GEOLOGY OF THE
DAMASCUS AREA

by

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INTRODUCTION

Location of Area

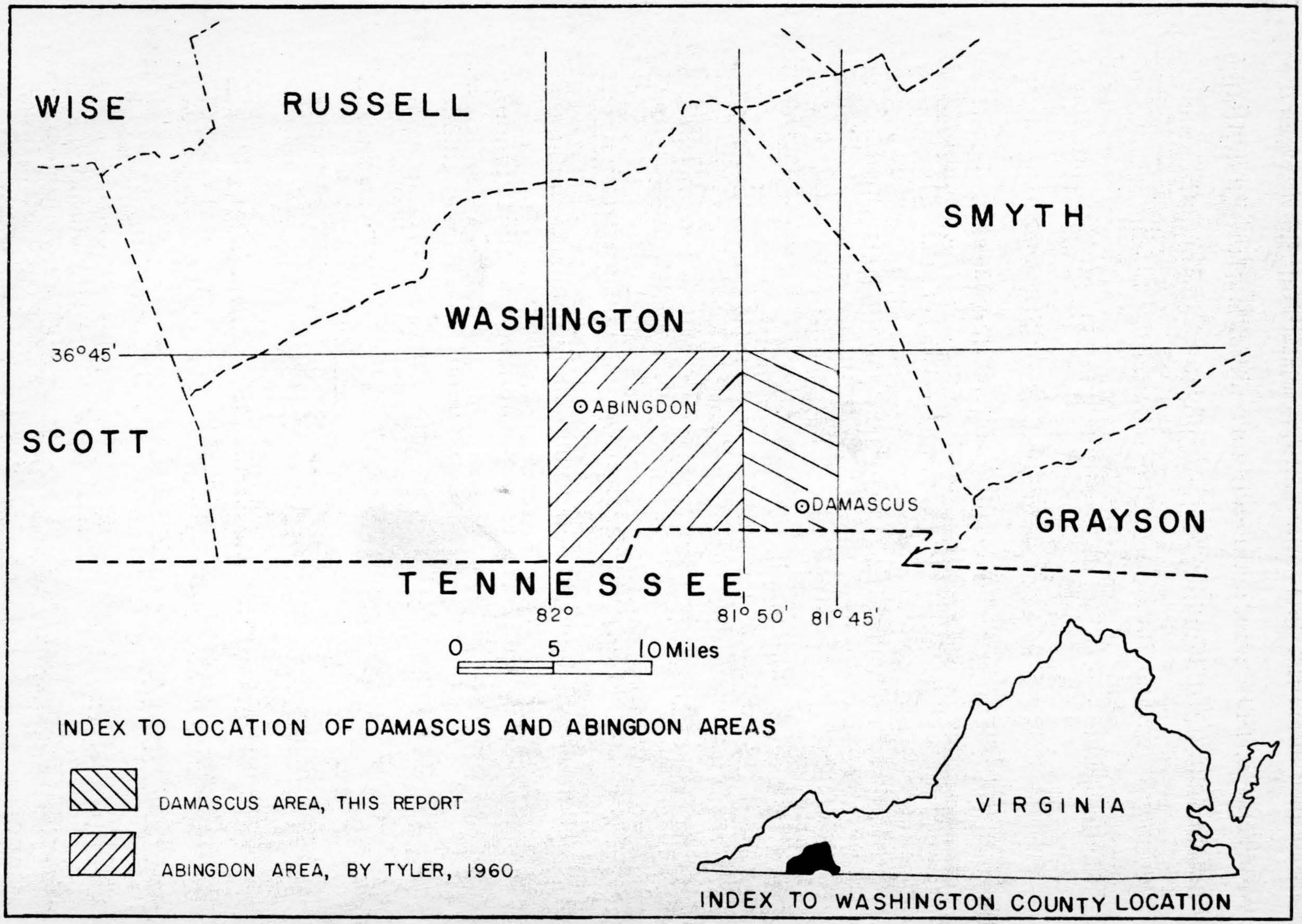
The Damascus area is located in the eastern part of Washington County, Virginia, and comprises an area of approximately 43 square miles. The area is bounded by 81° 45' and 81° 50' west longitude and by 36° 45' north latitude and the Tennessee State Line (see Plate 3, Index Map). The Damascus area includes the eastern two thirds of the Damascus Quadrangle and the Virginia part of the Laurel Bloomery Quadrangle, both of which are 7½-minute 1:2400-scale topographic maps issued by the Tennessee Valley Authority in 1938.

The town of Damascus, located in the south-central part of the area, is the only incorporated town within the area. Virginia Highway 91 crosses the central part of the area from north to south and, in Damascus, intersects U. S. Route 58 which crosses the southern part of the area from east to west. A branch of the Norfolk and Western Railway parallels U. S. Route 58 across the southern part of the area.

Methods of Study

The Damascus area was mapped using pace and compass procedures, and data were recorded on 7½-minute quadrangle topographic maps of the Tennessee Valley Authority and aerial photographs of the U. S. Soil Conservation Service. Geologic sections were measured with a steel tape.

PLATE 3



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Acknowledgments

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Regional Setting

The Damascus area lies within two geomorphic provinces. North and west of a northeast-trending line passing through Damascus is the Great Valley of the Appalachians; south and east of that line are Holston Mountain and the Iron Mountains, a part of the Unaka Mountain chain of the Blue Ridge Province.

The Damascus area lies within the Tennessee River drainage basin. The Middle and South Forks of the Holston River flow southwestward across the northwest and central parts of the area respectively. Laurel Creek flows northwest across the southern part of the area and empties into the South Fork of the Holston on the west side of the area. Beaverdam and Whitetop creeks enter the area from the south and east respectively and empty into Laurel Creek.

North and west of Damascus in the Appalachian Valley, the topography is gentle, with local relief ranging from 200 to 400 feet. South and east of Damascus in the Blue Ridge Province, the topography is characterized by high, steep ridges and narrow, deep valleys. In this area the local relief ranges from 800 to 1200 feet. The highest point in the area is 3302 feet on Holston Mountain at the Tennessee State Line. The lowest point is 1822 feet where Laurel Creek empties into the South Fork of the Holston River. Thus the maximum relief in the Damascus area is 1480 feet.

Previous Work

The areal geology, structure, and stratigraphy of the Damascus area was discussed and illustrated in a general way by Butts (1933, 1940) in his maps and descriptions of the geology of the Appalachian Valley. The southernmost part of the area was mapped by the U. S. Geological Survey in the course of manganese studies during World War II. The results of these studies have been published by King and others (1944), and by

King and Ferguson (1960). The Abingdon area, which adjoins the Damascus area on the west, was mapped and described by Tyler (1960).

The historical development of stratigraphic terminology in the Damascus area and adjacent areas is shown in Table 1.

Table 1
Development of stratigraphic terminology in the Damascus area and adjacent areas

<table>
<tr><th>KEITH, 1903, 1907</th><th colspan="2">BUTTS, 1940</th><th colspan="2">KING AND FERGUSON, 1960</th><th colspan="2">THIS REPORT</th></tr>
<tr><td rowspan="2">Tellico sandstone
Athens shale</td><td colspan="2">Athens formation</td><td colspan="2" rowspan="2">Rocks of Middle Ordovician age
(Lenoir limestone at base)</td><td colspan="2">Knobs formation
Paperville shale</td></tr>
<tr><td colspan="2">Lenoir limestone</td><td colspan="2">Effna limestone
Fetzer limestone
Lenoir-Mosheim limestones</td></tr>
<tr><td>Knox dolomite</td><td colspan="2">Beekmantown group
Chepultepec limestone
Conococheague limestone</td><td>Knox group</td><td>Jonesboro limestone
Conococheague limestone</td><td>Knox group</td><td>Aven formation
Barron Creek limestone
Conococheague formation</td></tr>
<tr><td>Nolichucky shale</td><td>Nolichucky shale</td><td rowspan="2">Elbrook dolomite</td><td colspan="2" rowspan="2">Elbrook dolomite</td><td rowspan="2">Elbrook formation</td><td>Widener limestone</td></tr>
<tr><td>Honaker limestone</td><td>Honaker dolomite</td><td>Upper dolomite
Middle limestone
Lower dolomite</td></tr>
<tr><td>Watauga shale
Shady limestone</td><td colspan="2">Rome formation
Shady dolomite</td><td colspan="2">Rome formation
Shady dolomite</td><td colspan="2">Rome formation
Shady dolomite</td></tr>
<tr><td>Erwin quartzite
Hampton shale
Unicoi formation</td><td>Chilhowee group</td><td>Erwin quartzite
Hampton shale
Unicoi formation</td><td>Chilhowee group</td><td>Erwin formation
Hampton formation
Unicoi formation</td><td>Chilhowee group</td><td>Erwin formation
Hampton formation
Unicoi formation</td></tr>
</table>

STRATIGRAPHY

General Features

The sedimentary rocks in the Damascus area range from Early Cambrian (?) to Middle Ordovician age, inclusive, comprising 14 formations (Table 1) which are differentiated into 11 map units. Probably all the rocks were deposited in a marine environment, and all except the youngest rocks were deposited in shallow water.

Approximately 13,000 feet of sedimentary rocks are exposed in the Damascus area. Rocks of questionable Early Cambrian age are about 3600 feet thick. The known Cambrian section is approximately 6800 feet thick. Rocks of Early Ordovician age range from 1000 to 1600 feet in thickness, and Middle Ordovician rocks range from a few feet to 800 feet in thickness.

The only major hiatus recognized in the Damascus area is that between the Lower Ordovician and the Middle Ordovician rocks. The hiatus is believed to represent most of late Early Ordovician time.

Chilhowee Group

Clastic rocks of the Chilhowee group constitute the oldest formations in the Damascus area. The Chilhowee group is exposed only in the southern and southeastern part of the area. The area underlain by the Chilhowee group lies within the Unaka

Mountains province (Fenneman, 1938, p. 173-174).

Safford (1856, p. 152-153) applied the name Chilhowee sandstone to the clastic sequence underlying the Shady dolomite on Chilhowee Mountain, Sevier and Blount Counties, Tennessee. The Chilhowee "sandstone" was later subdivided into three supposedly distinct formations: the Erwin quartzite, the Hampton shale, and the Unicoi formation (Keith, 1903); and the term "Chilhowee group" has been applied to the whole sequence. Subsequent work by the U. S. Geological Survey (King and others, 1944) has shown that each formation contains lithologies supposedly characteristic of the others, and therefore the lithologic implications should be dropped from the formation names. The formations were redefined (King and others, 1944) with the boundaries arbitrarily placed at widely traceable key horizons.

It must be emphasized that, with the exception of the amygdaloidal basalts and coarse conglomerates of the Unicoi, no single lithology is diagnostic of any formation in the Chilhowee group. At any given locality, the sequence of lithologies must be determined before traditional formation boundaries can be placed and then none too reliably. Because of this difficulty, Tyler (1960) mapped quartzites in the Hampton and Unicoi formations as Erwin, and red shales in the Unicoi as a fault block of Rome.

The Chilhowee group in and near the Damascus area is approximately 8000 feet thick (King and Ferguson, 1960, pl. 9, section 15), of which only the upper 4700 feet lie within the Damascus area.

Unicoi formation

Name.—The Unicoi formation was named by Campbell (1899, p. 3) for the many exposures of the formation in Unicoi County, Tennessee. King and Ferguson (1960, p. 36) have subsequently designated exposures of the Unicoi along the Nolichucky River southeast of Unaka Springs as the type section. The top of the Unicoi is placed at the top of a widely traceable thick-bedded quartzite approximately 3100 feet below the base of the Shady dolomite. This quartzite is easily recognized because it nearly always crops out in steep cliffs and holds up high ridges. The base of the Unicoi is not exposed in the Damascus area.

Distribution.—The Unicoi formation crops out as part of the Shady Valley thrust sheet in three areas: on the west side of Holston Mountain, in outcrops and roadcuts along Virginia Route 91 in the southwest corner of the area, and on Feathercamp Ridge and along Whitetop Creek east and northeast of Damascus.

Description.—The Unicoi formation in the Damascus area is composed of thick-bedded, conglomeratic and coarse-grained arkosic sandstone, a few beds of vitreous quartzite, and thin micaceous shale interbeds (Plate 5, A). Sandstone beds, ranging in compo-

Plate 5

A. Unicoi formation on State Highway 91 near Tennessee state line southeast of Damascus. Massive brownish-white, coarse-grained quartzites, gray to buff shaly siltstone, flaggy tuffaceous arkose and thin green micaceous shales.

B. Weathered Hampton formation behind house at Laurel Creek Bridge, State Route 91 in Laureldale.

Plate 5

sition from arkoses to slightly feldspathic quartzites, constitute approximately 75 per cent of the Unicoi formation in the Damascus area. The arkose beds are typically coarse-grained to conglomeratic, red, micaceous, and are separated by thin shale beds. Cross-bedding, ripple marks, and local lensing out of thick sandstone beds are common. The less feldspathic sandstone beds are generally vitreous, tan or gray, and weather to mottled brown or red-brown. Interbedded with the thick sandstone beds are a few thin, light-gray tuffaceous(?) friable sandstones.

The top of the Unicoi is marked by a 40-foot thick, cross-bedded, white, vitreous, pebbly, quartzite bed. Similar quartzites are scattered through the Unicoi in the Damascus area. These quartzites resemble the quartzites in the overlying Hampton and Erwin formations.

Sandy shale, siltstone, and thin-bedded, fine-grained sandstone are present throughout the Unicoi but constitute a small percentage of the formation in the Damascus area. A few beds of red, purple, and green clay shale are commonly present several hundred feet below the top of the Unicoi.

Amygdaloidal basalt is present in the Unicoi formation a short distance south of the Damascus area along Tennessee State Route 91. No basalt was found in the Damascus area, although beds stratigraphically as low as the basalt are probably present in covered intervals along Feathercamp Ridge.

Thickness.--The full thickness of the Unicoi is not exposed in the Damascus area. The upper 680 feet of the formation is exposed in the southeast corner of the area. An estimated 1500 feet of Unicoi underlies the area northeast of Damascus where the base of the formation is deleted by faulting. King and Ferguson (1960, pl. 9, section 15) measured approximately 5000 feet of Unicoi in the Iron Mountains just south of the Damascus area. The latter is probably one of the thickest sections of Unicoi in the Appalachians. T. J. Carrington (personal communication, 1961) reports only about 2220 feet of Unicoi at Skulls Gap, 10.5 miles northeast of Damascus.

Hampton formation

Name.--The Hampton formation was named for the town of Hampton, Carter County, Tennessee (Campbell, 1899, p. 3). King and Ferguson (1960, p. 40) have designated the exposures along the Doe River northwest of town as the type locality. In the Damascus area, the Hampton is characteristically a heterogenous formation of arkosic sandstone, siltstone, shale, and quartzite. Because of its lateral variability and its similarity to parts of the underlying Unicoi and overlying Erwin formations, the Hampton is best defined as the clastic sequence overlying the uppermost quartzite of the Unicoi and underlying the basal *Scolithus*-bearing Nebo quartzite member of the Erwin.

Distribution.—In the Damascus area, the Hampton formation crops out only in the Shady Valley thrust sheet. The lower part of the formation is well exposed in roadcuts along U. S. Route 58 east of Damascus, on the south bank of Laurel Creek near the eastern town limit of Damascus, and along Virginia Route 91 southeast of Damascus.

Description.—The Hampton formation in the Damascus area is a sequence of generally thin-bedded, non-resistant, heterogenous rocks overlying the upper quartzite of the Unicoi formation and underlying the basal quartzite member of the Erwin formation. In general, the Hampton formation is distinguished from the Erwin by the lack of thick vitreous quartzite beds and from the Unicoi formation by greater amounts of siltstone and shale. The Hampton in the area mapped can be divided into two indistinct members: an upper member of siltstone and shale with a few quartzite beds, and a lower member of siltstone and arkosic sandstone.

The thin-bedded and shaly rocks to which the term "Hampton shale" has been applied constitute about 84 per cent of the formation. These "shaly" rocks are generally greenish-gray, dark-gray, or dark-brown laminated siltstone and micaceous clay shale with a few thin beds of fine- to coarse-grained sandstone (see Plate 5, B). These bedsrarely crop out and are commonly covered by a thin silt loam soil which contains yellowish-brown shale and sandstone chips.

White or tan vitreous quartzites constitute only about four per cent of the formation and are found principally in the upper part. These quartzites resemble the quartzites in the Erwin formation but are predominantly thinner bedded. The upper member also contains a few thin beds of dark-red, hematite-cemented, coarse-grained sandstone which is strikingly similar to the "Clinton iron ores" of northwest Virginia.

Thick-bedded arkosic sandstones are generally limited to the lower part of the Hampton and constitute about 12 per cent of the formation. The sandstone beds are vitreous-appearing, greenish-gray, tan, or white and resemble quartzite on fresh surfaces (Plate 6, A). On weathering, the feldspar grains change to white or buff clay, and weathered surfaces are buff, rusty, or pink. Most of the sandstone beds are interbedded with siltstone and shale, but the basal 200 feet of the Hampton is an essentially uninterupted sequence of thick-bedded sandstone. This sandstone unit is quite resistant and holds up a high peak north of Laureldale.

Thickness.--The Hampton formation is 2,070 feet thick on London Bridge Branch, half a mile south of the Tennessee State Line (L. E. Smith in King and Ferguson, 1960, p. 114, section 15). The writer believes this is an accurate figure for the thickness of the Hampton in the Damascus area.

Plate 6

A. Thick coarse arkosic sandstone in Hampton formation along Road 1212, southern part of Damascus.

B. Silty sandstones near top of Erwin formation in Davis Hollow near State Highway 716, 400 feet south of Tennessee state line.

Plate 6

Erwin formation

Name.—The Erwin "quartzite" was named for the many exposures of white quartzite near Erwin, Unicoi County, Tennessee (Keith, 1903, p. 5). King and Ferguson (1960, p. 41) redefined the Erwin formation and designated the well-exposed section on the Nolichucky River southeast of Unaka Springs as the type locality. As redefined, the Erwin formation consists of siltstone, shale, fine-grained sandstone, vitreous quartzite, and ferruginous quartzite; the Erwin underlies the Shady dolomite and is marked at the base in northwest Tennessee and southern Virginia by a persistent white quartzite bed that contains *Scolithus*.

Distribution.—In the Damascus area, the Erwin formation crops out only on the southeast side of the Appalachian Valley northeast of Damascus, and on the west slope of the Iron Mountains and on the east slope of Holston Mountain. Good exposures of the Erwin formation are on the ridge northeast of Damascus (Geologic Section 2), and in cuts along Road 716 southwest of Damascus. The upper quartzite member is exceptionally well exposed at Backbone Rock, 1.5 miles south of the Tennessee State line in Shady Valley (Plate 7, A).

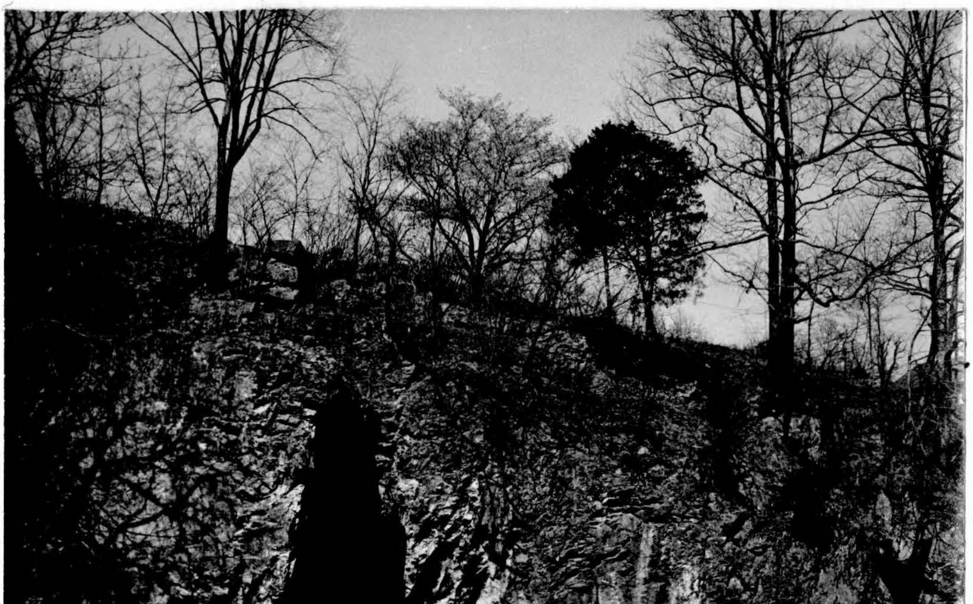
Description.—King and Ferguson (1960, p. 43) divided the Erwin formation into four members (Table 2). Northeast of Damascus, only the Helenmode member is recognized; the remainder of the

Plate 7

A. Hesse quartzite member of the Erwin formation displaying gross cross-bedding in coarse-grained white quartzite. Height of photograph approximately 10 feet. At Backbone Rock, Tenn.

B. Blue-gray, massive-weathering Shady dolomite below Virginia Route 91, on north side of Laurel Creek in Damascus.

Plate 7



formation is interbedded massive quartzite and thin-bedded siltstone, sandstone, and shale (see Geologic Section 2). All four members crop out as part of the Shady Valley thrust sheet south of Damascus. Massive vitreous quartzite is the most prominent and characteristic lithology of the Erwin, but quartzite constitutes only one third of the formation in the Shady Valley thrust sheet and only 50 per cent (or less) of the formation in the belt of outcrop bordering the Appalachian Valley northeast of Damascus. The quartzites of the Erwin are typically pure and thick-bedded, and crop out in resistant ledges in contrast to the thinner bedded, impure, less resistant quartzites in the underlying Hampton formation. Relative topographic potency is not, however, a reliable criterion for distinguishing the Erwin from the Hampton.

Table 2

MEMBER	THICKNESS (Feet)	LITHOLOGY
Helenmode	110	Silty carcareous shale and sandstone
Hesse quartzite	140 ±	Vitreous quartzite, minor shale
Murray shale	800 ±	Shale, siltstone, sandstone, quartzite
Nebo quartzite	60 ±	Scolithus-bearing vitreous quartzite

Members of the Erwin formation in the Shady Valley thrust sheet of the Damascus area (Data from King and Ferguson, 1960, pl. 9, sections 15 and 16).

The Nebo quartzite member in the Damascus area consists of 60 feet of massive quartzite at the base of the Erwin formation. This quartzite is white or gray, fine- to medium-grained and so tightly cemented with silica that individual grains are rarely seen. Scolithus is common and distinguishes the Nebo quartzite from similar quartzites in the Chilhowee group.

The Murray shale member is a thick sequence of buff to dark greenish-gray sandy siltstone and micaceous shale with thin interbeds of fine- to medium-grained arkosic sandstones. Locally, as at London Bridge Branch, vitreous quartzite beds are included in the member. Ferruginous quartzites and hematite-cemented arkosic sandstones are sparse throughout the Murray shale. The ferruginous beds range in thickness from a few inches to many tens of feet. Along London Bridge Branch, the lower part of the Murray shale contains a bed of massive ferruginous quartzite that is 60 feet thick.

The Hesse quartzite member consists of white or gray vitreous quartzite beds which form resistant ledges on the dip slopes of Holston and Iron Mountains south of Damascus. The quartzite is fine- to medium-grained, locally pebbly, and commonly ripple-marked or cross-bedded. Scolithus was not found in the Hesse quartzite on Holston and Iron Mountains.

The Helenmode member is poorly exposed in the Damascus area. According to King and Ferguson (1960, p. 43-44), the

Helenmode member is laterally persistent throughout northeast Tennessee and southern Virginia. Stose and Schrader (1923, p. 68) described the Helenmode member as the "transition beds" between the Shady and the Erwin. In outcrops in the Damascus area, the Helenmode member consists of soft, yellowish shale and mealy, porous, arkosic sandstone, commonly containing manganese nodules. The porous nature of the sandstone is probably the result of leaching of original carbonate cement.

Thickness.--The Erwin formation is approximately 1100 feet thick along London Bridge Branch on the Shady Valley thrust sheet (King and Ferguson, 1960, pl. 9, section 16), where all of the Erwin except the upper few feet of the Helenmode member is exposed. The writer was unable to locate the base of the Erwin in the belt of outcrop northeast of Damascus, but the thickness there is at least 1,000 feet.

Age and Correlation of Chilhowee Group

Age.--No fossils other than the worm tube(?) *Scolithus* were found in the Chilhowee group of the Damascus area. *Olenellus* and other Early Cambrian fossils have been reported from the uppermost (Helenmode) member of the Erwin formation in the Cranberry quadrangle, Tennessee (Keith, 1903, p. 5), and from equivalent beds in the Little River Gap of Chilhowee Mountain, Tennessee (Walcott, 1890, p. 36). Rodgers (1956, p. 397) reports an *Olenellus* fauna from beds equivalent to the middle of the Erwin (Murray shale) in the Great Smoky Mountains of Tennessee.

Scolithus, which may or may not be of organic origin, is common in the Hampton formation in adjacent areas, although none was found in the Hampton of the Damascus area. No fossils or organic structures have ever been identified in the Unicoi formation.

The Erwin formation in the Damascus area and elsewhere is Early Cambrian in age, but the age of the Hampton and Unicoi formations is in doubt. The writer believes that the latter formations are probably Cambrian, but in view of the lack of evidence, their ages are indicated as Cambrian(?).

Correlation.--King and Ferguson (1960, p. 32) correlated formations in the Chilhowee group of the Damascus area with differently named formations of the Chilhowee in east-central Tennessee and northern Virginia on the basis of similar lithologies, similar stratigraphic position, and, in the Erwin, similar fossils (Table 3).

Shady dolomite

Name.--The Shady dolomite was named for exposures in Shady Valley, Johnson County, Tennessee. The Shady dolomite is the oldest carbonate formation in the Appalachians and underlies the shales and carbonate rocks of the Rome formation. In the Damascus

Table 3

AGE		EAST-CENTRAL TENNESSEE	DAMASCUS AREA SW VIRGINIA & NE TENNESSEE	NORTHERN VIRGINIA
Lower Cambrian		Shady dolomite	Shady dolomite	Tomstown dolomite
	Chilhowee Group	Hesse sandstone Murray shale Nebo sandstone	Erwin formation	Antietam quartzite
Lower Cambrian(?)		Nichols shale	Hampton formation	Harpers shale
		Cochran formation	Unicoi formation	Weverton quartzite Loudoun formation
Pre-Cambrian(?)		Ocoee series	Mount Rogers volcanic group	Catoctin greenstone

Correlation of the Chilhowee Group in Virginia and Tennessee
(Modified after King and Ferguson, 1960, p. 32).

area, the Shady is largely blue-gray and white dolomite, with a few beds of shale and limestone.

Distribution.--The Shady dolomite is present in a belt trending northeast from Damascus and in a small area in Shady Valley near the Tennessee state line. The Shady is well exposed along Laurel Creek in Damascus (Plate 7, B) and on the hills half a mile north of Damascus. These outcrops are described in Geologic Sections 3 and 4 (Appendix). Elsewhere the Shady is obscured by reddish-brown residual(?) soil or by alluvium and colluvium. At the Tennessee state line near a manganese mine in Shady Valley, a single pinnacle of dolomite protrudes from reddish-brown manganiferous clay.

Description.--The general nature of the Shady in the Damascus area is shown in Geologic Sections 3 and 4 (reproduced in Appendix from King and Ferguson, 1960, p. 123-124). The lithology of the formation in and near the Damascus area is described in detail by King and Ferguson (1960, p. 44-52).

The Shady dolomite consists chiefly of thick-bedded, blue-gray dolomite, white dolomite, and "ribboned dolomite". A few beds of dolomitic shale are present, especially in the upper part. Vuggy, white, light-gray, and greenish-gray chert is common in the blue-gray dolomite beds. Jasperoid is common in soils overlying the Shady.

Blue-gray, finely-crystalline thick-bedded dolomite is the most common lithology in the Shady. This type of dolomite is commonly impure and weathers to a buff, porous mass of silt and clay (Plate 8, A). White dolomite is typically pure, massive, finely- to coarsely-crystalline, and thick-bedded. White dolomite is characteristic of the Shady but comprises only a small part of the formation.

"Ribboned dolomite" is present only in the poorly-exposed lower part of the Shady. The "ribboned" appearance is caused by alternating thin beds of light and dark dolomite. Locally "ribboned" limestone-dolomite is interbedded with the "ribboned dolomite". In the "ribboned" limestone-dolomite, the dark layers are limestone and the light layers are dolomite.

Thickness.--The upper and lower contacts of the Shady dolomite are not exposed in the Damascus area. The total thickness of the Shady is estimated to be approximately 1,200 feet. The thickest section exposed is the 1,056 feet of Shady dolomite along Laurel Creek. At least 150 feet of unexposed dolomite beds underlie the exposed section.

Age and Correlation.--No fossils were found in the Shady dolomite of the Damascus area. Resser (1938) and Butts (1940) report Early Cambrian fossils from the Shady dolomite near Quebec, Smyth County, Virginia. These beds are continuous with the Shady dolomite of the Damascus area (Butts, 1933); hence the Shady of the Damascus area is considered Early Cambrian in age.

Plate 8

A. Argillaceous, buff-weathering, Shady dolomite, exposed on Virginia Route 91, north side of Damascus.

B. Pleistocene alluvium overlying red and yellow Rome shales. Along Virginia Route 91, north of Damascus.

Plate 8

The Shady dolomite of southwestern Virginia is correlated with the Tomstown dolomite of northern Virginia and Pennsylvania because of similar lithology, stratigraphic position, and apparent age.

Rome formation

Name.--The Rome formation was named by Hayes (1891, p. 143) and by Walcott (1891, p. 305) for outcrops in the Coosa Valley near Rome, Georgia. The top of the Rome is placed at the highest bed of red shale underlying a thick sequence of argillaceous and shaly dolomites in the lower part of the Elbrook formation. The base of the Rome is placed at the lowest thick shale bed above several hundred feet of Shady dolomite. The Rome formation in the Damascus is a thick sequence of shale, limestone, dolomite, and a few sandy beds.

Distribution.--The Rome formation crops out in a northeast-trending belt in the southeast part of the area and is covered by the Holston Mountain thrust fault southwest of Damascus. The Rome is well exposed along Laurel Creek, on the hills north of Damascus, and in a roadcut along U. S. Route 58 in Damascus (Plate 8, B).

Description.--The Rome is a heterogenous formation consisting principally of red and maroon silty shales, yellow clay shales, and green sericitic shales. Interbedded with the shales are thin beds of siltstone and fine-grained sandstone, as well as a few thick units of limestone and dolomite. The red and green shale beds weather to small chips which are prominent in soils overlying the Rome. Yellow shale beds rarely crop out and probably represent argillaceous dolomite leached of carbonate minerals. The limestone and dolomite beds are predominantly blue-gray, finely crystalline, and resemble the blue-gray dolomite beds of the Shady dolomite.

Areas underlain by the Rome formation are easily recognized by the purple-red soil, the Upshur-Litz silt loam (Jurney and others, 1945, p. 59-60), and the steep-sided conical hills which typically develop on the formation (Plate 9, A).

Thickness.--The Rome formation is approximately 1,400 feet thick near Beech Grove School where the upper and lower contacts can be placed with reasonable accuracy. According to Nelson, Rodgers, and King (in King and Ferguson, 1960, p. 123), the thickness of the Rome on the north side of Laurel Creek Valley near Damascus is 1,800 feet. At this locality Nelson, Rodgers, and King ascribe anomalous thickness (1,125 feet) to a red shale unit (unit T, Geologic Section 3, Appendix). The red shale beds of unit T are intricately folded and faulted, and a precise measurement of thickness is probably impossible. The interpretation favored by the writer is that unit T is not over 700 feet thick; therefore the formation is approximately 1,400 feet thick at the Laurel Creek locality.

Plate 9

A. Level land (foreground), conical hills (middle), and Clark Mountain (background) underlain by Elbrook formation, Rome shale, and Erwin quartzite, respectively. Southeast side of Widener Valley, 3.5 miles northeast of Damascus.

B. Calcareous shale and leached dolomite of Rome formation overlain by coarse Pleistocene alluvium, along Route 58 in Damascus. Cobbles are Lower Cambrian quartzites.

Plate 9

Age and Correlation.--No fossils were found in the Rome formation in the Damascus area. Resser (1938, p. 25) reports an Olenellus fauna from a locality near Max Meadows, northeast along strike from the Damascus area. Middle Cambrian fossils have been reported from the Rome in other localities. In the absence of more conclusive evidence, the Rome is classified as Early and Middle Cambrian in this report.

The Rome is correlated with the Waynesboro formation of northern Virginia, Pennsylvania, and Maryland on the basis of similar stratigraphic position, lithology, and fossils.

Elbrook formation

Name.--The Elbrook formation was named by Stose (1906, p. 209) for outcrops near Elbrook, Franklin County, Pennsylvania. According to Wilson (1952, p. 304), the Elbrook at the type locality consists of thin-bedded to laminated dolomite and dolomitic shale, commonly alternating with limestone beds of various types. The Elbrook in the Damascus area is somewhat different in lithology from the type Elbrook, and therefore use of the name Elbrook may be inappropriate in southwestern Virginia.

Distribution.--The distribution of the Elbrook in the Damascus area is shown on the Geologic Map (Plate 1). The Elbrook is well exposed along Wright Branch in Widener Valley, along the north side of Laurel Creek Valley west of Damascus, and along

County Road 803 northwest of Rock Springs Church. The upper beds are well exposed along County Road 735 in the northwest part of the area.

Divisions.--The Elbrook is herein divided into four members (Table 4). Only the uppermost member is formally named and mapped as a separate unit. A detailed description of the formation is given in Geologic Section 5 (Appendix).

Table 4

MEMBER	THICKNESS (Feet)	DESCRIPTION
Widener limestone	152	Gray calcarenitic limestone and oolitic calcarenite, locally silty and dolomitic, sparse quartz sand. Crepicephalus fauna throughout.
Upper dolomite	467	Light-gray to tan finely crystalline dolomite, and dark-gray dolomite arenite.
Middle limestone	351	Gray calcarenitic limestone and "ribbon-banded" limestone-dolomite; some calcilutite, dolomite, and shaly dolomite.
Lower dolomite	695	Gray, tan, or olive-drab laminated argillaceous dolomite, shaly dolomite, few beds of finely crystalline dolomite and dark-gray limestone. Base not exposed.
Total thickness 1665+		

Members of the Elbrook formation in the Damascus area.

Lower dolomite member

The lower dolomite member is composed chiefly of light-gray, tan, or olive-drab, finely-crystalline, argillaceous dolomite. Many of the beds are laminated; the laminae represent varying concentrations of silt and clay. These dolomites weather to yellowish-tan shale which rarely crops out (Plate 10, A). In poorly exposed sections, the presence of the argillaceous dolomites is revealed by paper-thin, yellowish-tan flakes in the soil.

About ten per cent of the member consists of dark-gray, finely-crystalline thin-bedded limestone, commonly containing thin dolomite bands. The limestones tend to be resistant and commonly are the only outcropping beds in the lower member.

Beds of light- to dark-gray, finely-crystalline, massive dolomite occur in the lower part of the member. Black, scraggy, bedded chert and *Cryptozoon* chert is commonly associated with the massive dolomite beds.

The contact of the lower dolomite member of the Elbrook with the Rome formation is gradational. In field mapping, the contact was arbitrarily placed at the highest bed of red shale in the Rome.

Middle limestone member

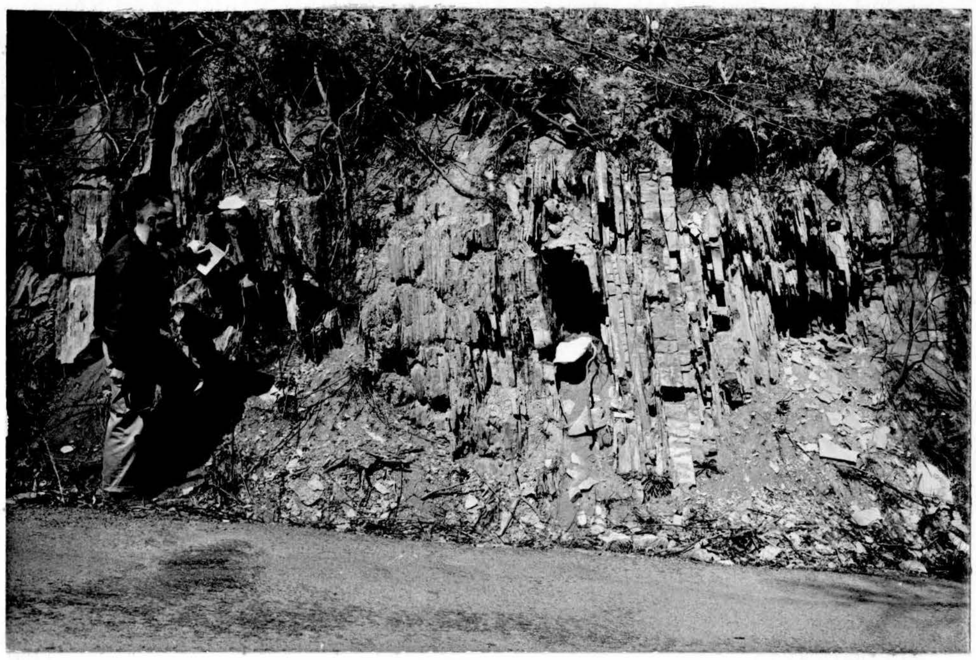
The middle limestone member is a mixture of various types of limestone, dolomite, and coarse carbonate clastics. The mem-

Plate 10

A. Elbrook shaly dolomites along Road 605, Widener Valley. (Unit 25 of Geologic Section 5.)

B. Blue-gray calcarenite and calcilutite with irregular dolomitic silt intercalations. Middle of Elbrook formation on Road 605 in Widener Valley. (In unit 32 of Geologic Section 5.)

Plate 10



ber is completely exposed along Road 605 at Wright Branch in Widener Valley. The middle limestone member closely resembles the Conococheague formation, and the two are easily confused.

Approximately 55 per cent of the member is medium- to dark-gray, thick-bedded, calcarenitic limestone, commonly containing dolomitic silt partings (see Plate 10, B). Calcarenitic limestone beds are composed of calcilutite-cemented calcarenite, calcilutite, and coarse-grained calcarenite with minor amounts of sand-size quartz, chert, and dolomite grains. Associated with the calcarenitic limestones are "ribbon-banded" limestone-dolomite beds. The "ribbon-banding" is formed by alternating thin beds of finely-crystalline limestone and dolomite. Locally the "ribbon-banded" beds grade into light-gray to tan dolomite.

Thick-bedded, pearly-gray, and light-tan calcilutite beds constitute about ten per cent of the member. The calcilutites are commonly partially dolomitized. All gradations from pure calcilutite to light-gray, finely-crystalline calcareous dolomite are present.

Thin beds of dark-gray shaly limestone, impure dolomite, and coarse carbonate clastics occur locally in the middle limestone member.

Upper dolomite member

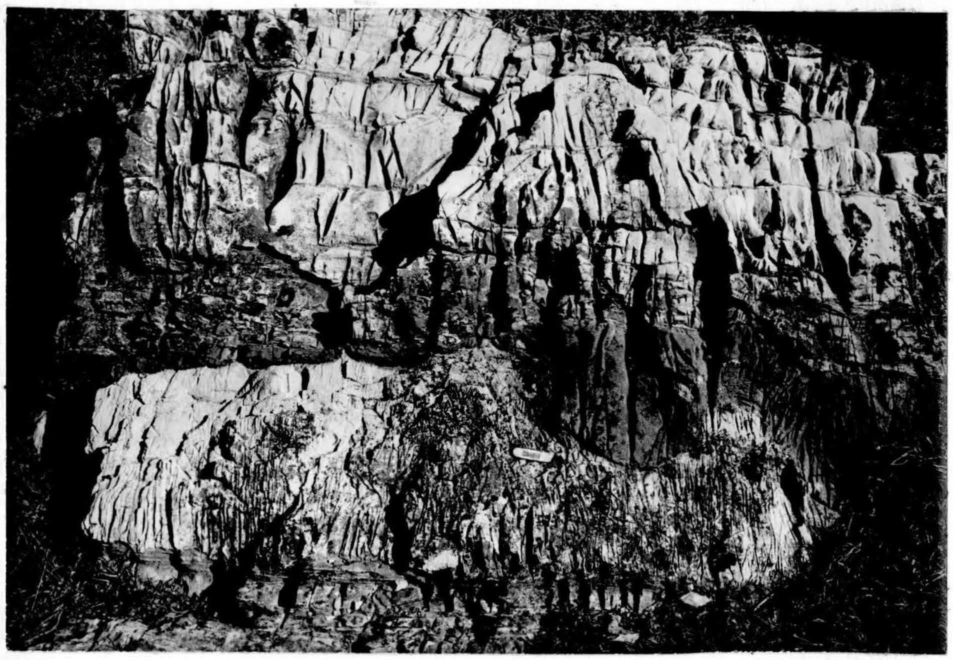
The upper dolomite member consists of two types of dolomite: light-colored, finely-crystalline dolomite and dark-gray, coarse-grained dolomite arenite (Plate 11). Approximately 75

Plate 11

A. Coarsely crystalline dolomite (dark) and finely crystalline dolomite (white) in upper dolomite member of Elbrook formation approximately 200 feet below the Widener limestone member. Southeast of Pleasant View Church in Widener Valley.

B. Thin-bedded, finely crystalline dolomite (light) and massive coarsely crystalline dolomite (dark) in upper dolomite member of Elbrook formation 100 feet below the Widener limestone. Southeast of Pleasant View Church, Widener Valley.

Plate 11



per cent of the member is light-gray, tan, or cream-colored, finely crystalline dolomite which weathers light-gray. This type of dolomite is laminated to thin bedded. Laminated units generally weather to massive outcrops; the laminae are seen on fresh surfaces as layers of different colors.

Dolomite arenite beds are medium- to dark-gray, thick-bedded, and consist of clastic dolomite grains, coarsely-crystalline dolomite, and rounded grains that may be dolomitized ooids. Some of the dolomite arenite beds have a vague pisolitic texture in which the clastic grains are aggregated into rounded masses with coarsely crystalline white dolomite in the interstices. The dolomite arenite beds weather to dark-gray or dark-brown rough-textured surfaces.

Widener limestone member

Name.--The name Widener limestone is proposed for the silty, dolomitic calcarenitic limestone that forms the uppermost member of the Elbrook formation. The member is named for Widener Valley where it is well exposed at three localities: at the type section on Wright Branch (units 78-90, Geologic Section 5, Appendix); in a field approximately 800 feet southeast of Pleasant View Church; and along Widener Branch, east of the Damascus area (Butts, 1940, p. 75). The top of the Widener limestone is placed at the highest limestone bed below several hundred feet of dolomite in the Conococheague formation. The

Plate 12

A. Cherty limestone and laminated dolomite in the Elbrook formation. Along Road 709 near BM G 186.

B. Small fold in dolomite-banded limestone. Elbrook formation along Road 709 near BM G 186.

Plate 12

base of the Widener is placed at the lowest limestone bed above the upper dolomite member of the Elbrook.

Description.—The Widener limestone is chiefly gray, thick-bedded, calcarenitic limestone, calcarenite, and limestone conglomerate. Irregular dolomitic silt intercalations, rounded dolomite clasts, and thin dolomite lenses are common in the calcarenitic limestone beds. Coarse-grained oolitic calcarenite lenses, commonly containing abundant trilobites, are characteristic of the Widener limestone but constitute about 10 per cent of the total thickness.

Thin-section studies reveal that the calcarenitic limestone consists of rounded to subangular detrital calcite and dolomite grains in a matrix of cloudy microcrystalline calcilutite and finely-crystalline mosaics of clear calcite. Detrital dolomite grains commonly show secondary overgrowths of crystalline dolomite. Localized clusters of medium-crystalline dolomite appear to have formed by replacement of calcilutite matrix.

Insoluble-residue studies on samples of calcarenitic limestone showed that insolubles constitute about ten per cent by weight of the rocks. The residues contained the following material: clay and silt, 65 per cent; fine- to medium-grained quartz sand, 15 per cent; pellets of manganese oxides, 10 per cent; fine-grained pyrite, 10 per cent; and a few crinoid or cystoid fragments.

In typical weathered appearance, the Widener limestone forms massive, rounded outcrops (see Plate 13, A). The dolomitic intercalations and dolomite clasts weather light-gray and stand out in relief giving a banded or "warty" appearance to the outcrop. The Widener is easily distinguished from other limestones in the area by the relative abundance of oolitic calcarenite and because it is underlain and overlain by dolomite.

Thickness.--The Widener limestone member is 152 feet thick at the type section on Wright Branch (Geologic Section 5, units 78-90), and ranges from 100 feet to 160 feet throughout the Damascus area.

Paleontology.--Altogether, fifty trilobite specimens were collected from the Widener limestone in various localities in and near the Damascus area. Collecting localities are listed in Table 5. The best collections were made from very coarse-grained oolitic calcarenite lenses. The fossils are rarely apparent on the outcrop surface and must be broken out of the rock.

Matrix adhering to the fossil specimens was removed with a grinding wheel and by picking with a sharp needle. The fossils were blackened with Kodak opaquing fluid and whitened with ammonium chloride for study and photography. Identifications by the writer were confirmed and, in some cases, corrected by Dr. Franco Rasetti of the Johns Hopkins University.

Plate 13

A. Typical exposure of the Widener limestone member of the Elbrook formation. Beds are overturned to southeast. Southeast of Pleasant View Church, Widener Valley.

B. Steeply overturned, thick-bedded Conococheague limestone exposed along Laurel Creek near Vails Mill.

Plate 13

A composite of collections from the Widener includes the following species (All these species except Kingstonia inflata Resser and Glaphyraspis(?) sp. are illustrated in Plates 27 and 28):

Coosina ariston (Walcott)
Coosina sp.
Crepicephalus rectus Resser
Crepicephalus sp. no. 1
Crepicephalus sp. no. 2
Crepicephalus sp. no. 3
Terranovella dorsalis (Hall)
Tricrepicephalus thoosa (Walcott)
Meteroraspis c.f. M. mutica Rasetti
Maryvillia arion (Walcott)
Llanoaspis modesta Lochman
Kingstonia inflata Resser
Pemphigaspis sp.
Blountia sp.
Coosella (?)
Glaphyraspis(?) sp.

Age and correlation.—The trilobite fauna of the Widener limestone forms a typical cratonic assemblage of the Crepicephalus zone of the Dresbach stage (lowermost Upper Cambrian). The Crepicephalus-zone fauna is widely recognized in the Appalachians: in the lower 300 feet of the Conococheague formation and upper part of the Elbrook in northern Virginia (Wilson, 1952); in the Nolichucky shale as far north as Giles County, Virginia; and in the upper Nolichucky and locally in the lower Maynardville of Tennessee (Bridge, 1956, p. 19). According to Lochman and Wilson (1958), the faunal elements of the Crepicephalus zone are relatively short-ranging and afford a means for precise correlation.

The Widener limestone is lithologically similar to the Maynardville limestone of Tennessee and occupies approximately the same stratigraphic position. However, the Maynardville contains an Aphelaspis fauna and only locally do the basal beds contain a Crepicephalus fauna, whereas the Widener contains a Crepicephalus fauna throughout the member. Therefore most of the Maynardville is younger than the Widener and may actually be a separate unit. If, however, subsequent mapping shows that the Widener and the Maynardville are a continuous but time-transgressive unit, then the name Widener should be suppressed.

Age and Correlation of the Elbrook Formation

Except for the Crepicephalus fauna of the Widener limestone member, no fossils other than Cryptozoon were found in the Elbrook. In northern Virginia the lower part of the Elbrook contains lower Middle Cambrian fossils (Resser, 1938, p. 23). The Honaker dolomite, which in northwestern strike-belts occupies the same stratigraphic position as the Elbrook, has been reported to contain Middle Cambrian fossils (Cooper, B. N., 1944, p. 19) near the base. The writer favors the interpretation that the Middle Cambrian-Upper Cambrian boundary lies somewhere in the upper half of the Elbrook but below the Widener limestone, if the custom of placing the Dresbach stage at the base of the Upper Cambrian is followed.

The Elbrook in the Damascus area is correlated with the Honaker dolomite and part of the Nolichucky formation of the northwestern belts in Virginia, with the Elbrook and lower Conococheague formations of northern Virginia, and with the Conasauga group of Tennessee.

Knox Group

The Knox group was defined by Safford (1869, p. 204) to include all the carbonate rocks beneath limestones, now referred to as the Lenoir, near Knoxville, Tennessee. As used herein, the Knox group includes all the beds overlying the Widener limestone member of the Elbrook formation and underlying the Canadian-Champlainian disconformity. The Knox group ranges from the upper Dresbachian to the middle Canadian in the Damascus area.

The Knox group in the Damascus area includes three formations whose total thickness ranges from 2,500 to 3,350 feet. The formations included in the Knox are, in ascending order: the Conococheague formation, the Barron Creek limestone, and the Aven formation.

Conococheague formation

Name.—Stose (1908, p. 701-703) named the Conococheague formation for limestones in the Lower Knox group exposed along Conococheague Creek west of Chambersburg, Pennsylvania.

Distribution.—The distribution of the Conococheague formation is shown on the Geologic Map (Plate 1). The formation is well exposed along Wright Branch and Beech Creek in Widener Valley and in the V. D. Kendrick quarry on Road 736 in the northwest corner of the area.

Description.—The Conococheague formation is chiefly dark-gray, thick-bedded cherty limestone with crinkly dolomitic silt intercalations (Plate 16, A). About a quarter of the formation consists of alternating thin-bedded limestone and dolomite which weathers to a "ribbon-banded" appearance characteristic of the Conococheague. The lower 300 feet of the formation is largely light-gray to tan, finely-crystalline dolomite and dark-gray dolomite arenite. Laminated dolomite occurs locally throughout the formation.

Lenticular beds of medium-grained, calcite-cemented sandstone are very common in the upper 500 feet of the formation and a few sandstone beds are common near the base (Plates 14, A and 17, A). Because the Barron Creek-Conococheague contact is gradational, the upper limit of the Conococheague is conveniently placed at the highest sandstone bed.

Plate 14

A. Cross-bedding in coarse-grained, well-sorted friable sandstone, Conococheague formation. Chestnut Ridge Anticline on Road 721.

B. Symmetrical megaripples in blue-gray calcarenitic limestone. Conococheague formation, at Edmundson Dam on the Middle Fork Holston River.

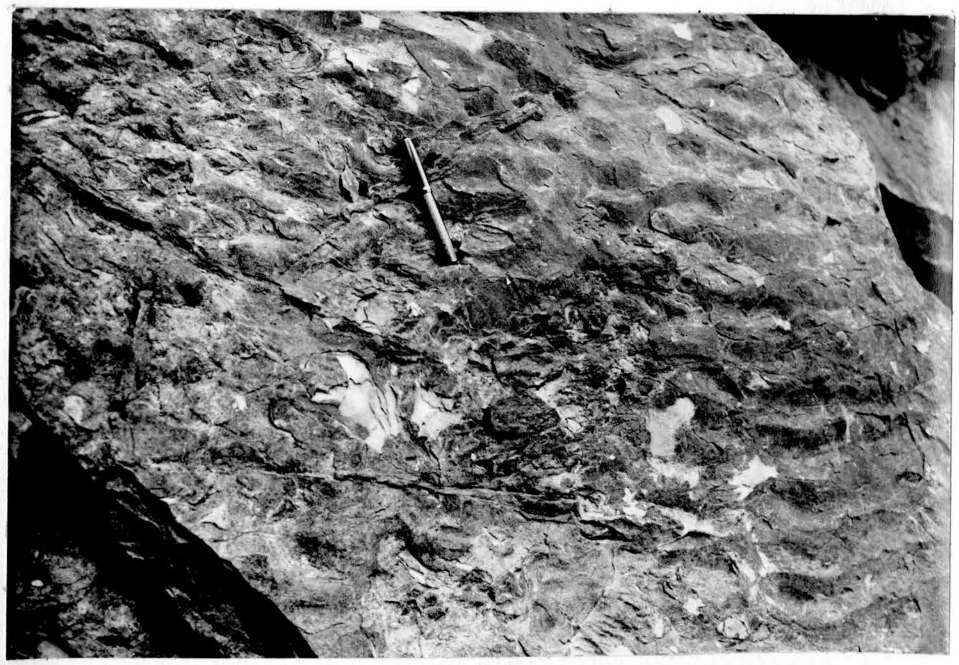
Plate 14

Plate 15

A. Algal (Cryptozoon?) structures partially replaced by black chert, underlain by blue-gray, dense calcarenitic limestone, and overlain by blue-gray calcarenite. Conococheague formation, below Edmundson Dam.

B. Ripple-marked, thin-bedded, gray limestone in Conococheague formation at Edmundson Dam.

Plate 15



A detailed description of the Conococheague is given in Geologic Section 5 (Appendix).

Thickness.—The Conococheague ranges in thickness from 1,550 to 1,800 feet in the Damascus area.

Paleontology, age, and correlation.—The Conococheague formation is sparsely fossiliferous except for the common occurrence of Cryptozoon (Plate 15, A). A few trilobite specimens, identified as Plethometopus sp. (Plate 28, Figs. 11 and 14) were found 580 feet above the base of the Conococheague near Pleasant View Church. Plethometopus indicates a Late Cambrian age for this part of the Conococheague. The exact stratigraphic range of the genus within the Upper Cambrian is in question.

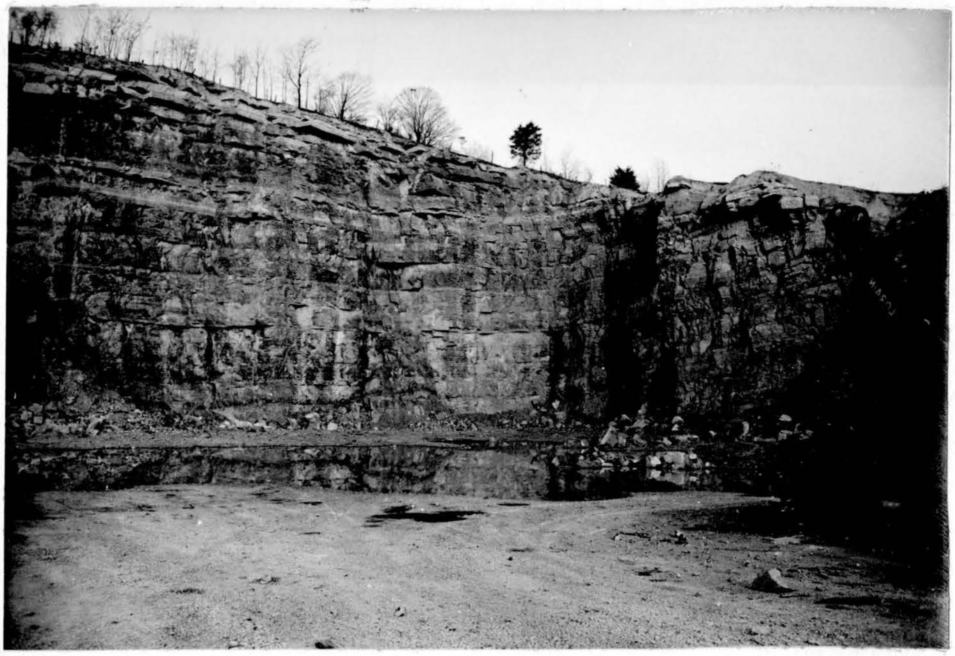
The Conococheague is traditionally considered Upper Cambrian, but recent studies in northern Virginia and Maryland indicate that the uppermost part of the type Conococheague is Lower Ordovician (Sando, 1957, p. 16; Rasetti, 1959, p. 377). Furthermore, in Tennessee meager faunal evidence suggests that the Cambro-Ordovician boundary lies in the middle of a sandstone-bearing sequence forming the upper part of the Copper Ridge dolomite and the lower part of the Chepultepec dolomite. This interval occupies approximately the same stratigraphic position as sandstone-bearing limestones in the upper 500 feet of the Conococheague. The writer has, on this basis, tentatively placed the Cambro-Ordovician boundary in the upper few hundred feet of the Conococheague.

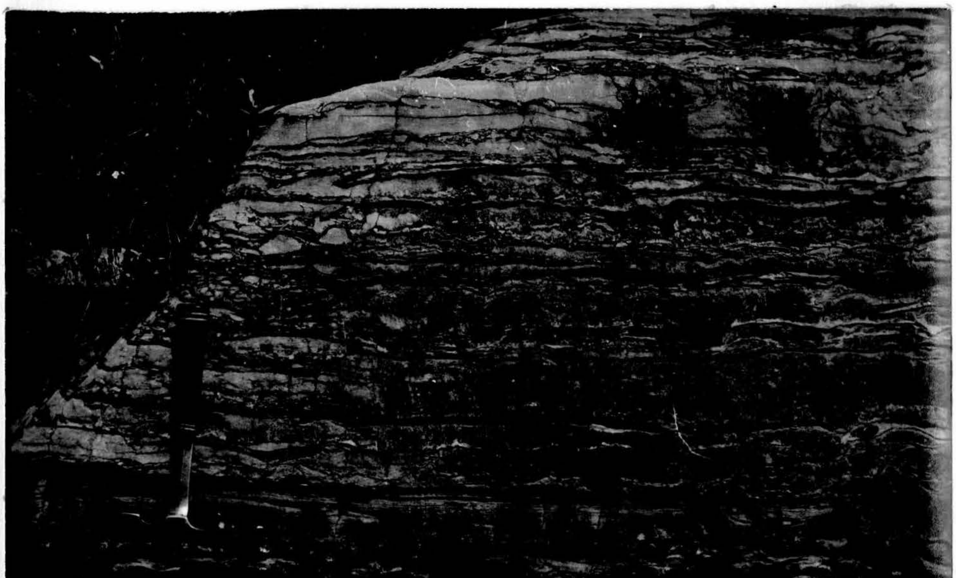
Plate 16

A. V. D. Kendrick quarry in thick-bedded Conococheague limestone. On Road 736 near Virginia Route 91.

B. Conococheague limestone with crinkly silty dolomite intercalations, typical weathered aspect. On Road 736, near northwest corner of Damascus area.

Plate 16





The Conococheague is tentatively correlated with the Copper Ridge dolomite and lower part of the Chepultepec dolomite in Tennessee and with the Copper Ridge dolomite in Virginia.

Barron Creek limestone

Name.--Tyler (1960, p. 30-34) named the Barron Creek limestone to replace "Chepultepec limestone" of Butts (1940, p. 95) and others. The Chepultepec was originally defined as a "cherty magnesian limestone" (Ulrich, 1911, p. 639) and is now defined as a dolomite formation in Alabama and Tennessee (Bridge, 1956, p. 37). The Barron Creek is named for clastic limestones exposed along Barron Creek, seven miles west of Damascus.

Distribution.--The Barron Creek limestone crops out in seven belts in the Damascus area; its distribution is shown on the Geologic Map (Plate 1). The Barron Creek is well exposed at the end of County Road 801 west of Pleasant View Church, along Buzzard Den Branch, and on the hill north of DeBusk Mill.

Description.--The Barron Creek limestone is chiefly gray and black thick-bedded calcarenite in a calcilutite matrix. Typical weathered surfaces are light blue-gray and smoothly rounded (Plate 17, B). Interweaving silt intercalations are locally abundant. Although black and white chert are both present in the Barron Creek, black chert predominates (Plate 18, B).

Plate 17

A. Dark-gray sandstone bed (behind hammer) overlain by nodular limestone with silty dolomitic intercalations. Conococheague formation on Road 736, northwest corner of Damascus area.

B. Typical outcrop appearance of Barron Creek limestone. Near top of formation north of DeBusk Mill.

Plate 17

Plate 18

A. Flat pebble limestone conglomerate underlain by thin sandy limestone bed (dark unit behind hammer head). The clastic limestone fragments consist of dark gray fine-grained limestone and were probably locally derived from underlying beds partially lithified by brief subaerial exposure. Barron Creek limestone, north of DeBusk Mill.

B. Black chert (flint) lying in a single bedding plane in laminated limestone. Barron Creek limestone, north of DeBusk Mill.

Plate 18

Thick lenticular beds of flat-pebble conglomerate, conglomeratic calcarenite, and sandy calcarenite are locally common (Plate 18, A and 19). A few beds of pink shaly dolomite and laminated limestone occur sporadically throughout the formation. A detailed description of the formation is given in Geologic Section 6 (Appendix).

Thickness.—The Barron Creek limestone ranges in thickness from 350 to 850 feet in the Damascus area. In Widener Valley and in the next belt of outcrop to the northwest, the Barron Creek ranges from 750 to 850 feet thick. It is approximately 600 feet thick at DeBusk Mill and ranges from 350 to 400 feet in the two belts near Chestnut Ridge.

Paleontology, age, and correlation.—The Barron Creek contains abundant brachiopods, gastropods, and cephalopods; however, identifiable specimens are rare. The following fossils from the Barron Creek were identified by the writer (locality descriptions are listed in Table 5):

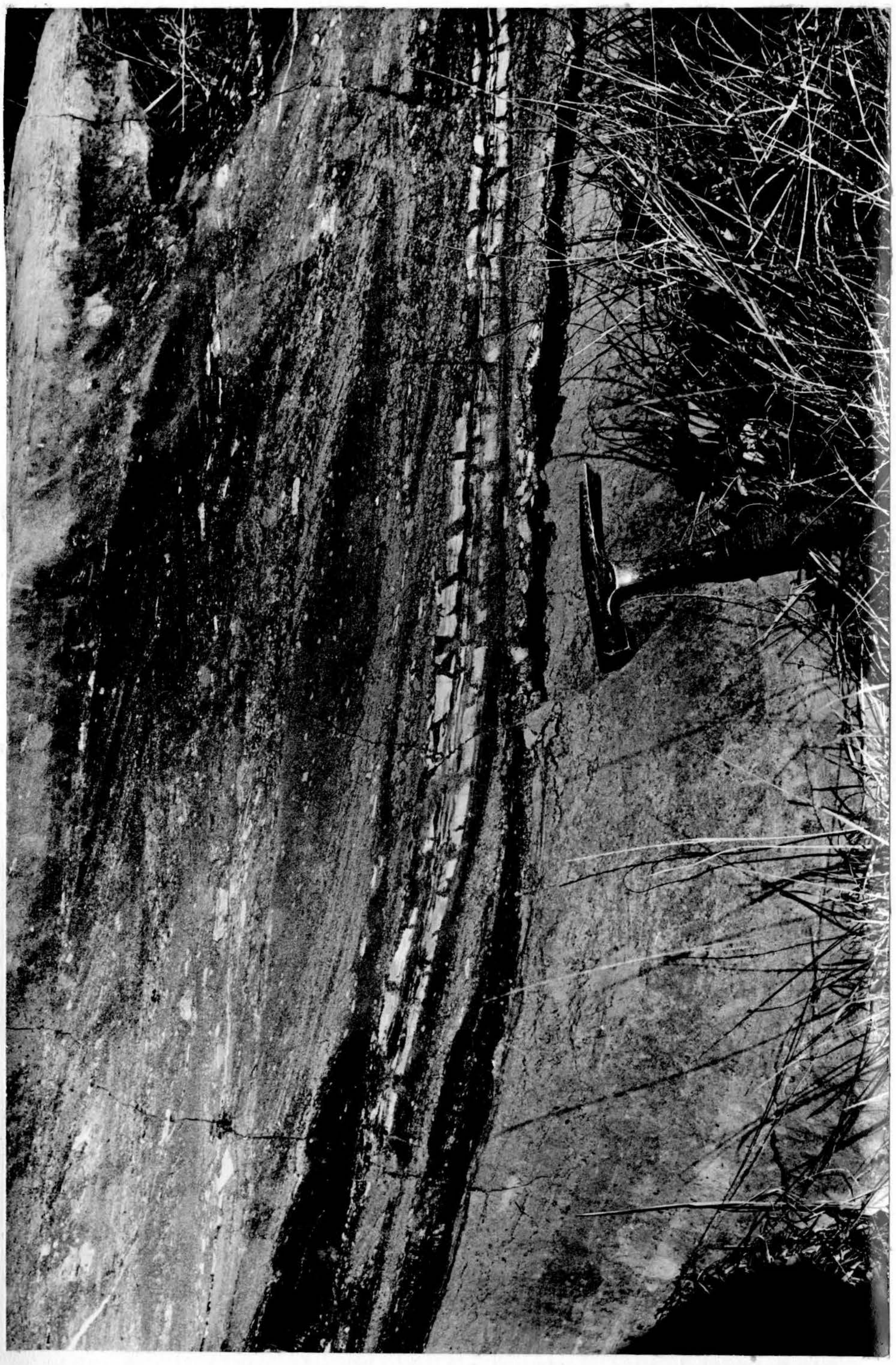
Locality	
10	*Finkelnburgia bellatula* Ulrich and Cooper
11	*Gasconadia* sp.
12	*Dakeoceras*(?) sp.

According to the faunal lists of Bridge (1956, p. 43), these species indicate a Gasconade age for the Barron Creek.

Plate 19

Shallow-water sedimentary structures in the Barron Creek limestone. The lower calcarenitic limestone is overlain by cross-bedded, sandy, conglomeratic calcarenite. A thin, lenticular, banded dolomite bed (white-weathering) shows pull-apart structure which probably represents mudcracks formed during a brief period of exposure. Angular fragments of this dolomite or similar dolomites were reworked and deposited in the overlying beds. Medium-grained quartz sand is concentrated in the dark areas. The irregular contact of the lowermost sandy bed with the underlying limestone was probably formed by differential compaction and flowage of lime-mud under the weight of the sandy bed. Barron Creek limestone north of DeBusk Mill.

Plate 19



The Barron Creek limestone is correlated with the Chepultepec dolomite in northwest strike belts in Tennessee, the lower part of the Jonesboro limestone in southeast strike belts of Tennessee, the Gasconade formation of Missouri, and the Chepultepec-Stonehenge limestones of the Central Appalachians.

Aven formation

Name.–Tyler (1960, p. 34-42) named the Aven formation for dolomites and limestones in the upper part of the Knox exposed at the old Avens Bridge site 6.5 miles south of Abingdon, Virginia. Aven formation, as defined by Tyler, replaces "Beekmantown" as used by Butts (1940, p. 102) as a formation name in southwest Virginia.

Distribution.–The Aven formation crops out in five strike belts whose distribution is shown on the Geologic Map (Plate 1). The Aven is well exposed along Virginia Highway 91 at Wright Bridge, along Road 709 northeast of High Point School and along Road 731 southeast of Lodi.

Description.–The Aven formation is characterized by light-gray to tan, thick-bedded, gray- or buff-weathering dolomite. The upper part of the formation consists of monotonously interbedded limestone and dolomite (Plate 20, B), whereas the lower part is chiefly dolomite. The dolomite beds are more resistant than the

Plate 20

A. Low-spired gastropod, possibly Helicotoma, in dark-gray, dense calcarenite. Barron Creek limestone, north of DeBusk Mill.

B. Aven formation in pasture at east end of Wright Bridge. Interbedded dolomite and limestone.

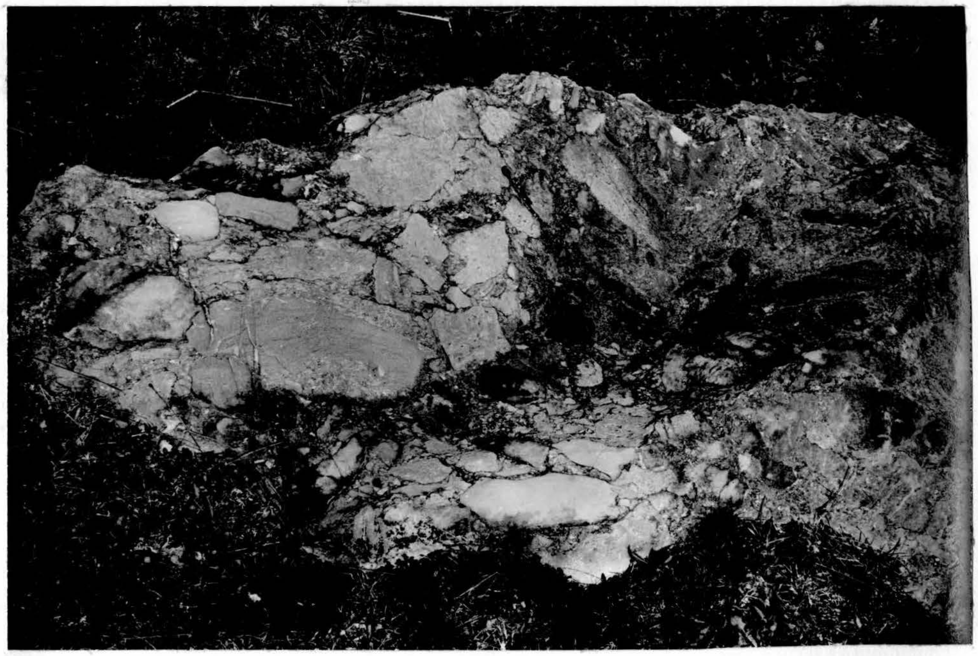
Plate 20

Plate 21

A. Limestone and dolomite breccia filling a sinkhole developed near the top of the Aven formation. The sinkhole, which measures 40 feet deep by 35 feet wide, was probably developed during subaerial exposure prior to the deposition of the overlying Lenoir limestone. North of Virginia Route 91 at Wright Bridge.

B. Stratified conglomerate at the top of the sinkhole breccia figured above. Pebbles are predominantly medium-gray, finely crystalline limestone; matrix is red and buff crystalline dolomite.

Plate 21



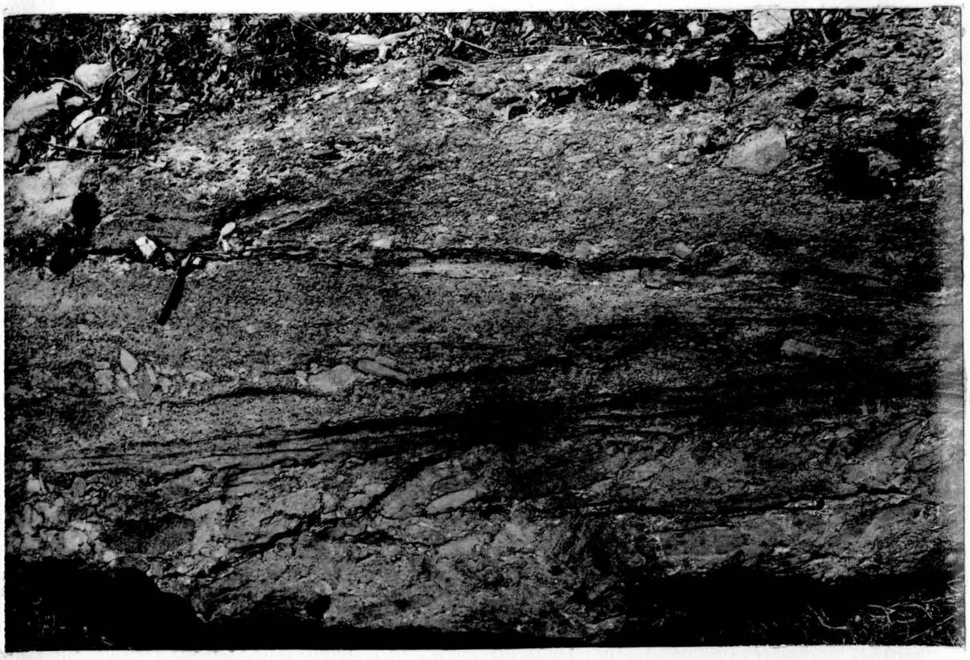
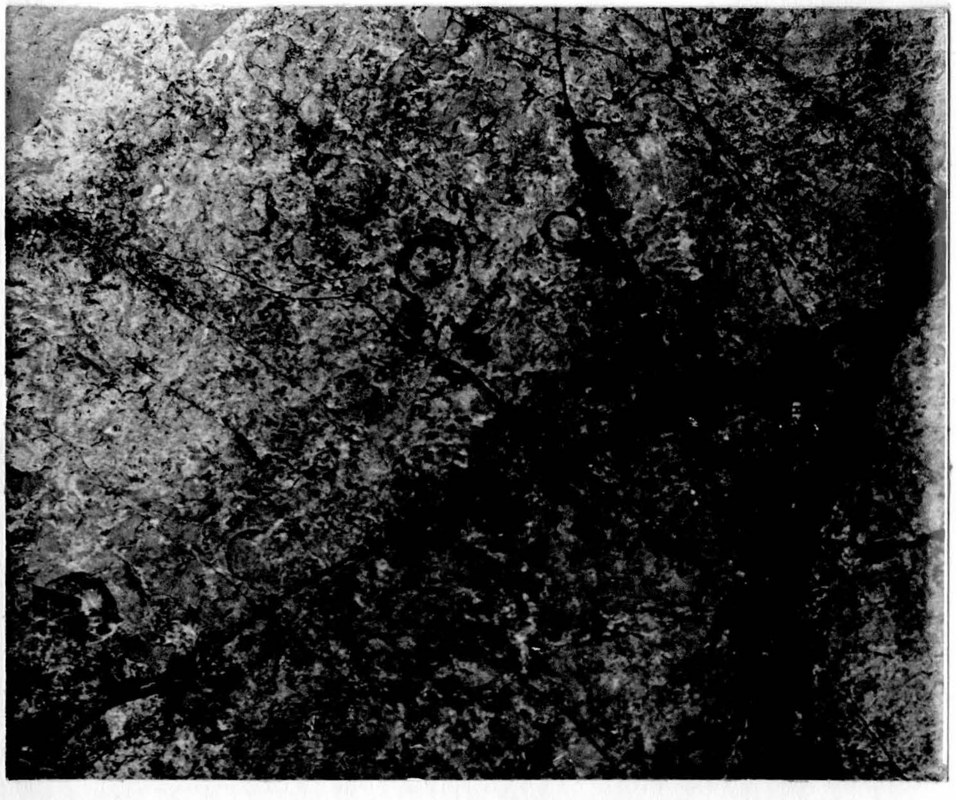


Plate 22

A. Coarse limestone and dolomite breccia near top of the sinkhole in the Aven formation described in Plate 21, A.

B. <u>Lecanospira</u>(?)-bearing, siliceous, calcarenitic limestone. Aven formation on Virginia Route 91, east of Wright Bridge.

Plate 22



limestones; in natural exposures, the formation commonly appears to be wholly dolomite.

The dolomite beds in the Aven are light- to dark-gray or tan, fine- to coarsely crystalline, and thick-bedded. Quartz sand grains are common in the lower dolomite beds. The limestone beds are chiefly light brownish-gray calcilutite and calcarenitic limestone of two types: one contains thin silt straticulations (Plate 23, A), whereas the other is massive and contains abundant small stringers and blebs of white chert (Plate 22, B).

The base of the Aven is placed at the lowest bed of dolomite overlying dark-gray limestones of the Barron Creek. The Aven disconformably underlies the Lenoir-Mosheim limestones. The upper contact is irregular and locally collapse breccias and sinkhole breccias occur at or near the top of the formation (Plates 21 and 22, A). Detailed descriptions of the formation are given in Geologic Sections 6 and 7 (Appendix).

Thickness.--The Aven formation ranges in thickness from 600 to 800 feet throughout the Damascus area.

Paleontology, age, and correlation.--*Lecanospira* and *Ophileta(?)* and other gastropods were found at two localities near the top of the Aven northeast of High Point School. The specimens of *Lecanospira* resemble *L. compacta* (Salter) which suggests a Roubidoux age, according to Ulrich and Bridge (*in* Bridge, 1930, p. 204). The Aven is probably correlative with the

Plate 23

A. Lenoir limestone (left) disconformably overlying the Aven formation, section overturned. Note the 8-foot deep collapse breccia at the top of the Aven in background. Near Wright Bridge.

B. Lecanospira-bearing chert in the Aven formation, 680 feet above the base. This type of chert forms by deep weathering of limestones like that shown in Plate 22, B. On Road 709, 1300 feet south of BM G 186.

Plate 23

Longview limestone of Tennessee and Alabama and with the "Beekmantown" dolomite in the northwestern strike belts of Virginia.

Middle Ordovician (Champlainian) Series

The Middle Ordovician series in the Damascus area consists of five formations: in ascending order, the Lenoir-Mosheim, Fetzer, and Effna limestones, the Paperville shale, and the Knobs sandstone and shale. At most localities, Lenoir-Mosheim limestones disconformably overlie the Aven formation. Locally, as at one locality 3,000 feet north of Vails Mill, the limestones are missing and the Paperville shale lies directly upon an irregular surface at the top of the Knox. Elsewhere the Middle Ordovician limestones range from a few feet to 105 feet in thickness.

Because of their thinness, the Lenoir-Mosheim, Fetzer, and Effna limestones were mapped together and are shown on the Geologic Map (Plate 1) as a single unit. Similarly, the Paperville shale and Knobs formation were mapped as a single unit.

Lenoir-Mosheim limestone undifferentiated

Name.--The Lenoir limestone was named by Safford and Killebrew (1876, p. 108, 130-131) for outcrops in Lenoir City, London County, Tennessee. The Mosheim limestone, which was named by Ulrich (1911, p. 413-414) for the Mosheim railroad station, Green County, Tennessee, was shown by Cooper and Cooper (1946,

p. 51-52) to be a facies of the Lenoir. As G. A. Cooper (1956, p. 78-79) points out, "the Mosheim is part of the Lenoir, but it is discontinuous and appears at different levels in the Lenoir". Because the Mosheim facies occurs at many different horizons in the Lenoir of the Damascus area, and locally comprises nearly the entire thickness of the Lenoir, use of the compound name seems appropriate.

Distribution.--The distribution of the Lenoir-Mosheim limestones is shown on the Geologic Map (Plate 1). The formation is well exposed at the three localities described in Geologic Sections 6, 8, and 9 (Appendix), at a locality 4,000 feet southwest of Roetown, and along Road 803 south of Mock Mill.

Description.--The Lenoir-Mosheim consists of interbedded calcarenitic limestone, calcilutite, and magnesian limestone. The basal few feet is commonly a limestone conglomerate containing limestone, dolomite, and chert fragments. Typical Lenoir limestone is gray to black calcarenitic limestone and biogenic calcarenite containing abundant wavy silt laminae which give the limestone a nodular and banded appearance in weathered outcrops. The Mosheim facies is medium brownish-gray to dark-gray, "birdseye" textured calcilutite. The upper part of the Lenoir-Mosheim commonly contains a thick bed of magnesian or partially dolomitized limestone.

Thickness.—The Lenoir-Mosheim limestones range from a few feet to 86 feet in thickness in the Damascus area. At two localities a short distance north of Roetown, the Lenoir-Mosheim limestones are absent.

Age and correlation.—The Lenoir-Mosheim is placed in the Chazyan stage by Twenhofel, et al (1954, chart 2) or in the Marmor stage of G. A. Cooper (1956, Chart 1). According to G. A. Cooper (1956, p. 72), the Lenoir formation contains faunal elements of the Crown Point and Valcour formations of New York.

Fetzer limestone

Name.—The Fetzer tongue of the Arline formation was named by B. N. Cooper and G. A. Cooper (in Cooper, G. A., 1956, p. 64) for Fetzer Creek, Polk County, Tennessee. In the Damascus area the Fetzer is a persistent, easily recognized bed underlying the Paperville shale, or the Effna limestone, and conformably(?) overlying the Lenoir-Mosheim formation.

Distribution.—The distribution of the Fetzer is shown on the Geologic Map (Plate 1). Fetzer is present at nearly every locality where the Middle Ordovician limestones are exposed. The Fetzer is best exposed on Road 721 at High Point School. Other well-exposed localities are described in Geologic Sections 6, 8, and 9 (Appendix).

Description.—The Fetzer is a dark-gray, impure, calcarenitic limestone. Interbedded with the limestone are wavy thin beds and laminae of silt and clay which give a nodular and banded appearance to the outcrop. Weathered surfaces of the Fetzer are a crust of yellowish-tan clay from which fossil fragments protrude. The Fetzer contains abundant fragments of crinoids, brachiopods, bryozoa, and corals (see Plate 24, B).

Thickness.—The Fetzer ranges from a few feet to 18 feet in thickness in the Damascus area. At two localities a short distance north of Roetown, the Fetzer limestone is missing.

Age and correlation.—G. A. Cooper (1956, chart 1) places the Fetzer limestone at the base of his Porterfield stage. According to Cooper, the Fetzer correlates with the Botetourt limestone in the Shenandoah Valley, the lower part of the Ward Cove limestone in Tazewell and Giles Counties, and the lower part of the Arline formation in southwest Virginia and Tennessee.

Effna limestone

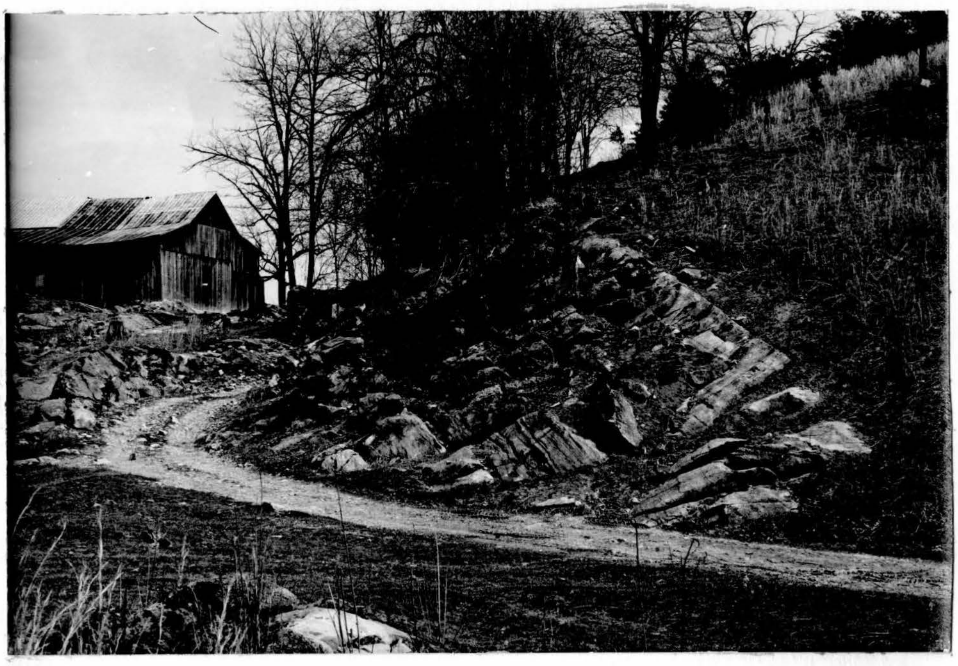
Name.—The Effna limestone was named by B. N. Cooper (1944, p. 59) for Effna, two miles east of Sharon Springs, Bland County, Virginia.

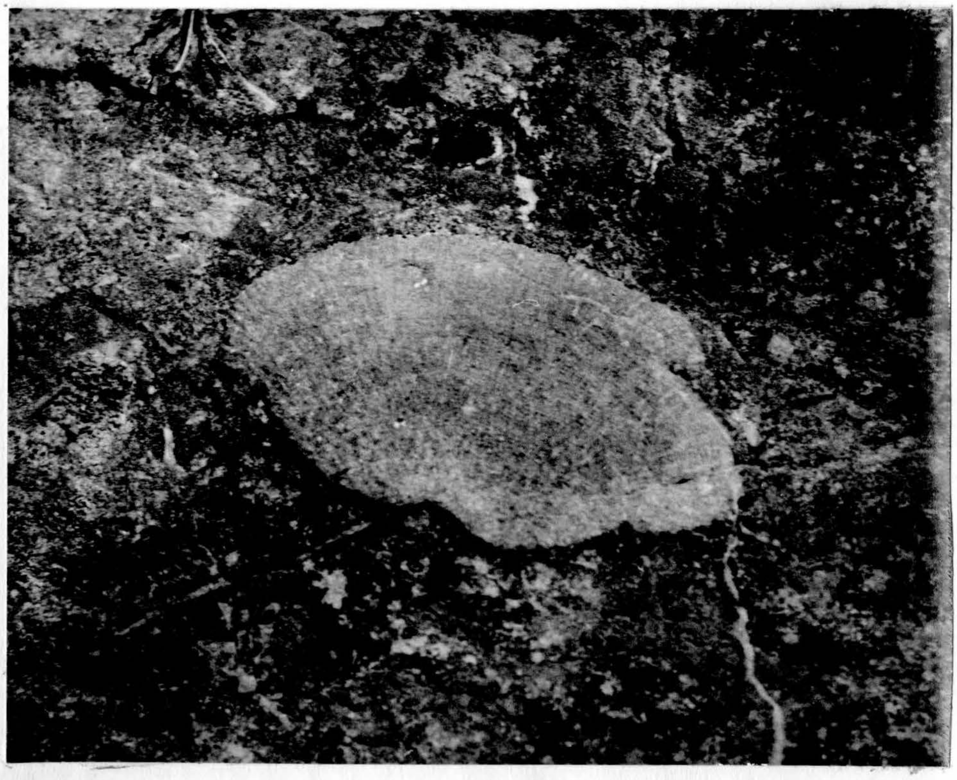
Plate 24

A. Lenoir and Fetzer limestones of Middle Ordovician age overlain by Paperville shale (grass-covered slopes at right). Fifteen hundred feet northeast of bridge over South Fork Holston River on Road 788. Outcrop described in Geologic Section 9.

B. Coral colony (diameter 6 inches) in Fetzer limestone. Locality same as above.

Plate 24





Distribution.—The Effna limestone crops out at a single locality one mile due north of Vails Mill (Geologic Section 9, Appendix) in the Damascus area.

Description.—The Effna, at the only exposure, is about ten feet thick and consists of thick-bedded, light-gray fossiliferous calcarenite. The contact with the underlying Fetzer limestone is not exposed.

Age and correlation.—G. A. Cooper (1956, chart 1) places the Effna limestone in his Porterfield stage. The Effna is correlated with the upper Arline and lower Rich Valley formations of the Marion area, Virginia.

Paperville shale

Name.—The Paperville shale was named by G. A. Cooper and B. N. Cooper (Cooper, G. A., 1956, p. 82). In the Damascus area, the Paperville conformably (?) overlies the Fetzer limestone or locally, the Effna limestone, and grades upward into the Knobs formation. At one locality 0.6 mile north of Vails Mill, the Middle Ordovician limestones are missing and the Paperville shale unconformably overlies the Lower Ordovician Aven formation.

Distribution.—The Paperville shale is exposed in three areas in the Damascus area: in the trough of the Roetown syncline where it is especially well exposed along Virginia Highway 91 and

Road 731; in the trough of the South Knobs syncline where it is exposed along the edge of the Lodi thrust fault; and in the trough of the River Knobs syncline where it is partially covered by a semi-klippe of the Lodi thrust sheet.

Description.--In typical development in the Damascus area, the Paperville is a black, highly carbonaceous, graptolitic, clay shale. Thin beds of gray siltstone and fine-grained sandstone are common but constitute no more than one third of the formation. A few thin, light-blue, argillaceous limestone beds occur several hundred feet above the base of the formation. The fact that the limestone beds were found only in the fresh roadcuts northwest of Wright Bridge suggests that argillaceous limestone may be more common in the formation but is rarely observed in the weathered outcrop.

The typical weathered aspect of the Paperville shale is yellowish-tan, paper-thin flakes or soft, plastic, yellowish clay with relict bedding. Artificial exposures such as roadcuts and quarries weather to buff or tan sharp angular fragments which ultimately break down to a yellowish clay. Areas underlain by the Paperville shale and the overlying Knobs formation are characterized by steep-sided conical hills (Plate 24, B) on which is developed a relatively unproductive soil, the Dandridge silt loam (Jurney, 1945, p. 69 and Table 3).

Thickness.—In every widely exposed section, the beds are complexly folded and faulted so that no more than a few hundred feet of section can be measured with any degree of accuracy. The writer believes that the formation is at least 300 feet thick in the Damascus area and possibly several times that thickness.

Paleontology, age, and correlation.—Graptolites may be found in the Paperville at nearly every outcrop of the black shale; however, the best collecting is in the deeply weathered yellowish-tan clay. Collections identified by the writer were made at two localities as follows:

1. Outcrop of yellowish-tan clay on Road 788 in Roetown syncline, north of dam on Laurel Creek in Roetown, within 100 feet of Aven-Paperville unconformity,

    Climacograptus modestus var. meridionales Ruedemann

    Diplograptus (Cryptograptus) augustifolius (Hall)

    Glossograptus ciliatus Emmons

    Diplograptus sp.

    Glyptograptus sp.

    Cryptograptus sp.

2. Dirt road on west bank of South Fork Holston River, south of Buck Bridge, 1.1 mile southeast of Lodi, within 50 feet of Fetzer limestone,

Dicellograptus moffatensis, var. alabamensis Ruedemann

Dicranograptus sp.

Glossograptus sp.

Obuloid brachiopod (Obulus?), genus undetermined

The forms are characteristic of the lower and middle zones of the Athens as described by Decker (1952) and are equivalent to the lower Normanskill (Mt. Merino) formation. Cooper, G.A. (1956) placed all of the Paperville, as well as the Fetzer, in his Porterfieldian stage. He believed that the two formations are conformable and indicated a hiatus between the Fetzer and the underlying Lenoir. The Paperville shale is considered by Cooper (1956, chart 1) to be correlative with the Rich Valley shale of the Marion, Virginia, area; with the Blockhouse shale of Tennessee; and with the Peery-Ward Cove limestones of the northwestern belts in Virginia.

Knobs formation

Name.--Tyler (1960, p. 52) named the Knobs formation "for a thick succession of sandstone, graywacke, and conglomerate" exposed in the South Knobs, River Knobs, and Great Knobs synclines in the Abingdon area. The Knobs formation conformably overlies the Paperville shale and is the youngest Paleozoic formation exposed in the Damascus area.

Distribution.—The Knobs formation crops out in the trough of the Roetown syncline, and in the South Knobs and Great Knobs synclines along the edge of the Lodi thrust sheet. The formation is well exposed in the Roetown syncline along Roads 731 and 724 and along Virginia Highway 91.

Description.—The Knobs formation consists of buff to brown interbedded sandstones, graywackes, and shales. The sandstone and graywacke beds are medium to thick bedded and highly feldspathic. These beds are poorly indurated and rarely crop out. The Knobs formation is at least 400 feet thick along Road 731 southeast of Lodi and may be many times that thickness.

Age and correlation.—The Knobs formation conformably overlies the Paperville shale and is probably of Middle Ordovician age throughout, but the precise age of the formation is not known. The formation is younger than the Paperville shale and lies in approximately the same stratigraphic position as the Tellico sandstone of Tennessee.

Unconsolidated deposits

General statement.—Unconsolidated deposits in the Damascus area consist of Recent and Pleistocene alluvium, colluvium, calcareous tufa, and residual(?) clays. Except for clays, which blanket much of the area, none of the unconsolidated deposits are very extensive.

Plate 25

A. Chevron folds in shale and thin-bedded sandstone of Knobs formation. Exposed along Road 731 (Widener Branch) in the Roetown syncline.

B. Typical steep-sided conical hills developed on Paperville shale and Knobs formation. In Roetown syncline southwest of Wright Bridge.

Plate 25

Alluvium.--Two types of alluvium are described: older, presumably Pleistocene alluvium not directly related to present streams, and Recent alluvium which has been deposited by streams flowing essentially in their present positions.

Occurrences of Pleistocene alluvium are rare, and are limited to slopes at the base of Holston and Iron mountains and to terraces above streams draining the mountain area. Alluvial deposits occur on the sides of the valley of Laurel Creek at elevations ranging from 50 to 100 feet above the present level of the creek (Plates 9B and 26). A broad, partially dissected alluvial fan lies at the foot of the Iron Mountains south of Beech Grove School. Along Virginia Route 91 east of Wright Bridge, about four feet of alluvium overlies a deep residual clay approximately 30 feet above the nearby stream.

Recent alluvial deposits are present in significant amounts only in the valleys of Laurel Creek, Beaverdam Creek, and Whitetop Creek. These deposits consist almost entirely of pebbles, cobbles, and boulders of quartzite derived from rocks of the Chilhowee group and are probably never more than 20 feet thick. Thin alluvial deposits are present along some of the broad flats bordering the South Fork of the Holston River, but the Middle Fork of the Holston is virtually free of alluvium.

Colluvium.--Colluvium is limited in occurrence to the slopes of ridges underlain by quartzites of the Chilhowee group. Nearly all of these slopes are covered with at least a thin veneer of

Plate 26

Alluvium of Lower Cambrian quartzite cobbles
50 feet above Laurel Creek. North of dam on
Laurel Creek in Roetown.

Plate 26

angular rock fragments. The most extensive colluvial masses lie on the north-facing slopes above Laureldale. An unusually well-exposed talus slope consisting of angular, unweathered blocks of the uppermost Unicoi quartzite extends from the top of Fork Mountain down to the highway. Another unusual colluvial deposit is exposed along U. S. Route 58 on the east side of Damascus. At this locality a mass of fresh and weathered angular quartzite fragments are cemented by silt and sand to form a fairly coherent steep outcrop.

Calcareous tufa.--Calcareous tufa, commonly called "fresh-water marl", occurs on the west bank of the South Fork of the Holston River at the west side of the area and in the bed of a stream about 1,000 feet north of Mock Mill. These two deposits cover an area of about one acre each and reach a maximum observed thickness of eight feet.

Residual clay.--Residual clay deposits, ranging in thickness from a few feet to 30 feet or more, blanket the bedrock throughout much of the Damascus area. The clays appear to be thickest overlying the Rome formation, Shady dolomite, and locally over the Paperville shale. Manganese oxide nodules are common in clays overlying the Shady dolomite and have been found in clays overlying nearly all the other carbonate formations as well. Locally the clays contain rock fragments foreign to the underlying formations. This fact suggests that the clays may not be wholly residual but are partially derived from transported material.

The age of clay accumulation is difficult to ascertain. King and Ferguson (1960, p. 90-91) suggest that most of the residual clays formed during a previous erosional cycle and that clay is not actively accumulating at the present time. The fact that the clays are commonly overlain by Pleistocene alluvium and are locally being dissected by stream and gully erosion tends to support this belief. However, the alluvium overlying thick clay deposits may not postdate the clay but may have created favorable conditions for rapid clay accumulation. If this is true, clay may be actively forming at present beneath areas overlain by thick alluvial and colluvial deposits.

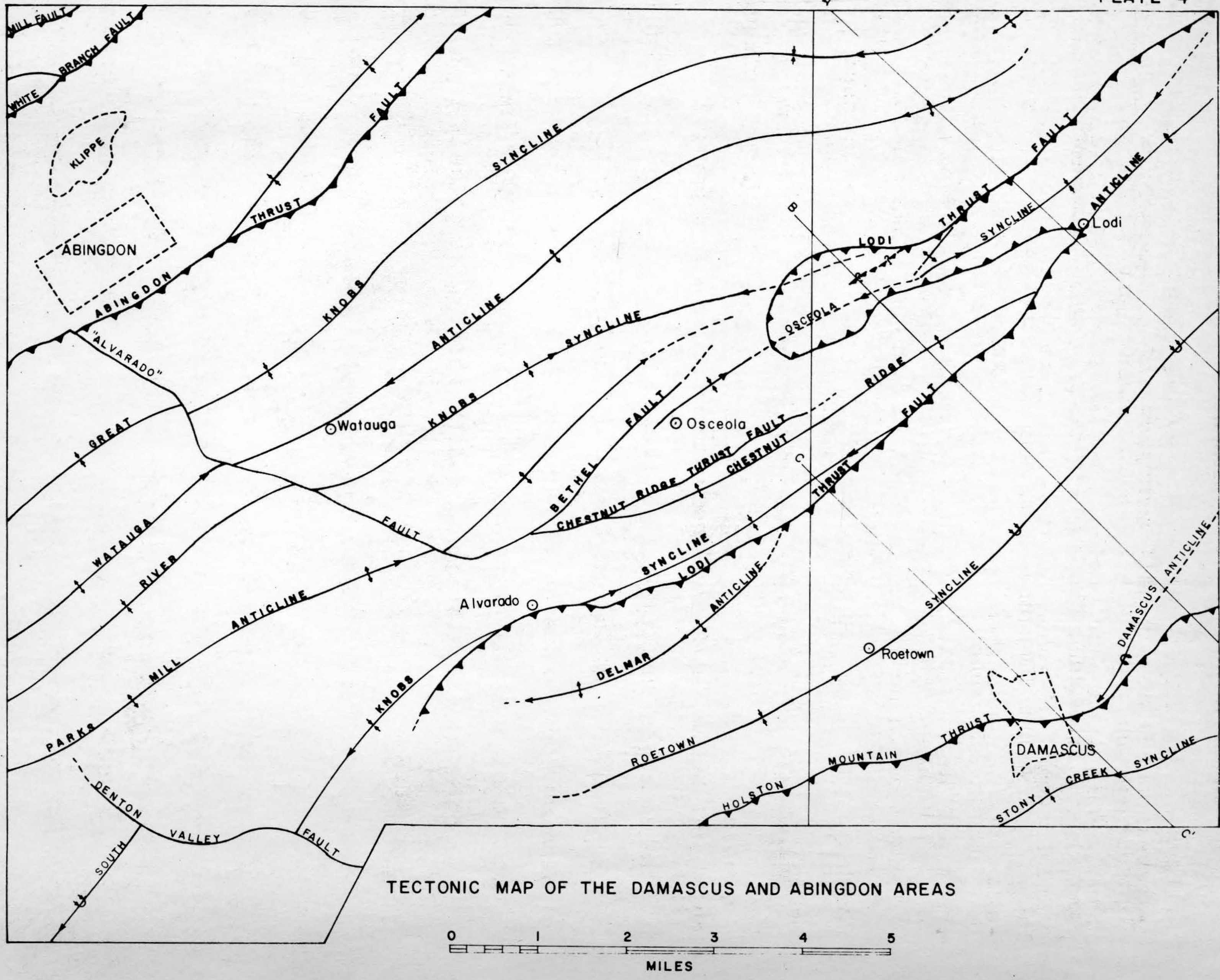
STRUCTURE

General statement.—The Damascus area lies within the southeasternmost fold belts of the Folded Appalachians and includes part of the Blue Ridge Province. The Holston Mountain thrust, which extends many tens of miles southwest and northeast of the Damascus area, trends northeast across the southern part of the area. The Holston thrust delineates the boundary between the folded Appalachians and the Blue Ridge Province, although in this area the structure in the Blue Ridge is similar to that in the folded Appalachians.

The rocks in the Damascus area have been folded into five synclines and four anticlines, which are broken by two major thrust faults. The various folds and faults in the Damascus area and the adjacent Abingdon area are shown on the Tectonic Map (Plate 4). The Damascus area can be subdivided into three structural units, the Shady Valley thrust sheet southeast of the trace of the Holston Mountain thrust, the rocks between the Holston Mountain thrust and the trace of the Lodi thrust, and the rocks northwest of the Lodi thrust which lie in the Abingdon thrust sheet of Tyler (1960).

Many of the structural features in the Damascus area extend into the adjacent Abingdon area. In order to interpret properly the structure of the Damascus area, the writer was forced to reinterpret some of the structures mapped by Tyler (1960) in the Abingdon area. A proper interpretation of the

PLATE 4



TECTONIC MAP OF THE DAMASCUS AND ABINGDON AREAS structure along the east side of the Abingdon area requires knowledge of the structure of the Damascus area. Such information was not available to Tyler at the time he wrote his report.

Major folds

Roetown syncline.--The Roetown syncline is the dominant structural feature in the Damascus area, encompassing nearly half of the mapped area (Plate 2). The northwest limb of the syncline includes all the formations from the Elbrook through the Knobs. The overturned southeast limb of the Roetown syncline includes a complete sequence of beds from the Erwin formation to the Knobs formation. The southeast limb of the southwestern end of the syncline has been overridden by the Holston Mountain thrust. The Roetown syncline plunges to the northeast within the Damascus area and extends to the Marion area where the fold has been described by B. N. Cooper (1936, p. 160) under the name Holston River syncline.

South Knobs syncline.--The South Knobs syncline occupies a small area on the west side of the Damascus area between the Chestnut Ridge anticline and the trace of the Lodi thrust (Plate 2, C-C'). The syncline is entirely cut out by the Lodi thrust in the vicinity of Luther Chapel. The evidence is not clear, but the outcrop pattern suggests a southwest plunge in the Damascus area. In the Abingdon area, the South Knobs syncline plunges northeast and southwest away from a structural high in the vicinity of Alvarado. The structure of the South Knobs syncline is further discussed in the section on the Lodi thrust.

Chestnut Ridge anticline.--The Chestnut Ridge anticline follows the crest of Chestnut Ridge in a northeast trend across the area. Southwest of Lodi the Conococheague formation forms the crest of the anticline and the anticline is slightly asymmetrical to the northwest. Northeast of Lodi, the Elbrook formation has been thrust over the Conococheague and younger formations, and the anticline is sharply overturned to the northwest.

Osceola syncline.--The trough of the Osceola syncline lies about 0.5 mile northwest of Lodi and generally parallels the crest line of the Chestnut Ridge anticline. The trough of the syncline is exceptionally well exposed along Road 803, 0.7 mile west of Liberty Hall School. In the Damascus area, the trough of the Osceola syncline is occupied by the Lodi thrust sheet, principally the Elbrook formation, except in a small area northwest of High Point School where the Conococheague and Barron Creek formations overlie the inferred position of the trough. West of the Damascus area, at a locality 0.8 mile west of High Point School, the trough of the Osceola syncline emerges from beneath the Lodi thrust sheet and follows the belt of outcrop of the Knobs and Paperville formations southwest, crossing U. S. Highway 58, one-quarter mile northwest of Osceola (see Tyler, 1960, Geologic Map). North of High Point School the position of the trough is not clearly defined, as a result of the complex structure in the rocks in the overthrust block (Plate 2, B-B'). The aberrant east-west strike on the northwest limb of the Osceola syncline near Mock Mill is apparently caused by the Parks Mill anticline and the River Knobs syncline (Tyler, 1960, Geologic Map) which merge with the northwest limb of the Osceola syncline in that area (Plate 4 and Plate 2, B-B').

The Osceola syncline plunges northeast in the vicinity of Osceola in the Abingdon area, but reverses plunge and plunges southwest in the vicinity of High Point School in the Damascus area. Northeast of Road 709, which marks the position of a cross-axial high, the syncline plunges northeast. The plunge is again reversed in the vicinity of Virginia Highway 91 near Lodi northeast of which the syncline plunges southwest.

Watauga anticline.--The Watauga anticline is a prominent structural high in the northwest part of the area (Plate 2, A-A'). The anticline plunges northeast and southwest from the culmination which lies on Road 735, approximately 1,000 feet east of the line of section A-A'.

The oldest unit exposed in the anticline is the middle limestone member of the Elbrook, and the shape of the anticline is clearly outlined by the outcrop pattern of the Widener limestone (Plate 1). The Watauga anticline plunges southwest across most of the Abingdon area (Plate 4), but in the Damascus area, the northeast end loses closure in the area west of Ebbing Springs

Church. At that locality, the anticline seems to merge with the northwest limb of the Osceola syncline. At the northern border of the Damascus area, in the triangular area between Tattle Branch and Hall Creek, the southwestward plunging nose of another anticline crops out. This anticline, which extends northeast out of the Damascus area, seems to be a distinct structure, separate from the Watauga anticline.

Great Knobs syncline.—The Great Knobs syncline is the northwesternmost structure in the Damascus area. The plunge of the syncline is about 10° to the west at the west side of the area. The trough of the syncline is occupied by the Barron Creek and Conococheague formations and the structure is relatively open.

Damascus anticline.—The crest of the Damascus anticline crops out on the hills at the foot of the Iron Mountains northeast of Damascus and trends northeast out of the area. Near Damascus, where the anticline disappears under the Holston Mountain thrust, the plunge is about 30° to the southwest. As interpreted by the writer, the crest of the Damascus anticline lies on the trace of the axial plane of a broad, overturned anticline at depth (Plate 2, B-B' and C-C'). The Damascus anticline is probably a small drag fold caused by the tendency of the overlying beds in the southeast limb of the Roetown syncline to be thrust upward out of the syncline as the syncline was forming.

Stony Creek syncline.--The trough of the Stony Creek syncline trends northeast across the southeast corner of the area. The syncline is a broad, open structure involving the Shady dolomite and the Chilhowee group, and plunges gently to the southwest. The writer concurs with the interpretation of Butts (1933, section E-E'), and King and Ferguson (1960) that the Stony Creek syncline is a folded thrust sheet.

Thrust faults

Lodi thrust fault.--The Lodi thrust is one of the major structural elements in the Damascus and Abingdon areas. The trace of the thrust extends from Bumgardner Branch in the South Knobs syncline (Abingdon area) northeast to Lodi (Damascus area), sharply reverses direction and trends west-southwest beyond the border of the Damascus area west of High Point School. The trace of the fault again swings around in the trough of the Osceola syncline and trends northeast to the northeast corner of the Damascus area.

The trace of the Lodi thrust in the Abingdon area between Alvarado and the border of the Damascus area was mapped by Tyler (1960, Geologic Map) as a northeast-trending portion of hi Alvarado oblique fault. Knowledge of the true nature of the Lodi thrust, as shown by detailed mapping in the Damascus area, made Tyler's interpretation untenable. The writer and A. T. Ovenshine mapped critical localities in the Abingdon area and came to the following conclusions:

1. The Paperville-Fetzer contact on the northwest limb of the South Knobs syncline at Alvarado is not offset. Thus the Alvarado oblique fault, which obviously offsets the axis of the next syncline to the northwest, the River Knobs syncline, does not pass through Alvarado, but either dies out or merges with the Bethel and Chestnut Ridge faults northwest of Alvarado. Tyler was apparently misled by the rapid changes in strike of the Middle Ordovician limestones near Alvarado. Henceforth, in this discussion, the oblique fault will be called the "Alvarado" fault.

2. The outcrops of the Aven, Lenoir-Mosheim, and Fetzer in the trough of the South Knobs syncline southwest of Alvarado are not inliers, but lie in fault contact with the Knobs formation on the northwest and are overlain by the Paperville shale in normal stratigraphic sequence on the southeast. The writer favors the interpretation that these "inliers" are part of the trough of the syncline faulted into their present position by the Lodi thrust.

3. The small curvilinear fault slice shown by Tyler southeast of the main Lodi fault in the area northwest of Drowning Ford Bridge does not exist. The aberrant attitudes in that area are the result of small local folds which are well exposed near Road 712 southwest of U. S. Route 58.

This evidence supports the writer's contention that the Lodi thrust is a single fault, traceable without complication from Bumgardner Branch to Lodi. From Bumgardner Branch northeast to Luther Chapel in the Damascus area, both the hanging wall and the foot wall of the fault are composed of successively older formations. Between Luther Chapel and Lodi, the hanging wall is the base of the Elbrook formation and the foot wall is the Conococheague. Along the trace of the fault between Lodi and High Point School, the hanging wall of the fault is composed of successively younger beds, until in the area north of High Point School, the hanging wall consists of an overturned section of upper Elbrook, Conococheague, and Barron Creek. Similarly, the foot wall of the fault is composed of younger beds to the west; along the trace of the Lodi thrust 1.2 miles north of High Point School, the Knobs formation forms the foot wall.

The writer favors the following hypothesis for the origin of the present configuration of the Lodi thrust. During Middle or Late Ordovician time, shortly after or during the final stages of deposition of the Knobs formation, gentle folds began to form as a result of compressional forces from the southeast or east. The largest structures to form were the Roetown and the Osceola synclines; the Delmar anticline, northeast part of the South Knobs syncline, and the Chestnut Ridge anticline were relatively shallow folds. While the folds were still relatively gentle, the Delmar anticline fractured at the Rome-Elbrook contact along a line trending somewhat more northerly than the present regional trend. From the root zone in which the fault was probably a bedding-plane thrust at the base of the Elbrook, the fault cut obliquely upward and across the younger formations. As the older formations were thrust out to the surface, the leading edge—in which the faulted-out structure of the Delmar anticline was still preserved—rode down into the Osceola syncline and became overturned. Continued compression, probably from a more southeasterly direction, folded the strata both above and below the fault. Late in the development of the folds, a new compressional force, this time from the south, produced the "Alvarado"-Bethel-Chestnut Ridge fault complex. This fault complex cuts across the folds with little regard for structure; the fault planes apparently are not folded.

<u>Holston Mountain thrust</u>.—The trace of the Holston Mountain thrust trends northeast across the southern part of the area, passing through the town of Damascus. The thrust has overridden the Damascus anticline and southwest of Damascus, the southeast limb of the Roetown syncline, throwing the Unicoi and Hampton in fault contact with formations ranging from the Erwin through the Conococheague. According to Butts (1933, section E-E') and King and Ferguson (1960, Section 1-3, Pl. 17), the Holston Mountain thrust continues under the Stony Creek

syncline and emerges on the southeast side of the syncline as the Iron Mountain thrust. The rocks above the two thrusts form the Shady Valley thrust sheet. According to King and Ferguson (1960, Plate 1 and p. 83), the Shady Valley thrust sheet has traveled at least ten miles northwest from its source.

GEOLOGIC HISTORY

From Early Cambrian (?) (or Late Precambrian) time through part of Early Ordovician time, the Damascus area was submerged under marine waters. The area was emergent during late Early Ordovician time and was resubmerged in Middle Ordovician time. The sea that covered the Damascus area was probably never deeper than a few hundred feet, and for long periods of time the area was probably nearly emergent.

During Early Cambrian(?) and earliest established Early Cambrian time, sand, silt, and mud were deposited in the Damascus area. The strand line undoubtedly shifted back and forth across the area depositing clean beach-type sands at one time and fine muds at another. Clastic sedimentation ceased abruptly, and lime-muds were deposited and later altered to dolomites of the Shady dolomite.

In latest Early Cambrian time and early Middle Cambrian time, mud and fine sand were again deposited in the Damascus area, while sporadic carbonate deposition continued. The resulting shales, limestones, dolomites, and sandstones of the Rome formation contain considerable red material. The red color was probably inherited from the source material rather than being developed in the basin of deposition.

Throughout the remainder of Middle Cambrian time, the amount of clastic material supplied to the shallow, carbonate-depositing sea diminished, and the shaly dolomites of the lower Elbrook were deposited. The influx of mud to the basin had nearly ceased by late Middle Cambrian time, and relatively pure carbonate material was deposited throughout Late Cambrian and Early Ordovician time. However, the environment of deposition was by no means uniform throughout Late Cambrian and Early Ordovician time, during which time the varied types of sediments of the upper Elbrook, Conococheague, Barron Creek, and Aven formations were deposited. Many of the rocks of these formations are carbonate clastics resulting from the transportation and deposition of limestone and dolomite particles. During Dresbachian time, a rich trilobite fauna flourished while intermittent periods of vigorous wave action deposited lenses of oölitic calcite sand on an otherwise slightly muddy calcareous bottom.

Brief influxes of quartzose sand, probably during periods of lower sea level, allowed thin beds of sand to be deposited with the lime-muds of the Conococheague formation.

During middle Early Ordovician time, quiet water conditions predominated while the fine limy-muds of the Aven formation were deposited. Regularly alternating conditions, possibly changes in depth, caused alteration of some of the limy-mud beds to dolomite.

During later Early Ordovician time, the sea withdrew from the Damascus area, and the upper surface of the Aven was subjected to subaerial erosion. Small stream channels were cut in the top of the Aven, and circulating ground water formed caverns and sinks below the top of the formation.

In Middle Ordovician time, the sea again encroached on the area, depositing limy mud and calcareous sand of the Lenoir-Mosheim formation. Influx of mud into the area and continued carbonate deposition formed the Fetzer limestone. After the Fetzer was deposited, carbonate deposition either sharply diminished or else rapid influx of carbonaceous mud masked the carbonate as the Paperville shale was deposited. Finally, a great flood of sand and mud inundated the area to form the Knobs formation, the youngest rocks exposed in the area.

During later Middle Ordovician or Late Ordovician time, the rocks in the area were deformed by folding and faulting. Deformation of the rocks may have continued intermittently throughout Paleozoic time. The Damascus area has probably stood above sea level since Middle Ordovician time. Erosion has removed much of the original rock cover from the area, exposing formations that were once deeply buried.

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APPENDIX

Geologic Section 1.—Erwin, Hampton, and Unicoi formations in Davis Hollow and Butt Mountain.
(After King and Ferguson, 1960, p. 114-115, section 15)

	Thickness (Feet)
SHADY DOLOMITE: At top of section; represented mainly by residual clay.	
CHILHOWEE GROUP:	
Erwin formation:	
Helenmode member:	
44. Shale and sandy shale. From here northward the member contains a thin but fairly prominent bed of quartzite in lower part. Thickness in different places is 90 to 130 ft.; average about	110
Hesse quartzite member:	
43. Quartzite, massive, white, vitreous. From here northward units 41 and 43 merge and unit 42 becomes indistinct	40
42. Quartzite, thin-bedded	40
41. Quartzite, massive	60
Murray shale member:	
40. Shale and siltstone; poorly exposed in Davis Hollow; northward, many quartzite beds appear and make up a large part of the section in the hills south of Damascus. Four traceable quartzite ledges are recognized, of which the second from the top is the thickest and most prominent; the lowest is dark colored and somewhat ferruginous	560
39. Quartzite, ferruginous	40
38. Siltstone, thin-bedded greenish	200
Nebo quartzite member:	
37. Quartzite, white, vitreous; contains Scolithus	60
Total Erwin formation	1,110

	Thickness (Feet)
Hampton formation:	
Upper division:	
36. Covered, probably shale.	240
35. Quartzite, light-gray, thick-bedded; speckled with brown spots; contorted in places.	20
34. Siltstone, thin-bedded, greenish; some thin to medium-bedded quartzite layers toward top	470
33. Sandstone, medium to thick-bedded, dark-greenish-gray, quartzitic.	30
32. Siltstone, thin-bedded, greenish	210
31. Quartzite, dark-gray, medium-grained and medium-bedded, vitreous, apparently without feldspar	40
30. Covered, probably shale.	190
Total Upper Division.	1,200
Lower division:	
29. Quartzite, light-gray, fine-grained, quartzose; in north fork of London Bridge Branch coarser and somewhat feldspathic. .	40
28. Siltstone, thin-bedded, greenish, with two beds of feldspathic sandstone; exposed in north fork, covered in south fork	420
27. Quartzite, massive, coarse-grained, arkosic.	60
26. Mostly covered; on adjacent hills are much float, and some outcrops of quartzite. . .	350
Total Lower division.	870
Total Hampton formation.	2,070

	Thickness (Feet)
Unicoi formation:	
Upper division:	
25. Quartzite, white, thick-bedded, coarse-grained; contains a little feldspar; forms cap and northwest slope of Butt Mountain.	145
24. Covered by talus	150
23. Quartzite, vitreous, somewhat arkosic and conglomerate; forms great masses of coarse blocky talus, and a ledge.	25
22. Covered by talus	125
21. Quartzite; forms a ledge	25
20. Covered by talus	125
19. Quartzite; forms a ledge	40
18. Covered by talus	50
17. Quartzite; forms a ledge	40
16. Slope, mostly covered, possibly soft arkose	525
15. Quartzite, vitreous.	25
Total Upper Division.	1,275
Lower division:	
14. Mostly covered in upper part. Lower down are float and some outcrops of micaceous shale; some quartz pebbles in float.	300
13. Basalt, amygdaloidal; float only along line of section; well exposed on Laurel Creek just south of State line, where it is divisible into following units:	
c. Basalt, dark-blue-gray, aphanitic; full of amygdales; strongly jointed.	50
b. Sandstone, medium-grained, arkosic; with conglomerate seams; dark-greenish on fresh surfaces; possibly tuffaceous	50
a. Basalt, dark, aphanitic; with irregular amygdales filled by pink mineral	50

		Thickness (Feet)
12.	Arkose, gritty	450
11.	Arkose, soft, fine-grained, and thinly fissile, dark-reddish shale; some interbedded gritty arkose	175
10.	Arkose, gritty	25
9.	Shale, arkosic below and argillaceous above, with interbedded pebbly arkose	530
8.	Conglomerate, coarse; in massive ledges, with well-rounded pebbles as much as 3 in. in diameter, mostly quartz, but including some of volcanic rocks of Mount Rogers group.	250
7.	Conglomerate, with quartz and feldspar pebbles as much as one-fourth inch across; outcrops scattered, mostly covered across valley of Laurel Creek	500
6.	Arkose, conglomeratic, vitreous, forming a very massive ledge on ridge southwest of Laurel Creek and a narrows on creek; beds 3 to 5 ft. thick, with thin shale partings; contains pebbles of quartz and feldspar as much as one-fourth in. across.	160
5.	Covered.	60
4.	Arkose and slate, each forming about half the unit	65
3.	Quartzite, coarse, arkosic; in 1- to 5-ft. beds, massive, and well cemented, of light greenish-gray color. Some beds contain quartz pebbles as much as one-fourth inch across, and some slate pebbles; there are some interbedded layers of dark argillaceous slate, one of which is as much as 10 ft. thick	205
2.	Slate, argillaceous, thin-bedded, micaceous; passing up into more massive argillite that contains interbedded arkosic quartzite.	70

Thickness (Feet)

1. Underlying beds that are not exposed in a continuous section: In lower part are coarse conglomerate beds with rounded quartz pebbles more than half an inch in diameter; higher up, the conglomerate is interbedded with finer-grained, thinner-bedded arkose. In upper part of unit on Lyons Branch, a mile northwest of Laurel Bloomery, is a bed of greenstone, possibly a basalt. Thickness uncertain, probably about. 700

Total Unicoi formation. 4,915

Unconformity

Mount Rogers volcanic group at base of section, resting on Iron Mountain fault, with Rome formation beneath.

Geologic Section 2.--Partial section of the Erwin formation on southeast slope of the hill 3,600 feet N 55° E of the intersection of U. S. Route 58 and Virginia Route 91 in Damascus.

		Thickness (Feet)
1.	Quartzite, white, medium-grained, vitreous, massive	10
2.	Covered, few chips of buff sandy siltstone in soil.	30
3.	Quartzite, tan, medium- to coarse-grained, massive	12
4.	Covered, few chips of fissile sandy shale	10
5.	Quartzite, tan, fine-grained. Two prominent sets of joints	10
6.	Covered, few chips of buff sandy shale.	15
7.	Quartzite, light-tan to white, vitreous, massive. megaripplemarks well exposed.	18
8.	Sandstone, feldspathic, buff, fine-grained. . . .	6
9.	Quartzite, white, vitreous, coarse-grained, massive	5
10.	Siltstone and sandstone: interbedded buff micaceous sandy siltstone and thin-bedded white to pink fine-grained arkosic sandstone. Few thin ferruginous sandstone beds.	60
	Total thickness measured.	176

Geologic Section 3.--Shady dolomite and Rome formation on north side of valley of Laurel Creek, beginning below within town limits of Damascus and proceeding westward.

(After King and Ferguson, 1960, p. 123-124, section 29-A)

		Thickness (Feet)
ELBROOK DOLOMITE:		
	Dolomite, thin-bedded, blue-gray, and shaly gray dolomite, having an abrupt contact with the underlying formation.	
ROME FORMATION:		
V.	Shale, red.	50
U.	Limestone	15
T.	Shale, fine-grained, red; with some slightly limy and slightly sandy layers (probably 400 feet too thick - J.R.D.)	1,125
S.	Limestone, blue-gray.	130
R.	Shale, red.	160
Q.	Limestone, thin-bedded, blue-gray	60
P.	Shale, red.	65
O.	Dolomite, silty, shaly; with a shale bed near middle.	40
N.	Covered	155
	Total Rome formation.	1,800
SHADY DOLOMITE:		
	Upper blue member:	
M.	Dolomite, blue; with a thin layer of buff shale 70 feet below top, and with oolitic dolomite at base; base lies at mill dam	197
L.	Covered	55
K.	Dolomite, medium- to thick-bedded, blue	90
J.	Dolomite, light-gray, compact	2

	Thickness (Feet)
I. Dolomite, medium- to thick-bedded, blue	25
H. Dolomite, light-gray, compact; fairly well bedded .	16
G. Dolomite, blue, well-laminated and well-bedded; gray colored in lower part.	35
F. Shale, buff, dolomitic; a thin layer of straight-bedded dolomite in middle	18
Upper white member:	
E. Dolomite, white, compact; contains pink streaks . .	90
D. Dolomite, blue; thick-bedded, with faint laminae and some blebby streaks	70
C. Dolomite, white or light-gray; massive beds, grading up into slightly darker gray dolomite	88
Middle blue member:	
B. Dolomite, blue, laminated with vague thin ribbons and recrystallized stringers in some beds	155
A. Covered, except for a single pinnacle of ribboned dolomite at base; this may lie near top of ribboned member	215
Part of Shady dolomite exposed	1,056

Lower beds poorly exposed and not measured; top of Erwin formation some distance beneath to east.

Geologic Section 4.--Shady dolomite on hills north of Damascus, near an abandoned quarry one-quarter mile northeast of Laurel Creek.

(After King and Ferguson, 1960, p. 124, Section 29-B)

ROME FORMATION: Red shale outcrops and float

	Thickness (Feet)
SHADY DOLOMITE:	
Upper blue member:	
H. Dolomite, light-blue-gray; much chert on surface	190
G. Shale, dolomitic, buff	5
Upper white member:	
F. Dolomite, white, massive; exposed above top of quarry	80
E. Dolomite, gray or white, massive; compact below, saccharoidal above; pink colored near joints; contains large veins of crystalline calcite or dolomite. Exposed in quarry	160
Middle blue member:	
D. Dolomite, blue, thick-bedded	50
C. Dolomite, light-gray, massive.	50
B. Dolomite, blue, somewhat laminated	50
A. Dolomite, blue-gray; in part well laminated, in part very thin-bedded and shaly; some blocks of dolomite contain thin recrystallized ribbons; one outcrop of blue limestone with thin dolomite ribbons. Unit is exposed in a series of pinnacles that project from dark red residual soil, much jasperoid float on surface	50
Part of Shady dolomite exposed.	635

Base of section; no lower beds exposed.

Geologic Section 5.--Elbrook, Conococheague, and Barron Creek formations along Wright and Buzzard Den Branches in Widener Valley, 3 miles northeast of Damascus. Section begins below at the uppermost outcrop of Rome shale, approximately 1,500 feet southeast of Wright Branch Bridge on Road 605. Top of section is approximately 1,100 feet N 74° W of the confluence of Buzzard Den Branch and Wright Branch.

	Thickness (Feet)
Aven formation (full thickness not determined)	
150. Dolomite, light-gray, finely crystalline, thick-bedded.	40
Barron Creek limestone (752 feet)	
149. Limestone, dark-gray to black. Mostly thick-bedded calcarenite with calcilutite matrix and abundant interweaving silty intercalations. Few thin beds of dolomite and limestone conglomerate. Individual units not measured . . .	752
Conocococheague formation (1,685.5 feet)	
148. Sandstone, light-gray, medium-grained, calcite-cemented, weathers buff	0.5
147. Dolomite, medium-gray, finely crystalline, laminated. Weathers blocky	2
146. Calcarenitic limestone, black to dark-gray. Abundant irregular silty dolomite laminae and bands ("ribbon rock" of reports), few thin beds of light-gray, fine-grained dolomite.	20
145. Sandstone, light-gray, medium-grained, calcite-cemented, weathers buff	1
144. Dolomite, light blue-gray, finely crystalline, thick-bedded.	2
143. Calcarenitic limestone, like unit 146	183
142. Covered (confluence of the two branches). . . .	25
141. Calcarenitic limestone, medium- to dark-gray, fine- to medium-grained, thick-bedded. Many very thin dolomitic silt intercalations. Very few dolomite bands. Few massive black limestone beds, 3-inch thick sandy limestone beds, and some black chert.	27

		Thickness (Feet)
140.	Sandstone, light-gray, medium-grained, with thin interbeds of black to dark-gray, fine-grained limestone, thin-bedded, weathers buff. Forms barrier in stream	1
139.	Covered	18
138.	Sandstone, like unit 140.	1
137.	Covered, few poorly exposed beds of gray calcarenitic limestone with abundant thin dolomitic silt intercalations. Some black chert. . .	77
136.	Calcarenitic limestone, medium- to dark-gray, fine- to medium-grained, thick-bedded. Many very thin dolomitic silt intercalations. Very few dolomite bands. Few massive limestone beds, few black chert nodules and thin beds, poorly exposed.	70
135.	Sandstone, like unit 140.	1
134.	Covered	6
133.	Sandstone, like unit 140.	1
132.	Limestone, like unit 136. Poorly exposed	18
131.	Sandstone, like unit 140, grades up into alternating thin-bedded limestone and sandy limestone . .	2
130.	Limestone, like unit 136, few thin sandy limestone beds.	45
129.	Sandstone, like unit 140.	1
128.	Limestone, like unit 136. Poorly exposed	27
127.	Sandstone, like unit 140.	1
126.	Covered	25
125.	Sandstone, light-gray, medium-grained, with thin interbeds of black to dark-gray, fine-grained limestone, thin-bedded, weathers buff. Forms barrier in stream	1

Thickness (Feet)

124. Calcarenitic limestone, medium- to dark-gray, fine- to medium-grained, thick-bedded. Many very thin dolomitic silt intercalations. Very few dolomite bands. Few massive limestone beds, few black chert nodules and thin beds 16

123. Sandstone, medium-gray, medium-grained, well-sorted, subrounded, calcite-cemented. Forms prominent barrier in stream 2

121. Limestone, like unit 124. 177

120. Sandstone, like unit 123. 2

119. Limestone, mostly dark-gray to black, calcarenitic. Few thin irregularly bedded dolomite beds. Locally abundant limestone-dolomite "ribbon rock". Few thick beds of dark-gray magnesian limestone and brownish-gray calcilutite. 258

118. Covered, few poorly exposed beds of limestone-dolomite "ribbon rock". 72

117. Limestone-dolomite, alternating 2-4 mm. thick limestone and dolomite units, both medium- to dark-gray, finely crystalline. Few "ribbon-banded" limestone-dolomite beds. Sparse 1-2 inch beds of black chert. Becomes massive, more pure limestone towards top 120

116. Dolomite, light-tan, finely crystalline, thick bed 2

115. Calcarenitic limestone, medium brownish-gray, thick-bedded. Massive at base, silty intercalations, dolomite laminae, and thin beds of black limestone towards top 57

114. Calcarenitic limestone, medium- to dark-gray, abundant dolomite bands and laminae. Few thin dolomite beds 49

113. Limestone and dolomite, interbedded in equal amounts. Thick-bedded dark brownish- to bluish-gray limestone with dolomitic partings, and massive, finely crystalline, light-gray dolomite. 21

		Thickness (Feet)
112.	Dolomite, dark-gray, finely crystalline, few limestone laminae	4
111.	Limestone interbedded dark brownish-gray calcilutite and black calcarenitic limestone. Few silty partings.	11
110.	Dolomite, light-tan, finely crystalline, massive.	4
109.	Calcarenitic limestone, black to dark blue-gray, local dolomite laminae. Includes four one-foot dolomite beds and some black bedded chert	59
Lower dolomite		
108.	Covered, few outcrops of limestone-dolomite "ribbon rock"	70
107.	Dolomite, light-gray, finely crystalline.	1
106.	Calcilutite, light brownish-gray, weathers dark blue-gray	2
105.	Dolomite, light-tan to medium-gray, finely crystalline, laminated, weathers massive with 1-4 inch shaly partings. Few 6-inch beds of black calcarenitic limestone. Some black, scraggy chert	87
104.	Covered	17
103.	Limestone-dolomite, "ribbon rock"	4
102.	Dolomite, light- to medium-gray, finely crystalline, thick-bedded.	10
101.	Limestone-dolomite, "ribbon rock" bands up to 2-inches wide. Limestone is black, dolomite is dark-gray	2
100.	Calcarenitic limestone, black, few thin silty intercalations, scattered sand grains and lentils.	4
99.	Sandstone, light-gray, medium-grained, well-sorted subrounded grains. Calcite-cemented. Weathers buff	4
98.	Dolomite, light-tan to light-gray, finely crystalline (saccharoidal), massive, upper part laminated	6

Thickness (Feet)

97. Calcarenitic limestone, dark-gray, fine-grained, partially dolomitized. 1

96. Dolomite, medium brownish-gray, very finely crystalline, thick-bedded, massive. Abundant calcite veins up to 1 mm. thick 6

95. Dolomite, light-gray, finely crystalline, thin- to medium-bedded. Thin beds contain abundant (25% of rock) well-rounded, medium-grained quartz sand grains. 5

94. Dolomite, medium-gray, very finely crystalline, massive. Contains laminae of varying compositions. Forms resistant ledge 3

93. Calcarenitic limestone, black to dark-gray, grades up into partially dolomitized limestone. . 3

92. Dolomite arenite, medium- to dark-gray, granular, clastic grains aggregated into pisolitic structures with white crystalline dolomite in interstices. Medium- to thick-bedded. Few thin pinkish units. Poorly exposed. 48

91. Dolomite, tan, finely crystalline (saccharoidal) thick-bedded, massive 3

ELBROOK FORMATION (1665 + feet)
Widener limestone member (152 feet) Type section

90. Calcarenitic limestone, dark-gray, with lenses of coarse-grained oolitic calcarenite. Abundant irregular dolomitic silt intercalations. Thin- to medium-bedded. 18

89. Calcarenite, dark-gray, medium- to very coarse-grained, oolitic. Abundant coarsely crystalline calcite in matrix. Massive. Locally contains lenses of flat pebble conglomerate. Contains trilobites:

<u>Blountia</u>, <u>Pemphigaspis</u>, <u>Tricrepicephalus</u>

<u>Meteoraspis</u>, <u>Glaphyraspis?</u>, <u>Kingstonia</u>,

<u>Maryvillia</u>, <u>Crepicephalus</u>. 2

	Thickness (Feet)
88. Calcarenitic limestone, medium-gray to medium-blue-gray, very compact. Abundant dolomitic silt intercalations	3
87. Calcarenitic limestone, dark-gray, partially dolomitized. Weathers to a "worm-eaten" appearance	7
86. Covered, few thin beds of fine-grained limestone with coarse calcite "eyes" near base	45
85. Calcarenite, dark-gray, poorly exposed	6
84. Calcarenitic limestone, medium-gray, dense, poorly exposed	8
83. Covered	12
82. Calcarenitic limestone, same as unit 88, grades up into partially dolomitized limestone with clastic dolomite fragments	8
81. Calcarenite, medium- to dark-gray, oölitic, abundant coarsely crystalline calcite in matrix, some pyrite. Trilobite: Coosina ariston	2
80. Calcarenitic limestone, like unit 88	21
79. Calcarenite, dark-gray, oölitic. Abundant coarsely crystalline (up to 1 cm. in diameter) calcite in matrix. Trilobites: Coosina ariston, two unidentified hypostoma	3
78. Calcarenitic limestone, dark-gray, compact, irregular dolomitic silt intercalations. Thick-bedded, grading upwards into thin-bedded limestone	17
Upper dolomite member (467 feet)	
77. Dolomite arenite, medium-gray, medium- to thick-bedded. Grades upward through a one-foot bed into overlying limestone	13
76. Dolomite, medium-gray, finely crystalline, irregularly thin- to medium-bedded	10

		Thickness (Feet)
75.	Calcarenitic limestone, medium-gray, fine-grained, abundant irregular dolomitic silt intercalations.	4
74.	Dolomite arenite, dark-gray, very coarse-grained, abundant white dolomite veins. Weathered surfaces show pisolitic texture. Medium-bedded	20
73.	Dolomite, medium-gray, finely crystalline, dense. White dolomite veins abundant. Thick-bedded. . .	6
72.	Dolomite arenite, medium- to dark-gray, granular-textured, thin- to medium-bedded. Few thin interbeds of dense, light-gray, finely crystalline dolomite.	58
71.	Covered (quartzite alluvium in stream).	63
70.	Mostly covered, few poorly exposed alternating beds of light-gray, finely crystalline dolomite and medium-gray dolomite arenite.	54
69.	Dolomite: alternating beds of light-gray finely crystalline dolomite and medium-gray dolomite arenite	12
68.	Dolomite, light-tan, finely crystalline, laminated. Weathers massive.	5
67.	Dolomite, light- to medium-gray, medium to finely crystalline, thick-bedded, massive. Lower one-foot is light-gray, finely crystalline dolomite .	13
66.	Dolomite, medium-gray, medium crystalline, massive	9
65.	Dolomite, cream-colored, finely crystalline, laminated. Weathers massive.	3
64.	Dolomite, very light-gray, medium crystalline, massive	5
63.	Dolomite, cream-colored, very finely crystalline, laminated	2
62.	Dolomite arenite, medium-gray, granular	2

		Thickness (Feet)
61.	Dolomite, light-gray, finely crystalline, some thinly laminated. Weathers massive	14
60.	Dolomite, light-gray, medium crystalline, saccharoidal, thick-bedded.	5
59.	Dolomite, light-gray, finely crystalline, laminated. Weathers massive, poorly exposed.	21
58.	Dolomite arenite, dark-gray, medium-grained	1
57.	Dolomite, light-gray, very finely crystalline, laminated. Weathers massive.	9
56.	Dolomite arenite, light-gray mottled, coarse-grained. Weathers rough.	2
55.	Dolomite, light-gray, finely crystalline, massive	6
54.	Dolomite, light-tan to light-gray, argillaceous. Alternating finely crystalline and granular arenite beds, one bed sandy	6
53.	Dolomite, light- to medium-gray, finely crystalline, thin- to medium-bedded	30
52.	Dolomite, light blue-gray, laminated, weathers massive	5
51.	Dolomite, light-gray, finely crystalline, grades upward to upper 20 feet of granular dolomite arenite	59
50.	Calcarenitic limestone, medium- to dark-gray, locally dolomitic. Thin- to medium-bedded.	7
49.	Dolomite, light-gray, finely crystalline, thick-bedded. Few thin beds of fissile argillaceous dolomite; one two-foot limestone bed near top	23
Middle limestone member (351.3 - 351.7 feet)		
48.	Calcarenitic limestone, dark-gray, dense, locally pebbly. Irregular dolomite intercalations sparse at base, increase towards top	6
47.	Dolomite, light-gray, finely crystalline.	1

	Thickness (Feet)
46. Calcarenitic limestone, pearly-gray, slightly dolomitized, thick-bedded	14
45. Dolomite, light-gray, argillaceous, weathers shaly. Grades upward into massive dolomite . . .	5
44. Calcarenitic limestone, medium brownish-gray, massive	3
43. Limestone, dark-gray, very fine-grained, argillaceous. Weathers shaly.	2
42. Dolomite, gray, calcareous, passes upward into light-gray, medium crystalline limestone, partially dolomitized	5
41. Dolomite, light blue-gray to tan, finely crystalline, argillaceous. Weathers to a yellowish-brown shale	10
40. Calcarenitic limestone, medium brownish-gray, mostly fine-grained, dense. Interbedded with "ribbon rock" limestone-dolomite beds. Generally thick-bedded. Lowest bed contained a 6-inch coarse limestone conglomerate with chert pebbles.	72
39. Limestone, medium- to dark-gray, finely crystalline, argillaceous. Few thick-bedded calcilutite beds	18
38. Limestone, gray, finely crystalline, argillaceous, thin-bedded. Weathers fissile. Includes a 2-inch black chert bed.	3
37. Calcarenitic limestone, medium-gray, thick-bedded. Top six inches is very coarse-grained with chert sand grains.	7
36. Limestone, light blue-gray, finely crystalline, argillaceous. Thin-bedded, weathers fissile. . .	7
35. Calcilutite, pearly-gray, massive, interbedded in equal amount with dark-gray, "ribbon banded" to laminated limestone-dolomite. Few massive thick-bedded partially dolomitized limestone beds. Some black chert nodules.	25

Thickness (Feet)

34. Limestone, mottled gray, crystalline, partially dolomitized. Grades up into fissile argillaceous dolomite and limestone. 12

33. Dolomite-limestone, light- and dark-gray respectively, "ribbon banded", some laminated, weathers to buff, massive ledges. 8

32. Limestone: interbedded impure light-tan calcilutite with "birdseye" texture, and dark-gray calcarenitic limestone with some dolomite "ribbon bands". Locally some calcarenite and limestone conglomerate with irregular silt partings 82

31. Dolomite, light-gray, finely crystalline, argillaceous, thin-bedded. Weathers shaly 8

30. Calcarenitic limestone, dark-gray, with light-gray, finely crystalline dolomite "ribbon bands". Dolomite increases towards top. 46

29. Calcarenite, medium-gray, both limestone and dolomite grains, weathers reddish-brown, fossiliferous 0.3-0.7

28. Calcarenitic limestone, black, abundant irregular dolomitic silty partings, few dolomite "bands", abundant "birdseye" texture, commonly vuggy . . . 16

Lower dolomite member (695 feet)

27. Limestone-dolomite, dark blue-gray, alternating laminae 2

26. Dolomite, dark-gray, finely crystalline, argillaceous, laminated. Weathers massive to flaggy, deep weathering produces shaly to papery yellowish flakes. 29

25. Dolomite, light-tan to olive-drab, finely crystalline, argillaceous, thin- to medium-bedded, weathers to yellow shale. Few thin siliceous dolomite beds 44

24. Dolomite, light-gray, finely crystalline. 2

23. Limestone, dark-gray, fine-grained, with thin gray dolomite bands. Few thin beds of dolomite and calcilutite 30

		Thickness (Feet)
22.	Dolomite, medium-gray, finely crystalline, single thick bed.	2
21.	Dolomite, medium-gray, and sparse light-gray limestone laminae	10
20.	Dolomite, light-gray to olive-drab, finely crystalline, medium- to thin-bedded. Weathers to yellowish shaly flakes.	28
19.	Dolomite, light- to medium-gray, finely crystalline, laminated. Weathers massive	3
18.	Dolomite, light-gray, finely crystalline, argillaceous, thin-bedded, weathers shaly.	16
17.	Dolomite, light-tan, very finely crystalline, siliceous, thick-bedded	10
16.	Limestone, black, fine-grained, thin-bedded. Some alternating limestone-dolomite laminae . . .	6
15.	Dolomite, light-tan to gray, finely crystalline, thick-bedded.	26
14.	Covered	10
13.	Chert, black, irregularly bedded.	1
12.	Dolomite, light-tan, finely crystalline, medium-bedded.	6
11.	Dolomite, light greenish-gray, finely crystalline, argillaceous. Thin-bedded, weathers to paper-thin flakes	9
10.	Chert, black, laminated	2
9.	Dolomite, light-gray, argillaceous, thin-bedded, weathers fissile.	9
8.	Covered	76
7.	Dolomite, medium- to dark-gray, finely crystalline, white dolomite veinlets, thin-bedded, massive outcrop.	19

	Thickness (Feet)
6. Limestone, dark-gray to black, and light- to medium-gray dolomite; both fine-grained. *Cryptozoon* chert.	35
5. Covered.	170
4. Clay, yellow-brown, soft and plastic. Relict bedding preserved. Believed to be deeply weathered argillaceous dolomite of the Elbrook.	150
Rome formation (total thickness not measured)	
3. Covered, 700 feet along traverse N 72° W, estimated thickness	585
2. Shale, red and yellow.	40
1. Covered.	

Geologic Section 6.--Fetzer limestone, Lenoir-Mosheim limestones, Aven formation, and Barron Creek limestone, exposed in fields 0.7 mile west of Pleasant View Church in Widener Valley, at west end of Road 801. On southeast flank of the Roetown syncline. Section begins 120 feet S 10° E from abandoned cabin.

	Thickness (Feet)
Paperville shale:	
1. Covered, soil suggests shale	
Fetzer limestone: (29 feet)	
2. Calcilutite, brownish-gray, "birdseye" textured, massive	11
3. Calcarenite, dark-gray, fine- to medium-grained, argillaceous. Irregular shaly partings, nodular. Abundant organic debris	18
Lenoir-Mosheim limestone: (23.5 feet)	
4. Calcarenite, calcilutite matrix, brownish-gray. Abundant wormy intergrowths of clear calcite. Sparse, thin (less than 1 mm. thick), crinkled clayey partings weather out in relief.	20
5. Calcilutite, brownish-gray. Partially dolomitized to finely crystalline gray dolomite	2.5
6. Calcarenite, calcilutite matrix, brownish-gray. Aphanitic on fresh surface.	1
. . . . Disconformity.	
Knox group:	
Aven formation (633 feet)	
7. Dolomite and limestone, interbedded in approximately equal amounts, thick-bedded. Limestone is mostly partially dolomitized	52
8. Dolomite, medium-gray, thick-bedded. Includes a few beds of limestone and dolomitic limestone . . .	54
9. Covered, a few poorly exposed dolomite beds	286
10. Dolomite, light- to medium-gray and tan, medium-grained, thick-bedded. Poorly exposed.	61
11. Chert, white, massive, vuggy.	2
12. Dolomite, light- to medium-gray, fine- to medium-grained, thick-bedded, scattered floating quartz sand grains	178

	Thickness (Feet)
Barron Creek limestone (832 feet)	
13. Limestone, dark-gray to black, mostly calcarenite with dense calcilutite matrix. Few medium-bedded fossiliferous limestone-pebble conglomerates. Small scattered white chert nodules. Interweaving dolomitic silt intercalations locally abundant. Contains gastropods and cephalopods	8
14. Dolomite, medium-gray, medium-crystalline to granular. Contorted bedding.	1
15. Shaly limestone, dark-gray.	1
16. Limestone, like unit 13	22
17. Covered	6
18. Limestone, like unit 13	12
19. Limestone, magnesian, many laminae of different compositions, weathers dark-gray.	3
20. Calcilutite and pellet calcilutite, abundant gastropods, black	4
21. Limestone, like unit 13.	29
22. Limestone, dark-gray, finely crystalline. Laminated with thin, even, silty partings; weathers fissile .	4
23. Limestone, like unit 13, poorly exposed	25
24. Dolomite, medium-gray, fine-grained	5
25. Limestone, like unit 13, lower 20 feet mostly covered	50
26. Covered, few thin beds of limestone like unit 13. .	23
27. Limestone, like unit 13 but free of silt laminae. .	14
28. Covered	9
29. Limestone, like unit 13, poorly exposed	16
30. Covered, few beds of limestone.	41
31. Limestone, like unit 13. Locally abundant partially silicified gastropods and cephalopods. Sparse fine grains of pyrite.	20

Thickness (Feet)

32. Limestone, dark-gray to black, mostly calcarenite with dense calcilutite matrix. Few medium-bedded fossiliferous limestone-pebble conglomerates. Small scattered white chert nodules. Interweaving dolomitic silt intercalations locally abundant. Poorly exposed. Contains gastropods and cephalopods. 27

33. Dolomite, medium-gray, finely crystalline, massive. . 2

34. Limestone, like unit 32 30

35. Covered, few thin limestone beds. 25

36. Calcarenite and limestone conglomerate, calcilutite matrix, black. Few fossil fragments. 10

37. Limestone, like unit 32 19

38. Dolomite, medium-gray, finely crystalline, massive. . 1

39. Limestone, like unit 32. Few thin beds of magnesian limestone, dark-gray, finely crystalline, buff-weathering. 221

40. Calcilutite, black, massive, with a few silty laminae. Contains Dakeoceras(?). 12

41. Covered 17

42. Limestone, dark-gray to black, mostly calcarenite with dense calcilutite matrix. Few medium-bedded fossiliferous limestone-pebble conglomerates. Small scattered white chert nodules. Interweaving dolomitic silt intercalations locally abundant. Contains gastropods and cephalopods. 2

43. Covered, few thin beds like unit 42, few black chert nodules 38

44. Shaly limestone, dark-gray, finely crystalline. . . . 2

45. Limestone, like unit 32 133

	Thickness (Feet)
Conococheague formation (total thickness not determined)	
46. Sandstone and sandy dolomite: medium-gray, finely crystalline sandy dolomite with one inch sandstone at top, alternating two to four inches of sandstone and dolomite beds at base	1.5
47. Calcilutite, dark-brownish-gray, thick-bedded. Abundant organic debris	6
48. Limestone, dark-gray to black, mostly calcarenite with dense calcilutite matrix. Few medium-bedded fossiliferous limestone-pebble conglomerates. Small scattered white chert nodules. Interweaving dolomitic silt intercalations locally abundant. Contains gastropods and cephalopods, dolomite laminae increase towards base.	100 +

Geologic Section 7.--Aven formation along Virginia Route 91 near east end of Wright Bridge, 1.5 miles northwest of Damascus. Units 1-51 were measured on hillside north of road, remainder measured south of road. Section begins on wagon road a few feet northeast of Wright Bridge.

	Thickness (Feet)
Lenoir limestone	
1. Covered	
2. Calcarenite, medium-gray, very coarse-grained and conglomeratic, contains limestone, dolomite, and chert pebbles up to 4 cm. in diameter. Fossiliferous	2-4
. . . . Disconformity (2 feet of relief).	
Aven formation (777 feet)	
3. Limestone, magnesian, light-tan, finely crystalline, thick-bedded.	4
4. Calcarenitic limestone, medium-gray, weathers blue-gray. Irregular thin silt intercalations, dolomite laminae in middle. Waxy gray chert lenses 2 feet above base, few thin beds of limestone conglomerate	9
5. Dolomite, light blue-gray to light-tan, finely crystalline, saccharoidal. Thick-bedded. Weathers dark-brown.	16
6. Calcilutite, light brownish-gray, irregular silt intercalations, grades downward into calcarenitic limestone	10
7. Dolomite, light-gray, finely crystalline, slightly calcareous, massive	6
8. Calcilutite, light brownish-gray, pure, "birdseye" texture	1
9. Dolomite, light blue-gray, finely crystalline, slightly calcareous	6
10. Calcilutite, some calcarenitic limestone, light brownish-gray, pure, "birdseye" texture. Irregular silt intercalations	6
11. Dolomite, light-tan, finely crystalline, massive. .	3

		Thickness (Feet)
12.	Calcilutite, some calcarenitic limestone, light brownish-gray, pure, "birdseye" texture. Irregular silt intercalations	1
13.	Dolomite, light-gray, finely crystalline, massive .	6
14.	Calcilutite, like unit 12, with thin, pink silt partings.	7
15.	Dolomite, light brownish-gray, finely crystalline, massive	3
16.	Calcilutite, like unit 12, but with abundant silt intercalations.	4
17.	Dolomite, light pinkish-tan, finely crystalline, massive	3
18.	Calcilutite, light brownish-gray, "birdseye" texture and some fossil fragments. Abundant silt intercalations and irregular silt blebs.	6
19.	Dolomite, light pinkish-tan, finely crystalline, massive	4
20.	Calcilutite, like unit 12, pure	12
21.	Dolomite, light-gray to light-tan, finely crystalline, thick-bedded, some beds laminated	36
22.	Calcilutite and calcarenitic limestone, light brownish-gray, small irregular stringers and blebs of white chert, medium-bedded. Contains <u>Lecanospira</u>	4
23.	Dolomite, light-gray, finely crystalline, massive .	4
24.	Calcilutite and calcarenitic limestone, light brownish-gray, small irregular stringers and blebs of white chert, medium-bedded	2
25.	Dolomite, light pinkish-tan, finely crystalline, light-gray chert nodules, thick-bedded.	24
26.	Calcilutite, like unit 24	3
27.	Dolomite, light brownish-gray, finely crystalline, cherty, massive	4

		Thickness (Feet)
28.	Dolomite, medium-gray, finely crystalline. Abundant laminae of limestone. Massive, weathers light-gray	4
29.	Calcilutite and calcarenitic limestone, light brownish-gray, small irregular stringers and blebs of white chert, medium-bedded, few silt intercalations at base	4
30.	Dolomite, light-gray, finely crystalline, massive .	8
31.	Calcilutite and calcarenitic limestone, light brownish-gray, small irregular stringers and blebs of white chert, medium-bedded, sparse "birdseye" texture, abundant gastropods	3
32.	Dolomite, medium-gray, finely crystalline, massive. Irregular white chert nodules up to 2 cm. in diameter scattered throughout	3
33.	Calcilutite, some calcarenitic limestone, light brownish-gray, pure, "birdseye" texture. Irregular silt intercalations	3
34.	Dolomite, light-gray, finely crystalline, some limestone laminae	2
35.	Calcarenitic limestone, medium-gray, partially dolomitized. Weathers to a "worm-eaten" appearance . .	4
36.	Dolomite, light-gray, finely crystalline.	1
37.	Calcarenitic limestone, medium-gray, abundant dolomite laminae, one 6-inch shaly bed in middle. . . .	10
38.	Dolomite and partially dolomitized limestone, light-gray, finely crystalline.	2
39.	Calcarenite, partially dolomitized, mottled light-gray and light brownish-gray.	5
40.	Dolomite, light-gray, finely crystalline, massive .	7
41.	Calcilutite and calcarenitic limestone, light brownish-gray, small irregular stringers and blebs of white chert, medium-bedded	15
42.	Dolomite, light-gray, finely crystalline, few thin beds of partially dolomitized limestone	2

		Thickness (Feet)
43.	Dolomite, calcareous, light-gray, finely crystalline	2
44.	Calcilutite and calcarenitic limestone, light brownish-gray, small irregular stringers and blebs of white chert, medium-bedded	2
45.	Limestone: alternating thin beds of calcilutite like unit 43 and partially dolomitized limestone, gray chert nodules in middle.	17
46.	Dolomite, light-gray, finely crystalline.	1
47.	Calcilutite, like unit 44	5
48.	Dolomite, light-gray, finely crystalline.	0.5
49.	Calcarenitic limestone, partially dolomitized, mottled gray, fine-grained and finely crystalline .	3
50.	Dolomite, light-gray, finely crystalline, massive. Few chert nodules	8
51.	Limestone and partially dolomitized limestone, gray, banded.	6
52.	Dolomite, light-gray, finely crystalline, massive .	2
53.	Calcilutite, some calcarenitic limestone, light brownish-gray, pure, "birdseye" texture. Irregular silt intercalations	3
54.	Dolomite, light pinkish-gray, finely crystalline. .	3
55.	Calcilutite, like unit 53	4
56.	Covered	9
57.	Calcilutite, like unit 44	2
58.	Dolomite, light-gray, finely crystalline.	2
59.	Calcilutite, like unit 53	3
60.	Dolomite, medium-gray, finely crystalline	5
61.	Calcilutite, like unit 53, white chert nodules. . .	7

		Thickness (Feet)
62.	Dolomite, light-gray, finely crystalline, massive	5
63.	Covered	13
64.	Dolomite, light blue-gray, finely crystalline, massive	7
65.	Calcarenitic limestone, dark-gray to black, many interweaving thin silt intercalations, thick-bedded.	4
66.	Dolomite, light blue-gray, finely crystalline, saccharoidal texture, thick-bedded. One-foot bed of partially dolomitized limestone in middle. Scattered quartz sand grains near top, incompletely exposed	39
67.	Calcarenitic limestone and partially dolomitized limestone, light blue-gray, fine-grained.	2
68.	Dolomite, light-gray, finely crystalline, massive .	7
69.	Calcilutite, some calcarenitic limestone, light brownish-gray, pure, "birdseye" texture. Irregular silt intercalations	11
70.	Dolomite, light blue-gray to light-gray, finely crystalline, saccharoidal texture, thick-bedded, weathers massive. Lowest beds are tan, cross-bedded and contain scattered quartz grains. Well exposed	80
71.	Calcilutite, like unit 69	6
72.	Dolomite, light-gray to light pinkish-gray, saccharoidal, medium-bedded, weathers slabby. Becomes thick-bedded, locally medium and coarsely crystalline with sand grains towards base. Few buff chert nodules at base. Poorly exposed.	49
73.	Covered	10
74.	Chert, white, vuggy, massive bed, iron-stained in vugs.	2
75.	Covered	23

	Thickness (Feet)
76. Dolomite, light-gray, finely crystalline, saccharoidal texture, white chert nodules	6
77. Covered, few poorly exposed dolomite beds	43
78. Dolomite: light blue-gray, saccharoidal, at top; grades downward into interbedded light-gray, medium crystalline dolomite, finely crystalline, blue-gray dolomite, and light-tan, sandy, medium- to coarsely crystalline dolomite. Mostly thick-bedded. Local lentils and beds of white chert. . .	129
Barron Creek limestone (full thickness not measured)	
79. Limestone, dark-gray, medium- to granular crystalline. Few fossil fragments and flat limestone pebbles	4
80. Dolomite, medium-gray, finely crystalline, massive	4
81. Calcarenitic limestone, black, dense, few limestone pebbles	4
82. Dolomite, medium-gray, finely crystalline, massive, white chert nodules	7
83. Calcarenitic limestone, medium-gray, few limestone pebbles. Few irregular, thin, silt intercalations.	18
84. Calcilutite, argillaceous, light buff-gray, weathers shaly.	1
85. Covered	8
86. Calcarenitic limestone, dark-gray, with regularly spaced dolomitic silt "ribbons" and laminae	8
87. Dolomite, light-gray, finely crystalline.	2
88. Limestone, like unit 86	8

<u>Geologic Section 8</u>.-Fetzer and Lenoir-Mosheim limestones southeast of abandoned shale quarry, 2,800 feet south of Mast Bridge, 400 feet northeast of Road 724 along Beech Creek. On southeast limb of Roetown syncline.

	Thickness (Feet)
Paperville shale	
11. Shale, black, carbonaceous, graptolitic; thickness not determined	
10. Covered	3
Fetzer limestone (14 feet)	
9. Calcarenite, impure, dark blue-gray, fine-grained. Abundant irregular silty laminae up to 10 mm. thick	14
Lenoir-Mosheim limestone (72.5 - 75.5 feet)	
8. Magnesian limestone, light-tan to light blue-gray, finely crystalline, thick-bedded. Weathers light buff-gray	12
7. Calcilutite, brownish-gray, thick-bedded. Locally abundant fossil debris and "birdseye" texture, few silty laminae	5
6. Covered	6
5. Calcilutite, brownish-gray, weathers light-gray, massive. Abundant "birdseye texture" and locally abundant fossils. Few silty laminae in middle. Abundant finely disseminated pyrite	38
4. Calcilutite, brownish-gray, with thin shaly dolomite partings	1.5
3. Calcilutite, brownish-gray, abundant "birdseye texture" and sparse fossil debris, vague pellet texture	2
2. Calcilutite, brownish-gray, sparse "birdseye texture", massive	8 - 11

\- - - - - - - - - - - - - - - Disconformity - - - - - - - - - - - - - -

	Thickness (Feet)
Aven formation	
1. Dolomite, light-gray, finely crystalline, laminated. Massive outcrops with "butcher block" weathering.	10

Geologic Section 9.--Effna, Fetzer, and Lenoir-Mosheim limestones on northwest side of knob, one mile due north of Vails Mill, 1,500 feet northeast of bridge over South Fork Holston River on Road 788, northwest limb of Roetown syncline.

	Thickness (Feet)
Paperville Shale	
12. Black shale float	
Effna limestone (10 feet)	
11. Calcarenite, light-gray, very coarse-grained crystalline calcite and fossil fragments, thick-bedded. Sparse small chalcopyrite blebs.	10
Fetzer limestone (9 feet)	
10. Calcarenitic limestone, black, finely crystalline, with sparse "birdseye texture", abundant irregular silty partings and clay blebs. Slightly punky weathering.	9
Lenoir-Mosheim limestone (86 feet)	
9. Partially dolomitized calcarenite, tan, fine- to medium-crystalline, locally coarse- to granular-crystalline and scattered coarse fossil fragments. Calcite locally predominant. Four-inch diameter coral colony two feet above base, trilobite fragments.	20
8. Calcarenitic limestone, medium- to dark brownish-gray, dense calcilutite matrix, sparse "birdseye texture", sparse pyrite. Abundant fossils weather out in relief. Contains a 3-foot thick by 12-foot long lens of fine- to medium-grained dolomitic calcarenite with wavy contorted bedding	21
7. Calcilutite, dark brownish-gray, blue weathering, thick-bedded, massive. Sparse "birdseye texture".	10
6. Calcarenite, dove-gray, coarse-grained, pellets and shell fragments, ½-3 mm. in diameter with sparse calcilutite matrix. Scattered white chert blebs. Contains cephalopods and gastropods . . .	6
5. Calcilutite, dove-gray, with scattered limestone pebbles and fossil fragments, thick-bedded, massive	6
4. Calcilutite, like unit 5, with abundant wavy silty laminae and clay blebs.	10

Thickness
(Feet)

3. Calcarenitic limestone, dark-gray, fine-grained, thick-bedded, massive. Center part has abundant clear calcite crystals 1/4-1 mm. in diameter, calcilutite at base 8

2. Calcilutite, dark-gray, coarse silt size, abundant dolomitic silty partings and scattered silt blebs. 5

- - - - - - - - - - - - - Disconformity - - - - - - - - - - - - -

Aven formation
Dolomite, light-gray, fine calcarenite, saccharoidal . 18

EXPLANATION OF PLATE 27

All the figured trilobite specimens are from the Crepicephalus zone in the Widener limestone of the Damascus area, Virginia.

Figure

1 - 3. - *Coosina ariston* (Walcott). 1, Cranidium, largely exfoliated, X3; locality, Elbrook unit 81, Geologic Section 5. 2, Pygidium, partly exfoliated, X4, locality no. 5. 3, Exfoliated pygidium, doublure exposed, X4; locality no. 9.

4. - *Coosella (?)* sp. Pygidium, exfoliated and incomplete, X4. Locality no. 7.

5. - *Crepicephalus* sp. no. 1. Exfoliated cranidium, X3. Locality, Elbrook unit 89, Geologic Section 5.

6. - *Coosina (?)* sp. Exfoliated cranidium, X4. Locality, Elbrook unit 79, Geologic Section 5.

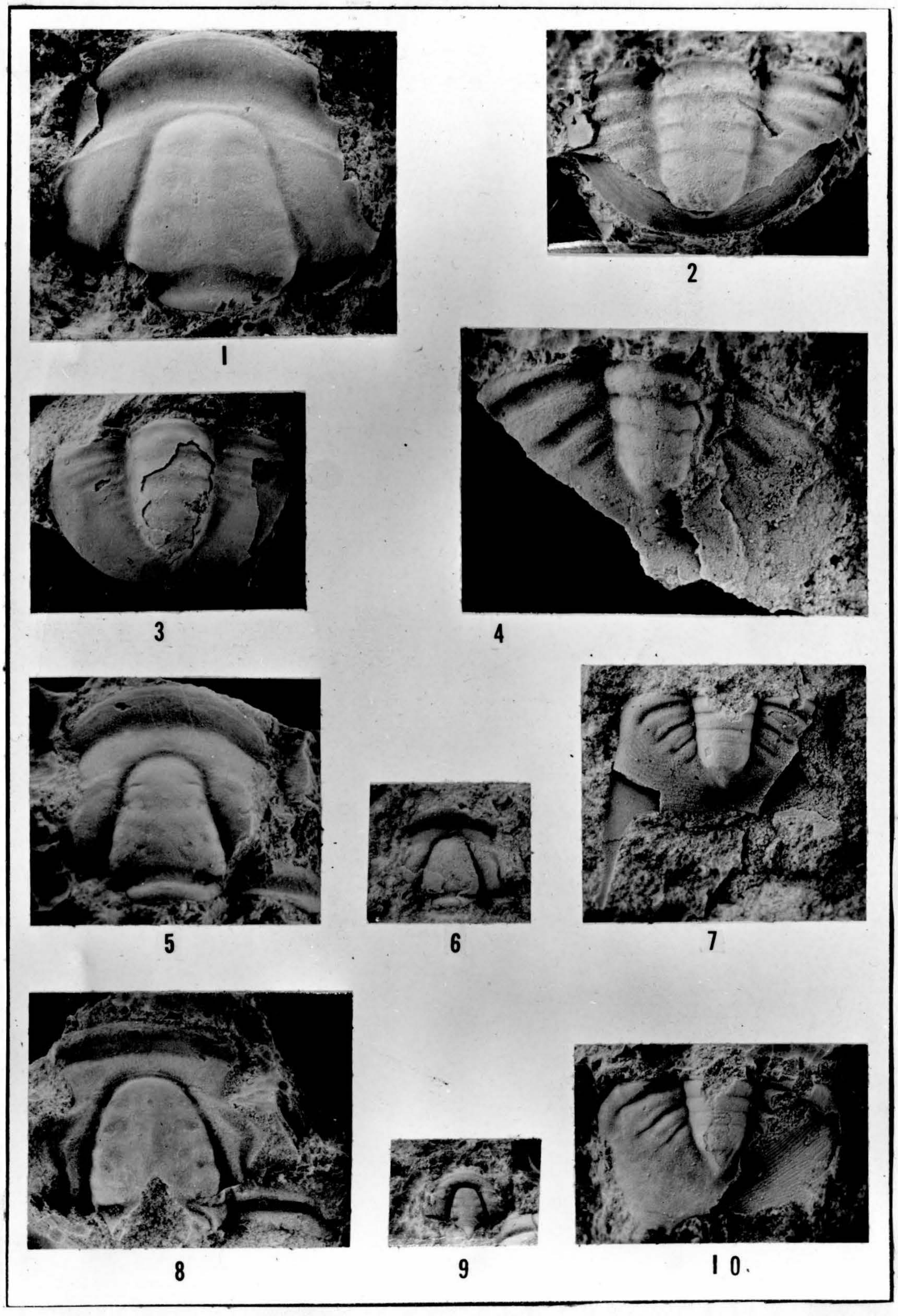
7. - *Crepicephalus rectus* Resser. Pygidium, test preserved except on spines, X4. Locality no.7.

8. - *Crepicephalus* sp. no. 2. Exfoliated cranidium, X3. Locality no. 7.

9. - *Terranovella dorsalis* (Hall). Cranidium, test preserved, X4. Locality no. 5.

10. - *Crepicephalus* sp. no. 3. Pygidium, partly exfoliated with doublure exposed, X4. Locality, Elbrook unit 89, Geologic Section 5.

Plate 27



EXPLANATION OF PLATE 28

All the figured trilobite specimens are from various localities in the Damascus area except Figure 10 which comes from a locality 0.73 mile west of the west boundary of the area. Figures 1-9 and Figures 12 and 13 are from the Crepicephalus zone in the Widener limestone. Figures 11 and 14 are specimens from the Conococheague formation.

Figure

1, 2 - Tricrepicephalus thoosa (Walcott). 1, Cranidium, partly exfoliated, X4; locality, Elbrook unit 89, Geologic Section 5. 2, Pygidium preserving test, spines broken, X2; locality no. 6.

3 - Meteoraspis, c.f. M. mutica Rasetti. Exfoliated cranidium, X4. Locality, Elbrook unit 89, Geologic Section 5.

4 - Coosina sp. Cranidium preserving test, X4, locality no. 7.

5,13 - Maryvillia arion (Walcott) pygidia, X4. 5, exfoliated. 13, partially exfoliated. Locality, Elbrook unit 89, Geologic Section 5.

6,10 - Llanoaspis modesta Lochman, X4. 6, Cranidium preserving test, locality no. 3. 10, Pygidium preserving test, locality no. 4.

7 - Blountia (?) sp. Exfoliated pygidium, probably flattened, X4. Locality, Elbrook unit 89, Geologic Section 5.

8, 9 - Blountia sp., X4. 8, Exfoliated cranidium. 9, Pygidium largely preserving test. Locality, Elbrook unit 89, Geologic Section 5.

11 - Plethometopus sp. Cranidium preserving test, X4. Locality no. 1.

12 - Pemphigaspis sp. (upper right), with Maryvillia arion pygidium. Cranidium preserving test, X4. Locality, Elbrook unit 89, Geologic Section 5.

14 - Plethometopus (?) sp. Exfoliated pygidium, X4. Locality no. 1.

Plate 28

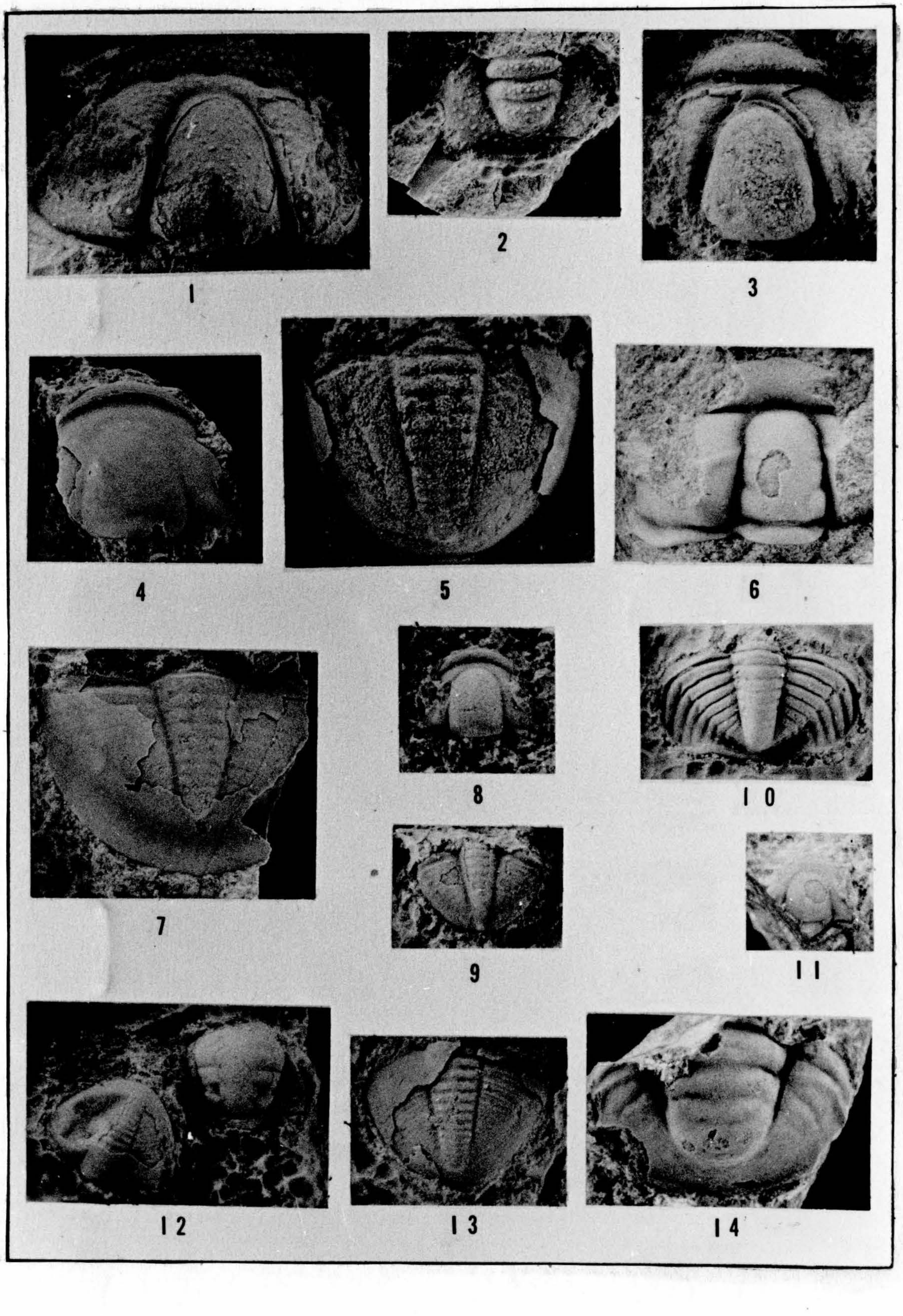


TABLE 5

Fossil Collecting Localities

All localities listed are in the Damascus area except no. 4 (8-12, 3) which is 0.73 mile west of the west boundary of the area. Numbers preceeding the location description refer to field notebook and fossil label numbers.

Locality Number	Location
	Conococheague limestone:
1	D-2-61. 580 feet above the base of Conococheague formation; behind house approximately 300 feet south of Pleasant View Church in Widener Valley.
	Widener limestone member of the Elbrook formation:
2	Elbrook units 79, 81, 89. Units of Geologic Section 5, Appendix. Wright Branch, Widener Valley.
3	7-22,7. 2,200 feet northwest of Damascus town limit.
4	8-12,3. 0.73 mile west of Damascus area, 250 feet west of stone fence at west end of Drowning Ford Bridge on U.S. Highway 58.
5	8-16,2. Two miles southwest of Lodi, 500 feet southwest of intersection of Roads 722 and 708.
6	8-16,4. Two miles southwest of Lodi, 1,000 feet N 75° E of intersection of Roads 722 and 708. Twenty feet above thick-bedded dolomite at base of Widener limestone.
7	9-21,10. On dirt road 950 feet southeast of Road 735, 2,800 feet east of LR 144.
8	9-22,4. One mile east-southeast of Greenfield Church, south of transmission line, 500 feet north of Road 735.
9	D-1-61. 1,150 feet south of Pleasant View Church in Widener Valley. Near middle of Widener member.
	Barron Creek limestone:
10	8-9,2. Two miles northwest of Damascus, 4,500 feet due north of Roetown School. Near top of Barron Creek limestone, in small grove of trees.

Locality Number	Location
11	In road cut just north of Craig Bridge, Virginia Highway 91. Near base of Barron Creek.
12	Barron Creek unit 40, Geologic Section 6, 204 feet above base. West of Pleasant View Church, Widener Valley.

ABSTRACT

Marine sedimentary rocks ranging in age from Early Cambrian(?) to Middle Ordovician, inclusive, crop out in the Damascus area. Approximately 13,000 feet of beds are exposed, comprising 14 formations. The stratigraphic succession is rather complete and is broken by a single recognizable hiatus which represents most of late Early Ordovician time. Clastic rocks of questionable Early Cambrian age are about 3,600 feet thick. Rocks of known Cambrian age are about 6,800 feet thick and consist of, in ascending order, clastic rocks, dolomite, shale and carbonate rocks, and mixed carbonate rocks. Carbonate rocks of Early Ordovician age range from 1,000 to 1,600 feet in thickness. Middle Ordovician rocks aggregate approximately 800 feet in thickness, the basal 100 feet of which is limestone and the remainder is shale and sandstone.

The Elbrook formation of Middle and Late Cambrian age is herein divided into four members of which one, the Widener limestone member, is formally named and mapped. A *Crepicephalus* fauna from the Widener limestone, and a single trilobite, *Plethometopus* sp. from the Conococheague formation are illustrated.

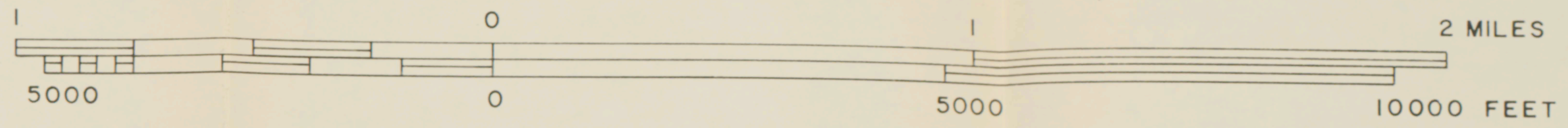
The strata have been folded into five synclines and four anticlines and are broken by two major thrust faults, the Lodi thrust and the Holston Mountain thrust. The faults were ini-

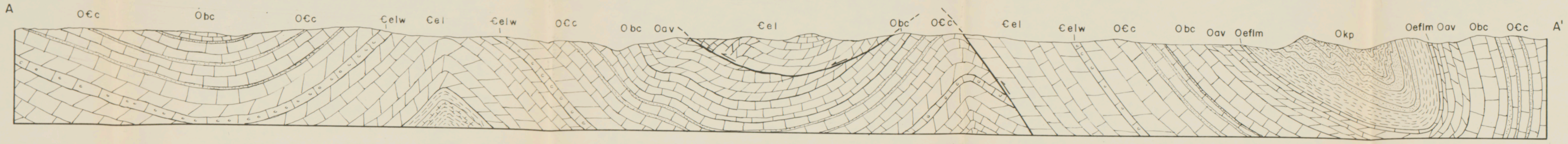
tially low-angle thrusts which have been folded with the overridden rocks so that locally the fault planes have steep dips.

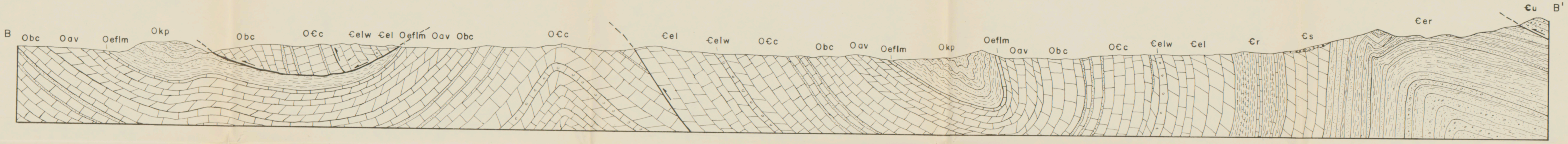
Derby, James Richard
Geology of the Damascus area.

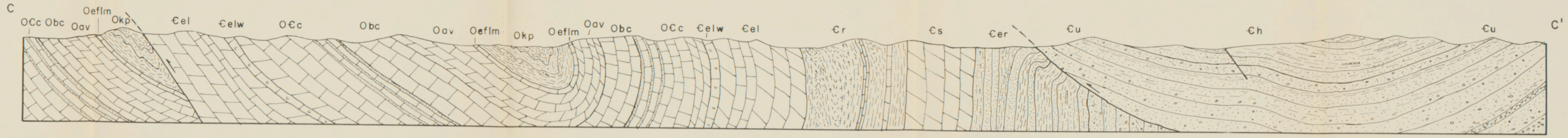
PLATE 2

SCALE 1:16,000









James R. Derby, 1961

EXPLANATION

Okp-Knobs and Paperville formations

Oeflm-Effna, Fetzer, and Lenoir-Mosheim limestones

Oav-Aven formation

Obc-Barron Creek limestone

OЄc-Conococheague formation

Єelw-Widener limestone member of Elbrook formation

Єel-Elbrook formation

Єr-Rome formation

Єs-Shady dolomite

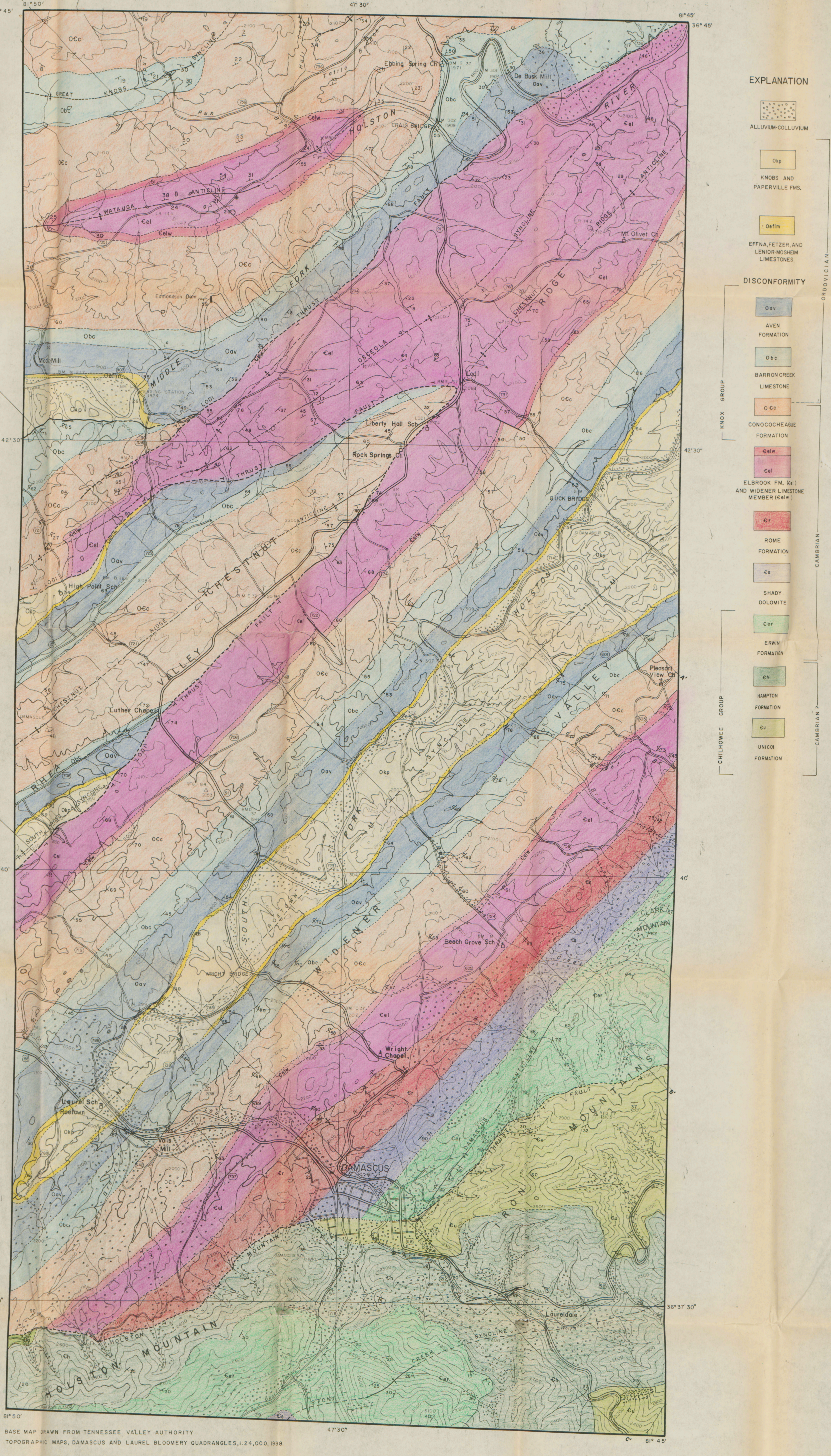
Єer-Erwin formation

Єh-Hampton formation

Єu-Unicoi formation

STRUCTURE SECTIONS OF THE DAMASCUS AREA, WASHINGTON COUNTY, VIRGINIA

Derby, James, Richard
Geology of the Damascus area



BASE MAP DRAWN FROM TENNESSEE VALLEY AUTHORITY
TOPOGRAPHIC MAPS, DAMASCUS AND LAUREL BLOOMERY QUADRANGLES, 1:24,000, 1938.

GEOLOGY MAPPED BY JAMES R. DERBY
1960 – 1961

GEOLOGIC MAP OF THE DAMASCUS AREA, WASHINGTON COUNTY, VIRGINIA

SCALE 1:16,000

1 0 1 2 MILES
5000 0 5000 10000 FEET

CONTOUR INTERVAL 100 FEET