FRED W. WALKER
Director
RALD F. MOORE
Deputy Director

DIVISIONS
FORESTRY
LITTER CONTROL
MINED LAND RECLAMATION
MINERAL RESOURCES
PARKS
VIRGINIA STATE TRAVEL SERVICE
PROGRAM
SALT WATER SPORT FISHING

COMMONWEALTH of VIRGINIA

DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT
DIVISION OF MINERAL RESOURCES
NATURAL RESOURCES BUILDING
McCORMICK ROAD
BOX 3667, CHARLOTTESVILLE, VA. 22903
(804) 293-5121
ROBERT C. MILICI, COMMISSIONER AND STATE GEOLOGIST

December 21, 1979

Dr. J. Richard Lucas
Dept. of Mining and Minerals
Engineering
213 Holden Hall
VPI & SU
Blacksburg, VA 24061

Dear Dick:

Here are four copies of our compilation of the geology and coal resources of the Richmond basin, which was performed under contract 80-405-001. The composite aeromagnetic map to be included with the report is currently at the shop and will be sent to you shortly to be include with the package.

We commonly have requests concerning the Richmond basin, and plan to put the report on open-file in our library after the first of the year. Please advise me if there are any restrictions concerning distribution of the report at this time.

Sincerely,

RCM

Robert C. Milici
Commissioner

RCM/am

Enc.

VIRGINIA DIVISION OF MINERAL RESOURCES
BOX 3667
CHARLOTTESVILLE, VIRGINIA

GEOLOGY AND COAL RESOURCES of the RICHMOND TRIASSIC BASIN

DECEMBER 1979

Performed under contract number 80-405-001
for the Department of Mining Engineering,
Virginia Polytechnic Institute and State
University

GEOLOGY OF THE RICHMOND BASIN

by: Bruce K. Goodwin
and
Kathleen M. Farrell

CONTENTS

ILLUSTRATIONS

Also included with this report are geologic maps of the Richmond basin within the Hallsboro, Fine Creek Mills, Clayville, Mannboro, Winterpock, Church Road, and Hebron 7.5 minute quadrangles, and a structural cross-section from Winterpock to the western margin of the basin.

THE RICHMOND BASIN

INTRODUCTION

Although coal was first reported in the Richmond basin as early as 1701, active mining began around 1750 (Nicolls, 1904), and mining contined on a commercial scale until the early 1920's, details of the stratigraphy, structure, and coal and gas reserves of the basin are not well understood. Old reports of mining activity are fragmentary and undoubtedly many old records have been lost. Also, since the comprehensive report of Shaler and Woodworth (1899), the basin has received little attention in the way of geologic investigations. Goodwin (1970) mapped the northern third of the basin, but the remainder has not been mapped since 1899, and never in detail. In recent years, the national energy need has created a necessity to carefully evaluate every known or potential source of energy within the country. Since the Richmond basin has produced coal in the past it is now mandatory to determine the quality, quantity and geologic setting of coal remaining within that basin. Natural gas may also occur within or in association with these coals. This possibility has added impetus to the need for a thorough study of the basin's coal and gas potential. Also the close proximity of the basin to the Richmond metropolitan area provides a ready market for any energy sources which might be derived from the basin.

Before details of the basin can be unravelled, it is necessary to summarize what has been determined about the basin in the past and to lay a broad framework into which later detailed investigations can be interwoven most effectively. This report is an attempt to summarize the existing knowledge about the stratigraphy, structure, and coal measures of the Richmond basin. A field reconnaisance with an emphasis on the basinal outline, the broad basinal structure, the extent of the coal measures, location of coal mines and prospect pits, and the gross stratigraphy of the southern two thirds of the basin was conducted in August,

September, October, and November, 1979. This mapping was on a scale of 1:24,000 using 7.5 minute topographic maps as a base. Concurrently, an extensive literature search was conducted and information from it was used to complement the field studies. Unfortunately time did not allow detailed field investigations and these must await a later date. Most of the information presented here has been obtained from the literature and this has been amplified and in some cases clarified by the recent field work. Hopefully it will summarize what is now known about the basin and will provide a basis for further study.

LOCATION AND CULTURAL FEATURES

The Richmond basin is located approximately 12 miles west of Richmond, Virginia. It is 33 miles long, has a maximum width of 9.5 miles, and encompasses a total area of about 170 square miles. Its entire extent is encompassed by parallels 37° 13' 45" and 37° 41' 40" north latitude and meridians 77° 37' 10" and 77° 50' 30" west longitude. Most of its area lies within Chesterfield County, but it also includes portions of Amelia, Goochland, Henrico, and Powhatan Counties. Ten 7.5 minute quadrangles contain parts of the basin. These are the Bon Air, Clayville, Church Road, Fine Creek Mills, Hallsboro, Hebron, Hylas, Mannboro, Midlothian, and Winterpock quadrangles. A small subsidiary basin to the east of the main basin lies within the Glen Allen quadrangle. Midlothian is the largest town in the area. Urbanization, spreading west and southwest from the Richmond metropolitan area is rapidly encroaching upon the basin. Numerous housing developments occur north of the James River, south of the James River near Midlothian and at the eastern end of Swift Creek Reservoir. Elsewhere, small communities occur at Winterpock, Skinquarter, Moseley, and Hallsboro.

Five major highways traverse the basin from east to west. These are Interstate 64, U. S. Highway 250 and State Highway 6 north of the James River and U. S. Highway 60 and U. S. Highway 360 south of the James River. A network of

State roads exist between the major highway. The Chesapeake and Ohio Railway crosses the area adjacent to the north side of the James River and the Southern Railway extends from Midlothian to Moseley. Both railways and all five major highways lead to Richmond. Several gas pipelines cut across the basin both north and south of the James River.

GEOGRAPHY AND PHYSIOGRAPHY

The Richmond basin is part of the Triassic lowland subprovince within the Piedmont physiographic province. It is composed of Triassic sedimentary rocks cut by a few diabase dikes. Much older crystalline igneous and metamorphic rocks surround the Richmond basin with Petersburg granite occurring along much of the eastern margin and gneisses and cataclastic rocks bordering it to the west. The basin, as well as the surrounding crystalline rocks, is characterized by a low, gently rolling terrain and presents a mature topography. Steepest slopes occur adjacent to the major streams. Deep weathering has produced a thick residual soil that obscures the bedrock and the upper portions of the bedrock have often been decomposed to a deep saprolite. Although most of the minerals in the saprolite have been reduced to clay and the material is soft and easily removed, the outlines of the grains or crystals within the rock as well as both primary or secondary structures, are frequently well preserved, and most observations of grain size and structure are made on saprolite in this area. Saprolite is thickest on the tops of hills where it may be over sixty feet thick. It becomes thinner on slopes and may be absent in stream bottoms where bedrock is often exposed. Bedrock or its saprolite are also concealed by high level gravels, terrace deposits along the James and Appomattox Rivers, and floodplain alluvium along many smaller streams. Floodplain deposits are much broader and more extensive along streams within the Richmond basin where they developed on sedimentary rocks than they are along streams flowing over the surrounding crystalline rocks. This is well shown

along Swift Creek where its tributaries west of the reservoir have broad floodplains, while on the crystalline rocks downstream from the reservoir, floodplains are negligible. This transition was even more marked before the reservoir was constructed.

Total relief within the Richmond basin is 303 feet with both the highest and lowest elevations occurring within the Midlothian quadrangle. Unexpectedly, the highest point lies near the center of the basin. The maximum and minimum elevation and total relief of the Richmond basin for the six quadrangles which encompass most of it as well as total relief for each of those quadrangles is as follows:

AREA	Maximum Elevation in feet	Minimum Elevation in feet	Total Relief of Richmond Basin in feet	Total Relief of Quadrangle in feet
Clayville quadrangle	360 +	210 -	150 +	220 +
Hallsboro quadrangle	380 +	180 -	200 +	200 +
Hylas quadrangle	250 +	140 -	110 +	240 +
Mannsboro quadrangle	370 +	160 -	210 +	210 +
Midlothian quadrangle	420 +	117	303 +	303 +
Winterpock quadrangle	330 +	160 -	170 +	201 +

The dominant use of land within the Richmond basin is for agriculture and timber. North of the James River and along the eastern portion of the basin from the James River to U. S. Highway 360, numerous subdivisions and some light industry occur and this area is rapidly increasing in population density. Much of this urbanization has taken place over the coal measures along the basin's eastern border from their northern terminus to south of Midlothian. Although urbanization is spreading westward and southward across the basin, much of the area in Chesterfield and Powhatan Counties is rural. Both beef and dairy cattle are raised in the area, and most crops are for the support of cattle production. Large areas in western Chesterfield County are owned by paper companies and provide a

good supply of timber for pulp.

The James River is the major watercourse in the area and traverses the basin from west to east about 8 3/4 miles from the basin's northern end. The Appomattox River flows in broad meanders across the southern end of the basin about 2 1/2 miles from the basin's southern terminus. The only other through flowing drainage is that of Swift Creek and its tributary Turkey Creek. Within the basin, the area north of the James River is drained primarily by Tuckahoe Creek which leads to the James River. Between the James River and U. S. Highway 60, except for the area around Midlothian, drainage is north to the James River along Salles Creek, Bernards Creek and its tributaries, and Norwood Creek and its tributaries. Midlothian is drained to the east by Falling Creek. Between U. S. Highway 60 and U. S. Highway 260, most of the area is drained by Swift Creek and its extensive tributary network of Tomahawk Creek, Turkey Creek, Horsepen Creek, Blackman Creek, and Dry Creek. Swift Creek flows east and eventually joins the Appomattox River near Petersburg. The western part of this segment of the basin drains west and south to the Appomattox River along Skinquarter Creek and Goode Creek. South of U. S. Highway 360, most of the drainage is south to the Appomattox River along Sappony Creek, Little Sappony Creek, and Winterpock Creek. In the small basin segment south of the Appomattox River, drainage is north to the Appomattox River along Winticomack Creek.

GEOLOGIC SETTING AND SURROUNDING LITHOLOGICS

Igneous and metamorphic crystalline rocks completely surround and underlie the Triassic sedimentary rocks of the Richmond basin. The Petersburg granite bounds the eastern margin of the basin from its northern end to Swift Creek Reservoir. In the city of Richmond this granite has been radiometrically dated at 330 ± 8 million years old. This date might not apply to the granite as a whole because the granite appears to have had a complex history. In the Hylas quadrangle the Petersburg granite is dominantly a medium grained, gray granite which is

nonfoliated and may locally be slightly porphyritic. From north of Midlothian to the Swift Creek Reservoir, a highly porphyritic phase of the Petersburg granite borders the basin. This granite contains abundant phenocrysts of K-feldspar up to 2 inches in length and these frequently define a faint to strong foliation within the rock. West of the dam and spillway of Swift Creek Reservoir the granite contains numerous large xenoliths of mafic gneiss adjacent to its contact with biotite and amphibole gneisses. From the reservoir to the basin's southern end, it is bordered to the east by gneisses. Although exact lithologies have not been determined, they appear to be dominated by mafic amphibole and biotite-rich gneisses and some mica schist. They also include minor granite gneiss and quartzite. For much of eastern margin's length, the Triassic sedimentary rocks appear to lie unconformably upon a weathered surface of granite and gneiss. This unconformity is cut by several cross faults, most of which are of small displacement. However, at least two cross faults cause major dislocations of the eastern margin.

The basin's western margin from its northern end to the north bank of the James River is bounded by cataclastic rocks composed dominantly of mylonites and ultramylonites. These cataclastic rocks are part of a broad cataclastic zone, referred to as the Hylas zone, which parallels the basin and extends north-northeast to disappear under the Coastal Plain. South of the James River the sedimentary rocks are in contact with gneisses, amphibolite, and possibly cataclastic rocks which may be an extension of the Hylas zone. The adjacent crystalline rocks have not been mapped south of the James River and their details are not well understood. Although nowhere directly exposed, the western margin of the basin is believed to be dominantly a fault contact. It may consist of one or a number of normal faults which are steeply inclined to the east. One such fault is exposed in the east end of the Boscobel quarry on the north side of the James River near Manakin where Triassic sedimentary rocks to the east are in fault

contact with granite to the west. The sedimentary rocks adjacent to the fault are highly folded and are cut by numerous minor normal faults. This fault is not at the true western margin of the basin, but rather is on the eastern side of a granite block which extends southward into the basin as shown by Goodwin (1970). South of U. S. Highway 360, the major fault or faults of the eastern border may lie within the exposed area of Triassic rocks with some nearly horizontal Triassic rocks lying west of the fault. The western border is transected by three major cross faults which have a large separation and cause extensive offsets of the western border.

Following deposition and probably deformation, the Triassic rocks were intruded by several diabase dikes. Many of these are only a few feet thick, but some are 25 to 50 feet across. The dikes have not been traced out in this study, but Shaler and Woodworth (1899) traced some for 5 or 6 miles along their length. During the Tertiary Period, coarse fluvial stream gravels were deposited over the eroded surface of the Triassic rocks by the ancestral James and Appomattox Rivers. The former extent of these gravels is unknown because they have since largely been eroded away. Now they occur as nearly horizontal cappings of some of the higher surfaces south of the James River and near the Appomattox River.

TRIASSIC BASIN STRATIGRAPHY

The low topographic relief, the incomplete records of old mine workings, the almost total absence of reliable drill hole information, and the lack of geophysical data preclude any detailed knowledge of the stratigraphy or the structure. Shaler and Woodworth (1899) considered the rocks of the Richmond basin to belong to the Newark Group of Triassic age. On the basis of Palynological studies, Cornet, Traverse, and McDonald (1973) and Cornet (1977) assigned these rocks to a late middle Carnian (Late Triassic) age. Cornet (1977) informally introduced the designation "Richmond Group" for those rocks contained

within the Richmond basin to distinguish them from similar rocks which developed in other Triassic-Jurassic basins in eastern North America. Olsen (1978) proposed the designation "Newark Supergroup" to include the sedimentary rocks in all the Triassic-Jurassic basins. Shaler and Woodworth (1899) divided the Triassic rocks in this basin into two groups: a lower Tuckahoe Group and an upper Chesterfield Group. Olsen retained these two group names to refer specifically to the Newark rocks in the Richmond basin.

As shown in Table 1, Shaler and Woodworth (1899) divided their two groups into smaller units. The lower Tuckahoe Group contains three subdivisions; the basal Boscobel boulder beds, the intermediate Lower barren beds, and the upper Productive coal measures. The upper Chesterfield Group contains two subdivisions; the lower Vinita beds and the upper Otterdale sandstones. The present study suggests that the boundary between these groups may not be well placed and should probably lie between the Vinita beds and the Otterdale sandstone. The boundary between the coal measures and the overlying Vinita beds is elusive and may be gradational, simply marking the transition from a swampy, vegetation-rich area to a more dominantly lacustrine environment. The highest coal beds are thin and discontinuous and some lithologies characteristic of the Vinita beds occur both within the Productive coal measures and the Lower barren beds. The rocks below and including the Vinita beds of Shaler and Woodworth are dominantly lacustrine, light gray, dark gray, and black sandstones, siltstones and shales although some fluvial sandstones are present. These contrast strongly with the Otterdale sandstones which are primarily deep red to reddish-brown to pinkish-white, coarse-grained fluvial sandstones with some conglomerate and siltstone.

Although Shaler and Woodworth's two groups will not be used here, their five subdivisions of Boscobel boulder beds, Lower barren beds, Productive coal measures, Vinita beds, and Otterdale sandstones, are useful and will be utilized as the basis for the discussion of the stratigraphy in this report. They are not

GROUPS	SUBDIVISIONS	GENERAL CHARACTERISTICS
Chesterfield Group	Otterdale sandstones	Coarse sandstones, often feldspathic. Thickness, 500+ feet.
	Vinita beds	Black fissile shales, carrying Estheria ovata, passing upward into and intercalating with gray sandstones. Thickness, 2,000 feet.
Tuckahoe Group	Productive coal measures	Interstratified beds of bituminous coal (usually 3 seams), coke, black shales, and feldspathic, micaceous sandstones. Thickness, 500 (?) feet.
	Lower barren beds	Sandstones and shales under coal beds, often with arkose. Thickness variable, from 0 to 300 feet.
	Boscobel boulder beds	Local deposits; boulders of gneiss and granite. Thickness variable, 0 to 50 feet.

Table 1. Lithologic units in the Richmond basin as described by Shaler and Woodworth (1899), p. 423. Modified slightly.

used as formations in precise sequence, but simply as a convenient framework in which to relate the stratigraphy. These same units were used on the 1963 Geologic Map of Virginia except that there the Lower barren beds were included with the Productive coal measures. It should also be mentioned that the 1963 map of the Richmond basin is the same as Shaler and Woodworth's 1899 map. This rather accurately reflects the lack of work done on this area in the intervening years.

Boscobel Boulder Beds and Conglomerate

The Boscobel boulder beds as described by Shaler and Woodworth (1899) consist of large angular blocks of gneiss set in a matrix of Triassic sandstone. The blocks are very large, often measuring 3 by 2 feet and some are more than 5 feet long. The rock is more a coarse boulder breccia than a conglomerate. Shaler and Woodworth (1899) described two areas where the boulder breccia occurs near the western border of the basin north of the James River. Goodwin (1970) mapped a broad band of boulder breccia along the western border of the basin north of the James River where the large fragments are dominantly of cataclastic rocks. This breccia is different in composition and texture from conglomerates which occur locally along the basin's eastern margin and in a few places along the western margin and different environments of deposition are suggested for the two deposits. Therefore they are discussed separately.

The coarse, boulder breccia appears to be confined to the western border. To date it has not been recognized south of the James River. The angular nature of the boulders implies little or no transportation and possibly they accumulated as talus piles at the base of a scarp along the faulted western margin. Although Shaler and Woodworth considered them to be the basal unit of the Triassic sediments, it is probable that they were deposited continuously in a vertical sequence as the basin deepened and other sediments were being deposited elsewhere within the basin. The lowermost part of the boulder beds may be contemporaneous

with conglomerates along the eastern margin and they may grade into basal conglomerates eastward.

True conglomerates on the eastern margin have been described north of the James River by Goodwin (1970) where well rounded cobbles and boulders of granite and quartz occur as a conglomerate interbedded with medium-to coarse-grained, cross-bedded gray sandstone. These conglomerates occur in localized areas north of the point where the coal measures disappear. South of the James River, coarse conglomerate has only been recognized at one small locality south of Swift Creek Reservoir at the Intersection of U. S. Highway 360 and State Road 621. There a deeply weathered orange-brown sandy matrix contains abundant rounded pebbles, cobbles, and boulders of gneiss, granite, and quartz. With the exception of the quartz clasts most of the large fragments have been completely decomposed and the rock is actually a conglomerate saprolite. This conglomerate appears to occur at the very border of the Richmond basin and is probably adjacent to two cross faults. Possibly conglomerates have not been recognized elsewhere along the eastern margin because much of that contact with the crystalline rocks is concealed beneath Quaternary alluvium of floodplains. That the basal conglomerates may be more extensive is suggested by a 1518 foot thick stratigraphic column compiled by Heinrich (1878) from mine workings and drill holes in the Midlothian area. Heinrick's detailed and instructive column is included as Appendix IA of this report and will be referred to several times. At the base of this column he shows 36 feet of yellowish-brown conglomerate containing boulders of granite with orthoclase feldspar. This is in contact with the crystalline basement.

A previously unrecognized extensive area of coarse conglomerate occurs on the southwest border of the basin south of the Appomattox River. This is an area which Shaler and Woodworth (1899) mapped as coal measures. It is underlain by brownish-orange coarse conglomerate with a coarse sand matrix and rounded cobbles of gneiss and quartz up to 6 inches in diameter. The conglomerate is interbedded

with brownish-orange coarse-grained arkosic sandstone. Although the contact with crystalline rocks has not been observed, it is probably a fault contact and this conglomerate has developed as a fanglomerate along the downthrown side of the fault scarp. The conglomerate most commonly dips gently away from the contact toward the center of the basin although locally it is horizontal or dips gently to the west. Its northeastern limit is concealed beneath the flood-plain of the Appomattox River.

Lower Barren Beds

The Lower barren beds occur between the crystalline basement and the coal measures. Where conglomerates are absent, the lower barren beds lie directly on basement. Their thickness is variable and locally they may be absent, in which case, the coal measures overlie basement. The variable thickness of the barren beds is shown by a comparison of four sections as follows. At Carbon Hill near Gayton, Kimball (Davis and Evans, 1938) (Appendix IB of this report) reported 160 feet of barren beds beneath the lowest coal. A deep hole drilled by a Richmond Syndicate in 1930 (Davis and Evans, 1938) between the James River and Midlothian showed 25 feet of barren beds. In Heinrich's section at Midlothian 571 feet of barren beds, including the basal 36 feet of conglomerate occur. To the south at Winterpock, Fontaine (1883) (Appendix IC of this report) showed 250 feet of basal barren beds. Where the coal measures are in direct contact with the crystalline rocks they are often in fault contact as seen in an old mine of the Black Heath district where carbonaceous black shale and coal beds are truncated by a faulted, slickensided surface of porphyritic granite. This mine has now been filled in.

The greatest detail of the Lower barren beds on the eastern margin has been presented in the column of Heinrich (1878). This is the only adequately described section of the Lower barren beds in existence. Heinrich divided the Lower barren beds into two segments, a lower sandstone group 251 feet thick and

a calciferous group 245 feet thick. The sandstone group is made up of 71.5 per cent sandstones and 28.5 per cent shales (slates in the terminology of Heinrich). The sandstones are dominantly grayish-white or gray and reddish-gray arkosic sandstones. Some contain carbonized vegetable remains and the sandstones in the upper part of the group are coarser grained. The shales are mostly black or brownish-black and some are highly bituminous. They contain plant fossils, fish scales, and some reptilian teeth. Heinrich also reported thin laminae and small concretions of limestone within the shales. The overlying calciferous group as described by Heinrich contains 72 per cent sandstone and 27 per cent shale. About 29 per cent of the sandstone is light gray to white, coarse-grained arkose, and the remainder is light to dark gray, carbonaceous, and arkosic. An oil bearing, brownish-gray sandstone 2 to 3 feet thick is reported near the top of this group. Much of it is described as being calcareous. The shales are dark gray, brownish-gray, black, and bituminous. Half of the shales are calcareous, containing streaks and concretions of calcium carbonate. Plant fossils and fish scales occur within the shales.

On the western margin of the basin, Shaler and Woodworth (1899) show several areas of coal measures and Lower barren beds. However, there is no deep drill hole information or coal mine data which gives details of the stratigraphy. Shaler and Woodworth provide two sections in the Lower barren beds near the western margin. One, a 215.5 foot section on Jones Creek north of the James River (Appendix ID of this report) contains 10.4 per cent red and brown sandstone and 89.6 per cent brown and gray shale. Further south along Turkey Creek, they measured a 2100 foot long section (Appendix IE of this report) composed of approximately: 53% shale, 43% sandstone, and 5% conglomerate, based on the measured thickness but not the computed thickness. The shales are dominantly red and green and only one 6 inch thick bed of bituminous shale is reported. The sandstones are mostly brown, vary from fine-to coarse-grained, and some are pebbly. One .5 inch seam of coal was exposed within a sandstone. Fresh exposures

of the Lower barren beds can be observed in the east end of the Boscobel quarry. There the rocks are of gray to dark gray carbonaceous micaceous sandstone and dark gray to black shales. Thin coal seams also occur and plant and fish fossils are relatively abundant.

From a comparison of Heinrich's (1878) data near the eastern margin and Shaler and Woodworth's (1899) information on the western margin, it appears that the western barren beds are more shaly than the eastern beds. Possibly the beds along the western margin mapped by Shaler and Woodworth as coal measures and Lower barren beds are actually higher in the section than supposed and may be associated with the Vinita beds. It would seem that the lengthy Turkey Creek section should have encountered coal unless the Lower barren beds are inordinately thick at that point.

From surface observations of exposures alone, a false impression is usually obtained of the relative abundance of sandstone and shale. The shale decomposes extremely rapidly whereas the sandstone resists weathering relatively well, although it is also invariably deeply weathered. In most poor stream exposures the shale is thus often removed or obliterated while exposures of sandstone remain in the bed of the stream. Hence a traverse down the stream reveals a possibly false preponderence of sandstone. Along the eastern margin the Lower barren beds of sandstone weather tan to brownish-orange and the shales weather to a gray or white clay. On the western margin in the areas mapped by Shaler and Woodworth (1899) as coal measures south of the James River, the sandstones weather brownish-orange to reddish-brown and the shales are dominantly red and green.

Productive Coal Measures

The Productive coal measures occur within a relatively short section of the stratigraphic column. Heinrich (1878) shows 32 feet six inches of coal within 90 feet of section in the Midlothian area. Fontaine (1883) shows 43 feet 5

inches feet of coal within 180 feet of section at the Clover Hill mine in Winterpock. At Carbon Hill north of the James River, Kimball (Davis and Evans, 1938), shows 25 feet 6 inches of coal within 112 feet of section. Between Midlothian and the James River, the report of the Richmond Syndicate (Davis and Evans, 1938) indicated only 18 feet 2 inches of coal in 164 feet of section. The Productive coal measures are considered to be bounded by the base of the lowest and the top of the highest persistant coal seams within the stratigraphic column, although with the sparcity of data points it is truly impossible to tell which coal seams are persistant over a large area.

The instructive stratigraphic column of Heinrich (1878) contains within his Carboniferous group 34 feet 9 inches of gray, coarse, arkosic sandstone with an oil bearing stratum near the bottom overlying the coals and 27 feet of gray arkosic sandstone and black shale underlying the coal. Between these the 90 feet of coal measures as defined above contain approximately 36.6% coal, 26% shale, and 37.4% sandstone. The sandstones are mostly gray and arkosic while the shales are dark gray and contain plant fossils. In other areas along the eastern margin similar sandstones and shales are associated with the coals. The only detailed petrographic study of the coal measures or the beds immediately above them, was conducted by Felicia Boyd on a 92 foot long core taken at Tuckahoe Village West near the former town of Gayton north of the James River. This core terminated in a large void when the hole penetrated an old mine working. It contains a dominance of gray to black arkosic sandstones, with minor gray to black or brown shale, and also penetrated a 5.5 foot thick sill of diabase. Boyd's log of this hole and her petrographic data are included as Appendix IF of this report.

On the western margin of the basin data about the coal measures is sparce. Russell (1892) describes two coal seams, 7 feet and 5 feet thick separated by 12 feet of shale in the Norwood mines south of the James River, and three coal seams

up to 12 feet, 4 feet, and 3 feet thick respectively from the upper to lower seam in the Old Dominion mines south of the Norwood workings. North of the James River near Manakin, Woodworth (1901) reports three coal beds, the upper one 6 to 8 feet thick, the middle 12 feet thick, and the lower 3 to 4 feet thick. From this it would appear that the coals are thinner to the west than they are to the east. Shaler and Woodworth present a 167 foot long section exposed in a gully near Manakin (Appendix IG of this report). It contains alternating beds of sandstone and shale with the majority of the beds being less than 2 feet thick. It also contains six beds of coal, one of which is 1.5 feet thick and the rest range between 2 and 8 inches in thickness. The thickest sandstone unit is 24 feet wide. The section contains a total of 200 feet 10 inches of shale, 162 feet 11 inches of sandstone, and 3 feet 6 inches of coal. Thus this section contains approximately 55% shale, 44% sandstone, and 1% coal. Sandstones are dominantly brown and reddish-brown and some are arkosic and micaceous. Shales vary in color from black to brown with some being reddish brown. The authors were uncertain whether this section lay above or below the main coal seams. Other sections of the coal measures are given in Appendix IH, II, IJ, IK, and IL. Further details on the coal beds will be given in a later section of this report. They will include information on the composition, thickness, and structure of the coals.

Vinita Beds

Above the Productive coal measures, Shaler and Woodworth (1899) describe 2000 feet of Vinita beds. At the base are black fissile shales containing fossils of Estheria ovata grading upward into and interbedded with gray sandstones. In exposures sandstones appear to dominate the lithology but this is probably because most of the shales and siltstones have been weathered away and obliterated. In weathered exposures the shales and siltstones are black

and gray, frequently fossiliferous, and finely bedded while the sandstones are fine-to coarse-grained, arkosic, and tan, orange-brown, or reddish-brown. They may be cross-bedded. These beds were probably deposited in environments which alternated between lacustrine and fluvial.

Measured sections of the Vinita beds are rare, but two published sections illustrate some of the details of this unit. Goodwin (1970) in a 60 foot section at the north end of Lake Salisbury in the Midlothian quadrangle (Appendix IM of this report) shows 27 feet of sandstone and 33 feet of shale, all weathered to saprolite. A 13 foot thick sequence of sandstone is cross-bedded and channeled. The shale is gray, yellowish-brown, and reddish-brown, while the sandstone is arkosic, micaceous, and varies in color from gray to brownish-red.

Once again Heinrich's (1878) section is useful in revealing an unweathered segment of the Vinita beds. Above his Carbonaceous group he shows 814 feet of dominantly gray sandstones and shales. He breaks this sequence down into three groups. The lowest, 191 feet thick, contains 64% white and light gray arkosic sandstone and 36% black and greenish-gray, frequently fossiliferous shales. He notes that two of the shales bear oil. The central unit, 334 feet thick, consists of 57% sandstones which are generally light gray, arkosic, and fine-grained. Dark gray and black shales which are often fossiliferous make up 47% of this unit. The upper unit, which extends to the surface and is 291 feet thick is 80% sandstone. These rocks are gray, fine-grained, and often arkosic. Light gray shale makes up the remaining 20%. A one inch thick coal seam also occurs. The Vinita beds here are overlain by 20 feet of Tertiary gravels.

Some conglomerates also occur within the Vinita beds. One, mentioned by Goodwin (1970), occurs near the center of the basin south of the James River where conglomerate with rounded quartz pebbles up to 2 inches in diameter in a sandy matrix is interbedded with medium-grained sandstone. Similar conglomerates, and possibly an extension of that same unit occur in the Hallsboro quadrangle along

and east of State Road 667 between Swift Creek and the northern border of the quadrangle. Rounded cobbles up to a foot in diameter occasionally occur within this conglomerate. The conglomerate's position in the stratigraphic sequence has not yet been determined.

Otterdale sandstone

Shaler and Woodworth (1899) describe the Otterdale sandstone, the youngest and upper Triassic unit in the Richmond basin, as coarse sandstones which are often arkosic. They estimated its thickness as more than 500 feet. Petrified logs, some as long as 25 feet and up to 4 feet in diameter and a few beds of lignite were reported in this unit. In general, the Otterdale sandstone is usually red or brownish-red to brown in color and is medium-to coarse-grained. Sandstones dominate and shales and siltstones are minor. The coarser sandstones are arkosic and are often cross-bedded. Channels have been cut into many beds and these in turn have been filled by gravels and sandstones. It is clear that the Otterdale sandstones were deposited primarily in a fluvial environment.

The Otterdale sandstone received little emphasis in the present study. The only detailed data on Otterdale stratigraphy, and in fact the only fresh specimens of the Otterdale were obtained from a 1552 foot deep drill hole sunk into these sandstones in 1978. This hole is located approximately 3200 feet southeast of the intersection of U. S. Highway 360 and State Road 666, and is only about 2500 feet from the western border of the basin. It penetrated 1514 feet of red sandstones before terminating in a fine-grained, black diabase. The entire sequence appears to be of Otterdale sandstone. The driller's log of the entire hole and a more detailed log of the bottom third of the section are given in Appendix IN. The rocks consist primarily of red coarse-grained sandstone, red to pink conglomerate sandstone, red micaceous fine-grained sandstone, and red cross-bedded fine-grained sandstone. Minor red sandy siltstones and shales also occur. Conglomeratic zones occur throughout the section.

If this hole is entirely within the Otterdale sandstone as it appears to be, then the Otterdale's 500 foot thickness as estimated by Shaler and Woodworth is in error. Instead, it must be more than 1500 feet thick. Unfortunately it is impossible to tell how much thicker the Otterdale sandstone is because drilling did not go beyond the diabase. Whether this diabase is an intrusive mass into the Triassic sediments or represents basement is unknown. However, its fine texture would imply that it is a dike or sill such as the numerous thin diabase intrusions found elsewhere within the basin. If the Otterdale sandstone is at least 1500 feet thick and if it overlies more than 2000 feet of Vinita beds plus the coal measures and the Lower barren beds, then the total thickness of Triassic sediments in at least this part of the basin would possibly be as much as 3500 to 4000 feet. This would also imply a faulted western border at this point with a large displacement along the fault. The possibility exists that the Vinita beds and the Otterdale sandstone are two facies which were deposited contemporaneously, or nearly at the same time in different environments. In this case the stratigraphic thickness may be closer to 2500 feet. Evidence supporting either point of view was not conclusive in the present reconnaisance study. It can only be obtained by future deep drilling through the Triassic sedimentary rocks into unequivocal basement.

Diabase Intrusives

Dikes and sills of diabase have intruded all of the Triassic sedimentary rocks. Several dikes are indicated on the 1899 map of Shaler and Woodworth, but they were not included in the present study. A few of the known dikes are over 20 feet thick but many smaller dikes, often only a few feet thick also occur. In the field their presence may only be marked by a few rounded boulders of diabase which have a rusty outer surface. Due to limited exposures it is highly speculative to try to convert isolated segments of diabase dikes into a coherent

pattern. This must await more detailed studies.

The presence of diabase dikes and sills has two major implications concerning exploration for coal and gas in this basin. First, in the Gayton district and also in the coal measures south of the James River on the eastern margin, diabase sills in proximity to coal beds ahve coked the coal in place. This natural coke was mined in the Gayton area. In forming the natural coke, volatiles were driven off from the coal thus reducing the amount of gas which would otherwise be expected to now occur within the original coals. However, most of the coal beds were not effected by the heat of the intrusions. Secondly, the presence of a thick diabase sill or dike will produce difficult and hence costly drilling. Therefore if their location is known, they can be avoided during drilling.

SURFICIAL GEOLOGY

Surficial units shown on the geologic map of the Richmond basin include Triassic sedimentary rocks, high level Tertiary gravels and alluvium, and Quaternary alluvium. Triassic units shown are border conglomerates, coal measures (which include both the Lower barren beds and the Productive coal measures), the Vinita beds, and the Otterdale sandstone. Diabase dikes are not shown. This discussion of the surficial geology will in general be restricted to the southern two thirds of the basin because the area within the Hylas and Midlothian quadrangles has already been described by Goodwin (1970). The mapping for this report was reconnaissance work and focused primarily on the margins of the basin and the extent of the coal measures. The field work necessary for the compilation of the geologic map was supplemented by the maps of Shaler and Woodworth, and by the soil survey of Chesterfield County by Hodges, et. al. (1978). The mapping was done using 7.5 minute topographic maps on a scale of 1:2400 as a base and these were then reduced to the scale of the composite map accompanying this report.

localities along the eastern border to south of the Swift Creek Reservoir. Invariably they occur over granite but close to the contact with the Triassic sedimentary rocks.

Two other problems exist in properly identifying the surficial lithologies. The first is the distinction between deeply weathered Triassic arkosic sandstone or conglomeratic sandstone and Quaternary alluvium associated with the floodplains of streams. This is critical because most Triassic exposures occur along streams. Both lithologies may have a similar grain size and may contain scattered rounded quartz pebbles, and if the stream is eroding Triassic arkoses, both may have similar mineralogy. Usually the arkosic sandstone weathers light brown to reddish-brown while the alluvium is light gray to brownish-gray, but the color distinction is not infallable because some sandstones are gray and some alluvium has been stained by iron oxide. Although a distinction can usually be made between the two, at times it must be tentative. Secondly, confusion may also arise in distinguishing between high level Tertiary gravels and deeply weathered Triassic conglomerates, particularly where the gravels have also been deeply weathered. In fresh exposures this problem is not severe because the pebbles and cobbles of the high level gravels are predominantly composed of quartz whereas in Triassic conglomerates the large fragments are very heterogeneous in composition and contain numerous pieces of granite and metamorphic rocks as well as quartz. Also, the high level gravels are usually confined to well defined upland surfaces while the conglomerates may occur at any elevation. Where gravels overlie weathered conglomerate the contact between them may be very difficult to determine. The change in lithology at the basin's borders exerted a strong control on stream paths. A traverse along the border of the basin shows that streams follow much of the basin's contact with the adjacent crystalline rocks and the contact is often concealed beneath flood plain deposits. These areas will be referred to below.

Basinal Margins

As previously mentioned, the Triassic sedimentary rocks of the Richmond basin are bounded and underlain by igneous and metamorphic rocks. Near the surface all lithologies are usually deeply weathered to saprolite or highly decomposed rock. Where well foliated gneisses occur it is relatively easy to discriminate between them and the Triassic sedimentary rocks. However, where a contact occurs between medium-to-coarse-grained, nonfoliated granite and medium-to-coarse-grained arkosic sandstone, the true lithology of the weathered rock may be extremely difficult to determine. Compositionally the two are very similar and if, as often occurs, the sandstone is massively bedded, the only valid criterion for distinction is the presence of angular crystals in the granite as opposed to the rounded grains of a sandstone. Unfortunately, coarse rectangular cleavage fragments and grains of feldspar often occur within the sandstone. Then it may be necessary to search for the few rounded pebbles which may be sparcely disseminated in the sandstone. In small exposures it may not be possible to distinguish between the two lithologies with confidence, and this is also true of the cuttings from shallow auger holes. Along much of the basin's eastern margin the sandstone lies unconformably upon the granite. Frequently the granite appears to have been weathered to produce quartz grains and angular feldspar fragments. These were transported only slightly, if at all, to produce the sediments of the arkosic sandstone. Usually a profound unconformity does not exist and locally the contact is almost a gradational one between granite, deeply weathered granite, and arkosic sandstone.

One aid to mapping the basin's eastern contact is that adjacent to the contact large boulders of relatively fresh granite up to 10 feet in diameter are often found at the surface. These are unusual in an area where all rocks are characteristically deeply weathered. These granite boulders were noted by Shaler and Woodworth (1899) in the Gayton area, and since have been found at numerous

alluvial fan deposits which developed along an escarpment during Triassic time. On the eastern margin of the basin, thin conglomerates may occur interbedded with arkosic sandstones, but the only mappable area of coarse conglomerate is south of Swift Creek Reservoir at a locally highly faulted and complex segment of the contact.

Coal Measures

As mapped, the coal measures include the Lower barren beds as well as the Productive coal measures. Only in this way can the unit be somewhat satisfactorily delineated on the map. Coal measures occur along much of the eastern margin. As mentioned in the section on stratigraphy, the coal beds usually occur within 100 feet of section and they may lie directly on basement or be separated from it by up to 600 feet of barren beds. South of Midlothian, a long, narrow outlying basin, the Stonehenge Basin of Shaler and Woodworth (1899) parallels the eastern margin. The coal seams form a double outcrop on the two borders of this basin, but at least on the east a considerable thickness of barren beds underlie the coals. As previously mentioned, the intervening area between this outlying basin and the major coal measures of the eastern margin may be granite or basal barren coarse arkosic sandstone. The distinction between the two lithologies could not be made at the present time. Shaler and Woodworth's interpretation was based on old mining and prospecting records and because better exposures may have been available at that time, their interpretation is used in the present map. They felt that the Stonehenge Basin had a faulted western margin and was unconformable upon the granite on its eastern edge. It may also lie within a small syncline and is separated from the main basin by a minor anticline crest where granite has been brought to the surface. Anticlinal and synclinal flexures have been reported from the old mine records all along the eastern margin at Gayton, Midlothian, and Winterpock.

large cross faults. The two southernmost faults and the resulting lithologic contrast along them exert a strong control on the meander pattern of the Appomattox River. There may be other smaller cross faults, but they were not apparent in this reconnaissance study. From its southern terminus the western contact trends slightly west of north in a straight line until it intersects a northwest trending cross fault south of the Appomattox River. This fault is flanked to the northeast by coarse conglomerates which extend to the floodplain of the Appomattox. The conglomerates are relatively resistant and appear to have inhibited lateral cutting by the river. South of the intersection of Horsepen Branch and State Road 622, the contact again assumes a path slightly west of north until reaching a large meander bend south of U. S. Highway 360. Here it is again displaced to the northwest, presumably along a cross fault approximately parallel to the fault mentioned previously. This fault can not be observed as it is entirely concealed beneath the floodplain of the Appomattox River. From the north bank of the river the contact then continues its northly trend for a distance of over 5 miles. It has a few minor deviations which may be due to minor cross faults, but these could not be observed. South of the sharp turn in the Chesterfield-Powhatan County line at Skinquarter Creek, the contact is offset two miles to the northeast along a northeasterly trending cross fault. The contact then continues slightly east of north until it reaches the James River.

Conglomerates

The extremely coarse, highly angular deposits of the Boscobel boulder beds as described by Shaler and Woodworth (1899) have not been observed south of the James River. Conglomerates do occur locally, but the most extensive area of coarse conglomerate occurs along the major cross fault south of the Appomattox River. There, conglomerates are closely related to the fault and may well be

Beginning at U. S. Highway 60 east of Midlothian, the contact follows a path almost due south and curving slightly west of south for a distance of about 4.6 miles. Shaler and Woodworth (1899) show two smaller basins, the area of the Union Pits and the Stonehenge basin lying to the east of the Richmond basin. These are separated from the main basin and from each other by intervening granite. These outlying basins may exist, but in the present study only one of them could be recognized and it may not in fact be completely separated from the main basin. Coals do appear to lie within an isolated area, but the intervening rock between this coal and the coal within the main Richmond basin may be granite or possibly only the sandstones of the Lower barren beds. Paucity of exposures did not allow this to be determined.

Near Nuttree Creek the contact turns sharply to the southwest and roughly parallels the southeastern shore of Swift Creek Reservoir almost to U. S. Highway 360. Good exposures in three small creeks between U. S. Highway 360 and the reservoir allow this contact to be located accurately. Shaler and Woodworth (1899) suggest that this northeast trending segment of the border is due to a large cross fault with the north side downthrown. Bedding strikes parallel to the contact here and a fault is a likely explanation for this large offset in the contact. Immediately south of U. S. Highway 360 the contact is complexly faulted. The contact then trends southerly once more but is offset along at least two cross faults before reaching Winterpock. South of State Road 655 the contact lies beneath the alluvium bounding Winterpock Creek for over 2.5 miles and then continues south-southwest, except for one minor offset, to a sharp bend of the Appomattox River where the meander loop appears to be controlled by the change in lithology. Along the Appomattox River and south along Winticomack Creek the contact is concealed beneath floodplain alluvium, but it appears to continue in a straight line to the southern terminus of the basin.

The western border has a general northerly trend, but is offset by three

The eastern coal measures probably extend as a band along the eastern margin from Midlothian southward for about 3 miles. Actual coal seams have only been reported or observed for the first 1 mile of this distance. However, beyond that distance exposures are rare and to date it is not possible to tell whether the coal measures continue southward, terminate by a facies change, or are faulted out. On the present map they have been carried southward primarily on the basis of the mapping by Shaler and Woodworth. The coal measures, or more specifically the Productive coal measures appear to be absent for a distance of 5.5 miles from State Road 604 to State Road 655. Lower barren beds may occur here but with the limited exposures it is not possible to distinguish them from the lower Vinita beds. This segment of the basinal margin is offset along several faults, and possibly the coals have been faulted out if they were once present. They may occur along some of the north-south trending margin of the basin, but none were observed. From south of State Road 655 the Productive coal measures occur as a continuous band along the basin's eastern margin through Winterpock and almost to the southern extremity of the basin. Only a few minor offsets occur along this distance. Coal was mined at several locations from north of Winterpock to the point where the coal measures cross Winterpock Creek to the south. From this point to the Appomattox River there are a few long abandoned prospect pits and Shaler and Woodworth (1899) reported coal from one prospect pit on the south side of the Appomattox River west of Namozine.

On the western margin the only active coal mining south of the James River took place at two dominent centers between the James River and U. S. Highway 60. One center is on the eastern margin of the prominent triangular upfaulted block of granite as shown by Goodwin (1970). The other is between Dutoy Creek and the basin's western margin about 3 miles north of U. S. Highway 60. How far this coal extends southward cannot be determined, but it does not appear to go beyond U. S. Highway 60, and definitely does not extend to the railroad at

Moseley. Relatively good exposures in railroad cuts and adjacent streams do not show any coal.

Elsewhere along the western margin, Shaler and Woodworth (1899) show large areas underlain by coal measures, one of which is along the northeast trending fault south of Moseley. Their section along Turkey Creek (Appendix IE of this report) shows a few thin coal seams in the area mapped as coal measures, but they consider this section to be of Lower barren beds since it lies unconformably on basement and no thick coals are present. Two steeply inclined faults occur within their section near the border. Coal also appears to be absent elsewhere along this fault and none is reported. Two interpretations may be made of the rocks in this area: (1) the basal beds may be a shaly phase of the Lower barren beds as indicated by Shaler and Woodworth (1899) and the Productive coal measures may not be present; and (2) these beds may be Vinita beds and the coal measures were never deposited here or have been faulted out. Lithologically the Turkey Branch section seems more similar to the Vinita beds than to the Lower barren beds along the eastern margin.

South of U. S. Highway 360, Shaler and Woodworth (1899) show large areas underlain by coal measures along the complex western margin. However, in this entire area they only reported one prospect pit which showed a trace of coal on the floodplain east of the Appomattox River north of State Road 602. Shaler and Woodworth's main reason for including these rocks within the coal measures was their interpretation of the structure in the area of Bevils Bridge. Although they presented several alternatives, their preferred hypothesis was that the major border fault lies east of the coal measures and the area east of the fault was downthrown while the basal coal measures remained at a higher elevation. Another possibility may be that west of the major border fault, the smaller faulted blocks are capped by Triassic sediments which were deposited in an environment where coals were not formed. That is, the major basin with

lacustrine deposits occurred east of the main fault while west of the fault only shallower, small troughs occurred and these were filled primarily by fluvial sediments. These may have formed late in the history of basin development after the formation of the coal measures and thus may be capped by younger Triassic sediments. The almost total absence of coals in this area casts doubts on whether the coal measures really appear here. Also the lithology in many places is more similar to that of the Otterdale sandstones than to either the coal measures or the Vinita beds. The Bevils Bridge area, as outlined in a later section, may well illustrate a series of step faults along the basin margin at this point.

In some areas such as along U. S. Highway 360, Shaler and Woodworth may have confused Tertiary gravels with Triassic sediments, and suggested this possibility themselves. On the south side of the Appomattox River a large area mapped as coal measures by Shaler and Woodworth (1899) is dominated by the coarse conglomerates mentioned previously. If these conglomerates were deposited as alluvial fans along a fault scarp, they are probably contemporaneous with the Otterdale sandstones, or occur high in the stratigraphic sequence above the basal barren beds. In summary, the known coal bearing beds along the western margin only occur north of U. S. Highway 60. Coal measures may extend further south but beyond one orally reported prospect pit there is no evidence for this. It would appear that the areas formerly mapped as coal measures are either Lower barren beds or are units higher in the sequence. If the second case is true, the coals may occur at depth.

Vinita beds and Otterdale sandstone

Most of the basin's interior is underlain by Vinita beds and Otterdale sandstone. Vinita beds occur to the north, east, and south while Otterdale sandstone occurs to the southwest. The boundary between these two units is largely taken from Shaler and Woodworth since the present study did not focus

on the units of the interior of the basin. Where the two units are in contact along stream valleys northwest of the Swift Creek Reservoir, the Otterdale sandstone appears to overlie the Vinita beds suggesting that the sandstones are younger. Also, Shaler and Woodworth (1899) showed Vinita beds both north and south of the Otterdale sandstone, implying that the Otterdale overlies the Vinita. However, the two may interfinger and the Otterdale and Vinita may simply be fluvial and lacustrine facies deposited contemporaneously. If the beds along the western margin mapped by Shaler and Woodworth as coal measures are neither coal measures nor Vinita beds, then at present we cannot determine how far, if at all, the Vinita beds extend beneath the Otterdale sandstone. The answer to this question could have been provided by the deep drill hole near the western border. However, after passing through over 1500 feet of Otterdale sandstone, drilling was terminated in a diabase and Vinita beds or coal measures were never reached. A detailed study of exposures may provide some clues as to whether these are two formations of sequential age or are two contemporaneous facies. However, a satisfactory answer to this question can only come from deep drilling through the entire sedimentary sequence into unquestionable basement.

STRUCTURE

The structure of the northern third of the basin has been described by Goodwin (1970) and therefore this discussion will focus on the basin's southern two thirds. In general the basin is bounded by an unconformity to the east and normal faults to the west although exposures of the contacts on either margin are rarely seen. As previously described both margins are cut by cross faults which may have large displacements.

Along the eastern margin, the beds strike roughly parallel to the contact and dip at an average of 30 or 35 degrees to the west. Variable dips may occur and locally they are as steep as 75 degrees westward. Some beds dip to the east. Old mine records and structure sections indicate several normal faults

that point to be an unconformity although two faults of unknown displacement, one only 400 feet from the basin's margin, cut the sequence. It should be noted that in the Turkey Creek section the 60 feet of section adjacent to the gneisses are unexposed and the first exposed rock is described as a sandstone with a schist breccia. Therefore, a fault may well occur here between the gneisses and the unequivocal Triassic rocks; the schist breccia even suggests the presence of a fault. The deep drill hole south of U. S. Highway 360 is only 2500 feet from the western contact and yet the core shows over 1500 feet of sedimentary rock where dips are at about 25 degrees to the east and conglomeratic sandstones occur at intervals throughout the sequence. This implies a fault of considerable displacement. Elsewhere, beds gently dipping to the west or even horizontal occur adjacent to the border. This is shown at Bevils Bridge and on the west side of the Appomattox River south of Bevils Bridge. At the latter location some conglomerate with cobbles exceeding 5 inches in diameter is inter-bedded with the sandstone. East of Bevils Bridge the border is complicated. Shaler and Wood worth (1899) presented a detailed discussion of this area in order to determine the structure of the boundary and to assign an age to the sedimentary rocks along the western border. They described a fault separating nearly horizontal sedimentary rocks overlying crystalline rocks on the west from steeply dipping Triassic sedimentary rocks on the east, and discussed several hypotheses to explain this sequence. The major factor leading Shaler and Woodworth to conclude that the gently inlcined and nearly horizontal beds are basal Triassic was the reported occurrence of a prospect pit with coal beds on the floodplain of the Appomattox north of Bevils Bridge. The present study identified two narrow bands of gneiss lying within Triassic sediments to the west of the fault described by Shaler and Woodworth. One of these is capped unconformably by nearly horizontal sandstones with a thin basal pebble zone. Their presence suggests that the

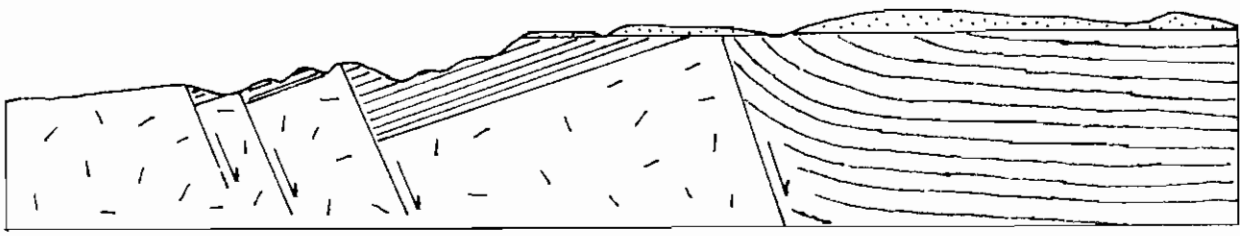


Figure 1. Structural cross-section of step faulted western margin of the Richmond basin at Bevils Bridge. Short random lines = granite and gneiss; parallel ruling = Triassic sedimentary rocks; stippled = Tertiary gravels.
Vertical exaggeration = X5

western border may contain a series of step faults, steeply dipping to the east and that the top of each faulted and slightly rotated block is capped by a thin cover of Triassic sedimentary rocks. This is illustrated in Figure 1. Of course, this interpretation does not resolve the stratigraphic position of the beds to the west of the easternmost fault any more than does the single fault of Shaler and Woodworth. If step faulting took place during initial basin formation, these beds could be equivalent to the coal measures in age. If faulting occured later, the beds may be later Triassic in age. Lithologically they do not appear to be greatly different from the Otterdale sandstone.

The larger cross faults may have large displacement. They post date the normal north-south sections of the basin margins, and displace them for a considerable distance. Along the major cross faults south of the Appomattox River, at the upper reaches of Skinquarter Creek, and south of Swift Creek Reservoir, bedding in the Triassic sedimentary rocks strikes parallel to the faults and dips away from them toward the basin's interior. Border conglomerates are associated with the fault south of the Appomattox River, and a gouge zone a few feet wide has been observed at the smaller cross fault on the eastern margin about 1.5 miles south of U. S. Highway 360.

A series of structure sections across the northern half of the basin are shown in Figure 2. These, together with the sections accompanying the geologic maps of the Hylas and Midlothian quadrangle, and the larger sections accompanying this report show the generalized structure of the basin. The sections indicate an unconformable eastern margin, a faulted western margin and a number of smaller faults and flexures within the basin. In the vicinity of the James River, the main part of the basin has a general synclinal shape. However, this is probably due to the upfaulted wedge-shaped block of granite extending southward into the basin. This block was probably upfaulted late in the history of the basin, dragging the rocks on its eastern flank upward and creating the western limb of

the broad syncline. This event may have been contemporaneous with the development of some of the large cross faults. In the James River area, the main border fault lies west of the upfaulted block. North and south of the James River section the effects of this upfaulted block cease and the cross-sections show beds gently inclined from east to west all across the basin. (Fig. 2)

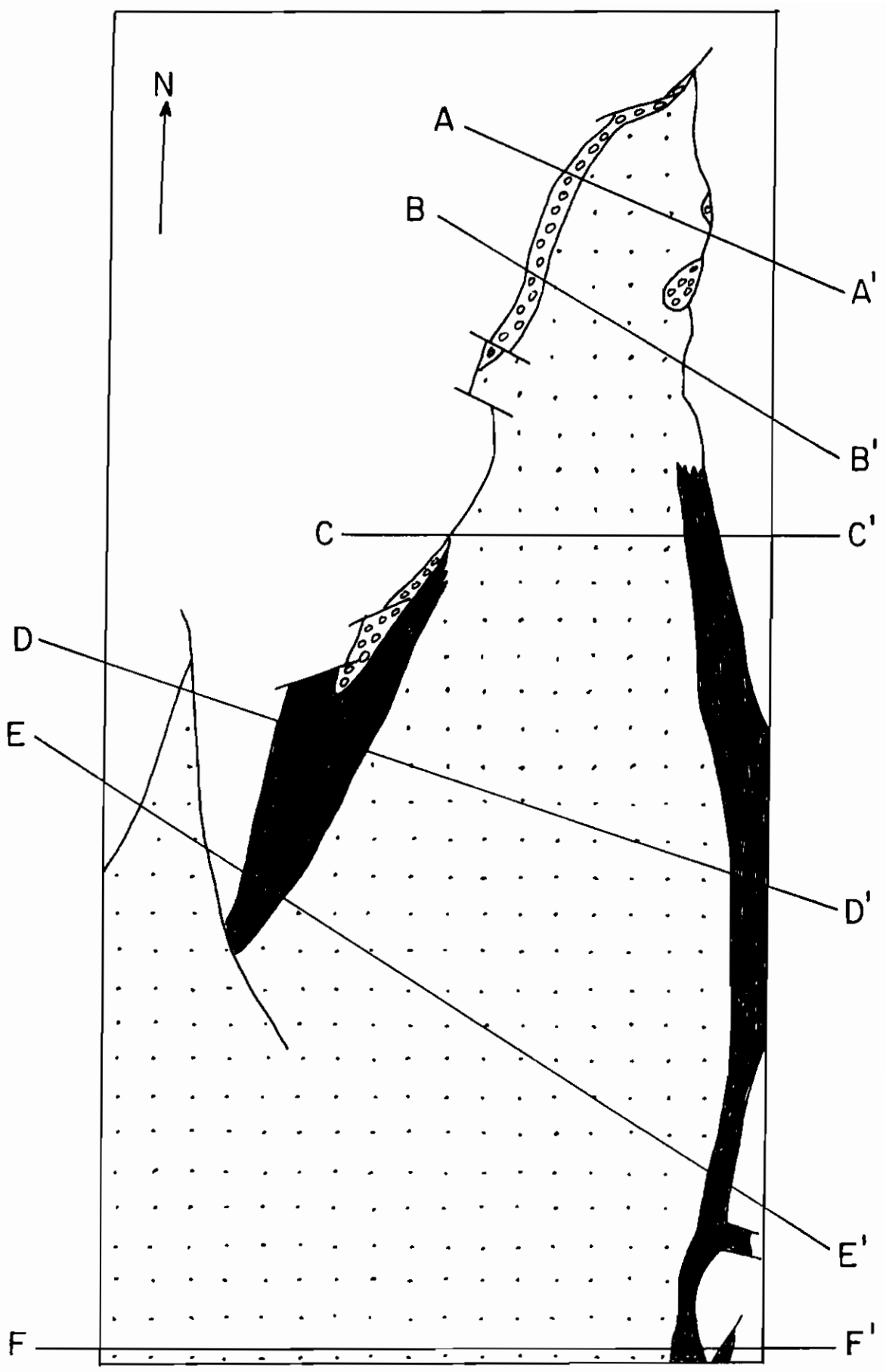
The exact thickness of Triassic sedimentary rocks within the basin or overlying the coal measures is unknown. Shaler and Woodworth estimated that the greatest thickness would most likely be found near the central part of the western border beneath the Otterdale sandstone, and that at least 3,000 feet of Triassic rocks may occur there. Their cross sections show that the beds are inclined westward from the eastern margin at an angle of 30 degrees and that this inclination continues with a few minor flexures until a depth of 2500 to 3000 feet is reached. At this depth the strata flatten out or dip gently toward the western margin where they have been rotated slightly along normal faults. No evidence has been found during the present study to negate either their estimate of the thickness or their general interpretation of the structure. Only a few drill holes give any information on the thickness of the sediments, and deep holes have not yet been drilled in the central part of the basin. Two holes are helpful to tell us a minimum thickness. The Salisbury hole reported by Shaler and Woodworth is about one mile from the eastern border north of Midlothian. Boring in this hole was terminated in shales underlying a bed of coke at 2,380 feet.

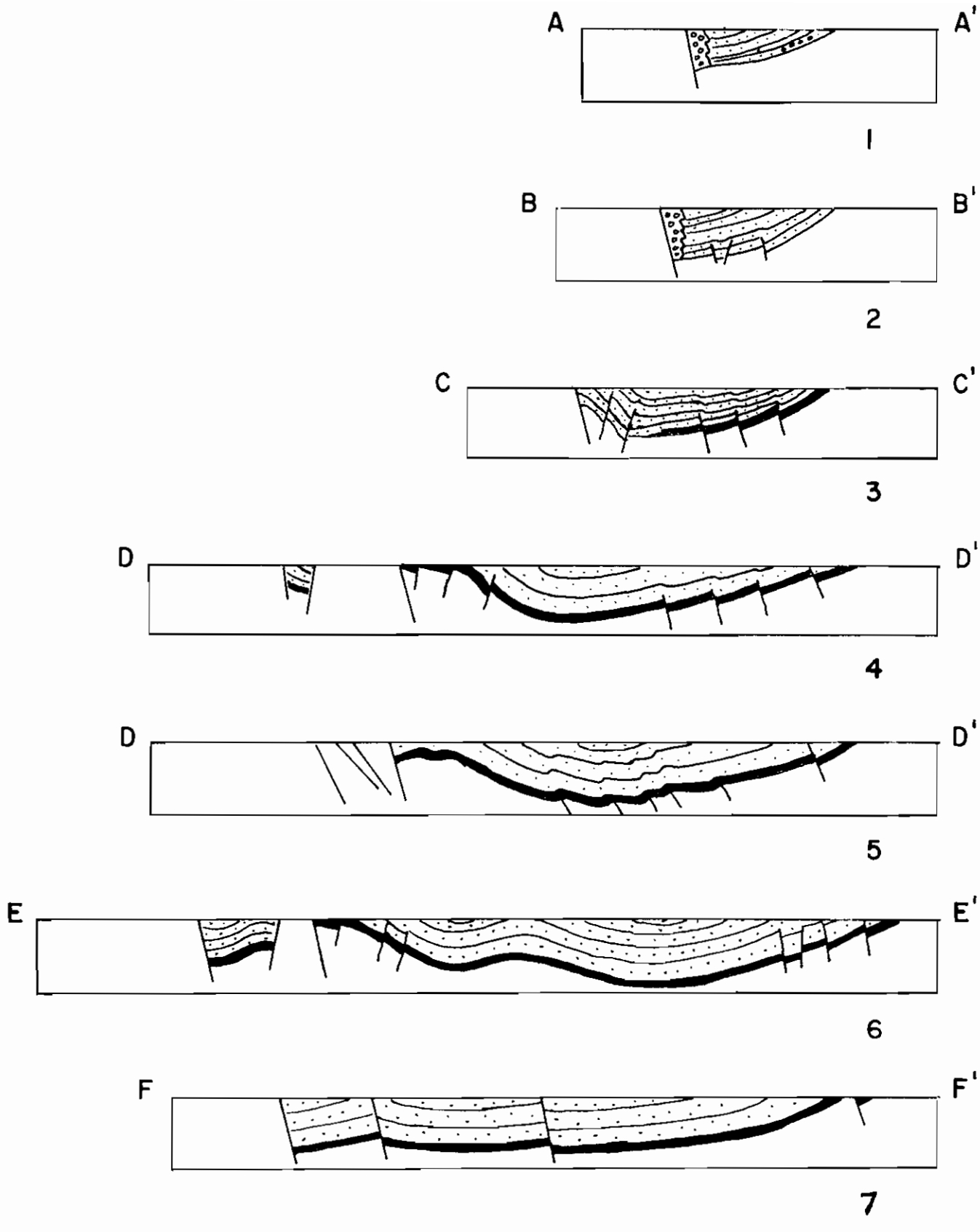
The only hole drilled near the western margin was that previously mentioned which was one-half mile from the border, penetrated 1514 feet of sandstone, and terminated in a diabase. From this information, all that we can say for certain is that the Triassic rocks are probably at least 2,500 feet thick within much of the basin south of the James River. They may well be from 3,000 to 3,500 feet

Figure 2. Diagrammatic structural cross-sections across the northern half of the Richmond basin. (on following pages)

A. Map showing location of structural cross-sections. Lithologies within the basin are indicated as follows: circles = boulder breccia (on western margin) and conglomerate (on eastern margin); black = Productive coal measures and Lower barren beds; dotted = sandstones and shales.

B. Structural cross-sections along lines shown on Figure 2-A. Sections 1, 2, 3, 4, and 6 are from Goodwin (1970). Sections 5 and 7 are modified from Shaler and Woodworth (1899). These sections illustrate the effects of the uplifted wedge-shaped granitic block in the area of the James River near the western border of the basin. To the east of the block the sediments within the main basin have been deformed into a broad synclinal configuration, and the true western border of the basin lies west of the upfaulted block. North and south of this area the sedimentary rocks are inclined gently westward across the basin, and the western border is marked by a steep normal fault of large displacement.


N
A
A'
B
B'
C
C'
D
D'
E
E'
F
F'


A
A'
1
B
B'
2
C
C'
3
D
D'
4
D
D'
5
E
E'
6
F
F'
7

thick. Only future deep drilling or geophysical exploration will provide an exact figure. The determination of the basin's thickness is critical because the coals occur near the bottom of the sequence.

DEEP RUN BASIN

A small basin containing Triassic sedimentary rocks occurs in the Glen Allen 7.5 minute quadrangle. It lies astride U. S. Highway 250 approximately 3.6 miles east of the eastern border of the Richmond basin. This basin, referred to as the Springfield or Deep Run basin by Rogers (1884), trends approximately N35E, is about 2.8 miles long, and has a maximum width of slightly over .4 mile. It is entirely enclosed by Petersburg granite. Its eastern border closely follows the path of Deep Run for .8 mile.

A former exposure in a borrow pit on the western edge of this basin south of I-64 revealed 500 feet of a fault contact between Petersburg granite and Triassic sedimentary rocks (Goodwin and Johnson, 1967). Displacement of the fault could not be determined, but the fault plane on the granite was highly slickensided and the adjacent granite was strongly chloritized with some epidote. The fault had an attitude of N45E, 68SE and the Triassic sedimentary rocks near the fault were highly contorted. This border fault was offset for a distance of 76 feet by a small cross fault trending N75W with the northeast side offset to the northwest. The western border of this basin is believed to be bounded by a normal fault.

No faulting was observed at the eastern border of this basin and there the Triassic rocks presumably lie unconformably upon the granite. The eastern contact was observed at two localities and in both cases a highly arkosic, coarse-grained, gray sandstone containing a few scattered, rounded quartz pebbles directly overlay Petersburg granite. The contact was gently inclined westward at 10 degrees or less and at one of the exposures the granite was slightly channeled. Gentle dips of but 10 to 20 degrees to the west generally occur near the eastern margin of the basin. Steep eastward dips of up to 74 degrees have been observed

near the western faulted margin. This basin is probably shallow and contains a maximum thickness of 400 feet of Triassic sedimentary rocks.

When the borrow pit mentioned above was active in 1966, a 157 foot long measured section was made of the Triassic rocks across the floor of the pit approximately at right angles to the contact. Here the sedimentary rocks had an average attitude of N50E, 60SE, although many minor deviations were encountered and the rocks were slightly folded. Portions of the section were cancealed, but it revealed a variable sequence of arkosic sandstone, siltstone, shale, coal, and thinly interbedded siltstone and arkose. This measured section is included in Appendix IO of this report, and it contains a total of 10 feet 2 inches of arkosic sandstone, 5 feet 4 inches of siltstone, 50 feet 2 inches of shale, 7 feet 6 inches of coal, and 16 feet of interbedded siltstone and arkosic sandstone. Although tending to weather brown to reddish-brown, where fresh the arkosic sandstone is light to dark gray, and the other lighologies, with the exception of the coals, vary from dark gray to greenish-gray to black. A seven foot deep vertical cut at the edge of the borrow pit showed channeling of a thick shale sequence with arkosic sandstone filling the channels. Deep cuts across the basin during construction of I-64/
minor faulting and folding.

Coal occurs in the Deep Run basin and several mines were formerly in operation both north and south of U. S. Highway 250 to the west of Deep Run. These have long been abandoned and most of the mining here was done by slave labor prior to the Civil War. The most recent attempt at coal mining in this basin was in 1938-39 when a shaft was sunk near Springfield Road. Records of production from that endeavor are not available but three coal seams over 8 feet thick were reported and the coal was said to be a good quality bituminous. The coal here usually occurs at shallow depths. Many old prospect pits, a few shafts, and numerous heaps of coal mining waste can still be found in this area.

Major Mining Centers and Brief History of Coal Mining

Coal was first reported in the Richmond basin in 1701 and the first active mining began around 1750 (Nicholls, 1904). However, little production was achieved until 1795, the first year in which the amount of coal mined exceeded 2000 tons. Since then, three major mining districts developed on the eastern margin of the basin, centered at Gayton north of the James River, and the towns of Midlothian and Winterpock south of the James River. Some mining was also done between the James River and Midlothian as well as in the Deep Run basin which lies to the east of the Richmond basin. On the western border of the basin mining took place at Manakin north of the James River and at two localities south of the James River; one near the river across from Manakin, and the other a few miles southwest of that point. On the eastern margin, many of the mines started out as open pits on the coal outcrop. These were then extended as inclines down the coal seams. Some deep shafts were driven down to the coals a short distance west of the border and then inclines worked the coals at the base of the shafts. On the western margin the coals were worked primarily by shafts. An account of the various mines in the area and the coal seams reported in those mines is included elsewhere in this report.

From 1780 to 1840 most of the coal produced was used locally for domestic purposes, although some was shipped from Richmond to Philadelphic and New York during the early part of the 19th century. About 2,892,645 tons of coal were produced during this period (Brown, et. al., 1952, Table 5)

From 1842 to 1880 the mines around Midlothian and Gayton were at the peak of their activity and mining also flourished in Winterpock. Some of the mines driven at that time were over 900 feet deep. Coal obtained during this period was used locally and also shipped to industrial centers; and production probably greatly exceeded that which occured prior to 1840. Most of the mines north of the James River around Gayton and Manakin closed down around 1880, and from then

until about 1930 production centered around Midlothian and Winterpock. The major exception was an incline at Gayton which extended for a total distance of 2400 feet and did not close until 1912. Peak production apparently occurred in 1835 with a total production of 201, 600 tons. In 1923, production was about 50,000 tons, and since 1930 production of coal from the Richmond basin has been negligible. Roberts (1928) reports only four mines operating in 1923, and only one of these was shipping any coal.

The latest mining ventures were of short duration. In the Deep Run basin an old shaft was reopened in 1938-39 but no records of production were available. During the period 1935-37, three small scale mining ventures were reported in the newspapers. One was a dragline operation in the Black Heath area, the second was a shallow incline near Winterpock, and the third was a shaft west of Dutoy Creek in Powhatan County. No production figures or length of mining acitivity could be found for these areas.

The Coal and Methane Resource

The major resources of the Richmond basin are coal, coke, and methane. As mentioned elsewhere, the coal is a good quality bituminous coal, and several analyses of the coal are given in Appendix II. Much coal remains within the ground and with modern mining methods it could be obtained. The rather dismal mining history of the basin has not been so much due to lack of coal as it has been to poor mining methods and economics. In the early days of mining much of the work was done by slave labor and little care was given to ventilation or proper support, resulting in numerous mine disasters.

Natural coke was produced where coal seams had been coked in place by the intrusion of nearby dikes and sills. The composition of this coke is similar to that of artificial coke and was sold commercially. Natural coke is most abundant between Gayton and Midlothian. This could be mined again and it also implies that much of the bituminous coal in the basin may provide a good coking coal.

Methane is associated with the coal beds. Some drill holes have reported gas and even traces of petroleum. Also the former mines were gassy and many of the mines were closed by methane explosions. The volume of methane within the coals is unknown and no tests on this have been done since there has been no modern drilling or mining to allow these studies. The coal does occur in thick seams which contain shale partings and laminations. It is also well jointed at right angles to bedding. With these natural partings it should lend itself well to fracking. Overburden should also be thick enough to cause methane to be released from the coals.

It is difficult, if not impossible, to determine the amount of coal which still exists beneath the Richmond basin. Shaler and Woodworth (1899) gave some estimates which are as valid today as they were then. With coal exposed on both the east and west margins, they assumed that except where faulted out, coal probably underlies much of the basin, or an area of approximately 150 square miles. From available mine data they suggested that the average thickness of the workable coals is 12 feet. From this they estimated that the basin contains an average of 12,000 tons of coal per acre or a total of 1,152,000,000 tons for the entire basin. This figure hinges on several variables. The extent of coal under the basin is not known with certainty and the present study suggests that the areas mapped by Shaler and Woodworth as coal measures along the south western margin may not exist. However, the coal measures may occur there at depth. The coals may become thinner toward the basin's interior but they may also thicken. The 12 foot thickness of coal by Shaler and Woodworth only included workable beds for coal mining. Many thinner seams are found and the total thickness of coal in a section often includes over 30 feet. Although they may not all be mineable, all may provide a source of methane. Finally, if the coals do extend beneath the basin, the depth to the coals is unknown. The probable occurrence of large volumes of coal and methane in this basin certainly warrant further investigation

to determine the actual reserves and the methods by which they may be extracted.

RECOMMENDATIONS

The Richmond basin should be studied in detail to determine its potential as a source of coal and methane. These studies should include small scale geologic mapping, deep drilling to basement, and geophysical work. Geologic mapping on a scale of 1:24,000 of the remainder of the basin will be accomplished during the next four years. This will include mapping of the Hallsboro, Clayville, Mannboro, and Winterpock 7.5 minute quadrangles. Several holes should be drilled to basement in order to determine depth to the coals, thickness of overlying sedimentary units and to obtain information on the quality and quantity of coal and gas. A series of holes should be drilled across the basin, preferably proceeding westward from known areas of coal at Midlothian or Winterpock. If coal is continuous across the basin, other holes should be drilled north and south of that line. In conjunction with or proceeding the drilling, seismic profiles and gravity studies of the basin should be done. These studies may aid in locating the holes to the best advantage. With the information obtained from field mapping, drill holes, and geophysical work it should be possible to develop an accurate picture of the basin, its structure, its stratigraphy, and its potential as a coal and gas producing area.

APPENDIX I.

STRATIGRAPHIC SECTIONS

A. Section of the Mesozoic rocks in the "Richmond Belt", at the old Midlothian coal mine from the granite upwards. After Heinrich, 1878, p. 256-260.

B. The section at Carbon Hill Mine. From Kimball, 1886. In Davis and Evans, 1938, Part I, p. 86.

C. The section at Clover Hill Mine. From Fontaine, 1883, p. 9.

D. The section near Boscabel Ferry, on Jones Creek. (Measured along roadcut). From Shaler and Woodworth, 1899, p. 428.

E. The Turkey Branch Section. From Shaler and Woodworth, 1899, p. 478-482.

F. A petrographic description of a core (Tuckahoe Village West: H-1) from the coal measures on the eastern margin of the Richmond Basin at Tuckahoe Village, Virginia.
   a. Core Description. Excerpted from "Cyclic Interbedding of arkosic sandstones and shales of the Richmond Triassic Basin in Virginia", a student research project by Felicia Boyd, College of William and Mary, Va., 1979.
   b. Core Log of Tuckahoe Village West: H-1. From Boyd, 1979, modified by K. Farrell.

G. The Cornwallis Hill Section. From Shaler and Woodworth, 1899, p. 470-473.

H. Logs of three shallow cores from the coal measures on the eastern margin of the Richmond Basin at Tuckahoe Village, Virginia.
   a. Tuckahoe Village West: H-2.
   b. Tuckahoe Village West: H-3.
   c. Tuckahoe Village West: H-4.

I. Measured stratigraphic section within Triassic coal measures along Gayton Road, 0.8 miles west of eastern margin of Midlothian Quadrangle. From Goodwin, 1970, p. 15-16.

J. Section on the Bailey's Hill property near Midlothian, Chesterfield County, Virginia. After Heinrich. From Rogers, 1928, p. 102.

K. The section at Midlothian, Va. (Modified by Russell, after Heinrich). From Wadleigh, 1938. In Davis and Evans, 1938, Part II, p. 45-46.

L. The section at Carbon Hill, Va., according to Russell. Reprinted from Wadleigh, 1938. In Davis and Evans, 1938, p. 45.

M. Measured stratigraphic section at northeast end of Lake Salisbury about 2 miles north-northwest of Midlothian. From Goodwin, 1970, p. 17.

N. Diamond Core drill hole record of core 2500 ft. east of the western border of the Richmond Basin.
   a. Driller's log.
   b. Detailed description of lower third of core.

O. Measured section of Triassic sediments in Deep Run Basin, Va. Measured by B.K. Goodwin.

A. Section of the Mesozoic Rocks in the "Richmond Belt", at the Old Midlothian Coal Mine, from the granite upwards. After Heinrich, 1878, p. 256-260.

THICKNESS	DESCRIPTION	TOTAL DISTANCE FROM GRANITE feet	in.
Bottom of section			
	I. Boulder formation, 36'.		
36'	Conglomerate, yellowish-brown, marly, friable rock, highly calcareous, containing boulders of granite with orthoclase feldspar, ...	36	
	II. Lower sandstone group, 251'.		
54'	Sandstone, feldspathic brown ferruginous, with small seams of carbonate of lime, particles of specular iron ore, red feldspar, and quartz pebbles, ...	90	
5'	Brownish-gray argillaceous sandstone and drab-colored slate containing vegetable impressions, ...	95	
19' 8"	Sandstone, arkose, white, containing blotches of clay, slightly ferruginous, and red feldspar in part, . .	114	8
6'	Slate, drab-colored, containing vegetable impressions,	120	8
3'	Sandstone, arkose, gray, containing fragments of teeth (saurian) and red feldspar, ...	123	8
8' 6"	Slate, gray and black, some highly bituminous, arenaceous, containing concretions of limestone, vegetable impressions, teeth and coprolites, ...	132	2
9' 6"	Sandstone, brownish-gray, oleiferous, containing red feldspar, ...	141	8
7' 4"	Sandstone, schistose, containing mineral charcoal at top of strata, and Slate, black, bituminous, containing vegetable impressions and coprolites, ...	149	
30'	Sandstone, arkose, white, slightly calcareous, partially coarse in smaller strata, with slaty bands at bottom of strata, ...	179	
11'	Sandstone, brownish gray and arkose; white, hard, oleiferous at bottom, ...	190	
13' 6"	Slate, black, highly bituminous, calcareous, containing Calamites, Cythere, Estheria, and carbonaceous sandstone containing slender vegetable stems, . . .	203	6
23' 5"	Sandstone, arkose, white, coarse, slightly calcareous, and pyritiferous argillaceous sandstone containing carbonaceous vegetable fossils, red feldspar, . . .	226	11
20'	Slate, black, bituminous, calcareous, containing fish-scales (Dictyopyge), Cythere, mineral charcoal, and and vegetable stems; also carbonaceous sandstone, red feldspar, ...	246	11

Section at Midlothian Coal Mine, cont.

THICKNESS	DESCRIPTION	TOTAL DISTANCE FROM GRANITE feet	in.
17' 4"	Sandstone, arkose, light gray, coarse, slightly calcareous, containing black mica; also arenaceous, dark drab-colored slate containing carbonaceous particles. Red feldspar makes its first appearance in this stratum, ...	264	3
23'	Sandstone, arkose, white, coarse, slightly calcareous, containing black mica; also drab-colored calcareous slate and carbonaceous sandstone, containing streaks of carbonate of lime, ...	287	3
III. Lower calciferous group, 245'.			
2'	Slate, black bituminous, containing streaks of carbonate of lime, fish-scales, Estheria, iron pyrites, and carbonaceous inclosures, ...	289	3
21'	Sandstone, arkose, light gray, coarse, with blotches of clay, oleiferous at top of strata; also argillaceous sandstone containing carbonaceous fossil stems, ...	310	3
9'	Dark-gray carbonaceous sandstone, slate and limestone, fish-scales (Dictyopyge), in black bituminous slate at bottom of strata, ...	319	3
22'	Sandstone, arkose, white, coarse at top of strata, calcareous, ...	341	3
10' 10"	Sandstone, dark brownish-gray, carbonaceous, and slaty, containing carbonized fossil stems, ...	352	1
11'	Sandstone, arkose, white and reddish gray, coarse and argillaceous; sandstone containing mineral charcoal, . . .	363	1
3'	Sandstone, drab-colored, micaceous and arenaceous limestone,	366	1
20'	Sandstone, arkose, light gray, partially coarse and calcareous, containing mineral charcoal and Calamites, . .	386	1
4' 9"	Sandstone, gray, carbonaceous, slate and limestone, . .	390	10
15' 3"	Sandstone, arkose, light gray, calcareous, ...	406	1
3'	Sandstone, dark gray, carbonaceous, slate and limestone,	409	1
23' 8"	Sandstone, arkose, light gray, mostly very coarse and hard, calcareous, containing blotches of clay and small strata of black slate, ...	432	9
13'	Sandstone, light gray, carbonaceous and slaty, strata containing mineral charcoal, ...	445	9
14' 6"	Sandstone and slate, drab-colored, containing long vegetable stems, carbonaceous particles, pyritiferous slates and small strata of limestone, ...	460	3
18'	Sandstone, arkose, grayish white, coarse, conglomerate, slightly calcareous, ...	478	3
17' 6"	Sandstone and slate, strata of gray and drab-colored argillaceous micaceous sandstone and slate, calcareous, containing coprolites; also some arkose, ...	495	9
6'	Sandstone, dark, brownish-gray, carbonaceous, argillaceous, containing carbonaceous inclosures, also arenaceous slates,	501	9
2'	Oil rock, strong, brownish-gray sandstone, ...	503	9
11' 7"	Sandstone, argillaceous, light gray, calcareous and arenaceous limestone; fire-clay at bottom of strata, . . .	515	4
16' 3"	Slate, black, highly bituminous, containing fish-scales, Estheria, bony coal, and concretions of limestone, . .	531	7

THICKNESS	DESCRIPTION	TOTAL DISTANCE FROM GRANITE feet	in.
	IV. Carbonaceous group, 150 feet.		
34' 9"	Sandstone, arkose, light gray, hard, partially coarse, containing an oil-bearing stratum near the bottom,	566	4
5'	First coal seam, 3½' of coal, 1½' slate,	571	4
6' 2"	Slate and schistose sandstone, dark gray, pyritiferous,	577	6
4' 3"	Sandstone, arkose, light gray, partially schistose, containing mineral charcoal,	581	9
8'	Slate, dark gray, vegetable impressions,	589	9
9' 10"	Sandstone, arkose, gray, with argillaceous blotches,	599	7
1'	Second coal seam,	600	7
9'	Slate, gray, containing carbonized vegetable stems,	609	7
9'	Sandstone, arkose, gray, hard, containing carbonaceous blotches,	618	7
12'	Third coal seam divided by slaty bands from 2" to 24",		
10' 3"	Sandstone, gray, silicious and gray slate, containing Calamites,	655	4
14' 6"	Coal seam divided by various slaty bands,		
4'	Slate, black and argillaceous sandstone, micaceous, containing crystals of calcite and thin sheets of the same; Equiseta, particles of coal,	659	4
11'	Sandstone, arkose, grayish white and drab-colored, argillaceous, slightly calcareous blotches of clay,	670	4
12'	Slate, black, bituminous, containing remains of fish (Tetragonolepis), Cythere and Estheria, and a stratum of limestone (sometimes 2 feet thick); carbonaceous sandstone in part, containing Taenopteris and Equisetum,	682	4
	V. Oleiferous group, 191 feet.		
10' 6"	Sandstone, arkose, gray, hard, and coarse, slightly calcareous and schistose sandstone,	692	10
7'	Slate, highly bituminous and carbonaceous sandstone, containing fish-scales and long vegetable stems,	699	10
4' 6"	Oil rock, sandstone, light gray, with greenish blotches, slightly calcareous,	704	4
17'	Sandstone, arkose, light gray, coarse; also schistose,	721	4
9'	Slate, black, containing fish-scales, Estheria, Calamites, and other vegetable impressions; also gray limestones,	730	4
24'	Sandstone, arkose, coarse, and carbonaceous sandstone, oleiferous near top of strata,	754	4
6' 8"	Sandstone, coarse and very hard, arkose, white,	761	
6' 6"	Slate, black, bituminous and greenish, calcareous and arenaceous, micaceous, containing marly limestone, fish-scales (Tetragonolepis), Cythere, Estheria, vegetable impressions and coaly particles,	767	6
13' 2"	Sandstones, gray, argillaceous and schistose; also feldspathic, containing mineral charcoal,	780	8
7' 8"	Slate, black bituminous, pyritiferous, containing fish-scales (Tetragonolepis), Estheria, Cythere, and long vegetable stems; also a stratum and concretions of a fibrous nearly black carbonate of lime and carbonate of iron; also a strong oil rock,	788	4

THICKNESS	DESCRIPTION	TOTAL DISTANCE FROM GRANITE feet	in.
32' 8"	Sandstone, arkose, grayish white, porous in two heavy strata, containing an oil rock near top of the last bench, .	821	0
3' 6"	Slate, greenish, dark drab-colored, and black, highly bituminous slate, containing Cythere, fish-scales, and carbonate of lime in thin sheets, sometimes oleiferous sandstone at bottom, ...	834	6
20' 6"	Sandstone, arkose, grayish white and gray argillaceous, partially large quartz pebbles (probably containing teeth of saurians), ...	851	
14' 9"	Sandstone and slates, drab-colored, arenaceous, and arenaceous limestone, ...	865	9
7' 9"	Slate, gray and black, containing fish-scales, Cythere, Estheria, Calamites, and other imperfect vegetable impressions, concretions of limestone, and iron pyrites upon the joints of the rock. (Teeth of saurians), . . .	873	5
VI. Upper calciferous group, 334 feet.			
28' 7"	Sandstone, arkose, light gray and schistose sandstone, with slaty strata, ...	902	
23'	Slate, gray, arenaceous and black fissile, containing fish-scales, Calamites, and long vegetable stems and limestone, arenaceous, drab-colored, in small strata; also some benches of arkose dividing it from the next, ...	925	
7' 9"	Slate, pyritiferous, containing in addition, Estheria, thin sheets of calcite and gypsum, ...	932	9
5' 9"	Sandstone, arkose, light gray, conglomerated and carbonaceous, ...	938	6
3' 6"	Slate, dark gray, pyritiferous, containing gypsum,	942	
16' 9"	Sandstone, arkose, light gray, coarse, slightly calcareous, ...	958	9
13' 10"	Slate, dark gray and drab-colored, containing calcareous concretions, pyritiferous, obscure vegetable impressions,	972	7
12' 4"	Sandstone, arkose, white, slightly calcareous, . . .	984	11
5' 1"	Slate, gray, calcareous, and 3' 6" limestone, . . .	990	
45' 1"	Sandstone, arkose, grayish white, calcareous, in heavy benches divided by slaty strata, ...	1035	1
18' 2"	Slate, black, pyritiferous, calcareous, containing fish-scales, Estheria, and limestone strata from 1" to 4", .	1053	3
27' 10"	Sandstone, arkose, light gray, coarse and calcareous, and argillaceous carbonaceous sandstones, ...	1081	1
30' 9"	Slate, gray and drab-colored, and arkose; small strata of limestone at the top, larger at the bottom, the latter in slate, containing fish-scales, ...	1111	10
36' 9"	Sandstone, greenish gray, fine-grained and arkose in middle of strata, ...	1148	7
29' 9"	Slate, black, micaceous, calcareous and argillaceous micaceous sandstone. obscure vegetable impressions, . . .	1178	4
15' 1"	Sandstone, arkose, grayish white, coarse, calcareous, . .	1193	5
13' 7"	Slate, black or bluish-black, compact, finely laminated and benches of ash-colored sandstone, near top of strata; obscure vegetable impressions, Calamites in lower part of strata, ...	1207	

THICKNESS	DESCRIPTION	TOTAL DISTANCE FROM GRANITE feet	in.
	VII. Upper sandstone group, 291 feet represented.		
30' 6"	Sandstone, gray schistose, containing micaceous limestone, with crystals of calcite upon bed plains, ...	1243	6
28' 5"	Sandstone, arkose, principally, and benches of schistose micaceous sandstone, containing vegetable impressions, .	1271	11
2' 6"	Slate, dark gray, arenaceous; Calamites, ...	1274	5
12' 11"	Sandstone, arkose principally, and dark brownish-gray fine-grained slate, calcareous sandstone, coarser at bottom, ...	1287	4
8'	Slate, dark gray, ...	1295	4
26'	Sandstone, ash-colored, fine-grained, calcareous, . .	1321	4
14' 11"	Slates, dark drab-colored and greenish gray, calcareous concretions at top, 6 " marly limestone at middle of stratum, also greenish-gray argillaceous sandstone in upper part, ...	1336	3
21'	Sandstone, arkose, light ash-colored, medium-grained, containing inclosures of clay, decomposed feldspar, calcareous, ...	1357	3
26' 4"	Shale, gray and drab-colored, obscure traces of vegetable remains, ...	1383	7
37' 5"	Sandstone, gray, argillaceous, fine-grained, . . .	1431	
24' 5"	Sandstone, arkose, gray, coarse, ...	1445	5
43' 5"	Sandstone, ash and buff-colored, calcareous in last four feet, ...	1489	10
5"	Coal seam, ...	1490	3
8' 5"	Shale, buff-colored, approaching fuller's earth. Recent deposits, from 5 to 46 feet, ...	1498	8
20'	Surface soil followed by soft buff and pink-colored conglomerate of red clay and quartz pebbles; also frequently a pure gravel bed, ...	1518	8

B. The Section at Carbon Hill Mine. From Kimball, 1886. In Davis and Evans, 1938, Part I, p. 86.

The following is a section of the Carbon Hill Collieries:

Soil	20 feet.
Alternate Slates and Sandstone	450
Cinder, so called, Fire clay with Nodular Pyrites	15
Slates and Sandstones	60
Coke seam (Coal) Coke 2 ft. 5 in.) Coal 3 ft. 6 in.)	6
Slates and sandstones	50
Second Coal Seam	6
Slates	17
Third Coal Seam	4½
Slates and Sandstones containing 6 in seam of coal	40
Fourth or Slope Seam 8 - 10 feet	9
Unexplored	150
Granite case of coal measures	0
	837½

C. The Section at Clover Hill Mine. From Fontaine, 1883, p. 9.

The Section of the coal beds at Clover Hill is as follows, beginning with the highest coal seam:

	Thickness.
15. Coal seam, local (?), 18 inches to	4 feet.
14. Interval, sandstone and shale	14 feet.
13. Coal seam, local	12 inches.
12. Interval, sandstone and shale	12 feet.
11. Coal seam, local	14 inches.
10. Interval, sandstone and shale	25 feet.
9. Coal seam, local	18 inches.
8. Interval, sandstone and shale	40 feet.
7. Upper bench of main coal	5 feet.
6. Interval, shale, varying in thickness	5 feet +.
5. Main coal, lower bench	15 to 26 feet.
4. Interval, sandstone and shale	10 feet.
3. Lower persistent coal bed	4 feet 9 inches.
2. Interval, sandstones and shales, about	250 feet.
1. Gneissic floor.	

D. The section near Boscabel Ferry, on Jones Creek. (Measured along roadcut). From Shaler and Woodworth, 1899, p. 428.

STRATA	THICKNESS Ft.	In.
Clay, brownish and whitish.	70	0
Shale, carbonaceous.	2	0
Clay, gray, decomposed shale.	35	0
Sandstone, brown.	1	0
Shale, slate-colored.	2	0
Shale, brown and gray, laminated.	14	0
Shale, brown.	8	0
Sandstone.	0	6
Shale, brown.	10	0
Sandstone, red.	6	0
Shale, brown.	16	0
Sandstone, red.	6	0
Shale, brown.	36	0
Sandstone.	9	0
Total	215	6

E. The Turkey Branch Section. From Shaler and Woodworth, 1899, p. 478-482.

Section on the Turkey Branch of Swift Creek.—One of the most complete natural exposures of the lower members of the Newark group in the Richmond Basin occurs on the western margin, near Mosley Junction, in the headwaters of Turkey Branch of Swift Creek (see Pl. XXXVIII). In the summer of 1896 heavy rains had washed down the sand in the bed of this stream, so that the bottom was unusually free from detritus, and the following section, giving a record of over 1,000 feet in thickness of strata from the base up, was observed:

Turkey Branch section. (In descending order.)

Strata.	Exposures (measured).	Thickness (computed).
	Feet.	*Feet.*
Clay, sandy, dip 45° E	15	10.60
Conglomerate	12	8.48
Clay, white	8	5.65
Sandstone, pebbly, dip steep east	72	50.90
Conglomerate	5	3.53
Sandstone, coarse, gray	8	5.65
Shale, green	16	11.31
Shale, red with green streaks, dip 90°	48	33.93
Sandstone	20	14.14
Shales, green	32	22.62
Sandstone, pebbly near top, dip 45° E	27	19.08
Shales, green and red	38	26.86
Shales, sandy, red and green	5	3.53
Conglomerate, with quartz pebbles from 3 to 5 inches long	6	4.24
Shale, red	36	25.45
Shale, green	20	14.14
Conglomerate, dip 45° E	36	25.45

Turkey Branch section. . . . ascending order —Continued.

Strata.	Exposures (measured).	Thickness (computed).
	Feet.	*Feet.*
Sandstone	30	21.21
Sandstone, with cross bedding or local unconformity at east end of an 18-foot bed; overlying the pebbly sands, dip 15° E, and the underlying layers are nearly vertical, indicating probably an overthrust. (See Pl. XXXVIII, station 1,800.)		
This exposure extends in the creek	18	12.72
No exposures	6	4.24
Sandstone, pebbly	6	4.24
Clay, greenish	9	6.36
Sandstone, fine-grained, dip about 45° E	15	10.60
Clay, sandy, light greenish to brown	18	12.72
Sandstone, brown	6	4.24
Clay, greenish	1	.70
Sandstone	2	1.41
Clay, green	6	4.24
Sandstone, dip 45° E	18	12.72
Shales, green, dip 60° or more E	3	2.12
Shales, red and brown	44	31.10
Sandstone	6	4.24
Shales, red, dip 45° E	50	35.35
Clay, light green	8	5.65
Sandstone, with pebbly bands	15	10.60
Clay, red and green	6	4.24
Sandstone, dip 45° E	41	28.98
Shales, bituminous, 6 inches thick, with	1.5	1.06
Shales, light-colored, 12 inches		
Sandstone, dip 70° E	4	3.76
Shale, greenish	10	9.40
Shale, red	15	14.10
Sandstone, greenish, dip 80° E	4	3.92
Sandstone, brown	10	9.40
Shales, greenish	8	7.52
Sandstone	6	5.64
Shale, red and green, dip about 70° E	37	34.78
Sandstone	6	5.64
Shale, red	2	1.73
Shale, green	2	1.73
Shale, red	3	2.59
(Here a fault, dip 60° E, cutting out this red shale bed. See section, Pl. XXXVIII, at station 1,100.)		

Turkey Branch section. (In descending order.—Continued.

Strata.	Exposures (measured).	Thickness (computed).
	Feet.	*Feet.*
Sandstone	10	8.66
Shale, red	6	4.24
Clay, green	7	5.65
Sandstone, containing a local seam of coal one-half inch thick	12	8.48
Conglomerate	4	2.82
Shale, brown and green, exposed on south bank facing the trap on north bank	5	3.53
Sandstone	12	8.48
Diabase dike, exposed in branch; at locality 1,390.		
Sandstone, brown and soft	5	3.53
Sandstone, fine red	9	6.36
Sandstone (?), brown and soft	3	2.12
Sandstone, dip 55° E	4	3.27
Shales	14	9.89
Sandstone, 35° E	12	6.88
Conglomerate, with quartz pebbles 3 inches long	18	12.72
Sandstone, gritty	18	12.72
Turkey branch diabase dike exposed here; dike 12 feet wide, nearly vertical, with ball weathering; strikes N. 87° E., and is partly excavated by the stream.		
Clay, green, 35° E	6	4.24
Grit	3	2.12
Clay, light-green, dip 45° E	2	1.41
Sandstone	4	2.82
Clay, light-green	3	2.12
Conglomerate, with quartz pebbles	9	6.36
Clay, greenish and reddish	11	7.77
Sandstone, greenish-brown, dip 50° E	18	12.72
Shales, red and green, under bridge, dip 45° E., strike NNE	24	16.96
Sandstone		4.00
Shales, red		10.00
No exposures for about 80 feet, equivalent to (?)		40.00
Sandstone, gritty, dip 15° E	16	4.14
Conglomerate, fine	14	3.62
Clay or light-colored fine sand	4	1.03
Clay, sandy and pebbly	3	.87
Clay, light colored	16	4.14
No exposure, but probably clay	18	6.19

Turkey Branch section. (In descending order)—Continued.

Strata.	Exposures (measured).	Thickness (computed).
	Feet.	*Feet.*
Clays, light-colored	15	6.34
Sandstones, brown	18	9.00
Sandstone, coarse, gritty, light-brown	27	15.49
Sandstone, fine brown, dip 40° E.	33	21.54
Clays, light-colored, dip 10° E., strike N. 12° E.	25	16.40
Sandstone, slate-green color	5	3.28
Sandstone, bed C, coarse brown, marked by small fall in bed of stream; joints, N. 32° E., N. 35° E., N. 37° E., a few scattered pebbles up to 2 inches in diameter	27	6.99
Clay, bed B, light-green, with sand partings, dip 15° E	13	3.36
Sandstone, bed A, brown; anticlinal exposure, base not seen	9	(?)
Clay, bed B, slate-colored, top not seen, synclinal exposure	16	(?)
Sandstone, bed A; fine brown; anticlinal exposure, low and flat fold; the bed here carries nodules up to 6 inches in diameter. The bed is overlain in the bank of the brook by the light-green clay, bed B	51	(?)
Clays, bed B, with sand partings, dip 25° W	40	19.03
Sandstone, bed C, coarse brown, dip 30° W	9	4.50
Shale, red, bed D, dip 60° W.	4	3.00
Sandstone, bed C, brown	3	3.00
(For a fault at this point see Pl. XXXVIII, locality 700, and fig. B, restoration of folds before overthrusting occurred.)		
Clay, brownish-green, bed B, partly cut out by fault on south side of brook, but from 10 to 12 feet thick in north bank	12	10.00
Sandstone, varying from fine to coarse pebbly near contact with clay	23	.....
Clay, bed B, light-green, dip 90°, 20 feet	.....	20.00
Unexposed; probably clay, becoming sandy, near next	.....	24.00
Shales, bed D, red, intersected by greenish walled joints, dip vertical	8	8.00
Clays, light-colored, sandy and pebbly, with bands of light-green clay	7	.....
Sandstone, brownish and greenish	33	.....
Clays	15	.....
Shales, red and green, dip 90° E.	3	.....

Turkey Branch section. (*In descending order*)—Continued.

Strata.	Exposures (measured).	Thickness (computed).
	Feet.	*Feet.*
Clays interstratified with red shales	16	
Sandstone, bed C, coarse brown	22	
Clays, light-green, wedging out at north bank	25	
Sandstone, bed A, fine brown, dip 15° E., strike N. 2° E	32	
Unexposed, but probably clays	80	
Clays, bed C, unsatisfactory exposures, whitish beds with quartz pebbles	85	
Sandstones, bed B, anticlinal exposure	13	
Clays, bed C	10	
Sandstones, bed B; anticlinal exposure	20	
Clays, bed C, dip 10° E	30	
Sandstone, bed B; low, flat anticline, tops not seen	6	
Clays, bed C, top not seen	20	
Sandstone, bed B; low, flat anticline, with schist breccia	30	
Clays, bed C, dipping gently E., with quartz pebbles	4	
Unexposed, probably some white clays with the sandstone, bed B	60	
Pre-Newark gneisses; surface dipping gently E		

F. A petrographic description of a core (Tuckahoe Village West: H-1) from the coal measures on the eastern margin of the Richmond Basin at Tuckahoe Village. Virginia.

a. Core Description. Excerpted from "Cyclic interbedding of arkosic sandstones and shales of the Richmond Triassic Basin in Virginia", a student research project by Felicia Boyd, College of William and Mary, 1979. Edited by K. Farrell.

The stratigraphic section, representing an apparent thickness of approximately 20 m (65.6 ft), is characterized by a cyclic interbedding of arkosic sandstones and shales. A series of fining upwards sequences consist of relatively clean, medium to coarse grained arkoses grading upwards into finer grained, more corroded and muddy arkosic wackes. Each cycle is completed by an unconformably overlying carbonaceous or argillaceous shale. Between major cycles are transitional, smaller scale cyles of arkosic wackes and shales.

The lowest and first major cycle appears to encompass a thickness of about 5 m (16.4 ft). (Thickness of the section here should be 6.5 m (21.3 ft) according to well-logging data, implying a loss of 22% of the core). The cycle begins with 200 cm (6.6 ft) of clean arkose, gray to black in color with large, observable, white feldspars giving the rock a speckled appearance. The arkose consists primarily of medium and medium-coarse, angular to subangular grains with quartz and feldspar as the dominant minerals. Micas delineate zones of weakness in the rocks and are parallel to bedding. Most are bent and deformed, presumably due to compaction. The grains are closely packed; grain boundaries are well-defined and there is little sericite or observable corrosion. The arkose section appears to exhibit graded bedding. The arkoses grade into a 110 cm (3.6 ft) unit of finer grained (medium-fine to fine) arkose-arkosic wackes. These rocks are tan to gray in color and have undergone sericitization. The unit is laminated with alternating medium and fine grained layers. This is followed by 45 cm (1.5 ft) of arkose much like the original arkose but with a larger percentage of seri-

cite and obvious graded bedding. A 2 cm (0.06 in.) thick coal lies unconformably on the arkose and is, in turn, overlian by 100 cm (3.3ft) of a fining upwards sequence of arkosic wackes. The arkosic wackes are muddy with a large percentage of sericite and corroded material. Quartz and feldspar are the dominant minerals, with total % feldspars actually exceeding quartz in places. There is a relative abundance of micas with a larger percentage of biotite than muscovite. The "cycle" culminates with 70 cm (2.3 ft) of finely laminated micaceous shales and low grade coals lying unconformably on the arkosic wackes.

The following division of units is 1.5 m (4.9 ft) in thickness (25% of this section of the core is missing) and is characterized by small scale cyclic interbedding of arkosic wackes and shales. The arkosic wackes are primarily medium-fine to fine grained in size with a black to brown muddy matrix (which, in some cases, make up more than 50% of the rock). Micas and very thin laminae of compacted clay are seen as black lines and delineate zones of weakness. Medium grained arkosic beds grade upward into fine grained units which, in turn, grade upward into or are unconformably overlain by shales. The fine grained units appear to include coarser grained lenses. The shales are finely laminated, muddy and micaceous. Some are interbedded consisting of rhythmic light and dark units. They are compacted and contain lenses of medium grained arkoses. In this particular section there are at least 5 minor cyles of interbedded arkosic wackes and shales, each cycle not more than 50 cm (1.6 ft) in thickness. The first two of these minor cycles consist primarily of arkosic material with only a thin layer of shale. The last units, however, only have a thin layer of arkose and are predominantly shale.

The next cycle of 105 cm (3.4 ft) begins with a 10 cm (.33 ft) graded arkose. The arkose is light gray in color with subangular, medium to fine

closely packed grains with little sericite or corroded material. Overlying arkosic wackes are as before, graded, muddy, medium-fine grained, and containing a large percentage of K feldspar (nearly exceeding quartz). The cycle is completed by an unconformably overlying 30 cm (1.0 ft) unit of very fine grained micaceous, carbonaceous shale.

The final cycle is a major one of 390 cm (12.8 ft) made up of several minor cycles. The first 200 cm (6.6 ft) are primarily arkoses. Arkosic wackes immediately overlie the shales of the previous cycle and are medium-fine and medium-coarse grained with a black muddy matrix, mostly due to primary clays. There are nearly equal amounts of quartz and feldspar, nearly equal amounts of K feldspar and plagioclase, and very little sericite or corroded material. Overlying arkoses are clean with sharp grain boundaries, little sericitization and almost no corrosion. The arkose is overlain by a 20 cm (0.7 ft) fine grained shale and an arkosic wacke interwoven with black shaley units. Finely disseminated pyrite is abundant in these units. This is followed by 80 cm (2.6 ft) of graded, coarse to medium to fine, clean and well consolidated arkosic sandstone which, in turn, is overlain by 65 cm (2.1 ft) of carbonaceous shale with medium-coarse grained arkosic lenses. There is a final 50 cm (1.6 ft) influx of muddy arkosic wackes consisting of alternating fine and medium-coarse grained layers. The remainder of the core is 500 cm (16.4 ft) of finely laminated argillaceous and carbonaceous shales interrupted by a cross cutting 150 cm (4.9 ft) thick diabase dike.

Brief Description of the Arkoses and Shales

The arkosic sandstones were primarily medium to medium-fine grained, angular to subangular, and poorly sorted. Quartz was, in most cases, the dominant mineral, ranging from straight extinction to strongly undulose and including both single and composite grains. K. feldspar was more

abundant than twinned plagioclase. Micas rarely exceeded 10% in abundance and, indeed, in most cases, made up only 5% of the unit. No pattern could be discerned concerning the ratio of muscovite to biotite in the core. The amount of clays, sericite (due to chemical weathering), and corroded material varied with rock type (and position in the sequence). Arkosic wackes, for example, had a large abundance of primary clays and/or sericite and corroded material. The arkoses exhibited varied degrees of consolidation. In some cases, the grains were interlocked or welded. In others, the fragments were held together by a breccia-like cement of sharply angular clastic fragments and clay. Other rocks were composed of individual grains floating in a clay or mud matrix. In the arkoses, compaction was evidenced by distorted mica flakes and bent lamellae of plagioclase. The micas were pinched and deformed between tightly packed sand grains and along bedding planes. All of the units exhibited lamination (micas, especially, were oriented so that flakes were lying parallel to bedding planes, in many cases, covering the entire bedding surface). Most of the units were graded.

The arkosic sandstones could be classifed as "immature". Certain characteristics indicate rapid transportation and little chemical weathering. In only one case, (in one thin section), was there less than 30% feldspars. In many cases, the feldspars had retained their original grain shape. Twinned plagioclases as inclusions within larger quartz and feldspar grains had remained intact. All of the grains were angular to subangular, having undergone little chemical weathering. The rocks are gray in color with no indication of subaerial weathering or iron oxidation. The only indication of chemical weathering is sericitization which is presumably due to burial and groundwater or hydrothermal infiltration and contamination. Micas, which would have been one of the first minerals to chemically decay, are seen in relatively large percentages.

The large percentage of detrital polycrystalline quartz grains and quartz grains exhibiting undulose extinction suggest a relatively immature sandstone because these grains are, in most cases, destroyed selectively by mechanical and chemical agents and are rare in mineralogically mature sandstones (Blatt and Christie, 1963). The shales were black to brown, carbonaceous and/or argillaceous, micaceous, and finely fissile laminated. Compaction of the shales is suggested by the undulatory internal structure and the parallelism of the micas. Many shale units include lenses of coarser grained arkoses.

b. Core Log of Tuckahoe Village West: H-1. From Boyd, 1979, Modified by K. Farrell.

THICKNESS FT.	M.	DESCRIPTION
TOP		
9.0	2.74	Fill. Dark gray and black shale. Fragments of cinders and silty clay.
17.2	5.26	Dark gray to black carbonaceous shale.
2.8	0.85	Shale, brown, carbonaceous, very fine grained, fissile.
4.5	1.37	Shale, brown to black, carbonaceous, very fine grained to muddy, micaceous. Locally highly carbonaceous.
1.6	0.38	Missing.
2.6	0.80	Shale, black, highly carbonaceous, fissile.
1.1	0.34	Underclay, tan.
0.5	0.15	Diabase, heavily weathered or underclay.
0.8	0.25	Diabase, weathered.
0.7	0.21	Diabase, slightly weathered.
3.5	1.07	Diabase dike.
1.6	0.48	Missing.
0.3	0.10	Shale, carbonaceous, laminated, with lenses of arkosic sandstone.
0.2	0.06	Fragments of black, carbonaceous shale and light gray mudstone or underclay.
0.7	0.20	Shale, carbonaceous with arkosic sandstone lenses.
0.3	0.08	Missing.
0.9	0.27	Arkosic sandstone; black muddy matrix, closely packed, subangular, graded bedding, fine to medium-coarse grained sandstone.
0.1	0.04	Arkosic sandstone; medium to medium-coarse grained, porous.
0.4	0.12	Arkosic sandstone; black muddy matrix, fine grained with lenses of medium-coarse grained sandstone, micaceous.
0.2	0.07	Arkosic sandstone, medium-coarse grained, micaceous and friable.
2.1	0.65	Shale, black, carbonaceous, interbedded with lenses of medium-coarse grained arkosic sandstone near top.
2.7	0.81	Arkosic sandstone, gray to black with graded bedding: 1.8 ft. (.55 m) graded, medium to medium-coarse grained, well-consolidated sandstone. 0.2 ft (.05 m) graded, medium grained sandstone with thin layers of medium to coarse grained sandstone. 0.1 ft (.04 m) fine grained rhythmic sandstone. 0.1 ft (.04 m) Intrusion of coarse grained dike. 0.4 ft (.11 m) Noticeably graded, fine-medium grained, gray to brown sandstone. 0.1 ft (.02 m) Shale, black, muddy.
0.3	0.08	Arkosic sandstone layers (black and muddy) interwoven with medium to fine grained black, shaly units, isolated grains in a matrix, high percentage of primary clays, angular. SLIDE 33.
0.4	0.13	Shale, brown, muddy, carbonaceous.

Key: Grain size

Very fine grained < .1mm
Fine grained: .1-.2 mm
Medium-fine grained: .3-.6 mm
Medium grained: .7-1.0 mm
Medium-coarse grained: 1.0-2.5 mm
Coarse grained: > 2.5 mm

THICKNESS FT.	THICKNESS M.	DESCRIPTION
top		
0.3	0.08	Arkosic sandstone; medium-fine grained, graded bedding. SLIDE 32.
1.0	0.30	Arkosic sandstone; black matrix, poorly sorted, medium-fine grained, uniform, no bedding, little corrosion. Angular, fresh, large pyrite grain. SLIDE 31.
0.5	0.15	Arkosic sandstone; brown, medium grained, subangular, porous, SLIDE 30.
0.2	0.06	Arkosic sandstone*; fine to medium-coarse grained, angular to subangular, closely packed, muddy, graded bedding. Unconformity. SLIDE 29.
0.1	0.04	Arkosic sandstone; very fine grained, rhythmic.
0.6	0.17	Arkosic sandstone*; black muddy matrix, angular to subangular, medium-fine and medium-coarse grained, graded bedding, diastem. SLIDE 28.
0.1	0.03	Arkosic sandstone; tan, granular, medium-fine grained, micaceous.
0.3	0.10	Arkosic sandstone with black shale layers; poorly sorted, medium-fine to medium grained.
0.2	0.05	Arkosic sandstone; medium grained, closely packed, laminated.
1.0	0.30	Shale, carbonaceous, very fine grained, muscovite visible in upper section.
0.5	0.14	Arkosic sandstone, black muddy matrix, medium grained, packed, poorly sorted.
0.2	0.06	Arkosic sandstone*; brown muddy matrix, medium-fine grained, angular, semi-well-consolidated, graded bedding. SLIDE 27.
0.2	0.05	Shale, sandy arkosic, with black muddy matrix. Matrix closely packed, graded bedding.
0.3	0.10	Lenses of very fine grained shaly arkosic sandstone and medium grained arkosic sandstone.
0.3	0.10	Brown shaley mudstone and medium-fine grained arkosic sandstone with lenses of medium grained sandstone. Angular to subangular, graded bedding, significant K-feldspar. SLIDE 25.
0.3	0.10	Arkosic sandstone, light colored, fine to medium grained, subangular, muddy matrix, closely packed, graded bedding, noticeable % of twinned plagioclase. SLIDE 24.
0.5	0.15	Arkosic sandstone*; black muddy matrix, medium-fine grained, angular to subangular, semi-consolidated, laminated. SLIDE 23.
0.2	0.05	Arkosic sandstone*; with black muddy matrix, medium grained, poorly sorted, angular.
0.2	0.05	Mudstone, black, shaly, very fine-grained.
0.7	0.22	Mudstone, brown, shaly, with fine grained arkosic sandstone lenses.
0.3	0.08	Shale, sandy arkosic, very fine grained, black, laminated and fissile, slight undulating pattern.
0.5	0.15	Shale, rhythmic, very fine grained, interbedded light and dark units, laminated, packed, lenses of medium-fine grained arkosic sandstone.
0.2	0.06	Shale, sandy, arkosic, very fine grained, hint of graded bedding, laminated, fractures infilled with biotite and mud. Overlying shale unit.
0.3	0.10	Cyclic fine grained sandy arkosic shale overlain by shale.

* Arkosic wacke in original log.

THICKNESS FT.	THICKNESS M.	DESCRIPTION
top		
0.3	0.08	Arkosic sandstone*; gray with overlying shale containing arkosic sandstone lenses; grains held by matrix, subangular, medium grained, graded bedding. SLIDE 19.
0.5	0.14	Mudstone, sandy, fine grained, cyclic, bedded, shaly parts undergoing coalification, semi-consolidated, noticeable mica making rock schist-like.
0.6	0.17	Mudstone, black, carbonaceous, shaly texture, micaceous.
0.8	0.25	Mudstone, black, shaly, enclosing arkosic sandstone lenses. Sandstone lenses are grayish-tan, packed, semiconsolidated, with angular to subangular grains, exhibit graded bedding. SLIDE 17.
0.3	0.10	Arkosic sandstone*; black, muddy, graded bedding, semi-consolidated, visible grains are angular, medium-fine grained. Matrix makes up more than 50%. SLIDE 16.
0.5	0.15	Arkosic sandstone*; tan (hematite), fine grained, welded, subangular, lenses of medium-fine grained sandstone, laminated. SLIDE 15.
0.2	0.06	Arkosic sandstone*, muddy, gray to brown, very fine grained, fine laminae, subangular.
0.5	0.15	Arkosic sandstone*; tan, fine-medium grained, subangular, well-consolidated, deformed micas along zones of weakness, laminated.
0.7	0.20	Arkosic sandstone*; gray to black, well-consolidated, medium-fine grained, subangular, deformed micas along zones of weakness, laminated. SLIDE 14.
0.3	0.1	Arkosic sandstone*; grayish-brown, poorly sorted, medium-fine grained, angular, consolidated.
1.0	0.3	Missing.
2.1	0.65	Shale, black, carbonaceous, muddy. Platy, fine grained, biotite forms fresh layers.
0.3	0.10	Arkosic sandstone*; grayish-brown, fine to medium-fine grained, friable, angular to subangular grains, abundant feldspar, much corrosion but grain boundaries sharp. Laminated. SLIDE 13.
2.6	0.80	Arkosic sandstone*; black and white, medium-fine to medium grained matrix; noticeable coarse grains, angular to sub-angular, graded bedding. SLIDE 12.
0.3	0.10	Arkosic sandstone; gray to black, medium-coarse grained, consolidated, laminated.
0.1	0.02	Shale, black.
1.4	0.43	Arkosic sandstone*; gray to tan, alternating medium-fine grained and medium grained sandstone layers; subangular, well consolidated, little matrix or cement, packed, graded bedding. SLIDE 11.
0.2	0.05	Arkosic sandstone; black, medium-fine grained, well consolidated, laminated.
0.2	0.05	Arkosic sandstone; gray to tan, medium-fine grained, well-consoli dated, subangular, mica laminae, laminated. SLIDE 10.
0.5	0.15	Arkosic sandstone; alternating layers of fine and medium grained sandstone, graded bedding.

* Arkosic wacke in original log.

THICKNESS FT.	M.	DESCRIPTION
top		
0.6	0.17	Arkosic sandstone*; tan, medium-fine grained, moderately well-sorted, granular, little corrosion but visible sericite, mica laminae, laminated. SLIDE 9.
2.2	0.68	Arkosic sandstone*; gray, medium grained, poorly sorted, sub-angular, well consolidated, visible matrix, graded bedding. SLIDE 8.
1.6	0.49	Arkosic sandstone, gray, medium-coarse grained, poorly sorted, well-consolidated, subangular, little matrix or cement, graded bedding. SLIDE 7.
0.4	0.12	Arkosic sandstone; gray, medium grained, poorly sorted, well-consolidated, angular to subangular, little matrix or cement, graded bedding. SLIDE 6.
2.5	0.75	Arkosic sandstone, gray to black, coarse grained, poorly sorted, laminated, well-consolidated, angular grains, little matrix or cement, little corrosion. (Looks like SLIDE 4). SLIDE 5.
0.2	0.05	Shale, black.
3.2	1.00	Missing.
1.8	0.55	Arkosic sandstone, black and white, medium grained, poorly sorted, well-consolidated, subangular, clean. SLIDE 4.
0.3	0.09	Arkosic sandstone*; tan, medium-fine grained, semi-consolidated, laminated, poorly sorted, grains packed by sericite and corroded material. SLIDE 3.
0.3	0.08	Missing.
0.1	0.04	Arkosic sandstone, gray to black, coarse grained, conglomeratic, loosely consolidated. SLIDE 2.
2.4	0.74	Missing. A few pieces of fine grained black coal.
4.6	1.41	Missing.
0.1	0.03	Trace of arkosic, fine grained, hematite coated, loosely cemented sandstone.
3.5	1.08	Missing.

* Arkosic wacke in originial log.

G. The Cornwallis Hill Section. From Shaler and Woodworth, 1899, p. 470-473.

Details of a natural section near Manakin, Virginia.—A gully just east of the brook coming down the east side of Cornwallis Hill exposes the following stratigraphic and structural features:

Section in gully near Manakin, Virginia, beginning at the upper (north) end of gully and top of section. Direction of gully, N. 15° W.

Strata.	Thickness.	
	Ft.	*in.*
Shales, sandy	10	0
Shales, reddish	3	0
Sandstone, thin bedded	42	0
Shales, reddish	1	0
Sandstone	3	0
Shales	6	0
Sandstone	3	0
Shales with sandstone partings	6	0
Sandstone, brown at surface	3	0
Shales, reddish purple, with local faulting	3	0
Shales, brown and sandy	3	0
Sandstone	4	0
Shales	1	0
Sandstone	0	8
Shales	0	1
Sandstone	0	6
Shales	0	4
Sandstone	5	0
Shales, reddish purple, carbonaceous in seams	4	0
Sandstone	15	0
Shales, brownish red	3	0
Sandstones with shaly partings	2	0
Sandstone	3	0
Shales, black	6	0
Shales, sandy, laminated, faulted	6	0
Sandstone	3	0
Shales, brown mud at surface	0	2
Shales, black, with Estheria	6	0
Shales, brown, sandy, and slickensided	24	0
Shales, carbonaceous	0	6
Shales, sandy, brown, laminated	5	0
Shales, with joints stained by iron oxide, light brown	1	1
Shales, black, thin-laminated, and carbonaceous, with 1-inch sill of decayed trap. The shale below the sill is concretionary with iron oxide at contact. Ganoid fish scales abundant in upper part of the shale. *Estheria ovata*; small variety, also, present	1	6

Section in gully near Manakin, Virginia, etc.—Continued.

Strata.	Thickness.	
	Ft.	*in.*
Shales, brown, sandy	0	5
Shales, grayish, with bits of plants and molds of ganoid scales, and blackish concretionary stains	0	3
Shales, brown, sandy	0	6
Shales, carbonaceous, 1 inch to	0	3
Shales, laminated, sandy	5	0
Shales, with ironstone concretions	1	0
Coal, 6 inches to	1	6
Shale, carbonaceous	3	0
Shale, brown, sandy	1	0
Sandstone	1	6
Shale, brown	0	6
Shale, blue, with a 1-inch layer of coal near top	1	0
Sandstone with rolled and broken shale	10+	
Shale, brownish	0	3
Coal, 3 inches to	0	6
Shales, laminated, separated from rocks above by a fault, amount of throw unknown	10	0
Coal, with shale partings, 6 inches to	0	8
Shale, ferruginous	0	8
Coal, 1 inch to	0	2
Shales, mottled	6	0
Coal, shaly	0	6
Shale	7	0
Sandstone	1	0
Shale	1	0
Sandstone, probably	2	0
Shale	0	3
Sandstone, red brown	5	0
Shale, brown	4	0
Sandstone, brown, shaly, 6 inches to	0	8
Shale, grayish	1	0
Shale, dark gray	0	4
Coal	0	2
Shales, brown	1	0
Sandstone, red brown	5	0
Shales, bluish gray, 3 inches to	0	6
Sandstone, gritty, brown	1	6
Sandstone, brown	1	0
Shales, brown, laminated; faulted, downthrow to the east	3	0

Section in gully near Manakin, Virginia, etc.—Continued.

Strata.	Thickness.	
	Ft.	*in.*
Sandstone, fine brown	0	6
Shale, with carbonaceous traces	0	3
Sandstone	2	0
Shales, brown and red	0	2
Sandstones, feldspathic with smoky quartz veins	0	2
Shales	1	0
Sandstone	3	0
Shales, with carbonaceous layer near top	1	6
Sandstone	2	0
Shale, cut by red-clay (?) dikes	1	0
Sandstone, veined with small smoky quartz crystals and cut by a small fault	1	0
Shale, light-brown	3	0
Sandstone, fine, brown, micaceous	1	0
Shale	0	3
Sandstone, gritty	0	4
Shale, in red and yellow bands	1	6
Sandstone: arkose with smoky quartz crystals; strike of veins N. 38° E. in bottom of bed	2	0
Shale, with thin seams of arkose; 3 inches to	0	4
Sandstone, brown	0	9
Shales, laminated to sandy	1	6
Sandstone, gritty	0	9
Shales, red-brown, sandy	0	6
Sandstone, fine, brown	2	0
Shales, passing upward into next above	0	9
Sandstone, with red pasty dikes, dip 60° W, 1 foot to about	2	0
Shales, fine, sandy	9	0
Sandstone, brown, micaceous, gritty and faulted	1	0
Shales	9	3
Sandstone, brown, micaceous	0	4
Shales, brown	0	9
Sandstone, fine, with shaly partings	3	0
Shales, sandy	1	0
Coal; strike N. 24° E. A lens from 0 inch to	0	0.5
Shales, with sandstone lenses. The shales weather with red faces. Numerous small slips occur with the downthrow on the east. There are a few minute veins of smoky quartz at base of the bed in an arkose layer	12	0
Sandstone	1	6

Section in gully near Manakin, Virginia, etc.—Continued.

Strata.	Thickness.	
	Ft.	*in.*
Shales	0	2
Sandstone	1	0
Shales, coarse, red and brown	1	6
Sandstone, brown	3	0
Shales	0	6
Sandstone	3	0
Sand-tone, grit with granitic detritus	0	6
Shales, cut by small faults	0	9
Sandstone	2	0
Shales, sandy and laminated	0	4
Sandstone, brown, micaceous	1	0
Shales, purple with small faults; 1 inch to	0	3
Sandstone, fine, brown	1	0
Shales, mottled red and white		
Sandstone with ferruginous concretions; brown yellow; thickness at least	3	0
Shale, with ferruginous concretions	3	0
Sandstone, strike N. 24° E	1	0
Shales, brown, thickness unknown. The sandstone above named now reappears, bending around the shales so as to strike N. 48° W. The following-named beds are the continuations, in reverse order, of the beds above the shale. These thicknesses are given for the sake of comparison; they should not, of course, be added to the preceding in obtaining a total for the section		
Sandstone, just mentioned	0	6
Shales, brown	2	0
Sandstone, light-brown, micaceous, pinching out from 3 feet to	0	6
Shales, brown; strike N. 41° W., dip 15° S	3	0
Sandstone, brown, micaceous, with concretions at base	8	0
Shales, brownish and micaceous	14	0
Sandstone, vertical	2	3

H. Logs of three shallow cores from the coal measures on the eastern margin of the Richmond Basin at Tuckahoe Village, Va.

a. TUCKAHOE VILLAGE WEST: H-2

THICKNESS FEET	DESCRIPTION
top	
4.0	Fill - coal, shale, cinders and silty clay.
6.0	Brown, silty clay.
0.5	Brown, semi-consolidated, weathered, micaceous shale with partings.
1.6	Dark gray, weathered, carbonaceous shale with oxidized partings. Fissile.
3.4	Dark gray, micaceous, highly carbonaceous shale.
1.1	Dark gray, micaceous shale. Fissile.

b. TUCKAHOE VILLAGE WEST: H-3

THICKNESS FEET	DESCRIPTION
top	
10.6	Fill - Coal, shale, cinders and silty clay.
5.8	Dark gray, micaceous, carbonaceous shale. Fissile

c. TUCKAHOE VILLAGE WEST: H-4

THICKNESS FEET	DESCRIPTION
top	
4.0	Fill - coal, shale, cinders and silty clay.
6.0	Brown, silty clay.
2.0	Dark gray, micaceous, carbonaceous shale. Slightly fissile.
1.8	Dark gray, highly fissile, micaceous, shale.
1.2	Dark gray, micaceous, carbonaceous shale. Breaks along partings.

I. Measured stratigraphic section within Triassic coal measures along Gayton Road, 0.8 miles west of eastern margin of Midlothian Quadrangel. From Goodwin, 1970, p. 15-16.

Lithology	Thickness (Feet)
Sandstone, arkosic, yellow-brown to reddish-brown, coarse-grained	2.0
Coal, dark-brown, clayey, indistinctly bedded	1.2
Shale, dull-brown to dark-brown, micaceous, carbonaceous throughout, gradational into overlying coal	1.3
Shale, dull-brown to dark-brown, micaceous	0.8
Shale, grayish-brown, micaceous, fissile	0.2
Shale, massive, thinly laminated, yellowish-brown, micaceous	1.5
Sandstone, arkosic, yellow-brown to reddish-brown, coarse-grained, lensoidal	0.4
Shale, gray to yellowish-brown, finely micaceous	0.8
Nodular zone: limonitic nodules, concentrically weathered	0.5
Shale, gray to yellowish-brown, slightly feldspathic, micaceous, slightly carbonaceous	0.8
Mudstone, massive-bedded, coarsely micaceous, feldspathic	5.5
Shale, gray mottled with hematitic-red, massive	3.2
Sandstone, arkosic, hematitic-red, fine-grained	1.0
Shale, light-gray mottled with reddish-brown, coarsely laminated, slightly silty	6.9
Shale, black and yellowish-brown, carbonaceous, blocky, coaly	0.8
Coal, lustrous, thinly laminated	0.6
Shale, light-gray mottled with reddish-brown, coarsely laminated, slightly silty	4.8
Sandstone, arkosic, white and black speckled, weathered yellowish-brown, fine- to medium-grained	0.3
Shale, gray to brown, finely laminated, contains plant fragments	0.3
Sandstone, arkosic, yellowish-brown, micaceous, fine- to coarse-grained, carbonaceous, shaly parting in center	1.0
Shale, brown to gray, local ferruginous zones, finely laminated, micaceous	5.4
Sandstone, arkosic, yellowish-brown, micaceous, fine- to coarse-grained	0.7
Shale, brown to gray, local ferruginous zones, finely laminated, micaceous	2.0
Total	42.0

J. Section on the Bailey's Hill property near Modlithian, Chesterfield County, Virginia. After Heinrich. From Rogers, 1928, p. 102.

Section on the Bailey's Hill property, near Midlothian, Chesterfield County, Virginia[a]

	Ft.	In.
Hard dark-gray sandstone	3	7
Hard bluish-gray sandstone	4	0
Blue-gray clay slate	2	3
Black slate	2	0
Gray argillaceous sandstone (jointed)	6	2
Gray slate and indurated shale (very jointed)	4	10
Top seam of coal	5–6	4
Gray slate, often interstratified with inferior bony coal	5–6	4
Clean good coal	3–4	0
Dark slate	0	1–2
Black coal, highly bituminous	9.8–12	0
Sulphur bend	0	1–7
Coal	2	7
Dark slate	0	1½
Good clean coal (bottom coal of main seam)	5	7
Light gray slate (gypsiferous)	0	9
Coal	1	6
Gray slate band	0	2
Coal	6	0
Slate (gray)	1	6
Coal	5 inches	1 0
Gray slate	1 "	
Hard gray sandstone (floor)	3 "	

[a] Section on the Bailey's Hill property, near Midlothian, Chesterfield County, Virginia.

K. The Section at Midlothian, Va. (Modified by Russell, after Heinrich). From Wadleigh, 1938. In Davis and Evans, 1938, Part II, p. 45-46.

	THICKNESS		DISTANCE ABOVE GRANITE	
	Feet	Inches	Feet	Inches
Sandstone, arkose	34	9	556	4
First coal seam, 5'6" coal 1'6" slate	5	0	571	4
Slate, sandstone, dark gray	6	2	577	6
Sandstone, light gray	4	2	581	9
Slate, dark gray	8	0	589	0
Sandstone, arkose, gray	9	10	599	7
Second coal seam	1	0	600	7
Slate, gray	9	0	609	7
Sandstone, gray, hard	9	0	618	7
Third coal seam divided by slaty bands from 2 to 24?	12	0	-	-
Sandstone and slate, gray	10	3	635	4
Fourth coal seam, divided by slaty-bands	14	0	-	-
Slate, black and sandstone	4	0	659	4

L. The Section at Carbon Hill, Va., according to Russell. Reprinted from Wadleigh, 1938. In Davis and Evans, 1938, p. 45.

Section at Carbon Hill, Virginia.

	Feet
Recent Formation, soil.	20
Alternation shales and sandstones	450
Cinders, so-called fire clay	135
Nodula Pyrites	15
Shales and sandstones	60
Coke seam (Coke 2'4" - Coal 3'8")	6
Shale and sandstone.	50
Coal seam	5
Shale, third seam	17
Coal	4.6
Shale and sandstone, containing 6" coal seam, second seam	40
Coal seam, slope seam 8 to 10 feet, first seam	9
Sandstone and slate to supposed granite base	180
	1032.6

M. Measured stratigraphic section at northeast end of Lake Salisbury about 2 miles north-northwest of Midlothian. From Goodwin, 1970, p. 17.

Lithology	Thickness (Feet)
Tertiary gravel (24.5 feet)	
Gravel, very coarse with cobbles, highly limonitized with sandy matrix	7.5
Gravel, very coarse with cobbles, moderately limonitized	17.0
Triassic shale and sandstone (60.0 feet)	
Sandstone, hematite-red to olive-brown, thin-bedded with some thin shale laminae	8.5
Shale, gray, laminated, weathers deep red in upper part	3.0
Sandstone, hematitic-red with splotches of yellow-brown, fine-grained, massive, arkosic, micaceous, with cross-bedding, channelled, some carbonaceous streaks, nearly vertical clay-filled joints prominent	13.0
Shale, mottled pale olive-drab to deep-red, very micaceous	19.0
Sandstone, arkosic, mottled yellowish-red to hematitic-red, micaceous, fine-grained	1.5
Shale, mottled yellowish-brown to hematitic-red	0.3
Sandstone, arkosic, hematitic-red, fine-grained	2.5
Shale, mottled yellowish-brown and hematitic-red	5.5
Sandstone, gray, organic-rich	1.5
Shale, mottled yellowish-brown and hematitic-red, sandy, micaceous	5.2
Conglomerate	

N. Diamond Core drill hole record of core 2500 ft. east of the western border of the Richmond Basin.
   a. Driller's log.
   b. Detailed description of lower third of core.

B. H. MOTT & SONS, INC.
MAIN OFFICE
HUNTINGTON, W. VA.

a. Driller's log.

DIAMOND CORE DRILL HOLE RECORD

FOR Gray Lumber Company ADDRESS Waverly, Va. DATE 3-8- 1978

ON NEAR Amelia COUNTY Chesterfield STATE Va.

HOLE NO. 1 (NX) EL DRILLER James C. Beavers DRILL NO.

CLASSIFICATION	THICKNESS OF STRATA FEET	THICKNESS OF STRATA INS. THS.	DEPTH FROM SURFACE FEET	DEPTH FROM SURFACE INS. THS.
Overburden	136	10	136	10
Red Sandstone w/White, Gray & Red Pebbles	76	4	213	2
Gray Sandstone	8	0	221	2
Green & Red Sandstone w/White Pebbles	20	10	242	0
Red Fire Clay w/White Pebbles	33	7	275	7
Firm Red Sandstone w/White Streaks Mixed	47	3	322	10
White & Red Sandstone w/Pebbles	23	4	346	2
Red Clay w/White Clay Mixdd	15	0	361	2
White Sandstone w/Green & Gray Streaks	5	0	366	2
Soft Red Clay w/White & Green Mixed	9	0	375	2
Red & White Sandstone	44	10	420	0
White Sandstone w/Red Streaks	63	0	483	0
Red Fire Clay	2	6	485	6
White Sandstone w/Red Sandstone Mixed	6	8	492	2
Red Sandstone w/White Pebbles Mixed	37	8	529	10
White Sandstone w/Red Sandstone Mixed	47	2	577	0
White Sandstone w/Red Sandstone & Pebbles	49	2	626	2
White Sandstone w/Pebbles	25	0	651	2
White Sandstone w/Red & Green Sandstone	24	5	675	7
Red Shale	0	2	675	9
White & Red Sandstone Mixed	12	0	687	9
White Sandstone	13	6	701	3
Red Shale w/Sandstone & Pebbles Mixed	10	9	712	0
Red Sandstone w/Pebbles Mixed	21	7	733	7
Red Sandstone w/White Sandstone Mixed	23	5	757	0
Red & White Sandstone w/Mud Mixed	21	6	778	6
White & Red Sandstone w/Pebbles Mixed	23	6	802	0
Red Sandstone w/Red Shale Streaks	25	0	827	0
Hard Red Sandstone w/Pebbles Mixed	6	11	833	11
Red Clay	0	1	834	0
Hard Red Sandstone w/Pebbles Mixed	3	6	837	6
Hard White & Red Sandstone w/Pebbles	40	0	877	6
Hard Red Sandstone w/White & Green Streaks	18	6	896	0
Crystalized Red & White Sandstone	25	0	921	0
Crystalized White & Red Sandstone	115	10	1036	10
Red & White Sandstone w/Pebbles	50	0	1086	10
Crystalized Sandstone w/Mud & Pebbles	22	8	1109	6
Crystalized Red & White Sandstone	80	4	1189	10
Red Fire Clay	0	5	1190	3
Crystalized White & Red Sandstone w/Peb.	41	3	1231	6
Hard Red Shale w/White Sandstone	24	3	1255	9

STARTED 10-31- 1977

COMPLETED 2-3- 1978

kh

FORM 1

B. H. MOTT & SONS, INC.

MAIN OFFICE
HUNTINGTON, W. VA.

DIAMOND CORE DRILL HOLE RECORD

FOR Gray Lumber Company ADDRESS Waverly, Va. DATE 3-8- 1978

ON NEAR Amelia COUNTY Chesterfield STATE Va.

HOLE No. 1 (NX) EL. DRILLER James C. Beavers DRILL No.

CLASSIFICATION	THICKNESS OF STRATA FEET	THICKNESS OF STRATA INS. THS.	DEPTH FROM SURFACE FEET	DEPTH FROM SURFACE INS. THS.
Crystalized Red Sandstone w/Pebbles	10	0	1265	9
Red Sandstone w/White Sandstone & Pebbles	40	3	1306	0
Crystalized Red Sandstone w/White Sandstone & Pebbles Mixed	24	9	1330	9
Crystalized Red Sandstone w/Red Shale	40	7	1371	4
Soft Red Sandstone w/Mud Mixed	11	5	1382	9
Crystalized Red Sandstone w/White Sandstone	8	10	1391	7
Hard Red Sandstone w/White Sandstone Mixed	99	0	1490	7
Hard Red Sandstone w/White Sandstone & Mud Mixed	23	5	1514	0
Black Shale w/Green Streaks	21	0	1535	0
Black Shale (Roller Bit)	17	0	1552	0

TOTAL DEPTH: 1552 Feet & 0 Inches

STARTED 10-31- 1977

COMPLETED 2-3- 1978

kh

FORM 1

b. Detailed description of lower third of core.

THICKNESS FEET	DESCRIPTION
top	
6.8	Pink and gray, poorly sorted, fine-grained, silty sandstone. Locally conglomeratic.
2.5	Red, predominantly fine-grained, sandy siltstone.
6.0	Gray and pink, medium-grained, well-sorted sandstone.
6.0	Pink and gray, very poorly sorted, sandy conglomerate and sandstone.
6.0	Red with blue mottling, silty, fine-grained, poorly sorted sandstone.
1.3	Missing.
7.0	Red wtih blue mottling, poorly sorted, fine-grained, silty sandstone. Locally conglomeratic.
5.0	Red, poorly sorted, coarse-grained, pebbly sandstone.
4.0	Red with green mottling, poorly sorted, fine-grained silty, arkosic sandstone.
5.8	Purple, coarse-grained, conglomeratic, arkosic sandstone.
4.2	Red with blue-motttling, poorly sorted, silty, medium-grained, arkosic sandstone.
2.0	Missing.
5.3	Red with blue mottling, poorly sorted, fine-grained, silty sandstone.
1.8	Pink, coarse-grained, arkosic, conglomeratic sandstone.
1.3	Red with green mottling, poorly sorted, fine-grained, silty sandstone.
6.6	Pink and gray, locally conglomeratic, medium-grained, arkosic sandstone.
1.6	Red with blue mottling, poorly sorted, fine-grained, silty sandstone.
7.3	Pink to red, very coarse-grained, arkosic sandstone and conglomerate.
3.0	Red with blue mottling, fine-grained, silty sandstone.
3.0	Missing.
2.0	Light gray, well sorted, medium to coarse-grained, arkosic sandstone.
1.5	Red, poorly sorted, silty, slightly conglomeratic sandstone.
1.7	Gray and pink, fine-grained, arkosic sandstone. Coarsens upward into a very coarse conglomerate.
3.0	Red with blue mottling, poorly sorted, fine-grained, arkosic, sandy siltstone.
4.3	Red with green mottling, very poorly sorted, arkosic, silty, pebbly sandstone.
2.0	Pink and gray, coarse-grained, arkosic sandstone and conglomerate.
3.9	Red with blue mottling, predominantly fine-grained, arkosic, sandy siltstone.
2.5	Red with green mottling, conglomeratic, poorly sorted, medium to coarse-grained, arkosic sandstone.
0.5	Red, arkosic, coarse-grained, sandy conglomerate.
3.0	Red, arkosic, conglmeratic, fine to medium-grained sandstone.
2.7	Missing.
1.3	Red with green mottling, poorly sorted, arkosic, fine to medium-grained sandstone.
7.0	Pink, coarse-grained, arkosic, poorly sorted, sandstone.
1.7	Brownish-orange with blue mottling, interbedded poorly sorted, arkosic sandy conglomerate and arkosic fine-grained sandstone.
10.3	Red with green mottling, poorly sorted, arkosic, fine-grained sandstone. Locally siltstone.
4.0	Red with green mottling, poorly sorted, arkosic, silty, coarse-grained sandstone.
1.3	Missing.
1.3	Red and gray, very coarse-grained, arkosic, conglomeratic sandstone.
1.2	Red, poorly sorted, arkosic, sandy siltstone.
1.1	Red, interbedded coarse-grained, arkosic conglmeratic sandstone and fine-grained, sandy siltstone.

THICKNESS FEET	DESCRIPTION
top	
4.3	Red, fine-grained, poorly sorted, sandy siltstone. Locally conglomeratic.
4.7	Red, poorly sorted, conglomeratic, silty sandstone. With thin layers of conglomerate.
3.0	Red and gray, very poorly sorted, conglomeratic, fine to medium-grained sandstone and shale.
2.8	Pink, medium to coarse-grained, micaceous, arkosic sandstone. Locally conglomeratic.
3.6	Red with blue mottling, poorly sorted, fine-grained, silty, arkosic sandstone with pebbles.
2.4	Pink, very coarse-grained, arkosic, conglomeratic sandstone.
14.2	Red and gray, interbedded very coarse-grained, arkosic sandstone and conglomerate.
2.5	Red, sandy, arkosic sandstone.
10.8	Red and gray, interbedded, coarse-grained, arkosic sandstone and conglomerate.
1.5	Red, coarse-grained, arkosic, conglomeratic sandstone.
0.5	Red, sandy breccia.
1.2	Red, coarse-grained, arkosic, conglomeratic sandstone.
0.2	Red, coarse-grained sandy breccia.
10.0	Gray with red striae, coarse-grained, arkosic, pebbly sandstone.
0.3	Red and gray conglomerate.
11.7	Red and gray, coarse-grained, conglomeratic, arkosic sandstone.
1.4	Missing.
1.2	Red, very coarse, sandy, arkosic conglomerate. Pebbles approx. 1 cm diam.
4.6	Red, poorly sorted, micaceous, conglomeratic, arkosic sandstone.
3.4	Red, micaceous sandstone.
1.5	Red and gray, coarse-grained, conglomeratic, arkosic sandstone.
5.3	Red, interbedded coarse-grained, conglomeratic sandstone and medium-grained, conglomeratic sandstone.
5.6	Red, micaceous, fine-grained, poorly sorted, arkosic sandstone.
6.0	Red, fine-grained, micaceous, silty sandstone.
2.5	Missing.
1.1	Red, fine-grained, poorly sorted, arkosic sandstone.
6.8	Red, poorly sorted, slightly pebbly, coarse-grained, arkosic sandstone.
6.2	Red, micaceous, poorly sorted, fine-grained, arkosic sandstone.
10.1	Red, interbedded sandy conglomerate and poorly sorted, fine-grained sandstone. Max. pebble size 3 cm diam.
4.7	Missing.
1.7	Gray and pink, very poorly sorted, coarse-grained, arkosic sandstone.
0.4	Red, fine-grained, poorly sorted, arkosic sandstone.
10.0	Red and gray, interbedded coarse and fine-grained, poorly sorted, conglomeratic, arkosic sandstone.
2.3	Gray and pink, sandy conglomerate.
1.8	Red, poorly sorted, coarse-grained, arkosic sandstone.
0.7	Red, fine-grained, silty sandstone.
3.5	Red, poorly sorted, fine and coarse-grained, arkosic sandstone.
1.4	Missing.
0.9	Red, poorly sorted, fine to coarse-grained, arkosic sandstone and shale.

THICKNESS FEET	DESCRIPTION
top	
0.8	Gray, poorly sorted, coarse-grained, arkosic sandstone.
2.8	Red, interbedded silty sandstone and poorly sorted, slightly conglomeratic, silty sandstone.
3.6	Gray and pink, poorly sorted, coarse-grained, arkosic sandstone. Locally conglomeratic.
0.6	Red and gray, poorly sorted, fine-grained sandstone. Locally conglomeratic.
3.4	Red, poorly sorted, fine-grained, arkosic sandstone.
1.8	Pink and gray, poorly sorted, coarse-grained, arkosic sandstone.
1.5	Red, sandy siltstone.
1.7	Gray and pink, poorly sorted, coarse-grained, conglomeratic arkosic sandstone.
8.7	Red, poorly sorted, fine-grained sandstone and shale.
1.7	Missing.
1.2	Gray and pink, poorly sorted, medium-grained, arkosic sandstone. Locally conglomeratic. Fining upward.
0.6	Gray, well sorted, medium-grained, arkosic sandstone.
0.3	Red, very fine-grained, micaceous sandstone.
8.9	Gray and pink, coarse-grained, poorly sorted, conglomeratic, arkosic sandstone.
1.0	Red, poorly sorted, fine-grained, silty sandstone.
3.1	Gray and pink, coarse-grained, conglomeratic, arkosic sandstone.
9.1	Red, interbedded poorly sorted, fine-grained, arkosic sandstone and shale.
0.6	Orange, poorly sorted, coarse-grained, conglomeratic, arkosic sandstone.
3.0	Red, poorly sorted, micaceous, fine-grained, arkosic sandstone.
8.2	Light purple, interbedded coarse-grained, arkosic sandstone and conglomerate.
2.7	Red, poorly sorted, micaceous, fine-grained, arkosic sandstone with pebbles.
2.0	Red, poorly sorted, coarse-grained, arkosic sandstone. Locally conglomeratic.
1.2	Pink, coarse-grained sandy conglomerate.
9.8	Pink and gray, very coarse-grained, arkosic sandstone. Locally conglomeratic.
2.1	Red, poorly sorted, fine-grained arkosic sandstone.
2.9	Red with green mottling, poorly sorted, conglomeratic, arkosic sandstone. Angular pea-sized pebbles to 1 cm diam.
0.3	Pink, sandy, arkosic conglomerate. Pebbles pea-sized.
1.8	Pink, poorly sorted, medium to coarse-grained, arkosic, conglomeratic sandstone. Pebbles less than 1 cm diam.
2.2	Red, interbedded fine-grained sandstone and conglomerate.
3.7	Red, poorly sorted, fine to coarse-grained, arkosic sandstone with pea-sized pebbles.
1.0	Red, poorly sorted, micaceous, sandy conglomerate. Pebbles less than 1 cm diam.
0.8	Red, sandy siltstone.
1.7	Red, poorly sorted, fine to medium-grained, arkosic sandstone.
7.4	Pink, poorly sorted, medium to very coarse-grained sandstone. Locally conglomeratic.
1.6	Missing.

THICKNESS FEET	DESCRIPTION
top	
3.6	Red, poorly sorted, fine-grained, arkosic sandstone.
1.4	Pink, very poorly sorted sandstone. Conglomeratic. Pebbles pea-sized.
0.5	Red, micaceous, fine-grained sandstone.
1.2	Pink, poorly sorted, medium to coarse-grained, arkosic sandstone.
1.3	Red, medium to coarse-grained, slightly conglomeratic, arkosic sandstone. Pebbles, pea-sized.
2.5	Red, poorly sorted, micaceous, fine-grained sandstone and siltstone.
6.7	Red, poorly sorted, micaceous, fine to medium-grained, arkosic sandstone interbedded with conglomerate (0.3 ft thick).
1.8	Missing.
3.6	Red, poorly sorted, micaceous, fine to medium-grained, arkosic sandstone.
1.4	Red, slightly conglomeratic, micaceous, poorly sorted, fine-grained, arkosic sandstone.
0.3	Red, fine-grained, silty sandstone.
1.0	Red, poorly sorted, fine-grained, arkosic sandstone. Pea-sized gravel concentrated at base.
0.1	Gray, poorly sorted, medium-grained, arkosic sandstone.
1.0	Red, fine-grained, silty sandstone.
5.1	Pink and gray, very coarse, arkosic, conglomeratic sandstone with angular and rounded cobbles up to 4 cm diam.
0.2	Pink, coarse-grained, micaceous, arkosic sandstone.
1.9	Missing.
0.5	Red and green mottling, fine-grained, sandstone.
0.7	Pink, poorly sorted, fine-grained, arkosic sandstone.
0.4	Red, poorly sorted, coarse-grained, arkosic sandstone.
0.2	Red, shale.
1.4	Red, poorly sorted, fine-grained, conglomeratic sandstone.
1.3	Purple, poorly sorted, micaceous, fine-grained, arkosic sandstone.
1.6	Purple, Poorly sorted, medium-grained, arkosic sandstone.
2.2	Red, sandy siltstone.
5.8	Red, poorly sorted, conglomeratic, arkosic sandstone.
1.7	Red, poorly sorted, fine-grained, arkosic sandstone.
2.0	Red, micaceous, sandy siltstone.
3.5	Pink, poorly sorted, arkosic, medium to coarse-grained sandstone.
2.0	Missing.
0.8	Red, poorly sorted, fine-grained sandstone.
0.9	Reddish-brown, fine-grained, poorly sorted sandstone. (Specimen 1A).
1.8	Purplish-red, micaceous, very fine-grained sandstone.
1.3	Missing.
1.7	Purplish-red, micaceous, very fine-grained, conglomeratic sandstone.
2.7	Purplish-red shale.
6.1	Pink and gray, very coarse-grained, conglomeratic, arkosic sandstone. (Specimen 1).
1.5	Purplish-red, poorly sorted, pebbly, fine-grained sandstone.
4.6	Red shale.
1.9	Light gray, feldspar-rich, poorly sorted, medium to coarse-grained silty sandstone.
1.6	Purplish, poorly sorted, micaceous, arkosic, fine-grained sandstone. Locally conglomeratic. (Specimen 3).
38.0	Diabase dike.

O. Measured section of Triassic sediments in Deep Run Basin, Virginia.

THICKNESS FEET	DESCRIPTION
top	
?	Cannel coal and bituminous shale.
12.0	Disturbed beds.
8.0	Normal beds.
3.0	Coaly material
12.0	Cover
2.7	Bituminous shale-coal.
31.0	Clay shale, gray-black, think oxidized zones.
0.3	Coal.
11.0	Maroon-deep orange, silty shale.
0.8	Coal.
1.3	Maroon- deep orange, silty shale.
1.6	Arkosic sand. Lower 3 inches oxidized, organic flecks.
1.0	Reddish-gray maroon siltstone, shaly, organic matter, micaceous.
0.5	Arkosic sandstone. Lower 3 inches oxidized.
4.3	Reddish-gray maroon clay-siltstone.
0.7	Oxidized sand.
5.9	Alternating silty shale and siltstone. Olive drab to oxidized brown. Scattered plant fragments.
0.5	Red-brown arkose, carbonaceous.
0.5	Clay, red-brown and bright orange. Carbonaceous stringers.
0.9	Red-brown, micaceous, arkosic sandstone. Beds of brown oraganic matter.
1.5	Arkose, greenish-gray, micaceous, fractured, stringers of carbonaceous and oxidized material.
	Fault with 0.5 inch displacement.
1.4	Arkose, greenish-gray, micaceous, fractured.
0.8	Light grayish-green sand; loosely consolidated; locally oxidized along fractures; local pods of carbonaceous material.
1.0	Oxidized, weakly consolidated arkose.
1.0	Dark gray shale. Locally oxidized along bedding planes.
0.7	Coal with 0.25 to 0.5 inch zones of oxidized shale.
8.4	Coal and shale. Coal beds up to 1.5 in. thick down to 0.25 in. thick. Interbedded; bulk is shale.
1.2	Arkose, micaceous, abundant plant fragments, shaly.
11.2	Interbedded siltstone and arkose, oxidized.
0.6	Gray clay shale.
0.2	Thin coal seam; very thin clay at base.
4.8	Interbedded siltstone and arkose; abundant plant fragments, oxidized.
4.7	Covered with muck.
	Chloritized granite. Slickensided.

APPENDIX II

CHEMICAL ANALYSES OF COAL FROM THE RICHMOND BASIN

Chemical analyses of bituminous coal from Midlothian Mine.

Sampling Date	Reference	Notes	Moisture	Volatiles	Fixed Carbon	Ash	Sulphur (sep. det.)	BTU	Fusing Point Fahr
1922	Treadwell, 1928, p.122	as received	1.35	32.80	59.67	6.18	1.39	14,290	-
1922	"	dry basis	-	33.25	60.49	6.26	1.41	14,486	-
1922	Wasleigh, 1938 Appen, C.	as received	1.12	36.38	54.66	7.84	1.07	13,984	2428
undated	Wadleigh, 1938, p.91	?	-	33.62	58.26	7.67	-	-	-
1934	Wasleigh, 1938 Appen, C.	?	0.00	40.46	53.82	5.72	1.36	14,663	-
1934	"	Dry basis	-	33.25	60.49	6.26	1.41	14,486	2310

Results of chemical analysis of a sample of screened coal from the Richmond Basin. From Jones, 1916. In Davis and Evans, 1938, p. 70.

Water	1.34
Volatile matter	33.45
Fixed carbon	57.05
Sulphur	2.00
Ash	6.16

From Wadleigh, 1938. In Davis and Evans, 1938, p. 81.

Samples of the "carbonite" from the Jewett Brothers mine mentioned were separated into two portions, a "dull" and a "lustrous" portion, and analysed separately by Doctor Brown with the following results:

	Dull Portion Per Cent	Lustrous portion Per Cent
Carbon	70.33	81.52
Volatile Matter	15.47	11.10
Ash	3.20	6.68
Moisture (loss at 100 degrees C.)	2.00	0.69
Sulphur	4.08	1.60
Specific Gravity	1.375	1.350

From Roberts, 1928, p. 108.

Analyses of Bituminous Coal from the Richmond Basin

No.	Analyst	Location of Mine or Pit	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur
1.	Alexander, J. H.	Midlothian	.....	31.60	61.10	7.10	..
2.	Andrews, G. W.	Coxe Mine (Clover Hill)	.....	38.50	55.00	6.50	..
3.	"	Richmond coal	.....	32.00	59.25	8.75	..
4.	Clemson, T. G.	Willis Pit (Aetna Shaft)	.....	28.80	66.60	4.60	..
5.	"	Anderson Pit (Dover)	.....	26.00	64.20	9.80	..
[a]6.	Fieldner, A. C.	Carbon Hill, near Gayton	2.81	25.70	62.47	9.02	1.11
[a]7.	"	" " " "	2.11	23.58	56.95	17.36	2.16
8.	Heinrich, O. J.	" " upper seam	1.40	20.60	60.80	17.20	.. ..
9.	"	" " 21-ft. seam	0.40	18.60	71.00	10.00	..
10.	Johnson, W. R.	Coxe Mine, (Clover Hill)	1.34	30.98	56.83	10.13	0.51
11.	"	Creek Company Shaft	1.45	26.79	60.30	8.57	2.89
12.	"	Midlothian average coal	2.46	29.74	53.01	14.74	0.06
13.	"	" New Shaft	0.67	31.21	56.40	9.44	2.27
14.	"	" screened coal	1.79	34.30	54.06	9.66	0.20
15.	"	" 900-ft. Shaft	1.17	27.28	61.08	10.47	.. ..
16.	"	Chesterfield Mining Co.	1.90	28.72	58.79	8.63	1.96
17.	"	Carbon Hill average coal	1.79	23.96	59.98	14.28	..
18.	"	Tippecanoe Pit	1.84	33.79	54.62	9.37	0.38
19.	"	Cranch Low Shaft, av. 4 spec.	.....	23.96	67.32	8.72	.....
20.	"	Scotts (Kennon) Pit	.....	33.70	60.86	5.44	.....
21.	"	Waterloo Shaft	.....	26.80	55.20	18.00	.. ..
22.	"	Deep Run Pit	.....	26.16	39.84	5.00	.. ..
23.	"	" " " av. 40 spec.	.....	21.57	67.96	10.47	.....
24.	"	Midlothian	1.01	28.74	56.11	14.14	2.38
25.	"	Barr's Deep Run Mine	1.79	19.78	67.96	10.48	.. ..
26.	McCreath, A. S.	Midlothian, Grove Shaft Ser.	1.03	38.23	54.27	6.44	1.52
27.	"	Midlothian average	1.05	36.49	46.70	15.76	2.23
28.	Rogers, W. B.	Coxe Mine (Clover Hill)	.....	29.12	65.52	5.36	.. ..
29.	"	Stone Henge	.....	36.50	58.70	4.80	.. ..
30.	"	Mill and Reed Creek Shaft	.....	38.60	57.80	3.60	.. ..
31.	"	Greenhole Shaft	.....	31.17	67.83	2.00	.. ..
32.	"	Maidenhead Shaft	.....	32.82	63.97	3.20	.. ..
33.	"	Old English Shaft	.....	35.82	53.36	10.82	.....
34.	"	" " middle bench	.....	28.40	66.50	5.10	.. ..
35.	"	" " top bench	.....	28.10	61.68	9.52	.. ..
36.	"	Powhatan Pits	.....	32.32	59.87	7.80	.....
37.	"	Anderson's Pit (Dover)	.....	23.80	66.78	4.92	.....
38.	"	T. M. Randolph Pit	.....	30.50	66.15	3.35	.....
39.	"	Coalbrookdale	.....	29.00	66.48	4.52	.....
40.	"	" Seam No. 1	.....	24.00	70.80	5.20	.....
41.	"	" " " 2	.....	22.83	54.97	22.20	.....
42.	"	" " " 3	.....	24.70	65.50	9.80	.....
43.	"	" " " 4	.....	21.33	56.07	22.60	.. ..
44.	"	Cranches Upper Seam	.....	30.00	64.60	5.40	.....
45.	"	Engine Shaft	.....	37.65	62.35	2.80	.. ..
46.	Silliman & Hubbard	Midlothian coal	2.00	31.62	58.26	7.67	.....
[b]47.	U. S. Geol. Survey	Richmond Basin	2.80	25.70	62.50	9.00	1.40

[a] Furnished by the U. S. Geological Survey; also published in Bureau of Mines Bulletin, No. 85, 1914, p. 106.

[b] U. S. Geological Survey, Prof. Paper 100-A, p. 32.

From Roberts, 1928, p. 109.

Analyses of the Richmond, Virginia, Natural Coke[43]

No.	Analyst	Location of Mine or Pit	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur
1.	Bailey, A. F.	Chesterfield County	.....	17.00	68.00	15.00	.....
2.	Clemson, T. G.	Chesterfield County	.....	10.70	83.30	6.00	.....
3.	Fieldner, A. C.	Gayton, Henrico County	2.54	16.28	70.24	10.54	1.31
4.	Heinrich, O. J.	Carbon Hill	1.57	9.64	79.93	8.86	.....
5.	Johnson, W. R.	Carbon Hill	1.12	11.98	75.08	11.83	.....
6.	Riggs, R. B.	Midlothian "Natural Coke"	1.66	13.65	63.17	12.86	4.70
7.	Rogers, W. B.	Chesterfield Natural Coke	.....	9.98	80.30	9.72	.....
8.	"	Chesterfield Natural Coke	.....	16.00	70.00	14.00	.....
9.	Wallace, W.	Carbon Hill, Gayton	1.56	14.26	81.61	2.24	0.33
10.	Wurtz, Henry	Richmond Basin Coal	0.44	14.08	77.17	8.31	.....

[a] Furnished by the U. S. Geological Survey; also published in Bureau of Mines Bulletin, No. 85, 1914, p. 106.

Table showing ranges of Triassic coal and coke of the Richmond Basin

Constituents	Maximum Range		Minimum Range		Average	
	Bit. Coal	Coke	Bit. Coal	Coke	Bit. Coal	Coke
Moisture	2.81	2.54	0.40	0.44	1.62	1.48
Volatile matter	38.60	17.00	18.60	9.64	28.95	13.36
Fixed carbon	71.00	81.61	39.84	63.17	60.39	74.88
Ash	22.60	15.00	2.00	2.24	9.14	9.94
Sulphur	2.38	4.70	0.06	0.33	1.49	2.11

[43] Fieldner, A. C., U. S. Bureau of Mines, Bulletin No. 85, 1914, p. 106.

Analyses of coal and coke from the Richmond Basin. From Roberts, 1928, p. 110.

The following table[44] gives the most recent analyses of the three samples of bituminous coal and one of coke.

Analyses of coal and coke

	No. in Anal. Table	Air Dried Loss	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	B. t. u.	$\frac{FC}{VM}$
Bit. Table	6	1.9	2.81	25.70	62.47	9.02	1.43	4.90	76.55	1.81	6.29	7496	13493	2.41
Bit. Table	7	1.4	2.11	23.58	56.95	17.36	2.16	4.44	69.22	1.59	5.23	6778	12200	2.47
Coke Table	3	1.9	2.54	16.28	70.24	10.94	1.31	.....	.....	.....	.....	.....	.....	4.32
Bit. Table	47	.....	2.80	25.70	62.50	9.00	1.40	.....	.....	.....	.....	.....	23490	2.43

[44]Fieldner, A. C., Analyses of Coal, Bureau of Mines, Bull. 85, pp. 166, 332, 333.

From Roberts, 1928, p. 112.

Specific gravity of Richmond Basin Coal

Serial No. in table of chemical analyses	Specific gravity
10	1.285
11	1.319
12	1.294
13	1.325
14	1.283
15	1.487
16	1.289
17	1.451
18	1.346
24	1.390
25	1.382
General average	1.346

From Woodworth, 1902, p. 38.

Analyses of coal taken by H. D. and W. B. Rogers, 1839.[a]

Description of coal and locality	Fixed carbon	Volatile matter	Ash.	Color of ash.
FROM NORTH SIDE OF JAMES RIVER.				
Capt. Thomas M. Randolph's	66.15	30.50	3.35	Light red.
Coalbrookdale, second seam	66.48	29.00	4.52	Light gray.
Anderson's pits, first seam	66.78	28.30	4.92	Do.
Barr's pits:				
First seam	70.80	24.00	5.20	Faint red.
Second seam	54.97	22.83	22.20	Strong red.
Third seam	65.50	24.70	9.80	Light brown.
Fourth seam	56.07	21.33	22.60	Strong red.
Crouch's lower shaft, upper seam, 140 feet below surface	64.60	30.00	5.40	
Scott's pits, formerly Woodward's	60.86	33.70	5.44	Light gray.
Waterloo shaft	55.20	26.80	18.00	
Deep Run pits	69.84	25.16	5.00	
FROM SOUTH SIDE OF JAMES RIVER.				
Stonehenge	58.70	36.50	4.80	Light reddish.
Engine shaft:				
Meadenhead	63.97	32.83	3.20	Strong red.
Heth, Potts & Co.	62.35	37.65	2.80	Reddish yellow.
Mills and Robb's Creek pit	57.80	38.60	3.60	Buff.
Will's pit	62.90	32.50	4.60	Light brown.
Greenhole shaft	67.83	30.17	2.00	Light red.
Colonel Heth's deep shaft (seam 30 to 40 feet thick):				
Bottom of seam	53.36	35.82	10.82	Light pinkish brown.
Middle of seam	66.50	28.40	5.10	Light brownish yellow.
Top of seam	61.68	28.80	9.52	Light pink to brown.
Powhatan pits, formerly worked by Captain Finney.	59.87	32.33	7.80	Pale buff.

From Woodworth, 1902, p. 37

Analyses of coke from Richmond Basin.

Constituent.	I.[a]	II.[b]
Carbon	80.30	67.13
Volatile matter	9.98	18.35
Ash	9.72	12.86
Water		1.66
Sulphur		1.70

[a] Coke from a heavy bed on the eastern margin near the James River; W. B. Rogers, Geology of the Virginias, reprint, 1884, p. 525.

[b] Natural coke collected by I. C. Russell from Midlothian: Bull. U. S. Geol. Survey No. 42, 1887, p. 146. Analyst, R. B. Riggs.

From Woodworth, 1902, p. 37.

Synoptical view of the characters and composition of certain coals from the Richmond area, according to W. R. Johnson (1844).[a]

Designation of coal.	Density.			Composition in 100 parts.							Fuel ratio.
	Specific gravity.	Pounds per cubic foot, calculated from specific gravity.	Weight in pounds per cubic foot by displacement.	Cubic feet of space to equal 1 ton.	Moisture, determined by steam dryling.	Volatile matter, other than moisture.	Fixed carbon.	Sulphur.	Coke.	Earthy matter.	
Bacon's Run	1.382	86.419	53.174	42.126	1.785	19.782	67.958	.....	78.433	10.475	3.48
Crouch and Snead's	1.451	90.719	53.593	41.797	1.785	23.959	50.976	0.427	74.256	14.289	2.50
Midlothian, 100 feet south, average	1.437	87.497	50.518	43.549	1.172	27.278	61.080	.....	74.550	10.467	2.62
Midlothian, average	1.294	80.895	51.011	41.470	2.455	29.796	53.012	0.058	67.749	14.735	2.20
Midlothian, screened	1.283	80.210	45.722	43.399	1.785	34.497	51.063	0.202	63.718	3.665	1.84
Clover Hill	1.285	80.355	45.485	49.270	1.339	31.628	56.831	0.511	66.985	10.172	2.11
Chesterfield Mining Co.	1.289	80.565	45.540	49.180	1.896	30.676	58.794	1.957	67.428	8.624	2.29

[a] Report of experiments on the evaporative power and other properties of coals, made under authority of the Navy Department of the United States. 28th Cong., 1st sess., Senate No. 386, pp. 1-607; see pp. 308-451. 1844.

Analysis of coals given by Prof. W. B. Rogers: 1840 from the "Geology of the Virginias". From Wadleigh, 1938. In Davis and Evans, 1938, p. 90.

Designation of Coals In 1840	Fixed Carbon	Volatile Matter	Ash	Color of Ash
North side James River				
Capt. Thomas W. Randolph	66.15	30.50	3.35	Light red
Coalbrookdale second seam	66.43	29.00	4.52	Light grey
Anderson's pits, first seam	65.78	28.30	4.92	Light grey
Barr's pits - 1st seam	70.80	24.00	5.20	Faint red
2nd seam.	54.97	22.83	22.20	Strong red
3rd seam	65.50	24.70	9.80	Light brown
4th seam	56.07	21.33	22.60	Strong red
Crouch, upper seam 110' deep	64.60	30.00	5.40	- -
Scott's pits (formerly Woodwards)	60.86	33.70	5.40	Light grey
Waterloo Shaft	55.20	26.80	18.00	- -
Deep Run pits	69.84	25.16	5.00	- -
Southside James River				
Stonehenge	58.70	36.50	4.80	Light reddish
Engine Shaft				
Maidenhead	63.97	32.83	3.20	Strong red
Heth, Potts & Co.	62.35	37.65	2.80	Reddish yellow
Mills & Reid's Creek pit	57.80	38.60	3.60	Buff
Mill's pit	62.90	32.50	4.60	Light brown
Greenhole Shaft	67.83	30.17	2.00	Light red
Capt. Heth's Old English Shaft, 30'				
to 40' thick Bottom	53.36	35.82	10.82	- -
Middle	66.50	28.40	5.10	- -
Top	61.68	28.80	9.52	- -
Powhatan Pits (Finney)	59.87	32.33	7.80	- -

Chemical analyses of coal from the Richmond Basin. From Wadleigh, 1938. In Davis and Evans, 1938, p. 84-85.

Virginia	Sample Laboratory Number	Condition	Proximate Moisture	Proximate Volatile Matter	Proximate Fixed Carbon
Henrico County.					
Cayton, 1 mile from, 5 miles	15050	1	2.81	25.70	68.47
north of Lorraine Carbon Hill		2	-	26.44	64.26
mine, C. bed (in main gangway		3	-	29.14	70.86
Opposite room 45, 5 ft. 6 in.					
bed					
3 foot 4 inch cut					
Same (in main gangway	15050	1	2.54	16.28	70.84
Opposite room 32 3 ft.		2	-	16.70	72.07
3 in. bed. 2 ft. 3 in. cut).		3	-	18.81	81.19
	15051				
1 mile from, 5 miles	15051				
north of Lorraine, Carbon		1	2.11	23.53	56.94
Hill Mine, B bed (face of		2	-	24.03	58.18
right gangway off slope 3,		3	-	29.28	70.72
20 ft. beyond room 21, 4 ft.					
11 in. bed, 4 ft. 9 in. cut					

Condition

1. As received
2. Dry.
3. Ash and moisture free.

In "Technical Paper" No. 365, issued in 1925, the Bureau of Mines also gives the fo...

Continued.

Cont. From Wadleigh, 1938. In Davis and Evans, 1938, p. 84-85.

Coing analyses, with the addition of determinations of the Ash-Softening temperature of th
samples, as follows:

Sample No.	Softening Temperature °F.
15059	2160
15062	2250
15061	2510

	Ultimate						Calorific Value	
Ash	Sulphur	Hydrogen	Carbon	Nitrogen	Oxygen	Air Drying Loss	Calories	British Therm Units
9.02	1.43	4.90	78.53	1.81	6.29	1.9	7496	13493
9.26	1.47	4.72	78.75	1.86	5.91		7713	13883
-	1.62	5.20	86.82	2.05	4.31	-	8502	15304
10.94	1.51	-	-	-	-	1.9	-	-
11.23	1.54	-	-	-	-	-	-	-
	1.51	-	-	-	-	-	-	-
17.33	2.15	4.44	69.22	1.59	5.23	1.4	6773	12200
17.73	2.21	4.30	70.72	1.62	3.42	-	6924	12463
-	2.69	5.23	85.96	1.97	4.15	-	8416	15149

From Bladen, undated. In Davis and Evans, 1938, p. 11.

Analysis of Coal from the Tuckahoe Valley

by Professor W. B. Rogers.

Name of Coal	Carbon.	Volatile Matter	Ash.
T. M. Randolph's	66.15	30.50	3.35
Anderson's	66.43	29.05	4.52
Barr's pit 1st seam -	70.80	24.00	5.23
" " 2nd "	54.97	22.83	22.20
" " 3rd "	65.80	24.70	9.50
" " 4th "	55.07	21.33	22.60
Crouch's upper seam	64.00	30.00	5.40

-o-

From Wadleigh, 1938. In Davis and Evans, 1938, p. 84.

1. The characters and composition of certain coals from the Richmond Area, from N. R. Johnson's "Report of Experiments on the evaporative power and other properties of coals made under authority of the Navy Department of the U. S., 1844."

Designation of Coal	Specific Gravity	COMBUSTION IN 100 PARTS					
		Moisture	Volatile Matter	Fixed Carbon	Sulphur	Coke	Earthy Matter
Barr's Deep Run	1.562	1.785	19.782	67.958	-	78.42	10.475
Crouch & Snead's Mine	1.451	1.735	28.959	59.976	0.427	74.26	14.280
Midlothian Coal Co. from shaft 900' deep	1.457	1.172	27.278	61.083	-	71.55	10.467
Creek Coal Company	-	1.450	26.790	60.30	2.880	-	8.570
Clover Hill Mines	1.285	1.339	32.210	56.93	0.514	-	10.152
Chesterfield Mining Co.	1.289	1.896	30.673	53.794	1.987	67.428	8.634
Midlothian Coal Co. average	1.294	2.460	29.796	53.012	0.580	67.748	14.737
Tippecanoe Pits	-	1.840	34.540	54.620	0.390	-	9.570
Midlothian, New Shaft 800 Ft. Deep	-	1.170	27.280	61.020	-	-	10.470
Midlothian, screened	[illegible]	-	[illegible]	[illegible]	[illegible]	-	[illegible]

From d'Invilliers, undated. In Davis and Evans, 1938, p.17.

Bed	No.	Water	Volatile Matter	Fixed Carbon	Sulphur	Ash	Total Coal	Total Thickness Coal Sample
C	1	.754	24.196	67.930	1.251	5.920	3'11"	3' 8"
C	3&4	.516	23.604	62.753	.927	9.150	4' 4"	3'11"
C	5	.916	25.534	61.065	.904	11.550	4' 8"	4'5"
C	6	.668	25.052	58.700	1.230	14.350	5' 8"	5' 3"
C	7	.964	22.636	59.005	1.105	16.290	5' 0½"	4' 9½"
C	8	.690	25.532	57.377	1.183	15.200	4' 8'	4' 7"
C	10	.542	26.158	56.254	1.336	15.300	5' 9"	5'10½"
C	11	.950	23.290	58.629	1.211	12.920	4' 6"	4' 6"
Average		.740	25.039	59.095	1.159	13.778	4' 9½"	4' 4½"
B	12	1.014	25.565	55.817	1.313	16.290	5' 6"	5' 6"
B	13&14	.802	25.588	63.440	1.620	9.020	4' 5"	3' 4"
B	15	.762	24.988	59.390	1.820	13.020	5' 4½"	5' 4½"
Average		.716	25.363	59.549	1.585	12.780	3' 9"	5' 5"
A	16	.498	25.072	57.840	2.010	16.500	4' 7"	3'11"
A	18	.756	22.434	55.917	1.943	20.950	6' 2"	6' 2"
A	19	.930	22.570	52.138	1.352	22.690	6' 5"	6' 1"
A	20	.862	25.968	51.777	2.753	20.640	5' 0½"	4' 9"
A	21	.680	21.740	50.103	2.007	25.470	5' 1½"	4' 9"
A	22	.460	22.870	55.547	2.163	19.240	6' 0"	5' 7"
Average		.698	22.724	55.562	2.030	20.925	5' 7"	5' 2"

From Kimball, 1886. In Davis and Evans, 1938, p. 92.
Chemical analyses of coal from the Carbon Hill Mine by Professor Rogers.

Moisture from 80 lbs.	11.15 per cent.
Other volatile matter from four specimens	11.977 per cent.
Earthy matter from 4209 lbs.	11.020 per cent.
Fixed carbon by difference	75.071 per cent

From Treadwell, 1928. In Davis and Evans, 1938, p. 121.

Analysis of samples of coal taken from the "C" and "B" seams of the Gayton mine are as follows:

	"C"	"B"
Moisture	2.81	2.11
Volatile Matter	25.70	23.58
Fixed Carbon	62.47	56.95
Ash	9.02	17.36
	100.00	100.00
Sulphur	1.43	2.16
B. T. U.	13,493	12,200
Ash Fusion	22.10	24.20

From Wadleigh, 1938. In Davis and Evans, 1938, p. 79-80.

Analyses of the Natural Coke are given in the following table, as taken from all available sources. Most of the analyses are old; the exception being one made in 1912 by the U. S. Bureau of Mines and given in its Bulletin 85 as follows:

	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	B.T.U. not determined
Sample as received	2.5	16.3	70.3	10.9	1.3	"
Dry basis	-	16.7	72.1	11.2	1.3	-

New Mexico Natural Coke has the following analysis:

	-	16.87	74.18	8.95	-	"

ANALYSES OF NATURAL COKE FROM THE RICHMOND BASIN.

Location of Mine	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	B.T.U.
Midlothian (1887	1.66	18.35	67.13	12.86	4.70	-
Chesterfield County	-	17.00	62.00	15.00	-	-
Chesterfield County	-	10.70	83.30	6.00	-	-
Carbon Hill	1.57	9.64	79.93	8.86	-	-
Carbon Hill	1.12	11.98	75.08	11.83	-	-
Chesterfield County	-	9.98	80.30	9.72	-	-
Chesterfield County	-	16.00	70.00	14.00	-	-
Carbon Hill	1.56	14.26	81.61	2.24	.33	-
Richmond Basin	0.44	14.08	77.17	8.31	-	-
Carbon Hill (1912)	2.54	16.23	70.24	10.94	1.41	Ash fusing temp. 2250 Degrees F.
Average of five analyses by different chemists, reported by Russell	-	12.50	79.93	6.55	0.25	-

From d'Invilliers, 1904, in Davis and Evans, 1938, p. 50.

Midlothian Coal Property: Crown Shaft Coal

Table No. 1 Sampled by E. V. D'Invilliers, Analyzed by A. S. McCreath.

Map No.	Sample	Water	Volatile Matter	Fixed Carbon	Sulphur	Ash	Total Section	Thickness Sampled
2	A	.710	30,150	48,377	1.883	19.140	4'1"	3'11"
3	B	.654	34,010	49,955	3.553	11.820	3'1"	2'3"
4	C	1.072	29,308	49,140	1.760	18.720	7'10"	5'1½"
5	D	.588	30,822	56,150	2.210	10.130	9'3"	4'9"
6	E	.700	31,150	59,273	1.627	7.250	5'1"	4'8"
7	F	.678	30,822	54,199	2.671	11.370	8'0"	7'10"
8	G	.603	32,307	51,472	2.741	12.977	6'8"	7'8"
9	H	.612	31,038	53,363	2.797	11.390	8'3"	5'4½"

Sample A and B represent respectively the coal from the top and bottom benches in a new level (see map) driven for temporary fuel supply, located about 25' below #8 level and 100' south of Dodd's Incline.

Sample C is from the side of the New Incline, just above where it joins the old Dodd's Incline and just east of #11 Level. Coal benches of 27", 21" and 13" separated by partings of 2l" and 1½" slate (excluded from sample).

Sample D Top Bench only samples, exclusive of 2" bone, from an offset 10' north of New Incline, and 148' below #11 Level.

Sample E Top Bench only 5'1" thick; sample excludes 5" bone and slate in 5 thin bands. S. side New Incline 160' below #11 Level.

Sample F Whole seam 8'; excludes 4 bone bands each ½" thick, New #3 Level, 33' N. from New Incline and 311' below #11 Level.

Continued.

Continuation of d'Invilliers, 1904.

Sample G 2 Benches, 4'6" and 3'2", excl. 1' slate parting. From north side of New Incline and 300' below Fill level.

Sample H Top Bench only 5'4½" (excl. ½" bone: parting slate here 1'5" and Bottom Bench exposing only 1'2"; not sampled. New Incline 340' below Fill level.

Chemical analyses of coal from the Midlothian Mine.
From d'Invilliers, 1904. In Davis and Evans, 1938, p. 52.

	Water	Volatile Matter	Fixed Carbon	Sulphur	Ash	Nitrogen	Ammonia
1	1.90%	29.48%	52.32%	2.67%	13.63%	1.40%	1.70%
2	1.51	29.75	60.50	1.91	6.33	1.57	1.91
3	1.63	28.52	56.90	2.12	10.83	1.33	1.63
4	1.28	31.83	59.79	1.04	6.05	-	-
5	.95	29.06	55.51	2.10	12.28	-	-
6	1.13	28.95	49.03	4.69	16.00	-	-

NOTES: The exact location of these samples, or just what portion of the seam they represent are not definitely known. The large percentage of Nitrogen determined in first three samples will be noted.

No. 1 is described as from New Incline, just below #11 level, four benches of coal in sample 24", 18", 4" and 14". Total 5'0" coal, excluding slate parting 13", 4" and 2".

No. 2 and 3 were taken from New Incline, one on north side and the other south side 45 and 50 feet respectively below knuckle of incline (::175' ∅ below #11 level.) As reported by Mr. Jones the section of the seam was; top coal 5'11"; slate 1'6"; coal 0'4"; slate 0'4", coal 1'6", only top coal bench samples. This section could not be verified and it is doubtful whether the top bench exceeds 4'11"; the variation in percentage of ash, 6.33 to 10.83% will be remarked.

No. 4 was taken on Main New Incline 20' blow No. 3 New Level or 321' below the #11 Level; sample of 6'3½" coal, excluding 0'1½" bone.

No. 5 from north side Incline below #3 Level, corresponding to Sample C.

No. 6 from west side of #3 Level 36 feet from Incline, corresponding to sample F.

From Wadleigh, 1938. In Davis and Evans, 1938, p. 93.

"A recent (1873) analysis of these coals made in Glasgow, Scotland, by Dr. William Wallace, gives the following results from seven analyses of samples from different mi- and locations. (in the Richmond Basin).

Volatile Matter	14.26 to 34.57 percent
(Fixed carbon	56.23 to 81.61 "
Coke (Sulphur	0.04 to 1.10 "
(Ash	2.24 to 8.38 "
Water (at 212 degrees F.)	0.82 to 1.80 "
Dry coke, per ton of coal	12 cwt. to 3 qrs. 13 lbs to 16 cwt. 3 qrs.10 lbs
Coke, percent	64.33 to 84.13
Sulphur in volatile matter	1.14 to 0.78 or in all 0.13 to 1
Heating power calculated	8.55 to 11.04
Specific gravity	1.219 to 1.521
Weight of a cubic foot	77.6 to 82.3 pounds
Weight per inch per acre	123 to 133 tons

APPENDIX III

COAL PRODUCTION IN THE RICHMOND BASIN

Summary of Coal Production. From Woodworth, 1902, p. 52.

SUMMARY OF PRODUCTION.

The following table shows the production of the Atlantic coast Triassic coal fields for the twenty years from 1880 to 1900:

Development of the Atlantic coast Triassic coal field by decennial periods.

Locality.	1880.			1890.		
	Production.	Value.	Average price per ton.	Production.	Value.	Average price per ton.
Chesterfield and Henrico counties of Virginia, and North Carolina	*Tons.* 43,429	$100,202	$2.30	*Tons.* 45,262	$77,864	$1.72

Locality.	Increase of 1890 over 1880.				1900.		
	Production.	Per cent.	Value.	Per cent.	Production.	Value.	Average price per ton.
Chesterfield and Henrico counties of Virginia, and North Carolina	*Tons.* 1,833	4	[b]$22,338	22	*Tons.* 57,912	$103,777	$1.79

Locality.	Increase of 1900 over 1890.			
	Production.	Per cent.	Value.	Per cent.
Chesterfield and Henrico counties of Virginia, and North Carolina	*Tons.* 12,650	27	$25,913	33

[a] N. H. Darton, Bull. U. S. Geol. Survey No. 138, p. 218. [b] Decrease.

Recorded production of coal in Virginia, 1748-1950, in short tons. From Brown et al., 1950, p. 42-43.

Table 6.--Recorded production of coal in Virginia, 1748-1950, in short tons
(Figures from Kavenaugh, 1748-1882; U. S. Geological Survey, 1883-1923; U. S. Bureau of Mines, 1924-1950)

Year	Southwest Virginia field								[e] Valley fields	[b] Richmond basin	Other	State total
	Buchanan County	Dickenson County	Lee County	Russell County	Scott County	Tazewell County	Wise County	Total				
[e] 1748-1882	....	....	....	....	....	....	....	....	....	7,222,167	....	7,222,167
1883	....	....	....	....	....	92,150	....	92,150	....	[d] 159,650	....	252,000
1884	....	....	....	....	....	256,435	....	256,435	....	[d] 79,565	....	336,000
1885	....	....	....	....	....	511,575	....	511,575	5,000	50,000	425	567,000
1886	....	....	....	....	....	639,751	....	639,751	17,200	28,000	....	684,951
1887	....	....	....	....	....	781,155	....	781,155	14,108	30,000	....	825,263
1888	....	....	[e] 5,000	....	....	988,300	....	993,300	46,700	33,000	....	1,073,000
1889	....	....	....	....	....	[f] 807,046	[g] 1,164	808,210	8,165	49,411	....	865,786
1890	....	....	....	....	....	[f] 759,038	....	759,038	5,627	19,346	....	784,011
1891	....	....	....	....	....	696,966	....	696,966	26,358	13,075	....	736,399
1892	....	....	....	....	....	614,333	....	614,333	27,216	33,656	....	675,205
1893	....	....	....	....	....	653,374	126,216	779,590	6,771	33,978	....	820,339
1894	....	....	....	....	....	827,706	330,731	1,158,437	....	[d] 70,646	....	1,229,083
1895	....	....	....	....	....	962,209	336,593	1,298,862	11,680	57,782	....	1,368,324
1896	....	....	....	....	....	785,345	357,607	1,142,952	16,101	95,670	....	1,254,723
1897	....	....	....	....	....	708,338	712,011	1,420,349	....	[d] 107,953	....	1,528,302
1898	....	....	....	....	....	782,015	992,723	1,774,738	....	[d] 40,536	....	1,815,274
1899	....	....	....	....	....	844,027	1,232,613	2,076,640	20,538	[h] 8,613	....	2,105,791
1900	....	....	....	....	....	970,666	1,363,570	2,334,236	9,814	[h] 49,504	....	2,393,754
1901	....	....	....	[f] 7,675	....	776,568	1,918,693	2,702,936	11,177	11,760	....	2,725,873
1902	....	....	....	[f] 7,831	....	723,753	2,422,417	3,154,001	12,786	16,206	....	3,182,993
1903	....	....	....	9,255	....	840,195	2,563,285	3,412,735	20,288	18,084	[i] 200	3,451,307
1904	....	....	....	177,133	....	871,720	2,359,661	3,408,514	....	2,100	[i] 300	3,410,914
1905	....	....	....	323,073	....	961,380	2,990,648	4,275,151	....	....	[i] 120	4,275,271
1906	....	....	....	302,896	....	910,638	3,041,225	4,254,759	....	....	[i] 120	4,254,879
1907	....	....	198,913	249,602	....	1,116,534	3,145,846	4,710,895	....	....	....	4,710,895
1908	....	....	464,261	255,893	....	980,014	2,558,874	4,259,042	....	....	....	4,259,042
1909	....	....	449,144	485,960	....	975,665	2,841,448	4,752,217	....	....	....	4,752,217
1910	....	....	797,096	792,763	....	1,187,146	3,730,992	6,507,997	....	....	....	6,507,997
1911	....	....	720,695	1,108,388	....	1,281,224	3,754,360	6,864,667	....	....	....	6,864,667
1912	....	....	751,276	1,293,145	....	1,302,043	4,500,174	7,846,638	....	....	....	7,846,638
1913	....	....	763,315	1,513,843	....	1,447,351	5,103,559	8,828,068	....	....	....	8,828,068
1914	....	....	732,935	1,236,114	....	1,323,530	4,620,702	7,913,281	46,254	....	....	7,959,535
1915	....	....	742,311	1,493,421	....	1,647,081	4,186,309	8,069,122	53,474	....	....	8,122,596
1916	....	....	828,000	1,950,036	....	1,588,044	5,228,945	9,595,025	112,449	....	....	9,707,474
1917	....	13,593	871,642	2,000,540	....	1,631,849	5,427,455	9,945,079	142,012	....	....	10,087,091
1918	....	110,931	888,400	1,998,144	....	1,624,736	5,514,132	10,136,343	153,465	....	....	10,289,808
1919	....	472,059	679,017	1,801,667	....	1,208,814	5,049,436	9,210,933	115,897	....	[i] 134,500	9,326,830
1920	....	614,904	946,125	2,122,841	....	1,323,712	6,062,325	11,069,957	174,149	....		11,378,606
[f] 1921	....	448,387	687,929	1,543,862	....	1,253,902	3,464,153	7,403,232	89,146	....	....	7,492,378
1922	....	870,234	762,305	2,070,574	....	1,563,847	5,022,866	10,289,826	148,475	....	[g] 52,873	10,491,174
1923	....	925,029	1,024,668	2,066,057	....	1,492,875	6,013,132	11,521,761	230,349	....	9,533	11,761,643
[r] 1924	....	794,237	1,140,102	1,602,073	....	1,801,430	5,164,420	10,502,262	191,202	....	....	10,693,464
1925	....	1,022,587	1,514,004	1,854,514	....	2,128,115	6,013,566	12,532,786	266,657	....	....	12,799,443
1926	....	1,115,377	1,971,387	1,863,968	....	2,347,552	6,563,059	13,861,343	272,043	....	....	14,133,386
1927	....	1,059,376	2,180,697	1,518,597	....	2,284,257	5,731,563	12,743,450	172,592	....	....	12,916,042
1928	....	746,006	2,200,152	1,260,016	....	2,410,491	5,061,702	11,728,637	172,296	....	....	11,900,933
1929	....	808,662	2,143,075	1,414,677	....	2,803,076	5,301,716	12,477,206	271,100	....	....	12,748,305
1930	....	987,172	1,739,276	1,254,745	....	2,506,636	4,179,347	10,667,226	240,151	....	....	10,907,377

Recorded production of coal in Virginia, cont.

1931	[r]	1,045,719	1,897,205	1,008,773	....	2,214,956	3,148,266	9,514,919	[q] 183,761	....	....	9,698,680
1932	40,883	769,726	1,542,502	674,069	....	1,807,586	2,700,533	7,535,299	156,981	....	....	7,692,180
1933	278,853	964,036	1,220,199	752,798	....	[w] 1,980,859	2,816,613	8,013,358	165,284	....	....	8,178,642
1934	573,262	1,176,101	1,123,366	771,531	500	2,693,756	2,836,162	9,174,678	202,003	....	....	9,376,681
1935	[1] 160,668	1,129,449	1,147,272	660,424	....	2,387,002	2,795,701	9,480,515	186,503	....	....	9,667,018
1936	2,235,071	1,340,486	1,342,773	[q] 642,162	....	2,968,536	2,934,224	11,463,252	198,384	....	....	11,661,636
1937	3,601,509	1,742,814	1,285,830	[q] 649,486	....	3,009,521	3,301,946	13,591,106	204,133	....	....	13,795,239
1938	3,742,470	1,370,506	987,821	[q] 509,554	....	2,800,449	2,732,504	12,143,304	[e] 139,732	....	....	12,283,036
1939	4,280,776	1,551,868	1,196,100	[q] 650,699	....	2,757,904	2,940,590	13,378,007	152,967	....	....	13,530,974
1940	4,874,311	1,767,582	1,420,683	606,270	[j] 29,197	3,283,135	3,193,440	15,174,618	173,457	....	....	15,348,075
1941	5,553,444	2,075,271	1,505,358	[x] 1,196,924	27,002	3,827,007	4,255,944	18,440,946	....	....	....	18,440,946
1942	5,978,697	2,083,496	1,559,256	1,146,692	....	4,352,497	4,705,460	19,966,103	[q] 230,071	....	....	20,136,179
1943	5,966,647	2,009,678	1,347,315	1,268,319	....	4,800,320	4,656,349	20,048,628	[q] 231,581	....	....	20,280,209
1944	5,922,513	1,676,358	931,063	1,216,399	....	4,679,970	4,866,206	19,292,400	[q] 221,465	....	....	19,513,874
1945	5,207,790	1,278,240	875,942	1,040,942	29,914	4,061,201	4,255,461	17,047,000	185,903	....	....	17,234,903
1946	4,472,647	1,333,648	599,001	1,188,603	44,446	3,844,197	3,825,987	15,346,529	180,366	....	....	15,526,895
1947	5,397,676	2,578,082	770,204	2,001,906	86,050	4,340,720	4,796,857	20,011,495	159,304	....	....	20,170,799
1948	4,914,452	2,836,657	950,283	1,499,155	5,471	3,943,220	4,214,336	17,823,574	175,831	....	....	17,999,405
1949	4,424,478	2,574,964	618,911	1,159,749	15,549	2,152,458	3,517,188	14,463,297	120,790	....	....	14,584,087
Total 1748-1949	68,826,147	41,102,234	47,522,804	54,221,428	238,129	118,956,343	203,768,253	534,635,338	6,379,656	8,230,702	198,071	549,443,761
[y] 1950	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	[z] 16,986,000
Total 1748-1950	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	566,429,761

[a] Valley fields include Montgomery, Pulaski, Wythe, Bland, and Smyth Counties.

[b] Richmond basin includes Henrico, Chesterfield, Goochland, and Powhatan Counties.

[c] Yearly production figures for this period are given in table 5.

[d] Includes Valley fields.

[e] Includes Russell, Buchanan, and Dickenson Counties.

[f] Includes Pulaski County.

[g] Includes Buchanan, Russell, Lee, Dickenson, and Wythe Counties.

[h] Includes Russell County.

[i] Small mines.

[j] Includes Pulaski and Montgomery Counties.

[k] Includes Lee and Pulaski Counties.

[l] Includes Pulaski and Montgomery Counties and small mines.

[m] Includes Pulaski, Montgomery, and Henrico Counties, and small mines.

[n] Includes small mines.

[o] Includes Scott County and small mines.

[p] Includes Scott County.

[q] Exclusive of production from wagon mines.

[r] Includes Richmond basin.

[s] Includes Scott County and Richmond basin.

[t] Includes wagon mines served by rail.

[u] From 1924 to present, wagon-mine production omitted.

[v] Includes the Tazewell County operations for one mine producing in both Tazewell County, Va., and McDowell County, W. Va. All tonnage for this mine in earlier years was tabulated in McDowell County, W. Va. (U. S. Minerals Yearbook, 1935, p. 303.)

[w] Includes Valley fields and Richmond basin.

[x] County totals not available.

[y] Preliminary.

Production of coal in the Richmond Coal Basin, 1748-1882, in short tons. From Brown et al., 1952, p. 37.

Table 5.--Production of coal from the Richmond basin, 1748-1882, in short tons

(Figures from Eavenson (1942), pp. 441-445)

Year	Tonnage	Year	Tonnage	Year	Tonnage	Year	Tonnage	Year	Tonnage	Year	Tonnage
1748	50	1771	500	1794	1,000	1817	58,000	1840	88,000	1863	112,068
1749	50	1772	400	1795	2,000	1818	59,000	1841	79,600	1864	111,742
1750	50	1773	400	1796	4,000	1819	60,000	1842	77,000	1865	73,730
1751	50	1774	400	1797	7,000	1820	62,000	1843	95,606	1866	70,912
1752	100	1775	400	1798	22,000	1821	64,000	1844	115,313	1867	90,810
1753	100	1776	400	1799	14,000	1822	54,000	1845	134,603	1868	96,184
1754	100	1777	500	1800	18,000	1823	43,966	1846	124,669	1869	115,564
1755	100	1778	500	1801	22,000	1824	67,040	1847	136,422	1870	90,200
1756	100	1779	500	1802	26,000	1825	66,720	1848	120,747	1871	101,932
1757	100	1780	500	1803	29,500	1826	88,641	1849	133,801	1872	95,973
1758	200	1781	500	1804	40,500	1827	84,720	1850	138,017	1873	101,504
1759	[illegible]	1782	500	1805	42,000	1828	100,080	1851	136,523	1874	81,851
1760	300	1783	400	1806	43,000	1829	93,350	1852	106,687	1875	88,706
1761	300	1784	400	1807	44,000	1830	102,799	1853	101,726	1876	57,182
1762	700	1785	400	1808	45,000	1831	104,320	1854	132,554	1877	67,907
1763	1,400	1786	400	1809	46,000	1832	132,033	1855	125,977	1878	50,000
1764	800	1787	400	1810	47,000	1833	159,697	1856	106,150	1879	45,000
1765	900	1788	400	1811	48,000	1834	124,000	1857	114,826	1880	43,079
1766	600	1789	400	1812	50,000	1835	201,600	1858	113,734	1881	50,000
1767	500	1790	400	1813	52,000	1836	124,000	1859	103,338	1882	112,000
1768	500	1791	400	1814	54,000	1837	112,000	1860	112,473		
1769	1,000	1792	400	1815	56,000	1838	107,999	1861	94,697	**Total**	**7,222,167**
1770	500	1793	700	1816	57,000	1839	96,000	1862	115,495		

BIBLIOGRAPHY

Bladen, John, undated.
Report on coal lands in Tuckahoe Valley. In Davis, I.F. and L.S. Evans, The Richmond Coal Basin: a compilation in three parts: 1938, Part I, p. 1-11.

Davis, I.F. and L.S. Evans, 1938.
The Richmond Coal Basin: a compilation in three parts:

d'Invilliers, E.V., 1904.
Geological Report on the Midlothian Coal Property. In Davis, I.F. and L.S. Evans, The Richmond Coal Basin: a compilation in three parts: 1938, Part I, p. 37-66.

d'Invilliers, E.V., undated.
Report on Coalbrook Operation. In Davis, I.F. and L.S. Evans, The Richmond Coal Basin: a compilation in three parts: 1938, Part I, p. 12-36.

Jones, Meriwether, 1916.
Report on the Richmond Coal Basin. In Davis, I.F. and L.S. Evans, the Richmond Coal Basin: a compilation in three parts: 1938, Part I, p. 67-83.

Kimball, Dr. I. P., 1886
Report on the Richmond Coal Basin and Mines. In Davis, I.F. and L.S. Evans, The Richmond Coal Basin: a compilation in three parts: 1938, Part I, p. 84-100.

McCanna, H.H., 1932
Report to subscribers to Richmond syndicate, 1932 (2 maps showing bore hole positions and sections). In Davis, I.F. and L.S. Evans, the Richmond Coal Basin: a compilation in three parts: 1938, Part I, p 101-117.

Roberts, J.K., 1928.
The gology of the Virginia Triassic: Bulletin 29, Conservation and Development Commission, Virginia Geological Survey, University of Virginia.

Treadwell, H.A., 1928.
Report on Richmond Coal Basin. In Davis, I.F. and L.S. Evans, The Richmond Coal Basin: a compilation in three parts: 1938, Part I, p. 118-127.

Wadleigh, Frank R., 1938.
The story of the Richmond, Va., Coal Field and its development, 1700-1934. In Davis, I.F. and L.S. Evans, The Richmond Coal Basin: a compilation in three parts: 1938, Part II, 163 p.

Woodworth, J.B., 1902.
The Atlantic Coast Triassic Coal Field: 22nd Annual Report, U.S.G.S., Part III, Washington, p. 25-53.

Brown ms. no.

ADDITIONAL REFERENCES

Olsen, P.E., 1978; On the use of the term Newark for Triassic and Early Jurassic rocks of eastern North America: Newsletters on Stratigraphy, vol. 7, p. 90-95.

Goodwin, B.K., and C.H. Johnson (1967); Geologic Structure and Stratigraphy of a portion of the Triassic basin at Deep Run, Henrico County, Virginia (Abs.): Va. Jour. Sci., vol. 18, p. 185.

Goodwin, B.K., (1971); The Structure of the Northern Half of the Richmond basin (Abs.): Va. Jour. Sci., vol. 22, p. 120.

Cornet, Bruce, Traverse, Alfred, and McDonald, N.G., (1973); Fossil spores, pollen, and fishes from Connecticut indicate early Jurassic age for part of the Newark Group: Science, vol. 182, p. 1243-1247.

Cornet, Bruce, (1977); The Palynostratigraphy and Age of the Newark Supergroup: Unpublished Ph.D Thesis, The Pennsylvania State University, 304p.

Clay, J.W., (1975); Soil survey of Henrico County, Virginia: U.S. Department of Agriculture Soil Conservation Service in cooperation with Virginia Polytechnic Institute and State University, 119 p.

Hodges, R.L., (1978); Soil survey of Chesterfield County, Virginia: U.S. Department of Agriculture Soil Conservation Service in cooperation with Virginia Polytechnic Institute and State University, 115 p.

MINERAL RESOURCES
of the
RICHMOND TRIASSIC BASIN

By: Gerald P. Wilkes

Mining District Notations

Deep Run Basin

This area represents one of four outlier basins in which the coal measures have been preserved. The coals dip steeply (up to 74^{o} east) on the western margin and gently (10^{o} to 20^{o} west) on the eastern margin. Early mining was achieved by slopes but later shafts were used to reach the coal. At least one coal of undetermined thickness was mined.

Carbon Hill District

The area covered by this district is on the east side and begins at the feathering out of the coal measures just south of the junction of Church and Gayton Roads and continues south to the James River. Included in this district are the mines in the Flat Branch (outlier) Basin. As compaired to the other mining districts, the Carbon Hill area has the fewest problems in continuity and variability in the coals. Minor rolls are indicated in past mining but were not severe enough to complicate 18th century mining practices. Four coals are present: The "Coke" seam is uppermost in the section and is so-named because it has been altered to natural coke by the intrusion of diabase dikes and/or sills. Average thickness of the coke seam is 6 to 8 feet. A 60 $\pm$ ft. sandstone and shale interval separates the "Coke" Seam from the underlying "C" Seam. This seam is from 2 to 5 ft. The "B" Seam (3 to 5 ft) is separated from the "C" by 12 $\pm$ ft. of shale and sandstone. Underlying the "B" is the "A" Seam, separated by 40 $\pm$ ft. of sandstone and shale. Average dip of coals is 25^{o} west.

Midlothian District

This district is on the east side of the basin, beginning at the James River and going south to the end of the coal measures (east of Swift Creek Reservoir). Included in this district are the Stonehenge, Union, and Blackheath Basins. Several rolls and minor faults in the strata had caused mining problems, but most could be rectified by methods used at the time of mining activity. Four coals are generally found in this district: The uppermost (first seam) averages 5 ft. (3.5 ft. coal and 1.5 ft. shale partings); the second seam is one ft. thick and is located in the 47 $\pm$ ft. sandstone and shale interval between the first and third seam (12 ft. with 0.2 to 2.0 ft. of shale partings), an unnamed coal (14 ft. thick) is separated from the third seam by 10 $\pm$ ft. of sandstone and shale. Average dip of coal is 22^{o} west, varying in places due to rolls in strata.

Clover Hill District

This district is on the east side of the basin, beginning near the junction of SR 664 and 655 and continues south across the Appomattox River to an area west of Whites Store. Three coals are represented in this district: The top seam (3 to 5 ft.) is separated from the main seam (7 to 20 ft.) by 10 to 30 ft. of sandstone and shale. A 40 to 50 ft. interval of sandstone and shales separates the main seam from the bottom seam (4 to 6 ft.)

Mining the coals were complicated by a squeeze in the strata which pinched the coals out for a surface distance of 1100 ft. This so-called "Garrett Trouble" is located approximately 1300 surface feet west of the coal outcrops. Mining was terminated when this structure was encountered.

Huguenot Springs District

The area delineated in this district is on the west side of the basin between north of Manakin and US 60. Two coals were measured in the Norwood Mine (index no. 37): the upper coal (5 to 7 ft. with shale partings) separated from the lower coal (6 ft. with shale partings) by 10 to 12 ft. of shale. In nearby mines, up to seven coals of unreported thickness have been noted. This district is plagued by structural difficulties (faults, rolls) which made mining practices hard to follow. Dips of the coals in the mines vary from 20^{o} to 30^{o} west and east.

DEEP RUN BASIN

Towne and Powell's Pits — Henrico County

Location: Index no. 1, west side of Springfield Road, 2500 ft. north of junction Springfield and Hungry Road.

Historical note: working 1842

Reference: Eavenson (1942)

Burton's Pits — Henrico County

Location: Index no. 2, west side of Deep Run drainage, north of U. S. 250.

Historical notes: worked by Grabs and Co., raised 250,000 bushels of coal in 1842, coal transported by the Fredericksburg and Richmond RR.

References: Eavenson (1942), Wooldridge (1842)

Deep Run Pits — Henrico County

Location: Index no. 3, west side of Deep Run drainage, south of U. S. 250.

Historical note: working in 1843

Reference: Eavenson (1942)

CARBON HILL DISTRICT

Maggie Pits — Henrico County

Location: Index no. 4, west side of Gayton Road, 2350 linear feet south of junction Gayton and Church Roads.

Historical note: working 1892

References: Eavenson (1942), Roberts (1929), Russell (1892)

Saunder's Shaft — Henrico County

Location: Index no. 5, west side of Gayton Road, 2400 linear feet south of junction Gayton and Church.

Historical notes:

1922-1936	Gayton Coal & Land Corp.	no operations
1914-1922	Herman J. Cook	" "
1904-1914	Old Dominion Dev. Co.	Operated Coalbrook
1910-1913	" "	"
1902-1904	Rust & Davis (bondholders)	no operations
1893-1902	Va. Coal & Coke Co.	Gayton, Saunders & Coalbrook open
1887-1893	Richmond Coal Min. & Mfg. Co.	Gayton & Saunders only

= From 1887 back Coalbrook owned by a different group from Gayton & Saunders=

1871-1887	James River Coal Co.	Gayton & Saunders
1867-1871	Virginia Coal Co.	" "
1834-1867	Several owners inclu. Carbon Hill Coal Co.	

220 ft. shaft, mined coke seam at 200 ft.

References: Swartout (1930), Woolfolk (1901), Rilee (1977), Wadleigh, (1938).

Deep Shaft — Henrico County

Location: Index no. 6, west side of Gayton Road, about 1000 feet north of Tuckahoe Village West.

Historical notes: dug in 1841 as Snead's Shaft, 350 ft. shaft cutting the "Coke" Seam and mining the "C" Seam, dip of coal averages 30°W, owned by T. R. Crunch & Snead and later by Crouches, connected with Air and Brooks Shafts, working 1887.

References: Kimball (1866), Newell (1888), Swartout (1930), Worth (1857)

Gayton Shaft — Henrico County

Location: Index no. 7, west side of Gayton Road at Tuckaloe Village West.

Historical notes: also Coke, Orchard, Twin and Breaker Shafts.

- One of 3 to be operated in the area after 1873 (See Coalbrook & Saunders); p. 24

- "Gayton shaft or Coke shaft formerly known as Orchard or Twin Shaft of which Breaker Shaft is the north shaft and was sunk to 180' to whin by Crouch & Snead about 1850. The other shaft, not so deep, about 40' south and afterwards filled with rock. The Richmond Coal Mining and Mfg. Co. dug this shaft to 325 foot".

	1922-1936	Gayton Coal & Land Corp.	no operations
	1914-1922	Herman J. Cook	" "
	1904-1914	Old Dominion Dev. Co.	Operated Coalbrook
Note: Gayton,	1910-1913	"	"
Saunders &	1902-1904	Rust & Davis (bondholders)	no operations
Coalbrook all	1893-1902	Va. Coal & Coke Co.	Gayton, Saunders & Coalbrook open
owned by one group	1887-1893	Richmond Coal Min.&Mfg.Co.	Gayton & Saunders only

= From 1887 back Coalbrook owned by a different group from Gayton & Saunders =

1871-1887	James River Coal Co.	Gayton & Saunders
1867-1871	Virginia Coal Co.	" "
1834-1867	Several owners incl. Carbon Hill Coal Co.	

(all of above from Swartout, 1930)

- Coals mined: Coke Seam - 8 to 10 ft. thick, 5 to 7 in. of shale in 2 partings, 325 ft. (vertical) deep at Gayton Shaft where intersects and then follows in slope for 1300 ft., dip averaging 25° W.
This bed is assumed to run horizontally at the center of the basin at a depth of 1500 ft.
It rises again on the west side at a dip of approximately 35° E at the western outcrop.
West outcrop is partially north & south of the James River.

Analysis:	
Moisture	0.90%
Vol Mat	5.75%
Fix Carb	86.72%
Ash	6.62%
Sulfur	0.60%

Coal No. 1 ("C" Seam) - lies 60 ft. below Coke Seam, thickness of 6 to 6.3 ft. w/ a 1" part.
Dip of approximately 25° W

Analysis:	
Moisture	0.79%
Vol Mat	26.65%
Fix Carb	69.20%
Ash	3.36%
Sulfur	0.63%

Coals Mined (cont): Coal No. 2 ("B" Seam) - lies 12 ft. below "C" Seam, 4 ft. thick w/one 1" parting.

Analysis:		
	Moisture	0.88%
	Vol Mat	26.99%
	Fix Carb	66.98%
	Ash	5.15%
	Sulfur	1.13%

Coal No. 3 ("A" Seam) - lies 40 ft. below "B" Seam, 7 ft. thick w/partings total 5-7 in., a widely mined coal.

Analysis		
	Moisture	0.70%
	Vol Mat	25.24%
	Fix Carb	66.11%
	Ash	7.95%
	Sulfur	1.04%

(the above data on coals mined, from Woolfolk, 1901)

References: Woolfolk (1901), Swartout (1930), d"Invilliers (1903 & 1904), Treadwell (1928), Jones (1917), Lawton (1942 & 1944), Roberts (1928), Wadleigh (1930), Rilee (1977).

Coalbrook Slope — Henrico County

Location: Index no. 8, south of Gayton Road, between Tuckahoe Creek and Copperas Branch.

Historical notes: also Carbon Hill Mine and Old Diminion Development Co. No. 1 Mine

1922-1936	Gayton Coal & Land Corp.	no operations
1914-1922	Herman J. Cook	" "
1904-1914	Old Dominion Dev. Co.	Operated Coalbrook
1910-1913	Old Dominion Dev. Co.	" "
1902-1904	Rust & Davis (bondholders)	no operations
1893-1902	Va. Coal & Coke Co.	Gayton, Saunders & Coalbrook open
1887-1893	Richmond Coal Min. & Mfg. Co.	Gayton & Saunders only

= From 1887 back Coalbrook owned by a different group from Gayton & Saunders =

1871-1887	James River Coal Co.	Gayton & Saunders
1867-1871	Virginia Coal Co.	" "
1834-1867	Several owners inclu. Carbon Hill Coal Co.	

separated from Deep Shaft by roll in the strata, Main slope is 1666 ft. west of coal outcrop, coals dip varies from 16°W to 35°W.

"A" COAL The "A" coal consists of 10 feet of coal strata, upper 5½ feet is of poor quality and unmarketable at present. The lower 4½ feet is cut up by slate partings and bands and would have to be crushed and washed before it could be marketed. Not at present operated and of no commercial value at the present time.

"B" COAL The "B" coal lies approximately 40 feet higher than the "A" coal and has an average thickness of 36 inches, and is consistent throughout the entire area developed.

"C" COAL The "C" coal lies from 1½ to 8 feet above the "B" coal with an average interval of about 5 feet, and this seam has a variable thickness of from 3½ to 6 feet, with an average thickness approximately 4 feet. These two seams, the "B" and "C" are worked in conjunction with one another in the existing slope. There are local area where one or more beds have been converted into natural coke by contact with or proximity to igneous rock intrusions (from Swartout, 1930).

References: Wadleigh (1930), Rilee (1977), Woolfolk (1901), d'Invilliers (1903), Swartout (1930).

Edge Hill Shaft — Henrico County

Location: Index no. 9, north side of Gayton Road on west side of Flat Branch.

Historical notes: worked by John Barr (1835), Richardson (1842), J. C. Deaton (1846), Perkins Novdson and John J. Worth; depth of shaft 264 ft. to the "B" Seam, cuts "Coke" Seam at 180 ft.

References: Wadleigh (1930), Rilee (1977), Kimball (1866), Daddow (1875) ? Eavenson (1942), Newell (1888).

Woodward and Cottrell's Pits — Goochland County

Location: Index no. 10, between U.S. 6 and Tuckahoe Creek, 4000 ft. east of junction SR 649 and U.S. 6.

Historical notes: also Trent Pits, Engine Shaft (No. 2) and Mule Shaft (No. 3); first mention 1835, working 1846; mine consists of two shafts:
Engine Shaft - TD 185 ft., mined "C" Seam (6 ft.) and "B" Seam (4.5 ft.)
Mule Shaft - TD 125 ft., cuts "C" and "B" Seams and mined "A" Seam (6 ft. coal)

References: Wadleigh (1930), Russell (1892), Daddow (1835), Newell (1888), Swartout (1930), Kimball (1866).

MIDLOTHIAN DISTRICT

Trabue's Pits — Chesterfield County

Location: Index nos. 11 and 12, 1000 to 2000 ft. south of the James River and 1500 ft. west of Salles Creek.

Historical notes: first mention in 1790, working 1815 to 1819, sold in 1835 to Thomas M. Burfoot and worked by Stanford, Duval and Co. as Burfoot's Pits.
Three beds encountered, uppermost natural coke, middle 3 ft. coal, lower 1 ft. coal.

References: Wadleigh (1930), Shaler and Woodworth (1899), Roberts (1928), Ritz (1975).

Major Clarke's Pits — Chesterfield County

Location: Index no. 13, west of Salles Creek, 4500 linear feet northeast of junction SR 902 and 711.

Historical notes: mentioned in 1842 that coal was mined here some years ago.

References: Ritz (1975), Wadleigh (1930), Wooldridge (1842).

Salle's Pits — Chesterfield County

Location: Index no. 14, west of Salles Creek, 1700 linear feet northeast of junction SR 902 and 711.

Historical notes: mentioned 1790, sold by Col. Heath to Wills Brown and Co., working 1835, later sold to English Co., shaft mine.

References: Wadleigh (1930), Ritz (1975), Roberts (1928), Shaler and Woodworth (1899).

Dickenson Coke Pit — Chesterfield County

Location: Index no. 15, on Falling Creek tributary, 3500 linear feet southwest of junction SR 711 and 720.

Historical notes: opened as test pit by the Richmond Syndicate (1930), mined coke seam 9 to 12 ft. thick.

References: Wadleigh (1930), Richmond Syndicate (1930).

Black Heath Pits — Chesterfield County

Location: Index no. 16, on tributary of Falling Creek, 3500 linear feet south of junction SR 711 and 720.

Historical notes: opened about 1788 by Heath Mining Co., working 1810 working 1835 by Chesterfield Mining Co., working 1839 to 1840, 1842, 1854 to 1855, by 1887 all that remained was a pond or swamp; slope mine (1350 ft. length), gas explosions in 1839 and 1844 with 40 and 11 killed, respectively; all cannon foundries in Richmond in 1838 use coal from this mine.

References: Wadleigh (1930), Taylor (1848), Cox and Heinrich (1888) Roberts (1928), Ritz (1975), Russell (1889), Rodgers (1840), Daddow and Bannon (1866), Clifford (1887), USBM (1934).

Buck and Cunliffe's Pits — Chesterfield County

Location: Index no. 17, at Black Heath Pond, approximately 3700 linear feet south of junction SR 711 and 720.

Historical notes: working 1790, also M'Call and Cunliffe 1791, Cunliffe's Old Pits 1838, mined out by 1842.

References: Wadleigh (1930), Roberts (1928).

Gowrie Pits — Chesterfield County

Location: Index no. 18, at junction of Falling Creek and tributary leading to Black Heath Pond, 4500 linear feet north of junction SR 677 and US 6.

Historical notes: working 1821, working 1839 (owned by Mosely & Brauder and leased to Geo. F. Swann).

References: Wadleigh (1930), Roberts (1928), Ritz (1975).

Etna Shaft — Chesterfield County

Location: Index no. 19, 100 feet west of the Southern Railway track, 2900 linear feet north of junction SR 677 and US 6.

Historical notes: also Willis Pits, Aetna Shaft; operated during the period 1842 to 1880.

References: Wadleigh (1930), Roberts (1928), Shaler and Woodworth (1899).

Hancock Shaft and Woodrow Shaft — Chesterfield County

Location: Index no. 20, 1000 ft. southwest of junction SR 624 and US 6.

Historical note: Located on Manders tract.

Reference: Chesterfield Co. Courthouse, Oct. 24th, 1944.

Rise Shaft and One Eye Slope — Chesterfield County

Location: Index no. 21, approximate location 2000 ft. south of junction US 6 and Falling Creek, west of Falling Creek.

Historical note: These and other mines worked area known as the Stonehenge Basin. This basin represents a group of outliers that have been isloated from the main basin by deformation and erosion. The other basins are the Deep Run, Edge Hill, Black Heath and Union Basins.

Reference: Heinrich (1873), Schmitz (1895) Chesterfield County (1944).

Pump Shaft — Chesterfield County

Location: Index no. 22, 2300 ft. due east of Watkins School on SR 754.

Historical note: 777 ft. shaft, 3.6 ft. coal at 716 ft., located on Midlothian Co. parcel; in 1840, 300,000 bushels were produced by 150 men and 25 mules. Explosion 1855 and sold at public auction 1869.

References: Wadleigh (1930), Cox and Heinrich (1888), d'Invilliers (1904), Schmitz (1895).

Sinking Shaft — Chesterfield County

Location: Index no. 23, 1500 ft. northeast of Watkins School on SR 754.

Historical note: Dug 1874 shaft 1016 ft., drill hole at bottom of shaft 322 ft., total depth 1338 ft.; no workable coal encountered; located on Mills tract.

References: Wadleigh (1930), d'Invillier (1904), Shaler and Woodworth (1899), Schuitz (1895), Woodworth (1902), Russell (1889).

Grove Shaft — Chesterfield County

Location: Index no. 24, west side of Falling Creek, 3200 ft. southeast of Watkins School.

Historical notes: Shaft sunk in the 1860's to 632 ft. (lower 18 ft. as sump) by the Midlothian Company organized in 1836. Explosion on Dodd's incline 1862 closed mined. Shaft began cleaning out 1873 , began shipments January 1876. Explosion of February 3rd, 1882 (gas and dust) closed mine until beginning of reopening in July 1882. Located 2200 ft. south of Pump Shaft and 600 ft. north of the Murphy Slope. Workings cut through three seams: top seam 14 ft., middle seam 12 ft., lower seam 4 ft.; sunk incline (Dodd's) on middle seam; approximate dip 22°W.

References: Wadleigh (1930), Cox and Heinrich (1888), d'Invilliers (1904), Wortham (1916), Jones (1917), Shaler and Woodworth (1899), Roberts (1928), Schmitz (1895).

Murphy Slope — Chesterfield County

Location: Index no. 24, west side of Falling Creek, 3600 ft. southeast of Watkins School.

Historical notes: Slope driven in 1890's, July 1923 incline measured 2,330 ft., dripping 19°W at surface and 70°W locally due to rolls in the strata. This year mined 50,000 tons with shale roof. Working "C" Seam, 42 to 74 inches of shale.

References: Wadleigh (1930), Treadwell (1928), Roberts (1928), Cox and Heinrich (1888), d"Invillier (1904), Wortham (1916), Jones (1917), Shaler and Woodworth (1899), Schmitz (1895).

Union Pits — Chesterfield County

Location: Index no. 25, location not field checked, north of US 60, south of SR 677.

Historical notes: opened 1827, working 1838 (operator Jacob Beach), 1880 (1,638 tons produced this year, total output to Richmond Market), mine operated on 8 ft. coal, located in an outlier basin (Union Basin).

References: Wadleigh (1930), Shaler and Woodworth (1899), Roberts (1928), Ritz (1975), Eavenson (1942).

Rowlett's Pits — Chesterfield County

Location: Index no. 34, tentitive location on hillside 3000 ft. due south of junction SR 602 and 621.

Historical notes: mentioned 1822, worked two years, southernmost workable coals in this district, worked coal 2 to 5 thick. Strike of coal N20° E.

References: Wadliegh (1930), Ritz (1975), Tuomey (1842).

Unnamed Pits — Amelia County

Location: Index no. 35, tentitive location on south side of Appomattox River where Winticomack Creek joins the River.

References: Eavenson (1942).

Huguenot Springs District

Dover Pits — Goochland County

Location: Index no. 36, a number of shafts and pits in the Manakin.

Historical notes: represents the oldest mines in the Field; worked by by Anderson and Moody, later by Dover Coal Mining Co., working 1842; strata inclinations change due to numerous north-south faults, three coals worked: top 4 to 8 ft., middle 4 to 12 ft., lower 3 to 4 ft.

References: Wadleigh (1930), Treadwell (1928), Kimball (1866), Roberts (1928), Russell (1889).

Norwood Slope — Goochland County

Location: Index no. 37, 3600 ft. north of junction SR 652 and 711.

Historical notes: working 1878, 1885, slope dips 20° to 25° west, slope length (1885) 300 ft. exposed two coals: upper coal 5 to 7 ft., lower coal 6 ft., both are irregular in thickness; three parallel faults exposed (5 or 6 ft. displacement) each dipping 50° to 70° east, coals pinch to stringers at each fault, at base of slope a larger fault was encountered.

References: Wadleigh (1930), Shaler and Woodworth (1899), Roberts (1928), Russell (1892), Jones (1916), Eavenson (1942).

Old Dominion Pits — Goochland County

Location: Index no. 38, location not field checked: two miles due west of junction SR 635 and 711.

Historical notes: owned by Capt. Finney as Powhattan Pits 1820, 1835, later Old Dominion Pits. As Powhattan Pits: two shafts for hoisting and pumping, one 105 ft. deep the other 180 ft. deep, 680 ft. slope driven on coal at bottom of shafts. Slope dip 25° to 30° east. Three coals occur in shafts: upper, 4.5 ft. at outcrop to 12 ft. downdip; middle, 1.5 to 2.0 ft. at outcrop to 4 ft. in lower part of mine; lower, 3 ft. of inferior quality coal 4 ft. below middle seam. Mine had one slope in upper seam and a shorter in the middle seam.

References: Wadleigh (1930), Lucas (1933), Roberts (1928), Russell (1889), Jones (1917).

Clover Hill District

Moody and Johnson's Pits — Chesterfield County

Location: Index no. 29, at the junction of Winterpock Creek and Clover Hill Road, 3300 linear feet north of Winterpock.

Historical notes: first mention 1841, one 100 ft. shaft.

References: Wadliegh (1930), Eavenson (1942), Ritz (1975).

Brighthope Shafts — Chesterfield County

Location: Index no. 30, 1800 ft. southwest of junction SR 664 and 603 in Winterpock; 1000 ft. northwest of Tabernacle Church.

Historical notes: working 1844, gas explosion 1859, operated by Brighthope Railway Co. (formerly Clover Hill Railroad) in 1860 , 19,040 tons produced by 1860, two gas explosions 1867, 1873 mine on fire from boilers at bottom of shaft, 1886 Brighthope Company produced 28,000 net tons, 30,000 net tons in 1887; 1888 coal sold for $3.50/ton wholesale, $4.50/ton retail; three coals worked: upper main coal 5 ft., lower main coal 13 to 26 ft., lower coal 4 ft.; three local coals totaling 6 ft. above upper main coal.

References: Wadleigh (1930), Cox and Heinrich (1888), Roberts (1928), Schmitz (1895).

Beaver Slope — Chesterfield County

Location: Index no. 31, tentitive location at the pond 900 ft. east of Tabernacle Church and 1100 ft. south of Winterpock.

Historical notes: slope located on east side of Garrett "Trouble", part of Brighthope Railway Company.

References: Wadleigh (1930), Schmitz (1895).

Raccoon Slope — Chesterfield County

Location: Index no. 32, tentitive location on east side of SR 621, 1400 feet north of junction SR 621 and 602.

Historical notes: slope on east of Garrett "Trouble", part of Brighthope Railway Company, open 1862, gas explosion 1863, one coal worked (7 or 8 ft. thick), explosion 1879, mine closed 1884 over royalty dispute, also reported is a 20 ft. coal.

References: Wadliegh (1930), Shaler and Woodworth (1899), Roberts (1928), Ritz (1975), Schmitz (1895), Eavenson (1942).

Rudd Mine — Chesterfield County

Location: Index no. 33, tentitive location on east side of Winterpock Creek 1000 ft. east of Winterpock.

Historical notes: operational 1923, 1935 by A. A. Rudd, 100 to 200 tons annual production for home use.

References: Roberts (1928).

Green Hole Pits — Chesterfield County

Location: Index no. 26, location not field checked, 2000 linear feet southeast of junction US 60, SR 624.

Historical notes: one of earliest in Midlothian District, working 1790, 1840, 1842, one shaft 400 ft., located in an outlier basin (Union Basin).

References: Wadleigh (1930), Roberts (1928), Ritz (1975), Russell (1892), Eavenson (1942).

Creek Company Pits — Chesterfield County

Location: Index no. 27, location not field checked, along Falling Creek, 3000 linear feet north of junction pipeline and SR 624.

Historical notes: working 1835 and 1842; includes Agaze Shaft as a Creek Company mine; coal mined by this company reportedly a top 6 ft. bed separated by an undetermined thickness of shale from a 48 ft. coal (2 ft. total shale partings).

References: Wadleigh (1930), Cox and Heinrich (1888), Kimball (1866), Roberts (1928), Ritz (1975).

Stonehenge Pits — Chesterfield County

Location: Index no. 28, along pipeline 1000 ft. north of junction of pipeline and SR 624.

Historical notes: dug 1796 by Martin Riley closed 1832, reopened 1846 by John J. Werth & Co. working 1848.

References: Wadleigh (1930), Roberts (1928), Rilee (1975).

Sayre and Sutherland, Inc — Henrico County

Location: Index no. 1, at northeast quadrant of intersection of Gayton Road and Cambride Drive.

Notes: Both holes completed October 1973.

Hole No. B-1: total depth 64.5 ft.

0 to 0.8 ft.	- Soil
0.8 to 3.5 ft.	- Clay-light brown, silty
3.5 to 18 ft.	- Siltstone-greyish tan
18 to 29 ft.	- Siltstone-light grey, with shale stringers
29 to 52 ft.	- Shale and coal interbedded
52 to 64.5 ft.	- Siltstone, light grey, with thin sandstone beds

Hole No. B-2: total depth 63.8 ft.

0 to 0.3 ft.	- Soil
0.3 to 8 ft.	- Clay, brown and grey, sandy
8 to 14.5 ft.	- Siltstone, brown, with coal seams (bloom)
14.5 to 35.5 ft.	- Siltstone, light grey, with shale and trace coal
35.5 to 48.8 ft.	- Sandstone, medium and dark grey, fine grained, with shale laminations
48.8 to 62.6 ft.	- Unconsolidated coal and shale fragments, mine drift.
62.6 to 63.8 ft.	- Shale, black

Froehling and Robertson, Inc. Henrico County

Location: Index no. 2, at Tuckahoe Village West subdivision.

Notes: Hole No. 1, TD 106.3 ft.

0 to 9.5 ft.	- Fill
9.5 to 34.3 ft.	- Shale, dark grey to black
34.3 to 45.1 ft.	- Coal
45.1 to 50.6 ft.	- Arkose
50.6 to 53.2 ft.	- Coal, impure
53.2 to 77.8 ft.	- Arkose with thin coals
77.8 to 92.0 ft.	- Arkose
92.0 to 106.3 ft.	- Void

Hole No. 2: total depth 16.6 ft.

0 to 4 ft.	- Fill (coal, shale, silty clay cinders)
4 to 10 ft.	- Clay, brown silty
10 to 16.6 ft.	- Shale, dark grey, highly weathered

Hole no. 3: total depth 16.4 ft.

0 to 10.6 ft.	- Fill (coal, shale silty clay, cinders)
10.6 to 16.4 ft.	- Shale, dark grey, moderately weathered

Hole no. 4: total depth 15 ft.

0 to 4 ft.	- Fill (coal, shale, silty clay, cinders)
4 to 10 ft.	- Clay, brown silty
10 to 15 ft.	- Shale, dark grey, slightly weathered

Salisbury Drill Hole — Chesterfield County

Location: Index no. 3, tentitive location 500 ft. east of junction SR 902 and CR 1012.

Historical notes: drilled 1898, TD 2386 ft. in shale, 13.2 ft. coke at 2320 ft.

References: Wadleigh (1930), Jones (1916), Shaler and Woodworth (1899).

Richmond Syndicate — Chesterfield County

Southeast hole

Location: Index no. 4, 2000 feet south of dam on Falling Creek.

Log: TD 2337 ft., 19 ft. coal encountered at undetermined depth. Not drilled by Richmond Syndicate.

Richmond Syndicate

Hole No. 3
Location: Index no. 5, 1000 feet east of dam on Falling Creek.
Drillers Log:

SEA LEVEL DATUM	DEPTH OF HOLE	THICKNESS OF STRATA	CLASSIFICATION.
213.50	0.00		
[illegible].50	15.00	15'-0"	Clay, yellow.
1[illegible]3.50	20.00	7'-0"	Shale, black.
175.50	43.00	23'-0"	Shale, light.
145.50	75.00	32'-0"	Shale, dark.
141.50	77.00	2'-0"	Sandstone, gray, fine, lime stre
1[illegible]2.50	96.00	19'-0"	Shale, dark.
1[illegible]1.50	97.00	1'-0"	Sandstone, coarse, arkose.
113.50	100.00	3'-0"	Shale, gray, some sandstone.
104.50	114.00	14'-0"	Shale, dark.
102.00	116.00	2'-0"	Sandstone, gray, coarse.
[illegible]	119.00	3'-0"	Slate and shale, micaceous.
[illegible]3.50	130.00	11'-0"	Shale, dark, and slate.
73.50	140.00	10'-0"	Sandstone, gray, fine, some shal
76.50	142.00	2'-0"	Clay, shaley, some black.
74.50	144.00	2'-0"	Sandstone, gray, fine.
71.50	147.00	3'-0"	Sandstone, whitish, gray, coarse
65.[illegible]	153.00	6'-0"	Slate, black and gray, lime stre
[illegible]	154.67	1'-8"	Slate, black.
53.50	165.00	10'-4"	Sandstone, light, gray, fine and coarse, some shale.
43.50	175.00	10'-0"	Shale, gray, and slate mixed, lime streaks near bottom.
39.58	178.92	3'-11"	Slate, black, lime streaks.
35.08	183.42	4'-6"	Sandstone, gray, fine, slate stre
34.16	184.34	0'-11"	Slate, black, lime streaks,
32.16	186.34	2'-0"	Shale, gray, hard.
30.16	188.34		
20.00	198.50		
15.00	203.50		
11.00	207.50		
00.50	218.[illegible]		

[illegible]05.00
23.50

23.50
33.50
[illegible].00

88 25 75
88 25 75

DIAMOND DRILL HOLE No.3 (Continued.)

SEA LEVEL DATUM	DEPTH OF HOLE	THICKNESS OF STRATA	CLASSIFICATION.
86.75	305.25	1'-0"	Coke, some slate mixed in.
96.75	315.25	10'-0"	Shale, gray.
110.67	329.17	13'-11"	Sandstone, light gray, fine.
110.75	329.25	0'-1"	Coal seam, highly bituminous.
111.83	330.33	1'-1"	Shale,
112.50	331.00	0'-8"	Limestone.
120.00	338.50	7'-6"	Shale, gray, lime streaks, some sandstone streaks.
121.67	340.17	1'-8"	Coal, bituminous.
122.59	341.09	0'-11"	Slate and shale, black and gray.
125.25	343.75	2'-8"	Shale, gray, clayey.
131.00	349.50	5'-9"	Shale and slate, gray, small streak coal at top.
138.00	356.50	7'-0"	Shale, dark gray, some slate and bituminous, bands.
150.62	369.12	12'-7½"	Shale, gray.
151.96	370.46	1'-4"	Coal, bituminous.
156.33	374.83	3'-10½"	Shale, gray, hard.
159.50	384.00	9'-8"	Sandstone, gray, fine.
169.50	388.00	4'-0"	Shale, gray.
170.00	388.50	0'-6"	Clay.
175.50	394.00	5'-6"	Shale, gray.
183.50	402.00	8'-0"	Sandstone, gray, fine, black slate and some coarse sandstone mixed.
198.50	417.00	15'-0"	Sandstone, gray, coarse, carbonaceous streaks.
198.67	417.17	0'-2"	Shale, gray.
198.75	417.25	0'-1"	Coal, bitiminous.
201.42	419.92	2'-8"	Shale, gray, carbonaceous.
213.17	431.67	11'-9"	Sandstone, gray, fine, some shale.
214.92	433.42	1'-9"	Sandstone, whitish gray.
219.50	438.00	4'-7"	Shale, dark gray, some sandstone streaks, some slate streaks.
224.50	443.00	5'-0"	Shale, gray.
232.00	450.50	7'-6"	Sandstone, gray, fine.
233.67	452.17	1'-8"	Slate, bituminous.
234.17	452.67	0'-6"	Coal, bituminous.
237.67	456.17	3'-6"	Sandstone, gray, coarse, arkose.
239.17	457.67	1'-6"	Shale, gray.
241.17	459.67	2'-0"	Sandstone, whitish gray, coarse.
243.67	461.17	1'-6"	Shale, gray.
263.00	481.50	20'-4"	Shale, black, some sandstone streaks.
268.75	487.25	5'-9"	Arkose.

Granite.

Hole completed at 11:00 A.M. 5/21/30/

Richmond Syndicate

Hole no. 4
Location: Index no. 6, 1000 feet northeast of dam on Falling Creek.
Drillers Log:

SEA LEVEL DATUM	DEPTH OF HOLE	THICKNESS OF STRATA	CLASSIFICATION
258.98	0	0	Ground level.
248.48	10.5'	10'-6"	Red tough clay.
232.48	26.5'	15'-0"	Yellow shaly clay.
231.48	27.5'	1'-0"	Dark shale.
230.73	28.25'	0'-9"	Lt. gray, soft sand rock.
220.73	38.25'	10'-0"	Dk. gray fine clay.
214.73	44.25'	6'-0"	Yellow clay.
206.73	52.25'	8'-0"	Hard gray shale.
205.73	53.25'	1'-0"	Soft gray sand-rock
202.73	56.25'	3'-0"	Dk. gray hard shale
200.40	58.58'	2'-4"	Yellow clay.
199.57	59.41'	0'-10"	Light clay-hard.
195.98	63.00'	3'-7"	Soft gray sand-ston (micaceous.
195.48	63.50'	0'-6"	Yellow shaly clay.
186.98	72.00'	8'-6"	Coarse argillaceous sand-stone, buff colored.
177.98	81.00'	9'-0"	Dark gray shale.
173.48	85.50'	4'-6"	Dark loose shaly shale.
169.98	89.00'	3'-6"	Light gray sand-stone micaceous.
165.98	93.00'	6'-0"	Light gray shale.
148.98	110.00'	15'-0"	Gray shale.
146.98	112.00'	2'-0"	Light gray fine
138.98	120.'		
128.48	130		
125.23			
119.48			
119.98			
110.48			
10[illegible]	73.48	73.48	

(HOLE #4 CONTINUED)

SEA LEVEL DATUM	DEPTH OF HOLE	THICKNESS OF STRATA	CLASSIFICATION.
59.08	190.00'	13'-6"	Slate, black, hard bituminous, lime streaks.
55.08	205.00'	4'-0"	Shale, dark gray.
45.98	215.00'	10'-0"	Sandstone, gray, fine grained, some shale, lime streaks, some limonite
35.98	225.00'	10'-0"	Slate, black bituminous.
23.81	235.17'	12'-8"	Sandstone, gray slatey, some shale.
19.90	240.00'	4'-10"	Slate and shale, black bituminous.
15.40	245.50'	5'-6"	Shale, gray.
07.93	251.00'	4'-6"	Sandstone, gray, coarse.
05.65	258.35'	8'-4"	Slate, black, bituminous, marly lime-stone.
00.34	259.33'	6'-0"	Sandstone, coarse, hard, whitish, mic
05.02	264.00'	4'-0"	Slate, black, soft.
07.02	266.00'	2'-0"	Slate, black.
19.02	278.00'	12'-0"	Sandstone, coarse, arkose.
20.52	279.50'	1'-6"	Slate, black.
28.02	287.00'	7'-6"	Sandstone, arkose.
30.02	289.00'	2'-0"	Sandstone, arkose, carbonaceous.
44.02	303.00'	14'-0"	Slate, black, and gray shale.
47.52	306.50'	3'-6"	Sandstone, light gray, fine grained.
51.52	310.50'	4'-0"	Sandstone, whitish, gray coarse grained, micaceous.
53.02	312.00'	1'-6"	Slate, black, clayey.
56.02	315.00'	3'-0"	Sandstone, light gray, fine grained, micaceous.
57.02	316.00'	1'-0"	Clay, gray.
65.02	324.00'	8'-0"	Sandstone, gray, fine and coarse grained.
66.52	325.50'	1'-6"	Slate and clay, soft.
68.02	327.00'	1'-6"	Slate, black, lime streaked.
75.02	334.00'	7'-0"	Sandstone gray and shale.
75.58	334.50'	0'-6"	Shale, soft, clayey, black.
77.52	336.50'	2'-0"	Sandstone, gray, fine grained.
81.02	340.00'	3'-6"	Slate, black, lime streaks.
83.02	342.00'		
93.02	352.00		
98.02	357.00		
103.02	362		
112.02	371		
114.32			
118.62			
122.62			
129.02			
141.02			
150.02			

(HOLE #4 CONTINUED)

SEA LEVEL DATUM	DEPTH OF HOLE	THICKNESS OF STRATA	CLASSIFICATION.
214.52	478.50'	5'-6"	Slate, soft, lime streaks.
219.02	473.00'	4'-6"	Shale, gray, fine, lime streaks.
224.52	468.50'	5'-6"	Shale, clayey, soft, some slate.
224.60	468.67'	0'-2"	Coke.
230.19	463.17'	5'-6"	Slate, gray, in streaks ½" to 6" clay.
230.02	469.00'	0'-10"	Clay.
232.82	491.08'	2'-10"	Slate, black, sulphur streaks.
247.65	506.66'	14'-10"	1'-0" Coke 0'-5" Shale and clay. 1'-7" Sandstone, gray 1'-6" Shale and sandstone 3'-3" Sandstone, gray, fine 6'-0" Slate, dark much broken, some clay mixed in. 1'-8" Coke.
243.32	507.34'	0'-0"	Shale, slaty, black, soft.
257.02	516.00'	0'-6"	Clay, and sandstone in alternate layers.
258.02	517.00'	1'-0"	Clay.
265.02	524.00'	7'-0"	Clay and black slate mixed, broken 4' core missing.
286.52	545.50'	22'-6"	Arkose, coarse, whitish grey.
324.52	583.50'	38'-0"	Granite.

Hole stopped at 4 P. M. 5/6/22.
Core slipped and 7'-6" remains in hole. Probably not broken off. Took more than 4 hours to drill 7'-6"
18 days to drill. Av. of 32.4 per day.

Richmond Syndicate

Hole no. 5

Location: Index no. 7, east side of Salisbury Road 3800 linear feet south of junction SR 902 and 711.

Drillers Log:

SEA LEVEL DATUM	DEPTH OF HOLE	THICKNESS OF STRATA	CLASSIFICATION.
300.53	60.50	6'-0"	Red Clay.
261.53	70.60	30'-0"	Sand and Gravel.
226.53	40.00	5'-0"	Yellow Clay.
[illegible]	42.50	2'-6"	Quartz Boulders.
[illegible]	45.50	3'-0"	Sandstone, light gray.
[illegible]	61.00	15'-6"	Clay, stiff, gray, and shale.
[illegible]	64.00	3'-0"	Sandstone, light gray, micaceous.
[illegible]	64.50	0'-6"	Clay.
	69.37	5'-0"	Shale, dark.
	72.34	3'-0"	Sandstone, gray, coarse, micaceous.
	77.00	4'-8"	Shale, clayey, gray, soft.
[illegible]	78.00 >95.00	1'-0"	Sandstone, light gray.
197.03	103.50	25'-6"	Clay, hard, shaly, gray, some shale.
[illegible]	109.00	4'-6"	Sandstone, light gray.
190.03	111.00	5'-0"	Clay, hard, shaly, gray.
175.53	125.00	15'-0"	Sandstone, coarse, light gray.
171.03	129.50	3'-6"	Shale, hard, gray, strata highly pit
157.53	145.00	13'-6"	Sandstone, light gray, coarse, micac
[illegible]	148.00	3'-0"	Sandstone, whitish, gray, coarse, soft.
[illegible]	151.00	3'-0"	Sandstone, gray, fine, strata pitched.
[illegible]	155.25	4'-3"	Shale, gray, slatey, strata steeply pit
[illegible]	157.25	2'-0"	Sandstone, light gray, fine, 2" slate s
[illegible]	161.00	3'-9"	Shale, gray, lime streaks, strata pitche
[illegible]	162.00	1'-0"	Crevice.
[illegible]	165.00	3'-0"	Shale, gray, strata pitched.
[illegible]	181.00	16'-0"	Shale, slatey, dark, lime streaked,
[illegible]	203.00	22'-0"	Shale, gray and black, slatey.
[illegible]	226.00	20'-0"	Shale, gray, soft, black slate partings.
58.53	241.00	18'-0"	Sandstone, whitish gray, conglomerate
	252.00		
	250.00		
41.53	259.00		
34.03	266.50		
30.03	270.50		
[illegible]	275.25		
16.53	284.00		
09.53	291.00		
05.53	295.[illegible]		
00.53	30[illegible]		

....

20.47			
22.47			
40.97			
[illegible]			
[illegible]			
[illegible]			

DIAMOND DRILL HOLE No.5 (Continued.)

SEA LEVEL DATUM	LENGTH OF HOLE	THICKNESS OF STRATA	CLASSIFICATION.
137.47	438.00	15'-0"	Shale, gray, lime streaks.
140.22	440.75	10'-9"	Shale, gray.
143.34	452.67	3'-11"	Clay, mixed with small pieces sl
1163.01	464.17	11'-6"	Shale, gray, carbonaceous blotch lime blotches.
166.14	464.67	0'-6"	Clay seam.
171.47	472.00	7'-4"	Sandstone, gray, fine, some slat partings, lime streaks in sla
174.14	474.67	2'-8"	Sandstone, whitish, coarse.
176.64	477.17	4'-5"	Slate, carbonaceous, in streaks, some shale mixed in.
186.47	487.00	7'-10"	Sandstone, gray, fine.

NOTE: Hole was stopped here on account of soft material from above elev. 101.5 filling up hole. Decided to ream hole but could not pull 4" pipe casing, so had to have special reamer made that would go inside same. This was done but had little success with this reamer. Received instructions from Punxsutawney to grout hole. Grouting was completed on 5/11/30. Drilling resumed at noon 5/14/30. Drill left old hole and started cutting new hole in soft strata. Got down to approximately elev. 0, or sea level when fine slate and bone would accumulate around rods above bit and start to tighten tools in hole. New driller and helper arrived this A.M. 5/20/30, and at conference it was decided to abandon hole and move far enough away to try and avoid soft strata.

Richmond Syndicate

Hole no. 7

Location: Index no. 8, southwest edge of large pond on Falling Creek.

Drillers Log:

		Feet	Inches	
47.88	294.16	2	4	
63.56	309.91	15	9	shale gray soft and hard and beds, white
65.23	311.58	1	8	sandstone white gray coarse
68.15	314.50	2	8	shale balck
69.65	316.00	1	6	sandstone gray coarse
80.98	327.33	11	4	shale gray
84.65	331.00	3	8	sandstone,gray, medium, mica
101.23	347.58	16	7	shale gray and red, mostly hard
114.56	360.92	13	4	sandstone, white gray, coarse
115.19	361.54		7½	shale gray, hard
115.77	362.12		7	coal, bituminous, bony
116.35	362.70		7	clay and slate mixed
127.65	374.00	11	3½	shale gray
172.40	418.75	44	9	shale, gray, some thin sandstone, some black shale
173.15	419.50		9	coal, bituminous
173.65	420.00		6	sandstone, dark gray coarse
227.90	474.25	54	3	shale, varigated, some hard, some soft and broken
242.32	488.67	14	5	light gray coarse
264.65	511.00	22	4	shale, dark and red, some black clayey
277.65	524.00	13	0	shale, mostly red, some gray
284.15	530.50	6	6	shale, light gray, hard
290.15	536.50	6	0	shale, black, broken, some gray
322.40	568.75	32	3	sandstone, light gray, coarse
327.15	573.50	4	9	shale dark gray, soft
335.65	582.00	8	6	shale, red
337.32	583.67	1	8	sandstone, gray, fine Dip 21° 15'

		Feet	Inches	
350.65	597.00	13	4	shale gray, thin gray sandstone, some soft clay
359.65	606.00	9	0	clay and black shale, soft, some pulverized
362.15	608.50	2	6	shale, gray, hard
390.07	636.40	27	6	sandstone gray, medium some coal streaks
442.15	688.50	52	1	shale, gray and black, some thin sandstones
475.40	721.75	33	3	sandstone, fine, gray, some gray shale, streaks and spots of coal
492.82	739.17	17	5	shale, gray, will
501.65	748.00	8	10	light gray, medium
502.98	749.33	1	4	shale, dark gray
509.63	755.58	6	3	sandstone, light gray
509.73	756.08		6	shale, light gray
511.65	750.00	1	11	sandstone, light
516.48	762.83	4	10	shale, gray
523.98	770.33	7	6	sandstone, light gray
533.31	779.67	9	4	shale, gray
537.65	784.00	4	4	shale, black
546.65	793.00	9	0	shale, gray
548.98	795.33	2	4	shale, very dark
551.65	798.00	2	8	shale, gray a sandstone streak
554.65	801.00	3	0	shale, dark gray, soft, clayey
562.65	809.00	8	0	shale, gray some black
564.65	811.00	2	0	shale, balck, broken
581.65	828.00	17	0	shale, gray
584.65	831.00	3	0	shale, light gray coarse
587.65	834.00	3	0	shale, gray
588.65	835.00	1	0	sandstone, light gray, coarse

		Feet	Inches	
600.15	846.50	11	6	shale, gray, some soft
617.65	864.00	17	6	sandstone, white gray, coarse
639.32	885.67	21	8	shale, gray, some sandstone streaks
648.65	895.00	9	4	sandstone, light gray, fine
675.15	921.50	26	6	shale, gray, some black, some sandstone streaks
681.40	927.75	6	3	sandstone, light gray, fine
719.40	965.75	38	0	shale, gray, some black and soft some thin sandstones
743.48	989.83	24	1	sandstone, light gray, fine
748.15	994.50	4	8	shale, gray and black, some pulverized
760.98	1007.33	12	10	shale, gray some black and pulverized, 1 clay seam
764.81	1011.17	3	10	sandstone, light and fine
946.15	1192.50	18	4	shale, gray, dark and black, some light gray sandstone up to 2 inches
951.50	1197.75	5	3	sandstone, light gray, coarse
955.15	1201.50	3	9	shale, gray
960.48	1206.83	5	4	sandstone, oil-heavy (1) <-= seepage
969.40	1215.75	8	11	sandstone, light gray, coarse
976.32	1222.67	6	11	sandstone, light gray, oil-bearing
984.65	1231.00	8	4	shale, gray and black
1017.65	1264.00	33	0	sandstone, light gray, oil-bearing - seepage
1022.15	1268.50	4	6	shale, gray
1023.48	1269.83	1	4	sandstone, gray, medium
1025.15	1271.50	1	8	shale, dark gray
1028.65	1275.00	3	6	sandstone, light gray, medium
1062.15	1308.50	33	6	shale, gray, white streaks, also sandstone streaks.

		Feet	Inches	
1068.15	1314.50	6	0	sandstone, white gray, coarse, shale splotches
1118.15	1364.50	50	0	shale gray and black
1124.82	1371.17	6	0	sandstone, dark gray oilbearing
1155.15	1401.50	30	4	shale, gray
1165.32	1411.67	10	2	sandstone, light gray, coarse, oil-bearing.
1220.15	1466.50	54	10	shale, dark gray, some black
1231.65	1478.00	11	6	sandstone, dark gray, coarse, 12 inches seeping oil
1234.40	1489.75	11	9	shale, gray, some black
1254.65	1501.00	11	3	sandstone, white gray, coarse
1302.65	1549.00	48	0	shale, gray and black
1305.65	1542.00	3	0	sandstone, dark gray
1353.15	1599.50	57	6	shale, gray and black
1358.15	1604.50	5	0	sandstone, white gray, coarse, oil-bearing - seepage
1360.48	1606.83	2	4	shale, gray, hard
1366.55	1613.00	6	2	sandstone, white gray, coarse, oil-bearing - seepage
1379.65	1626.00	13	0	shale, gray
1383.15	1629.50	3	6	sandstone, light gray, fine shale

Sea-level Datum	Depth from Surface	Thickness of Strata Feet	Inches	Classification
-1383.15	1629.50	11	0	Shale gray, some sections seeping oil
-1394.15	1640.50	1	6	Sandstone, light gray, fine.
-1395.65	1642.00	4	0	Shale, black and gray, broken
-1399.65	1646.00	8	9	Sandstone, whitish gray, coarse, oil seeping
-1408.40	1654.75	24	3	Shale, gray and dark, some sections sandstone.
-1432.65	1679.00	9	6	Sandstone, whitish gray, coarse
-1442.15	1688.50	3	0	Shale, dark gray
-1445.15	1691.50	4	6	Shale, sandy, black, pulverized when takne out
-1449.15	1696.00	27	0	Shale, gray and black some streaks of sandstone some white streaks
-1476.65	1723.00	6	0	Sandstone, oil seeping at places, some fine, some coarse
-1482.65	1729.00			Shale, much broken up.
-1522.15	1768.50 at this depth 8/4/30			

7 Hole

Richmond Syndicate

Hole no. 8

Location: Index no. 9, 2500 linear feet northeast of junction SR 902 and CR 1012.

Log: TD 1072 ft., no coal.

D. H. MOTT & SONS, INC.

MAIN OFFICE

HUNTINGTON, W. VA.

DIAMOND CORE DRILL HOLE RECORD

FOR Gray Lumber Company ADDRESS Waverly, Va. DATE 3-8- 19 78

ON NEAR Amelia COUNTY Chesterfield STATE Va.

HOLE NO. 1 (NX) EL. DRILLER James C. Beavers DRILL NO.

CLASSIFICATION	THICKNESS OF STRATA FEET	THICKNESS OF STRATA INS. THS.	DEPTH FROM SURFACE FEET	DEPTH FROM SURFACE INS. THS.
Crystalized Red Sandstone w/Pebbles	10	0	1265	9
Red Sandstone w/White Sandstone & Pebbles	40	3	1306	0
Crystalized Red Sandstone w/White Sandstone & Pebbles Mixed	24	9	1330	9
Crystalized Red Sandstone w/Red Shale	40	7	1371	4
Soft Red Sandstone w/Mud Mixed	11	5	1382	9
Crystalized Red Sandstone w/White Sandstone	8	10	1391	7
Hard Red Sandstone w/White Sandstone Mixed	99	0	1490	7
Hard Red Sandstone w/White Sandstone & Mud Mixed.	23	5	1514	0
Black Shale w/Green Streaks	21	0	1535	0
Black Shale (Roller Bit)	17	0	1552	0

TOTAL DEPTH: 1552 Feet & 0 Inches

STARTED 10-31- 19 77

COMPLETED 2-3- 19 78

kh

FORM 1

A and R Oil Company — Chesterfield County

Data uncomplete on these holes drilled in 1967.

Hole no. 1A, Martin
Location: Index no. 11, east side of Epps Falls Road, 5800 linear feet southwest of junction SR 621 and 602.
Log: TD 620 ft., no coal.

Hole no. 2A, Martin
Location: Index no. 12, east side of Epps Falls Road, 5000 linear feet southwest of junction SR 621 and 602.
Log: TD 520

Hole no. 1B, Martin
Location: Index no. 13, east side of Epps Fall Rd., 7200 linear feet southwest of junction SR 621 and 602.
Log: TD 520 ft, no coal.

Hole no. 2B, Martin
Location: Index no. 14, east side of Epps Falls Rd., 5600 linear feet southwest of junction SR 621 and 602.
Log: TD 482

Grey Lumber Company — Chesterfield County
Location: Index no. 10, 3100 linear feet southeast of junction SR 666 and US 360.
Drillers Log:

D. H. MOTT & SONS, INC.
MAIN OFFICE
HUNTINGTON, W. VA.

DIAMOND CORE DRILL HOLE RECORD

FOR Gray Lumber Company ADDRESS Waverly, Va. DATE 3-8- 1078

ON NEAR Amelia COUNTY Chesterfield STATE Va.

HOLE No. 1 (NX) EL. DRILLER James C. Beavers DRILL No.

CLASSIFICATION	THICKNESS OF STRATA FEET	INS. THS.	DEPTH FROM SURFACE FEET	INS. THS.
Overburden	136	10	136	10
Red Sandstone w/White, Gray & Red Pebbles	76	4	213	2
Gray Sandstone	8	0	221	2
Green & Red Sandstone w/White Pebbles	20	10	242	0
Red Fire Clay w/White Pebbles	33	7	275	7
Firm Red Sandstone w/White Streaks Mixed	47	3	322	10
White & Red Sandstone w/Pebbles	23	4	346	2
Red Clay w/White Clay Mixdd	15	0	361	2
White Sandstone w/Green & Gray Streaks	5	0	366	2
Soft Red Clay w/White & Green Mixed	9	0	375	2
Red & White Sandstone	44	10	420	0
White Sandstone w/Red Streaks	63	0	483	0
Red Fire Clay	2	6	485	6
White Sandstone w/Red Sandstone Mixed	6	8	492	2
Red Sandstone w/White Pebbles Mixed				
White Sandstone				
White Sandstone				
White Sandst				
White Sand				
Red Shale				
White &				
White				
Red				
Red				
Cry				
Hard				

2-

STARTED COMPLETED FORM 1

Annotated Reference to Coal in the Richmond Coal Field

G. P. Wilkes

Virginia Division of Mineral Resources

Abbreviations of Titles

AIME - American Institute of Mining Engineers
Am. Jour. Sci. - American Journal of Science
EMJ - Engineering and Mining Journal
Geol. Soc. Pa. - Geological Society of Pennsylvania
USBM - United States Bureau of Mines
USGS - United States Geological Survey
VDMR - Virginia Division of Mineral Resources
VGS - Virginia Geological Survey

Anonymous, "The Coal of Richmond (Virginia) Coal Field, Mined by the James River Coal Company", EMJ, vol. 18, 1874.

Anonymous, "Mine Failures, Up To and After 1865", Explains economic and mining failures at the following mines: Bright Hope, Raccoon, Clover Hill Mine (Cox), Sinking, Grove, Gayton, Coalbrook, Canal Shaft, Dover.

A & R Oil Co., "Geologic description of wells drilled in Chesterfield County, Virginia", 1979.

Ashburn, Albert, "USGS Mineral Resources for 1887, 1888", pp. 168-382.

Blandon, John, "Report on Mr. W. A. Blankenship's Farm, Chesterfield County, Virginia", Chesterfield C. H., June 15th, 1883. Generalized review of the Richmond Coal Field, discussion of Clover Hill Collieries which is located on the adjacent property of subject area.

Brown, A. and others, "Coal Resources of Virginia", USGS Circular 171, p. 35, 37-43, 1952. Historical growth and development of the Richmond Coal Field, production figures, map.

Bush, B. F., "Report on Coal Property, Old Dominion Development Co., Richmond, VA." January 8, 1911. Discussion of coals found within property boundaries, it's estimated tonnage, freight rates, mine production and expendatures.

Chesterfield County Courthouse, "Railey-Heth Coal Pits Lease" May 6th, 1811.

Clemson, T. G., "Analyses of Some of the Coal from the Richmond Mines", Geol. Soc. Pa., Trans., vol. 1, pt. 1, pp. 295-297, 1835.

Cornet, Bruce, "The Polynostratigraphy and Age of The Newark Supergroup"
The Pennsylvania State University, Dept. of Geosciences, Ph.d. thesis, November, 1977.

Corson, John J., III, "Richmond Turns to Coal Mining"
Manufacturers Record, August 7th, 1930.
Outlines earliest history of the coalfield (1704 and on) and continues, chronologically to cirra 1890's. Discusses briefly the Salisbury Corporation.

Cox, E. T. and O. J. Heinrich, "Prospectus of the Virginia Tidewater Coal Co. and Reports on the Property", Martin B. Brown, New York, January 1888.
Discussion concerning company's fiancial situation, mines on property, comparison in analyses to other coals, letters of recommendations and mining procedure, maps: location of company property (1"=3½ miles) and (1320'=1 in.).

Daddow, S. H., "Report on Basins in the Richmond Coal Field", 1875 (?).
Discussion of structural difficulties, especially at Carbon Hill, and mining methods used to compensate for structure. Cross-sections and Carbon Hill district map.

Daddow, Samuel, L. and Benjamin Bannan, "Coal, Iron, and Oil, etc.", Lippincott Co., Phila., pp. 47, 395-402, 1866.
Structure of basin, cross-sections, good description of the coal and various mines, production and cost figures, map.

Farraund, W. P., "The Virginia Mines Near Richmond and the James River", Pa. Senate Jour. vol. 2, pp. 567-568, 1833-1834.

Fontaine, William M., "Notes on the Mesozoic Strata of Virginia", Am. Jour. Sci., series 3, vol. 42, 1879.
General account of North American Triassic Basins.

Froehling and Robertson, Inc., "Logs of 4 Holes Drilled for Tuckahoe Village West", May and June 1971.

Gay, W. B., "The Richmond Coal Basin, Virginia", AIME, Trans. vol. 31, pp. 1011-1012, 1901.

Goodwin, B. K., "Geology of the Hylas and Midlothian Quadrangles, Virginia", VDMR, RI 23, pp. 32-37, 1970. Depositional history and structures in the basin, maps and cross-sections.

Heinrich, O.J., "The Midlothian Colliery, Virginia"
AIME, Trans., Vol.1, 1873.
Description of coal on the Midlothian property, types of mining systems used, main subject of working the Grove Shaft while parts were on fire, discussion of work in high-temperature situations, map of mine with discussion of various drifts used in corresponding conditions.

Henrich, O.J., "The Diamond Drill for Deep Boring Compaired to Other Systems of Boring."
AIME, Trans., Vol. 2, 1874.
Discussion of the engine and hoisting apparatus, derrick, bore-house, hoisting rope, diamond bit, accidents in boring, economic features.

Henrich, O. J., "Deep Borings with the Diamond Drill"
AIME, Trans, Vol. 3, 1875.
Observations on holes drilled on the Midlothian property with relation to hole mechanics and cost.

Heinrich, O.J., "What is the Best Method for Mining Thick Coal Seams?"
AIME, Trans., Vol. 2, 1875.
Choosing the best mining system based on size and pitch of seam, costs and comparison of seam, costs and comparison of various mining methods.

Heinrich, O.J., "An Account of an Explosion of Fire-damp at the Midlothian Colliery, Chesterfield, Virginia"
AIME, Trans., Vol. 5, 1876.
Description and plan of the Grove Shaft, borehole data, conditions and cause leading to the explosion, discussion of ventilation.

Heinrich, O.J., "The Mesozoic Formation in Virginia"
AIME, Trans, Vol. 6, 1878.
Geographic locations of the Petersburg, Taylorsville, Springfield, Richmond, Aguia, Farmville, Potomic, Barboursville, James River, Danville & Dan River deposits. Rock types, physical character of coals, structure, fossils, economics (coal, clay, oil shales, building

stone). Cross-sections: Richmond Basin, Piedmont region.

Heinrich, O. J., "Section of the Mesozoic Rocks in the "Richmond Belt at the Old Midlothian Coal Mine....".
AIME, Trans, Vol. 6, 1879.
Geologic section of the Midlothian Mine shaft.

Hotchkiss, Jedediah, "The Virginias - A Mining, Industrial and Scientific Journal"; vol. 1, 1880; vol. 2, 1881; vol. 4, 1883; vol. 6, 1885; Staunton, Virginia. Various articles and discussions by and about other author's reports in the Richmond Basin. Maps, cross-sections measured sections.

d'Invilliers: E.V., "Geological Report on the Coalbrook Slope Mine of the Richmond Coal Mining and Manufacturing Company, Henrico County, Virginia", December 1903.
Feasibility study of re-opening the mine, geographical position, geology & structure, geology of the coals in the Carbon Hill District.

d'Invilliers, E.V.,"Geological Report on the Midlothian Coal Property, (with Special Reference to the Grove Shaft)", Chesterfield County, Virginia. 1904
Outlines demand of coal, geology and structure of the basin, mining methods, coal analyses, cost evaluation, transportation.

Jones, Meriwether, "Coal Report on the Richmond Coal Basin", May, 1917.
Geographic position, general geology and structure, coal geology, engineering features of mining. Maps: Richmond Basin (3/8"=1 mile), Ideal Section of Richmond Coal Field, Plat of the Midlothian Property, Section across Stonehenge & Midlothian Properties, Cross Section of Grove Shaft, Coal Sections, Section at Carbon Hill.

Kimball, I.P., "The Richmond Coal Field Report", November 1866.
Geographic position, geologic position, structure, coal quality, listing of mines, mining problems, railroads.

Lawton, J., "Gayton Coal Mine Inspection Report", September 11, 1944.
Condition of the mine including: faults, water, coke seam, roof, floor and partings.

Lawton, J., "Report of Progress of Opening New Slope Next to Gayton Mine", August 10, 1942. Location of two slopes on either side of Old Gayton Mine, sections of coke seams, progress of mining.

Lawton, J., "Letter to Swartout for Purchase of Rails"
September 29, 1943.

Lemist, H. T. & C. F. Taylor, "Correspondance between Lamist and Taylor concerning Carbon Hill District", March 1921. Names of mines, history, water, labor, coals worked by individual mines, faults, tonnages.

Mathews, H. L., "Soils of Chesterfield County", January 1970. Soils maps of Chesterfield County.

Maurice, John F., "Letters to John Swartout", Sept. 23 & Oct 7, 1939. Concerns the possibility of reworking spoil piles, includes washability and ash analyses.

Miller, M.S., "Report on the Old Dominion Development Company Property, Lorraine, Virginia", May 2nd, 1913. Location of property and mineral interests, brief discussion of basin geology and coal & coke on property with tonnages in reserve, analyses and continuity of the seams.

Morrison, Andrew, "The City on the James - Richmond, Virginia" Geo. W. Englehardt (Pub), Richmond, VA., 1893. Coal dealers in Richmond.

Newell, F.H., "Memoranda Concerning The Old Workings of the Richmond Coal Mining & Mfg. Co." 1888. Discussion of several mines including: Trent, Sneads or Deep Shaft, Air, Brooks, Edge Hill, Turpin, Orchard or Twin, Breaker, Rail Road Shaft, Shelter Air Shaft, Eureka, Bowles Property (Saunders & Sycamore Shafts).

Richmond and Alleghany Railroad - contract to ship coal from the Richmond Coal Mining and Mfg. Co. Mine, May 3rd, 1887.

Richmond Coal Mining & Mfg. Co., Charter thereof, 1882. Reports of the property's position in the coal field, geology of the coals and economics by: J.T. Jones, H. F. Torrey, S. H. Daddow, W. T. Roberts, W. Robertson & Smith, J.I. Worth, and others.

Richmond Dispatch, "Natural Gas and Coal in Chesterfield County, Virginia", p. 3, Feb. 20, 1887.

Richmond Enquirer - Notes from January 1811 through December 1816 and January 1818 through November 1818." Articles mentioning the following mines: Heath, Bucks, Dover, Buck and Cunliffe, Creek, Union, Trabeau's, Deep Run, Powhattan, Midlothian Coal Mining Co., Salles', Barr (Deep Run area).

Richmond Syndicate - geologic logs, plats and sections of holes drilled in 1930 - 1931.

Rilee, Eugene T., Jr., "Draft Report of Abandoned Coal Mines in Henrico County", December 14th, 1977. Brief description of geology and mines located in the Gayton area. Includes location map.

Ritz, Michael C., "Coal Mining in Chesterfield County" Brief history of coal mining, locations of mines (with map), bibliography.

Roberts, J.K., "The Geology of the Virginia Triassic", VGS Bull. 29, pp. 94-116, 1928. Historical development, extent of the field,mining methods, structure of the coal beds, geologic sections, cross-sections, maps, production, analyses of coal, physical property of the coals, impurities, natural coke, mining machinery used.

Rodgers, W. B., "Report of Progress for the Virginia Geological Survey, 1839", Richmond, 1840.

Russell, I. C. "The Newark System", USGS Bulletin 85, 1892. Mining history, geological and commercial aspects of the basin. "The Newark System", Am. Geol., vol. 3, 1889.

Sayer & Sutherland, Inc., "Geotechnical Study, Tuckahoe Village, Henrico County, Virginia", December, 1977. Discussion of coal outcrops and mine locations in the Gayton area.

Sayre & Sutherland, Inc., "Soil Study, Phase I, Pine Street Baptist Church, Henrico County, Virginia" October 1973. Consultant report on feasibility of construction of church, considering the possibility of caving by underground mine workings. Description of two boreholes on property.

Schmitz, E. J., "The Structure of the Richmond Coal Basin", AIME Trans., vol. 24, pp. 397-408. Includes measured sections, maps and cross-sections.

Shaler, N.S. and J. B. Woodworth, "Geology of the Richmond Basin, Virginia", USGS 19th Annual Report, pp. 385-519, 1899. Excellent discussion of most aspects of the basin, illustrations, maps, cross-sections.

Silliman, B. and O. P. Hubbard, "Chemical Examination of Bituminous Coal from the Pits of the Mid Lothian (sic) Coal Mining Co.", Am. Jour. Sci. vol. 17, pp. 369-374, 1842.

Swartout, Jno. B., "A Compilation of Reports of the Richmond Coal Field", cirra 1930.
Discussion of stratigraphy, structure, coal and resources of the field. Authors cited include: W. D. Duke, J.S. Grasty, E.V.d'Invilliers, A.S. McCreath, F. R. Mason, E. O'Toole, C. H. Smith, T.M.R. Talcott, F. R. Wadliegh, Watson, J. W. Woolfolk, T. M. Worthham.

Tierney, Ed., "Letter to John Swartout", April 17th, 1942.
Briefly outlines why Tierney is closing the Gayton Mine and terms for selling equipment to Swartout.

Torrence, P. L., "Holes drilled along Springfield Road", August 1st, 1933.
General lithologic logs of three holes drilled.

Treadwell, H. A., "Preliminary Report on the Richmond Coal Basin" July, 1928.
Consultants report. Geographic location, coal quality, Gayton Mine discussion, geologic structure.

Tuomey, M., "Notice of the Appomattox Coal Pits", Farmers Register, vol. 10, no. 9, pp. 449-450, 1842. Authors' observations and recommendations for selected coal mines in the Appomattox River area of the basin.

U. S. B. M., "Analyses of Virginia Coals", Technical Paper 656, pp. 5, 18, 46-47, 52-53, 97 and 96, 1944.

Virginia Board of Public Works, Reports of,1867-1876.
Lists by year railroads shipments of coal and other freight.

Wadleigh, F. R., "The Story of the Richmond, Virginia, Coal Basin", open file report in library of VDMR, 113 p. cirra post-1930. Excellent in detail covering social, historical, economic and geological aspects relating to the coal in the basin. Complete bibliography.

Watson, T. L., "Mineral Resources of Virginia", J. P. Bell Co., Lynchburg, VA., pp. 339-347, 1907. Extent of basin, historical development, general geology, discussion of the coals with analyses, mines, map.

Woodworth,J.B., "The Atlantic Coast Triassic Coal Field", USGS 22nd Annual Report, pp. 31-42, 1902.

Woodworth, J. B., "The History and Conditions of Mining in the Richmond Coal-Basin, Virginia", AIME, Tech. Pub., vol. 31, pp. 477-484, 1902. Geology and some history, map, cross-sections.

Woolfolk, J. W., "Inspection of Richmond Coal Field", May 22, 1901.
Concerns basin north of the James River. List of tracts with acreage in coal area, discussion of the individual beds (includes "Coke Vein"), Gayton, Saunders and Coalbrook operational discussion, costs of mining, transportation, improvements, analyses.

Worthham, T. M., "The Richmond (VA.) Coal Basin"
March 10th, 1916.
Information from Watson, Grasty and others concerning general conditions and reserves in the coal areas. Includes letters of recommendation from railroads.

Bibliography Additions
(December 1979)

Clifford, William, "The Richmond Coal Fields, Virginia", Manchester Geol. Soc., V 19, 1887 and V 20, 1889.

Coryell, Martin, "The East Virginia Coal Field", Trans., AIME, V 3, 1875.

Froeling and Robertson, Inc., "Tuckahoe Village West Project", Richmond, VA., 1971.

Johnson, S. S., "Gravity Map of Virginia - Simple Bouguer Anomaly, 1:50,000," VDMR, 1977.

Johnson, S. S., "Bouguer Gravity, Northeastern Virginia and Eastern Shore Peninsula", VDMR RI 32, 1973.

Johnson, W. R., "Report of Experiments on the Evaporative Power and Other Properties of Coals Made Under the Authority of the Navy Department of the U. S.", 1844.

Sayre and Sutherland, Inc. "Pine Street Baptist Church West Project, Henrico County, Virginia", Richmond, VA. 1973.

Taylor, R. C., "Statistics of Coal", Geol. Soc. of Pa., Trans., V 1, 1835, pp. 275-297.

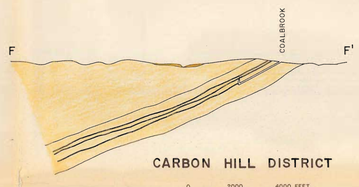
USBM, "Explosions in Virginia Coal Mines, 1839 to 1933", USBM IC 6166, 1934.

Woolridge, A. C., "Geological and Statical Notes of the Coal Mines in the Vicinity of Richmond, VA.", Am. Jour. Sci., V 43, 1842.

DISTRICT SECTIONS

DEEP RUN BASIN
(Sholer & Woodworth, 1898)

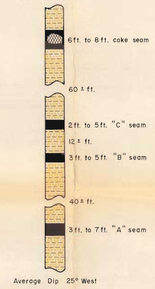
0 400 800 FEET



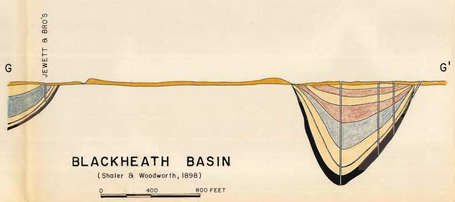
CARBON HILL DISTRICT

0 2000 4000 FEET

CARBON HILL
(Woodfolk, 1901)

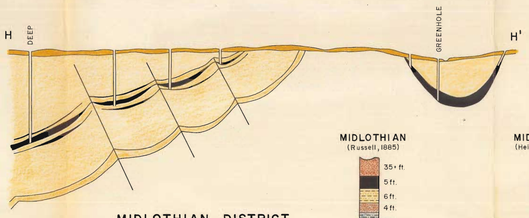


Average Dip 25° West



BLACKHEATH BASIN
(Sholer & Woodworth, 1898)

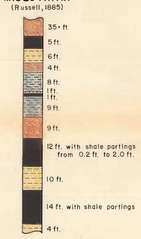
0 400 800 FEET



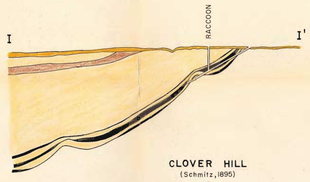
MIDLOTHIAN DISTRICT
(Sholer & Woodworth, 1898)

0 400 800 FEET

MIDLOTHIAN
(Russell, 1885)



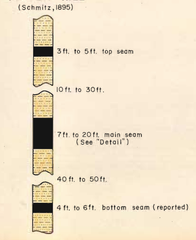
MIDLOTHIAN
(Heinrich, 1878)



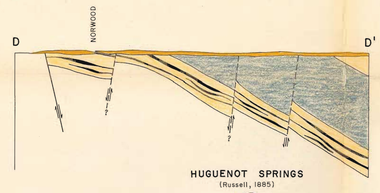
CLOVER HILL DISTRICT
(Sholer & Woodworth, 1898)

0 400 800 FEET

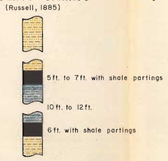
CLOVER HILL
(Schmitz, 1895)



CLOVER HILL "Detail"
(Schmitz, 1895)



HUGUENOT SPRINGS
(Russell, 1885)



HUGUENOT SPRINGS DISTRICT
(Goodwin, 1970)

0 1000 2000 FEET

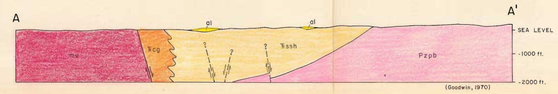
EXPLANATION—DISTRICT SECTIONS

- TERTIARY GRAVEL
- INTERBEDDED SANDSTONE AND SHALE
- SANDSTONE
- ARKOSE
- SHALE
- COAL
- BONE
- COKE

EXPLANATION—REGIONAL SECTIONS

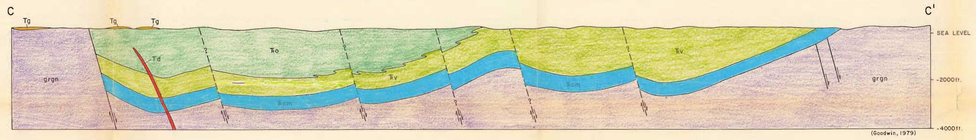
- al — ALLUVIUM
- Tg — TERTIARY GRAVELS
- Tos — OTTERDALE SANDSTONE
- Tv — VINITA BEDS
- Tssh — SHALE FACIES OF THE VINITA BEDS
- Tssh — INTERBEDDED SANDSTONE AND SHALE
- Pcm — COAL MEASURES
- Pcv — COARSE BOULDER BRECCIA (CONGLOMERATE)
- grgn — GRANITE GNEISS
- Pzpb — PETERSBURG GRANITE
- Pzmv — METAVOLCANIC ROCKS
- Pzd — DIKE

REGIONAL SECTIONS



(Goodwin, 1970)

(Goodwin, 1970)



(Goodwin, 1979)

0 2000 4000 6000 FEET

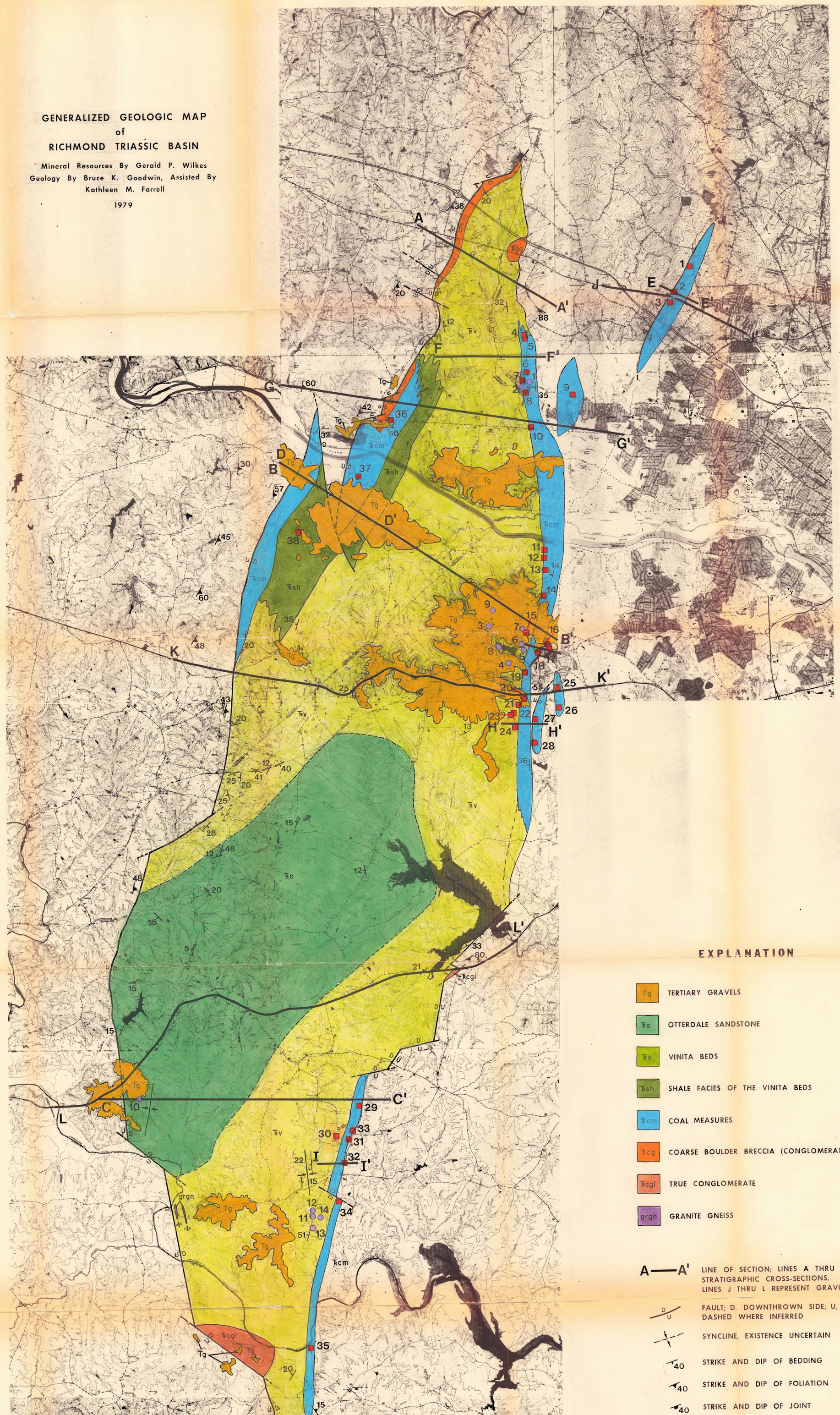
No vertical exaggeration

Drafting by Peterson & Chevalier

GENERALIZED GEOLOGIC MAP
of
RICHMOND TRIASSIC BASIN

Mineral Resources By Gerald P. Wilkes
Geology By Bruce K. Goodwin, Assisted By
Kathleen M. Farrell

1979



MINES

DEEP RUN BASIN

1 TOWNE AND POWELL
2 BURTON
3 DEEP RUN

CARBON HILL DISTRICT

4 MAGGIE
5 SAUNDER
6 DEEP SHAFT
7 GAYTON
8 COALBROOK (OLD DOMINION DEVELOPMENT CO. NO. 1)
9 EDGE HILL
10 WOODWARD AND COTTRELL

MIDLOTHIAN DISTRICT

11 12 TRABUE
13 MAJOR CLARKE
14 SALLE
15 DICKENSON
16 BLACK HEATH
17 BUCK AND CUNLIFFE
18 GOWRIE
19 ETNA
20 HANCOCK AND WOODROW
21 RISE AND ONE EYE
22 PUMP
23 SINKING
24 GROVE, AND MURPHY
25 UNION
26 GREEN HOLE
27 CREEK CO.
28 STONEHENGE

CLOVER HILL DISTRICT

29 MODY, AND JOHNSON
30 BRIGHTHOPE
31 BEAVER
32 RACCOON
33 RUDD
34 ROWLETT
35 PRINCE GEORGE COUNTY RECORDS MENTION PITS HERE 1835

HUGUENOT SPRINGS DISTRICT

36 DOVER
37 NORWOOD
38 OLD DOMINION

DRILL HOLES

1 SAYRE AND SUTHERLAND, INC., TWO HOLES
2 FROEHLING AND ROBERTSON, INC., FOUR HOLES
3 SALISBURY HOLE

RICHMOND SYNDICATE HOLES

4 SOUTHEAST DRILL HOLE
5 NO. 3
6 NO. 4
7 NO. 5
8 NO. 7
9 NO. 8
10 GREY LUMBER CO.

A AND R OIL CO.

11 HOLE 1A
12 HOLE 2A
13 HOLE 1B
14 HOLE 2B

EXPLANATION

- Tg — TERTIARY GRAVELS
- Tro — OTTERDALE SANDSTONE
- Trv — VINITA BEDS
- Trsh — SHALE FACIES OF THE VINITA BEDS
- Trcm — COAL MEASURES
- Trcg — COARSE BOULDER BRECCIA (CONGLOMERATE)
- Trcgl — TRUE CONGLOMERATE
- grgn — GRANITE GNEISS

A——A' LINE OF SECTION; LINES A THRU I REPRESENT STRATIGRAPHIC CROSS-SECTIONS, LINES J THRU L REPRESENT GRAVITY SURVEYS

D/U FAULT; D, DOWNTHROWN SIDE; U, UPTHROWN SIDE; DASHED WHERE INFERRED

SYNCLINE, EXISTENCE UNCERTAIN

40 STRIKE AND DIP OF BEDDING

40 STRIKE AND DIP OF FOLIATION

40 STRIKE AND DIP OF JOINT

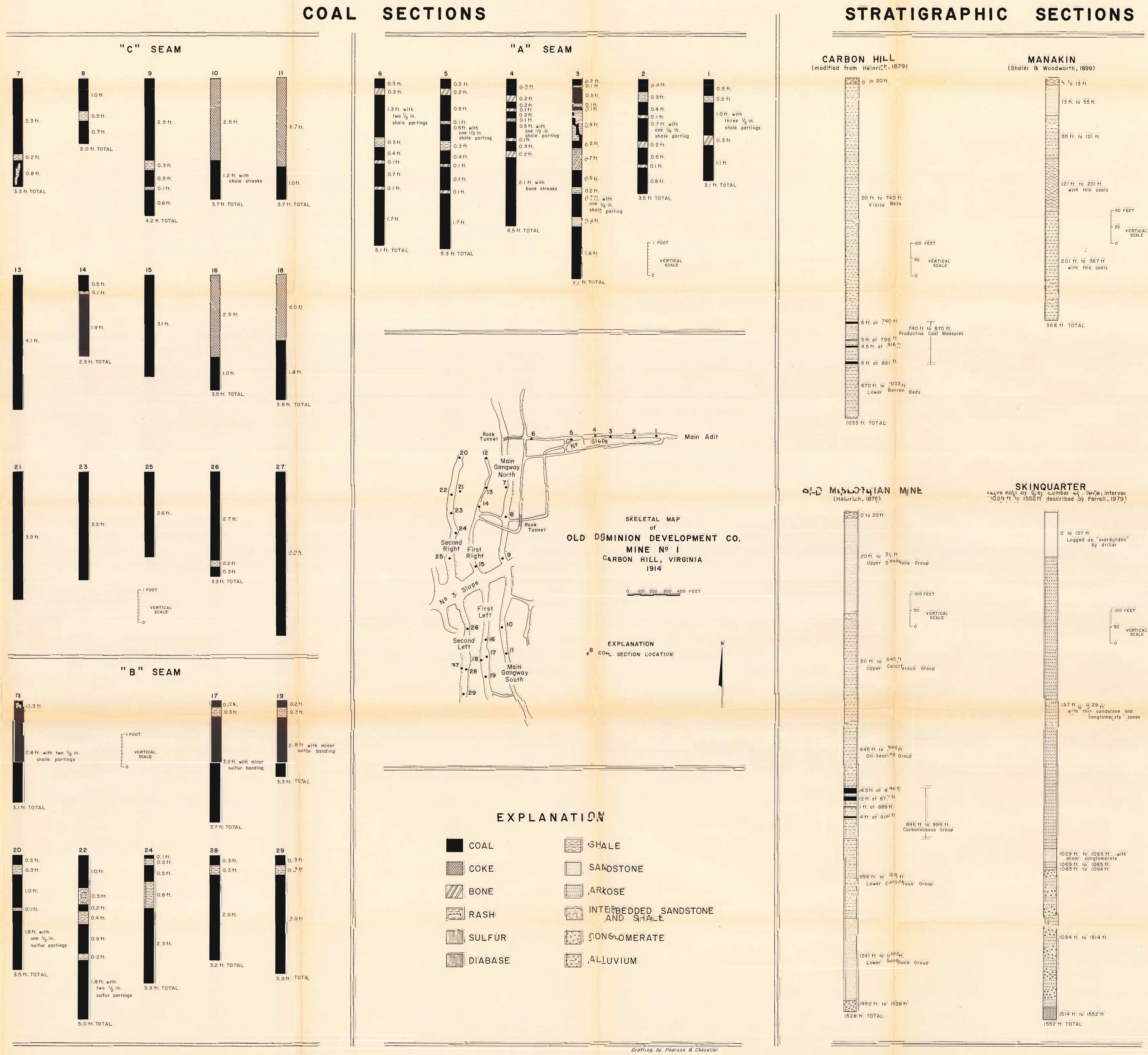
3 MINE LOCATION WITH INDEX NUMBER

3 DRILL HOLE LOCATION WITH INDEX NUMBER

SCALE 1:50000
0 2 MILES
0 2 KILOMETERS

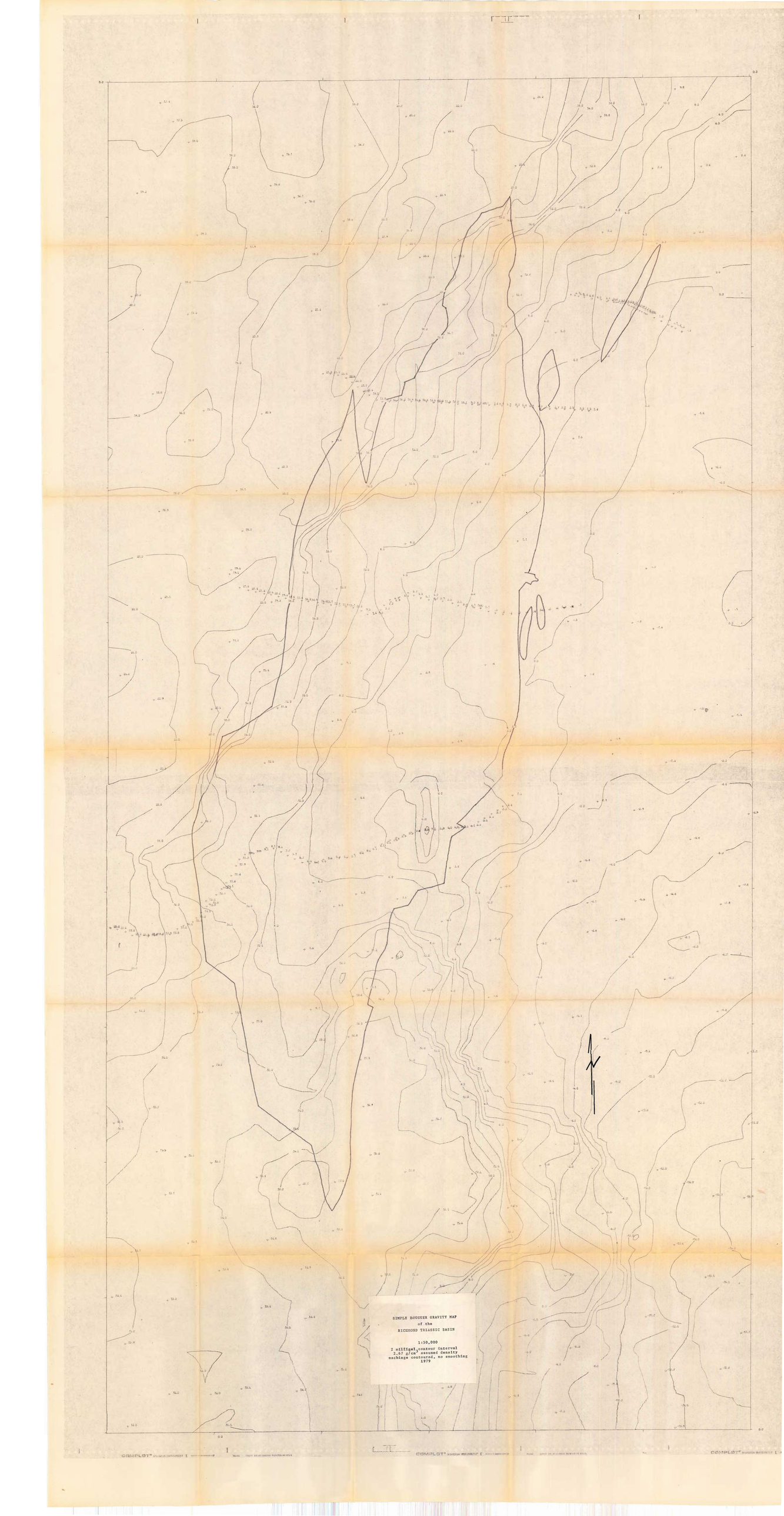
NORTH

Drafting by Pearson & Chevalier



COAL SECTIONS
"C" SEAM
"A" SEAM
"B" SEAM
SKELETAL MAP
of
OLD DOMINION DEVELOPMENT CO.
MINE Nº 1
CARBON HILL, VIRGINIA
1914
Main Adit
Rock Tunnel
Main Gangway North
Main Gangway South
First Right
Second Right
First Left
Second Left
EXPLANATION
COAL SECTION LOCATION
EXPLANATION
COAL
COKE
BONE
RASH
SULFUR
DIABASE
SHALE
SANDSTONE
ARKOSE
INTERBEDDED SANDSTONE AND SHALE
CONGLOMERATE
ALLUVIUM
STRATIGRAPHIC SECTIONS
CARBON HILL
MANAKIN
(Shaler & Woodworth, 1899)
OLD MIDLOTHIAN MINE
SKINQUARTER
1033 ft. TOTAL
368 ft. TOTAL
1528 ft. TOTAL
1552 ft. TOTAL
Drafting by Pearson & Chevalier


COMPOSITE AEROMAGNETIC MAP
of the
RICHMOND TRIASSIC BASIN
1:50,000
HANOVER CO.
HENRICO CO.
RICHMOND
POWHATAN CO.
CHESTERFIELD CO.
AMELIA CO.
DINWIDDIE CO.
Jordon Lake
FLOWN AND COMPILED BY
LOCKWOOD, KESSLER & BARTLETT, INC.
AIRBORNE GEOPHYSICS DIVISION
PASADENA, CALIFORNIA
SCALE
CONTOUR INTERVAL 20, 100, GAMMAS
TOTAL INTENSITY
AEROMAGNETIC CONTOUR MAP
PREPARED FOR
COMMONWEALTH OF VIRGINIA
DIVISION OF MINERAL RESOURCES
SURVEYED & COMPILED BY
geoterrex ltd
HOUSTON - TUCSON
FLOWN IN APRIL, 1972
TOTAL INTENSITY CONTOUR VALUE = OBSERVED
GEOTERREX PROJECT No. 82-94
Midlothian
Winterpock
Dinwiddie
SCALE
CONTOUR INTERVAL 10 GAMMAS
TOTAL INTENSITY
AEROMAGNETIC CONTOUR MAP
PREPARED FOR
UNITED STATES GEOLOGICAL SURVEY


SIMPLE BOUGUER GRAVITY MAP
of the
RICHMOND TRIASSIC BASIN
1:50,000
2 milligal contour interval
2.67 g/cm³ assumed density
machinge contoured, no smoothing
1979

GEOLOGIC MAP
of the
VALLEY COAL FIELDS

by
M. J. Bartholomew
1979

1 : 250000

N

Surface exposures and mined out areas
Coal measures of probable depths of less than 3000 ft.
Coal measures of probable depths of 3000 to 5000 ft.
Price formation west of pinch-out of coal measures
Area in which 3 to 7 coal seams are present locally
Facies change

Shale facies
Sandstone facies
Ft. Lewis Mtn. Area
Pulaski Block
(Brushy Mtn. Field)
(Little Walker Mtn. Field)
(Price Mtn. Field)
(Pulaski Field)
(Max Meadows Field)
Price Mountain Area
Saltville Block
Tract Mountain Area
Saltville Block
(Reed Creek Field)
Copper Creek / Narrows Block (Bland Field)

COMMONWEALTH of VIRGINIA

DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT

DIVISION OF MINERAL RESOURCES
NATURAL RESOURCES BUILDING
McCORMICK ROAD
BOX 3667, CHARLOTTESVILLE, VA. 22903
(804) 293-5121
ROBERT C. MILICI, COMMISSIONER AND STATE GEOLOGIST

December 28, 1979

Dr. J. Richard Lucas
Dept. of Mining and Minerals Engineering
213 Holden Hall
VPI & SU
Blacksburg, VA 24061

Dear Dick,

Enclosed are four copies of our compilation of the geology and coal resources of the Danville Basin, Farmville Basin, Southwest Virginia Coal Field and the Valley Coal Fields. Also enclosed, under separate cover, are four copies of the composite aeromagnetic map covering the Richmond Basin.

We plan to put this report in our library along with the Richmond Basin report. Please advise me if there are any restrictions concerning distribution of these reports at this time.

Sincerely,

Robert C. Milici /am

Robert C. Milici
Commissioner

RCM/am

Enc.

VIRGINIA DIVISION OF MINERAL RESOURCES
BOX 3667
CHARLOTTESVILLE, VIRGINIA

GEOLOGY AND COAL RESOURCES of the DANVILLE BASIN-FARMVILLE BASIN-SOUTHWEST VIRGINIA COAL FIELD-VALLEY COAL FIELDS

DECEMBER 1979

Performed under contract number 80-405-001
for the Department of Mining Engineering,
Virginia Polytechnic Institute and State
University.

Danville Triassic Basin

Selected Bibliography

Dribus, J. R., "Preliminary Study of the Uranium Potential the Dan River Triassic Basin System, North Carolina and Virginia", DOE, Bendix Field Engineering Corp., GJBX-131 (78), 26 p. and 1 microfiche plate, 1978.

Geddes, W. H., and Thayer, P. A., "Gravity Investigation of the Dan River Triassic Basin of North Carolina", in GSA Abstracts with Programs, Southeastern Section, 5th Annual Meeting, Vol. 3, No. 5, p. 312-313, 1971.

Geodata International, Inc., "Aerial Radiometric and Magnetic Survey of Central Appalachian Triassic Basin-Parts of Virginia and the Carolinas", Prepared as part of the aerial radiometric survey program for the U.S. Energy Research and Development Admin., Grand Junction Office, Contract No. AT(05-1) - 1644, Vol. 1, Vol. 2, and profiles, 1975.

Henika, W. S., "Geology of the Blairs, Mount Hermon, Danville, and Ringgold Quadrangles, Virginia", with sections on the Triassic System by Thayer, P. A., VDMR Pub. 2, 45 p., 1977.

Johnson, S. S., "Bouguer Gravity in Virginia, 36° 30' to 39° 30'N, 78° 00' to 79° 00 W", VDMR Rept. of Inv. 27, 40 p., 1971.

Johnson, S. S., "Bouguer Gravity in Virginia, 36° 30' to 38° 52' 30" N, 79° 00' to 80° 00' W", VDMR Rept. of Inv. 29, 38 p. 1972.

Jonas, Anna I., "Geology of the Kyanite Belt of Virginia", in Kyanite in Virginia, VDMR Bull. 38, p. 1-38, 1932.

Jones, P. L., and Ferguson, R. B., "Preliminary Basic Data Release, Greensboro 1° X 2° NTMS Area, North Carolina and Virginia", DOE, Savannah River Laboratory, GJBX-74 (78), 175 p., 6 oversize plates, and microfiche, (open file 1978).

LKB Resources, Inc., "NURE Aerial Gamma-Ray and Magnetic Reconnoissance Survey-Blue Ridge Area, Greensboro, Winston Salem and Johnson City Quadrangles, Greensboro NJ17-12 Quadrangle", Vol. II, Prepared for Dept. of Energy under contract to Bendix Field Engineering Corp., GJBX-16 (79), report and microfiche (1979).

LeGrand, H. E., "Geology and Ground-water Resources of Pittsylvania and Halifax Counties", VDMR Bull. 75, 86 p., 1960.

McKee, E. D., and others, "Paleotectonic Maps of the Triassic System", USGS Miscellaneous Geologic Investigations Map I-300, 1959.

Meyertons, C. T., "Triassic Formations of the Danville Basin", VDMR Rept. of Inv. 6, 65 p., 1963.

Meyertons, C. T., "The Geology of the Danville Triassic Basin of Virginia", Ph.D. Dissertation, Virginia Polytechnic Institute, Blacksburg, Va., 188 p., 1959.

Olson, P. E., Remington, C. L., Cornet, B., and Thomson, K. S., "Cyclic Change in Late Triassic Lacustrine Communities", Science, Vol. 201, No. 4357, p. 729-733. 1978.

Pickett, T. C., "Stratigraphy of the Dan River Triassic Basin in North Carolina", M. S. thesis, Univ. of North Carolina, Chapel Hill, N. C., 54 p., 1962.

Reinemund, J. A., "Geology of the Deep River Coal Field, North Carolina", USGS Prof. Paper 246, 159 p., 1955. (Brief reference to Danville Basin).

Roberts, J. K., "The Geology of the Virginia Triassic", VDMR Bull. 29, 205 p., 1928.

Rogers, W. B., "A Reprint of Annual Reports and Other Papers, on the Geology of the Virginias", D. Appleton and Company, New York, N. Y., p. 324-325, 1884.

Stone, R. W., "Coal on Dan River, North Carolina", in Contributions to Economic Geology (Short Papers and Preliminary Reports) 1910, Part II-Mineral Fuels, USGS Bull. 471, p. 137-169, 1912.

Stuckey, J. L., "North Carolina: Its Geology and Mineral Resources", North Carolina Department of Conservation and Development, Raleigh, N.C., pp. 133-141, 1965.

Thayer, P. A., Kirstein, D. S., and Ingram, R. L., "Stratigraphy, Sedimentology and Economic Geology of Dan River Basin, North Carolina", Carolina Geological Society Field Trip Guidebook, October 24-25, 1970, 44 p., 1970.

Thayer, P. A., "Stratigraphy and Geology of Dan River Triassic Basin, North Carolina", Southeastern Geology, Vol. 12, No. 1, 31 p., 1970.

U.S.G.S., "Aeromagnetic Map of the Danville Quadrangle, Pittsylvania County, Virginia, and Caswell County, North Carolina", USGS Geophysical Investigations Map GP-745, 1971.

Virginia Division of Mineral Resources, Aeromagnetic maps of the Appomattox, Brookneal, Chatham, Gladys, and Riceville Quadrangles, aeroradioactivity data also on Appomattox quadrangle, individual 15' quadrangles on open file at VDMR, scale 1:62,500, 1969, 1970.

Woodworth, J. B., "The Atlantic Coast Triassic Coal Field", in The Coal Fields of the United States, Twenty-second Annual Report of the United States Geological Survey, Part III, p. 49-53, 1902.

GEOLOGY AND COAL RESOURCES OF THE THE FARMVILLE TRIASSIC BASIN

G. P. Wilkes
Virginia Division of Mineral Resources

December 1979

Coal crops out along the eastern margin of the basin, about one mile north of Prince Edward Courthouse. The known areal extent of coal outcrop is limited to a 2.7 square mile area north of the Appomatox River. In a measured section near the center of this area coals are exposed within a 39 foot interval:

Measured Section of Triassic Rocks
in the Farmville Basin
Cumberland County, Virginia
G. P. Wilkes, 1977

In roadcut on SR 600, 0.2 mile north of the junction of SR 600 and 637. Measured south to north. Surface elevation 360 ft. (110 m). Strike: East-West, Dip: 12° S.

Feet	Meters	Description
1.7	0.52	Shale - blue-gray and red, plant fossils common, iron concretions.
0.9	0.27	Shale - gray, plant parts, grades to clay lower 0.2 ft. (0.06 m), joint strike N 75° W.
0.2	0.06	Shale - gray, with coal banding.
0.2	0.06	Coal - dull, soft.
0.7	0.21	Carbonaceous shale - iron stain and mica common.
0.3	0.09	Shale - dark gray, some carbonaceous matter, mica common.
4.5	1.37	Shale - light gray, buff and red, silty, mica, peat streaks in upper 2.4 ft. (0.73 m), plant parts.

Feet	Meters	Description
5.2	1.58	Sandstone - buff to light red, very fine grained, indurated but friable in places, mica common, iron staining, silty.
5.0	1.52	Shale - gray to light red, mica common, occasional carbonaceous zones 1/2 in. (1.27 cm).
0.5	0.15	Carbonaceous shale.
0.3	0.09	Shale - buff to medium grey.
0.8	0.25	Coal - dull, clean.
0.5	0.15	Carbonaceous shale.
0.7	0.21	Shale - dark gray, with carbonaceous zones, mica common.
0.5	0.15	Shale - light gray, mica common.
0.8	0.25	Sandstone - light gray, very fine grained, indurated, iron staining, mica common, joint strike N 84° W.
8.5	2.59	Shale - buff, light red and light, iron concretions, mica common, plant parts.
0.8	0.25	Carbonaceous shale.
0.6	0.18	Coal - dull, clean.
2.0	0.60	Carbonaceous shale.
4.0+	1.22+	Shale - buff, light red and light gray, mica common.
38.7	11.7	TOTAL SECTION

Core from a hole drilled three-quarters mile northwest of Farmville and five seams of coal in the a 54 foot interval:

Log Of Core Hole Located 3/4 Mile Northwest
of Farmville, Virginia
(from Roberts, 1928)
Approximate Elevation 325 ft. (99 m)

Feet	Meters	Description
2.0	0.6	Surface soil, clay and gravel
9.0	2.7	Sandstone
5.0	1.5	Slate - black
10.0	3.0	Sandstone
3.0	0.9	Slate - black
2.0	0.6	Sandstone - black, with lime streak
4.0	1.2	Slate - black
29.2	8.9	Slate
2.2	0.7	Coal
1.0	0.3	Slate
3.0	0.9	Shale - black, bituminous
3.5	1.1	Slate
1.0	0.3	Shale - black, sandy
14.5	4.4	Sandstone
1.1	0.3	Slate - black
2.5	0.8	Coal
0.6	0.2	Slate
2.2	0.7	Sandstone - argillaceous
2.0	0.6	Slate
2.0	0.6	Coal
1.0	0.3	Slate
2.5	0.8	Sandstone
0.6	0.2	Slate - black

Feet	Meters	Description
1.5	0.5	Coal
2.5	0.8	Slate - black, and sandstone
7.0	2.1	Conglomerate - sandy, gray
3.0	0.9	Slate - black
0.6	0.2	Coal
2.0	0.6	Shale - black, very soft
0.3	0.1	Slate - green, calcareous, hard
0.3	0.1	Slate - black
0.8	0.2	Slate - green, calcareous, hard
3.0	0.9	Slate - black

T. D. 124.9 feet or 38.1 meters

The continuity of the coal seams in the Basin is questionable due to the undulating structure and poor exposure. This is noted in the measured section where the strike is north-south, 30^{o} off the regional strike. The coals probably formed in a slow-moving deltaic environment, in which the variable coal-forming conditions resulted in (quick) pinching, swelling and termination. Post-depositional structural events further complicates the attitude of the coals.

Production from a house mine north of Farmville was mentioned in 1856. As with most new fields, the coal was used domestically by a few families. Mining was undoubtly primative due to lack of mining skills and relative limited quantity coal.

Serious speculation for coal mining began July 31st 1860. On this day John Dalby, president of the newly formed Piedmont Coal Company, leased land from Nancy Allen to exploit "mines of coal, or any other mineral or metal". Terms of the 12-month lease stipulated that PCC would supply all labor and capital. If production resulted, Nancy Allen would realize 1/3 of the total profit from coal sales.

The mine site was chosen just off the Buckingham Plank Road (State Route 600), a mile and a half west of Raines' Tavern. Evidently the owners of the operation had high hopes. A pumping and hoisting system was installed that would rival almost any operating in the South at that time. Transporation of coal was considered and a spur line from the nearby Tidewater and Western Railroad was constructed. This railroad, operating as a freight-hauler, ran "A main line of single track narrow gage...extending from Bermuda Hundred...to Farmville". At Bermuda Hundred, in Chesterfield County, the Farmville coal could be loaded into barges with coal mined from the Richmond area and sent to market.

A slope was dug and coal was produced from the mine starting in the 1860's. Problems soon emerged. The nature of the coal made mining difficult; the seams are thin and laterally variable. Structural problems in faulting, abrupt changes in attitude, and the presence of dikes made any mining plan impossible to follow. Reportedly, in the mine the coal rests against (faulted upward) basement. Water had to be continually pumped to keep the mine operational. The coal itself reportedly

has a high percentage of sulfur in the form of pyrite and much ash content. The coal was tested for metallurgical purposes and found to be poor; hard coke formed only under extremely high temperatures.

The quantity that could be mined and the quality of coal that was mined made the commercial market restrictive. Mine mouth price held at $2.50 per ton, which was competitive to the Richmond area coal. Transportation and cleaning costs, added to cost per ton, further restricted commercial development. Fortunately the mines were located in a populated area and sufficient coal was produced to supply homeowners with fuel.

During 1882 the Norfolk and Western Railway completed a line connecting the Pocahontas Coal Field in West Virginia with the major eastern marketing distribution points. The Pocahontas field has better mining availability. Even with transportation costs, these coals became competitive in the areas marketed by Richmond coal. By 1902 when the N & W completed a line into Wise County, Virginia, the demand for Richmond coal was further depressed by the great supply and, more importantly, demand for these "new" coals from the west.

Due to these circumstances and the marginal nature of the coal in the Farmville Basin the coal of the Piedmont mines never really gained a foothold in the market place. Last production from the Piedmont Mines was in the early 1890's. Some sources say that water in the mines became too much of a problem to keep the mine open. Others tell of poor quality coal or of

deteriorating mine condition. In hindsight, coal mining in the Farmville Basin was destined to a short and relatively unimportant life as geologic and historical evidence now indicates.

The Farmville area remained dormant from the closing of the mines in the 1890's until 1920's. At this time an undisclosed company dug several exploratory pits not more than 600 feet to the southwest of the Southernmost Piedmont Mine. The pits are on the present R. C. Dodl property. At least two small pits, 6' to 8' in diameter by 4' to 6' deep, and a larger pit 15' by 30' by 15' deep are located in the woods just northwest of the junction of SR 635 and 637. Carbonaceous shale is the major constituent of the spoil associated with the pits, and fist-size coal can be found in the spoil of the large pits.

Field investigations by the writer disclosed two areas that are assumed to be locations of the Piedmont Mines. The northernmost area is located about 4 miles north of Farmville on the property of Albry Jamison. At this site two shallow depressions within 10 feet of each other attest to the mines existence. A spoil pile of mostly carbonaceous shale is located nearby, an estimeated 60% of original spoil has been removed from the site sometime after mining was completed. Property owners ajoining this tract say that the mine trace runs under the house on the hill 1/4 mile due south of the mine.

It is difficult to say if second adit (located about 1 1/2 miles to the south of the aforemention site) is another mine,

physically independent, or is actually another portal of the same mine. A woman in the mobile home on the property told the writer (1977) that she had heard of a man entering the mine and "coming out somewhere else". This site is similar to the northern site in relation to depressions and spoil. In this case, the depressions have been filled with dirt and tree stumps. The spoil appears to be complete and undisturbed, measuring roughly 20' by 50' by 20' high.

Another pit located in the field is on an abandoned farm on the north side of the Appomattox River, about 3/4 mile north of Farmville. It is a small pit behind an outbuilding which may have been the Smith's Shop. Pieces of coal can be picked out of a spoil pile located nearby.

Literature mentions Flournoy's coal pit located in the outlier basin south of Hampden Sydney but this has not been verified in the field. This was probably a small house mine and production was used for domestic purposes.

Reserve estimates for this basin were not computed by the USGS (Brown, et. al. 1952) due to the undulating character of the stratigraphy, the unknown extent, quality, thickness, and number of coals. Based on the limited quantity of data in the literature, a commercial operation (surface of underground mining) could not survive due to lack of resources. The presence of methane in the coal has been noted in the literature or the limited drill hole information available in the area.

In order to assess the resource potential, a program of subsurface exploration must be instituted. With several drill holes and a proportionate number of core holes, augmented by surface geologic mapping, the perameters to assess resources will be satisfied.

BIBLIOGRAPHY OF COAL
in the
FARMVILLE TRIASSIC BASIN

G. P. Wilkes
1979

Brown, A., H. L. Berryhill, D. A. Tayler, J. V. A. Trembull, "Coal Resources of Virginia", USGS Cir. 171, 1952.

Brown, W. R., "Geology of the Dillwyn Quadrangle", VDMR, RI 10, 1969.

Daddow, S. L. and B. Bannan, "Coal, Iron, and Oil, etc.", Lippincott Co., Phila., Pa., 1866.

Emmons, E., "American Geology" Part III, Albany, N. Y.

Fontaine, W. M., "Notes on the Mesozoic Strata of Virginia", Am. Jour. Sci., Ser. III, vol. 42, 1879.

Heinrich, O. J., "The Midlothian Colliery, Virginia", Am. Inst. Min. Eng. Trans. Vol. 6, 1873.

_____, "The Mesozoic formation in Virginia", AIME Trans., Vol. 6, 1879.

Hotchkiss, Jedediah (ed. and pub.), "The Virginias - A Mining, Industrial and Scientific Journal", Vol. 1, p. 121-122, 133, 143; 1880.

_____, "The Virginias - A Mining, Industrial and Scientific Journal", Vol. 6, p. 84; 1882.

Krynne, P. D., "The Origin of Red Beds ", N. Y. Acad. of Sci., Trans., Ser. 2, Vol. 11, 1949.

Lasch, D. K. and G. P. Wilkes, "The Farmville Triassic Basin: An Integrated Geological/Geophysical Study", VA Acad. Sci. - May, 1979.

Patton, J. H., "Natural Resources of the United States", New York and London; 1886.

Roberts, Joseph K., "The Geology of the Virginia Triassic", V. G. S. Bull. 29; 1928.

Rogers, W. B., "Reprint of Annual Reports and Other Papers on the Geology of the Virginias", New York, p. 315-330; 1884.

Russel, I. C., "The Newark System", U. S. G. S. Bull. 85; 1892.

Schrader, F. C., R. W. Stone, S. Stanford, "Useful Minerals of the United States", U. S. G. S. Bull. 624, 1917.

Shaler, Nathaniel S. and Jay B. Woodworth, "Geology of the Richmond Basin, Virginia", U. S. G. S. 19th Annual Report, Part II; 1897-1898.

Sweet, P. C., "Analyses of Clay, Shale, and Related Materials - Southern Counties", VDMR MRR 12, 1973.

Watson, Thomas L., "Mineral Resources of Virginia", 1907.

Woodworth, J. B., "The Atlantic Coast Triassic Coal Fields", U. S. G. S. 22nd Annual Report, Part III; 1900-1901.

ABBREVIATIONS

AIME	American Institute of Mining Engineers
USGS	United States Geological Survey
VDMR	Virginia Division of Mineral Resources
VGS	Virginia Geological Survey

GENERALIZED GEOLOGIC MAP
of the
FARMVILLE TRIASSIC BASIN

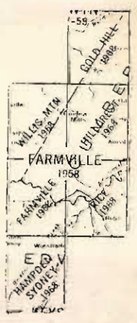
Virginia Division of Mineral Resources
December 1979

1:50,000

Explanation

- Triassic conglomerates, sandstones and shales
- Coal Measures
- Fault; D, Downthrown side; U, Upthrown side
- Mine or pit location

Generalized Location



Quadrangle Location

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

COMMONWEALTH OF VIRGINIA
DIVISION OF MINERAL RESOURCES
JAMES L. CALVER, STATE GEOLOGIST

HAMPDEN SYDNEY QUADRANGLE
VIRGINIA—PRINCE EDWARD CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
NW/4 KEYSVILLE 15' QUADRANGLE

5358 IV SE (PROSPECT)
5358 IV SE (RICE)
5358 II NE (ABILENE)
5358 III NE (GREEN BAY)
5358 II SE (EUREKA)
5358 III SE (MEHERRIN)
5358 IV SW (FARMVILLE)
CHARLOTTE COURT HOUSE 13 MI.
FARMVILLE 4.9 MI.
KEYSVILLE 6 MI.
CLARKSVILLE 60 MI.

78°30' 22'000m E. 723 724 725 27'30" 726 FARMVILLE 4.9 MI. 728 729 25' 730 2 030 000 FEET 731 732 78°22'30"
37°15' 4125 000m N. 4124 4123 4122 4121 12'30" 4120 4119 4118 4117 4116 4115 4114 4113 290 000 FEET 37°07'30"

Kingsville
BM 492
Hampden Sydney
Sewage Disposal
WT
Cem
Seminary Cem
Hampden-Sydney College
Mercy Seat Ch
Worsham
Farmville Lake
Tanyard Branch
Buffalo Creek
Little Buffalo Creek
Dickinson Branch
Briery River
Redd Branch
Bush River
Cem
BM 462
BM 506
BM 574
BM 542
BM 522
BM 439
Redd Shop
New Mt Ch
Ford
Mingo Creek
Little Creek
Briery Creek
Laon Br
Mountain Creek
Goodes Branch
Bush Branch
Cumps Creek
McPleasant Ch
New Bethel Ch

U D
U D
Triassic Sediments
Piedmont Crystallines
Outlier Basin of the Farmville Triassic Basin

Mapped, edited, and published by the Geological Survey

Control by USGS and USC&GS

Topography by photogrammetric methods from aerial photographs taken 1967. Field checked 1968

Polyconic projection. 1927 North American datum
10,000-foot grid based on Virginia coordinate system, south zone
1000-meter Universal Transverse Mercator grid ticks, zone 17, shown in blue

Fine red dashed lines indicate selected fence and field lines where generally visible on aerial photographs. This information is unchecked

Map photoinspected 1974
No major culture or drainage changes observed

MN GN 5° 89 MILS 1°33' 28 MILS
UTM GRID AND 1968 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000
1 MILE 1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 KILOMETER 1 5 0
CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, RESTON, VIRGINIA 22092
AND VIRGINIA DIVISION OF MINERAL RESOURCES, CHARLOTTESVILLE, VIRGINIA 22903
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

VIRGINIA
QUADRANGLE LOCATION

ROAD CLASSIFICATION
Primary highway, all weather, hard surface
Secondary highway, all weather, hard surface
Light-duty road, all weather, improved surface
Unimproved road, fair or dry weather
U. S. Route
State Route

INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1976

HAMPDEN SYDNEY, VA.
NW/4 KEYSVILLE 15' QUADRANGLE
N3707.5—W7822.5/7.5

1968
PHOTOINSPECTED 1974
AMS 5358 III NW—SERIES V834

Department of Conservation and Economic Development
Division of Mineral Resources
Robert C. Milici, State Geologist
Charlottesville, Virginia

Summary Data for Coal Resources in Virginia

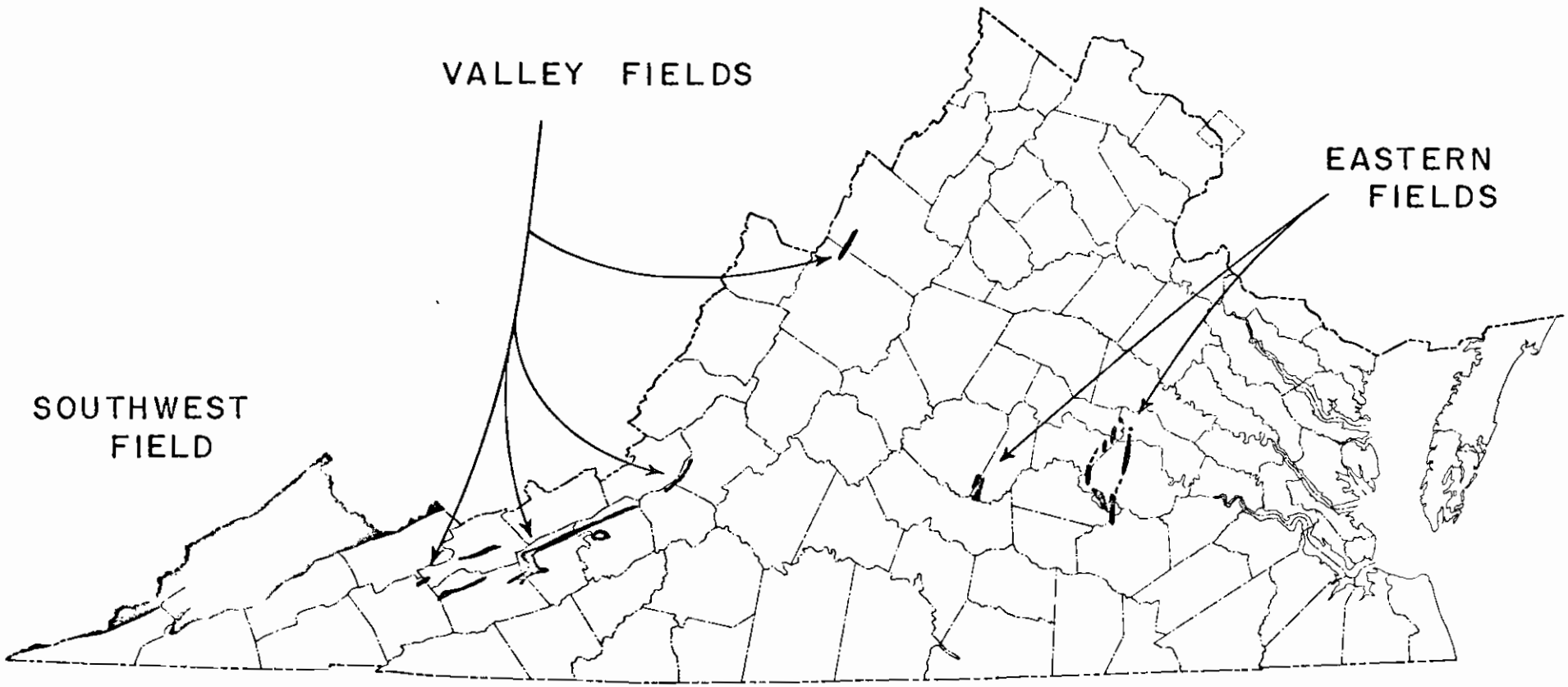
December 1979

Compiled by James A. Henderson, Jr.

Contents

INTRODUCTION

COAL RESOURCES OF VIRGINIA



Southwest Coal Field

The Southwest Virginia coal field contains over 96 percent of the total coal reserve base of the State. In this field approximately 1552 square miles (993,280 acres) are underlain by coal-bearing strata of Pennsylvanian age distributed approximately as follows:

County	Coal-bearing Area	
Buchanan	507 square miles	324,480 acres
Dickenson	332 square miles	212,480 acres
Lee	78 square miles	49,920 acres
Russell	84 square miles	53,760 acres
Tazewell	100 square miles	64,000 acres
Wise and Scott	451 square miles	288,640 acres

The coal in the Southwest Virginia field ranges chiefly from medium-volatile bituminous to high-volatile bituminous in rank. More than 50 named coal beds are present in this field. The first commercial mining began in 1883 and the field has been by far the most productive coal-producing area of the State. In 1973 a total of 33,869,387 tons were mined by tipple, strip, truck, and auger methods by a total of 729 mines. The deepest production is in Buchanan County at depths of over 1300 feet.

The U. S. Bureau of Mines estimates the Demonstrated Coal Base for underground mining of bituminous coal in this field as 2,833,000,000 short tons as of January 1, 1974, based on coal 28 inches or thicker to a depth of 1000 feet and representing 100 percent of the coal in place in the measured and indicated categories. The Virginia Department of Labor and Industry estimates the remaining reserves of bituminous coal in this field as 10,115,110,000 short tons as of January 1, 1974, based on coal 14 inches or thicker in the measured, indicated, and inferred categories. Strippable reserves of coal in the Southwest field have been estimated at 257,500,000 short tons, as of January 1, 1968, by the U. S. Bureau of Mines, based on a minimum coalbed thickness of 28 inches, a maximum overburden thickness of 120 feet, and an economic stripping ratio of 15:1 (feet to feet), and assumed to be all "available" coal that can be removed from the ground.

Valley Coal Fields

The Valley coal fields are located in parts of Augusta, Bland, Botetourt, Montgomery, Pulaski, Roanoke, Rockingham, Smyth and Wythe counties. The coal is chiefly semianthracite and has been produced in some of the fields from the Price Formation of Mississippian age. Most recent reported production was 1550 tons in 1970 and 36 tons in 1971 from Montgomery County.

1. North River field - in northern Augusta and Rockingham counties. No estimate of reserves is available.

2. North Mountain field - in northern Roanoke and southwestern Botetourt counties, a northeast extension of the Brushy Mountain field. No estimate of reserves is available.

3. Brushy Mountain field - about 2 miles south of and parallel to the northwestern boundary of and extending entirely across Montgomery County. Reserves reported in the following table.

4. Price Mountain field - an elliptical area, approximately 4 miles long and 1 mile wide, about 3 miles south of Blacksburg, Va., in Montgomery County. Reserves reported in the following table.

5. Little Walker Mountain field - a southwestward continuation of the Brushy Mountain field across the New River into the northern part of Pulaski County. Reserves reported in the following table.

6. Pulaski field - a small area near Pulaski, Virginia, in Pulaski County. Reserves reported in the following table.

7. Max Meadows field - an area about 6 miles long and less than 1 mile wide, north of the village of Max Meadows, Wythe County. Reserves reported in the following table.

8. Reed Creek field - in northern Wythe County. Reserves reported in the following table.

9. Bland field - about 20 miles long and 1-2 miles wide, extending across south-central Bland County. Impure, medium- to low-volatile bituminous coal that on an as-received basis, the average of 2 analyses shows 48.1% ash, 1.3% sulfur and 6,970 BTU. No estimate on reserves in this field.

10. Lick Creek field - an area about 10 miles long and 1 1/2 miles wide in western Bland County and northeastern Smyth County. No estimate of reserves in this field.

Reserves

County	Beds 28" to >42" [1]	Beds 14" to >42" [2]	Field [3]
Montgomery	72.76	89	Brushy Mountain
		43	Pilot Mountain
Pulaski	64.73	98	Little Walker Mountain
		44	Pulaski
Wythe	0	62	Max Meadows
		19	Reed Creek
TOTAL	137.49	355*	

*Includes 12 million tons production and mining losses from 1880's—1950.

[1] Measured and indicated reserves, in millions of tons, as of 1/1/74 and as reported in the U. S. Bureau of Mines Information Circular 8655.

[2] Indicated and inferred original reserves, in millions of tons, as reported in U. S. Geological Survey Circular 171.

[3] Note: Coal fields lie chiefly in the county indicated.

Definitions (From U.S.G.S. Circular 171)

Measured reserves - tonnage computed from dimensions revealed in outcrops, trenches, mine workings, and drill holes.

Indicated reserves - tonnage computed partly from specific measurements and partly from projection of visible data for a reasonable distance on geologic evidence.

Inferred reserves - reserves are those for which quantitative estimates are based on a broad knowledge of the character of the bed or region and for which there are few, if any, measurements.

The U. S. Bureau of Mines (IC 8655) has prepared a demonstrated coal reserve base of anthracite coal as of 1/1/74 at 137.5 million short tons including measured and indicated categories and based upon 28 inch and thicker coal to a maximum depth of 1000 feet and representing 100% of the coal in place.

Eastern Coal Fields

Richmond Basin - located about 8 miles west of Richmond, Virginia, the basin is about 33 miles long, north to south, with a maximum width of 9 miles, and covers about 150 square miles in parts of Amelia, Chesterfield, Goochland, Henrico and Powhatan counties. In the past, medium- to low-volatile bituminous coal has been produced from five areas: Manakin and Hugenot Springs in the northwestern section of the basin and Gayton and Coalbrook, Midlothian and Winterpock on the eastern edge of the basin. Some natural coke and semianthracite are present locally.

Production:

1748 - 1904	—	8.23 million tons
1910 - 1913	} —	small production
1921 - 1923		
1940 - 1941		

No estimate of coal reserves reported.

A computed average analysis of 47 bituminous coal analyses from the Richmond Basin, as reported in Virginia Geological Survey Bulletin 29, indicates 1.62% moisture, 28.98% volatile matter, 60.39% fixed carbon, 9.14% ash and 1.49% sulphur.

Farmville Basin - located about 30 miles west of the Richmond Basin, it is about 20 miles long, northeast to southwest with a miximum width of 5 miles and covers about 40 square miles in parts of Buckingham, Cumberland and Prince Edward counties. Some exploration for coal has been confined to a small area about 5 miles long at the eastern edge of the basin. No estimate of any coal reserves is reported.

Sources:

"Coal Resources of Virginia," U. S. Geological Survey Circular 171, 1952.

Annual Report of the Department of Labor and Industry for 1973.

"The Reserve Base of Bituminous Coal and Anthracite for Underground Mining in the Eastern United States," U. S. Bureau of Mines, Information Circular 8655, 1974.

"The Geology of the Virginia Triassic," Virginia Geological Survey Bulletin 29, 1928.

"Strippable Reserves of Bituminous Coal and Lignite in the United States," U. S. Bureau of Mines, Information Circular 8531, 1971.

PRODUCTION

Production in Southwest Coal Field by Bed During 1978

2 Name of Bed	Production: Millions of Short Tons	Percentage of Total Production
High Splint	0.23	0.72
Morris	0.37	1.15
Pardee	0.62	1.93
Wax	0.00	0.00
Gin Creek	0.00	0.00
Phillips	0.18	0.56
Low Splint	0.65	2.02
Taggart	1.31	4.08
Taggart Marker	0.46	1.43
Kirk	0.05	0.16
Harlan	0.20	0.62
Upper St. Charles	0.00	0.00
Lower St. Charles	0.15	0.47
Upper Standiford	0.05	0.16
Cedar Grove	0.24	0.75
Lower Cedar Grove	0.00	0.00
Pinhook	0.14	0.44
Kelly	0.92	2.87
Stone Creek	0.00	0.00
Imboden	1.54	4.80
Campbell Creek	0.12	0.37
Rocky Ford	0.00	0.00
Addington	0.00	0.00
Clintwood	1.93	6.01
Eagle	1.53	4.77
Blair	2.35	7.32
Lyons	0.63	1.96
Dorchester	2.31	7.20
Norton	0.50	1.56
Hagy	1.26	3.93
Splashdam	2.06	6.42
Upper Banner	1.54	4.80
Lower Banner	0.90	2.80
Big Fork	0.32	1.00
Caldwell	0.05	0.16
Kennedy	2.51	7.82
Aily	0.00	0.00
Raven	1.39	4.33
Jawbone	1.77	5.52
Tiller	1.20	3.74
Upper Seaboard	0.00	0.00
Greasy Creek	0.00	0.00
Middle Seaboard	0.07	0.22
Lower Seaboard	0,32	1.00
Upper Horsepen	0.22	0.68
Middle Horsepen	0.02	0.06
"C"	0.00	0.00
War Creek	0.00	0.00

Name of Bed	Production: Millions of Short Tons	Percentage of Total Production
Lower Horsepen	0.02	0.06
Pocahontas # 8	0.01	0.03
Pocahontas # 7	0.00	0.00
Pocahontas # 6	0.02	0.06
Pocahontas # 5	0.17	0.53
Pocahontas # 4	0.00	0.00
Pocahontas # 3	1.73	5.39
Cove Creek	0.02	0.06
Eagen	0.00	0.00
Carter	0.00	0.00
Tacus	0.00	0.00
Starnes	0.00	0.00
Burton's Ford	0.00	0.00
	32.09	

1. Calculated by subtracting coal reserves as of 1/1/79 from reserves as of 1/1/78 as reported in the 1977 and 1978 Annual Reports of the Virginia Department of Labor and Industry.

2. No attempt was made to correlate coal beds and names. Coal with the same name may not correlate from one area to another. e.g. The Raven coal of Wise County, according to USGS Circular 171, correlates to the Aily coal of Dickenson County.

Coals Mined in Buchanan County

Name of Bed	Production 1976 *	Production 1977 2*	Production 1978 3*	Production 1/1/79	Reserves as of 1/1/51
Cedar Grove	0.25	0.16	0.24	1.37	3.80
Lower Cedar Creek	0.00	0.00	0.00	0.82	2.27
Campbell Creek	0.16	0.09	0.12	48.49	49.75
Clintwood	0.52	0.42	0.30	62.17	92.78
Eagle	1.46	1.54	1.38	195.49	215.70
Blair	1.05	1.27	1.06	36.42	61.68
Dorchester	1.50	1.58	1.03	96.19	105.33
Hagy	1.61	1.50	1.23	267.69	303.77
Splashdam	1.60	1.97	1.46	653.02	708.50
Upper Banner	0.02	0.08	0.04	0.89	5.83
Lower Banner	0.11	0.24	0.06	280.32	286.43
Big Fork	0.00	0.00	0.00	9.46	9.53
Kennedy	2.12	1.96	2.26	734.15	771.95
Aily	0.04	0.00	0.00	42.25	42.29
Raven	1.50	1.45	1.06	512.37	575.69
Jawbone	0.80	1.53	1.00	327.69	336.93
Tiller	0.39	0.43	0.52	69.06	77.44
Lower Seaboard	0.09	0.01	0.00	7.55	7.65
War Creek	0.00	0.00	0.00	2.89	2.96
Pocahontas # 3	2.68	2.50	1.73	75.42	113.94
Total	15.9	16.73	13.49	3423.71	3774.22

* In million of short tons

1. Calculated by subtracting coal reserves as of 1/1/77 from reserves as of 1/1/76 as reported in the 1975 abd 1976 Annual Report of the Virginia Deptment of Labor and Industry (VDL&I).

2. Similar calculations as 1 using the 1976 and 1977 Annual Reports of the VDL&I.

3. Similar calculations as 1 using the 1977 and 1978 Annual Reports of the VDL&I.

4. Annual Report and supplement for the year 1978 from the VDL&I.

Coals Mined in Dickenson County

Name of Bed	Production 1976	Production 1977 2*	Production 1978 3*	Production 1/1/79	Reserves as of 1/1/51
Kelly	0.00	0.00	0.00	0.00	4.69
Imboden	0.00	0.09	0.02	2.47	4.38
Clintwood	0.62	0.47	0.41	66.62	79.04
Eagle	0.41	0.30	0.15	14.29	18.80
Blair	0.09	0.10	0.17	13.68	14.39
Lyons	0.00	0.05	0.04	8.84	9.04
Dorchester	0.03	0.07	0.16	92.77	94.42
Norton	0.05	0.02	0.00	1.25	1.51
Hagy	0.04	0.00	0.00	50.65	51.54
Splashdam	0.31	0.43	0.56	302.69	322.47
Upper Banner	1.82	1.59	1.17	290.67	325.43
Lower Banner	0.80	0.88	0.77	321.15	339.90
Kennedy	0.01	0.09	0.08	433.78	434.96
Aily	0.00	0.00	0.00	8.25	8.26
Raven	0.04	0.01	0.15	392.94	393.37
Jawbone	0.00	0.00	0.00	474.17	475.47
Tiller	1.08	0.61	0.31	5.47	94.45
Total	5.30	4.71	3.99	2479.69	2672.12

* In millions of short tons

1. Calculated by subtracting coal reserves as of 1/1/77 from reserves as of 1/1/76 as reported in the 1975 abd 1976 Annual Report of the Virginia Department of Labor and Industry (VDL&I).

2. Similar calculations as 1 using the 1976 and 1977 Annual Reports of the VDL&I.

3. Similar calculations as 1 using the 1977 and 1978 Annual Reports of the VDL&I.

4. Annual Report and supplement for the year 1978 from the VDL&I.

Coals Mined In Lee County

Name of Bed	Production 1976 1*	Production 1977 2*	Production 1978 3*	Remaining Reserves 1/1/79 4*	Reserves as of 1/1/51 4*
High Splint	0.01	0.01	0.00	0.00	0.84
Morris	0.02	0.00	0.03	2.55	2.77
Pardee	0.03	0.00	0.00	2.11	2.31
Wax	0.02	0.05	0.00	2.16	2.46
Gin Creek	0.02	0.00	0.00	1.59	1.63
Phillips	0.14	0.10	0.00	9.56	13.17
Low Splint	0.02	0.16	0.14	20.44	21.41
Taggart	0.22	0.31	0.31	39.42	46.59
Taggart Marker	0.01	0.00	0.00	28.57	32.89
Kirk	0.05	0.07	0.05	1.06	1.76
Harlan	0.29	0.26	0.20	112.18	117.67
Upper St. Charles	0.08	0.00	0.00	6.60	6.68
Lower St. Charles	0.24	0.12	0.15	32.51	33.63
Pinhook	0.00	0.00	0.00	9.13	9.13
Kelly	0.00	0.02	0.00	15.96	15.98
Stone Creek	0.00	0.00	0.00	0.63	0.63
Imboden	0.09	0.07	0.22	53.99	55.48
Clintwood	0.02	0.01	0.00	84.36	84.66
Blair	0.04	0.00	0.01	9.15	9.24
Lyons	0.00	0.00	0.00	5.73	5.77
Dorchester	0.00	0.04	0.02	1.71	2.01
TOTAL	1.30	1.22	1.13	439.41	466.71

* In millions of short tons

1. Calculated by subtracting coal reserves as of 1/1/77 from reserves as of 1/1/76 as reported in the 1975 and 1976 Annual Report of the Virginia Department of Labor and Industry (VDL&I).

2. Similar calculations as 1 using the 1976 and 1977 Annual Reports of the VDL&I.

3. Similar calculations as 1 using the 1977 and 1978 Annual Reports of the VDL&I.

4. Annual Report and supplement for the year 1978 from the VDL&I.

Coals Mined in Russell County

Name of Bed	Production 1976	Production 1977 2*	Production 1978 3*	Production 1/1/79	Reserves as of 1/1/51
Dorchester	0.00	0.08	0.00	0.00	0.08
Splashdam	0.01	0.00	0.02	8.21	8.58
Upper Banner	0.01	0.07	0.13	11.98	16.00
Lower Banner	0.13	0.05	0.02	42.22	45.87
Big Fork	0.15	0.29	0.32	3.57	4.80
Kennedy	0.18	0.12	0.15	125.66	128.09
Raven	0.01	0.03	0.08	97.08	98.84
Jawbone	0.66	0.51	0.32	241.82	249.47
Tiller	0.54	0.38	0.19	128.62	154.56
Burton's Ford	0.00	0.00	0.01	12.96	13.01
Total	1.69	1.53	1.24	672.12	719.30

* In millions of short tons.

1. Calculated by subtracting coal reserves as of 1/1/77 from reserves as of 1/1/76 as reported in the 1975 abd 1976 Annual Report of the Virginia Department of Labor and Industry (VDL&I).

2. Similar calculations as 1 using the 1976 and 1977 Annual Reports of the VDL&I.

3. Similar calculations as 1 using the 1977 and 1978 Annual Reports of the VDL&I.

4. Annual Report and supplement for the year 1978 from the VDL&I.

Coals Mined in Scott County

Name of Bed	Production 1976 1 *	Production 1977 2*	Production 1978 3*	Production 1/1/79 4*	Reserves as of 1/1/51
Jawbone	0.00	0.00	0.00	0.48	0.48
Cove Creek	0.00	0.00	0.02	2.29	2.46
Eagen	0.01	0.00	0.00	7.24	7.32
Carter	0.00	0.00	0.00	0.22	0.22
Tacus	0.00	0.00	0.00	7.09	7.09
Starnes	0.00	0.00	0.00	4.71	4.71
Burton's Ford	0.00	0.00	0.00	82.27	82.29
Total	0.01	0.00	0.02	104.30	104.57

* In millions of short tons

1. Calculated by subtracting coal reserves as of 1/1/77 from reserves as of 1/1/76 as reported in the 1975 abd 1976 Annual Report of the Virginia Department of Labor and Industry (VDL&I).

2. Similar calculations as 1 using the 1976 and 1977 Annual Reports of the VDL&I.

3. Similar calculations as 1 using the 1977 and 1978 Annual Reports of the VDL&I.

4. Annual Report and supplement for the year 1978 from the VDL&I.

Coals Mined in Tazewell County

Name of Bed	Production 1976 1*	Production 1977 2*	Production 1978 3*	Production 1/1/79 4*	Reserves as of 1/1/51
Lower Banner	0.00	0.00	0.00	0.32	0.34
Big Fork	0.00	0.00	0.00	0.99	0.99
Caldwell	0.00	0.00	0.05	4.82	4.87
Kennedy	0.08	0.03	0.00	8.78	9.24
Aily	0.00	0.00	0.00	1.90	1.90
Raven	0.17	0.13	0.02	30.31	33.40
Jawbone	0.01	0.13	0.03	72.34	73.74
Tiller	0.31	0.28	0.14	43.16	44.73
Upper Seaboard	0.00	0.00	0.00	34.62	35.52
Greasy Creek	0.00	0.00	0.00	12.86	12.86
Middle Seaboard	0.02	0.12	0.07	21.85	22.07
Lower Seaboard	1.03	0.70	0.32	68.97	74.38
Upper Horsepen	0.20	0.20	0.22	53.36	57.06
Middle Horsepen	1.41	0.10	0.02	30.70	32.86
"C"	0.00	0.00	0.00	18.00	18.11
War Creek	0.00	0.00	0.00	80.33	80.37
Lower Horsepen	0.00	0.08	0.02	21.02	21.40
Pocahontas #8	0.00	0.01	0.01	0.32	0.35
Pocahontas #7	0.00	0.00	0.00	7.02	7.11
Pocahontas #6	0.06	0.07	0.02	11.43	11.65
Pocahontas #5	0.23	0.20	0.17	41.45	42.20
Pocahontas #4	0.00	0.00	0.00	38.29	38.85
Pocahontas #3	0.07	0.12	0.00	83.70	84.36
Total	3.59	2.17	1.09	686.54	708.36

* In millions of short tons

1. Calculated by subtracting coal reserves as of 1/1/77 from reserves as of 1/1/76 as reported in the 1975 abd 1976 Annual Report of the Virginia Department of Labor and Industry (VDL&I).

2. Similar calculations as 1 using the 1976 and 1977 Annual Reports of the VDL&I.

3. Similar calculations as 1 using the 1977 and 1978 Annual Reports of the VDL&I.

4. Annual Report and supplement for the year 1978 from the VDL&I.

Coals Mined in Wise County

Name of Bed	Production 1976 1*	Production 1977 2*	Production 1978 3*	Production 1/1/79 4*	Reserves as of 1/1/51
High Splint	0.16	0.15	0.23	20.46	28.15
Morris	0.12	0.43	0.34	27.16	28.74
Pardee	0.74	0.53	0.62	65.68	74.19
Phillips	0.18	0.21	0.18	10.57	11.88
Low Splint	0.39	0.65	0.51	96.75	99.59
Taggart	1.47	1.04	1.00	84.31	121.29
Taggart Marker	0.34	0.47	0.46	79.26	85.79
Upper Standiford	0.03	0.05	0.05	65.19	70.34
Pinhook	0.02	0.06	0.14	3.65	3.87
Kelly	1.39	0.79	0.92	133.04	149.17
Imboden	1.89	1.43	1.30	145.61	186.33
Rocky Ford	0.00	0.00	0.00	0.24	0.24
Addington	0.00	0.01	0.00	4.29	4.36
Clintwood	1.23	0.88	1.22	153.12	167.39
Blair	0.78	0.92	1.11	149.70	157.02
Lyons	0.55	0.59	0.59	127.03	132.31
Dorchester	1.51	1.23	1.10	179.71	193.97
Norton	0.28	0.36	0.50	162.59	170.19
Hagy	0.00	0.01	0.03	8.95	9.08
Splashdam	0.00	0.02	0.02	8.68	11.36
Upper Banner	0.30	0.50	0.20	83.81	94.10
Lower Banner	0.08	0.08	0.05	113.55	116.78
Kennedy	0.04	0.02	0.02	112.41	112.85
Raven	0.11	0.11	0.08	129.90	130.71
Jawbone	0.63	0.44	0.42	150.22	157.40
Tiller	0.01	0.01	0.04	5.12	5.29
Cove Creek	0.00	0.00	0.00	0.19	0.19
Burton's Ford	0.00	0.00	0.00	8.34	8.42
Eagen	0.00	0.00	0.00	6.32	6.32
Starnes	0.01	0.00	0.00	2.70	2.71
Tacus	0.00	0.00	0.00	5.49	5.49
Total	12.26	10.99	11.13	2144.04	2345.60

* In millions of short tons

1. Calculated by subtracting coal reserves as of 1/1/77 from reserves as of 1/1/76 as reported in the 1975 abd 1976 Annual Report of the Virginia Department of Labor and Industry (VDL&I).

2. Similar calculations as 1 using the 1976 and 1977 Annual Reports of the VDL&I.

3. Similar calculations as 1 using the 1977 and 1978 Annual Reports of the VDL&I.

4. Annual Report and suplement for the year 1978 from the VDL&I.

Relative Importance of Strip - Mine Production in Virginia, 1969 - 1978

Year	Production All Methods (Short tons)*	Production Strip Mines (Short tons)*	Percent of Total Production by Strip Mines	Number of Strip Mines*	Average Production per Strip Mine (Short tons)
1978	32,004,341	9,783,537	30.6	279	35,066
1977	37,513,131	12,447,754	33.2	393	31,674
1976	39,995,546	12,959,491	32.4	399	32,480
1975	35,505,780	11,159,798	31.4	416	26,826
1974	34,283,753	10,048,467	29.3	355	28,306
1973	33,869,387	8,703,152	25.7	261	33,345
1972	33,995,841	8,296,742	24.4	267	31,074
1971	30,624,954	7,176,755	23.4	241	29,779
1970	34,974,724	5,103,462	14.6	181	28,196
1969	35,651,536	3,492,639	9.8	96	36,382

*Data from Annual Reports of the Department of Labor and Industry.

Relative Importance of Strip-Mine Production in Buchanan County, Virginia 1969-1978

Year	Production All Methods (short tons)*	Production Strip Mines (short tons)*	Percent of Total Production by Strip Mines	Number of Strip Mines*	Average Production per Strip Mine (short tons)
1978	13,461,962	1,890,609	14.0	69	27,400
1977	16,750,835	3,435,422	20.5	116	29,616
1976	15,803,507	3,761,864	23.8	100	37,619
1975	14,063,577	3,153,311	22.4	109	28,929
1974	14,292,618	3,007,781	21.0	102	29,488
1973	13,510,679	1,830,246	13.5	67	27,317
1972	13,223,862	1,357,502	10.3	66	20,586
1971	12,300,164	1,372,707	11.2	65	21,119
1970	14,814,524	1,170,968	7.9	60	19,516
1969	14,758,885	502,034	3.4	24	20,918

* Data from Annual Reports of the Department of Labor and Industry.

Relative Importance of Strip-Mine Production in Dickenson County, Virginia, 1969-1978

Year	Production All Methods (short tons)*	Production Strip Mines (short tons)*	Percent of Total Production by Strip Mines	Number of Strip Mines*	Average Production per Strip Mine (short tons)
1978	3,962,875	1,215,355	30.7	32	37,980
1977	4,727,524	1,461,289	30.9	50	29,226
1976	5,298,606	1,410,565	26.6	59	23,908
1975	5,372,040	1,224,873	22.8	53	23,111
1974	5,528,357	1,472,971	26.6	42	35,071
1973	4,796,005	902,374	18.8	33	27,345
1972	6,236,794	1,622,909	26.0	38	42,708
1971	5,634,167	1,322,448	23.5	39	33,909
1970	7,147,390	983,356	13.8	24	40,973
1969	7,953,282	872,490	11.0	15	58,166

*Data from annual Reports of the Department of Labor and Industry.

Relative Importance of Strip-Mine Production in Lee County, Virginia 1969 - 1978

Year	Production All Methods (short tons)*	Production Strip Mines (short tons)*	Percent of Total Production by Strip Mines	Number of Strip Mines	Average Production per Strip Mine (short tons)*
1978	1,003,848	302,069	30.1	16	18,879
1977	1,325,554	529,571	40.0	26	20,368
1976	1,300,172	562,716	43.3	26	21,643
1975	1,048,070	398,795	38.0	36	11,078
1974	966,287	195,485	20.2	17	11,499
1973	1,138,148	239,360	21.0	8	29,920
1972	1,045,300	226,930	21.7	15	15,129
1971	878,609	327,813	37.3	12	27,318
1970	1,126,983	322,215	28.6	12	26,851
1969	886,614	290,346	32.7	14	20,739

* Data from annual Reports of the Department of Labor and Industry.

Relative Importance of Strip-Mine Production in Russell County, Virginia, 1969 - 1978

Year	Production All Methods (short tons)*	Production Strip Mines (short tons)*	Percent of Total Production by Strip Mines	Number of Strip Mines*	Average Production per Strip Mine (short tons)
1978	1,225,673	491,265	40.1	17	28,898
1977	1,566,473	601,358	38.4	22	27,334
1976	1,708,030	421,997	24.7	21	20,095
1975	1,997,444	677,355	33.9	30	22,578
1974	1,823,389	451,462	24.7	19	23,761
1973	2,392,176	627,101	26.2	15	41,807
1972	2,636,094	787,566	29.9	11	71,597
1971	2,426,132	635,658	26.2	14	45,404
1970	2,311,473	265,567	11.5	9	29,507
1969	2,408,724	15,679	0.6	1	15,679

*Data from annual Reports of the Department of Labor and Industry.

Relative Importance of Strip-Mine Production in Scott County, Virginia, 1969 - 1978

Year	Production All Methods (short tons)*	Production Strip Mines (short tons)*	Percent of Total Production by Strip Mines	Number of Strip Mines	Average Production per Strip Mine (short tons)
1978	19,683	-------	0.0	---------	--------
1977	-------	-------	0.0	---------	----------
1976	12,685	8,825	69.6	1	8,825
1975	7,743	-----	0.0	-------	----------
1974	8,069	------	0.0	-------	----------
1973	8,678	1,800	20.7	1	1,800
1972	11,122	-----	0.0	---------	----------
1971	16,899	400	2.4	-------	---------
1970	11,113	1,800	16.2	1	1,800
1969	1,137	------	0.0	-------	----------

*Data from the Annual Reports of the Department of Labor and Industry.

Relative Importance of Strip-Mine Production in Tazewell County, Virginia 1969 - 1978

Year	Production All Methods (short tons)*	Production Strip Mines (short tons)*	Percent of Total Production by Strip Mines	Number of Strip Mines	Average Production per Strip Mines (short tons)
1978	1,111,529	182,688	16.4	6	30,448
1977	2,174,934	445,191	20.5	13	34,245
1976	3,582,656	296,680	8.3	10	29,668
1975	2,609,389	372,066	14.2	13	28,620
1974	1,839,389	329,916	17.9	9	36,657
1973	1,639,987	327,984	20.0	6	54,664
1972	1,794,876	457,827	25.5	13	35,217
1971	1,347,547	501,901	37.2	12	41,825
1970	1,115,252	328,331	29.4	10	32,833
1969	351,025	9,087	2.6	4	2,272

* Data from Annual Reports of the Department of Labor and Industry.

Relative Importance of Strip-Mine Production in Wise County, Virginia, 1968 - 1979

Year	Production All Methods (short tons)*	Production Strip Mines (short tons)*	Percent of Total Production by Strip Mines	Number of Strip Mines*	Average Production per strip mine (short tons)
1978	11,125,827	5,639,170	50.7	139	40,570
1977	10,967,811	5,974,919	54.5	166	35,993
1976	12,289,890	6,496,844	52.9	182	35,697
1975	10,407,517	5,333,397	51.2	175	30,476
1974	9,825,644	4,590,852	46.7	166	27,656
1973	10,383,714	4,774,287	46.0	131	36,445
1972	9,047,793	3,844,008	42.5	124	31,000
1971	8,021,400	3,015,828	37.6	99	30,463
1970	8,466,439	2,031,225	24.0	65	31,250
1969	9,289,369	1,803,003	19.4	38	47,447

* Data from the Annual Reports of the Department of Labor and Industry.

Summary of Permits Issued by the Division of Mined Land Reclamation in 1977*

County	Number of Permits	Total Acres	Average Acres per Permit	Average Pit Widths (feet)	Average Bench Widths (feet)	Average Height of Highwalls (feet)	Average Slope (Degree)	Average H p	Average Coal Thickness (inches)
Bland	2	4.5	2.25	5	40	-	25.0°	7.3	96
Buchanan	75	4407.1	58.8	102.4	126.2	54.4	27.8°	7.1	33.9
Dickenson	37	3016.9	81.5	155.6	197.2	56.2	25.2°	6.8	35.2
Lee	21	825.3	39.3	76.2	126.9	44.3	22.9°	6.5	37.1
Russell	14	806.5	57.6	94.7	188.4	78.0	27.5°	7.5	35.6
Scott	2	346.1	173.0	147.5	172.5	65.0	25.0°	7.0	40.7
Tazewell	12	382.2	31.8	76.5	139.4	55.0	27.3°	7.2	37.8
Wise	97	7265.0	74.9	158.2	273.9	59.4	21.6°	6.9	35.7
TOTAL	260 (1)	17,053.6							
STATE-WIDE AVERAGES			65.6	127.7	197.0	57.1 (2)	24.7°	6.9	34.6"

1
Includes 6 Prospecting Permits, 18 Underground Mines, 2 Refuse Piles, 1 Ventilation Fan Site, 2 Haul Roads, 3 Gas Wells

2
Total length of highwall: 1,610,672 ft. or 305 miles
Average length of highwall/permit: 6,195 ft.

* Grant T. Hollett-Division of Mined Land Reclamation, Big Stone Gap, Virginia

RESERVES

Demonstrated Coal Reserve Base of Virginia
January 1, 1974

1. Demonstrated Coal Reserve Base of Virginia on January 1, 1974 by Method of Mining (million short tons)*

Potential Mining Method		
Underground	Surface	Total
2,971	679	3,650

2. Demonstrated Reserve Base of Coal in Virginia on January 1, 1974 Potentially Minable by Underground Methods (million short tons)*

Anthracite	Bituminous	Subbituminous	Lignite	Total
138	2,833	-	-	2,971

3. Demonstrated Reserve Base of Coal in Virginia on January 1, 1974 Potentially Minable by Surface Methods (million short tons)*

Anthracite	Bituminous	Subbituminous	Lignite	Total
-	679	-	-	679

*Includes measured and indicated categories as defined by the U. S. Bureau of Mines and U. S. Geological Survey, and represents 100% of the coal in place. Calculations based upon bituminous coal and anthracite 28 inches or greater in thickness, and to a maximum depth of 1000 feet.

Source:
"Demonstrated Coal Reserve Base of the United States on January 1, 1974," A Mineral Industry Survey of the U. S. Bureau of Mines, June, 1974.

Demonstrated Coal Reserve Base

The U. S. Bureau of Mines has prepared information on coal reserves for the eastern United States. Information Circular 8655 published in 1974 is titled "The Reserve Base of Bituminous Coal and Anthracite Coal for Underground Mining in the Eastern United States." In Information Circular 8655, the data are presented for only underground mining on the basis of sulfur content. Information Circular 8680 published in 1975 is titled "The Reserve Base of U. S. Coals by Sulfur Content," and contains information on both underground and strippable reserves by sulfur content. The data are presented in terms of the coal reserve base, which utilizes the following criteria.

> Reserve Base: for Virginia includes in-place beds of bituminous coal and anthracite 28 inches or more thick that occur at depths to 1000 feet. Also it includes only coal from measured and indicated categories of reliability as defined below.
>
> Measured: Tonnage is computed from dimensions revealed in outcrops, trenches, mine workings, and drill holes. The points of observation and measurement are so closely spaced and the thickness and extent of coals are so well defined that the tonnage is judged to be accurate within 20 percent of true tonnage. Although the spacing of the points of observation necessary to demonstrate continuity of coal differs from region to region according to the character of the coalbeds, the points of observation are, in general, no greater than one-half mile apart. Generally, measured reserves are synonymous with proved reserves of other reports.
>
> Indicated: Tonnage is computed partly from specified measurements and partly from projections of visible data for a reasonable distance on the basis of geologic evidence. In general, the points of observation are about 1 mile apart, but they may be as much as 1 1/2 miles apart for beds of known continuity. Generally, indicated reserves are equivalent to proable reserves of other reports.

The United States Bureau of Mines and the United States Geological Survey have jointly developed a standarized classification system for estimating coal resources. The principles of this system and definitions of terms to be used in the classification system are given in the United States Geological Survey Bulletin 1450-A (1976) titled "Coal Resource Classification System of the U. S. Bureau of Mines and the U. S. Geological Survey." The reserve figures presented in this summary do not conform to the new classification system, but future resource estimates will follow the principles established in U.S.G.S. Bulletin 1450-A.

Underground coal reserve base, by State, rank, and bed thickness--January 1, 1974, million short tons*

State	Bituminous coal		Anthracite		Total,
	28-42 inches	>42 inches	28-42 inches	>42 inches	>28 inches
Alabama.....	1,014.19	783.90	0.00	0.00	1,798.09
Illinois.....	6,817.63	46,624.63	.00	.00	53,441.86
Indiana.....	1,881.69	7,066.80	.00	.00	8,948.49
Kentucky, east..	5,464.59	4,001.89	.00	.00	9,466.48
Kentucky, west..	502.89	8,217.00	.00	.00	8,719,89
Maryland.....	536.74	365.17	.00	.00	901.91
Michigan.....	98.85	18.79	.00	.00	117.64
Ohio.....	6,923.52	10,499.74	.00	.00	17,423.26
Pennsylvania....	8,199.01	14,589.93	3,584.87	3,445.35	29,819.16
Tennessee.....	492.40	174.73	.00	.00	667.13
Virginia.....	1,983.37	849.87	10.64	126.85	2,970.73
West Virginia...	11,205.17	23.172.60	.00	.00	34.377.77
Total.....	45,120.05	116,364.65	3,595.51	3,572.20	168,652.41

Underground reserve base of bituminous coal, by sulfur level and State, million short tons*

State	Sulfur level, percent				
	1.0 or less	1.1-3.0	>3.0	Unknown	Total[1]
Alabama.....	589	1,018	15	176	1,798
Illinois.....	1,034	5,848	33,648	12,908	53,442
Indiana.....	443	2,746	4,357	1,402	8,948
Kentucky, east.....	5,042	2,392	213	1,814	9,466
Kentucky, west.....	0	387	7,226	1,107	8,720
Maryland.....	107	625	171	0	902
Michigan.....	5	85	21	7	118
Ohio.....	116	5,450	10,110	1,754	17,423
Pennsylvania.....	982	16,013	3,568	2,216	22,789
Tennessee.....	140	371	101	54	667
Virginia.....	1,676	946	12	198	2,833
West Virginia.....	11,088	12,586	6,555	4,143	34,378
Eastern U.S. total.....	21,223	48,464	65,992	25,780	161,485

[1] Totals may not add due to rounding.

Underground reserve base of anthracite, by sulfur level and State, million short tons*

State	Sulfur level, percent				
	1.0 or less	1.1-3.0	>3.0	Unknown	Total[1]
Pennsylvania.....	6,199	182	0	649	7,030
Virginia.....	53	0	0	85	137
U.S. total.....	6,252	182	0	734	7,167

[1] Distribution may not add to total because of rounding.

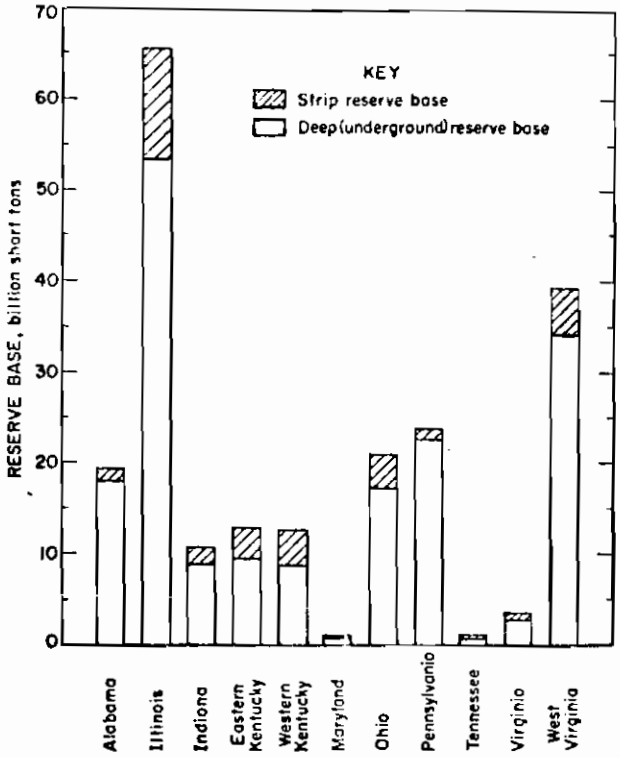
*Data from U.S.B.M. Inf. Circular 8655.

Reserve base of bituminous coal in coalbeds greater than 28 inches thick to a maximum depth of 1,000 feet, by mining method and sulfur content, million short tons[1]

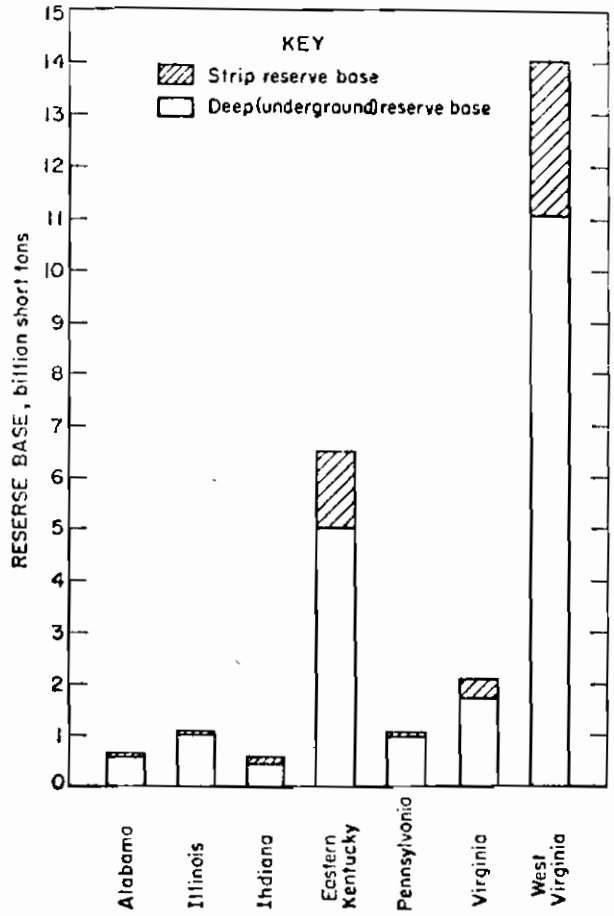
State	Mining method	Sulfur content, weight-percent				
		≤1.0	1.1-3.0	>3.0	Unknown	Total[2]
Alabama.....	Deep....	589.32	1,016.74	14.79	176.24	1,798.09
	Strip...	35.35	83.17	1.56	36.65	157.24
Georgia.....	Deep....	.33	0	0	.17	.50
	Strip...	0	0	0	0	0
Illinois.....	Deep....	1,034.68	5,848.37	33,647.64	12,908.44	53,441.86
	Strip...	60.37	1,493.04	9,321.32	1,347.78	12,222.86
Indiana.....	Deep....	443.54	2,746.61	4,355.12	1,402.45	8,948.49
	Strip...	105.25	559.23	907.20	101.56	1,674.08
Kentucky, eastern	Deep....	5,042.70	2,391.88	212.67	1,814.03	9,466.48
	Strip...	1,515.65	929.90	86.82	915.32	3,450.16
Kentucky, western	Deep....	0	386.58	7,226.36	1,107.11	8,719.89
	Strip...	.22	177.83	2,017.45	1,708.79	3,904.02
Maryland.....	Deep....	106.45	623.94	171.18	0	901.91
	Strip...	28.56	66.59	16.24	34.57	146.30
Michigan.....	Deep....	4.59	84.93	20.78	7.03	117.64
	Strip...	0	.49	.05	0	.56
North Carolina...	Deep....	0	0	0	31.25	31.25
	Strip...	0	0	0	.37	.37
Ohio.....	Deep....	115.45	5,449.88	10,109.36	1,754.09	17,423.26
	Strip...	18.87	990.96	2,524.87	117.93	3,653.89
Pennsylvania.....	Deep....	981.15	16,013.46	3,568.14	2,215.60	22,788.94
	Strip...	55.45	717.21	231.52	83.57	1,091.07
Tennessee.....	Deep....	139.29	369.98	101.37	53.87	667.13
	Strip...	65.54	163.19	55.22	34.12	319.59
Virginia.....	Deep....	1,676.05	945.42	12.03	198.31	2,833.24
	Strip...	411.58	218.06	2.06	46.69	679.24
West Virginia....	Deep....	11,086.60	12,583.41	6,552.88	4,142.92	34,377.77
	Strip...	3,005.46	1,422.82	270.40	509.55	5,212.02
Total.....	Deep....	21,220.15	48,461.20	65,992.32	25,811.51	161,516.45
	Strip...	5,302.30	6,822.49	15,434.71	4,936.90	32,511.40

[1] Includes only measured and indicated reserves.
[2] Distribution may not add to total because of rounding.

Data from U.S.B.M. Inf. Circular 8680



Reserve base of bituminous coal in the Eastern United States.



Reserve base of low-sulfur bituminous coal in the Eastern United States (≦1.0 percent sulfur).

Reserve base of anthracite, by mining method and sulfur content, million short tons[1]

State	Mining method	Sulfur content, weight-percent				
		≦1.0	1.1-3.0	>3.0	Unknown	Total[2]
Pennsylvania.....	Deep.....	6,198.53	181.71	0	649.05	7,030.22
	Strip.....	83.13	1.18	0	5.90	90.31
Virginia.....	Deep.....	52.49	0	0	84.96	137.49
	Strip.....	0	0	0	0	0
Total.....	Deep.....	6,251.02	181.71	0	734.01	7,167.71
	Strip.....	83.13	1.18	0	5.90	90.31

[1] Includes only measured and indicated reserves.
[2] Distribution may not add to total because of rounding.

Data from U.S.B.M. Inf. Circular 8680

Bituminous Coalbed Code Numbers
(Used in USBM Inf. Circ. 8655 and 8680)

001 Various

104 High Splint, No. 12

111 Cornett, Morris, No. 11

126 Limestone, No. 10, Pardee, Parsons, Smith

127 High Cliff, No. 9, Wax

133 Gin Creek, No. 8

135 Dean, Fire Clay, No. 7, Phillips

142 Buck Knob, Creveling, Low Splint, Mason, No. 6

151 C, Cedar Grove, Darby, Darby No. 5, Keokee, No. 5, Red Jacket, Roda, Taggart, Thacker, Upper Thacker

152 B, Dendron, Marker, Taggart Marker

154 Lower Cedar Grove, Lower Thacker

155 Kirk, No. 4

157 Alma, Harlan, Jackrock, No. 3, Puckett Creek, Upper Standiford, Wilson

160 Lower Standiford, No. 2-A, Upper St. Charles

161 Lower St. Charles, No. 2

164 Meadow, Pinhook

165 Five Foot, Kelly, Upper Bolling

166 Stone Creek

167 Campbell Creek Peerless

168 Burnwell, Campbell Creek, Freeburn, Imboden, Lower Bolling, Lower Campbell Creek, Lower Elkhorn, Lower Marrowbone, No. 1, No. 2 Gas, Pond Creek, Upper War Eagle, Warfield

171 Rocky Fork

172 Addington

174 Big Dorchester, Clintwood, Feds Creek, Matewan, North Fork, Norton No. 8

176 Eagle, Middle War Eagle, Mohawk

177 Bends Creek, Bentley, Blair

178 Lyons, Thompson

185 Big Dirt Seam, Dorchester, Esserville, Gladeville, Glamorgan, Haskell No. 3, Marcee, Norton No. 2

189 Middle Norton, Norton, Yellow Creek

195 Hagy, Lower War Eagle

210 Edwards, Splash Dam

214 Upper Banner

216 Cary, Gilbert, Lower Banner

232 Big Fork

250 Caldwell

252 Douglas, Harris, Kennedy, Widow Kennedy

253 Aily

259 Garden Hole, Jewell, Jewell Ridge, Lower Douglas, No. 6, Raven, Raven Red Ash, Red Ash

266 Iaeger, Jawbone, Lower Jewell, No. 5, Ratliff, Shannon

268 Jawbone-Tiller, Thick Tiller (Tiller and Jawbone)

269 Hogwallow, Lower Iaeger, No. 4, Tiller

271 Upper Seaboard

274 Greasy Creek, Sewell B

275 Middle Seaboard

285 Lower Seaboard, Sewell

293 Smith, Upper Horsepen, Welch

302 Little Raleigh, Middle Horsepen

304 C

311 Beckley, War Creek

319 Little Fire Creek, Lower Horsepen

323 Pocahontas No. 9

324 Pocahontas No. 8

325 Pocahontas No. 7

328 Cove Creek

329 Duncan, Egan

330 Carter

331 Milner, Tacus

332 Starns

334 Pocahontas No. 6

340 Burton's Ford

341 Pocahontas No. 5

342 Pocahontas No. 4

344 Pocahontas No. 3

357 Pocahontas No. 2

359 Pocahontas No. 1

799 Uncorrelated

UNDERGROUND BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS AND SULFUR RANGE - JANUARY 1, 1974
MILLION SHORT TONS

COUNTY: BUCHANAN

THICKNESS	BED	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO.OF ANAL	AVG S %
28-42	174	.00	1.06	2.50	2.31	1.12	.05	.00	.00	.00	.00	.00	7.07	239	.9
> 42		.00	.17	.41	.38	.18	.00	.00	.00	.00	.00	.00	1.17		
TOTAL		.00	1.23	2.91	2.69	1.30	.05	.00	.00	.00	.00	.00	8.24		
28-42	176	.00	.00	3.77	8.26	29.23	15.65	2.12	.00	.00	.00	.00	59.06	28	1.2
> 42		.00	.00	1.11	2.43	8.62	4.61	.62	.00	.00	.00	.00	17.42		
TOTAL		.00	.00	4.88	10.69	37.85	20.26	2.74	.00	.00	.00	.00	76.48		
28-42	177	.00	.00	.00	.17	.28	.00	.00	.00	.00	.00	.00	.46	3	1.1
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	.00	.00	.17	.28	.00	.00	.00	.00	.00	.00	.46		
28-42	185	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	13.64	13.64		
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	13.64	13.64		
28-42	195	.00	.00	18.26	33.25	50.98	6.89	.00	.00	.00	.00	.00	109.40	5	1.0
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	.00	18.26	33.25	50.98	6.89	.00	.00	.00	.00	.00	109.40		
28-42	210	.00	23.40	52.36	62.14	48.52	5.17	.38	.00	.00	.00	.00	191.81	56	.9
> 42		.00	7.16	16.03	19.02	14.85	1.58	.11	.00	.00	.00	.00	58.73		
TOTAL		.00	30.56	68.39	81.16	63.37	6.75	.49	.00	.00	.00	.00	250.54		
28-42	214	.00	.88	.00	.00	.00	.00	.00	.00	.00	.00	.00	.88	3	.6
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	.88	.00	.00	.00	.00	.00	.00	.00	.00	.00	.88		
28-42	216	.46	1.34	3.05	4.41	4.99	.77	.07	.00	.00	.00	.00	15.13	786	1.0
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.46	1.34	3.05	4.41	4.99	.77	.07	.00	.00	.00	.00	15.13		
28-42	252	.00	.00	26.00	64.22	106.77	.00	.00	.00	.00	.00	.00	197.01	13	1.1
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	.00	26.00	64.22	106.77	.00	.00	.00	.00	.00	.00	197.01		

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)
(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

Data from U.S.B.M. Inf. Circular 8655.

VIRGINIA

UNDERGROUND BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS AND SULFUR RANGE - JANUARY 1, 1974
MILLION SHORT TONS

THICKNESS	BED	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO.OF ANAL	AVG S %
COUNTY: BUCHANAN															
28-42	266	.00	78.83	49.35	.00	.00	.00	.00	.00	.00	.00	.00	128.19	6	.6
> 42		.00	4.04	2.53	.00	.00	.00	.00	.00	.00	.00	.00	6.58		
TOTAL		.00	82.87	51.88	.00	.00	.00	.00	.00	.00	.00	.00	134.77		
28-42	269	2.53	6.74	.00	.00	.00	.00	.00	.00	.00	.00	.00	9.28	5	.5
> 42		1.13	3.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	4.15		
TOTAL		3.66	9.75	.00	.00	.00	.00	.00	.00	.00	.00	.00	13.43		
COUNTY: TOTAL															
28-42		2.99	112.25	155.29	174.76	241.89	28.53	2.57	.00	.00	.00	13.64	731.93	1144	
> 42		1.13	14.38	20.08	21.83	23.65	6.19	.73	.00	.00	.00	.00	88.05		
TOTAL		4.12	126.63	175.37	196.59	265.54	34.72	3.30	.00	.00	.00	13.64	819.98		
COUNTY: 051 DICKENSON															
28-42	165	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	2.36	2.36		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	2.36	2.36		
28-42	174	.00	.00	.29	.31	.13	.00	.00	.00	.00	.00	.00	.76	42	.8
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	.00	.29	.31	.13	.00	.00	.00	.00	.00	.00	.76		
28-42	176	.00	.00	.00	.05	.34	.10	.00	.00	.00	.00	.00	.51	3	1.3
> 42		.00	.00	.00	.12	.69	.22	.00	.00	.00	.00	.00	1.04		
TOTAL		.00	.00	.00	.17	1.03	.32	.00	.00	.00	.00	.00	1.55		
28-42	178	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.03	.03		
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.03	.03		

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING).
(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

Data from U.S.B.M. Inf. Circular 8655.

UNDERGROUND BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS AND SULFUR RANGE - JANUARY 1, 1974
MILLION SHORT TONS

COUNTY: DICKENSON

THICKNESS	BED	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO.OF ANAL	AVG S %
28-42	185	.00	.00	.00	.03	.12	.00	.00	.00	.00	.00	.00	.16	6	1.2
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	.00	.00	.03	.12	.00	.00	.00	.00	.00	.00	.16		
28-42	195	.00	.00	.00	.00	.00	.16	.59	.22	.00	.00	.00	.98	4	2.0
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	.00	.00	.00	.00	.16	.59	.22	.00	.00	.00	.98		
28-42	210	.00	4.12	40.85	5.12	.15	.00	.00	.00	.00	.00	.00	50.25	263	.8
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	4.12	40.85	5.12	.15	.00	.00	.00	.00	.00	.00	50.25		
28-42	214	2.59	18.13	30.50	6.83	.82	.00	.00	.00	.00	.00	.00	58.89	835	.7
> 42		2.78	19.48	32.76	7.33	.88	.00	.00	.00	.00	.00	.00	63.25		
TOTAL		5.37	37.61	63.26	14.16	1.70	.00	.00	.00	.00	.00	.00	122.14		
28-42	216	.00	4.25	12.73	8.56	2.19	.05	.00	.00	.00	.00	.00	27.80	43	.8
> 42		.00	1.17	3.51	2.36	.60	.01	.00	.00	.00	.00	.00	7.68		
TOTAL		.00	5.42	16.24	10.92	2.79	.06	.00	.00	.00	.00	.00	35.48		
28-42	252	.00	.00	12.38	22.35	34.51	6.34	.00	.00	.00	.00	.00	75.52	10	.8
> 42		.00	.00	.50	.91	1.40	.25	.00	.00	.00	.00	.00	3.08		
TOTAL		.00	.00	12.88	23.26	35.91	6.59	.00	.00	.00	.00	.00	78.60		
28-42	259	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	51.77	51.77		
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	40.37	40.37		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	92.14	92.14		
28-42	266	.00	5.86	8.71	11.57	25.39	16.67	6.83	.00	.00	.00	.00	75.13	12	1.2
> 42		.00	.58	.87	1.15	2.54	1.67	.68	.00	.00	.00	.00	7.53		
TOTAL		.00	6.44	9.58	12.72	27.93	18.34	7.51	.00	.00	.00	.00	82.66		
28-42	269	2.47	9.12	.00	.00	.00	.00	.00	.00	.00	.00	.00	11.60	7	.5
> 42		7.84	28.98	.00	.00	.00	.00	.00	.00	.00	.00	.00	36.83		
TOTAL		10.31	38.10	.00	.00	.00	.00	.00	.00	.00	.00	.00	48.43		

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)
(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

Data from U.S.B.M. Inf. Circular 8655.

VIRGINIA

UNDERGROUND BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS AND SULFUR RANGE - JANUARY 1, 1974
MILLION SHORT TONS

COUNTY: DICKENSON

THICKNESS	BED	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO.OF ANAL	AVG S %
COUNTY: TOTAL															
28-42		5.06	41.48	105.46	54.82	63.65	23.32	7.42	.22	.00	.00	51.80	353.40	1225	
> 42		10.62	50.21	37.64	11.87	6.11	2.15	.68	.00	.00	.00	42.73	162.14		
TOTAL		15.68	91.69	143.10	66.69	69.76	25.47	8.10	.22	.00	.00	94.53	515.54		
COUNTY: 105 LEE															
28-42	127	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1	.8
> 42		.00	.00	.36	.00	.00	.00	.00	.00	.00	.00	.00	.36		
TOTAL		.00	.00	.36	.00	.00	.00	.00	.00	.00	.00	.00	.36		
28-42	133	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.63	1.63		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.63	1.63		
28-42	135	.00	.00	.83	.56	.00	.00	.00	.00	.00	.00	.00	1.40	28	.8
> 42		.00	.00	1.68	1.13	.00	.00	.00	.00	.00	.00	.00	2.82		
TOTAL		.00	.00	2.51	1.69	.00	.00	.00	.00	.00	.00	.00	4.22		
28-42	142	.00	.06	.09	.13	.36	.40	.30	.16	.07	.04	.00	1.64	26	1.3
> 42		.00	.38	.56	.77	2.16	2.40	1.76	.94	.42	.24	.00	9.67		
TOTAL		.00	.44	.65	.90	2.52	2.80	2.06	1.10	.49	.28	.00	11.31		
28-42	151	1.19	6.33	1.55	.10	.00	.00	.00	.00	.00	.00	.00	9.18	240	.6
> 42		.19	1.04	.25	.01	.00	.00	.00	.00	.00	.00	.00	1.52		
TOTAL		1.38	7.37	1.80	.11	.00	.00	.00	.00	.00	.00	.00	10.70		
28-42	152	.00	1.33	1.33	.00	.00	.00	.00	.00	.00	.00	.00	2.66	2	.7
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	1.33	1.33	.00	.00	.00	.00	.00	.00	.00	.00	2.66		

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)
(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

Data from U.S.B.M. Inf. Circular 8655.

UNDERGROUND BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS AND SULFUR RANGE - JANUARY 1, 1974
MILLION SHORT TONS

COUNTY: LEE

THICKNESS	BED	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO.OF ANAL	AVG S %
28-42	157	.00	1.31	1.94	2.76	8.72	13.05	13.93	10.48	6.02	4.52	.00	62.78	22	1.7
> 42		.00	.52	.77	1.09	3.46	5.19	5.54	4.16	2.39	1.79	.00	24.96		
TOTAL		.00	1.83	2.71	3.85	12.18	18.24	19.47	14.64	8.41	6.31	.00	87.74		
28-42	160	.00	.19	.33	.52	1.33	.85	.28	.00	.00	.00	.00	3.52	3	1.1
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	.19	.33	.52	1.33	.85	.28	.00	.00	.00	.00	3.52		
28-42	161	.00	.00	.00	.00	.00	.00	4.58	.00	.00	.00	.00	4.58	1	2.1
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	.00	.00	.00	.00	.00	4.58	.00	.00	.00	.00	4.58		
28-42	164	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.88	.88		
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.88	.88		
28-42	165	.00	.00	3.81	2.38	.00	.00	.00	.00	.00	.00	.00	6.20	3	.8
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	.00	3.81	2.38	.00	.00	.00	.00	.00	.00	.00	6.20		
28-42	168	.00	.00	2.16	2.82	5.42	2.72	.56	.00	.00	.00	.00	13.71	11	1.1
> 42		.00	.00	1.38	1.80	3.47	1.74	.35	.00	.00	.00	.00	8.77		
TOTAL		.00	.00	3.54	4.62	8.89	4.46	.91	.00	.00	.00	.00	22.48		
28-42	174	.00	.00	.00	.00	.00	1.06	.00	.00	.00	.00	.00	1.06	1	1.7
> 42		.00	.00	.00	.00	.00	10.07	.00	.00	.00	.00	.00	10.07		
TOTAL		.00	.00	.00	.00	.00	11.13	.00	.00	.00	.00	.00	11.13		

COUNTY: TOTAL

28-42	1.19	9.22	12.04	9.27	15.83	18.08	19.65	10.64	6.09	4.56	.88	107.61	338	
> 42	.19	1.94	5.00	4.80	9.09	19.40	7.65	5.10	2.81	2.03	1.63	59.80		
TOTAL	1.38	11.16	17.04	14.07	24.92	37.48	27.30	15.74	8.90	6.59	2.51	167.41		

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)
(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

Data from U.S.B.M. Inf. Circular 8655.

VIRGINIA

UNDERGROUND BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS AND SULFUR RANGE - JANUARY 1, 1974
MILLION SHORT TONS

COUNTY: RUSSELL

THICKNESS	BED	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO.OF ANAL	AVG S %
28-42	214	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	189	.6
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.02		
28-42	216	.00	.66	1.08	.22	.02	.00	.00	.00	.00	.00	.00	2.01	219	.7
> 42		.00	.73	1.19	.25	.02	.00	.00	.00	.00	.00	.00	2.21		
TOTAL		.00	1.39	2.27	.47	.04	.00	.00	.00	.00	.00	.00	4.22		
28-42	252	.00	.00	7.29	12.67	35.21	21.01	4.01	.00	.00	.00	.00	80.21	24	1.2
> 42		.00	.00	.48	.84	2.33	1.39	.26	.00	.00	.00	.00	5.33		
TOTAL		.00	.00	7.77	13.51	37.54	22.40	4.27	.00	.00	.00	.00	85.54		
28-42	259	.00	8.56	15.98	4.57	.00	.00	.00	.00	.00	.00	.00	29.12	16	.7
> 42		.00	.47	.88	.25	.00	.00	.00	.00	.00	.00	.00	1.61		
TOTAL		.00	9.03	16.86	4.82	.00	.00	.00	.00	.00	.00	.00	30.73		
28-42	266	.00	3.77	5.52	6.26	8.83	2.98	.00	.00	.00	.00	.00	27.34	12	.9
> 42		.00	21.79	31.90	36.17	51.02	17.21	.00	.00	.00	.00	.00	157.97		
TOTAL		.00	25.56	37.42	42.43	59.85	20.19	.00	.00	.00	.00	.00	185.31		
28-42	269	6.99	15.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	22.00	12	.5
> 42		19.92	42.73	.00	.00	.00	.00	.00	.00	.00	.00	.00	62.66		
TOTAL		26.91	57.73	.00	.00	.00	.00	.00	.00	.00	.00	.00	84.66		
28-42	340	.00	11.82	.00	.00	.00	.00	.00	.00	.00	.00	.00	11.82	1	.5
> 42		.00	.72	.00	.00	.00	.00	.00	.00	.00	.00	.00	.72		
TOTAL		.00	12.54	.00	.00	.00	.00	.00	.00	.00	.00	.00	12.54		

COUNTY: TOTAL

28-42	6.99	39.81	29.87	23.72	44.06	23.99	4.01	.00	.00	.00	.00	172.51	473	
> 42	19.92	66.44	34.45	37.51	53.37	18.60	.26	.00	.00	.00	.00	230.51		
TOTAL	26.91	106.25	64.32	61.23	97.43	42.59	4.27	.00	.00	.00	.00	403.02		

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)
(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

Data from U.S.B.M. Inf. Circular 8655.

UNDERGROUND BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS AND SULFUR RANGE - JANUARY 1, 1974
MILLION SHORT TONS

COUNTY: SCOTT

THICKNESS	BED	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO.OF ANAL	AVG S %
28-42	328	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.94	1.94		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.94	1.94		
28-42	329	.00	.00	.00	1.37	.00	.00	.00	.00	.00	.00	.00	1.37	1	.9
> 42		.00	.00	.00	2.23	.00	.00	.00	.00	.00	.00	.00	2.23		
TOTAL		.00	.00	.00	3.60	.00	.00	.00	.00	.00	.00	.00	3.60		
28-42	331	.00	.00	.00	.00	.00	.57	.00	.00	.00	.00	.00	.57	1	1.6
> 42		.00	.00	.00	.00	.00	.61	.00	.00	.00	.00	.00	.61		
TOTAL		.00	.00	.00	.00	.00	1.18	.00	.00	.00	.00	.00	1.18		
28-42	332	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	3.52	3.52		
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.06	.06		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	3.58	3.58		
28-42	340	.00	.00	.00	13.22	.00	.00	.00	.00	.00	.00	.00	13.22	2	.9
> 42		.00	.00	.00	21.13	.00	.00	.00	.00	.00	.00	.00	21.13		
TOTAL		.00	.00	.00	34.35	.00	.00	.00	.00	.00	.00	.00	34.35		
COUNTY: TOTAL															
28-42		.00	.00	.00	14.59	.00	.57	.00	.00	.00	.00	3.52	18.68	4	
> 42		.00	.00	.00	23.36	.00	.61	.00	.00	.00	.00	2.00	25.97		
TOTAL		.00	.00	.00	37.95	.00	1.18	.00	.00	.00	.00	5.52	44.65		
COUNTY: 185 TAZEWELL															
28-42	259	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.02	271	.7
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.02		

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)
(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

Data from U.S.B.M. Inf. Circular 8655.

VIRGINIA

UNDERGROUND BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS AND SULFUR RANGE - JANUARY 1, 1974
MILLION SHORT TONS

COUNTY: TAZEWELL

THICKNESS	BED	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO.OF ANAL	AVG S %
28-42	266	.00	26.76	6.40	.00	.00	.00	.00	.00	.00	.00	.00	33.17	8	.5
> 42		.00	6.74	1.61	.00	.00	.00	.00	.00	.00	.00	.00	8.36		
TOTAL		.00	33.50	8.01	.00	.00	.00	.00	.00	.00	.00	.00	41.53		
28-42	269	.00	1.59	2.65	3.20	4.24	1.12	.00	.00	.00	.00	.00	12.83	8	1.0
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	1.59	2.65	3.20	4.24	1.12	.00	.00	.00	.00	.00	12.83		
28-42	271	1.06	7.72	1.06	.00	.00	.00	.00	.00	.00	.00	.00	9.85	14	.5
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		1.06	7.72	1.06	.00	.00	.00	.00	.00	.00	.00	.00	9.85		
28-42	274	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	3.66	3.66		
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	3.66	3.66		
28-42	275	.00	.00	.00	1.12	.00	.00	.00	.00	.00	.00	.00	1.12	3	1.0
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	.00	.00	1.12	.00	.00	.00	.00	.00	.00	.00	1.12		
28-42	285	.00	.00	.00	3.74	11.69	3.78	.00	.00	.00	.00	.00	19.23	7	1.2
> 42		.00	.00	.00	.12	.39	.12	.00	.00	.00	.00	.00	.65		
TOTAL		.00	.00	.00	3.86	12.08	3.90	.00	.00	.00	.00	.00	19.88		
28-42	293	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.24	1.24		
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	8.74	8.74		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	9.98	9.98		
28-42	302	.00	2.82	2.82	.00	.00	.00	.00	.00	.00	.00	.00	5.64	2	.7
> 42		.00	1.41	1.41	.00	.00	.00	.00	.00	.00	.00	.00	2.83		
TOTAL		.00	4.23	4.23	.00	.00	.00	.00	.00	.00	.00	.00	8.47		
28-42	304	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	2.46	2.46		
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	2.46	2.46		

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)
(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

Data from U.S.B.M. Inf. Circular 8655.

UNDERGROUND BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS AND SULFUR RANGE - JANUARY 1, 1974
MILLION SHORT TONS

COUNTY: TAZEWELL

THICKNESS	BED	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO.OF ANAL	AVG S %
28-42	311	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	14.32	14.32		
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	2.11	2.11		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	16.43	16.43		
28-42	319	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	2.42	2.42		
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	2.42	2.42		
28-42	341	.00	5.94	3.87	.00	.00	.00	.00	.00	.00	.00	.00	9.82	23	.6
> 42		.00	3.67	2.40	.00	.00	.00	.00	.00	.00	.00	.00	6.08		
TOTAL		.00	9.61	6.27	.00	.00	.00	.00	.00	.00	.00	.00	15.90		
28-42	342	.00	.68	.00	.00	.00	.00	.00	.00	.00	.00	.00	.68	2	.5
> 42		.00	8.82	.00	.00	.00	.00	.00	.00	.00	.00	.00	8.82		
TOTAL		.00	9.50	.00	.00	.00	.00	.00	.00	.00	.00	.00	9.50		
28-42	344	.61	2.75	1.31	.00	.00	.00	.00	.00	.00	.00	.00	4.68	41	.6
> 42		.95	4.29	2.05	.00	.00	.00	.00	.00	.00	.00	.00	7.31		
TOTAL		1.56	7.04	3.36	.00	.00	.00	.00	.00	.00	.00	.00	11.99		
COUNTY:	TOTAL														
28-42		1.67	48.26	18.12	8.06	15.93	4.90	.00	.00	.00	.00	24.10	121.14	379	
> 42		.95	24.93	7.47	.12	.39	.12	.00	.00	.00	.00	10.85	44.90		
TOTAL		2.62	73.19	25.59	8.18	16.32	5.02	.00	.00	.00	.00	34.95	166.04		
COUNTY:	195 WISE														
28-42	104	.00	.15	.20	.04	.00	.00	.00	.00	.00	.00	.00	.41	232	.7
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	.15	.20	.04	.00	.00	.00	.00	.00	.00	.00	.41		

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)
(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

Data from U.S.B.M. Inf. Circular 8655.

VIRGINIA

UNDERGROUND BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS AND SULFUR RANGE - JANUARY 1, 1974
MILLION SHORT TONS

COUNTY: WISE

THICKNESS	BED	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO.OF ANAL	AVG S %
28-42	111	.00	1.04	.70	.00	.00	.00	.00	.00	.00	.00	.00	1.75	39	.7
> 42		.00	6.49	4.40	.00	.00	.00	.00	.00	.00	.00	.00	10.90		
TOTAL		.00	7.53	5.10	.00	.00	.00	.00	.00	.00	.00	.00	12.65		
28-42	126	.00	.00	2.20	4.52	6.67	.72	.00	.00	.00	.00	.00	14.15	27	1.0
> 42		.00	.00	5.25	10.78	15.90	1.71	.00	.00	.00	.00	.00	33.69		
TOTAL		.00	.00	7.45	15.30	22.57	2.43	.00	.00	.00	.00	.00	47.84		
28-42	142	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	31.95	31.95		
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	3.17	3.17		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	35.12	35.12		
28-42	151	.38	4.81	16.07	3.06	.00	.00	.00	.00	.00	.00	.00	24.32	140	.7
> 42		.26	3.22	10.76	2.05	.00	.00	.00	.00	.00	.00	.00	16.29		
TOTAL		.64	8.03	26.83	5.11	.00	.00	.00	.00	.00	.00	.00	40.61		
28-42	152	.00	1.55	2.15	2.93	8.61	11.78	12.14	9.39	5.74	5.44	.00	59.82	16	1.2
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	1.55	2.15	2.93	8.61	11.78	12.14	9.39	5.74	5.44	.00	59.82		
28-42	157	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	7.33	7.33		
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	3.07	3.07		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	10.40	10.40		
28-42	165	.00	.00	5.61	17.17	4.47	.00	.00	.00	.00	.00	.00	27.26	16	.9
> 42		.00	.00	1.60	4.92	1.28	.00	.00	.00	.00	.00	.00	7.81		
TOTAL		.00	.00	7.21	22.09	5.75	.00	.00	.00	.00	.00	.00	35.07		
28-42	168	.00	1.64	27.11	1.64	.03	.00	.00	.00	.00	.00	.00	30.47	2294	.7
> 42		.00	.16	2.74	.16	.00	.00	.00	.00	.00	.00	.00	3.08		
TOTAL		.00	1.80	29.85	1.80	.03	.00	.00	.00	.00	.00	.00	33.55		
28-42	174	.00	.00	3.41	4.20	8.71	5.79	2.62	.00	.00	.00	.00	24.75	12	1.2
> 42		.00	.00	3.09	3.81	7.90	5.25	2.37	.00	.00	.00	.00	22.45		
TOTAL		.00	.00	6.50	8.01	16.61	11.04	4.99	.00	.00	.00	.00	47.20		

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)
(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

Data from U.S.B.M. Inf. Circular 8655.

UNDERGROUND BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS AND SULFUR RANGE - JANUARY 1, 1974
MILLION SHORT TONS

COUNTY: WISE

THICKNESS	BED	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO.OF ANAL	AVG S %
28-42	177	.00	.08	.20	.28	.18	.00	.00	.00	.00	.00	.00	.77	27	.9
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	.08	.20	.28	.18	.00	.00	.00	.00	.00	.00	.77		
28-42	178	.00	.00	.97	1.67	5.41	4.51	1.71	.00	.00	.00	.00	14.28	3	1.4
> 42		.00	.00	.01	.03	.10	.08	.03	.00	.00	.00	.00	.27		
TOTAL		.00	.00	.98	1.70	5.51	4.59	1.74	.00	.00	.00	.00	14.55		
28-42	185	.00	.00	1.99	3.67	13.67	13.91	5.95	1.63	.00	.00	.00	40.81	28	1.4
> 42		.00	.00	1.04	1.91	7.13	7.25	3.10	.85	.00	.00	.00	21.29		
TOTAL		.00	.00	3.03	5.58	20.80	21.16	9.05	2.48	.00	.00	.00	62.10		
28-42	189	.00	.00	.00	7.93	38.55	3.71	.00	.00	.00	.00	.00	50.20	14	1.2
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	.00	.00	7.93	38.55	3.71	.00	.00	.00	.00	.00	50.20		
28-42	214	.00	8.52	10.75	2.14	.00	.00	.00	.00	.00	.00	.00	21.42	457	.7
> 42		.00	14.20	17.91	3.56	.00	.00	.00	.00	.00	.00	.00	35.69		
TOTAL		.00	22.72	28.66	5.70	.00	.00	.00	.00	.00	.00	.00	57.11		
28-42	216	.00	5.58	13.98	8.19	1.80	.00	.00	.00	.00	.00	.00	29.57	9	.8
> 42		.00	2.94	7.37	4.32	.95	.00	.00	.00	.00	.00	.00	15.60		
TOTAL		.00	8.52	21.35	12.51	2.75	.00	.00	.00	.00	.00	.00	45.17		
28-42	252	.00	.00	35.59	.00	.00	.00	.00	.00	.00	.00	.00	35.59	2	.8
> 42		.00	.00	14.35	.00	.00	.00	.00	.00	.00	.00	.00	14.35		
TOTAL		.00	.00	49.94	.00	.00	.00	.00	.00	.00	.00	.00	49.94		
28-42	259	.00	.00	6.90	8.32	13.78	5.74	1.63	.00	.00	.00	.00	36.36	19	1.1
> 42		.00	.00	2.51	3.03	5.02	2.09	.59	.00	.00	.00	.00	13.26		
TOTAL		.00	.00	9.41	11.35	18.80	7.83	2.22	.00	.00	.00	.00	49.62		
28-42	266	.00	8.79	9.05	4.98	2.50	.23	.00	.00	.00	.00	.00	25.57	51	.7
> 42		.00	12.81	13.19	7.26	3.65	.33	.00	.00	.00	.00	.00	37.26		
TOTAL		.00	21.60	22.24	12.24	6.15	.56	.00	.00	.00	.00	.00	62.83		

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)
(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

Data from U.S.B.M. Inf. Circular 8655.

VIRGINIA

UNDERGROUND BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS AND SULFUR RANGE - JANUARY 1, 1974
MILLION SHORT TONS

COUNTY: WISE

THICKNESS	BED	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO.OF ANAL	AVG S %
28-42	328	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.19	.19		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.19	.19		
28-42	340	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.32	1.32		
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.13	.13		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.45	1.45		
COUNTY: TOTAL															
28-42		.38	32.16	136.88	70.74	104.38	46.39	24.05	11.02	5.74	5.44	40.60	478.10	3386	
> 42		.26	39.82	84.22	41.83	41.93	16.71	6.09	.85	.00	.00	6.56	238.50		
TOTAL		.64	71.98	221.10	112.57	146.31	63.10	30.14	11.87	5.74	5.44	47.16	716.60		
STATE TOTAL															
28-42		18.28	283.18	457.66	355.96	485.74	145.78	57.70	21.88	11.83	10.00	134.54	1983.37	6949	
> 42		33.07	197.72	188.86	141.32	134.54	63.78	15.41	5.95	2.81	2.03	63.77	849.87		
TOTAL		51.35	480.90	646.52	497.28	620.28	209.56	73.11	27.83	14.64	12.03	198.31	2833.24		

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)
(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

Data from U.S.B.M. Inf. Circular 8655.

VIRGINIA

BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY BED, THICKNESS, TYPE OF MINING, AND SULFUR RANGE - JANUARY 1, 1974
(MILLION SHORT TONS)

COUNTY: BUCHANAN

THICKNESS	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO. OF ANAL	AVG S %
BED: 151														
DEEP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	4	.5
STRIP >28	2.55	2.55	.00	.00	.00	.00	.00	.00	.00	.00	.00	5.10		
TOTAL	2.55	2.55	.00	.00	.00	.00	.00	.00	.00	.00	.00	5.10		
BED: 154														
DEEP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.23	.23		
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.23	.23		
BED: 168														
DEEP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	29.91	29.91		
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	29.91	29.91		
BED: 174														
DEEP >28	.00	1.23	2.91	2.69	1.30	.05	.00	.00	.00	.00	.00	8.24	239	.9
STRIP >28	.00	4.78	11.23	10.35	5.03	.25	.00	.00	.00	.00	.00	31.66		
TOTAL	.00	6.01	14.14	13.04	6.33	.30	.00	.00	.00	.00	.00	39.90		
BED: 176														
DEEP >28	.00	.00	4.88	10.69	37.85	20.26	2.74	.00	.00	.00	.00	76.48	28	1.2
STRIP >28	.00	.00	2.39	5.24	18.52	9.91	1.34	.00	.00	.00	.00	37.43		
TOTAL	.00	.00	7.27	15.93	56.37	30.17	4.08	.00	.00	.00	.00	113.91		
BED: 177														
DEEP >28	.00	.00	.00	.17	.28	.00	.00	.00	.00	.00	.00	.46	3	1.1
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	.00	.00	.17	.28	.00	.00	.00	.00	.00	.00	.46		

(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)

Data from U.S.B.M. Inf. Circular 8680

VIRGINIA

BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS, TYPE OF MINING, AND SULFUR RANGE - JANUARY 1, 1974
(MILLION SHORT TONS)

COUNTY: BUCHANAN

THICKNESS		RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO. OF ANAL	AVG S %
BED: 185															
DEEP	>28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	13.64	13.64		
STRIP	>28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	13.64	13.64		
BED: 195															
DEEP	>28	.00	.00	18.26	33.25	50.98	6.89	.00	.00	.00	.00	.00	109.40	5	1.0
STRIP	>28	.00	.00	5.68	10.34	15.85	2.14	.00	.00	.00	.00	.00	34.02		
TOTAL		.00	.00	23.94	43.59	66.83	9.03	.00	.00	.00	.00	.00	143.42		
BED: 210															
DEEP	>28	.00	30.56	68.39	81.16	63.37	6.75	.49	.00	.00	.00	.00	250.54	56	.9
STRIP	>28	.00	7.72	17.28	20.51	16.01	1.70	.12	.00	.00	.00	.00	63.31		
TOTAL		.00	38.28	85.67	101.67	79.38	8.45	.61	.00	.00	.00	.00	313.85		
BED: 214															
DEEP	>28	.00	.88	.00	.00	.00	.00	.00	.00	.00	.00	.00	.88	3	.6
STRIP	>28	.00	.55	.00	.00	.00	.00	.00	.00	.00	.00	.00	.55		
TOTAL		.00	1.43	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.43		
BED: 216															
DEEP	>28	.46	1.34	3.05	4.41	4.99	.77	.07	.00	.00	.00	.00	15.13	786	1.0
STRIP	>28	.29	.83	1.89	2.73	3.09	.47	.04	.00	.00	.00	.00	9.37		
TOTAL		.75	2.17	4.94	7.14	8.08	1.24	.11	.00	.00	.00	.00	24.50		
BED: 252															
DEEP	>28	.00	.00	26.00	64.22	106.77	.00	.00	.00	.00	.00	.00	197.01	13	1.1
STRIP	>28	.00	.00	4.32	10.68	17.76	.00	.00	.00	.00	.00	.00	32.78		
TOTAL		.00	.00	30.32	74.90	124.53	.00	.00	.00	.00	.00	.00	229.79		

(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)

Data from U.S.B.M. Inf. Circular 8680

VIRGINIA

BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS, TYPE OF MINING, AND SULFUR RANGE - JANUARY 1, 1974
(MILLION SHORT TONS)

COUNTY: BUCHANAN

THICKNESS	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO. OF ANAL	AVG S %
BED: 266														
DEEP >28	.00	82.47	51.88	.00	.00	.00	.00	.00	.00	.00	.00	134.77	6	.6
STRIP >28	.00	7.77	4.61	.00	.00	.00	.00	.00	.00	.00	.00	11.99		
TOTAL	.00	90.24	56.49	.00	.00	.00	.00	.00	.00	.00	.00	146.76		
BED: 269														
DEEP >28	3.66	9.75	.00	.00	.00	.00	.00	.00	.00	.00	.00	13.43	5	.5
STRIP >28	.39	1.03	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.43		
TOTAL	4.05	10.78	.00	.00	.00	.00	.00	.00	.00	.00	.00	14.86		
COUNTY: TOTAL														
DEEP >28	4.12	126.63	175.37	196.59	265.54	34.72	3.30	.00	.00	.00	13.64	819.98	1148	
STRIP >28	3.23	24.83	47.40	59.85	76.26	14.47	1.50	.00	.00	.00	30.14	257.78		
TOTAL	7.35	151.46	222.77	256.44	341.80	49.19	4.80	.00	.00	.00	43.78	1077.76		
COUNTY: 051 DICKENSON														
BED: 165														
DEEP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	2.36	2.36		
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	2.36	2.36		
BED: 174														
DEEP >28	.00	.00	.29	.31	.13	.00	.00	.00	.00	.00	.00	.76	42	.8
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01		
TOTAL	.00	.00	.29	.31	.13	.00	.00	.00	.00	.00	.00	.77		
BED: 176														
DEEP >28	.00	.00	.00	.17	1.03	.32	.00	.00	.00	.00	.00	1.55	3	1.3
STRIP >28	.00	.00	.00	.61	3.53	1.12	.00	.00	.00	.00	.00	5.27		
TOTAL	.00	.00	.00	.78	4.56	1.44	.00	.00	.00	.00	.00	6.82		

(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)

Data from U.S.B.M. Inf. Circular 8680

VIRGINIA

BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS, TYPE OF MINING, AND SULFUR RANGE - JANUARY 1, 1974
(MILLION SHORT TONS)

COUNTY: DICKENSON

THICKNESS	≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO. OF ANAL	AVG S %
					RESERVES BY SULFUR RANGE, PERCENT									
BED: 178														
DEEP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.03	.03		
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.03	.03		
BED: 185														
DEEP >28	.00	.00	.00	.03	.12	.00	.00	.00	.00	.00	.00	.16	6	1.2
STRIP >28	.00	.00	.00	.09	.33	.00	.00	.00	.00	.00	.00	.43		
TOTAL	.00	.00	.00	.12	.45	.00	.00	.00	.00	.00	.00	.59		
BED: 195														
DEEP >28	.00	.00	.00	.00	.00	.16	.59	.22	.00	.00	.00	.98	4	2.0
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	.00	.00	.00	.00	.16	.59	.22	.00	.00	.00	.98		
BED: 210														
DEEP >28	.00	4.12	40.85	5.12	.15	.00	.00	.00	.00	.00	.00	50.25	263	.9
STRIP >28	.00	.10	1.06	.13	.00	.00	.00	.00	.00	.00	.00	1.31		
TOTAL	.00	4.22	41.91	5.25	.15	.00	.00	.00	.00	.00	.00	51.56		
BED: 214														
DEEP >28	5.37	37.41	63.26	14.16	1.70	.00	.00	.00	.00	.00	.00	122.14	835	.7
STRIP >28	1.76	12.52	20.72	4.64	.56	.00	.00	.00	.00	.00	.00	40.01		
TOTAL	7.13	49.93	83.98	18.80	2.26	.00	.00	.00	.00	.00	.00	162.15		
BED: 216														
DEEP >28	.00	5.42	16.24	10.92	2.79	.06	.00	.00	.00	.00	.00	35.48	43	.8
STRIP >28	.00	.67	2.01	1.35	.34	.00	.00	.00	.00	.00	.00	4.39		
TOTAL	.00	6.09	18.25	12.27	3.13	.06	.00	.00	.00	.00	.00	39.87		

(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)

Data from U.S.B.M. Inf. Circular 8680

VIRGINIA

BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS, TYPE OF MINING, AND SULFUR RANGE - JANUARY 1, 1974
(MILLION SHORT TONS)

COUNTY: DICKENSON

THICKNESS	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO. OF ANAL	AVG S %
BED: 252														
DEEP >28	.00	.00	12.88	23.26	35.91	6.59	.00	.00	.00	.00	.00	78.60	10	.8
STRIP >28	.00	.00	1.56	2.82	4.36	.80	.00	.00	.00	.00	.00	9.56		
TOTAL	.00	.00	14.44	26.08	40.27	7.39	.00	.00	.00	.00	.00	88.16		
BED: 259														
DEEP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	92.14	92.14		
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.73	.73		
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	92.87	92.87		
BED: 266														
DEEP >28	.00	6.44	9.58	12.72	27.93	18.34	7.51	.00	.00	.00	.00	82.66	12	1.2
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	6.44	9.58	12.72	27.93	18.34	7.51	.00	.00	.00	.00	82.66		
BED: 269														
DEEP >28	10.31	38.10	.00	.00	.00	.00	.00	.00	.00	.00	.00	48.43	7	.5
STRIP >28	.40	1.47	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.88		
TOTAL	10.71	39.57	.00	.00	.00	.00	.00	.00	.00	.00	.00	50.31		
COUNTY: TOTAL														
DEEP >28	15.68	91.69	143.10	66.69	69.76	25.47	8.10	.22	.00	.00	94.53	515.54	1225	
STRIP >28	2.16	14.56	25.35	9.64	9.12	1.92	.00	.00	.00	.00	.73	63.59		
TOTAL	17.84	106.25	168.45	76.33	78.88	27.39	8.10	.22	.00	.00	95.26	579.13		
COUNTY: 105 LEE														
BED: 104														
DEEP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	2	1.0
STRIP >28	.00	.00	.44	.80	.44	.00	.00	.00	.00	.00	.00	1.70		
TOTAL	.00	.00	.44	.80	.44	.00	.00	.00	.00	.00	.00	1.70		

(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)

Data from U.S.B.M. Inf. Circular 8680

VIRGINIA

BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS, TYPE OF MINING, AND SULFUR RANGE - JANUARY 1, 1974
(MILLION SHORT TONS)

COUNTY: LEE

THICKNESS	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO. OF ANAL	AVG S %
BED: 111														
DEEP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	3.50	3.50		
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	3.50	3.50		
BED: 127														
DEEP >28	.00	.00	.36	.00	.00	.00	.00	.00	.00	.00	.00	.36	1	.8
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	.00	.36	.00	.00	.00	.00	.00	.00	.00	.00	.36		
BED: 133														
DEEP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.63	1.63		
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.63	1.63		
BED: 135														
DEEP >28	.00	.00	2.51	1.69	.00	.00	.00	.00	.00	.00	.00	4.22	28	.8
STRIP >28	.00	.00	2.69	1.81	.00	.00	.00	.00	.00	.00	.00	4.51		
TOTAL	.00	.00	5.20	3.50	.00	.00	.00	.00	.00	.00	.00	8.73		
BED: 142														
DEEP >28	.00	.44	.65	.90	2.52	2.80	2.06	1.10	.49	.28	.00	11.31	26	1.3
STRIP >28	.00	.28	.41	.57	1.61	1.79	1.31	.70	.31	.17	.00	7.19		
TOTAL	.00	.72	1.06	1.47	4.13	4.59	3.37	1.80	.80	.45	.00	18.50		
BED: 151														
DEEP >28	1.38	7.37	1.80	.11	.00	.00	.00	.00	.00	.00	.00	10.70	240	.6
STRIP >28	2.33	12.39	3.03	.19	.00	.00	.00	.00	.00	.00	.00	17.97		
TOTAL	3.71	19.76	4.83	.30	.00	.00	.00	.00	.00	.00	.00	28.67		

(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)

Data from U.S.B.M. Inf. Circular 8680

VIRGINIA

BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS, TYPE OF MINING, AND SULFUR RANGE - JANUARY 1, 1974
(MILLION SHORT TONS)

COUNTY: LEE

THICKNESS	≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO. OF ANAL	AVG S %
						RESERVES BY SULFUR RANGE, PERCENT								
BED: 152														
DEEP >28	.00	1.33	1.33	.00	.00	.00	.00	.00	.00	.00	.00	2.66	2	.7
STRIP >28	.00	.88	.88	.00	.00	.00	.00	.00	.00	.00	.00	1.76		
TOTAL	.00	2.21	2.21	.00	.00	.00	.00	.00	.00	.00	.00	4.42		
BED: 157														
DEEP >28	.00	1.83	2.71	3.85	12.19	18.24	19.47	14.64	8.41	6.31	.00	87.74	22	1.7
STRIP >28	.00	.39	.58	.82	2.61	3.90	4.17	3.13	1.80	1.35	.00	18.79		
TOTAL	.00	2.22	3.29	4.67	14.79	22.14	23.64	17.77	10.21	7.66	.00	106.53		
BED: 160														
DEEP >28	.00	.19	.33	.52	1.33	.85	.28	.00	.00	.00	.00	3.52	3	1.1
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	.19	.33	.52	1.33	.85	.28	.00	.00	.00	.00	3.52		
BED: 161														
DEEP >28	.00	.00	.00	.00	.00	.00	4.58	.00	.00	.00	.00	4.58	1	2.1
STRIP >28	.00	.00	.00	.00	.00	.00	.90	.00	.00	.00	.00	.90		
TOTAL	.00	.00	.00	.00	.00	.00	5.48	.00	.00	.00	.00	5.48		
BED: 164														
DEEP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.88	.88		
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.88	.88		
BED: 165														
DEEP >28	.00	.00	3.81	2.38	.00	.00	.00	.00	.00	.00	.00	6.20	3	.8
STRIP >28	.00	.00	1.83	1.15	.00	.00	.00	.00	.00	.00	.00	2.99		
TOTAL	.00	.00	5.64	3.53	.00	.00	.00	.00	.00	.00	.00	9.19		

(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)

Data from U.S.B.M. Inf. Circular 8680

VIRGINIA

BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS, TYPE OF MINING, AND SULFUR RANGE - JANUARY 1, 1974
(MILLION SHORT TONS)

COUNTY: LEE

THICKNESS	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO. OF ANAL	AVG S %
BED: 168														
DEEP >28	.00	.00	3.54	4.62	8.89	4.46	.91	.00	.00	.00	.00	22.48	11	1.1
STRIP >28	.00	.00	.43	.57	1.10	.55	.11	.00	.00	.00	.00	2.78		
TOTAL	.00	.00	3.97	5.19	9.99	5.01	1.02	.00	.00	.00	.00	25.26		
BED: 174														
DEEP >28	.00	.00	.00	.00	.00	11.13	.00	.00	.00	.00	.00	11.13	1	1.7
STRIP >28	.00	.00	.00	.00	.00	.85	.00	.00	.00	.00	.00	.85		
TOTAL	.00	.00	.00	.00	.00	11.98	.00	.00	.00	.00	.00	11.98		
COUNTY: TOTAL														
DEEP >28	1.38	11.16	17.04	14.07	24.92	37.48	27.30	15.74	8.90	6.59	2.51	167.41	340	
STRIP >28	2.33	13.94	10.29	5.91	5.76	7.09	6.49	3.83	2.11	1.52	3.50	62.94		
TOTAL	3.71	25.10	27.33	19.98	30.68	44.57	33.79	19.57	11.01	8.11	6.01	230.35		
COUNTY: 167 RUSSELL														
BED: 214														
DEEP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.02	189	.6
STRIP >28	1.05	7.92	1.37	.06	.00	.00	.00	.00	.00	.00	.00	10.41		
TOTAL	1.05	7.92	1.37	.06	.00	.00	.00	.00	.00	.00	.00	10.43		
BED: 216														
DEEP >28	.00	1.39	2.27	.47	.04	.00	.00	.00	.00	.00	.00	4.22	219	.7
STRIP >28	.00	7.69	12.54	2.64	.30	.00	.00	.00	.00	.00	.00	23.18		
TOTAL	.00	9.08	14.81	3.11	.34	.00	.00	.00	.00	.00	.00	27.40		
BED: 252														
DEEP >28	.00	.00	7.77	13.51	37.54	22.40	4.27	.00	.00	.00	.00	85.54	24	1.2
STRIP >28	.00	.00	1.47	2.56	7.11	4.24	.81	.00	.00	.00	.00	16.21		
TOTAL	.00	.00	9.24	16.07	44.65	26.64	5.08	.00	.00	.00	.00	101.75		

(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)

Data from U.S.B.M. Inf. Circular 8680

VIRGINIA

BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS, TYPE OF MINING, AND SULFUR RANGE - JANUARY 1, 1974
(MILLION SHORT TONS)

COUNTY: RUSSELL

THICKNESS	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO. OF ANAL	AVG S %
BED: 259														
DEEP >28	.00	9.03	16.86	4.82	.00	.00	.00	.00	.00	.00	.00	30.73	16	.7
STRIP >28	.00	.29	.55	.15	.00	.00	.00	.00	.00	.00	.00	1.01		
TOTAL	.00	9.32	17.41	4.97	.00	.00	.00	.00	.00	.00	.00	31.74		
BED: 266														
DEEP >28	.00	25.56	37.42	42.43	59.95	20.19	.00	.00	.00	.00	.00	185.31	12	.9
STRIP >28	.00	.24	.35	.40	.56	.19	.00	.00	.00	.00	.00	1.75		
TOTAL	.00	25.80	37.77	42.83	60.41	20.38	.00	.00	.00	.00	.00	187.06		
BED: 269														
DEEP >28	26.91	57.73	.00	.00	.00	.00	.00	.00	.00	.00	.00	84.66	12	.5
STRIP >28	.04	.10	.00	.00	.00	.00	.00	.00	.00	.00	.00	.15		
TOTAL	26.95	57.83	.00	.00	.00	.00	.00	.00	.00	.00	.00	84.81		
BED: 340														
DEEP >28	.00	12.54	.00	.00	.00	.00	.00	.00	.00	.00	.00	12.54	1	.5
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	12.54	.00	.00	.00	.00	.00	.00	.00	.00	.00	12.54		
COUNTY: TOTAL														
DEEP >28	26.91	106.25	64.32	51.23	97.43	42.59	4.27	.00	.00	.00	.00	403.02	473	
STRIP >28	1.09	15.24	16.28	5.81	7.97	4.43	.81	.00	.00	.00	.00	52.71		
TOTAL	28.00	122.49	80.60	57.04	105.40	47.02	5.08	.00	.00	.00	.00	455.73		
COUNTY: 169 SCOTT														
BED: 328														
DEEP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.94	1.94		
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.94	1.94		

(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)

Data from U.S.B.M. Inf. Circular 8680

VIRGINIA

BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS, TYPE OF MINING, AND SULFUR RANGE - JANUARY 1, 1974
(MILLION SHORT TONS)

COUNTY: SCOTT

THICKNESS	≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO. OF ANAL	AVG S %
						RESERVES BY SULFUR RANGE, PERCENT								
BED: 329														
DEEP >28	.00	.00	.00	3.60	.00	.00	.00	.00	.00	.00	.00	3.60	1	.9
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	.00	.00	3.60	.00	.00	.00	.00	.00	.00	.00	3.60		
BED: 331														
DEEP >28	.00	.00	.00	.00	.00	1.18	.00	.00	.00	.00	.00	1.18	1	1.6
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	.00	.00	.00	.00	1.18	.00	.00	.00	.00	.00	1.18		
BED: 332														
DEEP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	3.58	3.58		
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	3.58	3.58		
BED: 340														
DEEP >28	.00	.00	.00	34.35	.00	.00	.00	.00	.00	.00	.00	34.35	2	.9
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	.00	.00	34.35	.00	.00	.00	.00	.00	.00	.00	34.35		
COUNTY: TOTAL														
DEEP >28	.00	.00	.00	37.95	.00	1.18	.00	.00	.00	.00	5.52	44.65	4	
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	.00	.00	37.95	.00	1.18	.00	.00	.00	.00	5.52	44.65		
COUNTY: 185 TAZEWELL														
BED: 232														
DEEP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	3.10	3.10		
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	3.10	3.10		

(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)

Data from U.S.B.M. Inf. Circular 8680

VIRGINIA

BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS, TYPE OF MINING, AND SULFUR RANGE - JANUARY 1, 1974
(MILLION SHORT TONS)

COUNTY: TAZEWELL

THICKNESS		RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO. OF ANAL	AVG S %
BED: 252															
DEEP	>28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	2	1.0
STRIP	>28	.00	.00	.00	4.55	.00	.00	.00	.00	.00	.00	.00	4.55		
TOTAL		.00	.00	.00	4.55	.00	.00	.00	.00	.00	.00	.00	4.55		
BED: 259															
DEEP	>28	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.02	271	.7
STRIP	>28	.00	5.56	12.64	2.56	.23	.00	.00	.00	.00	.00	.00	21.00		
TOTAL		.00	5.56	12.65	2.56	.23	.00	.00	.00	.00	.00	.00	21.02		
BED: 266															
DEEP	>28	.00	33.50	8.01	.00	.00	.00	.00	.00	.00	.00	.00	41.51	8	.5
STRIP	>28	.00	4.65	1.11	.00	.00	.00	.00	.00	.00	.00	.00	5.77		
TOTAL		.00	38.15	9.12	.00	.00	.00	.00	.00	.00	.00	.00	47.30		
BED: 269															
DEEP	>28	.00	1.59	2.65	3.20	4.24	1.12	.00	.00	.00	.00	.00	12.83	8	1.0
STRIP	>28	.00	.41	.69	.84	1.11	.29	.00	.00	.00	.00	.00	3.37		
TOTAL		.00	2.00	3.34	4.04	5.35	1.41	.00	.00	.00	.00	.00	16.20		
BED: 271															
DEEP	>28	1.06	7.72	1.06	.00	.00	.00	.00	.00	.00	.00	.00	9.85	14	.5
STRIP	>28	.21	1.55	.21	.00	.00	.00	.00	.00	.00	.00	.00	1.98		
TOTAL		1.27	9.27	1.27	.00	.00	.00	.00	.00	.00	.00	.00	11.83		
BED: 274															
DEEP	>28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	3.66	3.66		
STRIP	>28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.71	.71		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	4.37	4.37		

(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)

Data from U.S.B.M. Inf. Circular 8680

VIRGINIA

BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS, TYPE OF MINING, AND SULFUR RANGE - JANUARY 1, 1974
(MILLION SHORT TONS)

COUNTY: TAZEWELL

THICKNESS	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO. OF ANAL	AVG S %
BED: 275														
DEEP >28	.00	.00	.00	1.12	.00	.00	.00	.00	.00	.00	.00	1.12	3	1.0
STRIP >28	.00	.00	.00	.37	.00	.00	.00	.00	.00	.00	.00	.37		
TOTAL	.00	.00	.00	1.49	.00	.00	.00	.00	.00	.00	.00	1.49		
BED: 285														
DEEP >28	.00	.00	.00	3.86	12.08	3.90	.00	.00	.00	.00	.00	19.88	7	1.2
STRIP >28	.00	.00	.00	.25	.80	.26	.00	.00	.00	.00	.00	1.32		
TOTAL	.00	.00	.00	4.11	12.88	4.16	.00	.00	.00	.00	.00	21.20		
BED: 293														
DEEP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	9.98	9.98		
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.32	1.32		
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	11.30	11.30		
BED: 302														
DEEP >28	.00	4.23	4.23	.00	.00	.00	.00	.00	.00	.00	.00	8.47	2	.7
STRIP >28	.00	1.75	1.75	.00	.00	.00	.00	.00	.00	.00	.00	3.50		
TOTAL	.00	5.98	5.98	.00	.00	.00	.00	.00	.00	.00	.00	11.97		
BED: 304														
DEEP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	2.46	2.46		
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	2.46	2.46		
BED: 311														
DEEP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	16.43	16.43		
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.97	.97		
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	17.40	17.40		

(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)

Data from U.S.B.M. Inf. Circular 8680

VIRGINIA

BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS, TYPE OF MINING, AND SULFUR RANGE - JANUARY 1, 1974
(MILLION SHORT TONS)

COUNTY: TAZEWELL

THICKNESS	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO. OF ANAL	AVG S %
BED: 319														
DEEP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	2.42	2.42		
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.59	.59		
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	3.01	3.01		
BED: 341														
DEEP >28	.00	9.61	6.27	.00	.00	.00	.00	.00	.00	.00	.00	15.90	23	.6
STRIP >28	.00	.23	.15	.00	.00	.00	.00	.00	.00	.00	.00	.39		
TOTAL	.00	9.84	6.42	.00	.00	.00	.00	.00	.00	.00	.00	16.29		
BED: 342														
DEEP >28	.00	9.50	.00	.00	.00	.00	.00	.00	.00	.00	.00	9.50	2	.5
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	9.50	.00	.00	.00	.00	.00	.00	.00	.00	.00	9.50		
BED: 344														
DEEP >28	1.56	7.04	3.36	.00	.00	.00	.00	.00	.00	.00	.00	11.99	41	.6
STRIP >28	.04	.22	.10	.00	.00	.00	.00	.00	.00	.00	.00	.38		
TOTAL	1.60	7.26	3.46	.00	.00	.00	.00	.00	.00	.00	.00	12.37		
COUNTY: TOTAL														
DEEP >28	2.62	73.19	25.59	8.18	16.32	5.02	.00	.00	.00	.00	34.95	166.04	381	
STRIP >28	.25	14.37	16.65	8.57	2.14	.55	.00	.00	.00	.00	6.69	49.32		
TOTAL	2.87	87.56	42.24	16.75	18.46	5.57	.00	.00	.00	.00	41.64	215.36		
COUNTY: 195 WISE														
BED: 104														
DEEP >28	.00	.15	.20	.04	.00	.00	.00	.00	.00	.00	.00	.41	232	.7
STRIP >28	.00	.67	.91	.19	.02	.00	.00	.00	.00	.00	.00	1.81		
TOTAL	.00	.82	1.11	.23	.02	.00	.00	.00	.00	.00	.00	2.22		

(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)

Data from U.S.B.M. Inf. Circular 8680

VIRGINIA

BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY BED, THICKNESS, TYPE OF MINING, AND SULFUR RANGE - JANUARY 1, 1974
(MILLION SHORT TONS)

COUNTY: WISE

THICKNESS		RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO. OF ANAL	AVG S %
BED: 111															
DEEP	>28	.00	7.53	5.10	.00	.00	.00	.00	.00	.00	.00	.00	12.65	39	.7
STRIP	>28	.00	6.18	4.18	.00	.00	.00	.00	.00	.00	.00	.00	10.37		
TOTAL		.00	13.71	9.28	.00	.00	.00	.00	.00	.00	.00	.00	23.02		
BED: 126															
DEEP	>28	.00	.00	7.45	15.30	22.57	2.43	.00	.00	.00	.00	.00	47.84	27	1.0
STRIP	>28	.00	.00	2.52	5.17	7.62	.82	.00	.00	.00	.00	.00	16.16		
TOTAL		.00	.00	9.97	20.47	30.19	3.25	.00	.00	.00	.00	.00	64.00		
BED: 142															
DEEP	>28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	35.12	35.12		
STRIP	>28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	5.63	5.63		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	40.75	40.75		
BED: 151															
DEEP	>28	.64	8.03	26.83	5.11	.00	.00	.00	.00	.00	.00	.00	40.61	140	.7
STRIP	>28	.18	2.33	7.79	1.48	.00	.00	.00	.00	.00	.00	.00	11.80		
TOTAL		.82	10.36	34.62	6.59	.00	.00	.00	.00	.00	.00	.00	52.41		
BED: 152															
DEEP	>28	.00	1.55	2.15	2.93	8.41	11.78	12.14	9.39	5.74	5.44	.00	59.82	16	1.2
STRIP	>28	.00	.15	.21	.29	.86	1.18	1.22	.94	.57	.54	.00	6.01		
TOTAL		.00	1.70	2.36	3.22	9.47	12.96	13.36	10.33	6.31	5.98	.00	65.83		
BED: 157															
DEEP	>28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	10.40	10.40		
STRIP	>28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	10.40	10.40		

(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)

Data from U.S.B.M. Inf. Circular 8680

VIRGINIA

BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS, TYPE OF MINING, AND SULFUR RANGE - JANUARY 1, 1974
(MILLION SHORT TONS)

COUNTY: WISE

THICKNESS	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO. OF ANAL	AVG S %
BED: 165														
DEEP >28	.00	.00	7.21	22.09	5.75	.00	.00	.00	.00	.00	.00	35.07	16	.9
STRIP >28	.00	.00	9.26	28.33	7.37	.00	.00	.00	.00	.00	.00	44.98		
TOTAL	.00	.00	16.47	50.42	13.12	.00	.00	.00	.00	.00	.00	80.05		
BED: 168														
DEEP >28	.00	1.80	29.85	1.80	.03	.00	.00	.00	.00	.00	.00	33.55	2294	.7
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	1.80	29.85	1.80	.03	.00	.00	.00	.00	.00	.00	33.55		
BED: 174														
DEEP >28	.00	.00	6.50	8.01	16.61	11.04	4.99	.00	.00	.00	.00	47.20	12	1.2
STRIP >28	.00	.00	4.94	6.08	12.60	8.37	3.79	.00	.00	.00	.00	35.81		
TOTAL	.00	.00	11.44	14.09	29.21	19.41	8.78	.00	.00	.00	.00	83.01		
BED: 177														
DEEP >28	.00	.08	.20	.28	.18	.00	.00	.00	.00	.00	.00	.77	27	.9
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	.08	.20	.28	.18	.00	.00	.00	.00	.00	.00	.77		
BED: 178														
DEEP >28	.00	.00	.98	1.70	5.51	4.59	1.74	.00	.00	.00	.00	14.55	3	1.4
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	.00	.98	1.70	5.51	4.59	1.74	.00	.00	.00	.00	14.55		
BED: 185														
DEEP >28	.00	.00	3.03	5.58	20.80	21.16	9.05	2.48	.00	.00	.00	62.10	28	1.4
STRIP >28	.00	.00	.87	1.61	5.99	6.10	2.61	.71	.00	.00	.00	17.89		
TOTAL	.00	.00	3.90	7.19	26.79	27.26	11.66	3.19	.00	.00	.00	79.99		

(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)

Data from U.S.B.M. Inf. Circular 8680

VIRGINIA

BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS, TYPE OF MINING, AND SULFUR RANGE - JANUARY 1, 1974
(MILLION SHORT TONS)

COUNTY: WISE

THICKNESS	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO. OF ANAL	AVG S %
BED: 189														
DEEP >28	.00	.00	.00	7.93	38.55	3.71	.00	.00	.00	.00	.00	50.20	14	1.2
STRIP >28	.00	.00	.00	1.70	8.27	.79	.00	.00	.00	.00	.00	10.78		
TOTAL	.00	.00	.00	9.63	46.82	4.50	.00	.00	.00	.00	.00	60.98		
BED: 214														
DEEP >28	.00	22.72	28.66	5.70	.00	.00	.00	.00	.00	.00	.00	57.11	457	.7
STRIP >28	.00	4.70	5.92	1.18	.00	.00	.00	.00	.00	.00	.00	11.81		
TOTAL	.00	27.42	34.58	6.88	.00	.00	.00	.00	.00	.00	.00	68.92		
BED: 216														
DEEP >28	.00	8.52	21.35	12.51	2.75	.00	.00	.00	.00	.00	.00	45.17	9	.9
STRIP >28	.00	1.08	2.70	1.58	.34	.00	.00	.00	.00	.00	.00	5.72		
TOTAL	.00	9.60	24.05	14.09	3.09	.00	.00	.00	.00	.00	.00	50.89		
BED: 252														
DEEP >28	.00	.00	49.94	.00	.00	.00	.00	.00	.00	.00	.00	49.94	2	.9
STRIP >28	.00	.00	4.93	.00	.00	.00	.00	.00	.00	.00	.00	4.93		
TOTAL	.00	.00	54.87	.00	.00	.00	.00	.00	.00	.00	.00	54.87		
BED: 259														
DEEP >28	.00	.00	9.41	11.35	18.80	7.83	2.22	.00	.00	.00	.00	49.62	19	1.1
STRIP >28	.00	.00	.99	1.20	1.98	.82	.23	.00	.00	.00	.00	5.25		
TOTAL	.00	.00	10.40	12.55	20.78	8.65	2.45	.00	.00	.00	.00	54.87		
BED: 266														
DEEP >28	.00	21.60	22.24	12.24	6.15	.56	.00	.00	.00	.00	.00	62.83	51	.7
STRIP >28	.00	1.35	1.39	.77	.38	.03	.00	.00	.00	.00	.00	3.95		
TOTAL	.00	22.95	23.63	13.01	6.53	.59	.00	.00	.00	.00	.00	66.78		

(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)

Data from U.S.B.M. Inf. Circular 8680

VIRGINIA

BITUMINOUS COAL RESERVE BASE BY STATE, COUNTY, BED, THICKNESS, TYPE OF MINING, AND SULFUR RANGE - JANUARY 1, 1974
(MILLION SHORT TONS)

COUNTY: WISE

THICKNESS	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO. OF ANAL	AVG S %
BED: 328														
DEEP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.19	.19		
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.19	.19		
BED: 340														
DEEP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.45	1.45		
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.45	1.45		
COUNTY: TOTAL														
DEEP >28	.64	71.08	221.10	112.57	146.31	63.10	30.14	11.87	5.74	5.44	47.16	716.60	3386	
STRIP >28	.18	16.46	46.61	49.58	45.43	18.11	7.85	1.65	.57	.54	5.63	192.90		
TOTAL	.82	88.44	267.71	162.15	191.74	81.21	37.99	13.52	6.31	5.98	52.79	909.50		
STATE TOTAL														
DEEP >28	51.35	480.90	646.52	497.28	620.28	209.56	73.11	27.83	14.64	12.03	198.31	2833.24	6957	
STRIP >28	9.24	100.40	162.58	139.36	146.68	46.57	16.65	5.48	2.68	2.06	46.69	679.24		
TOTAL	60.59	581.30	809.10	636.64	766.96	256.13	89.76	33.31	17.32	14.09	245.00	3512.48		

(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)

Data from U.S.B.M. Inf. Circular 8680

Anthracite Coalbed Code Numbers
(Used in USBM Inf. Circ. 8655 and 8680)

376 Gunton, Merrimac (Upper Bench), No. 1

377 Brushy Mountain, Merrimac

378 Clark, Merrimac (Lower Bench), No. 2

379 Langhorne, No. 3

VIRGINIA

UNDERGROUND ANTHRACITE RESERVE BASE BY STATE, COUNTY, BED, THICKNESS AND SULFUR RANGE - JANUARY 1, 1974
MILLION SHORT TONS

COUNTY: MONTGOMERY

THICKNESS	BED	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO.OF ANAL	AVG S %
28-42	001	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	4.00	4.00		
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	16.23	16.23		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	20.23	20.23		
28-42	377	.32	1.37	2.52	1.22	.00	.00	.00	.00	.00	.00	.00	5.45	158	.8
> 42		2.82	11.86	21.79	10.59	.00	.00	.00	.00	.00	.00	.00	47.08		
TOTAL		3.14	13.23	24.31	11.81	.00	.00	.00	.00	.00	.00	.00	52.53		
COUNTY:	TOTAL														
28-42		.32	1.37	2.52	1.22	.00	.00	.00	.00	.00	.00	4.00	9.45	158	
> 42		2.82	11.86	21.79	10.59	.00	.00	.00	.00	.00	.00	16.23	63.31		
TOTAL		3.14	13.23	24.31	11.81	.00	.00	.00	.00	.00	.00	20.23	72.76		
COUNTY: 155	PULASKI														
28-42	001	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.19	1.19		
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	63.54	63.54		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	64.73	64.73		
COUNTY:	TOTAL														
28-42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.19	1.19		
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	63.54	63.54		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	64.73	64.73		
COUNTY: 197	WYTHE														
COUNTY:	TOTAL														
28-42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
> 42		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)

(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

Data from U.S.B.M. Inf. Circular 8655.

UNDERGROUND ANTHRACITE RESERVE BASE BY STATE, COUNTY, BED, THICKNESS AND SULFUR RANGE - JANUARY 1, 1974
MILLION SHORT TONS

COUNTY: WYTHE

THICKNESS	BED	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO.OF ANAL	AVG S %
STATE TOTAL															
28-42		.32	1.37	2.52	1.22	.00	.00	.00	.00	.00	.00	5.19	10.64	158	
> 42		2.82	11.86	21.79	10.59	.00	.00	.00	.00	.00	.00	79.77	126.85		
TOTAL		3.14	13.23	24.31	11.81	.00	.00	.00	.00	.00	.00	84.96	137.49		

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)

(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

Data from U.S.B.M. Inf. Circular 8655.

VIRGINIA

ANTHRACITE RESERVE BASE BY STATE, COUNTY, BED, THICKNESS, TYPE OF MINING, AND SULFUR RANGE - JANUARY 1, 1974
(MILLION SHORT TONS)

COUNTY: MONTGOMERY

THICKNESS	RESERVES BY SULFUR RANGE, PERCENT ≤.4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO. OF ANAL	AVG S %
BED: 001														
DEEP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	20.23	20.23		
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	20.23	20.23		
BED: 377														
DEEP >28	3.14	13.23	24.31	11.81	.00	.00	.00	.00	.00	.00	.00	52.53	158	.8
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	3.14	13.23	24.31	11.81	.00	.00	.00	.00	.00	.00	.00	52.53		
COUNTY: TOTAL														
DEEP >28	3.14	13.23	24.31	11.81	.00	.00	.00	.00	.00	.00	20.23	72.76	158	
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	3.14	13.23	24.31	11.81	.00	.00	.00	.00	.00	.00	20.23	72.76		
COUNTY: 155 PULASKI														
BED: 001														
DEEP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	64.73	64.73		
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	64.73	64.73		
COUNTY: TOTAL														
DEEP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	64.73	64.73		
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	64.73	64.73		
COUNTY: 155 PULASKI														

(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)

Data from U.S.B.M. Inf. Circular 8680

VIRGINIA

ANTHRACITE RESERVE BASE BY STATE, COUNTY, BED,
THICKNESS, TYPE OF MINING, AND SULFUR RANGE - JANUARY 1, 1974
(MILLION SHORT TONS)

COUNTY: PULASKI

THICKNESS	RESERVES BY SULFUR RANGE, PERCENT ≤ .4	.5-.6	.7-.8	.9-1.0	1.1-1.4	1.5-1.8	1.9-2.2	2.3-2.6	2.7-3.0	> 3.0	UNKNOWN	TOTAL	NO. OF ANAL	AVG S %
STATE TOTAL														
DEEP >28	3.14	13.23	24.31	11.81	.00	.00	.00	.00	.00	.00	84.96	137.49	158	
STRIP >28	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		
TOTAL	3.14	13.23	24.31	11.81	.00	.00	.00	.00	.00	.00	84.96	137.49		

(INCLUDES ONLY COAL FROM MEASURED AND INDICATED CATEGORIES OF RELIABILITY)

(DISTRIBUTION MAY NOT ADD TO TOTAL BECAUSE OF ROUNDING)

Data from U.S.B.M. Inf. Circular 8680

ANALYSES

ANALYSES OF SOME VIRGINIA COALS

Southwest Field

Source	Coal Bed	% Moisture	% Ash	% Sulfur	% Volatile Matter	% Fixed Carbon	BTU
2	Low Splint	2.3	6.0	0.9	38.2	53.5	13,720
1	Taggart	1.5 - 4.3	1.7 - 4.6	0.4 - 0.8	32.8 - 38.4	55.4 - 61.6	13,720 - 14,810
2	Kelly	4.93	8.32	0.72	—	—	13,119
1, 2	Imboden	1.8 - 3.0	1.2 - 10.2	0.6 - 0.9	33.0 - 38.0	53.6 - 61.3	13,230 - 14,450
1, 2, 3	Clintwood	1.0 - 6.01	2.2 - 11.52	0.56 - 1.7	30.87 - 38.5	55.22 - 61.9	12,295 - 14,530
3	Eagle	1.0 - 1.2	6.9 - 9.3	0.8 - 2.0	30.6 - 32.2	60.1 - 60.9	13,870 - 14,330
2, 3	Blair	1.0 - 3.1	4.4 - 14.2	0.96 - 1.2	29.4 - 32.3	56.4 - 63.3	13,040 - 14,750
1	Dorchester	2.0 - 5.3	4.1 - 10.2	0.8 - 2.6	31.8 - 36.1	53.4 - 59.7	13,270 - 14,380
2, 3	Hagy	0.7 - 4.86	7.85 - 12.7	0.9 - 1.4	29.9 - 31.0	56.29 - 57.4	13,378 - 13,460
3	Splash Dam	0.8	5.3 - 14.8	0.8 - 1.0	28.0 - 33.7	57.2 - 65.0	13,150 - 14,730
1	Upper Banner	1.6 - 3.9	4.1 - 14.4	0.5 - 1.3	30.4 - 37.4	51.9 - 63.1	12,600 - 14,690
1, 3	Lower Banner	0.5 - 8.1	5.6 - 11.2	0.6 - 1.8	21.4 - 36.6	54.6 - 69.5	13,030 - 14,370
3	Kennedy	0.7 - 1.0	3.9 - 6.1	1.0 - 1.3	23.1 - 27.5	68.6 - 70.8	14,640 - 14,890
3	Raven	0.4 - 1.1	3.8 - 4.6	0.5 - 1.1	21.3 - 31.3	64.7 - 74.6	14,920 - 15,190
1	Tiller	1.8 - 3.0	6.1 - 8.9	0.4 - 0.6	30.6 - 32.5	57.4 - 60.3	13,500 - 14,180
3	Pocahontas #3	0.4	7.6	0.6	17.3	75.1	14,420

Source: See following page.

Valley Fields

Source	Coal Bed	% Moisture	% Ash	% Sulfur	% Volatile matter	% Fixed Carbon	BTU
1	Merrimac	1.2 - 4.8	14.1 - 24.6	0.5 - 0.8	8.8 - 12.9	61.4 - 74.6	11,250 - 12,880
1	Langhorne	2.9 - 4.7	12.8 - 19.6	0.3 - 1.1	9.8 - 12.3	66.7 - 72.0	11,850 - 12,890

Source:

1 "Coal Resources of Virginia," U. S. Geological Survey Circular 171, 1952.

2 Company data

3 "Analyses of Tipple and Delivered Samples of Coal Collected During Fiscal Year 1966," U. S. Bureau of Mines, R.I. 6904, 1967.

Bituminous Coalbed Code Numbers
(Used in USBM Inf. Circ. 8655)

001 Various

104 High Splint, No. 12

111 Cornett, Morris, No. 11

126 Limestone, No. 10, Pardee, Parsons, Smith

127 High Cliff, No. 9, Wax

133 Gin Creek, No. 8

135 Dean, Fire Clay, No. 7, Phillips

142 Buck Knob, Creveling, Low Splint, Mason, No. 6

151 C, Cedar Grove, Darby, Darby No. 5, Keokee, No. 5, Red Jacket, Roda, Taggart, Thacker, Upper Thacker

152 B, Dendron, Marker, Taggart Marker

154 Lower Cedar Grove, Lower Thacker

155 Kirk, No. 4

157 Alma, Harlan, Jackrock, No. 3, Puckett Creek, Upper Standiford, Wilson

160 Lower Standiford, No. 2-A, Upper St. Charles

161 Lower St. Charles, No. 2

164 Meadow, Pinhook

165 Five Foot, Kelly, Upper Bolling

166 Stone Creek

167 Campbell Creek Peerless

168 Burnwell, Campbell Creek, Freeburn, Imboden, Lower Bolling, Lower Campbell Creek, Lower Elkhorn, Lower Marrowbone, No. 1, No. 2 Gas, Pond Creek, Upper War Eagle, Warfield

171 Rocky Fork

172 Addington

174 Big Dorchester, Clintwood, Feds Creek, Matewan, North Fork, Norton No. 8

176 Eagle, Middle War Eagle, Mohawk

177 Bends Creek, Bentley, Blair

178 Lyons, Thompson

185 Big Dirt Seam, Dorchester, Esserville, Gladeville, Glamorgan, Haskell No. 3, Marcee, Norton No. 2

189 Middle Norton, Norton, Yellow Creek

195 Hagy, Lower War Eagle

210 Edwards, Splash Dam

214 Upper Banner

216 Cary, Gilbert, Lower Banner

232 Big Fork

250 Caldwell

252 Douglas, Harris, Kennedy, Widow Kennedy

253 Aily

259 Garden Hole, Jewell, Jewell Ridge, Lower Douglas, No. 6, Raven, Raven Red Ash, Red Ash

266 Iaeger, Jawbone, Lower Jewell, No. 5, Ratliff, Shannon

268 Jawbone-Tiller, Thick Tiller (Tiller and Jawbone)

269 Hogwallow, Lower Iaeger, No. 4, Tiller

271 Upper Seaboard

274 Greasy Creek, Sewell B

275 Middle Seaboard

285 Lower Seaboard, Sewell

293 Smith, Upper Horsepen, Welch

302 Little Raleigh, Middle Horsepen

304 C

311 Beckley, War Creek

319 Little Fire Creek, Lower Horsepen

323 Pocahontas No. 9

324 Pocahontas No. 8

325 Pocahontas No. 7

328 Cove Creek

329 Duncan, Egan

330 Carter

331 Milner, Tacus

332 Starns

334 Pocahontas No. 6

340 Burton's Ford

341 Pocahontas No. 5

342 Pocahontas No. 4

344 Pocahontas No. 3

357 Pocahontas No. 2

359 Pocahontas No. 1

799 Uncorrelated

Coalbed code numbers between 850 and 999 represent combinations of two coalbeds that are mined simultaneously.

Anthracite Coalbed Code Numbers
(Used in USBM Inf. Circ. 8655)

376 Gunton, Merrimac (Upper Bench), No. 1

377 Brushy Mountain, Merrimac

378 Clark, Merrimac (Lower Bench), No. 2

379 Langhorne, No. 3

AVERAGE ANALYSES OF COAL BY STATE, COUNTY, AND BED

VIRGINIA

COUNTY	BED	MOISTURE A.R.	ASH A.R.	ASH DRY	SULFUR A.R.	SULFUR DRY	SULFUR M&AF	BTU A.R.	BTU DRY	BTU M&AF	NO. OF ANAL
BUCHANAN	001	3.1	8.3	8.6	.9	1.0	1.0	13,650	14,100	15,420	1152
	151	3.2	4.6	4.8	.3	.4	.4	14,150	14,620	15,360	4
	174	2.4	6.6	6.8	.7	.8	.8	14,000	14,340	15,390	239
	176	2.5	6.3	6.5	1.1	1.2	1.2	14,120	14,480	15,490	28
	177	3.4	9.0	9.4	1.0	1.1	1.2	13,410	13,880	15,320	3
	195	2.3	7.5	7.7	.9	1.0	1.0	13,950	14,280	15,470	5
	210	3.0	7.6	7.9	.7	.8	.8	13,860	14,300	15,530	56
	214	3.2	5.6	5.8	.4	.5	.5	14,080	14,540	15,440	3
	216	3.4	8.9	9.3	.9	1.0	1.1	13,650	14,130	15,580	786
	252	2.5	5.6	5.8	.9	1.0	1.0	14,330	14,700	15,600	13
	259	3.3	5.2	5.4	.5	.6	.6	14,360	14,850	15,690	101
	266	2.2	11.7	12.0	.5	.6	.6	13,110	13,400	15,230	6
	269	2.4	7.0	7.2	.4	.5	.5	13,920	14,260	15,370	5
	344			7.6		.6	.6		14,420	15,610	1
	890	3.3	6.7	7.0	1.1	1.2	1.2	13,860	14,330	15,410	1
	931	4.8	9.8	10.3	1.0	1.1	1.2	13,220	13,890	15,480	1
	969	4.9	6.8	7.2	.7	.8	.8	13,660	14,360	15,470	1
	971	1.9	3.0	3.1	.5	.6	.6	14,950	15,240	15,730	3
	988	3.0	5.9	6.1	.7	.8	.8	14,150	14,600	15,550	4
	COUNTY AVERAGE	3.1	8.2	8.5	.8	.9	.9	13,720	14,180	15,490	2412
DICKENSON	001	1.8	8.9	9.1	.6	.7	.7	13,820	14,090	15,500	125
	174	3.7	5.5	5.8	.7	.8	.8	13,880	14,420	15,300	42
	176	2.8	7.7	8.0	1.2	1.3	1.4	13,950	14,350	15,600	3
	177	2.0	5.5	5.7	.6	.7	.7	14,210	14,500	15,380	1
	185	2.7	7.5	7.8	1.0	1.1	1.1	14,150	14,540	15,770	6
	195	2.3	8.1	8.3	1.8	1.9	2.0	13,880	14,210	15,500	4
	210	2.7	10.0	10.3	.6	.7	.7	13,440	13,820	15,400	264
	214	1.8	7.5	7.7	.6	.7	.7	14,040	14,320	15,510	836
	216	2.4	7.0	7.2	.7	.8	.8	14,020	14,360	15,480	43
	252	2.7	7.8	8.1	.7	.8	.8	13,890	14,270	15,530	10
	266	2.1	15.8	16.2	1.0	1.1	1.3	12,370	12,640	15,080	12
	269	2.3	7.4	7.6	.4	.5	.5	14,190	14,520	15,720	7
	868	1.8	5.2	5.4	.6	.7	.7	14,410	14,690	15,530	1
	869	2.6	11.9	12.3	.7	.8	.9	13,260	13,610	15,520	1
	921	3.1	8.5	8.8	.7	.8	.8	13,690	14,140	15,500	47
	987	2.5	10.6	10.9	1.8	1.9	2.1	13,250	13,590	15,250	1
	COUNTY AVERAGE	2.1	8.2	8.4	.6	.7	.7	13,890	14,190	15,490	1403
LEE	001	4.9	9.2	9.7	1.0	1.1	1.2	12,680	13,330	14,760	241
	104	4.9	5.0	5.3	.8	.9	.9	13,520	14,220	15,010	2

Data from U.S.B.M. Inf. Circular 8655.

AVERAGE ANALYSES OF COAL BY STATE, COUNTY, AND BED

VIRGINIA

COUNTY	BED	MOISTURE A.R.	ASH A.R.	ASH DRY	SULFUR A.R.	SULFUR DRY	SULFUR M&AF	BTU A.R.	BTU DRY	BTU M&AF	NO. OF ANAL
LEE	126	3.5	8.3	8.7	.7	.8	.8	13,110	13,580	14,880	33
	127	4.4	5.9	6.2	.7	.8	.8	13,360	13,980	14,900	1
	135	2.9	8.3	8.6	.7	.8	.8	13,160	13,560	14,830	28
	142	2.9	7.7	8.0	1.1	1.2	1.3	13,320	13,720	14,910	26
	151	3.4	4.4	4.6	.4	.5	.5	13,840	14,320	15,010	240
	152	2.3	2.7	2.8	.6	.7	.7	14,540	14,890	15,310	2
	157	3.6	5.3	5.5	1.6	1.7	1.7	13,710	14,220	15,050	22
	160	3.2	8.9	9.2	1.0	1.1	1.2	12,980	13,410	14,770	3
	161	2.8	5.6	5.8	2.0	2.1	2.2	13,550	13,940	14,800	1
	165	3.2	6.4	6.7	.7	.8	.8	13,550	14,000	15,010	3
	166	3.0	4.5	4.7	1.8	1.9	1.9	13,660	14,090	14,790	1
	168	2.9	5.7	5.9	1.0	1.1	1.1	13,690	14,090	14,980	11
	174	3.2	2.1	2.2	1.6	1.7	1.7	14,060	14,520	14,850	1
	185	3.5	12.2	12.7	2.3	2.4	2.7	12,470	12,920	14,800	1
	866	2.6	8.4	8.7	.7	.8	.8	13,250	13,610	14,900	29
	923	5.1	4.5	4.8	.4	.5	.5	13,410	14,130	14,840	3
	925	5.0	9.5	10.1	3.1	3.3	3.6	12,670	13,340	14,840	1
	945	4.1	5.1	5.4	.7	.8	.8	13,440	14,020	14,820	5
COUNTY AVERAGE		3.9	7.0	7.3	.8	.9	.9	13,270	13,810	14,890	654
MONTGOMERY	377	2.3	21.1	21.6	.6	.7	.8	11,680	11,950	15,240	158
COUNTY AVERAGE		2.3	21.1	21.6	.6	.7	.8	11,680	11,950	15,240	158
PULASKI	377	1.3	21.7	22.0	.4	.5	.6	11,580	11,730	15,040	19
	379	2.0	22.1	22.6	.5	.6	.7	11,610	11,850	15,300	12
COUNTY AVERAGE		1.6	21.8	22.2	.5	.6	.7	11,590	11,780	15,130	31
RUSSELL	001	1.5	8.1	8.3	.5	.6	.6	14,000	14,210	15,500	14
	214	1.7	6.3	6.5	.4	.5	.5	14,160	14,420	15,420	189
	216	3.0	7.6	7.9	.5	.6	.6	13,660	14,100	15,300	219
	252	2.6	9.3	9.6	1.1	1.2	1.3	13,150	13,510	14,940	24
	253	2.6	4.3	4.5	.8	.9	.9	14,230	14,610	15,300	1
	259	2.5	6.1	6.3	.6	.7	.7	14,220	14,590	15,570	16
	266	2.0	15.6	16.0	.8	.9	1.0	12,430	12,660	15,090	13
	269	2.1	7.6	7.8	.3	.4	.4	13,890	14,190	15,390	13
	340	3.6	3.7	3.9	.4	.5	.5	14,230	14,760	15,360	1
	921	1.9	7.9	8.1	.4	.5	.5	13,810	14,070	15,310	3
COUNTY AVERAGE		2.4	7.4	7.6	.5	.6	.6	13,850	14,190	15,350	493

Data from U.S.B.M. Inf. Circular 8655.

AVERAGE ANALYSES OF COAL BY STATE, COUNTY, AND BED

VIRGINIA

COUNTY	BED	MOISTURE A.R.	ASH A.R.	ASH DRY	SULFUR A.R.	SULFUR DRY	SULFUR M&AF	BTU A.R.	BTU DRY	BTU M&AF	NO. OF ANAL
SCOTT	329	3.1	6.3	6.6	.8	.9	.9	13,630	14,080	15,070	1
	331	3.2	5.6	5.8	1.5	1.6	1.6	13,750	14,200	15,080	1
	340	2.7	6.8	7.0	.8	.9	.9	13,660	14,040	15,090	2
COUNTY AVERAGE		2.9	6.4	6.6	.9	1.0	1.0	13,680	14,090	15,080	4
TAZEWELL	001	4.5	11.1	11.7	.4	.5	.5	13,030	13,650	15,450	31
	164	2.7	11.7	12.1	.5	.6	.6	13,110	13,480	15,330	6
	216	3.2	8.9	9.2	.5	.6	.6	13,630	14,090	15,510	5
	252	3.9	5.2	5.5	.9	1.0	1.0	13,420	13,960	14,770	2
	259	3.1	5.7	5.9	.6	.7	.7	14,310	14,780	15,700	271
	266	2.3	13.6	14.0	.4	.5	.5	12,980	13,290	15,450	8
	269	3.4	7.5	7.8	.8	.9	.9	13,720	14,210	15,410	8
	271	2.7	5.4	5.6	.4	.5	.5	14,360	14,760	15,630	14
	275	3.1	3.9	4.1	.9	1.0	1.0	14,550	15,030	15,670	3
	285	3.0	4.2	4.4	1.1	1.2	1.2	14,480	14,940	15,630	7
	302	3.2	9.2	9.6	.5	.6	.6	13,730	14,190	15,690	2
	341	2.7	6.1	6.3	.5	.6	.6	14,460	14,860	15,860	23
	342			7.1		.5	.5		14,520	15,620	2
	344	3.2	4.4	4.6	.5	.6	.6	14,530	15,010	15,740	41
COUNTY AVERAGE		3.2	6.2	6.5	.6	.7	.7	14,180	14,650	15,670	423
WISE	001	3.6	8.8	9.2	.6	.7	.7	13,270	13,770	15,160	838
	104	3.5	7.5	7.8	.5	.6	.6	13,330	13,820	14,980	232
	111	3.6	7.9	8.2	.5	.6	.6	13,200	13,690	14,910	39
	126	3.0	8.4	8.7	.9	1.0	1.0	13,330	13,760	15,070	27
	151	2.1	4.8	5.0	.5	.6	.6	14,320	14,630	15,400	140
	152	2.6	4.2	4.4	1.0	1.1	1.1	14,430	14,820	15,500	16
	153	2.6	3.4	3.5	.5	.6	.6	14,450	14,840	15,380	10
	161	4.1	4.9	5.2	1.6	1.7	1.7	13,910	14,500	15,300	1
	165	3.2	6.7	7.0	.8	.9	.9	13,920	14,380	15,460	16
	168	2.9	10.6	11.0	.6	.7	.7	13,120	13,510	15,180	2294
	171	3.4	6.1	6.4	.7	.8	.8	13,940	14,430	15,420	1
	174	4.5	9.2	9.7	1.1	1.2	1.3	12,980	13,590	15,050	12
	177	2.4	6.0	6.2	.8	.9	.9	14,070	14,420	15,370	27
	178	3.5	5.6	5.9	1.2	1.3	1.3	14,030	14,540	15,450	3
	185	2.6	8.0	8.3	1.3	1.4	1.5	13,600	13,960	15,220	28
	189	2.7	8.2	8.5	1.1	1.2	1.3	13,590	13,970	15,270	14
	210	2.0	8.6	8.8	1.2	1.3	1.4	13,740	14,020	15,370	1
	214	1.7	6.8	7.0	.5	.6	.6	14,120	14,380	15,460	457
	216	2.2	8.8	9.0	.6	.7	.7	13,720	14,030	15,420	9
	252	2.0	10.4	10.7	.7	.8	.8	13,450	13,720	15,370	2

Data from U.S.B.M. Inf. Circular 8655.

AVERAGE ANALYSES OF COAL BY STATE, COUNTY, AND BED

VIRGINIA

COUNTY	BED	MOISTURE A.R.	ASH A.R.	ASH DRY	SULFUR A.R.	SULFUR DRY	SULFUR M&AF	BTU A.R.	BTU DRY	BTU M&AF	NO. OF ANAL
WISE	259	2.3	12.1	12.4	.9	1.0	1.1	12,970	13,200	15,150	19
	266	1.5	14.4	14.7	.6	.7	.8	12,710	12,900	15,120	51
	867	1.7	4.3	4.4	.6	.7	.7	14,390	14,660	15,330	8
	890	6.1	4.3	4.6	.6	.7	.7	13,620	14,510	15,210	1
	929	2.5	5.5	5.7	.8	.9	.9	14,150	14,510	15,390	1
	930	3.8	11.0	11.5	.8	.9	1.0	12,760	13,260	14,980	1
	972	3.5	8.0	8.3	.6	.7	.7	13,460	13,950	15,210	1
COUNTY AVERAGE		2.9	9.4	9.7	.6	.7	.7	13,330	13,730	15,200	4249
STATE AVERAGE		2.9	8.7	9.0	.7	.8	.8	13,530	13,940	15,310	9827

Data from U.S.B.M. Inf. Circular 8655.

Major, Minor, and Trace Element Analysis

Major, minor, and trace element analyses are available for selected coals in the Southwest Coal Field from the Virginia Division of Mineral Resources. Channel samples are being collected by the Division and the United States Geological Survey. Quantitative determinations are made for 24 major, minor, and trace elements (including Al, As, Cd, Cu, F, Hg, Mn, Na, Pb, Se, U, and Fn) and semiquantitative determinations are made for 15 to 20 additional trace elements (including B, Be, Cr, Ge, Mo, Ni, and V). In addition, the United States Bureau of Mines provides proximate and ultimate analyses, BTU and forms-of-sulfur determinations, and the ash fusibility and free swelling index for each coal sample.

Analysis results for 49 coal samples collected by U. S. Geological Survey personnel during 1975, are available in the U.S.G.S. Open-file report 76-468. These analyses and other data collected by the Virginia Division of Mineral Resources and the United States Geological Survey will be entered into the National Coal Data System.

BIBLIOGRAPHY OF COAL
in
SOUTHWESTERN VIRGINIA

December 1979

(Cochraine, E. M.). Free-swelling and grindability indexes of United States coals: U. S. Bur. Mines, Inf. Cir. 8025, 83 p., 1961,

Albernethy, R. F.
(Cochrane, E. M.). Fusibility of ash of United States coals: U. S. Bur. Mines, Inf. Cir. 7923, 363 p., 1960, (p. 11, 14, 276-287)

Abernethy, R. F.
(Gibson, F. H.). Direct determination of oxygen in coal: U. S. Bur. Mines, Rept. Inv. 6753, 21 p., 1966.

Abernethy, R. F.
(Gibson, F. H.; Frederic, W. H.). Phosphorus, chlorine, sodium, and potassium in United States coals: U. S. Bur. Mines, Rept. Inv. 6579, 34 p., 1965.

Abernethy, R. F.
(Hattman, E. A.). Colorimetric determination of beryllium in coal: U. S. Bur. Mines, Rept. Inv. 7452, 8 p., 1970.

Abernethy, R. F.
(Peterson, M. J.; Gibson, F. H.). Major ash constituents in United States coals: U. S. Bur. Mines, Rept. Inv. 7240, 9 p., 1969.

Allen, R. M.
Characteristics of some coal seams in southern West Virginia and southwestern Virginia: Mineral Industries Jour., vol. 3, no. 3, p. 3-4, 1956.

Althouse, H. W.
The Norton coals of the Big Sandy basin: Eng. and Min. Jour., vol. 77, p. 235-236, 1904.

(Milner, R. L.). Geologic map of the Elkhorn City quadrangle, Kentucky-Virginia: U. S. Geol. Survey, Geol. Quad. Map GQ-951, scale 1:24,000, 1972.

Aresco, S. J.
(and others). Analyses of tipple and delivered samples of coal collected during fiscal years 1951-1959: U. S. Bur. Mines, Rept. Inv. 4934, 4972, 5085, 5221, 5270, 533[illegible] 5401, 5489, 5615.

Aresco, S. J.
(and others). Analyses of tipple and delivered samples of coal (collected during the fiscal years 1960-1969): U. S. Bur. Mines, Rept. Inv. 5792, 6086, 6300, 6461, 6792, 6904, 7104, 7219, 1960-1969.

Arndt, H. H.
(and others). Coal, in Mineral resources of the Appalachian region: U. S. Geol. Surve Prof. Paper 580, p. 102-133, 1968.

Ashburner, C. A.
Coal: U. S. Geol. Survey, Min. Res. for 1887, p. 168-382, 1888.

Averitt, Paul
(Berryhill, L. R.; Taylor, D. A.). Coal resources of the United States, a progress report, October 1, 1953: U. S. Geol. Survey, Cir. 293, 49 p., 1953.

Averitt, P.
Coal resources of the United States, Janua 1960: U. S. Geol. Survey, Prof. Paper 400-B, p. B81-B82, 1960.

Averitt, P.
Coal reserves of the United States--A progress report, 1 January 1960: U. S. Geol. Survey, Bull. 1136, 116 p., 1961.

Averitt, P.
Coal resources of the United States, January 1, 1967: U. S. Geol. Survey, Bull. 1275, 116 p., 1969.

Averitt, Paul
Coal resources of the United States: U. S. Geol. Survey, Bull. 1412, 131 p., 1975.

Averitt, P.
Stripping-coal resources of the United States: U. S. Geol. Survey, Bull. 1252-C, p. C1-C20, 1968.

Bache, Franklin
Coal sections developed by recent operations in Wise County, Virginia: Eng.& Min. Jour., vol. 57, p. 605, 1894.; AIME, Trans., vol. 24, p. 70-80, 1895.

Bielicki, R. J.
(Perkins, J. H.: Kissell, F. N.). Methane diffusion parameters for sized coal particles--a measuring apparatus and some preliminary results: U. S. Bur. Mines, Rept. Inv. 7657, 12 p., 1972.

Birge, G. W.
(Wolfson, D. E.; Lynch, J. H.). Carbonizing properties of coals from Buchanan, Dickenson, Russell, Tazewell, and Wise counties, Virginia: U. S. Bur. Mines, Rept. Inv. 6355, 22 p., 1964.

Branson, C. C., editor
Pennsylvanian system in the United States--A symposium: Am. Assoc. Petroleum Geologists, Spec. Pub. 1, 508 p., 1962.

Breckenridge, L. P.
A study of four hundred steaming tests made at the fuel-testing plant at St. Louis, Missouri, 1904-1906: U. S. Geol. Survey, Bull. 325, 196 p., 1907.

(and others). Coal resources of Virginia: U. S. Geol. Survey, Cir. 171, 57 p., 1952.

Burrows, J. S.
Mine sampling and chemical analyses of coals U. S. Geol. Survey, Bull. 362, 23 p., 1908.

Butts, Charles
Coal resources and general geology of the Pound Quadrangle, Virginia: Va. Geol. Survey, Bull. 9, 61 p., 1914.

Campbell, M. R.
Coal as a recorder of incipient rocks metamorphism: Econ. geology, vol. 25, p. 675-696, 1930.

Campbell, M. R.
Coal fields of the United States: U. S. Geol. Survey, Bull. 394, p. 7-26, 1909.

Campbell, M. R.
Description of the Bristol quadrangle(Virginia-Tennessee): U. S. Geol. Survey, Geol. Atlas, Folio 59, 8 p., maps, 1899.

Campbell, M. R.
Description of the Estillville sheet (Kentucky-Virginia-Tennessee): U. S. Geol. Survey, Geol. Atlas, Folio 12, 5 p., 1894.

Campbell, M. R.
Description of the Pocahontas Sheet (Virginia-West Virginia): U. S. Geol. Survey, Geol. Atlas, Folio 26, 5 p., maps, 1896.

Campbell, M. R.
Description of the Tazewell quadrangle, (Virginia-West Virginia): U. S. Geol. Survey, Geol. Atlas, Folio 44, 1897.

Campbell, M. R.
Geology of the Big Stone Gap coal field of Virginia and Kentucky: U. S. Geol. Survey, Bull. 111, 106 p., 106 p., 1893.

Campbell, M. R.
History of geologic work in Wise County coal field and correlation of the coal beds: Va. Geol. Survey, Bull. 24, p. 73-139, 1923.

Campbell, M. R.
Miscellaneous analyses of coal samples from various fields of the United States: U. S. Geol. Survey, Bull. 471, p. 629-655, 1912.

Campbell, M. R.
Miscellaneous analyses of coal samples from various fields of the United States: U. S. Geol. Survey, Bull. 531, p. 331-355, 1913.

Campbell, M. R.
Analyses of coal samples from various fields of the United States: U. S. Geol. Survey, Bull. 541, p. 491-526, 1914.

Campbell, M. R.
Analyses of coal samples from various parts of the United States: U. S. Geol. Survey, Bull. 621, p. 251-375, 1916.

Campbell, M. R.
(Woodruff, E. G.). The Powell Mountain coal field, Scott and Wise counties, Virginia, coal and lignite: U. S. Geol. Survey, Bull. 431, p. 147-162, 1911.

Caruccio, F. T.
(Ferm, J. C.). Paleoenvironment-predictor of acid mine drainage problems (abs.): Geol. Soc. America Abs. Programs, vol. 6, no. 7, p. 683-684, 1974.

Catlett, Charles
Coal outcrops: AIME, Trans., vol. 30, p. 559-566, 1901.

Cavallaro, J. A.
(Johnson, M. T.; Deurbrouck, A. W.). Sulfu reduction potential of the coals of the Unit States: U. S. Bur. Mines, Rept. Inv. 8118, 323 p., 1976. (p. 36, 237-241)

Cetinbas, Abdurrahman
(and others). Methane and dust controls fc longwalls, Pocahontas no. 3 coalbed, Grundy, Virginia: U. S. Bur. Mines, Rept. Inv. 7849, 16 p., 1974.

Clarke, F. W.
(Whitfield, J. E.; Chatard, T. M.). Analys of coal, iron, and manganese ores from Virginia: U. S. Geol. Sur., Bull. 55, p. 85-1889.

Colemen, S. L.
(and others). A comparison of the concentration of trace metals of environmental concern in lignite: Geol. Soc. America, Abs. Programs, vol. 8, no. 6, p. 818, 1976.

Crump, Lulie H.
Fuels and energy data--United States by states and cenus divisions, 1973: U. S. Bur. Mines, Inf. Cir. 8722, 112 p., 1976.

Crump, Lulie
Fuels and energy data-United States by sta and census divisions, 1974: U. S. Bur. Mine Inf. Cir. 8739, 163 p., 1977.

Crump, Lulie H.
(Reading, Charles L.). Fuel and energy data--United States by states and regions: U. S. Bur. Mines, Inf. Cir. 8647, 82 p., 1974.

Darton, N. H.
Description of the Staunton quadrangle, Virginia-West Virginia: U. S. Geol. Survey, Geol. Atlas, Folio 14, 4 p., geol. map, 1894.

vis, Floyd
The Pocahontas coal mines: The Virginias, vol. 6, p. 170-171, 1885.

Davis, J. D.
(and others). Carbonizing properties of Lower Banner coal from no. 56 Mine, Dante, Russell County, Virginia: U. S. Bur. Mines, Tech. Paper 720, 45 p., 1949.

DeCarlo, J. A.
(Sheridan, E. T.; Murphy, Z. E.). Sulfur content of United States coals: U. S. Bur. Mines, Inf. Cir. 8312, 44 p., 1966.

Deurbrouck, A. W.
(Palowitch, E. R.). Survey of sulfur reduction Appalachian region coals by stage crushing: U. S. Bur. Mines, Inf. Cir. 8282, 37 p., 1966

Deurbrouck, A. W.
Preparation characteristics of coal from Russell County, Virginia: U. S. Bur. Mines, Rept. Inv. 6342, 32 p., 1963.

Deurbrouck, A. W.
Preparation characteristics of coa Tazewell County, Virginia: U. S. B Rept. Inv. 6297, 31 p., 1963.

Deurbrouck, A. W.
Sulfur reduction pote the United States: U. no. 7633, 289 p., 1

trich, R.
(Fara, M
rapid co
Spec.

Eavenson, H. W.
The first century and a quarter of Americ coal industry: Pittsburg, privately printed 701 p., 1942.

Eby, J. B.
(Campbell, M. R.). Analyses of Virginia co U. S. Bur. Mines, Tech. Paper 656, 159 p., 1

Eby, J. B.
Geology and mineral resources of Wise Coun and the coal-bearing portion of Scott County Virginia: Va. Geol. Survey, Bull. 24, 617 p. 1923.

Edmundson, R. S.
An occurrence of Devonian coal in Frederic County, Virginia: Va. Acad. Sci., Proc. for 1937-1938, p. 72, 1938.

Edwards, W. S.
Coals and cokes of West Virginia. (Handboo of coals and cokes of the Great Kanawha, New River, Flat Top, and adjacent coal districts in West Virginia): Cincinnati, Ohio, Robert Clark & Co., 162 p., 1892.

Elder, C. H.

Englund, K. J.
Geologic map of the Bramwell quadrangle, West Virginia-Virginia: U. S. Geol. Survey, Geol. Quad. Map GQ-745, scale 1:24,000, 1968.

Englund, K. J.
(and others). Geology of the Ewing quadrangle, Kentucky and Virginia: U. S. Geol. Survey, Geol, Map GQ-172, scale 1:24,000, 1961.

Englund, K. J.
(and others). Geology of the Ewing Quadrangle, Kentucky and Virginia: U. S. Geol. Survey, Bull. 1142-B, 23 p., 1963.

Englund, K. J.
(Landis, E. R.; Smith, H. L.). Geology of the Varilla Quadrangle, Kentucky-Virginia: U. S. Geol. Survey, Geol. Quad. Map GQ-190, scale 1:24,000, 1963.

Englund, K. J.
(DeLaney, A. O.). Intertonguing relations of the Lee Formation in southwestern Virginia: U. S. Geol. Survey, Prof. Paper 550-D, p. D47-D52, 1966.

Englund, K. J.
Stratigraphy of the Lee Formation in the Cumberland Mountains of southeastern Kentucky: U. S. Geol. Survey, Prof. Paper 501-B, p. B30-B38, 1964.

Englund, K. J.
Virginia, In The Mississippian and Pensylvanian (Carboniferous) systems in the United States: U. S. Geol. Survey, Prof. 1110-C, 21 p., 1979.

Evans, R. J.
(Bitler, J. R.). Coal surface mining reclamation costs, Appalachian and Midwestern coal supply districts: U. S. Bur. Mines, Inf. Circ. 8695, 50 p., 1975.

Fieldner, A. C.
(and others). Analyses of coal: U. S. Bur.

Fieldner, A. C.
(and others). Analyses of mine and car samples of coal collected in the fiscal years 1913-1916: U. S. Bur.Mines, Bull. 123, 478 p., 1918.

Fieldner, A. C.
Analyses of mine and car samples of coal collected in the fiscal years 1916 to 1919: U. S. Bur. Mines, Bull. 193, 291, 1922.

Fieldner, A. C.
(and others). Analyses of Virginia coals: U. S. Bur. Mines, Tech. Paper 365, 75 p., 1926. SW, Valley, Richmond.

Fieldner, A. C.
(and others). Carbonizing properties and petrographic composition of Lower Banner-bed coal from Keen Mountain Mine, Buchanan County, Virginia, and the effect of blending this coal with Pittsburgh-bed (Warden Mine) coal: U. S. Bur. Mines, Tech. Paper 616, 47 p., 1940.

Fieldner, A. C.
(and others). Carbonizing properties and petrographic composition of Upper-Banner coal from Clinchfield no. 9 mine, Dickenson County, Virginia, . . . and of the effect of blending these coals with Beckely-bed coal: U. S. Bur. Mines, Tech. Paper 584, 81 p., 1938.

Fieldner, A. C.
(and others). Carbonizing properties and petrographic description of Clintwood Bed Coal from Buchanan Mines no. 1and 2, Buchanan County, Virginia: U. S. Bur. Mines, Tech. Pape 570, 34 p., 1936.

Fieldner, A. C.
Coal for coke production: U. S. Bur. Mines, Inf. Cir. 7559, 21 p., 1950.

Fieldner, A. C.
(Davis, J. D.). Gas-, Coke- and byproduct-making properties of America coals and their determination: U. S. Bur. Mines (in cooperation) with the American Gas Association, Roda No. 3 mine properties, 1934.

Fieldner, A. C.
(and others). Methods and apparatus used in determining the gas-, coke-, and by-product making properties of American coals, with results on a Taggart Bed coal from Roda, Wise County, Virginia: U. S. Bur. Mines, Bull. 344, 107, 1931. (p. 52-103)

Fieldner, A. C.
Reserves (of) solid fuels....: Oil & Gas Jour., vol. 47, no. 46, p. 138-140, 142, 145, 1949.

Fieldner, A. C.
Typical analyses of coals of the United States: U. S. Bur. Mines Bull. 446, 45 p., 1942.

infinger, Gerald L.
(Cervik, Joseph). Drainage of methane from the verlying Pocahontas no. 4 coal bed from orkings in the Pocahontas no. 3 coalbed: . S. Bur. Mines, Rept. Inv. 8359, 15 p., 979.

isher, C. A.
The Pocket coal district, Virginia in the ittle Black Mountain coal field: U. S. Geol. urvey, Bull. 341, p. 409-418, 1909.

lynn, G. J.
Average heating values of American coals y rank and states: U. S. Bur. Mines, Inf. ir. 7538, 11 p., 1949.

iles, A. W.
Coal resources of Virginia: Jour. Eng., niv. Virginia, vol. 7, no. 1, p. 1-5, 1926.

Giles, A. W.
Geology and coal resources of Dickenson County, Virginia: Va. Geol. Survey, Bull. 21, 224 p., 1921.

Giles, A. W.
Geology and coal resources of the coal-bearing portion of Lee County, Virginia: Va. Geol. Survey, Bull. 26, 216 p., 1925.

Gray, T. E.
(Boley, C. C.). Preparation characteristics of coal from Dickenson County, Virginia: U. S. Bur. Mines, Rept. Inv. 5405, 31 p., 1958.

Gray, T. E.
(Boley, C. C.). Preparation characteristics of coal from Wise County, Virginia: U. S. Bur. Mines, Rept. Inv. 5391, 50 p., 1958.

Guyot, Arnold
The Great Flat-top coal field: Coal Trade Jour., vol. 25, p. 432, 719, 766, 1886; The Indus. South, vol. 6, p. 254-255, 1886.

Harnsberger, T. K.
Geology and coal resources of the coal-bearing portion of Tazewell County, Virginia: Va. Geol. Survey, Bull. 19, 195 p., 1919.

Hayes, C. W.
The coal fields of the United States: U. S. Geol. Survey, 22nd Annu. Rept. for 1900-01, pt. 3, p. 7-24, 1901. About the same material, U. S. Geol. Survey, Bull. 213.

Hinds, Henry
Coal resources of the Clintwood and Bucu Quadrangle, Virginia: Va. Geol. Survey, Bull. 12, 206 p., 1916.

Hinds, Henry
Geology and coal resources of Buchanan County, Virginia: Va. Geol. Survey, Bull. 18, 278 p., 1918.

Holmes, C. R.
(Wilson, J. E.; Davis, J. D.). Comparative yields of light oil, tar and constituents from carbonization tests of 800°, 900°, and 1000°C: U. S. Bur. Mines, Rept. Inv. 3695, 12 p., 1943.

Holmes, J. A.
Preliminary report on the operations of the fuel-testing plant of U. S. Geological Survey at St. Louis, Missouri, 1905: U. S. Geol. Survey, Bull. 290, 240 p., 1906.

Holmes, J. A.
Report of the U. S. fuel testing plant at St. Louis, Missouri, January 1, 1906 to June 30, 1907: U. S. Geol. Survey, Bull. 332, 297,p, 1908.

Irani, M. C.
(Jeran, P. W.; Deul, Maurice). Methane emission from U. S. coal mines in 1973, a survey. A supplement to Inf. Cir. 8558: U. S. Bur. Mines, Inf. Cir. 8659, 47 p., 1974.

Irani, M. C.
(and others). Methane emission from U. S. coal mines in 1975, a survey. A supplement to Information Circular 8588 and 8659: U. S. Bur. Mines, Inf. Cir. 8733, 55 p., 1977.

Janus, J. B.
(Shirley, B. S.). Analyses of tipple and devivered samples of coal (collected during the fiscal years 1972, 1973, 1974' Bur. Mines, Rept. Invs. 7712, 78' 1973, 1973, 1975.

Janus, J. B.
Analyses of ti
coal collected
197

Johre
(p. 16

Kessler, Theodore
(Sharkey, A. G., Jr.; Friedel, R. A.). Analysis of trace elements in coal by spark-source mass spectrometry: U. S. Bur. Mines, Rept. Inv. 7714, 8 p., 1973.

Killebrew, J. B.
Note on the coal field of southwestern Virginia: Eng. /Min. Jour., vol. 47, p. 64-65, 1889.

Kirgis, F. L.
(Rice, W. E.; Moran, H. E.). Typical analyses bituminous coals produced in District 7 and 8 (Eastern KY., Southern W. Va., Va., Northeastern Tenn., and N. C.): U. S. Bur. Mines with the Consumer's Counsel Div., Office of the Bituminous Coal Consumers' Counsel, Data Book, vol. 1, 28 p., 1941.

Kissell, F. N.
(Bielicki, R. J.). An in-situ diffusion parameter for the Pittsburgh and Pocahontas No. 3 coal beds: U. S. Bur. Mines, Rept. Inv. 7668, 13 p., 1972.

Kissell, Fred N.
Methane migration characteristics of the Pocahontas No. 3 coal bed: U. S. Bur. Mines, Rept. Inv. 7649, 19 p., 1972.

Lesley, Joseph Peter
Manual of coal and its topography: Phil., J. B. Lippincott & Co., 224 p., 1856.

Lesley, J. P.
The geological structure of Tazewell, Russell, and Wise counties in Virginia: Am. Phil. Soc., Proc., vol. 12, p. 489-513, 1873.

Lord, N. W.
Analyses of coals in the United States, with description of mine and field samples collected between July 1, 1904 and June 30, 1910: U. S. Bur. Mines, Bull. 22, 1200 p., 1913. (P. 196-201)

Lord, N. W.
Experimental work conducted in the chemical laboratory of the United States fuel testing plant at St. Louis, Mo., 1905-1906: U. S. Bur. Mines, Bull. 323, 49 p., 1907.

McCreath, A. S.
(Invilliers, E. V.). Geological and chemical report on a portion of Virginia and Tennessee coal and Iron Company's property ...Wise County, Virginia: Abingdon, Va. (?), 67 p., 1892

McCreath, Andrew Smith
(d'invilliers, E. V). The Clinch Valley coal fields: U. S. Geol. Survey Min. Res. for 1892, p. 521-526, 1893.

McCullock, C. M.
(Deul, M.; Jeran, P. W.). Cleat in bituminous coal beds: U. S. Bur. Mines, Rept. Inv. 7910, 25 p., 1974.

McCullock, C. M.
(Jeran, P. W.; Sullivan, C. D.). Geologic investigations of underground coal mining problems: U. S. Bur. Mines, Rept. Inv. 8022, 30 , 1975.

McCulloch, C. M.
(and others). Measuring the methane content of bituminous coal beds: U. S. Bur. Mines, Rept.

McNay, L. M.
Coal refuse fires; an environmental hazard: U. S. Bur. Mines, Inf. Cir. 8515, 50 p., 1971.

Medlin, J. H.
(and others). Inorganic geochemistry of low-to-medium-sulfur coal beds in southwestern Virginia-southeastern West Virginia (abs.): EOS (AGU, Trans.), vol. 56, no. 6, p. 458, 197

Meissner, C. R., Jr.
(Miller, R. L.). Geologic map of the Honaker quadrangle, Russell, Tazewell, and Buchanan counties, Virginia: U. S. Geol. Survey, Open-File Rep., no. 79-528, 34 p., map 1:24,000, 1979.

Meissner, Charles
Preliminary geologic map of the Duty Quadrangl Virginia: U. S. Geol. Survey, Open-file Rept., 76-161, 19 p., scale 1:24,000, 1976.

Melton, R. A.
(Ferm, J. C.). Geologic factors effecting roof conditions in the Pocahontas no. 3 coal seam southern West Virginia and southwestern Virginia, in Carboniferous depositional environments in the Appalachian region (Ferm, J. C. and Horne, J. C.): Carolina Coal Group, Univ. of S. C., p. 596-604, illus., 1979.

Melton, R. A.
Study of geologic factors effecting conditio in the Pocahontas no. 3 coal seams, southern West Virginia: Doctoral, Univ. of South Caroli 1978.

Meyertons, C. T.
Mineralogy of some coal mine roof shales (Virginia): Min. Industries Jour., vol. 3, no. 1, p. 1-3, 8, 1956,; Thesis, Mineralogica investigation of coal mine roof shales in par of the southern Appalachian coal field: Master's, V. P. I., 1956.

Miller, J. W.
Preparation characteristics of coal from Lee County, Virginia: U. S. Bur. Mines, Rept

Miller, M. S.
Large subsurface potential of low-sulfur Pocahontas No. 3 coal, southwest Virginia: Va. Miner., vol. 18, no. 1, p. 5-6, 1972.

Miller, M. S.
Stratigraphy and coal beds of Upper Mississippian and Lower Pennsylvanian rocks in southwestern Virginia: Va. Div. Miner. Resour., Bull. 84, 211 p., 1974.

Miller, R. L.
(Meissner, C. R., Jr.). Geologic map of the Big A Mountain quadrangle, Buchanan and Russell counties, Virginia: U. S. Geol. Survey, Geol. Quad. Map, no. GQ-1350, scale 1:24,000, 1977.

Miller, R. L.
(Roen, J. B.). Geologic map of the Keokee quadrangle, Virginia-Kentucky: U. S. Geol. Quad. Map, no. GQ-851, scale 1:24,000, 1971.

Miller, R. L.
(Roen, J. B.). Geologic map of the Pennington Gap quadrangle, Lee County, Virginia, and Harlan County, Kentucky: U. S. Geol. Survey, Geol. Quad. Map, no. GQ-1098, scale 1:24,000, 1973.

Miller, R. L.
(Englund, K. J.). Geology of southwest Virginia coal fields and adjacent areas;: Virginia Geology Field Conf., 7th, Guideb. no. 7, 30 p., 1975.

Miller, R. L.
Pennsylvanian formations of southwest Virginia: U. S. Geol. Survey, Bull. 1280, 62 p., 1969.

Mitchum, R. M., Jr.
Pottsville strata (Pennsylvanian) of part of the central Appalachian coal field: Doctoral, Northwestern Univ., 1954.

Moore, T. D.
(Zabetakis, M. G.). Effect of a surface borehole on longwall gob degasification (Pocahontas No. 3 coal bed): U. S. Bur. Mines, Rept. Inv. 7657, 9 p., 1972.

Padgett, G. V.
(and others). Interpreting depositional environments in coal exploration cores (abs) Geol. Soc. America, Abs. Programs, vol. 8, no. 2, p. 240-241, 1976.

Paone, James
(Morning, J. L.; Giorgetti, Leo). Land utilization and reclamation in the mining industry, 1930-1971: U. S. Bur. Mines, Inf. Cir. 8642, 61 p. 1974.

Parker, E. W.
Coal (Virginia): U. S. Geol. Survey, Min. Resourc. for 1891, p. 520-528, 1892.

Parks, B. C.
(O'Donnell, H. J.). Petrography of American coals: U. S. Bur. Mines, Bull. 550, 193 p., 1956.

Place, P. B.
Virginia coals; their classification and analyses: Combustion, vol. 7, no. 1, p. 26-32, 1935.

Pope, George S.
Government coal purchases under specificati with analyses for the fiscal year 1909-10: U. S. Bur. Mines, Bull. 41, 97 p., 1912

Pope, George S.
Government coal purchases under specificati with analyses for the fiscal years 1908-1915: U. S. Bur. Mines. Bul. 119, 119 p., 1916.

Reynolds, D. A.
(Wolfson, D. E.). Coal carbonization--ammonium sulfate yields from coals of various regions of the United States: U. S. Bur. Mine Rept. Inv. 4526, 15 p., 1949.

Reynolds, D. A.
Coal carbonization--Effects of blending Pocahontas no. 3 coal with 12 high-volatile coals: U. S. Bur. Mines, Rept. Inv. 4552, 8 p., 1949.

Reynolds, D. A.
(Davis, J. D.). Coal carbonization properties of medium volatile coals of different types: U. S. Bur. Mines, Rept. Inv. 3749, 8 p., 1944.

Rice, C. L.
Geologic map of the Jenkins West quadrangle, Kentucky and Virginia: U. S. Geol. Survey, Geol. Quad. Map, no. GQ-1126, scale 1:24,000, 1973.

Rice, C. L.
(Wolcott, D. E.). Geologic map of the Whitesburg quadrangle, Kentucky-Virginia: U. S. Geol. Survey, Geol. Quad. Map, no. GQ-1119, scale 1:24,000, 1973.

Rice, G. S.
Bumps in coal mines of the Cumberland Field, Kentucky and Virginia--Causes and remedy: U. S. Bur. Mines, Rept. Inv. 3267, 36 p., 1935.

Rippe, J. J.
(Verno, L. J.; Denton, G. H.). Application of coal petrography to exploration, preparation and sales at Pittston, in Coal preparation (Anonymous): Am. Mining Congr., Wash., D. C., 7 p., illus., 1978.

Roberts, J. K.
Geology of the Virginia Triassic: Va. Geol. Survey, Bull. 29, 205 p., 1928. (p. 94-116)

(and others). Coal recovery from bituminous coal surface mines in eastern United States, a survey: U. S. Bur. Mines, Inf. Cir. 8738, 14 p., 1977.

Selvig, W. A.
Analyses of ash from coals of the United States: U. S. Bur. Mines, Tech. Paper 679, 20 p., 1945.

Selvig, W. A.
(Gibson, F. H.). Analyses of ash from United States coals: U. S. Bur. Mines, Bull 567, 33 p., 1956.

Selvig, W. A.
(Ode, W. H.). Low temperature carbonizati assays of North American coals: U. S. Bur. Mines, Bull. 571, 56 p., 1957.

Selvig, W. A.
Methods and apparatus used in determining the gas-, and by product making properties American coals...Taggart Bed coal from Rod Wise County, Virginia: U. S. Bur. Mines, Bul 344, p. 52-103, 1931.

Shotts, R. Q.
Remaining recoverable coal of a part of the southern Appalachian field: Soc. Minign Eng., Trans., vol. 223, p. 138-147, 1962.

Snyder, Ned H.
Analyses of samples of delivered coal collected from July 1, 1915 to January 1, 1922 . . . .: U. S. Bur. Mines, Bull. 230, 174 p., 1922.

Snyder, N. H.
Analyses of delivered coals: U. S. Bur. Mines, Tech. Paper 365, 75 p., 1926. (p. 64-69)

(Aresco, S. J.). Analyses of tipple and delivered samples of coal (collected during fiscal years 1948-1950, inclusive): U. S. Bur. Mines, Bull. 516, 133 p., 1953.

Southern Railway System
Coal reserves of Virginia served by the Southern Railway System: Southern Railway System, 48 p., 1965.

Sprunk, G. C.
(and others). Splint coals of the Appalachian region; their occurrence petrography, and comparison of chemical and physical properties with associated bright coals: U. S. Bur. Mines, Tech. Paper 615, 59 p., 1940.

Stahnichenko, T. M.
(Zubovic, P.; Sheffey, N. B.). Beryllium content of American coals: U. S. Geol. Survey Bull. 1081-K, p. K253-K295, 1961.

Stadnichenko, T. M.
(and others). Concentration of germanium in ash of American coals--A progress report: U. S. Geol. Survey, Cir. 272, 34 p., 1953.

Stahl, R. W.
Survey of burning coal-mine refuse banks: U. S. Bur. Mines, Inf. Cir. 8209, p. 30-31, 1964.

Stanton, F. M.
(Fieldner, A. C.). Miscellaneous analyses of coal: U. S. Geol. Survey, Bull. 470, p. 629-655. 1911.

Stemple, D. T.
A study of problems encountered in multiple-seam coal mining in the eastern United States: VPI, Eng. Expt. Sta. Ser. no. 107, 64 p., 1956.

Stevens, David Woods
A survey of the factors which effect thining of the lower Mississippian coals in Montgomery County, Virginia: Master's, V. P. I., 1959.

A geological reconnaissance of parts of Lee, Wise, Scott, and Washington counties, Virginia: Am. Phil. Soc., Proc., vol. 19, p. 219-262, 1881; The Virginias, vol. 2, p. 22-27, 1881.

Stevenson, J. J.
Carboniferous of the Appalachian Basin: Geol. Soc. America, Bull. vol. 14, p. 15-96, 1903.

Stevenson, J. J.
Carboniferous of the Appalachian Basin: Geol. Soc. America, Bull., vol. 15, p. 37-210, 1904. (p. 147-156)

Stevenson, J. J.
The mineral resources of southwest Virginia: N. Y. Acad. Sci., Trans., vol. 1, for 1881-1882. p. 159-163, 1882.

Stevenson, J. J.
Notes on the Quinnimont Coal Group in Mercer County of West Virginia and Tazewell County, of Virginia: The Virginias, vol. 2, p. 186-187, 1881.

Stone, Ralph Walton
Coal mining at Dante, Virginia: U. S. Geol. Survey, Bull. 316, Pt. 2, p. 68-75, 1907.

Stone, R. W.
Coal resources of the Russell Fork Basin in Kentucky and Virginia: U. S. Geol. Survey, Bull. 308, 127 p., 1908.

Stone, R. W.
The Russell Fork Coal Field, Virginia: U. S. Geol. Survey, Bull. 316, pt. 2, p. 55-67, 1907.

Stow, M. H.
The mineral resources and mineral industry of Virginia: Richmond, Va., Advisory Council on Virginia Economy, 96 p., 1951.

Snyder, N. H.
(Aresco, S. J.). Analyses of tipple and delivered samples of coal (collected during fiscal years 1948-1950, inclusive): U. S. Bur. Mines, Bull. 516, 133 p., 1953.

Southern Railway System
Coal reserves of Virginia served by the Southern Railway System: Southern Railway System, 48 p., 1965.

Sprunk, G. C.
(and others). Splint coals of the Appalachian region; their occurrence petrography, and comparison of chemical and physical properties with associated bright coals: U. S. Bur. Mines, Tech. Paper 615, 59 p., 1940.

Stahnichenko, T. M.
(Zubovic, P.; Sheffey, N. B.). Beryllium content of American coals: U. S. Geol. Survey Bull. 1081-K, p. K253-K295, 1961.

Stadnichenko, T. M.
nd others). Concentration of germanium in ash of American coals--A progress report: U. S. Geol. Survey, Cir. 272, 34 p., 1953.

Stahl, R. W.
Survey of burning coal-mine refuse banks: U. S. Bur. Mines, Inf. Cir. 8209, p. 30-31, 1964.

Stanton, F. M.
(Fieldner, A. C.). Miscellaneous analyses of coal: U. S. Geol. Survey, Bull. 470, p. 629-655, 1911.

Stemple, D. T.
A study of problems encountered in multiple-seam coal mining in the eastern United States: VPI, Eng. Expt. Sta. Ser. no. 107, 64 p., 1956.

Stevens, David Woods
A survey of the factors which effect thining of the lower Mississippian coals in Montgomery County, Virginia: Master's, V. P. I., 1959.

Stevenson, J. J.
A geological reconnaissance of parts of Lee, Wise, Scott, and Washington counties, Virginia: Am. Phil. Soc., Proc., vol. 19, p. 219-262, 1881; The Virginias, vol. 2, p. 22-27, 1881.

Stevenson, J. J.
Carboniferous of the Appalachian Basin: Geol. Soc. America, Bull. vol. 14, p. 15-96, 1903.

Stevenson, J. J.
Carboniferous of the Appalachian Basin: Geol. Soc. America, Bull., vol. 15, p. 37-210, 1904. (p. 147-156)

Stevenson, J. J.
The mineral resources of southwest Virginia: N. Y. Acad. Sci., Trans., vol. 1, for 1881-1882, p. 159-163, 1882.

Stevenson, J. J.
Notes on the Quinnimont Coal Group in Mercer County of West Virginia and Tazewell County, of Virginia: The Virginias, vol. 2, p. 186-187, 1881.

Stone, Ralph Walton
Coal mining at Dante, Virginia: U. S. Geol. Survey, Bull. 316, Pt. 2, p. 68-75, 1907.

Stone, R. W.
Coal resources of the Russell Fork Basin in Kentucky and Virginia: U. S. Geol. Survey, Bull. 308, 127 p., 1908.

Stone, R. W.
The Russell Fork Coal Field, Virginia: U. S. Geol. Survey, Bull. 316, pt. 2, p. 55-67, 1907.

Stow, M. H.
The mineral resources and mineral industry of Virginia: Richmond, Va., Advisory Council on Virginia Economy, 96 p., 1951.

Swanson, V. E.
(Medlin, J. H. and others). Collection, chemical analysis, and evaluation of coal samples in 1975: U. S. Geol. Survey, Open-File Rept. no. 76-468, 503 p., 1975.

Thomson, R. D.
(York, H. F.). The reserve base of United States coals by sulfur content, Part 1, The eastern states: U. S. Bur. Mines, Inf. Cir. 8680, 537 p., 1975. (p. 257-273, 356-357, 471-474, 437-505)

Toenges
(Anderson, R. L.). Mining methods used in the Grundy coal field of Buchanan County, Virginia: U. S. Bur. Mines, Inf. Cir. 6928, 43 p., 1936.

Trumbull, J. V. A.
Coal fields of the United States, sheet 1: U. S. Geol. Survey, scale 1:5,000,000, 1960.

U. S. Bureau of Mines
Analysis of tipple and delivered samples of coal collected during fiscal year 1969, 1970, 1971, Rept. Invs. 7346, 7490, 7588, 1970, 1971, 1972

U. S. Bureau of Mines
Analyses of Virginia coals: U. S. Bur. Mines, Tech. Paper 365, 75 p., 1926.

U. S. Bur. Mines
Strippable reserves of bituminous coal and lignite in the United States: U. S. Bur. Mines, Inf. Cir. 8531, 148 p., 1971.

U. S. bureau of Mines
The reserve base of bituminous coal and anthracite for underground mining the eastern United States: U. S. Bur. Mines., Inf. Cir. 8655, 428 p., 1974. (p. 207-218, 231-282, 367-370, 383-401)

Valentine, W. E.
Preparation plants for Buchanan County coal: Mining Cong. Jour., vol. 55, no. 9, p. 53-55, 58, 1969.

Virginia Department of Labor and Industry. Division of Mines and Quarries.
Annual report. (Reports contain a statistical summary of coal-mining in Virginia for years indicated)

Walker, F. E.
(Hartner, F. E.). Forms of sulfur in United States coals: U. S. Bur. Mines, Inf. Cir. 8301, 51 p., 1966. (p. 38-40)

Walters, J. C.
(Ode, W. H.; Spinetti, L.). Plastic, agglutinating, and free-swelling properties of American coals: U. S. Bur. Mines, Bull. 610, 87 p., 1963.

Wanless, H. R.
Depositional basins of some Pennsylvanian coal beds in the United States, in Origin and constitution of coal, 3d Conf. Crystal Cliff, Nova Scotia, 1956: Halifax, Nova Scotia, Dept. Mines, p.94-128, [1961]

Wanless, H. R.
Geographic and stratigraphic distribution of Pennsylvanian coal in the United States (abs Econ. Geology, vol. 47, no. 7, p. 778-779, 1952; GSA Bull., vol. 63, no. 12, pt. 2, p. 1309, 1952.

Wanless, H. R.
Pennsylvanian correlation in the eastern interior and Appalachian coal fields: Geol. Soc. America, Spec. Paper 17, 130 p., 1939.

Wanless, H. R.
Pennsylvanian geology of part of the southern Appalachian coal field: Geol. Soc. America , Mem. 13, 132 p., 1946.

Watson, T. L.
Non-metallic minerals, in Mineral resources of Virginia, Pt. III: Lynchburg, Va., J. P. Bell Co., p. 188-401, 1907.

Wentworth, C. K.
Geology and coal resources of Russell County, Virginia: Va. Geol. Survey, Bull. 22, 179 p., 1922.

West Virginia University, School of Mines
Coal associated minerals of the United States-Pt. 4, Southern Appalachia...(Va., eastern Ky., Tenn., and Alabama): U. S., Dept. Interior, Office Coal Research, Coal and Research and Devel Rept. 8, pt. 4, 55 p., 1965.

Wier, C. E.
Coal stratigraphy and resources studies, 1949-1957: Econ. Geology, vol. 54, no. 4, p. 629-665, 1959.

Woodward, H. P.
Outline of the geology and mineral resources of Russell County, Virginia: Va. Geol. Survey, Bull. 49, 91 p., 1938. (p. 48-61)

Wu, W. R. K.
(Frederic, W. H.). Coal composition, coal plasticity, and coke strength: U. S. Bur. Mines, Bull. 661, 88 p., 1973.

Yarzab, Richard F.
(Abdel-Baset, Zeinab; Given, Peter H.). Hydroxyl contents of coals--new data and statistical analyses: Geochim. Cosmochim Acta, vol. 43, no. 3, p. 281-287, 1979.

Young, W. H.
(Anderson, R. L.). Thickness of bituminous coal and lignite seams mined in the United States in 1945: U. S. Bur. Mines, Inf. Cir. 7442, 17 p., 1947.

Young, W. H.
(Anderson, R. L.). T
coal and lignite sea
Bur. Mines, Inf. C

Young, W. H
Thickne
seams m
Cir.

PRELIMINARY REPORT ON THE VALLEY COAL FIELDS AS A POTENTIAL SOURCE OF GAS

by

Mervin J. Bartholomew

1979

INTRODUCTION

In southwestern Virginia (southwest of Botetourt and Craig counties) Mississippian-age coal measures are found within the overthrust belt of the Valley and Ridge geologic province. These coal measures were first mapped and described by Campbell and others (1925) who referred to them as the Valley Coal Fields. The measures occur mainly near the middle of the Price Formation and reach their maximum development on the Saltville thrust sheet where they are largely concealed beneath the structurally overlying Pulaski thrust sheet (Figure 1).

Only very minor occurrences of coal are found on the Pulaski thrust sheet, where thin seams of coal are found within the Price Formation on Fort Lewis Mountain within the Salem synclinorium, a major structure of the Pulaski block. Additional subsurface occurrences are also likely to be found on the Copper Creek/Narrows thrust sheet (Figure 1) in Bland, Smyth and Wythe counties. However, within this structural block, the coal seams are probably substantially thinner and more discontinuous than those on the structurally overlying Saltville block.

Thus, the primary focus of this report will be on the coal measures found on the Saltville block. On this structural block coal occurs in two major areas (Figure 2): 1) the Price Mountain area of Botetourt, Roanoke, Montgomery and Pulaski counties (this area includes the small outlier found just north of Draper Mountain); and 2) the Tract Mountain area of Wythe and Smyth counties.

PREVIOUS WORK

Very little geologic work has been done on the Valley Coal Fields since Campbell and others (1925) published their work. Included within their text are numerous measured sections of individual coal seams as well as analyses of many coals. They recognized and named both a major widespread coal seam, the Merrimac seam, and a minor coal seam, the Langhorne seam. The latter is reported by them to occur 20 to 70 feet beneath the Merrimac seam.

Subsequently, Stevens (1959) compiled additional information on these two seams in Montgomery County. He included the approximate depths that coal was encountered in several bore holes and maps of many of the major underground mines. He also provided a few additional analyses and stratigraphic measurements of individual coal seams. Kreisa and Bambach (1973) discussed environments of deposition of the entire Price Formation within both Montgomery and adjacent counties. However, they treat the coal measures in only a

very superficial manner, inasmuch as the focus of their paper was on interpretation of the Price Formation as a whole sequence and not on any of its individual units.

Most recently, detailed mapping of the coal measures and associated mines has been completed in the Blacksburg (Bartholomew and Lowry, 1979), Radford North (Schultz and Bartholomew, in press), and Staffordsville (Bartholomew and Schultz, in press) 7.5-minute quadrangles. This work lacks detailed measurements of individual coal seams; but, when combined with the previous work, provides a fairly sound basis for drawing conclusions, contained herein, concerning the regional stratigraphic and structural setting of the coal measures.

PRICE MOUNTAIN AREA OF THE SALTVILLE BLOCK

This area is that in which the best surface and subsurface data is currently available. Coal probably occurs in the subsurface over an area about 55 miles in length and 7 to 8 miles in width between Draper Mountain and Blacksburg, thence tapering to a point northeast of Blacksburg. Most of the coal is concealed beneath the structurally overlying Pulaski thrust sheet. Available subsurface and structural information indicates that between Draper Mountain and Blacksburg, both the Pulaski fault and the coal measures below it are folded into a series of broad, open, en echelon folds with low amplitudes (1000-3000 feet) and long wavelengths (2-3 miles). The structure may be

further complicated by small faults associated with this post-thrusting folding event. In addition, coal seams locally may be boudinaged along minor bedding plane faults so that individual seams may be either laterally discontinuous or thicken due to tectonic processes.

Within the southwestern portion of the Price Mountain area, the coal should be encountered at depths generally less than 3000 feet. Northeast of Blacksburg the depth to the coal measures is inferred to be between 3000 and 5000 feet based on subsurface projection of the stratigraphic sequence present in the Salem synclinorium. The structure here is likely to be just a moderately southeast-dipping limb of a syncline whose overturned southeast limb is abruptly truncated by the Pulaski fault.

Most of the coal seams are found within a 200 foot stratigraphic interval at the base of the nonmarine upper member of the Price Formation. The number and thickness of coal seams appears to be related to the dominant lithology within this interval. Where the interval is predominantly shale (shale facies on Figure 2), the seams are generally thinner, more discontinuous, and grade laterally into black shale. Even the Merrimac seam very likely is not continuous in this region. By contrast, in those regions where the interval is primarily interbedded sandstone and siltstone with some black shale (sandstone facies on Figure 2), more

coal seams are present and at least two (Merrimac and Langhorne) probably are continuous laterally over large areas. A small region on the map is shown where 3 to 7 seams of coal are presently known to occur; however, multiple seams are likely to be encountered throughout the region of the sandstone facies.

Thus, the portion of the Price Mountain area between Draper Mountain and Blacksburg appears to have the highest potential for recovery of gas based on the following factors: 1) abundant thick coal seams; 2) abundant sandstone beds to serve as reservoir rock; and 3) broad open folds which should provide excellent structural traps.

The portion of the Price Mountain area northeast of Blacksburg does not appear to have as good potential because of the probable depth to the coal measures as well as the probably poor structural setting.

TRACT MOUNTAIN AREA OF THE SALTVILLE BLOCK

This area is found along the footwall of the Tract Mountain fault, a major footwall structure (Saltville block) whose development preceded final emplacement of the structurally overlying Pulaski thrust sheet. The probable structure of this area is likely to be similar to that portion of the Price Mountain area northeast of Blacksburg. The subsurface projection of the Tract Mountain area to the southeast is based simply on the southwestward projection of the termination of

Mississippian beds along the Pulaski fault ramp zone as it has been determined in the Draper Mountain to Blacksburg area.

Hence, because of the probable structural setting as well as the strong likelihood that the shale/sandstone facies change takes place at a depth greater than 3000 feet, the Tract Mountain area is not considered to have as high a potential as the Price Mountain block.

COPPER CREEK/NARROWS BLOCK

Although this block may potentially contain a large subsurface area in which coal measures may be encountered, it is the least attractive block in terms of recovery of potential gas. Southwest of Saltville the coal measures are known to pinch out and the entire Price Formation has thinned considerably where compared to the same unit on the Saltville block. Likewise, the Copper Creek/Narrows block lies wholly within the shale facies region and, hence, coal seams are likely to be thin and discontinuous. This is supported by the meager data obtained by Campbell and others (1925) who generally reported that the few coal seams were only a few feet thick. Although both the thickness of individual seams as well as the abundance of seams is likely to increase toward the southeast in the subsurface, the increasing depth to the coal measures as well as the essentially unknown structural setting appears to make the Tract Mountain block relatively unattractive compared to the other areas where Mississippian coal occurs.

COAL

Campbell and others (1925) as well as Brown and others (1952) and Stevens (1959) all considered the coal in the Saltville block to be semi-anthracite whereas that in the Copper Creek/Narrows block was rated as medium- to low-volatile bituminous. The same writers also pointed out both the low-sulphur and high-ash content of these Mississippian coals.

Brown and others (1952) attempted to estimate original reserves for various small subdivisions (originally described by Campbell and others, 1925) of both the Saltville and Copper Creek/Narrows blocks. Because these estimates are based on incomplete information concerning both geologic structure (their estimates were based on simple dip-projection of the coal to a depth of 1000 feet) and stratigraphy of the coal-bearing portion of the Price Formation, they are probably low, particularly when the entire Valley Coal Fields are considered. Their total estimate of original reserves at a depth of less than 1000 feet was approximately 355 million tons. Their estimates of indicated and inferred reserves by field are: Brushy Mountain field - 89 million tons, Little Walker Mountain field - 98 million tons, Pulaski field - 44 million tons, Price Mountain field - 43 million tons, Max Meadows field - 62 million tons, Reed Creek field - 19 million tons and Bland field - no estimate. Thomson and York (1975) list 137,490,000 tons of measured and indicated coal for Montgomery and Pulaski counties, Virginia.

Stevens (1959) also attempted to estimate original reserves for both the Merrimac and Langhorne seams for a portion of northwestern Montgomery County. Although he assumed both a simple structural picture and a very conservative limit for the extent of the field, he did arrive at what are probably usable approximations of 9561 tons/acre and 4094 tons/acre for the Merrimac and Langhorne seams, respectively. His estimates for original reserves were approximately 400,000,000 tons and 170,000,000 tons, respectively, for the Merrimac and Langhorne seams within the area he considered. His estimates, of course, did not account for the numerous additional seams (all about the thickness of the Langhorne seam) which occur and were mined throughout the area he studied. Although these seams are discontinuous, they probably represent an approximate equivalent to one additional seam throughout his study area.

POTENTIAL GAS RESERVOIR

Stevens (1959) drew attention to the presence of methane which has caused numerous explosions and resulted in the deaths of many individuals working in the mines of the Valley Coal Fields. The methane is reported found in the coal measures below the water table; Stevens reports one mine in which 0.8MCF/day was measured. The methane also may be concentrated along fault surfaces and Stevens cites several instances in which penetration of such gas pockets caused explosions. Thus,

two types of potential gas reservoirs are possible in the Valley Coal Fields: 1) methane gas generated and confined within the coal itself; and 2) methane gas generated within the coal but which has been released into adjacent strata during deformation. Within the sandstone facies of the coal measures, both types of reservoirs are likely; whereas, in the shale facies only the first type is more likely because of the impermeable shales surrounding individual coal layers. Both anticlinal and fault traps are likely to be found associated with coal beds in the shale facies and both coal and sandstone beds in the sandstone facies.

No estimate of potential gas generation or production can be made at this time.

REFERENCES CITED

Bartholomew, M. J., and Lowry, W. D., 1979, Geology of the Blacksburg quadrangle, Virginia: Virginia Div. Min. Res., Publication 14 (GM 81B).

_____, and Schultz, A. P., in press, Geology of the Staffordsville quadrangle, Virginia: Virginia Div. Min. Res., Publication.

Brown, A., Berryhill, H. L., Jr., Taylor, D. A., and Trumbull, J. V. A., 1952, Coal resources of Virginia: United States Geol. Sur., Circular 171, 57 p.

Campbell, M. R., and others, 1925, The valley coal fields of Virginia: Virginia Div. Min. Res., Bulletin 25, 322 p.

Kreisa, R. D., and Bambach, R. K., 1973, Environments of deposition of the Price Formation (lower Mississippian) in its type area, southwestern Virginia: American Jour. Sci., Cooper Vol. 273-A, p. 326-342.

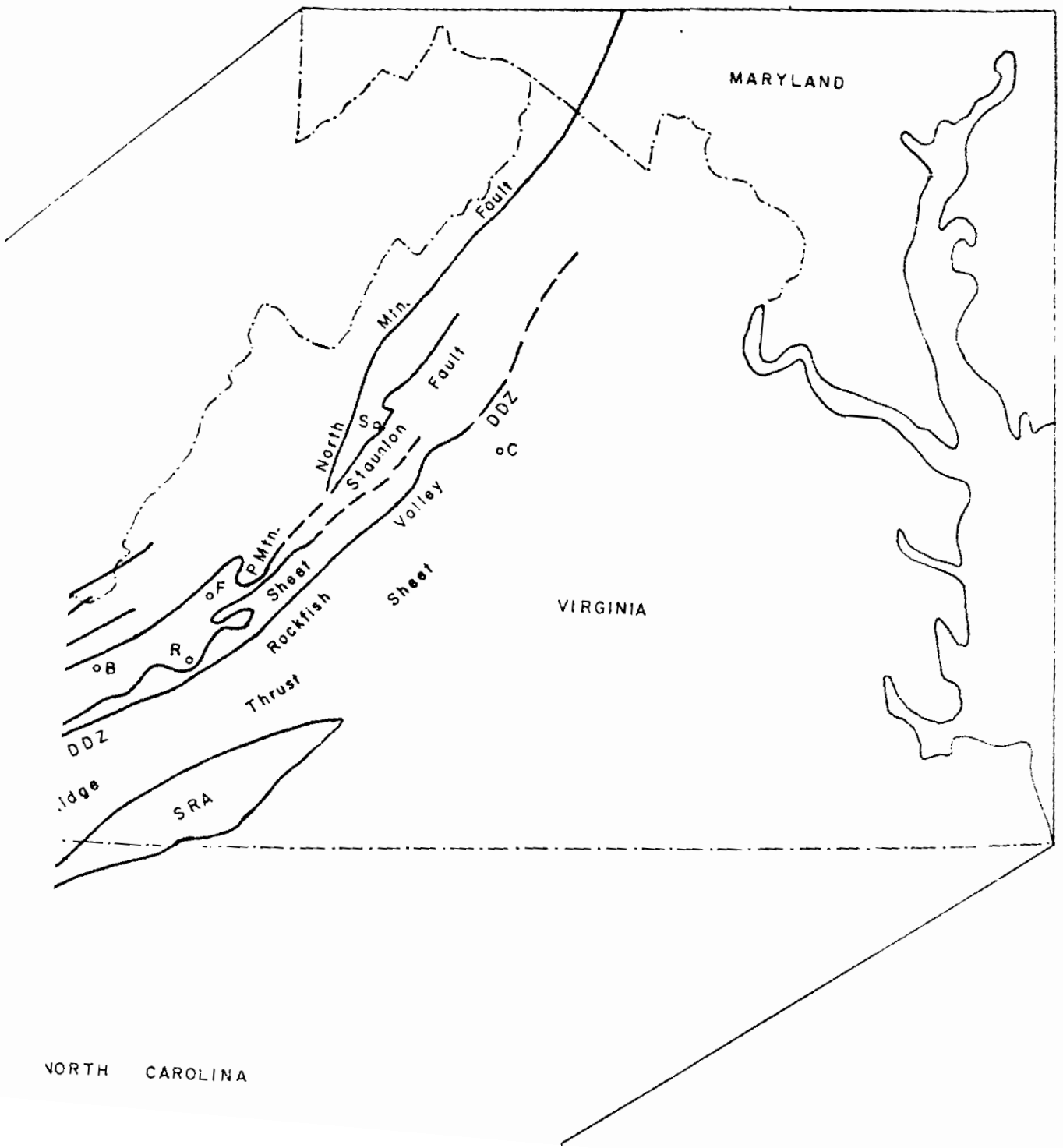
Schultz, A. P., and Bartholomew, M. J., in press, Geology of the Radford North quadrangle, Virginia: Virginia Div. Min. Res., Publication.

Stevens, D. W., 1959, A survey of the factors which affect mining of the lower Mississippian coals in Montgomery County, Virginia: Virginia Polytech. Inst. & State Univ., unpublished M.S. thesis, 75 p.

Thomson, R. D., and York, H. F., 1975, The Reserve Base of U. S. Coals by Sulfur Content (in two parts). 1. The Eastern States, United States Bureau of Mines, Inf. Circular 8680, 537 p.

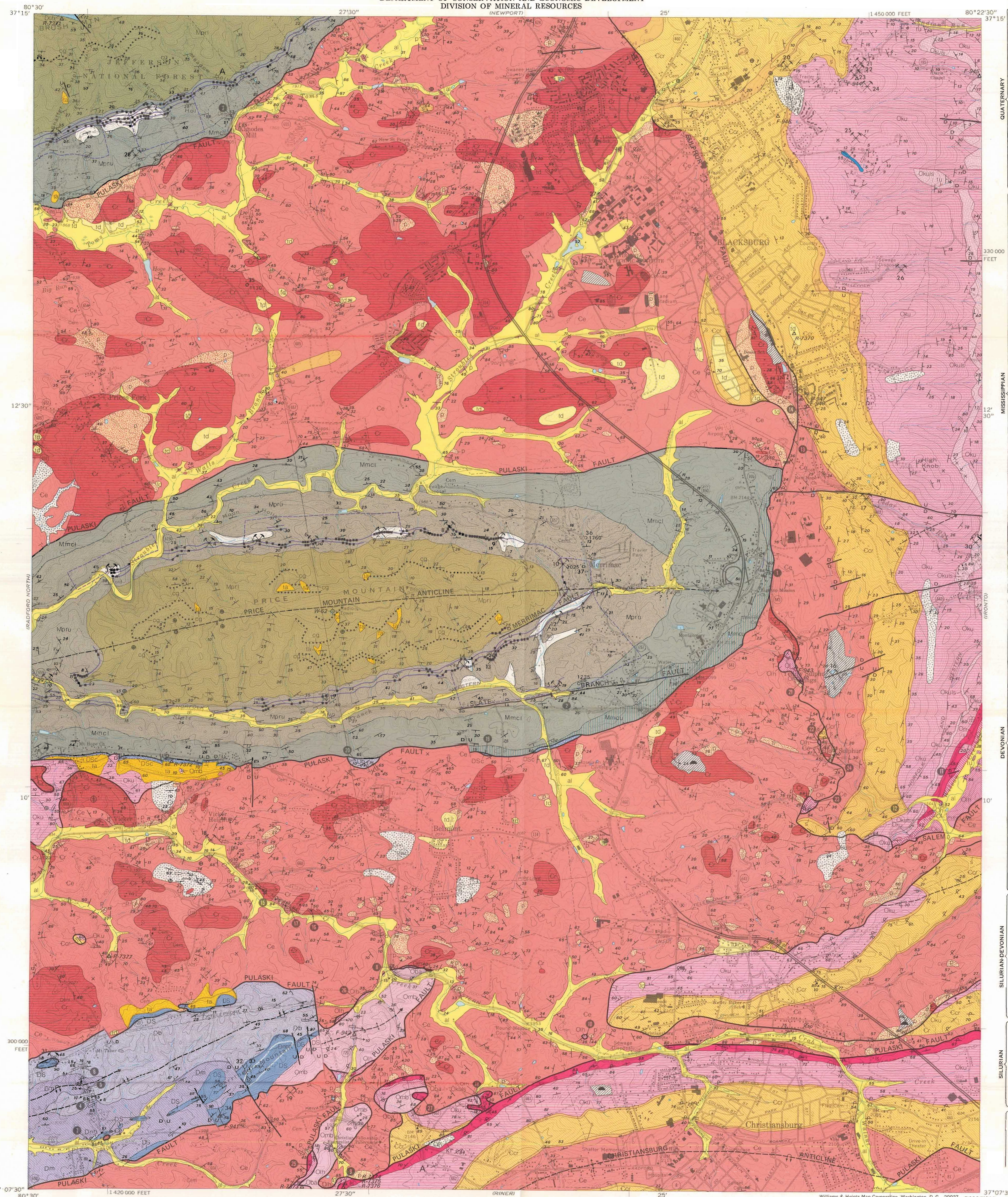
POSITION

IELDS



PUBLICATION 14
(GM 81B)
BLACKSBURG QUADRANGLE

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



ROCK CHARACTERISTICS

GEOLOGY OF THE BLACKSBURG QUADRANGLE, VIRGINIA

By M. J. Bartholomew and W. D. Lowry

1979

GEOLOGIC AND ECONOMIC FACTORS AFFECTING LAND MODIFICATION

Floodplains—are the level areas adjacent to streams which are covered by alluvium. Because they are subject to periodic flooding their use is generally restricted to agricultural or recreational development. The alluvium is easily removed and may be used as a source of sand and gravel. These excavations, however, are subject to landslides and collapse. Hard calcareous tufa deposits may underlie alluvium along some streams.

Areas of clastic rocks—Mississippian rocks crop out in the Price Mountain window and in the Saltville block, north of the leading edge of the Pulaski thrust (Figure 1). These rocks consist primarily of interbedded sandstone, siltstone and shale with local occurrences of coal. The land surface is gently rolling to hilly on the eastern end of Price Mountain. In contrast, the deeply dissected, steeply inclined flanks of Price and Brush mountains have abundant, gently sloping to flat spurs underlain by moderately dipping, resistant sandstone ledges. The top of Brush Mountain is relatively flat although narrow, whereas the top of Price Mountain is a broad, comparatively flat surface underlain by nearly horizontal strata. Soil is typically thin, except where the land surface is gently rolling or flat. The land is forested and suited for farming in only a few places. Residential development should be restricted to spurs and ridges because the narrow, V-shaped valleys may be subject to flash floods during major storms, and because landslides and collapse may occur where steep-sided slopes have been excavated or denuded. Ground water supplies from strata beneath the coal measures may be chemically and bacteriologically unacceptable because the dip of bedrock facilitates infiltration of acid mine waters and because waste effluent from drain fields and septic tanks along the upper slopes is likely to be a source of contamination. Depth to ground water is unknown at higher elevations, but is generally encountered at depths between 50 and 300 feet (15.3 and 30.5 m) at lower elevations. Numerous mine dumps and open or caved shafts and adits are along zones where the coal measures occur at the surface; known large-scale, subsurface, mined-out areas are shown on the geologic map.

Areas of clastic and carbonate rocks—the Barringer Mountain window and areas labeled A (Figure 1) are regions underlain by shales interbedded with some sandstone in the Brallier, Millboro, Martinsburg and Bays formations, or limestone in the Liberty Hall and Martinsburg formations. Local masses and narrow belts of resistant siliceous quartzite, cataclasite, chert and sandstone cap a number of hills and are likely to be encountered in some drill holes; excavation of these rocks will require blasting.

The land surface in the window is characterized by numerous narrow, steep-sided, flat-topped ridges separated by narrow, low-gradient stream valleys that are subject to flooding. Steep slopes may be subject to landslides when excavated or denuded. These lands are suitable for pasture and forestry uses. Residential development should be confined to the more stable flat-topped ridges and spurs. Shallow soil and rapid run-off may restrict the type and location of waste-disposal facilities. Small ground water supplies are usually available from depths between 50 and 100 feet (15.3 and 30.5 m). Large-scale development will necessitate sewage-treatment facilities and an outside water supply.

Areas of carbonate rocks—the Salem synclinorium, Christiansburg window, Crab Creek allochthon and area labeled B (Figure 1) are regions underlain by belts of (1) uniformly dipping dolomite and a few thin sandstone ledges of the Elbrook and Copper Ridge formations, (2) dolomite with considerable interbedded limestone in the upper part of the Knox Group, and (3) limestones of the New Market and Lincolnshire formations, and an undivided limestone unit (ls). The gently rolling land surface is covered by 5 to 20 feet (1.5 to 6.1 m) of light-brown residual soil which in places contains an abundant amount of gravel- and cobble-size chert and sandstone fragments derived from the underlying bedrock. The easily excavated colluvial veneer and saprolite may be as thick as 50 feet (15.3 m), but the saprolite is likely to contain bedrock pinnacles and, locally, chert and sandstone ledges and/or cavernous strata. The dip of these strata ranges from nearly flat in the northeast corner of the quadrangle to steeply dipping or vertical in the southeast corner. This land is suitable for agricultural and residential development, but sewage-treatment facilities are essential for large-scale developments to prevent contamination of ground- and surface-water supplies. Ground water is usually obtained from depths between 100 and 1000 feet (30.5 and 305 m), and potential for wells of moderate to large yields is present in some areas. Zones of cavernous rock and karst terrane are common, in which the ground water reservoir is very susceptible to contamination from unsanitary surface sources.

Areas of deformed rocks—the Blacksburg and Belmont synforms and areas labeled C (Figure 1) are regions underlain by chaotic, complexly folded, faulted and fractured bedrock of calcareous, polymictic breccia, shale of the Rome Formation, and dolomite with interbedded limestone and minor sandstone of the Elbrook and Copper Ridge formations. The gently rolling to moderately dissected land surface is covered by 5 to 20 feet (1.5 to 6.1 m) of light-brown residual soil that in places contains abundant gravel and cobble-size fragments of chert, sandstone, quartzite and vein quartz derived either from the underlying bedrock and/or from ancient terrace deposits. The colluvial veneer and saprolite ranges from 0 to 10 feet (0 to 3.1 m) above shale, but may be as thick as 50 feet (15.3 m) between pinnacles of dolomite and limestone. Inasmuch as surficial deposits do not always reflect the type and depth of underlying bedrock, borehole tests may be necessary prior to both deep excavations and the erection of large structures. The colluvial veneer and saprolite are easily excavated and the land is suitable for agricultural and residential development. Sewage-treatment facilities will be essential for large-scale development to prevent contamination of ground- and surface-water supplies. Ground water is generally encountered at depths between 100 and 300 feet (30.5 and 91.5 m) below ground surface.

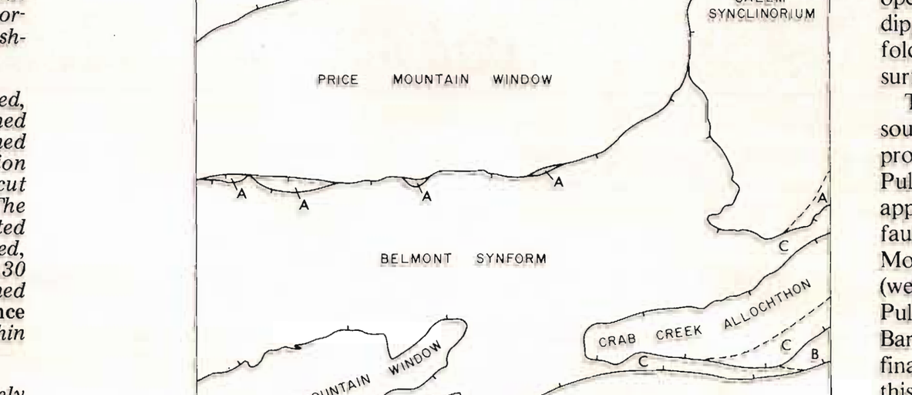


Figure 1. Major structural features delineating environment areas that affect land modification.

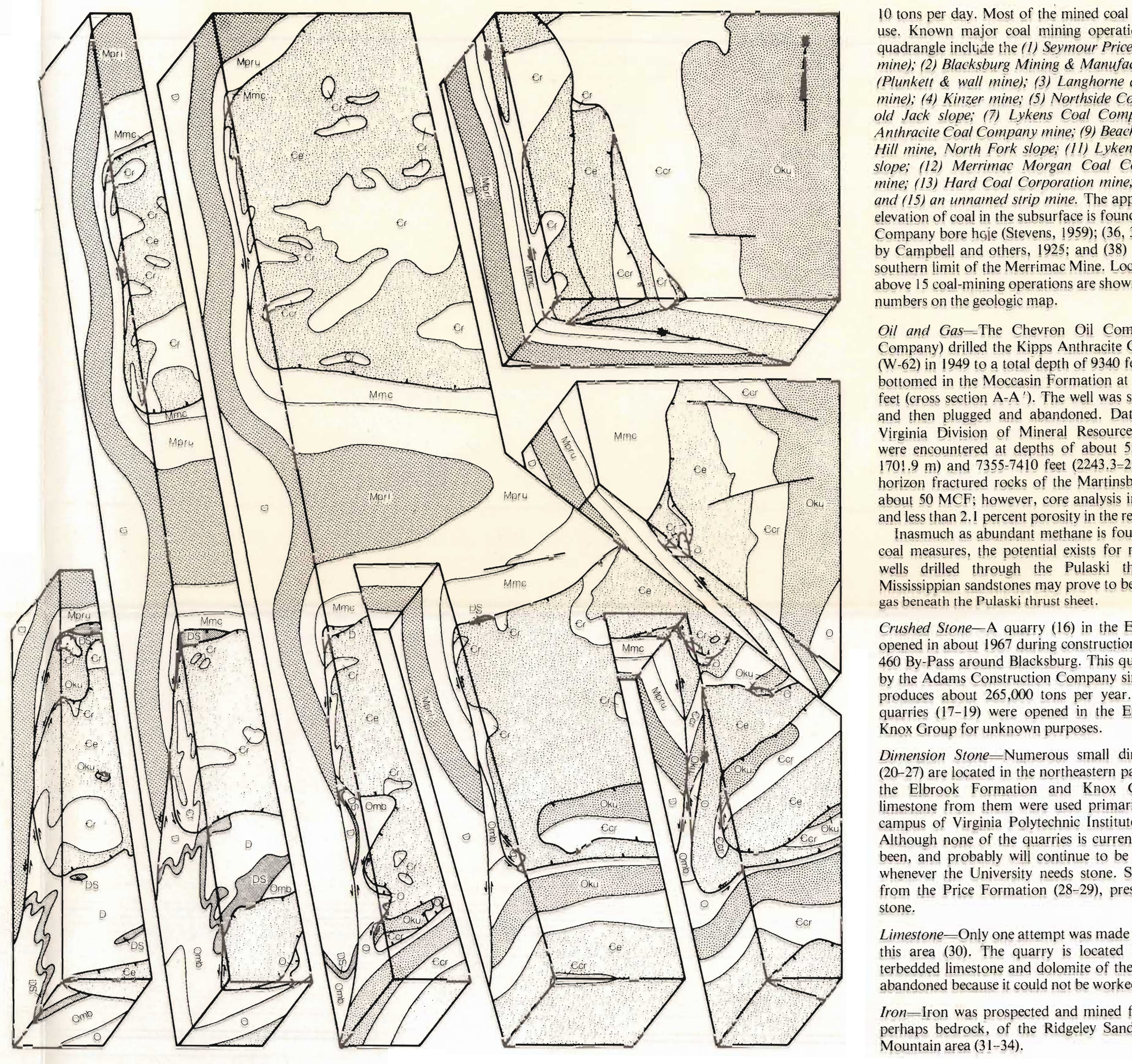


Figure 2. Block diagram showing deformation of bedrock in the Blacksburg quadrangle.

SUMMARY OF DEFORMATIONAL HISTORY

The complexly folded Pulaski thrust sheet (cross section A-A′) overlies autochthonous Mississippian rocks of the Saltville block exposed both in the Brush Mountain area and within the Price Mountain window (Figures 1 and 2). South of the window, Cambrian through Devonian rocks of the Saltville block are exposed in the Christiansburg and Barringer Mountain windows. Numerous tectonic slivers occur around these windows (REFERENCE LOCALITIES 8, 10, 18–20, 25–27) and along the leading edge of the Yellow Sulphur fault (REFERENCE LOCALITIES 21, 22, 23), which is probably a tear fault related to the Salem thrust. The tear fault is well exposed at REFERENCE LOCALITY 24 where it dips about 30° west. West of the Yellow Sulphur fault the numerous oblate domal occurrences of the Rome Formation are interpreted as resulting from interference patterns which were produced by multiple episodes of folding (F1, F2, and F3).

Early Paleozoic folds (F1) were identified only in the Rome and Elbrook formations (REFERENCE LOCALITIES 15, 16, 17). These structures are isoclinal folds with axial-plane foliation (in the Rome Formation) that probably developed during early Paleozoic deformation associated with metamorphism and thrusting in the Blue Ridge Province to the east. F1 folds are typically stretched out and sheared off so that the axial-plane foliation approximately parallels bedding in most exposures (REFERENCE LOCALITIES 15, 16). Axial surfaces of F1 folds are refolded (REFERENCE LOCALITY 15) about younger, tight, generally S-shaped F2 folds which are commonly associated with a well developed slip-cleavage in the phyllitic Rome Formation. Cleavage is infrequently developed in other younger shale units. The typical interference pattern resulting from F1 and F2 folding (REFERENCE LOCALITIES 15, 16, 17) is a Ramsay type 3 pattern (Ramsay, 1967, p. 531, Figure 10-13-I).

F2 structures include several generations of isoclinal to tight-to-open, asymmetric to strongly overturned folds (REFERENCE LOCALITIES 5, 6, 8, 15, 17) more or less genetically related to a middle to late Paleozoic phase of Valley and Ridge deformation. In this area this event culminated with emplacement of the Pulaski and the closely related Salem-Yellow Sulphur thrust sheets in post-early Mississippian time. The intensely disrupted nature of many of these F2 folds (REFERENCE LOCALITY 8), and the presence of F2 structures in tectonic slivers derived from the decapitated Christiansburg anticline, suggest that thrusting slightly post-dates F2 folding. Hence, the small-scale F2 structures probably developed at about the same time as the Christiansburg anticline, but prior to emplacement of the Pulaski thrust. By analogy F2 folds, which are along the leading edge of the Salem fault as well as within tectonic slivers associated with the Yellow Sulphur fault, can be inferred to slightly pre-date that thrusting and, therefore, are of approximately the same age as large-scale folds of similar trend in the Salem synclinorium. F1 structures have not been identified within the Salem synclinorium, where F2 folds are gently plunging, north-trending, open to tight folds (mineral locality 16) with steeply southeast-dipping axial surfaces. Northeast of Blacksburg this dominant fold type appears to be refolded about east-west trending axial surfaces.

The Crab Creek allochthon contains strata derived from the southern flank of the decapitated Christiansburg anticline, and probably was emplaced during early movement along the Pulaski thrust. In contrast, thrusting along the Pulaski fault appears to have terminated with movement along a branch of the fault (cross section A-A′) which decapitated the Barringer Mountain structure and probably the Christiansburg anticline (well below the Pulaski fault). Steepening and overturning of the Pulaski fault along the northern flanks of the Christiansburg and Barringer Mountain windows was probably concurrent with this final movement. Total movement on the Pulaski fault system in this quadrangle exceeds 10 miles (16 km).

F3 structures are broad, open, east-west-trending antiforms and synforms that have broadly warped the Pulaski thrust sheet during formation of the antiformal Price Mountain window and adjacent Blacksburg and Belmont synforms. These late-Paleozoic, post-thrusting folds are associated with numerous, nearly east-west trending, high-angle, oblique-slip faults such as the Merrimac and Slate Branch faults (REFERENCE LOCALITY 2). The faults are abundant along the plunging nose of the Price Mountain antiform, where they appear to converge down-plunge as the F3 folds die out along the western flank of the Salem synclinorium. This suggests that the F3 folds and the oblique-slip faults developed almost contemporaneously during late Paleozoic time; younger, north to northwest-trending high-angle faults are also present throughout the area.

The time of formation of the abundant breccia is uncertain, but multiple episodes of breccia formation are suggested by the following observations. First, the distinctive grayish-green breccia contains abundant, randomly oriented chips of grayish-green phyllitic mudstone derived from transitional beds of the lowermost Elbrook Formation, indicating that this type of breccia is post-metamorphism; second, layering within the more typical polymictic carbonate breccias is commonly folded about F2 and F3 axial surfaces, but not about F1; third, polymictic carbonate breccias occur in the cores of both F1 and F2 folds in lieu of a fold hinge; fourth, more massive types of polymictic carbonate breccias commonly truncate both F1 and F2 structures; fifth, massive breccia is very common along or near the Pulaski and Salem fault surfaces (REFERENCE LOCALITIES 8, 24); and sixth, masses of relatively cohesive breccia up to about 10 feet (3.05 m) in diameter are incorporated in younger breccia. Hence, breccia development appears to have been an integral part of the lengthy Paleozoic deformational history of the Pulaski-Salem thrust complex.

MINERAL RESOURCES SUMMARY

Coal—The Merrimac seam, which is the thickest and most laterally continuous seam in the main coal measures in this area, is at the base of the upper member of the Price Formation. Numerous thinner seams occur both stratigraphically above and below the Merrimac seam. In addition, a few thin, discontinuous seams are in the uppermost Price and overlying Maccrady formations, and these appear to grade laterally into shale over short distances. The number and thickness of the coal seams increase to the southwest along Brush Mountain and to the south or southwest in Price Mountain. The Merrimac seam consists of about 6 feet (1.8 m) of interbedded coal and shale, of which about 75 percent is very dry coal with a high ash content (Campbell and others, 1925; Stevens, 1959). Stevens estimated that the seam contains about 9561 tons of coal per acre; he also noted the occurrence of methane in the coal, particularly adjacent to faults and to a lesser extent when mining below the water table. Approximate mined-out areas of the Merrimac seam in the larger mines are shown on the geologic map; however, most of the smaller mines are believed to have been mined at least down to the water table, and mined-out areas may be more extensive than shown. The Merrimac Mine (12), which was the largest, closed in about 1934 because of a drainage problem (Stevens, 1959) related to the intersection of a stream with the Slate Branch fault above the southern limit of the mine. The mine was never reopened south of the fault, and no mines were opened south of Slate Branch because of an apparent termination of the Merrimac seam on what seemed to be a sharply overturned limb of an inferred syncline (Campbell and others, 1925). This incorrect structural interpretation was based upon correlation of the upper member of the Maccrady Formation with the Cloyd Conglomerate, normally found at the base of the Price Formation, and on the occurrence of Silurian and Devonian rocks along the southern flank of the Price Mountain window. The latter rocks, however, are tectonic slices transported along the sole of the Pulaski thrust, and there is no indication of an overturned limb along the southern flank of Price Mountain. Indeed, the surficial data suggests that the coal measures may extend southward beneath the Pulaski thrust sheet for a considerable distance (cross section A-A′). Core drilling and/or seismic profiles would be necessary to determine the location, thickness and quality of coal measures beneath the Pulaski thrust sheet both north and south of Price Mountain.

Stevens (1959) noted that an average of about 50 tons of coal per day was produced from the Northside mine (5) in 1958-1959, and that small operators generally mined an average of less than 10 tons per day. Most of the mined coal was for local domestic use. Known major coal mining operations in the Blacksburg quadrangle include the *(1) Seymour Price mine (Otey or College mine); (2) Blacksburg Mining & Manufacturing Company mine (Plunkett & wall mine); (3) Langhorne and Willis mine (Price mine); (4) Kinzer mine; (5) Northside Coal Company mine; (6) old Jack slope; (7) Lykens Coal Company mine; (8) Kipps Anthracite Coal Company mine; (9) Beacham mine; (10) Lykens Hill mine, North Fork slope; (11) Lykens Hill mine, Beacham slope; (12) Merrimac Morgan Coal Corporation, Merrimac mine; (13) Hard Coal Corporation mine; (14) Brumfield mine;* and *(15) an unnamed strip mine.* The approximate location and elevation of coal in the subsurface is found at: (35) Hudson Coal Company bore hole (Stevens, 1959); (36, 37) bore holes reported by Campbell and others, 1925; and (38) Merrimac seam at the southern limit of the Merrimac Mine. Locations of these and the above 15 coal-mining operations are shown by the corresponding numbers on the geologic map.

Oil and Gas—The Chevron Oil Company (The California Company) drilled the Kipps Anthracite Coal Company #1 Well (W-62) in 1949 to a total depth of 9340 feet (2848.7 m), where it bottomed in the Moccasin Formation at an elevation of −6870 feet (cross section A-A′). The well was selectively cored, logged and then plugged and abandoned. Data on open file at the Virginia Division of Mineral Resources indicates gas shows were encountered at depths of about 5220–5580 feet (1592.1-1701.9 m) and 7355-7410 feet (2243.3–2260.1 m). At the latter horizon fractured rocks of the Martinsburg Formation yielded about 50 MCF; however, core analysis indicated 0 permeability and less than 2.1 percent porosity in the reservoir rock.

Inasmuch as abundant methane is found in the Mississippian coal measures, the potential exists for recovery of this gas by wells drilled through the Pulaski thrust sheet. Likewise, Mississippian sandstones may prove to be a suitable reservoir for gas beneath the Pulaski thrust sheet.

Crushed Stone—A quarry (16) in the Elbrook Formation was opened in about 1967 during construction of the U. S. Highway 460 By-Pass around Blacksburg. This quarry has been operated by the Adams Construction Company since 1971, and currently produces about 265,000 tons per year. Three other dolomite quarries (17–19) were opened in the Elbrook Formation and Knox Group for unknown purposes.

Dimension Stone—Numerous small dimension-stone quarries (20–27) are located in the northeastern part of the quadrangle in the Elbrook Formation and Knox Group. Dolomite and limestone from them were used primarily for building on the campus of Virginia Polytechnic Institute and State University. Although none of the quarries is currently in use, several have been, and probably will continue to be operated intermittently whenever the University needs stone. Sandstone was quarried from the Price Formation (28–29), presumably for dimension stone.

Limestone—Only one attempt was made to operate a lime kiln in this area (30). The quarry is located in steeply dipping, interbedded limestone and dolomite of the Knox Group, and was abandoned because it could not be worked extensively.

Iron—Iron was prospected and mined from residual soils, and perhaps bedrock, of the Ridgeley Sandstone in the Barringer Mountain area (31–34).

REFERENCES CITED

Campbell, M. R., and others, 1925, The valley coal fields of Virginia: Virginia Div. of Mineral Resources Bulletin 25, 322 p.

Derby, J. R., 1965, Paleontology and stratigraphy of the Nolichucky Formation in southwest Virginia and northeast Tennessee: Virginia Polytechnic Institute and State University, unpublished Ph.D. dissertation, 468 p.

Glass, F. R., Jr., 1970, Structural geology of the Christiansburg area, Montgomery County, Virginia: Virginia Polytechnic Institute and State University, unpublished M.S. thesis, 80 p.

Hergenroder, J. D., 1958, Geology of the Radford area, Virginia: Virginia Polytechnic Institute and State University, unpublished M.S. thesis, 84 p.

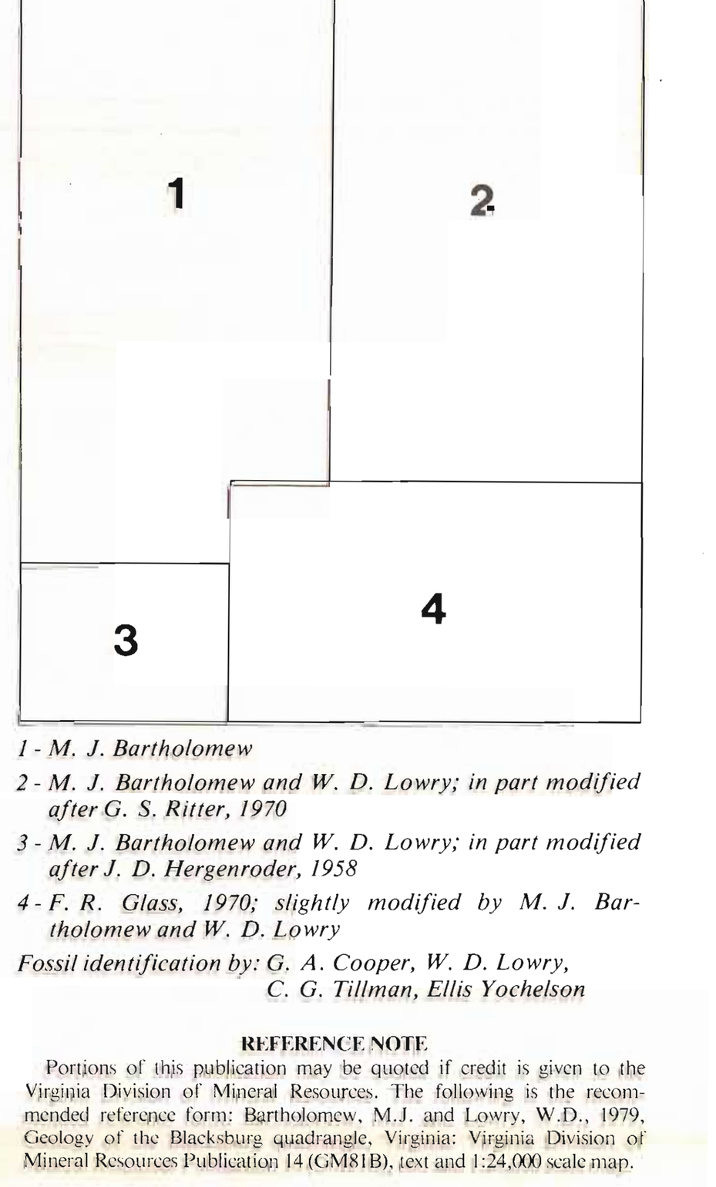
Kreisa, R. D., and Bambach, R. K., 1973, Environments of deposition of the Price Formation (lower Mississippian) in its type area, southwestern Virginia: American Jour. Sci., Cooper Vol. 273-A, p. 326-342.

Ramsey, J.G., 1967, Folding and fracturing of rocks: McGraw-Hill Book Co., New York, 568 p.

Ritter, G.S., 1970, Geology of the Blacksburg area, Montgomery County, Virginia: Virginia Polytechnic Institute and State University, unpublished M.S. thesis, 38 p.

Stevens, D. W., 1959, A survey of the factors which affect mining of the lower Mississippian coals in Montgomery County, Virginia: Virginia Polytechnic Institute and State University, unpublished M.S. thesis, 75 p.

Credit for geologic mapping.



1 - M. J. Bartholomew
2 - M. J. Bartholomew and W. D. Lowry; in part modified after G. S. Ritter, 1970
3 - M. J. Bartholomew and W. D. Lowry; in part modified after J. D. Hergenroder, 1958
4 - F. R. Glass, 1970; slightly modified by M. J. Bartholomew and W. D. Lowry

Fossil identification by: G. A. Cooper, W. D. Lowry, C. G. Tillman, Ellis Yochelson

REFERENCE NOTE

Portions of this publication may be quoted if credit is given to the Virginia Division of Mineral Resources. The following is the recommended reference form: Bartholomew, M.J. and Lowry, W.D., 1979, Geology of the Blacksburg quadrangle, Virginia: Virginia Division of Mineral Resources Publication 14 (GM81B), text and 1:24,000 scale map.