Delaware Water Gap National Recreation Area

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic Data for Delaware Water Gap National Recreation Area

dewa_geology.pdf

Version: 5/27/2021
Geologic Resources Inventory Map Document for Delaware Water Gap National Recreation Area

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Geologic Resources Inventory Map Document

Delaware Water Gap National Recreation Area, Pennsylvania, New Jersey and New York

Document to Accompany Digital Geologic-GIS Data
dewa_geology.pdf
Version: 5/27/2021

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Delaware Water Gap National Recreation Area, Pennsylvania, New Jersey and New York (DEWA).

Attempts have been made to reproduce all aspects of the original source products, including the geologic units and their descriptions, geologic cross sections, the geologic report, references and all other pertinent images and information contained in the original publication.

This document contains the following information:

1) About the NPS Geologic Resources Inventory Program – A brief summary of the Geologic Resources Inventory (GRI) Program and its products. Included are web links to the GRI GIS data model, and to the GRI products page where digital geologic-GIS datasets, scoping reports and geology reports are available for download. In addition, web links to the NPS Data Store and GRI program home page, as well as contact information for the GRI coordinator, are also present.

2) GRI Digital Maps and Source Citations – A listing of all GRI digital geologic-GIS maps produced for this project along with sources used in their completion. In addition, a brief explanation of how each source map was used is provided.

3) Map Unit List – A listing of all geologic map units present on maps for this project, generally listed from youngest to oldest.

4) Map Unit Descriptions – Descriptions for all geologic map units. If a unit is present on multiple source maps the unit is listed with its source geologic unit symbol, unit name and unit age followed by the unit's description for each source map.

5) Geologic Cross Sections – Geologic cross section graphics with source geologic cross section abbreviations.

6) Ancillary Source Map Information – Additional source map information presented by source map.
For each source map this may include a stratigraphic column, index map, map legend and/or map notes.

7) **GRI Digital Data Credits** – GRI digital geologic-GIS data and ancillary map information document production credits.

For information about using GRI digital geologic-GIS data contact:

Stephanie O'Meara  
Geologist/GIS Specialist/Data Manager  
Colorado State University Research Associate, Cooperator to the National Park Service  
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About the NPS Geologic Resources Inventory Program

Background

The Geologic Resources Inventory (GRI) provides geologic map data and pertinent geologic information to support resource management and science-informed decision making in more than 270 natural resource parks throughout the National Park System. Geologic resources for management consideration include both the processes that act upon the Earth and the features formed as a result of these processes. Geologic processes include: erosion and sedimentation; seismic, volcanic, and geothermal activity; glaciation, rockfalls, landslides, and shoreline change. Geologic features include mountains, canyons, natural arches and bridges, minerals, rocks, fossils, cave and karst systems, beaches, dunes, glaciers, volcanoes, and faults.

The GRI is one of 12 inventories funded by the National Park Service (NPS) Inventory and Monitoring Program. The Geologic Resources Division of the NPS Natural Resource Stewardship and Science Directorate administers the GRI. The NPS Geologic Resources Division partners with the Colorado State University Department of Geosciences to produce GRI products. Many additional partners participate in the GRI process by contributing source maps or reviewing products.

The GRI team undertakes three tasks for each park in the Inventory and Monitoring program: (1) conduct a scoping meeting and provide a summary document, (2) provide digital geologic map data in a geographic information system (GIS) format, and (3) provide a GRI report. These products are designed and written for nongeoscientists.

Products

Scoping Meetings: These park-specific meetings bring together local geologic experts and park staff to inventory and review available geologic data and discuss geologic resource management issues. A summary document is prepared for each meeting that identifies a plan to provide digital map data for the park.

Digital Geologic Maps: Digital geologic maps reproduce all aspects of traditional paper maps, including notes, legend, and cross sections. Bedrock, surficial, and special purpose maps such as coastal or geologic hazard maps may be used by the GRI to create digital Geographic Information Systems (GIS) data and meet park needs. These digital GIS data allow geologic information to be easily viewed and analyzed in conjunction with a wide range of other resource management information data.

For detailed information regarding GIS parameters such as data attribute field definitions, attribute field codes, value definitions, and rules that govern relationships found in the data, refer to the NPS Geology-GIS Data Model document available at: https://www.nps.gov/articles/gri-geodatabase-model.htm

Geologic Reports: GRI reports synthesize discussions from the original scoping meeting, follow up conference call(s), and subsequent research. Chapters of each report discuss the geologic setting of the park, distinctive geologic features and processes within the park, highlight geologic issues facing resource managers, and describe the geologic history leading to the present-day landscape. Each report also includes a poster illustrating these GRI digital geologic-GIS data.

For a complete listing of GRI products visit the GRI publications webpage: https://go.nps.gov/gripubs. GRI digital geologic-GIS data is also available online at the NPS Data Store: https://irma.nps.gov/DataStore/Search/Quick. To find GRI data for a specific park or parks select the appropriate park(s), enter “GRI” as a Search Text term, and then select the Search button.
For more information about the Geologic Resources Inventory Program visit the GRI webpage: https://www.nps.gov/subjects/geology/gri.htm. At the bottom of that webpage is a “Contact Us” link if you need additional information. You may also directly contact the program coordinator:

Jason Kenworthy
Inventory Coordinator
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The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) Division. Learn more about I&M and the 12 baseline inventories at the I&M webpage: https://www.nps.gov/im/inventories.htm.
GRI Digital Maps and Source Map Citations


The compiled park extent and vicinity map.


The above GRI digital geologic-GIS map was produced using the following sources, as well as sources listed with each standalone 7.5 minute quadrangle GRI digital geologic-GIS dataset (see the following page) that together comprise the park extent and vicinity map.

For all sources, please see each source map's page (click link included with map reference) for additional information about how a source map was used.


The following digital geologic-GIS (component) maps were produced as standalone datasets by the GRI because no other digital GIS representation of their respective source map exists. As mentioned above, these maps were compiled with other non-standalone sources to produce the park extent and vicinity map.

**Digital Bedrock Geologic-GIS Map of the Branchville 7.5' Quadrangle, New Jersey (GRI MapCode BRAV)**


**Digital Geologic-GIS Map of the Blairstown 7.5' Quadrangle, New Jersey (GRI MapCode BLST)**


**Digital Geologic-GIS Map of the Bushkill 7.5' Quadrangle, New Jersey and Pennsylvania (GRI MapCode BUSH)**


**Digital Bedrock Geologic-GIS Map of portions of the Culvers Gap and Lake Maskenozha Quadrangles, New Jersey (GRI MapCode CUGA)**


**Digital Bedrock Geologic-GIS Map of the Newton West 7.5' Quadrangle, New Jersey (GRI MapCode NEWE)**


**Digital Geologic-GIS Map of the Saylorsburg 7.5' Quadrangle, Pennsylvania (GRI MapCode SAYL)**


**Digital Geologic-GIS Map of the Stroudsburg 7.5' Quadrangle, New Jersey and Pennsylvania (GRI MapCode STRO)**

Additional information pertaining to each source map is also presented in the GRI Source Map Information (DEWAMAP) table included with the GRI digital geologic-GIS data.

**Index Map**

The following index map displays the extents of the GRI digital geologic-GIS maps produced for Delaware Water Gap National Recreation Area (DEWA). The boundary for Delaware Water Gap National Recreation Area (as of May 2021) is outlined in green. The extent of GRI digital geologic-GIS data is the same as the 7.5 minute quadrangles shown.

Index Map by Lucas Chappell (Colorado State University).
Map Unit List

The geologic units present in the digital geologic-GIS data produced for Delaware Water Gap National Recreation Area, Pennsylvania, New Jersey and New York (DEWA) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qal - Alluvium). Units are listed from youngest to oldest. No description for water is provided. Information about each geologic unit is also presented in the GRI Geologic Unit Information (DEWAUNIT) table included with the GRI geologic-GIS data. Some source unit symbols, names and/or ages may have been changed in this document and in the GRI digital geologic-GIS data. This was done if a unit was considered to be the same unit as one or more units on other source maps used for this project, and these unit symbols, names and/or ages differed. In this case a single unit symbol and name, and the unit's now recognized age, was adopted. Unit symbols, names and/or ages in a unit descriptions, or on a correlation of map units or other source map figure were not edited. If a unit symbol, name or age was changed by the GRI the unit's source map symbol, name and/or age appears with the unit's source map description.

Cenozoic Era

Quaternary Period

Qmd - Dumps
Qal - Alluvium
Qs - Swamp deposits
Qd - Surficial deposits
Qvf - Valley-fill glacial deposits
Qit - Till

Paleozoic Era

Devonian Period

Catskill Formation

Dcp - Catskill Formation, Packerton Member
   Dclr - Catskill Formation, Long Run Member
   Dcbr - Catskill Formation, Beaverdam Run Member
   Dcw - Catskill Formation, Walcksville Member
   Dcs - Catskill Formation, Shohola Member
   Dca - Catskill Formation, Analomink Red Shale Member
   Dcdr - Catskill Formation, Delaware River Member
   Dct - Catskill Formation, Towamensing Member
   Dcdf - Catskill Formation, Delaware River Flags Member

Dtr - Trimmers Rock Formation
   Dtm - Trimmers Rock Formation, Millrift Member
   Dtsb - Trimmers Rock Formation, Sloat Brook Member

Dhm - Hamilton Group, undifferentiated

Dmh - Mahantango Formation
   Dmhn - Mahantango Formation, Nis Hollow Member
   Dmu - Mahantango Formation, upper member
   Dmhc - Mahantango Formation, Centerfield Member
   Dmhf - Mahantango Formation, biostrome
   Dml - Mahantango Formation, lower member

Dm - Marcellus Shale
   Dmb - Marcellus Shale, Brodhead Creek Member
   Dmsu - Marcellus Shale, Stony Hollow and Union Springs Shale Members, undifferentiated
Db - Buttermilk Falls Limestone
Dou - Onondaga Limestone
Dp - Palmerton Sandstone
DSu - Devonian and Silurian rocks, undifferentiated
Ds - Schoharie Formation
Dse - Schoharie and Esopus Formations, undivided
De - Esopus Formation
Do - Oriskany Group, undivided
Dr - Ridgeley Sandstone
Dors - Ridgeley Sandstone and Shriver Chert, undivided
Dh - Helderberg Group, undivided
Dpe - Port Ewen Shale
Dph - Helderberg Group, Port Ewen Shale, Minisink Limestone, and New Scotland Formation, undifferentiated
Dmn - Minisink Limestone and New Scotland Formation, undivided
Dc - Coeymans Formation
Dkc - Kalkberg Limestone, Coeymans Limestone, Manlius Limestone

Devonian and Silurian Periods
DSlr - Lower Part of the Helderberg Group and Rondout Formation, undivided
DShr - Shriver Chert of the Oriskany Group, Helderberg Group, and Rondout Formation, undivided
DSrp - Rondout Formation
DSrd - Rondout and Decker Formations, undivided

Silurian Period
Sd - Decker Formation
Sbv - Bossardville Limestone
Sp - Poxono Island Formation
Sb - Bloomsburg Red Beds
Ss - Shawangunk Formation
    Sst - Shawangunk Formation, Tammany Member
    Ssl - Shawangunk Formation, Lizard Creek Member
    Ssm - Shawangunk Formation, Minsi Member
Sm - Mafic dike

Ordovician Period
Beemerville Intrusive Suite
    Obs - Beemerville Intrusive Suite, nepheline syenite
    Obt - Beemerville Intrusive Suite, tinguaite
    Obp - Beemerville Intrusive Suite, phonolite
    Obb - Beemerville Intrusive Suite, bostonite
    Obm - Beemerville Intrusive Suite, malignite
    Obl - Beemerville Intrusive Suite, lamprophyre
    Obo - Beemerville Intrusive Suite, ouachitite breccia
Martinsburg Formation
    Omp - Martinsburg Formation, Pen Argyl Member
    Omh - Martinsburg Formation, High Point Member
    Omhn - Martinsburg Formation, hornfels
    Omr - Martinsburg Formation, Ramseyburg Member
    Omrg - Martinsburg Formation, Ramseyburg Member, prominent graywacke-bearing intervals
    Omb - Martinsburg Formation, Bushkill Member
Oag - Austin Glen Formation
Qi - Jacksonburg Limestone
Ordovician and Cambrian Periods

**Ordovician and Cambrian Periods**

- **Ojl** - Cement limestone facies of Jacksonburg Limestone
- **Ow** - Wantage Sequence
- **Obu** - Upper Part of Beekmantown Group
- **Oe** - Epler Formation
- **Or** - Rickenbach Dolomite
- **Os** - Stonehenge Formation

**Proterozoic Eon**

- **Ymv** - Venite
- **Yba** - Microperthite alaskite
- **Ybh** - Hornblende granite
- **Ymr** - Marble
- **Yq** - Quartz-plagioclase-epidote-biotite gneiss
- **Yk** - Potassic feldspar gneiss
- **Ylo** - Quartz-oligoclase gneiss
- **Ya** - Amphibolite
Map Unit Descriptions

Descriptions of all geologic map units, generally listed from youngest to oldest, are presented below.

Qmd - Dumps (Holocene)

d - Dumps (Holocene)
Waste blocks of siltstone and cherty limestone from quarry operations at southwest end of Godfrey Ridge, and of dolomite, limestone, and shale from operations near Bossardsville. Description from source map: Saylorsburg Quadrangle

d - Slate dump, waste blocks of Martinsburg Formation (Holocene)
Waste blocks of slate from the Martinsburg Formation in piles more than 100 feet high. Used for road metal and lightweight aggregate. Description from source map: Stroudsburg Quadrangle

Qal - Alluvium (Holocene)

Qal - Alluvium (Holocene)
Clay, silt, sand, and gravel along streams. Description from source map: Belvidere and Portland Quadrangles

Qal - Alluvium (Holocene)
Deposits of clay, silt, sand, and gravel along streams. Description from source map: Bushkill Quadrangle

Qal - Alluvium (Holocene)
Silt, sand, and gravel in riverbed and flood-plain deposits of present streams. Description from source map: Saylorsburg Quadrangle

Qal - Alluvium and flood-plain deposits (Holocene)
Silt, sand, and gravel in riverbed and flood-plain deposits of present streams. Description from source map: Stroudsburg Quadrangle

Qs - Swamp deposits (Holocene and Pleistocene)

Qs - Swamp Deposits (Pleistocene and Holocene)
Clay, silt, sand, fine gravel, and partly decomposed plant material. Description from source map: Belvidere and Portland Quadrangles

Qs - Swamp deposits (Pleistocene and Holocene)
Deposits of clay, sand, fine gravel, and partly decomposed plant material. Generally very thin, but a peat deposit having a known area of about 10,000 square feet near Oak Grove has been mined to a depth of 40 feet. Description from source map: Bushkill Quadrangle

Qs - Swamp deposits (Holocene and Pleistocene)
Organic matter and clay, probably with disseminated silt and sand, in poorly drained areas. Description from source map: Saylorsburg Quadrangle

Qs - Swamp deposits (Holocene and Pleistocene)
Organic matter and clay, probably with disseminated silt and sand, in poorly drained areas. Possible source for peat. Description from source map: Stroudsburg Quadrangle

**Qd - Surficial deposits (Quaternary)**

**Qg - Undifferentiated glacial deposits (Pleistocene)**
Sand, gravel, till, and ground moraine of Wisconsin age. Description from source map: Belvidere and Portland Quadrangles

**Qd - Quaternary deposits (Quaternary)**
Clay, silt, sand, gravel, and peat found in alluvium along streams, glacial deposits of both Wisconsin and pre-Wisconsin age, and swamps. Description from source map: Blairstown Quadrangle

**Qd - Surficial deposits (Quaternary)**
Alluvium, glacial deposits of Wisconsin age, and swamp deposits of organic-rich muck, clay, silt, sand, and gravel. Description from source map: Branchville Quadrangle

**Qg - Undivided glacial deposits (Pleistocene)**
Deposits of stratified drift and till of probable Wisconsin age. Sand and gravel in stratified drift in valley paralleling U.S. Rte. 209 and in the Delaware Valley have been commercially exploited. Similar material is available in both areas. Description from source map: Bushkill Quadrangle

**Qd - Quaternary deposits (Quaternary)**
Alluvium, glacial deposits of both Wisconsin and pre-Wisconsin age, and swamp deposits consisting of clay, silt, sand, gravel, and partly decomposed plant material. Not shown on cross sections. Description from source map: Eastern Belvidere and Portland Quadrangles

**Qd - Surficial deposits (Quaternary)**
Alluvium, glacial deposits of Wisconsin age, and swamp deposits of organic-rich muck. Description from source map: Newton West Quadrangle

**Qg - Glacial deposits, undifferentiated (Pleistocene, Wisconsinan)**
Gravel, sand, and clay in till and stratified drift. More than 100 ft (30 m) thick in places. Description from source map: Saylorsburg Quadrangle

**Qg - Glacial deposits, undifferentiated (Pleistocene)**
Gravel, sand, silt, and clay in till and stratified drift (maximum thickness is 250+ feet under Delaware River near Shawnee Island). Exploited for sand and gravel. For detailed information on the glacial deposits see Epstein (1969). Description from source map: Stroudsburg Quadrangle

**Qvf - Valley-fill glacial deposits (Quaternary)**

valley-fill glacial deposits - Valley-fill Glacial Deposits (Quaternary)
Unconsolidated, stratified and unstratified deposits, mainly of Quaternary age. Well-sorted sands and gravels constitute one of the most productive aquifers in Monroe County. Median one-hour specific capacity is 2.85 gpm/ft; 24-hour potential well yield is 400 gpm; median water level below land surface is 10 feet; median saturated thickness is 65 feet. The water is low in solutes, generally soft, and potentially corrosive. Specific conductance is 117 micromhos; hardness is 2 gpg. Excessive concentrations of iron and manganese occur in water from these deposits.
Specific-capacity data are median values taken from Table 4 in text. Yield data are 25 percent values taken from Table 6. Water-level data are median values taken from Table 12. Specific-conductance data are median values taken from Table 7. Hardness data are median values taken from Table 7. Water-quality data are taken from two wells.

Description from source map: Monroe County Geology and Groundwater Resources

**Qit - Till (Pleistocene, Illinoian?)**

Deeply weathered grayish- to dark-yellowish-orange, light-to moderate-brown, and yellowish-red, cobbly, silty, and clayey till. Generally less than 20 ft (6 m) thick. Description from source map: Saylorsburg Quadrangle

**Qod - Older drift (Pleistocene)**

Deeply weathered grayish-orange to dark-yellowish-orange silty and clayey till generally about 10 feet thick. Description from source map: Stroudsburg Quadrangle

**Catskill Formation**

**Dcp - Catskill Formation, Packerton Member (Upper Devonian)**

Gray Sandstone and conglomerate, about 300 ft (91 m) thick. Shown in cross section only. Description from source map: Saylorsburg Quadrangle

**Dclr - Catskill Formation, Long Run Member (Upper Devonian)**

Alternating gray sandstone and red siltstone and shale. One-hour specific capacity is 0.19 gpm/ft; 24-hour potential yield is 40 gpm; water level below land surface is 46 feet; water is low in solutes, soft, and potentially corrosive. Specific conductance is 160 micromhos; hardness is 2 gpg. Description from source map: Monroe County Geology and Groundwater Resources

Sandstone, siltstone, shale, partly in fining-upward cycles. Medium- to medium-dark-gray, greenish-gray to olive-gray, and grayish-red; generally fine grained, silty, limonitic, micaceous, laminated to massive, planar-bedded and crossbedded sandstone with some channeled bases, load casts, and rare spiriferid brachiopods. Grayish-red, shaley and sandy, cross-laminated to massive, burrowed siltstone with minor irregular dark-yellowish-orange ferroan dolomite nodules, roots, and mudcracks. Grayish-red to greenish-gray, silty shale. Base placed at bottom of lowest red bed. Unit about 3,000 ft (914 m) thick. Top not exposed in quadrangle. Lowest 130 ft (40 m) exposed in roadcut just north of Appenzell (see Berg and others (1977) for detailed measured section). Description from source map: Saylorsburg Quadrangle
**Dcbr - Catskill Formation, Beaverdam Run Member (Upper Devonian)**

Greenish-gray sandstone and lesser amounts of siltstone and shale. Hydrologic information is from two wells. Average one-hour specific capacity is 0.18 gpm/ft; 24-hour potential well yield, probably the same as in the Long Run Member, is 45 gpm; average water level below land surface is 34 feet. No water-quality data. Description from source map: Monroe County Geology and Groundwater Resources

**Dcbr - Catskill Formation, Beaverdam Run Member (Upper Devonian)**

Sandstone, siltstone, and silty shale. Light-olive-gray to medium-dark-gray and moderate-brownish gray, very fine to fine-grained, limonitic, micaceous, partly silty, laminated and cross-laminated to planar bedded and crossbedded, fine- to thick-bedded sandstone that weathers dark yellowish orange to dark yellowish brown, with some load casts, channeled bases, burrows, and minor shale chips. Olive-gray to medium-dark-gray, generally thick bedded siltstone and silty shale. Several fossiliferous beds contain Tentaculites, crinoids, brachiopods, and plant fragments. Lower contact placed at top of uppermost red bed of underlying Walcksville Member. About 300 ft (91 m) thick. Uppermost 125 feet (38 m) exposed just north of Appenzell (see Berg and others (1977) for detailed measured section). Description from source map: Saylorsburg Quadrangle

**Dcw - Catskill Formation, Walcksville Member (Upper Devonian)**

Alternating greenish-gray sandstones and red shales. One-hour specific capacity is 0.12 gpm/ft; 24-hour potential yield is 35 gpm; water level below land surface is 50 feet; no water-quality data. Description from source map: Monroe County Geology and Groundwater Resources

**Dcw - Catskill Formation, Walcksville Member (Upper Devonian)**

Medium to moderate-greenish-gray, and grayish-red-purple, fine to medium-grained, limonitic, planar bedded and crossbedded, medium- to thick-bedded sandstone; and olive- to greenish-gray, grayish-red and medium-brownish-gray, laminated and ripple-laminated, bioturbated, partly mudcracked siltstone and silty shale with irregular ferroan dolomite concretions. Includes one 4 ft (1.2 m) thick, grayish-red-purple shale-chip conglomerate 0.7 mi (1.1 km) south of Appenzell. Beds are mostly in fining-upward cycles. Lower contact placed at base of first red bed above nonred rocks of underlying Towamensing member. About 1,600 ft (488 m) thick. Description from source map: Saylorsburg Quadrangle

**Dcs - Catskill Formation, Shohola Member (Upper Devonian)**

Interbedded 5- to 25-foot thick units of greenish-gray and grayish-red very fine to medium-grained sandstone and sandy shale and lesser medium-gray to medium-dark-gray sandstone and shale. Sandstones are predominantly low-rank graywackes. Beds are thin to very thick and most have simple or planar sets of small- to medium-scale, generally low-angle cross stratification. Sandstone units locally have intraformational conglomerates and load casts near their bases. Contacts with shale units are abruptly disconformable to gradational. Sandstones are poorly cleaved. Shale is thinly laminated and well cleaved. Mud cracks, convolute bedding, and sole marks are present near contacts with sandstone units. Member is more than 2,000 feet thick but the top is not exposed in quadrangle. Lower contact is gradational and is placed at top of highest red bed of the underlying Analomink. Greenish-gray and gray sandstone beds have been commercially exploited for flagstone. Red sandstone and shale is suitable for fill material. Description from source map: Bushkill Quadrangle
Dca - Catskill Formation, Analomink Red Shale Member (Upper Devonian)

Medium-grayish-red silty, micaceous, finely laminated, well-cleaved shale containing thin beds of brownish-gray sandy siltstone and silty very fine grained sandstone. Unit is the "first red" going up section in Upper Devonian sequence. Member is about 100 feet thick. Lower contact is gradational and is placed at base of lowest red bed. Rock from unit is suitable for fill material. Description from source map: Bushkill Quadrangle

Dcdr - Catskill Formation, Delaware River Member (Upper Devonian)

Cyclic sequences of gray, trough-crossbedded and planar-bedded, fine- to medium-grained sandstone and some red siltstone and claystone. Sandstone is in part feldspathic, forms small ledges, has blocky to flaggy fragmentation, and contains local calcareous, intraformational conglomerate. Discontinuous conglomeratic sandstone (red line and black circles) occurs near the top of the member in the northeastern and southwestern portions of the county. Thin siltstone and claystone in the northeast become thicker and more persistent to the southwest. Deposited by braided streams. Maximum thickness where overlain by the Lackawaxen Member is 2,600 feet; maximum thickness where the Lackawaxen is absent is 2,800 feet.

Groundwater Characteristics: Moderate infiltration capacity along fractures and some bedding planes. The median yields of domestic wells and nondomestic wells are 16 and 100 gal/min, respectively. Water is soft to moderately hard and low in dissolved solids.

Engineering Characteristics: Moderately difficult to difficult to excavate; sandstone and conglomeratic sandstone may require blasting. Slow to variable drilling rates. Generally maintains steep to vertical cut slopes; some rockfall may be anticipated after prolonged exposure. Excellent to good foundation for heavy structures. Slight to moderate percolation difficulty for septic systems developed in well-broken, weathered bedrock having good soil cover. Sanitary-landfill siting requires careful evaluation, but the unit is generally poorly suited.

Mineral Resources: Planar-bedded sandstone has good potential for flagstone, particularly in the northeastern third of the county, and some potential for dimension stone; waste piles at former flagstone quarries have potential for crushed rock. Claystone has marginal potential as material for building brick and floor brick.

Description from source map: Pike County Geology and Mineral Resources bedrock map

Dct - Catskill Formation, Towamensing Member (Upper Devonian)

Medium-gray sandstone containing interbedded silty shale and siltstone. One-hour specific capacity is 0.10 gpm/ft; 24-hour potential yield is 30 gpm; water level below land surface is 60 feet; no water-quality data. Description from source map: Monroe County Geology and Groundwater Resources

Dct - Catskill Formation, Towamensing Member (Upper Devonian)

Dominantly gray, fine- to medium-grained, trough-crossbedded sandstone; some planar-bedded sandstone; some lensoidal, intraformational conglomerate containing calcite cement, shale clasts, and carbonaceous material; and some thin, interbedded, dark-gray (lower part) and olive-gray (upper part)
siltstone and claystone. Sandstone has blocky to flaggy fragmentation. Member contains freshwater plant fossils and trace fossils (bivalve burrows). Deposited in fluvial environment of lower delta plain, including river mouth bars. Thickness ranges from 247 feet in the west to 1,625 feet in the northeast.

Groundwater Characteristics: Moderate infiltration capacity along fractures and some bedding planes. The median yields of domestic wells and nondomestic wells are 30 and 98 gal/min, respectively. Water is soft and low in dissolved solids.

Engineering Characteristics: Difficult to excavate; sandstone may require blasting. Slow drilling rate in sandstone; moderate drilling rate in siltstone. Generally maintains steep to vertical cut slopes; interbedded siltstone may contribute to rockfall. Excellent to good foundation for heavy structures. Generally suitable for septic systems developed in well-broken, weathered bedrock having a good soil cover. Sanitary-landfill siting requires careful evaluation, but the unit is generally poorly suited.

Mineral Resources: Planar-bedded sandstone has potential for flagstone. Sandstone has good potential for crushed rock. Claystone has marginal potential as material for building brick, floor brick, and lightweight aggregate, but presence of carbonate could cause problems.

Description from source map: Pike County Geology and Mineral Resources, bedrock map

Dct - Catskill Formation, Towamensing Member (Upper Devonian)
Medium-light-gray to medium-gray and olive-gray to greenish-gray, very fine to fine-grained, flaggy, limonitic, partly cross-bedded, thin- to thick-bedded sandstone that weathers light gray to olive gray and pale brown to grayish orange; and light-olive- to medium-greenish- and medium-gray, laminated to thin-bedded siltstone and silty shale. Lower contact placed at base of first flaggy sandstone above blocky siltstone or sandstone of Trimmers Rock Formation. About 300 ft (91 m) thick. Description from source map: Saylorsburg Quadrangle

Dcdf - Catskill Formation, Delaware River Flags Member (Upper Devonian)
Grayish-green, micaceous, laminated sandstone and lesser interbedded sandy shale. Beds range from a few inches to as much as 4 feet thick and split evenly into smooth flagstones 2 to 8 inches thick. Sandstones are low-rank graywackes and contain no marine fossils. Member is about 300 feet thick in quadrangle. Lower contact is gradational over a few feet and is placed at base of lowest grayish-green nonfossiliferous bed. Unit has been commercially exploited for flagstone. Description from source map: Bushkill Quadrangle

Dtr - Trimmers Rock Formation (Upper Devonian)
Interbedded very fine to fine-grained, medium-gray to medium-dark-gray, rarely dark-gray to greenish-gray, micaceous sandstone, siltstone, silty shale, and minor amounts of clay shale. Sandstones and siltstones are low-rank graywackes. Shale or sandstone units 5 to 25 feet thick are common, but much of formation consists of 10- to 50-foot thick intervals of interbedded and intergraded thin beds of clay to silty shale, siltstone, and sandstone. Unit is characterized by flow rolls and fairly abundant marine fossils as contrasted to overlying Delaware River Flags Member, and easily discernible, even bedding as contrasted to the underlying Mahantango Formation. Formation is about 1,700 feet thick and grades into the underlying Mahantango through an interval of 100-200 feet; contact is placed at base of lowest well-
bedded sandstone unit. Unit is suitable for use as fill material. Some of the upper sandstone beds could be used as flagstone. Description from source map: Bushkill Quadrangle

**Dtr - Trimmers Rock Formation (Upper Devonian)**

Gray and olive-gray, massive and fissile siltstone and minor shale. One-hour specific capacity is 0.18 gpm/ft; 24-hour potential yield is 90 gpm; water level below land surface is 33 feet; water is low in solutes, soft, and potentially corrosive. Specific conductance is 168 micromhos; hardness is 3.5 gpg. Description from source map: Monroe County Geology and Groundwater Resources

**Dtr - Trimmers Rock Formation (Upper Devonian)**

Thin- to medium-bedded sandstone, siltstone, and lesser silty shale in fining-upwards (Bouma) cycles. Sandstone is medium gray to medium dark gray and weathers light gray to light olive gray and pale yellowish brown to dark yellowish orange. Generally very fine grained, but a few beds are fine grained. Beds are laminated, cross laminated, parallel bedded to massive, fine to medium bedded, and generally blocky. Partly burrowed, some slightly calcareous beds contain abundant comminuted fossil debris of brachiopods, crinoids, and bryozoans. Basal contacts of sandstones are generally sharp and may contain load and groove casts. Siltstones are similar to the very fine-grained sandstones and are generally medium dark gray to dark gray, siliceous, dense, and laminated to massive. Silty shales are generally dark gray. Unit forms a colluvial shale-chip gravel of Quaternary age more than 20 ft (6 m) thick in places. Characteristically holds up a steeper slope than underlying Mahantango Formation (Dmh). Contact is transitional and placed at base of a dominantly siliceous siltstone sequence. About 1,060 ft (323 m) thick. Description from source map: Saylorsburg Quadrangle

**Dtm - Trimmers Rock Formation, Millrift Member (Upper Devonian)**

Dominantly dark-gray to medium-dark-gray siltstone, shale, and sandstone; Millrift Member contains approximately 60 percent very fine grained sandstone, whereas Sloat Brook Member is dominantly siltstone and silt shale. Generally thin to medium bedded, although some sandstone in the Millrift Member is thick bedded; well-developed joints; poorly developed cleavage; forms low, subparallel ledges; marine fossils are common (especially brachiopods). Siltstone and shale disintegrate to hackly, platy, and chippy fragments; sandstone disintegrates to rubbly and slabby fragments. Deposited mostly by density currents in marine prodelta. Formation thickness ranges from 720 to 1,825 feet; Millrift Member has a maximum thickness of 1,000 feet; Sloat Brook Member has a maximum thickness of 950 feet.

Groundwater Characteristics: Low to moderate infiltration capacity along fractures and some bedding planes. The median yields of domestic wells and nondomestic wells are 20 and 60 gal/min, respectively. Water is soft to moderately hard and in some places contains excessive manganese.

Engineering Characteristics: Moderately easy to difficult to excavate using heavy equipment; sandstone and some siltstone beds may require blasting. Fast to moderate drilling rates. Generally maintains very steep to vertical cut slopes; has potential for large rockfalls from curved joint surfaces. Good to excellent foundation for heavy structures. Sloat Brook Member is suitable for impoundments, but Millrift Member has well-developed joints that may present problems. Slight to moderate percolation difficulty is a problem for septic systems. Relatively narrow outcrop belt and presence of hard, fractured sandstone and siltstone beds are limiting factors for siting of sanitary landfills.

Mineral Resources: Shale has limited potential as material for building brick or facing brick. Sloat Brook Member has marginal potential for lightweight aggregate. Sloat Brook Member and lower part of Millrift Member have good potential for road metal and random fill. Upper part of
Millrift Member has material suitable for riprap and embankment facing, and may have some potential for building stone or concrete aggregate.

Description from source map: [Pike County Geology and Mineral Resources, bedrock map](#)

**Dtsb - Trimmers Rock Formation, Sloat Brook Member (Upper Devonian)**

Dtsb - Trimmers Rock Formation, Sloat Brook Member (Upper Devonian)
Dominantly dark-gray to medium-dark-gray siltstone, shale, and sandstone; Millrift Member contains approximately 60 percent very fine grained sandstone, whereas Sloat Brook Member is dominantly siltstone and silt shale. Generally thin to medium bedded, although some sandstone in the Millrift Member is thick bedded; well-developed joints; poorly developed cleavage; forms low, subparallel ledges; marine fossils are common (especially brachiopods). Siltstone and shale disintegrate to hackly, platy, and chippy fragments; sandstone disintegrates to rubbly and slabby fragments. Deposited mostly by density currents in marine prodelta. Formation thickness ranges from 720 to 1,825 feet; Millrift Member has a maximum thickness of 1,000 feet; Sloat Brook Member has a maximum thickness of 950 feet.

Groundwater Characteristics: Low to moderate infiltration capacity along fractures and some bedding planes. The median yields of domestic wells and nondomestic wells are 20 and 60 gal/min, respectively. Water is soft to moderately hard and in some places contains excessive manganese.

Engineering Characteristics: Moderately easy to difficult to excavate using heavy equipment; sandstone and some siltstone beds may require blasting. Fast to moderate drilling rates. Generally maintains very steep to vertical cut slopes; has potential for large rockfalls from curved joint surfaces. Good to excellent foundation for heavy structures. Sloat Brook Member is suitable for impoundments, but Millrift Member has well-developed joints that may present problems. Slight to moderate percolation difficulty is a problem for septic systems. Relatively narrow outcrop belt and presence of hard, fractured sandstone and siltstone beds are limiting factors for siting of sanitary landfills.

Mineral Resources: Shale has limited potential as material for building brick or facing brick. Sloat Brook Member has marginal potential for lightweight aggregate. Sloat Brook Member and lower part of Millrift Member have good potential for road metal and random fill. Upper part of Millrift Member has material suitable for riprap and embankment facing, and may have some potential for building stone or concrete aggregate. Description from source map: [Pike County Geology and Mineral Resources, bedrock map](#)

**Dhm - Hamilton Group, undifferentiated (Middle Devonian)**

Dh - Undifferentiated Hamilton Group (Middle Devonian)
Shale, siltstone. In eastern Orange County: Skunnemunk Formation, sandstone, conglomerate; Bellvale Formation, shale, sandstone; Cornwall Shale.

Note: The GRI used the extreme western extent of Orange County from the source map referenced below. The source unit description indicates only a portion of the complete Hamilton Group is present in eastern Orange County but is not clear how much of the Hamilton Group is present on other parts of the map.

Description from source map: [New York Geology, Lower Hudson Sheet, bedrock map](#)
Dmh - Mahantango Formation (Middle Devonian)

Medium-dark-gray siltstone and shale. One-hour specific capacity is 0.20 gpm/ft; 24-hour potential yield is 70 gpm; water level below land surface is 26 feet; water is low in solutes, soft, and potentially corrosive. Specific conductance is 200 micromhos; hardness is 2.5 gpg. Description from source map: Monroe County Geology and Groundwater Resources.

Groundwater Characteristics: Low to moderate infiltration capacity along fractures. The median yields of domestic wells and nondomestic wells are 16 and 34 gal/min, respectively. Water is soft to moderately hard.


Mineral Resources: Limited potential for lightweight aggregate. Shale has potential as material for building brick and floor brick, but may have to be pelletized. Derived colluvium is used for surfacing secondary roads and for random fill (locally called sharpstone).

Description from source map: Pike County Geology and Mineral Resources, bedrock map

Dmh - Mahantango Formation (Middle Devonian)

Interbedded, dark-gray siltstone, shale, and claystone. Shale is thickly laminated to thin bedded and fissile to subfissile. Siltstone is medium to thick bedded and subfissile to non-fissile. Formation has moderate to good cleavage development; hackly and splintery fragmentation; zones of nodules parallel to bedding; forms cliffs along Delaware River valley and low, strike ridges on uplands; locally fossiliferous. Deposited in open-shelf to gentle-slope marine environment. Thickness ranges from 1,300 feet in the north to 2,450 feet in the east.

Dm - Hamilton Group, Mahantango Formation (Middle Devonian)

Medium-dark-gray fossiliferous siltstone and silty shale. Lower contact gradational through a 25- to 50-
foot interval. About 2,000 feet thick. Description from source map: Stroudsburg Quadrangle

**Dmhn - Mahantango Formation, Nis Hollow Member (Middle Devonian)**

A medium-light- to medium-dark-gray, laminated to medium-bedded, blocky, siliceous, slightly fossiliferous siltstone to very fine grained sandstone that weathers moderate brown to dark-yellowish brown. About 15 ft (5 m) thick. Description from source map: Saylorsburg Quadrangle

**Dmu - Mahantango Formation, upper member (Middle Devonian)**

Medium-dark-gray, fairly coarse grained, thin-bedded siltstone and silty shale; member is about 700 feet thick and is separated from lower member by the "Centerfield Reef." Unit has been exploited for fill material. Description from source map: Bushkill Quadrangle

**Dmhc - Mahantango Formation, Centerfield Member (Middle Devonian)**

Calcareous siltstone biostrome containing abundant horn corals. The Centerfield is about 25 feet thick. Description from source map: Saylorsburg Quadrangle

Conspicuous zone, lies about 850 ft (259 m) above base of formation in Weir Mountain syncline and is about 550 ft (168 m) above base in the northeast. Centerfield is a biostrome about 15-25 ft (5-8 m) thick and consists of medium-dark- to dark-gray, partly calcareous siltstone and laminated to poorly bedded silty shale. Weathers olive gray and grayish orange to dark yellowish brown. Contains abundant brachiopods, crinoids, bryozoans, gastropods, pelecypods, trilobites, cephalopods, and solitary and colonial corals. Popular fossil collecting locality is along Pa. State Route 115, 0.5 mi (0.8 km) northwest of Saylorsburg. Unit is also well exposed along Interstate 80 in the northeast corner of quadrangle. Description from source map: Saylorsburg Quadrangle

**Dmhf - Mahantango Formation, biostrome (Middle Devonian)**

Medium-light gray siltstones weathering grayish orange to dark yellowish orange and moderate brown. Biostromes appear to be discontinuous and occur at varying stratigraphic horizons. Description from source map: Saylorsburg Quadrangle
Dml - Mahantango Formation, lower member (Middle Devonian)

Virtually same lithology as upper member. Unit is about 1,100 feet thick. Lower contact is gradational but is marked by fairly abrupt change from lighter colored, harder, siltstone to darker colored, softer, silty shale of the Brodhead Creek Member of the Marcellus Shale. Unit has been exploited for fill material. Description from source map: Bushkill Quadrangle

Dm - Marcellus Shale (Middle Devonian)

Dark-gray to black shale, locally arenaceous, weathers medium-gray; fissile, predominantly thin-bedded, locally thick-bedded and massive; limonite-stained, fossiliferous. Upper contact with the Mahantango Formation not exposed but regionally is gradational, spanning several feet and marked by a fairly abrupt change from lighter colored, harder, siltstone to darker colored, softer, silty shale (Alvord and Drake, 1971; Herpers, 1951). Thickness is approximately 900 feet. Lower contact covered but probably an abrupt change from black shale to silty limestone (Alvord and Drake, 1971; Epstein, 1973). To the northwest in Pennsylvania, drill core suggests a lower contact gradational over a 40-foot interval from a black shale downwards through a limy shale into the silty limestone of the Buttermilk Falls Limestone (Fletcher and Woodrow, 1971). Description from source map: Culvers Gap and Lake Maskenoza Bedrock

Dm - Marcellus Formation (Middle Devonian)

Grayish-black, carbonaceous, fissile shale and silty shale, commonly overlain by thick, saturated, unconsolidated deposits.

One-hour specific capacity is 0.36 gpm/ft; 24-hour potential yield is 110 gpm; water level below land surface is 23 feet; water is low in solutes, soft to moderately hard, and potentially corrosive. Specific conductance is <200 micromhos; hardness is 4 gpg. Description from source map: Monroe County Geology and Groundwater Resources

Dm - Marcellus Shale (Middle Devonian)

(Vanuxem, 1840) - Medium-gray weathering, dark-gray to grayish-black, thin- to thick-bedded, fossiliferous, fissile and limonite-stained locally arenaceous shale. Lower contact grades downward over 12 m (40 ft) from black shale through limy shale, into silty limestone of the Buttermilk Falls Limestone (documented in drill core data of Fletcher and Woodrow, 1970). Approximately 274 m (900 ft) thick. Description from source map: New Jersey Bedrock Map

Dmr - Marcellus Formation (Middle Devonian)

Thin-bedded, slightly siliceous, dark-gray to grayish-black clay shale and silty clay shale, and some thin beds of argillaceous siltstone. Well-developed cleavage; disintegrates to chippy, flaky, and splintery fragments; forms steep bluffs above Bushkill; few marine fossils; intermittent zones of quartz-chlorite nodules parallel to bedding. Deposited in anoxic marine environment well below effective wave base. Maximum thickness is 950 feet.

Groundwater Characteristics:
Low infiltration capacity along fractures. Two domestic wells have a median yield of 3.75 gal/min. Water is soft.

Engineering Characteristics:
Moderately easy to excavate using heavy equipment; blasting is not usually required. Fast drilling rates. Generally maintains steep cut slopes; disintegrates to small fragments after prolonged exposure. Fair to good foundation for heavy structures. Unsuitable for septic systems.
due to poor percolation. Not suitable for sanitary-landfill sites because of steep slopes.

Mineral Resources:
Shale has some potential as material for building brick, limited potential for facing or floor brick, and marginal potential for lightweight aggregate; quartz-chlorite nodules and bands may be deleterious constituents. Formation is used for random fill; derived colluvium may be used for moderately impervious fill packing around foundations laid in unconsolidated surficial deposits.

Description from source map: Pike County Geology and Mineral Resources, bedrock map

Dm - Marcellus Shale (Middle Devonian)
Upper 600-700 ft (183-213 m) consists of medium-dark-gray to grayish-black, laminated to poorly bedded, sparingly fossiliferous shale and silty shale that weathers light gray to medium gray, light brown to moderate yellowish brown, and dark yellowish orange to grayish orange (Brodhead Creek Member). Underlain by about 150 ft (46 m) of poorly exposed medium- to medium-dark-gray, laminated to thin-bedded, calcareous shaly siltstone and argillaceous limestone (Stony Hollow Member) and about 50 ft (15 m) of unexposed medium-dark-gray shale (Union Springs Shale Member). Basal contact not exposed, but probably sharp. Description from source map: Saylorsburg Quadrangle

Dmb - Marcellus Shale, Brodhead Creek Member (Middle Devonian)
Dmb - Hamilton Group, Marcellus Shale, Brodhead Creek Member (Middle Devonian)
Dark-gray, evenly laminated, silty clay shale and clayey silt shale. Unit commonly contains very hard limy concretions and is well cleaved; bedding is generally obscured. Member is about 750 feet thick. Lower contact is gradational. Description from source map: Bushkill Quadrangle

Dmb - Hamilton Group, Marcellus Shale, Brodhead Creek Member (Middle Devonian)
Dark-gray, laminated to poorly bedded, sparingly fossiliferous, silty shale; maximum thickness 800 to 900 feet. Contains medium-dark-gray shaly limestone concretions as much as 1 foot long. Lower contact not exposed, probably gradational. Quarried for fill. Description from source map: Stroudsburg Quadrangle

Dmsu - Marcellus Shale, Stony Hollow and Union Springs Shale Members, undifferentiated (Middle Devonian)
Dmsu - Hamilton Group, Marcellus Shale, Stony Hollow Member and Union Springs Shale Member, undifferentiated (Middle Devonian)
Stony Hollow is interbedded medium-dark-gray, very limy silty to sandy shale, silty shale, and slightly limy shale. Unit is fairly fossiliferous and is well cleaved. Lower contact is probably gradational. The Union Springs, a dark shale unit, is not exposed in quadrangle. Members have a combined thickness of about 200 feet. Lower contact of the Union Springs is probably abrupt. Members have been exploited for fill material. Description from source map: Bushkill Quadrangle

Dmsu - Hamilton Group, Marcellus Shale, Stony Hollow and Union Springs Shale Members, undifferentiated (Middle Devonian)
At the top the Stony Hollow is medium-dark-gray to medium-gray, laminated to thin-bedded, sparingly fossiliferous (poorly preserved brachiopods), partly burrowed, pyritic, interbedded calcareous shaly siltstone, silty shale, and argillaceous limestone. Limestone beds are continuous, but pinch and swell. About 150 feet thick. Grades downward into Union Springs which is medium-dark-gray, laminated shale, about 50 feet thick. Lower contact not exposed, but probably sharp. Description from source map:
Stroudsburg Quadrangle

Db - Buttermilk Falls Limestone (Middle Devonian)

Upper part is medium-gray to medium-dark-gray, fossiliferous limestone and clayey limestone containing beds and cobble-sized nodules of dark-gray chert. Middle part is medium-gray, fossiliferous, silty limy clay-stone containing lenses of light-medium-gray limestone. Lower part is medium-dark-gray, fossiliferous, very limy siltstone and claystone and clayey limestone containing beds, pods, and lenses of dark-gray chert. Lower 30 to 50 feet of formation is characterized by large crinoid columnals. Formation is about 270 feet thick. Lower contact is gradational through an interval of a few feet. Unit has been exploited for road metal. Description from source map: Bushkill Quadrangle.

Db - Buttermilk Falls Limestone (Middle Devonian)

Medium- to dark-gray, clayey to silty limestone; locally contains bedded and nodular black chert. Limestone weathers light- to medium-light-gray and is thin- to medium-bedded, flaggy, and fossiliferous. Thickness is approximately 270 feet. Lower contacts is gradational through several feet, from silty limestone into the interbedded limestone and calcareous siltstone of the Schoharie Formation. Description from source map: Culvers Gap and Lake Maskenozha Bedrock.

Db - Buttermilk Falls Limestone (Middle Devonian)

(Willard, 1938) - Light- to medium-light-gray-weathering, medium- to dark-gray, thin- to medium-bedded, fossiliferous, flaggy, clayey to silty limestone and nodular black chert. Lower contact grades downward through several meters (feet) of silty limestone to interbedded limestone and calcareous siltstone of the Schoharie Formation. Thickness is approximately 82 m (270 ft). Description from source map: New Jersey Bedrock Map.

Db - Buttermilk Falls Limestone (Middle Devonian)

In Godfrey Ridge consists of three members, from top to bottom: Stroudsburg Member—Medium- to medium-dark-gray, fossiliferous, fine- to medium-grained, cherty, locally argillaceous, irregularly bedded, thin- to medium-bedded limestone that weathers light to medium light gray; about 150 ft (46 m) thick; lower contact gradational. The Tioga Ash Bed, a light-olive- to medium-dark-gray tuffaceous siltstone to very fine grained sandstone and crystal tuff with abundant bleached mica flakes, about 1 ft (0.3 m) thick, is not exposed in the quadrangle, but crops out 27 ft (8.2 m) below the top of the Stroudsburg Member near Stroudsburg, Pa., 3 mi (4.8 km) east of the Saylorsburg quadrangle; McMichael Member—Poorly exposed medium-to medium-dark-gray, thin- to medium-bedded, calcareous, partly silty, fossiliferous shale and medium-gray, lenticular to poorly bedded, fine-grained limestone; about 40 ft (12 m) thick; and Foxtown Member Medium-to medium-dark-gray, light- to medium-light-gray-weathering, fine- to very coarse grained, irregularly bedded limestone interbedded with dark-gray to grayish-black chert, and medium-dark-gray, calcareous, evenly bedded shale and siltstone; fossiliferous with sparse large crinoid columnals in lower half. Lower contact transitional through about 6 ft (1.8 m) of slightly sandy, cherty, calcareous siltstone and silty limestone; about 80 ft (24 m) thick. The Buttermilk Falls Limestone has not been subdivided in Cherry Ridge. Leached by deep pre-Wisconsinan weathering to white, gray, orange, brown, and red clay (Epstein and Hosterman, 1969). Many pits and collapsed mine workings outline poorly exposed unit. About 263 ft (80 m) thick near Saylorsburg. Lower contact probably sharp. Description from source map: Saylorsburg Quadrangle.

Db - Buttermilk Falls Limestone, undifferentiated (Middle Devonian)

Consists of three members. At the top is irregularly bedded medium-gray to medium-dark-gray, light-gray- to medium-light-gray-weathering, fossiliferous, fine- to medium-grained, locally argillaceous limestone in beds and lenses 1 inch to 1 foot thick, and dark-gray to grayish-black chert in irregular
beds, lenses, and pods 1/\text{inch} to 1 foot thick. Upper 15 feet contain several 3- to 6-inch-thick beds of medium-gray to medium-light-gray, light-gray-weathering, medium- to very coarse grained limestone with abundant brachiopod debris. Member is 150 feet thick. Grades downward into the middle member which is evenly bedded to lenticular medium-gray to medium-dark-gray, medium-gray-weathering, calcareous, partly silty, fossiliferous shale in beds 2 inches to 1 foot thick and medium gray fine-grained limestone in beds, lenses, and nodules 1 to 3 inches thick. Limestone contains ostracodes and brachiopod and crinoid debris. At east end of Godfrey Ridge, middle member is 41-42 feet thick. Grades downward into the lower member which is interbedded medium-gray to medium-dark-gray, light-gray- to medium-light-gray-weathering, fine- to very coarse grained, irregularly bedded to lenticular limestone in beds 1 inch to 2 feet thick, medium-dark-gray, calcareous, evenly bedded shale and siltstone in beds 1 inch to 1 foot thick, and grayish-black to dark-gray chert. Chert in lower half of member occurs as irregular nodules 1/2 to 6 inches in diameter. Chert is more abundant in upper half where it makes up more than 50 percent of unit and contains beds of calcareous argillite 1 to 2 inches thick and limestone pods 2 to 6 inches in diameter. Large crinoid columnals as much as 1 inch in diameter are conspicuous in lower half of member. Basal bed is a 1-foot-thick medium-gray, light-gray-weathering, medium-to very coarse grained limestone. Lower contact sharp. Lower member is 82 feet thick. Description from source map:

Stroudsburg Quadrangle

Dou - Onondaga Limestone (Middle and Lower Devonian)

Dou - Onondaga Limestone (Lower and Middle Devonian)
Description not available. Members include: Seneca Limestone, Morehouse (cherty) Limestone, Nedrow Limestone, Egdecliff (cherty) Limestone, local bioherms, Buttermilk Falls Limestone, Schoharie Formation shale and limestone, Carlisle Center Siltstone, Esopus Shale. Description from source map:

New York Geology, Lower Hudson Sheet, bedrock

Dp - Palmerton Sandstone (Middle and Lower Devonian)

Dp - Palmerton Sandstone (Middle and Lower Devonian)
Medium-dark- to very light gray, medium- to very coarse grained, generally massive sandstone and conglomeratic sandstone with rounded quartz pebbles as much as 0.75 in, (2 cm) long. A few beds of siltstone to fine-grained sandstone in basal 4 ft (1.2 m). Rare favositid corals, crinoid columnals, and brachiopod molds. Weathers pale yellowish orange to dark yellowish orange and very pale orange to grayish orange. Iron stained and may contain moderate brown ironstone concretions 0.5 in. (1.3 cm) in diameter at base. Lower contact sharp and irregular, probably a slight disconformity. Thins from 66 ft (20 m) along Pa. State Route 33 to about 40 ft (12 m) 2 mi (3.2 km) to the northeast, where quartz pebbles are less than 0.5 in. (1.3 cm) long. Unit is covered north of Cherry Ridge, pinches out, and grades into upper Schoharie Formation and lower Foxtown Member of the Buttermilk Falls Limestone (Db) in Godfrey Ridge. Description from source map: Saylorsburg Quadrangle

DSu - Devonian and Silurian rocks, undifferentiated (Middle and Lower Devonian and Upper Silurian)

DSu - Devonian and Silurian rocks, undifferentiated (Middle and Lower Devonian and Upper Silurian)
Structurally complex sequence of carbonate rocks, shales and siltstones, and minor calcareous sandstone and conglomerate. See Table 1 in text for a description of the individual formations in this unit.
One-hour specific capacity is 0.26 gpm/ft; 24-hour potential yield is 160 gpm (carbonate rocks may yield much more); water level below land surface is 15 feet. Water in noncarbonates is generally low in solutes and moderately hard; specific conductance is 200 to 400 micromhos; hardness is 5 to 7 gpg. Water in the carbonates is generally high in solutes and hard to very hard; specific conductance is 400 to 750 micromhos; hardness is 8 to 19 gpg. Description from source map: Monroe County Geology and Groundwater Resources

DSu - Devonian and Silurian rocks, undifferentiated (Devonian and Silurian)
The digital representation of the Geologic Map of the Stroudsburg Quadrangle developed by the GRI contains this unit for area where bedrock units under surficial deposits were unknown. DSu was not mapped according to the original publication. Description from source map: Stroudsburg Quadrangle

Ds - Schoharie Formation (Lower Devonian)

Ds - Schoharie Formation (Lower Devonian)
Medium-dark-gray, well-cleaved, fossiliferous, thick-bedded, clayey, limy siltstone. Formation is about 100 feet thick. Lower contact is gradational. Unit has been exploited for road metal. Description from source map: Bushkill Quadrangle

Ds - Schoharie Formation (Lower Devonian)
Medium- to thick-bedded, silty to shaly, locally dolomitic limestone containing local thin ribs or pods of black chert; weathers yellowish-gray to locally pale-olive. Grades downward into medium- to dark-gray calcareous siltstone at base. Bioturbated (Taonurus). Thickness approximately 175 feet. Gradational lower contact is at the first massive siltstone (Alvord and Drake, 1971). Description from source map: Culvers Gap and Lake Maskenozha Bedrock

Ds - Schoharie Formation (Lower Devonian)
(Vanuxem, 1840) - Yellowish-gray- to locally pale-olive-weathering, medium- to dark-gray, medium- to thick-bedded, calcareous siltstone and lesser amounts of silty limestone. Locally contains thin ribs or pods of black chert in limestone. Limestone content decreases in lower part of unit. Contains the trace fossil Taonurus, a grazing trail. Lower contact gradational and placed at top of highest massive siltstone below lowest limestone. Thickness approximately 53 m (175 ft). Description from source map: New Jersey Bedrock Map

Ds - Schoharie Formation (Middle and Lower Devonian)
Medium-gray to grayish-black. massive and laminated, evenly bedded. cherty, calcareous siltstone and lesser fine-grained, sandy siltstone. More calcareous beds weather lighter gray. Upper beds are more cherty and limy than the interval in the Stroudsburg quadrangle to the east. Burrow mottling is common: Taonurus common in lower half. Brachiopods common. Lower contact gradational through an interval of 10-20 ft (3-6 m) at the southwest end of Godfrey Ridge in the Eureka Stone Co. quarry. Has less well-developed cleavage than underlying Esopus Formation. More resonant sound when hit with a hammer than the Esopus Formation (De). About 100 ft (30 m) thick. Description from source map: Saylorsburg Quadrangle

Ds - Schoharie Formation (Lower Devonian)
Medium-gray to grayish-black, massive and laminated, evenly bedded, calcareous siltstone and lesser fine-grained sandy siltstone. More calcareous beds weather lighter gray. Beds are a few inches to 6 feet thick. Dark-gray chert which weathers light gray is scattered throughout as rounded and irregular nodules and lenses as much as 2 inches thick. Chert more abundant towards top. Burrow mottling common. Horizontal burrows (Taonurus) abundant in lower half; vertical burrows more common in upper half. Brachiopods common. At east end of quadrangle unit is 103 feet thick. Lower contact gradational
and placed at base of lowest massive siltstone. Not as well cleaved as underlying Esopus Formation. When hit with hammer yields a firmer "ring" as compared to duller sound of Esopus. Possible use for crushed stone. Description from source map: Stroudsburg Quadrangle

**Dse - Schoharie and Esopus Formations, undivided (Middle and Lower Devonian)**

Dse - Schoharie and Esopus Formations, undivided (Middle and Lower Devonian)
Poorly exposed and deeply weathered. Units cannot be mapped separately in Cherry Ridge, but can be distinguished in the roadcut along Pa. State Route 33. Total thickness is probably no more than 150 ft (46 m).

Schoharie Formation- Medium-light- to dark-gray on fresher surfaces, evenly bedded, fossiliferous, cherty siltstone to fine-grained sandstone, with rare medium-grained sandstone. Weathers shades of gray, orange, and brown. Lower contact gradational. About 35 ft (11 m) thick.

Esopus Formation- Dark-gray, laminated to fine-bedded silty shale and shaley siltstone with abundant Taonurus. Weathers shades of gray and orange, generally darker than overlying Schoharie. Basal contact not exposed, but probably sharp.

Description from source map: Saylorsburg Quadrangle

**De - Esopus Formation (Lower Devonian)**

De - Esopus Formation (Lower Devonian)
Medium-d to dark-gray, silty shale and clayey to sandy siltstone. Unit is poorly fossiliferous and is well cleaved; bedding is moderately obscured. Formation is about 180 feet thick. Lower contact is abrupt and probably unconformable. Unit has been exploited for road metal. Description from source map: Bushkill Quadrangle

De - Esopus Formation (Lower Devonian)
Medium- to dark-gray, shaly to finely arenaceous siltstone, minor calcareous siltstone near top. Laminated to medium-bedded with local massive thick-bedded layers. Weathers medium-gray with limonite staining in places. Bioturbated (Taonurus). Cleavage is developed in the southwest part of outcrop belt but not in the northeast. Thickness approximately 300 feet. Lower contact is sharp and unconformable where the formation is underlain by coarse sandstones of the Ridgely (Epstein 1984). Where the clastics are absent, the lower contact is reported by Spink (1965) to be conformable and gradational through an interval of several feet in which arenaceous and calcareous siltstones become interbedded with, then replaced by, silty limestones. Description from source map: Culvers Gap and Lake Maskenozha Bedrock

De - Esopus Formation (Lower Devonian)
(Vanuxem, 1842) - Medium-gray weathering, medium- to dark-gray, laminated to medium-bedded, partly massive, shaly to finely arenaceous siltstone, containing minor calcareous siltstone near top, locally limonite stained. Contains Taonurus. Rocks are cleaved in southwest and extreme northeast part of outcrop belt but not in central region. Lower contact sharp and unconformable where underlying Oriskany Group is coarse quartz sandstone. Elsewhere, lower contact conformable; fine sandstone to siltstone grades downward several meters into silty limestone. Thickness approximately 91 m (300 ft). Description from source map: New Jersey Bedrock Map
De - Esopus Formation (Lower Devonian)
Medium- to dark-gray, medium-gray weathering, shaly to finely arenaceous, laminated siltstone and lesser silty shale and minor calcareous siltstone. Bedding generally indistinct. Contains thin beds of calcareous siltstone near the base 0.6 mi (1 km) north of Bossardsville, similar to those in the overlying Schoharie Formation. Lower contact sharp. About 180 ft (5 m) thick. Description from source map: Saylorsburg Quadrangle

De - Esopus Formation (Lower Devonian)
Medium- to dark-gray, medium-gray-weathering, well-cleaved shaly to finely arenaceous laminated siltstone and lesser silty shale and minor calcareous siltstone. Moderate-yellowish-brown to dark-yellowish-orange iron staining is distinctive. Extensively burrowed (Taonurus). Brachiopods uncommon. Bedding generally indistinct. Unit is 181 feet thick 1 mile east of East Stroudsburg. Lower contact sharp. Description from source map: Stroudsburg Quadrangle

Do - Oriskany Group, undivided (Lower Devonian)
Do - Oriskany Formation (Lower Devonian)
Interbedded thin to thick units of conglomeratic, limy, coarse-grained quartz sandstone and silty, quartzose limestone containing medium dark-gray, irregularly shaped masses and thin beds of chert and beds of limy shale; ratio of sandstone to other lithologies decreases downward. Lenses of partly silicified coquina are common. Sandstone occurs in lenticular beds a few inches to a few feet thick that locally coalesce to form ledges as much as 15 to 20 feet thick. Formation is about 110 feet thick. Lower contact is gradational. Unit has been exploited for road metal. Description from source map: Bushkill Quadrangle

Do - Oriskany Group, undivided (Lower Devonian)
Ridgely Sandstone- Medium-gray, medium- to thick-bedded quartz-pebble conglomerate and coarse quartz sandstone. Sand grains are moderately well sorted and subrounded. Rock has a carbonate cement and contains abundant brachiopods. Unit first occurs west of Peters Valley, thickens to the southwest. Thickness ranges from 0 to 32 feet.

Shriver Chert- Black to dark-gray siltstone and shale containing interbedded mottled, black and white chert and medium-gray, thin-bedded, medium-crystalline limestone. Lower contact is gradational. Unit only found in the southwestern part of the map area. Thickness ranges from 0 to 28 feet.

Glenarie Formation- Medium- to dark-gray, fossiliferous, thin- to medium-bedded, cherty, fine-grained silty limestone. Unit is thin in the southwest and thickens to the northeast where it constitutes most of the Oriskany Group. Lower contact is gradational. Formation thickness ranges from 55 to 170 feet. Total thickness of Oriskany Group is approximately 170 feet. Description from source map: Culvers Gap and Lake Maskenozha Bedrock

Do - Oriskany Group, undivided (Lower Devonian)
Thickness ranges from 38 m (125 ft) in southwest to 52 m (170 ft) in northeast. Description from source map: New Jersey Bedrock Map

Do - Oriskany Group, undivided (Lower Devonian)
Ridgeley Sandstone at top is medium- to light-gray, fine- to very coarse-grained, evenly to unevenly bedded, planar-bedded to crossbedded, calcareous sandstone (orthoquartzite) and lesser conglomerate with quartz pebbles as much as 0.5 inch (1 cm) long that weathers brownish orange to orange gray; minor beds and lenses of medium-gray siltstone: arenaceous and argillaceous, fine-grained limestone: and dark-gray chert. Fossiliferous, abundant spiriferid brachiopods. Shriver Chert at bottom is
interbedded dark-gray chert and medium-dark-gray limestone in about equal amounts and minor medium- to light-gray, medium- to very coarse-grained, calcareous sandstone and conglomerate. Oriskany is about 95 ft (29 m) thick. Lower contact sharp and placed at base of lowest chert bed. Description from source map: Saylorsburg Quadrangle

Dr - Ridgeley Sandstone (Lower Devonian)

Dr - Ridgeley Sandstone of the Oriskany Group (Lower Devonian)
Medium- to coarse-grained, limonitic and hematitic, conglomeratic sandstone with pebbles as much as 0.75 in. (2 cm) long; weathers medium gray to yellowish orange. Many spiriferid brachiopod molds. Poorly exposed on Cherry Ridge. Probably less than 100 ft (30 m) thick. Base not exposed. Description from source map: Saylorsburg Quadrangle

Dors - Ridgeley Sandstone and Shriver Chert, undivided (Lower Devonian)

Do - Oriskany Group, Ridgeley Sandstone and Shriver Chert, undivided (Lower Devonian)
Ridgeley Sandstone at top is medium- to light-gray, brownish-orange- to orange-gray-weathering, fine- to very coarse grained, evenly to unevenly bedded, planar-bedded to cross bedded, calcareous sandstone (orthoquartzite) and lesser quartz-pebble conglomerate with pebbles as much as 1/2 inch long, with minor beds and lenses of medium-gray siltstone, arenaceous and argillaceous fine-grained limestone, and dark-gray chert. Beds 4 to 7 inches thick. Fossiliferous, with abundant spiriferid brachiopods. Ridgeley is 14-16 feet thick. Lower contact sharp and placed at base of predominantly sandstone interval. Shriver Chert at bottom is interbedded chert and limestone in about equal amounts and minor medium- to light-gray, calcareous, medium- to very coarse grained sandstone and conglomerate with quartz pebbles as much as 1/2 inch long in beds 1 inch to 2 feet thick. Chert is dark gray and occurs as nodules, lenses, and irregular beds about 2 inches to more than 5 feet thick with abundant spiriferid brachiopods. Limestone is medium dark gray, light- to medium-gray- and light-tannish-gray weathering, fine grained, siliceous, fossiliferous, and in nodules, lenses, and irregular beds about 2 inches to more than 10 feet thick. Shriver is 54-82 feet thick. Lower contact sharp and placed at base of lowest chert. Description from source map: Stroudsburg Quadrangle

Dh - Helderberg Group, undivided (Lower Devonian)

Dh - Helderberg Group, undivided (Lower Devonian)
Port Ewan Shale, Minisink Limestone, New Scotland Formation and Coeymans Formation. Only in cross sections. Description from source map: Culvers Gap and Lake Maskenozha Bedrock

Dpe - Port Ewen Shale (Lower Devonian)

Dp - Helderberg Group, Port Ewan Shale (Lower Devonian)
Upper section is dark- to medium-dark-gray; calcareous siltstone and shale, fossiliferous. Lower section is medium-dark-gray, calcareous silty shale, irregularly bedded, nonfossiliferous. Thickness is approximately 150 feet. Lower contact is abrupt and marked by the first occurrence of limestone. Description from source map: Culvers Gap and Lake Maskenozha Bedrock

Dp - Port Ewen Shale (Lower Devonian)
(Clarke, 1903) - Upper part is medium-gray- weathering, dark-to medium-dark-gray, thin- to medium-
bedded, fossiliferous, calcareous siltstone and shale. Lower part is medium-dark-gray, irregularly bedded nonfossiliferous, calcareous silty shale. Lower contact abrupt and placed at top of uppermost medium-gray, argillaceous limestone in Minisink Limestone. Thickness approximately 46 m (150 ft). Description from source map: New Jersey Bedrock Map

Dhg - Helderberg Group, Port Ewen Formation (Lower Devonian)
No description given. Description from source map: New York Geology, Lower Hudson Sheet, bedrock

Dpe - Port Ewen Shale of the Helderberg Group (Lower Devonian)
Medium-dark-gray, calcareous, fossiliferous, laminated to irregularly bedded, burrowed shaly siltstone and silty shale. Conspicuous cleavage. Shalier in lower half. About 150 ft (46 m) thick. Lower contact not exposed but probably sharp. Description from source map: Saylorsburg Quadrangle

Dp - Helderburg Group, Port Ewen Shale (Lower Devonian)
Medium-dark-gray, light-tannish-gray-weathering, calcareous, pyritic, fossiliferous (including brachiopods, corals, ostracodes, trilobites, crinoids), laminated to irregularly bedded, burrowed shaly siltstone and silty shale. Conspicuous cleavage. More shaly and less fossiliferous in lower 60 feet. At east end of Godfrey Ridge, 151 feet thick. Lower contact sharp. Description from source map: Stroudsburg Quadrangle

Dph - Helderberg Group, Port Ewen Shale, Minisink Limestone, and New Scotland Formation, undifferentiated (Lower Devonian)

Dph - Helderberg Group, Port Ewen Shale, Minisink Limestone, and New Scotland Formation, undifferentiated (Lower Devonian)
Port Ewen Shale- Upper 90 feet is fossiliferous, medium-dark-gray, irregularly bedded, limy siltstone and shale. Lower 60 feet is medium-dark-gray irregularly laminated limy shale and siltstone. Formation is about 150 feet thick. Lower contact is abrupt.

Minisink Limestone- Fossiliferous medium-dark-gray to dark-gray, fine-grained, clayey limestone. Formation is about 14 feet thick. Lower contact is abrupt or gradational.

New Scotland Formation- Medium-dark-gray to dark-gray fossiliferous, silty, limy shale containing beds and lenses of fossiliferous, medium-gray, clayey, fine-grained limestone. Lower 20 to 30 feet contains fine nodules and nodular beds of dark-gray chert. Formation is about 75 feet thick. Lower contact is abrupt.

Description from source map: Bushkill Quadrangle

Dmn - Minisink Limestone and New Scotland Formation, undivided (Lower Devonian)

Dmn - Helderberg Group, Minisink Limestone and New Scotland Formation, undivided (Lower Devonian)
Minisink Limestone- Medium-gray, fine-grained argillaceous limestone, medium-bedded, some nodules and lenses of a more calcium-rich limestone. Maintains a uniform thickness of 20 feet (Epstein and others, 1967). Lower contact covered but gradational elsewhere in the region (Epstein and others, 1967).

New Scotland Formation- Upper section dark-gray, siliceous, laminated shale containing medium-dark-gray-
gray, very fine-grained limestone pods; also scattered beds and lenses of medium-gray, fine-grained argillaceous, fossiliferous limestone. Limestone contains small, dark-gray chert nodules. Lower section is medium-dark-gray, siliceous, calcareous, fossiliferous shale containing beds and lenses of medium-gray, fine-grained, argillaceous, very fossiliferous limestone. Contains nodules, lenses and local irregular beds of dark-gray chert. Total thickness of formation is approximately 75 feet. Lower contact is abrupt, at the top of a calcareous quartz sandstone.

Description from source map: Culvers Gap and Lake Maskenozha Bedrock

Dmn - Minisink Limestone and New Scotland Formation, undivided (Lower Devonian)

Minisink Limestone- (Epstein and others, 1967) - Light-medium-gray-weathering, medium-gray, fine-grained, medium-bedded, partly massive, argillaceous fossiliferous limestone. Some nodules and lenses of purer limestone occur locally. Lower contact gradational. Thickness uniformly 7 m (23 ft).

New Scotland Formation- Siliceous shale, argillaceous limestone, calcareous shale. Description from source map: New Jersey Bedrock Map

Dmn - Helderburg Group, Minisink Limestone and New Scotland Formation, undifferentiated (Lower Devonian)

Medium-gray, fine-grained, argillaceous, irregularly bedded, fossiliferous limestone with thin beds of medium-dark-gray calcareous shale (Minisink Limestone, 14 feet thick) underlain gradationally to abruptly by dark- to medium-dark-gray fossiliferous silty and calcareous shale with lenses of argillaceous limestone and dark-gray chert (New Scotland Formation, Maskenozha Member above the Flatbrookville Member below, about 70 feet thick). Lower contact sharp. See Epstein and others (1967) and Epstein and Epstein (1969) for details. Description from source map: Stroudsburg Quadrangle

Dc - Coeymans Formation (Lower Devonian)

Dc - Helderberg Group, Coeymans Formation (Lower Devonian)

Chiefly finely crystalline to bioclastic, sandy to silty, medium-gray, fossiliferous limestone containing lenses and nodules of medium-gray chert. In area north of Tocks Island a reef facies of unit which consists of medium-light-gray to light-pinkish-gray, coarse-grained, massive to crudely bedded bioclastic limestone is well exposed. Top of formation is marked by Stormville Member (not mapped), 5 to 20 feet thick, which consists of lenses of fine- to medium-grained sandy limestone, and fine- to coarse-grained, crossbedded, limy sandstone and quartz-pebble conglomerate. Formation is about 110 feet thick. Lower contact is either abrupt or gradational. Limestone beds have been exploited for agricultural lime. Description from source map: Bushkill Quadrangle

Dc - Helderberg Group, Coeymans Formation (Lower Devonian)

Stormville Member, a medium-light- to medium-gray, fine- to coarse-grained calcareous sandstone containing lenses of arenaceous limestone. Lower contact marked by scoured surface. Northeast of Wallpack Center, the Stormville Member is replaced by the Kalkberg Limestone, a medium-bedded, medium-gray, medium-grained silty limestone with lenses and nodules of black chert. southwest of Wallpack Center the Kalkberg Limestone grades into the Shawnee Island Member, a medium-gray, medium- to coarse-grained limestone, medium-bedded, flaggy to massive, with local bioherms. Throughout the map area the basal Depue Limestone Member consists of medium-dark-gray, very fine- to fine-grained limestone, thin- to medium-bedded, massive to flaggy. Total thickness of all units approximately 90 feet. All units are fossiliferous. The lower contact of each member is gradational unless otherwise stated. Lower contact of formation is abrupt and marked by first occurrence of argillaceous limestone (Epstein and others, 1967). Description from source map: Culvers Gap and Lake Maskenozha Bedrock.
**Dc - Helderburg Group, Coeymans Formation, undifferentiated (Lower Devonian)**

Medium- to dark-gray arenaceous and argillaceous fossiliferous limestone and medium- to light-medium-gray fine- to coarse-grained calcareous sandstone and quartz-pebble conglomerate. About 80 feet thick. Consists of, from bottom to top, the Depue Limestone, Peters Valley, Shawnee Island, and Stormville Members. See Epstein and others (1967) and Epstein and Epstein (1969) for details. Description from source map: Stroudsburg Quadrangle

**Dkc - Kalkberg Limestone, Coeymans Limestone, Manlius Limestone (Lower Devonian)**

At New York border consists of fine-grained, chert-bearing, argillaceous limestone (Kalkberg Limestone) grading downward through coarse-grained limestone (Coeymans Limestone) into fine-grained limestone (Manlius Limestone). Toward southwest these units grade into fine- to coarse-grained limestone with a marked increase in quartz sand that comprises the Coeymans Formation (Epstein and others, 1967). Total thickness 27 m (90 ft). Description from source map: New Jersey Bedrock Map

**DSlhr - Lower Part of the Helderberg Group and Rondout Formation, undivided (Lower Devonian and Upper Silurian)**

Poorly exposed limestone, argillaceous limestone, calcareous sandstone and conglomerate, calcareous shale and dolomite, presumably similar to the rocks of the Rondout Formation, Coeymans Formation, New Scotland Formation, and Minisink Limestone in Godfrey Ridge farther east (Epstein, 1973, in press a). 200 ft (61 m) thick. Description from source map: Saylorsburg Quadrangle

**DShr - Shriver Chert of the Oriskany Group, Helderberg Group, and Rondout Formation, undivided (Lower Devonian and Upper Silurian)**

Partly exposed for the first time in 1983 in quarry at Bossardsville. Shriver Chert, Port Ewen Shale, Minisink Limestone, and New Scotland Formation are not exposed. Coeymans Formation comprises leached (presumably formerly calcareous) sandstone and quartz-pebble conglomerate. Dolomite, shale, and limestone of the Rondout Formation are exposed, but division into members is not certain. About 170 ft (52 m) thick. Description from source map: Saylorsburg Quadrangle

**DSrp - Rondout Formation (Lower Devonian and Upper Silurian)**

Dolostone, limestone. Description from source map: New York Geology, Lower Hudson Sheet, bedrock
**DSrd - Rondout and Decker Formations, undivided (Lower Devonian and Upper Silurian)**

**DSrd - Rondout and Decker Formations, undifferentiated (Upper Silurian and Lower Devonian)**
Rondout Formation - Upper part is medium-dark-gray to light-gray shale, limy shale, and clayey limestone; middle part is laminated dolomite; lower part is sandy and clayey fossiliferous limestone. Formation is characterized by mud cracks and locally abundant leperditiid ostracodes and is about 30 feet thick. Lower contact is abrupt. Limestone beds have been exploited for agricultural lime.

Decker Formation - Lenses and beds of limy, fine- to coarse-grained sandstone and minor siltstone, quartz-pebble conglomerate, and fossiliferous sandy fine- to coarse-grained limestone. Formation is about 85 feet thick. Lower contact is gradational. Description from source map: Bushkill Quadrangle

**DSrd - Rondout and Decker Formations, undivided (Lower Devonian and Upper Silurian)**
Rondout Formation - Upper part of formation is medium-dark-gray, very fine- to fine-grained, medium-bedded, argillaceous limestone. The middle part is medium-gray argillaceous dolomite; medium-bedded, massive to laminated, locally forms deep desiccation columns, weathers grayish-orange. Basal beds consist of medium- to dark-gray, very fine- to medium-grained limestone, medium-bedded. Total thickness approximately 40 feet. Silurian-Devonian boundary is within the middle part of the unit (Denkler and Harris, 1988). Lower contact is abrupt, marked by first occurrence of quartz sandstone.

Decker Formation (Upper Silurian)- Unit light- to medium-gray, calcareous quartz siltstone and sandstone, locally fine-pebble conglomerate. Locally interbedded with medium-gray, medium- to coarse-grained, thin- to medium-bedded limestone and very fine-grained dolomite. Total thickness approximately 72 feet. Lower contact is gradational (Epstein and others, 1967). Description from source map: Culvers Gap and Lake Maskenozha Bedrock

**DSrd - Rondout and Decker Formations, undivided (Lower Devonian and Upper Silurian)**
Rondout Formation - (Clarke and Schuchert, 1899) - Upper part is medium-gray weathering, medium-dark-gray, very fine to fine-grained, medium-bedded, fossiliferous, argillaceous limestone. Middle part is light-medium-gray-weathering, medium-gray, laminated to medium-bedded, argillaceous dolomite. Locally contains deep desiccation polygons. Lower part is medium-gray-weathering, medium- to dark-gray, very fine to medium-grained, medium-bedded fossiliferous limestone. Silurian-Devonian boundary placed in middle of formation (Denkler and Harris, 1988). Lower contact abrupt and placed at top of highest calcareous quartz sandstone. Thickness approximately 12 m (40 ft).

Decker Formation - (White, 1882) - Light-gray- to yellowish-gray-weathering, light- to medium-gray, calcareous quartz siltstone, sandstone, and fine-pebble conglomerate locally interbedded with fossiliferous medium-gray, medium- to coarse-grained limestone and very fine grained, thin- to medium-bedded dolomite. Lower contact gradational. Thickness varies from 15 m (50 ft) near Duttonville to 25 m (82 ft) at Wallpack Center.
Description from source map: New Jersey Bedrock Map

**DSrd - Rondout and Decker Formations, undifferentiated (Lower Devonian and Upper Silurian)**
Light- to dark-gray, mud-cracked, calcareous shale and argillaceous limestone, dark- to medium-dark-gray mud-cracked laminated dolomite with leperditiid ostracodes, and medium-gray biostromal limestone (Rondout Formation; from bottom to top, Duttonville, Whiteport Dolomite, and Mashipacong Members, 30 feet thick) underlain abruptly by crossbedded to planar-bedded calcareous quartz-pebble conglomerate, sandstone, siltstone, and argillaceous limestone (Decker Formation, 85 feet thick). Lower contact gradational. See Epstein and others (1967) and Epstein and Epstein (1969) for details.
Description from source map: Stroudsburg Quadrangle
**Sd - Decker Formation (Upper Silurian)**

Interbedded limestone and minor conglomerate, shale, siltstone, and dolomite. Limestone is medium light to medium gray, greenish gray, and pale purplish gray; weathers grayish orange and yellowish orange: very fine to medium grained; fine to medium bedded; arenaceous, argillaceous, pyritic, partly dolomitic, and fossiliferous (brachiopods, corals, and ostracodes). Sandstone is medium light gray to medium gray, weathers grayish orange, yellowish orange, and yellowish gray: very fine to medium grained, partly conglomeratic with quartz pebbles as much as 0.5 in. (1.3 cm) long, fossiliferous, calcareous, and limonitic. Shale and siltstone are pale greenish gray, partly calcareous, and weather pale yellowish gray to dark yellowish orange. Dolomite is medium gray to greenish gray, very fine grained, calcareous, mudcracked, and weathers pale yellowish orange. Lower contact transitional. About 70-100 ft (21-30 m) thick. Description from source map: Saylorsburg Quadrangle

**Sbv - Bossardville Limestone (Upper Silurian)**

Medium-gray to medium-dark-gray, laminated, very fine grained, clayey limestone characterized by deep mud cracks, and dark-medium-gray very fine grained laminated limestone. Formation is about 100 feet thick. Lower contact is gradational. In areas to the west, unit has been exploited for concrete aggregate, road metal, and cement limestone. Description from source map: Bushkill Quadrangle

Medium-gray to medium-dark-gray, very fine-grained, argillaceous limestone and limestone, weathers medium bluish gray. Thin-bedded, laminated to ribbon-textured. Desiccation columns and cracks occur in southwestern part of map area. Total thickness is approximately 100 feet. Lower contact is gradational and placed at top of uppermost dolomite. Description from source map: Culvers Gap and Lake Maskenozha Bedrock

(White, 1882) - Light-gray to yellowish-gray-weathering, medium-gray to medium-dark-gray, very fine grained, locally fossiliferous, laminated to thin-bedded limestone and argillaceous limestone. Desiccation polygons occur in southwest. Lower contact is gradational and placed at top of uppermost dolomite. Thickness approximately 30 m (100 ft) in southwest, thinning to 3.1 m (10 ft) at New Jersey-New York State boundary. Description from source map: New Jersey Bedrock Map

Medium- to dark-gray and lesser pinkish-gray and greenish-gray, light- to medium-light-gray weathering, very fine grained, argillaceous and pyritic, laminated to thin bedded, rippled limestone that is mudcracked in many places. Abundant leperditiid ostracodes throughout, and minor crinoids, brachiopods, and rugose corals near the top. Lower contact sharp. 95 feet (29 m) thick in the quarries at Bossardsville. Description from source map: Saylorsburg Quadrangle

Medium-gray to dark-gray, light-gray to grayish-orange-weathering, fine-grained to sublithographic, laminated (algal laminations?) to thin-bedded, slightly argillaceous and dolomitic, partly ostracode-rich limestone and lesser light-olive-gray laminae of calcareous shale. Lower 30-40 feet contains mudcrack intervals more than 5 feet deep. About 100 feet thick. Lower contact not exposed. At top is 13 feet of mud-cracked, laminated, medium-dark-gray dolomite with bed of stromatolitic intraclastic limestone. Used for crushed stone. Description from source map: Stroudsburg Quadrangle
Sp - Poxono Island Formation (Upper Silurian)
Limy or dolomitic, light-olive-gray to green, silty to sandy shale or claystone, olive-green dolomite, and minor very thin beds of fine-grained, limy sandstone and limy siltstone. Formation is about 700 feet thick. Lower contact is gradational. Description from source map: Bushkill Quadrangle

Sp - Poxono Island Formation (Upper Silurian)
Greensish-gray, finely crystalline to aphanitic dolomite containing discontinuous lenses with disseminated, rounded quartz grains; local quartz sandstone beds and argillaceous dolomite. Unit is thin- to medium-bedded, and flaggy. Thickness unknown but thought to be approximately 600 feet, based on well data south of map area. Lower contact thought to be gradational (Spink, 1967; Alvord and Drake, 1971 Epstein, 1973). Exposed only near Hainesville and along Little Flat Brook between Layton and Hainesville. Unit delineated by drill data (table 1). Description from source map: Culvers Gap and Lake Maskenozha Bedrock

Sp - Poxono Island Formation (Upper Silurian)
(White, 1882) - Greensish-gray, finely crystalline to aphanitic, thin- to medium-bedded, flaggy dolomite containing discontinuous lenses of disseminated, rounded quartz grains. Some local quartz sandstone beds and argillaceous dolomite. Lower contact gradational (Epstein, 1973). Formation poorly exposed; located by drill data. Thickness estimated at 183 m (600 ft) from well data. Description from source map: New Jersey Bedrock Map

Sp - Poxono Island Formation (Upper Silurian)
Medium-gray to greenish-gray and pinkish-green-gray, laminated to medium-bedded, very fine grained, calcareous, and mudcracked dolomite that weathers yellowish-orange to yellowish-gray; greenish-gray to dark-gray, very fine grained calcareous shale that weathers light gray to yellowish gray; and medium-light-gray to pinkish-gray, laminated to fine-bedded, very fine grained, mudcracked, dolomitic and argillaceous limestone that weathers pale to dark yellowish orange and contains ostracodes. Some red sandy shale poorly exposed in lower half of formation. Dissication breccia of angular dolomite clasts in limestone matrix, 0.5 ft (15 cm) thick, forms top. Lower contact not exposed, but probably gradational. About 700 ft (213 m) thick, with considerable tectonic thickening and thinning. Description from source map: Saylorsburg Quadrangle

Sp - Poxono Island Formation (Upper Silurian)
Calcereous, dolomitic, light-olive-gray to green, laminated to massive shale, olive-green dolomite, sandstone, and siltstone. Partly mudcracked. Not exposed in Stroudsburg quadrangle. About 700 feet thick. Lower contact gradational. Shown in sections only. Description from source map: Stroudsburg Quadrangle

Sb - Bloomsburg Red Beds (Upper Silurian)
Quartzitic, limonitic, pale- to grayish-red, purple and greenish-gray to pale-green, crossbedded, very fine to coarse-grained, partly conglomeratic sandstone in massive beds 1 foot to more than 10 feet thick interbedded with pale-red to grayish-red-purple, grayish-green, pale-green, greenish-gray, and dark-gray shale and siltstone and minor conglomerate containing rounded to angular quartz and red jasper pebbles as much as 1/2 inch long. Unit consists of about 50 percent sandstone, 45 percent shale, and 5 percent conglomerate. The formation is 1,200-1,500 feet thick at the Delaware Water Gap. Description from source map: Belvidere and Portland Quadrangles
(White, 1883) - Grayish-red (5 R 4/2) to dark-reddish-brown (10 R 3/4) shale, siltstone, and sandstone. Unit is about 800 ft thick at the New Jersey-New York State line (Epstein and Lyttle, 1987). Lower contact is gradational. No outcrops were found in the quadrangle. Description from source map: Branchville Quadrangle

**Sb - Bloomsburg Red Beds (Middle and Upper Silurian)**

Red, green, and gray, crossbedded sandstone, some of which is mud cracked (50 percent), siltstone and shale (45 percent), and conglomeratic sandstone (5 percent). Formation is about 1,500 feet thick. Lower contact is gradational and is placed at base of first red bed going up section. Color contact is extremely irregular, cuts across bedding, and varies radically within short distances. Unit has been exploited for road metal and fill material. Description from source map: Bushkill Quadrangle

**Sb - Bloomsburg Redbeds (Upper and Middle Silurian)**

Grayish-red, thin- to thick-bedded siltstone, sandstone, and local quartz-pebble conglomerate, poorly to moderately sorted, massive, with local planar to trough cross-beded laminations. Conglomerate consists of matrix-supported quartz pebbles in grayish-red, fine-grained sandstone. Rock near the base is greenish-gray to light-gray, locally grayish-orange quartz sandstone to siltstone with subrounded grains; massive, planar-tabular to trough cross-bedded. Thickness is approximately 1500 feet. Lower contact is abrupt, at last occurrence of red sandstone. Description from source map: Culvers Gap and Lake Maskenozha Bedrock

**Sb - Bloomsburg Formation (Upper and Middle Silurian)**

Structurally complex sequence of carbonate rocks, shales and siltstones, and minor calcareous sandstone and conglomerate. See Table 1 in text for description of the individual formations in this unit. One-hour specific capacity is 0.26 gpm/ft; 24-hour potential yield is 160 gpm (carbonate rocks may yield much more); water level below land surface is 15 feet. Water in noncarbonates is generally low in solutes and moderately hard; specific conductance is 200 to 400 micromhos; hardness is 5 to 7 gpg. Water in the carbonates is generally high in solutes and hard to very hard; specific conductance is 400 to 750 micromhos; hardness is 8 to 19 gpg. Description from source map: Monroe County Geology and Groundwater Resources

**Sb - Bloomsburg Red Beds (Upper Silurian)**

(White, 1883) (High Falls Shale of previous usage) -Grayish-red, thin- to thick-bedded, poorly to moderately well sorted, massive siltstone, sandstone, and local quartz-pebble conglomerate containing local planar to trough cross-beded laminations. Conglomerate consists of matrix-supported quartz pebbles in grayish-red, fine-grained sandstone matrix. Locally, near base of unit, is greenish-gray, light-gray, or grayish-orange, massive, planar tabular to trough cross-beded quartz sandstone to siltstone with subrounded grains. Lower part of formation marked by several upward-fining sequences of light-gray sandstone grading through grayish-red, fine-grained sandstone and siltstone to grayish-red, mudcracked siltstone and mudstone. Each sequence is 1 to 3 m (3-10 ft) thick. Lower contact placed at bottom of lowermost red sandstone. Thickness approximately 460 m (1,510 ft). Description from source map: New Jersey Bedrock Map

**Sbs - Bloomsburg Formation (Upper Silurian)**

Shale, sandstone. Description from source map: New York Geology, Lower Hudson Sheet, bedrock

**Sb - Bloomberg Red Beds (Middle and Upper Silurian)**

Pale-red to grayish-red-purple and greenish-gray to pale-green, crossbedded to planar bedded, very fine to coarse-grained, thin- to thick-bedded, partly conglomeratic sandstone; and pale-red to grayish-red-purple, grayish-green, pale-green, and greenish-gray, shale and siltstone with well-developed cleavage, partly mudcracked and with scattered ferroan dolomite concretions. Fining-upward cycles, with basal channel sandstones, are abundant. Lower contact placed at base of the first red bed going up section. About 1,500 ft (457 m) thick. Description from source map: Saylorsburg Quadrangle
Sb - Bloomsburg Red Beds (Middle Silurian)
Quartzitic, limonitic, hematitic, pale-red to grayish-red-purple and greenish-gray to pale-green, crossbedded to planar-bedded, very fine to coarse-grained, partly conglomeratic sandstone with red shale clasts in beds one foot to more than ten feet thick; pale-red to grayish-red-purple, grayish-green, pale-green, greenish-gray, and dark-gray shale and siltstone with prominent cleavage, partly mud-cracked, cut-and-fill structures, scattered ferroan dolomite concretions, local fish scales; and minor conglomerate with rounded to angular quartz and lesser red jasper pebbles as much as one-half inch in length. Many beds laterally variable over short distances. Upward fining cycles, with basal channel sandstones, are abundant. Formation is generally finer grained higher in the section. It consists of about 50 percent sandstone, 45 percent shale and siltstone, and 5 percent conglomerate in the lower half exposed at Delaware Water Gap. The lower contact is extremely irregular and is placed at base of the first red bed going up section. Thus defined, the contact cuts bedding and rises more than 700 feet within a horizontal distance of less than one mile in Delaware Water Gap. Unit is 800-1,500 feet thick. Possible use for fill. Description from source map: Stroudsburg Quadrangle

Ss - Shawangunk Formation (Middle and Lower Silurian)
(Mather, 1840; Epstein and Epstein, 1972) - Unevenly to moderately well bedded, thin-to thick-bedded, light-gray (N 7) to medium-dark-gray (N 4) and light-olive gray (5 Y 6/1), medium- to coarse-grained, partly crossbedded, limonitic, pyritic, and feldspathic quartzite, conglomeratic quartzite, and quartz-, chert-, and shale-pebble conglomerate containing pebbles as much as 2 in. long. Lower contact is abrupt and unconformable. A decollement occurs along this contact elsewhere. Unit is about 1,100 ft thick at the New Jersey-New York State line (Epstein and Lyttle, 1987). Description from source map: Branchville Quadrangle

Ss - Shawangunk Formation, undivided (Middle Silurian)
No description provided for undivided formation. See Tammany, Lizard Creek and Minsi Member descriptions. Description from source map: Culvers Gap and Lake Maskenozha Bedrock

Ss - Shawangunk Formation (Middlen and Lower Silurian)
Quartzose sandstone and conglomerate and some siltstone and shale. Forms crests of Kittatinny and Blue Mountains. Hydrologic data from one well indicate yields are low (5 gpm or less) and water levels are deep (as much as 212 feet below land surface). Water is low in solutes, soft, and potentially corrosive. Specific conductance is 65 micromhos; hardness is 1 gpg. Description from source map: Monroe County Geology and Groundwater Resources
locally approaches an arkose in composition. Lower contact unconformable and, at places, is a fault of small displacement. Thickness approximately 427 m (1,400 ft). Description from source map: New Jersey Bedrock Map

**Ss - Shawangunk Formation (Middle and Lower Silurian)**
(Mather, 1840; Epstein and Epstein, 1972) - Unevenly to moderately well bedded, thin-to thick-bedded, light-gray (N 7) to medium-dark-gray (N 4) and light-olive gray (5 Y 6/1), medium- to coarse-grained, partly crossbedded, limonite, pyritic, and feldspathic quartzite, conglomeratic quartzite, and quartz-, chert-, and shale-pebble conglomerate containing pebbles as much as 2 in. long. Lower contact is abrupt and unconformable. A decollement occurs along this contact elsewhere. Unit is about 1,270 ft thick in this area (Epstein and Lyttle, 1987). Description from source map: Newton West Quadrangle

**Ssu - Shawangunk Formation, upper quartzite member (Lower and Middle Silurian)**
Evenly to unevenly bedded, medium-gray to medium-dark-gray, fine- to coarse-grained, partly crossbedded, limonitic, pyritic, conglomeratic (contains quartzite and argillite pebbles as much as 2 inches long) quartzite interbedded with unevenly bedded dark-gray argillite. Argillite constitutes about 2 percent of unit. Member is 816 feet thick at the Delaware Water Gap. Description from source map: Belvidere and Portland Quadrangles

**Ssu - Shawangunk Formation, upper member (Lower and Middle Silurian)**
Medium-gray to medium-dark-gray, fine- to coarse-grained, partly crossbedded, limonitic, pyritic, conglomeratic, evenly to unevenly bedded quartzite containing about 2 percent dark-gray argillite. Member is about 825 feet thick. Lower contact is gradational. Description from source map: Bushkill Quadrangle

**Sst - Shawangunk Formation, Tammany Member (Middle Silurian)**
Locally thin, black to dark-greenish-gray shale near upper contact. Medium- to medium-dark-gray, dark-greenish-gray, medium- to thick-bedded, sandstone and pebble conglomerate; well rounded grains, some limonite staining. Conglomerate consists of matrix-supported quartz pebbles as large as 2 inches in a poorly- to well-sorted, planar-tabular to trough cross-bedded sandstone. Contains subordinate shale clasts. Lower contact is gradational (Epstein and Epstein, 1972). Description from source map: Culvers Gap and Lake Maskenozha Bedrock

**Sst - Shawangunk Formation, Tammany Member (Middle Silurian)**
Medium-gray to medium-dark-gray, fine- to coarse-grained, planar-bedded to crossbedded, thin- to thick-bedded, conglomeratic quartzite with quartz and argillite pebbles as much as 2 in. (5 cm) long. Lower contact gradational. About 550 ft (168 m) thick. Description from source map: Saylorsburg Quadrangle

**Sst - Shawangunk Formation, Tammany Member (Upper Ordovician (?) to Middle Silurian)**
Medium-gray to medium-dark-gray fine- to coarse-grained planar-bedded to crossbedded, limonitic, pyritic, conglomeratic (quartz and argillite pebbles as much as 2 in. long), evenly to unevenly bedded quartzite containing about 2 percent dark-gray argillite. Rare ferroan dolomite beds and calcite and ferroan dolomite concretions. 800 to 1,500 feet thick. Lower contact gradational. Possible use as building stone. Description from source map: Stroudsburg Quadrangle
Ssl - Shawangunk Formation, Lizard Creek Member (Middle Silurian)

Ssm - Shawangunk Formation, middle argillite-bearing member (Lower and Middle Silurian)
Evenly to unevenly bedded, thin- to thick-bedded, medium-light gray to medium-dark gray and light-olive-gray, fine-to coarse-grained, partly cross bedded, limonitic, pyritic, and evenly to unevenly bedded, medium-dark-gray argillite. Member is 273 feet thick at the Delaware Water Gap. Description from source map: Belvidere and Portland Quadrangles

Ssm - Shawangunk Formation, middle member (Lower and Middle Silurian)
Medium-light-gray to medium-dark-gray and light-olive-gray fine- to coarse-grained, partly crossbedded quartzite interbedded with thin- to very thick-bedded evenly to unevenly bedded medium-dark-gray to dark-gray argillite. Member is about 275 feet thick. Lower contact is gradational. Description from source map: Bushkill Quadrangle

Ssl - Shawangunk Formation, Lizard Creek Member (Middle Silurian)
Light- to medium-dark-gray or greenish-gray, interbedded sandstone and shale, thin- to medium-bedded, planar-tabular to trough cross-bedded; grains well rounded, moderately to well sorted. Sparse graphite flakes. Member is discontinuous and found to the southwest of the map area. Lower contact is gradational (Epstein and Epstein, 1972). Description from source map: Culvers Gap and Lake Maskenozha Bedrock

Ssl - Shawangunk Formation, Lizard Creek Member (Middle Silurian)
Medium-light- to dark-gray and light-olive-gray, very fine to coarse-grained, laminated to thick-bedded, crossbedded, flaser-bedded, partly channeled, limonitic, burrowed quartzite that weathers grayish to dark yellowish orange and contains some flattened argillite pebbles; interbedded with abundant medium-to dark-gray, laminated to fine-bedded, flaser-bedded, burrowed siltstone and shale. Lower contact transitional and placed at base of lowest argillite in sequence of abundant argillite. About 600 ft (183 m) thick. Description from source map: Saylorsburg Quadrangle

Ssl - Shawangunk Formation, Lizard Creek Member (Upper Ordovician (?) to Middle Silurian)
Medium-light-gray to medium-dark gray and light-olive-gray fine- to coarse-grained, laminated to planar-bedded, rippled and flaser-bedded, limonitic, pyritic, and graphitic (rare), quartzose sandstone containing burrows and trails and rare ball-and pillow structure, interbedded with medium-dark-gray to dark-gray laminated, flaser-bedded, evenly to unevenly bedded, burrowed siltstone and shale containing rare fossils (eurypterids and Dipleurozoa, reported, and Lingula). Rare beds with collophane (carbonate fluorapatite) nodules and quartz pebbles. 273 feet thick at Delaware Water Gap. Lower contact gradational. Description from source map: Stroudsburg Quadrangle

Ssm - Shawangunk Formation, Minsi Member (Middle Silurian)

Ssl - Shawangunk Formation, lower conglomeratic member (Lower and Middle Silurian)
Unevenly to moderately well bedded, thin- to thick-bedded, light-gray to medium-dark-gray and light-olive-gray, medium-to coarse-grained, partly crossbedded, limonitic, pyritic and feldspathic quartzite, conglomeratic quartzite, and quartz-, chert-, and shale-pebble conglomerate containing pebbles as much as 2 inches long. Interbeds of dark-gray, irregularly bedded, locally mud-cracked argillite constitutes about 7 percent of unit. Member is 300 feet thick at the Delaware Water Gap. Description from source map: Belvidere and Portland Quadrangles

Ssl - Shawangunk Formation, lower member (Lower and Middle Silurian)
Light-gray to medium-dark-gray and light-olive-gray, medium- to coarse-grained, partly crossbedded, thin- to thick-bedded quartzite, conglomeratic quartzite, and quartz, chert, and shale-pebble conglomerate. Contains about 7 percent dark-gray, irregularly bedded, locally mud-cracked argillite.
Member is about 300 feet thick. Lower contact is abrupt and unconformable. Description from source map: Bushkill Quadrangle

**Ssm - Shawangunk Formation, Minsi Member (Middle Silurian)**

Light- to medium-gray to light-olive-gray, thin- to thick-bedded, poorly- to well-sorted, cross- to planar-bedded, quartzitic and feldspathic sandstone, quartzite, and quartz-pebble conglomerate. Most clasts are quartz, some are matrix-supported. Local limonite staining. Locally approaches an arkosic composition. Total thickness of Shawangunk formation is approximately 1,400 feet. Lower contact is covered but within the region varies from an unconformity to a disconformity (Epstein and Lyttle, 1987) to a fault of small displacement. Description from source map: Culvers Gap and Lake Maskenozha Bedrock

**Ssm - Shawangunk Formation, Minsi Member (Middle Silurian)**

Very light to dark-gray and moderate-greenish-gray, fine-to coarse-grained, planar-bedded to crossbedded. laminated to thick-bedded, partly burrowed, conglomeratic quartzite that weathers light brown and grayish to dark yellowish orange, with quartz pebbles as much as 0.5 in. (1.3 cm) long and argillite clasts as much as 5 in. (13 cm) long, and minor medium-dark- to dark-gray siltstone and shale. Lower unconformable contact not exposed. About 250 ft (76 m) thick. Description from source map: Saylorsburg Quadrangle

**S0sm - Shawangunk Formation, Minsi Member (Upper Ordovician (?) to Middle Silurian)**

Light-gray to medium-dark-gray medium- to coarse-grained crossbedded to planar-bedded, limonitic, pyritic, unevenly to moderately evenly bedded, thin- to thick-bedded quartzite, conglomeratic quartzite, and quartz-, chert-, and shale-pebble conglomerate (quartz pebbles as much as 2 in. long). About 7 percent dark-gray irregularly bedded laminated locally mud-cracked argillite. 303 feet thick at Delaware Water Gap. Lower contact abrupt. Possible use as building stone. Description from source map: Stroudsburg Quadrangle

**Smd - Mafic dike (Lower Silurian)**

Medium-gray to greenish-gray, containing feldspar phenocrysts in a fine-grained groundmass. Thought to be related to the Beemerville Instrusive Suite for which Zartmand and others (1967) obtained a K-Ar date corrected to 443 ± 20 Ma by Eby and others (1992) who obtained a fission-track date of 422 ± 14 Ma. Description from source map: Culvers Gap and Lake Maskenozha Bedrock

**S0bl - Lamprophyre, tinguait (phonolite with acicular acmite crystals), phonolite, bostonite (trachyte), and malignite (mafic nepheline syenite), undifferentiated (Early Silurian? and Late Ordovician)**

Light-medium- to medium-dark-gray, aphanitic to fine-grained, alkalic to calc-alkaline dikes and sills. Unit intrudes rocks from the Middle Proterozoic to the High Point Member of the Martinsburg Formation, but does not intrude the Shawangunk Formation. K-Ar date of 422±14 Ma from biotite phenocrysts in a minette (lamprophyre with biotite phenocrysts) dike (Charles Milton, written commun., 1972) suggests an Early Silurian age for some of these rocks. Description from source map: New Jersey Bedrock Map
Beemerville Intrusive Suite

Obs - Beemerville Intrusive Suite, nepheline syenite (Upper Ordovician)
Medium- (N 5) to dark-gray (N 3), medium- to coarse-grained syenite composed of nepheline, orthoclase, socialite, aegirine, and biotite containing minor amounts of magnetite, apatite, titanite, fluorite, zircon, and pyrite. Rock is undeformed, but has a flow foliation near contacts. Biotite from the syenite has been dated at 424±20 Ma by the Rb-Sr method and 437±22 Ma by the K-Ar method (Zartman and others, 1967). Rock occurs in two stocks and a small plug in the Rutan Hill diatreme. Description from source map: Branchville Quadrangle

Obt - Beemerville Intrusive Suite, tinguaite (Upper Ordovician)
Medium- (N 5) to dark-gray (N 3) to greenish-gray (5 FY 6/1) fine-grained rock containing phenocrysts of orthoclase, nepheline, biotite, and aegirine. The groundmass contains fine-grained equivalents of the phenocrysts as well as titanite, apatite, magnetite, and zircon. Rock occurs as thin dikes in the nepheline syenite and in sills and dikes in the Martinsburg Formation. Description from source map: Branchville Quadrangle

Obp - Beemerville Intrusive Suite, phonolite (Upper Ordovician)
Medium-dark-gray (N 4), very-fine-grained rock composed mostly of nepheline and orthoclase. The rock has been strongly sericitized and chloritized and much of it has been albitized and (or) carbonatized. Rocks occurs as thin dikes within nepheline syenite and in sills and dikes within the Martinsburg Formation and Beekmantown Group. Description from source map: Branchville Quadrangle

Obb - Beemerville Intrusive Suite, bostonite (Upper Ordovician)
Medium- (N 5) to dark-gray (N 3) very-fine-grained rock containing phenocrysts of orthoclase that are commonly strongly altered. The groundmass is also largely orthoclase and in places contains microperthite and (or) plagioclase as well as minor amounts of aegirine, biotite, magnetite, apatite, and zircon. Rock occurs as sills and dikes within the Martinsburg Formation. Description from source map: Branchville Quadrangle

Obm - Beemerville Intrusive Suite, malignite (Upper Ordovician)
Dark-gray (N 3), medium- to coarse-grained rock characterized by bluish-white orthoclase and dead-white nepheline phenocrysts and abundant biotite. The rock matrix consists of the phenocrystic minerals, aegirine, melanite, magnetite, apatite, and titanite. Rock occurs as sills in the Martinsburg Formation. Description from source map: Branchville Quadrangle
Obl - Beemerville Intrusive Suite, lamprophyre (Upper Ordovician)

Obl - Beemerville Intrusive Suite, lamprophyre (Upper Ordovician)
Dark-gray (N 3) to grayish-black, very-fine-grained, intensely altered mafic rock of problematic original mineralogy. Maxey (1976) found that the lamprophyre between the nepheline syenite bodies was a micromelteigite, that is orthoclase-free, whereas two other relatively unaltered lamprophyres in the area contained both orthoclase and nepheline and were micromalignites. Lamprophyre occurs as dikes in the Martinsburg Formation, Beekmantown Group, and Allentown Dolomite. Description from source map: Branchville Quadrangle

Obo - Beemerville Intrusive Suite, ouachitite breccia (Upper Ordovician)

Obo - Beemerville Intrusive Suite, ouachitite breccia (Upper Ordovician)
Dark-gray (N 3) to black (N 1) breccia having an extremely fine-grained matrix of calcite, magnetite, biotite, chlorite, albite, and apatite that contains megacrusts of biotite, pyroxene, orthoclase, magnetite, apatite, and nepheline. The breccia contains xenoliths of Middle Proterozoic rocks, carbonate rocks of the Lehigh Valley sequence, and slaty-cleaved Martinsburg Formation and autoliths of potassic syenite lamprophyre, and carbonatite. The breccia occurs in diatremes in the Martinsburg Formation. Biotite from the Rutan Hill diatreme has been dated at 436±41 Ma by the Rb-Sr technique and 437±22 Ma by the K-Ar technique (Zartman and others, 1967). Description from source map: Branchville Quadrangle

Martinsburg Formation

Omp - Martinsburg Formation, Pen Argyl Member (Upper and Middle Ordovician)

Omp - Martinsburg Formation, Pen Argyl Member (Upper and Middle Ordovician)
No description given. Shown in section only. Description from source map: Belvidere and Portland Quadrangles

Omp - Martinsburg Formation, Pen Argyl Member (Middle and Upper Ordovician)
Not exposed, but presence is known from float. Dark-gray to grayish-black, thin- to very thick bedded slate, carbonaceous slate, and lesser subgraywacke. About 5,000 ft (1,524 m) thick in adjoining quadrangles to south and east. Description from source map: Saylorsburg Quadrangle

Omp - Martinsburg Formation, Pen Argyl Member (Middle and Upper Ordovician)
Dark-gray to grayish-black, thick- to thin-bedded (beds are commonly more than 10 feet thick), evenly bedded claystone slate rhythmically intercalated with quartzose slate or subgraywacke and carbonaceous slate in fining upwards sequences. Basal subgraywacke contains sole marks and internal sedimentary structures suggestive of turbidites. Probably more than 5,000 feet thick. Lower contact gradational. Quarried extensively for slate and used locally for lightweight aggregate and fill. Description from source map: Stroudsburg Quadrangle

Omh - Martinsburg Formation, High Point Member (Upper Ordovician)

Omhp - High Point Member of Martinsburg Formation (Upper Ordovician)
(Drake, 1991) - Thick or thick-appearing graywacke that at places contains intervals or interbeds of dark-colored shale. The thick-appearing beds result from sedimentary amalgamation. The graywacke typically is dark gray (N 3) on fresh surfaces and weathers light gray (5 Y 4/1). Many bed tops are marked by the
scoured remnants of shale, and much of the graywacke contains abundant rip-up clasts of shale, some of which are as long as 7 in. Many graywacke beds have graded bases and parallel laminated tops, whereas grading is the only sedimentary structure in other beds. Shale is grayish black (N 2) where fresh and pale yellowish brown (10 YR 6/2) where weathered. The unit is characterized by abundant load casts, some of which are as long as 15 in. Most of the graywacke is silica cemented, but many beds in the lower part of the unit have carbonate in their matrix. The member grades down into the Ramseyburg. The contact is placed at the first appearance upsection of thick-bedded graywacke or amalgamated graywacke, containing clasts of dark-colored shale. Graptolites collected from the upper part of the unit in the adjoining Port Jervis South quadrangle were assigned to the Climacograptus spiniferus zone by Berry (1971), so at least that part is Edenian (Caradocian) in age (Drake and others, 1989). Unit has a maximum thickness of about 375 ft in this quadrangle. Description from source map: Branchville Quadrangle

**Omhp - Martinsburg Formation, High Point Member (Upper Ordovician)**
Medium-gray to medium-dark-gray, medium-grained quartz sandstone with calcareous to siliceous cement, medium- to thick-bedded, massive, containing rip-ups of medium- to dark-gray shale and siltstone, weathers light-yellowish-gray. In terms of Bouma (1962) turbidite model, contains T<sub>a</sub>b to T<sub>a</sub>c sequences. Interbedded with medium-dark-gray, thin- to medium-bedded shale to fine sandstone corresponding to turbidite sequences T<sub>b</sub>e to T<sub>c</sub>e. Thickness regionally estimated at 4,500 feet thick, but feathers out in map area. Unit has a facies contact with the Ramseyburg Member along strike to the southwest. Lower contact gradational and placed at bottom of last observed thick-bedded, silica-cemented quartz sandstone with shale rip-ups (Drake, 1991). Description from source map: Culvers Gap and Lake Maskenozha Bedrock

**Omh - Martinsburg Formation, High Point Member (Upper Ordovician)**
(Drake, 1991) - Medium-dark-gray, thin-bedded shale, siltstone and fine-grained sandstone, containing turbidite sequences T<sub>b</sub>cde to T<sub>c</sub>d of Bouma (1962). Interbedded with less abundant, light-yellowish-gray-weathering, medium-gray to medium-dark-gray, medium-grained, medium- to thick-bedded and massive, quartz- and calcareous-cemented quartz sandstone containing rip-ups of medium- to dark-gray shale and siltstone that commonly consist of Bouma (1962) turbidite sequences Tab to Ta. Restricted to northeast section of Martinsburg outcrop belt. Thermally metamorphosed near intrusive bodies. Grades along strike to the southwest into Ramseyburg Member by decrease in average grain size, absence of shale rip-ups, and lack of siliceous cement. Lower contact gradational and placed at base of lowermost thick-bedded graywacke or amalgamated graywacke containing shale rip-ups. Unit assigned to Orthograptus ruedemanni zone to Climacograptus spiniferus zone of Riva (1969, 1974) using graptolites collected by Parris and Cruikshank (1992). Thickness ranges from 0 to 1,370 m (0-4,500 ft). Description from source map: New Jersey Bedrock Map

**Omhn - Martinsburg Formation, hornfels (Upper and Middle Ordovician)**

**Omh - Hornfels (Upper and Middle Ordovician)**
Dark-gray (N 3) to black (N 1), extremely fine-grained, very hard rock formed by the contact metamorphism of rocks of the Martinsburg Formation by nepheline syenite of the Beemerville Intrusive Suite. Small areas of hornfels surround the larger Beemerville sills, but were not mapped because of poor exposure. Description from source map: Branchville Quadrangle
Omr - Martinsburg Formation, Ramseyburg Member (Upper and Middle Ordovician)

Omr - Martinsburg Formation, Ramseyburg Member (Middle and Upper Ordovician)
Dark-gray, medium-gray- to yellowish-brown-weathering, thin-bedded claystone slate interbedded with gray to medium-gray, yellowish-brown-weathering, medium- to thick-bedded, graded graywacke and graywacke siltstone. Member contains a thick slate unit near the top that has been commercially exploited near Slateford. Member ranges from about 2,800 to 3,600 feet thick. Description from source map: Belvidere and Portland Quadrangles

Omr - Ramseyburg Member of Martinsburg Formation (Upper and Middle Ordovician)
Medium- to dark-gray slate that alternates with beds of light- to medium-gray, thin- to thick-bedded graywacke and graywacke siltstone. Graywacke composes 20-30 percent of unit. Pelitic beds contain the mineral assemblage muscovite-chlorite-albite-quartz. Unit is about 930 m thick. Description from source map: Blairstown Quadrangle

Omr - Ramseyburg Member of the Martinsburg Formation (Upper and Middle Ordovician) (Drake and Epstein, 1967) - Interbedded medium- to dark-gray slate and light- to medium-gray graywacke and graywacke siltstone. The graywacke beds range from about an inch to about 5 ft in thickness and average about 1 ft. The beds are very continuous in outcrop. Texturally, most of the graywacke is fine grained, but medium-grained sandstone occurs at places. Many beds contain the complete Bouma (1962) sequences, but basal cut-out sequences, particularly Tc-e sequences are most common. The Ramseyburg has been difficult to date because of its sparse and poorly preserved graptolite fauna. Drake and others (1989) estimate that it is Edenian (Caradocian) in age. The unit is about 3,500 ft thick in this quadrangle. Description from source map: Branchville Quadrangle

Omr - Martinsburg Formation, Ramseyburg Member (Middle and Upper (?) Silurian)
Medium-gray to dark-gray, thick- to thin-bedded claystone slate alternating with beds of light-gray to medium-gray, thin- to thick-bedded graywacke and graywacke siltstone. Graywacke constitutes about 20 to 30 percent of the unit. Member is about 2,800 feet thick. Lower contact is gradational. Slate from upper part of unit has been commercially exploited in Bangor-Pen Argyl area. Material is suitable for use as lightweight aggregate. Description from source map: Bushkill Quadrangle

Omr - Martinsburg Formation, Ramseyburg Member (Upper and Middle Ordovician)
Medium-gray to brownish-gray graywacke siltstone and sandstone thin- to thick-bedded, carbonate-cemented, fine to medium-grained, interbedded with medium-gray to dark-gray, thin-bedded shale. Interbedded graywacke and shale may form complete Bouma (1962) turbidite sequences, 0Ta-e, but basal cut out sequences, Tc-e dominate. Approximately 5,500 feet thick. Lower contact is gradational, placed at bottom of last occurrence of thick-bedded graywacke siltstone to sandstone (Drake and Epstein, 1967). Description from source map: Culvers Gap and Lake Maskenozha Bedrock

Omr - Ramseyburg Member of Martinsburg Formation (Upper (?) and Middle Ordovician)
Medium- to dark-gray slate with alternating interbeds of light- to medium-gray, thin- to thick-bedded graywacke and graywacke siltstone. Graywacke composes 20-30 percent of unit. Pelitic beds contain mineral assemblage muscovite-chlorite-albite-quartz. Unit is about 930 m thick. Description from source map: Eastern Belvidere and Portland Quadrangles

Omr - Martinsburg Formation, Ramseyburg Member (Upper and Middle Ordovician) (Drake and Epstein, 1967) - Interbedded medium- to dark-gray, to brownish-gray, fine- to medium-grained, thin- to thick-bedded graywacke sandstone and siltstone and medium- to dark-gray, laminated to thin-bedded shale and slate. Unit may form complete turbidite sequences, Tabcdde (Bouma, 1962), but basal cutout sequences Tcde dominate. Basal scour, sole marks, and soft-sediment distortion of beds
are common in graywacke. Thermally metamorphosed near intrusive bodies. Lower contact placed at bottom of lowest thick- to very thick bedded graywacke, but contact locally grades through sequence of dominantly thin-bedded shale and slate and minor thin- to medium-bedded discontinuous and lenticular graywacke beds in the Bushkill member. Parris and Cruikshank (1992) correlate unit with Orthograptus ruedemanni to lowest part of Climacograptus spiniferus zones of Riva (1969, 1974). Thickness ranges from 640 m (2,100 ft) in Delaware River Valley, to 1,524 m (5,000 ft) near Stillwater, to 1067 m (3,500 ft) at New York State line. Description from source map: New Jersey Bedrock Map

Omr - Ramseyburg Member of the Martinsburg Formation (Upper and Middle Ordovician)
(Drake and Epstein, 1967) - Interbedded medium- (N 5) to dark-gray (N 3) slate and light- (N 7) to medium-gray (N 5) graywacke and graywacke siltstone. The graywacke beds range from about 1 in. to about 5 ft in thickness and average about 1 ft. The beds are very continuous in outcrop. Texturally, most of the graywacke is fine grained, but medium-grained sandstone occurs at places. Many beds contain the complete Bouma (1962) sequence, but basal cut-out sequences, particularly T_{c-e} sequences are most common. The Ramseyburg has been difficult to date because of its sparse and poorly preserved graptolite fauna. Drake and others (1989) estimate that it is Edenian (Caradocian) in age. The unit is about 3,500 ft thick in this quadrangle. Description from source map: Newton West Quadrangle

Omr - Martinsburg Formation, Ramseyburg Member (Middle and Upper Ordovician)
Slate and graywacke. About 2,700 ft (823 m) thick. Description from source map: Saylorsburg Quadrangle

Omr - Martinsburg Formation, Ramseyburg Member (Middle and Upper Ordovician)
Medium- to dark-gray claystone slate alternating, in part cyclically, with light- to medium-gray, thin- to thick-bedded graywacke and graywacke siltstone (turbidites). Graywacke comprises about 20-25 percent of unit. About 2,800 feet thick. Lower contact gradational. Omrg, prominent graywacke-bearing intervals. Upper part quarried for slate. Description from source map: Stroudsburg Quadrangle

Omr - Martinsburg Formation, Ramseyburg Member, prominent graywacke-bearing intervals (Upper and Middle Ordovician)

Omr - Martinsburg Formation, Ramseyburg Member, graywacke beds (Middle and Upper Ordovician)
Graywacke beds within the Ramseyburg Member. Description from source map: Belvidere and Portland Quadrangles

Omb - Martinsburg Formation, Bushkill Member (Middle Ordovician)
Thin-bedded, dark-gray, medium-gray-to yellowish-brown-weathering, claystone slate containing minor thin interbeds of claystone siltstone, carbonaceous slate and near the base, dolomitic siltstone. Unit typically is ribbon slate. Member is about 4,000 feet thick. Description from source map: Belvidere and Portland Quadrangles

Omb - Bushkill Member of Martinsburg Formation (Middle Ordovician)
Dark- to medium-gray, thin-bedded slate containing thin beds of quartzose slate, graywacke siltstone, and carbonaceous slate. Upper contact is gradational. Contains mineral assemblage muscovite-chlorite-albite-quartz. Unit is about 1,350 m thick. Description from source map: Blairstown Quadrangle

**Omb - Bushkill Member of the Martinsburg Formation (Middle Ordovician)**
(Drake and Epstein, 1967) - Basal part of unit is black (N 1) to dark-gray (N 3) slate that passes upward into interbedded slate and graywacke siltstone. Few beds exceed 4 in. and most are less than half an inch in thickness. Silt-clay ratios range from about 1:3 to 1:6, and the different rock types form "ribbons" on slaty cleavage surfaces. In terms of Bouma's (1962) turbidite model most beds lack one or more of the basal units and can be classed as Tb-e, Tc-e, or Td-e turbidites; Tc-e beds appear to be most common. Unit grades down into the Jacksonburg Limestone by a decrease in pelitic material and an increase of carbonate. It has been difficult to date because of its sparse graptolite fauna that represents a very restricted and extreme biofacies. Only a few species have been found and they are both long-ranging and hard to identify. The Bushkill is younger than the Jacksonburg Limestone so its lower part is probably of Rocklandian and Kirkfieldian (Caradocian) age. This age assignment is supported by graptolites collected by Weller (1903) from euxinic dark slate from the small quarry on the hill about 3,700 ft N. 14° E. from the Township School which, if properly identified, suggest Riva's Diplograptus multidens zone and a Rocklandian and Kirkfieldian (Caradocian) age (Drake and others, 1989). On the basis of graptolites collected elsewhere from the Bushkill, it ranges from Kirkfieldian (Llandeilian) to Edenian (Caradocian) in age (Drake and others, 1989). The unit is about 1,500 ft thick in this quadrangle. Description from source map: Branchville Quadrangle

**Omb - Martinsburg Formation, Bushkill Member (Middle and Upper (?) Silurian)**
Thin bedded claystone slate. Shown in section only. Description from source map: Bushkill Quadrangle

**Omb - Martinsburg Formation, Bushkill Member (Middle Ordovician)**
Medium to medium-dark-gray, thin-bedded slate and subordinate interbeds of thin graywacke siltstone cemented by both carbonate and silica. Complete Bouma turbidite sequences occur in places although one or more of the basal beds is most commonly absent. These are classed as Tb-e, Tc-e or Td-e. Approximately 1,500 feet thick. Lower contact is gradational and placed at last occurrence of dark-gray slate. Description from source map: Culvers Gap and Lake Maskenozha Bedrock

**Omb - Bushkill Member of Martinsburg Formation (Upper Ordovician)**
Dark- to medium-gray, thin-bedded slate containing thin beds of quartzose slate, graywacke siltstone, and carbonaceous slate. Upper contact is gradational. Contains mineral assemblage muscovite-chlorite-albite-quartz. Unit is about 1,350 m thick. Description from source map: Eastern Belvidere and Portland Quadrangles

**Omb - Martinsburg Formation, Bushkill Member (Middle Ordovician)**
(Drake and Epstein, 1967) - Interbedded medium- to dark-gray, thinly laminated to thick-bedded shale and slate and less abundant medium-gray to brownish-gray, laminated to thin-bedded siltstone. To the southwest, fine-grained, thin dolomite lenses occur near base. Complete turbidite sequences (Bouma, 1962) occur locally, but basal cutout sequences (Tbcde, Tcde or Tde) dominate. Conformable lower contact is placed at top of highest shaly limestone; elsewhere, lower contact is commonly strain slipped. Correlates with graptolite Climacograptus bicornis to Corynoides americanus zones of Riva (1969, 1974) (Parris and Cruikshank, 1992). Thickness ranges from 1,250 m (4,100 ft) in Delaware River Valley to 457 m (1,500 ft) at New York State line. Description from source map: New Jersey Bedrock Map

**Omb - Bushkill Member of the Martinsburg Formation (Middle Ordovician)**
(Drake and Epstein, 1967) - Basal part of unit is black (N 1) to dark-gray (N 3) slate that passes upward into interbedded slate and graywacke siltstone. Few beds exceed 4 in. and most are less than half an inch in thickness. Silt-clay ratios range from about 1:3 to 1:6, and the different rock types form "ribbons"
on slaty cleavage surfaces. In terms of Bouma's (1962) turbidite model, most beds lack one or more of the basal units and can be classed as Tb-e, Tc-e, or Td-e turbidites. Tc-e beds appear to be most common. Unit grades down into the Jacksonburg Limestone by a decrease in pelitic material and an increase of carbonate. The Bushkill Member has been difficult to date because of its sparse graptolite fauna that represents a very restricted and extreme biofacies. Only a few species have been found, and they are both long-ranging and hard to identify. The Bushkill is younger than the Jacksonburg Limestone so its lower part is probably of Rocklandian and Kirkfieldian (Caradocian) age. This age assignment is supported by graptolites collected by Weller (1903) from the Branchville quadrangle to the northeast (Drake and Monteverde, in press a). These graptolites, if properly identified, suggest Riva's (1974) Diplograptus multidens zone and a Rocklandian-Kirkfieldian (Caradocian) age (Drake and others, 1989). Graptolites, probably Glyptograptus euglyphus (S.C. Finney, written commun., 1985) collected from basal Bushkill at the intersection of Routes 521 and 612 in Middleville support this assignment. On the basis of graptolites collected elsewhere from the Bushkill, it ranges from Kirkfieldian to Edenian (Caradocian) in age (Drake and others, 1989). Graptolites, probably Glyptograptus euglyphus (S.C. Finney, written commun., 1985) collected from basal Bushkill at the intersection of Routes 521 and 612 in Middleville support this assignment. On the basis of graptolites collected elsewhere from the Bushkill, it ranges from Kirkfieldian to Edenian (Caradocian) in age (Drake and others, 1989). Graptolites, probably Glyptograptus euglyphus (S.C. Finney, written commun., 1985) collected from basal Bushkill at the intersection of Routes 521 and 612 in Middleville support this assignment. On the basis of graptolites collected elsewhere from the Bushkill, it ranges from Kirkfieldian to Edenian (Caradocian) in age (Drake and others, 1989). Graptolites, probably Glyptograptus euglyphus (S.C. Finney, written commun., 1985) collected from basal Bushkill at the intersection of Routes 521 and 612 in Middleville support this assignment. On the basis of graptolites collected elsewhere from the Bushkill, it ranges from Kirkfieldian to Edenian (Caradocian) in age (Drake and others, 1989). Graptolites, probably Glyptograptus euglyphus (S.C. Finney, written commun., 1985) collected from basal Bushkill at the intersection of Routes 521 and 612 in Middleville support this assignment. On the basis of graptolites collected elsewhere from the Bushkill, it ranges from Kirkfieldian to Edenian (Caradocian) in age (Drake and others, 1989). Graptolites, probably Glyptograptus euglyphus (S.C. Finney, written commun., 1985) collected from basal Bushkill at the intersection of Routes 521 and 612 in Middleville support this assignment. On the basis of graptolites collected elsewhere from the Bushkill, it ranges from Kirkfieldian to Edenian (Caradocian) in age (Drake and others, 1989). Graptolites, probably Glyptograptus euglyphus (S.C. Finney, written commun., 1985) collected from basal Bushkill at the intersection of Routes 521 and 612 in Middleville support this assignment. On the basis of graptolites collected elsewhere from the Bushkill, it ranges from Kirkfieldian to Edenian (Caradocian) in age (Drake and others, 1989). Graptolites, probably Glyptograptus euglyphus (S.C. Finney, written commun., 1985) collected from basal Bushkill at the intersection of Routes 521 and 612 in Middleville support this assignment. On the basis of graptolites collected elsewhere from the Bushkill, it ranges from Kirkfieldian to Edenian (Caradocian) in age (Drake and others, 1989). Graptolites, probably Glyptograptus euglyphus (S.C. Finney, written commun., 1985) collected from basal Bushkill at the intersection of Routes 521 and 612 in Middleville support this assignment. On the basis of graptolites collected elsewhere from the Bushkill, it ranges from Kirkfieldian to Edenian (Caradocian) in age (Drake and others, 1989).

Omb - Martinsburg Formation, Bushkill Member (Middle and Upper Ordovician)
Thin-bedded slate. About 6,000 feet (1,829 m) thick. Shown in section only. Description from source map: Saylorsburg Quadrangle

Omb - Martinsburg Formation, Bushkill Member (Middle and Upper Ordovician)
Dark- to medium-gray thin-bedded to laminated claystone slate with thin beds of quartzose and graywacke siltstone and carbonaceous slate in upward fining sequences. About 4,000 feet thick. Base not exposed in quadrangle. Formerly quarried for slate. Description from source map: Stroudsburg Quadrangle

Oag - Austin Glen Formation (Middle Ordovician)
Graywacke, shale. Description from source map: New York Geology, Lower Hudson Sheet, bedrock

Oj - Jacksonburg Limestone, undivided (Middle Ordovician)
Dark-gray, almost black, fine-grained, thin-bedded argillaceous limestone and light- to medium-gray, medium- to coarse-grained, largely well-bedded calcarenite and fine- to medium-crystalline, high-calcium limestone. Upper contact is gradational. Apparent intraformational unconformity marked by conglomerate within the Paulins Kill window. Lower contact marked by beds of dolomite pebble- to boulder conglomerate in main outcrop belt. Argillaceous beds contain mineral assemblage calcite-chlorite-muscovite-albite-quartz. Unit contains North American Midcontinent province Conodont Fauna (8-9). Unit probably ranges from about 90 to 110 m in thickness. Description from source map: Blairstown Quadrangle

Oj - Jacksonburg Limestone (Middle Ordovician)
(Spencer and others, 1908; Miller, 1937) - Lower part is light- (N 7) to medium-gray (N 5), medium- to coarse-grained, largely well-bedded calcarenite and fine- to medium-crystalline, high-calcium limestone. Unit has a dolomite pebble-to cobbles-conglomerate at its base. Upper part is dark-gray (N 3) to black (N 1) fine-grained, thin-bedded argillaceous limestone. Unit contains North American Midcontinent Province
Conodont Fauna 8-9, and is of Rocklandian and Kirkfieldian (Caradocian) age (Savoy and others, 1981). Unit is about 125-200 ft thick in this quadrangle. Description from source map: Branchville Quadrangle

**Oj - Jacksonburg Limestone (Middle Ordovician)**
Upper part (cement-rock facies), when present, is dark-gray to black, thin- to medium-bedded or massive, argillaceous limestone. Lower part (cement limestone facies) is dark-gray, medium to coarse-grained limestone, medium-bedded, locally a fossil hash, weathers medium-bluish-gray. Dolomite-cobble conglomerate may occur at the basal contact and in the lower section of the lower facies. Formation approximately 80 feet thick. Lower contact is the Beekmantown unconformity. Description from source map: Culvers Gap and Lake Maskenozha Bedrock

**Oj - Jacksonburg Limestone, undivided (Middle Ordovician)**
Mapped in tectonic units above the Sarepta thrust fault where it is too thin and poorly exposed to divide. Description from source map: Eastern Belvidere and Portland Quadrangles

**Oj - Jacksonburg Limestone (Middle Ordovician)**
(Kümmel, 1908; Miller, 1937) - Upper part is medium- to dark-gray, laminated to thin-bedded shaly limestone and less abundant medium-gray arenaceous limestone containing quartz-sand lenses. Upper part thin to absent to northeast. Lower part is interbedded medium- to dark-gray, fine- to medium-grained, very thin to medium-bedded fossiliferous limestone and minor medium- to thick-bedded dolomite-cobble conglomerate having a limestone matrix. Unconformable on Beekmantown Group and conformable on the discontinuous sequence at Wantage in the Paulins Kill area. Contains conodonts of North American midcontinent province from Phragmodus undatus to Aphelognathus shatzeri zones of Sweet and Bergstrom (1986). Thickness ranges from 41 to 244m (135-800 ft). Description from source map: New Jersey Bedrock Map

**Oj - Jacksonburg Limestone (Middle Ordovician)**
(Spencer and others, 1908; Miller, 1937) - Lower part is light- (N 7) to medium-gray (N 5), medium- to coarse-grained, largely well-bedded calcarenite and fine- to medium-crystalline, high-calcium limestone. Unit has a dolomite pebble-to cobble-conglomerate at its base. Upper part is dark-gray (N 3) to black (N 1), fine-grained, thin-bedded argillaceous limestone. Unit contains North American Midcontinent Province Conodont Fauna 8-9. and is of Rocklandian and Kirkfieldian (Llandeilian) age (Savoy and others, 1981). Unit is about 125-200 ft thick in this quadrangle. Description from source map: Newton West Quadrangle

**Ojl - Cement limestone facies of Jacksonburg Limestone (Middle Ordovician)**
**Ojl - Jacksonburg Limestone, cement limestone facies (Middle Ordovician)**
Medium- to dark-gray, fine- to medium-grained, medium- to thick-bedded, high-calcium crystalline limestone and lesser light-to light-medium-gray, medium- to coarse-grained calcarenite. Unit probably is as much as 200 feet thick in the southwest part of the map area, but thins rapidly to the east and north. Description from source map: Belvidere and Portland Quadrangles

**Ojl - Cement limestone facies of Jacksonburg Limestone (Middle Ordovician)**
Light- to medium-gray, medium- to coarse-grained, largely well-bedded calcarenite and fine- to medium-crystalline high-calcium limestone. Upper contact is gradational in main outcrop belt but is marked by a conglomerate and an apparent unconformity within the Paulins Kill window. Lower contact is marked by beds of dolomite pebble to boulder conglomerate in main outcrop belt. Contains North American Midcontinent province conodont fauna 8-9. Unit is 20-30 m thick. Description from source map: Eastern Belvidere and Portland Quadrangles
Ow - Wantage Sequence (Middle Ordovician)

Ow - Sequence at Wantage (Middle Ordovician)
(Monteverde and Herman, 1989) – Restricted, discontinuous sequence of interbedded limestone, dolomite, conglomerate, siltstone, and shale. Upper part is medium-yellowish-brown- to olive-gray-weathering, medium- to dark-gray, very fine to fine-grained, laminated to massive limestone and dolomite that grade down into underlying clastic rocks of lower part. Upper part locally absent. Lower part ranges from grayish-red, medium-gray, pale-brown, and greenish-gray to pale-green mudstone and siltstone containing disseminated subangular to subrounded chert-gravel, quartz-sand lenses, and chert-pebble conglomerate. Lower contact unconformable. Thickness ranges from 0 to 46 m (0-150 ft). Description from source map: New Jersey Bedrock Map

Ow - Wantage Sequence (Middle Ordovician)

Interbedded very thin to medium-bedded limestone, dolomite, siltstone, and argillite. Upper carbonate facies is conformable with the Jacksonburg Limestone and grades downward into silty argillite. The carbonate rocks are medium- (N 5) to dark-gray (N 3), massive to laminated, very fine- to fine-grained, and may have a very thin moderate-yellowish-brown (10 YR 5/4) to olive-gray (5 Y 3/2) alteration rind. Argillite ranges from mudstone to siltstone with minor disseminated subangular to subrounded chert pebbles. Commonly thin bedded. Some coarser-grained beds are cross-stratified. Unit ranges from a feather edge to about 150 ft thick. Description from source map: Newton West Quadrangle

Obu - Upper Part of Beekmantown Group (Lower Ordovician)

Obu - Kittatinny Supergroup, Beekmantown Group, upper part (Lower Ordovician)
Locally preserved upper sequence consists of thin- to thick-bedded, aphanitic to medium-grained dolomite, medium-light to medium-gray, locally laminated and slightly fetid, weathers light to medium-gray to yellowish-gray. Grades downward into a medium- to thick-bedded, medium- to coarse-grained, medium-dark to dark-gray dolomite; strongly fetid, with a mottled weathered surface and pods and lenses of dark-gray to black chert. Cauliflower-textured black chart beds of variable thickness also occur locally. Grades downward into the laminated to thin-bedded, fine- to medium-grained dolomite of the Beekmantown Group, lower part. Thickness varies because of erosion at the Beekmantown unconformity, generally averages 200 feet. Contains North American Midcontinent Province conodont fauna high C through low D, so unit is of Ibexian (Tremadocian) age. Unit consists of Rickenbach and Epler Formations of Drake and Lyttle (1985) and Drake and others (1985), and is the Ontelaunee Formation of Markewicz and Dalton (1977). Description from source map: Culvers Gap and Lake Maskenozha Bedrock

Obu - Upper Part of Beekmantown Group (Lower Ordovician)

Locally preserved upper beds are light- to medium-gray- to yellowish-gray-weathering, medium-light- to medium-gray, aphanitic to medium-grained, thin- to thick-bedded, locally laminated, slightly fetid dolomite. Medium-dark to dark-gray, fine-grained, medium-bedded, sparsely fossiliferous limestone lenses occur locally. Lower beds are medium-dark- to dark-gray, medium- to coarse-grained, mottled surface weathering, medium- to thick-bedded, strongly fetid dolomite that contains pods and lenses of dark-gray to black chert. Cauliflower-textured black chert beds of variable thickness occur locally. Gradational lower contact is placed at top of laminated to thin-bedded dolomite of the lower part (Obl) of the Beekmantown Group. Contains conodonts high in the Rossodus manitouensis zone to low zone D of the North American midcontinent province as used by Sweet and Bergstrom (1986). Upper beds are included in Epler Formation; lower beds are included in Rickenbach Dolomite of Drake and Lyttle (1985) and Drake and others (1985); entire upper part (Obu) is Ontelaunee Formation of Markewicz and Dalton (1977). Thickness ranges from 0 to 244 m (0-800 ft). Description from source map: New Jersey Bedrock Map
**Oe - Epler Formation (Lower Ordovician)**

**Oe - Beekmantown Group, Epler Formation (Lower Ordovician)**
Interbedded, very fine grained to cryptogranoar, light-to-medium-gray limestone and fine- to medium-grained, light- to dark-medium-gray dolomite. Nodular and bedded chert is common. Unit also contains beds and lenses of orthoquartzite. The formation ranges from 650 to 800 feet thick in this area. Description from source map: Belvidere and Portland Quadrangles.

**Oe - Epler Formation (Lower Ordovician)**
Interbedded fine- to medium-grained, light- to dark-medium- gray dolomite and lesser very fine grained to cryptogranoar, light- to medium-gray limestone. Upper contact sharp and unconformable in this map area. Confined to Paulins Kill window. Contains North American Midcontinent province Conodont Fauna (low D to E). Unit is about 200 m thick. Description from source map: Blairstown Quadrangle.

**Oe - Epler Formation (Lower Ordovician)**
Interbedded fine- to medium-grained light-gray to dark-medium-gray dolomite and lesser very fine grained to cryptogranoar light- to medium-gray limestone. Upper contact is sharp and unconformable. Contains North American Midcontinent province conodont fauna low D - E. Thins rapidly in the main outcrop belt and is almost totally absent in the Sarepta quarry. Is present in the Lyon Station-Paulins Kill nappe within the Paulins Kill window (see cross section A - A', section U - U' in this document ). Unit is about 270 m thick. Description from source map: Eastern Belvidere and Portland Quadrangles.

**Or - Rickenbach Dolomite (Lower Ordovician)**

**Or - Beekmantown Group, Rickenbach Formation (Lower Ordovician)**
Fine- to coarse-grained, light-medium- to medium-dark-gray dololutite, dolarenite, and dolorudite. Sedimentary breccia and bedded and nodular chert are common. The formation ranges from about 500 to 650 feet thick. Description from source map: Belvidere and Portland Quadrangles.

**Or - Rickenbach Dolomite (Lower Ordovician)**
Fine- to coarse-grained, light-medium- to medium-dark-gray dololutite, dolarenite, and dolorudite. Lower part characteristically thick bedded, upper part generally thin bedded and laminated. Upper contact is gradational where Epler Formation (Oe) is present, otherwise unconformable. Contains North American Midcontinent province Conodont Fauna (mid C to low D). Unit is about 135 to as much as 200 m thick. Description from source map: Blairstown Quadrangle.

**Or - Rickenbach Dolomite (Lower Ordovician)**
(Hobson, 1957) - Medium (N 5) to dark-gray (N 3), medium- to coarse crystalline, thick-bedded, cherty, fetid dolomite. Contains zones of solution collapse breccia. Unit in this quadrangle contains conodonts of the Rossodus manitouensis zone of the North American Midcontinent Province Conodont Fauna, so it is of Ibexian (Tremadocian) age. Unit grades down into the Stonehenge Formation and is 325 to about 500 ft thick in this quadrangle. Description from source map: Branchville Quadrangle.

**Or - Rickenbach Dolomite (Lower Ordovician)**
Fine to coarse-grained, light-medium to medium-dark-gray dololutite, dolarenite, and dolorudite. Lower part characteristically thick bedded, upper part generally thin bedded and laminated. Upper contact is gradational where Epler Formation (Oe) is present, otherwise is unconformable. Contains North American Midcontinent province conodont fauna high C - low D. Unit is about 220 m thick. Description from source map: Eastern Belvidere and Portland Quadrangles.
Or - Rickenbach Dolomite (Lower Ordovician)
(Hobson, 1957) - Medium (N 5) to dark-gray (N 3), medium- to coarse crystalline, thick-bedded, cherty, fetid dolomite. Contains zones of solution collapse breccia. Unit in this quadrangle contains conodonts of the Rossodus manitouensis zone of the North American Midcontinent Province Conodont Fauna, so it is of Ibexian (Tremadocian) age. Unit grades down into the Stonehenge Formation and is about 150 to 300 ft thick in this quadrangle. It appears to be absent at places in the Paulins Kill valley and on the northwest limb of the Redings Pond syncline in the southeastern corner of the quadrangle. Description from source map: Newton West Quadrangle

Os - Stonehenge Formation (Lower Ordovician)
Os - Stonehenge Limestone (Lower Ordovician)
Light- to medium-gray, fine- to medium-grained, typically silt-ribbed and laminated limestone, earthy limestone, and solution-collapse breccia. Contains moderate to abundant amounts of interbedded, fine- to medium-crystalline, light- to medium-gray dolomite, and in places, dark-gray chert. Limestone and some dolomite beds are characteristically mottled and burrowed, and in strongly tectonized zones, boudins of dolomite float in limestone. In many places, the limestone has been completely dolomitized. Upper contact is gradational. Contains North American Midcontinent province Conodont Fauna (A to mid C). In areas of poor exposure and complex structure the unit is difficult to separate from Epler Formation (Oe) without paleontologic evidence. Unit is about 250 m thick. Description from source map: Blairstown Quadrangle

Os - Stonehenge Formation (Lower Ordovician)
(Stose, 1908; Hobson, 1957; Drake and Lyttle, 1985) - Medium-light- (N 6) to medium-dark-gray (N 4), fine- to medium-grained, thin- to medium-bedded dolomite and typically silt-ribbed and laminated dolomite, earthy, burrowed dolomite, and solution collapse breccia. Dark-gray (N 3) bedded and nodular chert is common. In this quadrangle, the basal beds are very sandy. Elsewhere in northern New Jersey, the unit contains silt-ribbed, laminated beds of limestone. Contains conodonts of zone A to Rossodus manitouensis zone of the North American Midcontinent Province Conodont Fauna, so it is of Ibexian (Tremadocian) age. Grades down into the Allentown Dolomite and is about 600 to 650 ft thick in this quadrangle. Description from source map: Branchville Quadrangle

Obl - Kittatinny Supergroup, Beekmantown Group, lower part (Lower Ordovician)
Very thin- to thick-bedded interbedded dolomite and minor limestone. The upper section of the unit consists of laminated, fine- to medium-grained, very thin- to thick-bedded, light-olive- to dark-gray dolomite, may weather dark-yellowish-orange. The middle section of the unit is fine-grained dolomite with sily dolomite laminas and thin- to medium-bedded, fine-grained limestone. The dolomite is dark-gray, aphanitic to fine-grained, locally well laminated, and weathers olive-gray, light-brown, and dark-yellowish-orange. The limestone is medium-dark to dark-gray, typically displays dolomitic “reticulate” mottling, characterized by anastomosing, light-olive-gray to grayish-orange laminas surrounding lenses of limestone, weathers light-gray to light-bluish-gray. The lower section of the unit consists of aphanitic to coarse-grained, thinly laminated to medium-bedded dolomite having very thin to thin, black chert beds, quartz-sand laminas, and rare oolites. The dolomite is medium-light to dark gray, massive, mottled, vuggy and locally slightly fetid. A lensing, very coarse to coarse-grained, light-gray dolomite occurs in the lower part of the sequence. "Floating” quartz sand and quartz-sand stringers occur near the base of the unit. Unit thickness is about 600 feet. Lower contact is placed on top of a distinctive steel-gray quartzite. The Beekmantown Group, lower part, does not crop out in study area, but is described from regional data; shown only in cross section. Contains North American Midcontinent Province conodont fauna A to mid C, so is of Ibexian (Tremadocian) age. Unit is the Stonehenge Formation of Drake and Lyttle (1985) and Drake and others (1985), and consists of the Rickenbach Formation and Epler Formation of Markewicz and Dalton (1977). Description from source map: Culvers Gap and Lake
Maskenozha Bedrock

Os - Stonehenge Limestone (Lower Ordovician)
Light- to medium-gray, fine- to medium-grained, typically silt-ribbed and laminated limestone, earthy limestone, and solution-collapse breccia. Contains moderate to abundant amounts of interbedded fine- to medium-crystalline, light- to medium-gray dolomite, and, in places, dark-gray chert. Limestone and some dolomite beds are characteristically mottled and burrowed. In strongly tectonized zones, boudins of dolomite float in limestone. In many places, limestone has been completely dolomitized. Upper contact is gradational. Contains North American Midcontinent province conodont fauna A- mid C. In areas of poor exposure and complex structure unit is difficult to separate from Epler Formation without paleontologic evidence. Occurs only in tectonic units above Sarepta thrust fault. Unit is about 250 m thick. Description from source map: Eastern Belvidere and Portland Quadrangles

Obl - Lower Part of Beekmantown Group (Lower Ordovician)
Very thin to thick-bedded, interbedded dolomite and minor limestone. Upper beds are light-olive-gray to dark-gray, fine- to medium-grained, thin- to thick-bedded dolomite. Middle part is olive-gray-, light-brown-, or dark-yellowish-orange- weathering, dark-gray, aphanitic to fine-grained, laminated to medium-bedded dolomite and light-gray to light-bluish-gray-weathering, medium-dark- to dark-gray, fine-grained, thin- to medium-bedded limestone, that is characterized by mottling with reticulate dolomite and light-olive-gray to grayish-orange, dolomitic shale laminae surrounding limestone lenses. Limestone grades laterally and down section into medium- gray, fine-grained dolomite. Lower beds consist of medium-light- to dark-gray, aphanitic to coarse-grained, laminated to medium-bedded, locally slightly fetid dolomite having thin black chert beds, quartz-sand laminae, and oolites. Lenses of light-gray, very coarse to coarse-grained dolomite and floating quartz sand grains and quartz-sand stringers at base of sequence. Lower contact placed at top of distinctive medium-gray quartzite. Contains conodonts of Cordylodus proavus to Rossodus manitouensis zones of North American Midcontinent province as used by Sweet and Bergstrom (1986). Unit Obl forms Stonehenge Formation of Drake and Lyttle (1985) and Drake and others (1985), upper and middle beds are included in Epler Formation, and lower beds are in Rickenbach Dolomite of Markewicz and Dalton (1977). Unit is about 183 m (600 ft) thick. Description from source map: New Jersey Bedrock Map

Os - Stonehenge Formation (Lower Ordovician)
(Stose, 1908; Hobson, 1957; Drake and Lyttle, 1985) - Medium-light- (N6) to medium-dark-gray (N 4), fine- to medium-grained, thin- to medium-bedded dolomite and typically silt-ribbed and laminated dolomite, earthy, burrowed dolomite, and solution collapse breccia. Dark-gray (N 3) bedded and nodular chert is common. In this quadrangle, the unit contains silt-ribbed, laminated beds of limestone at many places. Contains conodonts of zone A to Rossodus manitouensis zone of the North American Midcontinent Province Conodont Fauna (J.E. Repetski, USGS, written commun., 1985), so it is of Ibexian (Tremadocian) age. Grades down into the Allentown Dolomite and is about 275 to 650 ft thick in this quadrangle. Description from source map: Newton West Quadrangle

OCc - Carbonate Rocks (Ordovician and Cambrian)
Bedrock unit concealed beneath surficial layers and undeterminable on original source publications. This generalized unit was inferred by GRI from surrounding geology as unit, OCc. The GRI digital representations of the geologic maps for the Blairstown Quadrangle, Belvidere and Portland Quadrangles, Eastern Belvidere and Portland Quadrangles, and Stroudsburg Quadrangle contain this unit. However, OCc was not a mapped unit in the original source publications.
OCa - Allentown Dolomite (lowest Lower Ordovician and Upper Cambrian)

Ca - Allentown Dolomite (Upper Cambrian)
Very fine to medium-grained, light-medium-gray to light-olive-gray to dark-medium-gray, rhythmically bedded dolotulite, dolarenite, and dolorudite. Unit is characterized by alternating light- and dark-weathering beds, abundant stromatolites, oolite beds, and scattered beds and lenses of orthoquartzite. The formation is about 1,700 feet thick where unfaulted. Description from source map: Belvidere and Portland Quadrangles

OCa - Allentown Dolomite (lowest Lower Ordovician and Upper Cambrian)
Very fine to medium-grained, light- to medium-dark gray, alternating light- and dark-gray weathering, rhythmically bedded dolomite containing abundant algal stromatolites, oolite beds, and scattered beds and lenses of orthoquartzite. Upper contact is gradational. Unit is about 575 m thick. Description from source map: Blairstown Quadrangle

OCa - Allentown Dolomite (Lowest Lower Ordovician and Upper Cambrian)
(Wherry, 1909) – Light- (N 7) to dark-gray (N 3), fine- to medium-crystalline, thin- to medium-bedded, massive to laminated, rhythmically bedded dolomite that typically weathers to light and dark gray. Nodular and bedded chert and orthoquartzite are common. Unit is characterized by oolite, algal stromatolites, intraformational conglomerate, ripple marks, and mud cracks. Conodonts have never been found in the unit, but shelly fauna collected from near the bottom and top of the formation elsewhere in New Jersey have, respectively, Dresbachian and Trempealeauan ages (Howell, 1945; Howell and others, 1950). The thickness of the unit cannot be determined in this quadrangle because of thrust faulting. It is about 1,900 ft thick in northern New Jersey. Description from source map: Branchville Quadrangle

OCa - Kittatinny Supergroup, Allentown Dolomite (lowest Lower Ordovician and Upper Cambrian)
Very thin- to very thick-bedded, interbedded dolomite with minor clastics. Upper dolomite is generally medium- to very thick-bedded, fine- to medium-grained with local coarse-grained beds, medium-dark to medium-light gray. “Floating” quartz sand and two sequences of medium-light to very light-gray, thin-bedded quartzite and discontinuous dark-gray chert lenses occur directly below the upper contact. A rhythmically bedded lower dolomite sequence is medium- to very light-gray weathering, contains oolites and stromatolites. Weathered exposures characterized by alternating light- and dark-gray beds. Ripple marks, cross-bedding, edgewise conglomerate, mud cracks, and paleosol zones occur in the lower unit. Interbedded shaly dolomite increases in abundance towards the lower gradational contact. Crops out only in the southeast corner of the map area. Thickness from estimates made outside the map area is about 1,900 feet. Description from source map: Culvers Gap and Lake Maskenozha Bedrock

OCa - Allentown Dolomite (lowest Lower Ordovician and Upper Cambrian)
Very fine to medium-grained, light-gray to medium-dark-gray, weathered to alternating light- and dark-gray bands, rhythmically bedded dolomite containing abundant algal stromatolites, oolite beds, and scattered beds and lenses of orthoquartzite. Upper contact is gradational. Unit is about 575 m thick. Description from source map: Eastern Belvidere and Portland Quadrangles

OCa - Allentown Dolomite (Lowest Lower Ordovician and Upper Cambrian)
(Wherry, 1909) – Very thin to very thick bedded dolomite containing minor orthoquartzite and shale. Upper part is medium-light- to medium-dark-gray, fine- to medium-grained, locally coarse-grained, medium- to very thick bedded dolomite. Floating quartz sand grains and two sequences of medium-light- to very light gray, thin-bedded quartzite and discontinuous, dark-gray chert lenses occur directly below upper contact. Rhythmically bedded lower dolomite beds alternate between light and dark gray weathering, medium and very light gray, fine and medium grained, and thin and medium bedded, which are interbedded with shaly dolomite. Ripple marks, crossbeds, edgewise conglomerate, mud cracks, oolites, and algal stromatolites occur throughout unit, but more typically in lower part. Shaly dolomite
increases downward toward lower conformable contact with the Leithsville Formation. Oldest beds contain trilobite fauna of early Late Cambrian age; younger beds contain latest Cambrian fauna (Howell, 1945; Howell and others, 1950). Thickness about 580 m (1,900 ft). Description from source map: New Jersey Bedrock Map

**OCa - Allentown Dolomite (Lowest Lower Ordovician and Upper Cambrian)**
(Wherry, 1909) - Light- (N 7) to dark-gray (N 3), fine- to medium-crystalline, thin- to medium-bedded, massive to laminated, rhythmically bedded dolomite that typically weathers to light and dark gray. Nodular and bedded chert and orthoquartzite are common. Unit is characterized by oolite, algal stromatolites, intraformational conglomerate, ripple marks, and mud cracks. Conodonts have never been found in the unit, but shelly fauna collected from near the bottom and top of the formation elsewhere in New Jersey have, respectively, Dresbachian and Trempealeauan ages (Howell, 1945; Howell and others, 1950). The thickness of the unit cannot be determined in this quadrangle because of thrust faulting. Unit is about 1,900 ft thick in northern New Jersey. Description from source map: Newton West Quadrangle

**CI - Leithsville Formation (Middle and Lower Cambrian)**

**Cl - Leithsville Formation (Middle (?) Cambrian)**
Shown in section only. No description given. Description from source map: Belvidere and Portland Quadrangles

**Cl - Leithsville Formation (Middle and Lower Cambrian)**
Interbedded light-medium- to dark-gray, fine- to coarse-grained dolomite and calcitic dolomite, light-gray to tan phyllite, and very thin beds and stringers of quartz and dolomite sandstone. Upper contact is gradational. Unit probably contains a major intraformational disconformity marking the Middle-Lower Cambrian boundary. Phyllite contains mineral assemblage muscovite-chlorite-albite-quartz. Unit is about 350 m thick. Description from source map: Blairstown Quadrangle

**Cl - Leithsville Formation (Middle and Lower Cambrian)**
(Wherry, 1909) - Thick-bedded, medium- (N 5) to medium-dark-gray (N 4) finely crystalline dolomite cyclically interbedded with platy- and shaly-bedded dolomite. Elsewhere in New Jersey, the unit contains archaeocyathids in its lowest part suggesting an intraformational disconformity separating rocks of Middle Cambrian age from those of Early Cambrian age (Palmer and Rozanov, 1976). The outcropping rocks in this quadrangle appear to belong to the lower part of the unit. Unit grades down into the Hardyston Quartzite. The thickness of the unit cannot be determined because of the glacial cover. In northern New Jersey, it is about 1,150 ft thick. Description from source map: Branchville Quadrangle

**Cl - Leithsville Formation (Middle and Lower Cambrian)**
(Wherry, 1909) - Thin- to thick-bedded dolomite containing subordinate siliciclastic rocks. Upper part is medium- to medium-dark-gray, fine- to medium-grained, pitted, friable, mottled and massive dolomite. Middle part is medium-gray, stylolitic, fine-grained, thin- to medium-bedded dolomite that is interbedded with shaly dolomite and, less commonly, varicolored quartz sandstone, siltstone, and shale. Lower part is medium-gray, medium-grained, medium-bedded dolomite containing quartz-sand grains in stringers and lenses near the contact with the Hardyston Quartzite. Archaeocyathids of Early Cambrian age suggest an intraformational disconformity separating rocks of Middle and Early Cambrian age (Palmer and Rozanov, 1976). Thickness approximately 305 m (1,000 ft). Description from source map: New Jersey Bedrock Map

**Cl - Leithsville Formation (Middle and Lower Cambrian)**
Thick-bedded, medium- (N 5) to medium-dark-gray (N 4) finely crystalline dolomite cyclically interbedded with platy- and shaly-bedded dolomite. Elsewhere in New Jersey, the unit contains archaeocyathids in
its lowest part, suggesting an intraformational disconformity separating rocks of Middle Cambrian age from those of Early Cambrian age (Palmer and Rozanov, 1976). The outcropping rocks in this quadrangle appear to belong to the lower part of the unit. Units grades down into the **Hardystone Quartzite**. In northern New Jersey, the unit is about 1,150 ft thick. Shown in section only. Description from source map: **Newton West Quadrangle**

**Ch - Hardyston Quartzite (Lower Cambrian)**

**Ch - Hardyston Quartzite (Lower Cambrian)**
Gray, brown-weathering quartzite, quartz-pebble conglomerate, arkosic sandstone, silty shale, and yellowish-brown, iron-stained jasper. Unit has maximum thickness of about 30 m. Description from source map: **Blairstown Quadrangle**

**Ch - Hardyston Quartzite (Lower Cambrian)**
Quartzite, arkosic quartzite, and conglomerate. Unit is assumed to be about 100 ft thick in the subsurface in this quadrangle. Unit contains Early Cambrian trilobites at several localities in northern New Jersey. Shown in section only. Description from source map: **Branchville Quadrangle**

**Ch - Hardyston Quartzite (Lower Cambrian)**
Light-gray (N 7), thin- to medium-bedded pebbly sandstone interlayered with beds containing quartz sand and pebbles in a dolomite matrix. Unit contains Early Cambrian trilobites at several localities in northern New Jersey. The unit is interpreted to be about 100 ft thick in the subsurface in this quadrangle. Shown in section only. Description from source map: **Newton West Quadrangle**

**Ymv - Venite (Middle Proterozoic)**

**Ymv - Venite (Middle Proterozoic)**
Mixed rock consisting of amphibolite containing veins, lenses, and irregular blotches of albite-oligoclase granite. Unit is thought to be partly mobilized, amphibolite-rich phases of the Losee Metamorphic Suite. Description from source map: **Blairstown Quadrangle**

**Yba - Microperthite alaskite (Middle Proterozoic)**

**Yba - Microperthite alaskite (Middle Proterozoic)**
Medium- to coarse-grained, light-pink to light-gray foliated alaskite and gneissoid alaskite composed largely of microperthite, quartz, and oligoclase. Description from source map: **Blairstown Quadrangle**

**Ybh - Hornblende granite (Middle Proterozoic)**

**Ybh - Hornblende granite (Middle Proterozoic)**
Medium- to coarse - grained, pink to light-gray, gneissoid granite, foliated granite, and sparse granite gneiss composed principally of microperthite, quartz, oligoclase, and hornblende. In granite gneiss phases microperthite has typically unmixed and rock contains free microcline and oligoclase. Unit contains fairly abundant interlayers of amphibolite (Ya) and migmatized Ya. Description from source map: **Blairstown Quadrangle**
Ymr - Marble (Middle Proterozoic)

Dolomite and calcite marble. Much of dolomite marble largely altered to serpentine, tremolite, and talc.
Description from source map: Blairstown Quadrangle

Yq - Quartz-plagioclase-epidote-biotite gneiss (Middle Proterozoic)

Light-gray, typically coarse-grained, rather massive, layered, calc-silicate rock associated with marble (Ymr)
Description from source map: Blairstown Quadrangle

Yk - Potassic feldspar gneiss (Middle Proterozoic)

Fine- to medium-grained, grayish-pink, pinkish-gray, light-gray, or light-greenish-gray gneiss and lesser
granofels that have a poor to fair foliation and are composed largely of quartz and potassic feldspar and
minor amounts of biotite and(or) magnetite and more rarely garnet and(or) sillimanite. Unit contains local
interlayers of feldspathic quartzite. In places unit has been partly mobilized to form sheets and irregular
bodies of alkali feldspar granite or quartz-rich granitoid. Description from source map: Blairstown
Quadrangle

Ylo - Quartz-oligoclase gneiss (Middle Proterozoic)

Medium-fine- to medium-coarse-grained, light-greenish-gray to grayish-green, poorly foliated,
granoblastic gneiss and lesser granofels composed principally of oligoclase and quartz and sparse
biotite, magnetite, and typically chloritized and shredded augite. Contains sparse to moderate amounts
of interlayered amphibolite. Rock is probably a metamorphosed quartz keratophyre. Description from
source map: Blairstown Quadrangle

Ya - Amphibolite (Middle Proterozoic)

Fine- to medium-grained, light- to dark-gray to nearly black rock composed principally of hornblende and
andesine. Some phases contain augite and more rarely hypersthene or biotite. Much of rock is probably
metasedimentary as it is interlayered with marble, calcareous metasedimentary rocks, and quartzo-
feldspathic metasedimentary rocks. Some may be metavolcanic. Description from source map:
Blairstown Quadrangle

Ya - Amphibolite (Middle Proterozoic)

Medium-grained, medium-dark-gray (N 4) to grayish-black (N 2) rock composed principally of hornblende
and andesine. Some phases contain clinopyroxene and (or) orthopyroxene and (or) biotite and other phases are magnetite-rich. Shown in section only. Description from source map: Branchville Quadrangle.
Geologic Cross Sections

The geologic cross sections present in the GRI digital geologic-GIS data produced for Delaware Water Gap National Recreation Area, Pennsylvania, New Jersey and New York (DEWA) are presented below. Note that some cross section abbreviations (e.g., A - A') may have been changed from their source map abbreviation in the GRI data so that each cross section abbreviation in the GRI data is unique. Cross section graphics were scanned at a high resolution and can be viewed in more detail by zooming in (if viewing the digital format of this document).

Cross Section A-A’

Graphic from source map: New Jersey Bedrock Map. Cross section NA-A’ on source map (although the above cross section is labeled A-A’, the respective line in the source GIS data is attributed as NA-A’). Only the Milford quadrangle portion of this cross section is relevant in the GRI geologic-GIS data.

Cross Section B-B’

Graphic from source map: Branchville Quadrangle. Cross section A-A’ on source map.

Cross Section C-C’

Graphic from source map: Branchville Quadrangle. Cross section B-B’ on source map.
Cross Section D-D'

Graphic from source map: Branchville Quadrangle. Cross section C-C' on source map.

Cross Section E-E'

Graphic from source map: Bushkill Quadrangle. Cross section B-B' on source map.

Cross Section F-F'

Graphic from source map: Bushkill Quadrangle. Cross section A-A' on source map.
Cross Section G-G'

Graphic from source map: New Jersey Bedrock Map. Cross section NB-B’ on source map (although the above cross section is labeled B-B”, the respective line in the source GIS data is attributed as NB-B’). Only the Flatbrookville quadrangle portion of this cross section is relevant in the GRI geologic-GIS data.

Cross Section H-H'

Graphic from source map: Newton West Quadrangle. Cross section A-A’ on source map.

Cross Section I-I'

Graphic from source map: Newton West Quadrangle. Cross section B-B’ on source map.
Cross Section J-J'

Graphic from source map: Bushkill Quadrangle. Cross section C-C' on source map.

Cross Section K-K'

Graphic from source map: Newton West Quadrangle. Cross section C-C' on source map.

Cross Section L-L'

Graphic from source map: Saylorsburg Quadrangle. Cross section C-C' on source map.
Cross Section M-M'

Graphic from source map: Saylorsburg Quadrangle. Cross section B-B' on source map.

Cross Section N-N'

Graphic from source map: Saylorsburg Quadrangle. Cross section A-A' on source map.

Cross Section O-O'

Graphic from source map: Stroudsburg Quadrangle. Cross section B-B' on source map.

Cross Section P-P'

Graphic from source map: Stroudsburg Quadrangle. Cross section C-C' on source map.
Cross Section Q-Q'

Graphic from source map: Stroudsburg Quadrangle. Cross section D-D' on source map.

Cross Section R-R'

Graphic from source map: Stroudsburg Quadrangle. Cross section E-E' on source map.

Cross Section S-S'

Graphic from source map: Stroudsburg Quadrangle. Cross section F-F' on source map.
Cross Section T-T'

Graphic from source map: Belvidere and Portland Quadrangles. Cross section B-B' on source map. Only the portion of this cross section that doesn't overlap with the Eastern Belvidere and Portland Quadrangles source map is relevant in the GRI geologic-GIS data.

Cross Section U-U'

Graphic from source map: Belvidere and Portland Quadrangles. Cross section A-A' on source map. Only the portion of this cross section that doesn't overlap with the Eastern Belvidere and Portland Quadrangles source map is relevant in the GRI geologic-GIS data.

Cross Section V-V'

Graphic from source map: Eastern Belvidere and Portland Quadrangles. Cross section A-A' on source map.
Cross Section W-W'

Graphic from source map: **Blairstown Quadrangle**, Cross section C-C’ on source map.

Cross Section X-X’

Graphic from source map: **Blairstown Quadrangle**, Cross section B-B’ on source map.

Cross Section Y-Y’

Graphic from source map: **Blairstown Quadrangle**, Cross section A-A’ on source map.
Cross Section Z-Z'

Graphic from source map: Saylorsburg Quadrangle. Cross section D-D' on source map.

Cross Section AA-AA'

Graphic from source map: Stroudsburg Quadrangle. Cross section A-A' on source map.

Cross Section BB-BB'

Graphic from source map: Belvidere and Portland Quadrangles. Cross section C-C' on source map.
Cross Section CC-CC'

Graphic from source map: Belvidere and Portland Quadrangles. Cross section D-D' on source map. Only the Portland quadrangle portion of this cross section is relevant in the GRI geologic-GIS data.

Cross Section DD-DD'

Graphic from source map: Eastern Belvidere and Portland Quadrangles. Cross section B-B' on source map. Only the Portland quadrangle portion of this cross section is relevant in the GRI geologic-GIS data.

Cross Section EE-EE'

Graphic from source map: Blairstown Quadrangle. Cross section D-D' on source map.
Ancillary Source Map Information

The following sections present ancillary source map information associated with sources used for this project.

Western Belvidere and Portland Quadrangles

The formal citation for this source.


This source depicts geology for western part of two 7.5 minute quadrangles, with the Portland Quadrangle being north of the Belvidere Quadrangle. Map data from only the Portland Quadrangle portion of this map was used in the compiled Digital Geologic-GIS Map of Delaware Water Gap National Recreation Area and Vicinity. Where this source map and the Geologic Map of the Eastern Parts of the Belvidere and Portland Quadrangles (Eastern Belvidere and Portland Quadrangles) overlap, data from the Geologic Map of the Eastern Parts of the Belvidere and Portland Quadrangles was used.

Prominent graphics and text associated with this source.
Some units in this correlation do not appear in the GRI digital geologic-GIS data because only the northern half of the source map (Portland Quadrangle) was used.

Graphic from source map: Belvidere and Portland Quadrangles
Map Legend

Some features in this legend do not appear in the GRI digital geologic-GIS data because only the northern half of the source map (Portland Quadrangle) was used.

Graphic from source map: Belvidere and Portland Quadrangles
Blairstown Quadrangle

The formal citation for this source.


Prominent graphics and text associated with this source.

Correlation of Map Units

Graphic from source map: Blairstown Quadrangle
Map Legend

EXPLANATION OF MAP SYMBOLS

Contact.—Dotted where concealed. Distribution and orientation of structural symbols near contact indicates degree of reliability.

Faults

- High angle—U. upstream side; D. downstream side
- Thrust fault—Arrows indicate relative horizontal movement. Dotted where concealed
- Thrust fault—Arrows on cross plate. Dotted where concealed.
- Queried where uncertain
- Small fault seen in outcrop, showing dip.

FOLDS

Folds of Proterozoic Age in Precambrian Rock—Folds in foliation and layering can be no older than F2. At least one phase of earlier folds can be recognized in section.

Anticline—Showing crest line and direction of plunge. May be overturned.

Syncline—Showing trough line and direction of plunge. May be overturned.

Folds of Paleozoic Age—Folds in both bedding and slaty cleavage. Phases named for geographic locations where well-displayed or for prominent major folds of that phase. Intact indicate phase from oldest to youngest: Mississippian (Mi); Silurian (Si); Ordovician (Oc); Pennsylvanian (P); Mesozoic (Mz); Cretaceous (Ck); Eocene (Ec); Oligocene (Oc); Miocene (Mc); Pliocene (Pc); Quaternary (q); Neogene (Ne).

Articulated—Showing crest line and direction of plunge. Dotted where concealed.

Oxidized anticline—Showing trace of axial surface and direction of dip of limbs. Dotted where concealed.

Oxidized syncline—Showing trace of axial surface and direction of dip of limbs. Dotted where concealed.

Clay seperation—Showing presence of clay separation or fault.

MINOR FOLDS

Minor Fold—Showing bearing and plunge.

Minor Fold in Slaty Cleavage

Minor Anticline On Anticline—Showing bearing and plunge.

Minor Anticline On Anticlane In Slaty Cleavage—Showing bearing and plunge.

Minor Apneumonic Field—Showing bearing and plunge.

Minor Apneumonic Folding Field—Showing bearing and plunge.

CLAY SEPARATION

(Phase of clay separation)

Strike and dip of beds—Dotted indicates top of bed shown from top to bottom features.

Inclined

- Vertical

- Overturned

Rotated more than 180°

Strike and dip of compositional layering

- Vertical

Strike and dip of crystalizational foliation

- Vertical

Strike and dip of mylonitic foliation

Strike and dip of transposition foliation

Strike and dip of slaty cleavage

Strike and dip of pelidonic cleavage

Strike and dip of smectite cleavage

LIMEY BEDS

(Phase of limey beds)

- Vertical

- Horizontal

- Dotted

- Bearing and plunge of colluvium

- Bearing and plunge of marine sedimentary rocks

- Bearing and plunge of metamorphic rocks

- Bearing and plunge of intrusive bodies

- Bearing and plunge of slaty cleavage

Graphic from source map: Blairstown Quadrangle
Tectonic Units and Fold Phase (Figure 1)

Graphic from source map: Blairstown Quadrangle
Geologic Discussion

INTRODUCTION
The Blairstown quadrangle is in northwestern New Jersey and lies across the contact of the Middle Proterozoic crystalline rocks of the New Jersey Highlands with the lower Paleozoic sedimentary rocks of the lower lying Kittatinny Valley. Glacial deposits are present throughout the quadrangle but are mapped only where they totally obscure the bedrock in Bear Swamp and along Paulins Kill near Blairstown. The rocks exposed in this quadrangle have been studied previously elsewhere in New Jersey and adjacent Pennsylvania and the reader is referred to Drake (1969, in press) for descriptions of the Middle Proterozoic rocks, and to Drake (1965, 1969), and Drake and Epstein (1967) for descriptions of the Cambrian and Ordovician rocks. Regionally, the quadrangle is within a complex tectonic terrane, the Taconides (Drake, 1980), that was first deformed during the Taconic orogeny. Recumbent folds and attendant thrust faults resulting from this Taconic deformation were subsequently overprinted by more upright folds and major thrust faults during the Alleghanian orogeny. These structures have been studied elsewhere within the region and have been described by Drake (1969, 1970, 1978), Drake and Lyttle (1980), MacLachlan (1964, 1967, 1979a, 1979b) and MacLachlan and others (1975). The structural geology of the Blairstown quadrangle is dominated by four major thrust faults: the Portland, Jenny Jump, Shades of Death, and Federal Springs.

STRATIGRAPHY
The quadrangle is underlain by gneisses and foliated granitoid rocks of Middle Proterozoic age and sedimentary rocks of Cambrian and Ordovician age. The pre-Middle Ordovician rocks of the sedimentary sequence were deposited on the great east-facing shelf of the North American craton after the opening of the proto-Atlantic Ocean. At the beginning of the Taconic orogeny, the shelf foundered and a foreland basin was formed that was filled by Middle and lower Upper Ordovician flysch deposits.

Middle Proterozoic rocks constitute the Jenny Jump, Marble Hill, Silver Lake I, and Petrus klippen and also occur on the narrow mountain in the extreme southeastern corner of the quadrangle. These rocks consist of marble and related quartz-plagioclase-epidote-biotite gneiss, and potassic feldspar gneiss of metasedimentary origin, amphibolite of uncertain but probably largely metasedimentary origin, oligoclase-quartz gneiss of the Losee Metamorphic Suite, venitic migmatite thought to be partly mobilized amphibolite-rich Losee, and hornblende granite and alaskite of the Byram Intrusive Suite. We believe that the Losee is the basement upon which the metasedimentary rocks were deposited. The stratigraphic relation of the other rocks cannot be determined. All these rocks were metamorphosed in upper amphibolite and/or hornblende granulite facies and deformed during the Grenville orogeny, at which time rocks of the Byram Intrusive Suite were syntectonically emplaced. The metasedimentary rocks have been transposed and foliation almost parallels layering except in the few recognized first-fold hinges. All mapped folds deform foliation so they can be no older than second folds. Proterozoic deformation has not been analyzed regionally as yet, but three fold phases were mapped in the adjacent Belvidere quadrangle (Drake and others, 1985) and four phases have been recognized in the Allentown East quadrangle in Pennsylvania (A. A. Drake, Jr., unpublished data). The rock relations and chemistry of the Middle Proterozoic rocks of the Reading Prong of New Jersey and eastern Pennsylvania have recently been discussed by Drake (1984).

The Cambrian and Ordovician rocks belong stratigraphically to the Lehigh Valley sequence first defined by MacLachlan (1967) and described in the Delaware Valley by Drake (1969). These rocks underlie the Kittatinny Valley and consist of, from the bottom up, the Hardyston Quartzite, the Leithsville Formation (mostly dolomite), the Allentown Dolomite, the Stonehenge Limestone, the Rickenbach Dolomite, the Epler Formation (dolomite and lesser interbedded limestone), the Jacksonburg Limestone and the Martinsburg Formation (slate and graywacke). The Hardyston, Leithsville, Allentown, Stonehenge, Rickenbach, and Epler were assigned to the Kittatinny Supergroup by Drake and Lyttle (1980). This was done because the carbonate units of the Supergroup constitute the Kittatinny Limestone of earlier usage (Bayley and others, 1914). The Hardyston was included in the Supergroup because it constitutes an
integral element of a continuous depositional sequence. The rocks have all been described elsewhere (Drake, 1969) so discussion herein will be restricted to new information gained by work in this quadrangle.

The Stonehenge Limestone is the basal formation of the Beekmantown Group in the Lebanon Valley sequence of central and east-central Pennsylvania (MacLachlan, 1967; MacLachlan and others, 1975) and in the Lehigh Valley sequence of east-central Pennsylvania (MacLachlan, 1979b), the Stonehenge was not recognized in eastern Pennsylvania or northwestern New Jersey until mapping was nearly complete in the Belvidere quadrangle to the west. In the Blairstown quadrangle, the Stonehenge is a prominent component of the Beekmantown Group in the Shiloh and Johnsonburg anticlines. It has not been recognized in the klippen of the Jenny Jump thrust sheet and was not known to be present within the Lyon Station-Paulins Kill nappe until two small exposures were found in the Portland quadrangle during the summer of 1983. In eastern Pennsylvania the Stonehenge appears to be restricted to the Irish Mountain nappe and does not extend very far east of the Berks-Lehigh County line (A. A. Drake, Jr., unpublished data). In eastern Pennsylvania, the Stonehenge is a lateral equivalent of the hypersaline dolomite of the Rickenbach Dolomite (MacLachlan, 1967; Drake, 1969) because the dolomite unit thins to the southwest at the expense of the limestone unit which thins to the northeast. These relations result from changing environments on the North American shelf and the reappearance of the Stonehenge in New Jersey probably reflects another environmental change during sedimentation.

In eastern Pennsylvania, the Jacksonburg Limestone, which unconformably overlies the Beekmantown Group, is a thick unit that is divided into a crystalline limestone-calcarenite member (termed cement limestone) and a dark shaly limestone member (termed cement rock). The formation thins markedly and rapidly east of Belvidere, New Jersey (Drake and others, 1985). Although both crystalline and dark shaly limestone can be recognized at places in the Shiloh and Johnsonburg anticlines, the formation is too thin and exposure is too poor to make separation of these units practicable. The Jacksonburg continues to thin to the northeast to the point that its lateral equivalent in New York, the Balmville Limestone of Holzwasser (1926), occurs only as lenses between units equivalent to the Beekmantown Group and Martinsburg Formation in that state (Offield, 1967).

STRUCTURAL GEOLOGY

In the years between 1959 and 1970, a nappe theory was devised to explain the highly complicated structural geology of the Reading Prong and adjacent Great Valley of central and eastern Pennsylvania and New Jersey (Gray, 1959; MacLachlan, 1964; Drake, 1969, 1970). More recently, however, the structural geology has proven to be more complex in that Taconic nappes of Middle Proterozoic and Lower Paleozoic rocks were later deformed by Alleghanian thrust faults and related folds linked to a deep-level basal decollement (Drake, 1978, 1980; Drake and Lyttle, 1980; Faill and McLaughlin, 1980, MacLachlan, 1979a, 1979b; MacLachlan and others, 1975). The major tectonic units in this quadrangle are the Allamuchy, Musconetcong (sensu stricto), and Lyon Station-Paulins Kill nappes of the Musconetcong nappe system of the Reading Prong nappe megasystem, the fragmented Jenny Jump thrust sheet, and the Frelinghuysen klippe.

The Allamuchy nappe is poorly understood because it has been little studied as yet. It is represented by the Marble Hill klippe and by the narrow ridge of Middle Proterozoic rocks and Hardyston Quartzite in the southeastern part of the quadrangle. Rocks of this nappe are brought above those of the Jenny Jump and Frelinghuysen klippen by the Shades of Death thrust fault. The nappe is a complex structure because rocks of the Kittatinny Supergroup crop out above the Shades of Death thrust fault in the Tranquility quadrangle to the east, and, on the basis of aeromagnetic data, almost certainly underlie part of Bear Swamp. Another major thrust fault, the Tranquility, lies within the rocks of the Kittatinny Supergroup and passes beneath the Proterozoic massif of Allamuchy Mountain as proved by diamond drilling near Andover in the Stanhope quadrangle (Baum, 1967). The narrow ridge of Middle Proterozoic rocks and Hardyston Quartzite is probably a hanging wall anticline above the Tranquility thrust fault. Nothing more can be said of the Allamuchy nappe at this time as no other data are available.
The Musconetcong nappe (sensu stricto) is represented in this quadrangle by the rocks of the Lehigh Valley sequence that lie beneath the Jenny Jump and Federal Springs thrust faults and above the Portland thrust fault. These rocks are in the upper limb of the nappe, which has been described at great length elsewhere (Drake, 1969, 1970, 1978).

The Lyon Station-Paulins-Kill nappe, described in detail by Drake (1978), lies within the Paulins Kill window that is framed by the Portland thrust fault. The bulk of the rocks within the window are in the upper limb of this nappe; however, the inverted rocks beneath the White Lake thrust fault within the White Lake inner window are probably in the lower limb of the nappe. This relation, first suggested by Drake (1978), shows that the crystalline core of the Lyon Station Paulins Kill nappe does not extend this far to the northeast. This conclusion is supported by aeromagnetic data (Drake, 1978).

The Jenny Jump thrust sheet is the most obvious structure in the quadrangle and has been recognized from the turn of the century (Lewis and Kummel, 1910–12; Bayley and others, 1914). The thrust sheet has been fragmented and now constitutes a litter of klippen on the upper limb of the Musconetcong nappe (sensu stricto) that range in size from the very large Jenny Jump and Hope klippen to the tiny Petrus, Leoville, and Montrose klippen. Reconstruction of these various klippen suggests that they form the crystalline core and upper limb of a nappe for the various klippen contain, in addition to Middle Proterozoic rocks, right-side-up, northwest-dipping rocks of the Kittatinny Supergroup from Hardyston Quartzite through Rickenbach Dolomite. If this reconstruction is correct, the Jenny Jump thrust sheet probably stemmed from a nappe beneath the Allamuchy nappe and above the Musconetcong (sensu stricto) nappe.

The Frelinghuysen klippe is a thrust sheet which lies above the Federal Springs thrust fault and beneath the Shades of Death thrust fault. This klippe was earlier termed the Johnsonburg-Greendell-Huntsburg tectonic unit by Drake and Lyttle (1980). The intra-klippe geology is quite complex. The Johnsonburg anticline, cored by carbonate rocks of the Kittatinny Supergroup, is folded around the Greendell syncline that is cored by Martinsburg Formation. To the east in the Tranquility quadrangle, klippen of Allentown Dolomite lie on the Martinsburg Formation within the Greendell syncline in the same way that the klippen of the Jenny Jump thrust sheet lie on Martinsburg of the Musconetcong nappe (sensu stricto). In addition, a klippe of Middle Proterozoic rocks and Hardyston Quartzite lies above carbonate rocks in the Frelinghuysen klippe. There is, then, at least one and perhaps two thrust sheets above the Frelinghuysen klippe. The complexities of this tectonic unit are recognized, but as yet not completely understood.

The map pattern of the rock units within the quadrangle, as well as the direct observation of small folds in the field, indicates that the rocks have been affected by five distinguishable phases of folds. These phases, following the usage of Tobisch and Fleuty (1969), have been named either for geographic localities where they are well displayed or for prominent major folds. This is done because all fold phases are not necessarily everywhere present, and a numerical chronology could become confusing.

The oldest fold phase, the Musconetcong, is named for the Musconetcong nappe and includes all the flattened folds related to nappe emplacement. The slaty cleavage in rocks of the Martinsburg Formation and the “flow” cleavages in the carbonate rocks are almost parallel to axial surfaces of Musconetcong folds. Where not appreciably affected by later folding, folds of this phase trend east-northeast. Musconetcong folds were called $F_{P1}$ folds in the Portland and Belvidere quadrangles to the west (Drake and others, 1985).

The next youngest fold phase, the Shiloh, is named for the Shiloh anticline. This fold phase was not recognized until the detailed mapping of this quadrangle was completed; Shiloh folds were probably confused with both Musconetcong and later fold phases in areas to the west. Shiloh folds are upright, open, and trend east-northeast. At places, they have a poor spaced cleavage almost parallel to their
axial surfaces. The axial surface of a major Shiloh fold, the Johnsonburg anticline, is folded by the later Greendell syncline.

The next youngest fold phase, the Hokendauqua, is named for Hokendauqua Creek in the northwestern part of the Catasauqua quadrangle in Pennsylvania, where these folds were first recognized (Drake, 1971). Hokendauqua folds are open, upright to steeply inclined, and trend northwest to north-northwest, and at many places have a fair-to-poor spaced cleavage. The Hokendauqua phase folded the bedding, slaty cleavage and "flow" cleavage of Musconetcong Folds and axial surfaces of Shiloh folds. Because of their trend, one must be careful not to confuse these folds with rotated Musconetcong folds. Hokendauqua folds were termed $F_{P2}$ in the Portland and Belvidere quadrangles to the west (Drake and others, 1985).

The next youngest set of folds, the Manunka Chunk, is named for the village of Manunka Chunk on the Delaware River in the Belvidere quadrangle, where many folds of this phase deform the slaty cleavage of the Martinsburg Formation. Manunka Chunk folds are abundant throughout the Great Valley of eastern Pennsylvania and New Jersey and deform the bedding, slaty and "flow"cleavage of Musconetcong folds, and the spaced cleavage of Hokendauqua folds. These folds range from open to isoclinal, are upright to gently inclined, and trend northeast. The abundant strain-slip cleavage in the Jacksonburg and Martinsburg Formations is about parallel to their axial surfaces. Manunka Chunk folds were called $F_{P3}$ folds in the Portland and Belvidere quadrangles to the west (Drake and others, 1985).

The youngest fold phase, the Stone Church, is named for the major Stone Church syncline that has been mapped from the Bangor quadrangle (Davis and others, 1967) to the Blairstown quadrangle, a distance of about 45 km. Stone Church folds trend from nearly east to east northeast, and most of those that have been identified are fairly broad, open, upright structures. At places, a poor spaced cleavage is almost parallel to the axial surfaces of Stone Church folds (Drake, 1969, 1978).

**TIME OF DEFORMATION**

Musconetcong and Shiloh folds clearly predate the emplacement of the Jenny Jump thrust sheet as klippen lie in troughs in Musconetcong slaty cleavage and the Shiloh anticline is transected by the thrust sheet. All available evidence suggests that Hokendauqua folds also predate the arrival of the Jenny Jump thrust sheet. Manunka Chunk folds post-date the Jenny Jump thrust sheet because carbonate and chert mylonite, which formed during its emplacement, is folded by these folds (Drake and Lyttle, 1980). The broad Stone Church folds postdate other structures. Their relation to the Shiloh folds is particularly straightforward because the Shiloh phase Johnsonburg anticline is folded around the Stone Church-phase Greendell syncline. The Portland and Federal Springs thrust faults predate Stone Church folding because these faults are deformed by major faults of that phase. The Shades of Death thrust fault postdates the Jenny Jump and Federal Springs thrust faults and the Musconetcong, Shiloh, and presumably, Hokendauqua folds. Regional nappes and, therefore, Musconetcong folds, stem from the Taconic orogeny (Drake, 1969, 1970, 1978, 1980; Drake and Lyttle, 1980). The Portland, Jenny Jump, Shades of Death, and Federal Springs thrust faults date from the Alleghanian orogeny because they transect the Taconic structures (Drake, 1978, 1980, Drake and Lyttle, 1980). The Manunka Chunk and Stone Church fold phases, therefore, are Alleghanian because they postdate Alleghanian thrust faults.

Text from source map: **Blairstown Quadrangle**

**References**


Drake, A. A., Jr., Kastelic, R. L., Jr., and Lyttle, P. T., 1985, Geologic map of the eastern parts of the


— 1979a, Major structures of the Pennsylvania Great Valley and the new geologic map of Pennsylvania (abs.): Geological Society of America Abstracts with Programs, v. 11, no. 1, p. 43.


References from source map: Blairstown Quadrangle
Branchville Quadrangle

The formal citation for this source.


Prominent graphics and text associated with this source.

Correlation of Map Units

Graphic from source map: Branchville Quadrangle
Map Legend

EXPLANATION OF MAP SYMBOLS

Contact—Dotted where concealed, quilled where uncertain. Distribution of structural symbols indicates reliability.

FAULTS

Thrust fault—Showing dip where known. Sawteeth on upper plate. Dotted where concealed.

High angle fault—Showing dip where known. U, upthrown side; A, downthrown side.

Fault seen in outcrop—Showing dip and relative motion where known.

Inclined

Vertical

FOLDS

Anticline—Showing crestline and direction of plunge. Dotted where concealed.

Oblong anticline—Showing trend of axial surface and direction of dip of limbs and plunge. Dotted where concealed.

Syncline—Showing trough line and direction of plunge. Dotted where concealed.

MINOR FOLDS

Minor anticline—Showing bearing and plunge.

Minor asymmetric fold—Showing bearing and plunge.

PLANAR FEATURES

(May be combined with linear features)

Strike and dip of beds—Ball indicates top of beds known from sedimentary features.

Inclined

Vertical

Overturned

Strike and dip of flow foliation

Inclined

Vertical

Strike and dip of mylonitic foliation

Strike and dip of composition foliation

Strike and dip of slaty or rough cleavage

Inclined

Vertical

Strike and dip of slaty cleavage and bedding parallel in strike but divergent in dip

Strike and dip of pseudo slaty cleavage related to thrust faulting

Strike and dip of crenulation cleavage

Strike and dip of spaced cleavage

Strike and dip of joints

Inclined

Vertical

Strike and dip of extension fractures

Inclined

Vertical

LINEAR FEATURES

(May be combined with planar features)

Bearing and plunge of elongation cleavage

Bearing and plunge of intersection of bedding and slaty cleavage

Inclined

Horizontal

Bearing and plunge of crenulation

Bearing and plunge of intersection of spaced cleavage and slaty cleavage

Bearing and plunge of grooves

OTHER FEATURES

Pit or quarry—S, slate; SH, shale

Fossil locality

Graphic from source map: Branchville Quadrangle
Chemical Analysis of Beemerville Intrusive Suite (Table 1)

Table 1.—Chemical analyses (weight percent) of some rocks of the Beemerville Intrusive Suite

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<td><strong>98.8</strong></td>
<td><strong>98.64</strong></td>
<td><strong>100.06</strong></td>
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</tbody>
</table>

Rapid rock analyses by M. Kavulak (1, 2, 3) and L. Mei (4), U.S. Geological Survey

1. Tinguaitae from crest of hill 755, 4,150 ft N. 63° E. from Township School, Branchville 7.5-minute quadrangle, N.J.
2. Malignite from road junction along Papakatinni Creek 11,550 ft N. 15° E. from Township School, Branchville 7.5-minute quadrangle, N.J.
3. Tinguaitae from sharp bend in unimproved road 7,800 ft N. 8° W. from Libertyville, Branchville 7.5-minute quadrangle, N.J.

Graphic from source map: Branchville Quadrangle

Geologic Discussion

INTRODUCTION

The Branchville quadrangle, in northern New Jersey, is mostly underlain by the lower Paleozoic rocks of the Kittatinny Valley. These lower Paleozoic rocks, particularly the Martinsburg Formation, are intruded by abundant stocks, dikes, and sills of the Late Ordovician Beemerville Intrusive Suite. Silurian rocks of the Appalachian Valley and Ridge underlie the northwestern corner of the quadrangle. Glacial and other surficial deposits (Qd) are abundant and were mapped where they totally obscure the bedrock. The sedimentary rocks exposed in this quadrangle have been studied elsewhere in New Jersey and eastern Pennsylvania and the reader is referred to Drake (1965, 1969, 1991) and Drake and Epstein (1967) for descriptions of the lower Paleozoic rocks, and Epstein and Epstein (1969, 1972) and Epstein and Lyttle (1987) for descriptions of the Silurian rocks. Many papers have been written on the rocks of the Beemerville Intrusive Suite. The most important are by Spencer and others (1908) and the much more recent paper by Maxey (1976).
Regionally, the quadrangle is within the complex tectonic terrane termed the Taconides by Drake (1980) and described in detail by Drake and others (1989). Here the lower Paleozoic rocks were first deformed during the Ordovician Taconic orogeny. These structures were later overprinted by those formed during the late Paleozoic Alleghanian orogeny. The geologic structure in this quadrangle is dominated by emergent thrust faults, as well as by interpreted blind thrust faults.

STRATIGRAPHY
The oldest rocks exposed in the quadrangle are these of the Allentown Dolomite (OCa). They are well exposed both in the Branchville area (southwestern corner of the quadrangle) and in the southeastern corner of the quadrangle. The Stonehenge Formation (Os) and Rickenbach Dolomite (Or) are well exposed in the Harmonyvale area in the southeastern part of the quadrangle. There are few outcrops of the Jacksonburg Limestone (Oj), but the unit can be seen both northeast and southwest of Harmonyvale and in the Branchville area.

Most of the quadrangle is underlain by rocks of the Martinsburg Formation, which has been interpreted to have been deposited in an evolving foreland basin (Drake, 1991). The basal euxinic Bushkill Member (Omb) reflects the stagnant conditions in the basin at that time. These rocks pass up into classic “distal” turbidites and then into more “proximal” turbidites of the Ramseyburg Member (Omr) and then into the much higher energy turbidites of the High Point Member (Omhp). The Bushkill is particularly well exposed in the southeastern corner of the quadrangle. There are abundant outcrops of Ramseyburg throughout the quadrangle. Particularly good exposures can be seen along the south border of the quadrangle, north of Frankford Plains, and near Wykertown. The High Point can be seen in scattered exposures along the southeast slope of Kittatinny Mountain southwest of the Branchville Reservoir. The unit passes beneath the Shawangunk Formation (Ss) east of the west boundary of the quadrangle. The Ramseyburg and High Point near the stock of nepheline syenite (Obs) of the Beemerville Intrusive Suite have been baked into hard blocky, very fine-grained hornfels (Omh) containing microscopic biotite and magnetite. Small areas of hornfels also occur around some of the larger dikes and sills, but these were not mapped.

There are good exposures of the Shawangunk Formation all along the crest of Kittatinny Mountain. The thick cover of glacial deposits on the northwest slope of the mountain completely obscures the bedrock and no outcrops of the Bloomsburg Red Beds were found.

IGNEOUS ROCKS
Rocks assigned to the herein revised and adopted Beemerville Intrusive Suite were first recognized by Emerson (1882), and have been described by Iddings (1898), Kemp (1889, 1892), Maxey (1976), Milton (1952), Spencer and others (1908), Wilkerson (1946, 1952), and Wolff (1902). Abundant chemical data for these rocks are presented by Maxey (1976). Rocks mapped in this quadrangle include nepheline syenite (Obs), tinguaite (Obt), phonolite (Obp), bostonite (Obb), malignite (Obm), lamprophyre (Obl), and ouachitite breccia (Obo).

Nepheline syenite forms two stocks on the southeast flank of Kittatinny Mountain, and also occurs as a small plug within the Rutan Hill diatreme. Tinguaite forms thin dikes that cut the nepheline syenite stocks and occur in dikes and probable sills in the Martinsburg Formation that can best be seen along Papakating Creek north of the Duck Pond thrust fault and on the southeast slope of Kittatinny Mountain downslope from the smaller nepheline syenite stock. New chemical analyses of tinguaite are given in table 1.

Phonolite forms thin dikes within the nepheline syenite stocks and abundant dikes and sills within the Martinsburg Formation. Many phonolite bodies as well as the other rock types are probably sills based on data obtained from traversing a small stream in the southeast slope of Kittatinny Mountain about 5,000 ft northeast of the quadrangle’s western boundary. Here, three phonolite and one tinguaite sills were mapped, but the rock is impregnated with abundant thin sills that are too small to map. Phonolite
bodies are also abundant on the hill northeast of Branchville. New chemical analyses of these rocks are given in table 1.

Bostonite dikes and sills are not abundant. They can be seen south of the large building 4,800 ft north-northwest of the Township School in Branchville and northeast of Wykertown.

Malignite is a biotite-rich rock that contains phenocrysts of orthoclase and nepheline. One body, of striking appearance and probably a sill, crops out southwest of the pond on the eastern border of the quadrangle about 5,000 ft N. 50° E. from Woodbourne. Other bodies occur along the road 5,500 ft S. 70° E. from Beemerville.

Lamprophyre dikes intrude hornfelsed Martinsburg in the area between the nepheline syenite stocks. Dikes also intrude rocks of the Allentown Dolomite and Beekmantown Group near the eastern border of the quadrangle northeast of Harmonyvale.

Ouachitite breccia forms the famous Rutan Hill diatreme as well as 10 smaller bodies. These diatremes pre-date at least the nepheline syenite and the phonolite, as these rocks intrude the Rutan Hill body. In addition to the above alkalic rocks, a small amount of carbonatite is present in this quadrangle. A dike of carbonatite, too small to show on the map, intrudes the Martinsburg Formation between the two nepheline syenite stocks. Carbonatite autoliths also occur in the Rutan Hill diatreme.

The alkalic rock-carbonatite sequence is restricted to the Branchville quadrangle and immediately adjacent parts of the Culvers Gap and Port Jervis South quadrangles. Lamprophyres having an alkalic chemistry, however, crop out in the Franklin quadrangle to the southeast and at other places within the Middle Proterozoic rocks in the New Jersey Highlands. It is uncertain at this time whether or not these rocks are related to, and are derived from the Beemerville Intrusive Suite magma stem. Elsewhere in the world, alkalic-carbonatite suites are restricted to rift environments. There is no evidence to support a rift event in the Late Ordovician in northern New Jersey. Ratcliffe (1981) suggested that this magmatism may be related to the fracturing of mantle rock at the junction of two tectonic salients of Taconic age. The evidence for this idea is not persuasive. Detailed seismic reflection and refraction studies will be necessary to determine why these rocks are where they are.

**STRUCTURAL GEOLOGY**

Two major thrust faults, the Crooked Swamp and Portland, bring younger rocks over older in this quadrangle because the rocks were already deformed before the thrust event. The Portland thrust fault has been mapped from the Stroudsburg quadrangle in eastern Pennsylvania (Epstein, 1973) to this quadrangle where it apparently dies out in an anticline about 10,500 ft west of the eastern border. Its trace is marked by fault-related pseudo slaty cleavage, spaced cleavage, and elongation lineation on slaty cleavage surfaces. Over this length, the Portland thrust fault brings rocks of the Martinsburg Formation over carbonate rocks of the Paulins Kill Valley. The carbonate rocks in the Branchville area are the northeast termination of the Paulins Kill belt. The Portland thrust fault is joined by the White Lake and Duck Pond thrust faults, both of which can be traced at least 16 mi southwest into the Blairstown quadrangle (Drake and Lyttle, 1985). The White Lake and Duck Pond thrust faults dissect the hinge of the Ackerman anticline, a major fold that has been mapped 27 mi from the Stroudsburg quadrangle (Epstein, 1973) to the southwest. This dissected antiformal structure is shown in the subsurface in section C-C’. It passes into a subsurface antclinorium shown in section A-A’ and B-B’ that has been traced to the Unionville quadrangle to the northeast (Drake and Monteverde, in press). The antclinorium appears to be a fault-bend fold (hanging-wall anticline) above a major ramp in a blind thrust fault in the carbonate rocks. Splays from the blind thrust are interpreted to have generated the array to closely-spaced low amplitude, low-wavelength folds seen in the quadrangle, as illustrated in the eastern part of section A-A’. This interpretation was made by Drake and Monteverde (1992) for what is thought to be the same structure in the Unionville quadrangle. All this was predicted by Sanders (1983) in the Middletown, N.Y., area to the northeast.
The Crooked Swamp thrust fault, in the southeastern corner of the quadrangle, is a northeastern continuation of the Shades of Death thrust system (Drake and Lyttle, 1980, 1985), which continues southwestward across New Jersey into Pennsylvania and northeastward into Orange County, New York as the Wallkill thrust fault (Drake and Monteverde, 1992). Over most of its length, this thrust system brings older rocks over younger, here and in the Newton East and Newton West quadrangles (A.A. Drake, Jr., unpub. data) Martinsburg is thrust onto carbonate rocks because of earlier deformation. Little of the nature of Crooked Swamp thrust fault can be determined because it is largely hidden beneath the Crooked Swamp. At places, the carbonate rocks in the footwall contain many faults of several different attitudes. In general they have a “beat-up” look and because of the brittle deformation contain many extension fractures. The Lafayette thrust fault here parallels the Crooked Swamp thrust and joins it to the northeast in the Hamburg quadrangle and to the southwest in the Newton East quadrangle (A.A. Drake, Jr., unpub. data). The carbonate rocks between the faults constitute a horse. In addition, the Lafayette fault is decorated at depth by an orphan of Middle Proterozoic rocks (see section B-B’) that crops out in the Newton East quadrangle to the south (A.A. Drake, Jr., unpub. data). An orphan (Lewis and Bartholomew, 1989) is a duplex having an incompatible stratigraphy that was plucked from a more hinterlandward footwall ramp.

There are two other thrust faults in the northeastern corner of the quadrangle. One passes into an anticline. The other, largely hidden by glacial deposits, may also pass into an anticline but its extent is not known.

In many places in Pennsylvania, New Jersey, and New York the contact of the Martinsburg Formation and the Shawangunk Formation is marked by the Blue Mountain décollement (Epstein and Epstein, 1967), a poorly understood element of central Appalachian geology. No direct evidence of décollement was found along this contact in the Branchville quadrangle. The mapped anticlines in the Shawangunk Formation are probably tip anticlines and could be related to splays from a possible Blue Mountain décollement as one would not expect a décollement within the competent High Point Member of the Martinsburg Formation. The Blue Mountain décollement, however, is not mapped in this quadrangle.

Timing of deformation is difficult to determine in the lower Paleozoic rocks. The Portland and associated faults and the Crooked Swamp and Lafayette faults are probably Alleghanian features as they bring younger rocks over older and thus post-date a pre-existing deformation. Both fault systems were found to be of Alleghanian age to the southwest (Drake and Lyttle, 1980). The age of the slaty cleavage is a different matter. Xenoliths of slaty-cleavage Martinsburg occur within the Rutan Hill diatreme, a fact recognized earlier by both Ratcliffe (1981) and Rowlands (1980). In addition, igneous rock from dikes can be seen to form small sills along the cleavage. In Pennsylvania, Lash (1987) has described slaty-cleaved rocks that are unconformably overlain by Upper Ordovician molasse. These data strongly imply that the cleavage is Taconic. Other geologists (see summary in Drake and Lyttle, 1980), for good reasons, think the slaty cleavage results from Alleghanian deformation. Mitra and Elliott's (1980) concept that cleavage youngs toward the foreland and therefore, may be time transgressive is philosophically pleasing, but impossible to document in the field. Perhaps planned isotopic dating will provide the solution. Without isotopic dating, timing of deformation remains a major problem here and throughout the Appalachians.

Text from source map: Branchville Quadrangle

References


Emerson, B.K., 1882, On a great dike of foyaite or elaeolite-syenite cutting the Hudson River shales in northwestern New Jersey: American Journal of Science, 3rd Series, v. 23, p. 302-308.


___1969, Geology of the Valley and Ridge province between Delaware Water Gap and Lehigh Gap,


Milton, Charles, 1952. Dikes of special petrologic interest in Sussex County, New Jersey, in Field Conference of Pennsylvania Geologists, 18th, Sussex County, New Jersey Trenton, New Jersey
Bureau of Geology and Topography. p. 132.


_1952, Tinguaite and bostonite in northwestern New Jersey: American Mineralogist, v. 37, p. 120-125.

Wolff, J.E., 1902, Leucite-tinguaite from Beemerville, New Jersey: Harvard University of Comparative
References from source map: Branchville Quadrangle
Bushkill Quadrangle

The formal citation for this source.


Prominent graphics and text associated with this source.

Correlation of Map Units

Graphic from source map: Bushkill Quadrangle
Map Legend

Contact
Long dashed where approximately located; short dashed where inferred; dotdash where concealed

Basal Mountain detritum
Long dashed where approximately located; short dashed where concealed

Steeply on upper plate, where overturned, overthrust in direction of dip, but on side of topographically higher plate

Anticline
Showing outline and direction of plunge: Dashed where approximately located; dotdash where concealed

Overturned anticline
Showing trace of axial surface and direction of dip of limbs and plunge: Dashed where approximately located; dotdash where concealed

Syncline
Showing outline and direction of plunge: Dashed where approximately located; dotdash where concealed

Overturned syncline
Showing trace of axial surface and direction of dip of limbs and plunge: Dashed where approximately located; dotdash where concealed

Minor anticline showing plunge

Minor syncline showing plunge

Planar Features
Incline Overturned Horizontal Vertical
Strike and dip of beds
Incline Vertical
Strike and dip of cleavage
Strike and dip of slip cleavage
Strike and dip of bedding and cleavage parallel in strike but divergent in dip

Linear Features
(May be combined with planar features)
Incline Horizontal
Bearing and plunge of intersection of bedding and cleavage

Rock containing disseminated mafic or ultramafic; boundaries are gradational and indefinite

Glacial grooves or striations
Point of observation at tip of arrow

Fossil locality

Mine or quarry
Mineral
Depth

Sand, gravel, or clay pit

Graphic from source map: Bushkill Quadrangle
References

References from source map: Bushkill Quadrangle
Culvers Gap and Lake Maskenozha Bedrock

The formal citation for this source.


Prominent graphics and text associated with this source.

Correlation of Map Units

Graphic from source map: Culvers Gap and Lake Maskenozha Bedrock
Map Legend

MAP SYMBOLS

Contact - solid where known; dashed where approximate; dotted where concealed; queried where uncertain.

Thrust faults - solid where known; dashed where approximate; dotted where concealed; queried where uncertain; sawteeth on overthrust plate.

FOLDS

Syncline, showing trace of trough line and direction of plunge

Anticline, showing trace of crest line and direction of plunge

Anticline, gently inclined to recumbent - showing trace of crest line, direction of dip of limbs, direction of plunge

Syncline, gently inclined to recumbent - showing trace of trough line, direction of dip of limbs, direction of plunge

Cleavage trough, showing trough line and direction of plunge

MINOR FOLDS

 Minor syncline - showing trough line and plunge

 Minor asymmetric fold - showing bearing and plunge of axis. \( \varphi \) indicates fold viewed down plunge.

PLANAR FEATURES

Strike and dip of beds - ball indicates top known from sedimentary structures

Inclined

Overturned

Strike and dip of slaty or spaced cleavage

LINEAR FEATURES

Bearing and plunge of intersection of bedding and cleavage

Bearing and plunge of extension lineation

Bearing and plunge of small fold seen in outcrop

Mine, quarry or open pit - \( r \), road metal

Domestic well showing rock unit - see table 1

Graphic from source map: Culvers Gap and Lake Maskenozha Bedrock
## Well Records Used to Outline Contact Between Bloomsburg Red Beds and Poxona Island Formation (Table 1)

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<td>8</td>
<td>21-5,976</td>
<td>0-40</td>
<td>overlain by sand, clay, gravel overlain by sand, clay, gravel overlain by</td>
<td>Sb</td>
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<tr>
<td></td>
<td></td>
<td>40-125</td>
<td>red rock</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>21-5,653</td>
<td>0-30</td>
<td>boulder and sand, clay, gravel overlain by sand, clay, gravel overlain by</td>
<td>Sb</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30-105</td>
<td>red rock</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>21-5,152</td>
<td>0-58</td>
<td>overlain by sand, clay, gravel overlain by sand, clay, gravel overlain by</td>
<td>Sb</td>
</tr>
<tr>
<td></td>
<td></td>
<td>58-123</td>
<td>red rock</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>21-5,258</td>
<td>0-15</td>
<td>overlain by sand, clay, gravel overlain by sand, clay, gravel overlain by</td>
<td>Sb</td>
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<td></td>
<td></td>
<td>15-250</td>
<td>red rock</td>
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<tr>
<td>12</td>
<td>21-5,113</td>
<td>0-50</td>
<td>overlain by sand, clay, gravel overlain by sand, clay, gravel overlain by</td>
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<tr>
<td></td>
<td></td>
<td>50-123</td>
<td>red shale, blue shale, yellow shale</td>
<td>Sp</td>
</tr>
<tr>
<td>13</td>
<td>21-5,168</td>
<td>0-55</td>
<td>overlain by sand, clay, gravel overlain by sand, clay, gravel overlain by</td>
<td>Sb</td>
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<tr>
<td></td>
<td></td>
<td>55-71</td>
<td>red rock</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>71-74</td>
<td>brown rock</td>
<td>Sb</td>
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<td>74-121</td>
<td>red rock</td>
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<td>soft rock</td>
<td>Sb</td>
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<td>154-173</td>
<td>red rock</td>
<td>Sb</td>
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<td>14</td>
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<td>0-50</td>
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<td>50-145</td>
<td>red rock</td>
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<td>0-20</td>
<td>overlain by sand, clay, gravel overlain by sand, clay, gravel overlain by</td>
<td>Sb</td>
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<td>20-175</td>
<td>red rock</td>
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<td>17</td>
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<td>0-77</td>
<td>overlain by sand, clay, gravel overlain by sand, clay, gravel overlain by</td>
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<td></td>
<td>77-84</td>
<td>limestone rock</td>
<td>Sp</td>
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<td>18</td>
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<td>0-20</td>
<td>overlain by sand, clay, gravel overlain by sand, clay, gravel overlain by</td>
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<td></td>
<td>20-123</td>
<td>red rock</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>21-7,721-5</td>
<td>0-5</td>
<td>overlain by sand, clay, gravel overlain by sand, clay, gravel overlain by</td>
<td>Sb</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5-15</td>
<td>red sandstone, quartzite and sandstone overlain by sandstone overlain by</td>
<td>Sb</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15-41</td>
<td>medium sand overlain by sandstone overlain by sandstone overlain by</td>
<td>Sb</td>
</tr>
<tr>
<td></td>
<td></td>
<td>41-50</td>
<td>medium to coarse sand overlain by sandstone overlain by sandstone overlain by</td>
<td>Sb</td>
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<td></td>
<td>50-52</td>
<td>quartzite boulder overlain by sandstone overlain by sandstone overlain by</td>
<td>Sb</td>
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<tr>
<td></td>
<td></td>
<td>52-56</td>
<td>coarse, pebbly sandstone overlain by sandstone overlain by sandstone overlain by</td>
<td>Sb</td>
</tr>
<tr>
<td></td>
<td></td>
<td>56-61</td>
<td>red shale, High Falls Formation</td>
<td>Sb</td>
</tr>
</tbody>
</table>

1. In absence of driller’s log noting overlain by thickness, depth of casing has been used for overlain by.

Graphic from source map: [Culvers Gap and Lake Maskenozha Bedrock](#)
References


References from source map: Culvers Gap and Lake Maskenozha Bedrock
Eastern Belvidere and Portland Quadrangles

The formal citation for this source.


This source depicts geology for eastern part of two 7.5 minute quadrangles, with the Portland Quadrangle being north of the Belvidere Quadrangle. Map data from only the Portland Quadrangle portion of this map was used in the compiled Digital Geologic-GIS Map of Delaware Water Gap National Recreation Area and Vicinity.

Prominent graphics and text associated with this source.

Correlation of Map Units

Some units in this correlation do not appear in the GRI GIS data because only the northern half of the map (Portland Quadrangle) was used.

Graphic from source map: Eastern Belvidere and Portland Quadrangles
Some features in this do not appear in the GRI GIS data because only the northern half of the map (Portland Quadrangle) was used.

Graphic from source map: Eastern Belvidere and Portland Quadrangles
References


References from source map: Eastern Belvidere and Portland Quadrangles.
Monroe County Geology and Groundwater Resources

The formal citation for this source.


This map was used to provide coverage for the East Stroudsburg 7.5 minute quadrangle and the Pennsylvania part of the Flatbrookville 7.5 minute quadrangle.

Prominent graphics and text associated with this source.

Correlation of Map Units

![Correlation of Map Units](image)

Some units in this correlation do not appear in the GRI digital geologic-GIS data because only portions of the source map (East Stroudsburg Quadrangle part of Flatbrookville Quadrangle) were used.

Graphic from source map: Monroe County Geology and Groundwater Resources
Map Legend

SYMBOLS

Formation or member contact
Includes approximately located and inferred contacts.

\[\text{U}\]
High-angle fault.
Includes approximately located and inferred faults.

\[\text{\rotatebox{90}{\text{\textbullet}}\text{\rotatebox{90}{\text{\textbullet}}\text{\rotatebox{90}{\text{\textbullet}}\text{\rotatebox{90}{\text{\textbullet}}}}\text{\rotatebox{90}{\text{\textbullet}}\text{\rotatebox{90}{\text{\textbullet}}\text{\rotatebox{90}{\text{\textbullet}}\text{\rotatebox{90}{\text{\textbullet}}}}}}}
Probable landslide scar
Sawteeth on mobile rock.

\[4450\]
Location of domestic well and county well number
Q indicates well taps unconsolidated deposits for water supply.

\[263\]
Location of composite well and county well number
Data for composite well are composed of the median values (such as well depth, casing depth, water level, yield, etc.) of five or more domestic wells in the immediate area of the composite well.

\[225\]
Location of public supply or industrial well and county well number

\[60\]
\[85\]
Thickness and saturated thickness of deposits, in feet
Top number indicates total thickness; bottom number indicates saturated thickness. Where present, \(>\) indicates drill did not reach bedrock.

Some feature in this legend do not appear in the GRI digital geologic-GIS data because only portions of the map (East Stroudsburg Quadrangle part of Flatbrookville Quadrangle) were used.

Graphic from source map: Monroe County Geology and Groundwater Resources
Generalized Cross Section of Monroe County

EXPLANATION OF SURFICIAL UNITS

ALLUVIUM
Mostly fine sands except in riverbed, where boulders occur.

TILL
Heterogeneous mixture of fine to coarse material; unstratified.

GLACIOACUSTRINE
Horizontal to slightly dipping layers of fine sand, silt, and clay. Small amount of coarse material present.

FLUVIOGLACIAL
Stratified deposits of silt to cobbles.

EXPLANATION OF BEDROCK FORMATIONS

DEVONIAN
Dms - NEW SCOTLAND FORMATION
Dem - COEYMANS FORMATION

SILURIAN
Sfd - RONDOUT FORMATION
Sfd - DRICKER FORMATION
Sfd - BOSSARDVILLE FORMATION
Spi - POXONO ISLAND FORMATION
Sb - BLOOMSBURG FORMATION

Note: Cross section adapted from Depman and Parrillo (1969).

Graphic from source map: Monroe County Geology and Groundwater Resources

Geologic Report

To view the geologic report, including figures, tables and graphics, click here: Monroe County Geology and Groundwater Resources Report

Report from source map: Monroe County Geology and Groundwater Resources

References

Hydrology by L. D. Carswell and 0.B. Lloyd, Jr.


References from source map: Monroe County Geology and Groundwater Resources
National Hydrography Dataset

The formal citation for this source.


This dataset was used for the Milford, Port Jervis South, Lake Maskenozha and Flatbrookville quadrangles where the sources maps used for those quadrangles did not clearly define the Delaware River. No graphics accompanied this digital dataset.

New Jersey Bedrock Map

The formal citation for this source.


This dataset was used the provide coverage for the New Jersey parts of the Milford, Port Jervis South and Flatbrookville 7.5 minute quadrangles. No graphics accompanied this digital dataset. Unit descriptions packaged with this data set reference the following publication:


New York Geology, Lower Hudson Sheet, bedrock

The formal citation for this source.


This map was used to provide coverage for the New York part of the Port Jervis South 7.5 minute quadrangle. No graphics accompanied this digital dataset.

New York Geology, Lower Hudson Sheet, brittle structures

The formal citation for this source.


This map was used to provide coverage for the New York part of the Port Jervis South 7.5 minute quadrangle. No graphics accompanied this digital dataset.
Newton West Quadrangle

The formal citation for this source.


Prominent graphics and text associated with this source.

Correlation of Map Units

Graphic from source map: [Newton West Quadrangle](#)
Map Legend

EXPLANATION OF MAP SYMBOLS

FAULTS

1. Fault trace—Showing trace of fault where known. Dotted where concealed.

2. Fault line—Showing trace of fault where known. Dotted where concealed.

3. Fault seen in outcrop—Showing dip and relative motion where known.

FOLDS

4. Anticline—Showing line of strike and direction of plunge where known. Dotted where concealed.

5. Syncline—Showing strike line and direction of plunge where known. Dotted where concealed.

OVERTURNED FOLDS

6. Overturmed anticline—Showing trace of axial surface and direction of dip of limbs and plunge where known. Dotted where concealed.

7. Overturmed syncline—Showing trace of axial surface and direction of dip of limbs and plunge where known.

8. Minor syncline—Showing bearing and plunge.

9. Minor asymmetric fold—Showing bearing, plunge, and direction of rotation of limbs.

10. Minor fold of cleavage

PLANEAR FEATURES

(May be combined with other features)

11. Strike and dip of bed—Ball indicates top of bed; arrow from sedimentary structures.

12. Inclined

13. Overturned

14. Vertical

15. Horizontal

16. Strike and dip of mylonitic foliation

17. Strike and dip of transposition fracture

18. Indicated

19. Vertical

20. Strike and dip of slaty or rough cleavage

21. Indicated

22. Vertical

23. Horizontal

24. Strike and dip of slaty cleavage and bedding parallel to strike but divergent in dip

25. Strike and dip of pseudo slaty cleavage referred to thrust faulting

26. Strike and dip of cleavage cleavage

27. Strike and dip of spaced cleavage

28. Indicated

29. Vertical

30. Strike and dip of joints

31. Indicated

32. Vertical

33. Strike and dip of extension fractures

LINEAR FEATURES

(May be combined with other features)

34. Bearing and plunge of elongation features

35. Bearing and plunge of intersection of bedding and slaty cleavage

36. Horizontal

37. Bearing and plunge of cleavage

38. Bearing and plunge of intersection of spaced cleavage and slaty cleavage

39. Bearing and plunge of grooves

OTHER FEATURES

40. Abandoned slate quarry

F. Fossil locality

Graphic from source map: Newton West Quadrangle
Geologic Discussion

INTRODUCTION
The Newton West quadrangle, located in northern New Jersey, is mostly underlain by lower Paleozoic rocks of the Kittatinny Valley segment of the Great Appalachian Valley. Silurian rocks of the Appalachian Valley and Ridge underlie the extreme northwestern corner of the quadrangle. Glacial and other surficial deposits (Qd) are abundant and were mapped where they totally obscure the bedrock. The rocks exposed in this quadrangle have been studied elsewhere in New Jersey and eastern Pennsylvania, and the reader is referred to Drake (1965, 1969) and Drake and Epstein (1967) for descriptions of the lower Paleozoic rocks, and Epstein and Epstein (1969, 1972) and Epstein and Lyttle (1987) for descriptions of the Silurian rocks.

Regionally, the quadrangle is within the complex tectonic terrane termed the Taconides by Drake (1980), and described in detail by Drake and others (1989). These Taconic structures were later overprinted by those formed during the late Paleozoic Alleghanian orogeny. The geologic structure in this quadrangle is dominated by emergent thrust faults, as well as by an interpreted sequence of blind thrust faults.

STRATIGRAPHY
The oldest rocks exposed in this quadrangle are those of the Allentown Dolomite (OCa). They are well exposed at many places in the southeastern part of the quadrangle as well as within the Paulins Kill valley. Rocks of the Stonehenge Formation (Os) crop out at many places in the southern part of the quadrangle, and good exposures can be seen south of Stillwater in the Paulins Kill valley. The Rickenbach Dolomite (Or) is also well exposed in the southeastern part of the quadrangle. This unit appears to be absent on the northwest limb of the Redings Pond syncline in the southeastern corner of the quadrangle and beneath the rocks of the sequence at Wantage northeast of Stillwater and southwest of Balesville in the Paulins Kill valley. This suggests that the Middle Ordovician unconformity has cut down into the Stonehenge Formation in these areas. The Stonehenge Formation and Rickenbach Dolomite constitute the Lower Ordovician Beekmantown Group.

The sequence at Wantage (Ow) consists of clastic and carbonate rocks that are irregularly preserved on the Middle Ordovician unconformity in northern New Jersey. The rocks north of Stillwater Station appear to grade up into the dolomite pebble and cobble conglomerate at the base of the Jacksonburg Limestone. The Jacksonburg Limestone (Oj) is poorly exposed, but outcrops can be seen in the southeastern part of the quadrangle and north of Swartswood Lake.

Rocks of the Martinsburg Formation are the most abundant in the quadrangle. The Martinsburg represents deposition in an evolving foreland basin (Drake, 1991). The basal euxinic Bushkill Member (Omb) reflects the stagnant conditions of the basin at that time. These rocks pass up into classic “distal” turbidites and then into the more “proximal” turbidites of the Ramseyburg Member (Omr). The Bushkill is best exposed north of Middleville near the western margin of the quadrangle and southeast of Lake Kemah on the northern margin of the quadrangle. It is absent near Stickles Pond where Ramseyburg directly overlies the Jacksonburg Limestone with no evidence of faulting. These rocks are on the northwest limb of a syncline, the axial trace of which is on the adjoining Newton East quadrangle (A.A. Drake, Jr., unpub. data). A thin layer of Bushkill crops out on the southeast limb of this syncline, and appears on the northwest limb farther to the northeast. This abnormal relation presumably results from the complexities of sedimentation within the foreland basin that cannot be reconstructed because of limited exposure. There are abundant outcrops of Ramseyburg in the central part of the quadrangle.

The Shawangunk Formation (Ss) can be seen in cliffs and other outcrops along the steep southeast slope of Kittatinny Mountain located in the northwestern corner of the quadrangle.

STRUCTURAL GEOLOGY
The major Portland thrust fault brings younger rocks of the Martinsburg Formation onto older carbonate
rocks because the rocks were already deformed before the thrust event. The Portland fault has been mapped over a distance of more than 30 mi from the Stroudsburg quadrangle in eastern Pennsylvania (Epstein, 1973) to near the eastern boundary of the Branchville quadrangle where it appears to pass into an anticline (Drake and Monteverde, in press a). The White Lake and Duck Pond thrust faults constitute the bounding surfaces of a large horse of carbonate rock that extends at least 15 mi southwest into the Blairstown quadrangle and 4 mi northeast into the Branchville quadrangle where both faults join the Portland fault on the surface.

The Shades of Death, Crooked Swamp, and Springdale thrust faults are members of the Shades of Death thrust system, which extends from Pennsylvania on the southwest (Drake and others, 1969) into Orange County, N.Y. (Drake and Monteverde, 1992b). In this quadrangle, the Crooked Swamp is the major fault of the system, as slip was transferred to it from the Shades of Death, which terminates a short distance to the east in the Newton East quadrangle (A.A. Drake, Jr., unpub. data).

The Springdale thrust fault joins the Crooked Swamp thrust fault both here and in the Tranquility quadrangle to the southwest (A.A. Drake, Jr., unpub. data). The rocks between these thrust faults, which are as young as the Bushkill Member of the Martinsburg Formation, constitute a large and complicated horse.

The Ackerman anticline in the Paulins Kill Valley has been mapped over a distance of 27 mi from the Stroudsburg quadrangle (Epstein, 1973) on the southwest to the Branchville quadrangle where its hinge is dissected by the White Lake and Duck Pond thrust faults (Drake and Monteverde, in press a). This anticlinal structure appears to pass into a subsurface anticlinorium in both the Branchville (Drake and Monteverde, 1992a) and Unionville (Drake and Monteverde, 1992b) quadrangles and thence into an outcropping anticline in the Wallkill Valley of New York (P.T. Lyttle, USGS, oral commun., 1990). This anticlinorium is interpreted to result from the jacking-up of the Martinsburg Formation by a blind duplex in underlying carbonate rocks. The anticlinorium has the shape of a fault-bend fold, as does the Ackerman anticline, suggesting that these structures are in the hanging wall above a major ramp. Such a structure was predicted by Sanders (1983) for the Middletown, N.Y. area.

The form of the complex fold array north of Swartswood Lake is not well constrained because of the thick glacial deposits, but the distribution of outcrops suggests that the pattern shown is reasonably correct. Those folds, as well as those in the Martinsburg Formation along the western boundary of the quadrangle, are interpreted to be an anticlinorium above a carbonate rock duplex.

The Newton anticline continues northeastward into the Newton East quadrangle where it is broken up by imbricate faults from the Crooked Swamp thrust fault.

Four phases of folds were mapped by Drake and Lyttle (1985) in the Blairstown quadrangle to the southwest, but only one phase of folding is evident in the rocks to the northeast in the Branchville and Unionville quadrangles (Drake and Monteverde, in press a,b). Both type I (eggbox) and type II (boomerang) interference folds have been recognized in Tranquility quadrangle to the south (A.A. Drake, Jr., unpub. data), although the fold history in that quadrangle have not as yet been determined. A northwest-trending fold was mapped north of Swartswood Lake and a few mesoscopic folds of the same orientation were also noted. These folds correlate with those of the Hokendauqua phase of Drake and Lyttle (1985) and Drake (1987) and are thought to result from constrictive flow in the northwest-directed tectonic regimen. It appears then, that this quadrangle lies on the northeastern boundary of the polyphase terrane that becomes increasingly complex to the southwest.

Timing of deformation is difficult to determine in this quadrangle. The Portland and associated faults, as well as the faults of the Shades of Death system, were interpreted to be of Alleghanian age to the southwest (Drake and Lyttle, 1980). The age of the slaty cleavage is a different matter. In the Branchville quadrangle to the northeast, xenoliths of slaty-cleaved Martinsburg Formation occur within the Rutan Hill
diatreme (Drake and Monteverde, in press a), an observation made earlier by both Ratcliffe (1981) and Rowlands (1980). In addition, igneous rocks form dikes, which can be seen to spread into small sills along the cleavage (Drake and Monteverde, in press a). In Pennsylvania, Lash (1987) described slaty-cleavage rocks that are unconformably overlain by Upper Ordovician molasse. These data strongly imply that the cleavage is Taconic. On the other hand other geologists (see summary in Drake and Lyttle, 1980), for good reasons, think the slaty cleavage resulted from Alleghanian deformation. Mitra and Eliott's (1980) concept that cleavage youngs toward the foreland and therefore, may be time transgressive is philosophically pleasing, but impossible to document in the field. Perhaps planned isotopic dating will provide the solution. Without isotopic dating, timing of deformation remains a major problem here and throughout the Appalachians.

Text from source map: Newton West Quadrangle

References


in press b, Bedrock geologic map of the Unionville quadrangle, Orange County, New York, and Sussex


Sanders, J.E., 1983, Reinterpretation of the subsurface structure of the Middletown gas well 1 (Crom-
Wells, Inc. 1 Fee) in light of concept of large scale bedding thrusts: Northeastern Geology, v. 5, p. 172-186.


References from source map: [Newton West Quadrangle](#)
Pike County Geology and Mineral Resources, bedrock map

The formal citation for this source.


This map was used to provide coverage for the Edgemere and Twelvemile Pond 7.5 minute quadrangles and the Pennsylvania parts of the Milford and Lake Maskenozha 7.5 minute quadrangles.

Prominent graphics and text associated with this source.

**Correlation of Map Units**

![Image of correlation chart]

Some units in this correlation do not appear in the GRI digital geologic-GIS data because only portions of the source map (Edgemere and Twelvemile Pond Quadrangles and parts of Milford and Lake Maskenozha Quadrangles) were used.

Graphic from source map: [Pike County Geology and Mineral Resources, bedrock map](#)
Map Legend

Some features in this legend do not appear in the GRI digital geologic-GIS data because only portions of the source map (Edgemere and Twelvemile Pond Quadrangles and parts of Milford and Lake Maskenozha Quadrangles) were used.

Graphic from source map: [Pike County Geology and Mineral Resources, bedrock map](#)

Geologic Report

To view the geologic report, including figures, tables and graphics, click here: [Pike County Geology and Mineral Resources Report](#)

Report from source map: [Pike County Geology and Mineral Resources, bedrock map](#)
Saylorsburg Quadrangle

The formal citation for this source.


Prominent graphics and text associated with this source.

Correlation of Map Units

Graphic from source map: Saylorsburg Quadrangle
Map Legend

EXPLANATION OF MAP SYMBOLS
(Note: Location of buried contacts and traces of axial planes of folds in areas of thick drift are conjectural. Only selected structure symbols are shown in the Godfrey Ridge and Cherry Ridge areas. See Epstein (in press a) for greater detail in these areas.)

Contact—Long dashed where approximately located; short dashed where inferred; dotted where concealed

Faults—Long dashed where approximately located; short dashed where inferred; dotted where concealed; queried where doubtful

Décollement—Sawteeth on upper plate. All décollements are named.

Thrust fault—Sawteeth on upper plate

High-angle fault—U, upthrown side; D, downthrown side

Folds—Showing trace of axial surface. Long dashed where approximately located; short dashed where inferred; dotted where concealed

Anticline

Syncline

Overturned anticline—Showing direction of dip of limbs

Overturned syncline—Showing direction of dip of limbs

Antiformal syncline—Southeast limb overturned, northwest limb rotated more than 180°. Showing direction of dip of limbs and plunge

Synformal anticline—Northwest limb overturned, southeast limb rotated more than 180°. Showing direction of dip of limbs and plunge

PLANAR FEATURES

Strike and dip of bedding

Inclined

Vertical

Overturned

Rotated more than 180°

Strike and dip of slaty cleavage

Strike and dip of bedding and slaty cleavage parallel in strike but divergent in dip

Strike and dip of crenulation cleavage

LINEAR FEATURES

Bearing and plunge of intersection of bedding and cleavage

Inclined

Horizontal

Bearing and plunge of intersection of slaty cleavage and crenulation cleavage

Bearing and plunge of bedding-plane slickensides

OTHER FEATURES

Rock quarry

Active

Abandoned

Shale borrow pit

Sand and gravel pit

Collapsed shaft of clay mine

Graphic from source map: Saylorsburg Quadrangle
Lithotectonic Units (Figure 1 and Table 1)

<table>
<thead>
<tr>
<th>Lithotectonic unit</th>
<th>Age of lithotectonic unit and stratigraphic sequence</th>
<th>Lithologic characteristics</th>
<th>Style of folding</th>
<th>Average size of folds</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Late and Middle Devonian: Upper part of Marcellus Shale and younger rocks</td>
<td>More than 10,000 ft (3,050m) of sandstone, conglomerate, siltstone, and shale. Lower 7,500 ft (2,300m) exposed in quadrangle</td>
<td>Nearly symmetric, concentric, predominantly flexural slip. Broad open folds (Weir Mountain syncline and Lehighton anticline with lower order superimposed folds)</td>
<td>Half wavelengths about 9,000 ft (2,740 m) and amplitudes that decrease from more than 2,000 ft (610 m) in the southwest to zero near Bossardville, a rate of decrease of about 625 ft/mi (118 m/km)</td>
</tr>
<tr>
<td>3</td>
<td>Middle Devonian to Late Silurian: Lower part of Marcellus Shale to upper part of Pocono Island Formation</td>
<td>1,300–1,600 ft (400–490m) of limestone, sandstone and dolomite; thin heterogenous formations</td>
<td>Asymmetric, concentric, and similar, flexural slip and flow, passive slip and flow. Cascade folds</td>
<td>Wavelengths average about 650 ft (200 m); amplitudes about 250 ft (80 m)</td>
</tr>
<tr>
<td>2</td>
<td>Late to Early Silurian: Lower part of Pocono Island Formation to Shawangunk Formation</td>
<td>3,200 ft (975m) of sandstone, shale, siltstone, and conglomerate; coarse toward base of unit</td>
<td>Asymmetric, concentric; flexural slip with minor passive slip and flow. Bedding slip and wedging in the Bloomsburg Red Beds</td>
<td>Wavelengths average about 1 mi (1.6 km); amplitudes 1,000–4,000 ft (300–1200 m)</td>
</tr>
<tr>
<td>1</td>
<td>Late and Middle Ordovician Martinsburg Formation</td>
<td>About 12,000 ft (3,700 m) of thick repetitive sequences of slate and graywacke. Few hundred feet at top present in quadrangle</td>
<td>Asymmetric, similar nearly isoclinal, nearly reentrant; mainly passive flow and slip</td>
<td>Exposed south of quadrangle where wavelengths average about 2,000 ft (600 m) and amplitudes about 1,000 ft (300 m). Small-scale imbricate faults; major thrusts (Portland fault) with possible displacements in miles south of quadrangle and inferred to be present under cover in the quadrangle</td>
</tr>
</tbody>
</table>

TABLE 1. Lithotectonic units in the Saylorsburg quadrangle (modified from Epstein and Epstein, 1967, 1969). Adjacent units are inferred to be separated by decollements or zones of decollement; Blue Mountain decollement separates units 1 and 2; Stony Ridge-Goffrey Ridge decollement separates units 2 and 3; although considerable northwest teleseism is indicated by bedrock slippage and wedging in the Bloomsburg Red Beds; Weir Mountain decollement separates units 3 and 4.

Graphic from source map: Saylorsburg Quadrangle
Equal-Area Projections, Poles to Bedding (Figure 2)

Graphic from source map: Saylorsburg Quadrangle

Equal-Area Projections, Poles to Cleavage (Figure 3)

Graphic from source map: Saylorsburg Quadrangle
Equal-Area Projections, Intersections of Bedding and Cleavage (Figure 4)

Graphic from source map: Saylorsburg Quadrangle

Equal-Area Projections, Poles to Joints (Figure 5)

Graphic from source map: Saylorsburg Quadrangle
Environments of Deposition (Figure 6)

FIGURE 6—Environments of deposition of Middle Ordovician through Upper Devonian rocks in the Saylorsburg quadrangle.

Graphic from source map: Saylorsburg Quadrangle
Geologic Discussion

INTRODUCTION
The Saylorsburg quadrangle is located in the Valley and Ridge Province of Monroe and Northampton Counties of eastern Pennsylvania. More than 13,000 ft (4,000 m) of sedimentary rocks ranging from Middle Ordovician to Late Devonian in age, are exposed in the quadrangle. These are overlain by a thin veneer of surficial materials of Holocene and Pleistocene age. The geology of the surrounding area has been mapped (fig. 1) including a detailed map of Godfrey Ridge and Cherry Ridge by Epstein (in press a) and several reports dealing with details of stratigraphy: the Catskill Formation (Berg and others, 1977; Epstein and others, 1974); Onesquethawan rocks (Epstein, 1984); Upper Silurian and Lower Devonian rocks (Epstein and others, 1967), and Silurian rocks (Epstein and Epstein, 1972).

STRUCTURE
Four lithotectonic units have been distinguished in the region (Epstein and Epstein, 1967, 1969; Epstein, 1971) which have different styles of folding and which are believed to be separated by décollements (table 1, fig. 1). These disharmonic structural relations are shown in cross sections A-A’ through D-D’, although a partially different interpretation is presented in cross section C-C’, which shows ramp faults cutting upsection from the Portland fault at depth. The Portland fault has been mapped to the east in the Portland quadrangle (Drake and others, 1969; 1985), and it plunges southwestward beneath the Martinsburg Formation in the Stroudsburg quadrangle (Epstein, 1973). This fault has been interpreted as a major Alleghanian structure that parallels bedding in the lower part of the Martinsburg Formation (Bushkill Member) in the hanging wall, and cuts Cambrian and Ordovician carbonate rocks in the upright limb of the underlying Lyon Station-Paulins Kill nappe (Drake, 1978; Drake and Lyttle, 1980). This alternative structural interpretation is acceptable for several reasons. Décollements above and below lithotectonic unit 3 explain the disharmonic folding, but the increased deformation near Blue and Kittatinny Mountains can be explained by proximity to a ramp from the Portland fault. However, no such ramp fault has been mapped which cuts exposed rocks of lithotectonic unit 3 in the Delaware Water Gap to Lehigh Gap area; therefore, the fault may be “blind” and not reach the surface. Folds in lithotectonic unit 3 die out, as shown by detailed cross sections across Godfrey and Cherry Ridges in the Saylorsburg, Stroudsburg, and East Stroudsburg quadrangles (Epstein, in press a), and in the Delaware Valley about 10 mi (16 km) to the northeast (Alvord and Drake, 1971, section C-C’). This indicates that the upper (Weir Mountain) décollement may die out just north of the Lehighton anticline and disharmonic folding in lithotectonic unit 3 may not persist north of that area. Another ramp is shown cutting upsection from the Portland fault in the center of section B-B’ and may be responsible for the formation of the Lehighton anticline.

Equal-area projections of poles to bedding, cleavage, intersections of bedding and cleavage, and joints in the quadrangle are shown in figures 2, 3, 4 and 5.

The average trends and plunges of the folds in each lithotectonic unit (B) are derived from the girdles defined by poles to bedding in figure 2. In passing from older to younger units, the fold axes are oriented to a more westerly direction, from S. 50° W. in lithotectonic unit 2, to S. 60° W. in unit 3, and to S. 63° W. in unit 4.

Slaty cleavage (fig. 3) is axial planar to and fans the folds and the maximum for cleavage in each plot statistically defines the strike and dip of the folds in each lithotectonic unit. These plots of cleavage likewise indicate a more westerly orientation of the folds for each younger lithotectonic unit.

Figure 4 shows plots for the intersection of bedding and slaty cleavage, a lineation which approximates the trends of the axes of the folds. This plot also shows a more westerly rotation of the axes of folds from older to younger rocks, and these axes are very close to the orientation derived from the plots of bedding in figure 2.
The plot of joints (fig. 5) shows that cross joints are the most conspicuous of all the joint types and agrees with the orientation of the folds. Longitudinal joints are generally less numerous, and oblique joints are even less common.

The difference in orientation of the folds in the three lithotectonic units is apparent on the geologic map. This difference may be explained by differential rotation of each unit as it moved northwestward on the underlying décollements. A regional geologic map, such as the Newark 1° x 2° quadrangle (Lyttle and Epstein, 1987), shows that the axes of the folds in lithotectonic units 2 and 3 in the Saylorsburg quadrangle are nearly parallel to the form surface in rocks of lithotectonic unit 4 of the southeastern corner of the Weir Mountain syncline. This rotation also extends downsection into the Martinsburg Formation, where, to the southeast in the Bangor quadrangle (Davis and others, 1967), there is an abrupt change in strike of structural elements from N. 72° E. in the western half of the quadrangle to N. 50° E. in the eastern half. These abrupt changes in structural strike are a very common feature along the length of the Valley and Ridge province in eastern Pennsylvania and New Jersey. They may be the result either of postfolding oroclinal bending or of strain discontinuities along strike during folding.

SEDIMENTOLOGY

The sedimentological history of the map units is summarized in figure 6. The Martinsburg Formation graywackes and shales were deposited in a rapidly subsiding flysch-turbidite basin developed during a Middle Ordovician plate collision. The source for the Martinsburg sediments was to the southeast, and the sediments covered a foundered older eastfacing carbonate bank. During Early to Middle Silurian time, mountains to the southeast that were uplifted during the Taconic orogeny were rapidly eroded and supplied sediment to streams that deposited sandstone and conglomerate of the Shawangunk Formation. Later, as the source area was eroded to gentler slopes, alluvium of meandering streams was deposited (Bloomsburg Red Beds). An intermediate transgressive phase (Lizard Creek Member) occurred during middle Shawangunk time. A complex sequence of tidal, offshore-bar, and shallow- to deep-neritic sediments was deposited during a period of relative crustal stability from the Late Silurian to the middle Early Devonian (Poxono Island Formation through Oriskany Group). A rapid change to deeper water deposition (Esopus Formation) was followed by gradual shallowing conditions (Schoharie Formation through Buttermilk Falls Limestone) in early Middle Devonian time. The black Marcellus shale reflects development of an anoxic basin below wave base, followed by shallowing and more open-water conditions during Mahantango (late Middle Devonian) time. The Trimmers Rock Formation marks the beginning of Late Devonian sedimentation and consists of clastic rocks with many structures characteristic of turbidite deposition. These sediments grade upwards into shallow marine delta-front and possibly fluvial sandstones of the Towamensing Member of the Catskill Formation. The Catskill delta then prograded with deposition of fluvial and nearshore sediments of the Walcksville Member. A transgression resulted in deposition of the marine fossil-bearing Beaverdam Run Member, followed by a return to regressive fluvial and nearshore deposits of the Long Run Member. Many more sediments were presumably deposited during the Paleozoic, but these have been eroded. They are exposed in Pennsylvania to the north and west. The sedimentological history in the Saylorsburg quadrangle continued with deposition of glacial deposits during the Pleistocene and, finally, alluvium during the Holocene.

Text from source map: Saylorsburg Quadrangle

References

Epstein, J. B., and Epstein, A. G., 1967, Geology in the region of the Delaware to Lehigh Water Gaps,


References from source map: Saylorburg Quadrangle

**Stroudsburg Quadrangle**

The formal citation for this source.


Prominent graphics and text associated with this source.
Correlation of Map Units

Graphic from source map: Stroudsburg Quadrangle
Map Legend

**Structural Symbols**

- **Contact**
  - Solid: where exposed or accurate within about 50 ft; long dashed where not exposed but probably accurate within 200 ft, based on outcrop evidence or fault mapping considered to be reliable; short dashed where inferred, based on fault mapping of largely covered areas, pressure or topographic expression of suspect stratigraphic units, or construction of geometric cross sections—contact probably not accurate within 200 ft of its actual location; dotted where constrained beneath water or unconsolidated deposits; queried where doubtful
- **Inclined**
- **Overturned**

**Deformation**

- Long dashed where approximately horizontal; short dashed where inferred; dotted where constrained. Incertests on upper plate.
- **Deposition**
  - Graphic from source map: Stroudsburg Quadrangle

**ONLY SELECTED PLANAR AND LINEAR STRUCTURE SYMBOLS ARE SHOWN FOR THE GODFREY RIDGE AREA**

- Strike and dip of beds
- Strike and dip of overturned beds
- Strike and dip of beds rotated more than 180°
- Strike of vertical beds
- Strike of horizontal beds

- **Antilith**
  - Showing trace of axial surface and direction of plunge.
  - Long dashed where approximately horizontal; short dashed where inferred; dotted where constrained; queried where doubtful

- **Syncline**
  - Showing trace of axial surface and direction of plunge.
  - Long dashed where approximately horizontal; short dashed where inferred; dotted where constrained; queried where doubtful

- **Overturned antilith**
  - Showing trace of axial surface and direction of dip of limbs and plunge.
  - Long dashed where approximately horizontal; short dashed where inferred; dotted where constrained; queried where doubtful

- **Overturned syncline**
  - Showing trace of axial surface and direction of dip of limbs and plunge.
  - Long dashed where approximately horizontal; short dashed where inferred; dotted where constrained; queried where doubtful

- **Minor fold in cleavage**
  - Showing bearing and plunge of axis
  - Water well
  - Number is depth to bedrock, in feet.
  - Letter symbol indicates lithology penetrated: S, slate; C, carbonate rock

- **Abandoned quarry or borrow pit**
  - Shale quarries in Moravian Formation shown on base
  - **Selected fossil locality**

Graphic from source map: Stroudsburg Quadrangle
Lithotectonic Units (Table 1)

<table>
<thead>
<tr>
<th>Lithotectonic unit</th>
<th>Age of lithotectonic unit and stratigraphic sequence</th>
<th>Lithologic characteristics</th>
<th>Style of folding</th>
<th>Average size of folds</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Late and Middle Devonian Upper part of Marcellus Shale and younger rocks</td>
<td>More than 10,000 feet of sandstone, conglomerate, siltstone, and shale. Lower 1700 feet exposed in quadrangle</td>
<td>Nearly symmetric, concentric, predominantly flexural slip. Broad open folds</td>
<td>Half wavelengths about 3000 feet and amplitudes about 600 feet that increase to more than 5 miles and 4200 feet, respectively, west of the Saylorsburg quadrangle</td>
</tr>
<tr>
<td>3</td>
<td>Middle Devonian to Late Silurian Lower part of Marcellus Shale to upper part of Poconos Island Formation</td>
<td>1,500 feet of limestone, shale, siltstone, sandstone, and dolomite; heterogeneous stratigraphic units between 5 and 180 feet thick</td>
<td>Asymmetric, concentric, and similar, flexural slip and flow, passive slip and flow. Cascade folds</td>
<td>Wavelengths average about 700 feet; amplitudes about 250 feet</td>
</tr>
<tr>
<td>2</td>
<td>Late to Early Silurian and possibly Late Ordovician Lower part of Poconos Island Formation to Shawangunk Formation</td>
<td>3,200 feet of sandstone, siltstone, shale, and conglomerate; coarser toward base of sequence</td>
<td>Asymmetric, concentric; flexural slip with minor passive slip and flow. Bedding slip and wedging in the Bloomsburg Red Beds</td>
<td>Wavelengths average about 1 mile; amplitudes 1,500–5,000 feet</td>
</tr>
<tr>
<td>1</td>
<td>Late and Middle Ordovician Martinsburg Formation</td>
<td>About 12,000 feet of thick monotonous sequences of slate and graywacke</td>
<td>Asymmetric, similar nearly isoclinal, nearly recurrent; mainly passive flow and slip, flexural slip near contact with Shawangunk Formation. Folds probably superimposed on upright limb of large regional nappe</td>
<td>Wavelengths 1000 to 3000 feet; amplitudes 400 to 5000 feet. Small-scale imbricate faults; major thrusts with possible displacements in miles south of quadrangle and inferred to be present under cover (Portland fault) in the quadrangle</td>
</tr>
</tbody>
</table>

Graphic from source map: Stroudsburg Quadrangle
GRI Digital Data Credits

This document was developed and completed by James Chappell and Lucas Chappell (Colorado State University) for the NPS Geologic Resources Division (GRD) Geologic Resources Inventory (GRI) Program. Quality control of this document by Stephanie O'Meara (Colorado State University).

The information in this document was compiled from GRI source maps, and is intended to accompany the digital geologic-GIS maps and other digital data for Delaware Water Gap National Recreation Area, Pennsylvania, New Jersey and New York (DEWA) developed by James Chappell, Jakob Suri, Stephanie O'Meara, Ron Karpilo and Derek Witt (Colorado State University) (see the GRI Digital Maps and Source Map Citations section of this document for all sources used by the GRI in the completion of this document and related GRI digital geologic-GIS maps). The GRI digital geologic-GIS maps, as well as additional map component documents and files were initially produced by James Chappell, Stephanie O'Meara, and Matt Schaeffer and Giorgia DeWolfe (GRD student interns), Aaron Rice and Max Jackl (CSU student interns), and others.

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