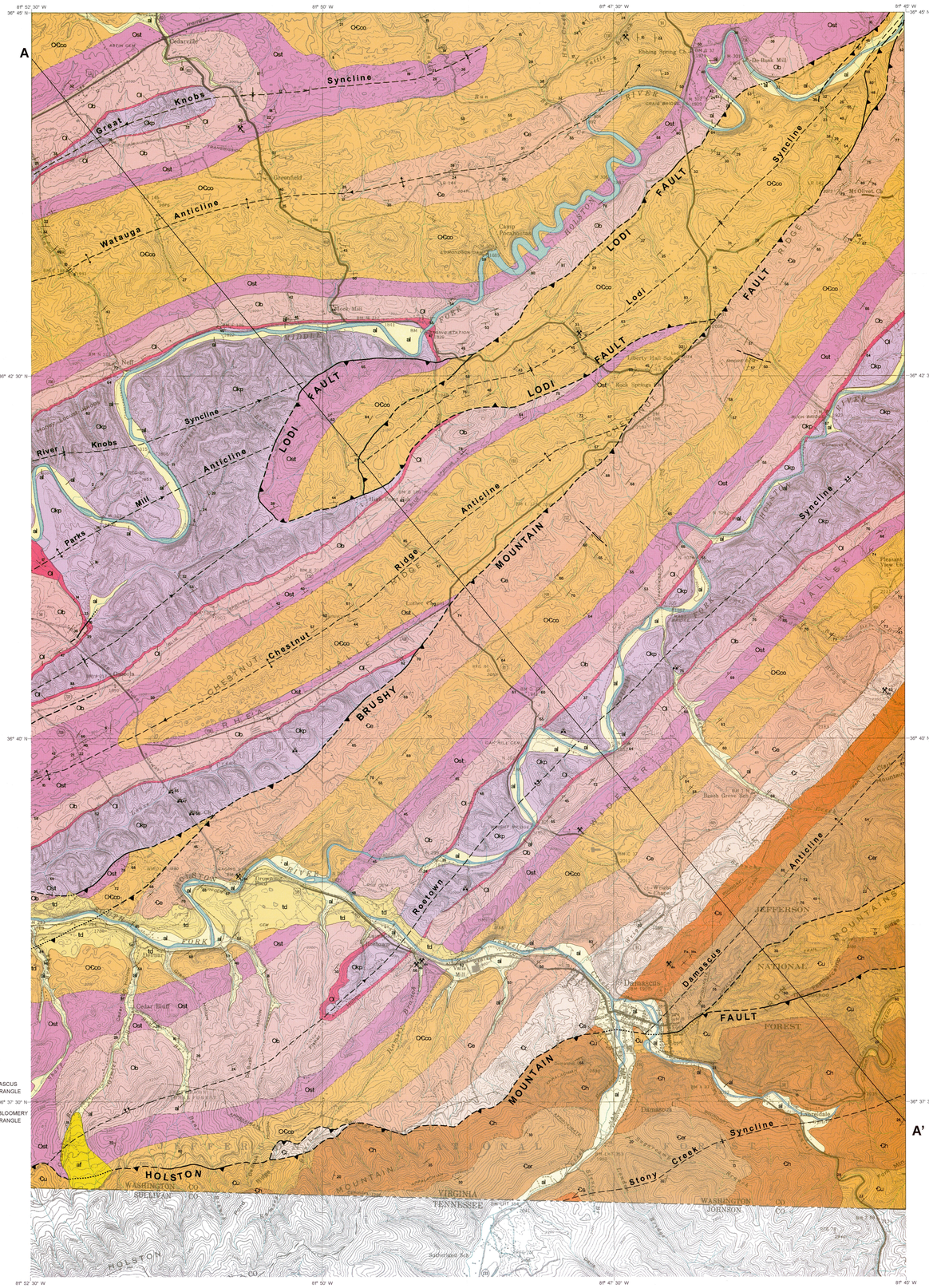
COMMONWEALTH OF VIRGINIA
DEPARTMENT OF MINES, MINERALS AND ENERGY
DIVISION OF MINERAL RESOURCES

PUBLICATION 172
GEOLOGY OF THE DAMASCUS AND
LAUREL BLOOMERY QUADRANGLES, VIRGINIA

GEOLOGY OF THE DAMASCUS AND LAUREL BLOOMERY QUADRANGLES, VIRGINIA

William W. Whitlock[1] and James R. Derby[2]

2005



DAMASCUS QUADRANGLE
36° 37' 30" N
LAUREL BLOOMERY QUADRANGLE

EXPLANATION

QUATERNARY

al **Alluvium**: Unconsolidated clay, silt, sand, gravel, cobbles, and boulders, including cobbles and boulders of quartzite from the Unicoi, Hampton, and Erwin Formations. Alluvium as much as 20 feet thick is along most streams in the map area.

af **Alluvial fan**: An alluvial fan of unknown thickness, at the head of Gimlet Branch, is comprised of rock from the Unicoi Formation along Holston Mountain.

td **Terrace deposit**: Unconsolidated clay, silt, sand, gravel, cobbles, and boulders, including cobbles and boulders of quartzite from the Unicoi, Hampton, and Erwin Formations. Terrace deposits, laid down during past higher stream levels, are as much as 250 feet above present stream levels.

ORDOVICIAN

Okp **Knobs formation of Tyler (1960) and Paperville Shale**
Knobs formation of Tyler (1960): Sandstone, light-olive-gray, medium- to thick-bedded, fine- to coarse-grained to conglomeratic, feldspathic. Siltstone, medium-gray to dark-greenish-gray, in beds 2 to 8 inches thick. Shale, silty, medium-gray to light-yellowish-brown to moderate-yellowish-brown, very thick-bedded with papery partings. Formerly the upper part of the Athens formation of Butts (1933).
Paperville Shale: Shale, with thin beds of siltstone and sandstone. Shale, dark-gray to brownish-gray to pale-yellowish-brown to dark-yellowish-orange, carbonaceous, calcareous, silty, fissile, contains graptolite fossils. Siltstone, olive-gray, thin- to medium-bedded, locally slightly calcareous. Sandstone, medium-light-gray to pale-brown, with thin layers of medium-dark-gray carbonaceous material, very fine-grained to fine-grained, feldspathic, micaceous, and clayey. Formerly the lower part of the Athens formation of Butts (1933). Thickness: Approximately 1600 feet for combined formations.

Ol **Lenoir Limestone** (includes Mosheim Member): Limestone, medium- to dark-gray, very fine-grained to fine-grained, medium- to thick-bedded, with wavy, silt laminations, black chert nodules common. Limestone, medium-brownish-gray to medium-gray, micrograined, thick-bedded to very thick-bedded, with "birdseye" calcite blebs. The lower several feet of the formation is very fine-grained to medium-grained, medium-light-gray, medium-bedded to very thick-bedded limestone, with limestone, dolostone, and chert fragments as much as 4 inches by 12 inches in size, derived from the underlying formation. The fragmental zone marks the Middle Ordovician unconformity. Significant paleotopographic relief is at the base of this formation. One paleo-sinkhole that is approximately 35 feet deep by 30 feet wide was recognized west of State Road 735 (road number not on map), between State roads 803 and 694, on the south limb of the Great Knobs synclie. Thickness: 0 to 105 feet.

-unconformity-

Ob **Beekmantown Formation**: Dolostone, light-brownish-gray to light-gray, fine- to coarse-grained, medium- to thick-bedded. The upper part of the formation contains several beds of light-brownish-gray, micrograined to fine-grained, silty, cherty limestone. Weathered chert beds commonly contain silicified molds of the planispiral gastropod, *Leconospira coerpacta* (Salter), that are widely found in the Beekmantown and equivalent rocks. Thickness: 600 to 800 feet.

Ost **Stonehenge Limestone**: Limestone, medium-dark-gray, very fine-grained to fine-grained, thick-bedded to very thick-bedded, with irregular silt partings. The silt partings are closely spaced (1 to 2 inches) in several intervals which causes the 1- to 2-foot-thick beds to be flaggy. Silt partings in several beds are pale red to moderate orangish pink. Limestone, medium-dark-gray, very thick-bedded, contains zones of abundant white, gray, and black chalcedonic chert. Beds of flat-pebble conglomeratic, conglomeratic limestone, and sandy limestone; as well as sparse shaley dolostone and laminated dolostone. Stonehenge limestones contain abundant brachiopods, cephalopods, and gastropods, including *Finkelnburgia bellatula* (Ulrich and Cooper), *Gasconadia* sp., and *Dakoceras* sp. Thickness: 350 feet along Chestnut Ridge to 850 feet in Widener Valley.

OCco **Conococheague Formation**: Limestone, in cycles 10 to 15 feet thick composed of: Limestone, dark- to medium-gray, very fine-grained, very thick-bedded, with abundant, closely spaced (0.5 to 1 inch) silt partings, and ribbon-bedded limestone, minor black chert. Limestone grades upward to limestone and dolomitic limestone, medium-light-gray, very fine-grained, thick-bedded, laminated. Generally capped by dolostone, very light-gray, very fine-grained, thick-bedded, laminated in some intervals, "butcher-block" weathering. In some cycles the base is limestone, medium-dark-gray to brownish-gray, micrograined, in beds 1 to 2 feet thick. Sandstone, very pale-orange to grayish-orange to dark-yellowish-orange, fine- to coarse-grained, thin- to thick-bedded, quartzose, calcite and dolomite cemented, in intervals as much as 20 feet thick. Sandstone beds are very common in the upper 500 feet of the formation, and a few sandstones or sandy limestones are present near the base of the formation. Thickness: 1550 to 1800 feet.

Ce **Elbrook Formation**: Although not mapped individually, the Elbrook is divisible into four, informal members: An upper limestone, an upper dolostone; a middle limestone; and a lower, argillaceous dolostone. Formation thickness: approximately 1665 feet.

Upper limestone: Limestone, medium-dark-gray, coarse-grained, very thick-bedded, commonly oolitic, locally conglomeratic, and limestone, medium-gray, very fine-grained to coarse-grained, medium-bedded, with silty streaks and bands, flaggy. Several limestones contain sparse quartz grains. Thrombolitic limestones in beds as much as 2.5 feet thick are locally present. Contains Upper Cambrian *Crepicephalus* zone trilobites. Thickness: 100 to 160 feet.

Upper dolostone member: Dolostone, light-gray, fine-grained, laminated to thin-bedded and dolostone, medium- to dark-gray, coarse-grained, medium- to thick-bedded. Thickness: Approximately 470 feet.

Middle limestone member: Limestone is in cycles 3 to 15 feet thick composed of: limestone, medium-dark-gray, very fine-grained, thick-bedded, overlain by "ribbon-banded" limestone, medium-dark-gray, very fine-grained, alternating every 1 to 2 inches with dolostone, medium-light-gray, weathers yellowish-gray, very fine-grained, capped by dolostone, light-gray, weathers yellowish-gray, very fine-grained, laminated, in beds 1 to 2 feet thick. Locally the thick limestones contain sparse, black chert nodules and discontinuous chert layers 1 to 2 inches thick. Thickness: Approximately 350 feet.

Lower argillaceous dolostone member: Dolostone, light-gray to olive-gray, fine-grained, laminated to thin-bedded, rarely medium- to thick-bedded, argillaceous, platy to shaly. Limestone, light-olive-gray, very fine-grained, argillaceous, platy weathering. Some of the dolostone laminates contain algal bioherms (commonly silicified) up to 1 foot high by 2 feet wide. A few beds of black, laminated chert are present. Thickness: 700± feet.

CAMBRIAN

Cr **Rome Formation**: Shale and silty shale with interbedded siltstone, sandstone, limestone, and dolostone. Shale, variegated grayish-red to pale-olive to dusky-yellow. Siltstone, light-brown to dark-yellowish-orange, thin-bedded. Sandstone, pale-pink to grayish-red, very fine-grained to fine-grained, thin-bedded. Limestone and dolostone, medium-gray, fine-grained, thin- to thick-bedded. Thickness: 1400± feet.

Cs **Shady Dolomite**: Dolostone, very light-brownish-gray, very fine-grained, thick-bedded to very thick-bedded, commonly contains chert, vuggy, white, light-gray, and greenish-gray. Dolostone, very light-gray, thin- to medium-bedded. Dolostone, medium-gray, fine-grained, thick-bedded. Dolostone, white, fine- to coarse-grained, thick-bedded. Dolomitic shale common in upper part. Ribbon-banded dolostone or interbedded dark-gray limestone and light-gray dolostone are present in lower part. Thickness: 1200± feet.

Cer **Chilhowee Group**
Erwin Formation: Very thick-bedded, orthoquartzite is the characteristic lithology of the Erwin Formation; however, two-thirds of the formation is shale, siltstone, and non-quartzose sandstone. Although not individually mapped, the Erwin is subdivided into four members (King and Ferguison, 1960). Formation thickness: 1000-1100 feet.

The members are, in descending order:

Helenmode Member: Shale, yellowish-gray, silty, calcareous, and sandstone, arkosic, with manganese nodules common. Thickness: Approximately 110 feet.

Hesse Quartzite: Quartzite, white to very light-gray, fine- to coarse-grained, locally pebbly, medium- to thick-bedded, with minor interbeds of shale. Thickness: Approximately 140 feet.

Murray Shale: Shale, yellowish-gray and siltstone, sandy, shaly, micaceous, dark-greenish-gray, with thin interbeds of sandstone, fine- to medium-grained, arkosic. Thin beds of white quartzite similar those in the Hesse. Thickness: Approximately 800 feet.

Nebo Quartzite: Quartzite, white to very light-gray, fine- to coarse-grained, medium- to thick-bedded, *Scolithus* tubes common. Thickness: Approximately 60 feet.

Ch **Hampton Formation**: Siltstone and shale, with interbeds of minor sandstone and quartzite. Siltstone, dark-yellowish-orange to greenish-gray, thin-bedded to very thin-bedded. Shale, dark-yellowish-orange, clay, laminated. Sandstone, medium-light-gray, very fine-grained to coarse-grained, very thin-bedded to thin-bedded. Quartzite, very light-gray, with reddish staining in some intervals, medium- to coarse-grained, with some zones of quartz granules, medium- to thick-bedded, cross-bedded. Sandstone, light-yellowish-brown and light-greenish-gray, fine- to coarse-grained, with zones of quartz granules, medium- to thick-bedded, feldspathic. Thickness: 2070 feet from measurements by L.E. Smith (King and Ferguson, 1960).

Cu **Unicoi Formation**: Sandstone, reddish-brown, medium- to coarse-grained, medium- to thick-bedded, conglomeratic, arkosic. Quartzite, white, pebbly, thick-bedded. Shale, micaceous, sandy, some clay shale. Upper 60 feet of formation is a ledge-forming, very thick-bedded quartzite. Thickness: Only the upper 1500 feet is present within the mapped area, the base has been cut out by faulting.

System and Series	Formation	Lithology
Quaternary	Alluvium, colluvium, terrace deposits, alluvial fan	
ORDOVICIAN — UPPER	Knobs formation of Tyler (1960) and Paperville Shale	
ORDOVICIAN — MIDDLE	Lenoir Limestone (Mosheim)	
ORDOVICIAN — LOWER	Beekmantown Formation	
ORDOVICIAN — LOWER	Stonehenge Limestone	
ORDOVICIAN — UPPER	Conococheague Formation	
ORDOVICIAN — MIDDLE	Elbrook Formation	
CAMBRIAN — LOWER	Rome Formation	
CAMBRIAN — LOWER	Shady Dolomite	
CAMBRIAN — LOWER	Chilhowee Group: Erwin Formation	
CAMBRIAN — LOWER	Chilhowee Group: Hampton Formation	
CAMBRIAN — LOWER	Chilhowee Group: Unicoi Formation	

SYMBOL LEGEND

ATTITUDE OF ROCKS
- Strike and dip of beds
- Strike of vertical beds
- Strike and dip of overturned beds

FOLD TRACES
- Anticline (with plunge direction)
- Syncline (with plunge direction)
- Overturned syncline (with plunge direction)

CONTACTS
- Solid where observed; dashed where location known to less than 50 meters; and dotted where location is inferred with a certainty of more than 50 meters.

FAULTS
- Solid where observed; dashed where location is known to less than 50 meters; barbs are on the upper plate of thrust fault. Arrows show direction of relative movement.
- Rock block slide

MINERAL RESOURCES
- Active quarry 1. Glade Stone, Inc.
- Inactive quarry Is limestone do dolostone
- Active shale pit
- Inactive shale pit
- Mineral prospect Fe Iron Mn Manganese

SCALE = 1:24,000

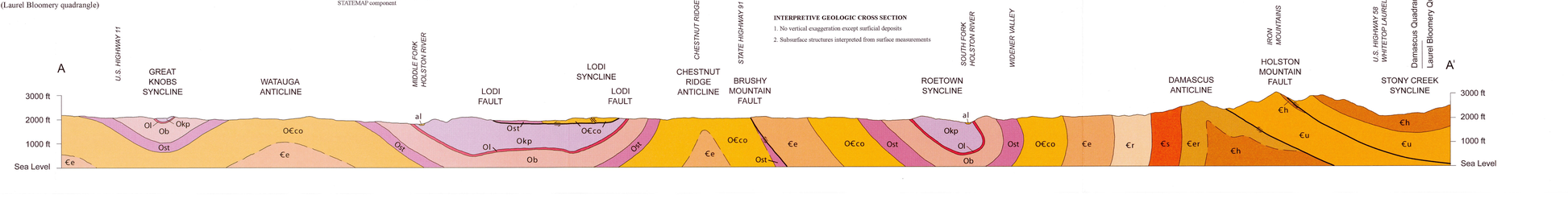
0 1 2 3 kilometers
0 1 2 miles
0 2,000 4,000 6,000 8,000 10,000 feet

Contour interval
20 feet (Damascus quadrangle)
40 feet (Laurel Bloomery quadrangle)

DECLINATION DIAGRAM
Direction of North and Magnetic Declination (MN) Indicated Diagram is approximate

Base maps are modified U. S. Geological Survey DRGs
1969 Damascus Quadrangle, Virginia
1969 Laurel Bloomery Quadrangle, Virginia
7.5-minute Series (1:24,000)
Projection: Polyconic
NAD 1927 Datum

Map preparation in cooperation with the U.S Geological Survey under the National Cooperative Geologic Mapping Program - STATEMAP component



INTRODUCTION

The Damascus 7.5-minute quadrangle and the Virginia portion of the Laurel Bloomery 7.5-minute quadrangle are located in southeastern Washington County, Virginia. Much of the map area lies within the Valley and Ridge physiographic province. The Holston and Iron mountains are underlain by Cambrian-age Unicoi, Hampton, and Erwin Formations and are part of the Blue Ridge province.

The topography consists primarily of broad, low hills formed on carbonate rocks, separated by ridges of sandstone, siltstone, and shale of the Paperville Shale and Knobs formation (of Tyler, 1960)(sic). The southern and southeastern parts of the map area are high ridges of Holston and Iron mountains, held up by sandstones and quartzites of the Unicoi, Hampton, and Erwin Formations.

Field work for this study was conducted between July 2002 and June 2003. The western third of the map area, mapped by Tyler (1960) as part of his Master's thesis at Virginia Polytechnic Institute, was remapped during this project. The eastern two-thirds of the map area, mapped by Derby (1961) as part of his Master's thesis at Virginia Polytechnic Institute, were field checked with additional mapping in several areas by the senior author.

STRATIGRAPHY

Approximately 13,500 feet of Cambrian- through Ordovician-age limestone, dolostone, shale, sandstone, quartzite, siltstone, and conglomerate are exposed in the map area. The rocks are divided into 11 mappable bedrock units. Alluvium, terrace deposits, and one alluvial fan deposit were also mapped. Colluvium along the slopes of Holston and Iron mountains is ubiquitous and was not mapped. Detailed lithologic descriptions are given in the explanation.

Chilhowee Group

The Unicoi, Hampton, and Erwin Formations, in ascending order, constitute the Cambrian-age Chilhowee Group and consist of interbedded sandstone, quartzite, siltstone, shale, and conglomerate. The Hampton Formation has less sandstone and quartzite than the underlying Unicoi Formation or the overlying Erwin Formation. The top of the Unicoi Formation is marked by a ledge-forming quartzite as much as 60 feet thick. This quartzite forms a prominent ledge along State Highway 91, approximately 0.5 mile north of the Virginia-Tennessee state line. The contact between the Hampton and the Erwin Formations is commonly above shale and thin-bedded sandstone and quartzite of the Hampton and below thick to very thick-bedded quartzites of the Erwin Formation. The contact is covered throughout much of the map area. These formations form the Holston and Iron mountains in the southern part of the map area.

Shady Dolomite

The Shady Dolomite is poorly exposed on the northwest slope of the Iron Mountains, east and northeast of Damascus. One good exposure is along the north bank of Laurel Creek in the town of Damascus. King and Ferguson (1960) measured approximately 1200 feet of dolostone and minor dolomitic shale along that outcrop. The contact with the overlying Rome Formation is covered throughout the map area.

Rome Formation

The Rome Formation forms a northeast trending belt west and north of Damascus. A fault slice of Rome is located west of the Holston Mountain fault at the head of Ramsey Branch in the Laurel Bloomery quadrangle. The formation is variegated grayish-red, pale-olive, and dusky-yellow shale, light-brown to dark-yellowish-orange, thin-bedded siltstone, and pale-pink to grayish-red, very fine-grained to fine-grained, thin-bedded sandstone, with interbedded, thin- to thick-bedded limestone and dolostone. The shaley composition and reddish color make it a distinctive unit between the underlying and overlying carbonate formations. The lower and upper contacts are not exposed in the map area. Much of the Rome is poorly exposed, but areas underlain by the formation are easily recognized by the purplish to reddish soil and the steep-sided, conical hills that develop on it.

Elbrook Formation

Three belts of the Elbrook Formation are exposed in the map area: Along the axis of the Watauga anticline north of the Middle Fork of the Holston River; south of the Brushy Mountain fault; and in a northeastward-trending belt west and north of Damascus. Although not mappable as individual units, the Elbrook can be divided into four, informal members (Derby, 1961, p. 40-52, table 4). An upper member consists of medium-dark-gray, coarse-grained, very thick-bedded, oolitic limestone and is 100 to 160 feet thick. It contains abundant trilobites of the early Late Cambrian *Crepicephalus* zone (Derby, 1961, 1965). Below the limestone member is an upper dolostone member composed of approximately 470 feet of light-gray, fine-grained, laminated to thin-bedded dolostone and medium- to dark-gray, coarse-grained, medium- to thick-bedded dolostone. A middle limestone member consists of 350 feet of limestone, in cycles that are 3 to 15 feet thick. The cycles are composed of: medium-dark-gray, very fine-grained, thick-bedded limestone; overlain by "ribbon-banded", medium-dark-gray, very fine-grained limestone, alternating every 1 to 2 inches with medium-light-gray, very fine-grained, dolostone, capped by light-gray, very fine-grained, laminated dolostone, in beds 1 to 2 feet thick. The lowest member is 700 feet of light-gray to olive-gray, fine-grained, laminated to thin-bedded, argillaceous dolostone and light-olive-gray, very fine-grained, argillaceous limestone. The Elbrook Formation is equivalent to the Honaker and Nolichucky Formations mapped in the Abingdon and Shady Valley quadrangles by Bartlett and Biggs (1980).

Conococheague Formation

The Conococheague Formation is widespread in the map area. It crops out across much of the northwestern part of Damascus quadrangle, along the axis of the Chestnut Ridge anticline, and on the north and south limbs of the Roetown synclie. A fault-bounded outcrop of Conococheague is north of Chestnut Ridge.

Throughout much of the formation the rocks are in cycles composed of: A lower thick-bedded limestone, overlain by interbedded laminated dolostone and limestone that gives the rock a "ribbon-rock" appearance, with a cryptalgal laminate of dolostone to dolomitic limestone at the top. These cycles are typically 10 to 15 feet thick. The cyclic nature of the rocks results in discontinuous outcrops of limestone on the natural slope. In contrast, the overlying Stonehenge Limestone normally crops out as thick intervals of limestone on the natural slope. Derby (1965) reported a trilobite, *Plethometopus convexus* (Whitfield) from 580 feet above the base of the Conococheague in Widener Valley. The *Trempealeauian* (Late Cambrian) species confirms the Late Cambrian age of the lower part of the formation.

The base of the Conococheague Formation is mapped below the lowest sandstone of the Conococheague and above the uppermost limestone of the Elbrook Formation. The sandstone was not found in some places. In these areas, the base is mapped at the bottom of the lowest dolostone of the Conococheague and above limestone of the Elbrook. The top of the Conococheague Formation is mapped at the top of the uppermost quartz sandstone in the upper Conococheague and below medium-gray, thick-bedded limestone of the Stonehenge Limestone. Where the sandstone was not found, the top is mapped above laminated to thick-bedded limestone and dolostone of the Conococheague and below the thick-bedded limestone of the Stonehenge. The Conococheague generally has a lower dolostone unit, which is approximately 300 feet thick (Derby, 1961).

Stonehenge Limestone

The Stonehenge Limestone is exposed throughout the map area in belts adjacent to the Conococheague Formation. The Stonehenge is generally a very thick-bedded, medium-dark-gray limestone. Minor silty zones are near the base. White, gray, and black chert nodules are present throughout the formation. The Stonehenge contains abundant brachiopods (*Finkelnburgia bellatula*), gastropods, and cephalopods. Rocks of this formation were mapped as Chepultepec Limestone by Bartlett and Biggs (1980) in the Abingdon and Shady Valley quadrangles adjacent to the west of this mapped area and as the Barron Creek limestone by Derby (1961) and Tyler (1960) in their Master's theses. Stonehenge Limestone conforms to terminology used east of the Pulaski fault. The trace of the Pulaski fault lies north of the map area.

Beekmantown Formation

The Beekmantown Formation crops out in northeastward-trending belts throughout the map area. The formation consists of light-brownish-gray to light-gray dolostone with several beds of light-brownish-gray limestone in the upper part of the formation. The base is mapped below dolostone of the Beekmantown and at the top of the limestone of the Stonehenge. The Middle Ordovician unconformity is at the top of the Beekmantown Formation. The erosional surface is marked by dolostone fragments from the underlying Beekmantown that are cemented into the overlying Lenoir Limestone and by breccia-filled paleosinkholes at the top of the Beekmantown Formation. The Beekmantown Formation was previously mapped as "Knox Group, upper part" by Bartlett and Biggs (1980) and as the Avem formation by Tyler (1960) and Derby (1961).

Lenoir Limestone

The Lenoir consists of medium- to dark-gray, medium- to thick-bedded limestone. Medium-gray, micrograined limestone near the base represents the Mosheim Member. The Mosheim was reduced to member status in Tennessee by Rodgers (1953). Medium- to very thick-bedded limestone in the lower several feet of the formation, which contains limestone, dolostone, and chert fragments, represents the Middle Ordovician unconformity.

The formation typically crops out along the base of knobs held up by the Paperville Shale and Knobs formation; however, in several areas, the Lenoir Limestone is absent because of non-deposition on "paleo-highs" of the Middle Ordovician unconformity. Lenoir Limestone is discontinuous along the eastern part of the knobs of the Great Knobs synclie where it crosses State Road 803 and on the south side of the knobs west of State Road 803. It is also discontinuous along the flanks of the Roetown synclie east of Laurel Creek. In these areas, Paperville Shale lies directly on the Beekmantown Formation. A limestone in the upper part of the Beekmantown Formation may have been misidentified in the Abingdon quadrangle where the Lenoir Limestone is discontinuous. This may have resulted in outcrop patterns of the Lenoir Limestone that do not match across the boundary between the Abingdon and Damascus quadrangles along the Great Knobs.

Paperville Shale and Knobs Formation (of Tyler, 1960), undivided

The Paperville Shale is primarily dark-gray to brownish gray, fissile shale with interbeds of sandstone and siltstone. The overlying Knobs formation (of Tyler, 1960) is predominantly sandstone with conglomerate, shale and siltstone interbeds. Knobs formation is an informal name proposed by Tyler (1960) in his Master's thesis at Virginia Polytechnic Institute. Bartlett and Biggs (1980) mapped these formations in adjacent areas as the Athens Formation (of Butts, 1933).

A transitional contact between the two formations is difficult to identify because of poor exposures on the natural slope. Therefore, they are mapped as one unit in the map area. The combined formations form the knobs along the Great Knobs syncline in the northwest part of the map area, south of the Middle Fork of the Holston River, north of the Brushy Mountain fault, and along the axis of the Roetown syncline along the South Fork of the Holston River.

STRUCTURE

The map area is underlain by synclines and anticlines separated by the Lodi, Brushy Mountain and Holston Mountain faults. The entire map area north of Holston and Iron Mountains is part of the Pulaski thrust sheet. The trace of the Pulaski fault lies northwest of the Damascus quadrangle. North of the Brushy Mountain fault, the anticlines and synclines are broad, open structures. Between the Brushy Mountain fault and the Holston Mountain fault the beds are steeply dipping to overturned in tightly folded synclines and anticlines. Unicoi, Hampton, and Erwin Formations of the Blue Ridge province underlie the Holston and Iron Mountains. These formations have been thrust northwest over the younger Valley and Ridge rocks. They are folded into the Stony Creek synclie.

Great Knobs Syncline

The Great Knobs synclie is in the northwest corner of the map area. Rocks in the northeastward-trending synclie have been folded into a symmetrical structure with dips of 8 to 38 degrees and a southwest plunge. Vertical dips within the synclie are of local extent only. The Knobs formation and Paperville Shale are the youngest rocks exposed in the axis of the synclie.

Watauga Anticline

The Watauga anticline is a northeastward-trending, broad, open fold southeast of the Great Knobs synclie. Second-order folds in the Stonehenge Limestone and Conococheague Formation flank the anticline. The Elbrook is the oldest formation exposed in the anticline within the map area. The axis of the anticline plunges southwestward and northeastward away from the Elbrook outcrop.

River Knobs Syncline and Parks Mill Anticline

A broad, relatively flat synclinal structure is in the western part of the map area, in the vicinity of the Middle Fork of the Holston River. Within the broad structure are the River Knobs synclie, the Parks Mill anticline, and an unnamed synclie. These second-order folds become more prominent to the southwest in the Abingdon quadrangle. The eastern part of these structures has been overridden by the Lodi fault.

Brushy Mountain and Lodi Faults

The Brushy Mountain fault is a northeastward-trending, steeply dipping thrust fault that extends from near the southwest corner to near the northeast cornar of the Damascus quadrangle. In the vicinity of Lodi, the Lodi thrust fault extends westward from State Highway 91 approximately 3.75 miles, wraps around northward to the vicinity of the Middle Fork of the Holston River, then trends northeastward to the northeast corner of the quadrangle. The Lodi fault was previously mapped as a continuation of the Brushy Mountain fault. These are here defined as two separate faults, because the main Brushy Mountain fault continues northeastward from Lodi as a relatively straight, steeply-dipping fault and the Lodi is a more circuitous, shallow-dipping fault.

Derby (1961) proposed that the relatively straight part of the Brushy Mountain fault, with Elbrook in the hanging wall, was a bedding plane component of the fault. He suggested that the shallow dipping part of the Lodi fault plane to the northwest resulted from an oblique break of the fault up section across younger formations. Continued northwestward movement resulted in the leading edge riding over, and into, a previously formed synclie, which further deformed the leading edge beds.

Current mapping supports Derby's hypothesis, with one addition. Continued pressure from the southeast formed an anticline within the fault block. When the rocks broke along the anticline, the current Brushy Mountain fault was formed. Continued movement resulted in the Brushy Mountain fault overriding a portion of the Lodi fault block.

Lodi Syncline

Within the Lodi thrust sheet, is the herein named Lodi synclie. The southwest extent of the synclie is terminated by a splay of the Lodi fault. In this area, folding and faulting have deformed beds of the Conococheague and Stonehenge formations. Dips range from 28 degrees northwest to beds that are overturned, dipping 27 degrees southeast. Northeast of this area of more strongly deformed rocks, beds of the Conococheague Formation are folded into a broad synclie with a slightly steeper southeast limb. On the southeast limb, beds dip 23 to 83 degrees northwest as compared to beds on the northwest limb that dip 12 to 46 degrees southeast.

Chestnut Ridge Anticline

The Brushy Mountain fault overlies a second geologic structure, the Chestnut Ridge anticline. The Conococheague Formation is the oldest formation exposed along the axis of the anticline. The anticline is a symmetrical fold with beds that dip as much as at 72 degrees southeast on the south limb and 78 degrees northwest on the north limb.

Roetown Syncline

The Roetown synclie is southeast of the Brushy Mountain fault. This is an overturned fold with a steeply dipping northwest limb and an overturned southeast limb. The Paperville Shale and Knobs formation are the youngest rocks exposed along the axis of the synclie. The beds are overturned in the southeast limb to the vicinity of the Rome Formation. Southeast of the Rome, the beds are steeply dipping right-side-up. Much of the deformation within this synclie was absorbed by movement within the Rome Formation. Evidence for this movement are the numerous small-scale folds and faults within the formation.

Damascus Anticline

Located northeast of the town of Damascus is the Damascus anticline. The southwestern extent of the anticlinal axis is overridden by the Holston Mountain fault. The structure is an asymmetrical anticline with steeply dipping to overturned beds on the northwest limb and more gently dipping beds on the southeast limb, although there are local areas on the southeast limb with overturned beds. In the center of the anticline is the Cambrian-age Erwin Formation.

Holston Mountain Fault

The Holston Mountain fault is at the western front of the Blue Ridge province. Older Unicoi and Hampton Formations have been thrust over younger Erwin through Stonehenge formations. Rankin and others (1972) recognized the fault northeast of Damascus and north of the Holston Mountain fault as a slice beneath the Holston Mountain fault.

Stony Creek Syncline

Rocks in the southeastern portion of the map area, south of the Holston Mountain fault, are folded into the Stony Creek synclie. Rocks within the syncline include Cambrian-age Unicoi, Hampton, and Erwin Formations of the Chilhowee Group and the Shady Dolomite. It is a broad, open syncline in which beds dip 13 to 60 degrees toward the axis.

ECONOMIC GEOLOGY

The only active quarry in the study area is Glade Stone, Inc., in the northern part of the Damascus quadrangle. It is approximately 0.5 mile west of State Highway 91, along State Road 736. The quarry produces roadstone and aggregate from limestone and dolostone of the Conococheague Formation. Other abandoned carbonate rock quarries in the map area have produced roadstone throughout the years. The locations of known quarries are shown on the geologic map.

There are numerous, small shale pits in the Paperville Shale. The shale is generally used for farm road material and fill. The locations of known shale pits are shown on the geologic map.

One iron and manganese prospect was located during the project. A local resident said the area had been mined in the 1950s. All that remains are two caved, dougout trenches that are 20 and 50 feet in length, and approximately 10 feet deep. Cobbles of coarse-grained quartzite with a thin black, metallic coating remain in the vicinity of the trenches. King and Ferguson (1960) described deposits of iron and manganese ore in the Shady Dolomite and Erwin Formation south of the map area in Tennessee. They explained that the iron and manganese originally occurred as disseminated material in the underlying bedrock, probably the Shady Dolomite. Weathering of the bedrock and transportation by groundwater resulted in deposition of the ore as oxides in the residual clays of the Shady or as a surface coating on the quartzites and sandstones of the Erwin Formation.

Samples of the Athens Shale (Paperville Shale and Knobs formation, undivided, of this report) were collected from adjacent areas during investigations by Johnson and others (1966). Analysis of the shale indicated it had potential uses as common brick and lightweight aggregate. One sample collected from residual clay (formation unknown) approximately 1 mile north of Damascus along State Highway 91 showed potential for use in making flower pots (Johnson and others, 1966).

KARST

Sinkholes and caves have developed in the limestone and dolostone beds of the Elbrook, Conococheague, and Stonehenge Formations. Karst development appears to be most prominent in association with flexure of the rocks along geologic structures. One sinkhole valley is noteworthy because it is near State Highway 58, approximately 0.25 mile south of Osceola. Sinkholes have developed in the Stonehenge and Conococheague Formations on the limbs of the Chestnut Ridge anticline. Approximately 0.25 mile west of State Highway 58, a cave is in the Stonehenge Limestone. West of the cave is a second sinkhole valley.

REFERENCES CITED

Bartlett, C.S., Jr. and Biggs, T.H., 1980, Geology of the Abingdon, Wyndale, Holston Valley, and Shady Valley quadrangles: Virginia Division of Mineral Resources Publication 16, 39 p.

Butts, Charles, 1933, Geologic map of the Appalachian Valley in Virginia: Virginia Geological Survey Bulletin 42, 56 p.

Derby, J.R., 1961, Geology of the Damascus area [M.S. thesis]: Virginia Polytechnic Institute, Blacksburg, 142 p.

Derby, J.R., 1965, Paleontology and stratigraphy of the Nolichucky Formation in southwest Virginia and northeast Tennessee [Ph.D. dissertation]: Virginia Polytechnic Institute, Blacksburg, 468 p.

Johnson, S.S., Denny, M.V. and Le Van, D.C., 1966, Analyses of clay, shale, and related materials--southwestern counties: Virginia Division of Mineral Resources Mineral Resources Report 6, 186 p.

King, P.B. and Ferguson, H.W., 1960, Geology of northeasternmost Tennessee: U.S. Geological Survey Professional Paper 311, 136 p.

Rankin, D.W., Espenshade, G.H., and Neuman, R.B., 1972, Geologic map of the west half of the Winston-Salem quadrangle, North Carolina, Virginia, and Tennessee: U.S. Geological Survey Miscellaneous Investigations Map I-709-A.

Rodgers, John, 1953, Geologic map of east Tennessee with explanatory text: Tennessee Division of Geology Bulletin, n. 58, pt. 2, 167 p.

Tyler, J.H., 1960, Geology and mineral resources of the Abingdon area, Washington County, Virginia [M.S. thesis]: Virginia Polytechnic Institute, Blacksburg, 121 p.

Digital editing and cartography by Elizabeth V. M. Campbell. Digital conversion by Rebecca Hope.

[1] Virginia Department of Mines, Minerals and Energy, Division of Mineral Resources, P.O. Box 144, Abingdon, VA 24212
[2] Consulting Geologist, P.O. Box 178, Leonard, OK 74043-0178