EXPLANATION

QUATERNARY

Qal — Alluvium
Thickness 1 to 5 meters
not mapped where estimated less than 1 meter

Interbedded, variably sorted, light-gray to brown gravel, sand, silt, and gray-blue to gray-brown clay. Confined to floodplains of perennial streams and discontinuous areas along ephemeral upland streams. Gravel composition is dominantly vein quartz with lesser amounts of quartzite, gneiss, schist, amphibolite, and ultramafic rock. Sands and silts are quartz-mica with variable amounts of metamorphic alumino-silicates (garnet, staurolite, kyanite, feldspar, tourmaline) and iron-titanium oxides (magnetite, ilmenite). Clays are predominantly kaolinitic. Sediment size and mineralogy reflect adjacent country rock and geomorphic setting.

Qt — Terrace deposits
Thickness generally less than 5 meters

Thin, clayey to sandy quartz gravel. Occurs along both sides of Western Run valley approximately 5 to 15 meters above present flood plain. Locally grades upslope into coarse colluvium.

unconformity

PROTEROZOIC Z TO ORDOVICIAN

gg — Gillis Group (undivided)
Thickness indeterminate.

Fine-grained, gray-green mica schist and silver-gray phyllite composed of variable amounts of muscovite, chlorite, quartz, epidote, and albite. Pyrite, altered to limonite in most exposures, and magnetite occur as accessories. Minor intercalated centimeter- to meter-thick quartzites, commonly with relict blue-gray detrital quartz granules and pebbles, are present locally. Top of unit not present in area mapped.

The contact between the Gillis Group and the Prettyboy Schist was mapped at the first appearance of gray phyllite interlayered with fine-grained mica schist northwest of distinct Prettyboy Schist.

ps — Prettyboy Schist
Estimated thickness 1,300 to 4,300 meters.

Fine- to medium-grained, green-gray magnetite-epidote-albite-chlorite-muscovite-quartz schist ± garnet ± biotite with accessory tourmaline, pyrite, apatite, and zircon. Albite commonly occurs as millimeter-sized porphyroblasts containing curved inclusion trails of opaques and epidote ± garnet. Minor intercalated greenish-gray to pale-tan epidote-chlorite-muscovite quartzite locally containing centimeter-sized quartz pebbles. Stringers, pods, and locally well-developed rods of milky quartz, representing the limbs and hinges of sheared-out isoclinal folds, are abundant. Schists weather to shades of brown and green. Quartzites weather tan to buff.

pg — Pleasant Grove Formation
Estimated thickness 1,500 to 2,000 meters.

Fine-grained, lustrous, gray-green magnetite-chlorite/biotite-muscovite-quartz schist ± plagioclase ± epidote with accessory tourmaline, apatite, and zircon, interlayered on a centimeter- to decimeter-scale with fine-grained, medium-gray quartzitic metagray-wacke and micaceous quartzite with the same basic mineralogy. Stringers and knots of milky quartz, representing the limbs and hinges of sheared-out isoclinal folds, are common. The schist possesses a distinctive phacoidal parting referred to as "oyster-shell structure," which is apparently the result of intense ductile shearing. In contrast, the metagraywackes and quartzites commonly display a uniform pinstriped appearance. Schist lithologies in the Pleasant Grove Formation weather to shades of greenish-brown, metagraywackes and quartzites weather tan to buff.

The contact between the Pleasant Grove Formation and the Prettyboy Schist is locally gradational and was mapped at the first occurrence of distinctly medium-grained mica schist with millimeter-sized plagioclase porphyroblasts northwest of the fine-grained, oyster-shell schist of the Pleasant Grove Formation. Note that the Pleasant Grove Formation is here considered to stratigraphically overlie the Prettyboy Schist, whereas, Muller (1985) originally placed the Pleasant Grove stratigraphically below the Prettyboy Schist.

The Pleasant Grove Formation as here mapped includes lithologies described as Pleasant Grove Schist by Crowley (1976) and some lithologies mapped as Prettyboy Schist by Crowley and others (1976).

LIBERTY COMPLEX

pr / um — Piney Run Formation
Thickness indeterminate; greater than 900 meters

Fine- to medium-grained, lustrous, silver-gray to greenish-gray garnet-biotite-muscovite-quartz schist ± chlorite ± plagioclase and accessory magnetite/ilmenite. Contains intercalated lenses and/or layers of light-greenish-gray to medium-gray garnet-biotite-hornblende-epidote quartzite ± plagioclase and of fine- to medium-grained epidote-biotite-plagioclase-quartz metagray-wacke ± garnet ± chlorite and accessory magnetite/ilmenite. Quartzite occurs in lenses 3 to 8 cm thick and metagraywacke occurs in layers 2 cm to 1 m thick with thin partings or intercalations of mica schist. In the southwestern part of the quadrangle, the metagraywacke locally contains lenses of pebbly metagraywacke 10 to 30 cm thick. Lenses and slabs of dark green amphibolite, 0.1 to 3 m thick, metamorphosed ultramafic rocks, 5 to 150 m thick, and small veins, stringers, and irregular segregations of milky quartz ± feldspar ± mica ± ilmenite occur throughout the outcrop belt. Schist lithologies weather to shades of rusty-gray and brown-gray, and metagraywacke weather to shades of brownish-grey or buff. Top of unit not present in area mapped.

um — *undifferentiated metamorphosed ultramafic and mafic rocks. Includes dark-green to black or gray, medium- to coarse-grained chlorite-amphibole fels and schist, chlorite-talc schist, serpentinite, and amphibolite.*

The Piney Run Formation is the strike equivalent of the Morgan Run Formation to the southwest, and hence is part of the allochthonous Liberty Complex (Muller and others, 1989). Therefore, the contacts of the Piney Run with the underlying Loch Raven and Pleasant Grove Formations are interpreted to be a pre- to early metamorphic thrust fault.

PHOENIX NAPPE

l — Loch Raven Formation
Estimated thickness 400 to 600 meters.

Medium- to coarse-grained, medium-gray biotite-muscovite schist ± plagioclase ± microcline with accessory magnetite/ilmenite, apatite, and tourmaline, and commonly containing porphyroblasts of garnet ± staurolite ± kyanite. Interlayered with zones of medium-grained, light- to medium-gray, magnetite/ilmenite-biotite-muscovite-plagioclase-quartz schist (Orlla Formation of Crowley, 1976). Chlorite is present locally as a retrograde alteration product. Scattered stringers and pods of milky quartz and quartz-feldspar ± mica ± ilmenite occur throughout the Loch Raven Formation. Pelitic schists are mica-spangled and weather to shades of rusty-gray and gray-brown. Psammitic schists weather tan to buff.

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

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

cm — Cockeysville Marble
Estimated thickness 150 to 400 meters.

Medium- to coarse-grained, layered to massive, white to light-gray 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, tremolite, and muscovite. Centimeter- to meter-scale quartz-tremolite segregations occur locally. Formation weathers tan to buff.

su — Setters Formation (undivided)
Estimated thickness 5 to 25 meters.

Medium-grained, light-gray to light-greenish-gray muscovite-microcline quartzite with accessory tourmaline and containing intercalated feldspathic mica-quartz schist. Overlain by medium- to coarse-grained, medium-gray, biotite-muscovite-feldspar-quartz schist, commonly with accessory tourmaline and porphyroblasts of garnet ± staurolite. The quartzite weathers buff to tan. The pelitic schist is mica-spangled, weathers to shades of brown and rusty-gray, and is indistinguishable from much of the Loch Raven pelitic schist.

The contact between the Setters Formation and the underlying Baltimore Gneiss is structurally concordant despite the fact that it is a major nonconformity.

unconformity

pCb — Baltimore Gneiss
Thickness indeterminate

Medium- to coarse-grained, light- to medium-gray, layered to streaked biotite-microcline-quartz-plagioclase gneiss and augen gneiss with accessory magnetite, allanite/epidote, sphene, apatite, and zircon. Microcline-quartz augen range up to 2 cm in length. Zones of medium-gray to dark-green hornblende-biotite-quartz-plagioclase gneiss ± garnet with intercalated garnet amphibolite also occur. Pegmatitic veins and segregations are common. Felsic gneisses weather to shades of brown, gray, and buff. Mafic gneisses and amphibolites weather gray-green to rusty-brown. Base of the unit is not present and only about 100 to 300 meters are exposed in the Phoenix nappe in this quadrangle.

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Notes on Stratigraphy, Structure, and Metamorphism

The bedrock of the Hampstead Quadrangle is part of an extensive terrane of polydeformed metamorphic rocks that underlies the Piedmont Province of central Maryland. Because of structural complexity, lack of fossils, and limited exposure, the age and subsurface geometry of this dominantly metaclastic sequence are poorly known. Thickness estimates have little stratigraphic value because of complex folding, faulting, and associated tectonic thinning, thickening, transposition of layering, and metamorphic recrystallization. Therefore, all bedrock thickness estimates are only very generalized structural thicknesses. Because the upper contact of the Gillis Group does not occur in the Hampstead Quadrangle, its thickness is given as indeterminate.

Of the eight crystalline rock units described in the explanation, only the Baltimore Gneiss, Setters Formation, Cockeysville Marble, and Loch Raven Formation are in well-established stratigraphic order. I interpret the Piney Run Formation to be equivalent to the Morgan Run Formation along strike to the southwest and, therefore, part of the allochthonous Liberty Complex (Muller and others, 1989). It occupies the core of a synform which appears to be coincident with the Sykesville syncline to the southwest (Muller, in press). The basal contact of the Piney Run with the underlying Loch Raven Formation to the southeast and with the underlying Pleasant Grove Formation to the northwest is a folded, pre- to early metamorphic thrust fault.

The Prettyboy Schist and the Gillis Group formerly have been mapped as part of the upper pelitic schist facies (Cleaves and others, 1968), or of the pelitic schist facies (Higgins and Fisher, 1971; Fisher and others, 1979) of the Wissahickon Formation. The Gillis Group, called Gillis Formation by Edwards (1986), is composed of lithologies equivalent to the Marburg, Ijamsville, and Urbana Formations in western Carroll and eastern Frederick counties.

The premetamorphic stratigraphic relationship of rock units northwest of and including the Pleasant Grove Formation to those to the southeast is still uncertain. Although the Pleasant Grove is shown as overlying the Prettyboy Schist on the southeastern limb of the Trenton antiform in cross-section A-A', I do not consider it to be a direct stratigraphic equivalent of the Gillis Group, which overlies the Prettyboy Schist on the northwest limb of the same antiform.

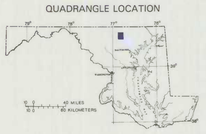
Muller and Edwards (1985) interpreted the Pleasant Grove Formation as lying along a major tectonic boundary, which they designated the Pleasant Grove Zone. Several major lithologic (Muller and others, 1989), structural, metamorphic, and igneous features of the Piedmont Province as a whole change across this zone in Maryland. Based on a variety of kinetic indicators, Krol and others (1990) have shown that the latest ductile shearing in the Pleasant Grove Zone was of a right-lateral, strike-slip nature. The strong deformation as evidenced by shear fabrics characteristic of the metapelites in this zone subsequently have been found locally in the underlying Prettyboy Schist. Therefore, the Pleasant Grove Zone is shown in cross-section A-A' as including Prettyboy Schist near the Pleasant Grove contact, and not as strictly coincident with the Pleasant Grove Formation.

All contacts between the major rock units are structurally concordant where observed, i.e., foliations on both sides of the contact are parallel. This does not necessarily imply premetamorphic stratigraphic conformity between the units, because strong and prolonged deformation may have either obscured or obliterated field evidence for initial discordance. Therefore, most contacts are shown on the map simply as undifferentiated geologic contacts. However, radiometric age data indicate a major nonconformity between the Baltimore Gneiss and the Setters Formation (Tilton and others, 1970).

The dominant planar structure in rocks of the Hampstead Quadrangle is a metamorphic foliation that ranges in type from a gneissosity through a schistosity to a phyllitic cleavage, and is commonly parallel to compositional layering. It formed during early Paleozoic (Taconian?) ductile deformation as a result of isoclinal folding and transposition of layering. The Phoenix nappe (Muller and Chapin, 1984) is an example of a map-scale, early isoclinal fold (F1). This dominant foliation has been deformed by open to isoclinal folds with gently northeast- and southwest-plunging axes. The Trenton antiform is a map-scale example of the widespread second fold phase (F2). Locally, a superimposed spaced cleavage resulting from F2 folding is well-developed. Right lateral shearing within the Pleasant Grove Zone occurred after F2 folding and appears to have utilized existing steep foliations and only locally generated shear bands.

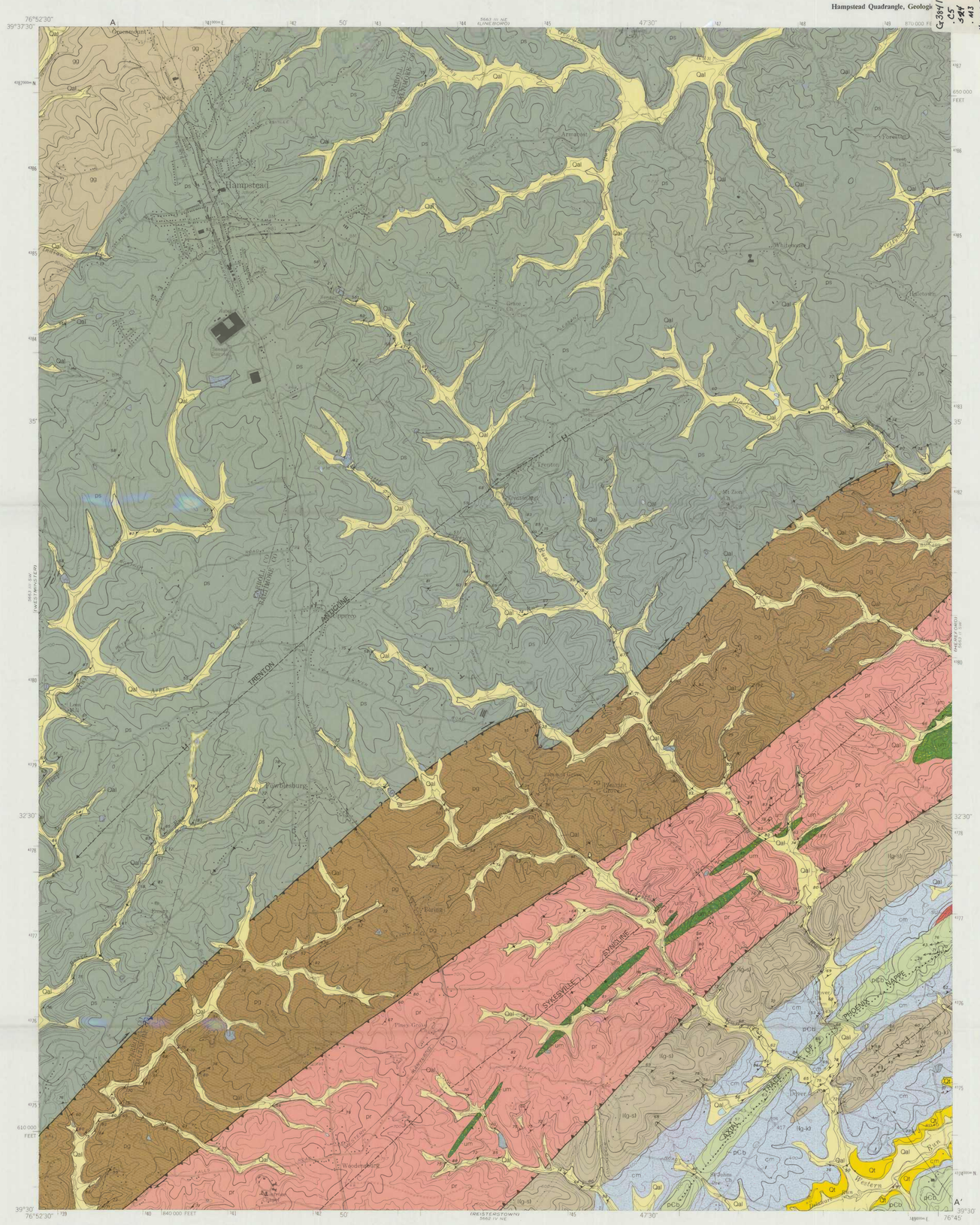
The grade of metamorphism in the Hampstead Quadrangle ranges from chlorite zone in the extreme northwest to garnet-kyanite-staurolite zone in the southeast. The grade increases fairly abruptly from greenschist facies to amphibolite facies across the Pleasant Grove Formation from northwest to southeast, again suggesting a possible tectonic boundary. The effects of retrograde metamorphism, such as the chloritization of garnet and biotite, are minor with the possible exception of the most intensely sheared parts of the Pleasant Grove zone. It is still uncertain whether or not the Pleasant Gove Formation was ever metamorphosed to conditions higher than chlorite-biotite zone.

QUADRANGLE LOCATION



GEOLOGIC SYMBOLS

- contact — generally approximate or inferred.
- 54 inclined / vertical — schistosity, foliation, or gneissic layering
- 85 inclined / vertical — spaced cleavage
- lineation — mineral lineation in the Piney Run Formation and units to southeast; quartz rodding in units to northwest
- 64 dextral rotation / 215 sinistral rotation / symmetrical — plunge of minor fold axes
- axial trace of F1 fold
- antiform / synform — axial trace of F2 fold
- axial trace of synclinal antiform (F2)
- thrust fault — teeth on upper plate — arrows indicate post-thrust right-lateral strike-slip shearing



Base map from U.S. Geological Survey
Hampstead Quadrangle, 7 1/2-minute series
1953 (photorevised 1974)

Field mapping done 1988-1989
Additional data from field notes of
W.P. Crowley, 1976-1977

GEOLOGIC MAP OF THE HAMPSTEAD QUADRANGLE, MARYLAND

by
Peter D. Muller
1991

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

Copies of map available from
Maryland Geological Survey
2300 St. Paul Street
Baltimore, MD 21218

UTM GRID AND 1974 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000
CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

GEOLOGIC CROSS SECTION

Horizontal scale same as map scale, no vertical exaggeration
Dashes represent trace of main folition
⊗ strike-slip movement away from viewer as seen in cross-section
⊙ strike-slip movement toward viewer as seen in cross-section