State of Maryland
Department of Natural Resources
MARYLAND GEOLOGICAL SURVEY
Emery T. Cleaves, Director

GEOLOGIC MAP OF THE WESTMINSTER QUADRANGLE, CARROLL COUNTY, MARYLAND

by
Jonathan Edwards, Jr.
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QUATERNARY

EARLY CAMBRIAN TO EARLY ORDOVICIAN

LATE PRECAMBRIAN

EXPLANATION

Qal

ALLUVIUM

Gray-brown to light brown, poorly sorted, coarse to fine sand, silt, and clay with sporadic lenses of subrounded quartz cobble gravel. In places includes chips and cobbles of local bedrock. May be as much as 15 feet thick. In smaller tributary streams, alluvium has not been shown, but is present as a thin veneer overlying channeled bedrock.

unconformity

Rocks of the Linganore Nappe

mf

GILLIS GROUP
MARBURG FORMATION

Silvery gray-tan, pale olive-tan, and waxy, pale bluish-green quartz-chlorite-muscovite phyllite, locally with abundant limonite pseudomorphs after pyrite in cubic crystals up to 1/2 inch in size. Includes thin layers of quartzite and may also contain a few thin zones of poorly exposed, dark gray, calcareous muscovite phyllite and thin interbeds of bluish-gray schistose limestone. Thickness of the formation is not known as neither top nor base are present within the area mapped.

ggq / gg ggc / ggl

GILLIS GROUP (undivided)

Dark to light silvery-gray, tan, and greenish-gray quartz-chlorite-muscovite phyllite, some with thin interbeds of white to pale green or tan quartz silt. Zones of bluish-green muscovite-chlorite phyllite and reddish-purple to pale purplish-gray muscovite phyllite are also prominent. Limonite pseudomorphs after pyrite in cubic crystals up to 1/2 inch in size occur locally within the gray and tan phyllites. Sporadic thin quartzites and quartzitic phyllites are also present. Thickness of assemblage is unknown because the rocks have been thoroughly deformed by close folding and cleavage.

(order of listing does not imply stratigraphic order)

ggq — Medium gray, gray-tan, and brown, fine- to medium-grained quartzite composed of rounded grains of quartz up to 1/16 inch in size, and phyllitic quartzite with interlayered phyllite. Thickness ranges from approximately 3 feet to greater than 20 feet.

ggp — Light silvery-gray to very dark gray, fine-grained argillaceous and calcareous muscovite phyllite. Very poorly exposed. Thickness not known.

ggl — Medium bluish-gray to white, thin-bedded, phyllitic limestone. Occurs in small lenticular bodies with maximum thickness approximately 10 feet. Thin interbeds of dark gray muscovite phyllite. Poorly exposed.

unconformity

scf

SAMS CREEK FORMATION

Predominantly lustrous green, purple, and gray phyllite but also contains abundant dark green to gray-green, sheared, phyllitic metabasalt and a few isolated lenses of marble. Adjacent to the Cranberry Fault the formation has been recrystallized into a massive and dense chlorite-actinolite fels or schist containing crystals of chloritoid. Green phyllite contains chlorite and muscovite. Purple and gray phyllites are composed primarily of sericite and muscovite with small amounts of magnetite and hematite and locally may contain thin calcite laminae. Metabasalt consists primarily of chlorite and epidote and has been strongly sheared. Magnetite crystals up to 1/8 inch in size are commonly present. Unit has been thoroughly deformed by cleavage and small-scale folds; therefore the thickness cannot be determined.

scm — White to gray and reddish-purple calcite-dolomite marble. Occurs locally as lenses within the Sams Creek Formation. Thickness ranges from less than 1 foot to greater than 30 feet.

overthrust fault

Stratigraphic relation uncertain

ps

PRETTYBOY SCHIST

Greenish gray-tan to medium gray, fine-grained quartz-muscovite-chlorite schist. Commonly contains small porphyroblasts of albite up to 1/16 inch in size. Magnetite crystals up to 1/16 inch may also be present. In places schist contains many lenses and pods of milky-white vein quartz. Thickness of unit not known.

psq — Lenses of light gray to tan, thinly laminated to slabby, fine-grained, schistose, muscovite-bearing quartzite. Ranges up to 20 feet in thickness.

Stratigraphic relation uncertain

pg

PLEASANT GROVE FORMATION

Lustrous medium gray to green-gray, fine-grained chlorite-quartz-muscovite schist or phyllite with distinctive phacoidal parting, or "oyster-shell structure," resulting from an anastomosing phyllonitic foliation. In places, fine laminar interlayers of thin muscovite-quartz phyllite or quartzite impart a pinstriped appearance to the rock. Thin stringers and pods of milky quartz which represent sheared-out limbs and hinges of minor isoclinal folds are locally abundant. Thickness not known.

SYMBOLS

- Geologic contact — generally inferred or approximate
- Strike and dip of foliation
- Strike and dip of crenulation cleavage or slip cleavage
- Strike and dip of joints
- Plunge of minor fold axes: dextral rotation
- sinistral rotation
- horizontal fold axes
- Overthrust fault — teeth on upper plate
- High-angle reverse fault — bars on hanging wall

NOTES ON STRATIGRAPHY, STRUCTURE, AND CORRELATION

The geologic formations present in the Westminster Quadrangle are part of an extensive terrane of polydeformed sedimentary and volcanic rocks which constitutes the western Piedmont of Maryland. Stratigraphic interpretation and correlation of rock units are hampered by poor exposure and structural complexity, as well as by the lack of fossils. Most primary sedimentary and volcanic structures in the rock units have been obscured or obliterated by close folding, foliation, and recrystallization. To a large extent, early-formed structures and foliation have been destroyed or modified by later episodes of tectonism.

The bedrock structure of the Westminster Quadrangle consists for the most part of a large nappe, the Linganore Nappe, which contains rocks ranging in age from Late Precambrian through Early Ordovician. This nappe has been thrust westward upon the flank of the Dug Hill Anticline, only a small part of which is present in the northwest corner of the quadrangle. These structures and the attendant metamorphism of the rocks to greenschist grade, as well as the pervasive foliation, are presumably the result of Taconic deformation. Two high-angle reverse faults of probable Late Paleozoic age displace both the rocks of the nappe and the subjacent formations.

The Sams Creek Formation, the oldest unit in the Westminster Quadrangle, is the basal unit of the Linganore Nappe. West of the Avondale Fault the Sams Creek is preserved in small, synformal klippen in thrust contact with the Marburg Formation on the southeast flank of the Dug Hill Anticline. Between the Avondale and Cranberry Faults, rock units overridden by the nappe are not exposed. Within the nappe, the Sams Creek, overlain by phyllites of the Gillis Group, is exposed in the crests of antiformal folds and also along the late, high-angle reverse faults. East of the Cranberry Fault, the Sams Creek does not appear, but is believed to lie beneath the large expanse of Gillis Group phyllites. Along strike to the northeast in York County, Pennsylvania, thin belts of the Sams Creek occur within the Gillis Group, probably brought up along similar reverse faults southeast of and parallel to the Cranberry Fault.

Fisher (1978) considered the Sams Creek to be Cambrian(?) or possibly as young as Ordovician(?) in age. Edwards (1984) equated the Sams Creek with the Late Precambrian Catoctin Formation in the Blue Ridge Region.

The Gillis Group consists of an assemblage of phyllitic metasediments, from oldest to youngest, of the Urbana, Ijamsville, and Marburg Formations. These three units have been mapped separately in western Carroll and eastern Frederick Counties. Eastward across the western Piedmont, the Ijamsville gradually thins and loses its distinctive color and lithologic character, thus making it difficult to distinguish between the similar lithologies of the Urbana and Marburg. In addition, these units have been severely deformed by several generations of folding and cleavage development. In the Westminster Quadrangle east of the Avondale Fault, these three units have been mapped as the Gillis Group, undivided.

The Urbana Formation in Maryland is generally accepted as correlative with the Lower Cambrian(?) Harpers Formation in the Appalachian region to the west (Scotford, 1951; Thomas, 1952; Hopson, 1964). Some of the quartzites and conglomerates in the Urbana elsewhere in the Piedmont of Maryland may be equivalent to the Lower Cambrian Weverton Formation in the Blue Ridge region, or the Chickies Formation in the Pennsylvania Piedmont. Schwab (1971) depicts the depositional environment of the shale-siltstone turbidite facies of the Harpers Formation in the Blue Ridge of central Virginia as a deep-water marine basin marginal to the continent.

The Ijamsville Formation overlies the Urbana Formation in the Sugarloaf Anticlinorium in southeastern Frederick County and correlates with the upper part of the Harpers Formation and the overlying Antietam Formation of the Appalachian region (Edwards, 1986). The purple, green, and tan phyllities and associated quartzites and sandy beds of the Ijamsville represent sediment derived from the erosion of weathered and oxidized surficial materials of the Early Paleozoic North American continent which were transported into the offshore deep-water marine basin during the Early Cambrian marine transgression (Edwards, 1986) and deposited as marine redbeds (Ziegler and McKerrow, 1975).

The Marburg Formation is a marine shale-siltstone sequence very similar in lithology to the Urbana Formation, which indicates a similar depositional environment in an offshore marine basin. Edwards (1984, 1986) proposed a Cambro-Ordovician age for the Marburg based on the lithologic similarity of some of its calcareous members, the Silver Run Limestone in particular, to the Frederick Formation in Maryland and to the Conestoga Formation in southeastern Pennsylvania. The Frederick bears a Late Cambrian fauna (Jonas and Stose, 1936; Stose and Stose, 1946; Rasetti, 1959; 1961; Reinhardt, 1974), and the Conestoga has been assigned an age range from Middle(?) Cambrian to Early Ordovician(?) based on tentative identification of fossils near York and from the eastern Chester Valley near Norristown (Stose and Jonas, 1939; Stose and Stose, 1944; Gohn, 1978).

In the New Windsor Quadrangle, Fisher (1978) mapped the phyllite lithology that here has been called Marburg as the Ijamsville Formation and correlated it with the Lower Cambrian Harpers Formation in the Appalachian region to the west. To the east, these rocks were correlated with the western or upper pelitic schist facies of the Wissahickon Formation (Fisher, 1978; Fisher, Higgins, and Zietz, 1979).

The Gillis Group, therefore, includes units that range in age from Early Cambrian through Early Ordovician. It is possible that some of the phyllites are of Late Precambrian age.

The stratigraphic and age relations of the Prettyboy Schist to the Gillis Group are uncertain. In contrast to the phyllitic rocks of the Gillis, the Prettyboy is a fine-grained schist, which implies a higher degree of metamorphism and/or a greater degree of susceptibility to recrystallization. The transition from one formation to the other is gradational across an interval of several hundreds of feet (hundreds of meters), and late, high-angle cleavage has all but destroyed earlier foliation and original bedding. Muller (1991) considers the Gillis to be younger than the the Prettyboy, although no volcanic rock unit equivalent to the Sams Creek Formation occurs between these two units at what would be the base of the Gillis. The Prettyboy may be a deep-water marine deposit upon which younger distal continental margin deposits of the Gillis were prograded. Other possibilities are that the Prettyboy may be a coeval easterly facies of the Gillis, or that it is younger than the Gillis and represents fine-grained, distal materials derived from an easterly source and heralding the approach of the accretionary melange of the Liberty Complex. In the vicinity of Holtwood Dam on both sides of the Susquehanna River in York and Lancaster Counties, Pennsylvania, sporadic small exposures of greenstone metabasalt occur within schists and phyllites which are probable equivalents to the Prettyboy (Robert C. Smith, II, written communication, 1989); Valentino, 1990). Similar metabasalts occur in the Peters Creek Formation in the extreme northwestern corner of Cecil County, Maryland (Gates and others, 1991).

Although the most distinguishing feature of the Pleasant Grove Formation is its prominent tectonic fabric, or "oystershell structure," the quartzose and phyllitic lithologies of the unit are distinct from both the coarser-grained and more schistose rocks of the Prettyboy Schist to the west and from rocks of the accretionary prism/subduction melange of the Liberty Complex to the east (Muller, 1991; Muller and Edwards, 1985; Muller and others, 1989). The tectonic fabric of the Pleasant Grove was produced by probable Late Paleozoic dextral strike-slip shear (Krol and Onasch, 1990). The Peters Creek Formation in northeastern Maryland and southeastern Pennsylvania is described as a proximal turbidite marginal to the Late Proterozoic-Early Cambrian North American continent and probably originated as a Late Proterozoic rift-basin deposit (Gates and others, 1991). It appears to be lithologically similar to the Pleasant Grove Formation but does not have the penetrative tectonic fabric of the Pleasant Grove.

The Linganore Nappe, which contains the basal Sams Creek Formation and the overlying phyllites of the Gillis Group, was thrust westward over the Urbana, Ijamsville, and Marburg Formations (Gillis Group equivalents) during the Late Ordovician Taconic Orogeny. The earliest foliation, parallel to layering, was produced during this deformation. Throughout its extent across the western Piedmont of Maryland, the base of the nappe, the Linganore Overthrust, is in contact with different units of the Gillis Group in the underlying terrane (Edwards, 1984). This suggests that these rocks must have been folded at an early stage in the Taconic deformation, prior to nappe emplacement. The presence of a number of klippen, fensters, and re-entrants along the trace of the Linganore Overthrust in western Carroll and eastern Frederick Counties indicates that these rocks were also folded subsequent to emplacement of the nappe. The pervasive, east-dipping regional foliation produced during this later stage of deformation has all but erased the early, nappe-related foliation. Fisher (1978) also described two generations of foliation in the central Piedmont of Carroll County.

The Avondale and Cranberry Faults are west-dipping, high-angle reverse faults, or backthrusts, which cut the Linganore Nappe and probably represent the final phase of Paleozoic deformation in the area. Parallel to these faults and related to their formation is a prominent crenulation cleavage, or slip cleavage that cuts across and folds all older foliations and cleavages. This may be the Marsten generation of cleavage described by Fisher (1978). The pronounced northeast-southwest grain to the topography developed on the Gillis Group terrane east of and parallel to the Cranberry Fault in the northern part of the Westminster Quadrangle may be due to additional unrecognized high-angle backthrusts. One such fault may be responsible for the re-entrant in the contact between the Prettyboy Formation and Gillis Group along the East Branch of the Patapsco River in the eastern part of the quadrangle.

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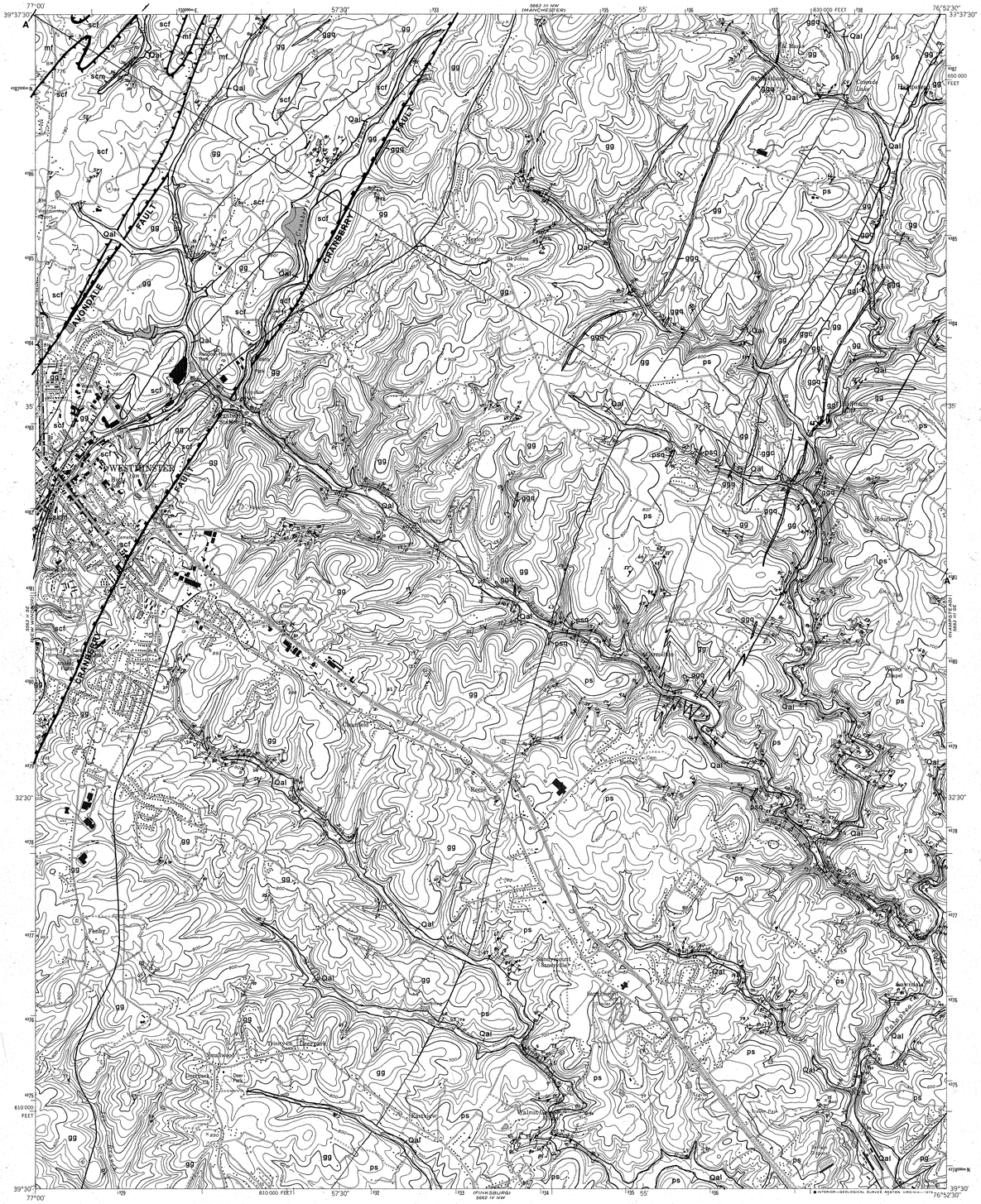
Westminster Quadrangle, geologic map



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2300 St. Paul Street
Baltimore, MD 21218-5210

GEOLOGIC CROSS SECTION

Horizontal scale same as map scale, no vertical exaggeration
Alluvial deposits not shown