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REINTERPRETATION OF THE GEOLOGY OF BROCKS GAP, ROCKINGHAM COUNTY, VIRGINIA[1]

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Brocks Gap, a water gap of the North Fork of the Shenandoah River through Little North Mountain, is in north-central Rockingham County, Virginia (Figure 1). The south end of Cooper Mountain, the southern extension of Little North Mountain in Rockingham County, is about 14 miles (23 km) southwest of Brocks Gap (Figure 1). Examination of the rocks exposed along State Highway 259 at Brocks Gap and State Road 732 at the southern end of Cooper Mountain has resulted in a stratigraphic and structural interpretation significantly different from that proposed by earlier workers (Butts, 1940-41; Woodward, 1943, 1951; Brent, 1960). Table 1 summarizes the stratigraphic nomenclature that has been used to describe the Upper Ordovician through Lower Devonian section exposed in Brocks Gap.[4]

Numbers preceded by "R" in parentheses (R-6799) identify sampled localities. The samples are on file in the repository of the Virginia Division of Mineral Resources and are available for examination.

STRATIGRAPHY

The rocks exposed at Brocks Gap are described beginning with the oldest beds exposed directly across State Highway 259 from the store at the east end of the

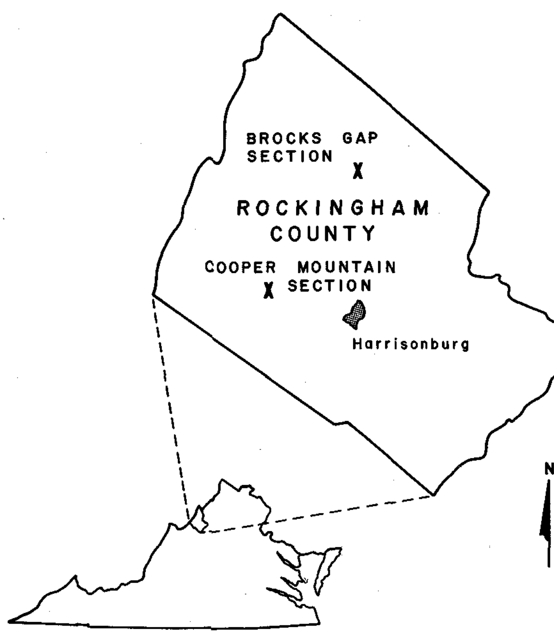

Figure 1. Index map showing location of the Brocks Gap section.

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1 Publication authorized by the Director, U. S. Geological Survey.

2 Virginia Division of Mineral Resources, Charlottesville, VA 22903.

3 U. S. Geological Survey, Reston, VA 22092.

4 Nomenclature used in this paper follows that used by the Virginia Division of Mineral Resources and does not necessarily conform to U. S. Geological Survey usage.

gap and proceeding westward to the youngest exposures just beyond the western end of the gap near State Road 621.

ORDOVICIAN SYSTEM

Martinsburg Formation: Only the upper 100 feet (30 m) of the Martinsburg Formation is exposed in the gap. The rock is a dark-gray lithic sandstone containing thin beds of gray shale. *Orthorhynchula,* a brachiopod, is present in the sandstone with at least two gastropod genera.

LOWER SILURIAN AND UPPER ORDOVICIAN ROCKS

Lower Silurian and Upper Ordovician sandstone: Table 1 summarizes the nomenclature that has been applied to this sandstone. Although the upper part of the unit is a purer quartz sandstone than the lower, the separation of the unit into discrete formations does not seem appropriate at present.

Most of the unit is composed of greenish-gray lithic sandstone. Several beds of polymictic conglomerate are present from about 150 feet (46 m) to 315 feet (96 m) above the base of the unit. The lowermost conglomerate layer (R-6801) contains angular clasts of silicified oolitic dolomite, slate, radiolarian chert, and volcanic rock (Figure 2). Beginning about 260 feet (79 m) above the base and continuing for the next 140 feet (43 m), thin layers (20-30 cm thick) of red mudstone and thick beds of maroon-gray feldspathic sandstone (R-6799) are interbedded with the greenish-gray sandstone (R-6800). These red and maroon-gray beds were not observed along State Road 732 at Cooper Mountain. The upper 75 to 100 feet (23-30 m) of the unit is somewhat better sorted, but it is not as clean as typical sandstone of the Tuscarora. Lithic sandstone of this unit from the south end of Cooper Mountain contains fluorapatite (R-6802). The thickness of the Lower Silurian and Upper Ordovician sandstone is estimated to be more than 500 feet (152 m).

SILURIAN SYSTEM

Rose Hill Formation: Rocks that were assigned to the Juniata Formation by Butts (1940-41), Woodward (1951), and Brent (1960) contain ostracodes (*Bonnemaia* cf. *B. celsa, Zygosella* sp.) of late Rose Hill age (Woodward, 1955; written communication, Jean Berdan, 1976; Figure 3). These rocks are very poorly exposed, fine-grained, maroon and gray, rusty brown weathering, micaceous, fossiliferous sandstone and red and tan siliceous shale. The thickness of the unit is about 210 feet (64 m).

Keefer Sandstone: A light-gray, fine- to medium-grained, silica-cemented sandstone, 53 feet (16 m) thick, is exposed near the center of Brocks Gap (Figure 4). This sandstone is thin- to medium-bedded and ripple marked in part (Figure 5). It was formerly termed

Table 1. Summary of the stratigraphic nomenclature at Brocks Gap.

BUTTS, 1940-41; WOODWARD, 1951	WOODWARD, 1955	BRENT, 1960	THIS PAPER	
		MILLBORO SHALE	MILLBORO SHALE	DEVONIAN
		NEEDMORE SHALE	NEEDMORE FORMATION	
		RIDGELEY SANDSTONE	RIDGELEY SANDSTONE	
		HELDERBURG GROUP	HELDERBERG GROUP	
		CAYUGA GROUP	TONOLOWAY FORMATION	SILURIAN
			WILLS CREEK FORMATION	
BLOOMSBURG FORMATION		CLINTON FORMATION	BLOOMSBURG FORMATION	
CACAPON DIVISION OF CLINTON FORMATION			SHALE OF "ROCHESTER" AGE	
TUSCARORA QUARTZITE	KEEFER SANDSTONE	CLINCH SANDSTONE	KEEFER SANDSTONE	
JUNIATA FORMATION	CLINTON (ROSE HILL) FORMATION	JUNIATA FORMATION	ROSE HILL FORMATION	
OSWEGO SANDSTONE	TUSCARORA SANDSTONE	OSWEGO FORMATION	LOWER SILURIAN AND UPPER ORDOVICIAN SANDSTONE	
	JUNIATA-OSWEGO FORMATIONS			ORDO-VICIAN
MARTINSBURG SHALE	MARTINSBURG SHALE	MARTINSBURG SHALE	MARTINSBURG FORMATION	

Figure 2. Photomicrograph of polymictic conglomerate. Note extensive pressure solution of lithic clasts with respect to quartz sand grains, large chert clasts (dark) at top, slate clasts in right center, silicified oolitic carbonate clast in center, volcanic clasts (dark) in lower right and lower left; fractured siltstone in lower center shows two stages of deformation prior to its emplacement in the conglomerate. Magnification approximately X4.

Tuscarora or Clinch sandstone (Butts, 1940-41; Woodward, 1951; Brent, 1960).

Shale of "Rochester" age: Interbedded gray, red, and green, rusty-weathering fossiliferous shale, 5 to 7 feet (about 2 m) thick, containing interbedded thin sandstone layers near the base, is exposed between the Bloomsburg and Keefer. Fossil ostracodes collected from this interval have been identified by Rader as being of middle Wenlockian ("Rochester") age.

Bloomsburg Formation: Red mudstone, shale, and siltstone compose most of the Bloomsburg Formation. Near the top of this 80-foot- (24-m-) thick unit, a white to light-gray, fine- to medium-grained quartz sandstone

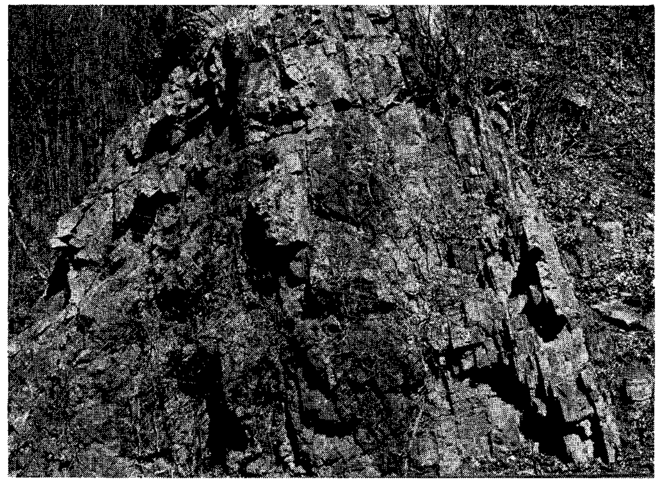
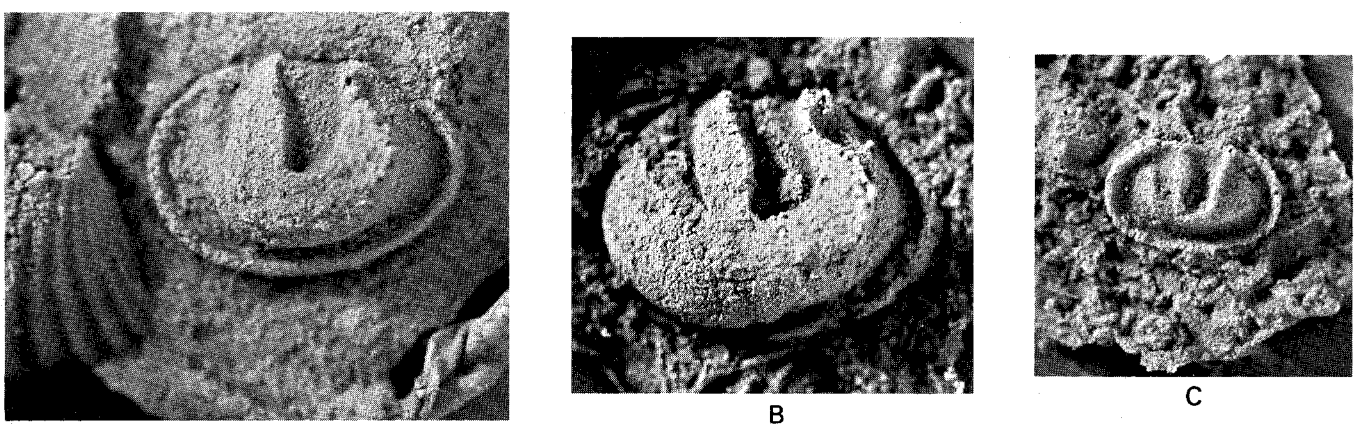


Figure 4. Keefer Sandstone near the center of Brocks Gap; section is overturned; top faces west (left).



A B C

Figure 3. Ostracodes from the Rose Hill Formation about 10 feet (3 m) below the Keefer Sandstone. A, *Bonnemaia* sp. cf. *B. celsa* Ulrich and Bassler, male, USNM 242833; B. same, female, USNM 242834; C, *Zygosella* sp., USNM 242835. Identifications and photographs of latex impressions furnished by Jean Berdan, U. S. Geological Survey. Magnification X10.

Figure 5. Ripple marks in the Keefer Sandstone.

is present. This silica-cemented sandstone is about 15 feet (5 m) thick (not exposed at road level).

Wills Creek Formation: The Wills Creek Formation is composed of 150 feet (46 m) of fine-grained, silty limestone and greenish-gray, calcareous siltstone. Fossils are rare and fragmental. This interval is covered at road level.

Tonoloway Formation: The Tonoloway is a gray, fine-grained, finely laminated limestone, covered at road level. Ostracodes are the only common fossil in this unit. The thickness is estimated to be about 200 feet (61 m).

DEVONIAN AND SILURIAN ROCKS

Helderberg Group: Scattered exposures of medium- to dark-gray, fine- to medium-grained, cherty limestone is exposed. The limestone near the top of the interval is sandy. Light- and dark-gray blocky chert float is present in the covered interval at road level. Woodward (1943, p. 51) reported a thin sandstone near the base of this interval. The thickness is estimated to be 400 feet (122 m).

DEVONIAN SYSTEM

Ridgeley Sandstone: Chimney Rock at the western end of the gap is a vertical ledge of Ridgeley Sandstone (Figure 6). The sandstone is white to light gray, coarse grained, and calcite cemented. Molds of brachiopods, pelecypods, and gastropods are common in float blocks. A thickness of 55 feet (17 m) at Chimney Rock has been measured (Brent, 1960).

Needmore Formation: Nonfissile, medium-gray, calcareous mudstone and blocky, dark-gray, very argillaceous limestone are characteristic of the Needmore Formation. Both rock types weather to an olive-green shaly material. Exposures are poor at Brocks Gap. The maximum thickness is estimated to be 100 feet (30 m).

Millboro Shale[5]*:* The Millboro Shale is composed of black, fissile, pyritic shale which weathers pinkish tan. Small bivalve and brachiopod fossils are common. Because of structural complications the thickness of the unit could not be determined.

STRUCTURE

Rockingham County spans the entire structural province in the Great Valley and extends eastward into the Blue Ridge province and westward beyond the Little North Mountain structural front (Figure 7). From east to west the major structural units of Rockingham County are: the western limb of the Blue Ridge anticlinorium, Massanutten synclinorium, Pulaski-Staunton fault, Mayland anticline, Linville Creek syncline, North Mountain fault system, Supin Lick syncline, and Adams Run anticline.

The Little North Mountain structural front (mid-province structural front of Rodgers, 1970) separates the more intensely folded and faulted lower Paleozoic carbonate rocks of the western Shenandoah Valley from the surficially younger folded Paleozoic rocks of the western foldbelt. Brocks Gap through Little North Mountain best displays many of the characteristics of this structural front in Rockingham County.

At Brocks Gap overturned Upper Ordovician through Middle Devonian mainly clastic rocks are

[5] Millboro Shale of Cooper (1939) herein adopted for U. S. Geological Survey usage.

Figure 6. Chimney Rock—a near vertical ledge of the Ridgeley Sandstone.

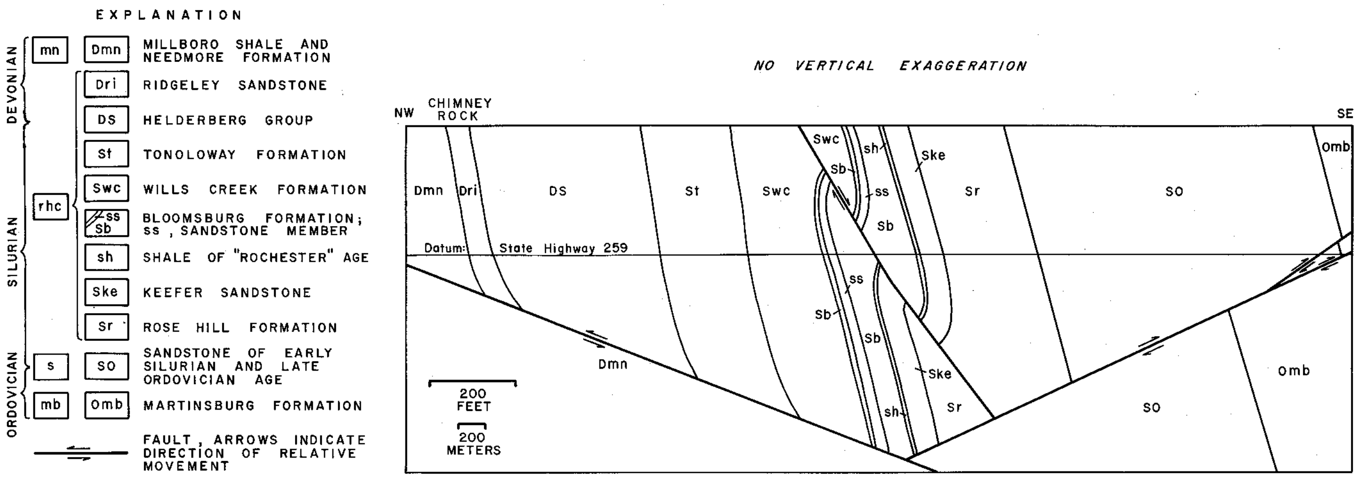


Figure 8. Diagrammatic geologic cross section through north side of Brocks Gap. (See Figure 9 for location along cross section A-A′.)

found west of the mapped trace of the North Mountain thrust fault (Brent, 1960) and form the footwall of this major fault. Middle and Upper Cambrian carbonate rocks are found in the hanging wall which has an apparent stratigraphic displacement of 5,000 to 10,000 feet (1,524-3,048 m). Giles (1927, p. 142) mapped a major thrust fault along the west side of Little North Mountain in Frederick County. A similar fault on the west side of Little North Mountain exists in the Stokesville area, Augusta County and southwestern Rockingham County (Darton, 1894; Rader, 1969).

The reassessment of the Upper Ordovician through Middle Silurian clastic sequence exposed in Brocks Gap when compared with surface exposures and drill cuttings from beds of the same age just to the west (Rader and Perry, 1976) provides a strong basis for Giles' (1927, 1942) hypothesis that Little North Mountain is a transported sequence. Red beds of the Juniata Formation (Upper Ordovician) which are about 500 feet (152 m) thick in the Adams Run anticline 2 miles (3 km) to the west are represented by only thin red-bed tongues at Brocks Gap. Comparable thinning is present throughout the Silurian and Lower Devonian sequence exposed in Brocks Gap as matched against that of the western Valley and Ridge foldbelt. In many respects the stratigraphy of rocks exposed in the gap is intermediate between that of Massanutten Mountain to the east and the western foldbelt. Moderate-scale faulting in the gap adds a further complication (Figure 8). Brent (1960) noted the westward-dipping reverse faults at the eastern end of Brocks Gap. Another fault in the center of the gap has a geometry similar to up-limb faults observed in the western foldbelt (Perry, 1971, 1975). Its present attitude is that of a steeply eastward-dipping normal fault at a low angle to bedding. Such faults in vertical or overturned beds farther west are clearly rotated thrust faults associated with folding (Perry, 1971, 1975). Such faults are termed flexural slip faults by Price (1965) or, more generally, compressional faults (Price, 1967). The writers believe that the fault exposed in central Brocks Gap developed originally as a westward-dipping reverse fault and rotated to its present attitude as the enclosing beds overturned. The westward-dipping reverse fault system at the eastern edge of Brocks Gap consists of extensional faults formed later as based on the stress trajectory analysis of folding by Dieterich and Carter (1969); therefore the authors interpret it to cut the up-limb fault (Figure 8). Similar relationships are exposed and can be clearly demonstrated farther west (Perry, 1971). On the basis of the writers' stratigraphic analysis as well as field relations to the north and south along Little North Mountain, it is inferred that a major eastward-dipping thrust fault, a branch of the North Mountain fault, underlies Brocks Gap. If this is true, then Little North Mountain in this area is a transported slice of Upper Ordovician to Middle Devonian rocks within the Little North Mountain fault system. A recently drilled core hole near the western edge of the gap commenced in slightly overturned chert and cherty limestone of the upper part of the Helderberg, then pentrated more strongly overturned and fractured beds and bottomed at 80 feet (24 m) in highly recrystallized, pressolved, and fractured beds of this unit in which bedding orientation could no longer be distinguished. These findings are consistent with the proposed depth to the major fault shown in Figure 8. It is reasonable to assume that the exposed westward-dipping reverse fault system at the eastern edge of Brocks Gap is antithetic to the major inferred fault and that they both developed concurrently. Further drilling and/or seismic reflection data are needed to confirm the presence, depth, and dip of the major inferred thrust fault.

On the basis of surface mapping by Brent (1960); the

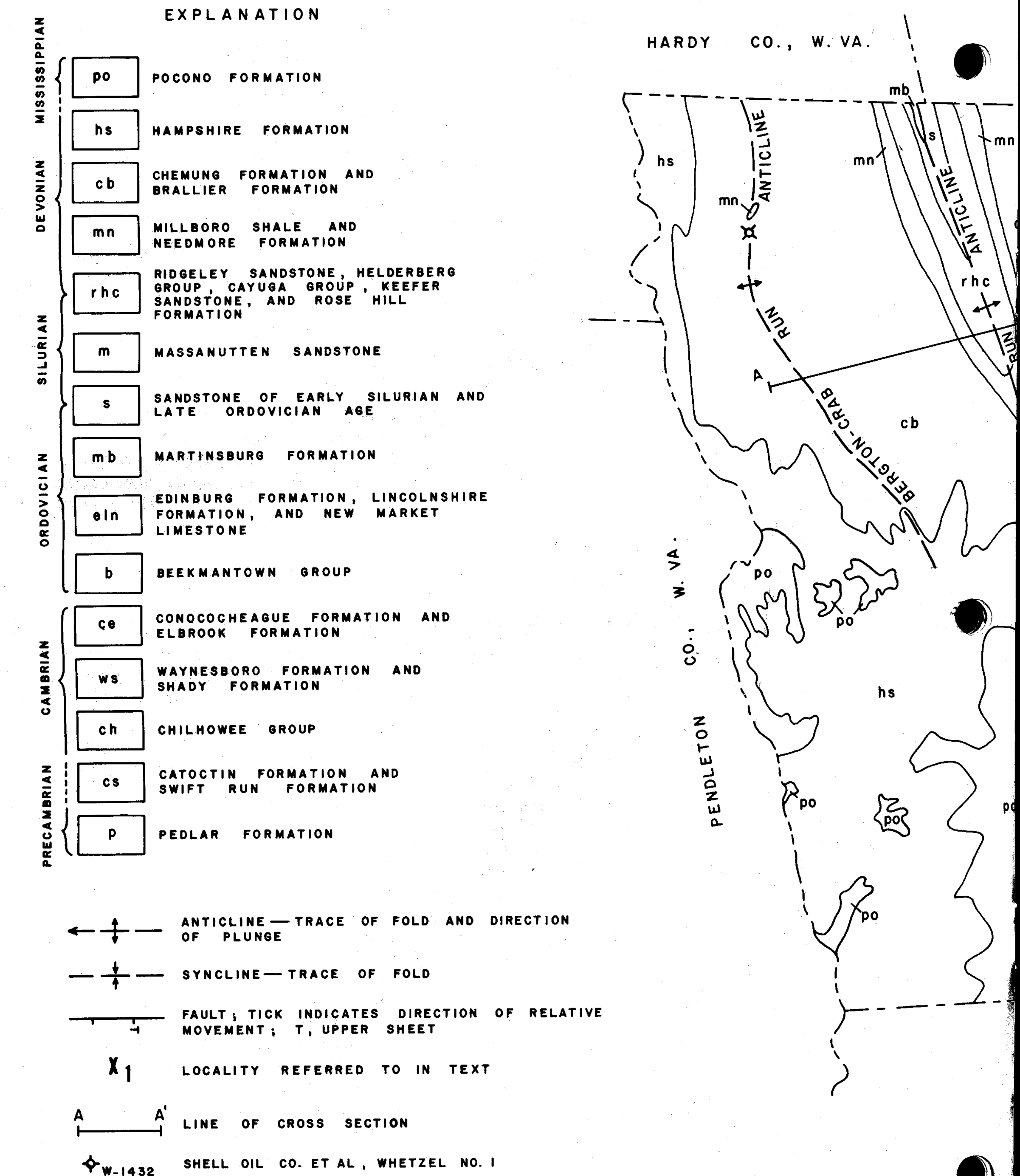
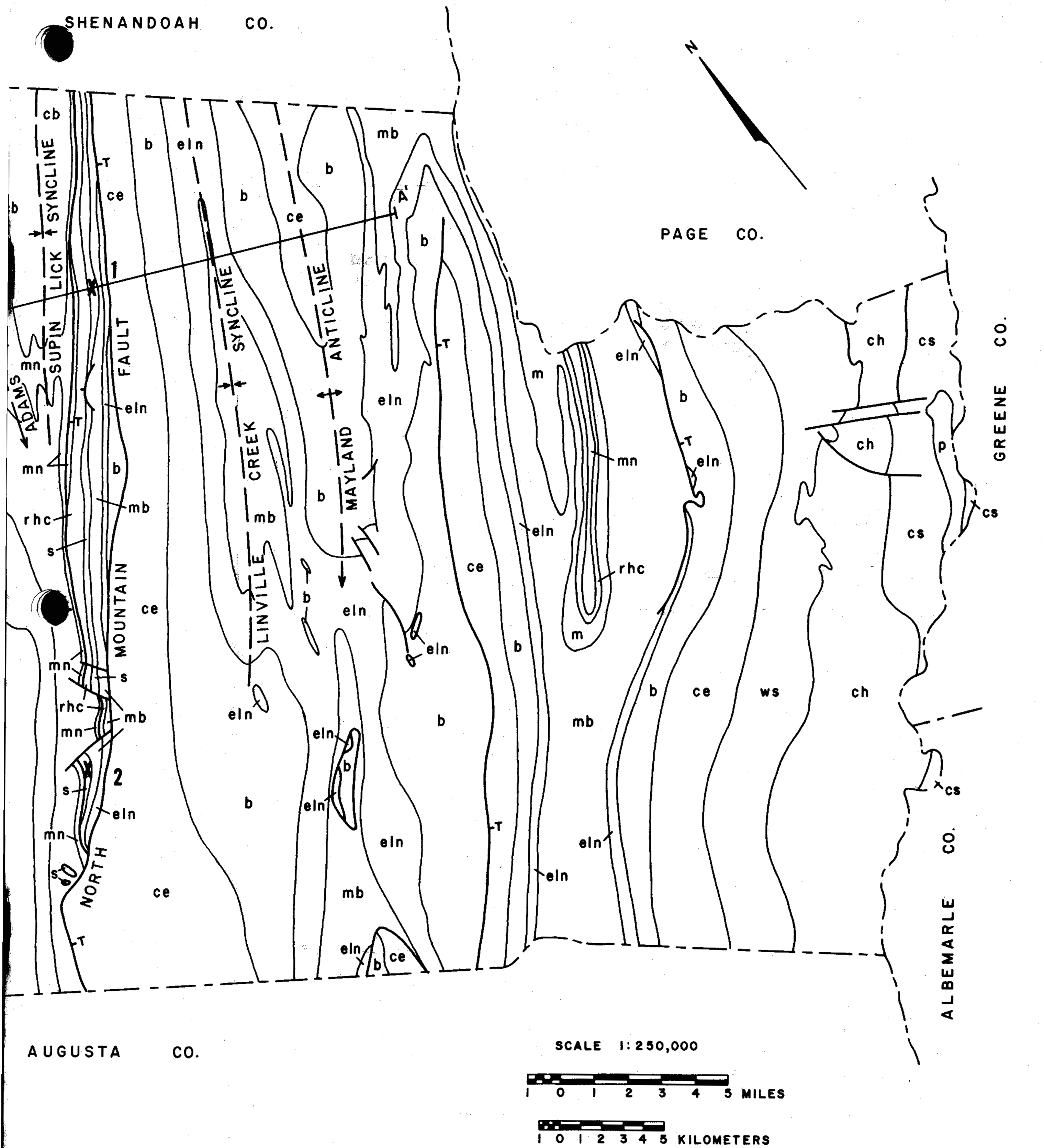


Figure 7. Generalized geologic map of Rockingham County (modified from Brent, 1960). The Edinburg Formation of Cooper and



Cooper (1946) is herein adopted for U. S. Geological Survey usage.

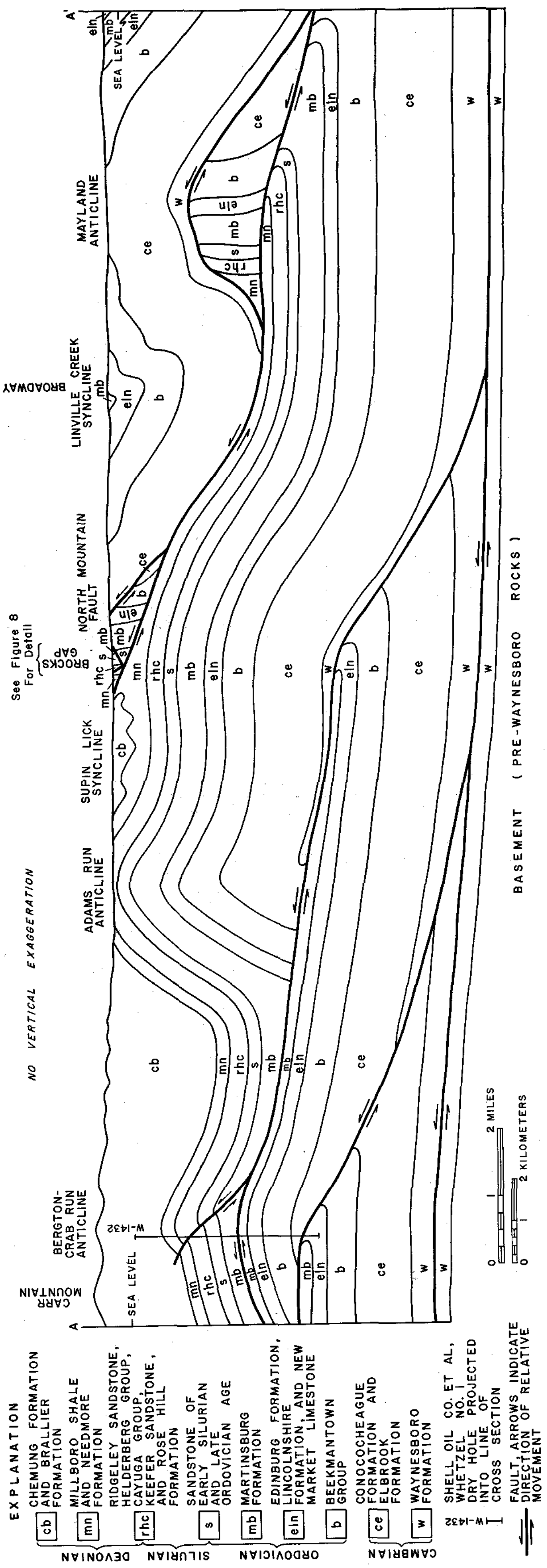


Figure 9. Geologic cross section A-A' extending from the Bergton-Crab Run anticline eastward through Brocks Gap to the Mayland anticline.

Shell Oil Co. et al, Whetzel No. 1 test hole for oil and gas; regional considerations, particularly the lack of active basement involvement in the structure of the western foldbelt (Gwinn, 1964, 1970; Perry, 1971, 1975; Jacobeen and Kanes, 1974, 1975); and the gravity work in Rockingham County by Hammer and Heck (1941) and Johnson (1971, 1972), Perry and Rader (1976) devised a cross-sectional model to the basement across much of Rockingham County (Figure 9). Perhaps the most controversial aspect of this model is the root zone of the inferred tectonic slice exposed at Brocks Gap which underlies the Mayland anticline about 7 miles (11 km) to the southeast. There the Little North Mountain fault system is inferred to have ramped upward from a décollement in the shales of the Lower Cambrian Waynesboro farther east to a décollement in the Middle Devonian black shales leaving a major tectonic slice in the axial portion of the Mayland anticline. This model requires approximately 8 miles (13 km) of differential westward transport of the Brocks Gap sequence with respect to the Adams Run anticline to the west.

ECONOMIC CONSIDERATIONS

X-ray analyses of samples from the undifferentiated Lower Silurian and Upper Ordovician sandstone (R-6799, R-6800, R-6801) and basal part of the Keefer Sandstone at Brocks Gap show the presence of fluoroapatite, which is disseminated through the matrix of sample R-6801 but is present as 1 to 3 cm size phosphorite nodules in the basal part of the Keefer. Phosphorite nodules have also been recovered from the upper part of the undifferentiated sandstone sequence at the south end of Cooper Mountain (R-6802). No quantitative data are available; however, similar deposits elsewhere in the Appalachian Mountains are subeconomic.

An economic consequence of the faulting shown in Figure 9 is the possibility of natural gas trapped in Silurian and Lower Devonian sandstones below the Little North Mountain thrust fault under the Mayland anticline and possibly in an intensely fractured and/or faulted section of such sandstones below the North Mountain fault between the Mayland anticline and the Supin Lick syncline just west of Brocks Gap. Samples of limestone from the Helderberg Group taken from Brocks Gap for C.A.I.[6] analysis emitted a distinct hydrocarbon odor when macerated. Middle Devonian black shale, if present below the Little North Mountain thrust fault (Figure 9), could provide a seal to

[6] Conodont Alteration Index, a measure of the thermal maturity of the rocks based on carbonization of organic material of the conodont elements (Epstein, Epstein, and Harris, 1975).

possible gas reservoirs in underlying sandstones. Only a carefully designed seismic reflection and drilling program can adequately evaluate these possibilities.

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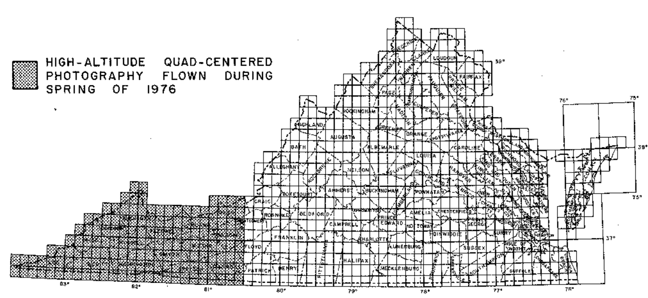
NEW AERIAL PHOTOGRAPHY OF SOUTHWESTERN VIRGINIA

High-altitude, quad-centered aerial photography, taken during the spring of 1976, is now available for southwestern Virginia from the vicinity of Radford to that of Cumberland Gap. This photography was taken to determine which 1:24,000-scale quadrangle maps need to be revised. Stereoscopic studies, in which the landscape appears to be three dimensional, can be made from the overlapping series of photographs. For each quadrangle there is one photograph that is uniquely centered on the topographic map and shows the entire area of the map. Land use, property lines, and types of vegetation can be interpreted from these photographs. A combination of information shown by the quad-centered photograph and its corresponding topographic map afford much usable data on the



landscape and man's activities. These photographs are at a scale of about 1:72,000; three-times enlargements make them about the same scale as the topographic map. Photographic reproductions and enlargements can be obtained *only* from Eastern Mapping Center, Topographic Division, U. S. Geological Survey, Reston, VA 22092. As an ordering aid a listing of the quad-centered photos for each of the 1:24,000-scale topographic maps can be obtained on request from the Virginia Division of Mineral Resources, Box 3667, Charlottesville, VA 22903.

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NEW PUBLICATIONS

(Available from the Division of Mineral Resources, Box 3667, Charlottesville, VA 22903; State sales tax is applicable only to Virginia addressees).

Bulletin 86. GEOLOGY OF THE SHENANDOAH NATIONAL PARK, VIRGINIA, by Thomas M. Gathright II; 93 p., 3 maps in color, 50 figs., 1976. Price: $5.00 plus $0.20 State sales tax, total $5.20.

The Shenandoah National Park lies astride a 70-mile segment of the Blue Ridge mountains in north-central Virginia. The park occupies more than 300 square miles in portions of eight counties and lies entirely within the Blue Ridge physiographic province.

Bedrock is of Precambrian, Cambrian, Ordovician, and Triassic age. Geologic units are shown in color on three geologic maps with a topographic base at the scale of 1:62,500 (1 inch equals approximately 1 mile). Summaries of the regional geology and cultural aspects in the park as related to geology, detailed descriptions of rock units, discussion of structural features, and the geologic history and origin of the Blue Ridge are included.

The report contains numerous excellent photographs of geologic features as well as several explanatory diagrams. A detailed road log along the 105 miles of Skyline Drive that extends along the crest of the Blue Ridge through the park serves as a guide to important geologic features that can be seen.

Report of Investigations 44. GEOLOGY OF THE LINDEN AND FLINT HILL QUADRANGLES, VIRGINIA, by Michael T. Lukert and Ernest B. Nuckols; 83 p., 2 maps in color, 26 figs., 21 tables, 1976. Price: $4.00 plus $0.16 State sales tax, total $4.16.

The Linden and Flint Hill 7.5-minute quadrangles are located in Clarke, Fauquier, Rappahannock, and Warren counties, northern Virginia. The quadrangles are mostly in the Blue Ridge and Piedmont physiographic provinces but the northwestern corner of the Linden quadrangle is in the Valley and Ridge province. Bedrock ranges in age from Precambrian to Mesozoic and includes 14 formations in addition to 4 types of dikes.

Mappable units are shown in color on two geologic maps at the scale of 1:24,000 (1 inch equals approximately 0.4 mile).

The area is located on the northwest limb of the gently northeastward-plunging Blue Ridge anticlinorium. The Stone Bridge anticline and the small-scale folds in the sedimentary rocks in the Linden quadrangle are overturned to the northwest and plunge gently to the northeast. Large-scale folding cannot be traced in the gneissic rocks, but variations in foliation trends suggest the possibility of its existence. Four major faults and several minor ones are present in the quadrangles.

Crushed stone has been produced from quartzites of the Harpers and Antietam formations and from the layered gneiss. Minor quantities of high-magnesium dolomite and copper mineralization occur locally.

Approximately 85 percent of the water wells for which data is available penetrate igneous and metamorphic rocks that are reliable producers of small to moderate yields from depths less than 300 feet. Wells in the Waynesboro Formation are the most shallow and successful from the clastic sedimentary rocks; information is not available for wells in carbonate rocks.

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NEW KENT COUNTY TOPOGRAPHIC MAP

A topographic map of New Kent County at the scale of 1:50,000 or 1 inch equals approximately 0.8 mile is now available. The map is 30 x 38 inches and shows roads, houses, forests, hills and other landforms, and streams and other water features in color and by symbols. An index to the larger scale 1:24,000-series topographic maps from which this map was made is available in the map margin. Three grid systems are available for referencing points of interest: latitude and longitude, Universal Transverse Mercator, and Virginia coordinate system. All major roads are identified by route number.

This map was produced by a cooperative program between the Virginia Division of Mineral Resources and the U. S. Geological Survey to make new and useful map products available to the public. It can be purchased from the Division of Mineral Resources, Box 3667, Charlottesville, VA 22903 for $2.00 plus 8 cents sales tax, a total of $2.08 per map. (For unfolded copies add $2.00 for each order of ten or fewer maps).

OIL AND GAS DEVELOPMENT IN VIRGINIA DURING 1975[1]

A total of 6,722,837 Mcf (thousand cubic feet) of natural gas was produced in Virginia during 1975, which is a decrease of 373,606 Mcf from 1974 production. Reported production was from 186 wells in five counties: Buchanan County, 4,321,349 Mcf; Dickenson County, 1,368,428 Mcf; Russell County, 1,223 Mcf; Tazewell County, 1,027,924 Mcf; and Wise County, 3,913 Mcf. Oil production in Lee County was 3,002 barrels from seven wells.

Thirty-six tests were drilled during the year. Columbia Gas Transmission Corporation drilled 16 of these holes in Buchanan, Dickenson, Scott, and Wise counties with combined footage of 76,680 feet of which 8 had a combined final open flow of 19,140 Mcf of gas; one well was waiting on fracture. Seven holes were plugged and abandoned. Seventeen tests were drilled in Dickenson County by Philadelphia Oil Company, a subsidiary of the Equitable Gas Company, with a combined footage of 85,689 feet; 10 of these wells had a combined final open flow of 4,597 Mcf. Five of the wells were awaiting fracture and 2 holes were being cleaned out. Tamik Oil Company in Lee County drilled

[1] Information supplied by W. W. Kelly, Jr., Virginia Division of Mines and Quarries.

Table 1. — Summary of Virginia drilling during 1975.

Operator	Lease	Well No.	Total Depth (feet)	Status
Buchanan County				
Columbia Gas Transmission Corporation	Landon Hackney	9766	4092	Gas well
"	Freelin Elswick, et. al.	20001	3582	Gas well
"	The Pittston Company	20212	4531	Plugged and abandoned
"	J. L. Elswick	20213	4337	Gas well
"	Bull Creek Coal Company	20214	4059	Gas well
Dickenson County				
Columbia Gas Transmission Corporation	The Pittston Company	20002	4668	Gas well
"	J. M. Owens, et. al.	20008	4869	Gas well
"	Ervin O'Quinn, et. al.	20016	4772	Plugged and abandoned
"	The Pittston Company	20211	4275	Will fracture
"	The Pittston Company	20215	4565	Gas well
Philadelphia Oil Company	The Pittston Company	P-32	4611	Gas well
"	Steinman Development Company	P-35	4763	Gas well
"	Nell Phipps, et. al.	P-36	5330	Cleaning out
"	Steinman Development Company	P-37	4520	Will fracture
"	Nell Phipps, et. al.	P-38	5752	Cleaning out
"	Steinman Development Company	P-39	4640	Will fracture
"	Nell Phipps, et. al.	P-40	5661	Gas well
"	Steinman Development Company	P-41	4732	Will fracture
"	Steinman Development Company	P-42	4804	Will fracture
"	Steinman Development Company	P-43	4718	Will fracture
"	Nell Phipps, et. al.	P-44	4996	Gas well
"	Nell Phipps, et. al.	P-45	5652	Gas well
"	Nell Phipps, et. al.	P-46	5504	Gas well
"	Brown Trust	P-47	4684	Gas well
"	Brown Trust	P-48	5154	Gas well
"	Brown Trust	P-49	5124	Gas well
"	Brown Trust	P-50	5044	Gas well
Lee County				
Tamik Oil Company	Roy E. Bledsoe	102	2379	Plugged and abandoned
Tamik Oil Company	Logan Snodgrass Heirs	103	1852	Oil well
Lee Oil Drilling Company	Wolfe-Snodgrass	1	2165	Oil well
Scott County				
Columbia Gas Transmission Corporation	Hagen Estate	20119	4918	Plugged and abandoned
"	Hagen Estate	20254	4745	Plugged and abandoned
Wise County				
Columbia Gas Transmission Corporation	Penn Virginia Corporation	20053-T	7081	Plugged and abandoned
"	Penn Virginia Corporation	20056-T	5337	Gas well
"	Hagen Estate	20117-T	3948	Plugged and abandoned
"	Penn Virginia Corporation	20253-T	6901	Plugged and abandoned

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two holes for a total footage of 4,231 feet. One well was completed as an oil producer and the other abandoned as a dry hole. Lee Oil Drilling Company finished drilling and completed one exploratory well in 1975 as an oil producer in Lee County, with a total depth of 2,165 feet. Total footage drilled during 1975 was 168,765 feet.

Four operators in Buchanan County produced 4,321,349 Mcf of gas: Ashland Oil, Inc., 542,471 Mcf; Cabot Corporation, 31,163 Mcf; Columbia Gas Transmission Corporation, 3,700,793 Mcf; and P & S Oil and Gas Corporation, 46,922 Mcf. Five wells were drilled in Buchanan County by Columbia Gas Transmission Corporation with a combined final open flow of 14,858 Mcf. Footage drilled totaled 20,601 feet.

In Dickenson County the Clinchfield Coal Company delivered 302,705 Mcf of gas to the pipelines of the Kentucky-West Virginia Gas Company and used 5,160 Mcf of gas in field operations. Columbia Gas Transmission Corporation produced 1,060,563 Mcf to give Dickenson County a total production of 1,368,428 Mcf. Seventeen wells were drilled in Dickenson County by the Philadelphia Oil Company with a combined final open flow of 4,597 Mcf; total footage drilled was 85,689 feet. Columbia Gas Transmission Corporation drilled five wells, which had a total footage of 23,149 feet and a final open flow of 3,792 Mcf.

In Lee County oil production by Tamik Oil Company and Lee Oil Drilling Company totaled 3,002 barrels. Tamik Oil Company produced 2,751 barrels from five wells in the Rose Hill field and one in the Ben Hur field. Lee Oil Drilling Company produced 251 barrels from one well in the Rose Hill field. Lee Oil Drilling Company also commenced drilling on two exploratory tests during the year.

The Clinchfield Coal Company used 1,223 Mcf of gas from one well in Russell County for use at its Carbo Lightweight Aggregate plant.

In Scott County, Columbia Gas Transmission Corporation drilled two development wells; both were dry holes and were plugged and abandoned.

Two operators in Tazewell County produced 1,027,924 Mcf of gas: Columbia Gas Transmission Corporation, 386,536 Mcf, and Consol-Ray Resources, 641,388 Mcf.

Westinghouse Electric Corporation commenced drilling an exploratory gas test in Washington County southwest of Saltville during the year.

Penn Virginia Corporation produced 3,913 Mcf of gas for local use from two wells in Wise County. Columbia Gas Transmission drilled four exploratory tests in the county, which had a total footage of 23,267 feet. Three of these wells were plugged and abandoned and the fourth well was completed as a producing well with a final open flow of 490 Mcf.

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TOPOGRAPHIC MAPS

Revised 7.5-minute quadrangle maps published from July 1 to September 1, 1976:

Revised Maps
- Duty
- Prospect

Advance Prints for Revision
- Middlesboro North
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Advance prints are available at $1.25 each from the Eastern Mapping Center, Topographic Division, U. S. Geological Survey, Reston, Virginia 22092.

PUBLISHED TOPOGRAPHIC MAPS

Total State coverage completed; index is available free. Updated photorevised maps, on which recent cultural changes are indicated, are now available for certain areas of industrial, residential, or commercial growth. Published maps for all of Virginia are available at $1.25 each (plus 4 percent State sales tax for Virginia residents) from the Virginia Division of Mineral Resources, Box 3667, Charlottesville, Virginia 22903.