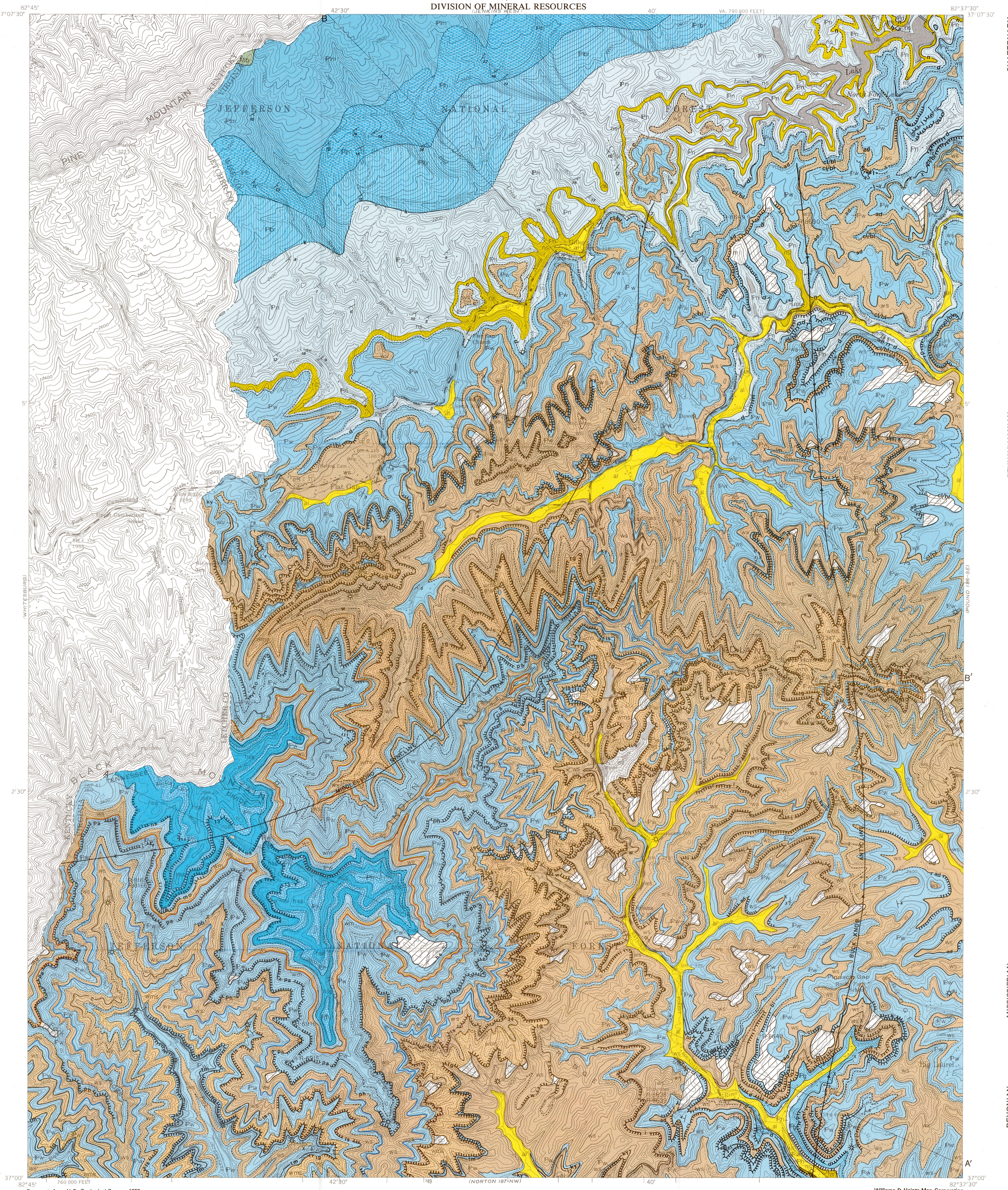

Base map from U.S. Geological Survey, 1955 (78-PR) Flat Gap Quadrangle, 7½ minute series.

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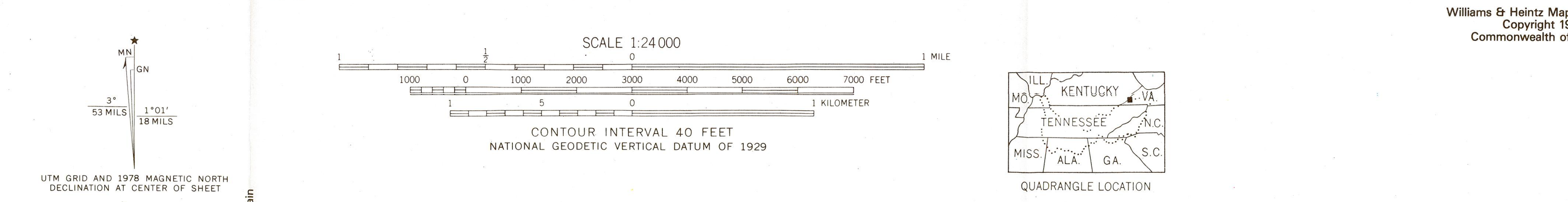

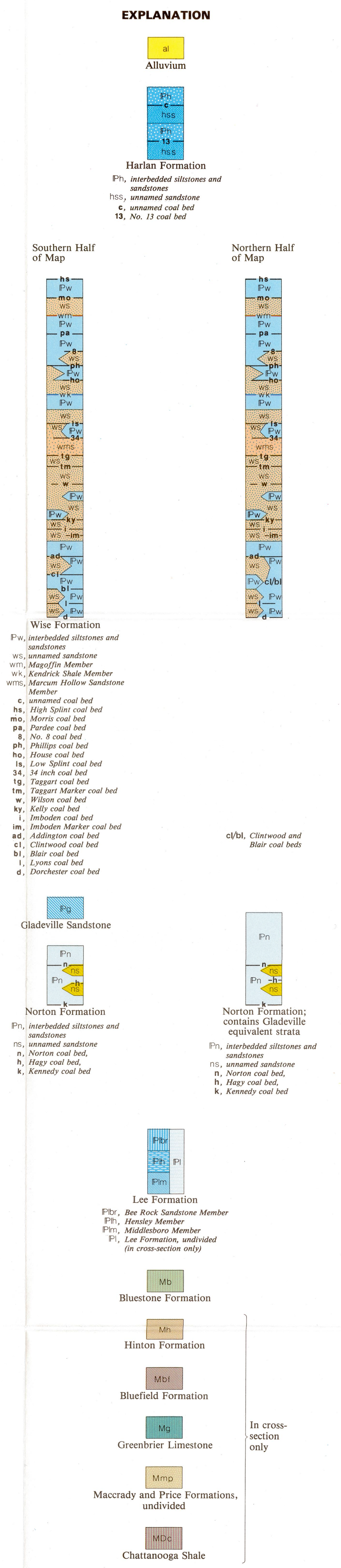

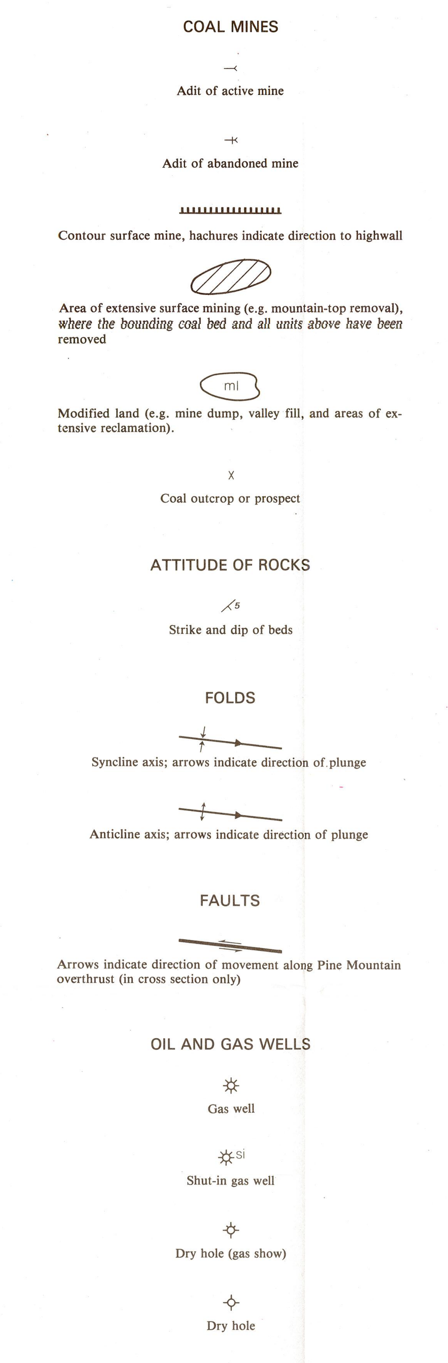

GEOLOGY OF THE VIRGINIA PORTION OF THE FLAT GAP QUADRANGLE

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INTRODUCTION

The Flat Gap quadrangle area is located in northwestern Wise County, Virginia and southeastern Letcher County, Kentucky and lies entirely within the Appalachian Plateaus physiographic province. The area described in this report is the Virginia portion, approximately 52 square miles, of the Flat Gap quadrangle. The geology of the Kentucky part of the area, was described by Rice and Wolcott (1973). The Virginia Polytechnic Institute and State University provided partial funding for the present study under contract number 231-818844-3-4125.

STRATIGRAPHY

The stratigraphic sequence exposed in the area is approximately 4800 feet thick and ranges in age from Upper Mississippian to Middle Pennsylvanian. This sequence is mainly siltstone, sandstone, and coal, although a few beds of shale and limestone are present.

The Paleozoic rocks in the area are divided into six formations which, from oldest to youngest, are the Bluestone, Lee, and Norton formations, the Gladeville Sandstone, and the Wise and Harlan formations. Surficial deposits of Quaternary age occur as flood plain alluvium and talus. The alluvial deposits are composed of clay, silt, sand, and cobbles with fragments or lenses of organic material. Talus deposits are made up of boulders of sandstone.

STRUCTURE

Structures in the quadrangle area were produced by a northwestward movement of the Pine Mountain block above the subhorizontal Pine Mountain thrust fault (Harris and Milici, 1977), which developed during the Alleghenian orogeny in Late Paleozoic time. The principal regional structure in the area is the Middlesboro syncline. The synclinal axis trends east to northeast and plunges in a northerly direction, towards North Fork Lake just east of Gilley. The axis of the Middlesboro syncline converges northward with the axis of the Buck Knob anticline, a north-trending fold. The western limb of this broad, low-amplitude anticline is slightly steeper than the eastern limb. The anticline plunges gently to the north, although, east of Dewey, the plunge reverses.

Sandstone beds have well-developed joint sets, and all coal beds have a well-developed cleat. These fractures tend to be parallel to subparallel; the dominant trend of the face cleat and the systematic joint sets is N50-75°E. Butt cleat and nonsystematic joints are approximately perpendicular to the dominant fracture sets.

ECONOMIC GEOLOGY

Coal

Coal is the most important mineral resource in the area. In general, it ranges from a high-volatile B to a high-volatile A bituminous coal.

Analyses of 27 coal samples are on file at the Division of Mineral Resources. The coal samples analyzed have the following ranges: fixed carbon, 53 to 65 percent; total sulfur, 0.5 to 2.6 percent; ash, 5.0 to 20.0 percent; and volatile matter, 33.0 to 37.0 percent. The heat values of the coals, on a moisture- and ash-free basis, are mostly between 13,500 and 15,500 Btu per pound.

The many surface and underground mines in the area produce from the Norton, Dorchester, Lyons, Blair, Clintwood, Addington, Imboden Marker, Imboden, Kelly, Upper St. Charles, Wilson, Taggart Marker, Taggart, 34-inch, Low Splint, House, Phillips, Pardee, High Splint, and the No. 13 coal beds. Surface mining is performed by contour and hilltop-removal methods. At places, as surface mining nears completion, additional coal is removed by horizontal augers at the base of the highwall. The coals are here described in ascending stratigraphic order, omitting coals of no present economic value.

Norton and Wise Formation Coals

Coal beds of the upper Norton and lower Wise formations are exposed along the Guest River and the South Fork of the Pound River where the drainage systems cut across the axis of the Buck Knob anticline and in the upturned beds of the overthrust block along Pine Mountain. Within the stratigraphic sequence, which ranges from the Kennedy coal below to the Addington coal above, a total of seven major and many minor coal beds occur in a 750- to 925-foot-thick coal-bearing zone. Above the Addington or Clintwood coals, the upper Wise Formation includes 15 coal beds in a 1700- to 1800-foot-thick interval. Reclamation of the mined land in this area is extensive, generally leaving the coal beds covered. Where exposed, the coal beds show well-developed cleat.

The Kennedy coal bed, at the base of the Norton Formation, is not mined in the area. Where exposed, the coal has a dip too steep for economic development, and the thickness is very irregular.

The Norton coal bed is the lowest coal bed surface mined along the axis of the Buck Knob anticline. A reclaimed mine bench lies approximately 50 feet below the base of the Gladeville Sandstone southeast of Lipps on the north bank of the Guest River. The coal bed is not exposed here, and its exact thickness is not known. North of Indian Mountain, the Norton coal averages 30 inches in thickness. In general, the Norton lies 80 to 100 feet below the Dorchester coal and close above a 40- to 90-foot-thick, feldspathic sandstone. In the northern half of the map area, the Gladeville Sandstone is thin to discontinuous. The thick sandstone below the Norton coal bed has generally been misidentified as the Gladeville..

The Dorchester (Glamorgan) coal lies 80 to 100 feet above the Norton coal. It is directly above the Gladeville Sandstone along Guest River and above siltstones and shales of the Norton Formation along the North and South Forks of the Pound River, north of Indian Mountain. The Dorchester coal has been mined by surface and underground methods throughout the area. The coal ranges from 30 to 44 inches thick throughout the area. North of Indian Mountain where the Gladeville Sandstone is absent, the Dorchester coal bed marks the boundary between the Norton and Wise formations.

The Lyons coal is 40 to 60 feet above the Dorchester coal and ranges from 0 to 25 inches in thickness. There has been surface mining along the Guest River and Big Branch and north of the South Fork of the Pound River. The coal is generally covered. It is exposed in road cuts along State roads 626 and 671 where it is 20 to 24 inches thick.

The Blair coal lies 40 to 70 feet above the Lyons coal, and its thickness ranges from 16 to 30 inches. A thin rider of silty coal, 6 to 12 inches thick, may be found 10 to 40 feet above the main bed but was not mapped separately.

The Clintwood coal beds also show much variation in thickness and stratigraphic separation. In general, two coal beds are separated by 1 to 25 feet of siltstone and shale, and lie 10 to 50 feet above the Blair coal. Along the Guest River, the lower bed of the Clintwood is 35 to 40 feet above the Blair. East of Lipps, the sandstone beds above the upper Clintwood thicken to 60 feet and locally cut out the upper coal bed. South of Pinnacle Gap, each coal bed has an average thickness of 12 inches and they are separated by 10 to 15 feet of siltstone. Northwest of Lipps, the upper and lower Clintwood beds are separated by only a thin shale parting and have a total thickness of 44 inches. To the north along the South and North forks of the Pound River, the Clintwood coal beds are only 10 to 20 feet above the Blair. They have been surface mined together and are mapped as a single bed in this area.

The Addington coal lies 40 to 70 feet above the Clintwood coal, averages 10 to 18 inches in thickness, and is discontinuous. It generally overlies a cross-bedded sandstone and is near the base of a thick siltstone unit containing marine fossils. The Addington coal is mined from the surface along Rocky Fork and Hall Branch where it is 14 inches thick. Elsewhere the coal is usually recovered with the Clintwood coal and can be found in the highwall of the Clintwood surface mines. The Addington coal is often referred to as the upper split of the Clintwood by property owners.

The Imboden Marker (Lower Bolling) coal is 26 to 49 inches thick and crops out 240 to 300 feet above the Clintwood coal. It is mined from the surface on a limited basis in association with the overlying Imboden coal.

The Imboden (Upper Bolling) coal lies 10 to 25 feet above the Imboden Marker. The coal thickness ranges from 30 inches on the ridge northwest of Dewey to 59 inches at Dixiana, where it is currently mined at the surface. Thirty-six inches of Imboden coal were measured at a surface mine along Phillips and Donald creeks.

The Kelly coal ranges from 30 feet above the Imboden along the ridge east of Flat Gap to 90 feet above it near Steer Branch. The coal is thin to discontinuous except where it locally thickens between Flat Gap and Donald Branch. Forty-five inches of coal and 6 inches of interbedded siltstone are present in an underground mine southwest of Flat Gap. Locally, the Kelly coal has been recovered by surface mining in association with the Imboden coal.

Detailed mapping has clarified the stratigraphic sequence of the Imboden Marker, Imboden, and Kelly coals. In the Flat Gap quadrangle area, the Imboden Marker is a thick and locally discontinuous coal. It is the lower of the two beds worked in the Imboden interval. The Kelly is a thin coal, except as noted on Donald Branch. Typically, it is separated from the Imboden by a thick sandstone. The section described by Eby (1923, p. 409, Loc. 605) is now identified as the Imboden Marker (2') and Imboden (3'5½") coal. The Kelly was not measured by Eby as it is separated from the Imboden by the thick sandstone and was thought to be above the Keeley seam.

The Upper St. Charles (Lower Standiford?) coal bed occurs approximately 260 feet above the Imboden and 20 to 40 feet below the Wilson (No. 4, Upper Standiford?) coal. The Upper St. Charles (not shown on map) averages 28 inches in thickness, and the Wilson averages 30 inches. They are currently being mined from the surface north of Critical Fork and in the vicinity of Steer Branch. The Wilson coal is being mined underground just north of Fox Gap.

The Taggart Marker coal crops out about 60 feet above the Wilson coal, with a maximum separation of 90 feet near Steve Horn Branch. The coal averages 25 inches in thickness throughout the area and has been mined at the surface in association with the overlying Taggart coal.

The Taggart coal (No. 5 in Kentucky) was mined extensively in the area. At present it is being recovered from north of Critical Fork and in the vicinity of Steer Branch. The coal is 28 inches thick in the southwestern part of the area but thickens to 58 inches south of Fox Gap. The coal is present in several splits over much of the area. The intervening rock is shale that generally grades upward to siltstone, above which is a cross-bedded sandstone. The sandstone commonly fills the entire interval between the coals. The upper split is a 20- to 30-inch coal that is a maximum of 18 feet above the main bed and is removed with the main bed. Several caved adits were seen in the Taggart coal along Roberts Branch, Steer Branch, and Phillips Creek.

A discontinuous coal, identified as the Owl (Ravenrock) crops out 90 feet above the Taggart. It is 45 inches thick where surface mining has been done along Phillips Creek.

In the area, the "34-inch coal," lies about 140 feet above the Taggart coal. Locally the company names applied to this coal are the "Low Splint E" and Cedar Grove. The "34-inch" coal averages 30 inches in thickness and is mined in association with the Low Splint coals. This coal was mined between Stidham Fork and Pine Branch, east of the Guest River and is currently being mined from the surface south of Fox Gap.

In the southern part of the area, the Low Splint coal, which lies from 60 to 80 feet above the "34-inch" coal forms a single bed. Locally the coal is known as the "No. 6". This coal is 56 inches in thickness near the head of Powell River but measures 25 inches in a drill hole on Black Mountain. There is an 8-inch shale parting above the base of the unit. In the central part of the area, the Low Splint coal lies 40 to 60 feet above the "34 inch" coal and contains two coal beds with intervening shale and sandstone. These beds are the Low Splint "C" and "D". Respectively, they range from 20 to 39 inches and from 9 to 14 inches in thickness. The thickness of the interveining shale and sandstone ranges from 6 inches to 12 feet. The Low Splint "C" and "D" beds were mined along Indian Mountain. There is one coal bed between the Low Splint "C" and the Kendrick Shale Member. Locally, coal companies call this coal the Low Splint "A". The Low Splint "A" lies about 70 feet above the Low Splint "C". Typically this coal averages 5 inches in thickness but measures 18 inches were it was mined between Pine Branch and Stidham Fork.

The House coal is the only economically significant coal between the Low Splint and the Phillips coals. It crops out 180 to 220 feet above the Low Splint and not far above a cliff-forming sandstone. The coal is a single bed up to 15 inches thick or is two splits totalling 37 inches, separated by 10 feet of siltstone and sandstone.

The Phillips (No. 7, Fire Clay) coal bed lies about 325 feet above the Low Splint coal. The Phillips is represented by as many as four splits. Each individual split averages 11 inches in thickness. The splits are separated by shale partings. The partings are 13 inches thick; with a total of 83 inches for the coal zone. The coal was mined from the surface along Roaring Fork and Guest River.

The Pardee (No. 10, Parsons) coal bed lies 325 feet above the Phillips coal. The coal is hard, blocky, and bright with few or no shale partings. The Pardee was mined at the surface and is currently being mined underground near the head of Straight Fork where the coal averages 40 inches in thickness.

The Morris (No. 11) coal was recovered from the surface along the upper reaches of Straight Fork. Drill holes and outcrops show it to be 12 to 24 inches thick including several shale partings.

The High Splint (No. 12) coal occurs about 100 feet above the Morris. This coal is being mined on Black Mountain, where it averages 55 inches in thickness but may thin or be absent within a few tens of feet. The coal is well cleated, and very bright with some masses of pyrite.

Harlan Formation Coals

The Harlan Formation contains several coal beds, two of which are currently being mined at the surface. The No. 13 coal, the lower one, is being extracted on Black Mountain, where it averages 42 inches in thickness. The coal is a few feet above a prominent sandstone and is not laterally persistent. An unnamed coal 40 to 90 feet above the No. 13 is the youngest coal mined in the area. This coal averages 18 inches in thickness.

Coking Operations

Coke was produced by the Westmoreland Coal Company from 1959 until February 1970. The company operated 180 Mitchell-type ovens along Roaring Fork just west of Pine Branch. The Taggart coal that formed the principal charge was obtained from their Pine Branch mine (Sweet, 1969). The coke was used chiefly by the iron and steel industry and the chemical industry.

Oil And Gas

The area includes part of the Stonega gas field. Production is from the Upper Devonian black shale and the Greenbrier Limestone (Big Lime) of Lower Mississippian age. Natural gas accumulation does not appear to be related to geologic structure but to lithologic changes, leading to differences in the reservoir porosity and permeability.

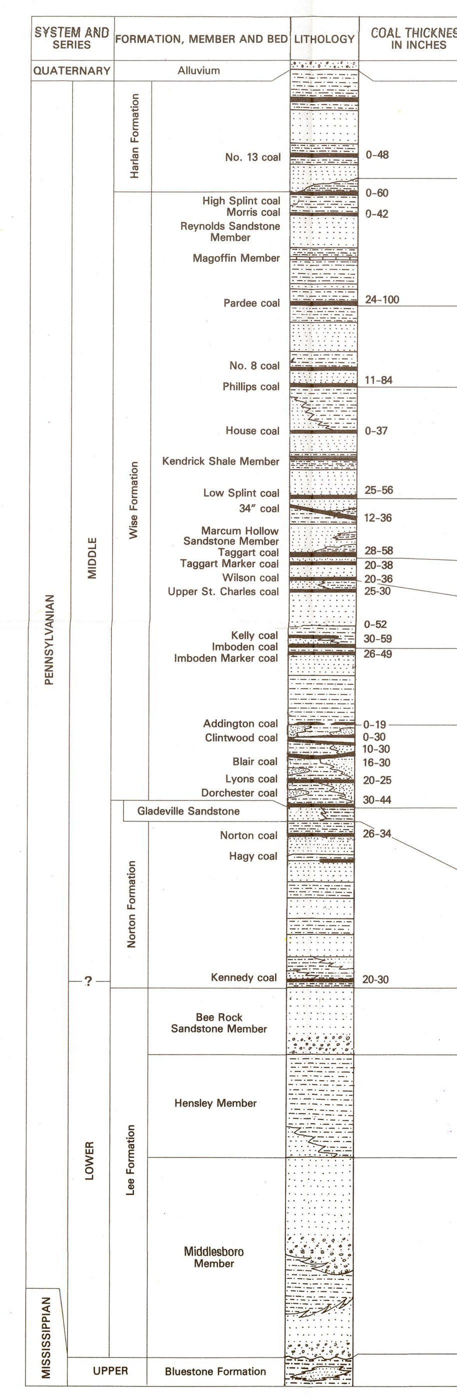
Since the earliest exploratory well was drilled in southwest Virginia near Ramsey in the early 1890's, a total of 151 gas wells have been permitted in Wise County as of August 31, 1985. Of the wells drilled in the Flat Gap quadrangle area, ten are producing gas, ten are currently shut-in gas wells, one is plugged and abandoned with a gas show, and three are dry, plugged, and abandoned. The average well depth to the black shale is about 5000 feet. Average initial flow in this part of the Stonega gas field ranges from a show to 40 MCFGPD. After hydraulic fracturing, the wells produce an average of 150 MCFGPD with an average rock pressure of 800 pounds after 48 hours. Total production for the eight gas wells was 38,205 MCF as of February 1985.

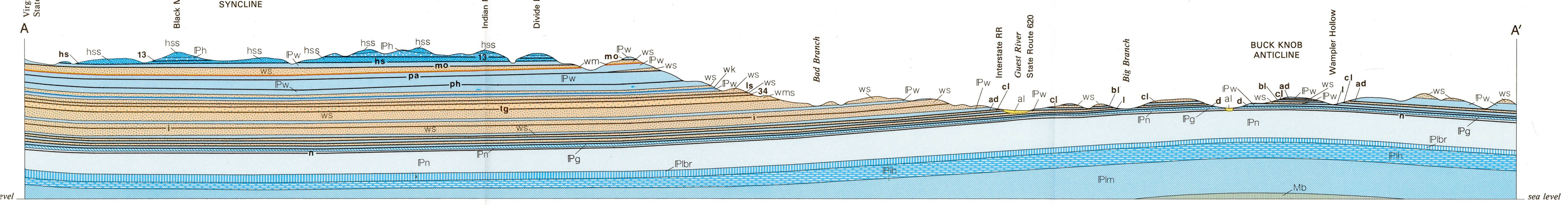
About 15 miles of a natural-gas pipeline, constructed by ANR Production Company in 1984, are located in the area.

Sandstone

Sandstones of the Bee Rock and Middlesboro members of the Lee Formation have economic potential as high-silica sand. The Lee Formation crops out on the southeast flank of Pine Mountain. Lee sandstones have not been quarried within the area; however, material from operations along strike to the west (Whitesburg quadrangle) have 98.57% SiO_2, 0.03% Fe_2O_3, and 1.245% Al_2O_3 (McGrain, 1956), and to the northeast (Jenkins East quadrangle) have 98.5%-99.2% SiO_2 (Musgrove, 1969, personal communication).

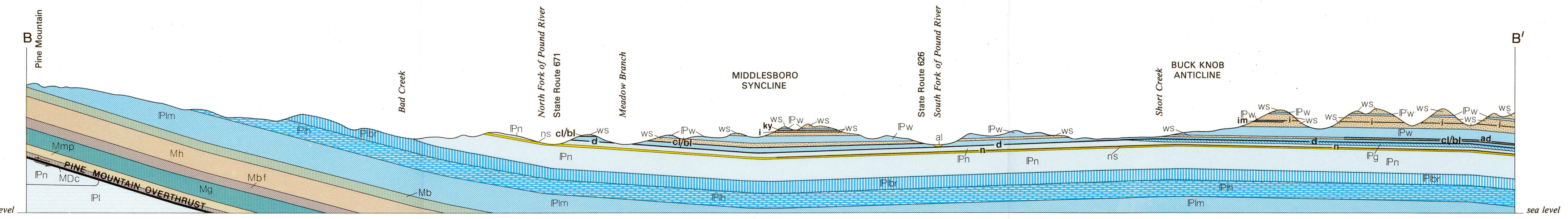
Hollenbeck and others (1967) sampled a sandstone of the Lee Formation in an abandoned quarry near Elkhorn City, Kentucky about 25 miles northeast of the area. They reported analyses as 99.3% SiO_2 and 0.07% Fe_2O_3 in sandstone of the upper half of the unit and 99.3% SiO_2 and 0.05% Fe_2O_3 in conglomerate of the lower half of the unit. They indicated that potential uses of the sand include the glass and foundry industries and coal-washing plants.





CROSS SECTION DESIGN

1. No vertical exaggeration.
2. Subsurface units interpreted from core-hole and oil and gas well data.
3. Thicknesses of alluvium and coal beds are diagrammatic.



REFERENCES

Eby, J. B., 1923, The geology and mineral resources of Wise County and the coal-bearing portion of Scott County, Virginia: Virginia Geological Survey Bulletin 24, 617 p.

Harris, L. D. and Milici, R. C., 1977, Characteristics of thin-skinned style deformation in the southern Appalachians, and potential hydrocarbon traps: U. S. Geological Survey Professional Paper 1018, 40 p.

Hollenbeck, R. P., Browning, J. S., and McVay, T. L., 1967, Industrial sand in Pike County, Kentucky: Kentucky Geological Survey, Series 10, Report of Investigations 7, 30 p.

McGrain, P., 1956, Recent investigations of silica sands of Kentucky: Kentucky Geological Survey, Series 9, Report of Investigations 11, 32 p.

Rice, C. L., and Wolcott, D. E., 1973, Geologic map of the Whitesburg quadrangle, Kentucky-Virginia and part of the Flat Gap quadrangle, Letcher County, Kentucky: U. S. Geological Survey, Quadrangle Map GQ-1119, scale 1:24,000.

Sweet, P. C., 1969, Coking industry in Virginia: Virginia Division of Mineral Resources, Virginia Minerals, v. 15, n. 1, p. 1-6.