COMMONWEALTH OF VIRGINIA
DEPARTMENT OF MINES, MINERALS AND ENERGY
DIVISION OF MINERAL RESOURCES

KEY

CONTACTS

Contact
Dashed where approximate

Coal Bed
Dashed where approximate

ATTITUDE OF ROCKS

Strike and dip of bed

Horizontal bed

CLEAVAGE

Strike and dip of cleavage

FOLDS

Anticline: showing trace of crest and direction of plunge

Syncline: showing trace of trough and direction of plunge

Minor anticline: showing direction and angle of plunge

Minor horizontal anticline

Minor syncline

Inclined kink fold, showing strike and dip of axial surface, bearing and plunge of axis

FAULTS

Solid line where exposed, dashed line where approximate. U, upthrown side; D, downthrown side; arrows indicate direction of relative movement; tick indicates direction of dip. A, indicates movement away from viewer. T, indicates movement toward viewer (in cross-section only).

COAL MINES

Adit of active mine

Adit of abandoned mine

Contour surface mine
hachures indicate direction to highwall

Area surface mined showing original extent of lowest coal removed.

Modified land (e.g. mine dump or valley fill)

Coal outcrop, prospect or measured section

GAS WELLS

Gas well

REPOSITORY NUMBER

R-8841
Collection point and repository number of coal sample with analysis on file at Virginia Division of Mineral Resources.

EXPLANATION

QUATERNARY

c — Colluvium

ld — Landslide-debris deposits

al — Alluvium

td — Terrace deposits

PENNSYLVANIAN

Wise Formation
ws, Unnamed sandstone
Pw, Interbedded shale, siltstone and sandstone
ad, Addington coal
cl, Clintwood-Blair coal
l, Lyons coal
l_2, Lyons coal (upper split)
l_1, Lyons coal (lower split)
d, Dorchester coal

Pg, Gladeville Sandstone

Norton Formation
Pn, Interbedded shale, siltstone and sandstone
ns, Unnamed sandstone
n_2, Norton coal (upper split)
n_1, Norton coal (lower split)
c, Unnamed coal
hr, Hagy rider coal
h, Hagy coal
sd, Splashdam coal
ub, Upper Banner coal
lb, Lower Banner coal
bf, Big Fork coal
k, Kennedy coal

Lower Norton and Upper Lee Formations
Pnm, McClure Sandstone Member
Pn, Interbedded shale, siltstone and sandstone
Plbr, Bee Rock sandstone Member
Plh, Hensley Member
a, Aily coal
r_3, Raven coal (upper split)
r, Raven coal
j, Jawbone coal

Lower Lee Formation
Plm, Middlesboro Member

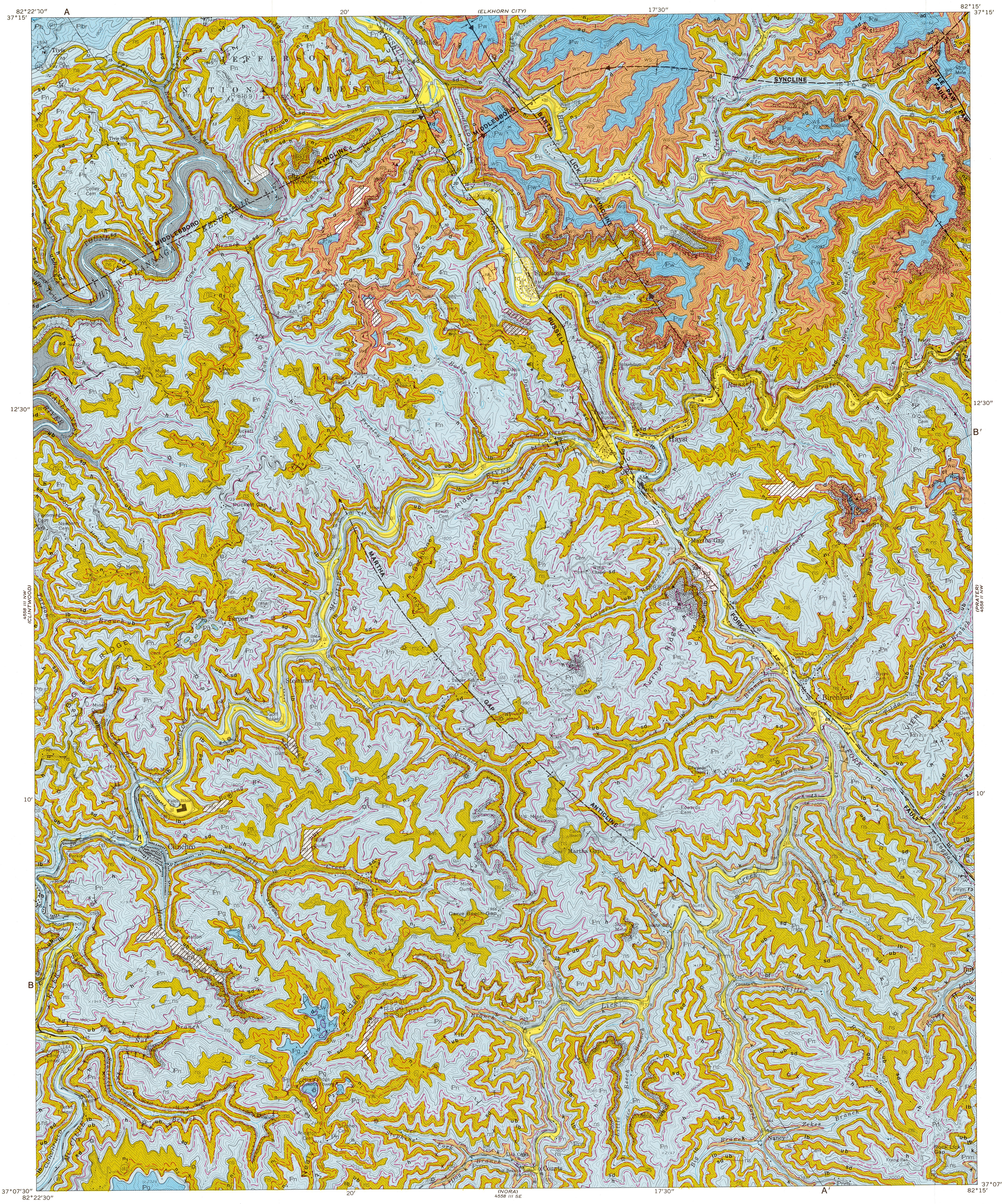
Pocahontas Formation (Pp)

MISSISSIPPIAN (cross-section only)

Bluestone Formation (Mb)

Hinton Formation (Mh)

Bluefield Formation (Mbf)



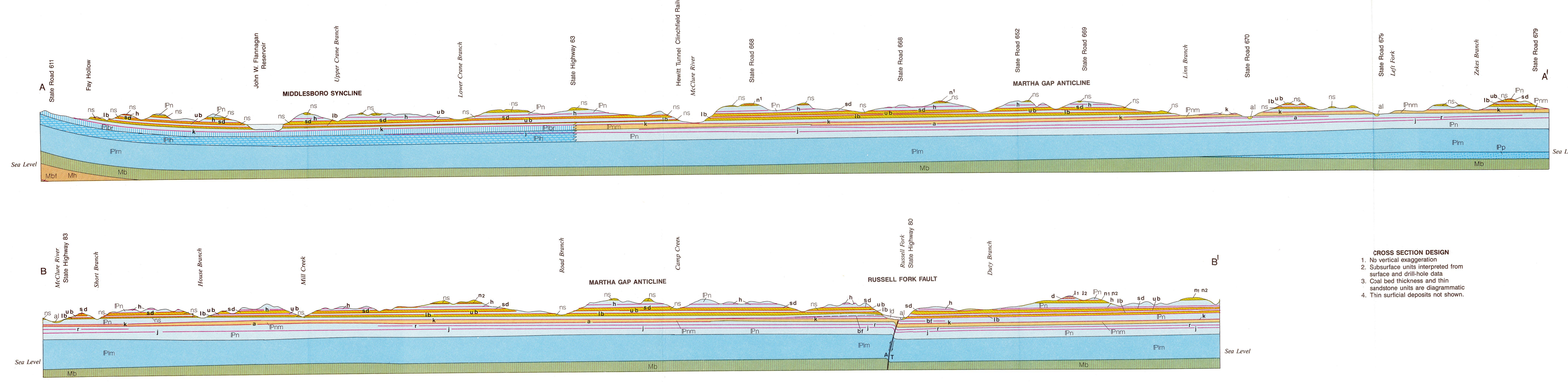
Base map from U.S. Geological Survey, 1963, PR 1977
Haysi quadrangle, 7½ minute series.

SCALE 1:24 000
CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

UTM GRID AND 1977 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

QUADRANGLE LOCATION

Project funded equally by the Commonwealth of Virginia and the U.S. Department of Interior, Office of Surface Mining, under a Technical Data Management System grant.



GEOLOGY AND MINERAL RESOURCES OF THE HAYSI QUADRANGLE, VIRGINIA

William S. Henika
1989

The Haysi quadrangle is located in the Appalachian Plateaus physiographic province in north-central Dickenson County, Virginia. The quadrangle constitutes an area of approximately 58 square miles which is underlain by sedimentary rocks of Lower to Middle Pennsylvania age. Topographically the area is characterized by steeply-sloping ridges and V-shaped valleys. The highest point, above the 2360-foot contour, is on Nealy Ridge in the southwestern part of the area; and the lowest point is below the 1160-foot contour on Russell Fork in the northern part of the area. Detailed geologic mapping in the area began in the fall of 1979 with the assistance of Peter S. Frischmann and was completed by W. S. Henika during the winter of 1987.

Approximately 1250 feet of Pennsylvanian sandstone, siltstone, shale, coal, and limestone beds are exposed in the area. These rock types belong to the Lee, Norton, and Wise Formations. The boundary between the Lee and the Norton Formations is defined by the top of the highest quartzose sandstone above the base of the of the Lee. In the northwestern corner of the area along the southeastern slope of Pine Mountain this boundary is at the top of the Bee Rock Sandstone Member. Quartzose sandstone of the Bee Rock is replaced laterally by lithic sandstones of the McClure Sandstone Member southeastward in the subsurface (cross section A-A′). The contact between the Lee and Norton Formations therefore is dropped some 600 feet, arbitrarily, to the next highest quartzose sandstone in the sequence (Miller, 1974, p. 70–78).

In previous reports the boundary between the Norton Formation and the overlying Wise Formation was incorrectly mapped in much of Wise County and all of Dickenson County (Whitlock and others, 1987). Earlier workers confused the Gladeville Sandstone with stratigraphically lower units in the Norton Formation. In Haysi quadrangle the Gladeville is a white quartz sandstone that is found only on Big Ridge in the Tarpon area and on Nealy Ridge along the southern border. The Gladeville Sandstone appears to thin out northeastwardly and cannot be used as a stratigraphic marker. Where the Gladeville Sandstone is not present, the base of the Wise Formation has been placed at the base of the Dorchester coal bed.

Four prominent marine fossil zones are present in the Norton and Wise Formations. The lowest zone, exposed along McClure River south of Puckett Gap, about 120 feet below the Lower Banner coal bed contains shells of inarticulate brachiopods. A similar zone with limestone nodules is exposed in road cuts along Viers Ridge in the southeastern part of the quadrangle about 20 feet above the Splash Dam coal. One of the most persistent marine zones occurs approximately 70 feet above the Hagy coal and is believed to be equivalent to the Eagle shale (White, 1891). This shaly zone is well exposed along State Road 654 at Carve Beech Gap where both brachiopod and gastropod shells may be found. Another marine zone near the top of the section is thought to be equivalent to the Cannelton limestone (White, 1885). It consists of an 8 to 10 foot zone of fissile shale with limestone nodules and brachiopod fossils directly above the Addington coal. The zone was exposed in a surface-mine highwall northeast of the site of the Bartlick Fire Tower in the northeastern corner of the quadrangle.

STRUCTURAL GEOLOGY

The Middlesboro syncline and the Russell Fork fault are regionally important structures. The Middlesboro syncline trends across the quadrangle in a northeast to southwest direction and generally parallels the course of Pound River to the Russell Fork fault. The syncline reflects the location and geometry of a subsurface tectonic ramp on the Pine Mountain fault which rotated the overlying rocks during thrusting (Rich, 1934; Harris and Milici, 1977). Beds on the northwest limb of the syncline have dips up to 16 degrees toward the southeast (cross section A-A′) whereas beds on the southeastern limb have much gentler dips to the northwest, generally less than 5 degrees.

The Russell Fork fault (Wentworth, 1921) has been recognized for many years to be a major strike-slip fault along which differential right lateral movement took place within the Cumberland block above the Pine Mountain fault. Miller (1974) postulated as much as 4 miles of strike slip movement based on stratigraphic evidence from gas well logs. Data from additional drill holes and detailed mapping currently available suggests the strike slip displacement may be less than one mile. The structure appears to be a high angle fault steeply inclined to the southwest, with as much as 250 feet of stratigraphic throw (cross section B-B′). The orientations of mesoscopic structures (kink folds, cleavage, and rodding) along the fault show abundant evidence of compression across the fault zone. There are very few mesoscopic structures observed which support a simple strike slip interpretation. It appears that the movement involved both dip slip and strike slip and is best described as transpressional.

The Little Paw Paw fault is similar to, but has a much smaller vertical component of displacement than, the Russell Fork fault. Along this fault there are also many compressional structures, including a series of folds or subsurface rolls in the Splashdam mine, that suggest transpressional movement. Maximum dip slip on this fault, within the quadrangle, appears to be less than 20 feet and the fault movement appears to terminate in the area east of the site of the Bartlick Fire Tower.

The Martha Gap anticline, herein named, was first noted in subsurface data, and is a broad uplift trending across the southeastern limb of the Middlesboro syncline. Mapping along McClure River disclosed dips of up to 15 degrees around the northwest plunging nose of the anticline. This anticline, and a syncline that trends with Barts Lick Creek, appear to parallel the Russell Fork fault. Along Pound River, McClure River, and Russell Fork, strata are inclined toward the Russell Fork fault across a 0.5 mile wide zone. Dips increase toward the fault, locally exceeding 20 degrees near Pound River. This flexure southwest of the fault may be related to a gently inclined tectonic ramp and detachment surface above the Kennedy coal. A ramp thrust may project the detachment upwards to a shaly zone below the Lower Banner coal. The cleavage, folding, and rodding characteristic of a detachment zone is well exposed in shale below the Lower Banner coal bed along the railroad cuts at Bartlick. Northeastwardly directed compressional forces, that may have formed the structural features associated with detachments in the Norton Formation, may also be responsible for many of the mesoscopic folds that trend at small angles to the Russell Fork fault.

ECONOMIC GEOLOGY

COAL

Minable coal occurs within the Norton and Wise Formations in the Haysi quadrangle. Some of the coal beds that are in the lower part of the Norton Formation southeast of McClure River are also present in time equivalent beds of the Lee Formation across the Middlesboro syncline in the northwestern part of the area. These coals may not be of minable thickness due to stratigraphic thinning to the northwest. Wise and Norton Formation coal in the map area is medium- to high-volatile A bituminous (Table).

Both surface and underground mining methods are used in the area. Mining is currently limited to the Hagy, Splash Dam, and Upper Banner coals. In the past significant amounts of coal were also mined from the Clintwood, Lyons, Dorchester, Norton, Lower Banner, Big Fork, and Kennedy coals.

As part of the Geohydrology of southwest Virginia (GEOHY) mapping project, the Department of Mines, Minerals and Energy geologists are standardizing coal names for coal beds mapped throughout the Cumberland Plateau of southwestern Virginia. The system is based on a standardized Pennsylvanian section first described in Wise County. Coal names used in this report have been correlated with the standardized section using surface and subsurface data. Where coal beds have been described using local names in the past, the locally used name is shown in parentheses if it differs from the standardized name.

The oldest and deepest coal considered in this report is the Jawbone. Deeper coals, including the Tiller coal, are not economically minable owing to their great depth, 200 to 300 feet below the Jawbone, or their discontinuous occurrence across the area. The Jawbone is shown on section A-A′ to be within the Lee Formation northwest of State Highway 83, and within the Norton Formation southeast of the highway. The arbitrary Lee/Norton formational boundary follows the 0 foot isolith of the Bee Rock sandstone determined from subsurface data (Miller, 1974, Figure 45).

Driller's logs from oil and gas tests suggest that the Jawbone is relatively continuous across the southwestern part of the quadrangle, and may contain 3 to 6 feet of coal at depths of 300 to 1000 feet below the local topographic surface. Drill data also indicate a split in the coal at several localities in the southern part of the area. The Jawbone is currently mined using the longwall method to the southwest in Caney Ridge quadrangle. Projection of the Jawbone toward the northwest, based on drill data, suggests the coal may be terminated beneath the upper quartzarenite member of the Lee Formation northwest of the Middlesboro syncline axis (cross section A-A′; Miller, 1974).

The Raven coal bed generally lies from 73 to 170 feet above the Jawbone coal bed and appears to be continuous within a siltstone sequence of the Norton Formation across the southwestern part of the area. It may also be continuous but 250 feet deeper in the area east of the Russell Fork fault. Subsurface data from driller's logs indicates the Raven bed ranges from 1 to 5 feet in thickness at depths of as much as 400 feet below drainage. Five sections measured from outcrops along Russell Fork contained resource thicknesses of 0.8 to 2.1 feet. The Raven may have been mined in a narrow surface mine along the southwestern bank of Frying Pan Creek at the southern boundary of the quadrangle. Surface and subsurface data suggest that the Raven coal bed is terminated to the northwest beneath the McClure sandstone or Bee Rock sandstone (cross section A-A′).

The Aily coal is the highest of several thin coal beds in a 200 foot thick shale-siltstone sequence above the Raven coal and below the McClure sandstone. The name Aily (Giles, 1921, p. 71) from a now defunct post office at the confluence of Lick Creek and Dog Branch (Count's Store) was applied to the most persistent of the beds above the Raven and is probably a split of the Raven coal. Dips computed from oil and gas tests indicate the Raven and Aily coal beds may come together beneath the McClure-Bee Rock sandstone to the northwest of McClure River. The Aily coal bed is generally less than 1 foot thick, and could only be traced locally along Lick Creek. The bed measured 1.5 feet at the type locality and is better exposed in a new cut about 0.4 mile south at the intersection of State Roads 670 and 661 in the Nora quadrangle. There the coal bed lies beneath the lower bed of the McClure sandstone, and is finely banded, aggregating 1.78 feet with many thin shaly partings.

The Kennedy coal is near the base of a thick sequence of shale and siltstone directly above the McClure sandstone member of the Norton Formation. Limited outcrop data and oil and gas logs indicate that although the Kennedy may be variable in thickness, ranging from less than 1 foot to 5 feet, it is relatively continuous across the quadrangle southwest of McClure River. The Kennedy coal was mined at several truck mines and small surface mines along the tributaries to Lick Creek and on Russell Fork in the southern part of the quadrangle. Thicknesses of the Kennedy interval measured along Lick Creek, indicate a 2 to 3 foot coal bed with a 0.5 to 0.8 foot thick rider coal 5 to 10 feet above the main bed. The Kennedy bed where it was mined along Left Fork contains 3.4 to 3.5 feet of solid, banded, bright coal.

The Big Fork coal lies in a thick shale sequence above the McClure sandstone and below a prominent ledge forming sandstone beneath the Lower Banner coal. It is usually found between 150 and 170 feet below the Lower Banner coal and 30 to 50 feet above the Kennedy coal. The drill records suggest it is thin and generally discontinuous and surface exposures are sparse. The coal was mined from old adits above State Road 745 along an unnamed tributary to Lick Creek in the southeastern part of the quadrangle. It appears to be less than 3 feet thick at that locality and is much thinner, 0.4 to 1.0 feet thick, at other localities. There is commonly a marine fossil zone in the shale and siltstone sequence between the Big Fork and the prominent sandstone beneath the Lower Banner coal zone.

The Lower Banner coal lies from 150 to 200 feet above the Kennedy coal bed. There is commonly a 40 to 70 foot thick sandstone that lies just below the Lower Banner coal. The coal varies considerably in thickness, ranging from 0.5 to 5.7 feet in 24 surface sections measured across the area. The thickest occurrences are in relatively steeply dipping beds exposed along McClure River near Haysi, and along the bluffs above Russell Fork southeast of Haysi.

The Lower Banner coal, measured at 24 localities, averages 1.97 feet in thickness with an average resource thickness of 1.38 feet in Haysi quadrangle. It commonly consists of an upper bed of cannel coal separated by one or two shale partings from a thicker fine-banded lower coal bed. The partings may vary from a fraction of a foot upwards to several feet. They form a major split in the coal in the southeastern part of the quadrangle where the Lower Banner is exposed in abandoned adits along tributaries to Lick Creek. The Lower Banner was also mined near the head of Skillet Branch and was opened near the mouth of Squirrel Camp Branch in the southwestern part of the quadrangle.

The Upper Banner coal is about 85 feet above the Lower Banner but may be from 50 to 110 feet above it locally. The Upper Banner is especially well developed in the southwestern part of the area averaging 4 to 5 feet in thickness. Most of the thicker coal was mined by the Clinchfield Mine No. 7 near Clinchco. In 56 measured sections located throughout the area, Upper Banner coal beds averaged 3.8 feet in thickness. It ranges from a thin, less than 1 foot thick, truncated remnant in the northwest along Lower Twin Branch and in the Haysi area to a coal zone nearly 50 feet thick containing three separate benches of coal beds that were surface mined in the area southeast of Lick Creek. In the southwestern part of the area where the coal was most extensively deep-mined, it contained a persistent sandstone parting about 0.1 feet thick in the upper bench of coal. This sandstone bed appears to contain volcanic detritus and may be the remnants of a volcanic ash deposit. It has been traced northeastward to the vicinity of Haysi but the upper bench which contains the probably volcanic ash parting is truncated beneath the massive sandstone that separates the Splash Dam and Upper Banner coal horizons. The Upper Banner coal bed is currently mined at several truck mines in the south central part of the area.

The Splash Dam coal lies from 70 to 110 feet above the Upper Banner, generally above a 75-foot-thick sandstone sequence. The bed is very persistent and was measured at 70 different locations across the quadrangle. It ranges in thickness from less than 1 foot in the southwestern part of the quadrangle to more than 5 feet in the northeastern part. The bed averaged 2.9 feet in thickness across the quadrangle area but has an average coal resource thickness of 2.5 feet owing to the persistence of one or more shale partings in the coal bed. The coal may be locally split into two benches separated by 10 to 20 feet of shale or sandstone. At some localities a distinctive marine fossil zone is found in shale 10 to 20 feet above the Splash Dam coal bed and at other localities the shale zone has been truncated by a discontinuous, channel form, sandstone body.

The Splash Dam is the most extensively mined coal bed in the quadrangle. Most of the thick Splash Dam coal was mined from Haysi quadrangle over the 50-year history of the Clinchfield Coal Co. mine at Splashdam, but significant reserves may have been left in several large unmined blocks and pillars within the mined area. The Splash Dam was also mined in the Flannigan reservoir area, where Giles (1921) misidentified the coal as the Upper Banner bed. The coal seems to thin uniformly from the northwest to the southeast on both sides of the Russell Fork fault.

The Hagy coal occurs 80 to 110 feet above the Splash Dam coal. Like the Splash Dam it is also very persistent across the area and there is a traceable marine fossil zone (Eagle Shale?) about 70 feet above the Hagy. Fifty-six sections of the Hagy coal were measured. They averaged 1.8 feet in thickness with a resource thickness of 1.7 feet; 9 were greater than 2.5 feet thick. The Hagy was not extensively mined in the area, but several abandoned drift mines and small surface mines are located in the Haysi area. The Hagy and Hagy rider coals are particularly well exposed along State Road 611 east of Flannigan Dam.

The unnamed coal was mapped only in an area northeast of Russell Fork where it is about 80 to 120 feet above the Hagy. Southwest of Russell Fork it was recognized on a few driller's logs but is not continuous across the area. Maximum thickness measured in the field was 1.1 feet on the ridge between Sandlick Branch and Tilda Anderson Branch.

The Norton (Dorchester) coal lies 180 to 220 feet above the Hagy coal. The Norton coal commonly overlies a massive sandstone, 40 to 80 feet thick, that was identified incorrectly as the Gladeville sandstone in earlier reports. The Norton coal generally occurs within a 40 to 60 foot thick zone of interbedded sandstone, shale and coal, commonly with two minable benches of coal which are mapped as the Norton 1 and Norton 2 coal beds. Both Norton coals were surface mined in the area along State Highway 63 southwest of the Mount Olive Church where the Lower Norton coal (Norton 1) was 4.2 feet thick and the Upper Norton coal (Norton 2) was 3.2 feet thick. Both coals contain shale partings that reduce the coal resource thicknesses at this mine to 3.7 feet and 2.4 feet respectively. The Norton coal zone was continuous across the entire area. The lower bed, measured at 18 localities is thinner on the average (1.7 feet) than the upper bed (2.1 feet) that was measured at 27 localities. Where only one bench of coal is well developed in the Norton coal zone it was named according to its stratigraphic position in the sequence, therefore the Norton coal that was strip mined at the head of Doty Branch in the eastern part of the area has been mapped as the Norton 2 bed. The complex geometrical relationships among beds in the Norton coal zone is particularly well illustrated in a highwall adjacent to baseball fields in the borrow area above Flannigan Dam.

The Dorchester (Lyons) coal lies 40 to 100 feet above the Upper Norton coal bed. The interval between the Norton and the Dorchester unit may consist either of interbedded shale and sandstone or massive lithic sandstone. The Dorchester coal in the southwestern part of the quadrangle, is commonly split into two or three benches of coal separated locally by as much as 50 feet of shale. At the time of the survey the Dorchester coal was exposed in ditches along a gas well access road north of the mouth of the Barts Lick Creek. There the lower split consisted of interbedded coal and shale aggregating 7.2 feet. The lower bench is separated by 14 feet of mottled-brown and gray-clay from an upper bench containing 4.3 feet of interbedded coal and black fissile shale. A coal resource thickness of 5 feet was calculated for this locality. The Dorchester coal was surface mined at the Clinchfield Jacobs Fork mine located northeast of Russell Fork above the town of Splashdam and at the Russell Prater Land Company mine located southwest of Russell Fork above White Branch. The Dorchester coal exposed at the Russell Prater mine was measured as two splits. The lower split which contained 2.7 feet of shaly coal is separated from the upper split containing 2.7 feet of interbedded shale and coal by 17 feet of shale and sandstone. Average thickness for 11 sections of Dorchester coal measured in the quadrangle is 2 feet.

The Lyons (Eagle, Blair) coal is generally from 30 to 60 feet above the Dorchester coal zone. In the northern part of Haysi quadrangle where the coal was surface mined on both sides of the Russell Fork fault the interval between the Dorchester and Lyons beds thins to 25 feet toward the fault, from both west and east. The Lyons coal is generally split into two benches; both have been extensively mined in the area. The two benches were mapped as one in the northern part of the area but have been mapped separately in the vicinity of the abandoned Sycamore Coal Company surface mine south of Russell Prater Creek in the eastern part of the area.

The lower Lyons coal bed was described previously as the Blair coal, whereas the Upper Lyons coal bed was previously described as the Eagle bed. Neither the name Eagle, which is a West Virginia name, or the name Blair, which was inaccurately projected into the area from the southwest, can be justified with stratigraphic evidence from gamma ray logs, core hole data, and detailed mapping.

The Lower Lyons (Blair) bench averaged 2.3 feet in thickness in 10 measurements across the area and 26 measurements of the Upper Lyons (Eagle) coal bed averaged 4.2 feet. Most of the thicker coal has been mined out in Haysi quadrangle.

The Clintwood coal bed is discontinuous across the area because it has been truncated by erosion beneath a thick sandstone sequence over much of the Haysi quadrangle. Where it is preserved the Clintwood occurs above a prominent sandstone bench 40 to 60 feet above the Upper Lyons coal. The Clintwood coal was mined on the ridge between Cane Creek and White Branch, south of Pound River in the northwestern part of the area, on the southeastern end of the large Clinchfield Jacobs Fork surface mine north of Haysi, and in the small Sycamore Coal Company surface mine south of Russell Prater Creek. A section of Clintwood coal, 4.2 feet thick, was measured at the mine south of Russell Prater Creek and is probably the thickest in the area. The nine sections of the Clintwood that could be measured in Haysi quadrangle averaged only 1.1 feet thick.

The Addington coal bed lies above a massive sandstone sequence that was deposited in a channel or series of channels cut deeply into the lower Wise Formation. The Clintwood/Addington sequence was best exposed in surface mine highwalls in the extreme northeastern corner of the area. In this area the Addington occurs about 35 feet above the Clintwood bench and at the base of a distinctive 30-foot-thick calcareous-black-shale zone thought to correlate with the Cannelton limestone. Although of no economic importance, the Addington coal is an important marker bed, near the top of the Pennsylvanian sequence preserved in the Haysi quadrangle.

NATURAL GAS

Natural gas production in the Haysi area is from an extension of the Nora gas field to the south. Drilling records indicate that at least 95 gas wells have been drilled in the Haysi quadrangle since 1949. Of the 95 wells recorded, 93 are currently listed as producing and 2 are listed as shut in. Production records indicate that some of the earlier gas wells in this area have been productive for 34 years.

The most productive reservoir in the area has been the Berea "sand" which is a 150-foot siliceous zone at the base of the Mississippian Big Stone Gap Member of the Chattanooga Shale. Outcrop-derived gamma ray logs and petrography of rock samples from the Mississippian-Devonian shale section, exposed to the south of the Haysi area along the Allegany structural front (Diffenbach and Henika, 1988) indicate the Berea is very fine grained and would be better described as a siliceous siltstone unit. Gas production from the Berea is apparently dependent on fracture permeability and continuous recharge from the surrounding organic-rich shale units. Eighty-two wells are producing from this zone at depths ranging from approximately 4000 to 5250 feet in the Haysi area.

In addition to the Berea, other reservoirs for natural gas include the "Big Lime" (27 wells), the "Maxon sand" (5 wells), the "Ravencliff sand" (2 wells), and the "Weir sands" (1 well). All of these have been produced and have been co-mingled with gas from the Berea and the Devonian shale units. All of the productive reservoirs were identified on outcrop using surface-derived, gamma-ray logs of measured stratigraphic sections. Porosity of producing reservoirs was calculated by cross plotting measurements from sidewall neutron and compensated density logs. Production from the Big Lime comes from thin (less than 10 feet thick) zones of 10 to 15 percent porosity in the Mississippian Greenbrier Limestone at depths of 3200 to 4000 feet. "Maxon sand" production is derived from relatively thin zones (less than 20 feet thick) of moderate- to low-porosity (3 to 10 percent) sandstone at depths of 2700 to 3100 feet. The Maxon sandstones are interbedded in the middle and lower part of the Mississippian Hinton Formation and include the Stoney Gap Member at the base. The "Ravencliff" reservoir is equivalent to the Tallery Sandstone Member at the top of the Hinton Formation. Henika (1988) described outcrops along the structural front to the south of this quadrangle. Production from the Ravencliff sand is derived from thin (5 to 12 foot thick) porous zones of 10 to 12 percent porosity in the middle of the 80-foot-thick quartzarenite of the Tallery at depths of approximately 2370 to 2570 feet.

The "Weir sands" correspond to siltstone units in the Price Formation also described from outcrop to the southeast. In the one producing well listed, Weir production came from a 26-foot perforated interval in siltstone, at a depth of approximately 4210 to 4250 feet.

Initial production rates for 40 of these wells that had data available ranged from 0 to 1240 Mcfg/day and averaged 178 Mcfg/day. All of the wells were stimulated by fracture or acid treatment or both. Production after stimulation ranged from 39 to 4409 Mcfg/day and the average for the 93 wells listed was 1133 Mcfg/day. Drilling in the area is expected to continue, as new distribution lines are constructed southeastward from the Nora compressor station.

OTHER MINERAL RESOURCES

Shale and siltstone, in the thick interval between the Lower Banner and Upper Banner coal beds, may have potential for use in the manufacture of lightweight aggregate. Samples collected from this interval exposed along State Highway 83 about 5 miles east of the boundary between Haysi and Prater quadrangles were cited for this use by Johnson and others (1966). Quartzarenite in the Bee Rock member of the Lee Formation and in the Gladeville Sandstone, may be a potential source of nonpolishing aggregate or high silica sand for the glass industry. Flaggy-bedded sandstone in the Wise Formation may have some potential as a decorative stone.

Sand, for local use, was pumped from stream deposits at several localities along Russell Fork near Birchleaf. The Howard Daniels Sand Company has produced sand for construction use and for traction sand from sites along Russell Fork north of Birchleaf.

ACKNOWLEDGMENTS

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Table. Coal-bed analyses (Virginia Division of Mineral Resources, Economic Section files).

Parameter	Range	Average
Volatile Matter	20.3-35.1%	28.8%
Fixed Carbon	42.8-62.4%	55.2%
Ash	2.8-34.3%	15.5%
Total Sulfur	0.6-3.6%	1.4%
Btu/lb.	9365-14,729	12,858

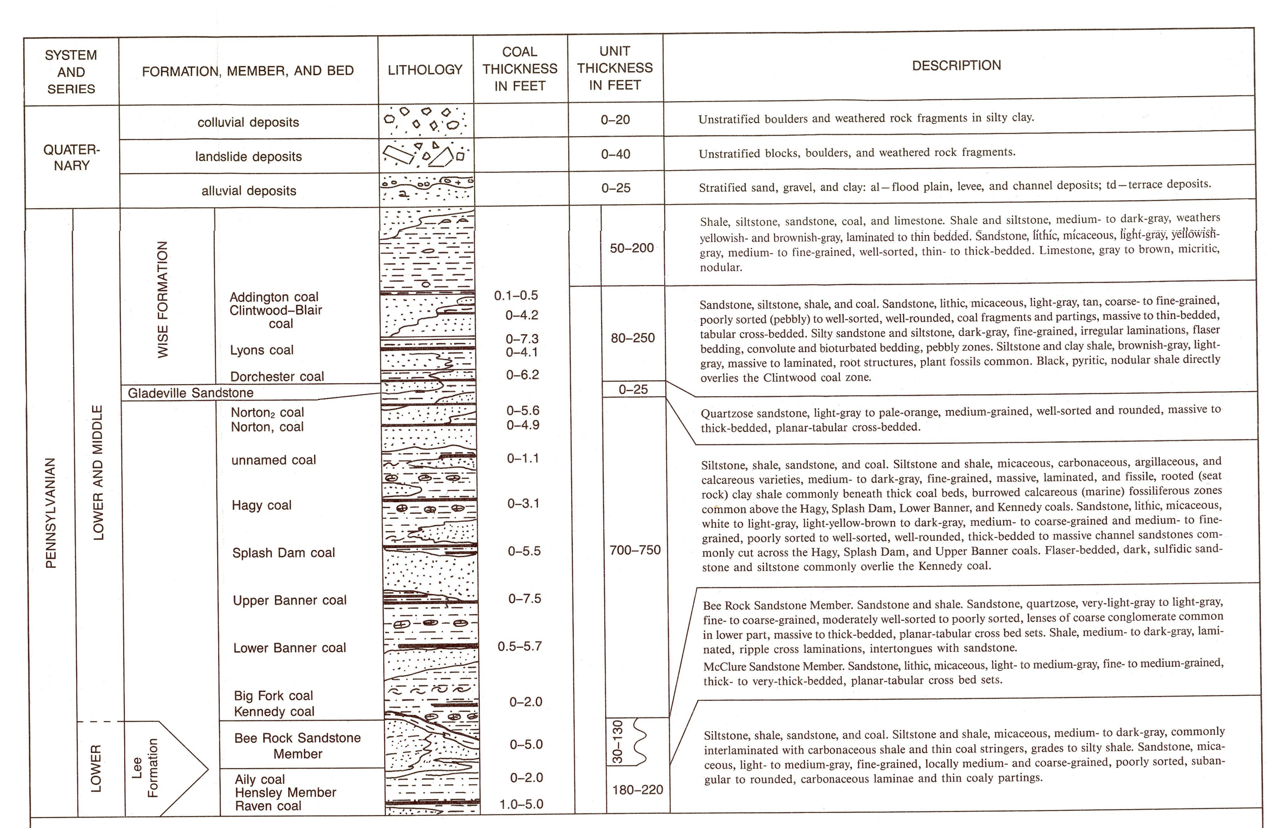

Figure 1. Columnar section of surface rocks

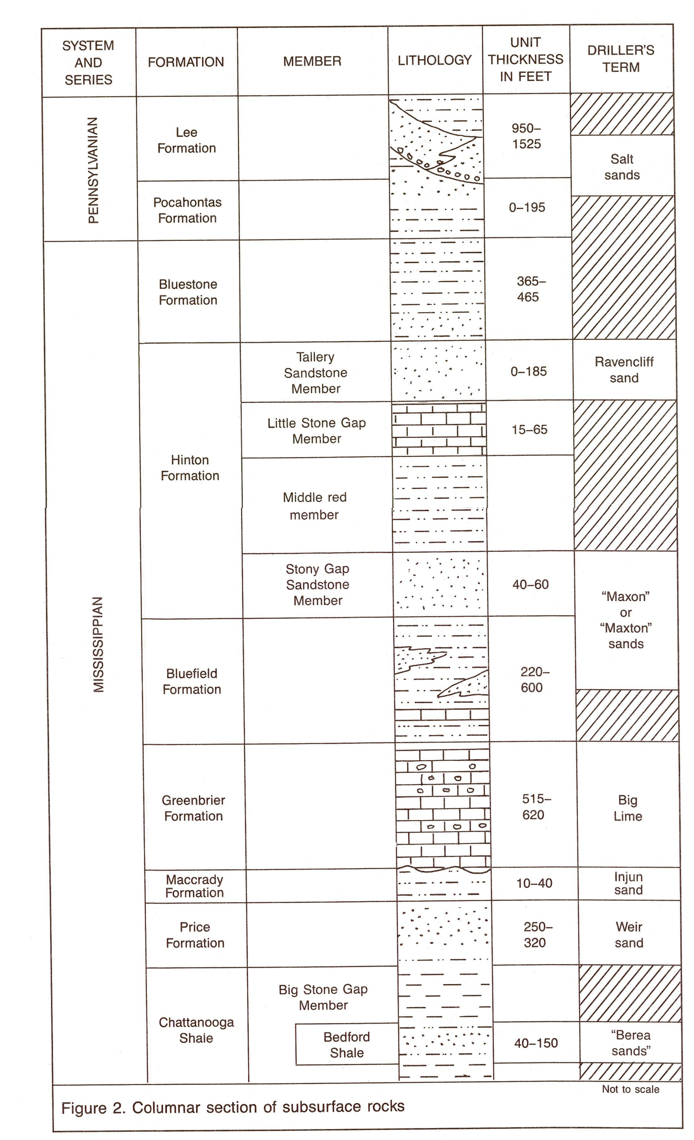

Figure 2. Columnar section of subsurface rocks