Ferm, Milici, and Eason, 1972; Galloway, 1972) presents a much clearer picture of the Mississippian and Pennsylvanian stratigraphy in southwestern Virginia.

Three depositional models representing three distinct periods of time were used to interpret the stratigraphic sequence from the base of the Greenbrier Limestone to the top of the Lee Formation. The models are depicted on Plate 2 and illustrate the close environmental association of the Greenbrier Limestone, Bluefield Formation, and most of the Hinton Formation which are interpreted by one model; the Little Stone Gap Member of the Hinton Formation, Princeton interval, Bluestone Formation, and Pocahontas Formation interpreted together in another model; and the Lee Formation and its lateral equivalents com-

prising a group of rocks with compatible environments as illustrated by a third model. These models and the formations they represent are reviewed from bottom to top in the following discussions.

GREENBRIER, BLUEFIELD, AND HINTON FORMATIONS

The upward succession of the Greenbrier, Bluefield, and Hinton formations consists of (1) thick, dense, highly fossiliferous limestone (Greenbrier Limestone), (2) gray and smaller amounts of red and green, calcareous shale (Bluefield Formation), (3) well-sorted, fine- to medium-grained quartz arenite (Stony Gap Sandstone Member of the Hinton Formation), and (4) shale, siltstone, sandstone, limestone, coal, and underclay (Hinton Formation).

The Greenbrier Limestone, which is roughly the equivalent of the Newman Formation of Kentucky, is about 750 to 850 feet thick in the southeastern portions of southwestern Virginia and 300 to 400 feet near the Virginia-Kentucky boundary. The unit is a variable sequence of fine to coarsely crystalline limestone beds which are party oolitic and contain a wide assemblage of marine organisms, brachiopods, pelecypods, cephalopods, gastropods, bryozoans, crinoids, corals, foraminifers, and plants. The Greenbrier thus represents chiefly a marine environment of deposition. Previous studies of the formation in Kentucky, West Virginia, and Virginia illustrated that the stratigraphic unit contains subtidal, intertidal, supratidal, and subaerial depositional features (Rittenhouse, 1944; Youse, 1964). A depositional environment that may contain these features is an offshore carbonate bar and island complex which evolves from subtidal to supratidal conditions (Ferm and others, 1971).

The Bluefield Formation averages about 400 to 500 feet in thickness, consists predominantly of finer clastics in the form of gray and often red and green, calcareous shales and siltstones and contains pelecypods, brachiopods, ostracods, bryozoans, crinoids, corals, and blastoids, which are indicative of a predominantly marine shallow-water environment. The marine invertebrates are not as abundant as in the Greenbrier, however, and it appears that the marine life existed in and on mud and clay detritus which was deposited just offshore based on the shaly character of the formation.The red sediments and associated marine animals indicate that open circulation and oxidizing conditions were normally present. A large predominantly marine area of environ-

ment several miles wide, and occurring between the offshore carbonate bars and islands, and the nearshore beach sands such as described by Ferm and others (1971) for similar sediments in Kentucky, could account for the deposition of the Bluefield Formation. The contact between the Bluefield and Greenbrier formations appears everywhere to be of a transitional and intertonguing nature; thus, the depositional environments were closely related.

The Stony Gap Sandstone Member, which occurs above the Bluefield sequence, is a well-sorted, fine- to medium-grained quartz arenite, commonly cross-bedded and ripple marked, that formed in a high-energy, barrier-island environment. The unit, which is normally about 100 feet thick, is persistent throughout the subsurface and appears to be gradational with sediments above and below.

Above the Stony Gap Sandstone is a widely variable lithologic sequence that makes up most of the remainder of the Hinton Formation. The sequence is composed of shale, siltstone, sandstone, limestone, coal, and underclay and does not readily indicate any particular type of environment. The limestone units are gray, thin, argillaceous, lenticular and may contain a few marine animal fossils, whereas the shales and siltstones are red to green to gray and may contain either plant fragments or marine shells. The sandstones are gray to white, normally silty, occasionally ripple marked, thin, and lenticular. The coals are thin, lenticular, impure and have associated underclay. The widely variable sequence as a whole is characteristic of a relatively quiet-water, back-barrier lagoon and mixed tidal-flat environment that was generally protected, allowing for a small amount of vegetation to take root. The presence of the fossiliferous limestone units and ripple-marked quartz-rich sandstones and red and green shales is evidence that the area was periodically subjected to the influence of currents and tides. The periodic flooding and drying, and percolating waters, would allow for the mobilization of iron, producing the occasional reddish coloration in the sediments (Walker, 1967; Clark, 1962).

The contact between the Stony Gap Sandstone Member and the overlying rocks is gradational and the units are closely related. However, the upward and landward progression of environmental units is ended with the Little Stone Gap Member, a persistent and highly fossiliferous unit that is highly indicative

of a marine environment. With the apparent "break" in compatible environments and because the Little Stone Gap Member appears to be closely related to overlying units, the base of the Little Stone Gap Member marks the termination of the Greenbrier-Bluefield-Hinton sedimentation and the initiation of another environmentally compatible group of rocks.

The gross regional stratigraphy of the Greenbrier-Bluefield-Stony Gap-lower Hinton rocks (Plates 2, 3, 4) illustrates that the back-barrier deposits of the Hinton overlie beach-barrier deposits of the Stony Gap Sandstone, which in turn overlie shallow and offshore marine deposits of the Bluefield and Greenbrier formations. All units gradually become thin to the northwest and the sequence thus represents a general progradational system which builds seaward in that direction. It appears from the general trend of sedimentation that the source areas were restricted to the southeast, and that the paleoslope was to the northwest.

LITTLE STONE GAP MEMBER, PRINCETON INTERVAL, BLUESTONE FORMATION, AND POCAHONTAS FORMATION

The sequence of rocks from the Little Stone Gap Member of the Hinton Formation upward through the Princeton interval, the Bluestone Formation including the Pride Shale Member, and the Pocahontas Formation represents another group of closely related environmental units that are clearly distinguishable from either stratigraphically higher or lower rocks. This sequence of rocks again represents an upward succession of environments from marine conditions through lagoonal, brackish, and freshwater, to subaerial swamp conditions.

The Little Stone Gap Member of the Hinton Formation is composed of gray, argillaceous limestone and highly calcareous shale with numerous brachiopods, bryozoans, pelecypods, and crinoids (Figure 15) which are clearly representative of a shallow, offshore, marine environment. The unit is generally about 50 to 60 feet thick, may be as much as 200 feet in the southeast, and less than 20 feet near the Virginia-Kentucky boundary. The sequence is remarkably persistent and everywhere easily identifiable in the subsurface. The shaly and silty nature suggest that the marine animals lived mostly in offshore fine silt and clayey detritus.

The Little Stone Gap Member is overlain by the Princeton interval, a fine- to coarse-grained, moderately to well-sorted quartz arenite, that occasionally contains quartz pebbles. The Princeton is laterally persistent and is normally 100 to 150 feet thick. In a few areas, the unit may exhibit abrupt thickening and thinning, but the quartzose nature is usually maintained. The same stratigraphic interval on the surface along the southeastern edge of the coal fields in Tazewell County is composed of several lithologic units that are atypical of the unit observed in the subsurface. In these outcrop areas, the interval between the Little Stone Gap Member and the Pride Shale Member of the Bluestone Formation is 250 to 350 feet and is composed of predominantly sandstone units that are commonly high in quartz content, usually well sorted, and exhibit current features such as cross-bedding and ripple marks. Interbedded with these sandstones are thin lenticular beds of shale, siltstone, and limestone. In this area only the uppermost sandstone unit, which is a fine- to coarse-grained, polymictic conglomerate with pebbles of shale, limestone, ironstone, and chert, is designated as the Princeton interval. The remainder of the interval has normally been referred to as the upper red member of the Hinton Formation, which is misleading because only a minor amount of the interval contains red sediments. The predominant lithology is sandstone relatively high in quartz. The finer clastic material, in which there are both marine invertebrate and plant fragments, rapidly diminishes to the northwest, and the unit becomes almost entirely a pure quartz sandstone.

The variability of the sequence in the southeastern outcrop area is evidence that some environmental conditions were briefly present there that were not present to the northwest. The predominance of quartz-rich and well-sorted sands with current features is characteristic of a high-energy environment. Thin beds of finer clastic material and the wide variation in fauna, however, are evidence that the high-energy environment was shifting and unstable. This condition could have been produced by changes in the tectono-environmental conditions of the sedimentary site, the transporting media of the sediments, location and tectonics of source areas, or perhaps a combination of these. The resulting, erratic and multi-directional shifting of the high-energy environment in the form of nearshore wave and current action could have deposited and then redistributed quartz-rich sands over both landward and seaward sediments. This would

account for the predominance of quartzose sandstones closely associated with both marine and land sediments. The rapid termination of the finer clastics to the northwest is evidence that the erratic conditions were of only a relatively brief period, and that the environmental system stabilized in that direction.

The general stratigraphic position of the Princeton interval in the subsurface throughout the area is evidence that the well-sorted, quartz-rich sands were deposited in a nearshore beach-barrier environment. Marine offshore sediments of the Little Stone Gap Member occur just below the Princeton and black, lagoonal shales of the Pride Shale Member overlie the Princeton. A beach barrier would have provided the quiet-water conditions necessary for the deposition of the Pride Shale Member. The Princeton sands thus separated marine, high-energy waters from a lagoonal and quiet-water environment.

The Pride Shale Member is a dark-gray to brownish-gray to black, evenly bedded and locally carbonaceous shale, which is interlaminated with dark-gray siltstone and argillaceous sandstone. Fossils are rare or generally absent with only a few uncertain organic fragments having been reported. In the upper portions of the Pride the shale grades upward into a gray, argillaceous siltstone which may in places contain a thin coal bed. The Pride Shale Member ranges in thickness from 70 to 325 feet, but does not appear to become thicker or thinner in any particular direction.

The consistent dark-gray shale of the Pride is characteristic of a quiet-water, lagoonal environment, where dark clays and silts were deposited directly behind beach-barrier sands. The argillaceous siltstone and thin, lenticular coaly deposits that occur in the upper portion of the Pride are evidence that the lagoon must have, on occasion, filled with clay and silt and become shallow enough to support plant life. The general absence of fossils within the Pride Shale is evidence, however, that the overall environment was not conducive to either plant or animal life.

Above the gray-shale sequence of the Pride Member is a group of varicolored shales and siltstones, with lesser amounts of sandstone, limestone, coal, and underclay, which constitute the remainder of the Bluestone Formation. The shales and siltstones are gray, green, and red, are commonly calcareous, locally carbonaceous and may contain either plant or shell fragments.

Small spherulitic nodules of siderite occur in both the shales and siltstones in the upper portion of the Bluestone Formation. The sandstones are gray to green, fine grained, silty, micaceous, usually thin, and discontinuous and may often be ripple marked. The limestones are gray, argillaceous, thin and lenticular, and may contain pelecypods and brachiopods. The coals are thin and lenticular and normally overlie a thin underclay.

The regional stratigraphic position of the Bluestone Formation, which always is between the beach-barrier sands of the Princeton interval and the alluvial and deltaic deposits of the Pocahontas Formation, is evidence that the Bluestone sediments were deposited in a back-barrier bay and lagoonal environment. The most obvious characteristic of the Bluestone is the distinctively brighter colors relative to the overlying sediments. These brighter colors and the presence of marine fossils are characteristic of sediments that were subjected to tides and periodic flooding and drying conditions during deposition. The rapid transitions from marine sediments to lagoonal silts and clays and even to coal and underclay deposits suggest that the local environment was at least partially blocked and at times totally cut off from marine waters. The well-sorted sands that now constitute the Princeton interval probably provided the barrier that occasionally cut off the flow of tides and currents into the area of deposition. This barrier was probably always present during the accumulation of sediments, but tidal channels and inlets that cut it could have provided circulation of marine waters into the back-barrier areas. With occasional filling of inlets, by longshore sediment drift, flood tidal channels probably filled and the progressively shallowing back-barrier area changed from a bay into a lagoon and eventually to marsh-swamp areas where vegetation could take root. Mud and silt brought in by freshwater streams probably provided most of the sediments that accumulated in the back-barrier area. The continued irregular occurrence of isolated sand lenses within the lagoonal fills, however, probably reflects overwash or high storm tides that moved coarser sediments into the areas of normally quiet-water deposition. Therefore, during this time, deposition was affected by both estuarine and barrier-coast processes, and consequently variable water salinities. The predominance of red and green marine shales throughout the Bluestone Formation, and the thin, lenticular nature of the coals, are evidence that the marsh conditions were only temporary and that the back-barrier areas

were normally submerged and subjected to the influence of tides and more oxygenated conditions. The siderite nodules in the upper Bluestone reflect temporary cessation of detrital influx into the bay areas.

Stratigraphically above the back-barrier sediments are the alluvial and delta-plain deposits of the Pocahontas Formation, which are characterized by coal beds, shale, and poorly sorted sandstone. The coals are relatively thick, laterally persistent, and are generally low-sulfur, low-volatile types. Thin underclays normally underlie the coal beds. The shales are gray to dark gray to black, locally silty, and carbonaceous, and may contain abundant plant fossils. The sandstones are mostly light gray, fine to medium grained, poorly sorted, thin to thick bedded, and relatively low in quartz content with abundant finely dispersed carbonaceous fragments and mica flakes (Figure 20). A few relatively pure quartzose sandstones (Figure 21) occur near the distal ends of the Pocahontas Formation (Plates 2, 4). These sandstones are unlike the quartz-rich sandstones of the Lee Formation, however, as they are finer grained, contain more clay matrix, are thinly laminated with carbonaceous and micaceous siltstone and shale, and are much thinner and have less lateral persistence than the Lee quartz arenites.

The poorly sorted sandstones, carbonaceous plant-bearing shales and abundant coals and underclays are characteristic of a continental environment where subaerial swamp conditions were present. The sediments were deposited in deltaic and alluvial complexes that were probably accumulating contemporaneously with back-barrier, beach-barrier, and offshore sediments of the Bluestone Formation, Princeton interval, and Little Stone Gap Member, respectively. The lower deltaic sediments of the Pocahontas Formation are known to intertongue with the back-barrier sediments of the Bluestone Formation (Englund, 1969). The basal quartzose sandstones in the Pocahontas Formation probably were deposited in the flood-tidal delta environment, where tidal currents and bay waves could have sorted and winnowed the fine sands.

The regional stratigraphic trend of the Pocahontas, Bluestone, Princeton, and Little Stone Gap sequence suggests a prograding system that migrated from the southeast to the northwest. The

deltaic and alluvial deposits of the Pocahontas overlap the back-barrier bay deposits of the Bluestone, which in turn overlap the beach-barrier deposits of the Princeton, which overlies the off-shore marine sediments of the Little Stone Gap. The sediments are generally thicker in the southeast, and thinner northwestward into southeastern Kentucky, indicating a northwestward, seaward advance of the shoreline towards more stable shelf-like conditions.

No transgressive stratigraphic sequence is preserved between the regressive sediments of the Greenbrier, Bluefield, and lower Hinton formations, and those of the Little Stone Gap Member and stratigraphically higher associated strata. Although the lithology immediately underlying the Little Stone Gap Member may change in a few places, the Little Stone Gap Member lies in conformity with the underlying strata. The absence of an erosional break and the presence of an environmental break at the base of the Little Stone Gap Member suggest that a change occurred which was uniform, but that conditions were such that a transgressive sequence was not very well preserved. Many stratigraphic studies demonstrate that in a transgressive-regressive sequence the transgressive sediments are commonly much thinner and are sometimes largely removed by the beveling action of a rapidly fluctuating and landward-advancing sea (Fisher, 1961, Schwartz, 1967; and Swift, 1967). As previously mentioned, the stratigraphic sequence above the Stony Gap Sandstone Member and below the Little Stone Gap Member is a widely variable lithologic sequence which overall is representative of a back-barrier lagoon and tidal-flat environment. A thin and poorly preserved transgressive sequence overlying tidal flat sediments that were subjected to periodic flooding and to the influence of currents and tides would be difficult to recognize.

The close association and intertonguing of the Bluestone Formation of the Mississippian System with the Pocahontas Formation of the Pennsylvanian System is evidence that no time break or erosional surface exists between these formations. The Mississippian-Pennsylvanian boundary in the southeastern area of the study (Figure 19) is defined by either fossils or changes in colors and lithology. As the most distinctive characteristic of the Bluestone Formation is the presence of red and green shales, its boundary was normally placed at the top of the uppermost red or green shale bed.

INITIAL DEPOSITION OF THE LEE FORMATION

The thinning and eventual obscurity of the prograding Pocahontas-Bluestone-Princeton-Little Stone Gap sequence to the northwest into Kentucky suggest that subsidence was decreasing towards the Cincinnati arch. It is generally believed that during late Mississippian time the Cincinnati arch was tectonically active (Eardley, 1951, p. 35; Seiver and Potter, 1956, p. 331; Meckel, 1970, p. 50-51). A slow and gradual upwarping of a landmass in central Kentucky or in the area of the Cincinnati arch could account for the gradual termination of subsidence during the deposition of the late Mississippian sediments. The rate of tectonic activity is beyond the scope of this report and can only be speculated. The subsurface data in Virginia (Plates 2, 3, 4) show, however, with the termination of active deposition of the Pocahontas-Bluestone-Princeton-Little Stone Gap sequence that an onlap period occurred during which the deltaic and lagoonal deposits of the Pocahontas and Bluestone formations were partially eroded with the initial onlap being represented by the basal Lee quartz arenites. The period of time involved between the termination of the Pocahontas-Bluestone-Princeton-Little Stone Gap stratigraphic sequence and the initiation of the transgressive Lee deposits is a regional question which is difficult to conclusively answer with the data and area involved in this report. Considering the recent studies of Ferm and others (1971), Smith and others (1971), Ferm (1972), Ferm, Milici, and Eason (1972), and Galloway (1972) in areas that are north, northwest, and west of the study area, it would appear that active deposition was uninterrupted and that a period of offlap occurred before the onlap of the Lee Formation into the Virginia area. However, considering the regional studies of Eardley (1951), Seiver and Potter (1956), Woodward (1957), and Meckel (1967), it would appear that a period of nondeposition and erosion occurred during which hundreds of feet of previously deposited sediments were exposed and a pre-Lee topography was developed.

In an attempt to resolve this regional question as it pertains to Virginia, an isopach map was constructed (Figure 56) from the top of the Kennedy coal bed to the base of the Lee Formation, which it was hoped would indicate a pre-Lee erosional surface or perhaps reflect structural control during the deposition of the Lee Formation. The Kennedy coal was used because it is one

of the more extensive beds in southwestern Virginia, and because it is just above drainage throughout much of the area, but normally just below the spudding elevations of oil and gas and coal exploration tests. The isopach map illustrates several well-defined thickness trends. The most prominent features are the northwestward-southeastward trending lows in central Buchanan, Dickenson, and Wise counties and the thinning trend along the boundary between Wise and Dickenson counties.

Comparison of the isopach map (Figure 56) with the isolith map of the lower quartz arenite member of the Lee (Figure 43) shows that the thickest accumulations of the lower quartz arenite coincide with the thick trends of the isopach map. Of particular significance is the thinning out and absence of the lower quartz arenite along the isopach thin trend along the boundary of Wise and Dickenson counties. Considering the coincidence of these maps and the pre-Lee geologic map (Figure 17) as developed earlier in this report, initial tendencies are to believe that Figure 56 illustrates a pre-Lee erosional topographic surface upon which the basal Lee sand deposited. The isolith maps of the middle and upper quartz arenite members of the Lee Formation (Figures 44 and 45) show definitely, however, that the thicker accumulations of quartz arenites of the Lee continued to coincide with the thick trends of the isopach map (Figure 56). This vertical stacking of the Lee quartz arenite members strongly suggests the structural control on sedimentation was a significant factor contributing to the high and low trends represented by Figure 56.

Thus, following the end of active deposition of the Pocahontas-Bluestone-Princeton-Little Stone Gap sequence, the Lee barrier-island quartz arenites may have continued to offlap northwestward into Kentucky before transgressing southeastward into the Virginia area. This possibility can only be conclusively answered with more detailed stratigraphic control in eastern Kentucky. Evidence in Virginia, however, suggests significant erosion either during or before transgression of the lower Lee quartz arenite member. The pre-Lee geologic map (Figure 17) and the graphic sections (Plates 2, 3, 4) show that southeastward the basal Lee quartz arenites successively overlie the lagoonal deposits of the Pride Shale Member, the lagoonal and deltaic deposits of the Bluestone Formation, and the deltaic and alluvial deposits of the Pocahontas Formation.

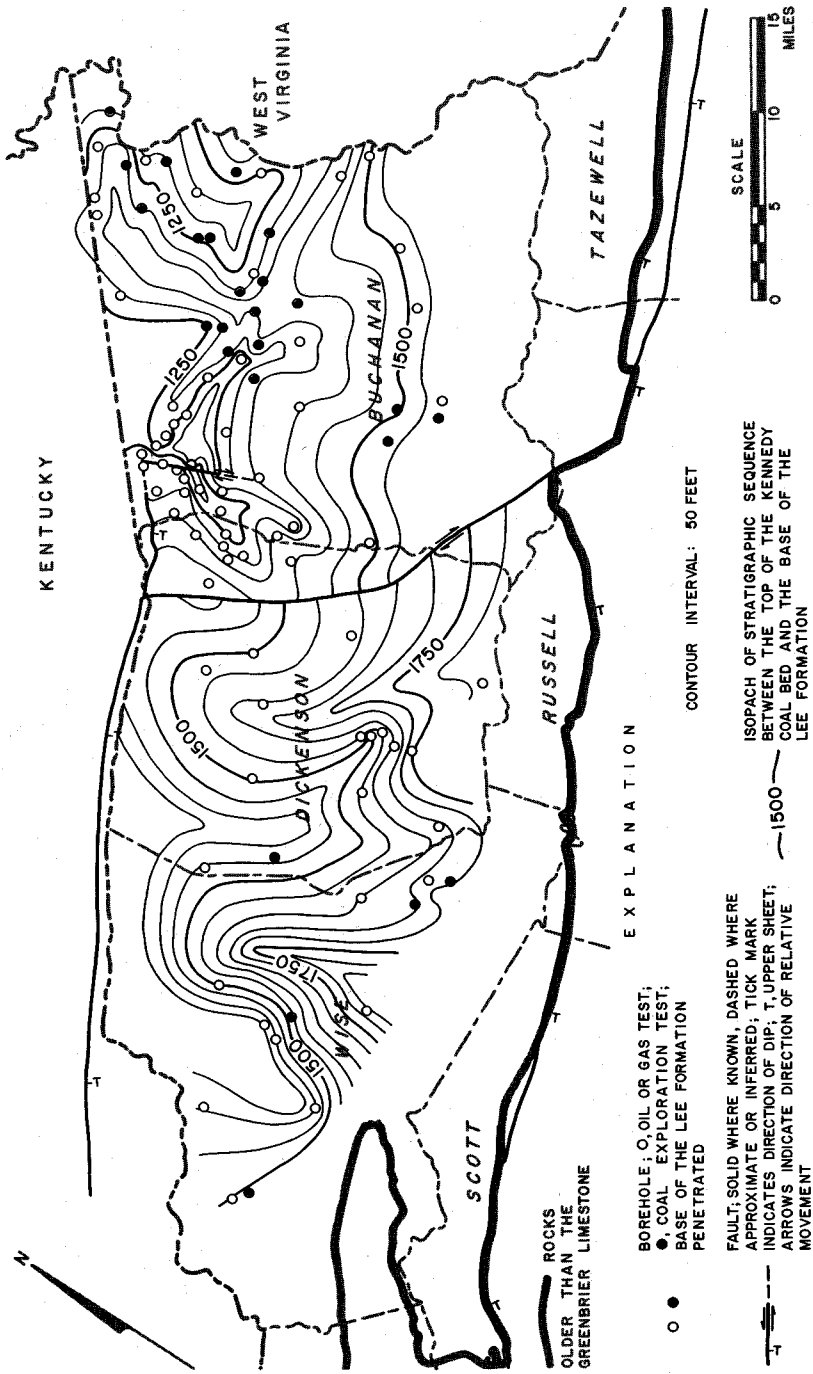


Figure 56. Isopach map from top of the Kennedy coal bed to the base of the Lee Formation.

The Pocahontas No. 3 coal bed was probably formed in a protected delta-plain environment during the deposition of the Little Stone Gap-Princeton-Bluestone-Pocahontas sequence. The bed was then later partially eroded during the initial onlap of the Lee Formation. Perhaps the stratigraphically higher Pocahontas coal beds were forming during this initial onlap stage, but erosion during transgression appears to have also partially destroyed these beds (Figures 27, 28, 29). Following the initial stage of Lee transgression, a regional period of offlap occurred that was accompanied by at least two distinguishable ocsillations of sea level establishing offlap-onlap tongues of the Lee quartz arenites in Virginia.

Projection of the basal Lee unconformity northwestward into Kentucky by reconnaissance study of selected oil and gas tests and review of the subsurface data accumulated by Jillson (1931) and Thomas (1960), tends to indicate that the unconformity becomes more pronounced to the northwest, truncating in succession the Pride Shale Member, the Princeton interval, the Hinton Formation, and the Bluefield Formation. The regional stratigraphic correlations, however, indicate that the thinning and termination of these units is due in part to facies change and decreasing supply and subsidence conditions. It is also probable that an unconformity would become even more obscured in the areas where the Lee quartz arenites overlie the quartz arenites of the Princeton and other Mississippian sandstone units. The thickness of the interval between the quartz arenite sands of the Princeton and the Lee quartz arenites is shown in Figure 57. As illustrated, the interval in the southeastern area of the Virginia coal fields is over 1000 feet, whereas in southeastern Kentucky the interval has decreased to about 50 feet. It is in these southeastern areas of Kentucky where recent workers (Ferm, Horne, Swinchatt, and Whaley, 1971; Smith, Dever, Horne, Ferm, and Whaley, 1971) have largely contended that there is no systemic break between Mississippian and Pennsylvanian rocks. It is also in these areas where Englund and Windolph (1971) illustrated that certain quartz arenite units which had been previously mapped as Pennsylvanian units were actually Mississippian units that are disconformably overlain by basal Pennsylvanian quartz arenites. The favored hypothesis here suggests that the Princeton quartz arenites (barrier island) in time became the Lee quartz arenites which first continued to offlap northwestward over offshore carbonate deposits and then transgressed south-

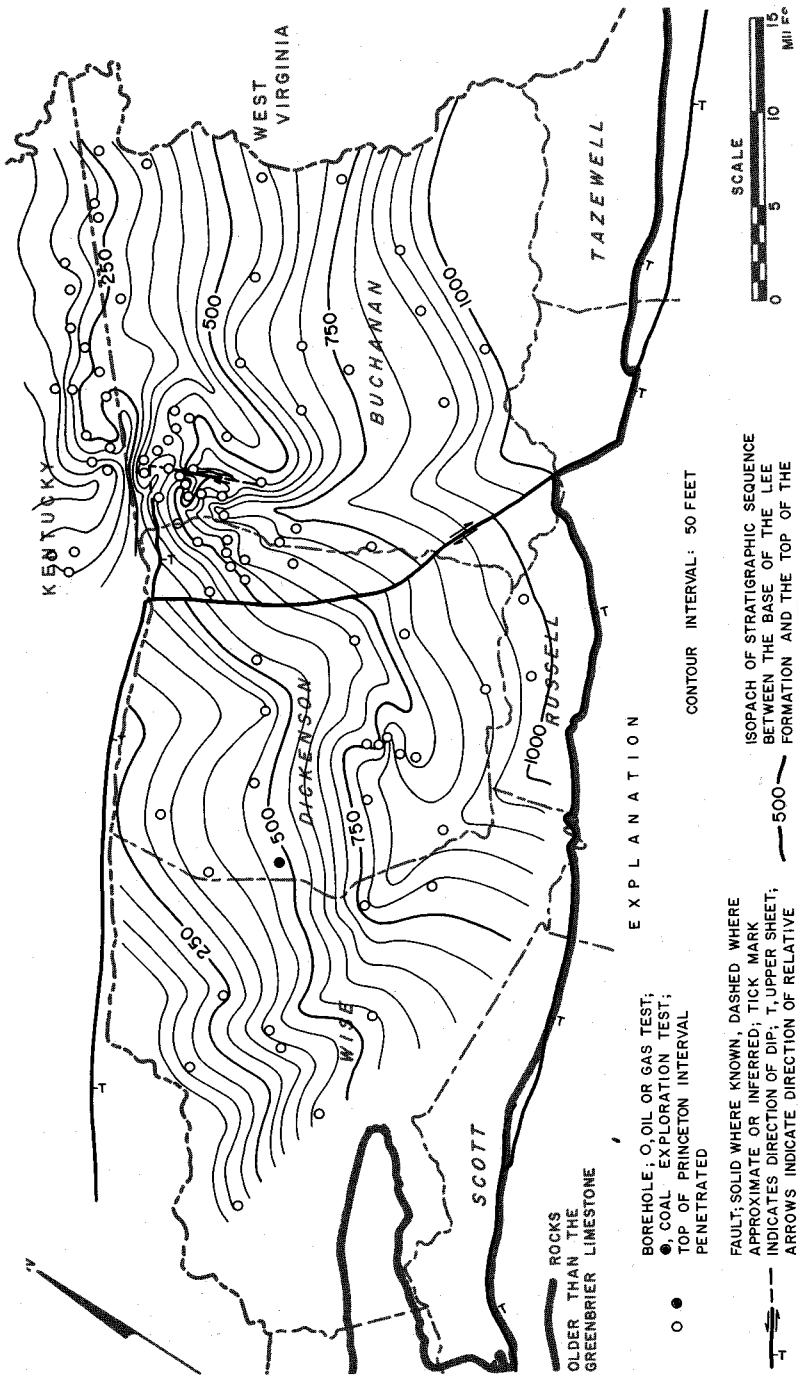


Figure 57. Thickness map from the top of the Princeton interval to the base of the Lee Formation.

eastward eroding progressively younger lagoonal and deltaic sediments which were subsiding relatively rapidly compared with rocks in southeastern Kentucky and the extreme northwestern study area.

LEE FORMATION

The massive quartz arenite units that characterize the Lee Formation in Virginia are extensively cross-bedded, have a considerable amount of sorting and rounding of grains and compositional maturity, and have generally been considered to be of a nearshore marine environment (Campbell, 1893; Mitchum, 1954; Bowen, 1963; Englund, 1966). In recent studies in areas of northern Alabama, Tennessee, Kentucky, and West Virginia equivalent units have been defined as beach-barrier deposits that have become quartz-enriched by reworking (Hobday, 1969; Ferm, Horne, Swinchatt, and Whaley, 1971; Ferm, Milici, and Eason, 1972; and Galloway, 1972).

The Lee quartz arenites are below drainage throughout most of southwestern Virginia, which limits the use of cross-bedding and current features in establishing their particular depositional environment. In a few areas the Lee can be observed in vertical sequence, but because of the normally overturned or steeply dipping nature of the beds it is difficult to derive any lateral relationships. The steeply dipping quartz arenites of the Lee display abundant current and cross-bedding features, the most characteristic of which are tabular sets of uniformly dipping, planar cross-beds that mainly have a south and southwest dip. A significant number of low-angle laminar and festoon cross-bedding features have a dip to the southeast or northwest. The dips of the cross-beds of the tabular sets normally range from 15° to 25° from the bedding.

Although no lateral relationships could be determined for the Lee sandstones, a general succession of units was observed in the vertical sequence. At the base, the Lee quartz arenites normally have a sharp, undulating and unconformable contact with underlying sediments. The basal units are also normally conglomeratic, containing large well-rounded quartz pebbles up to 1 inch in diameter. The pebbles occur either sporadically (Figure 35) or along bedding and cross-bedding planes (Figure 34). The basal conglomeratic quartz arenites appear to be part of large channel deposits that grade upward into massive, generally structureless

quartz arenites with occasional small- to medium-scale, high-angle cross-bedding. These units in turn grade upward into fine- to coarse-grained, planar cross-bedded quartz arenites, which appear to make up the largest percentage of the Lee quartz arenites. In places these planar cross-bedded quartz arenites are broken by thin- to thick-bedded units with no cross-bedding or by thin, fine-grained, ripple-marked beds with shale partings. Units with festoon cross-bedding appear to be randomly developed throughout the Lee quartz arenites. At the top of the sequence the Lee sandstones grade upward into fine-grained quartz arenites with low-angle laminar cross-beds, overlain in turn by very fine-grained, ripple-marked, silty, micaceous, lithic arenites and graywackes or thin beds of shale and siltstone interbedded with coal.

The succession described is only a generality, as fluctuations and disruptions of the sequence were frequently observed. In places, the upper portion also appears to be conglomeratic and the upper contact as abrupt as the lower portion. The abundant and variable cross-bedding and other current and bedding features indicate that the sandstones were subjected to the influences of tides and shifting currents, and that they are made up of several units or a stacking of several quartz-rich sandstones representing deposition in several closely related, nearshore beach environments.

The specific nature of the quartz arenites is best determined by study of the graphic sections and isolith and lithofacies maps of the Lee Formation. The Lee quartz arenites tongue out to the east and southeast (Plates 2, 3, 4; Figures 43, 44, 45) into a thickening sequence of relatively less quartzose and finer textured sediments containing coals and underclays, suggesting that the landward direction was to the southeast and east. The paleogeography during Lee time is more closely defined by the lithofacies map of the Lee Formation (Figure 58). In this map three end members were used to isolate depositional environments. The quartz arenites representing high-energy nearshore environments were used as one end member; shale, clay, and siltstone, representing principally quiet-water lagoonal, marsh, and tidal-flat deposits, were grouped into another end member; all other sand units including lithic arenites and graywackes, and arkosic arenites and graywackes, representing chiefly deposition by streams and rivers, were grouped into a third end member. As

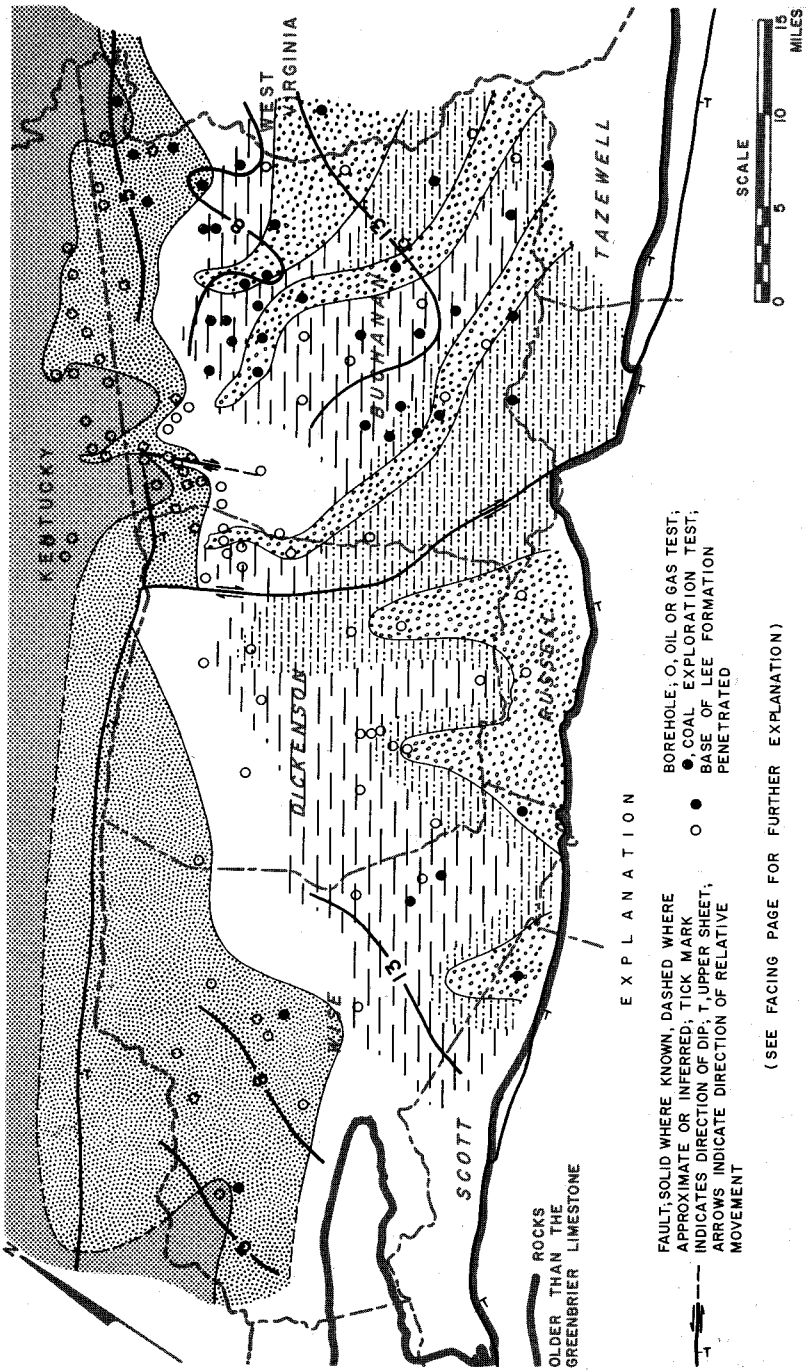
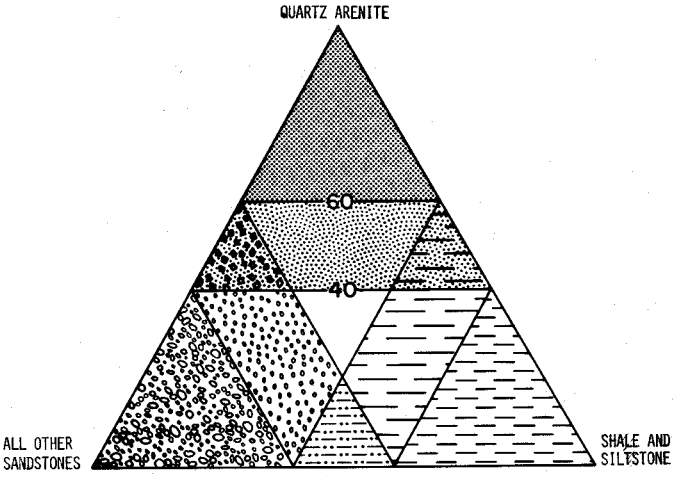


Figure 58. Lithofacies of the Lee Formation.



EXPLANATION

LEE FORMATION IS COMPOSED OF MORE THAN 60 PERCENT QUARTZ ARENITE

LEE FORMATION IS COMPOSED OF 40 TO 60 PERCENT QUARTZ ARENITE

LEE FORMATION IS COMPOSED OF APPROXIMATELY EQUAL AMOUNTS OF SHALE, SILTSTONE, QUARTZ ARENITE, ARKOSIC WACKES AND ARENITES, LITHIC ARENITES, AND GRAYWACKES

LEE FORMATION IS COMPOSED OF MORE THAN 40 PERCENT SHALE AND SILTSTONE

LEE FORMATION IS COMPOSED OF MORE THAN 80 PERCENT SHALE, SILTSTONE, AND SANDSTONE RELATIVELY LOW IN QUARTZ CONTENT

LEE FORMATION IS COMPOSED OF MORE THAN 40 PERCENT ARKOSIC WACKES AND ARENITES, AND LITHIC ARENITES AND GRAYWACKES

—8— NUMBER OF COAL BEDS PRESENT FROM THE BASE OF THE LEE FORMATION TO THE TOP OF THE JAWBONE COAL BED

NOTE: AN ENVIRONMENTAL SYSTEM DURING LEE TIME IN WHICH A MAIN BARRIER BEACH WAS LOCATED IN EASTERN KENTUCKY IS INTERPRETED FROM THE LITHOFACIES MAP. HIGH-ENERGY TIDAL DELTAS EXTENDED AT RIGHT ANGLES FROM THE BARRIERS INTO VIRGINIA. SOUTHEASTWARD ACROSS THE MAP THE PALEO-ENVIRONMENT TRANSGRESSES FROM BARRIER BEACH TO BACK BARRIER, LAGOON, AND TIDAL FLAT TO LOWER DELTA TO UPPER DELTA TO ALLUVIAL PLAIN.

shown, quartz arenites constitute over 60 percent of the formation in the southeastern Kentucky and extreme northwestern study area. This percentage decreases generally to the southeast. Southeastward the quartz sands gradually give way to finer textured sediments, principally shales and siltstones. Still farther southeastward, less quartzose sandstones become more prominent. As shown, these sandstones appear to be developed along relatively narrow, elongated areas, thin out to the west and northwest, and thicken to the east and southeast.

The lithofacies map illustrates that regionally the sea lay to the northwest and made southeastward invasions from that direction. A hypothetical model illustrating the paleogeography as interpreted from the lithofacies map is shown in Figure 59. The model shows a main beach barrier with a northeastward-trending shoreline in southeastern Kentucky, immediately adjacent to the southwestern Virginia area. Pronounced areas of quartz arenite deposition extend into central Wise County and into several separate areas in northwestern Buchanan County at right angles from the main barrier. The geometry and position of these quartz arenites suggests that they are largely the result of tidal deltas extending into back-barrier areas, and owe their genesis to flood currents entering the lagoon through tidal inlets and channels. The thin-bedded shales and siltstones, interbedded lenticular coals, and fine-grained, ripple-marked sandstones, into which the quartz arenites tongue out to the southeast, represent principally back-barrier lagoonal, marsh, and tidal-flat sediments. Further southeastward, with the increase of alluvial sandstones and relatively thicker and more persistent coal beds, the depositional environment gradually changes southeastward from lower delta to upper delta to alluvial plain.

The paleogeography shown by the lithofacies map is true only in a general sense, and represents the relative position of environments during the deposition of approximately 1300 to 1500 feet of Lower Pennsylvanian sediments. As illustrated by the graphic sections (Plates 2, 3, 4), in contrast with the previous environmental systems, the Lee sea had several transgressive and regressive phases. The lateral and vertical distribution of the Lee quartz arenites shown on the isoliths and graphic sections show that at least three advances of the sea took place during Lee time, producing the three quartz arenite members. The landward invasions, however, were less extensive during each successive advance.

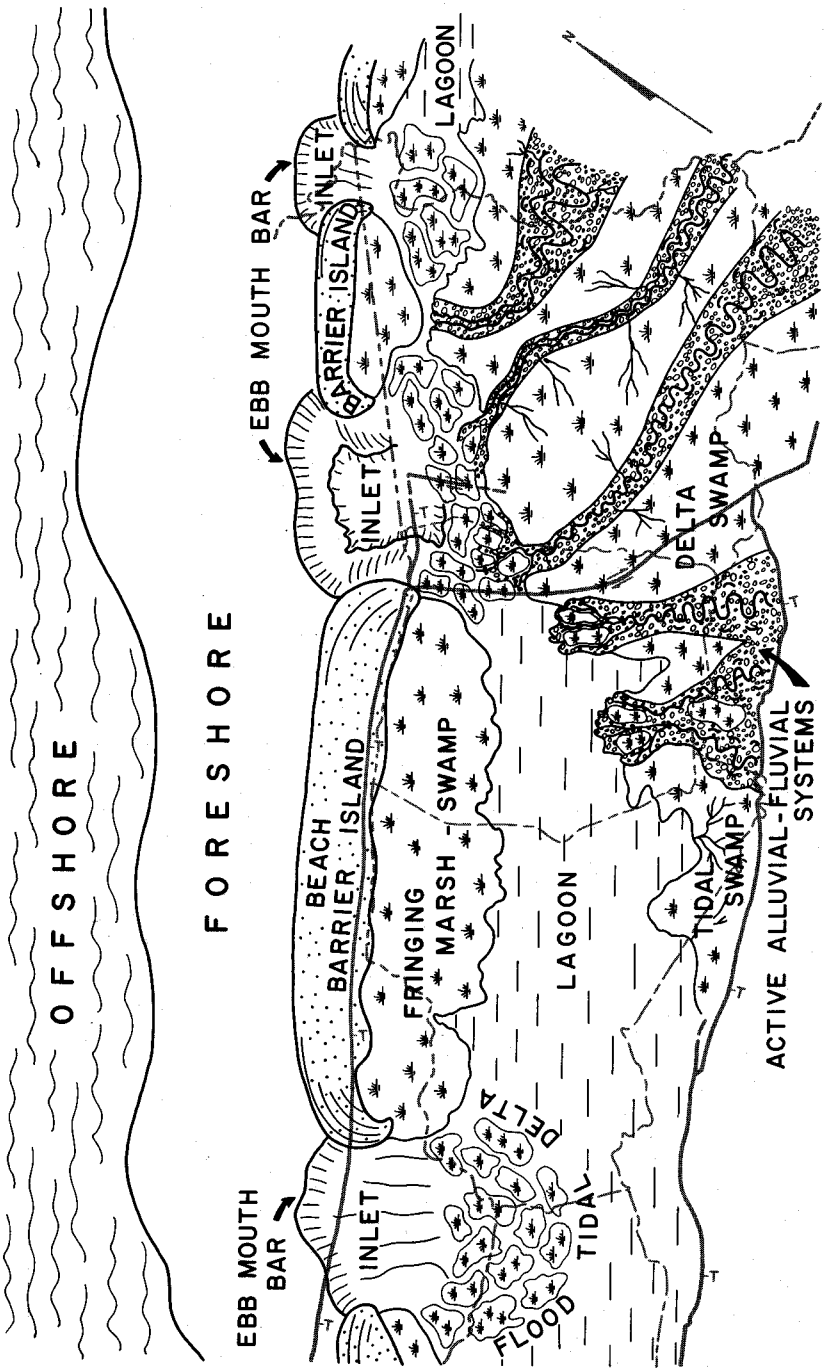


Figure 59. Hypothetical model illustrating paleogeography during Lee deposition.

The extensive distribution of the basal Lee quartz arenite member (Figure 43) illustrates that the initial landward advance of the marine waters inundated a structurally controlled pre-Lee topography (Figure 56) and deposited coarse sand and some coarser material over hundreds of square miles. Once established, the position of the Lee sea was controlled by the rate of influx of sediments brought in by streams and rivers from the east and southeast, and by the rate of subsidence in the areas of deposition. After the initial onlap, successive landward advances of high-energy environment were principally in the form of tidal deltas protruding into back-barrier lagoons and tidal-flats. The bedding features and general characteristics previously described resemble those established for tidal delta and barrier deposits in the recent studies of Kanes (1969); Davis, Ethridge, and Berg (1971); Ferm, Horne, Swinchatt, and Whaley (1971); Kraft (1971); Dickinson, Berryhill, and Holmes (1972); and Ferm, Milici, and Eason (1972). Among the most diagnostic characteristics are sharp basal contacts, the coarse and conglomeratic nature of the basal beds, and planar and festoon cross-bedding with a principal landward dip, but with several other directions present.

The only feature that is difficult to explain is the absence of shelly fossils. This characteristic, however, is generally typical of Pottsville quartz arenites described as tidal sediments. Ferm, Swinchatt, and Horne (1971, p. 19) reported the occurrence of molds and casts of marine fossils in Lee beach-barrier deposits in Carter County, Kentucky. Normally, the only fossils found in these sands are sparsely distributed plant fragments. Galloway (1972, p. 19-20) attributed the absence of marine invertebrate fossils to the destruction of carbonate material by ground waters and pointed out that the lack of shell fragments in apparent marine rocks, particularly adjacent to a detritus-rich, coal-forming depositional sequence, is not unusual in Pennsylvanian rocks or similar Cretaceous sediments.

The environmental patterns developed during Lee time (Figures 58, 59) were controlling factors in the distribution of the Lee coals. In general, the coals in the northwestern portion of the study area are limited by high-energy beach and tidal-delta environments, whereas in the southeastern portion the coals are limited by major streams of the alluvial plain facies. The Lower Horsepen coal in Buchanan County shown in Figure 51 illustrates this penomenon very well. The area in which the

coal is absent in southeastern Buchanan County roughly parallels two areas of major alluvial channel systems shown on Figure 58. The area in which the coal is absent in the north parallels the high-energy beach and tidal-delta areas. The thicker accumulations of Lower Horsepen coal appear to be concentrated in the areas of low-energy environment which also roughly coincides with those shown on Figure 58.

During the deposition of the War Creek coal (Figure 52), the swamp area was more widespread in Buchanan County. The absence of the coal in the north outlines an area that strikingly resembles the areal geometry of a tidal delta. The thicker accumulations of the coal in the north occur in areas which outline the perimeter of the tidal delta. The environmental conditions present during the deposition of the Upper Horsepen coal (Figure 53) appear to be similar to those of the War Creek coal.

Distribution maps of the Tiller and Jawbone coal beds (Figures 54, 55) in Buchanan County show that the high-energy beach areas were located farther northward and were not as important to the distribution of the coal beds in the Virginia area as was the case with stratigraphically lower coal beds. This observation relates well with the position of the seas during the later stages of Lee time as indicated by the isolith map of the upper quartz arenite member (Figure 45). Stream patterns appear to be the controlling factor relating to the occurrence and distribution of the Tiller and Jawbone coals.

Prediction of the coal beds in the Lee Formation is thus best achieved by reconstructing the paleoenvironments during the deposition of the coals. This is in contrast to the Pocahontas coals in which it has been shown (Figures 24, 26, 27, 28, 29) that the predictability is enhanced by knowing the stratigraphic position of the basal Lee unconformity.

As illustrated by the regional stratigraphic trends of the Lee Formation and equivalent strata, the source area was to the southeast and east. That the source area was made up of rising terrain of predominantly metamorphic and sedimentary rocks is indicated by several factors: the compositional maturity; the well-sorted and well-rounded grains of the Lee quartz arenites; the heavy-mineral suite consisting principally of tourmaline and zircon; fragments of shale, siltstone, quartzite, phyllite, and schist; the 10 to 1 ratio of monocrystalline to polycrystalline

quartz; the scarcity of igneous rock fragments; and the relatively low feldspar content. This generally agrees with regional interpretations by Seiver and Potter (1956), Branson (1962), and Meckel (1967, 1970). It is not entirely clear how the large, well-rounded, vein-quartz pebbles were transported across the continental deposits. The distributary sandstones of the Lee in the southeast and in the underlying Pocahontas Formation contain only minor quantities of pebbles. Bowen (1963) suggested that the pebbles were not transported continuously, but were delivered periodically. A more feasible consideration may be that the pebbles were brought in from a northern cratonic source. According to several regional studies, parts of the Canadian Shield contributed to basal Pennsylvanian sediments (Seiver and Potter, 1956; Branson, 1962; Meckel, 1967, 1970). The roundness of the pebbles indicate that they may have traveled great distances, particularly in relation to the finer grain fractions. The mode of transportation, considering the depositional trend of Pennsylvanian sediments, would have been principally longshore, high-energy currents that trended northeast-southwest.

SUMMARY

The stratigraphic record of Mississippian and Pennsylvanian rocks from the base of the Greenbrier Limestone (Mississippian) to the top of the Lee Formation (Pennsylvanian) can be divided into at least five periods of time.

(1) A generally progradational system in which a large sea regressed northwestward across the Maccrady-Price surface, depositing the Greenbrier, Bluefield, and lower Hinton formations.

(2) Southeastward transgression, the record of which was poorly preserved.

(3) Northwestward regression of the sea, resulting in the deposition of the Little Stone Gap Member, the Princeton interval, the Bluestone Formation, and the Pocahontas Formation.

(4) Continued offlap, then onlap of the Lee Formation resulting in erosion of previously deposited lagoonal-deltaic sediments.

(5) Regional offlap, although oscillations of the sea level established offlap-onlap tongues of Lee quartz arenites in the northwestern study area and lagoonal-deltaic deposits with their associated coals in the southeastern areas.

During these periods the regional tectonic framework remained much the same, being divided into two major elements: an area to the southeast and east of pronounced subsidence and

accumulation of thicker sediments; and a northwestern area of lesser subsidence and thinner sedimentation. During the periods of deposition the sea lay to the northwest and west and either made invasions over eastern land areas, or retreated towards Kentucky. The source area remained predominantly to the southeast and east, and the paleoslope during periods of deposition was normally to the northwest and west.

The recognition of these periods of time within the Carboniferous stratigraphy is essential in evaluating coal, the most valuable natural resource of southwestern Virginia. The occurrence of the highly regarded Pocahontas coal beds can largely be predicted by their stratigraphic relation to the unconformity marking the base of the Lee Formation, but the occurrence of the coal beds above the Pocahontas Formation is more dependent upon paleoenvironmental patterns during the deposition of the Lee quartz arenites.

The Carboniferous rocks were later subjected to strong lateral compressive forces which first produced the broad folds in the area and then the large Cumberland thrust sheet. Palynological studies and comparison of the coal characteristics are evidence that deformation and low-grade metamorphism associated with the compressional stresses is much more obvious in coal beds in flat-lying strata than in strata that have been upturned and folded. Coal beds in the relatively undisturbed rocks tend to be higher in fixed carbon and lower in volatile matter than those in beds that have been displaced in some manner. Subsurface data show additionally that strike-slip faulting, associated with the compressive stresses, offsets the valuable Pocahontas coals at depth.

The most significant stratigraphic conclusions developed during this study are the following: (1) the Pocahontas sequence containing the most valuable coal beds in the area is unconformably overlain by the Lee Formation; (2) the Lee Formation contains three mappable units herein referred to as the upper quartz arenite member, middle quartz arenite member, and lower quartz arenite member; (3) each of the quartz arenite members of the Lee tongues out successively from top to bottom to the southeast; (4) the upper quartz arenite member occurs only in the northwestern portions of Wise, Dickenson, and Buchanan counties; (5) the middle and lower quartz arenite members occur throughout most of Wise, Dickenson, and Bu-

chanan counties and the coal bearing portions of Scott and Russell counties, but cannot be recognized in any portion of Tazewell County; (6) the upper boundary of the Lee Formation is dependent upon the uppermost quartz arenite member that may be present in any specific area; (7) the upper boundary of the Lee Formation in this report is reestablished about 400 feet stratigraphically higher along the northwestern exposures near the Virginia-Kentucky boundary, coinciding with the upper boundary of the Lee Formation in Kentucky; (8) the Pocahontas No. 3 coal bed of the Pocahontas Formation and the War Creek coal of the Lee Formaton appear to have the greatest economic potential.

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APPENDIX

GEOLOGIC SUMMARIES

(Only boreholes used in mapping)

Samples are available for examination in the repository of the Virginia Division of Mineral Resources for those boreholes which have a repository number. INDEX NO. refers to the borehole number shown on Plate 1. The initials G. L. after ELEVATION indicates ground level. Under COALS IDENTIFIED the depth to the top of the coal is given to the nearest whole foot.

BUCHANAN COUNTY, VIRGINIA

CORE NAME: Long Branch INDEX NO. 1
LOCATION: 600 feet S of 37°30′00″
7200 feet E of 82°00′00″
ELEVATION: 1160 feet G. L. TOTAL DEPTH: 1473 feet
COALS IDENTIFIED: Jawbone coal at 506 feet; Tiller coal absent; War Creek coal at 1028 feet; Lower Horsepen coal at 1094 feet; (Kennedy coal estimated at 250 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	165+	165
Lee Formation	1285	1450
Pocahontas Formation	absent	

OPERATOR: United Fuel Gas Company INDEX NO. 2
FARM: National Shawmut Bank of Boston
WELL NO.: 8415-T
LOCATION: 5900 feet S of 37°30′00″
4650 feet W of 82°00′00″
ELEVATION: 1353.65 feet G. L. TOTAL DEPTH: 5567 feet
REPOSITORY NO.: W-286
COALS IDENTIFIED: Dorchester coal at 61 feet; War Creek coal at 1430 feet; Lower Horsepen coal ? at 1439 feet; (Kennedy coal estimated at 520 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	609+	609
Lee Formation	1193	1802
Pocahontas Formation	absent	
Bluestone Formation	287	2089
Pride Shale Member	114	2089

Princeton interval	134	2223
Hinton-Bluefield fms. (undiff.)	624	2847
Little Stone Gap Member	13	2236
Greenbrier Limestone	297	3144

OPERATOR: United Fuel Gas Company INDEX NO. 3
FARM: Zach Justice
WELL NO.: 8835
LOCATION: 7500 feet S of 37°30′00″
11,350 feet E of 82°05′00″
ELEVATION: 1343.51 feet G. L. TOTAL DEPTH: 4915 feet
REPOSITORY NO.: W-445
COALS IDENTIFIED: none; (Kennedy coal estimated at 530 feet; War Creek coal estimated at 1400 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	590+	590
Lee Formation	1240	1830
Pocahontas Formation	absent	
Bluestone Formation	200	2030
Pride Shale Member	70	2030
Princeton interval	129	2159
Hinton-Bluefield fms. (undiff.)	551	2710
Little Stone Gap Member	12	2171
Greenbrier Limestone	361	3071

OPERATOR: United Fuel Gas Company INDEX NO. 4
FARM: Zach Justice
WELL NO.: 8606
LOCATION: 12,650 feet S of 37°30′00″
6200 feet E of 82°05′00″
ELEVATION: 1101.64 feet G. L. TOTAL DEPTH: 4780 feet
REPOSITORY NO.: W-642
COALS IDENTIFIED: Splash Dam coal at 44 feet; (Kennedy coal estimated at 250 feet; War Creek coal estimated at 1160 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	304+	304
Lee Formation	1267	1571
Pocahontas Formation	absent	

Bluestone Formation	219	1790
Pride Shale Member	90	1790
Princeton interval	80	1870
Hinton-Bluefield fms. (undiff.)	552	2422
Little Stone Gap Member	23	1893
Greenbrier Limestone	402	2824

CORE NAME: Buffalo Fork INDEX NO. 5
LOCATION: 4200 feet N of 37°27'30"
4000 feet W of 82°00'00"
ELEVATION: 1200 feet G. L. approximate
TOTAL DEPTH: 1640 feet
COALS IDENTIFIED: Splash Dam coal at 77 feet; Upper Banner coal at 123 feet; Lower Banner coal at 207 feet; Raven coal at 503 feet; Jawbone coal at 570 feet; Tiller coal at 625 feet; Upper Horsepen coal at 962 feet; War Creek coal at 1149 feet; Lower Horsepen coal at 1198 feet; (Kennedy coal estimated at 310 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	356+	356
Lee Formation	1267	1623
Pocahontas Formation	absent	

OPERATOR: United Fuel Gas Company INDEX NO. 6
FARM: National Shawmut Bank of Boston
WELL NO.: 8917
LOCATION: 12,500 feet S of 37°30'00"
250 feet E of 82°00'00"
ELEVATION: 1513.46 feet G. L. TOTAL DEPTH: 5320 feet
REPOSITORY NO.: W-631
COALS IDENTIFIED: Jawbone coal at 820 feet; Lower Horsepen coal at 1510 feet; (War Creek coal estimated at 1400 feet; Kennedy coal estimated at 625 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1100+	1100
Lee Formation	737	1837
Pocahontas Formation	29	1866
Bluestone Formation	318	2184

Pride Shale Member	123	2184
Princeton interval	156	2340
Hinton Formation	220	2560
Little Stone Gap Member	17	2357
Stony Gap Sandstone Member	73	2560
Bluefield Formation	305	2865
Greenbrier Limestone	430	3295

CORE NAME: Guess Fork INDEX NO. 7

LOCATION: 5850 feet S of 37°27′30″
5600 feet E of 82°00′00″

ELEVATION: 1200 feet G. L.
approximate TOTAL DEPTH: 1600 feet

COALS IDENTIFIED: Splash Dam coal at 120 feet; Lower Banner coal at 218 feet; Rocky Fork or Kennedy coal split at 316 feet; Kennedy coal split at 356 feet; Raven coal at 478 feet; Jawbone and Tiller coals absent; Upper Horsepen coal at 891 feet; War Creek coal at 1144 feet; Lower Horsepen coal at 1270 feet; Pocahontas No. 3 coal absent

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	746+	746
Lee Formation	818	1564
Pocahontas Formation	6	1570

CORE NAME: Knox Creek INDEX NO. 8

LOCATION: 6900 feet N of 37°25′00″
1600 feet E of 82°02′30″

ELEVATION: 949 feet G. L. TOTAL DEPTH: 1268 feet

COALS IDENTIFIED: Aily coal at 64 feet; Jawbone coal at 236 feet; Tiller coal at 297 feet; Upper Horsepen coal at 634 feet; War Creek coal at 840 feet; (Kennedy coal is about 50 feet above the location of core site)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	478+	478
Lee Formation	760	1238
Pocahontas Formation	absent	

OPERATOR: United Fuel Gas Company INDEX NO. 9
FARM: Kentland Coal and Coke Company
WELL NO.: 8295-T
LOCATION: 50 feet N of 37°25′00″
5700 feet W of 82°05′00″
ELEVATION: 1241.1 feet G. L. TOTAL DEPTH: 5392 feet
REPOSITORY NO.: W-285
COALS IDENTIFIED: none; (Kennedy coal estimated at 430 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	500+	500
Lee Formation	1222	1722
Pocahontas Formation	absent	
Bluestone Formation	283	2005
Pride Shale Member	135	2005
Princeton interval	30	2035
Hinton Formation	452	2487
Little Stone Gap Member	50	2085
Stony Gap Sandstone Member	99	2487
Bluefield Formation	183	2670
Greenbrier Limestone	433	3103

CORE NAME: Laurel Fork INDEX NO. 10
LOCATION: 1300 feet S of 37°25′00″
2600 feet E of 82°00′00″
ELEVATION 1250 feet G. L.
approximate TOTAL DEPTH: 1597 feet
COALS IDENTIFIED: Lower Banner coal at 44 feet; Kennedy coal at 205 feet; Aily coal at 280 feet; Raven coal splits at 331 feet and 365 feet; Jawbone coal at 447 feet; Tiller coal at 524 feet; Upper Horsepen coal at 885 feet; War Creek coal at 1045 feet; Lower Horsepen coal at 1127 feet; Pocahontas No. 3 coal absent

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	670+	670
Lee Formation	730	1400
Pocahontas Formation	187	1587

CORE NAME: Hoover Camp Branch INDEX NO. 11
LOCATION: 6500 feet N of 37°22′30″
50 feet E of 81°57′30″

ELEVATION: 1440 feet G. L. approximate TOTAL DEPTH: 1690 feet

COALS IDENTIFIED: Kennedy coal at 200 feet; Aily coal at 273 feet; Raven coal splits at 350 feet and 386 feet; Jawbone and Tiller coals absent; Upper Horsepen coal at 957 feet; War Creek coal at 1093 feet; Lower Horsepen coal at 1149 feet; Pocahontas No. 3 coal absent

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	853+	853
Lee Formation	623	1476
Pocahontas Formation	195	1671

CORE NAME: Lester Fork INDEX NO. 12

LOCATION: 4600 feet N of 37°22′30″
3200 feet E of 82°02′30″

ELEVATION: 1200 feet G. L. approximate TOTAL DEPTH: 1510 feet

COALS IDENTIFIED: Kennedy coal at 76 feet; Raven coal at 243 feet; Jawbone coal at 345 feet; Tiller coal at 403 feet; Upper Horsepen coal at 815 feet; War Creek coal absent; Lower Horsepen coal at 1020 feet; Pocahontas No. 3 coal absent

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	650+	650
Lee Formation	669	1319
Pocahontas Formation	184	1503

CORE NAME: Left Fork of Lester Fork INDEX NO. 13

LOCATION: 1500 feet N of 37°22′30″
5800 feet E of 82°02′30″

ELEVATION: 1210 feet G. L. TOTAL DEPTH: 1566 feet

COALS IDENTIFIED: Kennedy coal at 128 feet; Raven coal at 294 feet; Jawbone coal at 400 feet; Tiller coal at 457 feet; Upper Horsepen coal at 854 feet; War Creek coal absent; Lower Horsepen coal at 1065 feet; Pocahontas No. 3 coal absent

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	708+	708
Lee Formation	657	1365
Pocahontas Formation	181	1546

OPERATOR: United Fuel Gas Company INDEX NO. 14
FARM: National Shawmut Bank of Boston
WELL NO.: 5810
LOCATION: 15,000 feet N of 37°20′00″
9850 feet W of 81°55′00″
ELEVATION: 1263.12 feet G. L. TOTAL DEPTH: 5302 feet
REPOSITORY NO.: W-102
COALS IDENTIFIED: War Creek coal at 835 feet; Lower Horsepen coal at 965 feet: (Well located about 40 below the Kennedy coal; Pocahontas No. 3 coal estimated at 1240 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1076+	1076
Lee Formation	136	1212
Pocahontas Formation	226	1438
Bluestone Formation	354	1792
Pride Shale Member	157	1792
Princeton interval	108	1900
Hinton Formation	374	2274
Little Stone Gap Member	48	1948
Stony Gap Sandstone Member	88	2274
Bluefield Formation	452	2726
Greenbrier Limestone	520	3246

CORE NAME: Right Fork INDEX NO. 15
LOCATION: 4650 feet N of 37°20′00″
5100 feet E of 82°00′00″
ELEVATION: 1415 feet G. L.
approximate TOTAL DEPTH: 1593 feet
COALS IDENTIFIED: Kennedy coal at 28 feet; Raven coal at 191 feet; Jawbone coal at 317 feet; Tiller coal at 373 feet; Middle Seaboard coal at 644 feet; Lower Seaboard coal at 672 feet; Upper Horsepen coal at 762 feet; Middle Horsepen coal at 804 feet; War Creek coal at 884 feet; Lower Horsepen coal absent; Pocahontas No. 3 coal at 1352 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1148+	1148
Lee Formation	191	1339
Pocahontas Formation	235	1574

CORE NAME: Lynn Camp INDEX NO. 16

LOCATION: 4750 feet N of 37°20′00″
3400 feet W of 82°05′00″

ELEVATION: 1570 feet G. L.
approximate TOTAL DEPTH: 1845 feet

COALS IDENTIFIED: Splash Dam coal at 165 feet; Kennedy coal at 442 feet; Aily coal at 547 feet; Raven coal at 608 feet; Jawbone coal at 715 feet; Tiller coal at 798 feet; Upper Horsepen coal at 1176 feet; Middle Horsepen coal at 1234 feet; War Creek coal at 1315 feet; Lower Horsepen coal at 1415 feet; Pocahontas No. 3 coal absent

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	993+	993
Lee Formation	700	1693
Pocahontas Formation	96	1789

CORE NAME: Upper Elkins Branch INDEX NO. 17

LOCATION: 2100 feet N of 37°20′00″
2300 feet W of 82°02′30″

ELEVATION: 1700 feet G. L.
approximate TOTAL DEPTH: 2010 feet

COALS IDENTIFIED: Hagy coal at 84 feet; Splash Dam coal at 219 feet; Upper Banner coal at 274 feet; Lower Banner coal at 385 feet; Kennedy coal at 510 feet; Aily coal at 614 feet; Raven coal at 674 feet; Jawbone coal at 793 feet; Tiller coal absent; Middle Seaboard coal at 1119 feet; Lower Seaboard coal at 1164 feet; Upper Horsepen coal at 1254 feet; Middle Horsepen coal at 1309 feet; War Creek coal absent; Lower Horsepen coal at 1499 feet; Pocahontas No. 3 coal absent

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1040+	1040
Lee Formation	773	1813
Pocahontas Formation	184	1997

OPERATOR: Pipe Line Construction and Drilling Company INDEX NO. 18

FARM: F. H. Curtis

WELL NO.: 2-A

LOCATION: 1650 feet N of 37°20′00″
8150 feet W of 82°00′00″

ELEVATION: 2009.8 feet G. L. TOTAL DEPTH: 6453 feet

REPOSITORY NO.: W-5

COALS IDENTIFIED: Blair coal at 20 feet; Hagy coal at 330 feet; Splash Dam coal at 449 feet; Upper Banner coal at 499 feet; Raven coal at 1016 feet; Upper Horsepen coal at 1500 feet; Lower Horsepen coal at 1775 feet; Pocahontas No. 4 coal absent; Pocahontas No. 3 coal absent; (Kennedy coal estimated at 740 feet; War Creek coal estimated at 1634 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1345+	1345
Lee Formation	688	2033
Pocahontas Formation	241	2274
Bluestone Formation	320	2594
Pride Shale Member	131	2594
Princeton interval	286	2880
Hinton Formation	412	3292
Little Stone Gap Member	25	2905
Stony Gap Sandstone Member	62	3292
Bluefield Formation	248	3540
Greenbrier Limestone	467	4007

CORE NAME: Upper Mill Branch INDEX NO. 19

LOCATION: 1450 feet S of 37°20′00″
3250 feet E of 82°02′30″

ELEVATION: 1650 feet G. L.
approximate TOTAL DEPTH: 1915 feet

COALS IDENTIFIED: Splash Dam coal at 57 feet; Upper Banner coal at 115 feet; Lower Banner coal at 227 feet; Kennedy coal at 365 feet; Aily coal at 465 feet; Raven coal at 540 feet; Jawbone coal at 647 feet; Tiller coal absent; Upper Horsepen coal at 1096 feet; War Creek coal at 1234 feet; Lower Horsepen coal at 1391 feet; Pocahontas No. 3 coal absent

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1022+	1022
Lee Formation	684	1706
Pocahontas Formation	200	1906

CORE NAME: Elkins Branch INDEX NO. 20
LOCATION: 4200 feet S of 37°20′00″
4500 feet W of 82°02′30″
ELEVATION: 1475 feet G. L.
approximate TOTAL DEPTH: 1775 feet
COALS IDENTIFIED: Upper Banner coal at 48 feet; Lower Banner coal at 88 feet; Kennedy coal at 226 feet; Aily coal at 310 feet; Jawbone coal at 523 feet; Tiller coal absent; Middle Seaboard coal at 871 feet; Lower Seaboard coal at 902 feet; Upper Horsepen coal at 982 feet; War Creek coal at 1151 feet; Lower Horsepen coal at 1231 feet; Pocahontas No. 3 coal at 1577 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	791+	791
Lee Formation	786	1577
Pocahontas Formation	182	1759

CORE NAME: Old Wolfpen Branch INDEX NO. 21
LOCATION: 300 feet N of 37°20′00″
900 feet W of 82°05′00″
ELEVATION: 1600 feet G. L.
approximate TOTAL DEPTH: 1888 feet
COALS IDENTIFIED: Splash Dam coal at 139 feet; Upper Banner coal at 178 feet; Lower Banner coal at 240 feet; Kennedy coal at 415 feet; Aily coal at 490 feet; Raven coal at 578 feet; Jawbone coal at 719 feet; Tiller coal at 785 feet; Middle Horsepen coal at 1232 feet; War Creek coal at 1315 feet; Lower Horsepen coal at 1416 feet; Pocahontas No. 3 coal at 1721 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	976+	976
Lee Formation	745	1721
Pocahontas Formation	143	1865

CORE NAME: New Wolfpen Branch INDEX NO. 22
LOCATION: 3900 feet S of 37°20′00″
6800 feet E of 82°07′30″
ELEVATION: 1300 feet G. L.
approximate TOTAL DEPTH: 1620 feet
REPOSITORY NO.: W-3081

COALS IDENTIFIED: Kennedy coal at 130 feet; Aily coal at 239 feet; Raven coal at 302 feet; Jawbone coal at 466 feet; Tiller coal at 503 feet; Upper Horsepen coal at 903 feet; Middle Horsepen coal at 966 feet; War Creek coal at 1088 feet; Lower Horsepen coal at 1148 feet; Pocahontas No. 3 coal at 1442 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	649+	649
Lee Formation	793	1442
Pocahontas Formation	164	1606

CORE NAME: Stiltner Creek INDEX NO. 23
LOCATION: 3300 feet S of 37°20′00″
3600 feet W of 82°07′30″
ELEVATION: 1260 feet G. L. approximate TOTAL DEPTH: 1580 feet
COALS IDENTIFIED: Kennedy coal at 183 feet; Aily coal at 286 feet; Raven coal at 341 feet; Jawbone coal at 496 feet; Tiller coal at 538 feet; Upper Horsepen Coal at 928 feet; Middle Horsepen coal at 970 feet; War Creek coal at 1057 feet; Lower Horsepen coal at 1161 feet; Pocahontas No. 3 coal absent

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	682+	682
Lee Formation	767	1449
Pocahontas Formation	47	1496

OPERATOR: United Fuel Gas Company INDEX NO. 24
FARM: Clell Ramey
WELL NO.: 9516
LOCATION: 1500 feet N of 37°20′00″
2800 feet E of 82°15′00″
ELEVATION: 1327.41 feet G. L. TOTAL DEPTH: 3940 feet
REPOSITORY NO.: W-3139
COALS IDENTIFIED: War Creek coal at 1290 feet (Splash Dam coal estimated at 107 feet; Kennedy coal estimated at 357 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	410+	410
Lee Formation	1215	1625

Pocahontas Formation	absent	
Bluestone Formation	413	2038
Pride Shale Member	165	2038
Princeton interval	99	2137
Hinton Formation	396	2533
Stony Gap Sandstone Member	84	2533
Bluefield Formation	142	2675
Greenbrier Limestone	476	3151

OPERATOR: United Fuel Gas Company INDEX NO. 25
FARM: J. G. Belcher
WELL NO.: 9580
LOCATION: 1350 feet S of 37°20′00″
2400 feet W of 82°12′30″
ELEVATION: 1036.33 feet G. L. TOTAL DEPTH: 3687 feet
REPOSITORY NO.: W-3134
COALS IDENTIFIED: Raven coal at 186 feet; War Creek coal at 966 feet; (Kennedy coal estimated at 30 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	90+	90
Lee Formation	1190	1280
Pocahontas Formation	absent	
Bluestone Formation	420	1700
Pride Shale Member	140	1700
Princeton interval	146	1846
Hinton Formation	342	2188
Stony Gap Sandstone Member	47	2188
Bluefield Formation	230	2418
Greenbrier Limestone	385	2803

OPERATOR: Columbia Gas Transmission Corporation INDEX NO. 26
FARM: Joseph L. Elswick
WELL NO.: 9646
LOCATION: 1750 feet S of 37°20′00″
2100 feet E of 82°12′30″
ELEVATION: 1165.82 feet G. L. TOTAL DEPTH: 3860 feet
REPOSITORY NO.: W-3603
COALS IDENTIFIED: None; (Kennedy coal estimated at 205 feet; War Creek coal estimated at 1120 feet)

	Thickness (feet)	Depth to base of unit (feet)
Post-Lee formations	320+	320
Lee Formation	1155	1475
Pocahontas Formation	15	1490
Bluestone Formation	424	1914
Pride Shale Member	214	1914
Princeton interval	110	2024
Hinton Formation	331	2355
Stony Gap Sandstone Member	38	2355
Bluefield Formation	257	2612
Greenbrier Limestone	440	3052

OPERATOR: Columbia Gas Tranmssion Corporation INDEX NO. 27
FARM: Lynn Camp Coal Corporation
WELL NO.: 9639
LOCATION: 2200 feet S of 37°20′00″
6300 feet W of 82°10′00″
ELEVATION: 1613.26 feet G. L. TOTAL DEPTH: 4328 feet
REPOSITORY NO.: W-3601
COALS IDENTIFIED: Splash Dam coal at 371 feet; (Kennedy coal estimated at 630 feet; War Creek coal estimated at 1500 feet)

	Thickness (feet)	Depth to base of unit (feet)
Post-Lee formations	1133+	1133
Lee Formation	746	1879
Pocahontas Formation	70	1949
Bluestone Formation	397	2346
Pride Shale Member	147	2346
Princeton interval	181	2527
Hinton Formation	287	2814
Stony Gap Sandstone Member	30	2814
Bluefield Formation	267	3081
Greenbrier Limestone	432	3513

OPERATOR: United Fuel Gas Company INDEX NO. 28
FARM: Lynn Camp Coal Corporation
WELL NO.: 9590
LOCATION: 700 feet S of 37°20′00″
3800 feet W of 82°20′00″

ELEVATION: 1094.22 feet G. L. TOTAL DEPTH: 3815 feet
REPOSITORY NO.: W-3138
COALS IDENTIFIED: Kennedy coal at 98 feet; Jawbone coal at 388 feet; War Creek coal at 965 feet; Lower Horsepen coal at 1060 feet; Pocahontas No. 3 coal absent

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	170+	170
Lee Formation	1220	1390
Pocahontas Formation	absent	
Bluestone Formation	461	1851
Pride Shale Member	107	1851
Princeton interval	98	1949
Hinton Formation	423	2372
Stony Gap Sandstone Member	126	2372
Bluefield Formation	176	2548
Greenbrier Limestone	440	2988

OPERATOR: Columbia Gas Transmission Corporation INDEX NO. 29
FARM: Lynn Camp Coal Corporation
WELL NO.: 9640
LOCATION: 4500 feet S of 37°20′00″
3500 feet W of 82°10′00″
ELEVATION: 1328.98 feet G. L. TOTAL DEPTH: 4213 feet
REPOSITORY NO.: W-3602
COALS IDENTIFIED: Kennedy coal at 294 feet; (War Creek coal estimated at 1140 feet); Pocahontas No. 3 coal absent

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	380+	380
Lee Formation	1162	1542
Pocahontas Formation	not determined	
Bluestone Formation	?	2033
Pride Shale Member	263	2033
Princeton interval	135	2168
Hinton Formation	338	2506
Stony Gap Sandstone Member	34	2506
Bluefield Formation	273	2779
Greenbrier Limestone	396	3175

OPERATOR: United Fuel Gas Company INDEX NO. 30
FARM: Lydia Belcher
WELL NO.: 9517
LOCATION: 900 feet S of 37°20′00″
1250 feet E of 82°15′00″
ELEVATION: 1360.47 feet G. L. TOTAL DEPTH: 4055 feet
REPOSITORY NO.: W-3114
COALS IDENTIFIED: None; (Kennedy coal estimated at 390 feet; War Creek coal estimated at 1322 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	429+	429
Lee Formation	1228	1657
Pocahontas Formation	absent	
Bluestone Formation	404	2061
Pride Shale Member	134	2061
Princeton interval	165	2226
Hinton Formation	393	2619
Stony Gap Sandstone Member	129	2619
Bluefield Formation	178	2797
Greenbrier Limestone	428	3225

OPERATOR: United Fuel Gas Company INDEX NO. 31
FARM: Robert and David Bell
WELL NO.: 9518
LOCATION: 6500 feet S of 37°21′00″
4850 feet E of 82°15′00″
ELEVATION: 1277.2 feet G. L. TOTAL DEPTH: 3947 feet
REPOSITORY NO.: W-3135
COALS IDENTIFIED: Upper Banner coal at 62 feet; Lower Banner coal at 98 feet; Kennedy coal at 204 feet; (War Creek coal estimated at 1111 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	238+	238
Lee Formation	1257	1495
Pocahontas Formation	absent	
Bluestone Formation	390	1885
Pride Shale Member	169	1885
Princeton interval	156	2041
Hinton-Bluefield fms. (undiff.)	558	2599
Greenbrier Limestone	399	2998

OPERATOR: Columbia Gas Transmission Corporation INDEX NO. 32
FARM: Robert and David Bell
WELL NO.: 9636
LOCATION: 5600 feet N of 37°17′30″
5800 feet E of 82°15′00″
ELEVATION: 1562.08 feet G. L. TOTAL DEPTH: 4184 feet
REPOSITORY NO.: W-3320
COALS IDENTIFIED: Splash Dam coal at 232 feet (Kennedy coal estimated at 530 feet; War Creek coal estimated at 1570 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	991+	991
Lee Formation	816	1807
Pocahontas Formation	absent	
Bluestone Formation	425	2232
Pride Shale Member	160	2232
Princeton interval	133	2365
Hinton Formation	339	2704
Stony Gap Sandstone Member	24	2704
Bluefield Formation	254	2958
Greenbrier Limestone	411	3369

OPERATOR: United Fuel Gas Company INDEX NO. 33
FARM: George C. Charles
WELL NO.: 9591
LOCATION: 2250 feet N of 37°17′30″
3250 feet W of 82°12′30″
ELEVATION: 1587.12 feet G. L. TOTAL DEPTH: 4250 feet
REPOSITORY NO.: W-3133
COALS IDENTIFIED: Hagy coal at 128 feet; (Kennedy coal estimated at 520 feet; War Creek coal estimated at 1440 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	618+	618
Lee Formation	1114	1732
Pocahontas Formation	absent	
Bluestone Formation	548	2280
Pride Shale Member	170	2280
Princeton interval	110	2390
Hinton Formation	422	2812

Little Stone Gap Member	20	2410
Stony Gap Sandstone Member	107	2812
Bluefield Formation	183	2995
Greenbrier Limestone	454	3449

OPERATOR: United Fuel Gas Company INDEX NO. 34
FARM: The Pittston Company
WELL NO.: 9584-A
LOCATION: 7300 feet N of 37°17′30″
2250 feet W of 82°15′00″
ELEVATION: 1408.67 feet G. L. TOTAL DEPTH: 4025 feet
REPOSITORY NO.: W-3280
COALS IDENTIFIED: Kennedy coal at 165 feet; War Creek coal at 1121 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	205+	205
Lee Formation	1237	1442
Pocahontas Formation	absent	
Bluestone Formation	411	1853
Pride Shale Member	185	1853
Princeton interval	147	2000
Hinton Formation	595	2595
Stony Gap Sandstone Member	140	2595
Bluefield Formation	134	2729
Greenbrier Limestone	492	3221

Pine Mountain fault zone (at depth 2525-2532 feet)

OPERATOR: Columbia Gas Transmission Corporation INDEX NO. 35
FARM: The Pittston Company
WELL NO.: 9637
LOCATION: 3100 feet N of 37°17′30″
3600 feet W of 82°15′00″
ELEVATION: 1702.39 feet G. L. TOTAL DEPTH: 4340 feet
REPOSITORY NO.: W-3318
COALS IDENTIFIED: Hagy coal at 175 feet; Splash Dam coal at 287 feet; Kennedy coal at 558 feet; War Creek coal at 1528 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	660+	660
Lee Formation	1164	1824

Pocahontas Formation	41	1865
Bluestone Formation	446	2311
Pride Shale Member	193	2311
Princeton interval	130	2441
Hinton Formation	355	2796
Stony Gap Sandstone Member	19	2796
Bluefield Formation	268	3064
Greenbrier Limestone	477	3541

OPERATOR: Clinchfield Coal Company INDEX NO. 36
FARM: Big Sandy Fuel Corporation
WELL NO.: 213
LOCATION: 14,300 feet N of 37°15′00″
1500 feet E of 82°15′00″
ELEVATION: 1620 feet G. L. TOTAL DEPTH: 5650 feet
REPOSITORY NO.: W-331
COALS IDENTIFIED: Hagy coal at 112 feet; Splash Dam coal at 230 feet; (Kennedy coal estimated at 500 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	664+	664
Lee Formation	1154	1818
Pocahontas Formation	absent	
Bluestone Formation	433	2251
Pride Shale Member	156	2251
Princeton interval	167	2418
Hinton-Bluefield fms. (undiff.)	599	3017
Little Stone Gap Member	14	2432
Greenbrier Limestone	487	3504

OPERATOR: United Fuel Gas Company INDEX NO. 37
FARM: The Pittston Company
WELL NO.: 9583
LOCATION: 2800 feet S of 37°17′30″
4250 feet W of 82°15′00″
ELEVATION: 1579.77 feet G. L. TOTAL DEPTH: 4241 feet
REPOSITORY NO.: W-3262
COALS IDENTIFIED: Hagy coal at 33 feet; Splash Dam coal at 74 feet; Kennedy coal at 388 feet; (War Creek coal estimated at 1370 feet)

	Thickness (feet)	Depth to base of unit (feet)
Post-Lee formations	490+	490
Lee Formation	1241	1731
Pocahontas Formation	absent	
Bluestone Formation	466	2197
Pride Shale Member	257	2197
Princeton interval	68	2265
Hinton-Bluefield fms. (undiff.)	550	2815
Greenbrier Limestone	524	3339

OPERATOR: Columbia Gas Transmission Corporation INDEX NO. 38
FARM: The Pittston Company
WELL NO.: 9635
LOCATION: 2550 feet S of 37°17′30″
3900 feet E of 82°15′00″
ELEVATION: 1888.24 feet G. L. TOTAL DEPTH: 4587 feet
REPOSITORY NO.: W-3319
COALS IDENTIFIED: None; (Kennedy coal estimated at 840 feet; War Creek coal estimated at 1800 feet)

	Thickness (feet)	Depth to base of unit (feet)
Post-Lee formations	931+	931
Lee Formation	1104	2035
Pocahontas Formation	50?	2085?
Bluestone Formation	525	2610
Pride Shale Member	154	2610
Princton interval	118	2728
Hinton Formation	365	3093
Stony Gap Sandstone Member	61	3093
Bluefield Formation	193	3286
Greenbrier Limestone	531	3817

OPERATOR: United Fuel Gas Company INDEX NO. 39
FARM: Bull Creek Coal Company
WELL NO.: 9582
LOCATION: 1500 feet S of 37°17′30″
2100 feet W of 82°10′00″
ELEVATION: 1307.71 feet G. L. TOTAL DEPTH: 5600 feet
REPOSITORY NO.: W-3059

COALS IDENTIFIED: Pocahontas No. 3 coal at 1451 feet; (Kennedy coal estimated at 151 feet; War Creek coal estimated at 1031 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	711+	711
Lee Formation	730	1441
Pocahontas Formation	145	1586
Bluestone Formation	400	1986
Princeton interval	185	2171
Hinton-Bluefield fms. (undiff.)	645	2816
Little Stone Gap Member	20	2191
Greenbrier Limestone	460	3276

OPERATOR: Columbia Gas Transmission Corporation INDEX NO. 40

FARM: The Pittston Company

WELL NO.: 9645

LOCATION: 5950 feet N of 37°15′00″
7600 feet E of 82°15′00″

ELEVATION: 1732 feet G. L. TOTAL DEPTH: 4582 feet

REPOSITORY NO.: W-3606

COALS IDENTIFIED: None; (Kennedy coal estimated at 700 feet; War Creek coal estimated at 1640 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1283+	1283
Lee Formation	698	1981
Pocahontas Formation	53	2034
Bluestone Formation	508	2542
Pride Shale Member	208	2542
Princeton interval	168	2710
Hinton Formation	444	3154
Stony Gap Sandstone Member	146	3154
Bluefield Formation	130	3284
Greenbrier Limestone	536	3820

OPERATOR: Columbia Gas Transmission Corporation INDEX NO. 41

FARM: The Pittston Company

WELL NO.: 9643

LOCATION: 4500 feet N of 37°15′00″
3850 feet E of 82°15′00″

ELEVATION: 1599.33 feet G. L. TOTAL DEPTH: 4472 feet

REPOSITORY NO.: W-3379

COALS IDENTIFIED: Splash Dam coal at 277 feet; War Creek coal at 1590 feet; (Kennedy coal estimated at 620 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	665+	665
Lee Formation	1188	1853
Pocahontas Formation	30?	1883
Bluestone Formation	675	2558
Pride Shale Member	325	2558
Princeton interval	36	2594
Hinton Formation	364	2958
Stony Gap Sandstone Member	49	2958
Bluefield Formation	240	3198
Greenbrier Limestone	501	3699

OPERATOR: Columbia Gas Transmission Corporation INDEX NO. 42

FARM: H. Claude Pobst

WELL NO.: 9638

LOCATION: 6700 feet N of 37°17′30″
5100 feet E of 82°07′30″

ELEVATION: 1163.16 feet G. L. TOTAL DEPTH: 4056 feet

COALS IDENTIFIED: War Creek coal at 996 feet; (Kennedy coal estimated to be about 15 feet above well location; Pocahontas No. 3 coal estimated at 1268 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Lee Formation	1244+	1244
Pocahontas Formation	204	1448
Bluestone Formation	390	1838
Pride Shale Member	238	1838
Princeton interval	194	2032
Hinton Formation	396	2428
Stony Gap Sandstone Member	36	2428
Bluefield Formation	276	2704
Greenbrier Limestone	500	3204

CORE NAME: Six and Twenty Mile INDEX NO. 43

LOCATION: 50 feet S of 37°17'30"
4000 feet E of 82°07'30"

ELEVATION: 1550 feet G. L.
approximate TOTAL DEPTH: 1835 feet

COALS IDENTIFIED: Kennedy coal at 289 feet; Aily coal at 379 feet; Jawbone coal splits at 576 feet and 613 feet; Tiller coal at 672 feet; Upper Horsepen coal at 1079 feet; War Creek coal at 1220 feet; Lower Horsepen coal at 1348 feet; Pocahontas No. 3 coal at 1648 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	870+	870
Lee Formation	746	1616
Pocahontas Formation	196	1812

CORE NAME: Lower Mill Branch INDEX NO. 44

LOCATION: 4950 feet N of 37°17'30"
600 feet E of 82°05'00"

ELEVATION: 1550 feet G. L.
approximate TOTAL DEPTH: 1872 feet

COALS IDENTIFIED: Splash Dam coal at 75 feet; Upper Banner coal at 139 feet; Lower Banner coal at 187 feet; Kennedy coal at 317 feet; Aily coal at 410 feet; Raven coal at 493 feet; Jawbone coal at 650 feet; Tiller coal at 704 feet; Upper Horsepen coal at 1092 feet; War Creek coal at 1290 feet; Lower Horsepen coal at 1418 feet; Pocahontas No. 3 coal at 1672 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	888+	888
Lee Formation	761	1649
Pocahontas Formation	210	1859

CORE NAME: Slate Creek INDEX NO. 45

LOCATION: 2400 feet N of 37°17'30"
3000 feet E of 82°02'30"

ELEVATION: 1220 feet G. L.
approximate TOTAL DEPTH: 1465 feet

COALS IDENTIFIED: Jawbone coal at 117 feet; Tiller coal at 182 feet; Upper Horsepen coal at 583 feet; War Creek coal at 790 feet; Pocahontas No. 3 coal at 1209 feet; (Kennedy coal estimated at about 180 feet above core site)

	Thickness (feet)	Depth to base of unit (feet)
Post-Lee formations	855+	855
Lee Formation	352	1207
Pocahontas Formation	249	1456

OPERATOR: Pipe Line Construction and Drilling Company INDEX NO. 46
FARM: A. L. Powers
WELL NO.: 1
LOCATION: 10,650 feet N of 37°15′00″
8700 feet E of 82°05′00″
ELEVATION: 1509.25 feet G. L. TOTAL DEPTH: 3725 feet
REPOSITORY NO.: W-2
COALS IDENTIFIED: Kennedy coal at 40 feet; Pocahontas No. 3 coal at 1375 feet; (War Creek coal estimated at 960 feet)

	Thickness (feet)	Depth to base of unit (feet)
Post-Lee formations	562+	562
Lee Formation	798	1360
Pocahontas Formation	230	1590
Bluestone Formation	470	2060
Pride Shale Member	290	2060
Princeton interval	58	2118
Hinton Formation	503	2621
Little Stone Gap Member	67	2185
Stony Gap Sandstone Member	84	2621
Bluefield Formation	439	3060
Greenbrier Limestone	450	3510

OPERATOR: Pipe Line Construction and Drilling Company INDEX NO. 47
FARM: F. H. Curtis
WELL NO.: 1-B
LOCATION: 250 feet N of 37°15′00″
LOCATION: 10,550 feet W of °05′00″
ELEVATION: 1208.5 feet derrick floor TOTAL DEPTH: 5751 feet
REPOSITORY NO.: W-4
COALS IDENTIFIED: Pocahontas No. 4 coal at 1280 feet; Pocahontas No. 3 coal at 1309 feet; (Kennedy coal estimated to be about 116 feet above well location; War Creek coal estimated at 880 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	465+	465
Lee Formation	811	1276
Pocahontas Formation	228	1504
Bluestone Formation	430	1934
Pride Shale Member	234	1934
Princeton interval	116	2050
Hinton Formation	395	2504
Little Stone Gap Member	59	2109
Stony Gap Sandstone Member	144	2504
Bluefield Formation	556	3060
Greenbrier Limestone	344	3404

OPERATOR: United Producing Company, Inc. INDEX NO. 48

FARM: Lon B. Rodgers

WELL NO.: 14-2694

LOCATION: 4300 feet S of 37°20′00″
4500 feet E of 81°55′00″

ELEVATION: 2364 feet G. L. TOTAL DEPTH: 5226 feet

REPOSITORY NO.: W-280

COALS IDENTIFIED: Splash Dam coal at 292 feet; Kennedy coal at 649 feet; Raven coal at 838 feet; Pocahontas No. 5 coal at 2040 feet; Pocahontas No. 4 coal at 2160 feet; Pocahontas No. 3 coal at 2176 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1931+	1931
Lee Formation	100	2031
Pocahontas Formation	425	2456
Bluestone Formation	307	2763
Pride Shale Member	92	2763
Princeton interval	192	2955
Hinton Formation	448	3403
Little Stone Gap Member	69	3024
Stony Gap Sandstone Member	166	3403
Bluefield Formation	657	4060
Greenbrier Limestone	469	4529

OPERATOR: United Producing Company, Inc. INDEX NO. 49
FARM: Clinchfield Coal Corporation
WELL NO.: 6-2940
LOCATION: 7050 feet S of 37°20′00″
11,000 feet E of 81°50′00″
ELEVATION: 2034.7 feet G. L. TOTAL DEPTH: 4843 feet
REPOSITORY NO.: W-401
COALS IDENTIFIED: Kennedy coal at 40 feet; Jawbone coal at 390 feet; Tiller coal at 420 feet; Pocahontas No. 5 coal at 1534 feet; Pocahontas No. 4 coal at 1602 feet; Pocahontas No. 3 coal at 1677 feet; (War Creek coal estimated at 1120 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1426+	1426
Lee Formation	107	1533
Pocahontas Formation	447	1980

OPERATOR: United Producing Company, Inc. INDEX NO. 50
FARM: Pocahontas Mining Corporation
WELL NO.: 2-2415
LOCATION: 7250 feet N of 37°15′00″
9000 feet W of 81°50′00″
ELEVATION: 2202.02 feet G. L. TOTAL DEPTH: 5008 feet
REPOSITORY NO.: W-126
COALS IDENTIFIED: None

	Thickness (feet)	*Depth to base of unit (feet)*
Bluestone Formation	428+	2449
Pride Shale Member	210	2449
Princeton interval	140	2589
Hinton Formation	474	3063
Little Stone Gap Member	79	2668
Stony Gap Sandstone Member	125	3063
Bluefield Formation	532	3595
Greenbrier Limestone	762	4357

CORE NAME: Linn Camp Branch INDEX NO. 51
LOCATION: 5500 feet N of 37°15′00″
2900 feet E of 82°52′30″
ELEVATION: 2060 feet G. L. TOTAL DEPTH: 1743 feet

COALS IDENTIFIED: Raven coal at 61 feet; Jawbone coal at 227 feet; Tiller coal at 260 feet; Middle Seaboard coal at 662 feet; Lower Seaboard coal at 704 feet; Upper Horsepen coal at 849 feet; War Creek coal at 958 feet; Pocahontas No. 6 coal at 1363 feet; Pocahontas No. 5 coal at 1406 feet; Pocahontas No. 4 coal at 1528 feet; Pocahontas No. 3 coal at 1559 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1243+	1243
Lee Formation	92	1335
Pocahontas Formation	407+	?

OPERATOR: United Fuel Gas Company INDEX NO. 52

FARM: Pocahontas Mining Corporation

WELL NO.: 9140-T

LOCATION: 1200 feet N of 37°15′00″
7700 feet E of 81°50′00″

ELEVATION: 1962.28 feet G. L. TOTAL DEPTH: 5030 feet

REPOSITORY NO.: W-717

COALS IDENTIFIED: Jawbone coal at 170 feet; Tiller coal at 202 feet; Greasy Creek coal at 613 feet; Middle Seaboard coal at 677 feet; Upper Horsepen coal at 880 feet; Middle Horsepen coal at 903 feet; War Creek coal at 1032 feet; Pocahontas No. 9 coal at 1229 feet; Pocahontas No. 8 coal at 1256 feet; Pocahontas No. 6 coal at 1415 feet; Pocahontas No. 4 coal at 1531 feet; Pocahontas No. 3 coal at 1598 feet; (Kennedy coal estimated at 170 feet above well)

	Thickness (feet)	*Depth to base of unit (feet)*
New River Formation	1270+	1270
Pocahontas Formation	520	1790
Bluestone Formation	360	2150
Pride Shale Member	230	2150
Princeton interval	240	2390
Hinton Formation	693	3123
Little Stone Gap Member	40	2430
Stony Gap Sandstone Member	71	3123
Bluefield Formation	330	3453
Greenbrier Limestone	836	4289

OPERATOR: Pipe Line Construction and Drilling Company INDEX NO. 53
FARM: R. J. Carlson
WELL NO.: 1
LOCATION: 650 feet N of 37°15′00″
4000 feet W of 81°55′00″
ELEVATION: 2122.62 feet G. L. TOTAL DEPTH: 4731 feet
REPOSITORY NO.: W-1
COALS IDENTIFIED: Lower Banner coal at 70 feet; Kennedy coal at 243 feet; Pocahontas No. 3 coal at 1900 feet; (War Creek coal estimated at 1360 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1700+	1700
Lee Formation	60	1760
Pocahontas Formation	450	2210
Bluestone Formation	465	2675
Pride Shale Member	280	2675
Princeton interval	123	2798
Hinton Formation	722	3520
Little Stone Gap Member	42	2840
Stony Gap Sandstone Member	129	3520
Bluefield Formation	410	3930
Greenbrier Limestone	554	4484

Virginia Pocahontas Mine No. 2 air shaft INDEX NO. 54
LOCATION: 1000 feet S of 37°15′00″
1150 feet E of 81°57′30″
ELEVATION: 1449 feet G. L. TOTAL DEPTH: 1351 feet
COALS IDENTIFIED: Jawbone coal at 43 feet; Tiller coal at 77 feet; Greasy Creek coal at 434 feet; Middle Seaboard coal at 481 feet; Lower Seaboard coal at 524 feet; Upper Horsepen coal at 611 feet; Middle Horsepen coal at 671 feet; War Creek coal at 794 feet; Lower Horsepen coal at 943 feet; Pocahontas No. 9 coal at 1005 feet; Pocahontas No. 6 coal at 1230 feet; Pocahontas No. 3 coal at 1342 feet; Pocahontas No. 4 and No. 5 coals absent

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1093+	1093
Lee Formation	134	1227
Pocahontas Formation	124+	?

Virginia Pocahontas Mine No. 1 shaft INDEX NO. 55
LOCATION: 2900 feet S of 37°15′00″
3850 feet E of 82°02′30″
ELEVATION: 1201 feet G. L. TOTAL DEPTH: 1184 feet
COALS IDENTIFIED: Upper Horsepen coal at 467 feet; Middle Horsepen coal at 528 feet; War Creek coal at 644 feet; Lower Horsepen coal at 763 feet; Pocahontas No. 6 coal at 1027 feet; Pocahontas No. 4 coal at 1107 feet; Pocahontas No. 3 coal at 1152 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	939+	939
Lee Formation	88	1027
Pocahontas Formation	170+	?

OPERATOR: United Producing Company, Inc. INDEX NO. 56
FARM: Yukon Pocahontas Coal Company
WELL NO.: 1-1454
LOCATION: 5000 feet S of 37°15′00″
9100 feet E of 82°05′00″
ELEVATION: 1206 feet G. L. TOTAL DEPTH: 6271 feet
REPOSITORY NO.: W-7
COALS IDENTIFIED: War Creek coal at 629 feet; Pocahontas No. 3 coal at 1105 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	864+	864
Lee Formation	119	983
Pocahontas Formation	351	1334
Bluestone Formation	415	1749
Pride Shale Member	152	1749
Princeton interval	152	1901
Hinton Formation	610	2511
Little Stone Gap Member	86	1987
Stony Gap Sandstone Member	27	2511
Bluefield Formation	279	2790
Greenbrier Limestone	695	3485

OPERATOR: United Fuel Gas Company INDEX NO. 57
FARM: The Pittston Company
WELL NO.: 9586
LOCATION: 850 feet S of 37°15′00″
7000 feet W of 82°10′00″

ELEVATION: 1549.99 feet G. L. TOTAL DEPTH: 4511 feet

REPOSITORY NO.: W-3110

COALS IDENTIFIED: Observed Splash Dam coal seam about 5 feet above well location while visiting well site; (Kennedy coal estimated at 330 feet; War Creek coal estimated at 1270 feet; Pocahontas No. 3 coal estimated at 1700 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	908+	908
Lee Formation	791	1699
Pocahontas Formation	141?	1840?
Bluestone Formation	393	2233
Pride Shale Member	184	2233
Princeton interval	96	2329
Hinton Formation	412	2741
Stony Gap Sandstone Member	121	2741
Bluefield Formation	401	3142
Greenbrier Limestone	513	3655

OPERATOR: Clinchfield Coal Company INDEX NO. 58

FARM: M. J. Wood and Charles Deel

WELL NO.: 125

LOCATION: 14,700 feet N of 37°10′00″
5700 feet E of 82°15′00″

ELEVATION: 1424.1 feet G. L. TOTAL DEPTH: 3748 feet

COALS IDENTIFIED: Upper Banner coal at 54 feet; Raven coal at 490 feet; Jawbone coal at 603 feet; Tiller coal at 724 feet; Pocahontas No. 3 coal at 1660 feet; (Kennedy coal estimated at 290 feet; War Creek coal estimated at 1290 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	880+	880
Lee Formation	764	1644
Pocahontas Formation	178	1822
Bluestone Formation	530	2352
Princeton interval	15	2367
Hinton-Bluefield fms. (undiff.)	765	3132
Little Stone Gap Member	77	2444
Greenbrier Limestone	596	3728

OPERATOR: United Fuel Gas Company INDEX NO. 59
FARM: The Pittston Company
WELL NO.: 9587
LOCATION: 200 feet N of 37°12′30″
1800 feet W of 82°12′30″
ELEVATION: 1475.9 feet G. L. TOTAL DEPTH: 5860 feet
REPOSITORY NO.: W-3082
COALS IDENTIFIED: Upper Banner coal at 57 feet; Lower Banner coal at 126 feet; Pocahontas No. 3 coal at 1680 feet (Kennedy coal estimated at 340 feet; War Creek coal estimated at 1310 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	907+	907
Lee Formation	705	1612
Pocahontas Formation	288	1900
Bluestone Formation	445	2345
Pride Shale Member	180	2345
Princeton interval	65	2410
Hinton Formation	512	2922
Little Stone Gap Member	35	2445
Stony Gap Sandstone Member	42	2922
Bluefield Formation	283	3205
Greenbrier Limestone	508	3713

CORE NAME: Shortridge Branch INDEX NO. 60
LOCATION: 9000 feet N of 37°10′00″
1150 feet W of 82°05′00″
ELEVATION: 1390 feet G. L. approximate TOTAL DEPTH: 1342 feet
COALS IDENTIFIED: Jawbone coal splits at 53 feet and 91 feet; Tiller coal splits at 165 and 172 feet; Upper Horsepen coal at 623 feet; Middle Horsepen coal at 687 feet; War Creek coal at 815 feet; Lower Horsepen coal at 921 feet; Pocahontas No. 9 coal at 956 feet; Pocahontas No. 5 coal at 1216 feet; Pocahontas No. 4 coal at 1286 feet; Pocahontas No. 3 coal at 1307 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	346+	346
Lee Formation	870	1216
Pocahontas Formation	126+	?

CORE NAME: Three Fork Branch INDEX NO. 61
LOCATION: 6650 feet N of 37°10′00″
4800 feet E of 82°05′00″
ELEVATION: 1680 feet G. L. approximate TOTAL DEPTH: 1545 feet
COALS IDENTIFIED: Aily coal at 47 feet; Raven coal at 110 feet; Jawbone coal splits at 253 feet and 299 feet; Tiller coal at 391 feet; Greasy Creek Coal at 639 feet; Middle Seaboard coal at 735 feet; Lower Seaboard coal at 771 feet; Upper Horsepen coal at 882 feet; Middle Horsepen coal at 926 feet; War Creek coal at 1019 feet; Lower Horsepen coal at 1174 feet; Pocahontas No. 9 coal at 1226 feet; Pocahontas No. 6 coal at 1406 feet; Pocahontas No. 5 coal splits at 1445 feet and 1454 feet; Pocahontas No. 4 coal at 1495 feet; Pocahontas No. 3 coal at 1534 feet; (Kennedy coal estimated at about 95 feet above core site)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1312+	1312
Lee Formation	90	1402
Pocahontas Formation	143+	?

CORE NAME: Rattlesnake Branch INDEX NO. 62
LOCATION: 4800 feet N of 37°10′00″
2400 feet W of 82°05′00″
ELEVATION: 1640 feet G. L. approximate TOTAL DEPTH: 1645 feet
COALS IDENTIFIED: Aily coal at 48 feet; Raven coal at 114 feet; Jawbone coal splits at 247 feet and 306 feet; Tiller coal splits at 365 feet and 375 feet; Greasy Creek coal at 615 feet; Upper Horsepen coal at 835 feet; Middle Horsepen coal at 903 feet; War Creek coal at 996 feet; Lower Horsepen coal at 1135 feet; Pocahontas No. 5 coal at 1446 feet; Pocahontas No. 4 coal at 1494 feet; Pocahontas No. 3 coal at 1542 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	554+	554
Lee Formation	878	1432
Pocahontas Formation	208+	?

CORE NAME: Crooked Branch INDEX NO. 63
LOCATION: 200 feet S of 37°10′00″
3850 feet E of 82°05′00″

ELEVATION: 1590 feet G. L. approximate TOTAL DEPTH: 1424 feet

COALS IDENTIFIED: Jawbone coal splits at 90 feet and 139 feet; Tiller coal at 188 feet; Greasy Creek coal at 487 feet; Middle Seaboard coal at 584 feet; Lower Seaboard coal at 604 feet; Upper Horsepen coal at 707 feet; Middle Horsepen coal at 773 feet; War Creek coal at 867 feet; Lower Horsepen coal at 1020 feet; Pocahontas coal No. 5 at 1292 feet; Pocahontas coal No. 4 at 1355 feet; Pocahontas coal No. 3 at 1419 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1214+	1214
Lee Formation	64	1278
Pocahontas Formation	145+	?

CORE NAME: Indian Grave Gap INDEX NO. 64

LOCATION: 3100 feet S of 37°10′00″
3050 feet W of 82°02′30″

ELEVATION: 1905 feet G. L. approximate TOTAL DEPTH: 1853 feet

COALS IDENTIFIED: Kennedy coal at 108 feet; Aily coal at 218 feet; Raven coal at 335 feet; Jawbone coal at 531 feet; Tiller coal at 579 feet; Greasy Creek coal at 896 feet; Middle Seaboard coal at 977 feet; Lower Seaboard coal at 1008 feet; Upper Horsepen coal at 1102 feet; War Creek coal at 1279 feet; Lower Horsepen coal at 1417 feet; Pocahontas No. 9 coal at 1538 feet; Pocahontas No. 5 coal at 1738 feet; Pocahontas No. 4 coal at 1785 feet; Pocahontas No. 3 coal at 1848 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1660+	1660
Lee Formation	33	1693
Pocahontas Formation	160+	?

OPERATOR: United Producing Company, Inc. INDEX NO. 65

FARM: Yukon Pocahontas Coal Company

WELL NO.: 2-1466

LOCATION: 1800 feet S of 37°10′00″
10,050 feet W of 82°00′00″

ELEVATION 1751 feet G. L. TOTAL DEPTH: 5100 feet

REPOSITORY NO.: W-9

COALS IDENTIFIED: Jawbone coal at 424 feet; Tiller coal at 484 feet; Greasy Creek coal at 769 feet; Upper Horsepen coal at 953 feet; War Creek coal at 1120 feet; Lower Horsepen coal at 1258 feet; Pocahontas No. 9 coal at 1373 feet; Pocahontas No. 4 coal at 1637 feet; Pocahontas No. 3 coal at 1700 feet; (Kennedy coal estimated at about 40 feet above well site; Pocahontas No. 5 coal estimated at 1580 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1517+	1517
Lee Formation	17	1534
Pocahontas Formation	466	2000
Bluestone Formation	371	2371
Pride Shale Member	166	2371
Princeton interval	209	2580
Hinton Formation	655	3235
Little Stone Gap Member	65	2645
Stony Gap Sandstone Member	90	3235
Bluefield Formation	345	3580
Greenbrier Limestone	743	4323

Beatrice Pocahontas Mine; skip shaft INDEX NO. 66

LOCATION: 1000 feet S of 37°20′00″
2000 feet E of 82°00′00″

ELEVATION: 1362 feet G. L. approximate TOTAL DEPTH: 1448 feet

COALS IDENTIFIED: Greasy Creek coal at 412 feet; Middle Seaboard coal at 465 feet; Lower Seaboard coal at 488 feet; Upper Horsepen coal at 578 feet; Middle Horsepen coal at 645 feet; War Creek coal at 800 feet; Lower Horsepen coal at 939 feet; Pocahontas No. 6 coal splits at 1208 feet and 1226 feet; Pocahontas No. 4 coal at 1281 feet; Pocahontas No. 3 coal at 1343 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1133+	1133
Lee Formation	75	1208
Pocahontas Formation	240+	?

OPERATOR: United Producing Company, Inc. INDEX NO. 67

FARM: Yukon Pocahontas Coal Company

WELL NO.: 5-1647

LOCATION: 10,800 feet S of 37°15′00″
9100 feet E of 82°00′00″

ELEVATION: 1826.4 feet G. L. TOTAL DEPTH: 4358 feet

REPOSITORY NO.: W-19

COALS IDENTIFIED: Kennedy coal at 99 feet; Tiller coal at 507 feet; War Creek coal at 1202 feet; Pocahontas No. 6 coal at 1642 feet; Pocahontas No. 3 coal at 1767 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1510+	1510
Lee Formation	111	1621
Pocahontas Formation	461	2082
Bluestone Formation	410	2492
Princeton interval	159	2649
Hinton Formation	626	3275
Little Stone Gap Member	64	2713
Stony Gap Sandstone Member	54	3275
Bluefield Formation	346	3621
Greenbrier Limestone	727	4348

OPERATOR: Pipe Line Construction and Drilling Company INDEX NO. 68

FARM: L. M. Fugate

WELL NO.: 1

LOCATION: 9400 feet S of 37°15′00″
400 feet E of 81°55′00″

ELEVATION: 2288.25 feet G.L. TOTAL DEPTH: 6658 feet

REPOSITORY NO.: W-43

COALS IDENTIFIED: None

	Thickness (feet)	*Depth to base of unit (feet)*
Bluestone Formation	625+	2680
Pride Shale Member	216	2680
Princeton interval	136	2816
Hinton Formation	561	3377
Little Stone Gap Member	64	2880
Stony Gap Sandstone Member	70	3377
Bluefield Formation	414	3791
Greenbrier Limestone	779	4570

CORE NAME: Grassy Creek INDEX NO. 69
LOCATION: 6500 feet S of 37°12′30″
1500 feet E of 82°57′30″
ELEVATION: 1720 feet G. L. approximate TOTAL DEPTH: 1930 feet
COALS IDENTIFIED: Jawbone coal at 157 feet; Tiller coal at 236 feet; Greasy Creek coal at 615 feet; Middle Seaboard coal at 704 feet; Lower Seaboard coal at 732 feet; Upper Horsepen coal at 793 feet; Middle Horsepen coal splits at 839 and 853 feet; War Creek coal splits (?) at 979 feet, 1003 feet, 1048 feet, 1062 feet; Lower Horsepen coal at 1131 feet; Pocahontas No. 9 coal at 1237 feet; Pocahontas No. 6 coal at 1434 feet; Pocahontas No. 4 coal at 1501 feet; Pocahontas No. 3 coal at 1569 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1271+	1271
Lee Formation	135	1406
Pocahontas Formation	508	1914

OPERATOR: United Fuel Gas Company INDEX NO. 70
FARM: Hugh McRae
WELL NO.: 1-6431
LOCATION: 3550 feet S of 37°10′00″
9300 feet E of 82°00′00″
ELEVATION: 1799.14 feet G. L. TOTAL DEPTH: 4800 feet
REPOSITORY NO.: W-6
COALS IDENTIFIED: Upper Horsepen coal at 603 feet; War Creek coal at 780 feet (?); Lower Horsepen coal at 933 feet; Pocahontas No. 6 coal at 1239 feet; Pocahontas No. 4 coal at 1350 feet; Pocahontas No. 3 coal at 1408 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1132+	1132
Lee Formation	52	1184
Pocahontas Formation	568	1752
Bluestone Formation	418	2170
Pride Shale Member	196	2170
Princeton interval	196	2366
Hinton Formation	611	2977
Little Stone Gap Member	71	2437
Stony Gap Sandstone Member	130	2977
Bluefield Formation	621	3598
Greenbrier Limestone	610	4215

CORE NAME: Sevenmile Branch INDEX NO. 71
LOCATION: 5500 feet S of 37°10′00″
4500 feet W of 82°55′00″
ELEVATION: 1800 feet G. L. approximate
TOTAL DEPTH: 1542 feet

COALS IDENTIFIED: Greasy Creek coal at 284 feet; Middle Seaboard coal at 381 feet; Lower Seaboard coal at 424 feet; Upper Horsepen coal at 610 feet; War Creek coal at 706 feet; Lower Horsepen coal at 842 feet; Pocahontas No. 7 coal at 1047 feet; Pocahontas No. 6 coal at 1151 feet; Pocahontas No. 4 coal at 1269 feet; Pocahontas No. 3 coal at 1322 feet

	Thickness (feet)	*Depth to base of unit (feet)*
New River Formation	1016+	1016
Pocahontas Formation	512	1528

CORE NAME: Trace Fork INDEX NO. 72
LOCATION: 5500 feet S of 37°12′30″
6700 feet E of 81°52′30″
ELEVATION: 1885 feet G. L. approximate
TOTAL DEPTH: 1820 feet

COALS IDENTIFIED: Middle Seaboard coal at 416 feet; Lower Seaboard coal at 458 feet; Upper Horsepen coal at 602 feet; Middle Horsepen coal at 666 feet; War Creek coal at 775 feet; Lower Horsepen coal at 922 feet; Pocahontas No. 9 coal at 998 feet; Pocahontas No. 8 coal at 1008 feet; Pocahontas No. 7 coal at 1120 feet; Pocahontas No. 6 coal at 1202 feet; Pocahontas No. 3 coal at 1400 feet

	Thickness (feet)	*Depth to base of unit (feet)*
New River Formation	1009+	1009
Pocahontas Formation	771	1780

OPERATOR: United Fuel Gas Company INDEX NO. 73
FARM: Pocahontas Mining Corporation
WELL NO.: 9138-T
LOCATION: 11,450 feet S of 37°15′00″
9000 feet E of 81°50′00″
ELEVATION: 1958 feet G. L. TOTAL DEPTH: 5170 feet
REPOSITORY NO.: W-711

COALS IDENTIFIED: Jawbone coal at 120 feet; Tiller coal at 164 feet; War Creek coal at 970 feet; Lower Horsepen coal at 1110 feet; Pocahontas No. 7 coal at 1321 feet; Pocahontas No. 6 coal at 1402 feet; Pocahontas No. 3 coal at 1600 feet; (Kennedy coal estimated at 210 feet above well site)

	Thickness (feet)	*Depth to base of unit (feet)*
New River Formation	1250+	1250
Pocahontas Formation	570	1820
Bluestone Formation	420	2240
Pride Shale Member	222	2240
Princeton interval	210	2450
Hinton Formation	718	3168
Little Stone Gap Member	70	2520
Stony Gap Sandstone Member	48	3168
Bluefield Formation	408	3576
Greenbrier Limestone	879	4455

OPERATOR: Pocahontas Mining Corporation INDEX NO. 74
CORE NAME: Seng Camp Fork
LOCATION: 600 feet S of 37°12′30″
200 feet W of 81°47′30″
ELEVATION: 2260 feet G. L. TOTAL DEPTH: 1500 feet
COALS IDENTIFIED: Greasy Creek coal at 384 feet; Middle Seaboard coal at 466 feet; Lower Seaboard coal at 536 feet; Upper Horsepen coal at 689 feet; Middle Seaboard coal at 747 feet; War Creek coal at 857 feet; Lower Horsepen coal at 946 feet; Pocahontas No. 9 coal at 1061 feet; Pocahontas No. 8 coal at 1112 feet; Pocahontas No. 7 coal at 1201 feet; Pocahontas No. 6 coal at 1294 feet; Pocahontas No. 5 coal at 1334 feet; Pocahontas No. 4 coal at 1372 feet; Pocahontas No. 3 coal at 1464 feet

	Thickness (feet)	*Depth to base of unit (feet)*
New River Formation	1125+	1125
Pocahontas Formation	375+	?

CORE NAME: Jewell Ridge INDEX NO. 75
LOCATION: 9000 feet N of 37°10′00″
12,200 feet E of 81°50′00″

ELEVATION: 2550 feet G. L. TOTAL DEPTH: 1820 feet

COALS IDENTIFIED: Jawbone coal at 191 feet; Tiller coal at 268 feet; Upper Seaboard coal at 632 feet; Greasy Creek coal at 669 feet; Middle Seaboard coal at 740 feet; Lower Seaboard coal at 816 feet; Upper Horsepen coal at 1010 feet; War Creek coal at 1097 feet; Lower Horsepen coal at 1194 feet; Pocahontas No. 8 coal at 1449 feet; Pocahontas No. 7 coal at 1559 feet; Pocahontas No. 6 coal at 1621 feet; Pocahontas No. 5 coal at 1669 feet; Pocahontas No. 4 coal at 1714 feet; Pocahontas No. 3 coal at 1798 feet

	Thickness (feet)	*Depth to base of unit (feet)*
New River Formation	1467+	1467
Pocahontas Formation	353+	?

OPERATOR: Clinchfield Coal Company INDEX NO. 76

FARM: Andrew Thomas

WELL NO.: 102

LOCATION: 3900 feet S of 37°10′00″
5600 feet W of 82°10′00″

ELEVATION: 1373.2 feet G. L. TOTAL DEPTH: 5847 feet

REPOSITORY NO.: W-142

COALS IDENTIFIED: Raven coal at 153 feet; Jawbone coal at 268 feet; Pocahontas No. 4 coal at 1448 feet; Pocahontas No. 3 coal at 1470 feet; (Kennedy coal estimated at 47 feet above well site; War Creek coal estimated at 1000 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	555+	555
Lee Formation	885	1440
Pocahontas Formation	274	1714
Bluestone Formation	465	2179
Pride Shale Member	151	2179
Princeton interval	112	2291
Hinton Formation	494	2785
Little Stone Gap Member	51	2342
Stony Gap Sandstone Member	133	2785
Bluefield Formation	502	3287
Greenbrier Limestone	449	3736

TAZEWELL COUNTY, VIRGINIA

CORE NAME: Indian Creek INDEX NO. 77
LOCATION: 8000 feet S of 37°15′00″
5300 feet E of 81°45′00″
ELEVATION: 2421.82 feet G. L. TOTAL DEPTH: 1390 feet
COALS IDENTIFIED: Greasy Creek coal at 269 feet; Middle Seaboard coal at 356 feet; Lower Seaboard coal at 411 feet; Upper Horsepen coal at 525 feet; Middle Horsepen coal at 607 feet; Lower Horsepen coal at 836 feet; Pocahontas No. 9 coal at 930 feet; Pocahontas No. 8 coal at 1004 feet; Pocahontas No. 7 coal at 1108 feet; Pocahontas No. 6 coal at 1197 feet; Pocahontas No. 5 coal at 1267 feet; Pocahontas No. 4 coal at 1306 feet; Pocahontas No. 3 coal at 1376 feet; (War Creek coal absent)

	Thickness (feet)	*Depth to base of unit (feet)*
New River Formation	1006+	1006
Pocahontas Formation	384+	?

OPERATOR: United Fuel Gas Company INDEX NO. 78
FARM: New River and Pocahontas Consolidation Coal Company
WELL NO.: 9050
LOCATION: 14,400 feet S of 37°15′00″
15,250 feet W of 81°40′00″
ELEVATION: 2361.28 feet G. L. TOTAL DEPTH: 5145 feet
REPOSITORY NO.: W-565
COALS IDENTIFIED: Middle Seaboard coal at 70 feet; Upper Horsepen coal at 310 feet; Middle Horsepen coal at 436 feet; Pocahontas No. 9 coal at 728 feet; Pocahontas No. 8 coal at 768 feet; Pocahontas No. 7 coal at 865 feet; Pocahontas No. 5 coal at 1018 feet; Pocahontas No. 3 coal at 1135 feet; (War Creek coal estimated at 520 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
New River Formation	830+	830
Pocahontas Formation	590	1420
Bluestone Formation	470	1890
Pride Shale Member	290	1890
Princeton interval	150	2040
Hinton Formation	985	3025

Little Stone Gap Member	180	2220
Stony Gap Sandstone Member	50	3025
Bluefield Formation	722	3747
Greenbrier Limestone	679	4426

OPERATOR: United Fuel Gas Company INDEX NO. 79
FARM: New River and Pocahontas Consolidation Coal Company
WELL NO.: 9364
LOCATION: 8600 feet N of 37°10′00″
1600 feet E of 81°45′00″
ELEVATION: 2884.55 feet G. L. TOTAL DEPTH: 5705 feet
REPOSITORY NO.: W-3390
COALS IDENTIFIED: None; (War Creek coal estimated at 920 feet; Pocahontas No. 3 coal estimated at 1640 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
New River Formation	1340+	1340
Pocahontas Formation	562	1902
Bluestone Formation	480	2382
Pride Shale Member	256	2382
Princeton interval	153	2535
Hinton Formation	1106	3641
Stony Gap Sandstone Member	44	3641
Bluefield Formation	504	4145
Greenbrier Limestone	817	4962

OPERATOR: Consolidation Coal Company INDEX NO. 80
FARM: Pocahontas Fuel Company
WELL NO.: 6
LOCATION: 10,500 feet N of 37°10′00″
8450 feet W of 81°40′00″
ELEVATION: 2395.5 feet G. L. TOTAL DEPTH: 5538 feet
REPOSITORY NO.: W-1239
COALS IDENTIFIED: Lower Horsepen coal at 318 feet; Pocahontas No. 9 coal at 480 feet; Pocahontas No. 8 coal at 560 feet; Pocahontas No. 7 coal at 688 feet; Pocahontas No. 6 coal at 820 feet; Pocahontas No. 4 coal at 1018 feet; Pocahontas No. 3 coal at 1118 feet; (War Creek coal estimated at 100 feet)

	Thickness (feet)	Depth to base of unit (feet)
New River Formation	600+	600
Pocahontas Formation	760	1360
Bluestone Formation	730	2090
Pride Shale Member	300	2090
Princeton interval	310	2400
Hinton Formation	60+	?
Little Stone Gap Member	60	2460

CORE NAME: Jackson Fork INDEX NO. 81
LOCATION: 5800 feet N of 37°19′00″
11,200 feet W of 81°40′00″
ELEVATION: 2217.1 feet G. L. TOTAL DEPTH: 747 feet
COALS IDENTIFIED: Pocahontas No. 7 coal at 199 feet; Pocahontas No. 6 coal at 244 feet; Pocahontas No. 5 coal at 315 feet; Pocahontas No. 4 coal at 405 feet; Pocahontas No. 3 coal at 465 feet; (War Creek coal estimated at 140 feet above the core site)

	Thickness (feet)	Depth to base of unit (feet)
New River Formation	173+	173
Pocahontas Formation	564	737

OPERATOR: Consolidation Coal Company INDEX NO. 82
FARM: Pocahontas Fuel Company
WELL NO.: 4
LOCATION: 400 feet S of 37°10′00″
4650 feet E of 81°45′00″
ELEVATION: 2699.6 feet G. L. TOTAL DEPTH: 5511 feet
REPOSITORY NO.: W-1237
COALS IDENTIFIED: War Creek coal at 410 feet; (Pocahontas No. 3 coal estimated at 1120 feet; Lower Seaboard coal estimated at 50 feet)

	Thickness (feet)	Depth to base of unit (feet)
New River Formation	730+	730
Pocahontas Formation	770	1500
Bluestone Formation	600	2100
Pride Shale Member	180	2100
Princeton interval	140	2240

Hinton Formation	1160	3400
Little Stone Gap Member	30	2270
Stony Gap Sandstone Member	100	3400
Bluefield Formation	520	3920
Greenbrier Limestone	820	4740

CORE NAME: Middle Creek INDEX NO. 83

LOCATION: 6850 feet N of 37°10′00″
5300 feet W of 81°45′00″

ELEVATION: 2429 feet G. L. TOTAL DEPTH: 1156 feet

COALS IDENTIFIED: Lower Seaboard coal at 47 feet; Upper Horsepen coal at 166 feet; Middle Horsepen coal at 267 feet; War Creek coal at 350 feet; Lower Horsepen coal at 468 feet; Pocahontas No. 9 coal at 582 feet; Pocahontas No. 8 coal at 669 feet; Pocahontas No. 7 coal at 737 feet; Pocahontas No. 6 coal at 871 feet; Pocahontas No. 5 coal at 922 feet; Pocahontas No. 4 coal splits at 1049 feet and 1054 feet; Pocahontas No. 3 coal at 1141 feet

	Thickness (feet)	*Depth to base of unit (feet)*
New River Formation	681+	681
Pocahontas Formation	475+	?

CORE NAME: Murray Hollow INDEX NO. 84

LOCATION: 3700 feet N of 37°10′00″
10,500 feet E of 81°50′00″

ELEVATION: 2397.79 feet G. L. TOTAL DEPTH: 1573 feet

COALS IDENTIFIED: Middle Seaboard coal at 334 feet; Lower Seaboard coal at 426 feet; Upper Horsepen coal at 548 feet; Middle Horsepen coal at 599 feet; War Creek coal at 728 feet; Lower Horsepen coal at 804 feet; Pocahontas No. 9 coal at 927 feet; Pocahontas No. 7 coal at 1112 feet; Pocahontas No. 6 coal at 1182 feet; Pocahontas No. 5 at 1246 feet; Pocahontas No. 3 coal at 1446 feet

	Thickness (feet)	*Depth to base of unit (feet)*
New River Formation	1020+	1020
Pocahontas Formation	553+	?

OPERATOR: Ashland Oil and Refining Company INDEX NO. 85
FARM: Youngstown Mines Corporation
WELL NO.: 1-4147
LOCATION: 100 feet S of 37°10′00″
7000 feet W of 81°45′00″
ELEVATION: 2994.7 feet G. L. TOTAL DEPTH: 5900 feet
REPOSITORY NO.: W-1475
COALS IDENTIFIED: Upper Seaboard coal at 345 feet; Middle Seaboard coal at 427 feet; Lower Seaboard coal at 490 feet; Upper Horsepen coal at 680 feet; Middle Horsepen coal at 730 feet; War Creek coal splits at 910 feet and 945 feet; Lower Horsepen coal at 1127 feet; Pocahontas No. 8 coal at 1288 feet; Pocahontas No. 7 coal at 1395 feet; Pocahontas No. 6 coal at 1454 feet; Pocahontas No. 5 coal at 1550 feet; Pocahontas No. 4 coal at 1603 feet; Pocahontas No. 3 coal at 1680 feet

	Thickness (feet)	*Depth to base of unit (feet)*
New River Formation	1295+	1295
Pocahontas Formation	785	2080
Bluestone Formation	525	2605
Pride Shale Member	195	2605
Princeton interval	170	2775
Hinton-Bluefield fms. (undiff.)	1665	4440
Little Stone Gap Member	195	2970
Greenbrier Limestone	745	5185

CORE NAME: Town Hill Creek INDEX NO. 86
LOCATION: 13,000 feet N of 37°05′00″
24,500 feet W of 81°45′00″
ELEVATION: 2500 feet G. L. approximate
TOTAL DEPTH: 2065 feet
COALS IDENTIFIED: Jawbone coal at 113 feet; Tiller coal at 205 feet; Upper Seaboard coal at 369 feet; Greasy Creek coal at 406 feet; Middle Seaboard coal at 447 feet; Lower Seaboard coal at 547 feet; Upper Horsepen coal at 654 feet; Middle Horsepen coal at 688 feet; War Creek coal at 856 feet; Lower Horsepen coal at 1076 feet; Pocahontas No. 9 coal at 1131 feet; Pocahontas No. 8 coal at 1147 feet; Pocahontas No. 7 coal at 1245 feet; Pocahontas No. 6 coal at 1335 feet; Pocahontas No. 5 coal at 1397 feet; Pocahontas No. 4 coal at 1489 feet; Pocahontas No. 3 coal at 1596 feet

	Thickness (feet)	Depth to base of unit (feet)
New River Formation	1161+	1161
Pocahontas Formation	699	1860

DICKENSON COUNTY, VIRGINIA

OPERATOR: United Fuel Gas Company INDEX NO. 87
FARM: The Pittston Company
WELL NO.: 9585
LOCATION: 5500 feet N of 37°15′00″
6500 feet W of 82°15′00″
ELEVATION: 1487.18 feet G. L. TOTAL DEPTH: 4165 feet
REPOSITORY NO.: W-3090
COALS IDENTIFIED: Kennedy coal at 415 feet; (War Creek coal estimated at 1360 feet)

	Thickness (feet)	Depth to base of unit (feet)
Post-Lee formations	470+	470
Lee Formation	1301	1771
Pocahontas Formation	absent	
Bluestone Formation	502	2273
Pride Shale Member	261	2273
Princeton interval	40	2313
Hinton Formation	365	2678
Little Stone Gap Member	33	2346
Stony Gap Sandstone Member	37	2678
Bluefield Formation	203	2881
Greenbrier Limestone	521	3402

OPERATOR: Clinchfield Coal Company INDEX NO. 88
FARM: Big Sandy Fuel Corporation
WELL NO.: 210
LOCATION: 1400 feet S of 37°15′00″
1500 feet W of 82°15′00″
ELEVATION: 1753 feet G. L. TOTAL DEPTH: 5860 feet
REPOSITORY NO.: W-283
COALS IDENTIFIED: Dorchester coal at 27 feet; Kennedy coal at 764 feet; (War Creek coal estimated at 1630 feet)

	Thickness (feet)	Depth to base of unit (feet)
Post-Lee formations	825+	825
Lee Formation	1184	2009
Pocahontas Formation	19	2028
Bluestone Formation	539	2567
Pride Shale Member	154	2567
Princeton interval	47	2614
Hinton Formation	343	2957
Little Stone Gap Member	49	2663
Stony Gap Sandstone Member	185	2957
Bluefield Formation	368	3325
Greenbrier Limestone	568	3893

OPERATOR: Clinchfield Coal Company INDEX NO. 89
FARM: Big Sandy Fuel Corporation
WELL NO.: 209
LOCATION: 2900 feet S of 37°15′00″
4150 feet W of 82°15′00″
ELEVATION: 1473 feet G. L. TOTAL DEPTH: 5554 feet
REPOSITORY NO.: W-282
COALS IDENTIFIED: Hagy coal at 30 feet; Splash Dam coal at 160 feet; Kennedy coal at 447 feet; War Creek coal at 1368 feet

	Thickness (feet)	Depth to base of unit (feet)
Post-Lee formations	583+	583
Lee Formation	1154	1737
Pocahontas Formation	absent	
Bluestone Formation	554	2291
Pride Shale Member	203	2291
Princeton interval	51	2342
Hinton Formation	463	2805
Little Stone Gap Member	36	2378
Stony Gap Sandstone Member	35	2805
Bluefield Formation	231	3036
Greenbrier Limestone	574	3610

OPERATOR: Columbia Gas Transmission Corporation INDEX NO. 90
FARM: The Pittston Company
WELL NO.: 9642

LOCATION: 5700 feet S of 37°15′00″
7950 feet W of 82°15′00″
ELEVATION: 1539.35 feet G.L. TOTAL DEPTH: 4379 feet
REPOSITORY NO.: W-3604
COALS IDENTIFIED: Splash Dam coal at 170 feet; War Creek coal at 1492 feet; (Kennedy coal estimated at 550 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	598+	598
Lee Formation	1286	1884
Pocahontas Formation	absent	
Bluestone Formation	500	2384
Pride Shale Member	241	2384
Princeton interval	52	2436
Hinton Formation	471	2907
Stony Gap Sandstone Member	54	2907
Bluefield Formation	202	3109
Greenbrier Limestone	558	3667

OPERATOR: United Fuel Gas Company INDEX NO. 91
FARM: The Pittston Company
WELL NO.: 9589
LOCATION: 3550 feet S of 37°15′00″
3450 feet W of 82°17′30″
ELEVATION: 1283.91 feet G. L. TOTAL DEPTH: 4109 feet
REPOSITORY NO.: W-3112
COALS IDENTIFIED: Splash Dam coal at 112 feet; (Kennedy coal estimated at 420 feet; War Creek coal estimated at 1420 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	518+	518
Lee Formation	1334	1852
Pocahontas Formation	absent	
Bluestone Formation	365	2217
Pride Shale Member	243	2217
Princeton interval	95	2312
Hinton-Bluefield fms. (undiff.)	541	2853
Little Stone Gap Member	15	2327
Greenbrier Limestone	547	3400

OPERATOR: Clinchfield Coal Company INDEX NO. 92
FARM: Big Sandy Fuel Corporation
WELL NO.: 214
LOCATION: 9350 feet S of 37°15′00″
4550 feet W of 82°15′00″
ELEVATION: 1546 feet G. L. TOTAL DEPTH: 5665 feet
REPOSITORY NO.: W-348
COALS IDENTIFIED: Hagy coal at 75 feet; Splash Dam coal at 142 feet; Upper Banner coal at 249 feet; Lower Banner coal at 300 feet; Kennedy coal at 426 feet; Jawbone coal at 787 feet; Pocahontas No. 3 coal at 1722 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	516+	516
Lee Formation	1206	1722
Pocahontas Formation	149	1871
Bluestone Formation	474	2345
Princeton interval	15	2360
Hinton Formation	401	2761
Little Stone Gap Member	90	2450
Stony Gap Sandstone Member	121	2761
Bluefield Formation	393	3154
Greenbrier Limestone	548	3702

OPERATOR: United Fuel Gas Company INDEX NO. 93
FARM: The Pittston Company
WELL NO.: 9588
LOCATION: 2850 feet N of 37°12′30″
8800 feet W of 82°15′00″
ELEVATION: 1566.34 feet G. L. TOTAL DEPTH: 4485 feet
REPOSITORY NO.: W-3111
COALS IDENTIFIED: Hagy coal at 81 feet; Lower Banner coal at 317 feet; War Creek coal at 1513 feet; (Kennedy coal estimated at 540 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	595+	595
Lee Formation	1325	1920
Pocahontas Formation	55	1975
Bluestone Formation	452	2427
Pride Shale Member	241	2427

Princeton interval	44	2471
Hinton Formation	413	2884
Stony Gap Sandstone Member	51	2884
Bluefield Formation	280	3164
Greenbrier Limestone	591	3755

OPERATOR: Clinchfield Coal Company INDEX NO. 94
FARM: T. K. Colley
WELL NO.: 113
LOCATION: 10,500 feet N of 37°10′00″
1950 feet E of 82°15′00″
ELEVATION: 1575 feet G. L. TOTAL DEPTH: 4578 feet
COALS IDENTIFIED: Upper Banner coal at 85 feet; Tiller coal at 785 feet; (Kennedy coal estimated at 385 feet; War Creek coal estimated at 1440 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	943+	943
Lee Formation	835	1778
Pocahontas Formation	160	1938
Bluestone Formation	471	2409
Pride Shale Member	139	2409
Princeton interval	22	2431
Hinton Formation	339	2770
Little Stone Gap Member	86	2517
Stony Gap Sandstone Member	40	2770
Bluefield Formation	592	3362
Greenbrier Limestone	483	3845

OPERATOR: Clinchfield Coal Company INDEX NO. 95
FARM: S. C. Mullins
WELL NO.: 111
LOCATION: 12,500 feet N of 37°10′00″
10,450 feet E of 82°25′00″
ELEVATION: 1334.5 feet G.L. TOTAL DEPTH: 6064 feet
COALS IDENTIFIED: Kennedy coal at 79 feet; Aily coal at 240 feet; Raven coal at 313 feet; Jawbone coal at 420 feet; Tiller coal at 484 feet; War Creek coal at 1217 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	166+	166

Lee Formation	1443	1609
Pocahontas Formation	absent	
Bluestone Formation	414	2023
Princeton interval	absent	
Hinton-Bluefield fms. (undiff.)	712	2735
Little Stone Gap Member	5	2028
Greenbrier Limestone	531	3266

OPERATOR: Clinchfield Coal Company INDEX NO. 96
FARM: William McFall
WELL NO.: 197
LOCATION: 2250 feet N of 37°10′00″
2400 feet W of 82°30′00″
ELEVATION: 1500.0 feet G. L. TOTAL DEPTH: 4899 feet
COALS IDENTIFIED: None; (War Creek coal estimated at 1420 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Lee Formation	?	1950
Pocahontas Formation	absent	
Bluestone Formation	329	2279
Pride Shale Member	329	2279
Princeton interval	63	2342
Hinton Formation	398	2740
Little Stone Gap Member	23	2365
Stony Gap Sandstone Member	179	2740
Bluefield Formation	185	2925
Greenbrier Limestone	430	3355

OPERATOR: Clinchfield Coal Company INDEX NO. 97
FARM: Isaac Cochran
WELL NO.: 205
LOCATION: 5000 feet N of 37°10′00″
550 feet W of 82°20′00″
ELEVATION: 1356.3 feet G. L. TOTAL DEPTH: 5395 feet
REPOSITORY NO.: W-132
COALS IDENTIFIED: Kennedy coal at 30 feet; Aily coal at 150 feet; Raven coal at 218 feet; (War Creek coal estimated at 1140 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	627+	627
Lee Formation	913	1540
Pocahontas Formation	absent	

Bluestone Formation	535	2075
Pride Shale Member	255	2075
Princeton interval	180	2255
Hinton Formation	400	2655
Little Stone Gap Member	27	2282
Stony Gap Sandstone Member	53	2655
Bluefield Formation	220	2875
Greenbrier Limestone	620	3495

OPERATOR: Clinchfield Coal Company INDEX NO. 98
FARM: Arch Rose
WELL NO.: 105
LOCATION: 7050 feet S of 37°10′00″
12,000 feet W of 82°20′00″
ELEVATION: 1431.3 feet G. L. TOTAL DEPTH: 5364 feet
REPOSITORY NO.: W-137
COALS IDENTIFIED: Aily coal at 210 feet; Raven coal at 308 feet; Jawbone coal at 447 feet; War Creek coal at 1173 feet; (Kennedy coal estimated at 100 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	679+	679
Lee Formation	1027	1706
Pocahontas Formation	absent	
Bluestone Formation	399	2105
Princeton interval	183	2288
Hinton Formation	440	2728
Little Stone Gap Member	22	2310
Stony Gap Sandstone Member	43	2728
Bluefield Formation	444	3172
Greenbrier Limestone	375	3547

OPERATOR: Clinchfield Coal Company INDEX NO. 99
FARM: E. A. Smith
WELL NO.: 208
LOCATION: 14,150 feet S of 37°10′00″
5700 feet W of 82°25′00″
ELEVATION: 1459.4 feet G. L. TOTAL DEPTH: 5223 feet
REPOSITORY NO.: W-281

COALS IDENTIFIED: Kennedy coal at 117 feet; Aily coal at 204 feet; Raven coal at 298 feet; Jawbone coal at 358 feet; Tiller coal at 447 feet; War Creek coal at 1212 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	583+	583
Lee Formation	1037	1620
Pocahontas Formation	absent	
Bluestone Formation	459	2079
Pride Shale Member	237	2079
Princeton interval	166	2245
Hinton Formation	456	2701
Little Stone Gap Member	45	2290
Stony Gap Sandstone Member	131	2701
Bluefield Formation	349	3050
Greenbrier Limestone	372	3422

OPERATOR: Clinchfield Coal Company INDEX NO. 100
FARM: David Short
WELL NO.: 118
LOCATION: 13,800 feet N of 37°05′00″
9200 feet W of 82°30′00″
ELEVATION: 1857.7 feet G. L. TOTAL DEPTH: 3852 feet
COALS IDENTIFIED: Blair coal at 105 feet; Lyons coal at 134 feet; Lower Banner coal at 682 feet; Aily coal at 1021 feet; War Creek coal at 1826 feet; (Kennedy coal estimated at 890 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	896+	896
Lee Formation	1454	2350
Pocahontas Formation	absent	
Bluestone Formation	386	2736
Pride Shale Member	114	2736
Princeton interval	12	2748
Hinton Formation	392	3140
Little Stone Gap Member	22	2770
Stony Gap Sandstone Member	140	3140
Bluefield Formation	197	3337
Greenbrier Limestone	479	3816

OPERATOR: Clinchfield Coal Company INDEX NO. 101
CORE NAME: Cranesnest River
LOCATION: 300 feet N of 37°05′00″
3950 feet E of 82°30′00″
ELEVATION: 1492 feet G. L. TOTAL DEPTH: 2500 feet
COALS IDENTIFIED: Kennedy coal at 207 feet; Raven coal at 418 feet; Jawbone coal at 612 feet; War Creek coal at 1276 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	?	?
Lee Formation	?	1644
Pocahontas Formation	46	1690
Bluestone Formation	433	2123
Pride Shale Member	169	2123
Princeton interval	33	2156
Hinton Formation	291+	?
Little Stone Gap Member	53	2209

OPERATOR: Clinchfield Coal Company INDEX NO. 102
FARM: Jasper H. Sutherland
WELL NO.: 132
LOCATION: 14,900 feet N of 37°05′00″
6550 feet W of 82°15′00″
ELEVATION: 1500.4 feet G. L. TOTAL DEPTH: 5866 feet
COALS IDENTIFIED: Jawbone coal at 262 feet; War Creek coal at 1024 feet; Pocahontas No. 3 coal at 1528 feet; (Kennedy coal estimated at 50 feet above well site)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	638+	638
Lee Formation	890	1528
Pocahontas Formation	193	1721
Bluestone Formation	464	2185
Pride Shale Member	159	2185
Princeton interval	185	2370
Hinton Formation	398	2768
Little Stone Gap Member	64	2434
Stony Gap Sandstone Member	61	2768
Bluefield Formation	602	3370
Greenbrier Limestone	515	3885

OPERATOR: Clinchfield Coal Company INDEX NO. 103
FARM: John M. Powers
WELL NO.: 112
LOCATION: 4050 feet N of 37°05′00″
4950 feet E of 82°15′00″
ELEVATION: 1420.8 feet G. L. TOTAL DEPTH: 5744 feet
COALS IDENTIFIED: Jawbone coal at 45 feet; War Creek coal at 866 feet; Pocahontas No. 4 coal at 1339 feet; Pocahontas No. 3 coal at 1354 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	391+	391
Lee Formation	928	1319
Pocahontas Formation	326	1645
Bluestone Formation	506	2151
Pride Shale Member	205	2151
Princeton interval	148	2299
Hinton Formation	552	2851
Little Stone Gap Member	65	2364
Stony Gap Sandstone Member	157	2851
Bluefield Formation	419	3270
Greenbrier Limestone	753	4023

OPERATOR: Clinchfield Coal Company INDEX NO. 104
FARM: J. C. Rasnick
WELL NO.: 103
LOCATION: 2950 feet S of 37°05′00″
5150 feet W of 82°20′00″
ELEVATION: 1504.3 feet G. L. TOTAL DEPTH: 3910 feet
REPOSITORY NO.: W-138
COALS IDENTIFIED: Raven coal at 169 feet; Jawbone coal at 343 feet; War Creek coal at 1097 feet; Pocahontas No. 4 coal at 1514 feet; Pocahontas No. 3 coal at 1528 feet; (Kennedy coal estimated at 70 feet above well site)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	603+	603
Lee Formation	887	1490
Pocahontas Formation	208	1698
Bluestone Formation	536	2234
Pride Shale Member	201	2234
Princeton interval	78	2312

Hinton-Bluefield fms. (undiff.)	912	3224
Little Stone Gap Member	66	2378
Greenbrier Limestone	634	3858

OPERATOR: Clinchfield Coal Company INDEX NO. 105
FARM: H. P. Phillips
WELL NO.: 101
LOCATION: 5450 feet S of 37°05′00″
4400 feet W of 82°20′00″
ELEVATION: 1520.5 feet G. L. TOTAL DEPTH: 4551 feet
REPOSITORY NO.: W-144
COALS IDENTIFIED: Aily coal at 28 feet; Raven coal at 176 feet; Jawbone coal at 324 feet; Tiller coal at 350 feet; (Kennedy coal estimated at 60 feet above well site; War Creek coal estimated at 1025 feet; Pocahontas No. 4 coal estimated at 1470 feet; Pocahontas No. 3 coal estimated at 1490 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	592+	592
Lee Formation	863	1455
Pocahontas Formation	229	1684
Bluestone Formation	516	2200
Pride Shale Member	129	2200
Princeton interval	145	2345
Hinton Formation	585	2930
Little Stone Gap Member	86	2431
Stony Gap Sandstone Member	245	2930
Bluefield Formation	314	3244
Greenbrier Limestone	653	3897

OPERATOR: Clinchfield Coal Company INDEX NO. 106
FARM: David Colley
WELL NO.: 107
LOCATION: 8200 feet S of 37°05′00″
1100 feet W of 82°20′00″
ELEVATION: 1517.4 feet G. L. TOTAL DEPTH: 5804 feet
REPOSITORY NO.: W-143
COALS IDENTIFIED: Raven coal at 190 feet; Jawbone coal at 321 feet; Tiller coal at 354 feet; War Creek coal at 1083 feet; Pocahontas No. 4 coal at 1509 feet; Pocahontas No. 3 coal at 1530 feet; (Kennedy coal estimated at 50 feet above well site)

	Thickness (feet)	Depth to base of unit (feet)
Post-Lee formations	631+	631
Lee Formation	878	1509
Pocahontas Formation	301	1810
Bluestone Formation	538	2348
Pride Shale Member	208	2348
Princeton interval	72	2420
Hinton-Bluefield fms. (undiff.)	686+	?
Little Stone Gap Member	71	2491

OPERATOR: Clinchfield Coal Company INDEX NO. 107
FARM: David Colley
WELL NO.: 204
LOCATION: 12,550 feet S of 37°05′00″
850 feet W of 82°20′00″
ELEVATION: 1888.4 feet G. L. TOTAL DEPTH: 6666 feet
REPOSITORY NO.: W-130
COALS IDENTIFIED: Kennedy coal at 250 feet; Raven coal at 508 feet; Jawbone coal at 658 feet; War Creek coal at 1433 feet; Pocahontas No. 3 coal at 1871 feet

	Thickness (feet)	Depth to base of unit (feet)
Post-Lee formations	965+	965
Lee Formation	900	1865
Pocahontas Formation	300	2165
Bluestone Formation	513	2678
Pride Shale Member	248	2678
Princeton interval	131	2809
Hinton Formation	543	3352
Little Stone Gap Member	90	2899
Stony Gap Sandstone Member	86	3352
Bluefield Formation	430	3782
Greenbrier Limestone	574	4356

OPERATOR: Clinchfield Coal Company INDEX NO. 108
FARM: E. J. Long
WELL NO.: 211
LOCATION: 12,850 feet N of 37°00′00″
50 feet E of 82°20′00″
ELEVATION: 1926.2 feet G. L. TOTAL DEPTH: 4505 feet
REPOSITORY NO.: W-279

COALS IDENTIFIED: Kennedy coal at 217 feet; Jawbone coal at 636 feet; War Creek coal at 1442 feet; Pocahontas No. 3 coal at 2011 feet; (Pocahontas No. 4 coal estimated at 1980 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	955+	955
Lee Formation	1007	1962
Pocahontas Formation	280	2242
Bluestone Formation	514	2756
Pride Shale Member	316	2756
Princeton interval	130	2886
Hinton Formation	534	3420
Little Stone Gap Member	67	2953
Stony Gap Sandstone Member	181	3420
Bluefield Formation	597	4017
Greenbrier Limestone	469	4486

OPERATOR: Clinchfield Coal Company INDEX NO. 109
FARM: Finis E. McCoy
WELL NO.: 145
LOCATION: 11,300 feet N of 37°00′00″
1150 feet E of 82°25′00″
ELEVATION: 2300.4 feet G. L. TOTAL DEPTH: 6431 feet
COALS IDENTIFIED: War Creek coal at 1736 feet; Pocahontas No. 3 coal at 2183 feet (Kennedy coal estimated at 620 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1386+	1386
Lee Formation	797	2183
Pocahontas Formation	273	2456
Bluestone Formation	531	2987
Pride Shale Member	140	2987
Princeton interval	128	3115
Hinton Formation	616	3731
Little Stone Gap Member	80	3195
Stony Gap Sandstone Member	119	3731
Bluefield Formation	211	3942
Greenbrier Limestone	703	4645

OPERATOR: Clinchfield Coal Company INDEX NO. 110
FARM: J. M. Kiser
WELL NO.: 193
LOCATION: 7450 feet N of 37°00′00″
2350 feet E of 82°15′00″
ELEVATION: 2366 feet G. L. TOTAL DEPTH: 7245 feet
COALS IDENTIFIED: Hagy coal at 19 feet; Splash Dam coal at 104 feet; Upper Banner coal at 140 feet; Lower Banner coal at 218 feet; War Creek coal at 1800 feet; Pocahontas No. 4 coal at 2296 feet; Pocahontas No. 3 coal at 2320 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1210+	1210
Lee Formation	1059	2269
Pocahontas Formation	273	2542
Bluestone Formation	628	3170
Pride Shale Member	198	3170
Princeton interval	190	3360
Hinton Formation	677	4037
Little Stone Gap Member	79	3439
Stony Gap Sandstone Member	37	4037
Bluefield Formation	588	4625
Greenbrier Limestone	567	5192

OPERATOR: Clinchfield Coal Company INDEX NO. 111
FARM: Virginia Iron, Coal, and Coke Company
WELL NO.: 215
LOCATION: 3550 feet S of 37°00′00″
10,300 feet E of 82°25′00″
ELEVATION: 2244.0 feet G. L. TOTAL DEPTH: 5481 feet
REPOSITORY NO.: W-402
COALS IDENTIFIED: Upper Banner coal splits at 96 feet and 110 feet; Lower Banner coal splits at 208 feet and 261 feet; Jawbone coal at 875 feet; Tiller coal at 902 feet; Pocahontas No. 4 coal at 2207 feet; Pocahontas No. 3 coal at 2226 feet; (Kennedy coal estimated at 465 feet; War Creek coal estimated at 1650 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1195+	1195
Lee Formation	904	2099
Pocahontas Formation	397	2496

Bluestone Formation	475	2971
Pride Shale Member	254	2971
Princeton interval	159	3130
Hinton Formation	649	3779
Little Stone Gap Member	70	3200
Stony Gap Sandstone Member	117	3779
Bluefield Formation	553	4332
Greenbrier Limestone	520	4852

RUSSELL COUNTY, VIRGINIA

CORE NAME: Lewis Creek INDEX NO. 112

LOCATION: 2300 feet S of 37°07′30″
1700 feet E of 82°00′00″

ELEVATION: 2340 feet G. L. approximate

TOTAL DEPTH: 2364 feet

COALS IDENTIFIED: Aily coal at 166 feet; Raven coal at 271 feet; Jawbone coal at 457 feet; Tiller coal at 599 feet; Greasy Creek coal at 880 feet; Middle Seaboard coal at 992 feet; Lower Seaboard coal at 1043 feet; Upper Horsepen coal at 1154 feet; Middle Horsepen coal at 1228 feet; War Creek coal at 1340 feet; Lower Horsepen coal at 1452 feet; Pocahontas No. 9 coal at 1511 feet; Pocahontas No. 7 coal at 1685 feet; Pocahontas No. 6 coal at 1809 feet; Pocahontas No. 4 coal at 1894 feet; Pocahontas No. 3 coal at 1956 feet; (Kennedy coal estimated to be less than 10 feet above well site)

	Thickness (feet)	*Depth to base of unit (feet)*
New River Formation	1548+	1548
Pocahontas Formation	710	2258

OPERATOR: Penn-Ohio Gas Company INDEX NO. 113

FARM: Clinchfield Coal Company

WELL NO.: 1 (272)

LOCATION: 10,550 feet N of 37°00′00″
6000 feet E of 82°10′00″

ELEVATION: 2075 feet G. L. TOTAL DEPTH: 6160 feet

REPOSITORY NO.: W-2901

COALS IDENTIFIED: Jawbone coal splits at 55 feet and 65 feet; Tiller coal at 74 feet; War Creek coal at 949 feet; Pocahontas No. 7 coal at 1476 feet; Pocahontas No. 6 coal at 1564 feet; Pocahontas No. 4 coal at 1785 feet; Pocahontas No. 3 coal at 1800 feet

	Thickness (feet)	Depth to base of unit (feet)
Post-Lee formations	?	?
Lee Formation	?	1463
Pocahontas Formation	502	1965
Bluestone Formation	493	2458
Pride Shale Member	178	2458
Princeton interval	123	2581
Hinton-Bluefield fms. (undiff.)	1451	4032
Little Stone Gap Member	100+	2681
Greenbrier Limestone	585	4617

OPERATOR: Clinchfield Coal Company INDEX NO. 114
FARM: John W. LaForce
WELL NO.: 182
LOCATION: 1000 feet S of 37°00′00″
11,000 feet W of 82°10′00″
ELEVATION: 1880.7 feet G. L. TOTAL DEPTH: 6950 feet
COALS IDENTIFIED: Jawbone coal at 210 feet; Tiller coal at 267 feet; Pocahontas No. 5 coal at 1873 feet; Pocahontas No. 4 coal at 1896 feet; Pocahontas No. 3 coal at 1954 feet; (War Creek coal estimated at 1140 feet)

	Thickness (feet)	Depth to base of unit (feet)
Post-Lee formations	560+	560
Lee Formation	1080	1640
Pocahontas Formation	477	2117
Bluestone Formation	495	2612
Pride Shale Member	212	2612
Princeton interval	201	2813
Hinton Formation	677	3490
Little Stone Gap Member	105	2918
Stony Gap Sandstone Member	120	3490
Bluefield Formation	471	3961
Greenbrier Limestone	858	4819

WISE COUNTY, VIRGINIA

OPERATOR: Clinchfield Coal Company INDEX NO. 115
FARM: J. T. Chase
WELL NO.: 163

LOCATION: 7950 feet S of 37°05′00″
11,600 feet W of 82°35′00″
ELEVATION: 1942.3 feet G. L. TOTAL DEPTH: 5248 feet
COALS IDENTIFIED: Clintwood coal at 90 feet; Blair coal at 143 feet; Aily coal at 1076 feet; War Creek coal absent (Kennedy coal estimated at 950 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1002+	1002
Lee Formation	1448	2450
Pocahontas Formation	absent	
Bluestone Formation	218	2668
Pride Shale Member	218	2668
Princeton interval	112	2780
Hinton Formation	282	3062
Little Stone Gap Member	59	2839
Stony Gap Sandstone Member	135	3062
Bluefield Formation	266	3328
Greenbrier Limestone	472	3800

OPERATOR: Clinchfield Coal Company INDEX NO. 116
FARM: Virginia Coal and Iron Company
WELL NO.: 143
LOCATION: 13,000 feet S of 37°05′00″
10,900 feet W of 82°40′00″
ELEVATION: 2225.3 feet G. L. TOTAL DEPTH: 5349 feet
REPOSITORY NO.: W-146
COALS IDENTIFIED: War Creek coal at 2530 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Lee Formation	?	2933
Pocahontas Formation	absent	
Bluestone Formation	157	3090
Pride Shale Member	157	3090
Princeton interval	61	3151
Hinton Formation	356	3507
Little Stone Gap Member	14	3165
Stony Gap Sandstone Member	65	3507
Bluefield Formation	233	3740
Greenbrier Limestone	425	4165

OPERATOR: Clinchfield Coal Company INDEX NO. 117
FARM: Virginia Coal and Iron Company
WELL NO.: 180
LOCATION: 6000 feet N of 37°00′00″
8400 feet E of 82°45′00″
ELEVATION: 2386.6 feet G. L. TOTAL DEPTH: 5596 feet
COALS IDENTIFIED: Kelly coal at 566 feet; Imboden coal at 625 feet; Kennedy coal at 1685 feet; (War Creek coal estimated at 2700 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1702+	1702
Lee Formation	1377	3079
Pocahontas Formation	absent	
Bluestone Formation	282	3361
Pride Shale Member	282	3361
Hinton Formation	457	3818
Little Stone Gap Member	20	3381
Stony Gap Sandstone Member	194	3818
Bluefield Formation	125	3943
Greenbrier Limestone	517	4460

OPERATOR: Clinchfield Coal Company INDEX NO. 118
FARM: Virginia Coal and Iron Company
WELL NO.: 216
LOCATION: 7050 feet N of 37°00′00″
11,650 feet E of 82°40′00″
ELEVATION: 2372.3 feet G. L. TOTAL DEPTH: 4056 feet
REPOSITORY NO.: W-418
COALS IDENTIFIED: Norton coal at 228 feet; Kennedy coal at 915 feet; War Creek coal absent

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	919+	919
Lee Formation	1352	2271
Pocahontas Formation	absent	
Bluestone Formation	407	2678
Pride Shale Member	231	2678
Princeton interval	153	2831
Hinton Formation	367	3198
Little Stone Gap Member	50	2881
Stony Gap Sandstone Member	128	3198
Bluefield Formation	273	3471
Greenbrier Limestone	504	3975

OPERATOR: Clinchfield Coal Company INDEX NO. 119
FARM: Virginia Coal and Iron Company
WELL NO.: 144
LOCATION: 1200 feet N of 37°00′00″
8500 feet E of 82°40′00″
ELEVATION: 2322.9 feet G. L. TOTAL DEPTH: 4006 feet
REPOSITORY NO.: W-340
COALS IDENTIFIED: Dorchester coal at 53 feet; Norton coal at 150 feet; Kennedy coal at 810 feet; War Creek coal absent

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	834+	834
Lee Formation	1376	2210
Pocahontas Formation	absent	
Bluestone Formation	393	2603
Pride Shale Member	163	2603
Princeton interval	?	?
Hinton Formation	?	?
Bluefield Formation	?	3402
Greenbrier Limestone	543	3945

CORE NAME: Rocky Fork INDEX NO. 120
LOCATION: 850 feet N of 37°00′00″
4200 feet E of 82°37′30″
ELEVATION: 2200 feet G. L. approximate
TOTAL DEPTH: 2525 feet
COALS IDENTIFIED: Clintwood coal at 40 feet; Blair coal at 117 feet; Dorchester coal at 185 feet; Norton coal at 279 feet; Hagy coal at 535 feet; Splash Dam coal at 638 feet; Kennedy coal at 972 feet; Jawbone coal at 1274 feet; Tiller coal absent; War Creek coal at 2058 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1010+	1010
Lee Formation	1502	2512
Pocahontas Formation	absent	

OPERATOR: Clinchfield Coal Company INDEX NO. 121
FARM: Dunn Coal and Land Company
WELL NO.: 148

LOCATION: 1750 feet N of 37°00′00″
5600 feet E of 82°30′00″
ELEVATION: 1873.8 feet G. L. TOTAL DEPTH: 5738 feet
COALS IDENTIFIED: Jawbone coal at 536 feet; War Creek coal at 1305 feet; Pocahontas No. 4 coal at 1730 feet; Pocahontas No. 3 coal at 1740 feet; (Kennedy coal estimated at 120 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	816+	816
Lee Formation	906	1722
Pocahontas Formation	213	1935
Bluestone Formation	579	2514
Pride Shale Member	200	2514
Princeton interval	68	2582
Hinton Formation	684	3266
Little Stone Gap Member	85	2667
Stony Gap Sandstone Member	177	3266
Bluefield Formation	349	3615
Greenbrier Limestone	395	4100

OPERATOR: Clinchfield Coal Company INDEX NO. 122
FARM: Virginia Coal and Iron Company
WELL NO.: 217
LOCATION: 13,500 feet S of 37°00′00″
10,250 feet W of 82°45′00″
ELEVATION: 2049.5 feet G. L. TOTAL DEPTH: 5364 feet
REPOSITORY NO.: W-566
COALS IDENTIFIED: Dorchester coal at 779 feet; War Creek coal at 2482 feet; (Kennedy coal estimated at 1400 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1455+	1455
Lee Formation	1450	2905
Pocahontas Formation	absent	
Bluestone Formation	155	3060
Pride Shale Member	155	3060
Princeton interval	66	3126
Hinton Formation	359	3485
Little Stone Gap Member	35	3161
Stony Gap Sandstone Member	140	3485
Bluefield Formation	300	3785
Greenbrier Limestone	470	4255

CORE NAME: Callahan Creek INDEX NO. 123
LOCATION: 15,100 feet S of 37°00′00″
8000 feet W of 82°45′00″
ELEVATION: 1891.54 feet G. L. TOTAL DEPTH: 2696 feet
COALS IDENTIFIED: Blair coal at 284 feet; Lyons coal at 366 feet; Dorchester coal at 423 feet; Norton coal at 484 feet; Jawbone coal absent; War Creek coal at 2135 feet (Kennedy coal estimated at 1055 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1056+	1056
Lee Formation	1524	2580
Pocahontas Formation	absent	

OPERATOR: New York Mining and Manufacturing Company INDEX NO. 124
FARM: Graham
WELL NO.: 1
LOCATION: 12,950 feet N of 36°55′00″
1550 feet W of 82°40′00″
ELEVATION: 2136 feet G. L. TOTAL DEPTH: 6057 feet
REPOSITORY NO.: W-1249
COALS IDENTIFIED: Hagy coal at 178 feet; Splash Dam coal at 258 feet; Lower Banner coal at 466 feet; Kennedy coal at 643 feet; Jawbone coal at 911 feet; Tiller coal at 1016 feet; War Creek coal absent; (Norton coal estimated at 40 feet above well site)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	702+	702
Lee Formation	1401	2103
Pocahontas Formation	absent	
Bluestone Formation	472	2575
Pride Shale Member	221	2575
Princeton interval	150	2725
Hinton Formation	290	3015
Little Stone Gap Member	75	2800
Stony Gap Sandstone Member	159	3015
Bluefield Formation	413	3428
Greenbrier Limestone	437	3865

CORE NAME: Bear Creek INDEX NO. 125
LOCATION: 700 feet S of 36°57′30″
1000 feet E of 82°35′00″
ELEVATION: 2070 feet G. L. TOTAL DEPTH: 748 feet
COALS IDENTIFIED: Upper Banner coal at 52 feet; Lower Banner coal at 128 feet; Kennedy coal at 395 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	432+	432
Lee Formation	?	?

OPERATOR: Clinchfield Coal Company INDEX NO. 126
FARM: Wise Development Company
WELL NO.: 187
LOCATION: 14,550 feet N of 36°55′00″
4800 feet E of 82°35′00″
ELEVATION: 2197.7 feet G. L. TOTAL DEPTH: 5914 feet
COALS IDENTIFIED: Splash Dam coal at 42 feet; Raven coal at 848 feet; Jawbone coal at 945 feet; War Creek coal at 1943 feet; (Kennedy coal estimated at 500 feet)

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	692+	692
Lee Formation	1638	2330
Pocahontas Formation	absent	
Bluestone Formation	547	2877
Pride Shale Member	170	2877
Princeton interval	151	3028
Hinton Formation	506	3534
Little Stone Gap Member	55	3083
Stony Gap Sandstone Member	110	3534
Bluefield Formation	436	3970
Greenbrier Limestone	464	4434

CORE NAME: Whiteoak Branch INDEX NO. 127
LOCATION: 4150 feet S of 36°57′30″
800 feet E of 82°32′30″
ELEVATION: 2110 feet G. L. TOTAL DEPTH: 770 feet
COALS IDENTIFIED: Kennedy coal splits at 249 feet and 270 feet; Raven coal at 546 feet; Jawbone coal at 630 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	770+	?

CORE NAME: Toms Creek INDEX NO. 128
LOCATION: 3200 feet N of 36°57′30″
750 feet E of 82°27′30″
ELEVATION: 2014.23 feet TOTAL DEPTH: 2174 feet
COALS IDENTIFIED: Kennedy coal at 179 feet; Aily coal splits at 284 feet and 309 feet; Raven coal at 440 feet; Jawbone coal splits at 557 feet, 567 feet and 595 feet; Tiller coal absent; War Creek coal at 1410 feet; Pocahontas No. 5 coal at 1524 feet; Pocahontas No. 4 coal at 1819 feet; Pocahontas No. 3 coal at 1843 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	905+	905
Lee Formation	914	1819
Pocahontas Formation	294	2113

OPERATOR: Clinchfield Coal Company INDEX NO. 129
FARM: Virginia Iron, Coal, and Coke Company
WELL NO.: 207
LOCATION: 9800 feet S of 37°00′00″
4750 feet W of 82°25′00″
ELEVATION: 2099.44 feet G. L. TOTAL DEPTH: 6277 feet
REPOSITORY NO.: W-131
COALS IDENTIFIED: Kennedy coal at 300 feet; Aily coal at 410 feet; Raven coal at 539 feet; Jawbone coal at 741 feet; War Creek coal at 1553 feet; Pocahontas No. 3 coal at 1998 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1047+	1047
Lee Formation	923	1970
Pocahontas Formation	309	2279
Bluestone Formation	483	2762
Pride Shale Member	159	2762
Princeton interval	?	?
Hinton Formation	?	3410
Stony Gap Sandstone Member	68	3410
Bluefield Formation	723	4133
Greenbrier Limestone	471	4604

CORE NAME: Little Creek INDEX NO. 130
LOCATION: 1000 feet N of 37°57′30″
1400 feet W of 82°25′00″
ELEVATION: 2089.55 feet TOTAL DEPTH: 2198 feet
COALS IDENTIFIED: Kennedy coal at 173 feet; Aily coal splits at 302 feet and 324 feet; Raven coal at 438 feet; Jawbone coal splits at 565 feet, 569 feet, 573 feet; Tiller coal at 679 feet; War Creek coal at 1412 feet; Pocahontas No. 3 coal at 1869 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	892+	892
Lee Formation	977	1869
Pocahontas Formation	311	2180

CORE NAME: Russell Creek INDEX NO. 131
LOCATION: 4900 feet N of 36°55′00″
950 feet E of 82°20′00″
ELEVATION: 1643.32 feet TOTAL DEPTH: 2035 feet
COALS IDENTIFIED: Raven coal estimated at 30 feet above core site; Jawbone coal splits at 107 feet and 131 feet; Tiller coal splits at 158 feet and 188 feet; War Creek coal at 1073 feet; Pocahontas No. 5 coal at 1525 feet; Pocahontas No. 4 coal at 1654 feet; Pocahontas No. 3 coal at 1690 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	436+	436
Lee Formation	1089	1525
Pocahontas Formation	484	2009

SCOTT COUNTY, VIRGINIA

CORE NAME: Little Stoney Creek INDEX NO. 132
LOCATION: 1650 feet S of 36°52′30″
700 feet E of 82°27′30″
ELEVATION 2200 feet G. L. approximate TOTAL DEPTH: 1546 feet
COALS IDENTIFIED: War Creek coal at 658 feet; Pocahontas No. 4 coal at 1153 feet; Pocahontas No. 3 coal at 1189 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Lee Formation	1148+	1148
Pocahontas Formation	372	1520

KENTUCKY

OPERATOR: Columbia Gas Transmission Corporation — INDEX NO. 133
FARM: Berwind Corporation
WELL NO.: 9617
LOCATION: 3200 feet N of 37°27′30″
2350 feet E of 82°07′30″
ELEVATION: 1264.59 feet G. L. — TOTAL DEPTH: 3100 feet
COALS IDENTIFIED: None

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	630+	630
Lee Formation	1255	1885
Bluestone Formation	160	2045
Pride Shale Member	90	2045
Princeton interval	60	2105
Hinton-Bluefield fms. (undiff.)	520	2625
Greenbrier Limestone	412	3037

OPERATOR: United Fuel Gas Company — INDEX NO. 134
FARM: Berwind Corporation
WELL NO.: 9618
LOCATION: 2600 feet S of 37°27′30″
1750 feet W of 82°07′30″
ELEVATION: 1518.73 feet G. L. — TOTAL DEPTH: 3342 feet
COALS IDENTIFIED: None

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	818+	818
Lee Formation	1342	2160
Bluestone Formation	135	2295
Pride Shale Member	90	2295
Princeton interval	72	2367
Hinton-Bluefield fms. (undiff.)	551	2918
Greenbrier Limestone	384	3302

OPERATOR: United Fuel Gas Company INDEX NO. 135
FARM: Kentland Coal and Coke Company
WELL NO.: 9477
LOCATION: 6700 feet N of 37°25′00″
250 feet E of 82°10′00″
ELEVATION: 1463.84 feet G. L. TOTAL DEPTH: 3940 feet
COALS IDENTIFIED: None

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	755+	755
Lee Formation	1307	2062
Bluestone Formation	158	2220
Pride Shale Member	120	2220
Princeton interval	83	2303
Hinton-Bluefield fms. (undiff.)	504	2807
Greenbrier Limestone	407	3214

OPERATOR: United Fuel Gas Company INDEX NO. 136
FARM: Kentland Coal and Coke Company
WELL NO.: 9411
LOCATION: 800 feet N of 37°24′00″
2500 feet W of 82°10′00″
ELEVATION: 1431.05 feet G. L. TOTAL DEPTH: 3915 feet
COALS IDENTIFIED: None

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	613+	613
Lee Formation	1325	1938
Bluestone Formation	212	2150
Pride Shale Member	100	2150
Princeton interval	115	2265
Hinton-Bluefield fms. (undiff.)	482	2747
Greenbrier Limestone	428	3175

OPERATOR: United Fuel Gas Company INDEX NO. 137
FARM: Kentland Coal and Coke Company
WELL NO.: 9440
LOCATION: 3500 feet N of 37°25′00″
6600 feet E of 82°15′00″
ELEVATION: 1228.25 feet G. L. TOTAL DEPTH: 3727 feet

COALS IDENTIFIED: None

	Thickness (feet)	Depth to base of unit (feet)
Post-Lee formations	695+	695
Lee Formation	1184	1879
Bluestone Formation	87	1966
Pride Shale Member	87	1966
Princeton interval	89	2055
Hinton-Bluefield fms. (undiff.)	520	2575
Greenbrier Limestone	394	2969

OPERATOR: United Fuel Gas Company INDEX NO. 138
FARM: Berwind Corporation
WELL NO.: 9520
LOCATION: 1500 feet S of 37°25′00″
2100 feet W of 82°12′30″
ELEVATION: 1239 feet G. L. TOTAL DEPTH: 3733 feet
COALS IDENTIFIED: None

	Thickness (feet)	Depth to base of unit (feet)
Post-Lee formations	529+	529
Lee Formation	1211	1740
Bluestone Formation	235	1975
Pride Shale Member	117	1975
Princeton interval	45	2020
Hinton-Bluefield fms. (undiff.)	550	2570
Greenbrier Limestone	423	2993

OPERATOR: United Fuel Gas Company INDEX NO. 139
FARM: Kentland Coal and Coke Company
WELL NO.: 9426
LOCATION: 4800 feet S of 37°25′00″
6300 feet W of 82°10′00″
ELEVATION: 1401.95 feet G. L. TOTAL DEPTH: 3909 feet
COALS IDENTIFIED: None

	Thickness (feet)	Depth to base of unit (feet)
Post-Lee formations	675+	675
Lee Formation	1185	1860
Bluestone Formation	260	2120

Pride Shale Member	100	2120
Princeton interval	75	2195
Hinton-Bluefield fms. (undiff.)	578	2773
Greenbrier Limestone	337	3110

OPERATOR: United Fuel Gas Company INDEX NO. 140
FARM: James Thorneberry
WELL NO.: 9424
LOCATION: 2600 feet N of 37°22′30″
14,000 feet E of 82°15′00″
ELEVATION: 1280.97 feet G. L. TOTAL DEPTH: 3736 feet
COALS IDENTIFIED: None

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	505+	505
Lee Formation	1210	1715
Bluestone Formation	245	1960
Pride Shale Member	91	1960
Princeton interval	67	2027
Hinton-Bluefield fms. (undiff.)	593	2620
Greenbrier Limestone	395	3015

OPERATOR: United Fuel Gas Company INDEX NO. 141
FARM: Nikitie Flannery
WELL NO.: 9565
LOCATION: 2600 feet N of 37°22′30″
2100 feet E of 82°15′00″
ELEVATION: 1114 feet G. L. TOTAL DEPTH: 3618 feet
COALS IDENTIFIED: None

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	390+	390
Lee Formation	1222	1612
Bluestone Formation	251	1863
Pride Shale Member	108	1863
Princeton interval	80	1943
Hinton-Bluefield fms. (undiff.)	517	2460
Greenbrier Limestone	377	2837

OPERATOR: United Fuel Gas Company INDEX NO. 142
FARM: Berwind Corporation
WELL NO.: 9600
LOCATION: 3400 feet S of 37°22′30″
3950 feet W of 82°15′00″
ELEVATION: 1112.10 feet G. L. TOTAL DEPTH: 3662 feet
COALS IDENTIFIED: None

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	430+	430
Lee Formation	1170	1600
Bluestone Formation	155	1755
Pride Shale Member	65	1755
Princeton interval	10	1765
Hinton-Bluefield fms. (undiff.)	681	2446
Greenbrier Limestone	374	2820

OPERATOR: United Fuel Gas Company INDEX NO. 143
FARM: J. S. Cline
WELL NO.: 9482
LOCATION: 5300 feet S of 37°22′30″
2100 feet E of 82°15′00″
ELEVATION: 1556.36 feet G. L. TOTAL DEPTH: 4115 feet
COALS IDENTIFIED: None

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	782+	782
Lee Formation	1245	2027
Bluestone Formation	225	2252
Pride Shale Member	126	2252
Princeton interval	97	2349
Hinton-Bluefield fms. (undiff.)	563	2912
Greenbrier Limestone	400	3312

OPERATOR: United Fuel Gas Company INDEX NO. 144
FARM: G. C. Rowe
WELL NO.: 9526
LOCATION: 7600 feet N of 37°20′00″
2250 feet W of 82°15′00″
ELEVATION: 1352.73 feet G. L. TOTAL DEPTH: 3891 feet
COALS IDENTIFIED: None

	Thickness (feet)	Depth to base of unit (feet)
Post-Lee formations	602+	602
Lee Formation	1300	1902
Bluestone Formation	78	1980
Pride Shale Member	78	1980
Princeton interval	135	2115
Hinton-Bluefield fms. (undiff.)	545	2660
Greenbrier Limestone	375	3035

OPERATOR: United Fuel Gas Company INDEX NO. 145
FARM: Kentland Coal and Coke Company
WELL NO.: 9418
LOCATION: 7500 feet S of 37°22′30″
4300 feet E of 82°22′30″
ELEVATION: 1139.85 feet G. L. TOTAL DEPTH: 4495 feet
COALS IDENTIFIED: None

	Thickness (feet)	Depth to base of unit (feet)
Post-Lee formations	626+	626
Lee Formation	1187	1813
Bluestone Formation	142	1955
Pride Shale Member	142	1955
Princeton interval	15	1970
Hinton-Bluefield fms. (undiff.)	512	2482
Greenbrier Limestone	323	2805

OPERATOR: United Fuel Gas Company INDEX NO. 146
FARM: Kentland Coal and Coke Company
WELL NO.: 9421
LOCATION: 3900 feet N of 37°20′00″
4500 feet W of 82°20′00″
ELEVATION: 985.36 feet G. L. TOTAL DEPTH: 3466 feet
COALS IDENTIFIED: None

	Thickness (feet)	Depth to base of unit (feet)
Post-Lee formations	403+	403
Lee Formation	1228	1631
Bluestone Formation	130	1761
Pride Shale Member	130	1761

Princeton interval	26	1787
Hinton-Bluefield fms. (undiff.)	512	2299
Greenbrier Limestone	380	2679

OPERATOR: United Fuel Gas Company INDEX NO. 147
FARM: Kentland Coal and Coke Company
WELL NO.: 9423
LOCATION: 1500 feet N of 37°20′00″
9800 feet W of 82°20′00″
ELEVATION: 915.88 feet G. L. TOTAL DEPTH: 4296 feet
COALS IDENTIFIED: None

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	311+	311
Lee Formation	1224	1535
Bluestone Formation	150	1685
Pride Shale Member	150	1685
Princeton interval	66	1751
Hinton-Bluefield fms. (undiff.)	459	2210
Greenbrier Limestone	421	2631

WEST VIRGINIA

CORE NAME: Panther Creek INDEX NO. 148
LOCATION: 5100 feet S of 37°22′30″
2600 feet E of 81°52′30″
ELEVATION: 1535 feet G. L. approximate TOTAL DEPTH: 1682 feet
COALS IDENTIFIED: Jawbone coal at 196 feet; Tiller coal at 287 feet; Upper Seaboard coal at 482 feet; Greasy Creek coal at 513 feet; Middle Seaboard coal at 574 feet; Lower Seaboard coal at 594 feet; Upper Horsepen coal at 665 feet; Middle Horsepen coal at 713 feet; War Creek coal at 872 feet; Lower Horsepen coal at 997 feet; Pocahontas No. 9 coal at 1062 feet; Pocahontas No. 7 coal at 1260 feet; Pocahontas No. 6 coal at 1309 feet; Pocahontas No. 5 coal at 1403 feet; Pocahontas No. 4 coal at 1447 feet; Pocahontas No. 3 coal at 1496 feet

	Thickness (feet)	*Depth to base of unit (feet)*
Post-Lee formations	1137+	1137
Lee Formation	109	1246
Pocahontas Formation	400	1646

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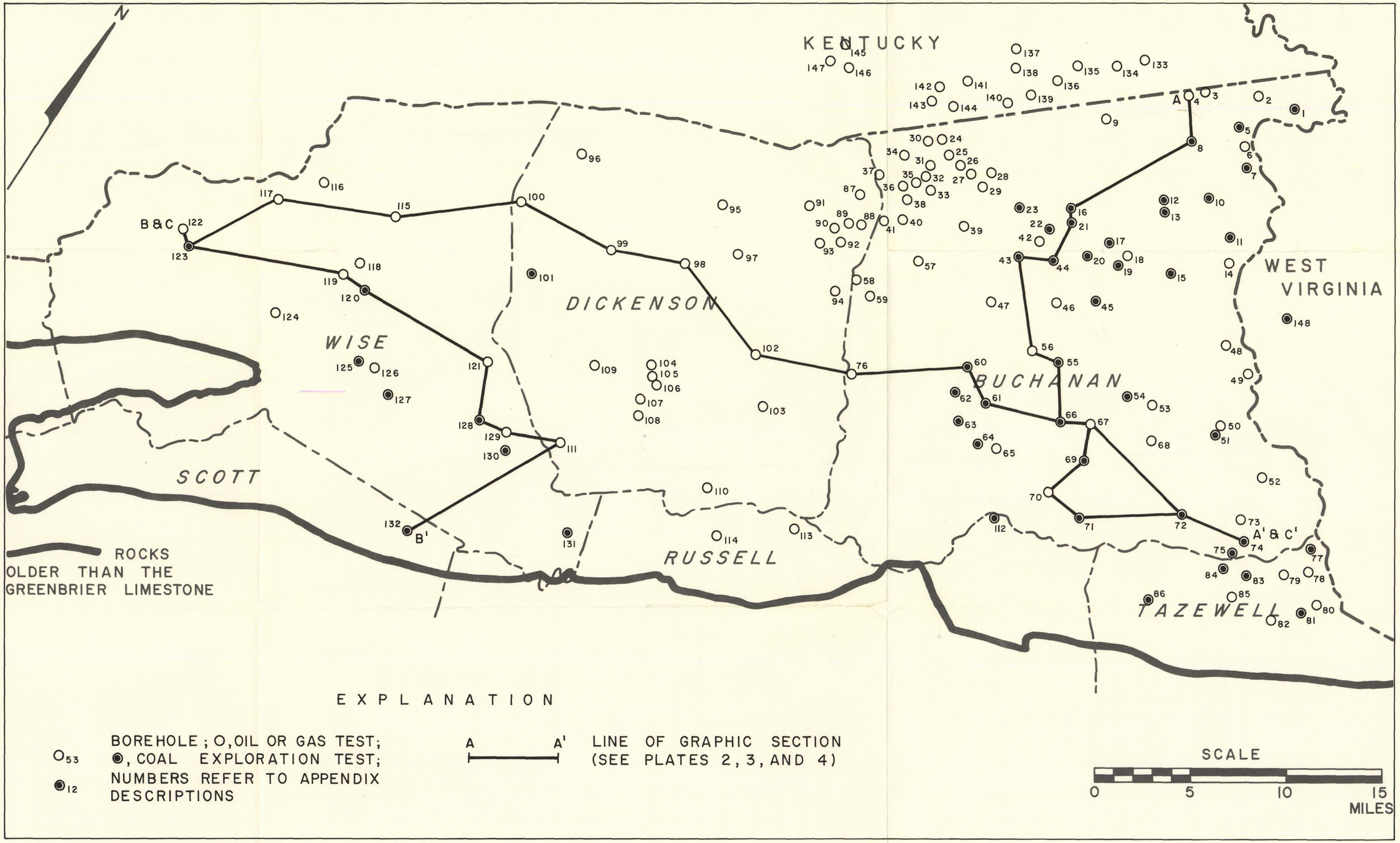
COMMONWEALTH OF VIRGINIA
DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT
DIVISION OF MINERAL RESOURCES
James L. Calver
Commissioner of Mineral Resources and State Geologist



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UPPER MISSISSIPPIAN AND LOWER PENNSYLVANIAN ROCKS OF SOUTHWESTERN VIRGINIA
BY MARSHALL S. MILLER
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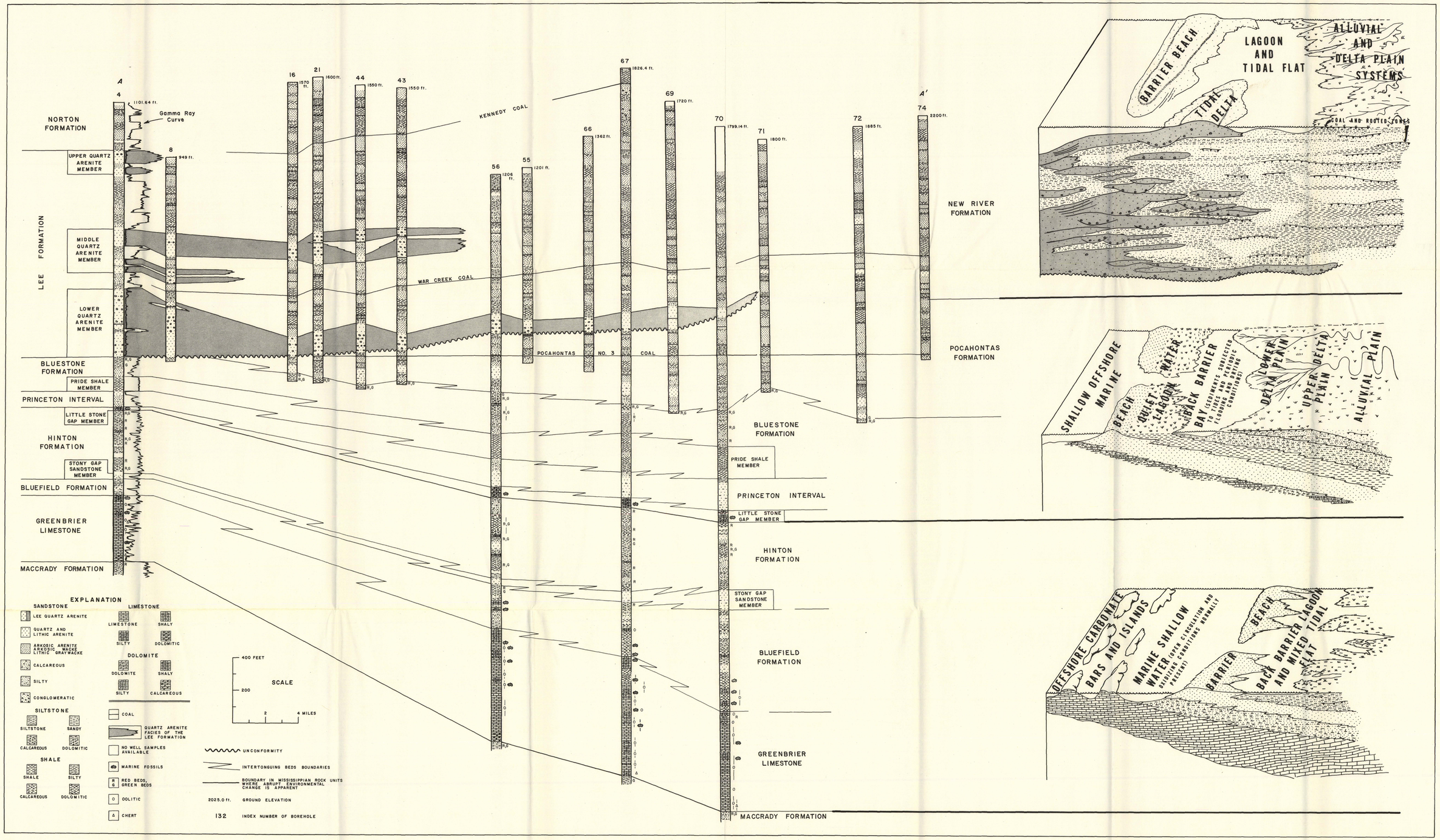
James L. Calver
Commissioner of Mineral Resources and State Geologist



GRAPHIC SECTION ALONG LINE A-A', AND DEPOSITIONAL MODELS, UPPER MISSISSIPPIAN AND LOWER PENNSYLVANIAN ROCKS OF SOUTHWESTERN VIRGINIA

By Marshall S. Miller
1974

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT
DIVISION OF MINERAL RESOURCES
James L. Calver
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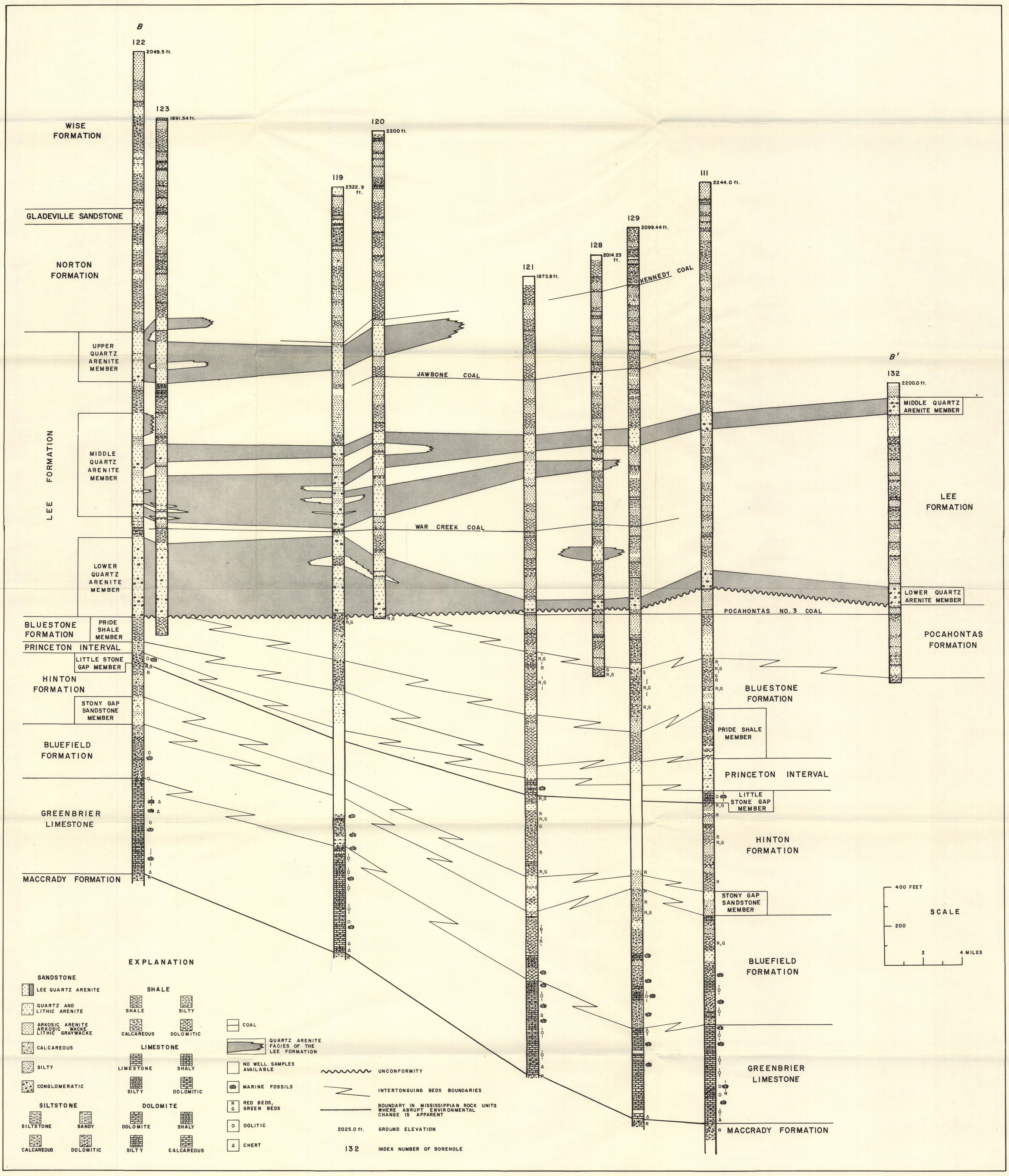

GRAPHIC SECTION ALONG LINE B-B', UPPER MISSISSIPPIAN AND LOWER PENNSYLVANIAN ROCKS OF SOUTHWESTERN VIRGINIA

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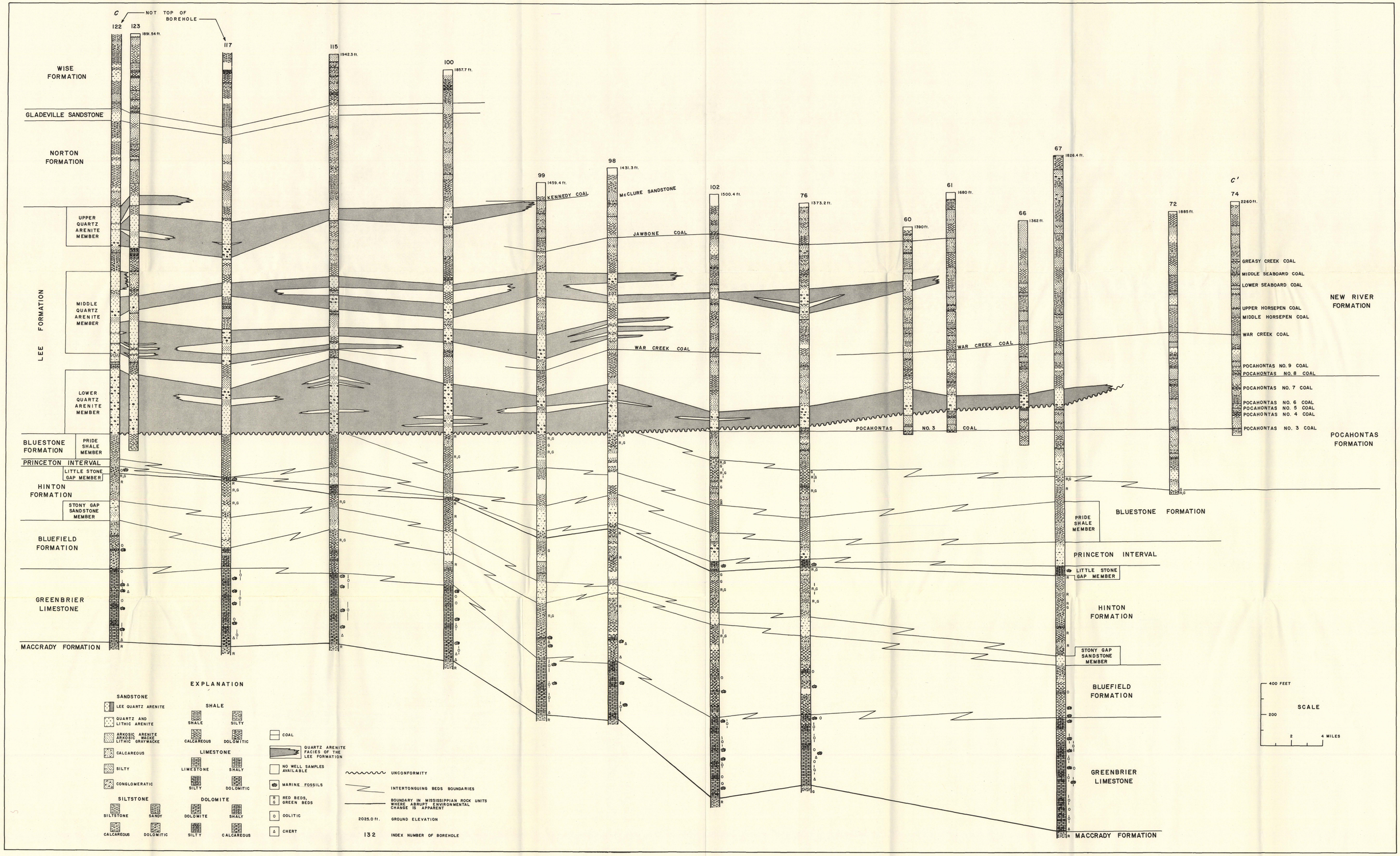

GRAPHIC SECTION ALONG LINE C-C', UPPER MISSISSIPPIAN AND LOWER PENNSYLVANIAN ROCKS OF SOUTHWESTERN VIRGINIA

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