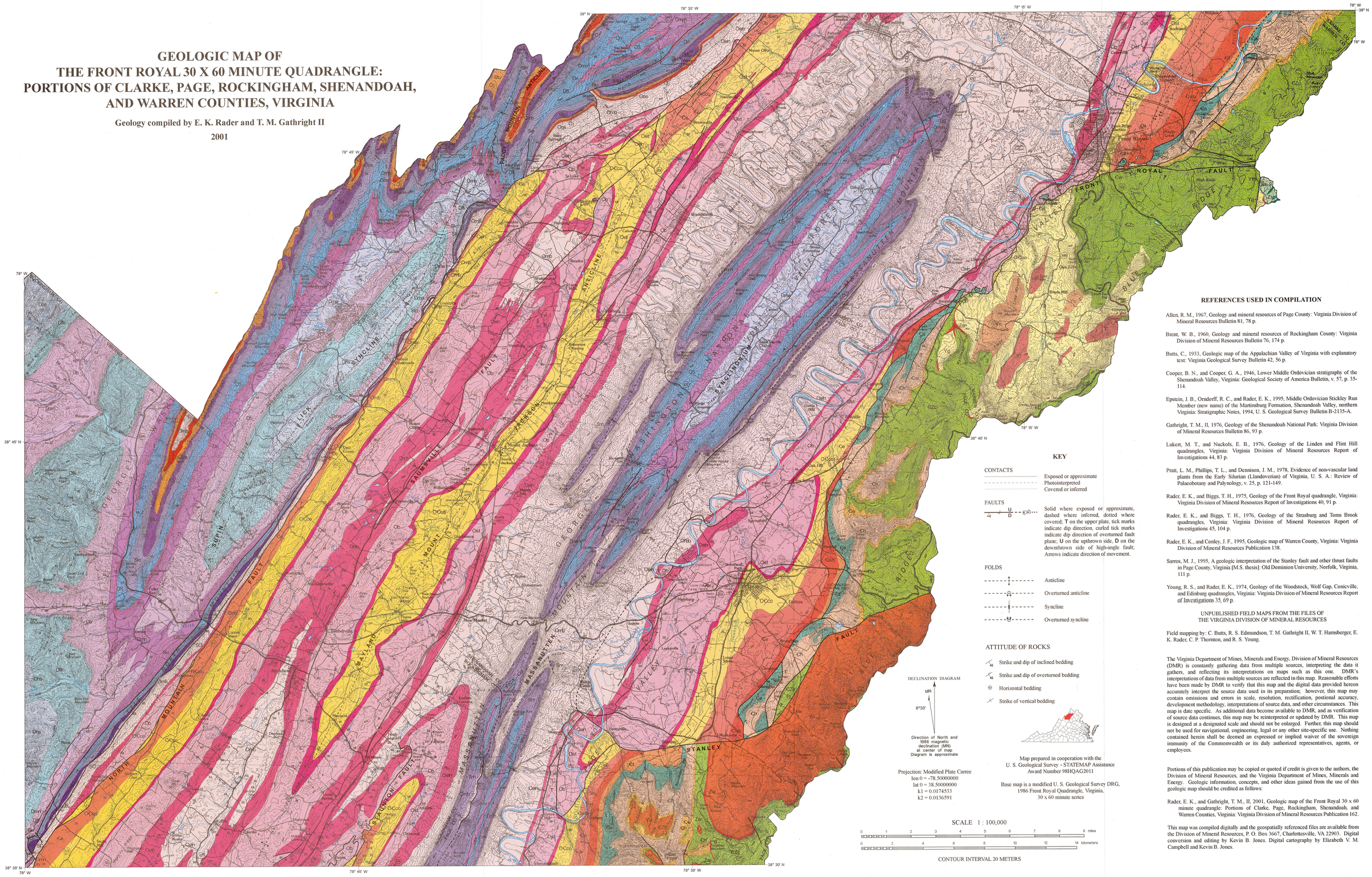
COMMONWEALTH OF VIRGINIA
DEPARTMENT OF MINES, MINERALS AND ENERGY
DIVISION OF MINERAL RESOURCES

PUBLICATION 162
GEOLOGIC MAP OF THE FRONT ROYAL 30 X 60 MINUTE
QUADRANGLE: PORTIONS OF CLARKE, PAGE, ROCKINGHAM,
SHENANDOAH, AND WARREN COUNTIES, VIRGINIA

GEOLOGIC MAP OF THE FRONT ROYAL 30 X 60 MINUTE QUADRANGLE: PORTIONS OF CLARKE, PAGE, ROCKINGHAM, SHENANDOAH, AND WARREN COUNTIES, VIRGINIA

Geology compiled by E. K. Rader and T. M. Gathright II

2001



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UNPUBLISHED FIELD MAPS FROM THE FILES OF
THE VIRGINIA DIVISION OF MINERAL RESOURCES

Field mapping by: C. Butts, R. S. Edmundson, T. M. Gathright II, W. T. Harnsberger, E. K. Rader, C. P. Thornton, and R. S. Young.

KEY

CONTACTS
- Exposed or approximate
- Photointerpreted
- Covered or inferred

FAULTS
- Solid where exposed or approximate, dashed where inferred, dotted where covered; T on the upper plate, tick marks indicate dip direction, curled tick marks indicate dip direction of overturned fault plane; **U** on the upthrown side, **D** on the downthrown side of high-angle fault; Arrows indicate direction of movement.

FOLDS
- Anticline
- Overturned anticline
- Syncline
- Overturned syncline

ATTITUDE OF ROCKS

- Strike and dip of inclined bedding
- Strike and dip of overturned bedding
- Horizontal bedding
- Strike of vertical bedding

DECLINATION DIAGRAM

MN
8°30'

Direction of North and 1986 magnetic declination (MN) at center of map. Diagram is approximate

Projection: Modified Plate Carree
lon 0 = -78.50000000
lat 0 = 38.50000000
k1 = 0.0174533
k2 = 0.0136591

SCALE 1 : 100,000

0 1 2 3 4 5 6 7 8 9 miles

0 2 4 6 8 10 12 14 kilometers

CONTOUR INTERVAL 20 METERS

Map prepared in cooperation with the
U. S. Geological Survey - STATEMAP Assistance
Award Number 98HQAG2011

Base map is a modified U. S. Geological Survey DRG, 1986 Front Royal Quadrangle, Virginia, 30 x 60 minute series

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This map was compiled digitally and the geospatially referenced files are available from the Division of Mineral Resources, P. O. Box 3667, Charlottesville, VA 22903. Digital conversion and editing by Kevin B. Jones. Digital cartography by Elizabeth V. M. Campbell and Kevin B. Jones.

EXPLANATION

INTRUSIVE ROCKS

Peridotite

p — Dark- to greenish-dark-gray peridotite composed of chlorite, phlogopite, hydrobiotite pseudomorphs after olivine and pyroxene with accessory garnet, rutile, and magnetite; secondary minerals include dolomite, ankerite, ilmenite, magnetite, epidote, quartz, serpentine, talc, calcite, and perovskite (Rader and Biggs, 1976). Intrusive in the Martinsburg Formation.

Diabase

d — Diabase, greenish-black, finely crystalline to aphanitic, composed of augite, labradorite with minor olivine and magnetite.

Metabasalt

g — Dark-grayish-green, aphanitic metabasalt composed of plagioclase, chlorite, and magnetite; hydrothermal alteration of country rock observed near Boyds Mill, Warren County.

Amphibolite

am — Amphibolite dikes composed of actinolite with or without plagioclase and accessory chlorite, epidote, and sphene (Lukert and Nuckols, 1976). Intrusive in Middle Proterozoic rocks in Warren County.

PALEOZOIC AND PROTEROZOIC ROCKS

Hampshire Formation

Dhs — Shale, mudstone, siltstone, and sandstone Shale, mudstone, and siltstone, dusky- to grayish-red, in part micaceous. Sandstone, medium- to brownish-gray, thin- to thick-bedded, cross-laminated, in part micaceous and feldspathic; no reported fossils. Basal contact placed above the youngest fossiliferous sandstone and shale of the Forelands Formation overlain by redbeds. Thickness approximately 2000 feet in Rockingham County; in Shenandoah County the preserved thickness ranges from 550 to 750 feet.

Forelands Formation

Dfk — Sandstone, siltstone, and minor shale, interbedded. Sandstone, brownish-gray, medium- to coarse-grained, medium- to thick-bedded, in part cross-laminated; conglomeratic beds common, sandstone most abundant in the upper part of the formation; many beds very fossiliferous. Siltstone, medium- to thick-bedded, dominant in lower part of unit. Shale, interbedded with sandstone and siltstone throughout section. Brownish-red shale common in upper half of section. Basal contact mapped at the base of fossiliferous sandstone underlain by micaceous shale and thin-bedded siltstone. Thickness approximately 2200 feet.

Brallier Formation

Db — Shale, siltstone, and minor sandstone, interbedded, dark-gray to greenish-gray, weathers light-brownish-gray; grain size increases upward in section; sandstone more abundant in upper part of section, thin- to medium-bedded; sparsely fossiliferous. Base of formation placed at the top of a thick sandstone unit of the underlying Mahantango Formation or black shale of the Millboro Shale. Thickness: 1000 to 1800 feet.

DEVONIAN

Mahantango Formation

Dma — Mudstone, sandstone, and shale Mudstone, dark- to olive-gray, hackly weathering, locally very fossiliferous, bedding obscure, spheroidal weathering common. Sandstone, medium-gray, fine-grained, medium- to very-thick-bedded, locally fossiliferous. Base gradational, mapped at the base of olive-gray beds overlying black, fissile shale. Near to southern end of Supin Lick Syncline the Mahantango cannot be mapped as a separate unit and its equivalents are included in the Millboro Shale. Thickness ranges from 0 to 1100 feet; in the Massanutten Synclinorium about 900 feet.

Marcellus Shale, Tioga Ash, and Needmore Formation, undivided

Dmrn — **Marcellus Shale:** shale, dark-gray to black, fissile, with interbeds of dark-gray argillaceous limestone or calcareous shale, locally very fossiliferous, thickness approximately 400 feet. **Tioga Ash:** alternating gray, silty shale and siltstone, brown, biotite-bearing, calcareous tuff, and fissile black shale. **Needmore Formation:** dark-greenish-gray, fossiliferous shale and calcareous mudstone with thin black shale at base; thickness: about 120 feet.

Millboro Shale, Tioga Ash, and Needmore Formation, undivided

Dmn — **Millboro Shale:** shale, dark-gray to black, fissile, with interbeds of dark-gray argillaceous limestone or calcareous shale, locally very fossiliferous, thickness approximately 400 feet.

MASSANUTTEN SYNCLINORIUM

Devonian and Silurian rocks, undivided

DS — **Ridgeley Sandstone:** quartzarenite, light- to yellowish-gray, fine- to coarse-grained, locally conglomeratic, thin- to thick-bedded, generally cross-laminated, calcareous cement, friable when weathered, fossiliferous; thickness: 0 to 50 feet. **Helderberg Group:** limestone, light- to dark-gray, fine- to coarse-grained, laminated to thick-bedded, with black, nodular chert and white to light-gray, blocky chert; upper portion may be sandy; thickness: 50 to 100 feet. **Keyser Limestone:** limestone, medium- to dark-gray, fine- to coarse-grained, fossiliferous; thickness: 75 to 150 feet. **Tonoloway Limestone:** limestone, medium- to dark-gray, fine-grained, laminated, rippled, sparse fossils; thickness: 50 to 100 feet. **Wills Creek Formation:** limestone, light- to medium-gray, fine- to coarse-grained, fossiliferous; gray calcareous siltstone; greenish-gray calcareous mudstone; thickness approximately 130 feet. **Bloomsburg Formation:** dusky-red mudstone with interbedded fine- to medium-grained, thick-bedded, cross-laminated, ferruginous sandstone and dusky-red shale, several quartzarenite beds; thickness approximately 400 feet. **McKenzie Formation:** medium-gray, yellowish weathering, calcareous shale, may be fossiliferous; thickness: 0 to 25 feet.

WEST OF NORTH MOUNTAIN FAULT

Ridgeley Sandstone

Dri

Helderberg Group, Keyser Limestone, Tonoloway Limestone, Wills Creek Formation, Bloomsburg Formation, and McKenzie Formation, undivided

DS

SILURIAN

Keefer Sandstone and Rose Hill Formation, undivided

Skr — **Keefer Sandstone:** sandstone, light-gray, fine- to coarse-grained, locally conglomeratic, cross-laminated, quartz cement or overgrowths, thin green to purple shale beds near base, sparsely fossiliferous (*Skolithos*, *Arthrophycus*); thickness ranges from 20 to 70 feet, thickens to the southwest. **Rose Hill Formation** (Clinton Formation of earlier reports) sandstone and shale. Sandstone, light-gray to dusky-red, fine- to coarse-grained, cross-laminated; gray sandstone identical to the overlying Keefer and the underlying Tuscarora, very resistant to weathering, makes ledges. Shale, green, yellowish-brown, and dusky-red, commonly contains limonitic lenses from the weathering of thin limestone beds. Fossiliferous. Thickness 150 to 500 feet.

Tuscarora Formation

Stu — Sandstone and quartzite. Sandstone, light-gray, weathers rusty-brown, fine- to coarse-grained, commonly conglomeratic, clasts 0.25 to 0.5 inch, thin- to thick-bedded, cross-laminated, quartz cement, matrix less than 1%. Quartzite, light-gray, fine- to medium-grained, cemented by overgrowths, thick-bedded. Thin, red, green, or purple shale near base and top of unit. Sandstone generally overlain by quartzite. Contacts gradational, basal contact mapped at the base of the oldest thick sandstone bed, upper contact mapped at the first thick shale sequence overlying a thick quartzite. Thickness: 100 to 150 feet.

Juniata Formation

Oj — Sandstone, dusky-red, fine- to medium-grained, cross-laminated, in part feldspathic. Sandstone, light-gray to white, fine- to medium-grained, thick-bedded, cross-laminated, base often contains red shale clasts. Shale and mudstone, dusky-red, weathers lumpy. Thickness: 50 to 300 feet.

Oswego Formation

Oos — Sandstone, greenish-gray, fine- to coarse-grained, conglomeratic with chert, quartz, and lithic clasts, medium- to thick-bedded, minor interbeds of olive-gray shale. Thickness: 50 to 600 feet.

Martinsburg Formation

Omb — Upper 100 to 200 feet: brown, medium- to coarse-grained sandstone, may be fossiliferous. Middle 3000 to 4000 feet: olive-green, silty shale, dark-gray siltstone, and medium- to coarse-grained sandstone, locally contains pebbles. Lower 400 to 900 feet: medium-gray to grayish-black, very-fine-grained, very-thin-bedded, argillaceous limestone with interbedded medium- to dark-gray calcareous shale.

Massanutten Sandstone

Sm — Sandstone, very-light- to medium-gray, fine- to coarse-grained, locally conglomeratic, cross-laminated, matrix less than 5%, quartz cement less than 10%, thin black carbonaceous shale beds with plant fossils in the lower 150 feet of formation (Pratt and others, 1978). Quartzite, light-gray, cross-laminated, medium-grained, framework grains with overgrowths, matrix less than 0.5%, cement less than 1%. Upper one-third of formation contains sandy shale interbedded with sandstone; weathers brownish- to reddish-gray. Thickness: approximately 900 feet.

unconformity

Silurian and Ordovician rocks, undivided

SO

ORDOVICIAN

Edinburg Formation, Lincolnshire Limestone, and New Market Limestone, undivided

Oeln — **Edinburg Formation:** black, fine-grained to aphanic limestone with black shale partings, pyrite common (Liberty Hall lithofacies of Cooper and Cooper, 1946), and medium- to light-gray, fine- to coarse-grained, nodular limestone with thin black shale partings (Lantz Mill lithofacies of Cooper and Cooper, 1946). Top of the Edinburg marked by a 30- to 60-foot thick very-fine-grained, medium-gray, thick-bedded limestone (St. Luke Member). East of Little North Mountain a greenish-gray siltstone occurs about 15 feet above the base of the Edinburg (Tumbling Run Siltstone Member). K-bentonites, some with basal chert or silicified zones, common, particularly near the base and top. Fossiliferous. Thickness: 425 to 500 feet. **Lincolnshire Limestone:** limestone, light- to very-dark-gray, fine- to coarse-grained, medium- to very-thick-bedded; dark-colored limestone with black chert nodules, generally parallel to bedding; light-colored, coarse-grained limestone, generally at the top of the formation, composed of fossil fragments (Murat Limestone Member). Upper contact gradational with the overlying Edinburg, lower contact unconformable with the underlying New Market. Thickness: 25 to 250 feet. **Unconformity. New Market Limestone:** lower unit: medium- to dark-gray, fine-grained, thin-bedded, argillaceous, in part dolomitic, bioturbated limestone, carbonate pebble conglomerate common at base; upper unit: medium-gray, aphanic, thick-bedded limestone with scattered, rhomboid-shaped quarry calcite crystals; high-calcium limestone quarried in the area. Thickness: 0 to 200+ feet.

unconformity

Beekmantown Formation

Ob — Dolostone, medium- to light-gray, weathers very-light-gray, fine-grained; medium- to thick-bedded, weathered surfaces exhibit a "butcher-block" structure, sparse fossils; limestone, medium-gray, fine-grained, fossiliferous limestone; light- to medium-gray, fine-grained, laminated dolomitic limestone and dolostone with mottled beds; lenses and beds of gray chert common. Upper contact unconformable; lower contact placed at the oldest thick-bedded dolomite overlying dark-gray limestone of the Stonehenge Limestone. Thickness: 2200 to 2400 feet.

Stonehenge Limestone

Dst — **Upper Stonehenge:** medium- to dark-gray and black, fine- to medium-grained limestone, thin beds of micerated fossil debris common. Thickness ranges from 400 to 500 feet. **Stoufferstown Member** (Lower Stonehenge): dark-gray to black, fine-grained limestone with thin, sheet-like partings; partings crinkly because of cleavage; and thin beds of coarse-grained, bioclastic limestone. Thickness: 50 to 150 feet.

Conococheague Formation

OCco — **Upper Conococheague:** light- to dark-gray, fine-grained, laminated limestone, dolomitic limestone, and dolostone with flat-pebble conglomerate beds. The following lithologies occur as erosional-surface-bounded packages (from base to top): oolitic, coarse-grained calcarenite; stromatolitic limestone; ribbon-banded limestone and dolostone; interbedded fine-grained limestone and dolostone; and dolostone, commonly containing mudcracks; sandstone beds in uppermost part of formation, some sandstone beds cross-laminated. **Big Spring Station Member** (lower 200 to 500 feet of Conococheague): light-gray, fine-grained dolostone; medium- to dark-gray, fine-grained laminated limestone and dolomitic limestone, gray, brown-weathering, coarse-grained sandstone and dolomitic sandstone; beds of flat-pebble conglomerate in dolostone. Thickness: 2200 to 2600 feet.

CAMBRIAN

Elbrook Formation

Ce — Bulk of formation: dark- to medium-gray, fine- to medium-grained limestone, dolomitic limestone, dolostone, and dolomitic shale. Lithologies commonly occur as erosion-surface-bounded sequences of algal limestone overlain by laminated dolostone. Ground surface frequently covered with decalcified, ocherous, shale-like chips. Thickness ranges from 2000 to 2500 feet. Lower 300 to 400 feet green to greenish-gray, fine-grained dolostone, dolomitic limestone, and shale; brown-weathering calcareous siltstone marks the top of unit.

Waynesboro Formation

Cwb — Upper 300 feet: dusky-red to olive-gray, fine- to medium-grained sandstone and dusky-red to gray shale. Middle 400 feet: medium- to dark-gray, saccharoidal dolostone and fine-grained limestone. Lower 500 feet: dusky-red, olive-gray, and dark-gray shale and dusky-red to brownish-gray, fine- to medium-grained sandstone. Thickness approximately 1200 feet.

Tomstown Dolomite

Ct — Upper unit: light- to dark-gray, fine- to coarse-grained, medium- to thick-bedded, locally laminated dolostone; white chert rosettes and nodules in upper 50 feet; thickness about 600 feet. Middle unit: very-light- to medium-gray, medium-grained, very-thick-bedded dolostone and high-magnesium dolostone; thickness about 200 feet. Lower unit: dark-gray to black, very-fine-grained, thin- to very-thin-bedded limestone and dolomitic limestone with argillaceous laminations; thickness about 325 feet. Total thickness: 1100 to 1200 feet.

Antietam Formation

Ca — White to light-gray, fine- to coarse-grained, silica-cemented, vitreous quartzite and subarkose with phyllite partings. *Skolithos* common. Thickness: 350 to 600 feet.

Harpers Formation

Ch — Upper 1100 feet: gray, fine- to medium-grained sandstone and quartzite, in part ferruginous. Lower 900 feet: gray to olive-gray phyllite and sandy phyllite with interbedded lithic sandstone. Thickness approximately 2000 feet.

Weverton Formation

Cw — Upper 150 feet: quartz-pebble conglomerate and micaceous sandstone. Middle 300 feet: greenish-gray sandy phyllite and micaceous sandstone. Lower 150 feet: basal conglomerate composed of subangular to rounded quartz and flat shale clasts in a matrix of sand-sized quartz and lithic grains (includes sericite and chlorite), quartz cement, overlain by light-gray, conglomeratic quartzite with interbedded greenish-gray sandy phyllite. Thickness: 500 to 600 feet.

unconformity

Catoctin Formation

GZc — Grayish-green to dark-yellowish-green, fine-grained, schistose metabasalt composed of albite, epidote, chlorite, actinolite, magnetite, hematite, sphene, and pyroxene; amygdule fillings of albite, quartz, calcite, epidote, chlorite, and jasper, tops of flows locally autobrecciated. Interbedded lithologies include: purple meta-arkose, phyllite, rhyolitic metatuff, epidosite, and lithic metasandstone. Thickness: ranges from 1500 to 3000 feet.

LATE PROTEROZOIC

Swift Run Formation

Zsr — Dark-greenish-brown, sandy and pebbly metagraywacke and meta-arkose; silver-gray and purple, tuffaceous phyllite; thin beds of metabasalt. Thickness: ranges from 0 to 200 feet.

MIDDLE PROTEROZOIC

unconformity

Leucogranite

Yl — Leucocratic, yellowish-gray, coarse-porphyroblastic, gneissic granite composed of quartz, perthite, and microcline; accessory minerals include biotite and plagioclase; alteration minerals include epidote and sericite from feldspar; contains 1- to 3-centimeter augen composed of aggregates of feldspar in a finer-grained, quartz-feldspar matrix; occurs as ovoid bodies of varying size and as dikes that cut charnockite and granulite. Some of the rocks shown as leucogranite contain varying amounts of closely associated granulite.

Charnockite

Yc — Melanocratic, grayish-blue-green to dusky-blue-green, massive to slightly-foliated, coarse-grained, heterogranular to porphyritic charnockite composed of perthite, plagioclase (perthite > plagioclase), orthopyroxene, and quartz; accessory minerals include biotite, opaque minerals, zircon, and locally, pargasite; alteration minerals are uralite as kelephitic rims on orthopyroxene, and chlorite that partially replaces biotite; develops rusty-brown rinds on weathered surfaces; feldspares are vitreous and greasy-green; rock is generally pristine in hand specimen but may show development of retrograde minerals in thin section. Rocks mapped as charnockite occur as distinct masses, as mixed charnockite-granulite rocks, and as discrete interlayers (many of which are too small to map) in granulite.

Granulite

Yg — Light- to olive-gray, medium-grained, compositionally foliated, generally garnetiferous, generally equigranular granulite composed of perthite, plagioclase (perthite to plagioclase ratio 3 to 1), and quartz; accessory minerals are biotite, microcline, orthopyroxene, garnet, and opaque minerals; alteration minerals are epidote and sericite from feldspar, uralite from orthopyroxene, and chlorite from biotite. Quartz-rich compositional layers alternate with feldspar-rich layers; compositional layers terminate abruptly, producing a dashed-pattern texture; garnet porphyroblasts larger than the matrix and aggregates of garnet blasts are common; unit may locally contain 2- to 3-millimeter quartz and feldspar porphyroblasts.

Granulite and charnockite, undivided

Yu — Page County

Flint Hill Gneiss

Yfh — Light-gray to gray, medium- to coarse-grained, segregation-layered quartzofeldspathic biotite gneiss composed of quartz, plagioclase, microcline, green biotite, ilmenite, and titanite; accessory minerals include epidote, apatite, and zircon. Segregation layering defined by quartz-feldspar- and biotite-rich domains on the order of a few millimeters thick; migmatitic leucosomes of quartz and alkali feldspar cut segregation layering in places; veins of blue quartz common (Lukert and Nuckols, 1976).