EXPLANATION

UNCONSOLIDATED STRATA

QUATERNARY

Qa

Alluvium

Interbedded, variably sorted, light grey to brown gravel, sand, silt, and grey-blue to grey-brown clay. Confined to floodplains of perennial streams and discontinuous areas along ephemeral upland streams. Thickness 1-5 meters, not mapped where estimated less than 1 meter. Sediment size and mineralogy reflect adjacent country rock and geomorphic setting. Gravel composition is dominantly vein quartz with lesser amounts of quartzite, gneiss, schist, amphibolite, and ultramafic rock. Sands and silts are dominantly quartz-mica with variable amounts of metamorphic alumino-silicates (garnet, staurolite, kyanite, feldspar, tourmaline) and iron-titanium oxides (magnetite, ilmenite). Clays are predominantly kaolinitic.

Qrs

Bouldery rock slide deposits along the steep slopes of the Gunpowder Falls valley.

Overprint: Areas of detached blocks of bedrock; susceptible to slumping or sliding types of mass movements.

Qt

Terrace deposits approximately 5-15 meters above present valley bottoms of Western Run and Piney Run. Thin (< 5 meters) clayey to sandy quartz gravel, which locally grades into coarse colluvium towards valley slopes.

unconformity

INTRUSIVE ROCKS

MESOZOIC

d

Diabase dike

Hard, massive, fine to medium-grained, dark grey to black pyroxene-plagioclase diabase. Location and trend of dikes inferred from accumulations of rounded, rusty-weathering diabase clasts and scattered low outcrops.

top of the crystalline stratigraphic section

pz

Prettyboy Schist (thickness indeterminate)

Fine to medium-grained plagioclase-chlorite-muscovite-quartz schist ± garnet with accessory epidote, magnetite and tourmaline. Plagioclase commonly occurs as millimeter-sized porphyroblasts. Limonitized pyrite cubes are present locally. Garnet is commonly chloritized. Minor intercalated epidote-chlorite-muscovite quartzite ± garnet and chlorite-epidote schist. Stringers and knots of milky quartz (limbs and hinges of sheared-out isoclinal minor folds) are abundant. Discordant quartz ± ilmenite veins scattered throughout. Medium-grained schists are sparkly green-grey and weather to shades of brown and green. Quartzite is greenish-grey and epidote-chlorite schist is medium green.

The contact between Prettyboy Schist and Pleasant Grove Formation is less gradational than contacts between other metaclastic units north of the Phoenix Nappe. It was mapped on the basis of the first occurrence of distinctly medium-grained mica schist containing millimeter-sized feldspar porphyroblasts occurring north of the belt of fine-grained, strongly tectonized mica schist and quartzite.

pg

Pleasant Grove Formation *
(estimated thickness 1500 - 2000 meters)

Fine-grained epidote-chlorite-muscovite-quartz schist ± biotite ± garnet with accessory plagioclase and magnetite interlayered on a millimeter- to decimeter-scale with fine-grained feldspathic mica-quartz schist and micaceous quartzite having the same basic mineralogy. Stringers and knots of milky quartz (limbs and hinges of sheared-out isoclinal minor folds) are pervasive. The schist possesses a distinctive phacoidal parting referred to informally as 'oyster-shell structure'. The more quartzofeldspathic lithologies, in contrast, commonly display a uniform pinstriped appearance. Schists are lustrous grey-green and weather to shades of greenish-brown. Quartzofeldspathic schist and quartzite are medium grey and weather tan to buff.

The distinctive 'oyster-shell structure' found in the Pleasant Grove Formation appears to be an expression of intense ductile shearing and possible phyllonitization. This shearing apparently was concentrated in the Pleasant Grove Formation although all of the metamorphic rocks in the area are tectonites which experienced significant ductile strain. Because metamorphic crystallization followed most of the shearing in the Pleasant Grove Formation annealed microtextures now predominate.

The contact between the Pleasant Grove and Piney Run Formations appears to be gradational and was mapped on the basis of the first occurrence of fine-grained schist exhibiting 'oyster-shell structure' north of the Baltimore Gneiss.

**includes lithologies described as Pleasant Grove Schist by Crowley (1976) and lithologies mapped as Prettyboy Schist by Crowley and others (1976).*

pr

Piney Run Formation
(estimated thickness 2000-2500 meters)

Fine to medium-grained porphyroblastic (garnet) biotite-muscovite schist ± chlorite (1) and minor graphitic biotite schist (2) interlayered with fine to medium-grained garnet-biotite and garnet-hornblende quartzofeldspathic schist (3) and epidote-biotite and epidote-hornblende quartzite (4). The calc-silicate quartzite and quartzofeldspathic schist occur as discontinuous layers averaging 3-8 centimeters in thickness. Biotite quartzites vary from several centimeters to approximately one meter in thickness and are gradational with biotite quartzofeldspathic schists. Veins, stringers, and irregular segregations of quartz ± ilmenite and quartz + feldspar ± mica ± ilmenite are scattered throughout. (1) is lustrous silver-grey to greenish-grey and weathers shades of rusty-grey and brown-grey, (2) is dark grey to black. (3) and (4) are medium grey and weather buff to tan.

a *Amphibolite. Lenses and/or layers of dark green, fine to medium-grained epidote amphibolite varying in thickness from 4 centimeters to 5 meters. The amphibolite lens at Whitehall, Maryland is rich in magnetite and is strongly sheared.*

um *Undifferentiated ultramafic and mafic rocks. Dark green to black to grey, medium to coarse-grained chlorite-amphibole fels and schist, chlorite-talc schist (blackwall), serpentinite, amphibolite, and uralitized gabbro. These lithologies occur in slices and lenses ranging in thickness from meters to several tens of meters and in length from several tens of meters to several kilometers.*

I interpret the Piney Run Formation to be a segment of a tectonic melange belt extending from at least as far south as Fairfax County, Virginia, northeast across Maryland to southern Pennsylvania. I consider bodies of ultramafic rock found in the Piney Run Formation to be exotic material tectonically incorporated into a metaclastic sequence (cf. interpretation of Crowley, 1976). Exposures of the Piney Run Formation along strike to the southwest reveal that the discontinuous lensoidal nature of many of the quartzitic lithologies result from tectonic dismemberment.

Although part, or all, of the metaclastic sequence above the Cockeysville Marble may be allochthonous, local field evidence of fault contacts is inconclusive and therefore, only normal geologic contacts are shown. The contact between the Piney Run and Loch Raven Formations appears to be gradational. The Piney Run Formation is mapped on the basis of the first occurrence of interlayered garnet-mica schist and hornblende-bearing quartzite north of the Phoenix Nappe.

Loch Raven Formation **
(estimated thickness 400-600 meters)

Medium to coarse-grained, porphyroblastic (garnet ± staurolite ± kyanite) biotite-muscovite schist containing accessory tourmaline, magnetite and graphite. Chlorite is present locally as a retrograde alteration product. The schist is interlayered on a scale of meters to tens of meters with medium-grained muscovite-biotite quartzofeldspathic schist containing accessory garnet and magnetite/ilmenite. The dominant feldspar in both lithologies is an intermediate plagioclase. Stringers and irregular segregations of quartz ± ilmenite and quartz + feldspar ± mica ± ilmenite are scattered throughout. The large inlier of Loch Raven passing through Butler, Maryland contains a discontinuous basal zone (not shown) of medium-grained microcline-bearing muscovite-biotite schist and quartzofeldspathic schist. The basal potassic schist and more common aluminous schist occur locally as thin infolded layers in the Cockeysville Marble outcrop belts in the Butler-Priceville-Verona area. The inlier of Loch Raven at Glencoe, Maryland is locally rich in centimeter-sized quartz and quartz + feldspar lumps which give the rock a metaconglomeratic appearance. North of the Phoenix Nappe thin intercalated garnet-biotite quartzite layers appear and increase in abundance as the contact with the Piney Run Formation is approached. Aluminous schists are medium grey and spangled, and weather to shades of rusty-grey and brown-grey. Quartzofeldspathic schists are light to medium and weather buff to tan.

(g-s) *Garnet-staurolite facies; garnet and staurolite common.*

(g-k) *Garnet-kyanite facies; garnet and kyanite common, staurolite rare.*

(g-k-s) *Garnet-kyanite-staurolite facies; garnet, kyanite, and staurolite common*

a *Amphibolite. A single 1-3 meter thick layer of dark green, fine to medium-grained garnet amphibolite and associated greenish-grey clinopyroxene-garnet-quartz rock southwest of Butler, Maryland.*

m *Marble. A single lens of tan-grey, medium-grained phlogopitic marble east of Butler, Maryland.*

ns *Poorly exposed and strongly weathered lens of talc schist north of Glencoe, Maryland.*

***includes quartzofeldspathic schists similar to those comprising the bulk of the Oella Formation of Crowley (1976), as well as aluminous schist of Crowley's (1976) Loch Raven Schist.*

Cockeysville Marble
(thickness indeterminate)

Medium to coarse-grained, layered to massive phlogopitic marble with minor intercalated calcareous phlogopite-diopside gneiss. Both dolomitic and calcitic marble are present, but were not differentiated in mapping. Common accessory minerals are quartz, pyrite, and muscovite. Centimeter- to meter-scale quartz-tremolite segregations are present locally. White to light grey when fresh; cream, tan and buff when weathered.

sz *Silicified zone. Reddish purple to tan to buff, very fine to fine-grained silica rock. Locally brecciated, but healed. Occurs as accumulations of clasts along the marble-Baltimore Gneiss contact east of Priceville, Maryland. Many samples have a honeycombed appearance which thin section evidence indicates is the result of dissolution of cryptocrystalline silica from millimeter-sized vugs. The rock appears to be a hydrothermal deposit related to brittle faulting along the contact.*

p *Pegmatite. Medium- to coarse-grained quartz-feldspar ± muscovite ± tourmaline pegmatite, locally with quartz-feldspar intergrowth. Light grey, tan-weathering. May be as young as Silurian.*

Setters Formation
(estimated thickness 3-300 meters)

s *Setters Formation undivided. Includes medium-grained biotite-muscovite-feldspar-quartz gneiss as well as potassic quartzite and aluminous schist.*

sq *Quartzite member. Medium-grained muscovite-microcline quartzite with accessory tourmaline containing subordinate feldspathic mica-quartz schist and muscovite quartzite and rare stretched quartz-pebble conglomerate. Layering is centimeter-to decimeter-scale and foliation surfaces in quartzites are quite planar. Quartzite is light grey to light greenish-grey and weathers light pinkish-grey to tan.*

sas *Aluminous schist member. Medium to coarse-grained porphyroblastic (garnet-staurolite) biotite-muscovite-quartz-feldspar schist ± kyanite with accessory tourmaline. The schist is medium grey and spangled and weathers buff to light brown. It is indistinguishable in hand specimen from garnet-staurolite grade aluminous schist of the Loch Raven Formation.*

Each lithology contains scattered veins, stringers and irregular segregations of quartz and quartz-feldspar ± mica. The contact between the Setters Formation and Baltimore Gneiss is structurally conformable despite a major stratigraphic unconformity. Setters lithologies adjacent to the contact are enriched in potassium feldspar and/or muscovite.

unconformity

PROTEROZOIC Z (?) — ORDOVICIAN

GLENARM SUPERGROUP

WISSAHICKON GROUP

pCb

Baltimore Gneiss
(thickness indeterminate)

Medium to coarse-grained, layered to streaked and augenitic biotite-microcline-quartz-plagioclase gneiss containing zones of interlayered hornblende-biotite-quartz-plagioclase gneiss ± garnet and amphibolite ± garnet. Locally, the layered gneiss grades into highly segregated migmatite consisting of quartz-feldspar ± biotite mobilizate and biotite-plagioclase ± hornblende ± garnet restite which display complex polyphase folding (e.g. along Piney Creek adjacent to I-83 and north-northwest of Glencoe along Gunpowder Falls). Discordant to concordant veins and segregations of quartz and pegmatite are widespread. Felsic varieties of gneiss range in color from white to light grey to pinkish-grey and weather to various shades of grey, brown, and pink. Mafic gneisses and amphibolites range from medium grey to dark greenish-black and weather to grey-green to rusty brown.

Overprint: Medium to coarse-grained muscovite-bearing cataclastic augen gneiss.

b *Brecciated gneiss. An isolated occurrence of very hard, light grey-green to pink, chloritized and silicified (healed) gneiss breccia and cataclasite near Glencoe.*

us *Poorly exposed and strongly weathered lens of medium-grained tremolite-actinolite schist north of Gough Church.*

g *Foliated granite. A concordant body of medium to coarse-grained, pink to tan foliated biotite-muscovite granite occurring along the Setters Formation - Baltimore Gneiss contact north-northwest of Glencoe, Maryland. May be early Paleozoic in age.*

22 inclined schistosity, gneissic and compositional layering

vertical schistosity, gneissic and compositional layering

8 tight to isoclinal fold axis lineation

15 mineral or rock lineation

geologic contact; approximated by distribution of rock exposures, float, and contrasts in soil composition and topography

high-angle brittle fault with uncertain movement sense; dotted where concealed, otherwise approximate

ductile fault or shear zone — relative width of zone indicated by wavy line boundaries

trace of anticlinal fold axis

trace of synclinal fold axis

trace of anticlinal synform

trace of synclinal antiform

Notes on Bedrock Stratigraphy

The bedrock underlying the Hereford quadrangle is part of an extensive terrane of multiply-deformed metamorphic rocks crossing central Maryland. Because of structural complexity, lack of fossils, and limited exposure the age and subsurface geometry of the sequence are only broadly constrained. Of the seven major metamorphic units described in the explanation only the Baltimore Gneiss, Setters Formation, and Cockeysville Marble are in reasonably certain stratigraphic order. Part, if not all, of the dominantly metaclastic sequence above the Cockeysville Marble may be allochthonous in view of recently proposed regional tectonic relationships (Brown and Pavlides, 1981; Drake and Morgan, 1981; Drake and Lyttle, 1981).

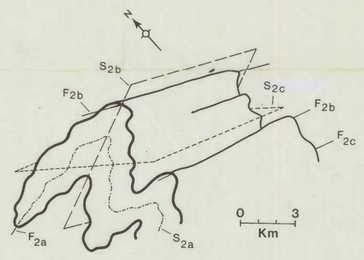
Estimated thicknesses of the various units were determined from outcrop width and average dip in areas of uniform dip direction. They do not represent true stratigraphic thicknesses because of complex folding and associated tectonic thinning, thickening, and transposition of layering.

Notes on Structure and Metamorphism

Metamorphic rocks of the Hereford quadrangle exhibit both mesoscopic and microscopic evidence of polyphase deformation and metamorphism (e.g. refolded folds, retrograde alteration). The dominant mesoscopic planar structure associated with the major early Paleozoic (Taconian-Acadian) ductile tectonism is a mica schistosity and transposed compositional layering. The gneissic layering in the Baltimore Gneiss, however, may be in part a relict feature formed during pre-Paleozoic (Grenvillian) deformation and metamorphism. The schematic diagram of macroscopic folding in the Hereford quadrangle illustrates the general geometric relationships between the various fold phases (F_{2a}, F_{2b}, F_{2c}) and associated planar structural elements (S_{2a}, S_{2b}, S_{2c}). Structural notation is from Muller and Chapin (1984).

All geologic contacts between metamorphic units are structurally conformable, i.e., foliations on both sides of a contact are subparallel. This does not, however, necessarily imply pre-metamorphic stratigraphic conformity between units. Radiometric age data (Tilton and others, 1970) strongly suggest the basal Glenarm Supergroup (Crowley, 1976) was deposited unconformably on the approximately 1.1 billion year old Baltimore Gneiss. The local absence of the Setters Formation along the Glenarm-Baltimore Gneiss contact is probably the result both of nondeposition and subsequent deformation. Unconformities and pre-metamorphic thrust faults may be present in the Glenarm units; however, if so, they too have been obscured by subsequent tectonism.

Scattered exposures of silicified breccias within or along the contacts of the Baltimore Gneiss are presumed to have formed during an episode(s) of post-metamorphic brittle faulting. Locally, this minor, high-angle faulting has resulted in the offset of geologic contacts. Both the faults and healed breccias have characteristics similar to those of Mesozoic structures elsewhere in the Appalachian Piedmont and therefore, are considered to be of Mesozoic (Triassic-Jurassic) age.



Schematic three-dimensional representation of macroscopic folding in the Hereford Quadrangle. Surface outlined by the solid line represents the contact between the Baltimore Gneiss and the Glenarm sequence. Modified from Moller (1979).

Axial surface of early F_{2a} nappe.

Representative axial surface of F_{2b} folding.

Representative axial surface of late F_{2c} folding.

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DEPARTMENT OF NATURAL RESOURCES
MARYLAND GEOLOGICAL SURVEY
Kenneth N. Weaver, Director

Copies of Map available from
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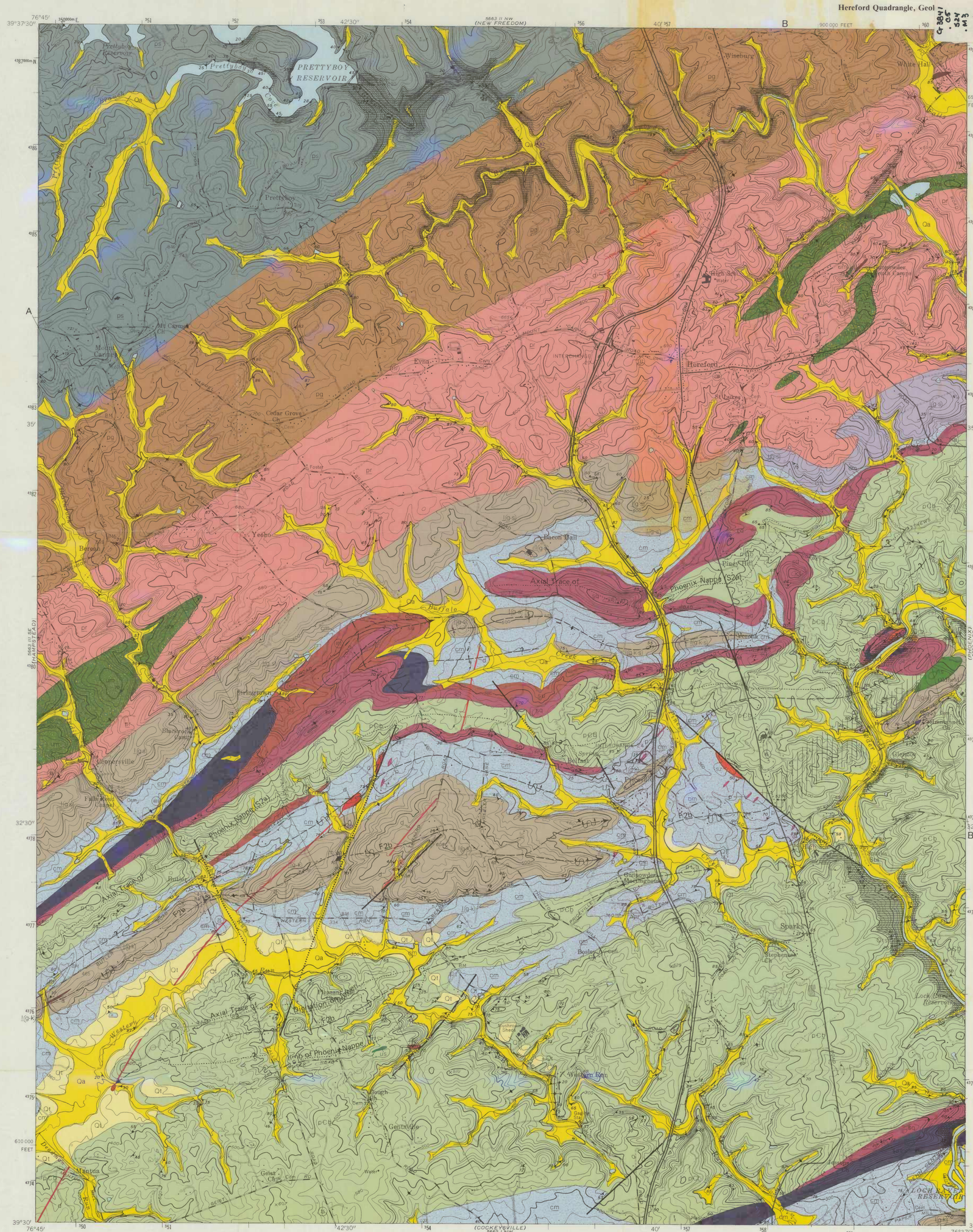
MAP COLLECTION



Base map from U.S. Geological Survey, 1958, (photorevised 1974) Hereford Quadrangle 7½ Minute Series

Field work conducted 1980-1982

Topography from aerial photographs by photogrammetric methods 1944. Aerial photographs taken 1943. Culture revised by the Geological Survey 1958. Photorevised 1974.

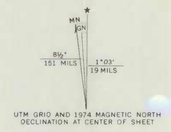
Williams & Heintz Map Corporation, Capitol Heights, Md. 20743

GEOLOGIC MAP OF THE HEREFORD QUADRANGLE, MARYLAND

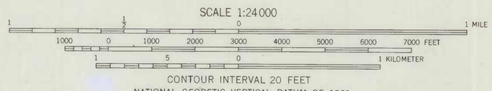
By

Peter D. Muller

1985

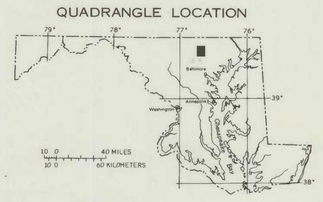


UTM GRID AND 1974 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET



CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

QUADRANGLE LOCATION



CROSS SECTION B-B'
Horizontal scale same as map scale, no vertical exaggeration

CROSS SECTION A-A'
Horizontal scale same as map scale, no vertical exaggeration