Geologic Map of the New Windsor Quadrangle, Carroll County, Maryland

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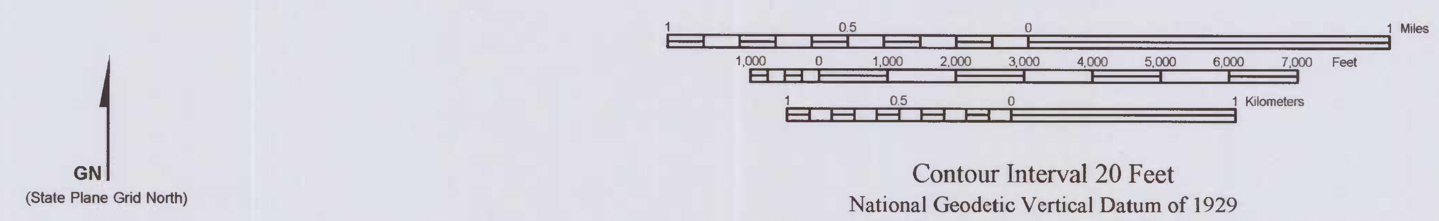
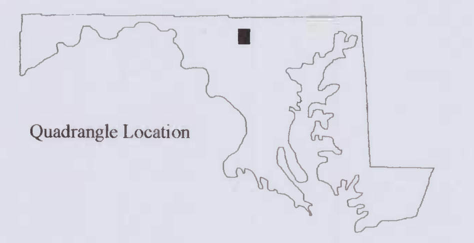
2004

A reinterpretation of Fisher (1978)

Scale 1:24,000





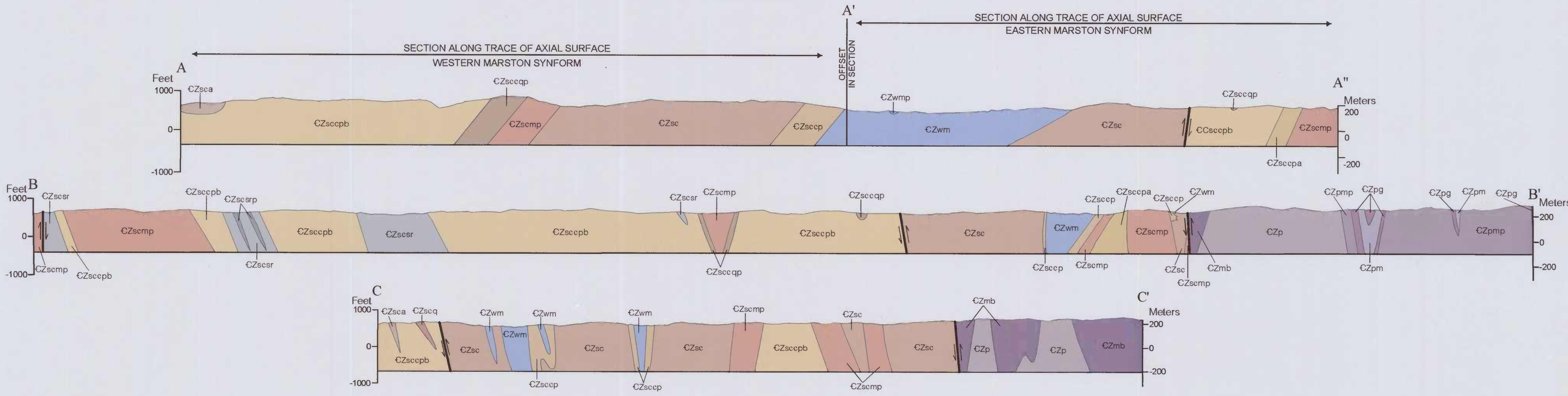
Contour Interval 20 Feet
National Geodetic Vertical Datum of 1929
(To convert elevations to the North American Vertical Datum of 1988, subtract 1 foot)
(To convert from feet to meters, multiply by 0.3048)

Adjoining 7.5' Quadrangle Names
New Windsor Quadrangle, shaded

1	2	3
4		5
6	7	8

1. Taneytown
2. Littlestown
3. Manchester
4. Union Bridge
5. Westminster
6. Libertytown
7. Winfield
8. Finksburg

SCHEMATIC CROSS SECTIONS A-A", B-B', AND C-C'
No Vertical exaggeration.
Surficial deposits not shown. Relative motion of faults shown by arrows.



(1978) that crops out west of the Avondale fault.

Late Proterozoic

Metabasalt "a" (€Zsca)
Interlayered massive to schistose metabasalt ("greenstone") and green to greenish blue chlorite phyllite that is virtually indistinguishable from (€Zsc), but retained here as a separate unit to aid in comparing this to Fisher's (1978) map. Phyllite locally contains irregular, mottled patches of white mica and quartz, resembling amygdaloidal volcanic clasts; metabasalt locally contains relict amygdules filled with quartz, albite, epidote, and chlorite. Corresponds to the Ijamsville metabasalt (ijgs) of Fisher (1978) that crops out west of the Avondale fault.

Chlorite phyllite (€Zsccp)
Green to greenish blue chlorite phyllite. Contains subordinate amounts of paragonite and muscovite and variable amounts of quartz. Chloritic laminae commonly alternate with white mica-albite-quartz layers up to 5 mm (0.2 inch) thick; most of these layers parallel axial-plain cleavage and must be tectonic in origin, but some may be relict bedding laminations (Fisher, 1978). Locally contains volcaniclastic fragments or amygdaloidal phyllite up to 3 cm (1.2 inches) long in a hematite-chlorite-white mica phyllite matrix. A few rocks contain scattered amygdules filled with quartz, albite, epidote, and chlorite and flattened parallel to the cleavage. Corresponds to the Sams Creek chlorite phyllite (sccp) of Fisher (1978).

Chlorite phyllite "a" (€Zsccpa)
Tan to dark-greenish-blue albite-quartz-muscovite-chlorite phyllite and albite-quartz-muscovite phyllite interbedded with chlorite phyllites and muscovite phyllites like those of Sams Creek chlorite phyllite "b". Phyllite "a" may be distinguished from phyllite "b" by the presence of euhedral albite porphyroblasts, commonly about 0.5 mm on a side. Well exposed only along the major stream valleys; weathers readily to a thick, tan, quartzose saprolite that underlies the higher ridges in the eastern part of the quadrangle. Corresponds to the Wissahickon albite phyllite (wap) of Fisher (1978) that crops out west of the Avondale fault.

Chlorite phyllite "b" (€Zsccpb)
Dark-bluish gray quartz-paragonite-muscovite-chlorite phyllite. Commonly contains limonite pseudomorphs after pyrite and minute disseminated flakes of hematite. This unit includes phyllites indistinguishable from those in (€Zsccp), but most are more micaceous and contain fewer volcaniclastic breccia fragments. Chloritic laminae commonly alternate with mica-albite-quartz layers up to 5 mm thick; much of the layering is axial to minor folds and clearly metamorphic, but some may be relict bedding. Corresponds to the Ijamsville chlorite phyllite (ijcp) of Fisher (1978) that crops out west of the Avondale fault.

The micas and chlorite characteristically are segregated as pinstripe laminations spaced 1 to 3 cm (3/8 to 1 inch) apart and parallel to cleavage. Disrupted fold hinges are locally preserved between cleavage laminations. Crops out extensively and commonly forms low ridges capped by a thin sandy soil. Corresponds to the Ijamsville mica-chlorite-quartz phyllite (ijqp) of Fisher (1978) east of the Avondale fault.

Metabasalt (€Zpg)
Schistose to massive metabasalt interlayered with green to greenish blue chlorite phyllite and minor gray hematite-muscovite phyllite. The metabasalt contains fine-grained chlorite, actinolite, albite, epidote, and quartz with minor sphene and magnetite. Most of the rock has a schistose texture, but locally epidote pods and porphyritic basaltic texture is well preserved. Corresponds to the Sams Creek metabasalt (scgs) of Fisher (1978) that is east of the Avondale fault and occurs within the Prettyboy Schist or muscovite phyllite subunit.

Marble (€Zpm)
Light gray to white, massive dolomitic marble. Discontinuous areas of marble that crop out east of the Avondale fault were previously mapped as Wakefield Marble, but the stratigraphic equivalency cannot be established. This marble is moderately well exposed in places; occupies topographic depressions and weathers to a thin red soil, locally covered by slope wash from adjacent hills.

Muscovite phyllite (€Zpmp)
Buff to light-olive-green quartz-muscovite phyllite with subordinate silvery gray quartz-paragonite-muscovite-chlorite phyllite and muscovite-quartz phyllite. Numerous limonite cubes, up to 2 cm (3/4 inch) on a side, are pseudomorphs after pyrite. Hematite and tourmaline are common accessory minerals. Very poorly exposed; weathers easily into a thick resistant saprolite containing abundant chips of phyllite. Underlies broad, gently sloping hills. Corresponds to select parts of the Ijamsville muscovite phyllite (ijmp) of Fisher (1978) east of the Avondale fault that are associated with the Prettyboy Schist.

Quartzite (€Zpq)
Light gray to tan to reddish, schistose quartzite up to 6 m (20 feet) thick with individual layers 15 to 60 cm (6 to 24 inches) thick that are interbedded with muscovite phyllites and chlorite phyllites. Lenses or pods of white vein quartz are also common. Corresponds to parts of the Ijamsville quartzite (ijq) of Fisher (1978) east of the Avondale fault that occur within the Prettyboy Schist.

NOTES ON THE GEOLOGIC STRUCTURE AND STRATIGRAPHY OF THE PIEDMONT ROCKS IN THE NEW WINDSOR QUADRANGLE

GEOLOGIC SETTING

With the exception of a small area of Triassic sedimentary rocks of the Gettysburg Basin in the northwest corner, the New Windsor 7.5-minute quadrangle lies within the Westminster terrane of the western Piedmont Upland of Maryland. Rocks of the Westminster terrane are metamorphic (greenschist facies) that reflect multiple phases of deformation.

Recent geologic mapping in the Piedmont has resulted in stratigraphic and structural relationships for these rocks of the Westminster terrane that differ from interpretations of Fisher, who produced a geologic map of this quadrangle in 1978. In general, the current map retains Fisher's geologic contacts and structural measurements but revises the structural and stratigraphic relationships (including formation names) to offer an interpretation consistent with the recent regional interpretations. Limited field reconnaissance during the preparation of this current map resulted in a few relatively minor revisions to Fisher's contacts.

Regional Piedmont mapping (e.g., Southworth and others, 2002) indicates that the Westminster terrane consists of polymetamorphic rocks that occur in fault-bounded packages, or assemblages. Each package contains a variety of lithologies that are often similar from one package to another but lithologies vary in their relative proportions in different packages.

In the New Windsor quadrangle the lithologies can be grouped into two distinct assemblages of greenschist-facies metamorphic rocks: one consisting mainly of metasedimentary rocks, the other containing a considerable amount of metavolcanic rocks and marble along with metasedimentary rocks.

The mainly metasedimentary assemblage consists predominantly of phyllites and schists, with subordinate metalimestone and metabasalt and minor amounts of quartzite. The Marburg Formation and Prettyboy Schist constitute this assemblage in the map area. These rocks are thought to represent original sedimentary accumulations in offshore, deep-water depositional environments.

The metavolcanic and metasedimentary assemblage includes metabasalt of the Sams Creek Formation as well as phyllites, limestone, quartzite, and large to small bodies of Wakefield Marble. The metabasalts represent ocean floor deposits and possibly the remains of volcanic islands or seamounts built on oceanic crust (Smith and Barnes, 1994; Southworth, 1996). The associated marble appears to represent shallow-water carbonates that formed in proximity to volcanic islands or seamounts.

The ages of these two rock sequences have not been determined, but estimates range from as old as Late Proterozoic and Cambrian to as young as Early Ordovician. Southworth and others (2002) depict all metamorphic rocks of the Westminster terrane to have been deposited during the Late Proterozoic to Early Cambrian. These deposits were subsequently subjected to several phases of deformation and metamorphism during the Paleozoic

The Westminster terrane lies unconformably beneath the Late Triassic New Oxford Formation in the northwest corner of the quadrangle. It is also intruded with subparallel north-striking diabase dikes of Jurassic age. Surficial deposits of Quaternary alluvium are found along modern streams.

STRUCTURE

Summary

Bedrock units of the Westminster terrane have a complex structural and metamorphic history. Regionally the Westminster terrane is characterized by polydeformed and polymetamorphosed rocks in a system of imbricate thrust sheets (e.g., Southworth, 1996, 1998, 1999; Southworth and others, 2002.)

In the New Windsor quadrangle, the metavolcanic and metasedimentary rocks of the Sams Creek Formation and the associated Wakefield Marble appear to be structurally separate from the areas underlain by the Marburg Formation and Prettyboy Schist. The precise structural disposition of these units is unclear, but may be a fault contact (Edwards, 1993a and 1993b; Southworth and others, 2002). This stands in clear contrast to mapping by Fisher (1978), who recognized fewer faults in the area. High-angle faults of the Cranberry fault system, interpreted to be compressional in nature, cut through the metasedimentary assemblage (Marburg Formation and Prettyboy Schist) and appear to separate this assemblage from the metavolcanic-metasedimentary assemblage (Sams Creek Formation). Southworth (1998; 1999) and Southworth and others (2002) indicate that the contact between the Marburg and Sams Creek Formations is a thrust fault.

Triassic rocks of the New Oxford Formation, in the northwest corner of the map, represent part of the Gettysburg Basin. It is widely accepted that early Mesozoic continental rifting formed the Gettysburg Basin. This basin was originally connected to a second basin, the Culpeper Basin, and together they formed a large down-faulted basin that filled with sediments eroding from Blue Ridge and Piedmont highlands (Southworth and others, 2002).

Folds

Fisher (1978) provided a detailed discussion of fold history in the New Windsor quadrangle. The current map has not altered Fisher's (1978) interpretation of fold history. Therefore, a summary of his interpretations is provided below; refer to Fisher's 1978 map for full discussion and details.

Fisher (1978) recognized three major generations of folding in the New Windsor quadrangle. These are, from oldest to youngest, the Wakefield Valley folds (W), the Marston folds (M), and the Jasontown folds (J). These folds are identified both on Fisher's (1978) map and on the current geologic map by the letters W, M, and J, respectively, on the fold axes. There are some folds that are of uncertain age and are unmarked on the map.

Fisher indicated that the earliest generation of folds, the Wakefield Valley folds, appear closest the original form along the axis of the Marston synform where the effects of the subsequent deformation is minimized. Cross section A-A" on this map follows that of Fisher (1978) and is a two-part (offset) cross section following the Marston synform.

Wakefield folds were deformed by the Marston generation of deformation. Marston generation folds generally have north-northeast trending axial planes and are associated with cleavage that trends parallel to the fold axial planes. Subsequently, the Jasontown generation of folding produced several steeply dipping, northeast trending kink zones that offset strike lines of the Marston cleavage.

In addition to the principal fold generations, there may have been one or more other generations of deformation based on complex crenulation cleavages and associated crinkles and minor folds visible in many outcrops. These features do not appear to discernibly affect the map pattern and, because the time relationships are far from clear, Fisher did not divide them into named fold generations.

Faults

Fisher (1978) recognized at least two generations of steeply dipping faults in the New Windsor quadrangle. Those offsetting the Triassic rocks are presumably normal faults associated with continental rifting that formed the Gettysburg Basin during the Mesozoic. A much earlier set of faults appears to have been folded by the Marston cleavage. Fisher's cross sections indicated the "early faults" dip to the southeast. Although Fisher showed this earlier set as normal faults, he admitted that the relative sense of motion was uncertain and that they could be reverse faults. Based on regional mapping and related revisions to the structural-tectonic framework (e.g., Edwards, written communication, 1997; Southworth and others, 2002), the current map shows Fisher's "early faults" as reverse faults, steeply dipping to the southeast. Presumably these early faults resulted from compressional forces associated with orogenic events during the Paleozoic.

Mapping in the surrounding quadrangles by Edwards (1993a, 1993b, 1994, 1996) identified a series of additional subparallel faults, which he collectively called the Cranberry fault system. Although he initially interpreted these as east-verging, high-angle reverse faults, he later considered them to be west-verging, high-angle reverse faults (Edwards, written communication, 1997). Each fault is actually a narrow band, or zone, of closely spaced, parallel or en echelon faults. In places, some of the faults show a component of strike slip movement. Dips range from nearly vertical to steeply southeast.

Although not mapped by Fisher (1978), two of those faults – the Cranberry fault and the Avondale fault – trend at approximately N30°E as they cross the southeastern part of the New Windsor quadrangle. The Avondale fault appears to form the boundary for the revised packaging of the lithologic units in the map area, separating the Sams Creek Formation-Wakefield Marble on the west (footwall) from the Marburg Formation on the east side (hanging wall).

Regionally, the traces of the Avondale and Cranberry faults are relatively straight and do not appear to be strongly affected by folding. Therefore, the Cranberry fault system appears to postdate Fisher's "early faults." Edwards (1993b) suggested that the Avondale and Cranberry faults are likely to represent a final phase of Paleozoic deformation, presumably the Alleghenian orogeny. He speculated that faulting could be contemporaneous with Marston folding, given prominent crenulation cleavage that parallels these faults in the Westminster quadrangle (just east of New Windsor).

STRATIGRAPHY AND CORRELATION

The reinterpretation of the structural-lithologic framework of the area produces two fault-bounded assemblages in the map area: the Prettyboy Schist-Marburg Formation to the east and the Sams Creek Formation-Wakefield Marble to the west. Stratigraphic interpretation and correlation of rock units are hampered by poor exposure and structural complexity, as well as by the lack of fossils and absolute dates. Most primary sedimentary and volcanic structures in the rock units have been obscured or obliterated by folding, foliation, and recrystallization. To a large extent, early-formed structures and foliation have been destroyed or modified by later episodes of tectonism.

Several of Fisher's (1978) rock units have been reassigned to other formations in the current map. In general, the Wissahickon albite phyllite of Fisher (1978) is now mapped as the Prettyboy Schist east of the Avondale Fault. Recent field reconnaissance shows that phyllites formerly assigned to Wissahickon by Fisher (1978) are more schistose than phyllitic. Fisher's Ijamsville phyllites west of the Avondale fault are now mapped as phyllite members of the Sams Creek Formation and east of the Avondale fault as phyllites of the Marburg Formation and Prettyboy Schist. Fisher's Silver Run Limestone has been reassigned to the Sams Creek Formation in the current interpretation. The relatively small bodies of metabasalt east of the Avondale fault, which were formerly identified as Sams Creek greenstone, are now mapped as part of the Marburg and Prettyboy Formations. It is possible that these small bodies of metabasalt may be detached and isolated remnants of Sams Creek metabasalt or its equivalent. Stratigraphic continuity, however, cannot be established. On this map, the Sams Creek Formation is absent east of the Avondale fault, presumably as a result of erosion following tectonic deformation and faulting.

The Sams Creek Formation as shown of this map now includes lithologies of metabasalt, phyllites, quartzite, limestone and marbles. With the reassignment of much of Fisher's (1978) Ijamsville phyllite west of Avondale fault into the revised Sams Creek Formation, metabasalt is no longer the dominant lithology, in terms of outcrop area, in the Sams Creek Formation in the New Windsor quadrangle. However, the formation still contains considerable amounts of metabasalt, more than any of the other formations on the current map.

The age of the Sams Creek Formation remains a matter of some speculation. Edwards (1993b) considered it the oldest unit in the area. Southworth and others (2002), however, suggest that the Sams Creek Formation may stratigraphically overlie – and therefore be younger than – the Marburg Formation in this part of the Piedmont.

Fisher (1978) considered the Sams Creek Formation to be Cambrian(?) or possibly young Ordovician(?) in age. Edwards (1984) equated the Sams Creek with the Late Proterozoic Catoctin Formation, and Southworth and others (2002) considered it to be Late Proterozoic(?) to Early Cambrian(?).

The Wakefield Marble is spatially associated with the Sams Creek Formation and is most clearly expressed by the fold belt and broad valleys in the central and southwestern parts of the map area. The Wakefield Marble has been considered younger than the Sams Creek Formation (e.g., Fisher, 1978), as a member within the Sams Creek (e.g., Edwards, 1986), or even older than the Sams Creek (e.g., Jonas and Stose, 1938). Due to the Wakefield Marble's axial position in the synforms and its being flanked by the Sams Creek metabasalt, the current map concurs with Fisher's interpretation and retains formation status for the Wakefield Marble, at least for the major outcrop areas associated with the fold belt that occurs in the map area.

The Silver Run Limestone and associated phyllite member are here included in the Sams Creek Formation. Fisher (1978) included it in the Ijamsville Phyllite, which is not recognized on the current map, and Edwards (1986) included it as a member of the Marburg Formation. As currently mapped, the Silver Run Limestone occurs at or near the top of the Sams Creek Formation. Fisher (1978) interpreted the alternating graded clastic carbonate beds and argillaceous material of the Silver Run as representing the periodic influx of carbonate debris (possibly turbidites or a polymictic slide mass) derived from a Cambrian and Ordovician carbonate shelf to the northwest into a shale basin. If so, the Silver Run probably represents the distal edge of an off-shelf carbonate wedge and associated slide masses represented by parts of the Frederick Formation, west of the New Windsor quadrangle (Brezinski, 2004).

The Marburg Formation is predominantly made up of various phyllites with minor quartzite and metabasalt (greenstone) in the map area. The original depositional environment of the Marburg Formation has been interpreted as offshore marine (deepwater-rise) (e.g., Kunk and others, 2004). Edwards (1984, 1986) proposed a Cambrian to Ordovician age for the Marburg, though others suggest ages ranging from possibly Late Proterozoic and/or Cambrian (e.g., Drake, 1994; Southworth 1998; Southworth and others 2002).

The stratigraphic relationship between the Marburg Formation and adjacent units is not fully defined. In the New Windsor quadrangle, the contact between the Marburg and the Sams Creek Formations is shown as a high-angle reverse fault (the Avondale fault). Southworth and others (2002) suggest that the Marburg may stratigraphically underlie the Sams Creek Formation and may structurally overlie the Prettyboy Schist in the vicinity. Due to similarities in lithology, however, previous authors have suggested that the Marburg Formation and Prettyboy Schist may have originally had a facies relationship, with the Marburg more proximal and Prettyboy Schist more distal (Drake, 1994; Howard, 1994).

The Prettyboy Schist is the uppermost unit in what was previously known as the Wissahickon Group, a name now abandoned in Maryland (Gates and others, 1991). The current map shows Prettyboy Schist where Fisher (1978) showed Wissahickon albite phyllite east of the Avondale fault. The Prettyboy consists mainly of uniform, fine-grained plagioclase-chlorite-muscovite-quartz schist, with euhedral albite porphyroblasts common. However, the Prettyboy, as shown on the current map, also contains boudins of phyllite, metabasalt, and quartzite. Crowley (1976), who named the Prettyboy Schist, assigned its age as Cambro-Ordovician(?). However, Drake (1994) revised the age to Late Proterozoic and Early Cambrian, a designation continued in later mapping (e.g., Southworth and others, 2002) and retained on the current map.

Explanation of Map Symbols

Geologic Symbols

Contacts

Geologic contact; approximately located dotted where concealed

Cross section line

Faults

Fault, dashed where inferred; dotted where concealed; relative motion shown
U Upthrown side
D Downthrown side

Major Folds in Bedding

Approximate trace of axial surface and direction of plunge. Dotted where concealed. WV indicates folds of Wakefield Valley generation; unmarked folds are of uncertain age.

WV Overturned anticline
WV Syncline
WV Overturned syncline

Major Folds in Cleavage

Approximate trace of axial surface and direction of plunge. Dotted where concealed. M indicates folds of Marston generation, classified in terms of the form of the Wakefield Valley cleavage. J indicates folds of the Jasontown generation, classified in terms of the form of the Marston cleavage. Unmarked folds are classified in terms of the form of the locally dominant cleavage, but are of uncertain age.

M J Antiform
M Overturned antiform
M J Synform
M Overturned synform

Lineations

Lineation at intersection of bedding and Marston cleavage; bearing and plunge shown

Lineation at intersection of Wakefield Valley and Marston cleavages; bearing and plunge shown

Planar Features

For a single measurement, the point of observation is at the midpoint of the symbol. For multiple measurements (combined symbols), the point of observation is at the tail-end junction point common to all symbols.

Bedding

Inclined bedding strike and degree of dip shown

Vertical bedding strike shown

Foliation

Strike and dip of early schistosity or foliation–Approximately parallel to axial planes of folds in bedding; mostly developed during Wakefield Valley folding

Inclined foliation in metamorphic rock strike and degree of dip shown

Vertical foliation in metamorphic rock strike shown

Cleavage

Strike and dip of crenulation cleavage or second schistosity–Approximately parallel to axial plane of folds in early schistosity; mostly produced during Marston folding

Inclined crenulation cleavage strike and degree of dip shown

Vertical crenulation cleavage strike shown

Strike and dip of late crenulation cleavage cutting earlier crenulation cleavages

Inclined cleavage strike and degree of dip shown

Horizontal cleavage strike and degree of dip shown

Base Map Symbols

Topography

Topographic index contour (100-ft interval)

Topographic intermediate contour (20-ft interval)

Hydrography

Stream

Water body (eg. lakes, ponds, rivers)

Supplemental Information
Use Constraints: These data represent the results of data collection/processing for a specific Department of Natural Resources, Maryland Geological Survey activity and indicate general existing conditions. As such, they are only valid for the intended use, content, time, and accuracy specifications. The user is responsible for the results of any application of the data for other than their intended purpose. The Maryland Geological Survery makes no warranty, expressed or implied, as to the use or appropriateness of the licensed data, and there are no warranties of merchantability or fitness for a particular purpose of use. The Maryland Geological Survey makes no representation to the accuracy or completeness of the data and may not be held liable for human error or defect. Data are only valid at 1:24,000 scale. Data should not be used at a scale greater than that.

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Original geologic field mapping conducted in 1967-1970 by G.W. Fisher, assisted by P. G. Robelen and Juergen Rhinehardt. Limited field reconnaissance conducted in 1996-2000 by Scott Southworth. Limited field reconnaissance conducted in 2003 and 2004 by J. P. Reger and D. K. Brezinski. Geologic map compiled in digital form and edited by Heather Quinn, Maryland Geological Survey and Brent Anderson and Catherine Luckhardt of Towson University, Center for Geographic Information Sciences.

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REFERENCES CITED

Brezinski, D.K., 2004, Stratigraphy of the Frederick Valley and its Relationship to Karst Development: Maryland Geological Survey Report of Investigations No. 75, 101 p.

Drake, A.A., Jr., 1994, The Soldiers Delight Ultramafite in the Maryland Piedmont, in Stratigraphic Notes, 1993: U.S. Geological Survey Bulletin 2076, A1-A14.

Edwards, Jonathan, Jr., 1986, Geologic map of the Union Bridge quadrangle, Carroll and Frederick Counties, Maryland: Maryland Geological Survey, scale 1:24,000.

_____, 1993a, Geologic map of the Manchester quadrangle, Carroll County, Maryland: Maryland Geological Survey, open-file map, scale 1:24,000.

_____, 1993b, Geologic map of the Westminster quadrangle, Carroll County, Maryland: Maryland Geological Survey, open-file map, scale 1:24,000.

_____, 1994, Geologic map of the Libertytown quadrangle, Carroll and Frederick Counties, Maryland: Maryland Geological Survey, open-file map, scale 1:24,000.

_____, 1996, Geologic map of the Winfield quadrangle, Carroll and Frederick Counties, Maryland: Maryland Geological Survey, open-file map, scale 1:24,000.

Fisher, G.W., 1978, Geologic map of the New Windsor quadrangle, Carroll County, Maryland: U.S. Geological Survey Miscellaneous Investigations Series, Map I-1037, 1 sheet, scale 1:24,000.

Gates, A.E., Muller, P.D., and Valentino, D.W., 1991, Terranes and tectonics of the Maryland and southeast Pennsylvania Piedmont, in Schultz, A., and Compton-Gooding, E., Geologic evolution of the eastern United States, Field trip guidebook, NE-SE Geological Society of America: Virginia Museum of Natural History, Guidebook 2, p. 1-27.

Higgins, M. W., 1973, Superimposition of folding in the northeastern Maryland Piedmont and its bearing on the history and tectonics of the central Appalachians: Am. Jour. Sci., v. 273-A, p. 150-195.
Howard, C.S., 1994, Structural and tectonic evolution of Late Proterozoic through Early Cambrian metasedimentary rocks, York County, Pennsylvania: Newark, University of Delaware, unpublished Ph.D. dissertation, 218 p.

Jonas, A.I. and Stose, G.W., 1938, New formation names used on the geologic map of Frederick County, Maryland: Washington Academy of Sciences Journal, v. 28, no. 8, p. 345-348

Kunk, M. J., Froelich, A. J., and Gottfried, D., 1992, Timing of emplacement of diabase dikes and sheets in the Culpeper basin and vicinity, Virginia and Maryland; 40Ar/39Ar age spectrum results from hornblende and K-feldspar in granophyres [abs]: Geological Society of America Abstracts with Programs, v. 24, no. 1, p.25.

REFERENCES CITED (continued)

Kunk, M.J., Wintsch, R.P., Southworth, C.S., Mulvey, B.K, Naeser, C.W., and Naeser, N.D., 2004, Multiple Paleozoic metamorphic histories, fabrics, and faulting in the Westminster and Potomac terranes, Central Appalachian Piedmont, Northern Virginia and Southern Maryland, in Southworth, Scott and Burton, William (eds.), Geology of the National Capital Region – Field Trip Guidebook, NE-SE Geological Society of America: U.S. Geological Survey Circular 1264, p. 163-188.

Muller, P.D., Candela, P.A., and Wylie, A.G., 1989, The Liberty Complex; Polygenetic melange in the central Maryland Piedmont, in Horton, J.W., Jr., and Rast, N., eds., Melanges and olistostromes of the U.S. Appalachians: Geological Society of America Special Paper 228, p. 113-134.

Rankin, D.W., Drake, A.A., and Ratcliffe, N.M., 1990, Geologic map of the U.S. Appalachians showing the Laurentian margin and the Taconic orogen, plate 2, in Hatcher, R.D., Jr., Thomas, W.A., and Viele, G.W., eds., The Appalachian-Ouachita orogen in the United States: Geological Society of America, The Geology of North America, Boulder, v. F-2, scale 1:2,000,000.

Smith, R.C., II, and Barnes, J.H., 1994, Geochemistry and geology of metabasalt in southeastern Pennsylvania and adjacent Maryland, in Faill, R.T., and Sevon, W.D., eds., Various aspects of Piedmont geology in Lancaster and Chester Counties, Pennsylvania: Guidebook, 59th Annual Field Conference of Pennsylvania Geologists, p. 45-71.

Southworth, Scott, 1996, The Martic fault in Maryland and its tectonic setting in the central Appalachians, in Brezinski, D.K. and Reger, J.P., Studies in Maryland Geology: Maryland Geological Survey Special Publication No. 3, p. 205-221.

_____, 1998, Geologic map of the Poolesville quadrangle, Frederick and Montgomery Counties, Maryland, and Loudoun County, Virginia: U.S. Geological Survey, Geologic Quadrangle Map GQ-1761, scale 1:24,000.

_____, 1999, Geologic map of the Urbana quadrangle, Frederick and Montgomery Counties, Maryland: U.S. Geological Survey, Geologic Quadrangle Map GQ-1768, scale 1:24,000.

Southworth, Scott, Brezinski, D.K., Drake, A.A., Burton, W.C., Orndorff, R.C., Froelich, A.J., Reddy, J.E., and Denenny, Danielle, 2002, Digital geologic map and database of the Frederick 30 x 60 minute quadrangle, Maryland, Virginia, and West Virginia: U.S. Geological Survey, Open-File Report OF-02-437, scale 1:100,000.

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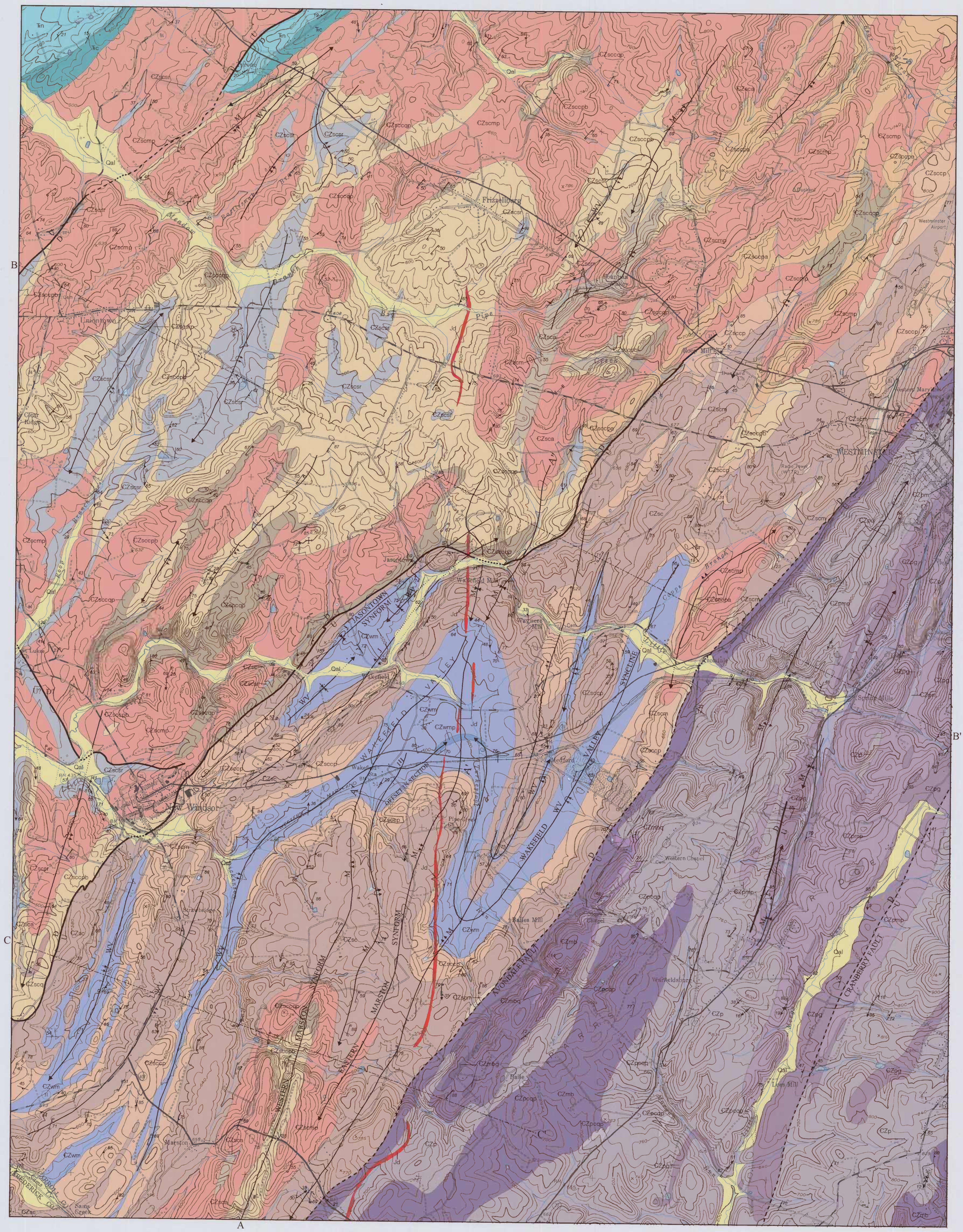
http://www.mgs.md.gov/



77°7'30"W 390000 392000 77°5'0"W 394000 396000 77°2'30"W 398000 400000 77°0'0"W

Base map from U.S. Geological Survey
7.5-minute Series (Topographic)
New Windsor, MD, 1977
1971 magnetic north declination (center of sheet): 7.5 degrees west
(To determine current magnetic declination see: http://www.ngdc.noaa.gov/cgi-bin/seg/gmag/fldsnth1.pl)

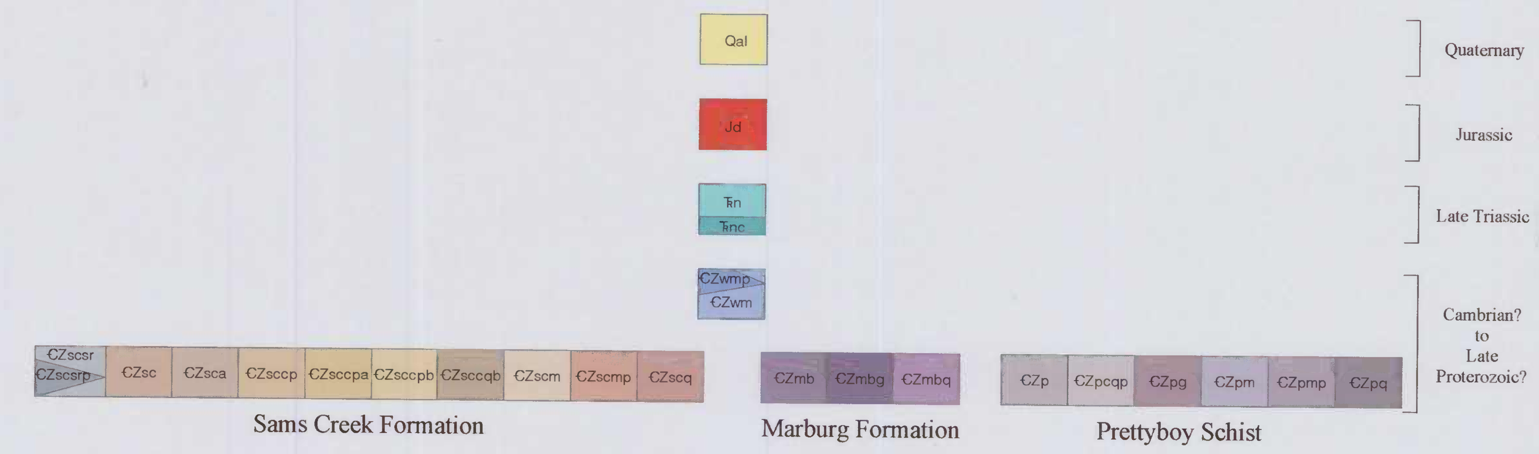
Hydrology layer shown is from USGS digital line graphs (DLGs) for this quadrangle
Topography and cultural/transportation layers from USGS stable-base film separates
(Topography from aerial photographs by stereophotogrammetric methods. Aerial photographs taken 1943.
Photorevised from aerial photographs taken 1971; not field checked (mainly culture and drainage changes).
Map photoinspected 1977; no major culture or drainage changes observed.)

Current map projection:
Maryland State Plane Coordinate System 1987
(Projection: Lambert Conformal Conic, 1980 geodetic reference system)
(Horizontal Datum: North American Datum 1983)

State Plane 2000-meter grid tics and coordinates shown in blue
Geographic coordinates (latitude-longitude) shown near corners and 2.5' intervals (in black)

Geologic Map of the New Windsor Quadrangle, Carroll County, Maryland

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

The geologic contacts on this map closely reflect original mapping of the New Windsor quadrangle by George Fisher (1978), but the current geologic interpretation involves significant changes in many of Fisher's formation assignments and how those geologic units are interrelated. Recent mapping in the region (e.g., Southworth, 1999; Southworth and others, 2002; and Kunk and others, 2004) has shown that the metamorphic rocks of the Westminster terrane occur in fault-bounded packages containing a variety of lithologies that are generally similar from one package to another. (See discussion under "Structural Geology.") Stratigraphic relationships are uncertain, and a structural packaging of the various lithologies, as is applied in this current map, offers a reasonable alternative based upon currently accepted interpretations.

As a result of this regional reinterpretation, some lithologic units that Fisher considered to be in different formations are now considered part of the same formation. In some areas, this resulted in several mapping units with the same or similar lithologies occurring within one formation. (For example, parts of chlorite phyllite units from three formations of Fisher are now considered part of the Sams Creek Formation west of the Avondale fault.)

Further study will be needed to determine whether these similar lithologies are distinct enough to be recognized. For the current map, the original lithologic mapping units of Fisher are retained and, as necessary, given a sequential letter for identification (for example, Sams Creek Formation chlorite phyllite, chlorite phyllite "a", and chlorite phyllite "b").

Quaternary

Qal **Quaternary**
Well to poorly stratified, unconsolidated, light brown sand and gravel, with minor silt and clay, underlie flood plains of many of the streams. Thickness mostly 1 to 2 m (3-6 feet) with bottoms of channels commonly on bedrock. The alluvium is Quaternary in age.

Jurassic

Jd **Jurassic dike(s)**
Massive to highly jointed, medium- to dark-gray, fine- to medium-grained diabase, weathering orange brown. Occurs in dikes marked by rows of large, rounded, residual diabase boulders in the soil. They may be more continuous than shown. The age of the dikes in central Maryland and northern Virginia was revised from Triassic to early Jurassic (Kunk and others, 1992).

GETTYSBURG BASIN

Late Triassic

Ꞧn / Ꞧnc **New Oxford Formation**
The characteristic lithology of the New Oxford Formation is a dark reddish brown siltstone, shale, and micaceous arkose, weathering to a thick, dark red soil. Bedding in the siltstone and shale ranges from fissile to finely laminated and includes intervals with abundant root casts. The arkose occurs in poorly defined beds 20 to 100 cm (8 to 40 inches) thick. Throughout the region, the siltstone-shale-arkose unit overlies a basal quartz-pebble conglomerate (Ꞧnc), which contains subangular to moderately rounded pebbles and cobbles of vein quartz up to 12 cm (5 inches) in diameter and scattered tabular pebbles of micaceous phyllite in a white to red coarse-grained arkosic matrix with interbedded coarse-grained, micaceous arkose. The top of the New Oxford is not exposed in the map area. Of a total thickness of about 250 m (820 feet), only 20 to 90 m (65 to 300 feet) is thought to occur in the New Windsor quadrangle.

WESTMINSTER TERRANE

Late Proterozoic to Cambrian?

ЄZwmp / ЄZwm **Wakefield Marble**
Massive to thickly bedded reddish, light gray, or white dolomite-calcite marble. The name Wakefield is here restricted to outcrops in the larger continuous fold belt of marble in the southwest part of the New Windsor and adjacent Union Bridge quadrangles, such as in the Wakefield Valley, where it is associated with a broad belt of the metabasalts of the Sams Creek Formation. (Smaller areas of marble outcrops occur within other lithologic units and are herein mapped simply as a marble within those other units.) At the interpreted base, the Wakefield marble is a reddish or buff interval that contains numerous chloritic partings and rare blocks of amygdaloidal metabasalt; stratigraphically higher, the marble is light gray to white and contains little chlorite. A silvery blue muscovite-chlorite phyllite (ЄZwmp) occupies an axial position in one part of the synformal structure near the center of the quadrangle. Its actual stratigraphic relationship to the marble is unclear, but is here placed at the top of the marble because of its location on a synclinal axis. This phyllite does not crop out, but is recognized only as weathered fragments in dark-brown clayey soil.

Sams Creek Formation

ЄZscsr / ЄZscsrp **Silver Run Limestone Member**
Light bluish gray to medium gray, thin- to medium-bedded, locally laminated argillaceous limestone with stratification up to 10 cm (4 inches) thick. Locally interbedded with tan muscovite-chlorite phyllite (ЄZscsrp). This phyllite does not crop out, occurring only as weathered chips in the clay residuum. Some of the thicker limestone beds grade upward from calcite at the base to argillaceous dolomite at the top. The limestone is poorly exposed, except along a few stream valleys; weathers rapidly to a moderately thick residuum.

ЄZsc **Metabasalt**
Schistose to massive metabasalt ("greenstone") interlayered with green to blue chlorite phyllite and minor gray hematite-muscovite phyllite. The metabasalt consists primarily of fine-grained chlorite, actinolite, albite, epidote, and quartz with minor sphene and magnetite. It commonly contains flattened and stretched blebs of chlorite and amygdules filled with concentric layers of chlorite, quartz, epidote, and ankerite. The amygdules are concentrated in zones of fragmental hematitic metabasalt 0.5 to 3 m (1.5 to 10 feet) thick, which Fisher (1978) interpreted as possibly being relict flow tops. Pods up to 20 cm (8 inches) long of metabasalt, largely replaced by epidote, locally give the rock a coarse, nodular appearance. Most of the rock has a schistose texture, but in places porphyritic basaltic texture is well preserved. Quartz-epidote veins 0.2 to 10 cm thick commonly parallel the main schistosity. This is the characteristic lithology of the Sams Creek Formation in its original designation. Corresponds to the Sams Creek greenstone (scgs) of Fisher

ЄZsccqp **Mica-chlorite-quartz phyllite**
Light-tan to light-grayish-green. The micas and chlorite are typically segregated into prominent pinstripe laminations spaced 1 to 3 cm (0.4 to 1.2 inches) apart and parallel to cleavage. Resistant to weathering; crops out extensively and commonly forms low ridges capped by a thin sandy soil. Corresponds to the Ijamsville mica-chlorite-quartz phyllite (ijqp) of Fisher (1978) that crops out west of the Avondale fault.

ЄZscm **Marble**
Typically light gray to white, massive dolomitic marble. Isolated or discontinuous pod-like lensoidal bodies of marble that crop out west of the Avondale fault and previously mapped as Wakefield Marble, but whose stratigraphic equivalency cannot be established. These marble bodies may or may not be at the same stratigraphic level as the main belt of Wakefield Marble in Wakefield Valley. Moderately well exposed in places; occupies topographic depressions and weathers to a thin red soil, locally covered by slope wash from adjacent hills. Three small areas of carbonate rock within a narrow belt of Sams Creek metabasalt (ЄZsca) at Fountain Valley, west of Westminster, were mapped as the Silver Run by Fisher (1978). However, two of the three areas contain quarries that expose light gray marble and not the gray limestone typical of the Silver Run. Therefore, these three areas were reassigned to the Wakefield Marble (Edwards, unpublished data, 1996), but are now shown as (ЄZscm). Corresponds to small areas of the Wakefield Marble (wm) or, as noted above, Silver Run limestone (srl) of Fisher (1978) west of the Avondale fault.

ЄZscmp **Muscovite phyllite**
Buff to light-olive-green quartz-muscovite phyllite with subordinate silvery gray quartz-paragonite-muscovite-chlorite phyllite and muscovite-quartz phyllite. Contains abundant limonite cubes, up to 2 cm (0.8 inch) across, that are pseudomorphs after pyrite. Hematite and tourmaline are common accessory minerals. Poorly exposed; weathers easily into a thick resistant saprolite containing abundant chips of phyllite. Underlies broad, gently sloping hills. Corresponds to the Ijamsville muscovite phyllite (ijmp) of Fisher (1978) that crops out west of the Avondale fault.

ЄZscq **Quartzite**
Thickly bedded tan to reddish quartzite. Contains relict detrital quartz grains up to 3 mm (0.1 inch) in diameter, rare clasts of microcline and albite, minor muscovite and feldspar, and traces of sphene, tourmaline, and epidote. Quartzite beds 15 to 60 cm (6 to 24 inches) thick are interbedded with muscovite and chlorite phyllites; also in massive, poorly bedded sequences up to 30 m (91 feet) thick. Very resistant to weathering. Corresponds to the Ijamsville quartzite (ijq) of Fisher (1978) that crops out west of the Avondale fault.

Late Proterozoic to Cambrian?

ЄZmb **Marburg Formation**
Buff to light-olive-green quartz-muscovite phyllite with subordinate silvery gray quartz-paragonite-muscovite-chlorite phyllite and muscovite-quartz phyllite. Contains abundant limonite cubes, up to 2 cm (0.8 inch) across, that are pseudomorphs after pyrite. Hematite and tourmaline are common accessory minerals. Very poorly exposed; weathers easily into a thick resistant saprolite containing abundant chips of phyllite. Underlies broad, gently sloping hills. Corresponds to select parts of the Ijamsville muscovite phyllite (ijmp) of Fisher (1978) that crop out east of the Avondale fault and in the southeastern corner of the map area.

ЄZmbg **Metabasalt**
Green to greenish blue chlorite phyllite with interlayered massive to schistose metabasalt ("greenstone"). Phyllite locally contains irregular, mottled patches of white mica and quartz, resembling amygdaloidal volcanic clasts; metabasalt locally contains relict amygdules filled with quartz, albite, epidote, and chlorite. Corresponds to parts of the Sams Creek metabasalt (scgs) of Fisher (1978) that are associated with phyllite now included in the Marburg Formation.

ЄZmbq **Quartzite**
Tan to reddish quartzite. Beds of quartzite 15 to 60 cm thick (6 to 24 inches) interbedded with muscovite and chlorite phyllites. Very resistant to weathering. Corresponds to the parts of the Ijamsville quartzite (ijq) of Fisher (1978) east of the Avondale fault that are associated with phyllite now included in the Marburg Formation.

ЄZp **Prettyboy Schist**
Greenish gray-tan to medium gray, fine-grained albite-chlorite-muscovite-quartz schist, containing euhedral albite porphyroblasts up to 1.5 mm (1/16 inch). Schist is the dominant lithology of the Prettyboy, but it also contains boudins of phyllite, metabasalt, and quartzite. Corresponds to the Wissahickon albite phyllite (wap) of Fisher (1978).

ЄZpcqp **Mica-chlorite-quartz phyllite**
Light-tan to light-grayish-green mica-chlorite-quartz phyllite.