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

GEOLOGY OF THE BRISTOL AND WALLACE QUADRANGLES, VIRGINIA

CHARLES S. BARTLETT, JR.
AND
HARRY W. WEBB

REPORT OF INVESTIGATIONS 25

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

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GEOLOGY OF THE BRISTOL AND WALLACE QUADRANGLES, VIRGINIA

By

CHARLES S. BARTLETT, JR.[1] AND HARRY W. WEBB[2]

ABSTRACT

The Bristol and Wallace 7.5-minute quadrangles, covering an area of 78.5 square miles, are located in Washington County in southwestern Virginia, entirely within the Valley and Ridge physiographic province. The quadrangles are underlain by bedrock ranging in age from Lower Cambrian through Upper Mississippian and including Ordovician, Silurian, and Devonian rocks. The outcropping rocks are assigned to 30 formations of which 27 were sufficiently thick, well exposed, and lithologically different to be separately mapped. One of the most complete sections of Mississippian rocks in North America is exposed. Quaternary alluvium and terrace deposits were also mapped.

The major structural features consist of parts of the Greendale and Beaver Creek synclines and of the Saltville, Pulaski-Staunton, Spurgeon, and Bristol fault blocks. The formational outcrop belts and major fault traces are mostly aligned northeast-southwest; they mainly have a southeasterly dip. The Bristol fault is anomalous to the others in that it has an arcuate fault trace. The largest stratigraphic displacement of geologic units is about 16,000 feet along the Saltville fault trace, where the Cambrian Rome Formation is in contact with the Mississippian Pennington Formation.

Crushed stone is produced from limestone in the Bristol quadrangle. Pure and impure limestone and dolomite, carbonate rock and sandstone for decorative stone, sandstone potentially useful for glass sand, sand and gravel, and shale potentially useful for brick are available adjacent to a transportation network of roads and railways. Similarities to nearby present- and past-productive areas indicate possible occurences of gas, oil, barite, gypsum, anhydrite, and salt.

INTRODUCTION

The Wallace and Virginia part of the Bristol 7.5-minute quadrangles (Plate 1) are located in Washington County, southwestern Virginia (Figure 1). They encompass a combined area

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of 78.5 square miles bounded by longitudes 82°07′30″ W. and 82°15′00″ W., latitude 36°45′00″ N., and the Virginia-Tennessee state line (Figure 1). The area, located in the Valley and Ridge physiographic province, is characterized by elongate steep sand-

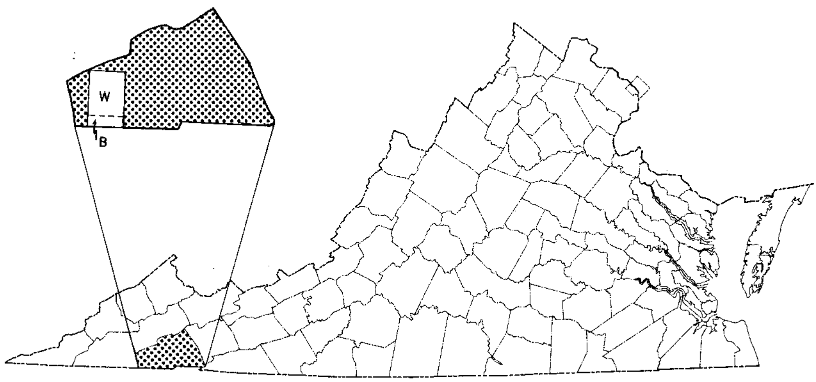

Figure 1. Index map showing location of the Bristol and Wallace quadrangles, Washington County, Virginia.

Figure 2. Large sinkholes in the Gasper limestone just north of Free Hill Church in Caney Valley.

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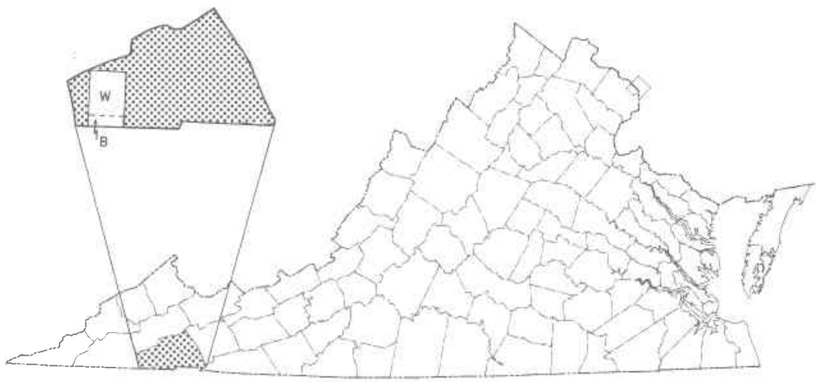

Figure 1. Index map showing location of the Bristol and Wallace quadrangles, Washington County, Virginia.

Figure 2. Large sinkholes in the Gasper limestone just north of Free Hill Church in Caney Valley.

stone, limestone, and dolomite mountains; by dissected sandstone and shale ridges; and by broad rolling hills and lowlands underlain mainly by limestone and dolomite. Portions of the limestone terrane are marked by numerous sinkholes (Figure 2).

The highest elevation, approximately 2950 feet above sea level, is on Clinch Mountain in the northwest corner of the map area; the lowest, approximately 1370 feet, is about 2 miles to the south on the North Fork of the Holston River. Total relief is about 1580 feet (Figure 3). Northwest of Rich Valley the region is mostly rugged, hilly, or mountainous, forested, and sparsely populated. To the southeast, except for Walker Mountain and Big Ridge, topography is more subdued; the land is mostly cleared and in various cultural uses. Industrial and residential development in and around Bristol, Virginia, covers about 6 square miles. A good transportation network is available: U. S. Highways 11, 19, 58, and 421; Interstate Highways 81 and 381; Norfolk and Western Railroad and Southern Railway; and numerous State Roads (Figure 4). The Walker Moun-

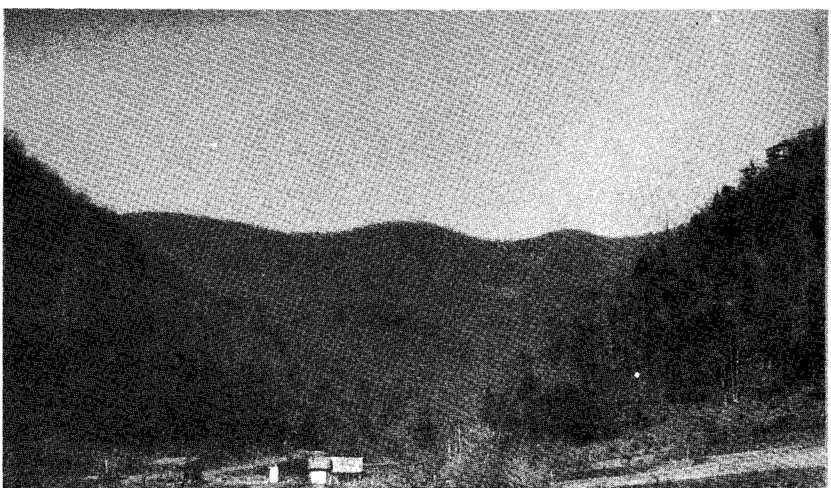

Figure 3. Wooten Gap, a watergap in Little Mountain, view to the north. The mountain is formed by the resistive Mississippian Price Formation; beyond the gap the higher Clinch Mountain is capped by quartzitic sandstone of the Tuscarora Formation; lowland in foreground is terrace along North Fork of Holston River.

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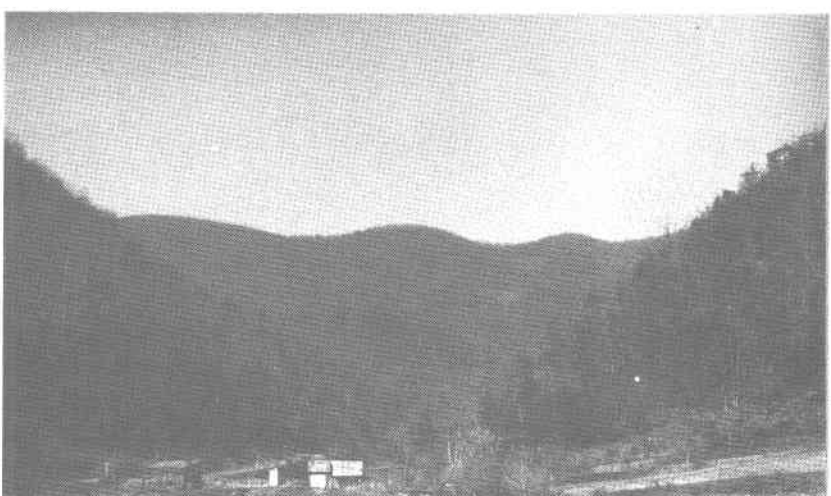

Figure 3. Wooten Gap, a watergap in Little Mountain, view to the north. The mountain is formed by the resistive Mississippian Price Formation; beyond the gap the higher Clinch Mountain is capped by quartzitic sandstone of the Tuscarora Formation; lowland in foreground is terrace along North Fork of Holston River.

tain area forms a divide between drainage flowing northerly to the North Fork of the Holston River from that flowing southerly to the South Fork of the Holston River.

The general features of the geology of the quadrangles were described by Campbell (1899) and Butts (1933, 1940-41). A detailed study by Averitt (1941) of a part of the Greendale syncline was examined and incorporated (Plate 1) except for a few deletions and additions of structural detail. Unpublished student theses of the adjoining Wyndale quadrangle by Berry-

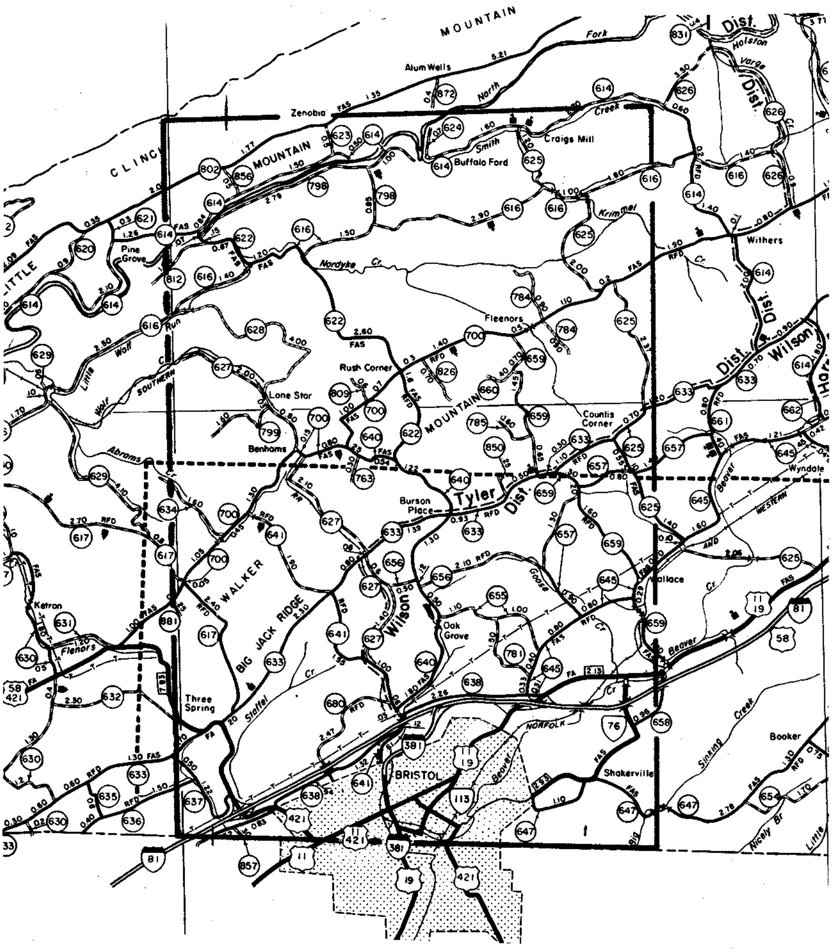

Figure 4. Highways, roads, and railroads in the Bristol and Wallace quadrangles (from Virginia Department of Highways, 1969, Washington County primary and secondary highway systems).

hill (1949) and the Abingdon quadrangle by Tyler (1960) were of assistance. Data on the adjoining portion of Tennessee, as depicted on the 1966 Geologic Map of Tennessee and Rodgers (1953), were considered. Other publications, listed in the references of this report, supplied information.

Field work by the senior author extended through a 10-week portion of the summer of 1968, and a 16-week field season in 1969. The junior author participated in some field work and aided in the preparation of the report and geologic map. Jeffery Link was a field assistant during the summer of 1969. The study was financed by the Virginia Division of Mineral Resources and special thanks are given to Dr. James L. Calver, who authorized the project. R. C. Milici and S. W. Maher, Tennessee Division of Geology, examined parts of the mapped area; the authors benefited from a discussion with them of stratigraphic terminology and outcrop boundaries of geologic units common to both States. Dr. N. F. Sohl and staff of the Paleontology and Stratigraphy Branch of the U. S. Geological Survey identified numerous fossil collections for the writers. The cooperation of the active quarry operator and area citizens who allowed access to their properties is appreciated.

Numbers preceded by "R" in parentheses (R-4036) correspond to localities where rock samples were collected (Plate 1); fossil-collection localities are indicated by "F". Samples and fossils are on file in the repository of the Virginia Division of Mineral Resources.

STRATIGRAPHY

Paleozoic rocks cropping out in the quadrangles are assigned to 30 formations of which 27 were sufficiently thick, well exposed, and lithologically different to be separately mapped (Plate 1). Stratigraphic sections from the mapped and adjacent areas, totalling approximately 52,000 feet of exposed rock, were measured and described in detail, megascopically and microscopically; more than 45,000 feet were within the Bristol and Wallace quadrangles. The area is underlain by a nearly complete sequence of bedrock ranging from the Lower Cambrian Rome Formation into the Upper Mississippian Pennington Formation (Table 1). The maximum thickness of the Paleozoic rocks in the quadrangle is about 16,000 feet. One of the best-exposed, most fossiliferous, and complete sections of Mississippian rocks in North America is present in the Greendale syncline

(Cooper 1948, p. 261-262) of which 6800 feet are in the Wallace quadrangle. Sand, clay, gravel, and colluvium of Quartenary are present along floodplains and terraces.

Table 1. — Geologic formations in the Bristol and Wallace quadrangles, Virginia.

Age	Name	Character	Approximate thickness in feet
Quaternary	Alluvium	Varicolored, unconsolidated sand, clay and gravel.	0-50±
	Terrace deposits	Varicolored unconsolidated sand, clay, and gravel; colluvium.	?
Mississippian	Pennington Formation	Interbedded gray siltstone, shaly sandstone, argillaceous limestone, and silty shale; mostly maroon and greenish-gray in upper portion; abundant fossils.	1335+
	Cove Creek limestone	Gray, argillaceous limestone, most of which is thinly laminated, weathers to pale-gray; slightly fossiliferous.	1000-1220
	Fido Sandstone	Maroon to brown, cross-bedded, thick-bedded, fine-grained sandstone; thin-bedded limestone in upper part; fossiliferous.	50
	Gasper limestone	Gray to light-gray, argillaceous, shaly weathering, thin- to thick-bedded limestone; partly crinoidal; few oolitic layers; fossiliferous.	740-870
	Ste. Genevieve limestone	Gray, argillaceous, medium-bedded limestone; uppermost beds are maroon, crinoidal limestone; lower portion contains gray, cherty, medium- to coarse-grained, crinoidal limestone with horn corals; some calcareous sandstone; fossiliferous.	1185-1205

Age	Name	Character	Approximate thickness in feet
Mississippian	Hillsdale Limestone	Light- to dark-gray, cherty, dense, medium-bedded limestone; in part has sulfurous odor on fresh break; fossiliferous.	275
	Little Valley Formation	Gray, calcareous shale predominant in upper portion; gray, cherty limestone and thin sandstone beds in middle part; gray, shaly limestone and thin-bedded sandstone in lower part; abundant fossils.	570
	Maccrady Formation	Maroon and light-green shale and mudstone; pink micaceous siltstone.	60
	Price Formation	Gray, medium-bedded sandstone and siltstone; conglomeratic at top; thin glauconitic beds and plant fragments in thin carbonaceous beds in upper part; gray silty shale predominant in lower part; fossiliferous.	565+
	Big Stone Gap Shale	Black, fissile shale with conodonts, small brachiopods and plant fragments.	10±
Devonian	Chemung Formation	Light-gray siltstone and sandstone interbedded with light greenish-gray, silty shale; quartz-pebble conglomerate at top; fossiliferous.	130
	Brallier Formation	Greenish-gray to black, silty shale with minor light-gray siltstone interbeds; sparsely fossiliferous.	940±
	Millboro Shale	Dark-gray to purple and orange, fissile shale, some slightly silty; abundant dwarf fauna.	100±

Age	Name	Character	Approximate thickness in feet
Devonian	Huntersville Formation	White to gray, blocky chert; gray-brown glauconitic siltstone and sandstone; abundant fossils.	60±
Silurian	Clinton Formation	Light-gray to purplish-gray, thick-bedded siltstone and standstone, conglomeratic; light greenish-gray and maroon, silty shale in upper part; some ostracods.	220±
	Tuscarora Formation	Light-gray, thick-bedded, ripple-marked, and cross-bedded sandstone.	?
Ordovician	Moccasin Formation	Maroon and mottled maroon to light-gray, argillaceous, thin-bedded limestone; sparsely fossiliferous.	160+
	Middle Ordovician rocks, undivided	Light-gray, thin-bedded, knobby limestone with two thick beds of pink, coarse-grained limestone; some brown, calcareous clay shale in lower portion; fossils abundant.	110-230+
	Athens Formation	Gray, fissile shale with minor light-gray thin-bedded, argillaceous limestone along the Pulaski-Staunton fault; gray, hackly, graptolitic shale in southeastern exposures.	200+
	Lenoir and Mosheim limestones	Lenoir Limestone: Gray to dark-gray, thick-bedded limestone with minor chert. Mosheim Limestone: Light-gray, dense, medium-bedded limestone with numerous white calcite inclusions; sparsely fossiliferous.	30-270

Age	Name		Character	Approximate thickness in feet	
Ordovician	Knox group, upper part		Light-gray, fine- to coarse-grained, cherty dolomite with minor beds of blue-gray limestone; zones of collapse breccia with pockets of gray and maroon shale in upper part; abundant white chert float with dolomolds; moderately fossiliferous in some limestone beds.	685-2200	
	Chepultepec Formation		Dark blue-gray, thick-bedded, partly cherty limestone with minor gray, calcareous dolomite; worm trail-like features common; sparsely fossiliferous.	150-800	
Cambrian	Copper Ridge Formation	Conococheague Formation	Copper Ridge Formation: more than half gray to light-gray, medium-bedded dolomite with gray, sandy, cherty, medium-bedded limestone and thin beds of brown medium-grained sandstone near base and in middle and upper portions. Conococheague Formation: more than half dark-gray to blue-gray, medium-bedded, partly cherty limestone, with light-gray, dense dolomite and numerous thin beds of brown, medium-grained sandstone near base and in middle and upper portions; fossils rare.	1095-1195	1790-1820
	Maynardville Formation		Dark-gray, thick-bedded, partly sandy, straticulate limestone.	100-170	

Age	Name	Character	Approximate thickness in feet
Cambrian	Nolichucky Formation	Gray-green, silty, fissile shale; blue-gray, argillaceous, very thin- to medium-bedded limestone with some limestone-pebble conglomerate; northernmost outcrop area contains distinctive blue-gray, thick-bedded, oolitic limestone in middle part; fossiliferous.	150-530
	Honaker Formation	Gray to light-gray, medium-bedded, partly cherty dolomite; interbeds of dark blue-gray, partly algal-banded limestone in middle portion.	1140-1445±
	Pumpkin Valley Shale	Gray-brown, gray-green and maroon, silty, partly micaceous shale with minor thin beds of gray dolomite.	350+
	Rome Formation	Interbedded gray-brown, gray-green, and maroon silty shale; maroon and yellow-ocher, calcareous siltstone; and light-gray, argillaceous, calcareous dolomite.	55-200±

CAMBRIAN SYSTEM

Rome Formation

The Rome Formation was named by Hayes (1891, p. 143) for shales and sandstones near Rome, Georgia. Butts (1940, p. 57) assigned all rocks between the Honaker dolomites and limestones and the Shady dolomites to the Rome. Rodgers and Kent (1948, p. 4-9) restriced the formation to the Lower Cambrian siltstone, sandstone, shale, and dolomite portion. They named the Middle Cambrian portion of mainly silty shale, the Pumpkin Valley Shale. The latter classification is used in this report.

The Rome Formation is exposed only along the northwestern erosional edge of the Saltville fault block for a distance of about 2 miles between Benhams and Lime Hill; the base is not present. Exposed upper beds range from a thickness of 54 feet (Section F) to about 200 feet on the hillslopes southwest of Benhams. The upper contact, although gradational, is mapped at the top of the youngest thick beds of dolomite beneath a predominantly shale section. The formation consists of very fine-grained, light-gray dolomite in thick or massive beds; maroon and grayish-green silty shale; and yellow-ocher and maroon siltstone. The dolomite layers comprise nearly 40 percent of the total thickness; they characteristically weather to an orange-brown silty clay. The shales (R-4036) are generally fissile and may have crinkly and lustrous bedding surfaces. The best exposures of Rome occur on State Road 631 near Valley Institute, which is along structural strike about one mile west of the Wallace quadrangle. Except for a few fucoid markings, part of which might be worm and trilobite trails, no fossils were found.

Pumpkin Valley Shale

Bridge (1945, map) first used the name Pumpkin Valley Shale for part of the Rome Formation. Rodgers and Kent (1948, p. 7-9) more precisely defined the Pumpkin Valley as a silty shale with a lower Middle Cambrian trilobite fauna from exposures in Pumpkin Valley, Hawkins County, Tennessee. The base is comformable with the older Rome Formation; upper contact with the Honaker Formation is characterized by a change from shale to dolomite and limestone.

The Pumpkin Valley is composed of maroon, grayish-green, and grayish-brown, silty shale (R-4037) with minor, thin beds of gray dolomite. It is easily weathered, has poor exposures, and is overlain by maroon soil. Its outcrop belt follows Rich Valley, paralleling to the southeast that of the Rome (Plate 1). It is partly covered by Quarternary alluvium along Abrams Creek and its tributaries. Shales of the Pumpkin Valley (R-4037) crop out along State Road 700 about 0.4 mile northeast of its junction with Campground Road (State Road 641) in Rich Valley. The thickness of the Pumpkin Valley is estimated to be about 350 feet (Section F).

Honaker Formation

The base of the Honaker Formation was placed at the top of the Pumpkin Valley Shale and its top was mapped above thin-bedded dolomites which are overlain by limestone or shale of the Nolichucky Formation. The formation is exposed in four principal outcrop belts; these will be described from north to south (Plate 1). The most northerly is about 0.3 mile wide and extends along Rich Valley from Lime Hill, in a northeasterly arc to the eastern border of the map near Rocktown. Only in a part of this outcrop belt is the Honaker completely exposed; elsewhere it is terminated by faults. Near Lime Hill the complete Honaker unit is slightly more than 1140 feet thick (Section H); six miles to the northeast a partial thickness of 1222 feet was measured.

The Honaker is composed of light gray, medium-bedded, very fine-grained dolomite; some is calacareous or grades to a dolomitic limestone. Some beds give off a sulfurous odor on fresh breaks. Weathering along intersecting fracture sets has caused a distinctive "butcher-block" erosional pattern on exposed surfaces of many dolomitic beds (Figure 5). Pure limestones are rare; in section H probably less than 100 feet is limestone. On

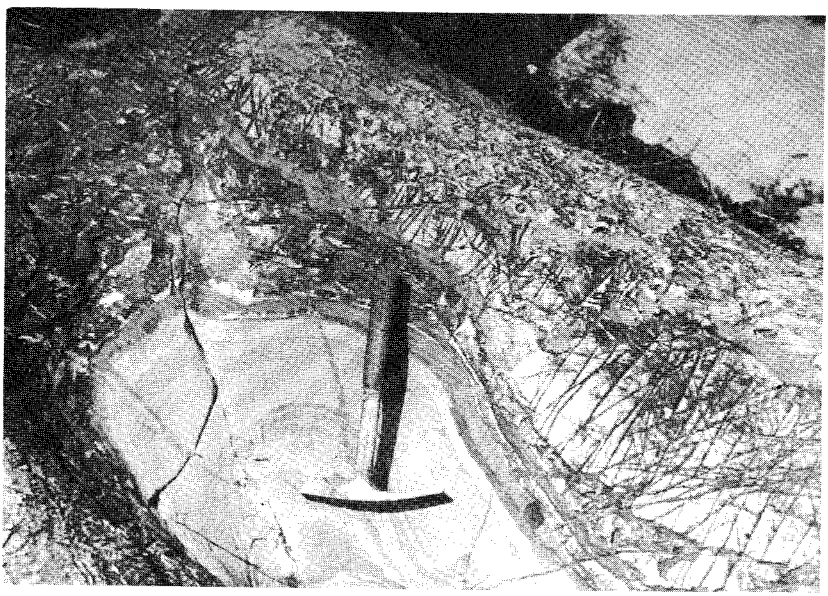

Figure 5. "Butcher-block" weathered dolomite (above hammer handle) interbedded with laminated limestone (hammer head area) in middle part Countiss Ridge area.
of the Honaker Formation near junction of State Roads 633 and 659 in

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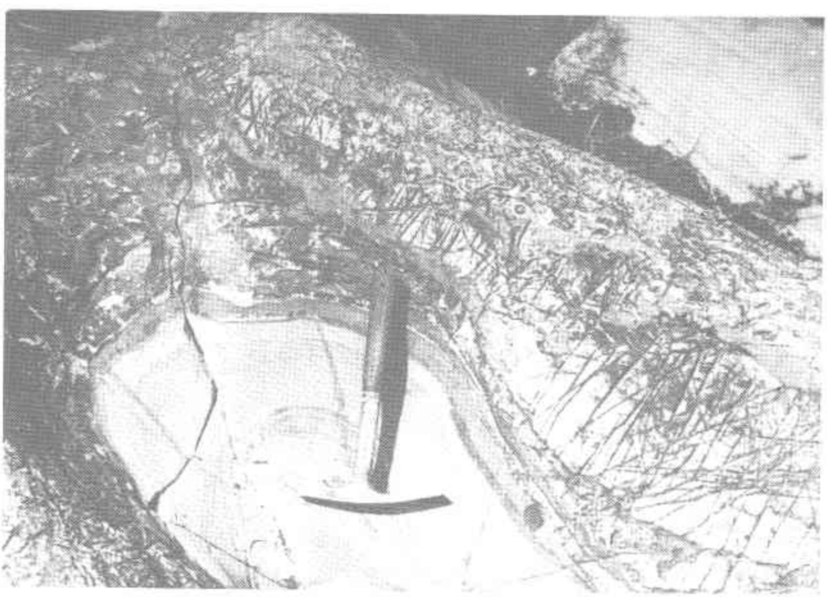

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fresh outcrops chert is rarely seen, but light-gray and gray chert is common in the soil developed on the Honaker. A zone of light-gray and gray-banded algal chert (R-4039) occurs about 200-350 feet below the top of the formation.

A second outcrop belt, about 1.7 miles to the southeast, extends from Dishner Valley on the west edge of the map area to Countiss Ridge on the northeast. It is bounded on the northwest by the Pulaski-Staunton fault. This belt broadens from 0.3 mile wide on the southwest to as much as 1.7 miles wide near Countiss Ridge to the northeast as a result of folding and faulting. Along Section J north of Countiss Ridge a partial thickness of 690 feet was measured. As compared to the belt to the north the proportion of dark-gray, micrograined limestone has increased (R-4048). The limestone commonly contains mound-like algal-banded structures from about 350 to 600 feet below the top of the Honaker. This limestone is responsible for the extensive development of sinkholes to the west of Phillips Spring.

A third outcrop belt of the Honaker begins at the southwest corner of the map near the Virginia-Tennessee State line and

Figure 6. Cryptozoon features in steeply dipping limestone of middle part of the Honaker Formation about 1.3 miles southwest of school at Wallace in fields 200 feet north of State Road 645.

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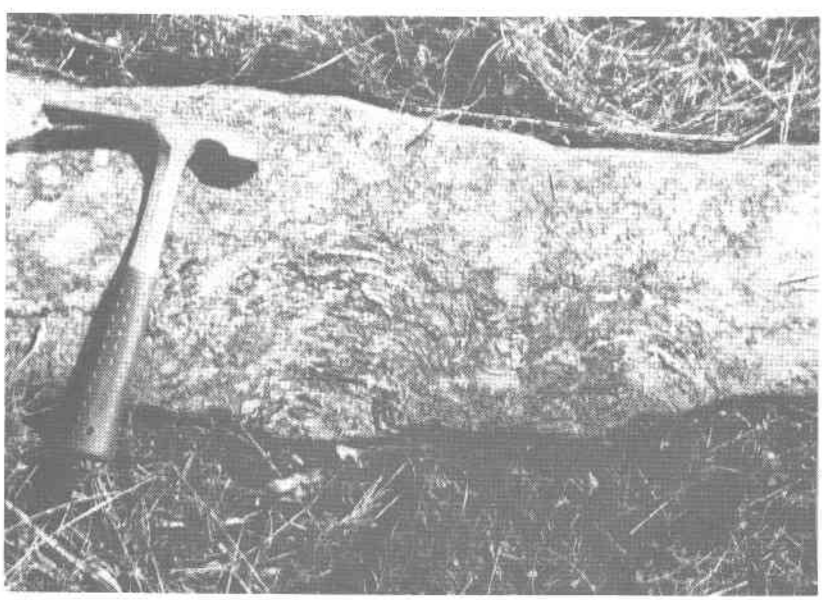

Figure 6. Cryptozoon features in steeply dipping limestone of middle part of the Honaker Formation about 1.3 miles southwest of school at Wallace in fields 200 feet north of State Road 645.

extends northeastward to the edge of the map near Wallace. It is bounded on the northwest by the Spurgeon fault and in part on the southwest by the Bristol fault. The outcrop width increases from about 0.1 mile on the southwest to about 1.5 miles on the northeast.

The fourth and southernmost belt extends from the State line at the southwest corner of the map peripherally near the Bristol city limits to the State line east of the city; it is separated by secondary faults into three contiguous parts. Partial sections of Honaker within these last two described belts total 1445 feet on Goose Creek (Section L; R-4051) southwest of Wallace and 1113 feet on Susong Branch (Section M) just northwest of Bristol. The outcrop belt crossing Goose Creek is predominantly dolomite, but a notable zone of algal-banded limestone (Figure 6) is consistently present between 300 and 600 feet from the top. In some places large masses of algal chert weather from this zone.

In the three outcrop belts located south of the Pulaski-Staunton fault, much of the lower exposed portion of the Honaker along fault zones consists of a highly brecciated dolomite, crushed and partially cemented. In these belts the Honaker Formation is the oldest unit exposed. Honaker exposures can also be seen adjacent to the intersection of Interstate Highway 81 and U. S. Highway 58 and 421. Algal features are exposed adjacent to the junction of State Roads 636 and 637 in Dishner Valley near Steele Creek and to the northwest of Big Ridge along Campground Road about 0.3 mile west of its junction with State Road 627. Fossils were not found in the Honaker except for algal features in limestones and cherts and a few beds with markings suggestive of worm trails.

Nolichucky Formation

The base of the Nolichucky is mapped above the youngest Honaker dolomite below grayish-green shale or bluish-gray limestone. The top of the unit is placed above the youngest grayish-green shale beneath ribbon-banded limestones. The Nolichucky Formation is a readily recognizable unit of fossiliferous, grayish-green shale; thin- to medium-bedded, bluish-gray limestone; oolitic limestone; and limestone-pebble conglomerate. The formation crops out as a continuous belt along the northwest side of Walker Mountain, as six outcrop segments in the southern part of the map area, and as a portion of the synclinal structure at Countiss Ridge. This unit commonly produces knobby hills or steep sloping ridges.

In the northernmost belt about 0.4 mile south of Lime Hill, typical Nolichucky is exposed in cuts along State Road 617 (Section H) where it consists of 532 feet of grayish-green, fissile, silty and partly calcareous shale; micrograined light-gray, partly sandy or argillaceous, limestone; oolitic limestone (R-4041); and some limestone-pebble conglomerate. Shale comprises almost half of the total section and is concentrated mainly in two units near the upper and middle parts. A distinctive, mappable, oolitic limestone bed approximately 20 feet thick (Figure 7) is located about 230 feet from the top of the Nolichucky. This limestone is well exposed in a prominent bend in State Road 625 along Walker Mountain about 0.25 mile southeast of Rocktown.

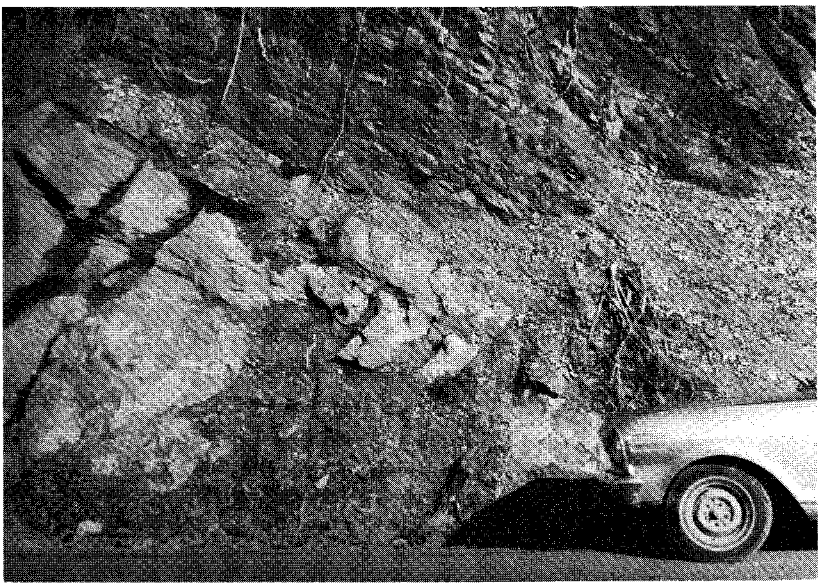

Figure 7. Distinctive oolitic limestone of the Nolichucky Formation overlain by grayish-green shale (Plate 1, No. 3).

In its southerly outcrops the Nolichucky is thinner and becomes progressively more variable in thickness and lithology, but always retains one or more of the distinct lithologies described above. Along the Southern Railway cut through Big Ridge (Section K) it is 435 feet thick; at Countiss Ridge (Secat Countiss Ridge. This unit commonly produces knobby hills or steep sloping ridges.

In the northernmost belt about 0.4 mile south of Lime Hill, typical Nolichucky is exposed in cuts along State Road 617 (Section H) where it consists of 532 feet of grayish-green, fissile, silty and partly calcareous shale; micrograined light-gray, partly sandy or argillaceous, limestone; oolitic limestone (R-4041); and some limestone-pebble conglomerate. Shale comprises almost half of the total section and is concentrated mainly in two units near the upper and middle parts. A distinctive, mappable, oolitic limestone bed approximately 20 feet thick (Figure 7) is located about 230 feet from the top of the Nolichucky. This limestone is well exposed in a prominent bend in State Road 625 along Walker Mountain about 0.25 mile southeast of Rocktown.

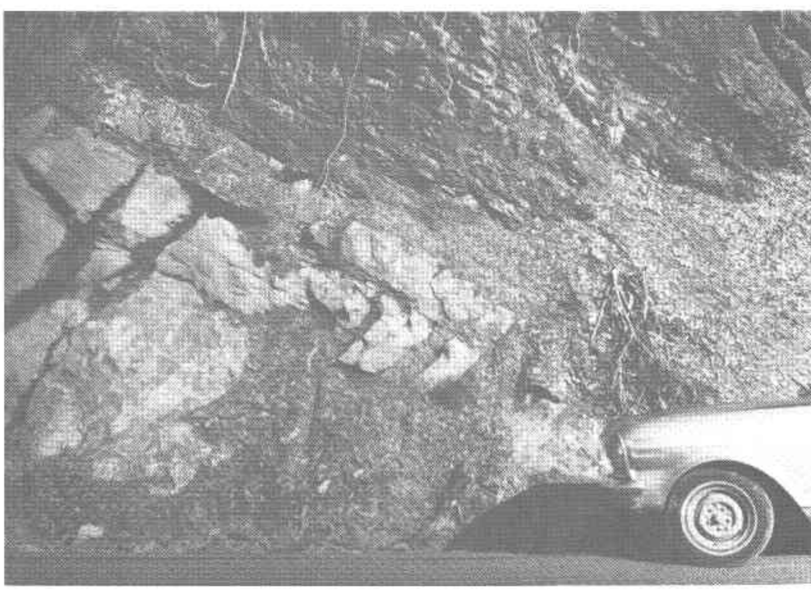

Figure 7. Distinctive oolitic limestone of the Nolichucky Formation overlain by grayish-green shale (Plate 1, No. 3).

In its southerly outcrops the Nolichucky is thinner and becomes progressively more variable in thickness and lithology, but always retains one or more of the distinct lithologies described above. Along the Southern Railway cut through Big Ridge (Section K) it is 435 feet thick; at Countiss Ridge (Section J) only the lower 261 feet is present. Lithologies and fossils are well exposed in a small, abandoned quarry along State Road 640 just northwest of Oak Grove community. About 0.3 mile east of U. S. Highway 58 and 421 along Big Ridge, the Conococheague Formation is in contact with the Honaker dolomite; the absence of the Nolichucky and its varying thickness along this part of Big Ridge suggests a disconformity. Along Goose Creek southwest of Wallace the Nolichucky is only 152 feet thick and is composed almost entirely of bluish-gray, thin-bedded, knobby limestone (R-4052), and thin beds of limestone-pebble conglomerate and thin shale partings (Section L). This is the thinnest section and the greatest percentage of carbonate beds that were measured. Southernmost outcrops of the Nolichucky occur in fault slices along the outer environs of Bristol. These follow arcuate patterns in response to the southwestward plunge of the Beaver Creek syncline. The formation is 346 feet thick on Susong Branch (Section M; R-4059); and 316 feet along Interstate Highway 381 (Section N). In good exposures along Section N about one-third of the formation is typical grayish-green shale; especially noteworthy are 13 one- to two-foot thick beds

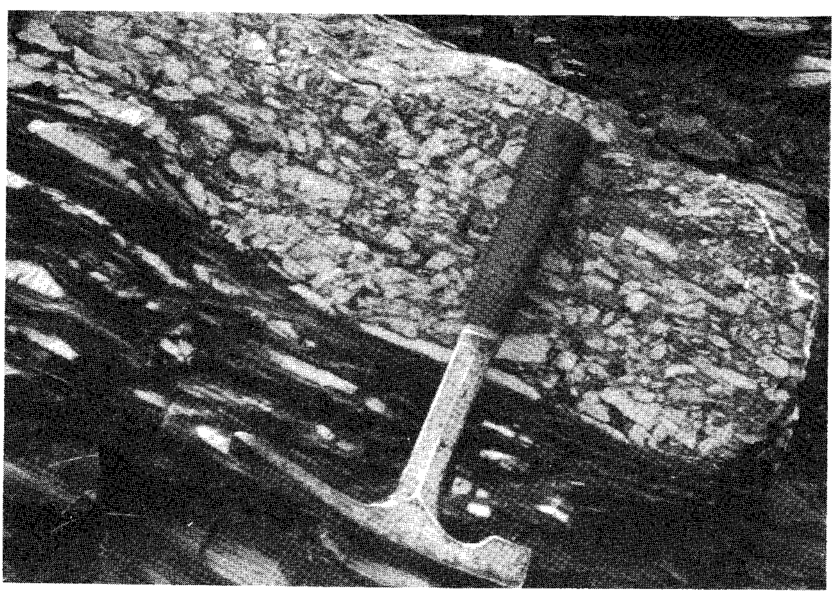

Figure 8. Limestone-pebble conglomerate in upper part of the Nolichucky Formation along Interstate Highway 381 just southwest of its junction with Interstate Highway 81.

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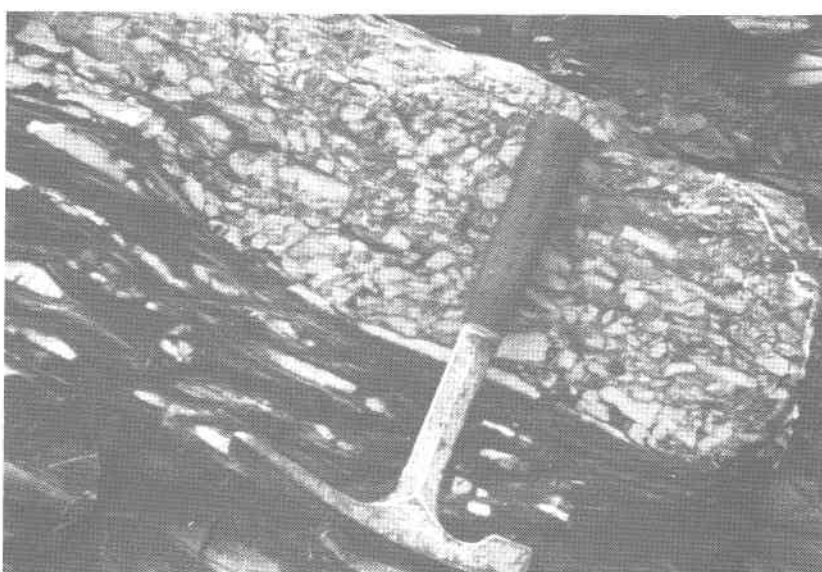


Figure 8. Limestone-pebble conglomerate in upper part of the Nolichucky Formation along Interstate Highway 381 just southwest of its junction with Interstate Highway 81.

of limestone-pebble conglomerate (R-4061) (Figure 8). Good exposures containing fossils occur along Valley Drive just northwest of its intersection with U. S. Highway 11. A unique occurrence of a 15-foot thick, medium-grained, friable, feldspathic sandstone (R-4060, note that location symbol on Plate 1 has the number omitted) at the base of the Nolichucky is located about 0.6 mile north of the intersection of Spurgeon Lane and Commonwealth Avenue in the northern outskirts of Bristol.

The Nolichucky is abundantly fossiliferous with many black phosphatic shells of the brachiopod *Dicellomus*. A partial listing of fossils from various places in the map area follows: the brachiopod **Dicellomus appalachia* Walcott; trilobites *Aphelaspis quadrata*? Resser, *Blountiella buttsi*? Resser, *? *Coosia alethes* (Walcott), *Coosia calanus* (Walcott), *Crepicephalus rectus* Resser, *cf., *Grenevievella* sp., *Marvillia bristolensis* Resser, *Norwoodella saffordi* (Walcott), **Norwoodella* cf. *N. saffordi* (Walcott), *Tricrepicephalus cedarensis* Resser, and *Tricrepicephalus simplex* Resser; cystoid plates; and trails and irregular markings on some bedding surfaces probably made by worms or trilobites.

Maynardville Formation

As originally described by Oder (1934, p. 475-476) the Maynardville is a nearly chert-free limestone and dolomite unit named for exposures near Maynardville, Union County, Tennessee. The Maynardville was mapped with the basal part of the Conococheague and Copper Ridge formations (Plate 1) due to its narrow and irregular outcrop pattern and because of lithologic similarity to those units. The base of the Maynardville occurs at the change to the thick-bedded, ribbon-banded limestone from the grayish-green shale, conglomerate, or knobby limestone of the Nolichucky Formation. A brown, fine-grained sandstone in the lowermost part of the Copper Ridge and Conococheague (Cooper, 1944, p. 14, 25; Butts, 1940, p. 94) is the upper boundary.

The Maynardville is composed mainly of thick-bedded, in part ribbon-banded and straticulate, dark-gray, very fine grained, partly sandy limestone (R-4049). Argillaceous and dolomitic laminations, weathering to slightly raised ridges, are

*Fossils indentified by the Paleontology and Stratigraphy Branch of the U.S. Geological Survey, Washington, D.C. Other fossils were identifed by the senior author of this report.

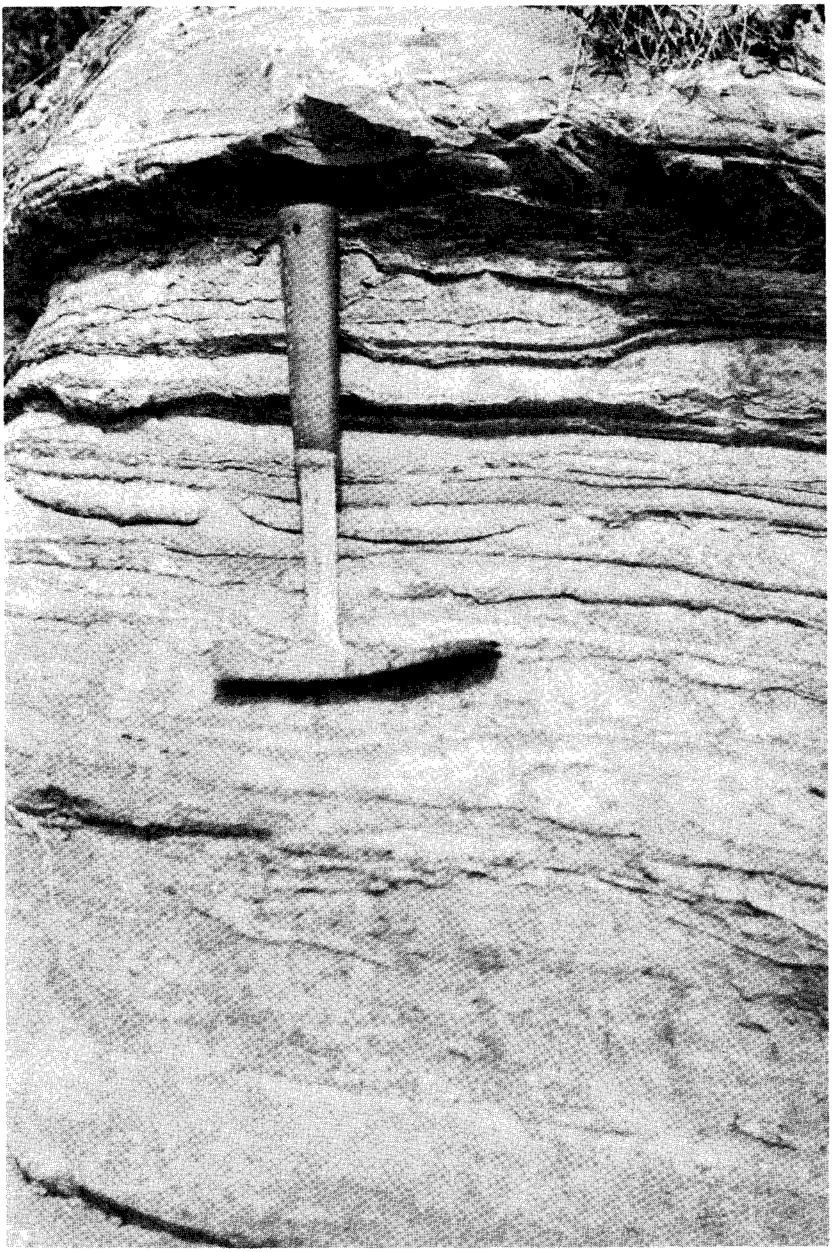


Figure 9. Ribbon-banded limestone of the Maynardville Formation along Section H on State Road 612 about 0.6 mile southeast of Lime Hill.

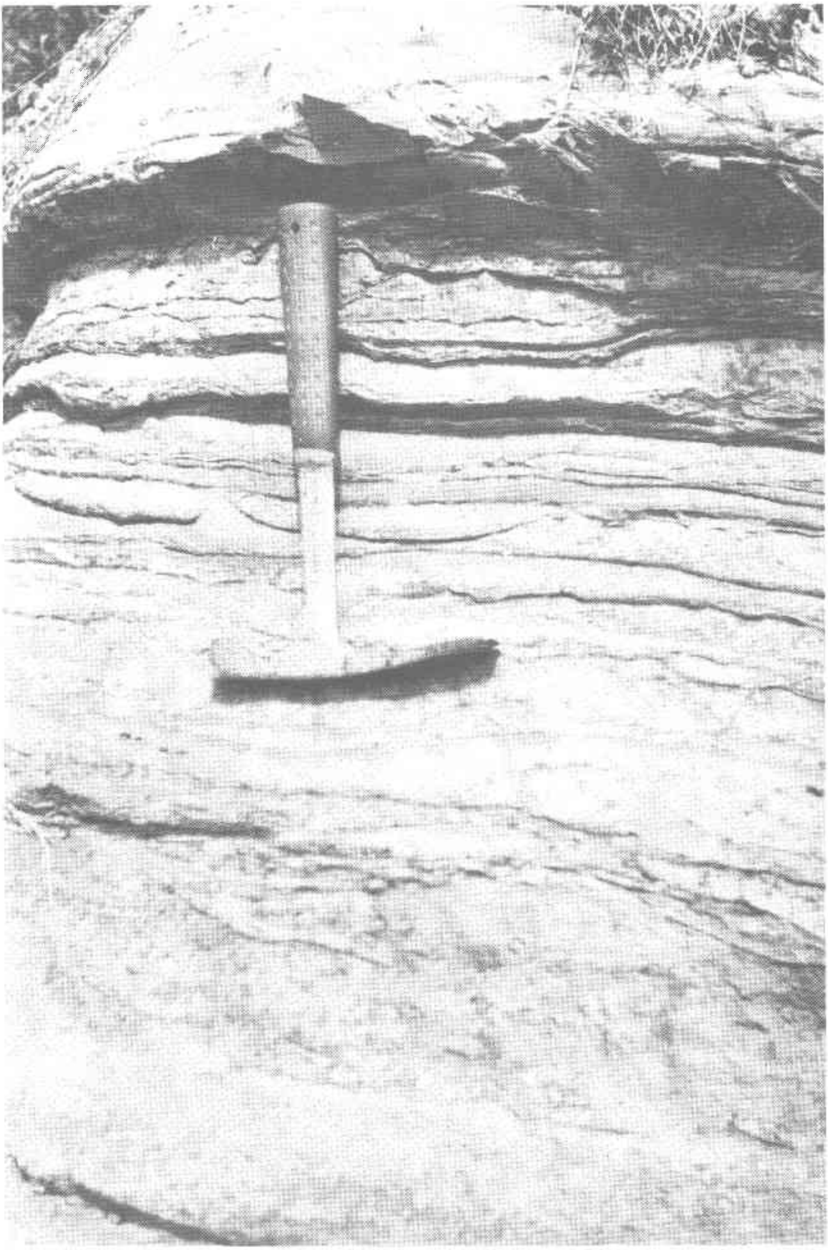


Figure 9. Ribbon-banded limestone of the Maynardville Formation along Section H on State Road 612 about 0.6 mile southeast of Lime Hill.

abundant (Figure 9; similar laminations also commonly occur in the Copper Ridge or Conococheague and rarely in the Honaker). In a few places the upper part of the Maynardville contains some thin beds of light-gray dolomite (Section H). Along Campground Road (State Road 641) about 6 feet of gray, silty shale is present near the middle of the unit. The formation is well exposed at the west end of State Road 655 in the Oak Grove area. The thickness of the Maynardville ranges from 97 feet (Section H) to 172 (Section I). Some limestones contain broken fragments of probable trilobites and brachiopods (Section I, units 2 and 4).

Copper Ridge Formation

The Copper Ridge Formation was named by Ulrich (1911, p. 548, 635-636, Plate 27) for exposures of dolomite along Copper Ridge, northeast of Knoxville, Tennessee. Because the Conococheague and the Copper Ridge are mostly penecontemporaneous formations and both contain varying proportions of limestone, dolomite and sandstone, the following criteria were followed to distinguish them. Where more than 50 percent of the exposed carbonates are dolomite, the rock was mapped as Copper Ridge; where more than 50 percent was limestone, it was mapped as Conococheague. The base of the Copper Ridge was placed beneath the oldest brown, fine-grained sandstone above Maynardville carbonates. To facilitate mapping, these two units were combined into one map unit. The top of the Copper Ridge is above a thick section of light-gray dolomite below bluish-gray Chepultepec limestone.

The single belt of Copper Ridge is along the northwest side of Walker Mountain (Plate 1). Along Abrams Creek and State Road 640 it is 1094 feet thick (Section I) and is composed principally of light-gray dolomite with some limestone in the middle part (R-4043). The limestone is highly variable in composition: observed limestones include oolitic, sandy, or as thin layers of limestone-pebble conglomerate. Light-gray and gray chert is found in both the limestone and dolomite as irregular nodular masses; some of the chert is oolitic (R-4042). Floating, fine-grained, well-rounded, quartz sand grains are common in some beds of both limestone and dolomite. One of the most useful identification characteristics of both the Copper Ridge and Conococheague formations are thin beds of brown, fine- to medium-grained, well-rounded, friable sandstone interbedded with carbonates. These beds, less than 1-foot thick, occur consistently near the base and top of the formation. Because of their relatively insoluble nature, blocks of weathered sandstone float are common, many near bedrock positions. Similar sandstone beds rarely occur in older formations or in the younger Knox Group, upper part.

Rarely, broken shell fragments of trilobites and brachiopods were found in a few limestone layers (Section H, unit 49, and Section I, unit 24). Algal-banded structures, identical to ones found in the Honaker, were seen in a limestone (Section I, unit 43) and in a chert.

Conococheague Formation

The Conococheague was named by Stose (1908, p. 701) for a series of limestones and thin sandstones exposed along Conococheague Creek, Franklin County, Pennsylvania. The formation is mostly penecontemporaneous with the Copper Ridge Formation and was mapped as the facies which contains more than 50 percent limestone. The top of the Conococheague was placed above beds of limestone and dolomite with sandstone interbeds and below the thick unit of predominantly bluish-gray, fossiliferous limestone of the Chepultepec Formation. The base was located below fine-grained sandstones that are interbedded with dolomite and some limestone. As previously mentioned, the Conococheague and underlying Maynardville Formation have been combined into one map unit.

The Concocoheague is exposed in several belts south of the Pulaski-Staunton fault trace (Plate 1). It consists primarily of gray, micrograined, cherty limestone (R-4053); some gray, fine-grained dolomite; and brown, fine- to coarse-grained sandstone (R-4045). In the fields along State Road 640 southwest of Oak Grove a significant 11-foot sandstone is present about 110 feet above the base of the formation; eastward along State Road 655 this sandstone is ripple-marked (Figure 10). Along Susong Branch (Section M) the formation is 1820 feet thick and nearly 90 percent limestone; along Goose Creek (Section L) the formation is 1790 feet thick and more than 75 percent limestone. Within a distance of less than three miles between the nearest complete sections of the Copper Ridge (Section H) and Conococheague (Section M) these equivalent units have thickened from 1196 to 1820 feet. Typical lithologies of the Conococheague are well exposed along Section M. Few fossils were found in the Conococheague. Low-spired gastrpod fragments occur at several localities in Bristol (Section M, unit 9).

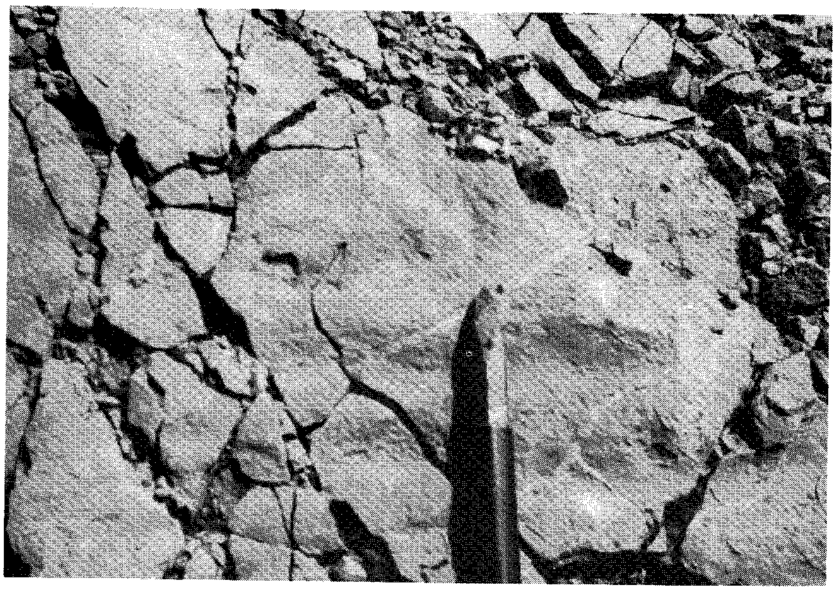


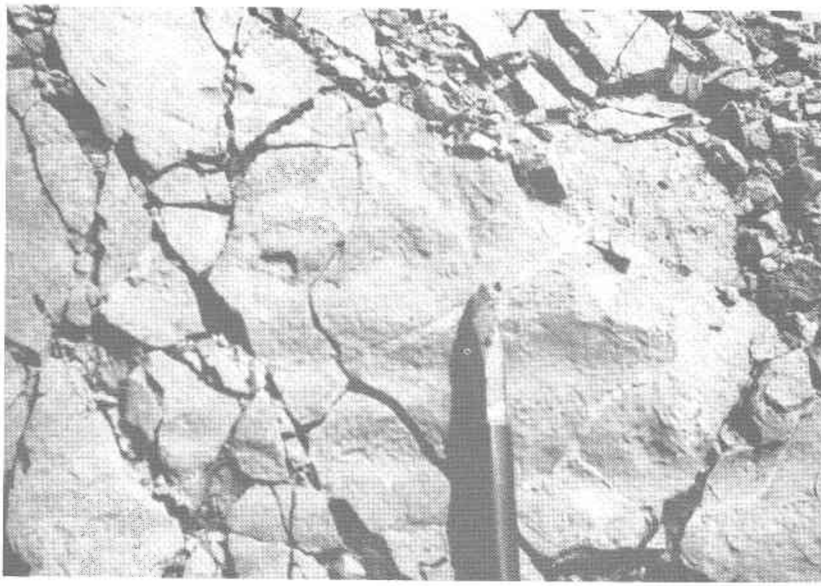
Figure 10. Ripple-marked sandstone in lower part of the Conococheague Formation on State Road 655 about 0.5 mile northeast of Oak Grove. Chisel is 22 cm (8.6 inches) long.

ORDOVICIAN SYSTEM

Chepultepec Formation

The base of the Chepultepec was mapped beneath the oldest bluish-gray, fossiliferous limestone with worm trail-like markings and above the sandstone-bearing dolomite-limestone units of the Upper Cambrian. The top was placed below the porcellaneous, chert-bearing dolomites of the upper Knox group.

The Chepultepec is exposed near the crest of Walker Mountain, in Bristol, and in four belts in the Bristol area (Plate 1). Along Section I across Walker Mountain the Chepultepec consists of 147 feet of bluish-gray, medium-bedded, very fine-grained limestone commonly marked by worm trail- and borings-like features that weather to slightly raised light-brown irregularities. About 2 miles to the southwest along State Road 641 the Chepultepec also includes much gray dolomite and at least one bed of well exposed along Section M. Few fossils were found in the Conococheague. Low-spired gastrpod fragments occur at several localities in Bristol (Section M, unit 9).



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Along Section L southwest of Wallace the Chepultepec is 801 feet thick. It consists mainly of bluish-gray to dark-gray, very fine-grained, thick-bedded limestone with occasional black chert nodules and bedding planes commonly marked by worm trail-like features (R-4055). Exposures of nearly half of the formation can be seen in and around an abandoned rock quarry (Plate 1, No. 9) where bedding planes are clearly marked by mudcracks (Figure 11) indicating shallow-water deposition. Partial exposures of the Chepultepec occur in the Vulcan Materials Corporation quarry (Plate 1, No. 11) about 0.5 mile east of Bristol where the upper part of the formation is in thrust-fault contact with the underlying Middle Ordovician Lenoir and Mosheim limestones. The Chepultepec in the quarry area is a bluish-gray, fairly pure limestone. In the southeast corner of the

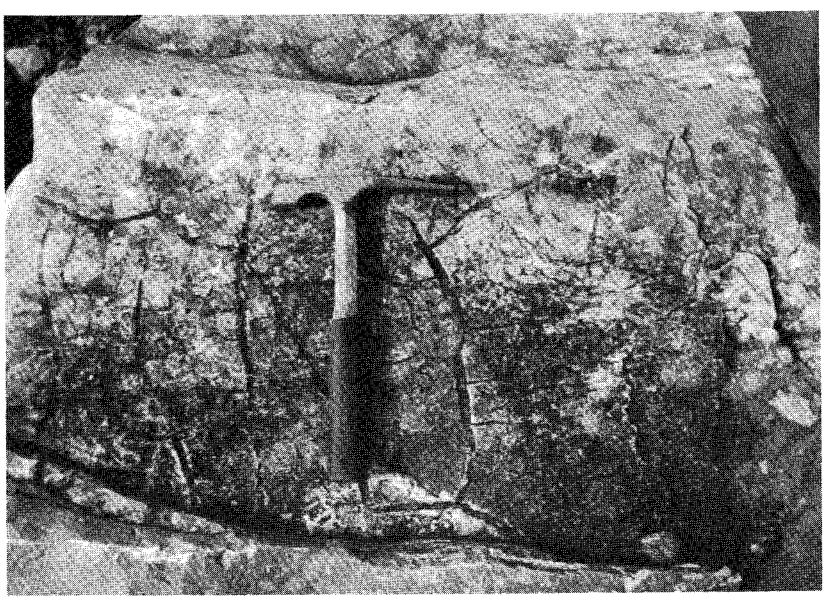

Figure 11. Mudcracks on bedding surface of the Chepultepec limestone along east side of inactive quarry (Plate 1, No. 9).

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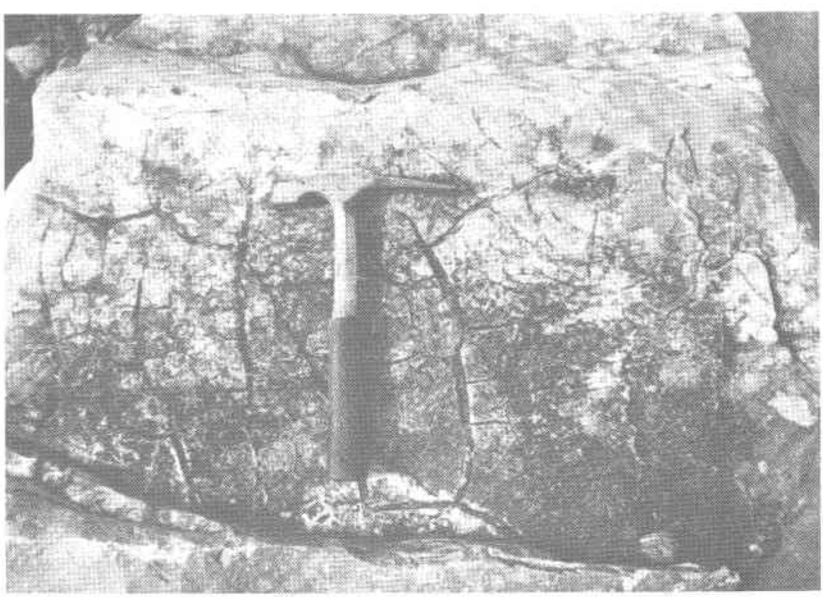

Figure 11. Mudcracks on bedding surface of the Chepultepec limestone along east side of inactive quarry (Plate 1, No. 9).

map area and in the northern part of Bristol, outcrops with lithologies similar to those in the quarry are present.

Fossils, especially low-spired gastropods and curved cephalapods, are present in many Chepultepec outcrops. The following were identified: cephalopods *Clarkoceras* ? sp. and *Dakeoceras ?* sp.; *gastropods* **Bucanella* cf. *B. nana* (Meek), **Eccyliomphalus gyroceras* (Roemer), *Eccyliopterus* sp., **Gasconadia* sp., *Gasconadia putilla* (Sardeson), *and* **Prohelicotoma uniangulata* (Hall); and trilobites **Hystricurus* ? sp. and **Macropyge* ? sp. The occurence of *Eccyliomphalus, Gasconadia,* and *Phoheliocotoma* is confirmation of earliest Ordovician age of the Chepultepec (personal communication, E. L. Yochelson, 1969).

Knox Group, Upper Part

The name Knox Dolomite was first used by Safford (1869, p. 204) to include all the rocks from the top of the Nolichucky Formation to the base of the Middle Ordovician limestones in Knox County, Tennessee. As distinct formations were mapped within this interval the name Knox was given group status by Rodgers and Kent (1948). Equivalents to the upper part of this group were designated as Beekmantown dolomite (Butts, 1933) or as Longview, Kingsport, and Mascot formations (Rodgers, 1953). Although lithologies representative of those found in the Mascot Dolomite, Kingsport Formation, and Longview Dolomite can be seen at scattered localities in the map area, it is not possible to map them separately or to even be certain that they are present in all exposure belts because of discontinuous outcrops. Rather than give these rocks a precise name which would indicate equivalence to rock units in other areas, the term Knox group, upper part, is used here. It does not imply inclusion or exclusion of any of the stratigraphic names discussed above.

The base of the Knox is mapped below procellaneous chert-bearing dolomites and above Chepultepec fossiliferous limestones. The top is located at the post-Knox unconformity, which has been documented as one of the most significant and widespread erosional unconformities in the Appalachin Region (Butts, 1940, p. 119; Cooper, 1944, p. 33; Rodgers, 1953, p. 53-54, 59; Colton, 1970, p. 16, 19, 23). In the map area this erosional surface is evidenced by the great variation in thickness of the upper Knox rocks, the apparent karst topography and collapse zones in rocks beneath this surface, the wide range of thickness of the over-

Figure 12. Erosional unconformity with undulating knife-edge contact between dolomite at top of the Knox group (hammer handle) and base of the Mosheim Limestone (hammer head); hillslope along Section L south of service station at intersection of State Road 658 and Interstate Highway 81.

Figure 12. Erosional unconformity with undulating knife-edge contact between dolomite at top of the Knox group (hammer handle) and base of the Mosheim Limestone (hammer head); hillslope along Section L south of service station at intersection of State Road 658 and Interstate Highway 81.

lying limestone beds, the abrupt lithologic change from Knox dolomite to Mosheim limestone, the presence of clasts of upper Knox dolomite in the basal beds of Mosheim limestone (Figure 13) and occasional exposures of the irregular surface itself (Figure 12).

Along Walker Mountain the upper Knox is 1669 feet thick along Campground Road (State Road 641) and 2204 feet about two miles southwestward along State Road 617 (Section H). At these localities the upper Knox is mainly light-gray, medium-bedded cherty dolomite (R-4045). The upper part consists of very fine-grained or micrograined dolomite similar to that of the Mascot Dolomite. The lower third of the section consists of medium- to coarse-grained dolomite, possibly equivalent to the Kingsport Formation and Longview Dolomite. Much of the area underlain by upper Knox rocks consists of a deeply weathered reddish, residual clay with great quantities of angular chert from pebble to boulder size. Most chert is characteristically white and porcellaneous, except where stained to yellows and reds by iron oxides. Some chert is algal-banded in light-gray to gray rounded patterns; occasionally it is oolitic. A useful recognition feature of the upper Knox, especially where only residuum occurs, is chert with dolomolds (rhombic-shaped voids; R-4044). Limestone and sandstone comprise a relative insignificant portion of the upper Knox. Beds of bluish-gray micrograined limestone occur about 300 to 500 feet from the base and about 700 to 800 feet from the top. These limestones, particularly in the upper part, contain a few fossil gastropods, cephalopods, and rarely, fragments of trilobites (Section H, units 79 and 80). Thin beds of brown, fine-grained sandstone occur in the lower 300 feet of the unit at some localities.

Northeast of Bristol, the upper Knox, 685 feet thick (Section L), consists of chert and dolomite similar to that on Walker Mountain. Two zones of dolomite collapse-breccia and a zone of chaotic beds consisting of blocks of limestone and dolomite with interfillings of grayish-green and maroon calcareous shale (R-4056) are also present along Section L. Beds above and below these zones seem relatively undisturbed. Similar features have been noted in Tennessee in the upper Knox in the zinc-bearing beds (Harris, 1969) and are interpreted to be related to cave solution and roof collapse during the development of the post-Knox erosional surface. In the business district of Bristol, adjacent to the State line, the Knox is overlain by reddish saprolite and abundant chert with dolomolds. Exposures just southeast of the Vulcan Materials Corporation quarry (Plate 1, No. 2) and to the east near Carmack cemetery consist of cherty dolomite and limestone.

Fossils occur in the limestone and occasionally in the cherts of the upper Knox. Two localities provided the majority of the fossils (Section H, units 79 and 80; Section L, units 36 and 37): the cephalopod *Campbelloceras* sp.; gastropods *Ceratopea* sp., *Eccyliopterus* sp., *Hormotoma* sp., *Lecanospira compacta* (Salter), *Lophonema* ? sp., *"*Murchisonia*"* sp. indet., * cf. *Pararaphistoma* sp., *Plethospira* ? sp., and *Roubidouxia* sp.; nautiloid and trilobite fragments; algal-banded chert; and worm trail-like features.

Lenoir and Mosheim Limestones

In the area of this report the Lenoir and Mosheim limestones have been considered as a single unit for purposes of mapping because of poor exposures and a narrow outcrop belt. The base was mapped at an abrupt lithologic change from light-gray dolomite of the Knox group to dove-gray limestone of the Mosheim. The top was mapped at the change from limestones of the Lenoir to dark-gray shale of the overlying Athens Formation.

The Lenoir-Mosheim north of the Pulaski-Staunton fault ranges in thickness from less than 30 feet to about 270 feet. About 0.4 mile east of Three Springs the limestones are 121 feet thick (Section H). About 1.2 miles northeast of Three Springs these units increase from 53 to 269 feet in a distance of about 150 yards. South of Interstate Highway 81 the limestones are 102 feet thick (Section L); the lower 49 feet is composed of light-gray micrograined limestone and dolomite resembling the Mosheim (Butts, 1940, p. 136); the upper 62 feet is dark-gray and gray, partly very fine-grained, thick-bedded limestone (R-4057) resembling the Lenoir (Butts, 1940, p. 140). Lithologies of other outcrops to the south are similar to those along Section L. A basal conglomerate, at two localities near Shakesville, consists of subangular clasts of upper Knox dolomite in a matrix of micrograined bluish-gray limestone, which resembles the Mosheim (Figure 13).

Most of the following fossils were collected along Section L: gastropods *Eotomaria* ? sp., **Helicotoma* sp., **Loxoplocus*

(Lophospira) cf. *L. (L) bicincta* (Hall), **Loxoplocus (Lophospira)* sp. indet., and *Trochonemella trochonemoides* (Ulrich) ?; and the ostracod *Isochilina* ? sp. The gastropods confirm a Middle Ordovician age (personal communication, E. L. Yochelson, 1969), but did not permit formational assignment. Brachiopods and echinoderm columnals are present in some beds near the Pulaski-Staunton fault trace.

Figure 13. Dolomite clasts of upper part of Knox group incorporated into overlying Mosheim Limestone just above erosional unconformity; about 200 feet east of Shakesville in barnyard driveway just east of small creek. Chisel is 22 cm (8.6 inches) long.

Athens Formation

The base of the Athens Formation was mapped below a thick section of dark-gray shale and above the limestones of the underlying Lenoir-Mosheim. The stratigraphic top is not present; it has been either removed by erosion or is concealed beneath fault blocks. In outcrops adjacent to the Pulaski-Staunton fault trace, a maximum partial thickness of about 200 feet of the formation is present just west of Campground Road (State Road 641) ; it is mostly a gray, fissile shale with about 14 feet of highly fractured, fossiliferous, thin-bedded, dark-gray, very-

(Lophospira) cf. *L. (L) bicincta* (Hall), **Loxoplocus (Lophospira)* sp. indet., and *Trochonemella trochonemoides* (Ulrich) ?; and the ostracod *Isochilina* ? sp. The gastropods confirm a Middle Ordovician age (personal communication, E. L. Yochelson, 1969), but did not permit formational assignment. Brachiopods and echinoderm columnals are present in some beds near the Pulaski-Staunton fault trace.

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Limestone beds adjacent to the Pulaski-Staunton fault contain some brachiopod fragments, crinoid stems, possible cystoid plates, and the small coral *Lichenara* ?. The lower beds of shale near Shakesville contain an abundant Middle Ordovician graptolite fauna and an occasional rounded impression of inarticulate brachiopods. Fossils collected from the formation include the brachiopod * *Lingulella* ? sp.; graptolites * *Amplexograptus confertus* (Lapworth), *Climacograptus scharenbergi* Lapworth, * *Dicellograptus* ? sp., * *Diplograptus* ? sp., *Diplograptus foliaceus* (Murchison), * *Glyptograptus* cf. *G. teretiusculus*, and *Nemagraptus gracilis* (Hall).

Middle Ordovician Rocks, Undivided

Near the western border of the map, just north of Lime Hill, an overturned section of Middle Ordovician rocks is present in a slice along the Saltville fault (Plate 1). Stratigraphically older rocks have been deformed so that they overlie younger ones. Throughout this 1.2-mile-long belt, the stratigraphic base of this rock unit is covered by the southeast-bounding fault; the top of the unit either grades into the Moccasin Formation or is terminated at the erosional edge of the northwest-bounding fault. Some of the rock types (Sections G, F) resemble those mapped as Ottosee and Holston limestones by Butts (1940, p. 148-154, 170-178) and as Benbolt and Wardell formations by Cooper and Prouty (1943, p. 868-875). The fauna suggests a Middle Ordovician age of Chazyan or early Black River. Identified bryozoans are similar to those occuring in the Tumbez and Arline formations (personal communication, O. L. Karklins, 1970). The nearest Middle Ordovician rocks crop out about 2 miles to the southeast where lithologies are dissimilar to those found in the fault slice. Because of the lack of definitive lithologic and faunal data, and the narrow outcrop belt these rocks are mapped as Middle Ordovician rocks, undivided.

Three distinct rock units are exposed along Section G. From oldest to youngest they are: Unit 1, about 100 feet of brown, calcareous, clayey shale with interbeds of thin-bedded, light-gray, fine- to coarse-grained, fossiliferous limestone (R-4034); Unit 2, about 50 feet of grayish-brown, thin-bedded, mostly fine-grained, very fossiliferous limestone, which includes about 14 feet of pinkish-gray, very coarse-grained, marble-like limestone near the top (R-4035, Section F); and Unit 3, about 50 feet of interbedded maroon and light-gray, fine-grained, fossiliferous limestone. The upper part of unit 3 is transitional into the maroon, argillaceous limestones of the Moccasin Formation. Other good exposures are present in the abandoned quarry (Plate 1, No. 2) about 0.5 mile northeast of Lime Hill where 109 feet of the Middle Ordovician limestones are present between the bounding faults (Section F).

Fossils occur throughout these Middle Ordovician rocks with bryozoans being particularly abundant. The following were collected from unit 1, the oldest rocks: the brachiopod *Sowerbyella* sp. ; bryozoans *Graptodictya* sp. and *Pachydictya* cf. *P. senilis* Coryell; the ostracod *Isochilina* sp. ; and echinoderm stem fragments. Unit 2 included the following: bryozoans * *Graptodictya* sp. , * *Hallopora* sp. , * *Ottoseetaxis* sp. , and **Pachyaictya* cf. *P. senilis* Coryell; the sponge *Nidulites pyriformis* Bassler; and echinoderm stem sections. The following were identified from unit 3, the youngest rocks: brachiopods * *Dinorthis willardi* Cooper and *Hesperothis* ? sp. ; bryozoans *Batostoma sevieri* Bassler, * *Batostoma* cf. *B. suberassum* Coryell, * *Chazydictya* ? sp. , * *Coeloclema* ? sp. , * *Constellaria* sp. , * *Halloporina* sp. , * *Hemiphragma* sp. , * *Heterotrypa* sp. , * *Pachydictya* cf. *P. senilis* Coryell, * *Phylloporina* sp. , * *Ottoseetaxis* sp. , * *Scenellopora* sp. , and * *Stictopora* sp. ; the gastropod *Lophospria* ? sp. ; the sponge (?) *Receptaculites occidentalis* Salter; and a cystoid calyx fragment and ostracod fragments.

Moccasin Formation

The Moccasin Formation is present only along the Saltville fault just north of Lime Hill (Plate 1), where it is overturned to the northwest. The stratigraphic top of this unit is in fault contact with the Tuscarora Formation. The basal boundary was mapped above the uppermost blue-gray limestone of a transition zone of interbedded bluish-gray and maroon argillaceous limestones in the top part of the underlying Middle Ordovician, undivided. Along Section G a partial thickness of 162 feet of the Moccasin is exposed which consists mainly of maroon or mottled maroon and light-gray, thin-bedded, argillaceous limestone with maroon, calcareous shale partings (R-4033). Above the limestone is a covered interval which is overlain by gray, thick-bedded, coarse-grained, fossiliferous limestone. This latter limestone is probably younger than the Moccasin, but because of its limited extent was included in the map unit. The following fossils occur in the gray limestone: brachiopods *Camarotoechia plena* (Hall) ? , *Dalmanella* sp. , *Rafinesquina* sp. , *Sowerbyella* sp. , *Strophomena incurvata* ? (Shephard), and *Zygospira* sp. ; the bryozoan *Rhinidictya* ? sp. ; ostracods; and echinoderm columnals.

SILURIAN SYSTEM

Tuscarora Formation

The Tuscarora was named by Darton and Taft (1896, p. 2) for Lower Silurian quartzitic sandstone exposed on Tuscarora Mountain, Pennsylvania. In southwestern Virginia the name Clinch Sandstone has been used for similar beds (Butts, 1940, p. 229; Cooper, 1944, Pl. 11; Harris and Miller, 1958, map). Rodgers (1953, p. 100), however, indicates that at the type locality (Safford, 1856, p. 167) the Clinch includes rocks from Lower Silurian to Lower Devonian in age. The term Tuscarora is used in this report to include only Lower Silurian rocks; Middle Silurian beds are mapped as the Clinton Formation.

The Tuscarora is poorly exposed along Clinch Mountain; the base is not present within the mapped area. The upper contact was placed at the top of the youngest quartzitic sandstone below a section composed mainly of siltstone and shale; a few feet of Clinton-like siltstone is included (Plate 1). The formation consists of light-gray, medium-to massive-bedded, fine- to medium-grained, quartzitic sandstone (R-4004) with some silty shale and siltstone, especially in the upper part. The sandstone is commonly cross-bedded and some bedding planes are ripple-marked. Fossils in the Tuscarora consist of *Arthrophycus* on some bedding surfaces and of *Scolithus* perpendicular to the bedding.

Clinton Formation

The Clinton in the Wallace quadrangle has lithologies similar to those of the Keefer Sandstone and Rose Hill Shale; it was not subdivided, however, because of scarcity of outcrops. The lower contact with the Tuscarora was mapped at the top of the youngest quartzitic sandstone below a section mainly of siltstone and shale. The upper, transitional, contact was placed above the youngest brown to maroon sandstone below fossiliferous, cherty, or glauconitic sandstones of the Huntersville Formation.

The Clinton is poorly exposed on the heavily wooded, middle and lower slopes of Clinch Mountain (Plate 1). It is composed of interbedded light-gray and dark purplish-brown silty shale and siltstone, some gray fine-grained sandstone, and more than 20 feet of thick-bedded conglomeratic sandstone (R-4005) at the top. Some of the shale and siltstone is highly ferruginous. The sandstones are commonly cross-bedded; a paleocurrent direction of N. 15° W. was determined for one exposure. Ostracods are present in upper siltstone layers below cherty beds of the Huntersville Formation.

DEVONIAN SYSTEM

Huntersville Formation

The Huntersville Formation occurs as a narrow band along the lower slopes of Clinch Mountain northwest of Poor Valley. For mapping purposes, the base of the formation was placed below the oldest chert or glauconitic sandstones that rest on brown to maroon sandstones of the Clinton Formation. The top was placed at the base of black and varicolored shales of the Millboro. The Huntersville consists of white, thin-bedded, iron-stained, blocky, fossiliferous chert (R-4006) ; cherty, glauconitic sandstone; and greenish-gray siltstone. Its thickness is estimated to be about 10 to more than 60 feet. The chert is the most conspicious lithology; where bedrock is not exposed, chert is usually present in the soil.

The formation contains abundant fossils, many of which are silicified. One bed of cherty, glauconitic sandstone has nearly one-half of the species collected from this formation. The ostracods collected occur in the Huntersville Formation although none are diagnostic (personal communication, J. M. Berdan, 1969). The brachiopods, identified by J. T. Dutro, Jr. (personal communication, 1970) are characteristic of the Huntersville in the Appalachian region. The following were collected from the mapped area (Plate 1) and from along State Road 612 on the adjacent Mendota quadrangle to the west: brachiopods *Amphi-*

genia curta (Meek and Worthen), * *Anoplia nucleata* (Hall), *Anoplotheca acutiplicata* (Conrad), *Charionella scitula* Hall, *Chonetes mucronatus* Hall, * *Constellirostra* sp. , * *Eodevonaria arcuata* (Hall), * *Leptocoelia* sp. , * *Longispina mucronatus* (Hall), *Pholidops areolata* Hall, * *Schuchertella* ? sp. , *Schuchertella pandora* (Billings), * *"Spirifer" macrus* Hall, *Spirifer varicosus* Hall, and *Stropheodonta perplana* (Conrad) ; the bryozoan *Cystodictya ovatipora* (Hall) ; the gastropod *Playceras* sp. ; ostracods * *Aechimina* sp. , * *Berounella* sp. , * ? *Bollia diceratina* Swartz and Swain, * *Ctenoloculina* sp. , * *Eustephanella catastephanes* (Swartz and Swain), * *Healdia* sp., * *Kirkbyella* sp. , * *Pachydomella* ? sp. , * *Reticestus* ? sp. , * *Strepulites* sp. , * *Subligaculum* sp. , * *Tubulibairdia* sp. , and * *Ulrichia* sp. ; the trilobite *Proetus crassimarginatus* Hall; and crinoid columnals.

Millboro Shale

The Millboro Shale has been divided into two units, the Marcellus and Naples (Butts, 1940, p. 309). Fossils were found that are diagnostic of each unit, but lithologic criteria were lacking to separately map them. The lower contact with the underlying Huntersville was mapped at the highest stratigraphic position where chert rubble was found or at occasional creek exposures of the chert-shale contact. The upper, gradational boundary was placed below the oldest thin siltstones of the Braillier Formation and above the change from relatively non-silty Millboro shales to silty Braillier shales.

The Millboro is very poorly exposed along the lower, and mostly forested, southeast slopes of Clinch Mountain (Plate 1). The shale is mostly dark gray (R-4007) on fresh exposures; weathered colors include light gray, orange, light-greenish gray, or purplish gray. It is fissile and highly fractured. Some mud-cracks were noted on a few bedding surfaces. Upper beds become slightly silty near the transition to the Brallier.

The Millboro has a varied and abundant dwarf fauna. These fossils occur as imprints on bedding planes. The following were found along State Road 612 mainly on the adjacent Mendota quadrangle to the west of the mapped area: brachiopods *Leiorhycnhus limitare* (Vanuxem) [1], [2] and *Schizobolus concentricus* (Vanuxem) [1], [2]; cephalopods *Orthoceras* sp.[1] and *Probeloceras lutheri* Clarke[2]; the crustacean *Spathiocaris emersoni* Clarke?[2];

[1]Indicative of Marcellus unit and [2]of Naples unit (Butts, 1940, p. 313, 316).

pelecypods *Pterochaenia fragilis?* (Hall)[2], *Lunulicardium* sp.[2], and *Paracardium doris* (Hall)[2]; the pteropod *Styliolina fissurella* (Hall)[1,2]; and carbonized plant stems and disc-shaped microscopic spores.

Brallier Formation

The Brallier Formation is very poorly exposed; bounding contacts of the formation are transitional and rarely seen. The base was mapped below siltstones above the comparatively non-silty shales of the Millboro. The top was placed below the oldest occurrence of Chemung fossils and a progressive increase of siltstone interbeds upward in the stratigraphic section.

The Brallier underlies the bottom and bounding slopes of Poor Valley (Plate 1). Structural attitudes in Poor Valley are generally steeper than those on Clinch or Little mountains because its shales are incompetent relative to the sandstones and siltstones of the mountain-forming formations. Lack of exposures and variability of dip preclude accurate measurement of the Brallier, but it is estimated to be about 940 feet thick. This formation is composed predominantly of greenish-gray to grayish-brown, hackly, silty shale; a minor amount of siltstone and sandstone is present. The upper part contains some dark-gray to black, fissile shales indistinguishable from those of the underlying Millboro. A few thin beds of light-brown, dense siltstone and very fine-grained sandstone (R-4008) occur at irregular intervals. The shales weather to light-yellowish, light-brownish, or purplish tints. The Brallier is sparsely fossiliferous; some carbonized, disc-shaped plant spores were found in the lower dark shales.

Chemung Formation

Hall (1839, p. 295-296, 322-326) named the Chemung Formation for a unit of sandstone and shale exposed at Chemung Narrows, near Elmira, New York. The Chemung in southwestern Virginia may be younger than the Chemung of New York (Cooper, 1944, p. 139). The name, however, is used for a map unit in this report because of long-established usage in Virginia and lithologic similarity to the Chemung rocks as described by Butts (1940, p. 323-328). An increase in siltstone beds and the oldest position of Chemung fossils were used to determine the lower gradational contact with the underlying

Brallier. The upper contact was mapped at the top of a distinctive quartz-pebble conglomerate beneath the overlying black shales of the Big Stone Gap Shale.

The Chemung forms one narrow outcrop belt along the northwest slopes of Little Mountain (Plate 1). It is about 130 feet thick at Wooten Gap (Section A) where it is well exposed, but appears to thin to the southwest. In the Southern Railway cutbanks near the community of Mendota, about 3 miles west of the mapped area, it is absent. At Wooten Gap the Chemung

Figure 14. Quartz-pebble conglomerate at top of the Chemung Formation at outcrop in Robinette Gap on east side of State Road 856.

Formation consists of interbedded light greenish-gray, silty, micaceous shale; gray, thin-bedded, fossiliferous siltstone (R-4010); fine-grained sandstone; and a quartz-pebble conglomerate. Shale is dominant in the lower half of the section, siltstone increases in the upper half, and sandstone is present only near the top. At the top of the Chemung is a mappable bed of quartz-pebble conglomerate (Figure 14; R-4009). This conglomerate, 1 foot in thickness at Wooten Gap, increases to 7 feet at Robinette Gap, 1.5 miles to the southwest.

Brachiopods and pelecypods are present in many siltstone and

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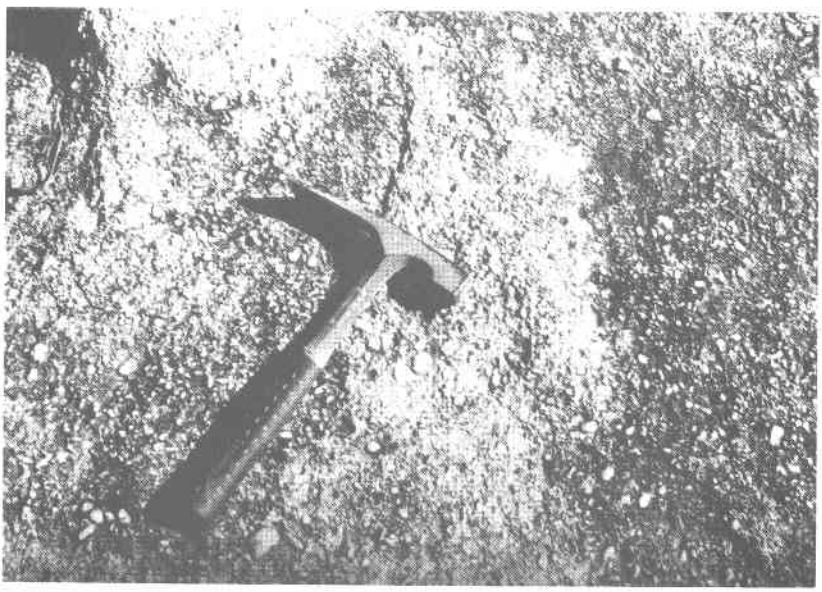

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Brachiopods and pelecypods are present in many siltstone and some shale beds; there are some zones of compacted masses of brachopod molds and casts. The species listd below are from Wooten Gap: brachiopods *Atrypa reticularis* (Linné), *Atrypa spinosa* Hall, *Camarotoechia congregata* (Conrad), *Camarotoechia contracta* (Hall), *Carniferella carinata* Hall, **Chonetes* cf. *C. scitulus* Hall, **Cyrtospirifer* aff. *C. disjunctus* (Sowerby), *"*Leiorhynchus*" *mesicostale* (Hall), *Spirifer marcyi*? Hall, and *Spirifer mesistrialis* Hall; and pelecypods *Edmondia?* sp. and *Solemya*? sp.

MISSISSIPIAN SYSTEM

Big Stone Gap Shale

The Big Stone Gap Shale is mapped with the overlying Price Formation because it is only about 10 feet thick in the area, has discontinuous outcrops, and is Mississippian in age. Roen, Miller, and Huddle (1964, p. B 43-B 47) conclude from conodont studies that the Devonian-Mississippian systemic boundary is within the unit. Conodonts collected from the shale in the Wallace quadrangle, however, belong only to the Lower Mississipian, Kinderhookian Series (personal communication, J. W. Huddle, 1970).

Although only one good exposure of the formation was found at a roadcut in Wooten Gap, it is probably continuous to the southwest to at least Robinette Gap where black-shale float occurs at about the same stratigraphic position. At Wooten Gap (Section A) there is 10 feet of black, fissile shale containing conodonts, rarely oval brachiopods, and plant fossils. Specimens from Section A were identified by the United States Geological Survey and placed in their reference collection (USGS 24071-PC). The collection contained the following: the brachiopod **Orbiculoidea* sp; conodonts **Hindeodella* sp., **Prioniodina* sp., **Siphonodella duplicata* Branson and Mehl, **Spathognathodus* sp., and **Synprioniodina* sp. Other fossils include the conodonts *Ligonodina pectinata* Ulrich and Bassler and *Nothognathella* sp., and cordaitean leaves and plant spores.

Price Formation

The Price Formation is bounded by black shale of the underlying Big Stone Gap Shale and maroon and green shale and siltstone of the overlying Maccrady Formation. To facilitate mapping the Big Stone Gap Shale and Price Formation have been combined as a single map unit. The Price supports Little Mountain, where it is well exposed in gaps and along the slopes (Figure 3). Sections at Wooten Gap (Section A) and in Robinette Gap have similar lithologies and thicknesses. Exposures at Wooten Gap consist of approximately 565 feet of mostly gray, silty shale and thin-bedded, gray siltstone in the lower half of the section, and interbedded shale, siltstone, and sandstone in the upper half. The sandstone is gray, mostly medium-bedded, and very fine- to fine-grained except for irregular conglomeratic layers in the upper 10 to 20 feet of the formation (R-4011). The uppermost sandstone beds, especially the conglomeratic layers, are generally arkosic with weathered white feldspar. The upper half consistently has beds of green, glauconitic, fossiliferous shale, siltstone, and sandstone from 3 inches to 1 foot thick (R-4012). Seven glauconitic beds occur at Wooten Gap from 100 to 200 feet below the top of the Price. Abundant plant fragments and thin carbonaceous beds also are present locally in the upper half; they are exposed at the south end of Robinette Gap.

Fossils in the Price were found mostly in the glauconitic beds and a few other sandstone and siltstone layers. The brachiopods indicate a Lower Mississippian age, probably Osagian Series (personal communication, J. T. Dutro, Jr., 1970). The following fossils were found in outcrops at Wooten Gap and Robinette Gap: brachiopods *Camarotoechia* sp., **Chonetes* sp., *C. shumardonus* De Koninck, *Dictyoclostus burlingtonensis* (Hall), *Euphemites galericulatus* (Winchell), **Punctospirifer* sp., *Reticularia pseudolineata* (Hall) **Schellwienella* ? sp., *Schuchertella desiderata* Hall and Clark, **Spirifer* cf. *S. stratiformis* Meek, *S. winchelli* ? Herrick, **Teteracamera* ? sp., and **Torynifer* cf *T. pseudolineata* (Hall); bryozoans *Cystodictya* sp., *Fenestrellina regalis ?* (Ulrich), *Fenestrellina tenax* (Ulrich), *Polypora impressa* ? (Ulrich), and *Rhombopora* sp.; pelecypods *Allorisma* ? sp., *Aviculopecten* ? sp., and *Solemya* ? sp.; the gastropod *Oxydiscus* sp.; **Lepidodendron* bark pattern; and crinoid columnals.

Maccrady Formation

The Maccrady Formation is poorly exposed. Its base is mapped at the top of the conglomeratic sandstones of the Price Formation and its top at the oldest, gray, argillaceous limestones of the Little Valley Formation. Scattered outcrops indicate that it extends as a narrow belt at the southeast base of Little Mountain (Plate 1). It is mostly covered by alluvium, colluvium, or terrace deposits or by the North Fork of the Holston River. The best exposures are in a narrow valley 0.3 mile northeast of Buffalo Ford and near a stock pond about 0.3 mile east of the south entrance to Wooten Gap. The Maccrady is 57 feet thick along Section B. It is characteristically composed of maroon, pink, and light-green, soft, micaceous shale or thin-bedded mudstone with minor amounts of maroon siltstone (R-4013) and light-gray to pink, fine-grained sandstone. Some of the shale contains scattered fine-sized quartz grains. No fossils were found.

Little Valley Formation

The Little Valley Formation underlies a 0.3-mile-wide belt partially inundated by the North Fork of the Holston River (Plate 1). The lower boundary was mapped at the oldest, argillaceous limestone above the sandstones and shales of the Maccrady Formation; the upper boundary was placed at the top of a shale and shaly limestone unit, and below a thick-bedded dark-gray limestone in the basal part of the overlying Hillsdale Limestone. Nearly complete exposures of the formation are present on River Ridge, along Horseshoe Bend, and northeast of the State Road 622 crossing of the North Fork, Holston River. At Horseshoe Bend (Section B) the formation is 570 feet thick.

The Little Valley includes mainly argillaceous limestone with some shale and a minor amount of sandstone. The limestone is gray, argillaceous, fossiliferous, medium to thick bedded, and in part cherty (R-4015). Some oolitic limestone is present about 200 feet from the base. The cherty limestone contains bedded rows of gray, irregular, chert nodules that protrude on deeply weathered surfaces. These closely resemble similar layers in the overlying Hillsdale Limestone; cherty limestones in the Little Valley, however, have intervening shale units. The shale is dark-gray, black or grayish-brown, mostly fissile, and fossiliferous (R-4014). It is principally confined to two units in the upper one-third of the section, which totals about 60 feet in thickness. From one to three beds of light grayish-brown, medium-bedded, fine-grained, calcareous sandstone are consistently present in the lower half of the Little Valley; some of the sandstones are cross-bedded. Averitt (1941, p. 17-29) indicates that it is from similar Little Valley sandstones that natural gas was produced in the Early Grove gas field, about three miles to the west of the mapped area. Averitt found that these sands had less than 5 percent porosity and very low permeability; exposures of similar sandstones in the mapped area all appear to have very low porosity.

The Little Valley is the most fossiliferous Mississippian formation in the mapped area. Fossils are abundant in most beds, except sandstones. Brachiopods and pelecypods confirm the age to be Upper Mississippian. Fossils from the Little Valley Formation include the following: brachiopods **Anthracospirifer* cf. *A. leidyi* (Norwood and Pratten), *Athyris lamellosa* (L'Eveille), **Composita* cf. *C. subquadrata* (Hall), *Dictyoclostus burlingtonensis* (Hall), *Dictyoclostus inflatus* (McChesney), **Inflatia* ? sp., *Girtyella turgida* (Hall), *Orbiculoidea* sp., *Productus (Linoproductus) altonensis* Norwood and Pratten, **Punctospirifer* cf. *P. transversa* (McChesney), *Spirifer bifurcatus* Hall, **Syringothyris* cf. *S. textus* (Hall), and **Tetracamera* ? sp.; bryozoans *Cystodictya lineata* Ulrich, *Dichotrypa flabellum* ? (Rominger), *Fenestralia sancti-ludovici* Prout, *Fenestrellina serratula* (Ulrich), *Hemitrypa proutana* Ulrich, *Rhombopora simulatrix* Ulrich, and *Tabulipora tuberculata* (Prout); corals *Neozaphrentis* sp., *Syringopora virginica* Butts, and **Zaphrentites* sp.; pelecypods *Allorisma* ? sp., **Aviculopecten* sp., *Aviculopecten monroensis* ? Worthen, **Caneyella sp.*, * ? *Cypricardinia* sp., *Edmondia* ? sp., **Grammysia* sp., *Megambonia* sp., *Nuculana* sp., * ? *Nuculites* sp., * *Phestia* sp., **Posidonia becheri* Bronn, and **Wilkingia* sp.; the gastropod *Meekospira* sp.; the mollusc *Hyolithes* ? sp.; the ostracod **Graphiadactyllis* sp.; and crinoid columnals, plant stems, nautiloid fragments, and a cephalapod imprint.

Hillsdale Limestone

Reger (1926, p. 451, 487-491) named the Hillsdale Limestone for limestone containing black chert nodules that is exposed east of Hillsdale in Monroe County, West Virginia. Butts (1933, map) used the term St. Louis limestone for this formation. Cooper (1944, p. 158) considered the name Hillsdale Limestone to be more applicable in southwestern Virginia because of its proximity, lithology, and fossil content. The lower contact was mapped at the base of a thick-bedded, dark-gray limestone above Little Valley shales and shaly limestones. The upper contact was mapped at the top of dark-gray, cherty limestones below the oldest common occurrence of the distinctive elliptical columnals of *Platycrinus penicillus*.

The Hllsdale crops out along a single 100- to 250-yard-wide northeasterly-trending belt, which extends for about 5 miles (Plate 1). It is well exposed along slopes on the southeast side of the North Fork of the Holston River valley and along the northwest slopes of Smith Creek valley near Craigs Mill. Other outcrops are located on hill slopes in the middle of Horseshoe Bend and just southeast of nearby Riverview Church.

The Hillsdale on the west side of Horseshoe Bend (Section B) is about 275 feet thick. It consists mainly of light- to dark-gray, dense, fine-grained, partly cherty, fossiliferous limestone (R-4016). The chert is light-gray to black, at places may contain silicified fossils (Section C, unit 3), and is rounded to very irregular in shape. It may be scattered or in distinct rows parallel to bedding planes in the limestone. The chert commonly protrudes about half an inch on weathered surfaces. Some gray chert and a few limestone layers display a faint banding suggestive of algal material. Minor beds of oolitic and shaly argillaceous limestone are occasionally present. A faint sulfurous odor is emitted from freshly broken chips of some limestone layers.

Tabulate coral colonies and silicified horn corals are an aid in the identification of the Hillsdale. Brachiopods, gastropods, crinoids, and other fossils are abundant in some beds. The following fossils were collected from the Hillsdale: corals **Aulopora* sp., *Lithostrontionella prolifera* (Hall), **Syringopora virginica* Butts, and *Zaphrentis spinulosa* Miline-Edwards and Haime; brachiopods **Cleiothyridina* cf. *C. sublamellosa* (Hall), **Composita* ? sp., *Dictyoclostus burlingtonensis* (Hall), *Dictyoclostus inflatus* (McChesney), *Girtyella indianensis* (Girty), and *Spirifer leidyi* Norwood and Pratten; bryozoans *Cystodictya* ? sp., *Fenestrellina* sp., and *Tabulipora* sp.; the crinoid *Echinocrinus* sp.; *gastropods* * ? *Bellerophon* sp.; *Bellerophon sublaevis* ? Hall, and *Donaldina sp.;* the nautiloid *Michelinoceras* sp.; the pelecypod *Nucula* sp.; and algal-banded chert and limestone.

Ste. Genevieve Limestone

The Ste. Genevieve Limestone was named by Shumard (1859, p. 406) for limestone exposed along the bluffs of the Mississippi River from one to two miles south of Ste. Genevieve, Missouri. Precise correlation of rocks in Virginia with those of the Ste. Genevieve at its type locality is questionable (Weller, 1948, pl. 2; Cooper, 1944, p. 160; Cooper, 1948, p. 262). Butts (1940, p. 366-372), however, used the name Ste. Genevieve for rocks similar to those found in the mapped area (Plate 1). As no other suitable name is available, this interval is informally designated as Ste. Genevieve limestone. The lower boundary of the Ste. Genevieve was mapped above dark-gray, cherty limestones of the Hillsdale Limestone below the oldest common occurrence of *Platycrinus penicillus*. The upper contact with the

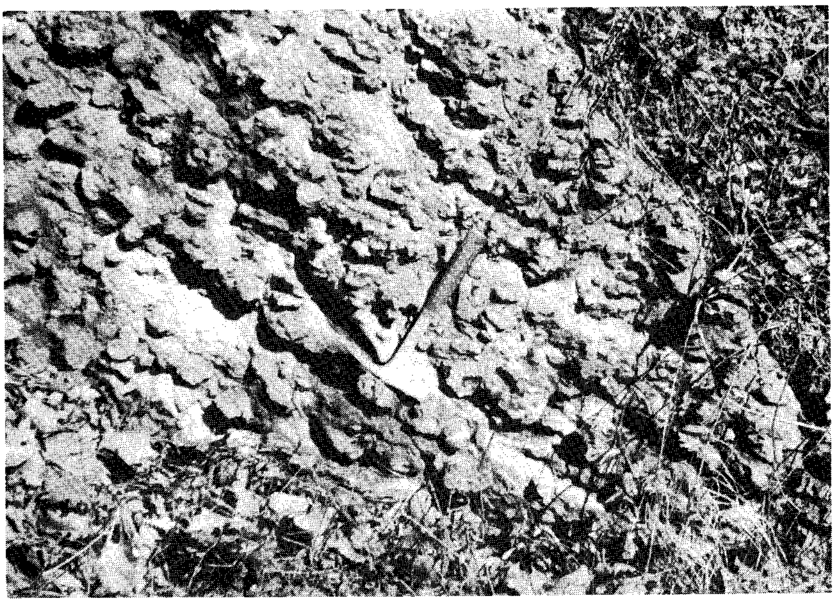

Figure 15. Fossiliferous chert nodules in crinoidal limestone of the lower part of the Ste. Genevieve limestone in east bank of State Road 622 along Nordyke Creek about 100 yards south of North Fork of Holston River.

Gasper limestone was placed at the top of a distinctive, 15- to 20-foot-thick bed of maroon crinoidal limestone (R-4021; Section C, unit 33). This bed has been previously used for mapping the Ste. Genevieve-Gasper boundary in the Greendale syncline (Butts, 1940, p. 369-370; Averitt, 1941, p. 17). This upper contact is also the youngest common occurrence of the Ste. Genevieve guide fossil *Platycrinus penicillus*, which consists of elliptical, spiny, crinoid columnals.

The Ste. Genevieve occurs south of the North Fork of the

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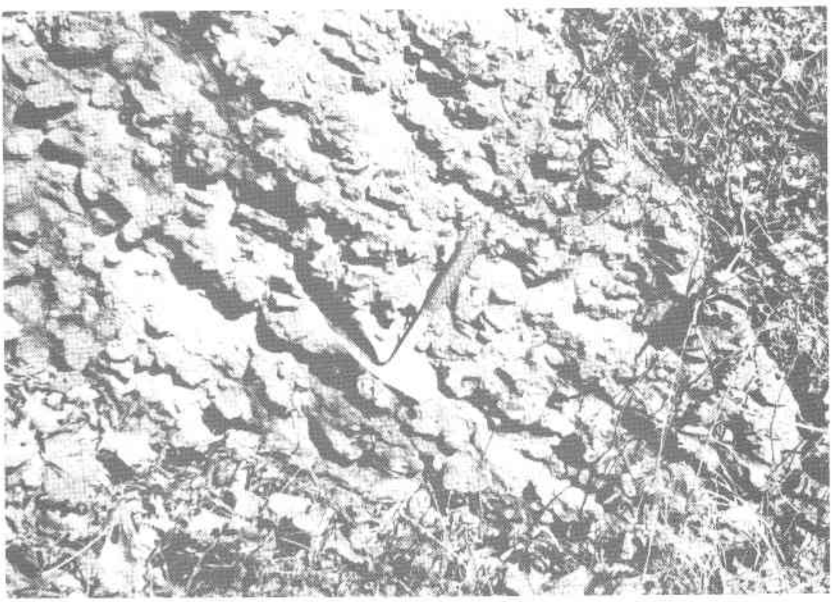

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The Ste. Genevieve occurs south of the North Fork of the

Holston River, where it underlies a hilly region with some large sinkholes (Plate 1). It is well exposed in Muddy Hollow along State Road 798 (Section C), in hillside outcrops about 0.5 mile east of Muddy Hollow (Section D), and along the south end of Horseshoe Bend (Section B). In Muddy Hollow the formation, 1205 feet thick (Section C), consists mainly of gray, argillaceous, shaly-weathering, medium-bedded limestone. Cherty limestone (Figure 15) is common in the lower 200 feet of the section (R-4018, R-4020); some beds are lithologically similar to the underlying Hillsdale, although the fauna differs. Beds of coarse-grained crinoidal limestone (R-4019) are abundant, particularly in the lower half of the section. Argillaceous, calcareous siltstone and very fine-grained sandstone (R-4017) occur in two to three thin units in various parts of the sequence. These clastic layers appear to increase in number and thickness toward the northeast.

Fossils in the Ste. Genevieve are found primarily in the crinoidal and cherty beds. The horn coral *Cystelasma quinquiseptatum* and the crinoid *Platycrinus penicillus* were considered by Butts (1940, p. 373) to be diagnostic of the Ste. Genevieve limestone. The following fossils were collected from the formation: brachiopods *Chonetes chesterenis* Weller, *Cliothyridina sublamellosa* ? (Hall), *Dictyoclostus burlingtonensis* (Hall), Girtyella indianensis (Girty), and **Reticulariina* ? sp.; bryozoans *Fenestrellina tenax* (Ulrich), *Glyptopora* sp., and *Polypora* sp.; corals **Cystelasma quinquiseptatum* Ulrich, **Uaphrentites* cf. *Z. spinulosa* (Milne-Edwards and Haime), and a tabulate coral (possibly *Syringopora* sp.); crinoids *Delocrinus* ? sp. and *Platycrinus penicillus* Meek and Worthen; and algal-banded chert, a blastoid, and a nautiloid.

Gasper Limestone

The Gasper Formation was named by Butts (1917, p. 64-84) for partly oolitic limestones exposed in bluffs along the Gasper River in Warren County, Kentucky. Sutton and Weller (1932, p. 430, 440-441) consider the formation to be inadequately defined; Weller (1948, Plate 2) and Cooper (1944, p. 164-165) also have questioned the usage of the name. Butts (1940, p. 375-378), however, used the name Gasper for rocks equivalent to those found in the map area (Plate 1). As no other suitable name is available, this interval is informally designated the Gasper limestone. The Gasper is bounded by the maroon, crinoidal limestone at the top of the underlying Ste. Genevieve limestone and by the dark, maroon sandstones of the overlying Fido Sandstone.

The thick limestone forms an outcrop belt that extends for nearly 8 miles across a hilly sinkhole-marked terrain on the northwest side of Caney Valley (Figure 2). Good exposures are present in Muddy Hollow along State Road 798 (Section C) and along an unnamed creek about one mile east of Muddy Hollow (Section D); respective thicknesses are 743 and 866 feet.

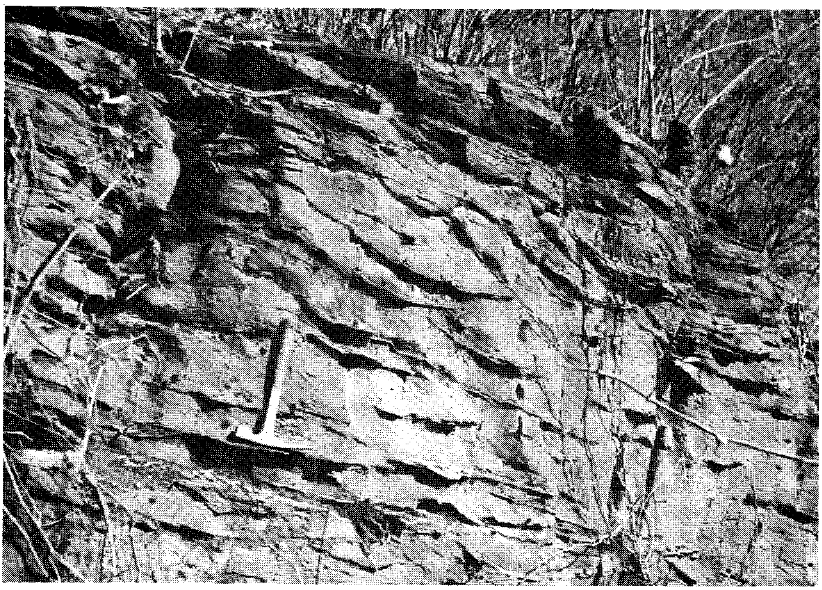

Figure 16. Crinoidal limestone that is cross-bedded in upper part of Gasper limestone; north side of State Road 622 along Nordyke Creek in Caney Valley.

The Gasper consists of uniformly light-gray, argillaceous limestone; thick beds weather to a crumbly, shaly appearance. The limestone beds are similar to those of the Cove Creek, and it would be difficult to differentiate them except for the intervening Fido sandstones and some lithologic varieties within the Gasper. Limestones that are pure and very fine-grained are interbedded throughout the formation. These commonly contain abundant crinoids (Figure 16), brachiopods, and blastoids (R-4022). The blastoids increase noticeably upward in the secal limestone at the top of the underlying Ste. Genevieve limestone and by the dark, maroon sandstones of the overlying Fido Sandstone.

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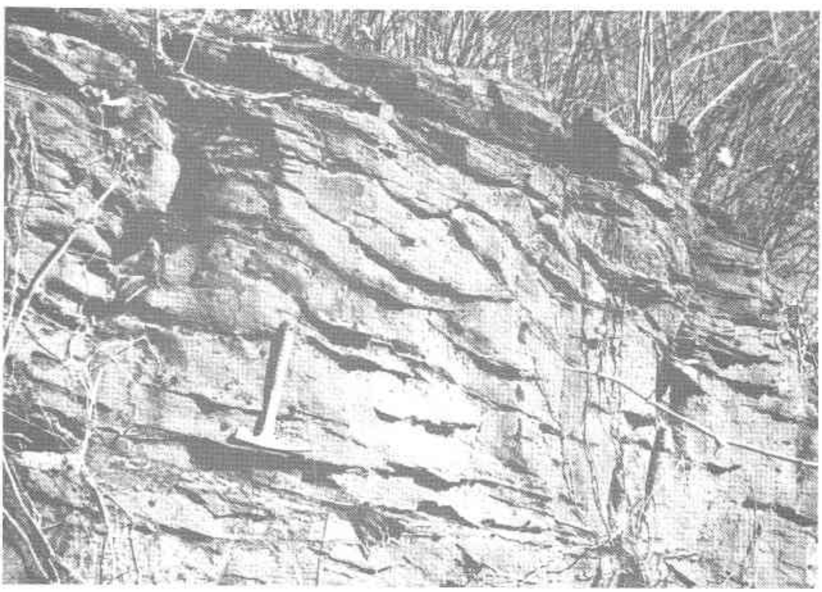

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The blastoid, *Pentremites,* indicates that the formation is of early Chesterian age (personal communication, J. T. Dutro, Jr., 1970). *Platycrinus penicillus,* the Ste. Genevieve guide fossil of Butts (1940, p. 373), was rarely found in these rocks. *Pterotocirnus serratus* was considered by Butts (1940, p. 380-381) to be indicative of Gasper age. The following fossils were collected: the brachiopod *Cliothyridina sublamellosa* (Hall); bryozoans *Fenestrellina tenax* (Ulrich) and *Septopora cestriensis* Prout; blastoids **Pentremites* sp. and *Pentremites planus* ? Ulrich; crinoids *Agassizocrinus* cf. *A. ovalis* Miller and Gurley, *Platycrinus penicillus* Meek and Worthen, and *Pterotocrinus serratus* Weller.

Fido Sandstone

The Fido Sandstone was named by Butts (1927, p. 16) for maroon sandstones exposed near the old post office of Fido, which is located on the adjoining Mendota quadrangle to the

Figure 17. Maroon Fido Sandstone that is cross-bedded; north side of State Road 616 about 300 yards west of Johnson Cemetery in Caney Valley.

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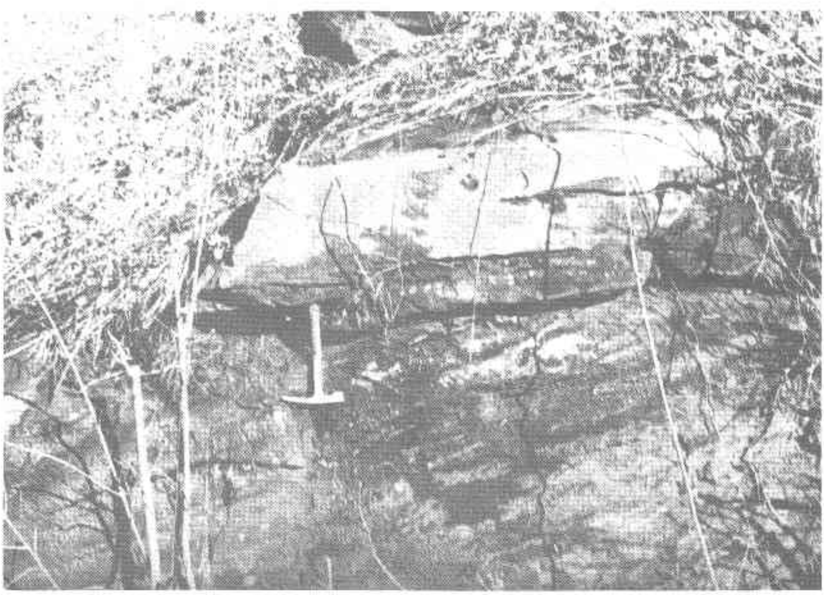

Figure 17. Maroon Fido Sandstone that is cross-bedded; north side of State Road 616 about 300 yards west of Johnson Cemetery in Caney Valley.

west and in the same structural belt as the Fido of the mapped area. The boundaries of this distinctive formation are placed at the top of the youngest maroon or brown sandstone and at the bottom of the oldest similar-type sandstone between the underlying Gasper and overlying Cove Creek limestones.

The Fido is easily recognized by dark-maroon outcrops between bounding gray limestones or by residual maroon soil. It is well exposed near the junction of State Roads 625 and 616 in the northeastern part of Caney Valley. Along Section D it is 53 feet thick, the lower 47 feet being dark brown and maroon, fine-grained, cross-bedded (Figure 17), calcareous, fossiliferous, thick-bedded sandstone (R-4024), and the upper 6 feet a mottled light-gray and maroon, argillaceous limestone (R-4025). The sandstone is friable and very porous where the calcareous cement and fossil fragments have been leached away.

Most fossils are fragmented or occur as poorly preserved molds in the sandstone. The brachiopod, **Reticulariina* cf. *R. spinosa* (Norwood and Pratten), confirms the early Chesterian age of the Fido (personal communication, J. T. Dutro, Jr., 1970). Other fossils include crinoid columnals and imprints of bryozoan fragments.

Cove Creek Limestone

Butts (1927, p. 16) named the Cove Creek for exposures of argillaceous limestones along Cove Creek on the adjoining Mendota quadrangle to the west. Exposures along Cove Creek are located in the same structural belt as those in the Wallace quadrangle. Its stratigraphic boundaries are distinguished by the underlying maroon sandstones of the Fido and the overlying interbedded shales and sandstones of the Pennington.

The Cove Creek Limestone forms an irregularly shaped pattern of outcrop along the steep slopes of the southeast side of Caney Valley (Plate 1), which includes a finger-like projection along Rattle Creek and its tributary, and an inlier in Vickers Hollow. The formation is poorly exposed because most of the limestone weathers to a crumbly, shaly residue. The Cove Creek consists primarily of light-gray to greenish-gray, argillaceous, thick-bedded limestones which have thin, brownish laminae on weathered surfaces (R-4026, R-4027). Drab, very light-gray, weathered surfaces are characteristic. Good exposures can be seen along Section E on Nordyke Creek and the adjacent

State Road 622 (Figure 18). Thickness of the Cove Creek ranges from approximately 1000 to 1200 feet.

Fossils are scarce in the formation except for thin beds in the middle portion containing crinoid stem fragments, the bryozoans *Fenestrellina* sp. and *Archimedes* sp., and the brachiopod *Spiriferina transversa* (McChesney).

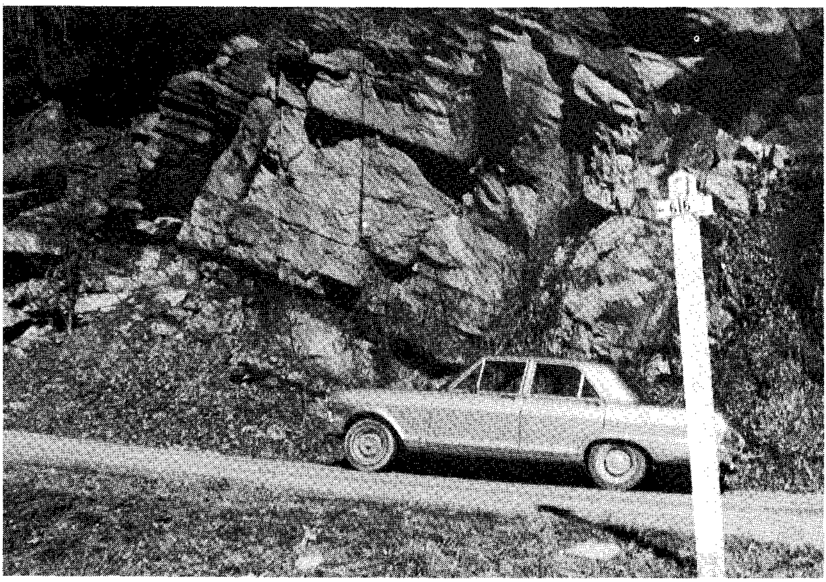

Figure 18. Thick-bedded Cove Creek Limestone along Section E at junction of State Roads 616 and 622.

Pennington Formation

The Pennington Formation crops out in a broad belt between Rich Valley and Caney Valley. The base of the formation was mapped below interbedded shales and sandstones and above argillaceous limestones of the Cove Creek Limestone. The youngest beds are covered by Cambrian, Ordovician, and Silurian rocks of the Saltville fault block; because of this cover a complete section of Pennington is not exposed. In good outcrops along Nordyke Creek (Section E) a partial section of the Pennington is at least 1335 feet thick. Another 350 feet of exposures (Section E) in an adjacent fault block to the south may be additional section. The lithology of the Pennington is the most variable of any of the geologic units mapped. It consists of com-

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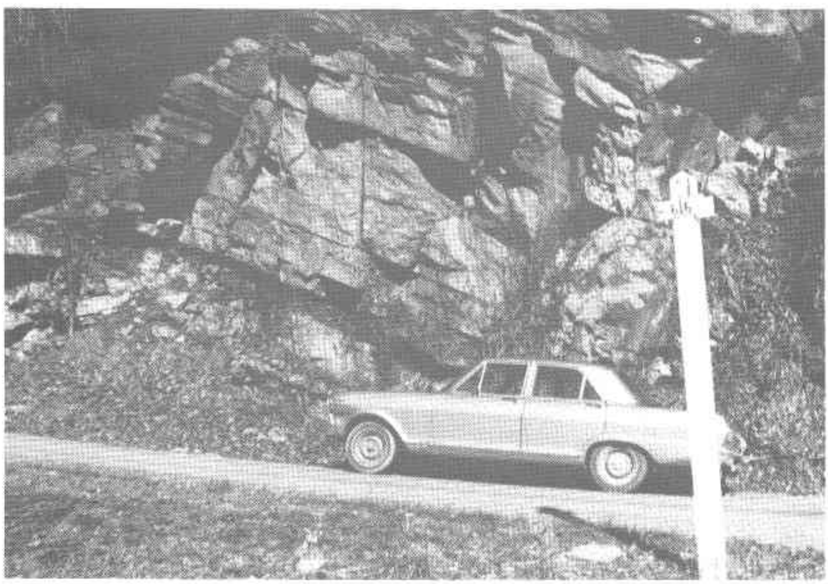

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The fossil content is as highly variable as its lithology. Fossils are most abundant in the lower, non-redbeds, especially in calcareous siltstones and sandstones and in the few limestones. Fossils provide the easiest means of differentiating the red shales of the Pennington and Rome where they are in fault contact. The brachiopods indicate a middle Chesterian age (personal communication, J. T. Dutro, Jr., 1970). The large tapered pelecypod *Sulcatopinna missouriensis,* found occasionally in the redbed upper portion of the Pennington, is indicative of Late Mississipian age (Butts, 1940, p. 401). Fossils that were collected include the following: the blastoid *Penetremites* sp.; brachiopods * *Anthracospirifer* cf. *A. leidyi* (Norwood and Pratten), **Chonetes* cf. *C. chesterensis* Weller, **Diaphragmus* aff. *D. elegans* (Norwood and Pratten), *Dictyoclostus burlingtonensis* (Hall), *Dictyoclostus parvus* Meek and Worthen, *Dicyoclostus scitulus* Meek and Worthen, *Dielasma* cf. *D. arkansanum* Weller, **Orthotetes* sp., **Ovatia* cf. *O. ovata* (Hall), and **Punctospirifer?* sp.; bryozoans *Archimedes* sp., *Fenestrellina serratula* (Ulrich), *Fenestrellina tenax* (Ulrich), *Polypora* sp., and *Tabulipora tuberculata* (Prout); the crinoid *Platycrinus penecillus* Meek and Worthen; pelecypods *Allorisma ?* sp., *Aviculopecten* sp., * ? *Grammysia* sp., *Posidonomya* ? sp., and *Solemya* ? sp.; **Lepido-*

dendron bark; plant seeds *Lagenostoma* or *Calymmatotheca* sp. (personal communication, R. E. McLaughlin, 1969); nautiloid fragments; and worm trails and borings.

QUATERARY SYSTEM

Flood plain alluvium as much as 50 feet thick is present along the North Fork of the Holston River; lesser thicknesses are found along many of the streams. It is composed mainly of unconsolidated clay with intermixed pebbles or subrounded cobbles of nearby bedrock types such as chert, limestone, and siltstone. Along the North Fork of the Holston River, it includes

Figure 19. Terrace levels about 0.4 miles upstream on south side from bridge of State Road 622 over North Fork of Holston River. House and barn are on upper terrace about 20 feet above river; lower terrace on field in foreground below buildings is about 10 feet above river; alluvial material is located at river margin.

numerous blocks of siltstone and sandstone from the Price, Clinton, and Tuscarora formations.

Two terrace deposits (Figure 19) were mapped as a single unit along the North Fork of the Holston River. The lowest, adjacent to the river, is about 10 feet above river level; the highest, farther back, is at about 20 feet. The deposits are not continuous *dendron* bark; plant seeds *Lagenostoma* or *Calymmatotheca* sp. (personal communication, R. E. McLaughlin, 1969); nautiloid fragments; and worm trails and borings.

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Two terrace deposits (Figure 19) were mapped as a single unit along the North Fork of the Holston River. The lowest, adjacent to the river, is about 10 feet above river level; the highest, farther back, is at about 20 feet. The deposits are not continuous along the river margins; at any given place there may be none, one, or two, but of the two the lowest is more often present. Their composition is similar to that of the floodplain alluvium. Adjacent to bedrock outcrops, the terrace material becomes coarser with the addition of colluvium. The deposits can be seen by looking southward from State Road 614 about 0.25 mile northeast of its junction with State Road 622.

Travertine, a porous precipitate of calcium carbonate, is found in some portions of the stream beds in and near Bristol. A particularly good deposit occurs along Beaver Creek in Monroe Park, just northwest of the junction of Valley Drive asd Old Abingdon Pike.

STRUCTURE

The major structural features consist of parts of the Greendale and Beaver Creek synclines and of the Saltville, Pulaski-Staunton, Spurgeon, and Bristol fault blocks; also unnamed subsidiary folds and faults are present. The formational outcrop belts and major fault traces are mostly aligned northeast-southwest; they generally have a southeasterly dip. The Bristol fault is anomalous to the others in that it has an arcuate fault trace, which has mainly southeasterly and westerly dips. The largest stratigraphic displacement of geologic units is about 16,000 feet along the Saltville fault trace, where the Cambrian Rome Formation is in contact with the Mississippian Pennington Formation. None of the fault planes are well exposed. The sinuous portion of the Spurgeon fault trace has been calculated to be inclined about 10 degrees. The relative straightness of most of the other fault traces, however, indicates that they have a steeper inclination.

GREENDALE SYNCLINE

The area northwest of the Saltville fault is within the northwestern limb of the Greendale syncline, which is one of the major regional structures extending through southwestern Virginia into northeastern Tennessee (Butts, 1933, map). Rocks exposed range in age from the Silurian Tuscarora Formation to the Mississippian Pennington Formation (Plate 1, cross-section B-B′). The rocks have an average southeasterly dip of 20 to 30 degrees except where affected by minor folding or where adjacent to faults. The major axis and eastern limb of the syncline are concealed beneath the Saltville thrust block. Portions of the Ste.

Genevieve through Pennington outcrop belts are faulted or folded in the eastern part of the area. Part of the Nordyke Creek syncline and the Wolf Run anticline (Averitt, 1941, p. 35-36) are present as subsidiary folds in the Pennington outcrop belt in the western part. These structures can be seen in exposures along roads paralleling Nordyke Creek (State Road 622) and Wolf Run (State Road 627). Other folds to the south of these appear to be extensions of the Abrams Falls syncline and Early Grove anticline (Averitt, 1941, p. 33-35).

Three normal faults were mapped in the Greendale syncline. Their traces trend about 60-80 degrees from the major structural features. The fault located across Caney Valley near Free Hill Church has a vertical displacement of about 40 feet; this displacement in the distinctive Fido Sandstone is quite apparent. The plane of the fault, which crosses the axis of the Nordyke Creek syncline, has a stratigraphic displacement of 41 feet and is inclined about 66 degrees to the southwest. It is exposed along the south side of State Road 622. The north-south orientation of many stream channels, and of the Holston River channel at Horseshoe Bend, is indicative of a well-developed fracture system in this direction. The fault crossing Nordyke Creek adjacent to the Saltville fault may be a thrust fault; its trace is mostly parallel to that of the Saltville.

SALTVILLE FAULT

The Saltville thrust fault, one of the major faults of the southern Appalachians extending from Virginia through Tennessee into Georgia (Cohee and others, 1961; Rodgers, 1953, Figure 5; Virginia Division of Mineral Resources, 1963), bounds the Greendale syncline on the southeast (Plate 1). Rocks are exposed in the Saltville fault block ranging from Cambrian Rome Formation into the Tuscarora Formation (Plate 1, cross-section C-C′). Except where adjacent to faults, these have an average southeasterly dip of about 25°. Along approximately two-thirds of the Saltville fault trace, the brecciated Cambrian Honaker Formation (R-4040) is in thrust contact with the Mississippian Pennington Formation; this is a stratigraphic displacement of about 16,000 feet. To the southwest of Benhams, displacement increases as the Cambrian Rome Formation overlies the Pennington Formation.

Northeast of Benhams the Saltville fault trace is almost straight; occasionally a few feet of fractured rock are exposed.

To the southwest brecciated beds (R-4038) are common and drag folds occur in older units of the upper plate of the Saltville fault block. Also the trace of the fault becomes undulatings which probably indicates a lower angle for the fault plane than to the northeast. Good exposures of the fault plane were not seen along its entire trace.

In the southwestern part of Rich Valley this block has several thrust slices containing Cambrian, Ordovician, and Silurian rocks (Plate 1). Near Benhams one slice has southeastward-dipping Honaker beds. Along the southwestern side the bounding fault trace of this slice has been offset by a normal fault. Ordovician beds in another slice near Lime Hill are structurally overturned to the northwest and north, with stratigraphically older beds overlying younger. A normal fault, affecting Honaker and Nolichucky rocks, is present southeast of Benhams.

PULASKI-STAUNTON FAULT

A structurally complex belt of Cambrian and Ordovician rocks (Plate 1) extends northeastward-southwestward through the middle of the mapped area. It is bordered on the northwest by the Pulaski-Staunton thrust fault, which is a regional structural feature extending from northern Virginia into Tennessee (Cohee and others, 1961; Rodgers, 1953, Figure 5; Virginia Division of Mineral Resources, 1963). It is covered by the Spurgeon fault block on the southeast (Plate 1, cross-section B-B′). Also, within this belt are two unnamed thrust faults, a syncline at Countiss Ridge, and an area of brecciated Honaker rocks. Along the northeastern part of the trace of the Pulaski-Staunton fault, the Cambrian Honaker Formation is thrust over the upper Knox group indicating a stratigraphic displacement of approximately 3000 feet. Displacement gradually increases southwestward along the fault trace to about 5000 feet approximately 0.5 mile south of the junction of Reedy Creek Road and Campground Road, where the Cambrian Honaker Formation is in fault contact with the Ordovician Athens shales. The incompetent shales of the Athens probably provided, in part, the surface along which the Pulaski-Staunton fault block moved in this area. The Honaker Formation is commonly brecciated, especially near fault traces. Deformation in some areas extends as much as 0.5 mile southeast of the fault trace. Some of these fractured rocks have been cemented with white calcite and dolomite. A normal fault, which offsets Honaker beds, is present in Dishner Valley and extends across Steele Creek.

A secondary fault in this complex belt joins the Pulaski-Staunton fault about one mile northeast of Three Springs. Though outcrops are scarce along the central portion of the trace, the position of scattered brecciated beds suggests that this fault is continuous to the Phillips Spring area. In its eastern portion this secondary fault is joined by another; as indicated in cross-section A-A′ (Plate 1) these faults probably merge at depth. Along these secondary faults, the Honaker is thrust upon Honaker Formation. Though exposures are lacking to determine the inclination of the fault plane, the sinuous trace of the Pulaski-Staunton fault suggests a more gentle dip than that of the secondary associated faults.

A portion of an unnamed asymmetric syncline in which Honaker and Nolichucky formations are exposed is present in the Countiss Ridge area (Plate 1, cross-section A-A′). The southeastern limb is the steeper. The axis of this structure can be traced from the east edge of the map southwestward for about 3.5 miles, and northeastward about 3 miles. A partial section of 260 feet of lower Nolichucky shales and limestones is present in the trough (Section J). Structural reversal along the axial plane of this feature can be seen along State Road 625 where it intersects Countiss Ridge. The rough topography underlain by the Nolichucky Formation depicts the position of this structure.

SPURGEON FAULT

The southeastern third of the map area is underlain primarily by two large fault blocks with associated secondary faults (Plate 1). The northern block is bounded on the northwest by the Spurgeon fault; this fault extends from Tennessee into Virginia (Rodgers, 1953, Figure 5). The southern block is bounded by the Bristol fault, which is peripheral to the Bristol city limits. The southern block in part overlies the northern.

Along the southwestern two-thirds of the Spurgeon fault, Middle Cambrian Honaker beds are in contact with Upper Cambrian Conococheague rocks (Plate 1, cross-section B-B′). The minimum stratigraphic displacement near the western boundary of the Wallace quadrangle is about 1200 feet. Displacement increases northeastward toward the mid-portion of the trace to near 2000 feet; farther to the northeast this decreases to as little as 500 feet north of Wallace. From the highly sinuous trace of the fault plane its inclination was computed to be about 10 degrees southeasterly. The abrupt termination of steep topography at the east end of Big Ridge depicts the position of the Spurgeon fault trace where Honaker dolomites have been thrust over Nolichucky carbonates and shales; the distinct topography is produced by erosional differences between these units (Figure 20). Just northwest of the area where the Spurgeon fault trace crosses Campground Road (State Road 641), there is a reversal of dip in Conococheague beds. Frictional drag along the lower plate, during fault movement, could have formed this reversal by

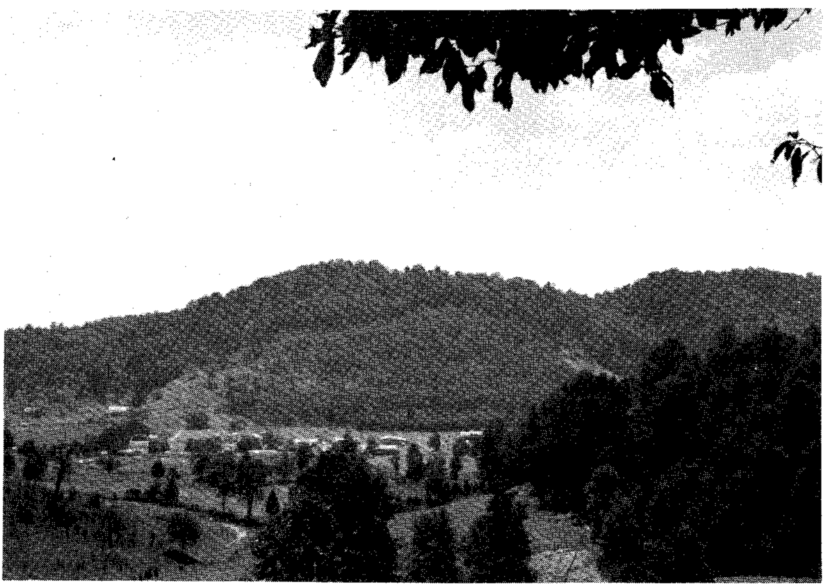

Figure 20. Topography of Big Ridge; the crest is supported by resistant beds of the Nolichucky Formation. The ridge is terminated on the left side (east) where the Nolichucky is covered by the Spurgeon fault block; fields and hills in foreground are underlain by Honaker Formation of this block.

rotating these beds from a southeastern inclination to that of a northwestern one. Along State Road 680 north of Bristol, good exposures of fractured beds occur along the Spurgeon fault.

Near Clayman Ridge the Spurgeon fault is joined by a secondary thrust, which extends northeasterly about subparallel to the east margin of the map. The distance between these traces as 500 feet north of Wallace. From the highly sinuous trace of the fault plane its inclination was computed to be about 10 degrees southeasterly. The abrupt termination of steep topography at the east end of Big Ridge depicts the position of the Spurgeon fault trace where Honaker dolomites have been thrust over Nolichucky carbonates and shales; the distinct topography is produced by erosional differences between these units (Figure 20). Just northwest of the area where the Spurgeon fault trace crosses Campground Road (State Road 641), there is a reversal of dip in Conococheague beds. Frictional drag along the lower plate, during fault movement, could have formed this reversal by

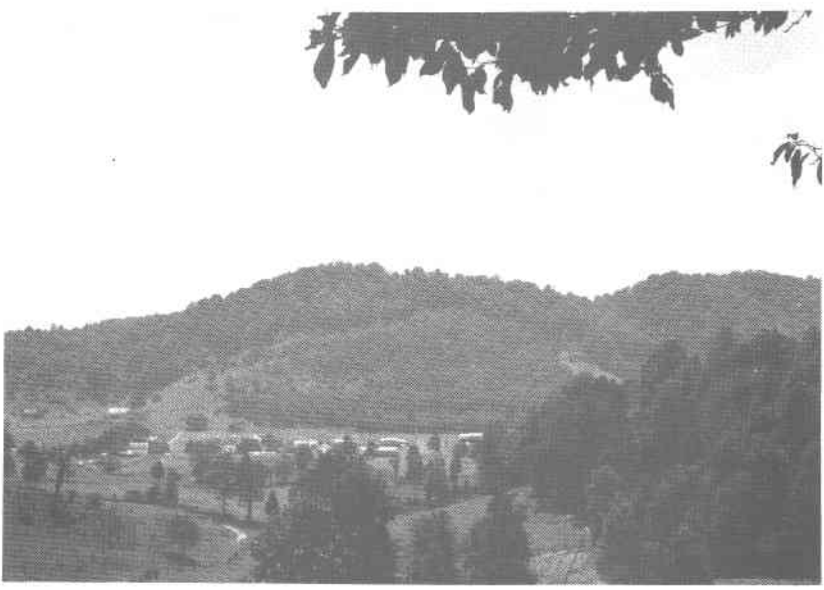

Figure 20. Topography of Big Ridge; the crest is supported by resistant beds of the Nolichucky Formation. The ridge is terminated on the left side (east) where the Nolichucky is covered by the Spurgeon fault block; fields and hills in foreground are underlain by Honaker Formation of this block.

rotating these beds from a southeastern inclination to that of a northwestern one. Along State Road 680 north of Bristol, good exposures of fractured beds occur along the Spurgeon fault.

Near Clayman Ridge the Spurgeon fault is joined by a secondary thrust, which extends northeasterly about subparallel to the east margin of the map. The distance between these traces increases northeastward to a maximum of about 0.75 mile. Honaker is overlain by Honaker Formation along this fault. As depicted on cross section A-A′ (Plate 1), this secondary fault probably merges at depth with the Spurgeon; its less irregular trace is evidence that the fault plane has a steeper inclination than that of the Spurgeon fault. Honaker rocks that are located between these faults have been highly shattered, tightly folded, and brecciated, especially near the Spurgeon fault trace (R-4050). Exposures of dolomite breccia and gouge partly cemented by calcite are present for 0.3 mile along State Road 640 about 0.5 mile south of Oak Grove. Breccia or shattered rock alternates

Figure 21. Brecciated dolomite (at and above hammer handle) sandwiched between relatively undisturbed thin-bedded dolomite in the Honaker Formation at the Spurgeon fault trace; 0.5 mile south of Oak Grove near tributary of Mumpower Creek behind a house.

with beds that appear relatively undisturbed in some outcrops; movement appears to have been by sliding along bedding planes (Figure 21).

An unnamed thrust fault is located south of Interstate 81, in the southeastern corner of the mapped area. Maximum stratigraphic displacement mapped is on the east end of the fault increases northeastward to a maximum of about 0.75 mile. Honaker is overlain by Honaker Formation along this fault. As depicted on cross section A-A′ (Plate 1), this secondary fault probably merges at depth with the Spurgeon; its less irregular trace is evidence that the fault plane has a steeper inclination than that of the Spurgeon fault. Honaker rocks that are located between these faults have been highly shattered, tightly folded, and brecciated, especially near the Spurgeon fault trace (R-4050). Exposures of dolomite breccia and gouge partly cemented by calcite are present for 0.3 mile along State Road 640 about 0.5 mile south of Oak Grove. Breccia or shattered rock alternates

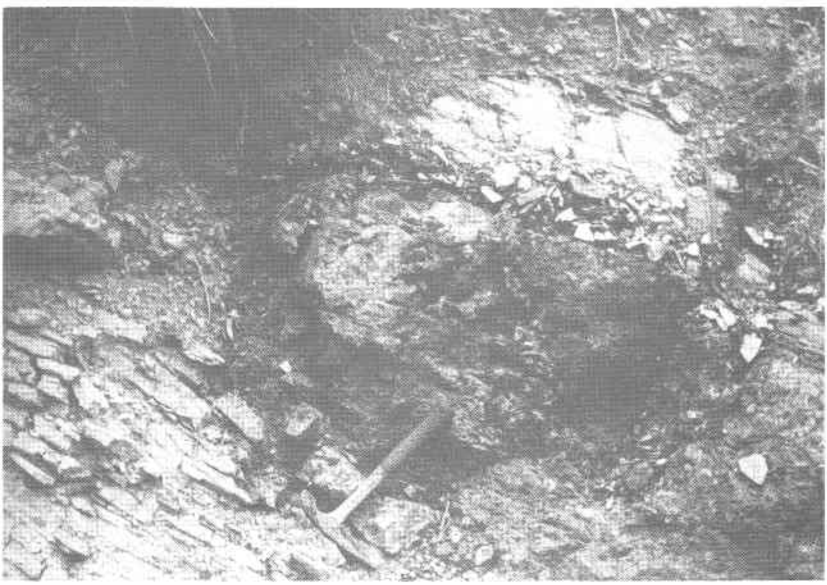

Figure 21. Brecciated dolomite (at and above hammer handle) sandwiched between relatively undisturbed thin-bedded dolomite in the Honaker Formation at the Spurgeon fault trace; 0.5 mile south of Oak Grove near tributary of Mumpower Creek behind a house.

with beds that appear relatively undisturbed in some outcrops; movement appears to have been by sliding along bedding planes (Figure 21).

An unnamed thrust fault is located south of Interstate 81, in the southeastern corner of the mapped area. Maximum stratigraphic displacement mapped is on the east end of the fault

Figure 22. Vulcan Materials Company quarry (Plate 1, No. 11); contorted, steeply dipping Chepultepec limestone is thrust over gently inclined Lenoir-Mosheim Limestone. Fault trace is located in photograph about 0.25 inches above automobile.

Figure 22. Vulcan Materials Company quarry (Plate 1, No. 11); contorted, steeply dipping Chepultepec limestone is thrust over gently inclined Lenoir-Mosheim Limestone. Fault trace is located in photograph about 0.25 inches above automobile.

where the upper Knox group is overlain by the Athens Formation. Displacement decreases and terminates to the southwest where Knox is adjacent to Knox. To the southwest of this fault are several small folds in lower Ordovician rocks.

In the vicinity of Shakesville, Lower and Middle Ordovician rocks are folded into a narrow, mainly northeasterly-southwesterly trending syncline (Plate 1, cross-section B-B′). Part of the western limb of this structure is covered by the Bristol fault block, and by an adjacent small fault block located across the State boundary. The axial plane of this syncline, where adjacent to these fault blocks, changes direction to about north-south. This fold is nearly symmetrical with generally moderate dips on both limbs. Incompetent shales of the Athens Formation are exposed in the axial portion of the syncline. These are partially foliated and the bedding is deformed by minor folds. Reversal of dip at the trough of this structure can be seen along King Mill Pike (State Road 647).

In the small fault block, extending across the State boundary, Lower Ordovician rocks overlie Middle Ordovician ones. The west side of this block is covered by the Bristol fault block (Plate 1). Though the bounding fault trace trends from the Virginia-Tennessee State line northwesterly across the structural grain of the overthrust rocks, structural attitudes are similiar to those in the overthrust rocks. Folding and faulting are well exposed in two fensters depicted in quarries of the Vulcan Materials Company. In the larger quarry (Plate 1, No. 11) well-exposed, fossiliferous limestone beds of the Chepultepec Formation overlie Lenoir and Mosheim limestones (Figure 22); the latter beds are inclined about 13 degrees to the southeast. The fault plane, which is exposed in the quarry walls, is inclined less than 15 degrees to the southwest. The stratigraphic displacement is about 1000 feet. Thrusting appears to have come from the southwest.

BRISTOL FAULT

The fault block in the southern part of the map area, which is bounded by the Bristol fault, has an arcuate trace which extends from Tennessee into Virginia, and then back into Tennessee (Rodgers, 1953, Figure 5, p. 137). The fault plane probably underlies the city of Bristol (Plate 1, cross-section C-C′). The trace is aligned with the regional structural trend on the northwest side of the fault block. On the eastern side it crosses this trend, which probably indicates that the Bristol fault block was folded either before or during the fault movement and not afterwards. Cambrian Honaker to Ordovician upper Knox rocks that are exposed in the fault block have been folded into the southwestward-plunging Beaver Creek syncline. The youngest beds at the State line are those of the upper Knox group. The axis of this syncline has been displaced by two minor thrust faults. The Bristol and Spurgeon fault traces converge to the southwest; at the map margin they are only about 400 feet apart geographically.

Geologic units adjacent to the fault block range in age from Middle Cambrian to Middle Ordovician. The stratigraphic displacement along the northwest portion of the Bristol fault trace ranges from about 600 to 1200 feet; in the eastern portion this increases southward to about 4000 feet. In order to determine the relative direction of movement of this block, lithologies of the Nolichucky Formation within the fault block were compared with those in the other mapped structural belts. Lithologies of this formation within the block most closely resembled lithologies in structual belts to the northwest. The Nolichucky in the structual belt located to the south of Wallace, which is partly overlain by the Bristol fault block, is dissimilar as it is thinner and has a greater percentage of carbonate beds. These observations indicate that the relative movement of the block may have been toward the northeast. Campbell (1899, p. 6) in his regional study of this area, also suggested a northeast direction of movement.

BEAVER CREEK SYNCLINE

The Bristol fault block has been folded into a large broad structure, herein called the Beaver Creek syncline. This structure underlies the city of Bristol and extends from just north of Interstate Highway 81 southward into Tennessee. The syncline plunges to the southwest with exposed rocks ranging in age from Cambrian Honaker to Ordovician upper Knox (Section M; Plate 1; cross-section C-C′). As previously mentioned in the discussion of the Bristol fault, this structure was probably folded either before or during the time of emplacement of the fault block.

In the northern part of the syncline the axis is offset by secondary thrust faults, with displacements in Cambrian rocks as much as 100 feet, producing a shingle-block structure (Campbell, 1925, p. 33-34). This offset probably indicates an additional stage of deformation after folding. In the Virginia Heights-Spring Garden area of Bristol the traces of these faults are well marked by the abrupt terminations of topography underlain by the Nolichucky Formation in the overthrust blocks. The hilly terrain in Bristol, Virginia, is produced by resistant dolomite, shale, and sandstone beds of Cambrian rocks. The subdued area, which includes the commercial district of the city, is underlain by less resistant Ordovician carbonates.

ECONOMIC GEOLOGY

Crushed stone is produced from limestones in the Bristol quadrangle; in the past, carbonate decorative-stone and shale for building roads have been quarried. Pure and impure limestone and dolomite, carbonate rock and sandstone for decorative stone, sandstone potentially useful for glass sand, sand and gravel, and shale potentially useful for brick are available adjacent to a transportation network of roads and railways. Similarities to nearby present- and past-productive areas indicate possible occurrences of gas, oil, barite, gypsum, anhydrite, and salt.

INDUSTRIAL LIMESTONE AND DOLOMITE

The Vulcan Materials Company, Midsouth Division, produces crushed stone from the Bristol quarry about 0.5 mile east of Bristol (Plate 1, No. 11). The first rock quarried was from fine-grained, dark-gray, broken and folded, Chepultepec limestone which overlies and is in fault contact with similar Lenoir-Mosheim limestone (Figure 22) ; currently, the Lenoir-Mosheim is being quarried.

In the past, crushed stone has been produced from limestone and dolomite of the Honaker Formation (Plate 1, Nos. 6-7), the Conococheague Formation (No. 8), the Chepultepec Formation (No. 9), and the Lenoir-Mosheim limestones (No. 10). All five quarries have additional reserves. Physical tests of sampled rocks from other localities that are potential sources of coarse crushed-stone aggregate are listed in Table 2.

Table 2. — Physical tests of aggregate samples (data modified from Parrott, 1954; Gooch, Wood, and Parrott, 1960).

Type Rock (Geologic Unit)	Location	Specific Gravity	Absorption	Los Angeles Abrasion	Loss Grading	Soundness	Bituminous Adhesion Weight	Est.
limestone (Chepultepec)	Lat. 36°37′20″ Long. 82°09′00″	2.75	0.56	30.1	A	—	91	99
dolomite (Honaker)	Lat. 36°36′30″ Long. 82°13′00″	2.84	0.36	22.1	A	—	80	95
limestone (Hillsdale-Ste. Genevieve)	Lat. 36°43′30″ Long. 82°14′30″	2.67	0.16	28.1	A	OK	96	98
dolomite (Honaker)	Lat. 36°36′15″ Long. 82°14′30″	2.82	0.67	36.1	A	OK	73	95
dolomite (Honaker)	Lat. 36°39′00″ Long. 82°14′45″	2.75	1.29	24.1	A	OK	—	—
dolomite (Honaker)	Lat. 36°40′10″ Long. 82°08′30″	2.84	0.25	29.1	A	OK	—	—
dolomite (Knox group, upper part)	Lat. 36°36′20″ Long. 82°07′35″	2.73	0.36	21.1	A	OK	100	100
limestone (Chepultepec)	Lat. 36°36′17″ Long. 82°08′9″	2.76	0.41	26.1	—	—	—	—

More than half of the mapped area is underlain by limestone and dolomite. Large amounts of pure limestone occur in the Mosheim Limestone and Middle Ordovician, undivided, unit. About 1.5 miles northeast of Three Springs the Mosheim contains about 270 feet of pure limestone; along Section F northeast of Lime Hill the Middle Ordovician contains about 90 feet. Scattered intervals of pure limestone are also present in the Gasper, Ste Genevieve, Chepultepec, and Conococheague formations. Pure dolomite beds are scattered through the Knox group, upper part, and Copper Ridge and Honaker formations from Walker Mountain southward to Bristol. Significant amounts of potentially commercial impure siliceous limestone and dolomite of Mississippian age is present in the Caney Valley and North Fork Holston River areas, and of Cambro-Ordovician age in Rich Valley and southeast of Walker Mountain.

In the past, decorative building-stone from the Middle Ordovician unit has been quarried about 4 miles northwest of Bristol (Plate 1, Nos. 1, 2). It consists of a pink, gray, and brown, coarse-grained limestone with abundant fossils, which is about 90 feet thick in the vicinity of quarry number 2 along Section F, and about 100 feet thick along Section G. The proximity of this limestone to Bristol as well as to the nearby Southern Railway and U. S. Highways 58 and 421 should be a consideration for future commercial development. Other potentially commercial decorative stone includes maroon, crinoidal limestone at the top of the Ste. Genevieve limestone and the gray, oolitic limestone near the middle of the Nolichucky Formation. The maroon Ste. Genevieve limestone, located in the belt to the northwest of Caney Valley, is 15 feet thick along Section C and 36 feet in Section D. The gray Nolichucky limestone, which extends along the northern slopes of Walker Mountain, is about 20 feet thick in Section H.

SHALE

Shale samples from two localities show potential use for common brick (Table 3). Several small quarries in the Nolichucky Formation adjacent to State Roads (Figure 7) have produced shale for road building (Plate 1, Nos. 3, 4, 5, 7). Several other small shale quarries are scattered through the area. Potentially commercial shale is available from the Millboro Shale and Brallier Formation in Poor Valley, the Pumpkin Valley Shale of Rich Valley, the Athens Formation along the

Pulaski-Staunton fault, and the various belts of Nolichucky Formation peripheral to Bristol and along the northwest side of Walker Mountain. All are within 6 miles of either an interstate highway or a railroad. The Pumpkin Valley Shale along Section F has about 190 feet of shale; the Athens Formation in the vicinity of Campground Road (State Road 641) about 180 feet; the Nolichucky Formation near Bristol from 70 feet (Section K) to 140 feet (Section M) and 140 feet at quarry number 3. The

Table 3—Potential uses of clay materials from the Bristol and Wallace quadrangles (data compiled from Johnson, Denny, and Le Van, 1966).

Repository Number	Location	Formation	Sampled Interval	Potential Use
R-2517	Roadcut, 1.0 mile east of Benhams, on the south side of State Road 640 about 0.4 mile by road west of the intersection with State Road 622.	Nolichucky	Across 12 feet of weathered shale	Common brick
R-2518	Roadcut, 2.3 miles northeast of Benhams, on the northwest side of State Road 700 about 0.3 mile by road northeast of intersection with State Road 622.	Pennington	Composite of fresh and weathered shale and siltstone samples across 85 feet	Common brick

Countiss Ridge belt of the Nolichucky Formation, about 2 miles due north of Wallace, is especially significant as 120 feet of shale (Section J) is exposed on the northwest limb of a shallow syncline; both limbs of this structure are adjacent to State Road 625.

SANDSTONE

Sandstone is restricted primarily to Silurian and Mississippian rocks along Clinch and Little mountains and in upper Mississippian rocks adjacent to the Saltville fault. An exposure of Fido Sandstone in Caney Valley about 0.5 mile southeast of the south end of Muddy Hollow near State Road 616 is a potential source of coarse road aggregate (Parrott, 1954, p. 64). Its physical characteristics are: specific gravity 2.73; absorption 0.93; Los Angeles Loss, abrasion 24.5, grading A; soundness OK. About 50 feet of fine-grained, maroon to brown Fido sandstone is present along Section D. A quartz conglomerate and conglomeratic sandstone in the uppermost part of the Chemung Formation along the northwest base of Little Mountain may have potential use as decorative-stone. A typical outcrop is at Robinette Gap where it is 7 feet thick (Figure 14). Sandstone and siltstone, which might be used as crushed stone for roads, occur in the Pennington and Price formations. The Pennington has sandstones as much as 40 feet thick (Section E) and the Price as much as 75 feet (Section A). Some white to gray, friable, iron-free sandstone is present along the southeast side of Clinch Mountain in the Tuscarora Formation. Five to six miles to the southwest of the map area, similar sandstone has been quarried for making glass, ferrosilicon, and ceramic products (Gildersleeve and Calver, 1945); this quarry is now inactive. Sand and gravel supplies are present as terrace and alluvium deposits along the North Fork of the Holston River.

GAS AND OIL

The mapped area does not have gas or oil production to date. The Holston Oil and Gas Company drilled a test hole on the W. E. Leonard farm by cable-tool methods about 1910 to a total depth of approximately 2600 feet (Averitt, 1941, p. 40). The hole is about 2 miles northwest of Benhams at the mouth of Leonard Hollow. Drilling began in the Pennington Formation on the northwest side of the Nordyke Creek syncline. At a depth of about 650 feet an aquifer was encountered, which produced an artesian flow to about 30 feet above the ground level (personal communication, D. Leonard, 1969).

The abandoned Early Grove gas field is located about 3 miles to the west in the Mendota quadrangle within the structural belt that extends into the mapped area. Wells produced gas from several sandstones in the Little Valley Formation from the Early Grove anticline; the sandstones had an average porosity of 1.6 percent and a permeability of 0.00285 millidarcys (Averitt, 1941, p. 38). The deepest test in the field was the Tidewater Oil Company and Wolfs Head Oil and Refining Company hole on the E. D. Smith farm, which was drilled to a total depth of 7222 feet into the Ordovician Juniata Formation; gas shows were present in Little Valley sandstones and an oil show in a Tuscarora sandstone.

Much additional drilling is needed to test the commercial gas and oil potential of this area. Test wells located on structural highs within beds of sufficient permeability and porosity could encounter economic production in sandstones, limestones, and shales of Ordovician to Mississippian age. Of especial interest would be tests to the Little Valley Formation and deeper horizons along structures extending from the Early Grove area, particularly along the Wolf Run anticline. Exploration drilling along the northwest edge of the Saltville fault could test possible anticlinal structures for fault traps present below the fault plane.

MISCELLANEOUS MINERALS

Along the North Fork of the Holston River, Withington (1965, p. B-31) has postulated possible subsurface mineral deposits of gypsum, anhydrite, and salt within the area adjacent to the Saltville fault. As ground water in areas of anhydrite and gypsum may show high amounts of sulfate, abnormal concentrations noted from springs and other surface waters could localize sites for exploratory drilling. There is production of these minerals about 15 miles to the northeast of Plasterco and Saltville within a structural belt extending into the map area.

Just east of the mapped area, adjacent to State Road 658, barite nodules are present in the Athens Formation (personal communication, J. Fagan, 1970). The community of Barytes, just northeast of Bristol, in the early 1900's was the site of a barite-grinding plant for materials from outside the Wallace and Bristol, Virginia quadrangles (Watson, 1907, p. 325, Plate XLIX).

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APPENDIX

STRATIGRAPHIC SECTIONS

Detailed tabulations of the thickness and lithologic descriptions of more than 30,000 feet of exposed rock units are described as stratigraphic sections A through N (Plate 1). Additional sections were measured and described in the map area and in adjacent qaudrangles for further stratigraphic control. Most geologic units in the various fault blocks are included. The fossils that were used to assist in determining the stratigraphic position and age of the rocks are listed with the numbered units in which they were found. Most specific fossil identifications were by paleontologists of the Paleontology and Stratigraphy Branch, U. S. Geological Survey, Washington, D. C.; collection numbers for fossils retained by them are indicated USGS 24071-PC or similarily. Stratigraphic positions of representative rock samples placed in the Virginia Division of Mineral Resources rock repository are indicated by numbers preceded by "R" in parentheses (R-4012).

Section A: Wooten Gap

From north end of Wooten Gap in Little Mountain southward through gap along State Road 623 to North Fork of Holston River (Figure 3); strike N. 70° E., dip 26° SE. (Note: Line of section should extend approximately 0.1 mile farther north than shown on Plate 1.)

		Thickness Feet
Price Formation (564 feet; additional upper few feet covered by river bed)		
25	Sandstone, argillaceous, gray, very fine-grained, thin- and medium-bedded	77
24	Siltstone, argillaceous, gray	24
23	Siltstone, gray, medium- and thick-bedded	11
22	Sandstone, glauconite, green, very fine-grained; four species of brachiopods (*Spirifer* cf. *S. striatiformis* Meek, *Punctospirifer* sp.), two of bryozoans, and one of pelecypods	1
21	Siltstone, gray	8
20	Siltstone, glauconitic, green; contains some brachiopod and bryozoan fragments	5
19	Shale, silty, gray, and gray siltstone	12
18	Shale, gray, and green, glauconitic siltstone; in three layers, 3-6 inches thick	5
17	Siltstone, shaly, gray, thin-bedded; possibly small fault	10
16	Siltstone and sandstone, brown, very fine-grained, hematitic; brachiopods and bryozoans (R-4012); thin partings of green, micaceous, silty, glauconitic shale which contains bright-green, very fine- to fine-grained, rounded glauconite grains	5

		Thickness Feet
15	Siltstone and shale; partly covered	46
14	Sandstone, glauconitic, green, fine-grained; bryozoan fragments	1
13	Siltstone and sandstone, dark-gray, very fine-grained, medium-bedded	9
12	Siltstone, dark-gray, thin-bedded	18
11	Shale, silty, gray; a few beds of thin-bedded, gray, shaly siltstone	82
10	Covered; silty shale chips in soil	250
Big Stone Gap Shale (10 feet)		
9	Shale, fissile, black; contains the conodonts *Hindeodella* sp. , *Prioniodina* sp. , *Siphonodella duplicata* Branson and Mehl, *Spathognathodus* sp. , and *Synprioniodina* sp. (USGS 24071-PC), the brachiopod *Orbiculoidea* sp. (USGS 24071-PC); carbonized plant fragments (Cordaitean stems), and spores	10
Chemung Formation (131 feet)		
8	Sandstone, light-gray, mostly fine- to medium-grained; lenticular bed of quartz-pebble conglomerate up to 1-foot thick near top	9
7	Shale and sandstone, gray, fine- to medium-grained, thin-bedded	11
6	Sandstone, silty, light-gray, very fine-grained	3
5	Shale, light greenish-gray; interbeds of gray siltstone, approximately 1-foot thick spaced about every 5 feet (R-4010); three species of brachiopods including "*Leiorhynchus*" *mesicostale* (Hall)	40
4	Siltstone, gray, thin- to medium-bedded; five species of brachiopods including *Chonetes* cf. *C. scitulus* Hall, *Cyrtospirifer* aff. *C. disjunctus* (Sowerby), and *Leiorhynchus*? sp.	2
3	Shale, silty, micaceous, light greenish-gray; thin interbeds of greenish-gray, argillaceous siltstone; fauna includes two species of brachiopods, *Chonetes* cf. *C. scitulus* Hall, "*Leiorhynchus*" *mesicostale* (Hall), and two of pelecypods	66
Brallier Formation (upper part, 33 feet)		
2	Covered; could be lower Chemung Formation in part	31
1	Siltstone, gray, thin-bedded; exposed in creek bed	2

Section B: Horseshoe Bend

From north end of Horseshoe Bend to its south end at the North Fork of the Holston River; N. 70° E., dip 25° SE.

Ste. Genevieve limestone (upper part, 366 feet)		
51	Limestone, sandy, light-gray, wavy-laminated, massive-bedded; causes rapids in river	10
50	Limestone, gray, thinly laminated	12
49	Limestone, crinoidal, gray-brown, coarse-grained; partly siliceous	16
48	Limestone, shaly, gray, dip 20° SE	6
47	Limestone, crinoidal, gray, coarse-grained	1
46	Covered for the most part; contains some very fine-grained, brown sandstone	19

		Thickness Feet
45	Limestone, crinoidal, gray, coarse-grained	1
44	Limestone, gray, very thin-bedded	4
43	Limestone, oolitic, light-gray, coarse-grained, thick-bedded	2
42	Limestone, light-gray, medium- to thin-bedded; bryozoans; mostly covered	42
41	Covered	190
40	Limestone, cherty, gray, dense, thick-bedded; abundant light-gray chert nodules; abundant bryozoans and some silicified horn corals	21
39	Covered; may be partly Hillsdale Limestone	42
Hillsdale Limestone (275 feet)		
38	Limestone, cherty, light-gray, fossiliferous; irregular-shaped chert nodules	59
37	Limestone, light-gray, dense	21
36	Limestone, gray, fossiliferous; partly covered	30
35	Limestone, shaly, gray; bryozoans	3
34	Limestone, cherty, dark-gray, dense; abundant black chert nodules	5
33	Limestone, gray; light-gray to black, irregular-shaped chert nodules; very fossiliferous zones	70
32	Limestone, gray to dark-gray, medium-bedded; fossils include bryozoans, productid brachiopods, and colonies of the tabulate coral *Syringopora virginica* Butts (R-4016)	79
31	Limestone, light-gray, fine-grained, medium-bedded	8
Little Valley Formation (570 feet)		
30	Limestone, shaly, and light-gray to gray, calcareous shale; fossiliferous	108
29	Limestone, argillaceous, gray	1
28	Shale, fissile, dark-gray to black; dense, siliceous; hematitic layers near base; very fossiliferous including five species of brachiopods, four of pelecypods, one of bryozoans, one of ostracods, and carbonized plant stems	41
27	Limestone, gray, medium-bedded; very fossiliferous including the brachiopods *Anthracospirifer* ? sp. , *Inflatia* sp. , *Punctospirifer* cf. *P. transversa* (McChesney), and *Syringothyris* cf. *S. textus* (Hall) ; the pelecypods *Aviculopecten* sp. , ? *Nuculites* sp. , and *Wilkingia* sp. ; the ostracod ? *Paraparchites* sp. ; bryozoans; crinoid stems; and nautiloids	2
26	Limestone, gray, thin-bedded	19
25	Shale, grayish-brown; some argillaceous limestone	19
24	Limestone, shaly, grayish-brown; very fossiliferous with brachiopods, bryozoans, and pelecypods	3
23	Limestone, gray; some crinoids	5
22	Limestone, cherty, dark-gray, dense, medium-bedded; rows of gray chert nodules protrude on weathered surfaces; sulfurous odor on fresh break	23
21	Limestone, shaly, gray; abundant fossils including brachiopods, bryozoans, horn corals, ostracods, and crinoid stems	66

		Thickness Feet
20	Limestone, cherty, gray, thick-bedded; abundant gray chert nodules; very fossiliferous with horn corals, bryozoans, brachiopods, and crinoid stems	16
19	Limestone, gray, dense, medium- and thick-bedded	14
18	Sandstone, calcareous, light grayish-brown, very fine- to fine-grained, medium-bedded, ripple-marked	5
17	Limestone, oolitic, dark-gray	2
16	Limestone, gray, dense, medium-bedded	25
15	Limestone, gray, dense; some small gray chert nodules	3
14	Limestone, gray, dense, medium-bedded	7
13	Limestone, oolitic, dark-gray (R-4015)	1
12	Limestone, gray; weathers to shaly appearance	20
11	Limestone, shaly, gray, thin-bedded	68
10	Covered	18
9	Limestone, shaly, gray to light-gray, thin-bedded	32
8	Covered	68
7	Limestone, light grayish-brown, thick-bedded	4
Maccrady Formation (57 feet)		
6	Shale and mudstone, maroon and light-green; weathers to red and brown soil (R-4013)	29
5	Siltstone, micaceous, reddish-brown, thin-bedded, and maroon mudstone	8
4	Covered for the most part; reddish soil with fragments of maroon and light-green silty shale	20
Price Formation (upper 28 feet)		
3	Siltstone, micaceous, greenish-gray, thin-bedded; contains pelecypods and carbonized plant fragments; transition zone between Maccrady and Price formations	14
2	Covered in part; siltstone, gray, thin-bedded	9
1	Sandstone, argillaceous, gray, very fine-grained; some sandstone layers medium- to coarse-grained and medium-bedded	5

Section C: Muddy Hollow

From 0.05 mile southeast of Riverview Church southward along Muddy Hollow to small hill in Caney Valley, 0.2 mile south of junction of State Roads 616 and 798; strike 65° E., dip 25° SE.

Fido Sandstone (Lower part, 10 feet)		
40	Sandstone, reddish-brown, fine-grained, friable	10
Gasper limestone (743 feet)		
39	Limestone, argillaceous, gray; few crinoids	195
38	Limestone, argillaceous, light-gray to gray; moderately fossiliferous with crinoids, blastoids, and bryozoans	156
37	Limestone, oolitic, light-gray, coarse-grained; composed mainly of rounded and oblong oolites with mostly crinoid stem fragments as centers; two species of bryozoans	3
36	Limestone, shaly, gray; sparsely fossiliferous, mainly crinoid fragments	275
35	Limestone, gray, micrograined; abundant fossils include crinoids,	

		Thickness Feet
	brachiopods, and the blastoid *Pentremites* (R-4022)	55
34	Limestone, argillaceous, gray; thin zones of white crinoid fragments	59
Ste.	*Genevieve limestone* (1205 feet)	
33	Limestone, crinoidal, dark-maroon, thick-bedded; blastoids (*Pentremites* sp. R-4021)	15
32	Limestone, shaly, gray	338
31	Limestone, argillaceous, crinoidal, gray, dense, thin-bedded	21
30	Limestone, crinoidal, gray and grayish-brown, coarse-grained; *Platycrinus penicillus* Meek and Worthen	44
29	Limestone, argillaceous, gray; crinoids, brachiopods, and blastoids	9
28	Limestone, argillaceous, dark-gray, dense, thick-bedded; weathers to shaly, light-brown appearance	72
27	Limestone, crinoidal, gray	41
26	Limestone, shaly, gray; some medium-bedded, dense limestone	78
25	Limestone, crinoidal, gray with red tinge, coarse-grained, massive-bedded; three species of crinoids and one of bryozoans (R-4019)	42
24	Covered	35
23	Sandstone, calcareous, brown, very fine-grained, massive-bedded	14
22	Limestone, shaly, gray	45
21	Limestone, crinoidal, blue-gray, thick-bedded	11
20	Limestone, shaly, gray; weathers greenish-gray	50
19	Limestone, crinoidal, gray; interbedded with greenish-gray, argillaceous limestone	5
18	Limestone, shaly, gray; weathers greenish-gray	22
17	Limestone, gray, dense, thick-bedded; upper part is medium- to coarse-grained; abundant large crinoids, brachiopods, and bryozoans	39
16	Limestone, crinoidal, light-gray, very coarse-grained	11
15	Limestone, argillaceous, gray; weathers greenish-gray; few thin crinoidal zones	62
14	Limestone, argillaceous, light-gray, fine-grained, thick-bedded; chert nodules rare; crinoidal beds	34
13	Limestone, sandy, gray; contains brown, fine- to medium-grained, subrounded quartz; projecting arenaceous laminations on weathered surface	5
12	Limestone, argillaceous, sandy, gray; weathers to residue of brown, very fine-grained quartz; chert nodules in upper part	5
11	Limestone, argillaceous, gray and greenish-gray, laminated, medium-bedded; becomes more argillaceous in upper portion; partly covered	45
10	Limestone, cherty, gray, thick-bedded; abundant light-gray chert nodules, very fossiliferous with silicified brachiopods, crinoids, bryozoans, horn and tabulate corals, and nautiloids (R-4018)	34

		Thickness Feet
9	Limestone, gray; chert nodules, more abundant in upper part; abundant bryozoans and crinoids; some silicified brachiopods in chert nodules	40
8	Limestone, argillaceous, gray, medium-bedded; bryozoans	17
7	Limestone, shaly, dark-gray; crinoids, brachiopods, and bryozoans	5
6	Limestone, cherty, gray, dense; brachiopods	5
5	Covered in part; gray, medium-bedded limestone with brachiopods	39
4	Limestone, crinoidal, cherty, gray, thick-bedded, dense; contains rows of flattened black chert nodules with horn corals, bryozoans and crinoids (*Platycrinus penicillus* Meek and Worthen)	22
Hillsdale Limestone (upper part, 162 feet)		
3	Limestone, cherty, gray, very fine-grained, thick-bedded; dark gray chert nodules; some algal-banded limestone; upper part very fossiliferous with silicified horn corals, high- and low-spired gastropods, and tabulate corals (*Syringopora virginica* Butts)	45
2	Covered	112
1	Limestone, cherty, dark-gray, dense	5

Section D: East Muddy Hollow

From 0.1 mile southwest of Riverview Cemetery on hillside west of Horseshoe Bend southeastward across hills and along unnamed stream to near its headwaters, 0.6 mile south of State Road 616; strike N. 60° E., dip 24° SE.

Pennington Formation (lower part, 20 feet)		
53	Shale, silty, and gray, micaceous siltstone	20
Cove Creek Limestone (1219 feet)		
52	Mostly covered; exposures of argillaceous, light-gray limestone rare	563
51	Limestone, argillaceous, grayish-green, thinly laminated (R-4027)	237
50	Limestone, gray, medium-bedded; crinoid stems and brachiopods	4
49	Limestone, argillaceous, grayish-green; thin brown laminae; fenestrate bryozoans	415
Fido Sandstone (53 feet)		
48	Sandstone, brown, very fine- to fine-grained; molds of the brachiopod, *Reticulariina* cf. *R. spinosa* (Norwood and Pratten), and crinoids	4
47	Limestone, argillaceous, mottled light-gray and maroon; fossils include crinoid stems, bryozoans, and brachiopods (R-4025)	6
46	Sandstone, brown, very fine- to fine-grained, cross-bedded	5
45	Sandstone, maroon, fine-grained, subangular to subrounded, cross-bedded, very friable, thick-bedded; molds of brachiopods and crinoid stems (R-4024)	38
Gasper limestone (866 feet)		
44	Covered by State Road 616	25

		Thickness Feet
43	Limestone, light-gray, thick-bedded; fossiliferous beds contain crinoid and blastoid fragments	138
42	Covered for the most part; contains some light-gray, thick-bedded limestone	78
41	Limestone, light-gray, thick-bedded; abundant bryozoans	23
40	Limestone, argillaceous, light-gray, thick-bedded; weathers to crumbly, shaly appearance	159
39	Limestone, light-gray, thick-bedded; abundant bryozoans	27
38	Limestone, argillaceous, light-gray; weathers to shaly, light-brown appearance	104
37	Limestone, oolitic, light-gray; fossils include crinoid and blastoid fragments	14
36	Limestone, argillaceous, light-gray; weathers to shaly, light-brown appearance	15
35	Limestone, oolitic, light grayish-brown, fine-grained, with crinoids and bryozoans (R-4023)	9
34	Limestone, argillaceous, light-gray; weathers to shaly, light-brown appearance	114
33	Limestone, gray, dense, thick-bedded; abundant bryozoans, crinoids, blastoids, and brachiopods	77
32	Limestone, crinoidal, gray	4
31	Limestone, argillaceous, light-gray, thinly laminated, medium-bedded; weathers shaly and light grayish-brown	79
Ste. Genevieve limestone (1184 feet)		
30	Limestone, gray; contains crinoidal layers; grades upward to irregularly spaced, maroon-banded, massive-bedded limestone	36
29	Limestone, crinoidal, maroon, thick-bedded	12
28	Limestone, shaly, light-gray; some fine-grained, brown sandstone float	318
27	Covered for the most part; mainly argillaceous limestone	90
26	Limestone, dark-gray, dense, medium- to thin-bedded	112
25	Limestone, light-gray, medium-grained, medium-bedded	16
24	Limestone, argillaceous, gray, medium-bedded	25
23	Limestone, crinoidal, gray, medium-crystalline; horn corals, small gastropods, and crinoid stems of *Platycrinus penicillus* Meek and Worthen	15
22	Limestone, shaly, light-gray; weathers light-brown; the horn coral, *Zaphrentites* sp. , common near base	135
21	Limestone, crinoidal, gray, coarse-grained	3
20	Limestone, argillaceous, crinoidal, reddish-brown, coarse-grained	1
19	Limestone, crinoidal, light-gray, coarse-grained; fossils include the brachiopod *Reticulariina*? sp., fenestrate bryozoans, and horn corals	18
18	Limestone, shaly, gray	108
17	Limestone, crinoidal, light-gray	33
16	Limestone, shaly, gray; weathers light-brown; abundant bryozoans and the large horn coral *Zaphrentites* cf. *Z spinulosa* (Milne-Edwards and Haime)	25

		Thickness Feet
15	Limestone, crinoidal, light-gray, coarse-grained, medium-bedded; abundant fossils include crinoids, horn corals, bryozoans, and productid brachiopods	23
14	Limestone, cherty, gray, dense, massive-bedded; abundant gray chert nodules; cliff-former	6
13	Limestone, crinoidal, light-gray, medium- to coarse-grained	27
12	Limestone, argillaceous, gray; contains some gray chert nodules	5
11	Limestone, argillaceous, gray; weathers pale greenish-gray; fauna of large pink crinoid stems, large brachiopods and bryozoans	44
10	Limestone, cherty, light-gray; gray chert nodules	4
9	Siltstone, argillaceous, greenish-gray, calcareous, dense	2
8	Limestone, crinoidal, gray, medium- to coarse-grained, medium- to thick-bedded	27
7	Limestone, shaly, gray; weathers grayish-brown	17
6	Limestone, crinoidal, light-gray	15
5	Limestone, cherty, gray; gray chert nodules; crinoids, brachiopods and bryozoans; forms small ridge (R-4020)	32
4	Limestone, crinoidal, light-gray; fossils include horn corals, fenestrate bryozoans, and crinoids. This is the oldest occurence of *Platycrinus penicillus* Meek and Worthen found in these sections	35
Hillsdale Limestone (upper part, 77 feet)		
3	Limestone, cherty, gray; weathers to light grayish-brown	28
2	Limestone, cherty, gray, medium-bedded, fossiliferous; irregular-shaped, light-gray cherty masses in layers spaced about 1.0 to 1.5 feet apart	4
1	Limestone, crinoidal, light-gray, medium-grained; abundant horn corals; algal structures in lower part; some dark-gray to black, fine-grained, medium-bedded limestone with sulfurous odor on fresh break, strike N. 60° E., dip 26° SE.	45

Section E: Nordyke Creek

From Caney Valley along State Road 622 and hillslopes adjacent to Nordyke Creek southeastward to Rich Valley near intersection of State Roads 622 and 700; structural attitude variable. (Note: Line of section on Plate 1 should extend about 100 feet farther southeastward than shown.)

Honaker Formation (20+ feet)		
52	Dolomite, gray, dense, medium-bedded	20±
Saltville fault (trace crosses just south of road intersection)		
Pennington Formation (in fault zone 350 ± feet)		
51	Shale and siltstone, maroon and greenish-gray; few brachiopods and pelecypods; outcrop crumpled and faulted, thickness uncertain	17±
50	Covered	270±
49	Shale, maroon; dip averages 25° SE.	63±
Fault		
Pennington Formation (1335 feet)		

		Thickness Feet
48	Shale, silty, maroon and light-greenish-gray; some silty, light-gray, very fine-grained, thick-bedded sandstone in upper part; dip 20° S.	38
47	Sandstone, very fine-grained, and light-gray, medium-bedded siltstone	5
46	Covered	18
45	Sandstone, silty, brown, very fine-grained, thin-bedded; possible worm borings	5
44	Shale and siltstone, micaceous, maroon	43
43	Sandstone, light-gray, very fine-grained, thick-bedded	5
42	Siltstone and sandstone, dark-maroon, very fine-grained, thick-bedded; grades upward to interbedded medium-bedded siltstone and maroon, silty shale; dip 17° S.	32
41	Siltstone, maroon, thin- to medium-bedded, and some maroon shale; dip 22° S.	34
40	Siltstone, gray, thin-bedded; interbedded with brown, medium-bedded, silty sandstone; fossils include carbonaceous plant fragments, pelecypods, and the brachiopods *Chonetes chesterensis* Weller and *Orthotetes* sp.	109
39	Covered in part; maroon and light-green, micaceous siltstone and shale; dip 24° S. (R-4032)	81
38	Covered in part; argillaceous siltstone which is gray, calcareous, and thick-bedded; irregular dips across an anticline and syncline near sharp road curve	35
37	Siltstone, maroon, and maroon and greenish-gray shale; some very fine-grained, brown sandstone with bryozoans	10
36	Siltstone, argillaceous, gray, calcareous, and argillaceous limestone with abundant fossils; minor beds of gray shale; fossils include crinoid stem sections, spiriferid brachiopods, and three species of bryozoans	65
35	Sandstone, maroon, very fine-grained, thick-bedded, and maroon shale	20
34	Sandstone and siltstone, gray, calcareous	28
Fault (displacement estimated to be 41 feet)		
33	Sandstone, maroon, very fine-grained, medium-bedded, and maroon and greenish-gray shale. Probably a repeat of unit 35 in part	13
32	Sandstone, very fine-grained, and bluish-gray, argillaceous siltstone that is moderately fossiliferous with bryozoans and the spiriferid brachiopods *Anthracospirifer* cf *A. leidyi* (Norwood and Pratten) and *Diaphragmus*? sp. . The upper 28 feet are possibly a repeat of unit 34	98
31	Sandstone, very fine-grained and thin-bedded; grayish-brown siltstone containing crinoids and spiriferid brachiopods	10
30	Covered	10
29	Siltstone, argillaceous, light gray, thin-bedded; pelecypods and brachiopods; partly covered	36

		Thickness Feet
28	Siltstone, argillaceous, calcareous, medium-bedded; very fossiliferous with four species of bryozoans, the brachiopods *Chonetes* ? sp., *Orthotetes* sp., *Ovatia* cf., *O. ovata* (Hill), *Orthotetes* sp. , and *Punctospirifer*? sp. , pelecypods, and crinoid stems	38
27	Sandstone, brown, very fine-grained, and thin- to medium-bedded, light-gray siltstone	14
Possible disconformity (channelling present between bedding)		
26	Siltstone, shaly, calcareous; abundant bryozoans and carbonaceous fossil plants	32
25	Siltstone, shaly, calcareous; carbonaceous plant fragments	30
24	Limestone, argillaceous, light-gray; abundant bryozoans consisting of two species; calcareous shale in part (R-4031)	6
23	Siltstone, bluish-gray, calcareous, micaceous, thin- to thick-bedded	22
22	Sandstone, brown, very fine- to fine-grained, cross-bedded, medium-bedded; molds of bryozoans, crinoids, and brachiopods (*Ovatia*? sp.); some interbeds of shaly siltstone and gray, silty shale	20
21	Limestone, sandy, gray, crinoidal; sand grains are fine and subrounded	15
20	Sandstone, brown, very fine-grained, hematitic, medium-bedded; crinoid molds	37
19	Siltstone, and very fine-grained, very calcareous, medium-bedded sandstone; some beds contain large crinoid stem molds up to 27 mm. diameter and the brachiopod *Diaphragmus* aff. *D. elegans* (Norwood and Pratten) (R-4030)	36
18	Siltstone, gray, micaceous, argillaceous, medium-bedded; some spheroidal weathering; fossils include pelecypods, crinoids, and brachiopods (*Chonetes* cf. *C. chesterensis* Weller); dip 8° S.	19
17	Siltstone, gray, calcareous, micaceous, massive-bedded; fossiliferous with pink, coarse-grained crinoid fragments, productid brachiopods, and pelecypods	33
16	Siltstone and shale interbedded, greenish-gray, micaceous; two species of brachiopods including *Ovatia* cf. *O. ovata* (Hall), and two of pelecypods including ? *Grammysia* sp.	8
15	Siltstone, gray, slightly calcareous, thick-bedded	18
14	Covered	13
13	Shale, gray, silty, micaceous; some greenish-gray shale in middle portion; siltstone beds more numerous upward to top of unit; measured in creek bed (R-4029)	103
12	Siltstone, gray, thin-bedded; argillaceous, silty shale; some grayish-brown, very fine-grained, silty sandstone with crinoid stems and the brachiopod *Diaphragmus* ? sp. ; dip 14° S.	42
11	Covered	37
10	Shale, silty, bluish-gray, micaceous	44
9	Sandstone, brown, very fine-grained; fossil molds of crinoid stems and the two species of brachiopods including *Chonetes* cf.	

		Thickness Feet
	C. chesterensis Weller and *Spirifer* sp. (R-4028)	19
8	Siltstone, bluish-gray, micaceous, thin-bedded; pelecypods	10
7	Sandstone, brown, very fine-grained, silty, medium-bedded; some thin-bedded, gray siltstone in middle part	18
6	Shale, silty, greenish-gray, micaceous, and brownish-gray, thin- to medium-bedded, dense, slightly calcareous siltstone	11
5	Covered; probably shale	15
Cove Creek Limestone (1009 feet)		
4	Limestone, very argillaceous, greenish-gray, medium- to thick-bedded; weathers to cream-buff with thin, brown, argillaceous laminated appearance; dip at top 17° S. (R-4026) (Figure 18)	800
3	Limestone, gray; very fossiliferous with crinoid and blastoid fragments	3
2	Limestone, argillaceous; thin, silty laminations; dip 22° S.	206
Fido Sandstone (10+ feet)		
1	Sandstone, maroon, medium-grained, calcareous	10+

Section F: Fleenor Quarry

Measured through fields and along old road on east side of Fleenor Quarry from north of quarry southeastward to State Road 700 in Rich Valley; structural attitude variable; Ordovician beds overturned.

Honaker Formation		
11	Dolomite, gray, medium-bedded.	
Pumpkin Valley Shale (340 feet)		
10	Covered for the most part; maroon shale chips in fields	151
9	Shale, silty, grayish-brown, micaceous; strike N. 70° E., dip 27° SE.	189
Rome Formation? (upper part, 54 feet)		
8	Chert and dolomite breccia, light-gray, slightly calcareous; probable fault zone	17
7	Dolomite, calcareous, light-gray, micrograined	37
Fault		
Middle Ordovician rocks, undivided (109 feet)		
6	Covered for the most part; includes distinctive pinkish-gray, coarse-grained, marble-like limestone (R-4035)	22
5	Covered	23
4	Limestone, light-gray, to grayish-brown, coarse-grained, medium-bedded; abundant fossils including the bryozoans *Chazydictya?* sp. , *Coeloclema?* sp. , *Hemiphragma* sp. , *Heterotrypa* sp. , *Halloporina* sp. , *Phylloporina* sp. , *Pachydictya* cf. *P sensilis* Coryell, and *Stictopora* sp., cystoid plates, and the brachiopod *Dinorthis willardi* Cooper	22
3	Limestone, light-gray, coarse-grained, medium-bedded; crinoids and bryozoans including *Batostoma* cf. *B. suberassum* Coryell	42
Fault		
Pennington Formation (84 feet+)		
2	Shale, clayey, brownish-green, and silty, maroon shale	39

		Thickness Feet
1	Sandstone, argillaceous, maroon, very fine-grained, dense, medium- to thin-bedded; some interbedded silty, maroon shale	45

Section G: North Lime Hill

Measured on hillside 100 yards east of State Road 617, approximately 0.3 mile north of Lime Hill; structural attitude variable; Ordovician beds overturned. (Note: younger stratigraphic units measured on adjoining Mendota quadrangle to the west.)

Pennington Formation		
11	Sandstone, argillaceous, brown, slightly arkosic, very fine-grained, interbedded with reddish-brown shale	20
Fault		
Moccasin Formation (lower part, 162 feet)		
10	Limestone, fossiliferous, gray and grayish-brown, very coarse-grained, thick-bedded; composed mainly of fossil fragments of crinoids, brachiopods, and bryozoans	11
9	Covered	61
8	Limestone, argillaceous, maroon, thin-bedded, interbedded with coarse-grained, thin-bedded, mottled maroon and light-gray limestone having maroon, calcareous shale partings; fossils rare (R-4033)	90
Middle Ordovician rocks, undivided (232 feet)		
7	Limestone, interbedded maroon and light-gray; light-gray more common; very fossiliferous in lower beds with abundant bryozoans (*Constellaria* sp. , *Chazydictya*? sp., *Halloporina* sp. , *Ottoseetaxis* sp. , *Pachydictya* cf. *P. senilis* Coryell, *Scenellopora*? sp. , *Stictopora* sp.), ostracods, brachiopods, and the large sponge *Receptaculites* sp.	50
6	Limestone, marble-like, pink and light-gray, very coarse-grained, thick-to massive-bedded; composed mainly of fossil shell fragments	14
5	Limestone, fossiliferous, grayish-brown, micrograined to coarse-grained, thin-bedded; contains brachiopods, crinoids, ostracods, sponges, and the bryozoans *Graptodictya* sp. , *Hallopora* sp. , *Ottoseetaxis* sp. , and *Pachydictya* cf. *P. senilis* Coryell	39
4	Shale, clayey, brown, calcareous, hackly; interbeds of thin-bedded, fine-to coarse-grained, light-gray limestone more numerous toward base; very fossiliferous with the bryozoans *Graptodictya* sp. , *Pachydictya* cf. *P. senilis* Coryell, brachiopods, crinoids, and ostracods (R-4034)	90
3	Limestone, light-gray, coarse-grained, thick-to massive-bedded	11
2	Covered, probable fault zone	28
Fault		
Rome Formation		
1	Quartzite, light-gray, dense	20

Section H: Lime Hill Road

From Lime Hill southeastward along State Road 617 to unnamed hill southeast of Three Springs; strike N. 50° E., dip 20° - 29°. (Note: (1)

	Thickness Feet
Section location line on Plate 1 should be continuous; it is situated just to west of the road where omitted in Copper Ridge and Chepultepec map units. (2) It should extend about 50 feet farther southeast than shown.)	
Honaker Formation	
99 Dolomite, dark-gray, micrograined, brecciated	20
Pulaski-Staunton fault	
Athens Formation (lower part, 11 feet)	
98 Shale, gray; weathers light-gray; some very thin-bedded, fractured, gray limestone	11
Lenoir and Mosheim limestones (121 feet)	
97 Limestone, gray, medium-grained, oolitic, very thin-bedded; fossil fragments; highly fractured with some calcite filled veins	3
96 Limestone, bluish-gray, slightly oolitic; some gray chert nodules with very thin argillaceous bands; brachiopods, crinoids, and trilobites	20
95 Covered	17
94 Limestone, gray, thin-bedded, micrograined	64
93 Limestone, dove-gray, thin- to medium-bedded, micrograined (R-4046)	17
Knox Group, upper part (2204 feet)	
92 Dolomite, light-gray, very fine-grained, thick-bedded; some white chert	168
91 Limestone, dark bluish-gray, micrograined	1
90 Dolomite, light-gray, very fine-grained, medium- to thick-bedded; abundant white chert with rhombic dolomolds	28
89 Dolomite, marble-like, light-gray and pink, very coarse-grained	2
88 Dolomite, light-gray, very fine-grained; much white chert with rhombic dolomolds; middle portion covered (R-4044)	437
87 Dolomite, light-gray, very fine-grained, medium-bedded; some white chert	73
86 Limestone, bluish-gray, micrograined, medium-bedded; argillaceous laminae	1
85 Dolomite, light-gray, micrograined to coarse-grained; medium-bedded	13
84 Limestone, bluish-gray, micrograined, medium-bedded, argillaceous laminations	11
83 Dolomite, light-gray, micrograined, thick-bedded	9
82 Dolomite, light-gray, very coarse-grained, interbedded with micrograined, bluish-gray limestone	6
81 Covered	6
80 Dolomite, light-gray, very fine-grained interbedded with micrograined, bluish-gray limestone; abundant fossils including gastropods, cephalapods, nautiloids, and trilobites	17
79 Limestone, bluish-gray, micrograined; irregular, argillaceous laminae; zones of medium-bedded, limestone-pebble conglomerate; cherty zone at top of unit; fossils in chert and limestone	11
78 Dolomite, light-gray, fine- to coarse-grained, medium-bedded	6
77 Covered; white-chert float	168

		Thickness Feet
76	Dolomite, light-gray, medium- to coarse-grained, medium-bedded; some white chert	17
75	Covered; residual clay with white chert	84
74	Dolomite, light-gray, micrograined, medium-bedded	5
73	Covered; residual clay with white chert	50
72	Dolomite, light-gray, micrograined	11
71	Covered for the most part; residual cherty clay; chert is white to gray with dolomolds	294
70	Covered; chert float with dolomolds	269
69	Bedded chert, orange to white, thick-bedded; partly covered	25
68	Covered; white- and gray-chert float, some algal-banded	123
67	Dolomite, light-gray to gray, very fine-grained to micrograined; sandy in upper part with rounded, fine-grained quartz	73
66	Dolomite, light-gray, very fine- to medium-grained, thick-bedded	39
65	Dolomite, gray to light-gray, micrograined to medium-grained; white chert masses in upper part	67
64	Limestone, dolomitic, light bluish-gray, micrograined; worm trail-like markings on bedding surfaces; gastropod fragments; few interbeds of light-gray, micrograined dolomite	50
63	Dolomite, light-gray, micrograined	17
62	Covered	62
61	Dolomite, light-gray, fine-grained, thick-bedded	11
60	Covered; some sandy, white-chert float	50
Chepultepec Formation (161 feet)		
59	Limestone, blue, thick-bedded; yellowish-brown irregular laminae	28
58	Covered on road; total of 161 feet (units 58 and 59) of Chepultepec limestone measured at sink on crest of hill, 0.3 miles west of road	133
Copper Ridge Formation (1196 feet)		
57	Covered for the most part; two thin beds of fine- to medium-grained, brown sandstone	181
56	Covered; some sandstone float	130
55	Dolomite, light-gray, micrograined	6
54	Limestone, bluish-gray, micrograined	17
53	Covered	17
52	Dolomite, gray, micrograined	17
51	Covered	56
50	Chert, oolitic, white; siliceous matrix	1
49	Limestone, bluish-gray, very fine-grained; very thin argillaceous laminae: fossil fragments of brachiopods and trilobites; partly covered	34
48	Conglomerate, limestone-pebble, gray, micrograined; pebbles range up to 2-inches diameter with oolitic and fine-grained matrix	1
47	Limestone, bluish-gray, micrograined, thin- to medium-bedded	45

		Thickness Feet
46	Dolomite, light-gray, micrograined to fine-grained; mostly covered	684
45	Sandstone, brown, fine- to medium-grained, subrounded; beds slightly contorted	7
Maynardville Formation (97 feet)		
44	Dolomite, light-gray, micrograined; a few beds of micrograined, gray limestone	22
43	Limestone, bluish-gray, micrograined; partly sandy with fine to medium, rounded quartz grains, and straticulate argillaceous bands (Figure 9); some thin beds of light-gray dolomite in top portion of unit	75
Nolichucky Formation (532 feet)		
42	Shale, silty, greenish-gray; partly covered	90
41	Limestone, gray, micrograined with brown argillaceous laminae which weather as raised ribs spaced about one inch apart	4
40	Shale, grayish-green, fissile, calcareous; in part micaceous and very silty with trilobite fragments and numerous small black shells of the brachiopod *Dicellomus appalacia* Walcott	136
39	Limestone oolitic, dark-gray, massive-bedded; mostly rounded oolites of 2 mm. in diameter, fine-grained matrix; oolites weather to reddish-orange (R-4041) (Figure 7)	19
38	Conglomerate, limestone-pebble, gray; rounded pebbles up to 3 inches in diameter with gray micrograined matrix	3
37	Limestone, gray, micrograined	16
36	Shale, grayish-brown, calcareous	3
35	Limestone, light-gray, micrograined to medium-grained	4
34	Shale, grayish-brown, calcareous, hackly	3
33	Limestone, oolitic, light-gray, micrograined, very thin-bedded; argillaceous interbeds	7
32	Limestone, oolitic, gray; oolites, mainly 1 mm. in diameter, in very fine-grained matrix, weather brown	1
31	Limestone, light-gray, micrograined, thin-bedded	18
30	Limestone, gray, fine-grained, slightly glauconitic; interbedded with gray, calcareous, hackly, clayey shale	4
29	Shale, grayish-green, hackly to fissile, weathers brown; minor beds of gray, coarse-grained, partly oolitic limestone	118
28	Limestone, gray, micrograined, medium-bedded; argillaceous in upper part with trilobite fragments	37
27	Limestone, sandy, grayish-brown, thin-bedded; quartz is very fine-grained	7
26	Limestone, oolitic, gray, medium-bedded	5
25	Limestone, shaly; gray-green shale partings, upper part sandy; stylolites	4
24	Limestone, oolitic, gray, medium-bedded; weathers to brown color; oolites mostly 2 mm. in diameter	3
23	Limestone, argillaceous, light-gray, medium-grained, shaly to thin-bedded; oolitic interbeds, trilobite fragments; some interbeds of very fine-grained, angular, micaceous sandstone	12

		Thickness Feet
22	Shale, grayish-green, slightly silty, calcareous, hackly	3
21	Limestone, oolitic, gray, medium-bedded, weathers brown; oolites mostly 2 mm. in diameter	7
20	Limestone, sandy, sightly oolitic, gray, thin- to medium-bedded; quartz is very fine-grained	12
19	Limestone, silty to sandy, gray, thin-bedded; very fine-grained quartz in a very fine-grained carbonate matrix which weathers brown	16
Honaker Formation (upper part, 1140 feet)		
18	Dolomite, gray, slightly calcareous, thin-bedded; weathers to shaly appearance	17
17	Dolomite, light-gray, micrograined, medium- to thin-bedded; weathers light-brown	84
16	Dolomite, dark-gray, micrograined; interbedded with dolomite, calcareous, very fine-grained	28
15	Dolomite, light-gray, micrograined, medium-bedded	28
14	Dolomite, calcareous, light-gray, micrograined	37
13	Covered for the most part; light-gray and gray algal-banded chert in lower portion; some oolitic, light-gray, very fine-grained, porous dolomite (R-4039)	130
12	Limestone, dolomitic, dark-gray, very fine-grained	26
11	Dolomite, gray; vuggy porosity; thin interbeds of dark-gray dolomitic limestone and some chert with vugs having quartz crystals	143
10	Limestone, dark-gray, fine-grained	11
9	Dolomite, gray, very fine-grained	48
8	Covered	20
7	Dolomite, gray, very fine-grained	22
6	Covered	78
5	Dolomite, argillaceous, light-gray, very fine-grained, medium to thin-bedded; some thinly laminated	153
4	Dolomite, dark- gray, fine-grained, thin- to medium-bedded; slight sulfurous odor on fresh break	39
3	Limestone, gray, fine-grained, medium-bedded, interbedded with very thin-bedded gray dolomite; partly covered	62
2	Dolomite, gray, very fine-grained, calcareous, medium-to very thin-bedded	39
1	Dolomite, light-gray, very fine-grained, medium-to thin-bedded; some beds in lower part have vuggy porosity and strong sulfurous odor on fresh break	175

Basal units not exposed; unit number 1 is near Honaker Formation contact with Pumpkin Valley Shale.

Section I: Benhams Road

From about 0.3 mile northwest of junction of State Roads 622 and 640 southeastward near Abrams Creek to Revival Center Church; average strike N. 30° E., dip 19° SE. (Note: Line of section extends about 300 feet farther northwest than shown on Plate 1.)

		Thickness Feet
Pulaski-Staunton fault		
Knox Group, upper part (lower part, 651 feet)		
62	Dolomite, light-gray, very fine-grained, dense; weathers to "butcher-block" pattern; upper beds contain some irregularly shaped, white chert	90
61	Covered	56
60	Dolomite, light-gray, very fine-grained, dense; weathers to "butcher-block" pattern; upper beds cherty	84
59	Covered for the most part; scattered chert residue	118
58	Dolomite, light-gray, medium-grained, cherty	17
57	Dolomite, pinkish-gray, fine-to coarse-grained; in part sandy with medium-to coarse-grained, rounded quartz; some irregularly shaped chert; very fine crystals of siderite	11
56	Covered; large residual blocks of white chert	90
55	Dolomite, cherty, light-gray, very fine-grained	17
54	Dolomite, light-gray, very fine-grained, dense, thin-to medium-bedded	56
53	Dolomite, light-gray, medium-grained, interbedded with white, friable chert containing scattered rhombic molds; deep weathering and minor folds in borrow pit 100 yards west of road	50
52	Dolomite, gray, very fine-grained, thin-bedded; in part slightly calcareous	62
Chepultepec Formation (147 feet)		
51	Limestone, bluish-gray, very fine-grained; worm trail-like markings on bedding surfaces; about 10 feet above base are some curved cephalopods and large low-spired gastropods	97
50	Conglomerate, limestone-pebble, brownish-gray, micrograined	2
49	Limestone, bluish-gray, very fine-grained; irregular worm trail-like markings on some bedding surfaces	22
48	Limestone, argillaceous, light-gray, very fine-grained, thin-bedded	2
47	Limestone, bluish-gray, micrograined, thin-to thick-bedded; thin argillaceous laminae; weathers very light-gray	24
Copper Ridge Formation (1094.5 feet)		
46	Dolomite, light-gray, very fine-grained, dense; weathers to "butcher-block" appearance	146
45	Covered for the most part; light-gray, very fine-grained dolomite; dense, micrograined, gray, limestone-pebble conglomerate	62
44	Limestone, light-gray, very fine- to fine-grained, thick-bedded	14
43	Conglomerate, limestone-pebble, gray, micrograined; algal-banded layers	3
42	Limestone, sandy, light-gray; weathers brown; sand grains are very fine to fine, rounded; interbedded with light-gray dolomite and a few chert lenses and micrograined, argillaceous, limestone (R-4043)	9
41	Dolomite, gray, fine-grained and with interbeds in upper part of dark-gray, micrograined limestone	22
40	Dolomite, sandy, gray, thinly-laminated, very fine- to fine-	

		Thickness Feet
	grained at base; some thinly laminated, bluish-gray, micrograined limestone with probable brachiopod fragments	6
39	Sandstone, brown, mostly medium-grained, subrounded, porous, cross-bedded	1
38	Limestone, light-gray, micrograined, and light-gray limestone-pebble conglomerate	7
37	Dolomite, light-gray, sucrosic, fine-grained	42
36	Conglomerate, oolitic, limestone-pebble, gray; interbedded with blue-gray limestone, and light-gray dolomite with oolitic chert which is light-gray with medium- to coarse-grained rounded oolites	94
35	Dolomite, light-gray, very fine-grained	6
34	Limestone, gray, slightly argillaceous	16
33	Limestone, sandy, light-gray, very fine-grained; sand is very fine angular quartz; some oolites	17
32	Sandstone, light-gray, very fine- to fine-grained, subangular; stained yellow-brown; siliceous cement	2
31	Dolomite, light-gray, very fine-grained; sandy in uppermost beds; partly covered	48
30	Limestone, gray, very fine-grained interbedded with light-gray, sucrosic, very fine-grained dolomite	20
29	Limestone, cherty, gray, very fine-grained	2
28	Dolomite, light-gray, sucrosic, very fine-grained	37
27	Limestone, sandy, gray and grayish-grown, micrograined; faintly laminated; very fine quartz grains in carbonate matrix and some oolitic chert nodules	16
26	Dolomite, light-gray, slightly calcareous, micrograined to very fine-grained	8
25	Conglomerate, dolomite-pebble, limey, gray; gray, oolitic chert nodules	17
24	Conglomerate, oolitic, limestone-pebble; cobbles to 6 inches in diameter; abundant trilobite fragments; very fine-grained, light-gray dolomite; oolitic chert nodules; straticulate limestone	22
23	Limestone, light-gray, micrograined; oolitic, white to light-gray chert nodules	1
22	Limestone and dolomite, interbedded, light-gray	10
21	Chert, oolitic, light-gray, medium-grained; rounded oolities, partly with white rims (R-4042)	0.3
20	Limestone, light-gray to gray, micrograined; contains chert layers and nodules; fragments of brachiopods and triobites	8
19	Dolomite, light-gray, sucrosic, very fine-grained	18
18	Dolomite, light-gray, medium-grained; poorly exposed	185
17	Covered	25
16	Dolomite, gray to light-gray, sucrosic, fine- to medium-grained, thick-bedded	22
15	Dolomite, light-gray to gray; sucrosic, very fine-grained, thin- to medium-bedded	151
14	Limestone, gray, very fine-grained, dense, slightly argillaceous	6

		Thickness Feet
13	Dolomite, light-gray, micrograined; rare, very fine quartz grains in carbonate matrix; with "butcher-block" weathering	17
12	Limestone, gray, very fine-grained, thinly laminated	6
11	Sandstone, light-brown, medium-grained, rounded to subrounded, frosted, porous; siliceous cement; probably weathered from sandy limestone	0.2
10	Limestone, bluish-gray, micrograined; brown laminations; layers of fine to very-fine, subrounded quartz grains	28
Maynardville Formation (172 feet)		
9	Limestone, gray, micrograined	73
8	Limestone, gray, micrograined; silty grayish-brown laminations	11
7	Limestone, oolitic, gray, slightly sandy, medium-grained; oolites are medium- to coarse-grained, well-rounded, and weather to an orange color	2
6	Limestone, gray, very fine-grained; silty grayish-brown laminations	11
5	Conglomerate, oolitic, limestone-pebble; gray, micrograined matrix; oolites are medium- to coarse-grained, rounded, gray, and weathered to an orange color	2
4	Limestone, gray, very fine-grained; silty, grayish-brown laminations; possible trilobite fragments	22
3	Conglomerate, limestone-pebble, gray; very fine-grained matrix; pebbles of silty limestone weather slightly raised	1
2	Limestone, gray, very fine-grained; crinkly, slightly projecting, straticulate bands; few beds with trilobite and brachiopod fragments; some thin interbeds of micrograined, light-gray dolomite	50
Nolichucky Formation (upper part, 20 feet)		
1	Shale, clayey, and grayish-brown and grayish-green shale that is slightly silty and hackly	20

Section J: Countiss Ridge

From near Harley Spring southeastward to near Sweetie Hollow; strike N. 30° E., dip 7-24° SE.

Nolichucky Formation (lower part, 261.5 feet)		
22	Shale, grayish-green; some oolitic limestone at top of hill; contains the brachiopod *Dicellomus appalachia* Walcott and the trilobite *Norwoodella* cf. *N. saffordi* (Walcott); upper part of unit not present as it has been eroded	120
21	Limestone, light-gray, micrograined, massive-bedded; protruding grayish-brown, argillaceous bands	70
20	Limestone, shaly, light-gray, very thin-bedded; some gray-shale partings	20
19	Limestone, intraformational conglomerate, gray, micrograined; pebbles in medium-grained matrix	0.5
18	Shale, light grayish-brown, calcareous, hackly; thin beds of fine-grained limestone; weathers yellowish-brown; some minor faulting	51
Honaker Formation (upper part, 690 feet)		

		Thickness Feet
17	Dolomite, light-to dark-gray, micrograined to very fine-grained, very thin-bedded to mostly thick-bedded; partly laminated	342
16	Limestone, dark-gray, straticulate, micrograined; cryptozoon; some black chert and minor dolomite beds	14
15	Dolomite, light-to dark-gray, micrograined to medium-grained	45
14	Limestone, dark-gray, micrograined; cryptozoon; some worm trail-like markings on bedding surfaces	6
13	Limestone, gray, micrograined to fine-grained; lesser amount of dolomite	79
12	Limestone, bluish-gray, straticulate, micrograined; worm trail-like markings on bedding planes; grades upward into banded limestone and dolomite (R-4048)	11
11	Dolomite, light-gray, micrograined, thinly laminated, medium-bedded; grades upward into shaly dolomite	22
10	Limestone, dark-gray, micrograined, straticulate, dense; worm trail-like markings protruding slightly on bedding planes	8
9	Dolomite, dark-gray, micrograined, fractured; mostly covered except for upper and lower parts	56
8	Limestone, dark-gray, micrograined, straticulate; clear calcite streaks and blebs	6
7	Dolomite, light-gray, micrograined to very fine-grained, calcareous, thinly laminated, dense	33
6	Limestone, dark-gray, micrograined, medium-bedded, dense	6
5	Dolomite, gray to light-gray, micrograined, very thinly laminated to thin-bedded	6
4	Covered	28
3	Dolomite, calcareous, light-gray, very fine-grained, porous, very thin-bedded	11
2	Limestone, light-gray, very fine-grained, sucrosic, slightly vuggy; interbeds of gray, banded, crytozoon chert	6
1	Dolomite, dark-gray, very fine-grained, dense; fractured near Pulaski-Staunton fault	11

Pulaski-Staunton fault

Section K: Big Ridge

From middle of gap in Big Ridge along Southern Railroad and Campground Road (State Road 641) southeastward for about 0.25 mile; average strike N. 30° E., dip 26° SE. (Note: Line of section should extend about 200 feet farther northwest than shown on Plate 1.)

Conococheague Formation (lower part, 101 feet)

17	Sandstone, brown, fine-grained, cross-bedded	5
16	Limestone, gray, interbedded with light-gray dolomite	73
15	Covered	22
14	Sandstone, brown, fine-grained, subrounded	1

Maynardville Formation (104 feet)

13	Limestone, gray, very fine-grained, thick-to medium-bedded; partly banded (R-4049)	104

Nolichucky Formation (435 feet)

		Thickness Feet
12	Limestone; some beds of limestone-pebble conglomerate of micrograined pebbles in oolitic and coarse-grained matrix; trilobite fragments; weathers brown with slightly protruding argillaceous partings	57
11	Limestone, thin-bedded, silty, shaly; siliceous limestone; streaks of very fine-grained sandstone; limestone-pebble conglomerate of very fine-grained pebbles in oolitic and coarse-grained matrix	14
10	Shale, greenish-gray, contains the small brachiopod *Dicellomus appalachia* Wolcott; four beds of limestone-pebble conglomerate; some siltstone	27
9	Limestone, bluish-gray, very thin-bedded; fragments of trilobites; four layers of oolitic, limestone-pebble conglomerate	25
8	Shale, grayish-green, hackly; some very argillaceous gray limestone and three beds of limestone-pebble conglomerate which pinch and swell in thickness	66
7	Covered; mainly shale	65
6	Conglomerate, oolitic, limestone-pebble, gray, thin- to medium-bedded	10
5	Shale, gray, interbedded with medium- to thin-bedded limestone, and oolitic limestone with coarse, rounded, dark-gray oolites	48
4	Limestone, oolitic, gray, thin- to medium-bedded	6
3	Limestone, gray, micrograined, and very thin-bedded conglomerate with rounded and flattened, micrograined pebbles in a medium-grained matrix	47
2	Shale, grayish-green, fissile, interbedded with thin- and medium-bedded, dense, fine- and medium-grained, gray limestone; contains trilobite fragments; a few thin beds of dolomite near base	70
Honaker Formation		
1	Dolomite, light-gray to gray, fine- to medium-grained, medium-bedded.	

Section L: Goose Creek

From fault about 0.2 mile northwest of junction of State Roads 656 and 657 southward along Goose Creek to Norfolk and Western Railroad, then southward and eastward through fields and along State Road 76 to about 0.2 mile south of Interstate Highway 81 near exit 4. (Note: section location line in Knox, Lenoir-Mosheim, and Athens map units omitted on Plate 1 south of the exit; it should extend southward along quadrangle margin to fault.)

Fault

Athens Formation (lower part, 147 feet)

45	Shale, dark-gray, hackly, foliated; weathers brown; the graptolite *Diplograptus* common on some bedding surfaces	147

Lenoir and Mosheim limestones (102 feet)

		Thickness Feet
44	Limestone, argillaceous, dark-gray, thick-bedded; a few small pyrite crystals; partly covered including upper contact (R-4057)	17
43	Limestone, gray, micrograined to very fine-grained, thick-bedded; fossiliferous with brachiopods and high-spired gastropods including *Helicotoma* sp.	28
42	Limestone, dark-gray, micrograined, dense, thick-bedded	17
41	Dolomite, light-gray, very fine-grained, with calcite crystals in veinlets	6
40	Limestone, light gray, micrograined, dense; fossiliferous with the gastropod *Loxoplocus* (*Lophspira*) cf. *L.* (*L*) *bicincta* (Hall)	34
Unconformity (Contact between units varies about 25 feet due to erosion) (Figure 12)		
Knox Group, (*uppper part*) (685 feet)		
39	Dolomite, gray, very fine-grained, medium-bedded	174
38	Limestone, light-gray, fine-grained; argillaceous laminae, some oolitic interbeds; measured along exit 4 of Interstate Highway 81	14
37	Dolomite, light-gray, cherty interbedded with gray straticulate limestone containing low-spired gastropods	28
36	Chaotic beds; light-gray, fine-grained dolomite; grayish-green and maroon, calcareous shale in irregular pockets; gray and purplish-gray, micrograined, straticulate, fossiliferous limestone in which the low-spired gastropods "*Murchisonia*" sp. and cf. *Pararaphistoma* are common; trilobite fragments rare; some pyrite crystals (R-4056)	22
35	Dolomite, light-gray, sucrosic, fine-grained, cherty, thick-to massive-bedded; some beds micrograined and thinly laminated; includes a 3-foot-thick zone of dolomite-chert collapse-breccia	159
34	Covered for the most part; abundant white-chert float with dolomolds; a few outcrops of light-gray, fine to very-fine grained, thick-to medium-bedded, cherty dolomite	120
33	Dolomite, light-gray, fine-to very fine-grained, thick-to medium bedded; some white to light-gray chert in thin layers and nodules; includes a 1-foot-thick zone of dolomite-breccia	28
32	Covered; abundant float of white chert with dolomolds; distinctive soil is orange-red	140
Chepultepec Formation (801 feet)		
31	Limestone, gray, micrograined, massive; irregularly spaced argillaceous laminae; weathers to mottled light pink and light gray; upper part covered; fossils in beds about 100 yards north of U.S. Highway 11 incude a high-spired gastropod, a flat-coiled cephalapod, and two species of the small trilobites ? *Macropyge* sp. and ? *Hystricurus* sp.	414
30	Limestone, dark-gray; black chert nodules; worm trail-like markings on bedding planes; partly covered	63
29	Dolomite, gray, micrograined, medium-bedded	3
28	Limestone, gray, very fine-grained, weathers to light bluish-gray, massive to medium-bedded; in part thinly laminated with	

		Thickness Feet
	some black chert nodules and argillaceous worm trail-like markings on some bedding planes	129
27	Covered	86
26	Limestone, bluish-gray; some black chert nodules; partly covered; dip 20° SE.	106
Conococheague Formation (1790 feet)		
25	Covered; top not exposed	56
24	Limestone, dark-gray, micrograined, straticulate	1
23	Covered; float blocks of subrounded, fine-to coarse-grained, brown sandstone and light-gray chert	335
22	Limestone, dark bluish-gray, micrograined, laminated	1
21	Covered; some sandstone float	179
20	Limestone, gray, micrograined; weathers to light-gray; gray chert nodules at base; straticulate in upper part; at top of unit are float blocks of medium-grained, rounded, brown sandstone; dip 34° SE. (R-4054)	28
19	Sandstone, brown, fine-to medium-grained, subrounded, frosted, well-sorted	3
18	Limestone, bluish-gray, micrograined, straticulate; thinly laminated in part; at base float of medium-grained, subrounded, brown sandstone; dip 34° SE	118
17	Covered; sandstone float	118
16	Dolomite, light-gray, micrograined, calcareous; interbeds of micrograined, gray limestone with layers of black chert nodules (R-4053)	118
15	Limestone, light-gray, micrograined to very fine-grained, thin- to very thin-bedded, dense; some beds of dolomitic limestone and dolomite	275
14	Few exposures of limestone and dolomite; much float of gray to light-gray chert, some very fine oolitic	275
13	Limestone, gray, medium-bedded; argillaceous laminae	140
12	Dolomite, light-gray, very fine-grained; some dark-gray, limestone with argillaceous light-gray laminations	138
11	Sandstone, brown, very-fine to fine-grained, subrounded, friable	1
10	Dolomite, light-gray, very fine-grained, partly laminated; partly sandy with very fine-grained quartz	4
Maynardville Formation (106 feet)		
9	Limestone, dark-gray, very fine-grained, dense, thick-bedded	106
Nolichucky Formation (152 feet)		
8	Limestone, bluish-gray, thick-and thin-bedded, with grayish-brown, argillaceous laminations which weather to orange-brown; knobby; some thin-layers of limestone-pebble conglomerate and oolitic limestone with trilobite fragments	114
7	Limestone, dark-gray, medium-grained, medium-to thin-bedded; few trilobite fragments (R-4052)	38
Honaker Formation (1445 feet)		
6	Dolomite, light-gray, micrograined, medium- to thin-bedded; occasional pyrite crystals; near top is fine-grained, massive-	

		Thickness Feet
	bedded, gray dolomite	359
5	Covered	287
4	Limestone, bluish-gray, micrograined to very fine-grained, laminated; some layers with cryptozoon mounds; interbeds of dolomite weathering to very light gray; some thin beds of oolitic limestone and limestone-pebble conglomerate consisting of light-gray micrograined pebbles in a very fine-grained, gray matrix; dip 56° SE.	89
3	Dolomite, light-gray, very fine-grained, medium- to thick-bedded; micrograined, dark-gray limestone; average dip 52° SE.	168
2	Dolomite, light-gray, very fine-grained, thin-bedded; fine-grained, sucrosic, medium-bedded dolomite; some float blocks of black and gray cryptozoon chert; unit poorly exposed (R-4051)	542
1	Fault breccia; very fine-grained, calcareous dolomite; breccia fragments cemented by white calcite; dip variable	

Fault

Section M: Susong Branch

From 500 feet north of Interstate Highway 81 adjacent to Wagner Road southeastward along Susong Branch to approximately 800 feet south of Euclid Avenue in Bristol; strike N. 35°. E., dip 21-84° SE.

Knox Group, upper part		
28	Not exposed; to west and south of section in Bristol City it is characterized by light-gray dolomite and abundant white chert with distinctive dolomite rhomb molds	
Chepultepec Formation (752 feet)		
27	Covered; contact projected from nearby field data in Bristol City	525
26	Dolomite, gray, very fine-grained, calcareous, medium-bedded	2
25	Limestone, dark-gray, very fine-grained, dense, thick-bedded; reddish-brown, wavy argillaceous bands; fossil gastropods. The contact, located at the ball field, has fossil beds at northeast end of field under light posts	225
Conococheague Formation (1820.3 feet)		
24	Dolomite, light-gray; some limestone, gray, micrograined	100
23	Quartzite, light-gray, fine-to medium-grained, thin-bedded	1
22	Limestone, gray, micrograined; sandy in part; mostly covered	74
21	Limestone, gray, micrograined; straticulate with argillaceous bands; some thin layers of limestone-pebble conglomerate	25
20	Sandstone, brown, fine- to coarse-grained, subrounded, friable	0.3
19	Limestone, dark-gray, micrograined; some thin interbeds of light-gray dolomite, partly with straticulate appearance	19
18	Mostly covered; 2-foot quartzite bed near top which is light-gray, very fine- to medium-grained, and calcareous	27
17	Sandstone, brown, fine- to medium-grained, subanguler to subrounded, friable; located beneath footbridge	2

		Thickness Feet
16	Limestone, dark-gray, micrograined to very fine-grained; thin beds and nodules of black chert; partly covered in upper part to Randolph Avenue	186
15	Sandstone, brown, medium-grained, well-sorted, rounded; gray limestone with thin sandy bands	8
14	Limestone, dark gray, very fine-grained; partly covered	362
13	Sandstone, light grayish-brown, quartzitic, very fine- to fine-grained	2
12	Limestone, dark-gray, very fine-grained; top of unit at Wagner Road bridge	161
11	Dolomite, light-gray, fine-grained; with brown, fine- to medium-grained, rounded, friable, 1-inch-thick standstone bed	18
10	Covered	161
9	Limestone, gray, micrograined; few fossil fragments of gastropods; resembles limestone of Chepultepec Formation	10
8	Limestone, gray to light-gray, micrograined to very fine-grained; minor beds of light-gray dolomite	541
7	Limestone, dark-gray, very fine-grained, medium- to thick-bedded, dolomitic, interbedded with very fine-grained, medium-bedded, light-gray to gray dolomite	96
6	Dolomite, light-gray to gray, very fine-grained, medium-bedded; weathers to buff color	27
Maynardville Formation (134 feet)		
5	Limestone, dolomitic, dark-gray, very fine-grained, medium-to thick-bedded; some beds straticulate; partly covered	134
Nolichucky Formation (346 feet)		
4	Limestone, bluish-gray, knobby, very thin-bedded; shaly partings which weather to brown silt and very fine sand; some grayish-green shale beds; less fossiliferous than unit 3; upper portion partly covered	205
3	Shale, gray to grayish-green, slightly silty; some very thin-bedded, argillaceous, knobby limestone; numerous cystoid plates, the brachiopod *Dicellomus appalachia* Walcott, and the trilobite *Norwoodella* cf. *N. saffordi* Walcott (R-4059)	141
Honaker Formation (uppermost 1113 feet exposed to Bristol fault)		
2	Dolomite, gray to light-gray, very thin- to medium-bedded, micrograined to very fine-grained; trace of pyrite crystals; some gray, coarsely crystalline dolomite at top; mostly covered; probably some limestone beds	913
1	Shattered zone: fractured, gray dolomite with calcite veinlets; dips are erratic near Bristol fault	200
Bristol fault		

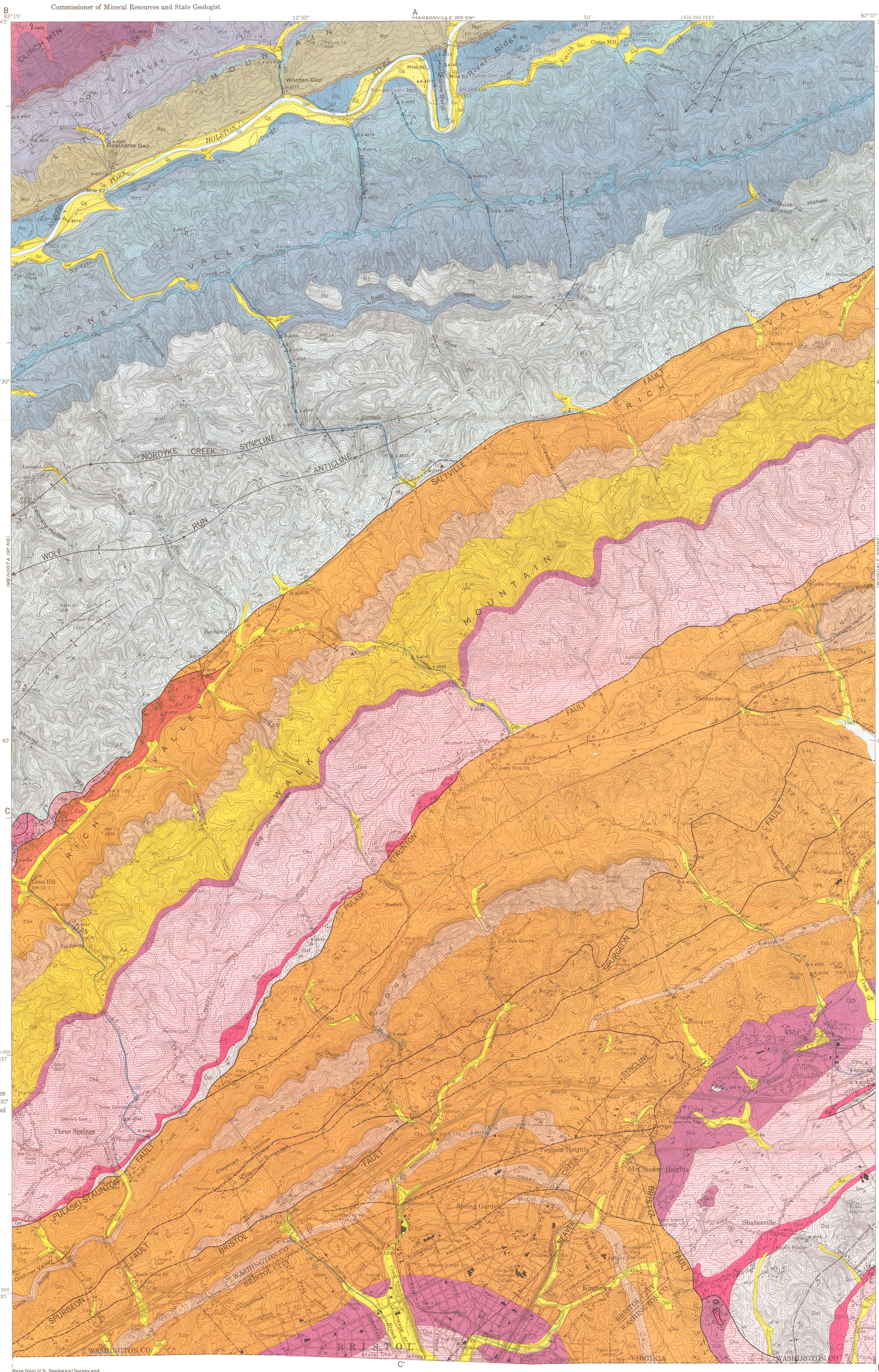
Section N: Interstate 381

From southwest of junction of Interstate Highway 381 and Exit 2 of Interstate Highway 81 southwestward along high road cut of Interstate Highway 381; strike N. 20° E., dip 28° SE.

		Thickness Feet
Conococheague Formation (lower part, 20 feet)		
12	Limestone, gray, very fine-grained, very thinly laminated, straticulate	20
Maynardville Formation (87 feet)		
11	Limestone, dark-gray, micrograined to very fine-grained, mostly covered	87
Nolichucky Formation (316.5 feet)		
10	Covered, upper contact not exposed	47
9	Limestone, gray, knobby, very thin-bedded, silty; contains shale partings which decrease in number toward top and 12 limestone conglomerate beds similar to unit 8 (Figure 8); limestone becomes more silty toward top	111
8	Limestone conglomerate, medium-bedded, oolitic in top half; gray, micrograined, rounded, limestone pebbles to 2 inches in diameter in coarse-grained matrix (R-4061)	2
7	Limestone, knobby, interbedded with gray to grayish-green, calcareous, very thin-bedded shale; contains the brachiopod *Dicellomus appalachia* Walcott; some medium-bedded limestone	78
6	Shale, gray, silty, fissile; minor limestone beds	25
5	Limestone, gray, micrograined to very fine-grained, medium-bedded, argillaceous; few beds slightly oolitic with trilobite fragments; upper part more knobby; red-brown streaks and splotches on weathered surface; some coarse-grained, dark-gray limestone	25
4	Limestone, gray, knobby, very thin-bedded; argillaceous partings; many beds with trilobite fragments; some thin beds of gray shale	28
3	Shale, dark-gray, very fissile, silghtly silty	0.5
Honaker Dolomite (upper part, 268 feet)		
2	Dolomite, light-gray to dark-gray, thinly laminated to medium-bedded, micrograined to very fine-grained, some beds with vugs and pyrite crystals	267
1	Limestone, lightgray, micrograined	1

INDEX

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



Base from U.S. Geological Survey and Tennessee Valley Authority,
Bristol Quadrangle 1959, Wallace Quadrangle 1960
Bristol and Wallace Quadrangles, 7½-Minute Series

GEOLOGIC MAP OF THE BRISTOL AND WALLACE QUADRANGLES, VIRGINIA

Geology by Charles S. Bartlett, Jr. and Harry W. Webb

1960 MAGNETIC DECLINATION

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET

QUADRANGLE LOCATION

1970

EXPLANATION

CENOZOIC — QUATERNARY

Qal — Alluvium
Varicolored unconsolidated sand, clay, and gravel.

Qg — Terrace deposits
Varicolored unconsolidated sand, clay, and gravel; colluvium.

PALEOZOIC — MISSISSIPPIAN

Mp — Pennington Formation
Interbedded gray siltstone, shaly sandstone, argillaceous limestone, and silty shale; mostly maroon and greenish-gray in upper portion.

Mcc — Cove Creek Limestone
Gray, argillaceous limestone, most of which is thinly laminated; weathers to pale gray.

Mf — Fido Sandstone
Maroon to brown, cross-bedded, thick-bedded, fine-grained sandstone; partly crinoidal.

Mgp — Gasper limestone
Gray to light-gray, argillaceous, thin- to thick-bedded limestone; partly crinoidal; few oolitic layers.

Msg — Ste. Genevieve limestone
Gray, argillaceous, medium-bedded limestone; uppermost beds are maroon, crinoidal limestone; lower portion contains gray, cherty, medium-grained, crinoidal limestone with horn corals; some calcareous sandstone.

Mhd — Hillsdale Limestone
Light- to dark-gray, cherty, dense, medium-bedded limestone.

Mlv — Little Valley Formation
Gray, calcareous shale predominant in upper portion; gray, cherty limestone and thin sandstone beds in middle part; and gray, shaly limestone in lower part.

Mmc — Maccrady Formation
Maroon and light-green shale and mudstone and pink, micaceous siltstone.

Mpr — Price Formation
Gray, medium-bedded sandstone and siltstone; conglomeratic at top; thin glauconitic beds in upper part; gray, silty shale in middle and lower portions. Includes black, fissile Big Stone Gap Shale at bottom.

DEVONIAN

Dch — Chemung Formation
Light-gray siltstone and sandstone interbedded with light greenish-gray, silty shale; quartz-pebble conglomerate at top.

Db — Brallier Formation
Greenish-gray to black, silty shale with minor light-gray siltstone interbeds.

Dm — Millboro Shale
Dark-gray to purple and orange, fissile, slightly silty shale.

Dht — Huntersville Formation
White to gray, blocky chert; gray-brown siltstone and sandstone with some glauconite.

SILURIAN

Scl — Clinton Formation
Light-gray to purplish-gray, thick-bedded siltstone and sandstone; conglomeratic at top; contains some light greenish-gray and maroon, silty shale.

Stu — Tuscarora Sandstone
Light-gray, thick-bedded, ripple-marked, cross-bedded sandstone.

ORDOVICIAN

Om — Moccasin Formation
Maroon and mottled maroon to light-gray, argillaceous, thin-bedded limestone.

Omu — Middle Ordovician rocks, undivided
Light-gray, thin-bedded, knobby limestone with two thick beds of pink, coarse-grained limestone; some brown calcareous shale in lower portion.

Oat — Athens Formation
Gray, fissile shale, with minor light-gray, thin-bedded, argillaceous limestone along the Pulaski-Staunton fault.

Olm — Lenoir and Mosheim limestones
Lenoir: gray to dark-gray, thick-bedded limestone with minor chert. Mosheim: light-gray, dense, medium-bedded limestone with numerous white calcite inclusions.

Oku — Knox group, upper part
Light-gray, fine- to coarse-grained, cherty dolomite with some beds of blue-gray limestone; zones of collapse breccia with pockets of gray and maroon shale in upper part.

Och — Chepultepec Formation
Dark blue-gray, thick-bedded, partly cherty limestone with minor gray dolomite.

CAMBRIAN

Ꞓco — Conococheague Formation; **Ꞓcr** — Copper Ridge Formation
Conococheague: dark-gray to blue-gray, medium-bedded, partly cherty limestone, with light-gray, dense dolomite and numerous thin beds of brown, medium-grained sandstone near base and in middle and upper portions. Bottom portion includes Maynardville Formation that consists of dark-gray, thick-bedded, partly sandy, straticulate limestone. Copper Ridge: gray to light-gray, medium-bedded dolomite, with gray, sandy, cherty limestone and thin beds of brown, medium-grained sandstone near base and in middle and upper portions. Bottom includes Maynardsville.

Ꞓn — Nolichucky Formation
Gray-green, silty, fissile shale and blue-gray, argillaceous, very thin- to medium-bedded limestone, with some limestone-pebble conglomerate; distinctive blue-gray, thick-bedded, oolitic limestone present in middle part in northernmost outcrop area.

Ꞓhk — Honaker Formation
Gray to light-gray, medium-bedded, partly cherty dolomite; interbeds of dark blue-gray limestone with algal zones in middle portion.

Ꞓpv — Pumpkin Valley Shale
Gray-brown, gray-green, and maroon, silty, partly micaceous shale with minor thin beds of gray dolomite.

Ꞓr — Rome Formation
Interbedded gray-brown, gray-green, and maroon silty shale; maroon calcareous siltstone; and light-gray argillaceous dolomite.

CONTACTS

- exposed
- approximate
- covered or inferred

FOLDS

- Anticline—trace of axial plane and direction of plunge of axis
- Syncline—trace of axial plane and direction of plunge of axis

FAULTS

THRUST

- exposed
- approximate
- covered or inferred
- T — overthrust side

NORMAL

- exposed
- approximate
- U — upthrown side
- D — downthrown side

BRECCIA

b — Brecciated beds

ATTITUDES OF ROCKS

- 45 — Strike and dip of beds
- 60 — Strike and dip of overturned beds
- Strike of vertical beds
- Horizontal beds

QUARRIES

Active quarry
11. Vulcan Materials Company, Midsouth Division—limestone (crushed stone)

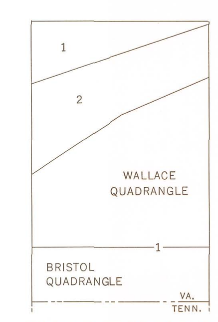
Inactive or abandoned quarry
1. Limestone (decorative stone)
2. Limestone (decorative stone)
3. Shale
4. Shale
5. Shale
6. Dolomite
7. Dolomite and shale
8. Dolomite and limestone
9. Limestone
10. Limestone

OIL AND GAS TEST

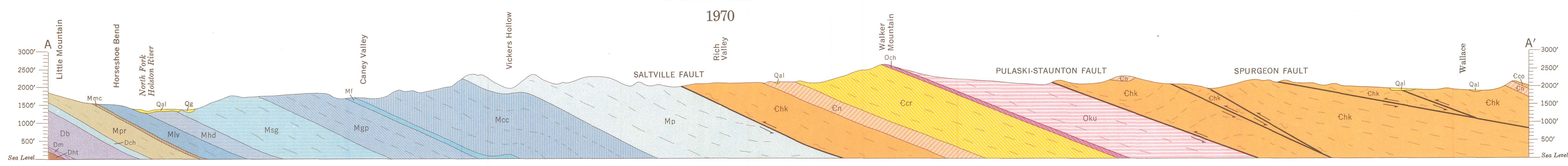
Dry hole
Holston Oil and Gas Company, W. E. Leonard

SAMPLE LOCATIONS

- R-4050 — Location and repository number of sampled lithology
- R-2517 — Location of sample with potential use for common brick manufacture
- F — Location from which fossils were collected
- Ⓐ — Location of measured stratigraphic section that is described in text



CREDIT FOR GEOLOGIC MAPPING
1. Bartlett and Webb
2. After Averitt, 1941



Interpretive cross sections
with no vertical exaggeration