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Preliminary Geologic Map of the Mountain Falls Quadrangle, Frederick and Shenandoah Counties, Virginia, and Hampshire County, West Virginia

by

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards or with the North American Stratigraphic Code.

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INTRODUCTION

Geologic mapping of the Mountain Falls 7½′ quadrangle was begun in 1990 and completed in 1992.

The Mountain Falls quadrangle, in the Winchester 30x60 minute quadrangle, lies within the Valley and Ridge geologic province of Virginia and West Virginia, and includes part of the Great Valley subprovince (fig. 1). It is underlain by sedimentary rocks ranging in age from Early Cambrian to Late Devonian, which were folded and faulted during the Alleghanian orogeny, and which are locally concealed by Quaternary surficial materials of various kinds.

Most of the quadrangle lies in Frederick and Shenandoah Counties, Virginia, and a small part is in Hampshire County, West Virginia. The geology of Frederick County has been mapped at a scale of 1:62,500 by Butts and Edmundson (1966), and both Virginia counties were previously mapped in reconnaissance by Butts (1933) at a scale of 1:250,000. The bedrock geology of the Hampshire County area was shown at 1:62,500 by Tilton and others (1927) and more recently by Dean and others (1985) at 1:24,000. A compilation of conodont age and color alteration index (CAI) determinations in the Winchester quadrangle was recently published by Harris and others (1994), and Orndorff and Goggin (1994) produced a map of sinkholes and karst-related features in the Shenandoah Valley, including part of the Mountain Falls quadrangle. Froelich and others (1992), in a recent study of surficial deposits in the Winchester 30′ x 60′ quadrangle, cored materials representing a possible meander cutoff of Cedar Creek southwest of Star Tannery.

STRATIGRAPHY

The Mountain Falls quadrangle is underlain by Paleozoic sedimentary rocks ranging in age from Early Cambrian to Late Devonian, and by unconsolidated Quaternary surficial deposits. The Paleozoic rocks represent a virtually continuous depositional sequence on a shallow, slowly subsiding continental shelf. They are represented by mainly passive-margin carbonate rocks during the Cambrian through Early Ordovician, active-margin limestones and flysch turbidites resulting from uplift associated with the early phases of the Taconic orogeny to the east during the Middle and Late Ordovician, molassic sandstones in the Early and Middle Silurian, shallow-water carbonates in the Late Silurian to Early Devonian, and a renewal of clastic sedimentation in the late Early Devonian through Late Devonian, including distal deposits associated with the Catskill delta. Paleozoic rocks in the quadrangle are about 18,000 ft (5,400 m) thick.

Surficial materials include alluvium, colluvium, and terrace deposits.

STRUCTURE

Bedrock in the quadrangle was strongly deformed during the Alleghanian orogeny. Major structures include the North Mountain thrust zone, the Mt. Pleasant syncline, and the Great North Mountain anticlinorium; these are complicated by numerous smaller structures (fig. 2). Most structures verge northwestward, reflecting the transport direction during deformation.

The North Mountain thrust (Giles, 1927, 1942; Butts and Edmundson, 1939; Edmundson, 1940) is a zone of thrust faults dipping to the southeast, the principal one of which, at the southeastern base of Little North Mountain, places Cambrian Waynesboro or Elbrook Formation on Ordovician Martinsburg Formation; many fault slices of the intervening formations are exposed along this fault (see also the adjacent Middletown quadrangle of Orndorff and others, 1993). A number of splays of this thrust cut out much of the section above the Martinsburg along and on the northwestern slopes of the mountain, especially at the eastern edge of the quadrangle and to the northeast; some of these fault splays may continue southwestward across the quadrangle, where the section appears to be complete, but they could not be detected during mapping because of poor exposure. Other faults in the quadrangle appear to be local adjustments to folding or backthrusts, as at Pinnacle Rock at the north edge of the map.

The Mt. Pleasant syncline (Butts and Edmundson, 1966, p. 86-87) extends some 40 miles (64 km) from a few miles southwest of the Mountain Falls quadrangle northeastward to the West Virginia line. The southeast limb, generally vertical or overturned, is truncated by the North Mountain thrust zone; the northwest limb dips gently southeastward. The Great North Mountain anticlinorium (Butts, 1940, p. 453-454; Butts and Edmundson, 1966, p. 87-91), of similar extent, is characterized by numerous subsidiary folds and faults on its flanks. Many bedrock exposures show intensive outcrop-scale folding.

Axial plane cleavage is associated with small, tight folds in shales or siltstones, particularly in the Martinsburg, Bloomsburg, and Wills Creek Formations. Joints are common, generally steeply dipping to vertical, and tend to strike more or less parallel to either the regional dip or regional strike of the beds.

MINERAL RESOURCES

The principal mineral resources in the quadrangle include limestone and dolomite, sandstone, and manganese.

Limestone and dolomite have been obtained from a crushed-rock quarry in the Conococheague Formation along Tumbling Run, in the southeastern part of the quadrangle, and from a number of small pits apparently for local farm use.

A small amount of sand has been quarried from exposures of

the Oriskany Sandstone a mile northwest of Gravel Springs. A major glass sand quarry is currently active in the Oriskany near Gore, Virginia, about 10 mi (16 km) north of the Mountain Falls quadrangle; Lowry (1954) reported an analysis of 99.16% silica. Harris (1972) reported on high-silica resources from both the Tuscarora Quartzite and Oriskany ("Ridgeley") Sandstone in northern Virginia, including a sample from the Tuscarora in the Mountain Falls quadrangle, taken from Short Mountain at Highway 55, which was described as being 99.6% SiO_2.

Manganese has been mined from supergene deposits in the Oriskany Sandstone and underlying limestones of the Helderberg Group in Cedar Creek Valley, Frederick and Shenandoah Counties (Stose and Miser, 1922; Monroe, 1942). In the Mountain Falls quadrangle, the principal mines were located on Mineral and Limestone Ridges, although there has been no activity since 1957 (Butts and Edmundson, 1966, p. 112). Cox (1991) sampled the manganese-bearing interval at Richards Run, Paddy Run (near Mineral Ridge), and other localities near the quadrangle, and reported manganese contents ranging from 100 to 1,500 ppm; a correlation was suggested between the manganese deposits and paleozones associated with manganese enrichment of carbonate cements by meteoric groundwater.

The remains of a small furnace stands along Cedar Creek at the eastern edge of the quadrangle, apparently for smelting iron, but the source of the ore is unknown. Nearby pits in the Chemung Formation show no evidence of an appreciable iron content. This furnace may be the "Zane's Charcoal Furnace" reported by Lesley (1859, p.65) as being situated on Cedar Creek in Frederick County and abandoned in 1828.

The Marcellus Shale and Mahantango Formation have been quarried locally for road metal.

DESCRIPTION OF MAP UNITS

Qa **Alluvium** (Holocene)-- Silt, clay, sand, and gravel, forming floodplain and stream-bed deposits; occurs along most streams, shown where thickest and most extensive. May be as much as 30 ft (9 m) thick; probably less than 7 ft (2 m) thick in most places. Gravel is generally composed of rounded to subangular cobbles and boulders of quartzite, locally includes angular to subrounded carbonate clasts

Qc **Colluvium** (Holocene and Pleistocene)-- Boulders and cobbles mostly of quartzite and sandstone, covers steep slopes and floors mountain hollows; clasts commonly many feet across, generally angular or subangular; deposits as much as 10 ft (3 m) or more thick; widely distributed, shown only where very thick or conspicuous

Qt **Terrace deposits** (Pleistocene?)-- Silt, sand, and gravel, highly weathered, occur along sides of stream valleys; gravel composed of rounded cobbles and pebbles of sandstone, quartzite, or less commonly, chert.

Probably as much as 30 ft (9 m) thick

Dh **Hampshire Formation** (Upper Devonian)-- Interbedded sandstone, shale, mudstone, and siltstone, grayish red to reddish gray or brownish gray. Sandstone, fine grained, micaceous, locally arkosic; thin to thick bedded, commonly crossbedded, locally ripple marked. Upper part of formation absent; lowermost 50 ft (15 m) exposed in trough of Mount Pleasant syncline at east edge of quadrangle; base gradational, placed at base of unfossiliferous redbed sequence overlying gray, fossiliferous sandstones of the Chemung Formation

Dcr

Dc **Chemung Formation** (Upper Devonian)-- Interbedded sandstone, siltstone, and minor shale. Sandstone, medium to dark gray, brownish gray, olive gray, or grayish red, very fine to fine grained, some beds medium to coarse grained, locally conglomeratic; thin to thick bedded, beds commonly as much as 4 ft (1.5 m), locally 20 ft (6 m) thick; commonly crossbedded; fossiliferous, mainly crinoid columnals and brachiopods. Siltstone, brownish gray, reddish brown, or yellowish brown, and shale, red to reddish brown, moderate to olive green, yellowish brown to grayish orange. **Dcr**, upper part of formation, containing prominent red to reddish-brown shales and siltstones, as much as 100 ft (30 m) thick, at base overlain by gray fossiliferous sandstone and shale; this and lower, thinner redbed intervals are probably tongues of overlying Hampshire Formation. Thickness of formation ranges from about 1,500 ft (460 m) to about 2,500 ft (760 m). Base gradational; placed so as to separate predominantly thick-bedded, fossiliferous sandstones above from predominantly thin-bedded, generally unfossiliferous sandstones below. Formation best exposed along Cedar Creek near east edge of map, along Highway 55, and along County Road 714 adjacent to and northwest of Turkey Run

Db **Brallier Formation** (Upper Devonian)-- Interbedded shale, siltstone, sandstone, and mudstone. Shale and mudstone, olive gray, locally silty. Siltstone, dark gray, thin to medium bedded, locally flow rolled in beds some 4 ft (1.2 m) thick. Sandstone, olive-gray or medium to dark gray, very fine grained to medium grained, thin to medium bedded, locally ripple marked; more abundant in upper part of formation. Thickness ranges from 1,000 ft (305 m) to about 1,800 ft (550 m). Base gradational, placed so as to separate interbedded thin-bedded sandstone and shale above from thick-bedded to massive sandstone below. Unit best exposed in stream cuts along Cedar Creek and in road cuts along Highway 55 and along County Road 606 southeast of Mountain Falls

Dms

Dm **Mahantango Formation** (Middle Devonian)-- Predominantly mudstone and shale, with two thick sandstone units at top. Mudstone, dark gray to dark olive gray, brownish gray, or greenish gray, bedding obscure; commonly spheroidally weathered, breaks down into small hackly chips; very fossiliferous, notably with spiriferid brachiopods. Shale, dark gray to olive gray, more abundant toward base of unit. Sandstone, micaceous, medium gray to olive gray, very fine grained to medium grained, medium to thick bedded with faint, even laminae and cross laminae; massive weathering; in two units 40 to 60 ft (12 to 18 m) thick, separated by about 40 ft (12 m) of mudstone, at top of unit; sandstone commonly includes calcareous beds with abundant remains of the brachiopod *Ambocoelia*; sandstone-bearing section mapped separately as sandstone member (**Dms**); apparently the Clearville Siltstone Member of Hasson and Dennison (1988). Thickness of the Mahantango 1,000 to 1,400 ft (300 to 425 m). Base of unit gradational, placed so as to separate predominantly olive-gray, fossiliferous shale and mudstone above from predominantly black, highly fissile shale below. Mudstone best exposed in the Gravel Springs area and along Highway 55 northwest of Star Tannery; sandstone best exposed in quarry near Highway 55 bridge over Cedar Creek, along County Road 604 to the northeast, and in new roadcuts on County Road 606 southeast of Mountain Falls

Dmr **Marcellus Shale** (Middle Devonian)-- Shale and limestone. Shale, medium gray to black, very fissile, weathers to platelets or paper-thin chips, black to light brown; and limestone, dark gray, fine grained, argillaceous, in a few beds 1 to 6 ft (0.3 to 2 m) thick, mainly in upper part of unit. Marcellus ranges in thickness from 200 to 550 ft (60 to 170 m); locally thinned or thickened by faulting along the northwestern slopes of Little North Mountain. Base gradational, placed at base of platy black, fissile shale overlying greenish-gray shale and mudstone with thin interbeds of black shale. Well exposed along Highway 55 northwest of Star Tannery and along County Road 600

Dn **Needmore Shale** (Middle and Lower Devonian)-- Shale and mudstone, olive gray or greenish gray to medium gray, calcareous, fossiliferous; contains thin interbeds of black calcareous siltstone, black limestone, and black shale in upper part. Thickness about 115 to 175 ft (35 to 55 m); thinned or absent due to faulting along northeastern part of Little North Mountain. Base sharp, placed at top of highest sandstone of underlying Oriskany Sandstone. Good exposures are found in roadside ditches near Mountain View Church and in an excavation about 1/4 mi (0.4 km) to the northwest, and

in a borrow pit along Fishers Hill Road over Little North Mountain

Do **Oriskany Sandstone** (Lower Devonian)-- Sandstone, light gray to tan, medium to coarse grained, locally conglomeratic with pebbles as much as 1/4 in. (6 mm) across; thin bedded to massive, commonly crossbedded; fossiliferous, with locally abundant molds of shelly fauna, mainly brachiopods; calcareous in part; friable when weathered. Commonly forms low ridges with prominent ledges; where beds are vertical, wall-like ledges as high as 15 ft (5 m) and as thick as 25 ft (8 m) are common. The formation, also commonly called Ridgeley Sandstone (Woodward, 1943; Rader and Biggs, 1976), ranges in thickness from 50 to 125 ft (15 to 40 m) but reported to be 275 ft (84 m) thick near Wardensville, ten miles west of the quadrangle (Swartz, 1929, p.60); thinned to about 4 ft (1.2 m) due to faulting along northeastern part of Little North Mountain. Base sharp, placed at base of sandstone overlying cherty limestone. Forms excellent outcrops at Richards Run, along County Road 608 southwest of Pembroke Springs, and on Limestone and Mineral Ridges

DSh **Helderberg Group** (Lower Devonian and Upper Silurian)-- Limestone and minor sandstone and chert of the Licking Creek, New Creek, and Keyser Limestones. Limestone, medium to dark gray, fine to coarse grained, irregularly bedded, fossiliferous. Sandstone, brownish gray, coarse grained, cross laminated, in a single bed 3 to 8 ft (1 to 2.5 m) thick. Chert, black, gray, and white, in nodules or irregular beds several inches (fraction of a meter) thick; most abundant in upper part of unit. Base of unit placed at base of coarse-grained crinoidal limestone overlying platy, laminated limestone. Group is 250 to 350 ft (75 to 110 m) thick; thin or absent along northeastern part of Little North Mountain due to faulting. Well exposed along Richards Run, near Pembroke Springs, and on Limestone and Mineral Ridges. Outcrop belt generally marked by abundant chert float in soil

Sto **Tonoloway Limestone** (Upper Silurian)-- Limestone, medium to dark gray, typically very fine grained, thin bedded to laminated, even to wavy or crinkly bedded; locally contains mud cracks and ripple marks; fossiliferous, including algal structures; weathers to light-bluish-gray platy float. Contains sparse thin sandy beds and sparse thin black chert nodules. Base of unit placed at base of predominantly evenly laminated, pure limestone above silty, sandy, or shaly limestone. About 200 to 400 ft (60 to 120 m) thick; apparently absent due to faulting along the northeastern part of Little North Mountain. Best exposed in the Pembroke Springs area and on Limestone and Mineral Ridges

Swc **Wills Creek Formation** (Upper Silurian)-- Shale, limestone, siltstone, dolomite, mudstone, and sandstone, interbedded. Shale and mudstone, siliceous or calcareous, red, yellow, olive gray, and gray; limestone, medium gray to dark gray, fine grained, nodular to evenly laminated, commonly argillaceous, locally fossiliferous, contains sparse white chert nodules, weathers to light yellowish- to greenish-gray shaly chips; siltstone, red, brownish gray, and yellowish gray; dolomite, light yellowish gray, interlaminated with limestone; sandstone, brownish gray, yellowish gray, and dark gray, very fine grained to medium grained, hard to friable. Lithologic units in beds as much as 2 ft (0.6 m) thick. Base of formation placed at base of variegated shale and limestone interbeds above thick red sandstone interval; thickness about 150 to 300 ft (45 to 90 m); apparently absent due to faulting along the northeastern part of Little North Mountain. Best exposed along Paddy Run and in the Pembroke Springs area

Sbm **Bloomsburg and McKenzie Formations, undivided** (Upper and Middle Silurian)-- Sandstone, siltstone, mudstone, shale, and limestone. Bloomsburg Formation: Sandstone, grayish-red, very fine grained, irregularly bedded; and mudstone, grayish red, mainly as thin interbeds in sandstone; commonly forms minor folds with conspicuous axial plane cleavage; about 150 to 200 ft (45 to 60 m) thick. Best exposed along Paddy Run in a breached anticline north of Mineral Ridge. McKenzie Formation: shale and limestone, interbedded, very highly weathered; shale, gray to olive gray, forms most of unit, most abundant near top; limestone, light to medium gray, fine to coarse grained, thin to medium bedded, very fossiliferous; formation not exposed in this quadrangle, presence known from residual soil, lithology from nearby exposures; about 100 to 150 ft (30 to 45 m) thick; base placed at top of quartzite of the underlying Keefer Sandstone. The Rochester Shale, reported at the base of the McKenzie in West Virginia and Maryland (Woodward, 1941, p. 106-116), has not been recognized in this area (Butts, 1940, p. 247). The Bloomsburg and McKenzie are absent along the northeastern part of Little North Mountain due to faulting.

Sk **Keefer Sandstone** (Middle Silurian)-- Quartzite, light gray to very light gray, generally coarse grained to conglomeratic with a few fine-grained beds, generally massive in lower part, medium or thin bedded above, commonly crossbedded; contains locally abundant *Scolithus*. Where steeply dipping, commonly forms topographic bench with ledges 6 to 10 ft (2 to 3 m)

high, locally as much as 20 ft (6 m) high, and 10 to 50 ft (3 to 15 m) wide; forms falls at Mountain Falls, just north of quadrangle boundary (Nunan, 1971, fig. 9). About 30 to 50 ft thick (9 to 15 m); absent along the northeastern part of Little North Mountain due to faulting. Base placed at base of light-gray quartzite overlying shale or red sandstone. Generally well exposed; excellent exposures occur along Highway 55 at Duck Run and in Paddy Gap

DS **Helderberg Group, Tonoloway Limestone, Wills Creek, Bloomsburg, and McKenzie Formations, and Keefer Sandstone, undivided** (Lower Devonian through Middle Silurian)-- Units thinned or removed by faulting and (or) concealed by colluvium along the northwestern slopes of Little North Mountain

Sr **Rose Hill Formation** (Middle Silurian)-- Sandstone, quartzite, and shale, interbedded. Sandstone and quartzite, reddish gray to grayish red, brown, gray, and variegated, fine to coarse grained, thin to thick bedded, ferruginous, hard; sparse crossbedding, burrows; red sandstone most abundant in lower part of formation. Shale, gray to black, in part silty, hackly weathering, occurs as thin interbeds in sandstone or thick sets in upper part of formation. About 350 to 450 ft (110 to 140 m) thick, except along the northeastern part of Little North Mountain, where it has been thinned to about 50 ft (15 m) by faulting; base gradational over as much as several tens of feet (about 10 m), placed at base of lowest beds of reddish gray or brown sandstones interbedded with light gray quartzite. Well exposed along Highway 55 at Duck Run and in Paddy Gap

St **Tuscarora Quartzite** (Middle and Lower Silurian)-- Quartzite, light gray to very light gray, few beds pinkish gray; medium to coarse grained, some beds as much as 6 in. (15 cm) thick are pebbly, conglomeratic, with quartz clasts as much as 3/4 in (2 cm) in length; thin to thick bedded, locally with faint laminae; commonly crossbedded. Trace fossil *Scolithus* locally abundant. Very hard; forms ledges, generally along mountain crests, as much as 25 ft (7.5 m) high. Full thickness is about 250 to 350 ft (75 to 110 m); thins along northeastern part of Little North Mountain to about 15 ft (5 m) as a result of faulting. Base sharp or gradational over a few feet (about a meter) in which thin red sandstone beds are interbedded with light-gray quartzite; placed at base of lowest gray quartzite. Well exposed on most mountain crests in quadrangle, along Highway 55 in the gap of Duck Run, and in Paddy Gap

Oj **Juniata Formation** (Upper Ordovician)-- Sandstone and shale. Sandstone, the dominant lithology, is grayish red to

moderate red, fine to coarse grained, laminated to thick bedded, crossbedded; fine-grained laminated or cross laminated, platy weathering sandstone is the most common rock type. Shale, grayish red, occurs as thin beds and partings, most abundant in upper part of unit. Unit ranges from 50 to 250 ft (15 to 75 m) in thickness; thin or absent as a result of faulting along northeastern part of Little North Mountain. Base gradational, placed at base of lowest red sandstone overlying greenish-gray conglomeratic sandstone. Locally well exposed as ledges along mountain crests, as on Spring Mountain, and in sparse outcrops on mountain slopes; partly exposed along Highway 55 at Short Mountain, and in Paddy Gap

Oo **Oswego Sandstone** (Upper Ordovician)-- Sandstone, grayish green to olive gray or brownish gray, medium to very coarse grained, conglomeratic, very poorly sorted; pebbles and cobbles subangular to well rounded, composed of chert, quartz, and sandstone. Medium bedded to massive, locally crossbedded. Ranges from 100 to 250 ft (30 to 75 m) thick, thin or absent as a result of faulting along the northeastern part of Little North Mountain. Base sharp, placed at base of coarse-grained conglomeratic sandstone overlying shale or fine-grained gray sandstone. Forms distinctive, well exposed ledges in Paddy Gap, along Highway 55 at Short Mountain (Nunan, 1971, Fig. 10), along the secondary road just north of Dry Gap, along Fishers Hill road, and in scattered outcrops on mountain slopes

Om **Martinsburg Formation (upper part)** (Upper and Middle Ordovician)-- Shale, siltstone, and sandstone, interbedded. Shale, dark gray to black, locally silty or calcareous; siltstone, dark gray to dark bluish gray, laminated, platy, locally calcareous and fossiliferous, some laminae with cross beds and scour-and-fill; sandstone, light to medium gray, thin to medium bedded, fine to very fine grained, fossiliferous, in upper part of unit. Unit forms two belts of outcrop: southeast of Little North Mountain, where it is in the overturned footwall beneath principal fault of the North Mountain thrust zone; and in the northeastern part of the quadrangle, where it forms the core of the Great North Mountain anticlinorium. Thickness ranges from about 1,500 ft (450 m) to about 3,000 ft (900 m); base not exposed in northeastern belt, removed by faulting in the southeastern belt. Formation poorly exposed; best exposures are found in hollows on the southeastern slopes of Little North Mountain, in Paddy Run just west of the quadrangle boundary, and in Duck Run at Short Mountain

Oms **Stickley Run Member of the Martinsburg Formation** (Middle

Ordovician) (Epstein and others, 1993)-- Limestone, medium gray to grayish black, very fine grained, laminated to thin bedded, argillaceous; exposed in a small fault slice in the North Mountain thrust zone at the east edge of the quadrangle

Oe **Edinburg Formation** (Middle Ordovician)-- Limestone, medium gray, fine grained, thin bedded; occurs in a small fault slice in the North Mountain thrust zone in the Hockmans Run area; poorly exposed

Oln **Lincolnshire and New Market Limestones, undivided** (Middle Ordovician)-- Limestone, medium gray, fine grained, massive; contains scattered gray to pink chert nodules. Top and base not present; occurs in a fault slice in the North Mountain thrust zone in eastern part of quadrangle; locally well exposed

Op **Pinesburg Station Dolomite of the Beekmantown Group** (Middle Ordovician)-- Dolomite, light to dark gray, fine to coarse grained and saccharoidal, thick bedded; contains beds and nodules of dark gray to black chert. About 1,500 ft (450 m) exposed in the Mountain Falls quadrangle; top of unit is not present in the quadrangle, and lower part is equivalent to upper part of underlying Rockdale Run Limestone in the adjacent Middletown quadrangle (Orndorff and others, 1993) as a result of an abrupt facies change. Base gradational, placed at base of lowest coarse-grained, thick-bedded dolomite above fine-grained, thin-bedded limestone and dolomite. Unit occurs in southeastern corner of quadrangle; well exposed along Cedar Spring Run

Or **Rockdale Run Formation of the Beekmantown Group** (Middle and Lower Ordovician)-- Limestone and dolomite interbedded. Limestone, medium to dark gray, fine grained, laminated to thin bedded. Dolomite, light to medium brownish gray, fine grained, laminated to thin bedded. Unit forms abundant outcrops; fossiliferous, stylolitic. Limestone locally burrowed, algal, conglomeratic, forming carbonate cycles. About 500 ft (150 m) thick. Base gradational, placed at base of lowest dolomitic interval above dark gray, thick bedded limestone of underlying unit. Occurs in fault slices in the North Mountain fault zone and in an outcrop belt in the southeastern corner of quadrangle, where it is well exposed along Cedar Spring Run and in fields west of County Road 757

Os **Stonehenge Limestone of the Beekmantown Group** (Lower Ordovician)-- Limestone, medium to dark gray, fine grained, crinkly laminated; forms abundant, massive outcrops in which bedding is commonly obscure; contains algal bioherms, scattered blebs of black chert. About 300 to 400 ft (90 to 120 m) thick. Base relatively sharp, placed below dark-gray limestone overlying ribboned limestone or dolomite of underlying unit.

Well exposed in fields along County Road 757 near junction with 638 and to the northeast.

ss

OCc **Conococheague Limestone** (Lower Ordovician and Upper Cambrian)-- Limestone and minor interbedded dolomite and sandstone. Limestone, light to dark gray or bluish gray, fine grained to micritic, thin bedded; weathers light bluish gray; contains white to black chert nodules, thin beds of edgewise conglomerate; some beds argillaceous. Dolomite, light to dark gray, locally pinkish gray, fine grained, laminated; forms ribboned pattern where interbedded with limestone. Carbonate beds form cycles 6 to 30 ft (2 to 9 m) thick that include intraformational conglomerate, algal bioherms, crossbedded grainstone and oolite, ribbon rock, and laminated, mudcracked dolomite (Orndorff and Epstein, 1994). Sandstone, light pinkish gray to medium gray, medium to coarse grained, thin to medium bedded, crossbedded; weathers yellowish gray to dark gray, commonly with pitted surfaces; locally calcareous, in many places contains ripped-up carbonate clasts in lower part of beds. Forms three or more beds from a few inches (5-10 cm) to as much as 30 ft (9 m) thick throughout unit; thicker beds, which generally form low ridges, are mapped separately (**ss**). Formation 2,000 to 2,500 ft (600 to 750 m) thick. Base sharp, placed at base of lowest sandstone bed. Unit occurs in a broad belt in southeastern part of map and in a fault slice in the North Mountain fault zone; generally well exposed; excellent exposures occur along Highway 55 south of Mulberry Run (Orndorff and Epstein, 1994, Stop 3) and in an abandoned quarry along Tumbling Run; sandstone beds generally well exposed where transected by streams, such as along the south side of Mulberry Run just west of Highway 55, and in road cuts, such as County Road 623 northeast of Mt. Carmel Church

Ce **Elbrook Formation** (Upper and Middle Cambrian)-- Limestone, dolomite, and minor shale, interbedded. Limestone, medium to dark bluish gray, fine grained to micritic, evenly thin bedded; some beds dolomitic, argillaceous, platy weathering, especially in lower part; fossiliferous, ribboned in upper part; sparse tan, gray, or black chert nodules. Dolomite, light to dark gray or grayish yellow, very fine to fine grained, laminated to thin bedded, weathers light to dark gray or yellowish gray; locally silty, argillaceous, platy weathering, pyritic; contains sparse gray chert nodules. Shale, yellowish brown to reddish gray, locally dolomitic, as sparse thin interbeds. Thickness ranges from 2,000 to 2,500 ft (600 to 750 m). Base generally absent as a result of faulting; placed so as to separate dominantly gray carbonate beds above from

dominantly red shale below. Forms broad outcrop belt in hanging wall of North Mountain thrust zone, commonly with abundant outcrop; well exposed along County Road 623

Cwb **Waynesboro Formation** (Middle and Lower Cambrian)-- Shale and siltstone, reddish gray to dusky yellow, interbedded; approximately 200 ft (60 m) of uppermost part of formation preserved in the hanging wall of the North Mountain thrust zone at south-central margin of map; poorly exposed

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