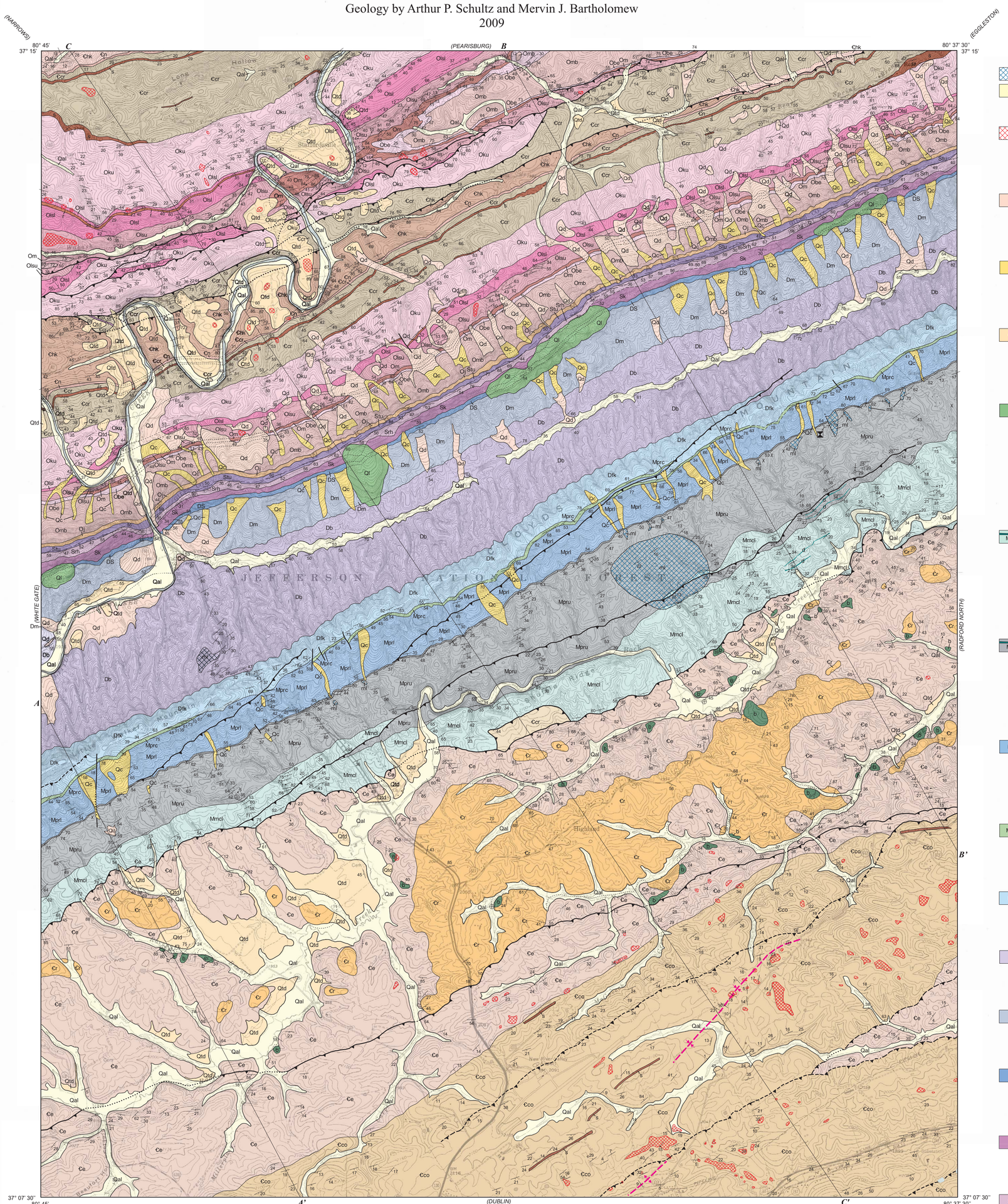
GEOLOGIC MAP OF STAFFORDSVILLE QUADRANGLE, VIRGINIA

Geology by Arthur P. Schultz and Mervin J. Bartholomew
2009



Basemap, modified U.S. Geological Survey DRG
1965 Staffordsville Quadrangle, Virginia

Polyconic projection: UTM zone 17, NAD 1927

Digital cartography by Aaron Cross
and Elizabeth V. M. Campbell

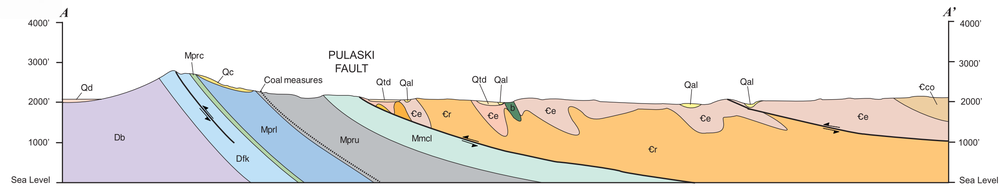
SCALE 1:24,000

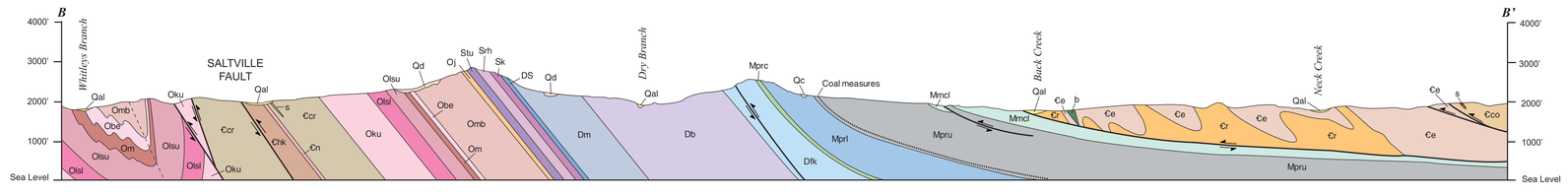
1 0.5 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 0.5 0 1 KILOMETER

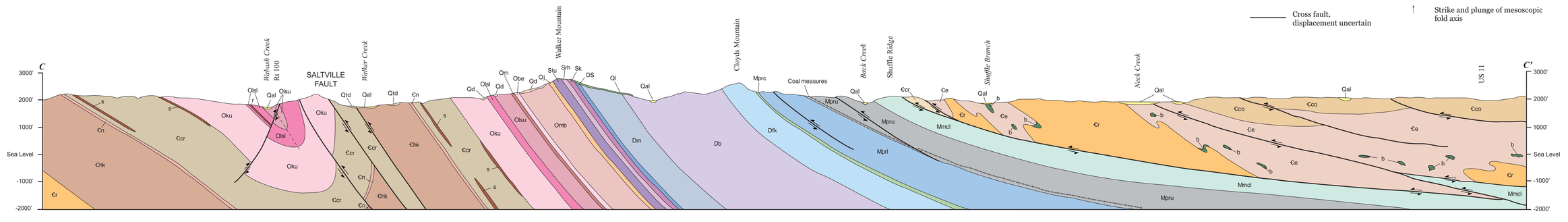
CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

MN GN
7°47' 138 MILS
2°11' 3 MILS
2009 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

Geology mapped from 1980 to 1983







ACKNOWLEDGEMENT

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SUGGESTED REFERENCE

Schultz, Arthur P., and Bartholomew, Mervin J., 2009, Geologic Map of the Staffordsville quadrangle, Virginia: Virginia Division of Geology and Mineral Resources Open File Report 09-02, 1:24,000-scale geologic map

DESCRIPTION OF MAP UNITS

QUATERNARY

m: **Modified land**: Man-made alterations including mine dumps.

Qal: **Alluvium**: Unconsolidated light-gray to light-brown sand, silt, and clay, with channels and lenses of pebbles, cobbles, and boulders of quartzite, sandstone, and chert. Deposits are stratified and often crossbedded and/or graded bedded. Thicknesses from less than 1 to more than 30 feet (0.3 to 9 m).

Sinkholes: Areas mapped as sinkhole topography consist of rolling low hills with round to irregularly shaped sinkholes, clusters of sinkholes, or cave openings. These features have formed from solution or collapse of carbonate bedrock. Sinkholes are delineated from closed depression contours on the 1:24,000 scale topographic map. The most extensive sinkholes occur in limestone bedrock of the Conococheague Formation, however sinkholes also occur in other carbonate rocks of Cambro-Ordovician age.

Qd: **Debris deposits**: Unsorted, angular to rounded, boulders, cobbles, and pebbles of sandstone, quartzite, siltstone, shale, chert, and minor rock types within a matrix of sand, silt, and clay. Deposits range from 3 feet (1 m) to greater than 30 feet (10 m) in thickness and include alluvial fans, foot-slope deposits, debris fans, debris flows, and debris avalanches (Schultz and others, 1991). Deposits typically occur in narrow V-shaped valleys along steeper mountain slopes and as broad aprons on the adjacent gentler slopes of the valleys.

Qc: **Colluvium**: Blocky accumulations of erosion resistant boulders and cobbles of generally angular sandstone and quartzite with minor amounts of siltstone, shale, and chert; includes block streams, block fields, and talus. Deposits range from 0 to 30 feet (0 to 9 m) thick and are derived from nearby strata of Mississippian, Devonian and Silurian age (Schultz and others, 1991). Generally occurs on the higher elevation slopes below bedrock escarpments and may grade downslope into more matrix-supported debris type deposits.

Qtd: **Terrace deposits**: Rounded cobbles and boulders of vein quartz, metaquartzite, quartzose and feldspathic sandstone, and chert in a dark brown to dark red-brown, extensively weathered soil matrix. Terraces range from 1 to over 30 feet (0.3 to over 9 m) thick. Terraces associated with New River, Walker Creek, and Back Creek range from about 20 feet (6 m) to over 300 feet (90 m) above the present floodplains. In places, discontinuous, 0.5- to 3-inch- (1- to 6- cm-) thick, dark red-brown, ferruginous hardpans occur which cement the matrix and clasts of the terrace deposits.

Ql: **Bedrock landslides**: The two general types of bedrock failures on dip slopes underlain by Silurian and Devonian rocks are coherent bedrock block slides and gravitational sags or "sackungen" (Schultz, 1986; Schultz and Southworth, 1989; Schultz and others, 1991). Sackungen are large slabs of coherent sandstone and quartzite that have rotated or sagged downslope from the crest of the mountain. These rotated blocks form downslope bulges and open depressions, while linear valleys along the crest of the mountain forming distinctive double ridges. Sackung range from less that 500 feet (150 m) long to upwards of 2000 feet (610 m) long. Bedrock landslides consist of large rotated slabs of Silurian age sandstone and quartzite that have detached from the upper slopes of the dip slope and moved toward the valley bottom. These features range from less that 300 feet (90 m) to greater than 2000 feet (610 m) long.

MISSISSIPPIAN

Mmcl-d: **Maccrady Formation (lower member)**: Dominantly mottled maroon and green mudstone in 20- to 50-foot- (6 to 15 m) thick sequences with interbedded sandstone, minor siltstone, and dolomite beds. Interbedded sandstones are typically medium-gray, 1 to 3 feet (0.3 to 0.9 m) thick, thinly bedded, fine- to medium-grained, and contain both feldspathic rock fragments and mica. Near the base of the formation, a thick sequence of maroon, medium- to coarse-grained, cross-bedded sandstones occur. Scattered 1- to 3-foot (0.3 to 0.9 m) lenses and beds of olive-gray to medium-gray or mottled maroon and gray, fine-grained, massive to nodular-bedded dolomite also occur (d), primarily near the contact with the underlying Price Formation. The lower Maccrady is about 600 feet (185 m) thick and is characteristically veneered by a thin maroon soil. The upper member is tectonically removed by the Pulaski fault.

Mpru-d: **Price Formation (upper member)**: Gray, quartzose sandstone, mottled maroon and green mudstone, dark-gray siltstone, and black mudstone and/or coal. The coal measures are found near the base of this member except for a local bed at the Bell Hampton Mine, which is at a stratigraphically higher position. Most coal beds appear to be laterally discontinuous over distances of just a few miles. Quartzose sandstone is typically medium- to brownish-gray, medium- to coarse-grained, cross-bedded, and contains abundant feldspathic rock fragments and mica. Medium-gray siltstone is thinly bedded and, below coal beds, disrupted by roots. The member is generally covered by 1 to 3 feet (0.3 to 0.9 m) of light brown, sandy soil. The unit thins southwestward from about 1500 feet (460 m) to about 1000 feet (305 m).

Mprl: **Price Formation (lower member)**: Interbedded sandstone and siltstone, the siltstone content increases southwestward along outcrop belt. Both the fine-grained to medium-grained sandstone and the siltstone are medium-gray, platy (due to alignment of mica flakes parallel to bedding or cross-bedding), well layered or cross-bedded, and contain abundant feldspathic rock fragments and mica. Clay-gall conglomerates and medium-gray mudstone beds occur locally. A thin, light-brown, sandy soil typically covers this map unit. The lower member is about 1000 feet (305 m) thick and is stratigraphically underlain by the basal Cloyd Conglomerate Member of the Price Formation.

Mprc: **Price Formation (basal Cloyd Conglomerate Member)**: Consists of 20 to 60 feet (6 to 18 m) of massive to very thick bedded, cross-bedded sequences, grading from quartz-cobble conglomerate at the base to quartz-pebble conglomerate to coarse-grained sandy conglomerate at the top. A thin veneer of quartz gravel and sand commonly form a loose soil between the abundant outcrops of this member.

DEVONIAN

Dfk: **Foreknobs Formation**: Cyclic sequences of dark-gray to brownish-gray or reddish-gray, fine- to medium-grained, fossiliferous, graded beds of sandstone and siltstone with minor mudstone. Most of the sequences are truncated by the overlying sequence producing 3- to 20-foot- (0.9 to 6.0 m) thick sandstone ledges that are thicker and more abundant near the top of the formation and thinner near the base. Total thickness is about 800 feet (245 m).

Db: **Brallier Formation**: Cyclic sequences of 2- to 6-inch- (5 to 15 cm) thick beds of medium-gray, well-laminated, commonly crossbedded, fine-grained sandstone and siltstone overlain by dark-gray to black mudstone. The thickness and percentage of the sandstone and siltstone beds decrease downward so that mudstone predominates over the coarser clastics near the base and vice versa near the top of the formation. Thickness ranges from about 2000 to 3500 feet (610 to 1070 m).

Dm: **Millboro Shale**: Dark-gray to black, thinly bedded, sparsely fossiliferous, fissile mudstone and black shale. Contains abundant concretions and disseminated sulfides as well as a few thin beds of carbonate. Thickness ranges from about 1000 to 1300 feet (305 to 400 m).

DEVONIAN AND SILURIAN

DS: **Lower Devonian and upper Silurian, undivided**: Consists of interbedded light-gray, medium- to coarse-grained quartzose sandstones in 5- to 40-foot thick (1.5 to 12 m) ledges, separated by poorly exposed intervals of dark-gray fine-grained friable sandstones and siltstones with minor mudstones. The thickness is about 60 feet (18 m).

SILURIAN

Sk: **Keefer Sandstone**: Light-gray to white, predominantly thick-bedded but also massive, cross-bedded, rippled, medium- to coarse-grained quartzose sandstone and fine- to medium-grained orthoquartzite. Burrowed beds and minor reddish-brown sandstone also occur with interbedded minor quartz-pebble conglomerate and greenish-gray siltstone and mudstone lenses. The thickness is approximately 200 feet (60 m).

Srh: **Rose Hill Formation**: Interbedded, hematite-cemented, dark-brownish-red, fine- to medium-grained, ferruginous sandstone and dark-reddish-gray mottled mudstone and siltstone. Lesser amounts of interbedded, fossiliferous, burrowed red siltstone and mottled greenish-gray shale. Thickness is approximately 140 feet (45 m).

Stu: **Tuscarora Formation**: Massive, fine-grained, light-gray to white orthoquartzite interbedded with massive and cross-bedded, medium- to coarse-grained, light-gray to white quartzose sandstone with lenses of quartz-pebble conglomerate and greenish-gray siltstone and mudstone. Both trough and planar cross bedding occur throughout the section. Thickness is approximately 100 feet (30 m).

ORDOVICIAN

Oj: **Juniata Formation**: Predominantly interbedded maroon to dark reddish-brown, mottled siltstone and mudstone with thin beds of fine-grained reddish-brown sandstone. Fossil *Lingula* fragments and reduction spots are locally common. The thickness is about 150 feet (45 m).

Omb: **Martinsburg Formation**: Upper portion consists of interbedded 0.5- to 1.0-foot (15 to 30 cm) thick beds of massive, fine-grained, medium-gray sandstone with fossil debris and medium-gray well-laminated calcareous mudstone. This grades down section into dominantly medium- to dark-gray, coarse-grained, bioclastic limestone interbedded with medium-gray, well laminated calcareous mudstone. The thickness is estimated to be about 1100 feet (335 m). The use of Martinsburg Formation in this area follows past usage by Butts (1933, 1940) and Cooper (1961).

Obe: **Eggleston and Bays Formations, undivided**: Interbedded greenish-gray, calcareous mudstone and dark greenish-gray, fine-grained limestone with interbeds of siltstone comprise the upper portion of the unit (Eggleston Formation). Limestone content decreases downward as siltstone and calcareous sandstone content increases, so that the lower unit is primarily fine- to medium-grained, and locally coarse-grained, greenish-gray calcareous sandstone with a few interbeds of maroon siltstone at base of unit (Bays Formation). Total thickness is about 60 feet (18 m).

Om: **Moccasin Formation**: Interbedded maroon and greenish-gray calcareous mudstone with thin beds of fine-grained, medium-gray limestone and maroon siltstone. The lower 3 to 5 feet (0.9 to 1.5 m) of the unit is pinkish-gray to maroon limestone. The thickness is estimated to be about 50 feet (15 m).

Olsu: **Middle Ordovician limestone, undivided, upper member**: Thin to medium-bedded, light gray, oncolitic skeletal limestone, pellet and ooid limestone, lime mudstone, and thin buff shales. Includes Whitten, Wassum and Wardell Formations of Cooper (1961). This unit overlies nodular, thin-bedded, dark gray to black, shaly skeletal limestone that includes the Benbolt and Chatham Hill Formations of Cooper (1961). Along the outcrop belts of the Saltville thrust sheet and the northwest limb of the Spruce Run syncline this upper member is about 500 feet (155 m) thick. Along the southeastern limb of the Spruce Run syncline, as well as farther southwest, this unit is tectonically thinned to as little as 100 feet (30 m).

Olsl-r: **Middle Ordovician limestone, undivided, lower member**: Skeletal grainstones equivalent to the Effna and Ward Cove Formations of Cooper (1961) overlying thick-bedded, dark-gray, burrowed, cherty, fine-grained limestone equivalent to the Lincolnshire Formation of Cooper (1961), which is locally oncolitic. This, in turn, overlies thin- and medium-bedded, gray, cherty pellet limestone, fenestral limestone and skeletal limestone, light gray shale and shaly limestone in lower part, and basal lithoclastic breccias and dolomite that are equivalent to the Blackford, Elway, and Five Oaks Formations of Cooper (1961). Locally a silicified carbonate marker bed is present near the base of the lower member. Within the Saltville thrust sheet, the thickness of this member varies considerably along strike. It reaches a maximum thickness of about 500 feet (155 m) where a basal conglomerate with dolomite cobbles is present in a local trough, and then thins to less than 100 feet (30 m) where a high area existed on the underlying unconformity surface. Basal red beds (r) occur locally. Within the Narrows thrust sheet on the northwest flank of the Spruce Run syncline, the lower member is about 350 feet (105 m) thick. Along the southeast limb of the Spruce Run syncline the lower member is tectonically thinned to as little as 100 feet (30 m).

Oku: **Upper Knox Group, undivided**: Medium- to light-gray, fine-grained dolomite typically in 1- to 3-foot (0.3 to 0.9 m) thick beds which are internally either massive or stylolitically laminated. The unit commonly contains light gray, laminated chert as well as 0.5- to 2.0-foot (15 cm to 0.6 m) thick beds and lenses of nodular chert that are often irregularly shaped and vuggy. The thickness is estimated to be about 1000 feet (305 m). The rocks mapped as upper Knox Group are equivalent to the Knox Group (upper part) as mapped on the Blacksburg quadrangle (Bartholomew and Lowry, 1979) and the portion of the Knox Group as described by Cooper (1961) and the Beekmantown Formation of Butts (1933, 1940).

ORDOVICIAN AND CAMBRIAN

OCco-s: **Conococheague Formation**: Cyclic 3- to 4.5-feet (0.9 to 1.4 m) thick sequences of basal intraformational limestone- and dolomite-clast conglomeratic limestone overlain by millimeter to centimeter laminated blue gray limestone. This part of the cycle is overlain by bluish-gray "ribbon" limestone. Tops of the cycles are capped by blocky, light gray dolomite. In places, the upper part of the cycles may consist of light pink dolomitic mudstone. These cycles are interbedded with chert-bearing stromatolitic dark gray limestone, light pink limestone and dolomite, rippled and mud-cracked light gray limestone and dolomite, and distinctively white weathered, highly fractured, blocky dolomite and oolitic chert. Discontinuous, medium- to fine-grained, light gray, 1- to 8-inch (2.5 to 20 cm) thick carbonate cemented quartz sandstones (s) are present near the base of the unit and throughout the section but exposures are relatively rare. Total thickness is between 1800 and 2000 feet (550 and 610 m).

CAMBRIAN

Ccr-s: **Copper Ridge Formation**: Medium- to light-gray, fine-grained dolomite typically in 1- to 3-foot (0.3 to 0.9 m) thick beds, algal laminated and often interbedded with lenses of dolomitic, quartzose sandstones and nodular, laminated chert. Silicified carbonate sandstones (s), which range up to 4 feet (1.2 m) thick, occur as discontinuous beds and lenses. Stromatolites and cross-bedded silicified oolites are present locally. Approximately 1000 feet (305 m) thick. The Copper Ridge is mapped on the Narrows and Saltville thrust sheets and is roughly equivalent to the Conococheague on the Pulaski thrust sheet.

Ccn: **Nolichucky Formation**: Medium- to light-gray, thin-bedded, argillaceous dolomite. The unit is approximately 20 feet (6 m) thick. The Nolichucky is present only on the Narrows and Saltville thrust sheet and is roughly equivalent to the upper Elbrook of the Pulaski thrust sheet.

Cchk: **Honaker Formation**: Medium- to light-gray, poorly algal laminated to stylolitically laminated, fine-grained dolomite in 1- to 3-foot (0.3 to 0.9 m) beds. Stylolitic laminations often form pink partings. Chert occurs as nodules generally 4 inches (10 cm) or less across. Minor limestone beds occur in the lower part of the Honaker Formation. Approximately 2,300 feet (705 m) of Honaker occurs in the hanging wall of the Saltville fault on the western edge of the area. To the northeast most of the Honaker is truncated by the Saltville fault. Within the Narrows thrust sheet, the Honaker is about 2,800 feet (855 m) thick. The Honaker mapped on the Narrows and Saltville thrust sheets is roughly equivalent to the middle and lower Elbrook of the Pulaski thrust sheet.

Ce: **Elbrook Formation**: Upper part consists of 3- to 20-foot (0.9 to 6 m) thick alternating tan and gray, irregularly banded, partially dolomitized limestone interbedded with 1- to 3-foot (0.3 to 0.9 m) thick stylolitic, dark gray, fine-grained dolomitic limestone and massive bedded, 3- to 6-foot (0.9 to 1.8 m) thick, thrombolitic dolomite. Occasional 5- to 10-foot (1.5 to 3 m) thick cyclic packages of 1.5- to 2.5-inch (4 to 6 cm) thick intraformational dolomite clasts, limestone conglomerate are overlain by 1- to 3-foot (0.3 to 0.9 m) thick ribbon banded, partially dolomitized limestone overlain by 3-foot (1 m) thick massive dolomite. Middle part consists of cyclic sequences 3- to 20-foot (0.9 to 6 m) thick, partially dolomitized, wavy laminated limestone with 1- to 10-foot (0.3 to 3 m) thick, centimeter-laminated, light-gray, argillaceous dolomite and 1- to 15-foot (0.3 to 4.5 m) thick cherty dolomite with thin evaporite-disrupted laminations. The lower part of the middle section consists of cyclic interbedded sequences of 3- to 20-foot (0.9 to 6 m) thick, flat and stromatalitic algal laminates and 1- to 10-foot (0.3 to 3 m) thick centimeter-laminated argillaceous dolomite. The lower Elbrook is dominantly 15- to 30-foot (4.5 to 9 m) thick centimeter-laminated, argillaceous dolomite, 3- to 10-foot (0.9 to 3 m) thick, massive bedded, light-gray dolomite and 3- to 20-foot (0.9 to 6 m) thick algal laminated dark-gray dolomite and dolomitic limestone. Light olive-green and pale-pink argillaceous dolomite occurs near the base of the formation. Near Radford an undeformed section of the lowermost Elbrook consists of two 1-foot (0.3 m) thick, maroon phyllitic mudstones interbedded with 3- to 6-foot (0.9 to 1.8 m) thick olive-gray, massive-bedded dolomite and 1- to 6-foot (0.3 to 1.8 m) thick centimeter-laminated dolomite. The total thickness of the Elbrook Formation ranges from 1,800 to 2,000 feet (550 to 610 m).

b: **Tectonic breccia (Elbrook Formation)**: Light- to medium-gray, massive to crudely-layered, well to poorly indurated breccia consisting of angular to rounded unsorted clasts of dolomite, limestone and chert in an unsorted matrix of dolomite. Forms sill- and dike-like bodies up to 50 feet (15 m) thick. A second type of breccia consists of light to medium grayish-green fragments of phyllitic, dolomitic mudstone and dolomite in dolomitic cement.

Cr: **Rome Formation**: Interbedded mottled maroon and green phyllitic mudstone and very minor 3-foot (0.9 m) thick, dark-gray, fine-grained dolomite. The total thickness of the Rome cannot be determined due to complex folding.

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MAP SYMBOLS

For all contact, fault, and fold symbols: lines are solid where the location is exact, long-dashed where the location is approximate; short-dashed where the location is inferred; dotted where the location is concealed. Teeth are on the upthrown block.

- Contact, approximate
- Contact, covered
- Fold axis
- Thrust fault, known
- Thrust fault, approximate
- Thrust fault, inferred
- Thrust fault, covered
- Cross fault, displacement uncertain
- Strike and dip of inclined beds
- Strike of vertical beds
- Strike and dip of overturned beds
- Horizontal beds
- Strike and plunge of mesoscopic fold axis
- Shaft
- Inactive mine
- Prospect
- Adit
- Coal bed

Interpretive cross-sections

1. No vertical exaggeration except surficial deposits.
2. Subsurface structures interpreted from surface measurements.
3. Subsurface breccia is diagamatic.