U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science Directorate
Geologic Resources Division

Delaware Water Gap

GRI Ancillary Map Information Document

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

dewa_geology.pdf

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Geologic Resources Inventory Map Document for Delaware Water Gap

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Geologic Resources Inventory Map Document

Delaware Water Gap, NJ, PA

Document to Accompany Digital Geologic-GIS Data

dewa_geology.pdf

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This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Delaware Water Gap, NJ, PA (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.

National Park Service (NPS) Geologic Resources Inventory (GRI) Program staff have assembled the digital geologic-GIS data that accompanies this document.

For information about the status of GRI digital geologic-GIS data for a park contact:

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About the NPS Geologic Resources Inventory Program

Background

Recognizing the interrelationships between the physical (geology, air, and water) and biological (plants and animals) components of the Earth is vital to understanding, managing, and protecting natural resources. The Geologic Resources Inventory (GRI) helps make this connection by providing information on the role of geology and geologic resource management in parks.

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 Geologic Resources Inventory aims to raise awareness of geology and the role it plays in the environment, and to provide natural resource managers and staff, park planners, interpreters, researchers, and other NPS personnel with information that can help them make informed management decisions.

The GRI team, working closely with the Colorado State University (CSU) Department of Geosciences and a variety of other partners, provides more than 270 parks with a geologic scoping meeting, digital geologic-GIS map data, and a park-specific geologic report.

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: http://science.nature.nps.gov/im/inventory/geology/GeologyGISDataModel.cfm

Geologic Reports: Park-specific geologic reports identify geologic resource management issues as well as features and processes that are important to park ecosystems. In addition, these reports present a brief geologic history of the park and address specific properties of geologic units present in the park.

For a complete listing of Geologic Resource Inventory products and direct links to the download site visit the GRI publications webpage http://www.nature.nps.gov/geology/inventory/gre_publications.cfm

GRI geologic-GIS data is also available online at the NPS Data Store Search Application: http://irma.nps.gov/App/Reference/Search. 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: http://www.nature.nps.gov/geology/inventory, or contact:

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The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) Division.

GRI Digital Maps and Source Map Citations

The GRI digital geologic-GIS maps for Delaware Water Gap, NJ, PA (DEWA):
Map sources only partially used were included in the compiled digital geologic map for Delaware Water Gap National Recreation Area, whereas quadrangle maps used in entirety are included in the compiled map and as separate digital maps.

Digital Geologic Map of Delaware Water Gap National Recreation Area and vicinity, Pennsylvania, New Jersey and New York (*GRI MapCode DEWA*)

Carswell, L.D. and Lloyd, O.B., Jr., 1979, Geology and Groundwater Resources of Monroe County, Pennsylvania, Pennsylvania Geological Survey, Water Resources Report W 47, 1:48,000 scale. (*GRI Source Map ID 2375*)

Davis, Drew K., Sevon, W.D., Berg, Thomas M., and Schultz, Lane D., 1989, Bedrock Geologic Map of Pike County, Pennsylvania, Showing Locations of Selected Wells, Pennsylvania Geological Survey, Water Resources Report W 65, 1:50,000 scale (*GRI Source Map ID 4456*)

Drake, A.A., Kastelic, R.L. and Lyttle, P.T., 1985, Geologic Map of the Eastern Parts of the Belvidere and Portland Quadrangles, Warren County, New Jersey, U.S. Geological Survey, Miscellaneous Investigations Series Map I-1530, 1:24,000 scale. (*GRI Source Map ID 1558*)

Drake, A.A., Epstein, J.B. and Aaron, J.M., 1969, Geologic Map and Sections of Parts of the Portland and Belvidere Quadrangles, New Jersey and Pennsylvania, U.S. Geological Survey, Miscellaneous Investigations Series Map I-552, 1:24,000 scale (*GRI Source Map ID 1559*)

Fisher, D.W., Isachsen, Y.W., and Rickard, L.V., 1970, Geologic Map of New York - Lower Hudson Sheet, New York State Museum, Map and Chart Series 15, 1:250,000 scale. (*GRI Source Map ID 7288*)

Pallis, T. and Marzulli, W., 2006, Landslides in New Jersey, New Jersey Geological Survey, Digital Geodata Series DGS 06-3, 1:100,000 scale. (*GRI Source Map ID 74874*)

Pristas, R.P., 2007, Surficial Geology of New Jersey, New Jersey Geological Survey, Digital Geodata Series DGS 07-2, 1:100,000 scale. (*GRI Source Map ID 74858*)

Pristas, R.P., 2004, Bedrock Geology of New Jersey, New Jersey Geological Survey, Digital Geodata Series DGS 04-6, 1:100,000 scale. (*GRI Source Map ID 7285*)

Sevon, W.D., Berg, Thomas M., Schultz, Lane D., and Crowl, G.H., 1989, Geology and Mineral Resources of Pike County, Pennsylvania (Plate 1, Bedrock Geology), Pennsylvania Geological Survey, County Report C 52 (plate 1), 1:50,000 scale. (*GRI Source Map ID 4459*)

Sevon, W.D., Berg, Thomas M., Schultz, Lane D., and Crowl, G.H., 1989, Geology and Mineral Resources of Pike County, Pennsylvania (Plate 2, Surficial Geology), Pennsylvania Geological Survey, County Report C 52 (plate 2), 1:50,000 scale. (*GRI Source Map ID 4794*)

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

Alvord, Donald C., and Drake, Avery Ala Jr., 1971, Geologic Map of the Bushkill Quadrangle, Pennsylvania and New Jersey, U.S. Geological Survey, Geologic Quadrangle Map GQ-908, 1:24,000 scale. (*GRI Source Map ID 1566*)

Digital Geologic Map of the Branchville Quadrangle, Sussex County, New Jersey (*GRI MapCode BRAV*)

Drake, A.A., Monteverde, D.H., 1992, Bedrock Geologic Map of the Branchville Quadrangle, Sussex County, New Jersey, U.S. Geological Survey, Geologic Quadrangle Map GQ-1700, 1:24,000 scale. (*GRI Source Map ID 1561*)

Digital Geologic Map of the Newton West Quadrangle, Sussex and Warren Counties, New Jersey (*GRI MapCode NEWE*)

Drake, Avery Ala Jr., 1992, Geologic Map of the Newton West Quadrangle, Sussex and Warren Counties, New Jersey, U.S. Geological Survey, Geologic Quadrangle Map GQ-1703, 1:24,000 scale. (*GRI Source Map ID 1563*)

Digital Geologic Map of the Blairstown Quadrangle,Warren County, New Jersey (*GRI MapCode BLST*)

Drake, A.A., Lyttle, P.T., 1985, Geologic Map of the Blairstown Quadrangle, Warren County, New Jersey, U.S. Geological Survey, Geologic Quadrangle Map GQ-1585, 1:24,000 scale. (*GRI Source Map ID 1562*)

Digital Geologic Map of the Saylorsburg Quadrangle, Monroe and Northampton Counties, Pennsylvania (*GRI MapCode SAYL*)

Epstein, Jack B., 1990, Geologic Map of the Saylorsburg Quadrangle, Monroe and Northampton Counties, Pennsylvania, U.S. Geological Survey, Geologic Quadrangle Map GQ-1638, 1:24,000 scale. (*GRI Source Map ID 1556*)

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

Epstein, Jack B., 1973, Geologic Map of the Stroudsburg Quadrangle, Pennsylvania and New Jersey, U. S. Geological Survey, Geologic Quadrangle Map GQ-1047, 1:24,000 scale. (*GRI Source Map ID 1555*)

Digital Geologic Map of the Culvers Gap Quadrangle, Sussex County, New Jersey (*GRI MapCode CULV*)

Witte, R.W. and Epstein, J.B., 2005, Surficial Geologic Map of the Culvers Gap Quadrangle, Sussex County, New Jersey, New Jersey Geological Survey, Geologic Map Series GMS 04-1, 1:24,000 scale. (*GRI Source Map ID 73984*)

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

Map Unit List

The geologic units present in the digital geologic-GIS data produced for Delaware Water Gap, NJ, PA (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 Geologic Unit Information (UNIT) table included with the GRI geology-GIS data.

Geologic Map Units

Cenozoic Era

Quaternary Period

Qafl - Artificial fill (Qafl)
Qmd - Mine dump deposits (Qmd)
Qp - Peat (Qp)
Qud - Undifferentiated surficial deposits (Qud)
Qs - Swamp and marsh deposits (Qs)
Qal - Alluvium (Qal)
Qaf - Alluvial fan deposits (Qaf)
Qaoo - Alluvium and olean outwash, undifferentiated (Qaoo)
Qac - Alluvium and colluvium, undifferentiated (Qac)
Qba - Boulder accumulations (Qba)
Qsr - Shale-chip rubble (Qsr)
Qoic - Olean ice, contact stratified sand and gravel (Qoic)
Qokt - Olean kame terrace (Qokt)
Qot - Olean till (Qot)
Qta - Talus deposits (Qta)
Qst - Stream terrace deposits (Qst)
Qst2 - Stream terrace deposits, younger Minisink Valley terrace (Qst2)
Qst3 - Stream terrace deposits, older Minisink Valley terrace (Qst3)
Qe - Eolian deposits (Qe)
Qed - Sand dunes (Qed)
Qg - Glacial deposits, undifferentiated (Qg)
Qmt - Meltwater terrace deposits (Qmt)
Qtq - Till, derived from Kittatinny Mountain (Qtq)
Qtk - Till, derived from Kittatinny and Minisink Valley (Qtk)
Qk - Kame (Qk)
Qod - Glacial lake delta deposits from proglacial lakes (Qod)
Qv - Valley, train deposits (Qv)
Qf - Outwash fan, near Branchville (Qf)
Qfdb - Outwash fan, Dry Brook (Qfdb)
Qfa - Outwash fan, Adams Creek (Qfa)
Qwmrk - Recessional moraine (Qwmrk)
Qdfm - Dingmans Ferry recessional moraine (Qdfm)
Qom - Ogdensburg, Culvers Gap recessional moraine (Qom)
Qm - Recessional moraine (Qm)
Qd - Glacial lake delta deposits, Lake Owassa (Qd)
Qfd - Outwash fan, Dingmans Creek (Qfd)
Qwft - Glaciofluvial terrace deposits (Qwft)
Qwfv - Glaciofluvial plain deposits (Qwfv)

Qwic - Ice, contact deposits (Qwic)
Qit - Older till (Qit)

Paleozoic Era

Devonian Period

Dclr - Catskill Formation, Long Run Member (Dclr)
Dcbr - Catskill Formation, Beaverdam Run Member (Dcbr)
Dcw - Catskill Formation, Walcksville Member (Dcw)
Dcs - Catskill Formation, Shohola Member (Dcs)
Dca - Catskill Formation, Analomink Red Shale Member (Dca)
Dcd - Catskill Formation, Delaware River Flags Member (Dcd)
Dct - Catskill Formation, Towamensing Member (Dct)
Dtr - Trimmers Rock Formation, undivided (Dtr)
Dtm - Trimmers Rock Formation, Millrift Member (Dtm)
Dtsb - Trimmers Rock Formation, Sloat Brook Member (Dtsb)
Dmh - Hamilton Group, Mahantango Formation (Dmh)
Dmu - Hamilton Group, Mahantango Formation, Upper Member (Dmu)
Dmhn - Hamilton Group, Mahantango Formation, Nis Hollow Member (Dmhn)
Dmhc - Hamilton Group, Mahantango Formation, Centerfield Member (Dmhc)
Dml - Hamilton Group, Mahantango Formation, Lower Member (Dml)
Dmhf - Hamilton Group, Mahantango Formation, Biostrome (Dmhf)
Dh - Hamilton Group, Mahantangle Formation and Marcellus Shale, undivided (Dh)
Dm - Hamilton Group, Marcellus Shale (Dm)
Dmb - Hamilton Group, Marcellus Shale, Brodhead Creek Member (Dmb)
Dmsu - Hamilton Group, Marcellus Shale, Stony Hollow and Union Springs Shale Members, undivided (Dmsu)
Dou - Onondaga Limestone, undivided (Dou)
Db - Onondaga Limestone, Buttermilk Falls Limestone (Db)
Dpt - Palmerton Sandstone (Dpt)
Dse - Schoharie Formation and Esopus Formation, undivided (Dse)
Ds - Schoharie Formation (Ds)
De - Esopus Formation (De)
Do - Oriskany Group, undivided (Do)
Dr - Oriskany Group, Ridgley Sandstone (Dr)
Drs - Oriskany Group, Ridgley Sandstone and Shriver Chert, undivided (Drs)
Dhg - Helderburg Group (Dhg)
Dph - Helderburg Group, Port Ewan Shale, Minisink Limestone, and New Scotland Formation, undivided (Dph)
Dp - Port Ewan Shale (Dp)
Dmn - Helderburg Group, Minisink Limestone and New Scotland Formation, undivided (Dmn)
Dc - Helderburg Group, Coeymans Formation, undivided (Dc)

Devonian and Silurian Periods

DShr - Lower part of Helderburg Group and Rondout Formation, undivided (DShr)
DSohr - Shriver Chert of the Oriskany Group, Helderburg Group and Rondout Formation, undivided (DSohr)
DSrp - Rondout Formation (DSrp)
DSrd - Rondout Formation and Decker Formation, undivided (DSrd)
DSu - Undifferentiated Devonian and Silurian rocks (DSu)

Silurian Period

Sd - Decker Formation (DSd)
Sbv - Bossardville Limestone (Sbv)
Sp - Poxono Island Formation (Sp)
Sbcu - Bloomsburg Red Beds, disseminated chalcocite (Sbcu)
Sb - Bloomsburg Red Beds (Sb)
Ss - Shawangunk Formation, undivided (Ss)
Sst - Shawangunk Formation, Tammany Member (Sst)
Ssl - Shawangunk Formation, Lizard Creek Member (Ssl)
Ssm - Shawangunk Formation, Minsi Member (Ssm)
SObl - Beemerville Intrusive Suite, undifferentiated dikes (SObl)

Ordovician Period

Obs - Beemerville Intrusive Suite, nepheline syenite (Obs)
Obt - Beemerville Intrusive Suite, tinguaite (Obt)
Obp - Beemerville Intrusive Suite, phonolite (Obp)
Obb - Beemerville Intrusive Suite, bostonite (Obb)
Obm - Beemerville Intrusive Suite, malignite (Obm)
Obla - Beemerville Intrusive Suite, lamprophyre (Obla)
Obo - Beemerville Intrusive Suite, Ouachitite Breccia (Obo)
Omh - Hornfels (Omh)
Omp - Martinsburg Formation, Pen Argyl Member (Omp)
Omhp - Martinsburg Formation, High Point Member (Omhp)
Omr - Martinsburg Formation, Ramseyburg Member (Omr)
Omrg - Martinsburg Formation, Ramseyburg Member, graywacke beds (Omrg)
Omb - Martinsburg Formation, Bushkill Member (Omb)
Oag - Austin Glen Formation (Oag)
Oj - Jacksonburg Limestone (Oj)
Ojl - Jacksonburg Limestone, cement limestone facies (Ojl)
Ow - Sequence at Wantage (Ow)
Obu - Beekmantown Group, upper part (Obu)
Obl - Beekmantown Group, lower part (Obl)
Oe - Beekmantown Group, Epler Formation (Oe)
Or - Beekmantown Group, Rickenbach Dolomite (Or)
Os - Stonehenge Formation (Os)

Ordovician and Cambrian Periods

OCa - Allentown Dolomite (OCa)
OCc - Carbonate rocks (OCc)

Cambrian Period

Cl - Leithsville Formation (Cl)
Ch - Hardyston Quartzite (Ch)

Proterozoic Eon

Ymv - Venite (Ymv)
Yba - Byram Intrusive Suite, microperthite alaskite (Yba)
Ybh - Byram Intrusive Suite, hornblende granite (Ybh)

Ymr - Marble (Ymr)
Yq - Quartz-plagioclase-epidote-biotite gneiss (Yq)
Yk - Potassic feldspar gneiss (Yk)
Ylo - Oligoclase-quartz gneiss (Ylo)
Ya - Amphibolite (Ya)

Map Unit Descriptions

Descriptions of all geologic map units, generally listed from youngest to oldest, are presented below. Where data were derived from County Report 52, corresponding lithologic descriptions from Water Resources Report W 65 are also included.

Qafl - Artificial fill (Holocene)

af - Artificial Fill (Holocene) - Unconsolidated, compacted mixture of rock fragments, sand, silt, and clay, or concrete that is used for roadway fill or earth dams. Generally several feet thick.

Groundwater Characteristics: No aquifer potential.

Engineering Characteristics: Moderately easy to excavate. Generally good slope stability; susceptible to erosion. Good foundation for heavy structures where specifically designed.

Mineral Resources: No mineral resources.

GRI Source Map ID 4794 (County Report C52, plate2)

af - Artificial fill (Holocene) - Rock waste, soil, gravel, sand, silt, and manufactured materials put in place by man. As much as 25 feet (8m) thick. Not shown beneath roads and railroads where it is less than 10 feet (3m) thick. Primarily used to raise the land surface, construct earthen dams, and form a solid base for roads and railways. *GRI Source Map ID 73984* (GMS 04-1)

Qmd - Mine dump deposits (Holocene)

d - Slate dump (Holocene) - Waste blocks of slate from the Martinsburg Formation in piles more than 100 feet high. Used for road metal and lightweight aggregate. *GRI Source Map ID 1555* (GQ-1047)

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 . *GRI Source Map ID 1556* (GQ-1638)

Qp - Peat (Holocene)

Decayed vegetation, commonly water saturated. Occurs in undrained or poorly drained natural depressions; thickly vegetated; water table is at or near the surface. Product of accumulation and partial decay of vegetation below water level. Large deposits are 10 feet thick or more.

Groundwater Characteristics: No aquifer potential.

Engineering Characteristics: Easy to excavate. Unsuitable for foundations, septic systems, and sanitary-landfill sites because the water table is at or near the surface.

Mineral Resources: Abundant potential as soil conditioner.

GRI Source Map ID 4794 (County Report C52, plate2)

Qud - Undifferentiated surficial deposits (Quaternary)

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. *GRI Source Map ID 1558* (I-1530)

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. *GRI Source Map ID 1562* (GQ-1585)

Qd - Surficial Deposits (Quaternary) - Alluvium, glacial deposits of Wisconsin age, and swamp deposits of organic-rich muck, clay, silt, sand, and gravel. *GRI Source Map ID 1561* (GQ-1700)

Qd - Surficial Deposits (Quaternary) - Alluvium, glacial deposits of Wisconsin age, and swamp deposits of organic-rich muck. *GRI Source Map ID 1563* (GQ-1703)

Qs - Swamp and marsh deposits (Holocene and Pleistocene)

Qs - Swamp deposits (Holocene and Pleistocene) - 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. *GRI Source Map ID 1566* (GQ-908)

Qs - Swamp Deposits (Holocene) - Unconsolidated clay, silt, and sand mixed with partly decomposed organic material; may contain cobbles and boulders. Occurs in shallow, undrained areas that commonly have standing water and a thick overstory of trees. Most deposits are thought to be less than 6 feet thick. No aquifer potential. Easily excavated. Unsuitable for foundations, septic systems, and sanitary-landfill sites because of the high water table. No known mineral resources.

> Groundwater Characteristics: No aquifer potential.
>
> Engineering Characteristics: Easily excavated. Unsuitable for foundations, septic systems, and sanitary-landfill sites because of the high water table.
>
> Mineral Resources: No known mineral resources.

GRI Source Map ID 4794 (County Report C52, plate2)

Qs - Swamp deposits (Holocene and Pleistocene) - Clay, silt, sand, fine gravel, and partly decomposed plant material. *GRI Source Map ID 1559* (I-552)

Qs - Swamp deposits (Quaternary) - Organic matter and clay, probably with disseminated silt and sand, in poorly drained areas. Possible source for peat. *GRI Source Map ID 1555* (GQ-1047)

Qs - Swamp deposits (Holocene and Pleistocene) - Organic matter and clay, probably with disseminated silt and sand, in poorly drained areas. *GRI Source Map ID 1556* (GQ-1638)

Qs - Swamp and Marsh deposits (Holocene and late Pleistocene) - Deposited in modern freshwater wetlands. Peat and organic clay, silt, and minor sand; gray, brown, black. As much as 40 feet thick.

GRI Source Map ID 74858 (DGS 07-2)

Qs - Swamp and Bog deposits (Holocene and late Wisconsinan) - Dark brown to black, partially decomposed remains of mosses, sedges, trees and other plants, and muck underlain by laminated organic-rich silt and clay. Accumulated in kettles, shallow postglacial lakes, poorly-drained areas in uplands, and hollows in ground moraine. As much as 25 feet (8m) thick. Locally interbedded with alluvium and thin colluvium. *GRI Source Map ID 73984* (GMS 04-1)

Qal - Alluvium (Quaternary)

Qal - Alluvium (Holocene) - Deposits of clay, silt, sand, and gravel along streams. *GRI Source Map ID 1566* (GQ-908)

Vfg - 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 capacity1 is 2.85 gpm/ft; 24-hour potential well yield 2 is 400 gpm; median water level below land surface3 is 10 feet; median saturated thickness is 65 feet. The water is low in solutes, generally soft, and potentially corrosive. Specific conductance4 is 117 micromhos; hardness 5 is 2 gpg. Excessive concentrations of iron and manganese occur in water from these deposits. *GRI Source Map ID 2375* (Water Resource Report W47)

Qal - Alluvium (Holocene) - Unconsolidated, poorly stratified, poorly to moderately well sorted mixture of clay, silt, sand, gravel, cobbles, and some boulders. Clasts are angular and platy to well rounded; composition reflects the underlying bedrock. Alluvium has flat and smooth to very rough surfaces and occupies valley bottoms. Alluvium is a fluvial deposit in valley bottoms. Thickness is generally unknown, but most deposits are thought to be not more than several feet thick.

> Groundwater Characteristics: Locally may yield large quantities of water to wells.
>
> Engineering Characteristics: Easy to excavate; generally shallow depth to bedrock. Unsuitable for septic systems and construction because of the potential for flooding.
>
> Mineral Resources: No known mineral resources.

GRI Source Map ID 4794 (County Report C52, plate2)

Qal - Alluvium (Holocene) - Clay, silt, sand, and gravel along streams. *GRI Source Map ID 1559* (I-552)

Qal - Alluvium and flood-plain deposits (Holocene) - Silt, sand, and gravel in riverbed and flood-plain deposits of present streams. *GRI Source Map ID 1555* (GQ-1047)

Qal - Alluvium (Holocene) - Silt, sand, and gravel in riverbed and flood-plain deposits of present streams. *GRI Source Map ID 1556* (GQ-1638)

al - Recent alluvium (Quaternary) - Oxidized fine sand to gravel, permeable, generally confined to flood plains within a valley, in larger valleys may be overlain by silt, subject to flooding, thickness 1-10 meters. *GRI Source Map ID 7288* (Map and Chart Series 15)

Qal - Alluvium (Holocene and late Pleistocene) - Deposited in modern floodplains and channels. Sand, gravel, silt, minor clay and peat; reddish brown, yellowish brown, brown, gray. Contains variable

amounts of organic matter. As much as 20 feet thick. *GRI Source Map ID 74858* (DGS 07-2)

Qal - Alluvium (Holocene) - Stratified, moderately- to poorly-sorted sand, gravel, silt, and minor clay and organic material deposited by the Delaware River and its tributaries. Locally bouldery. As much as 25 feet (8m) thick. Includes planar- to cross-bedded gravel and sand, and cross-bedded and rippled sand in channel deposits, and massive and parallel-laminated fine sand, and silt in flood-plain deposits. *GRI Source Map ID 73984* (GMS 04-1)

Qaf - Alluvial fan deposits (Quaternary)

Qaf - Alluvial Fan (Pleistocene) - Unconsolidated, poorly stratified, poorly to moderately well sorted mixture of clay, silt, sand, gravel, cobbles, and some boulders. Clasts are angular and platy to well rounded; composition reflects the underlying bedrock. Alluvial fans have relatively smooth, fan-shaped surfaces and low to steep gradients, and occur at the mouths of tributaries. Alluvial fans are fluvial deposits at tributary mouths. Thickness is generally unknown, but most deposits are thought to be not more than several feet thick.

Groundwater Characteristics: Locally may yield large quantities of water to wells.

Engineering Characteristics: Easy to excavate; generally shallow depth to bedrock. Unsuitable for septic systems and construction because of the potential for flooding.

Mineral Resources: No known mineral resources.

GRI Source Map ID 4794 (County Report C52, plate2)

Qaf - Alluvial fan deposits (Holocene and late Pleistocene, locally middle Pleistocene) - Contain minor amounts of organic matter. Form fans at mouths of steep streams. Sand, silt, pebble-to-cobble gravel; reddish brown, yellowish brown to brown. As much as 40 feet thick. *GRI Source Map ID 74858* (DGS 07-2)

Qaf - Alluvial-fan deposits (Holocene and late Wisconsinan) - Stratified, moderately to poorly sorted sand, gravel, and silt in fan-shaped deposits. As much as 35 feet (11 m) thick. Includes massive to planar-bedded sand and gravel and minor cross-bedded channel-fill sand. Beds dip as much as 30° toward the trunk valley. Locally interlayered with poorly sorted, sandy-silty to sandy gravel. Typically graded to postglacial terraces or the modern floodplain. More rarely graded to glacial outwash terraces. Most fans dissected by modern streams. *GRI Source Map ID 73984* (GMS 04-1)

Qaoo - Alluvium and olean outwash, undifferentiated (Pleistocene)

Qaoo - Alluvium and Olean Outwash Undifferentiated (Pleistocene) - Outwash consists of unconsolidated, stratified sand and gravel, and some boulders. Outwash has planar bedding and crossbedding; a large variation in clast size may occur from bed to bed; composition is dominated by Catskill Formation lithologies; occurs as valley fill in larger valleys. Alluvium consists of clay, silt, and very fine grained sand on flood-plain surfaces and coarser material in stream channels. Outwash was deposited by glacial meltwater streams. Alluvium was deposited by streams not of glacial origin. Combined thickness ranges from several feet to 501 feet at Matamoras.

Groundwater Characteristics: High infiltration capacity. Median yield of domestic wells is 22 gal/min. Water has good quality.

Engineering Characteristics: Easy to excavate. Maintains moderate to gentle cut slopes; has potential for slumping. Generally unsuitable for septic systems because of potential for contamination of groundwater. Moderate to poor foundation for heavy structures; flooding is a potential hazard in many places.

Mineral Resources: Source of coarse and fine aggregate; screening and washing are generally required, and crushing may be required; groundwater may be encountered at shallow depths in some valley bottoms.

GRI Source Map ID 4794 (County Report C52, plate2)

og - Outwash sand and gravel (Quaternary) - Coarse to fine gravel with sand, proglacial fluvial deposition. *GRI Source Map ID 7288* (Map and Chart Series 15)

Qac - Alluvium and colluvium undifferentiated (Quaternary)

Stratified, thinly bedded, moderately to poorly sorted sand, silt, and minor gravel in thin sheets laid down on the floors of small upland tributaries and the lower parts of adjacent slopes. Interlayered with and overlying silty to silty-sandy diamicton (interpreted as a mass-flow deposit). Locally shaly. As much as 15 feet (5 m) thick. *GRI Source Map ID 73984* (GMS 04-1)

Qba - Boulder accumulations (Pleistocene)

Unsorted, unconsolidated mixture of angular to rounded boulders up to 6 feet or more in diameter, but generally less than 3 feet. Mainly sandstone having relatively flat to very rough surfaces. Occurs in open flats, below ledges, in small drainages, around the margins of peat deposits, and on swamp surfaces. Deposits result from glaciation and/or colluviation. Thickness is unknown, but appears to range from 1 foot to several feet.

Groundwater Characteristics: No aquifer potential.

Engineering Characteristics: Easy to excavate. Moderate slopes; unstable where loaded or undercut. Unsuitable for foundations. May be unsuitable for septic systems and sanitary-landfill sites.

Mineral Resources: Potential source of riprap.

GRI Source Map ID 4794 (County Report C52, plate2)

Qsr - Shale-chip rubble (Pleistocene)

Qsr - Shale-Chip Rubble (Pleistocene) - Unconsolidated, poorly to well-bedded, wedge-shaped deposits of angular, elongate to platy fragments of claystone and siltstone generally 1 to 2 inches long. Rubble has open interstices. Fragments have a thin clay coating; elongate fragments generally have their long axis parallel to the slope. Formed by accumulation of mass-wasted fragments (colluvium) at the base of steep cliffs. Thickness is variable; maximum is about 50 feet at the base of slopes.

Groundwater Characteristics: No aquifer potential.

Engineering Characteristics: Easy to excavate. Moderate slopes; unstable where loaded or undercut. Unsuitable for foundations. May be unsuitable for septic systems and sanitary-landfill sites.

Mineral Resources: Excellent source of material for random fill and surfacing for low-use secondary roads (locally called sharpstone).

GRI Source Map ID 4794 (County Report C52, plate2)

Qsc - Shale-chip colluvium (Holocene and late Wisconsinan) - Thin to thickly bedded, noncompact, poorly sorted light yellowish-brown (10YR 6/4) to brownish-yellow (10YR 7/6) or light olive-brown (2.5Y 5/2) framework-supported, shale-chip gravel, containing as much as 80 percent unweathered to lightly weathered angular to subangular shale chips, and minor tabular pebbles and cobbles of siltstone and sandstone. Interstitial material consists of silty sand. Forms aprons below cliffs and some steep slopes on the west side of Minisink Valley; as much as 20 feet (3 m) thick. Beds dip as much as 25° toward valley. In places the distal (downslope) beds are interlayered with wind-blown sand and alluvium. Graded to glacial and postglacial stream terraces in valley. *GRI Source Map ID 73984* (GMS 04-1)

Qoic - Olean ice-contact stratified sand and gravel (Pleistocene)

Unconsolidated, stratified sand and gravel, commonly containing large boulders. Abrupt textural changes between beds and lenses; composition reflects underlying bedrock of the region; includes valley-bottom and valley-side kames and kame terraces, and some upland kames. Forms hummocky surface topography; kames have undrained depressions; kame terraces have undulating sloping surfaces. Deposited by fluvial action in close proximity to stagnant ice. Thickness is variable and generally unknown, ranging from several feet to more than 200 feet.

Groundwater Characteristics: High infiltration capacity. Median yield of domestic wells is 20 gal/min. Water has good quality.

Engineering Characteristics: Generally easy to excavate; large boulders may be encountered. Maintains only moderate to gentle cut slopes; potential for slumping. Generally unsuitable for septic systems and sanitary landfills because sand and gravel afford little or no attenuation of chemical and bacterial contaminants. Poor to unsuitable foundation for heavy structures.

Mineral Resources: Source of coarse and fine aggregate; crushing, screening, and washing are generally required; groundwater may be encountered in valley bottoms.

GRI Source Map ID 4794 (County Report C52, plate2)

Qokt - Olean kame terrace (Pleistocene)

Unconsolidated, stratified sand and gravel, commonly containing large boulders. Abrupt textural changes between beds and lenses; composition reflects underlying bedrock of the region; includes valley-bottom and valley-side kames and kame terraces, and some upland kames. Forms hummocky surface topography; kames have undrained depressions; kame terraces have undulating sloping surfaces. Deposited by fluvial action in close proximity to stagnant ice. Thickness is variable and generally unknown, ranging from several feet to more than 200 feet.

Groundwater Characteristics: High infiltration capacity. Median yield of domestic wells is 20 gal/min. Water has good quality.

Engineering Characteristics: Generally easy to excavate; large boulders may be encountered. Maintains only moderate to gentle cut slopes; potential for slumping. Generally unsuitable for septic systems and sanitary landfills because sand and gravel afford little or no attenuation of chemical and bacterial contaminants. Poor to unsuitable foundation for heavy structures.

Mineral Resources: Source of coarse and fine aggregate; crushing, screening, and washing are generally required; groundwater may be encountered in valley bottoms.

GRI Source Map ID 4794 (County Report C52, plate2)

Qot - Olean till (Pleistocene)

Qot - Olean till (Pleistocene) - Unsorted and nonstratified mixture of clay, silt, sand, pebbles, cobbles, and boulders. Reddish brow in most of the county; brown to gray where it overlies the Trimmers Rock and Mahantango Formation; moderately cohesive; composition reflects underlying bedrock; shallow soil profiles; occurs mainly on lower slopes or in valley bottoms. Deposited as lodgment till at the base of ice or as ablation till by melting ice. Thickness ranges from 6 feet to over 200 feet.

Groundwater Characteristics: Moderate to high infiltration capacity. Four domestic wells have a median yield of 28 gal/min. Water has good quality.

Engineering Characteristics: Moderately easy to excavate; some problems due to large boulders. Generally fast drilling rates. Generally maintains gentle to moderate cut slopes; susceptible to landslide failure where water saturated. Poor to good foundation for heavy structures. Not suitable for septic systems. Suitable in some places for sanitary-landfill sites.

Mineral Resources: Useful as artificial fill.

GRI Source Map ID 4794 (County Report C52, plate2)

br - Bedrock and Thin Olean Till, Undivided (Paleozoic and younger) - Rock exposures and till less than 6 feet thick. Includes rock ledges having steep faces up to several feet high; broken rock is common at the base of ledges. Unvegetated, gently dipping rock surfaces adjacent to ledges may have scattered large boulders and glacially striated surfaces. See Olean Till for description of till.

Groundwater Characteristics: Till has no aquifer potential because of inadequate thickness.

Engineering Characteristics: Thin till is easily excavated. Till thickness is inadequate for septic systems and sanitary-landfill sites.

Mineral Resources: Till may be used for artificial fill.

GRI Source Map ID 4794 (County Report C52, plate2)

t - Till (Quaternary) - Variable texture (boulders to silt), usually poorly sorted sand-rich diamict, deposition beneath glacier ice, permeability varies with compaction, thickness variable (1-50 meters).
GRI Source Map ID 7288 (Map and Chart Series 15)

Qta - Talus deposits (Quaternary)

Qta - Talus (Holocene and late Pleistocene) - Forms steep aprons at the base of cliffs. Deposited by rockfall after retreat of the late Wisconsinan glacier. Angular blocks and boulders of gneiss, quartzite, or diabase (depending on location) with little or no matrix material; gray, white, and reddish-purple. As much as 20 feet thick. *GRI Source Map ID 74858* (DGS 07-2)

Qta - Talus deposits (Holocene and late Wisconsinan) - Unsorted, nonstratified, angular boulders as much as 15 feet (4m) long; cobbles, and smaller fragments of quartzite and quartz-pebble conglomerate forming aprons over rock and till at the base of bedrock cliffs and steep hillslopes on Kittatinny Mountain. As much as 20 feet (6m) thick. *Source Map ID 73984* (GMS 04-1)

Qst - Stream terrace deposits (Quaternary)

Qst - Postglacial stream terrace deposits (Holocene and late Pleistocene) - Form stream terraces with surfaces up to 40 feet above the modern floodplain. Where more than one terrace occurs, the youngest is designated Qst1; the older, higher terrace is Qst2. Laid down after late Wisconsinan glacial deposition ended. Sand, silt, pebble-to-cobble gravel; yellowish brown to reddish brown. As much as 20 feet thick. *GRI Source Map ID 74858* (DGS 07-2)

Qst - Stream terrace deposits (Holocene and late Wisconsinan) - Stratified, well- to moderately-sorted, massive to laminated, and minor cross-bedded fine sand and silt in terraces flanking present and late postglacial stream courses. As much as 20 feet (6 m) thick. Overlies glacial and postglacial fluvial, planar to cross-bedded pebbly sand and gravel; as much as 10 feet (3 m) thick. In Minisink Valley (Delaware River valley) deposits form two distinct terraces. The younger (Qst2) flanks recent and late postglacial stream courses and overlies early to late postglacial fluvial gravel and sand. It lies 20 to 35 feet (6 to 11 m) above the mean annual elevation of the Delaware River and chiefly consists of as much as 20 feet (6 m) of fine sand and silt overlying as much as 10 feet (6 m) of pebble gravel and sand. The older (Qst3) flanks late glacial and early postglacial stream courses and overlies glacial outwash and early postglacial fluvial sand and gravel. It lies 40 to 50 feet above the river and consists of as much as 10 feet of fine and medium sand. Subscript "a" indicates elevation of terrace is slightly lower than similar nearby terraces. This lower substage has not been shown to be correlative throughout Minisink Valley at map scale. The lower elevation may be due to erosion or differences in local depositional conditions. *GRI Source Map ID 73984* (GMS 04-1)

Qst2 - Stream terrace deposits, younger Minisink Valley terrace (Quaternary)

Stratified, well- to moderately-sorted, massive to laminated, and minor cross-bedded fine sand and silt in terraces flanking present and late postglacial stream courses. As much as 20 feet (6 m) thick. Overlies glacial and postglacial fluvial, planar to cross-bedded pebbly sand and gravel; as much as 10 feet (3 m) thick. In Minisink Valley (Delaware River valley) deposits form two distinct terraces. The younger (Qst2) flanks recent and late postglacial stream courses and overlies early to late postglacial fluvial gravel and sand. It lies 20 to 35 feet (6 to 11 m) above the mean annual elevation of the Delaware River and chiefly consists of as much as 20 feet (6 m) of fine sand and silt overlying as much as 10 feet (6 m) of pebble gravel and sand. The older (Qst3) flanks late glacial and early postglacial stream courses and overlies glacial outwash and early postglacial fluvial sand and gravel. It lies 40 to 50 feet above the river and consists of as much as 10 feet of fine and medium sand. Subscript "a" indicates elevation of terrace is slightly lower than similar nearby terraces. This lower substage has not been shown to be correlative throughout Minisink Valley at map scale. The lower elevation may be due to erosion or differences in

local depositional conditions. *GRI Source Map ID 73984* (GMS 04-1)

Qst3 - Stream terrace deposits, older Minisink Valley terrace (Quaternary)

Stratified, well- to moderately-sorted, massive to laminated, and minor cross-bedded fine sand and silt in terraces flanking present and late postglacial stream courses. As much as 20 feet (6 m) thick. Overlies glacial and postglacial fluvial, planar to cross-bedded pebbly sand and gravel; as much as 10 feet (3 m) thick. In Minisink Valley (Delaware River valley) deposits form two distinct terraces. The younger (Qst2) flanks recent and late postglacial stream courses and overlies early to late postglacial fluvial gravel and sand. It lies 20 to 35 feet (6 to 11 m) above the mean annual elevation of the Delaware River and chiefly consists of as much as 20 feet (6 m) of fine sand and silt overlying as much as 10 feet (6 m) of pebble gravel and sand. The older (Qst3) flanks late glacial and early postglacial stream courses and overlies glacial outwash and early postglacial fluvial sand and gravel. It lies 40 to 50 feet above the river and consists of as much as 10 feet of fine and medium sand. Subscript "a" indicates elevation of terrace is slightly lower than similar nearby terraces. This lower substage has not been shown to be correlative throughout Minisink Valley at map scale. The lower elevation may be due to erosion or differences in local depositional conditions. *GRI Source Map ID 73984* (GMS 04-1)

Qe - Eolian deposits (late Pleistocene)

Locally of early to middle Pleistocene and Pliocene age on uplands. Form sand sheets and, locally, dunes. Windblown fine sand and silt; very pale brown, yellowish brown. As much as 15 feet thick. *GRI Source Map ID 74858* (DGS 07-2)

Qed - Sand dunes (late Wisconsinan)

Well sorted, thinnly bedded, yellowish-brown (10YR 5/4) and brown (10YR 5/3) fine sand and very fine sand in low mounds and ridges on outwash deposits in Minisink Valley. As much as 10 feet thick (3 m). *GRI Source Map ID 73984* (GMS 04-1)

Qg - Glacial deposits, undifferentiated (Pleistocene)

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. *GRI Source Map ID 1566* (GQ-908)

Qg - Undifferentiated glacial deposits (Pleistocene) - Sand, gravel, till, and ground moraine of Wisconsin age. *GRI Source Map ID 1559* (I-552)

Qg - Glacial deposits, undifferentiated (Wisconsinan) - Gravel, sand, silt, and clay in till and stratified drift (maximum thickness is 2W+ feet under Delaware River near Shawnee Island). Exploited for sand and gravel. For detailed information on the glacial deposits see Epstein (1969). *GRI Source Map ID 1555* (GQ-1047)

Qg - Glacial deposits, undifferentiated (Wisconsinan) - Gravel, sand, and clay in till and stratified drift. More than 100 ft (30 m) thick in places. *GRI Source Map ID 1556* (GQ-1638)

Qmt - Meltwater terrace deposits (late Wisconsinan)

Stratified, well- to moderately-sorted sand, cobble-pebble to pebble gravel, and minor silt deposited by meltwater streams as terraces incised in valley-train, glacial lake delta deposits, and other meltwater-terrace deposits. As much as 20 feet (6m) thick. Sediment and bedforms similar to the downstream, distal part of valley-train deposits. Includes bouldery strath terraces cut in till along meltwater stream courses in uplands. May also include the distal part of valley-train deposits where they have cut into older valley-train deposits downvalley. *GRI Source Map ID 73984* (GMS 04-1)

Qtq - Till, derived from Kittatinny Mountain (late Wisconsinan)

Qwtk - Kittatinny Mountain Till (late Wisconsinan) - Deposited directly from glacial ice during the late Wisconsinan glaciation. Clayey silt to silty sand with some to many pebbles and cobbles and few to many boulders; olive brown, brown, gray, reddish brown. As much as 150 feet thick, generally less than 40 feet thick. *GRI Source Map ID 74858* (DGS 07-2)

Qtq - Till (late Wisconsinan) - Scattered patches of noncompact to slightly compact, bouldery "upper till" overlying a blanket-like compact "lower till" deposited chiefly on bedrock and locally some older pre-Wisconsinan surficial deposits. Slightly compact to compact, unstratified, poorly sorted yellowish-brown (10YR 5/4), brown (10YR 5/3, 7.5 YR 5/4) to light olive-brown (2.5Y 5/4) and reddish-brown (5YR 4/3) silty sand and sand containing 10 to 20 percent gravel. As much as 50 feet (15m) thick. Locally overlain by thin, discontinuous, noncompact, poorly sorted and layered sand and minor silty sand, similar in color to lower till, that contains as much as 35 percent gravel, and minor thin beds of well- to moderately-sorted sand and pebbly sand. Clasts chiefly consist of unweathered quartz-pebble conglomerate, quartzite, red sandstone, and red shale. Matrix is a varied mixture of quartz, rock fragments, silt, minor feldspar, and clay. Till derived chiefly from quartzite, quartz-pebble conglomerate, and red sandstone bedrock on Kittatinny Mountain. *GRI Source Map ID 73984* (GMS 04-1)

Qtk - Till, derived from Kittatinny and Minisink Valley (late Wisconsinan)

Scattered patches of noncompact to slightly compact, bouldery "upper till" overlying a blanket-like compact "lower till" deposited chiefly on bedrock and locally some older pre-Wisconsinan surficial deposits. Compact, unstratified, poorly sorted yellowish-brown (10YR 5/4), light yellowish-brown (2.5Y 6/4), light olive-brown (2.5Y 5/4) to grayish-brown (2.5Y 5/2), gray (5Y 5/1) to olive-gray (5Y 5/2) noncalcareous to calcareous silt and sandy silt that typically contains 5 to 15 percent gravel. As much as 200 feet (61 m) thick. Locally overlain by thin, discontinuous, noncompact to slightly compact, poorly sorted, indistinctly layered yellow-brown (10YR 5/6-8), light yellowish-brown (10YR 6/4) sandy silt that contains as much as 30 percent gravel, and minor thin beds of well- to moderately sorted sand, gravel, and silt. Clasts chiefly consist of unweathered slate, siltstone and sandstone, dolomite, limestone, chert, minor quartzite, and quartz-pebble conglomerate. Matrix is a varied mixture of unweathered quartz, rock fragments, and silt; minor constituents include feldspar and clay. Till derived chiefly from slate, graywacke, dolomite, and minor limestone bedrock in Kittatinny Valley, and limestone, argillaceous limestone, shale, and sandstone bedrock in Minisink Valley. *GRI Source Map ID 73984* (GMS 04-1)

Qk - Kame (late Wisconsinan)

k - Kame deposits (Quaternary) - Coarse to fine gravel and/or sand, includes kames, eskers, kame terraces, kame deltas, ice contact, or ice cored deposition, lateral variability in sorting, texture and permeability, may be firmly cemented with calcareous cement, thickness variable (10-30 meters). *GRI Source Map ID 7288* (Map and Chart Series 15)

Qk - Kame (late Wisconsinan) - Stratified well- to poorly-sorted sand, boulder- to pebble-gravel, silt, and interbedded flowtill in small collapsed hills and ridges overlying till. Presumed to be ice-hole and crevasse fillings. As much as 50 feet (15m) thick. Attitude of bedding is highly variable. *GRI Source Map ID 73984* (GMS 04-1)

Qod - Glacial lake delta deposits from proglacial lakes (late Wisconsinan)

Qwde - Late Wisconsinan glacial delta deposits (late Wisconsinan) - Deposited in deltas and other ice-contact landforms in glacial lakes during the late Wisconsinan glaciation. Sand, pebble-to-cobble gravel, minor silt; yellowish brown, reddish brown, light gray. As much as 150 feet thick. *GRI Source Map ID 74858* (DGS 07-2)

Qod - Glacial-lake delta deposits (late Wisconsinan) - Stratified sand, gravel, and silt deposited by meltwater streams in proglacial lakes at and beyond the stagnant glacier margin. Includes well sorted sand and boulder-cobble to pebble gravel in planar to cross-bedded glaciofluvial topset beds that are as much as 25 feet (8m) thick. Overlies and grades into foreset beds that dip 20° to 35° basinward and consist of well- to moderately-sorted, rhythmically-bedded cobble-pebble and pebble gravel and sand. These beds grade downward and outward into ripple cross-laminated and parallel-laminated sand, silt and pebble gravel that dip less than 20°. Lower foreset beds grade into gently inclined prodelta bottomset beds of rhythmically-bedded, ripple cross-laminated to graded fine sand and silt with minor clay drapes. Thickness may be as much as 100 feet (30m). Qd deposits were laid down in glacial Lake Owassa, Kittatinny Valley (fig. 1). Qod deposits were laid down in narrow sediment-dammed proglacial lakes in Paulins Kill and Wallpack Valleys. Deposits are extensively kettled, and in long lake basins, topset beds are extensively aggraded in their upstream sections. *GRI Source Map ID 73984* (GMS 04-1)

Qv - Valley-train deposits (late Wisconsinan)

Stratified, well- to moderately-sorted sand, boulder-cobble to pebble gravel, and minor silt deposited by meltwater streams at and extending well beyond (greater than five miles (8 km)) the glacier's margin (fig. 1). As much as 100 feet (30 m) thick. The proximal part of the deposit consists of massive to horizontally-bedded and imbricated coarse gravel and sand, and planar to tabular and trough cross-bedded, fine gravel and sand in bars, and channel-lag deposits with minor cross-bedded sand in channel-fill deposits. Clasts generally are smaller downstream, where sand is more abundant, and trough and planar cross-bedding, and graded beds are more common. Based on well records (Table 1) overlies glacial lake deposits previously laid down in sediment-dammed proglacial lakes. In places overlain by nonlayered, well-sorted, very fine sand and fine sand presumed to be eolian; as much as 5 feet (2 m) thick. In Minisink Valley forms shingled sets of outwash terraces. Number after unit label indicates relative age of unit in valley. Lower numbers represent older deposits. *GRI Source Map ID 73984* (GMS 04-1)

Qf - Outwash fan, near Branchville (late Wisconsinan)

Stratified, well- to moderately-sorted sand, cobble-pebble gravel, and minor silt deposited by meltwater streams in fan-shaped deposits at the mouth of large tributaries in Minisink Valley. As much as 60 feet (18m) thick. Includes massive to planar-bedded sand and gravel, and minor cross-bedded and channel-fill sand. Bedding generally dips towards the trunk valley by as much as 10°. Fan deposits are graded to valley-train deposits. *GRI Source Map ID 73984* (GMS 04-1)

Qfdb - Outwash fan, Dry Brook (late Wisconsinan)

Stratified, well- to moderately-sorted sand, cobble-pebble gravel, and minor silt deposited by meltwater streams in fan-shaped deposits at the mouth of large tributaries in Minisink Valley. As much as 60 feet (18m) thick. Includes massive to planar-bedded sand and gravel, and minor cross-bedded and channel-fill sand. Bedding generally dips towards the trunk valley by as much as 10°. Fan deposits are graded to valley-train deposits. *GRI Source Map ID 73984* (GMS 04-1)

Qfa - Outwash fan, Adams Creek (late Wisconsinan)

Stratified, well- to moderately-sorted sand, cobble-pebble gravel, and minor silt deposited by meltwater streams in fan-shaped deposits at the mouth of large tributaries in Minisink Valley. As much as 60 feet (18m) thick. Includes massive to planar-bedded sand and gravel, and minor cross-bedded and channel-fill sand. Bedding generally dips towards the trunk valley by as much as 10°. Fan deposits are graded to valley-train deposits. *GRI Source Map ID 73984* (GMS 04-1)

Qwmrk - Recessional moraine (late Wisconsinan)

Deposited directly from glacial ice along recessional ice margins during the late Wisconsinan glaciation. Kittatinny Mountain Till as in unit Qwtk forming morainic ridges and knolls. As much as 80 feet thick. *GRI Source Map ID 74858* (DGS 07-2)

Qdfm - Dingmans Ferry recessional moraine (late Wisconsinan)

Unstratified to poorly stratified sand, gravel, and silt deposited at the active margin of the Kittatinny and Minisink Valley ice lobes. As much as 80 feet (24m) thick. Consists of poorly compact stony till, silty-sandy compact till, and minor lenses and layers of water-laid sand, gravel, and silt, in discontinuous, bouldery, chiefly cross-valley segmented ridges marking the former lobate glacier margin. Overlies "lower till" in uplands and locally, outwash in river valleys. Locally named Ogdensburg-Culvers Gap (Qom) and Dingmans Ferry moraine. *GRI Source Map ID 73984* (GMS 04-1)

Qom - Ogdensburg-Culvers Gap recessional moraine (late Wisconsinan)

Unstratified to poorly stratified sand, gravel, and silt deposited at the active margin of the Kittatinny and Minisink Valley ice lobes. As much as 80 feet (24m) thick. Consists of poorly compact stony till, silty-sandy compact till, and minor lenses and layers of water-laid sand, gravel, and silt, in discontinuous, bouldery, chiefly cross-valley segmented ridges marking the former lobate glacier margin. Overlies "lower till" in uplands and locally, outwash in river valleys. Locally named Ogdensburg-Culvers Gap (Qom) and

Dingmans Ferry (Qdfm) moraine. *GRI Source Map ID 73984* (GMS 04-1)

Qm - Recessional moraine (late Wisconsinan)

Unstratified to poorly stratified sand, gravel, and silt. As much as 30 feet (9m) thick. Consist of poorly compact, stony till, silty-sandy compact till, and minor lenses and layers of water-laid sand, gravel, and silt, in small, uncorrelated, hummocky transverse ridges. *GRI Source Map ID 73984* (GMS 04-1)

Qd - Glacial lake delta deposits, Lake Owassa (late Wisconsinan)

Stratified sand, gravel, and silt deposited by meltwater streams in proglacial lakes at and beyond the stagnant glacier margin. Includes well sorted sand and boulder-cobble to pebble gravel in planar to cross-bedded glaciofluvial topset beds that are as much as 25 feet (8m) thick. Overlies and grades into foreset beds that dip 20° to 35° basinward and consist of well- to moderately-sorted, rhythmically-bedded cobble-pebble and pebble gravel and sand. These beds grade downward and outward into ripple cross-laminated and parallel-laminated sand, silt and pebble gravel that dip less than 20°. Lower foreset beds grade into gently inclined prodelta bottomset beds of rhythmically-bedded, ripple cross-laminated to graded fine sand and silt with minor clay drapes. Thickness may be as much as 100 feet (30m). Qd deposits were laid down in glacial Lake Owassa, Kittatinny Valley (fig. 1). Qod deposits were laid down in narrow sediment-dammed proglacial lakes in Paulins Kill and Wallpack Valleys. Deposits are extensively kettled, and in long lake basins, topset beds are extensively aggraded in their upstream sections. *GRI Source Map ID 73984* (GMS 04-1)

Qfd - Outwash fan, Dingmans Creek (late Wisconsinan)

Stratified, well- to moderately-sorted sand, cobble-pebble gravel, and minor silt deposited by meltwater streams in fan-shaped deposits at the mouth of large tributaries in Minisink Valley. As much as 60 feet (18m) thick. Includes massive to planar-bedded sand and gravel, and minor cross-bedded and channel-fill sand. Bedding generally dips towards the trunk valley by as much as 10°. Fan deposits are graded to valley-train deposits. *GRI Source Map ID 73984* (GMS 04-1)

Qwft - Glaciofluvial terrace deposits (late Wisconsinan)

Form terraces deposited by glacial streams during the late Wisconsinan glaciation. Sand, pebble-to-cobble gravel, minor silt; yellowish brown to reddish brown. As much as 40 feet thick. *GRI Source Map ID 74858* (DGS 07-2)

Qwfv - Glaciofluvial plain deposits (late Wisconsinan)

Form plains deposited by glacial streams during the late Wisconsinan glaciation. Sand, pebble-to-cobble gravel, minor silt; yellowish brown to reddish brown. As much as 80 feet thick. *GRI Source Map ID 74858* (DGS 07-2)

Qwic - Ice-contact deposits (late Wisconsinan)

Form knolls and ridges higher than adjacent glacial-lake levels or glaciofluvial plains. Deposited in ice-walled basins during the late Wisconsinan glaciation. Sand, pebble-to-cobble gravel, few to some boulders, minor silt; yellowish brown to reddish brown. As much as 150 feet thick. *GRI Source Map ID 74858* (DGS 07-2)

Qit - Older till (Quaternary)

Qod - Older drift (Pleistocene (Illinoian?)) - Deeply weathered grayish-orange to dark-yellowish-orange silty and clayey till generally about 10 feet thick. *GRI Source Map ID 1555* (GQ-1047)

Qit - Till (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. *GRI Source Map ID 1556* (GQ-1638)

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

Dclr - 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. *GRI Source Map ID 2375* (Water Resource Report 47)

Dclr - Long Run Member (Upper Devonian) - 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). *GRI Source Map ID 1556* (GQ-1638)

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

Dcbr - 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. *GRI Source Map ID 2375* (Water Resource Report 47)

Dcbc - Beaverdam Run Member (Upper Devonian) - Sandstone. siltstone, and silty shale. Light-olivegray 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). *GRI Source Map ID 1556* (GQ-1638)

Dcw - Catskill Formation, Walcksville Member (Upper Devonian)

Dcw - 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. *GRI Source Map ID 2375* (Water Resource Report 47)

Dcw - Walcksville Member (Upper Devonian) - Medium to moderate-greenish-gray, and grayish-redpurple, 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-redpurple 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. *GRI Source Map ID 1556* (GQ-1638)

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. *GRI Source Map ID 1566* (GQ-908)

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. *GRI Source Map ID 1566* (GQ-908)

Dcd - Catskill Formation, Delaware River Flags Member (Upper Devonian)

Dcd - 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. *GRI Source Map ID 1566* (GQ-908)

Dcdr - Deleware 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 Charateristics: 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.

GRI Source Map ID 4459 (County Report C 52)

Dcdr - Deleware River Member (Upper Devonian) - Cyclic sequences of gray, planar-bedded and crossbedded, fine- to medium-grained sandstone. Some thin red siltstone and claystone occur in the northeast and become thicker and more abundant to the southwest. Thin conglomeratic beds occur locally near the top of the member. Maximum thickness where overlain by the Lackawaxen Member is 2,600 feet; maximum thickness where the Lackawaxen is absent is 2,800 feet.

> Water-Bearing Properties: Adequate supplies for domestic wells; median yield is 16 gal/min. Capable of high yields. Median yield of nondomestic wells is 100 gal/min, and median specific capacity is 0.76 (gal/min)/ft.

GRI Source Map ID 4456 (Water Resource Report W 65)

Dct - Catskill Formation, Towamensing Member (Upper Devonian)

Dct - 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. *GRI Source Map ID 2375* (Water Resource Report 47)

Dct - 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.

GRI Source Map ID 4459 (County Report C 52)

Dct - Towamensing Member (Upper Devonian) - Dominantly light- to medium-gray, crossbedded, fine-to medium-grained sandstone; some planar-bedded sandstone; some interbedded siltstone and claystone; some intraformational conglomerate. No coarse-grained sandstone or conglomeratic beds are known to occur. Siltstone and claystone beds are generally less than 2 feet thick. Thickness of the member ranges from 247 feet in the west to 1,625 feet in the northeast.

Water-Bearing Properties: Excellent supplies for domestic wells; median yield is 30 gal/min, and specific capacity is 0.36 (gal/min)/ft. Adequate supplies for nondomestic wells. Water is soft.

GRI Source Map ID 4456 (Water Resource Report W 65)

Dct - Towamensing Member (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. *GRI Source Map ID 1556* (GQ-1638)

Dtr - Trimmers Rock Formation, undivided (Upper Devonian)

Dt - Trimmers Rock Sandstone (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. *GRI Source Map ID 1566* (GQ-908)

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. *GRI Source Map ID 2375* (Water Resource Report 47)

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. *GRI Source Map ID 1556* (GQ-1638)

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

Dtm - 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.

GRI Source Map ID 4459 (County Report C 52)

Dtm - 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. Both members are generally thin to medium bedded, although a few sandstone beds in the Millrift are thick bedded. Formation thickness ranges from 720 to 1,825 feet; Millrift Member has a maximum thickness of 1,000 feet and Sloat Brook Member has a maximum thickness of 950 feet.

Water-Bearing Properties: Supply is adequate for domestic wells. Median yield is 20 gal/min for domestic wells and 60 gal/min for nondomestic wells. Median specific capacity is 0.26 (gal/min)/ft for domestic wells and 1.0 (gal/min)/ft for nondomestic wells. Water contains excessive manganese in some places.

GRI Source Map ID 4456 (Water Resource Report W 65)

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

Dtm - 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.

GRI Source Map ID 4459 (County Report C 52)

Dtm - 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. Both members are generally thin to medium bedded, although a few sandstone beds in the Millrift are thick bedded. Formation thickness ranges from 720 to 1,825 feet; Millrift Member has a maximum thickness of 1,000 feet and Sloat Brook Member has a maximum thickness of 950 feet.

Water-Bearing Properties: Supply is adequate for domestic wells. Median yield is 20 gal/min for domestic wells and 60 gal/min for nondomestic wells. Median specific capacity is 0.26 (gal/min)/ft for domestic wells and 1.0 (gal/min)/ft for nondomestic wells. Water contains excessive manganese in some places.

GRI Source Map ID 4456 (Water Resource Report W 65)

Dmh - Hamilton Group, Mahantango Formation, undivided (Middle Devonian)

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. *GRI Source Map ID 2375* (Water Resource Report 47)

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.

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.

Engineering Characteristics: Easy to moderately difficult to excavate. Moderate drilling rate. Maintains steep cut slopes. Good foundation for heavy structures. Generally unsuitable for septic systems because of poor percolation. Potentially suitable for sanitary-landfill sites.

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).

GRI Source Map ID 4459 (County Report C 52)

Dmh - Mahantango Formation (Middle Devonian) - Interbedded, dark-gray siltstone, claystone, clay shale, and silt shale. Siltstone is medium to thick bedded, and shale is thickly laminated to thin bedded; however, bedding is commonly indistinct. Thickness ranges from 1,300 feet in the north to 2,450 feet in the east.

Water-Bearing Properties: Adequate supplies for domestic and nondomestic wells. Median specific capacity is 0.09 (gal/min)/ft for domestic wells and 0.16 (gal/min)/ft for nondomestic wells. Water is slightly basic and soft to moderately hard.

GRI Source Map ID 4456 (Water Resource Report W 65)

Dm - 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. *GRI Source Map ID 1555* (GQ-1047)

Dmh - Mahantango Formation (Middle Devonian) - Medium-dark-gray to dark-gray, bioturbated, laminated to finely bedded, fossiliferous shaly siltstone and silty shale. Several biostromes (F) are mappable and are medium-lightgray siltstones weathering grayish orange to dark yellowish orange and moderate brown. Biostromes appear to be discontinuous and occur at varying stratigraphic horizons. One conspicuous zone, the Centerfield Member (Dmhc), 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. Nis Hollow Member (Dmhn) is 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. Lower contact of unit with the Marcellus Shale (Dm) is transitional through about 100 ft (30 m). Weathers to a thick shale-chip gravel in places. About 2,100 feet (640 m) thick. *GRI Source Map ID 1556* (GQ-1638)

Dmu - Hamilton Group, 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. *GRI Source Map ID 1566* (GQ-908)

Dmhn - Hamilton Group, 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. *GRI Source Map ID 1556* (GQ-1638)

Dmhc - Hamilton Group, Mahantango Formation, Centerfield Member (Middle Devonian)

cr - "Centerfield Reef" (Middle Devonian) - Calcareous siltstone biostrome containing abundant horn corals. The Centerfield is about 25 feet thick. *GRI Source Map ID 1566* (GQ-908)

cr - Centerfield biostrome (Middle Devonian) - Calcareous siltstone containing abundant corals and other shelly forms, about 900 feet above base of formation. About 25 feet thick. *GRI Source Map ID 1555* (GQ-1047)

Dmhc - Centerfield Member (Middle Devonian) - 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. *GRI Source Map ID 1556* (GQ-1638)

Dml - Hamilton Group, 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. *GRI Source Map ID 1566* (GQ-908)

Dmhf - Hamilton Group, 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. *GRI Source Map ID 1556* (GQ-1638)

Dh - Hamilton Group, Mahantango Formation and Marcellus Shale, undivided (Middle Devonian)

Shale, siltstone. Part of Hamilton Group 2600-2800 ft. (790-850 m). *GRI Source Map ID 7288* (Map and Chart Series 15)

Dm - Hamilton Group, Marcellus Shale (Middle Devonian)

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. *GRI Source Map ID 2375* (Water Resource Report 47)

Dmr - Marcellus Shale (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.

GRI Source Map ID 4459 (County Report C 52)

Dmr - Marcellus Shale (Middle Devonian) - Dark-gray to grayish-black, slightly siliceous clay shale and silty clay shale; minor argillaceous siltstone. Intermittent zones of quartz-chlorite nodules occur parallel to bedding. Some marine fossils are present. Maximum thickness is 950 feet.

Water-Bearing Properties: Not an important aquifer in Pike County.

GRI Source Map ID 4456 (Water Resource Report W 65)

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. *GRI Source Map ID 1556* (GQ-1638)

Dm - Marcellus Shale (Devonian) - *GRI Source Map ID 7285* (DGS 04-6)

Dmb - Hamilton Group, Marcellus Shale, Brodhead Creek Member (Middle Devonian)

Dmb - 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. *GRI Source Map ID 1566* (GQ-908)

Dmb - 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. *GRI Source Map ID 1555* (GQ-1047)

Dmsu - Hamilton Group, Marcellus Shale, Stony Hollow and Union Springs Shale Members, undivided (Middle Devonian)

Dmsu - Stony Hollow Members 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. *GRI Source Map ID 1566* (GQ-908)

Dmsu - 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 silt-stone, 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. Possible use for fill. *GRI Source Map ID 1555* (GQ-1047)

Dou - Onondaga Limestone, undivided (Middle and Lower Devonian)

Description not available. Members include:
Seneca Limestone, Morehouse (cherty) Limestone, Nedrow Limestone, Egdecliff (cherty) Limestone, Schoharie Formation shale and limestone, Carlisle Center Siltstone, Buttermilk Falls Limestone and Esopus Shale.
GRI Source Map ID 7288 (Map and Chart Series 15)

Db - Onondaga Limestone, Buttermilk Falls Limestone (Middle Devonian)

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/.inch to 1 foot thick. Upper 15 feet contain several 3- to 6-inch-thick beds of medium-gray to mediumlight-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 cringed 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 cringed 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. *GRI Source Map ID 1555* (GQ-1047)

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. *GRI Source Map ID 1556* (GQ-1638)

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. *GRI Source Map ID 1566* (GQ-908)

Db - Buttermilk Falls Limestone (Devonian) - Clayey to silty limestone, thin- to medium-bedded. *GRI Source Map ID 7285* (DGS 04-6)

Dpt - 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. *GRI Source Map ID 1556* (GQ-1638)

Dse - Schoharie Formation and Esopus Formation, 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. *GRI Source Map ID 1556* (GQ-1638)

Ds - Schoharie Formation (Middle and 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. *GRI Source Map ID 1566* (GQ-908)

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. *GRI Source Map ID 1555* (GQ-1047)

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. *GRI Source Map ID 1556* (GQ-1638)

Ds Schoharie (Devonian) - Calcareous siltstone and silty limestone, medium- to thick bedded. *GRI Source Map ID 7285* (DGS 04-6)

De - Esopus Formation (Lower Devonian)

De - Esopus Formation (Lower Devonian) - Medium-dark 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 disconformable. Unit has been exploited for road metal. *GRI Source Map ID 1566* (GQ-908)

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-yellowishorange 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. *GRI Source Map ID 1555* (GQ-1047)

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. *GRI Source Map ID 1556* (GQ-1638)

De - Esopus Formation (Devonian) - Shaly to sandy siltstone, minor calcareous siltstone, laminated to medium-bedded. *GRI Source Map ID 7285* (DGS 04-6)

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. *GRI Source Map ID 1566* (GQ-908)

Do - Oriskany Group, undivided (Lower Devonian) -
Members include:
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. *GRI Source Map ID 1556* (GQ-1638)

Do - Oriskany Group (Devonian) -
Members include:
Ridgley Sandstone - Quartz-pebble conglomerate and sandstone.
Shriver Chert - Siltstone and shale with interbedded chert and cherty limestone.
Glenarie Formation - Silty limestone with local chert lenses. *GRI Source Map ID 7285* (DGS 04-6)

Dr - Oriskany Group, Ridgley Sandstone (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. *GRI Source Map ID 1556* (GQ-1638)

Drs - Oriskany Group, Ridgley 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 2feet 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. *GRI Source Map ID 1555* (GQ-1047)

Dhg - Helderburg Group, undivided (Lower Devonian)

West of Albany: Alsen, Becraft, New Scotland, Kalkberg, Coeymans, and Manlius Limestones; Rondout Dolostone. South of Albany: Port Ewen, Alsen thru Manlius Limestones; Rondout Dolostone. *GRI Source Map ID 7288* (Map and Chart Series 15)

Dph - Helderburg Group, Port Ewan Shale, Minisink Limestone, and New Scotland Formation, undivided (Lower Devonian)

Port Ewen Shale, upper 90 feet is fossiliferous, medium-dark-gray, irregularly bedded, limy siltstone and shale. Lower 60 feet is mediumdark-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. *GRI Source Map ID 1566* (GQ-908)

Dp - Helderburg Group, Port Ewan Shale (Lower Devonian)

Dp - Port Ewen Shale (Lower Devonian) - Medium-dark-gray, light-tannish-gray-weathering, calcareous, pyritic, fossiliferous (including brachiopods, corals, ostracodes, trilobites, cringeds), 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. *GRI Source Map ID 1555* (GQ-1047)

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. *GRI Source Map ID 1556* (GQ-1638)

Dp - Port Ewen Shale (Devonian) - Calcareous siltstone and shale, thin- to medium-bedded. *GRI Source Map ID 7285* (DGS 04-6)

Dmn - Helderburg Group, Minisink Limestone and New Scotland Formation, undivided (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. *GRI Source Map ID 1555* (GQ-1047)

Dc - Helderburg Group, Coeymans Formation, undivided (Lower Devonian)

Dc - 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. *GRI Source Map ID 1566* (GQ-908)

Dc - 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 80feet 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. *GRI Source Map ID 1555* (GQ-1047)

Dkc - Kalkberg Limestone, Coeymans Limestone, Manlius Limestone, undivided and Coeymans Formation (Devonian) -
Members Include:
Kalkberg Limestone - Limestone and argillaceous limestone, fine-grained.
Coeymans Limestone - Limestone and less abundant argillaceous limestone.
Manlius Limestone - Limestone, very fine- to finegrained.
Coeymans Formation - Calcareous sandstone and argillaceous to arenaceous limestone. *GRI Source Map ID 7285* (DGS 04-6)

DShr - Lower part of Helderburg 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. *GRI Source Map ID 1556* (GQ-1638)

DSohr - Shriver Chert of the Oriskany Group, Helderburg 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. *GRI Source Map ID 1556* (GQ-1638)

DSrp - Rondout Formation (Lower Devonian and upper Silurian)

Srp - Rondout Formation (upper Silurian) - Dolostone, limestone. Part of Undifferentiated Silurian Rocks I, 0-400 ft. (0-120 m). *GRI Source Map ID 7288* (Map and Chart Series 15)

Note: Although the source publication lists this unit as Silurian in age, more recent publications

list the Rondout Formation as Devonian and Silurian.

DSrd - Rondout Formation and Decker Formation, undivided (Lower Devonian and upper Silurian)

DSrd - Rondout and Decker Formations, undifferentiated (Lower Devonian and upper Silurian) -
Members include:
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. *GRI Source Map ID 1566* (GQ-908)

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. *GRI Source Map ID 1555* (GQ-1047)

DSrd - Rondout and Decker Formations (Devonian and Silurian) -
Members include:
Rondout Formation - Limestone, argillaceous limestone, and argillaceous dolomite.
Decker Formation - Calcareous quartz siltstone, sandstone, and pebble conglomerate, and minor limestone and dolomite. *GRI Source Map ID 7285* (DGS 04-6)

DSu - Undifferentiated Devonian and Silurian rocks (upper Silurian to Middle Devonian)

DSu - Devonian and Silurian Rocks, Undifferentiated (upper Silurian to Middle Devonian) - 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. *GRI Source Map ID 2375* (Water Resource Report 47)

DSu - Devonian and Silurian Rocks, Undifferentiated (Devonian and Silurian) - The digital representation of the Geologic Map of the Stroudsburg Quadrangle contains this unit. However, DSu was not mapped according to the original publication. *GRI Source Map ID 1555* (GQ-1047)

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. *GRI Source Map ID 1556* (GQ-1638)

Sbv - Bossardville Limestone (upper Silurian)

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. *GRI Source Map ID 1566* (GQ-908)

Sbv - Bossardville Limestone (upper Silurian) - 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. *GRI Source Map ID 1555* (GQ-1047)

Sbv - Bossardville Limestone (upper Silurian) - 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. *GRI Source Map ID 1556* (GQ-1638)

Sbv - Bossardville Limestone (Silurian) - Limestone and argillaceous limestone. *GRI Source Map ID 7285* (DGS 04-6)

Sp - Poxono Island Formation (upper Silurian)

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. *GRI Source Map ID 1566* (GQ-908)

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. Dessication 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. *GRI Source Map ID 1556* (GQ-1638)

Sp - Poxono Island Formation (Silurian) - Dolomite and minor quartz sand beds and argillaceous dolomite. *GRI Source Map ID 7285* (DGS 04-6)

Sbcu - Bloomsburg Red Beds, dessiminated chalcocite (upper Sillurian)

Isolated portion of Bloomsburg Red Beds containing disseminated chalcocite. Boundaries are gradational and indefinite. *GRI Source Map ID 1566* (GQ-908)

Sb - Bloomsburg Red Beds (upper and middle Silurian)

Sb - Bloomsburg Red Beds (upper and middle 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. *GRI Source Map ID 1566* (GQ-908)

Sb - Bloomsburg Red Beds (upper and middle 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. *GRI Source Map ID 1559* (I-552)

Sb - Bloomsburg Red Beds (upper Silurian) (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. *GRI Source Map ID 1561* (GQ-1700)

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-redpurple, 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. *GRI Source Map ID 1555* (GQ-1047)

Sb - Bloomsburg Red Beds (upper and middle Silurian) - Pale-red to grayishred-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. *GRI Source Map ID 1556* (GQ-1638)

Sbs - Bloomsburg Formation (upper Silurian) - Shale, sandstone. Part of Undifferentiated Silurian Rocks II, 0-1800 ft. (0-550 m). *GRI Source Map ID 7288* (Map and Chart Series 15)

Ss - Shawangunk Formation, undivided (middle and lower Silurian)

Ss - Shawangunk Formation (middle 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. *GRI Source Map ID 2375* (Water Resource Report 47)

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). *GRI Source Map ID 1561* (GQ-1700)

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 (5Y 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). *GRI Source Map ID 1563* (GQ-1703)

Ss - Shawangunk Formation (Silurian) - Sandstone, pebble conglomerate, shale, and quartizite. *GRI Source Map ID 7285* (DGS 04-6)

Sst - Shawangunk Formation, Tammany Member (middle and lower Silurian)

Ssu - Upper Member (middle and lower 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. *GRI Source Map ID 1566* (GQ-908)

Ssu - Upper Quartzite Member (middle and lower 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. *GRI Source Map ID 1559* (I-552)

Sst - 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. *GRI Source Map ID 1555* (GQ-1047)

Sst - Tammany Member (middle Silurian) - Medium-gray to medium-dark-gray, fine- to coarse-grained, limonitic, 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. *GRI Source Map ID 1556* (GQ-1638)

Ssl - Shawangunk Formation, Lizard Creek Member (middle and lower Silurian)

Ssl - Lower Member (middle and lower 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. *GRI Source Map ID 1566* (GQ-908)

Ssm - Middle Argillite-Bearing Member (middle and lower Silurian) - Evenly to unevenly bedded, thin- to thick-bedded, medium-lightgray to medium-dark-gray and light-olive-gray, fine-to coarse-grained, partly cross bedded, limonitic, pyritic, and evenly to unevenly bedded, medium-darkgray argillite. Member is 273 feet thick at the Delaware Water Gap. *GRI Source Map ID 1559* (I-552)

Ssl - 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. *GRI Source Map ID 1555* (GQ-1047)

Ssl - 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. *GRI Source Map ID 1556* (GQ-1638)

Ssm - Shawangunk Formation, Minsi Member (middle and lower Silurian)

Ssm - Middle Member (middle and lower Silurian) - Medium-light-gray to medium-dark-gray and lightolive-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. *GRI Source Map ID 1566* (GQ-908)

Ssl - Lower Conglomeratic Member (middle and lower 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. *GRI Source Map ID 1559* (I-552)

SOsm - 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. *GRI Source Map ID 1555* (GQ-1047)

Ssm - Minsi Member (middle and lower? 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. *GRI Source Map ID 1556* (GQ-1638)

SObl - Beemerville Intrusive Suite, Undifferentiated dikes (Silurian and Ordovician)

Lamprophyre, tinguaite, phonolite, bostonite and malignite. *GRI Source Map ID 7285* (DGS 04-6)

Obs - Beemerville Intrusive Suite, Nepheline syenite (Upper Ordovician)

Medium- (N5) to dark-gray (N3), 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. *GRI Source Map ID 1561* (GQ-1700)

Obt - Beemerville Intrusive Suite, Tinguaite (Upper Ordovician)

Medium- (N5) to dark-gray (N3) to greenish-gray (5 FY 6/1) fine-grained rock containing phenocrysts of orthoclase, nepheline, biotite, and aegirine. The groundmass contains fine-grained eqivalents 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. *GRI Source Map ID 1561* (GQ-1700)

Obp - Beemerville Intrusive Suite, Phonolite (Upper Ordovician)

Medium-dark-gray (N4), very-finegrained 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. *GRI Source Map ID 1561* (GQ-1700)

Obb - Beemerville Intrusive Suite, Bostonite (Upper Ordovician)

Medium- (N5) to dark-gray (N3) 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. *GRI Source Map ID 1561* (GQ-1700)

Obm - Beemerville Intrusive Suite, Malignite (Upper Ordovician)

Dark-gray (N3), 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, aegerine, melanite, magnetite, apatite, and titanite. Rock occurs as sills in the Martinsburg Formation. *GRI Source Map ID 1561* (GQ-1700)

Obla - Beemerville Intrusive Suite, Lamprophyre (Upper Ordovician)

Dark-gray (N3) 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. *GRI Source Map ID 1561* (GQ-1700)

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

Dark-gray (N3) to black (N1) breccia having an extremely fine-grained matrix of calcite, magnetite, biotite, chlorite, albite, and apatite that contains megacrysts 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). *GRI Source Map ID 1561* (GQ-1700)

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. *GRI Source Map ID 1561* (GQ-1700)

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

Omp - Pen Argyl Member (Upper and Middle 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. *GRI Source Map ID 1555* (GQ-1047)

Omp - Pen Argyl Member (Upper and Middle 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. *GRI Source Map ID 1556* (GQ-1638)

Omhp - 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. Label shown in parentheses where concealed by surficial deposits. *GRI Source Map ID 1561* (GQ-1700)

Omh - High Point Member (Ordovician) - Shale, siltstone, and sandstone. *GRI Source Map ID 7285* (DGS 04-6)

Omr - Martinsburg Formation, Ramseyburg Member (Upper and Middle Ordovician)

Omr - Martinsburg Formation, Ramseyburg Member (Upper? and Middle Ordovician) - 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. *GRI Source Map ID 1566* (GQ-908)

Omr - Ramseyburg Member (Upper and Middle Ordovician) - Dark-gray, medium-grayto 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. *GRI Source Map ID 1559* (I-552)

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. *GRI Source Map ID 1558* (I-1530)

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. *GRI Source Map ID 1562* (GQ-1585)

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 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. *GRI Source Map ID 1561* (GQ-1700)

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 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. *GRI Source Map ID 1563* (GQ-1703)

Omr - 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. *GRI Source Map ID 1555* (GQ-1047)

Omr - Ramseyburg Member (Ordovician) - Graywacke sandstone and siltstone, shale and slate. *GRI Source Map ID 7285* (DGS 04-6)

Omrg - Martinsburg Formation, Ramseyburg Member, graywacke beds (Upper and Middle Ordovician)

Omrg - Graywacke beds within the Ramseyburg Member (Upper and Middle Ordovician) - *GRI Source Map ID 1559* (I-552)

Omrg - Ramseyburg Member - graywacke beds (Upper and Middle Ordovician) - Prominent graywacke-bearing intervals. Upper part quarried for slate. *GRI Source Map ID 1555* (GQ-1047)

Omb - Martinsburg Formation, Bushkill Member (Upper and Middle Ordovician)

Omb - Bushkill Member (Upper and Middle Ordovician) - Thin-bedded, dark-gray, medium-gray-to yellowish-brown-weathering, claystone slate containing minor thin interbeds of graywacke siltstone, carbonaceous slate and near the base, dolomitic siltstone. Unit typically is ribbon slate. Member is about 4,000 feet thick. *GRI Source Map ID 1559* (I-552)

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. *GRI Source Map ID 1558* (I-1530)

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. *GRI Source Map ID 1562* (GQ-1585)

Omb - Bushkill Member of the Martinsburg Formation (Middle Ordovician) (Drake and Epstein, 1967) - Basal part of unit is black (N1) to dark-gray (N3) 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-ratios range from about 1:3 to 1:6, the lithologic change forming "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. *GRI Source Map ID 1561* (GQ-1700)

Omb - Bushkill Member of the Martinsburg Formation (Middle Ordovician) (Drake and Epstein, 1967) - Basal part of unit is black (N1) to dark-gray (N3) 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 RocklandianKirkfieldian (Caradocian) age (Drake and others, 1989). Graptolites,

probably Glyptograptus euglyph us (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). The unit is about 1,900 ft thick north of the Portland thrust fault, about 950 ft thick near Newton, and absent near Stickles Pont where the Ramseyburg Member is in sedimentary contact with the Jacksonburg Limestone. *GRI Source Map ID 1563* (GQ-1703)

Omb - Bushkill Member (Upper and Middle 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. *GRI Source Map ID 1555* (GQ-1047)

Omb - Bushkill Member (Ordovician) - Shale, slate, less abundant siltstone, and minor dolomite lenses. *GRI Source Map ID 7285* (DGS 04-6)

Oag - Austin Glen Formation (Middle Ordovician)

(Pawlet in Vermont) - Graywacke, shale. Part of Lorraine, Trenton, and Black River Groups up to 1600 ft. (490 m). *GRI Source Map ID 7288* (Map and Chart Series 15)

Oj - Jacksonburg Limestone (Middle Ordovician)

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. *GRI Source Map ID 1558* (I-1530)

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. *GRI Source Map ID 1562* (GQ-1585)

Oj - Jacksonburg Limestone (Middle Ordovician) (Spencer and others, 1908; Miller, 1937) - Lower part is light- (N7) to medium-gray (N5), 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 (N3) to black (N1) 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. *GRI Source Map ID 1561* (GQ-1700)

Oj - Jacksonburg Limestone (Middle Ordovician) (Spencer and others, 1908; Miller, 1937) - Lower part is light- (N7) to medium-gray (N5), 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 (N3) to black (N1), 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. *GRI Source Map ID 1563* (GQ-1703)

Oj - Jacksonburg Limestone (Ordovician) - Shaly limestone, arenaceous limestone, and minor dolomite-cobble conglomerate siltstone, and shale. *GRI Source Map ID 7285* (DGS 04-6)

Ojl - Jacksonburg Limestone, cement limestone facies (Middle Ordovician)

Ojl - 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. *GRI Source Map ID 1559* (I-552)

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. *GRI Source Map ID 1558* (I-1530)

Ow - Sequence at Wantage (Middle Ordovician)

Ow - Sequence at Wantage (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 (10YR 5/4) to olive-gray (5Y 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. *GRI Source Map ID 1563* (GQ-1703)

Ow - Wantage Sequence (Ordovician) - Limestone, dolomite, conglomerate, siltstone, and shale. *GRI Source Map ID 7285* (DGS 04-6)

Obu - Beekmantown Group, upper part (Ordovician)

Dolomite and minor limestone. *GRI Source Map ID 7285* (DGS 04-6)

Obl - Beekmantown Group, lower part (Ordovician)

Dolomite and minor limestone. *GRI Source Map ID 7285* (DGS 04-6)

Oe - Beekmantown Group, Epler Formation (Lower Ordovician)

Oe - Epler Formation (Lower Ordovician) - Interbedded, very fine grained to cryptogranular, 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. *GRI Source Map ID 1559* (I-552)

Oe - Epler Formation (Lower Ordovician) - Interbedded fine- to medium-grained light-gray to dark-medium-gray dolomite and lesser very fine grained to cryptogranular 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'). Unit is about 270 m thick. *GRI Source Map ID 1558* (I-1530)

Oe - Epler Formation (Lower Ordovician) - Interbedded fine- to medium-grained, light- to dark-medium- gray dolomite and lesser very fine grained to cryptogranular, 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. *GRI Source Map ID 1562* (GQ-1585)

Or - Beekmantown Group, Rickenbach Dolomite (Lower Ordovician)

Or - Rickenbach Dolomite (Lower Ordovician) - Fine- to coarse-grained, light-medium- to medium-darkgray dololutite, dolarenite, and dolorudite. Sedimentary breccia and bedded and nodular chert are common. The formation ranges from about 500 to 650 feet thick. *GRI Source Map ID 1559* (I-552)

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 (0e) is present, otherwise is unconformable. Contains North American Midcontinent province conodont fauna high C - low D. Unit is about 220 m thick. *GRI Source Map ID 1558* (I-1530)

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 (0e) 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. *GRI Source Map ID 1562* (GQ-1585)

Or - Rickenbach Dolomite (Lower Ordovician) (Hobson, 1957) - Medium (N5) to dark-gray (N3), 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. *GRI Source Map ID 1561* (GQ-1700)

Or - Rickenbach Dolomite (Lower Ordovician) (Hobson, 1957) - Medium (N5) to dark-gray (N3), 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. *GRI Source Map ID 1563* (GQ-1703)

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. 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. *GRI Source Map ID 1558* (I-1530)

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 (0e) without paleontologic evidence. Unit is about 250 m thick. *GRI Source Map ID 1562* (GQ-1585)

Os - Stonehenge Formation (Lower Ordovician) (Stose, 1908; Hobson, 1957; Drake and Lyttle, 1985) - Medium-light- (N6) to medium-darkgray (N4), 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. Elsewhwere 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 in to the Allentown Dolomite and is about 600 to 650 ft thick in this quadrangle. *GRI Source Map ID 1561* (GQ-1700)

Os - Stonehenge Formation (Lower Ordovician) (Stose, 1908; Hobson, 1957; Drake and Lyttle, 1985) - Medium-light- (N6) to medium-darkgray (N4), 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 (N3) 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. Label shown in parentheses where concealed by surficial deposits. *GRI Source Map ID 1563* (GQ-1703)

OCa - Allentown Dolomite (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 dololutite, 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. *GRI Source Map ID 1559* (I-552)

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. *GRI Source Map ID 1558* (I-1530)

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. *GRI Source Map ID 1562* (GQ-1585)

OCa - Allentown Dolomite (Lowest Lower Ordovician and Upper Cambrian) (Wherry, 1909) - Light- (N7) to dark-gray (N3), 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. *GRI Source Map ID 1561* (GQ-1700)

OCa - Allentown Dolomite (Lowest Lower Ordovician and Upper Cambrian) (Wherry, 1909) - Light- (N7) to dark-gray (N3), 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. *GRI Source Map ID 1563* (GQ-1703)

OCa - Allentown Dolomite (Ordovician and Cambrian) - Dolomite, and less abundant quartzite and shale. *GRI Source Map ID 7285* (DGS 04-6)

OCc - Carbonate rocks (Cambrian to Ordovician)

Bedrock unit concealed beneath surficial layers and undeterminable on original publications. Inferred by NPS GRI from surrounding geology as unit, OCc. The digital representations of the Geologic Map of the Blairstown Quadrangle, (GQ-1585) *GRI Source Map ID 1562*, the Geologic map and sections of parts of the Portland and Belvidere Quadrangles, (I-552) *GRI Source Map ID 1559*, and the Geologic Map of the Stroudsburg Quadrangle, (GQ-1047) *GRI Source Map ID 1555,* contain this unit. However, OCc was not mapped according to the original publications.

Cl - Leithsville Formation (Middle and Lower Cambrian)

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. *GRI Source Map ID 1562* (GQ-1585)

Cl - Leithsville Formation (Middle and Lower Cambrian) (Wherry, 1909) - Thick-bedded, medium- (N5) to medium-dark-gray (N4) 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. *GRI Source Map ID 1561* (GQ-1700)

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. *GRI Source Map ID 1562* (GQ-1585)

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. *GRI Source Map ID 1562* (GQ-1585)

Yba - Byram Intrusive Suite, 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. *GRI Source Map ID 1562* (GQ-1585)

Ybh - Byram Intrusive Suite, 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. *GRI Source Map ID 1562* (GQ-1585)

Ymr - Marble (Middle Proterozoic)

Dolomite and calcite marble. Much of dolomite marble largely altered to serpentine, tremolite, and talc. *GRI Source Map ID 1562* (GQ-1585)

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

Light-gray, typically coarse-grained, rather massive, layered, calc-silicate rock associated with marble (Ymr). *GRI Source Map ID 1562* (GQ-1585)

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. *GRI Source Map ID 1562* (GQ-1585)

Ylo - Oligoclase-quartz gneiss (Middle Proterozoic)

Losee Metamorphic Suite. 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. *GRI Source Map ID 1562* (GQ-1585)

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. *GRI Source Map ID 1562* (GQ-1585)

GRI Source Map Information

Geologic Map of the Bushkill Quadrangle (GQ-908)

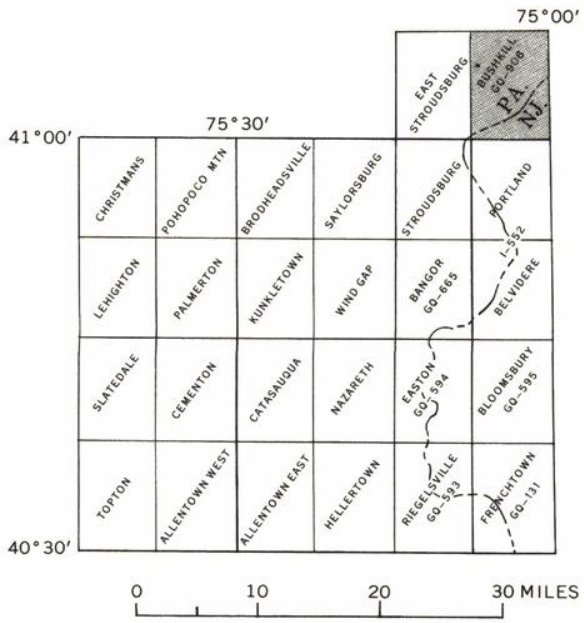
Alvord, Donald C., and Drake, Avery Ala Jr., 1971, Geologic Map of the Bushkill Quadrangle, Pennsylvania and New Jersey, U.S. Geological Survey, Geologic Quadrangle Map GQ-908, 1:24,000 scale. (*GRI Source Map ID 1566*)

Correlation of Units

Extracted from: [(GQ-908)]

Location and Index Map

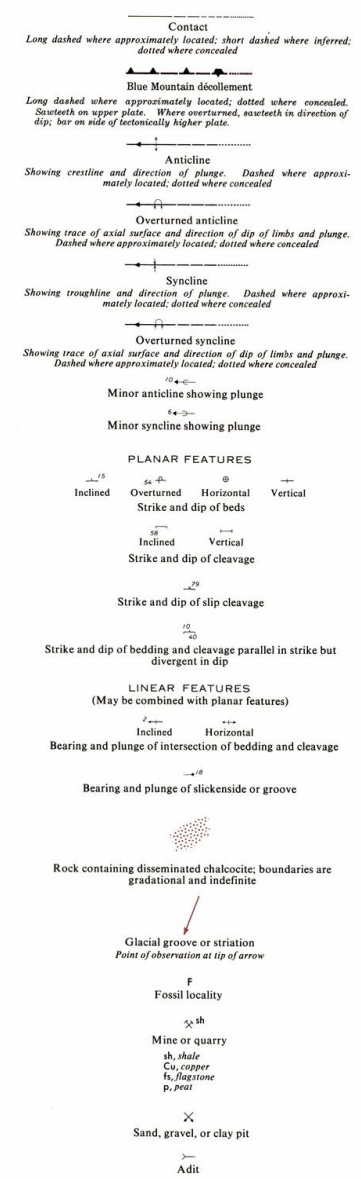
QUADRANGLE LOCATION



INDEX MAP OF PART OF EASTERN PENNSYLVANIA AND WESTERN NEW JERSEY SHOWING LOCATION OF BUSHKILL QUADRANGLE AND NEARBY PUBLISHED GEOLOGIC MAPS

Extracted from: (GQ-908)

Legend



Extracted from: [(GQ-908)]

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———1938, A Paleozoic section at Delaware Water Gap: Pennsylvania Geol. Survey, 4th ser., Bull. G11, 35 p.

———1939, The Devonian of Pennsylvania: Pennsylvania Geol. Survey, 4th ser., Bull. G19, 481 p.

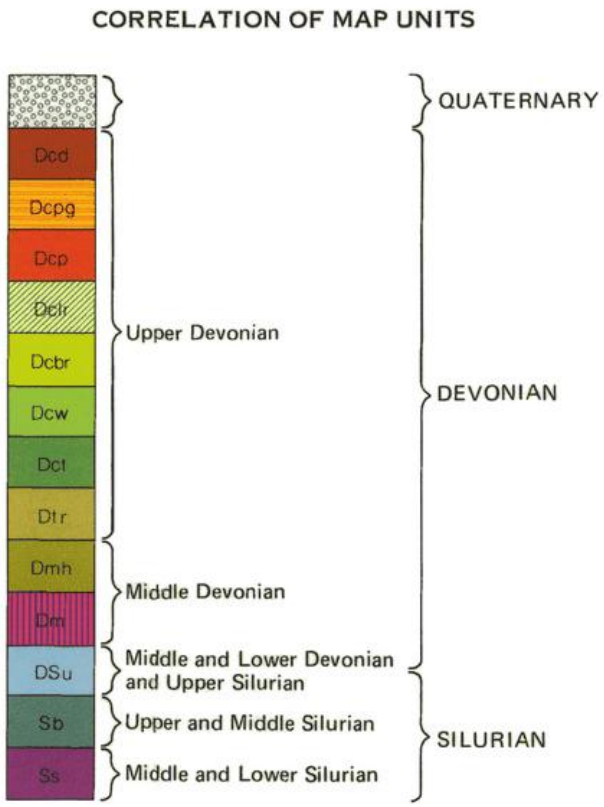
Extracted from: (GQ-908)

Geology and Groundwater Resources of Monroe County (Water Resources Report W 47)

Carswell, L.D. and Lloyd, O.B., Jr., 1979, Geology and Groundwater Resources of Monroe County, Pennsylvania, Pennsylvania Geological Survey, Water Resources Report W 47, 1:48,000 scale. (*GRI Source Map ID 2375*)

***Note: Only a portion of this map was used for this GIS dataset; some graphics such as correlations and cross sections may contain more data that what depicted in the GIS dataset.*

Correlation of Units



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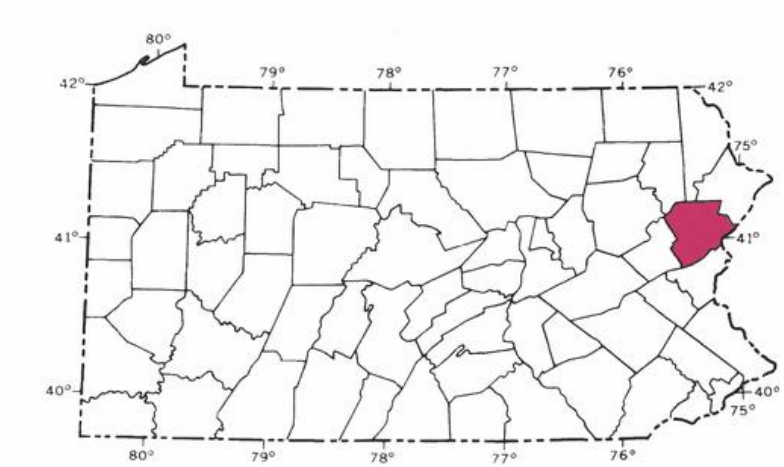
Location Map



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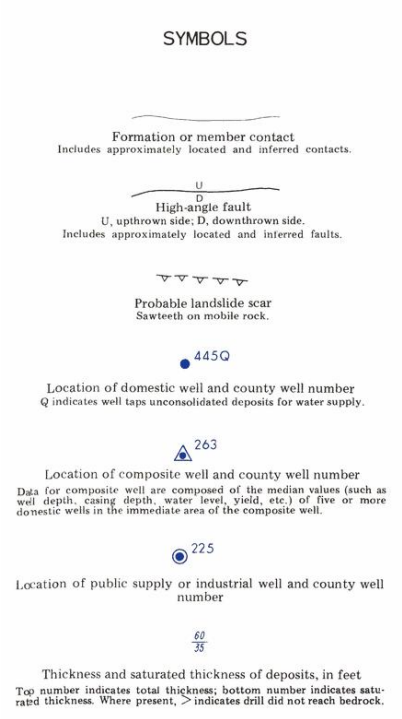


Extracted from: (Water Resource Report 47)

Bedrock Geologic Map of Pike County, Showing Location of Selected Wells (Water Resources Report W 65)

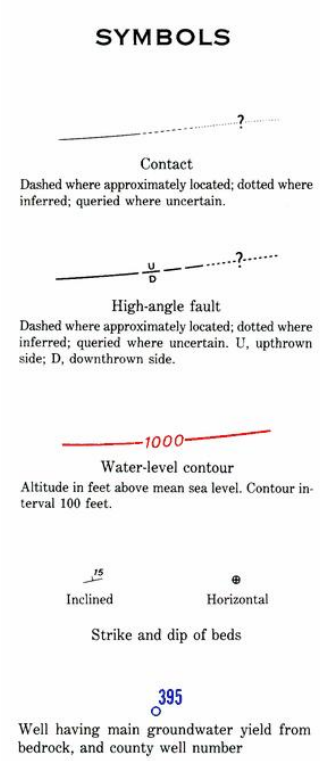
Davis, Drew K., Sevon, W.D., Berg, Thomas M., and Schultz, Lane D., 1989, Bedrock Geologic Map of Pike County, Pennsylvania, Showing Locations of Selected Wells, Pennsylvania Geological Survey, Water Resources Report W 65, 1:50,000 scale (*GRI Source Map ID 4456*)

> ***Note: Only a portion of this map was used for this GIS dataset; some graphics such as correlations and cross sections may contain more data that what depicted in the GIS dataset. This particular water resources publication covers the same area and displays similar geologic information as County Report C52. Lithologic descriptions and corresponding properties were extracted from this map to supplement respective lithologic descriptions from County Report 52. See Map Unit Descriptions section for more information.*

Location Map

Extracted from: (Water Resources Report 65)

Legend



Extracted from: (Water Resources Report 65)

Bedrock Geologic Map of the Branchville Quadrangle (GQ-1700)

Drake, A.A., Monteverde, D.H., 1992, Bedrock Geologic Map of the Branchville Quadrangle, Sussex County, New Jersey, U.S. Geological Survey, Geologic Quadrangle Map GQ-1700, 1:24,000 scale. (*GRI Source Map ID 1561*)

Report

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 (Ova). 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. Shall 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 (0bt), phonolite (0bp), bostonite (0bb), malignite (0bm), lamprophyre (0bl), and ouachitite breccia (0bo).

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 (see below).

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 - n 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 (see below).

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 anticlinorium 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 anticlinorium 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 decollement (Epstein and Epstein, 1967), a poorly understood element of central Appalachian geology. No direct evidence of decollement 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 decollement as one would not expect a decollement within the competent High Point Member of the Martinsburg Formation. The Blue Mountain decollement, however, is not mapped in this quadrangle.

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

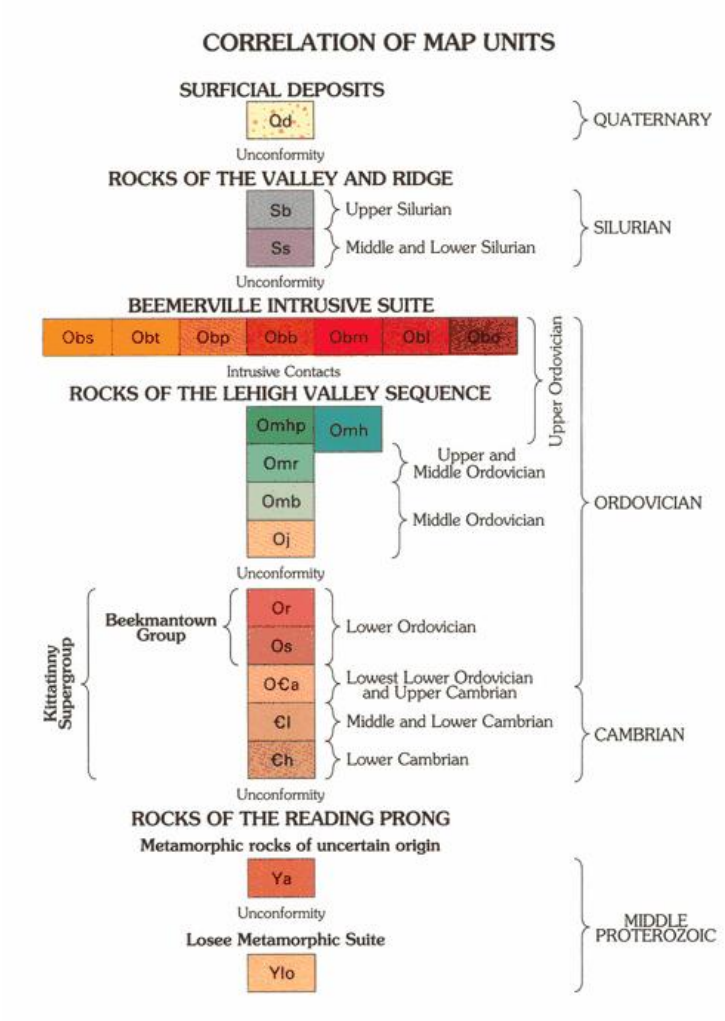
	1	2	3	4
SiO_2	56.4	44.9	54.9	59.2
Al_2O_3	21.1	17.3	21.5	20.4
Fe_2O_3	0.90	5.4	0.9	1.4
FeO	2.3	2.2	2.9	2.3
MgO	0.32	1.5	0.54	0.33
CaO	2.7	9.3	2.8	0.79
Na_2O	4.7	6.8	1.5	4.6
K_2O	6.4	5.1	10.3	7.4
H_2O+	1.1	1.5	1.7	1.3
H_2O-	0.15	0.23	0.19	0.14
TiO_2	0.36	1.4	0.48	0.46
P_2O_5	0.11	1.6	0.22	0.14
MnO	0.26	0.37	0.31	0.30
CO_2	2.2	1.2	0.40	1.3
Total	99.0	98.8	98.64	100.06

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

1. Tinguaite 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 Papakatinny Creek 11,550 ft N. 15° E. from Township School, Branchville 7.5-minute quadrangle, N.J.
3. Tinguaite from sharp bend in unimproved road 7,800 ft N. 8° W. from Libertyville, Branchville 7.5-minute quadrangle, N.J.
4. Phonolite from 820-foot contour on southeast slope of hill 2,950 ft S. 74° E. from BM 843, southeast corner of Culvers Gap 7.5-minute quadrangle, N.J.–Pa.

Extracted from: (GQ-1700)

Correlation of Units

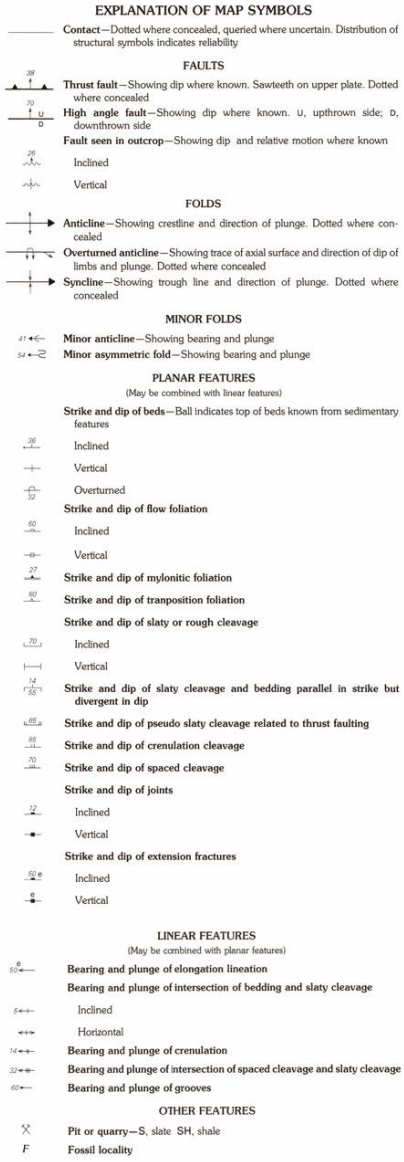


Extracted from: (GQ-1700)

Location Map

Extracted from: (GQ-1700)

Legend



EXPLANATION OF MAP SYMBOLS

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

FAULTS

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

70 U D **High angle fault**—Showing dip where known. U, upthrown side; D, downthrown side

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

26 Inclined

Vertical

FOLDS

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

Overturned anticline—Showing trace 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

41 **Minor anticline**—Showing bearing and plunge

54 **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

36 Inclined

Vertical

32 Overturned

Strike and dip of flow foliation

60 Inclined

Vertical

27 **Strike and dip of mylonitic foliation**

60 **Strike and dip of tranposition foliation**

Strike and dip of slaty or rough cleavage

70 Inclined

Vertical

14 65 **Strike and dip of slaty cleavage and bedding parallel in strike but divergent in dip**

65 **Strike and dip of pseudo slaty cleavage related to thrust faulting**

85 **Strike and dip of crenulation cleavage**

70 **Strike and dip of spaced cleavage**

Strike and dip of joints

12 Inclined

Vertical

Strike and dip of extension fractures

50 e Inclined

e Vertical

LINEAR FEATURES

(May be combined with planar features)

e 50 **Bearing and plunge of elongation lineation**

Bearing and plunge of intersection of bedding and slaty cleavage

5 Inclined

Horizontal

14 **Bearing and plunge of crenulation**

32 **Bearing and plunge of intersection of spaced cleavage and slaty cleavage**

60 **Bearing and plunge of grooves**

OTHER FEATURES

Pit or quarry—S, slate **SH**, shale

F **Fossil locality**

Extracted from: (GQ-1700)

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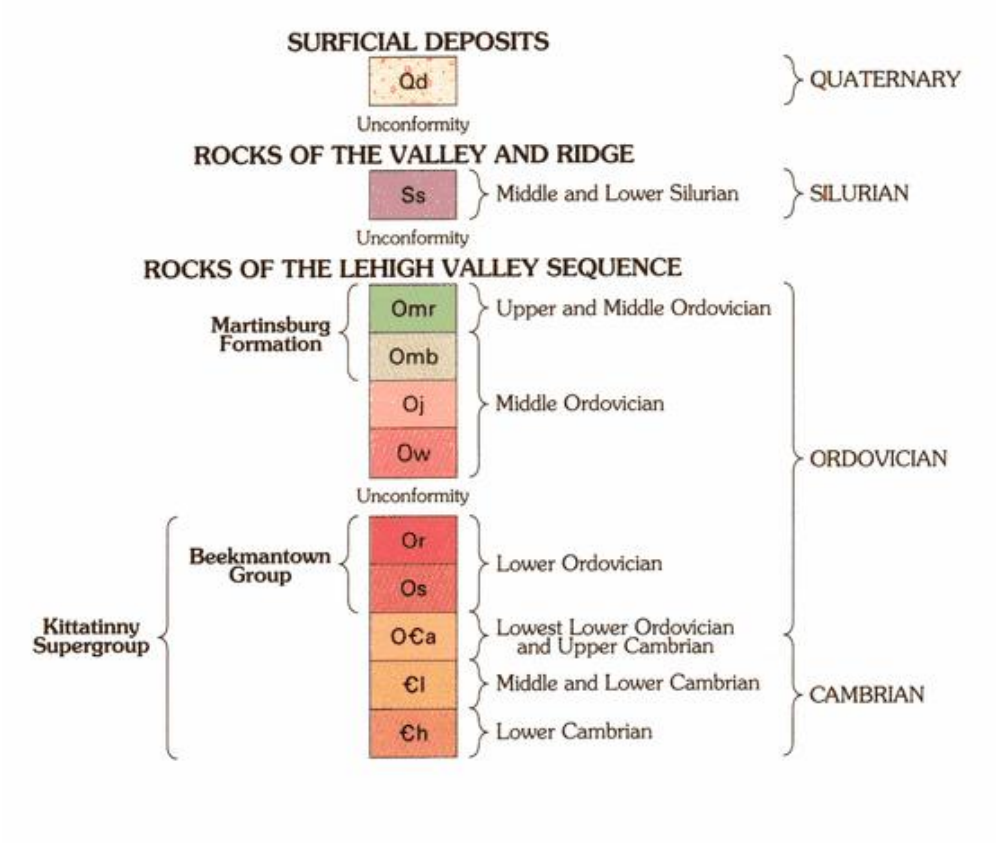
Extracted from: (GQ-1700)

Geologic Map of the Newton West Quadrangle (GQ-1703)

Drake, Avery Ala Jr., 1992, Geologic Map of the Newton West Quadrangle, Sussex and Warren Counties, New Jersey, U.S. Geological Survey, Geologic Quadrangle Map GQ-1703, 1:24,000 scale. (*GRI Source Map ID 1563*)

Correlation of Units

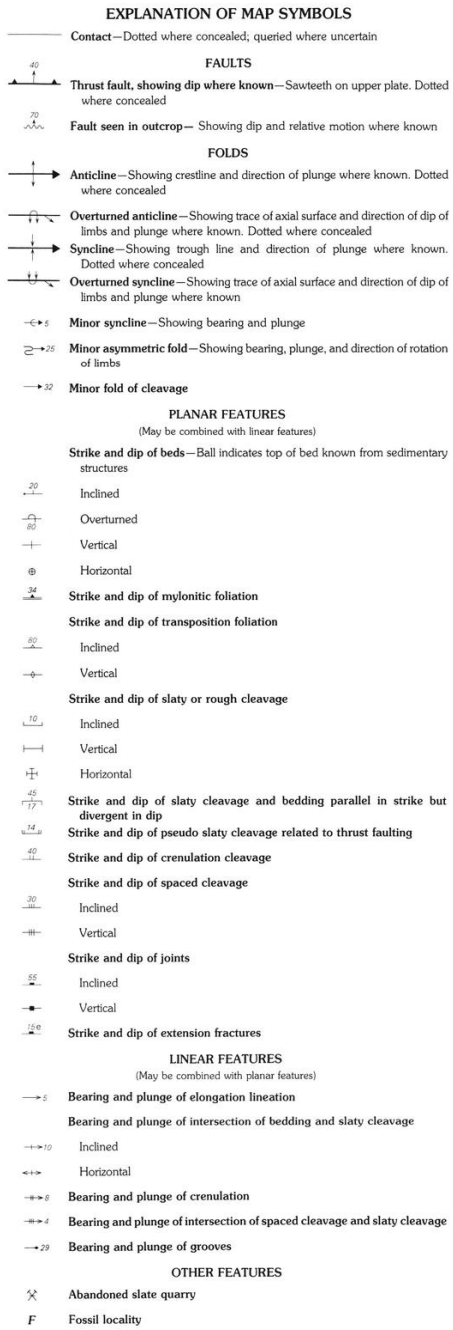


Extracted from: (GQ-1703)

Location Map

Extracted from: (GQ-1703)

Legend



Extracted from: (GQ-1703)

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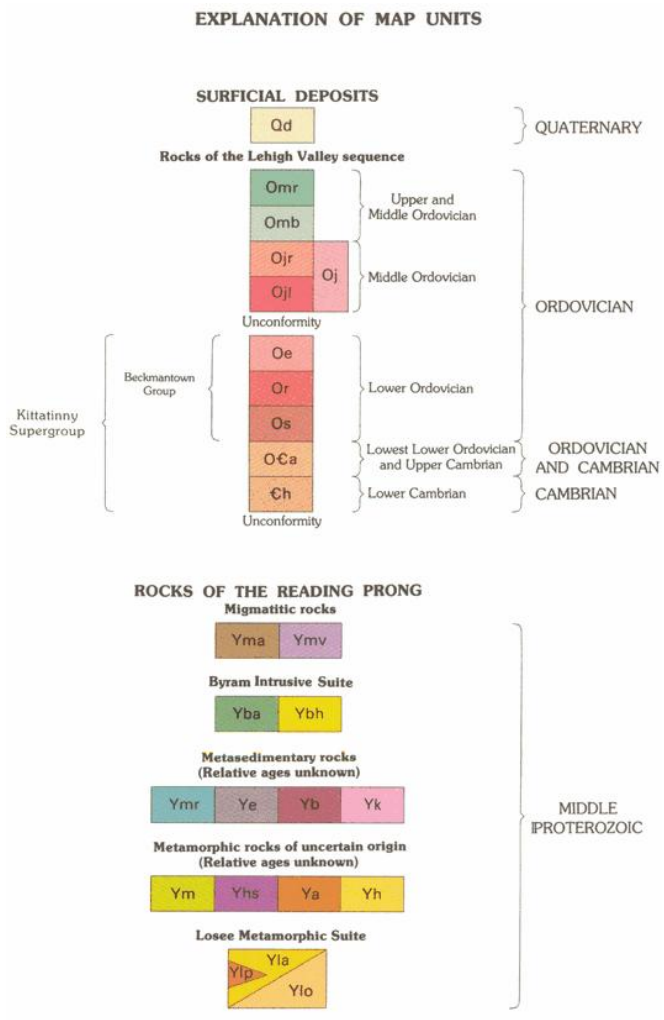
Extracted from: (GQ-1703)

Geologic Map of the Eastern Parts of the Belvidere and Portland Quadrangles (I-1530)

Drake, A.A., Kastelic, R.L. and Lyttle, P.T., 1985, Geologic Map of the Eastern Parts of the Belvidere and Portland Quadrangles, Warren County, New Jersey, U.S. Geological Survey, Miscellaneous Investigations Series Map I-1530, 1:24,000 scale. (*GRI Source Map ID 1558*)

***Note: Only a portion of this map was used for this GIS dataset; some graphics such as correlations and cross sections may contain more data that what depicted in the GIS dataset.*

Correlation of Units

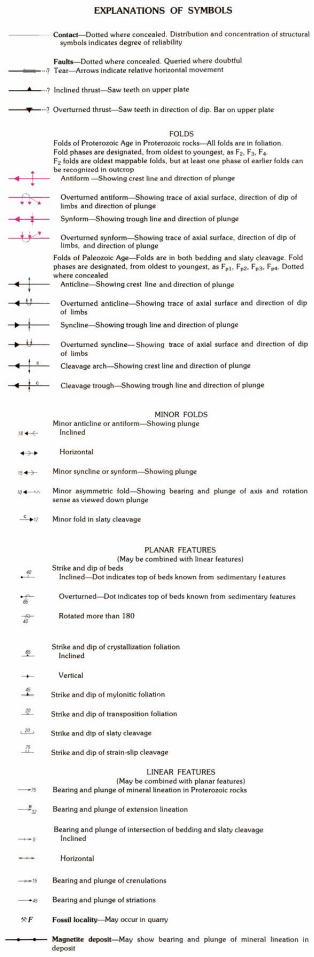


Extracted from: (I-1530)

Location Map

Extracted from: (I-1530)

Legend



EXPLANATIONS OF SYMBOLS

Contact—Dotted where concealed. Distribution and concentration of structural symbols indicates degree of reliability

Faults—Dotted where concealed. Queried where doubtful

Tear—Arrows indicate relative horizontal movement

Inclined thrust—Saw teeth on upper plate

Overturned thrust—Saw teeth in direction of dip. Bar on upper plate

FOLDS

Folds of Proterozoic Age in Proterozoic rocks—All folds are in foliation. Fold phases are designated, from oldest to youngest, as F_2, F_3, F_4. F_2 folds are oldest mappable folds, but at least one phase of earlier folds can be recognized in outcrop

Antiform —Showing crest line and direction of plunge

Overturned antiform—Showing trace of axial surface, direction of dip of limbs and direction of plunge

Synform—Showing trough line and direction of plunge

Overturned synform—Showing trace of axial surface, direction of dip of limbs, and direction of plunge

Folds of Paleozoic Age—Folds are in both bedding and slaty cleavage. Fold phases are designated, from oldest to youngest, as F_{p1}, F_{p2}, F_{p3}, F_{p4}. Dotted where concealed

Anticline—Showing crest line and direction of plunge

Overturned anticline—Showing trace of axial surface and direction of dip of limbs

Syncline—Showing trough line and direction of plunge

Overturned syncline—Showing trace of axial surface and direction of dip of limbs

Cleavage arch—Showing crest line and direction of plunge

Cleavage trough—Showing trough line and direction of plunge

MINOR FOLDS

Minor anticline or antiform—Showing plunge

Inclined

Horizontal

Minor syncline or synform—Showing plunge

Minor asymmetric fold—Showing bearing and plunge of axis and rotation sense as viewed down plunge

Minor fold in slaty cleavage

PLANAR FEATURES
(May be combined with linear features)

Strike and dip of beds

Inclined—Dot indicates top of beds known from sedimentary features

Overturned—Dot indicates top of beds known from sedimentary features

Rotated more than 180

Strike and dip of crystallization foliation

Inclined

Vertical

Strike and dip of mylonitic foliation

Strike and dip of transposition foliation

Strike and dip of slaty cleavage

Strike and dip of strain-slip cleavage

LINEAR FEATURES
(May be combined with planar features)

Bearing and plunge of mineral lineation in Proterozoic rocks

Bearing and plunge of extension lineation

Bearing and plunge of intersection of bedding and slaty cleavage

Inclined

Horizontal

Bearing and plunge of crenulations

Bearing and plunge of striations

Fossil locality—May occur in quarry

Magnetite deposit—May show bearing and plunge of mineral lineation in deposit

Extracted from: (I-1530)

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Drake, A. A., Jr., and Lyttle, P. T., 1980, Alleghanian thrust faults in the Kittatinny Valley, New Jersey, *in* Manspeizer, Warren, ed., Field studies of New Jersey geology and guide to field trips Fifty-second Annual Meeting of the New York Geological Association: Newark, Rutgers University p. 91–114.

Extracted from: (I-1530)

Geologic Map of the Blairstown Quadrangle (GQ-1585)

Drake, A.A., Lyttle, P.T., 1985, Geologic Map of the Blairstown Quadrangle, Warren County, New Jersey, U.S. Geological Survey, Geologic Quadrangle Map GQ-1585, 1:24,000 scale. (*GRI Source Map ID 1562*)

Report

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 attendent 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, 19796), 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, 19796; 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 measystem, 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 Frelinghuys... en 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).

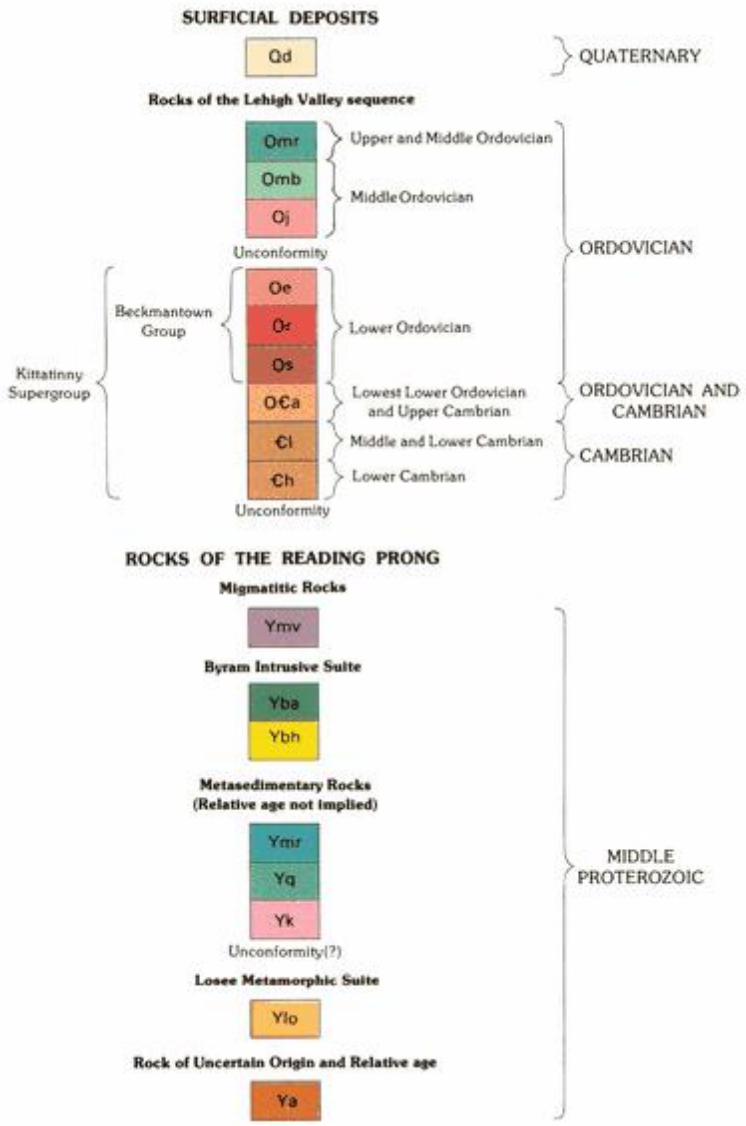
The youngest fold phase, the Stone Church, is named for the major Stone Church syncline that has been mapped from the Bangor quadrangle (Davis and others, 1967) to the Blairstown quadrangle, a distance of about 45 km. Stone Church folds trend from nearly east to east-northeast, and most of those that 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 folds 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.

Extracted from: (GQ-1585)

Correlation of Units

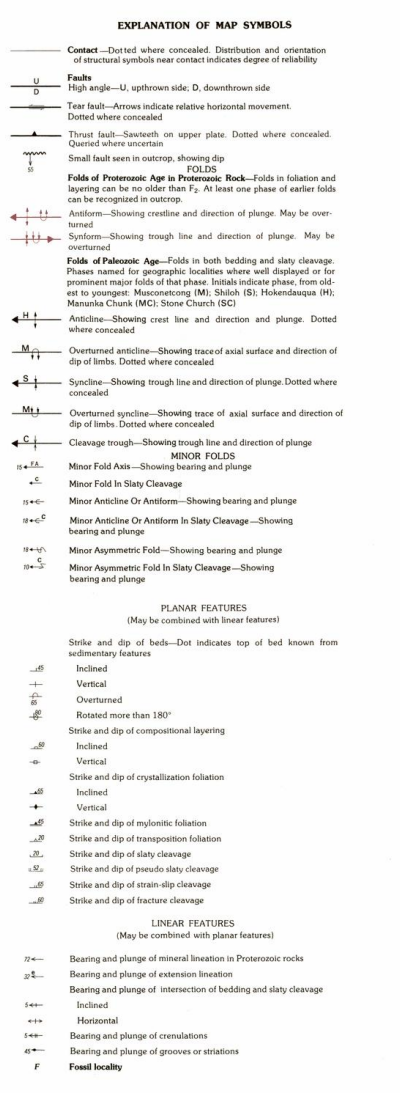


Extracted from: (GQ-1585)

Location Map

Extracted from: (GQ-1585)

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, upthrown side; D, downthrown side

Tear fault—Arrows indicate relative horizontal movement. Dotted where concealed

Thrust fault—Sawteeth on upper plate. Dotted where concealed. Queried where uncertain

Small fault seen in outcrop, showing dip

FOLDS

Folds of Proterozoic Age in Proterozoic Rock—Folds in foliation and layering can be no older than F_2. At least one phase of earlier folds can be recognized in outcrop.

Antiform—Showing crestline and direction of plunge. May be overturned

Synform—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 localities where well displayed or for prominent major folds of that phase. Initials indicate phase, from oldest to youngest: Musconetcong (M); Shiloh (S); Hokendauqua (H); Manunka Chunk (MC); Stone Church (SC)

Anticline—Showing crest line and direction and plunge. Dotted where concealed

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

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

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

Cleavage trough—Showing trough line and direction of plunge

MINOR FOLDS

Minor Fold Axis—Showing bearing and plunge

Minor Fold In Slaty Cleavage

Minor Anticline Or Antiform—Showing bearing and plunge

Minor Anticline Or Antiform In Slaty Cleavage—Showing bearing and plunge

Minor Asymmetric Fold—Showing bearing and plunge

Minor Asymmetric Fold In Slaty Cleavage—Showing bearing and plunge

PLANAR FEATURES
(May be combined with linear features)

Strike and dip of beds—Dot indicates top of bed known from sedimentary features

Inclined

Vertical

Overturned

Rotated more than 180°

Strike and dip of compositional layering

Inclined

Vertical

Strike and dip of crystallization foliation

Inclined

Vertical

Strike and dip of mylonitic foliation

Strike and dip of transposition foliation

Strike and dip of slaty cleavage

Strike and dip of pseudo slaty cleavage

Strike and dip of strain-slip cleavage

Strike and dip of fracture cleavage

LINEAR FEATURES
(May be combined with planar features)

Bearing and plunge of mineral lineation in Proterozoic rocks

Bearing and plunge of extension lineation

Bearing and plunge of intersection of bedding and slaty cleavage

Inclined

Horizontal

Bearing and plunge of crenulations

Bearing and plunge of grooves or striations

Fossil locality

Extracted from: [(GQ-1585)]

Tectonic Fold Map

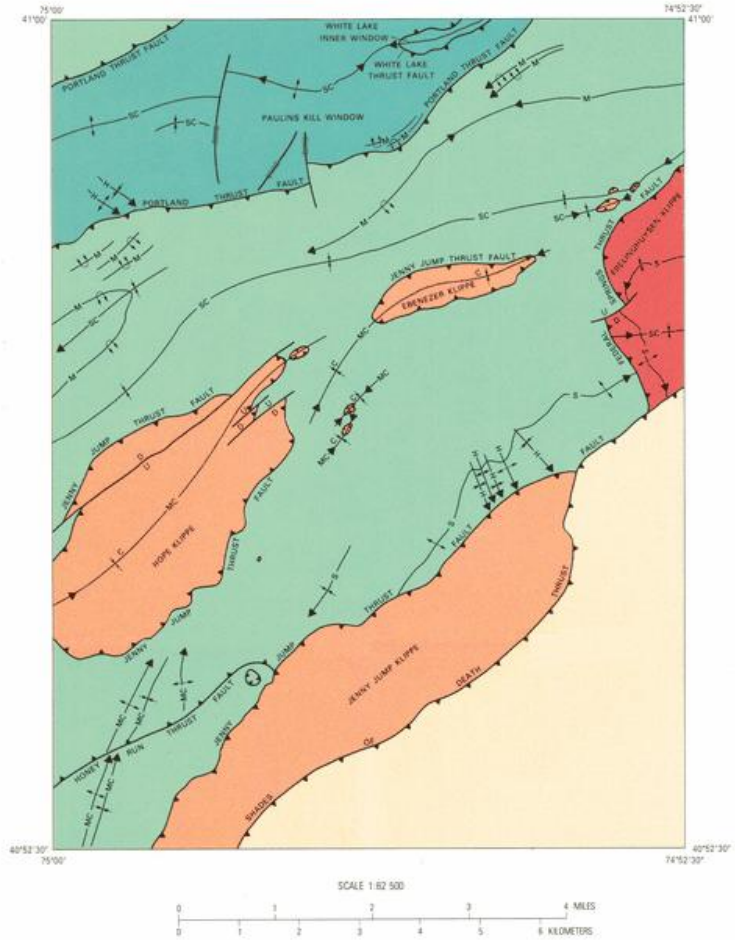


FIGURE 1—Map showing tectonic units and fold phases in the Blairstown quadrangle.

EXPLANATION

Allamuchy nappe

Jenny Jump thrust sheet

Frelinghuysen thrust sheet

Musconetcong nappe

Lyon Station-Paulins Kill nappe

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

Thrust fault—Sawteeth on upper plate

Tear fault—Arrows indicate relative horizontal movement

Folds—Folds in both bedding and slaty cleavage. Phases named for geographic localities where well displayed or for prominent major folds of that phase. Initials indicate phases, from oldest to youngest: Musconetcong (M); Shiloh (S); Hokendaupau (H); Manunka Chunk (MC); Stone Church (SC)

MC— Anticline—Showing crestline and direction of plunge

M— Overturned anticline—Showing trace of axial surface and direction of dip of limbs

S— Syncline—Showing troughline and direction of plunge

M— Overturned syncline—Showing trace of axial surface and direction of dip of limbs

C— Cleavage trough—Showing trough line and direction of plunge

Extracted from: [(GQ-1585)]

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Extracted from: (GQ-1585)

Geologic Map and Sections of Parts of the Portland and Belvidere Quadrangles (I-552)

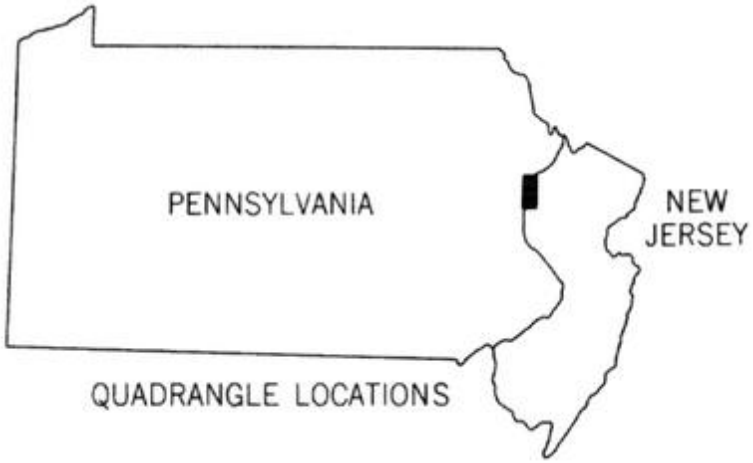
Drake, A.A., Epstein, J.B. and Aaron, J.M., 1969, Geologic Map and Sections of Parts of the Portland and Belvidere Quadrangles, New Jersey and Pennsylvania, U.S. Geological Survey, Miscellaneous Investigations Series Map I-552, 1:24,000 scale (*GRI Source Map ID 1559*)

***Note: Only a portion of this map was used for this GIS dataset; some graphics such as correlations and cross sections may contain more data that what depicted in the GIS dataset.*

Correlation of Units

Extracted from: [(I-552)]

Location Map



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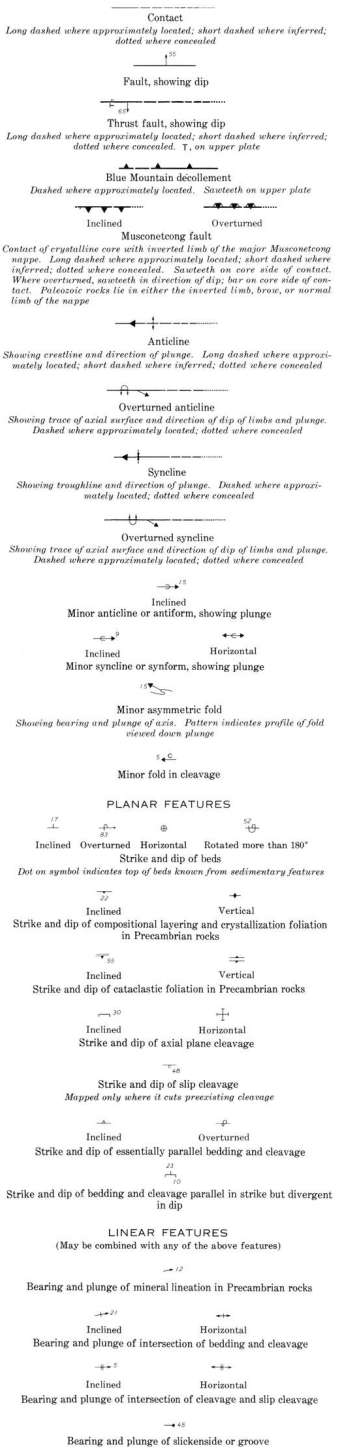
Legend



Extracted from: [(I-552)]

Geologic Map of the Saylorsburg Quadrangle (GQ-1638)

Epstein, Jack B., 1990, Geologic Map of the Saylorsburg Quadrangle, Monroe and Northampton Counties, Pennsylvania, U.S. Geological Survey, Geologic Quadrangle Map GQ-1638, 1:24,000 scale. (*GRI Source Map ID 1556*)

Report

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 (see figure 1 below) including a detailed map of Godfrey Ridge and Cherry Ridge by Epstein(in press a land 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 (see table 1 and figure 1 below). 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 2-5.

The average trends and plunges of the folds in each lithotectonic unit 43) 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.

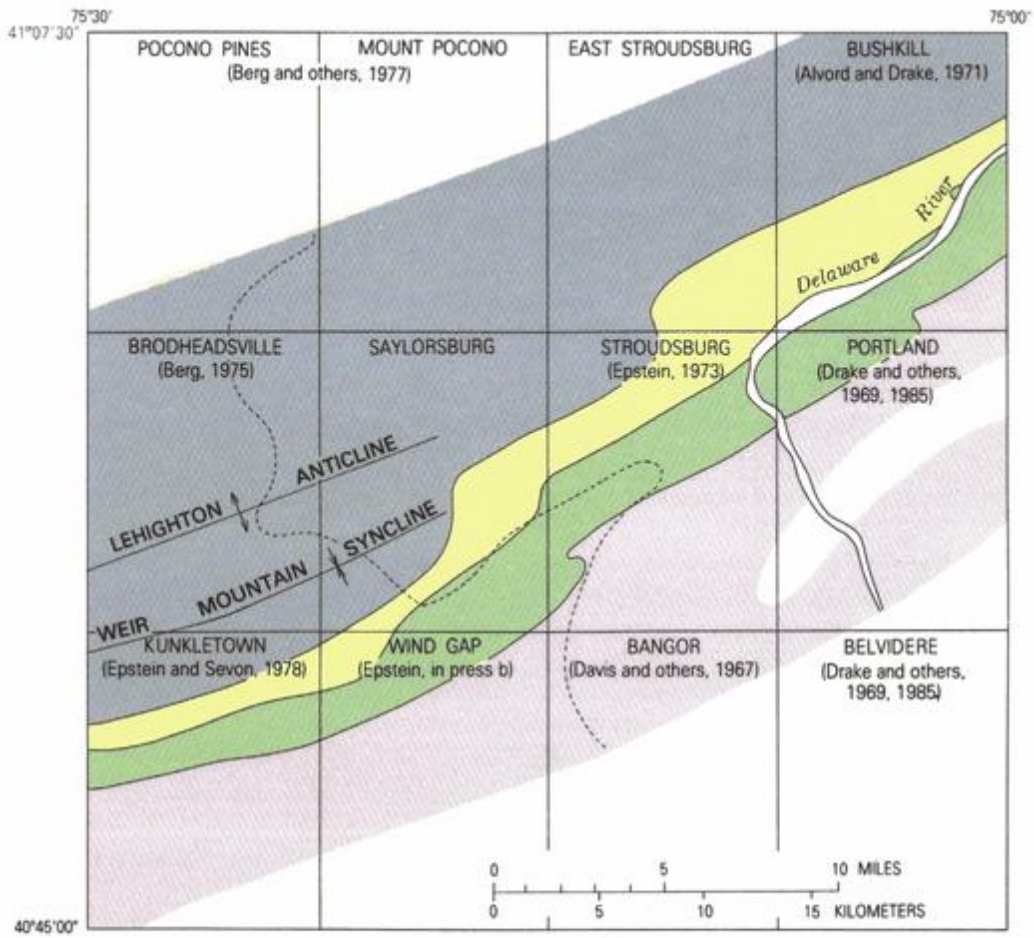
Slaty cleavage (fig. 3) is axial planar to and fans the folds and the maximum for cleavage in each plot statistically defines the strike and dip of the folds in each lithotectonic unit. These plots of cleavage likewise indicate a more westerly orientation of the folds for each younger lithotectonic unit.

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.



EXPLANATION

See table 1 for description of lithotectonic units

Lithotectonic unit 4

Lithotectonic unit 3

Lithotectonic unit 2

Lithotectonic unit 1

Contact

Anticline
Showing trace of axial plane

Syncline
Showing trace of axial plane

Maximum southwest extent of the Wisconsinan (Woodfordian) glacier

FIGURE 1—Generalized geologic map of the Saylorsburg and surrounding quadrangles.

SEDIMENTOLOGY

The sedimentological history of the map units is summarized in figure 6 below. 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 east-facing 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). Au 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 near-shore 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.

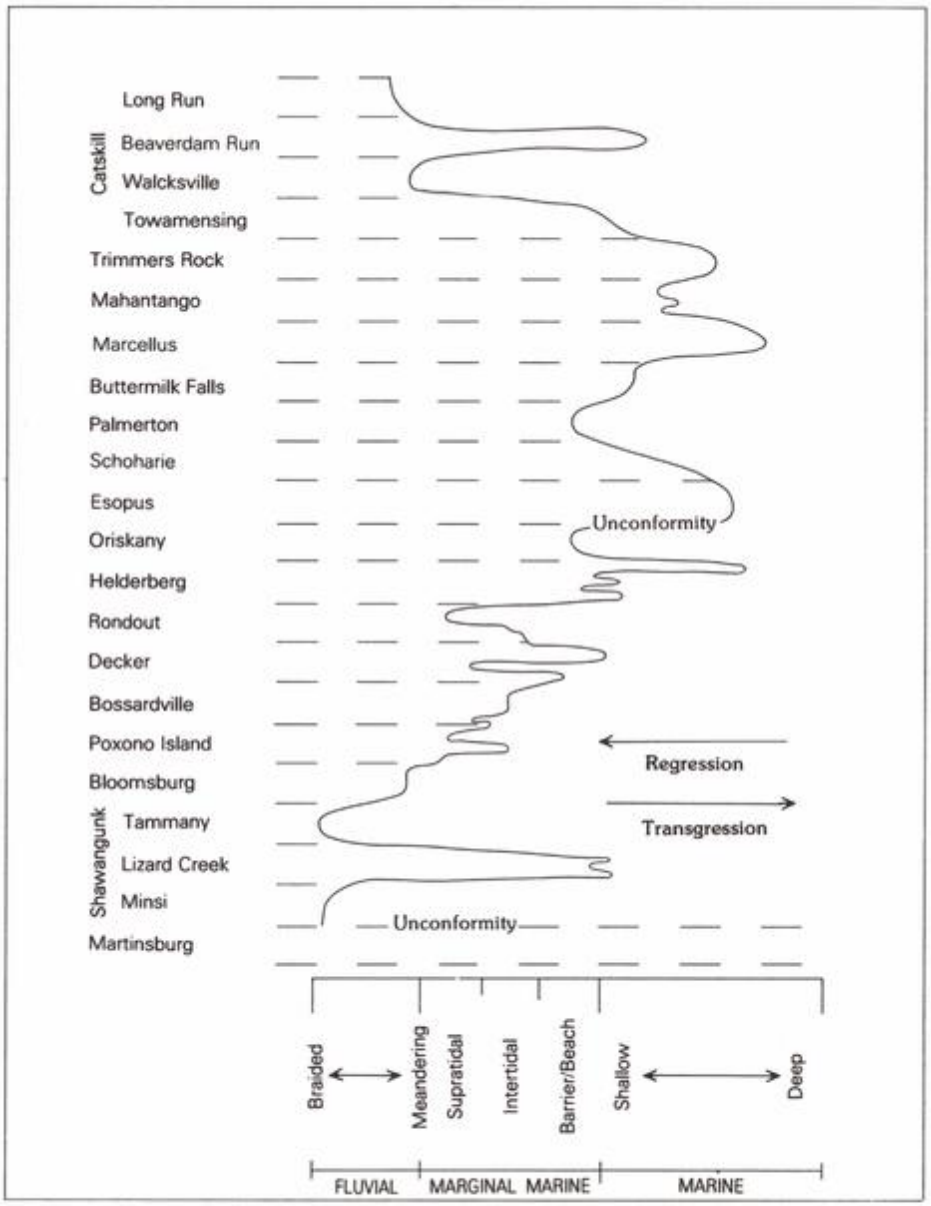
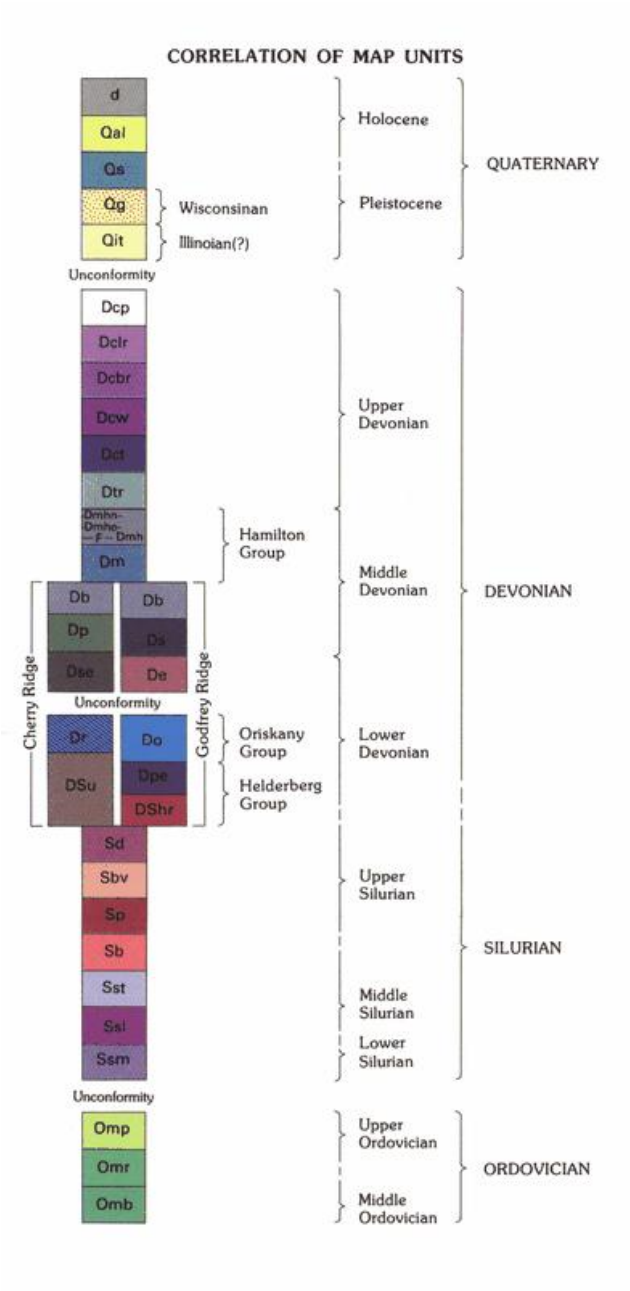


FIGURE 6 —Environments of deposition of Middle Ordovician through Upper Devonian rocks in the Saylorsburg quadrangle.

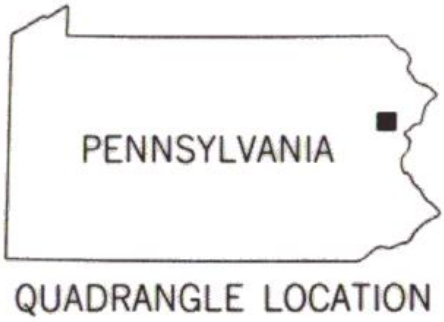
Extracted from: (GQ-1638)

Correlation of Units



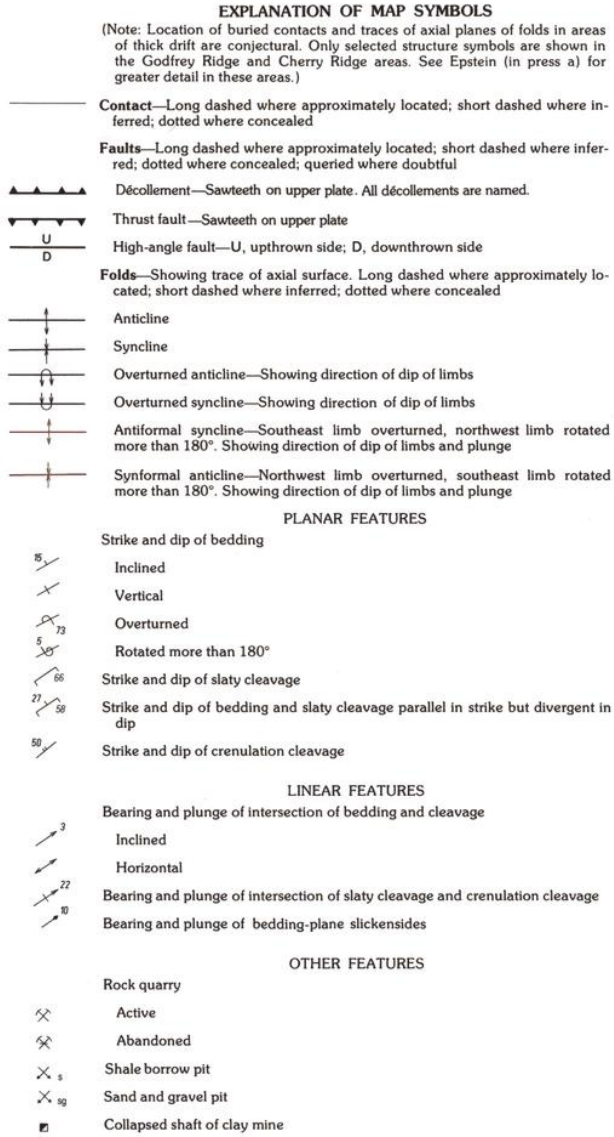
Extracted from: (GQ-1638)

Location Map



Extracted from: (GQ-1638)

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

U
D
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

15
Inclined

Vertical

73
Overturned

5
Rotated more than 180°

66
Strike and dip of slaty cleavage

27
58
Strike and dip of bedding and slaty cleavage parallel in strike but divergent in dip

50
Strike and dip of crenulation cleavage

LINEAR FEATURES

Bearing and plunge of intersection of bedding and cleavage

3
Inclined

Horizontal

22
Bearing and plunge of intersection of slaty cleavage and crenulation cleavage

10
Bearing and plunge of bedding-plane slickensides

OTHER FEATURES

Rock quarry

Active

Abandoned

s
Shale borrow pit

sg
Sand and gravel pit

Collapsed shaft of clay mine

Extracted from: [(GQ-1638)]

Table 1

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

Litho-tectonic unit	Age of lithotectonic unit and stratigraphic sequence	Lithologic characteristics	Style of folding	Average size of folds
4	Late and Middle Devonian: Upper part of Marcellus Shale and younger rocks	More than 10,000 ft (3,050m) of sandstone, conglomerate, siltstone, and shale. Lower 7,500 ft (2,300m) exposed in quadrangle	Nearly symmetric, concentric, predominantly flexural slip. Broad open folds (Weir Mountain syncline and Lehighton anticline with lower order superimposed folds)	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 Bossardsville, a rate of decrease of about 625 ft/mi (118 m/km)
3	Middle Devonian to Late Silurian: Lower part of Marcellus Shale to upper part of Poxono Island Formation	1,300–1,600 ft (400–490m) of limestone, sandstone and dolomite; thin heterogenous formations	Asymmetric, concentric, and similar, flexural slip and flow, passive slip and flow. Cascade folds	Wavelengths average about 650 ft (200 m); amplitudes about 250 ft (80 m)
2	Late to Early Silurian: Lower part of Poxono Island Formation to Shawangunk Formation	3,200 ft (975m) of sandstone, siltstone, shale, and conglomerate; coarse toward base of unit	Asymmetric, concentric; flexural slip with minor passive slip and flow. Bedding slip and wedging in the Bloomsburg Red Beds	Wavelengths average about 1 mi (1.6 km); amplitudes 1,000–4,000 ft (300–1200 m)
1	Late and Middle Ordovician Martinsburg Formation	About 12,000 ft (3,700 m) of thick repetitive sequences of slate and graywacke. Few hundred feet at top present in quadrangle	Asymmetric, similar nearly isoclinal, nearly recumbent; mainly passive flow and slip	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

For sale by U.S. Geological Survey, Map Distribution, Box 25286, Federal Center, Denver, CO 80225

Extracted from: (GQ-1638)

Projections

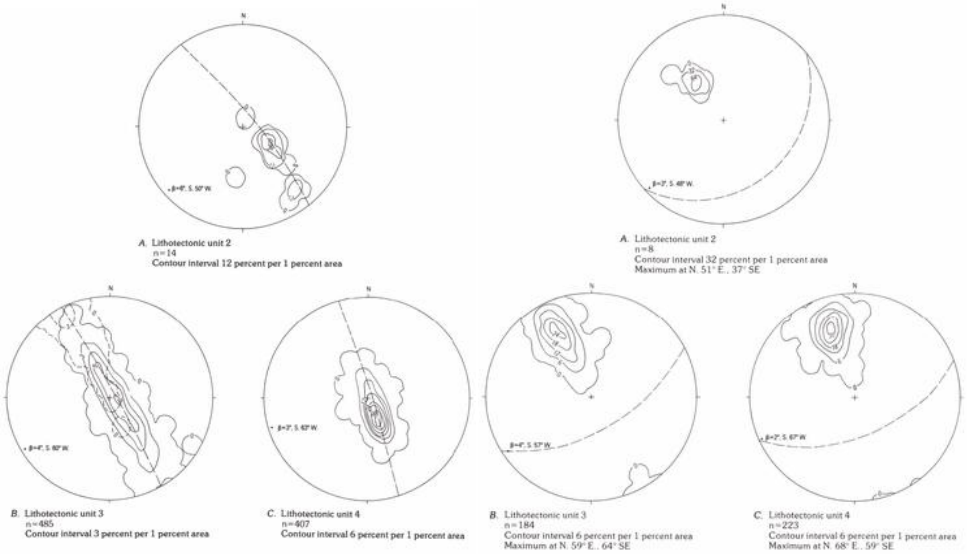


FIGURE 2—Equal-area projections (lower hemisphere) of poles to bedding. Solid contours are upright beds. Short-dashed contours are overturned beds. Long-dashed lines are girdles defined by poles to bedding. Solid circles are fold axes (β).

FIGURE 3—Equal-area projections (lower hemisphere) of poles to cleavage. Dashed lines are mean attitudes of cleavage derived from the maxima. Solid circles are fold axes (β) from plots of intersection of bedding and cleavage in figure 4.

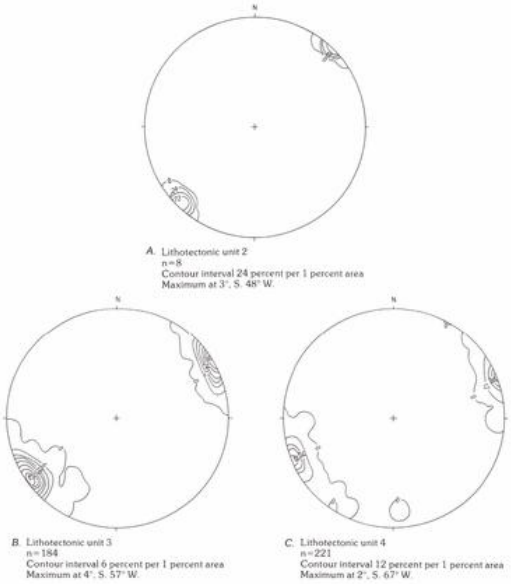


FIGURE 4—Equal-area projections (lower hemisphere) of intersections of bedding and cleavage, approximating trends of the fold axes.

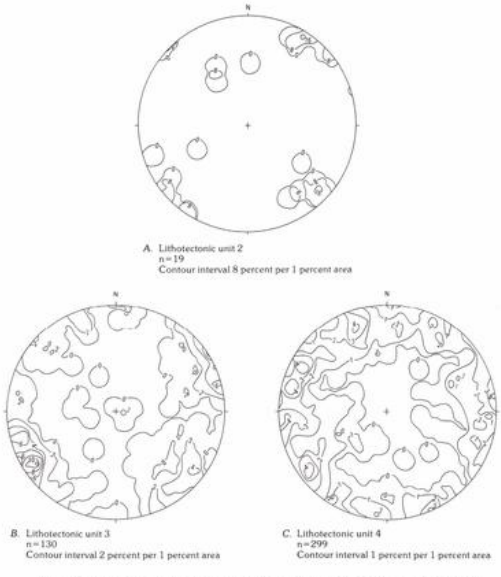


FIGURE 5—Equal-area projections (lower hemisphere) of poles to joints. Cross and longitudinal joints make up most of the joint sets.

Extracted from: [(GQ-1638)]

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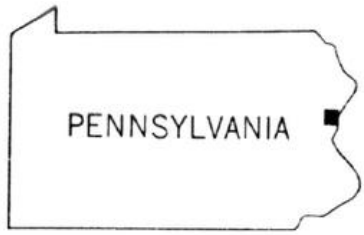
Extracted from: (GQ-1638)

Geologic Map of the Stroudsburg Quadrangle (GQ-1047)

Epstein, Jack B., 1973, Geologic Map of the Stroudsburg Quadrangle, Pennsylvania and New Jersey, U. S. Geological Survey, Geologic Quadrangle Map GQ-1047, 1:24,000 scale. (*GRI Source Map ID 1555*)

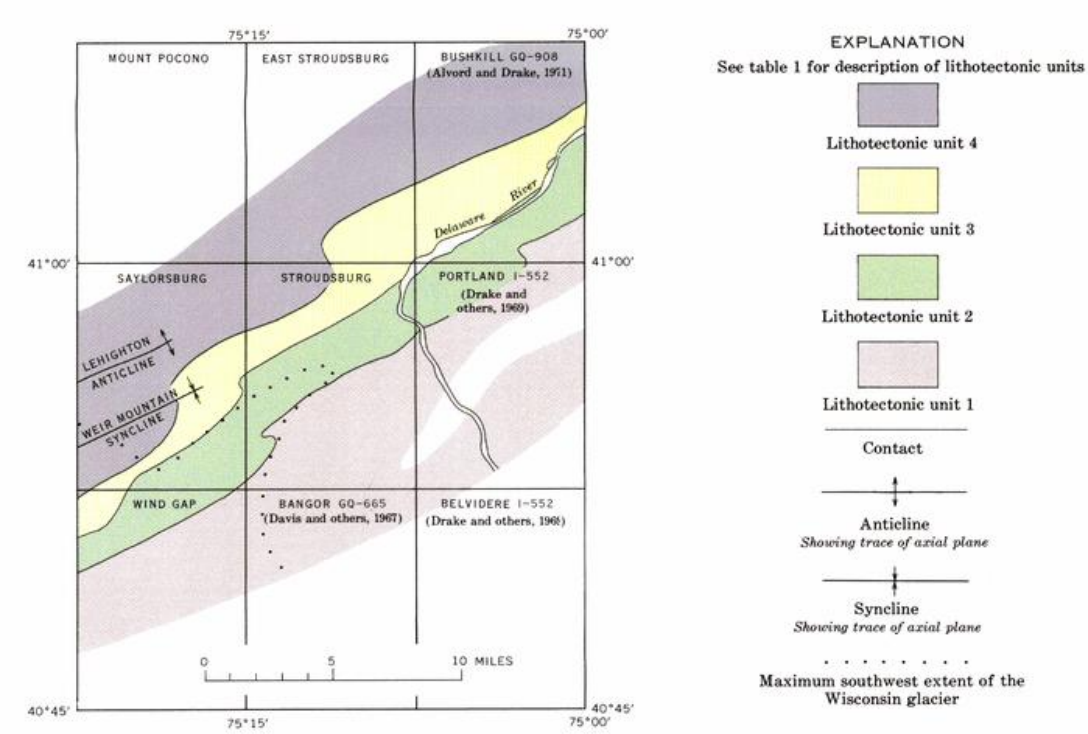
Location Map



QUADRANGLE LOCATION

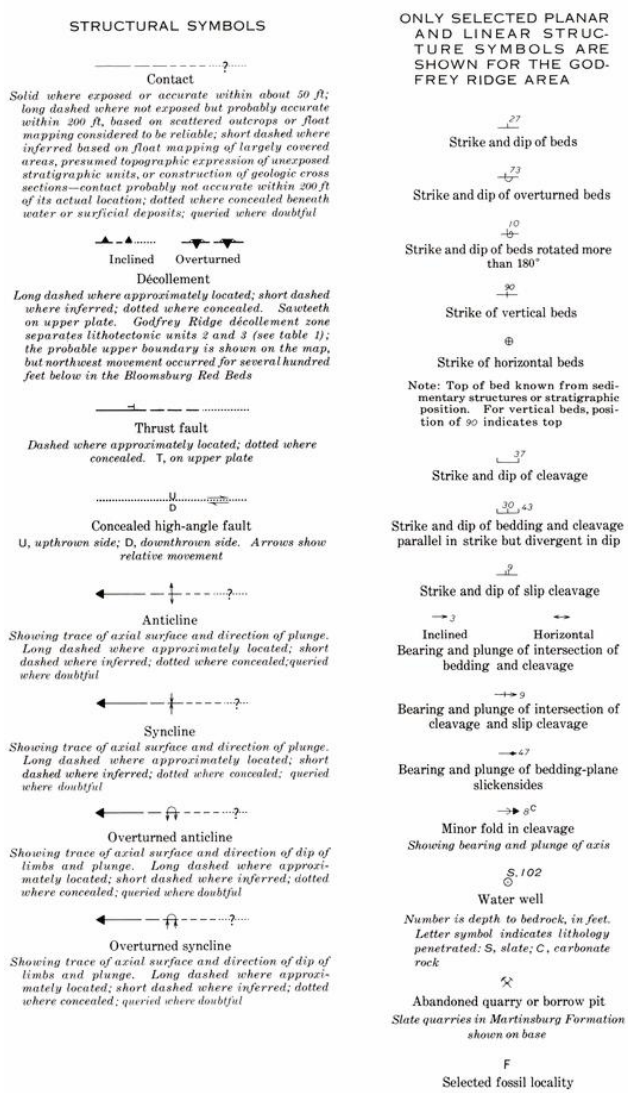
Extracted from: (GQ-1047)

General Geology



Extracted from: (GQ-1047)

Legend



Extracted from: [(GQ-1047)]

Table 1

TABLE 1.—Lithotectonic units in the Stroudsburg quadrangle (modified from Epstein and Epstein, 1967, 1969). [Adjacent units are believed to be separated by a décollement or zone of décollement; Blue Mountain décollement separates units 1 and 2; Godfrey Ridge décollement zone separates units 2 and 3, although considerable northwest telescoping is indicated by bedding slippage and wedging in the Bloomsburg Red Beds; Weir Mountain décollement separates units 3 and 4 (see Epstein, 1971, for details).]

Lithotectonic unit	Age of lithotectonic unit and stratigraphic sequence	Lithologic characteristics	Style of folding	Average size of folds
4	Late and Middle Devonian Upper part of Marcellus Shale and younger rocks	More than 10,000 feet of sandstone, conglomerate, siltstone, and shale. Lower 1700 feet exposed in quadrangle	Nearly symmetric, concentric, predominantly flexural slip. Broad open folds	Half wavelengths about 3,000 feet and amplitudes about 600 feet that increase to more than 5 miles and 4,200 feet, respectively, west of the Saylorsburg quadrangle
3	Middle Devonian to Late Silurian Lower part of Marcellus Shale to upper part of Poxono Island Formation	1,500 feet of limestone, shale, siltstone, sandstone, and dolomite; heterogeneous stratigraphic units between 5 and 180 feet thick	Asymmetric, concentric, and similar, flexural slip and flow, passive slip and flow. Cascade folds	Wavelengths average about 700 feet; amplitudes about 250 feet
2	Late to Early Silurian and possibly Late Ordovician Lower part of Poxono Island Formation to Shawangunk Formation	3,200 feet of sandstone, siltstone, shale, and conglomerate; coarser toward base of sequence	Asymmetric, concentric; flexural slip with minor passive slip and flow. Bedding slip and wedging in the Bloomsburg Red Beds	Wavelengths average about 1 mile; amplitudes 1,500-5,000 feet
1	Late and Middle Ordovician Martinsburg Formation	About 12,000 feet of thick monotonous sequences of slate and graywacke	Asymmetric, similar nearly isoclinal, nearly recumbent; mainly passive flow and slip, flexural slip near contact with Shawangunk Formation. Folds probably superimposed on upright limb of large regional nappe	Wavelengths 1,000 to 3,000 feet; amplitudes 400 to 2,000 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

Extracted from: (GQ-1047)

Geologic Map of New York (Map and Chart Series 15)

Fisher, D.W., Isachsen, Y.W., and Rickard, L.V., 1970, Geologic Map of New York - Lower Hudson Sheet, New York State Museum, Map and Chart Series 15, 1:250,000 scale. (*GRI Source Map ID 7288*)

***Note: Only a portion of this map was used for this GIS dataset; some graphics such as correlations and cross sections may contain more data that what depicted in the GIS dataset.*

**No legends, explanations or additional graphics were available with this digital dataset*

Landslides in New Jersey (DGS 06-3)

Pallis, T. and Marzulli, W., 2006, Landslides in New Jersey, New Jersey Geological Survey, Digital Geodata Series DGS 06-3, 1:100,000 scale. (*GRI Source Map ID 74874*)

***Note: Only a portion of this map was used for this GIS dataset; some graphics such as correlations and cross sections may contain more data that what depicted in the GIS dataset.*

**No legends, explanations or additional graphics were available with this digital dataset -- some source fields retained in data to convey feature specific information*

Surficial Geology of New Jersey (DGS 07-2)

Pristas, R.P., 2007, Surficial Geology of New Jersey, New Jersey Geological Survey, Digital Geodata Series DGS 07-2, 1:100,000 scale. (*GRI Source Map ID 74858*)

***Note: Only a portion of this map was used for this GIS dataset; some graphics such as correlations and cross sections may contain more data that what depicted in the GIS dataset.*

Bedrock Geology of New Jersey (DGS 04-6)

Pristas, R.P., 2004, Bedrock Geology of New Jersey, New Jersey Geological Survey, Digital Geodata Series DGS 04-6, 1:100,000 scale. (*GRI Source Map ID 7285*)

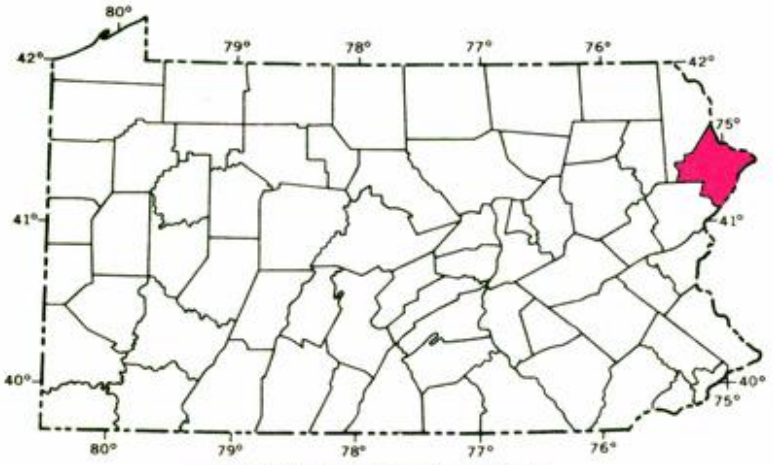
***Note: Only a portion of this map was used for this GIS dataset; some graphics such as correlations and cross sections may contain more data that what depicted in the GIS dataset.*

Geology and Mineral Resources of Pike County, Plate 1 - Bedrock Geology (County Report C 52)

Sevon, W.D., Berg, Thomas M., Schultz, Lane D., and Crowl, G.H., 1989, Geology and Mineral Resources of Pike County, Pennsylvania (Plate 1, Bedrock Geology), Pennsylvania Geological Survey, County Report C 52, 1:50,000 scale. (*GRI Source Map ID 4459*)

***Note: Only a portion of this map was used for this GIS dataset; some graphics such as correlations and cross sections may contain more data that what depicted in the GIS dataset.*

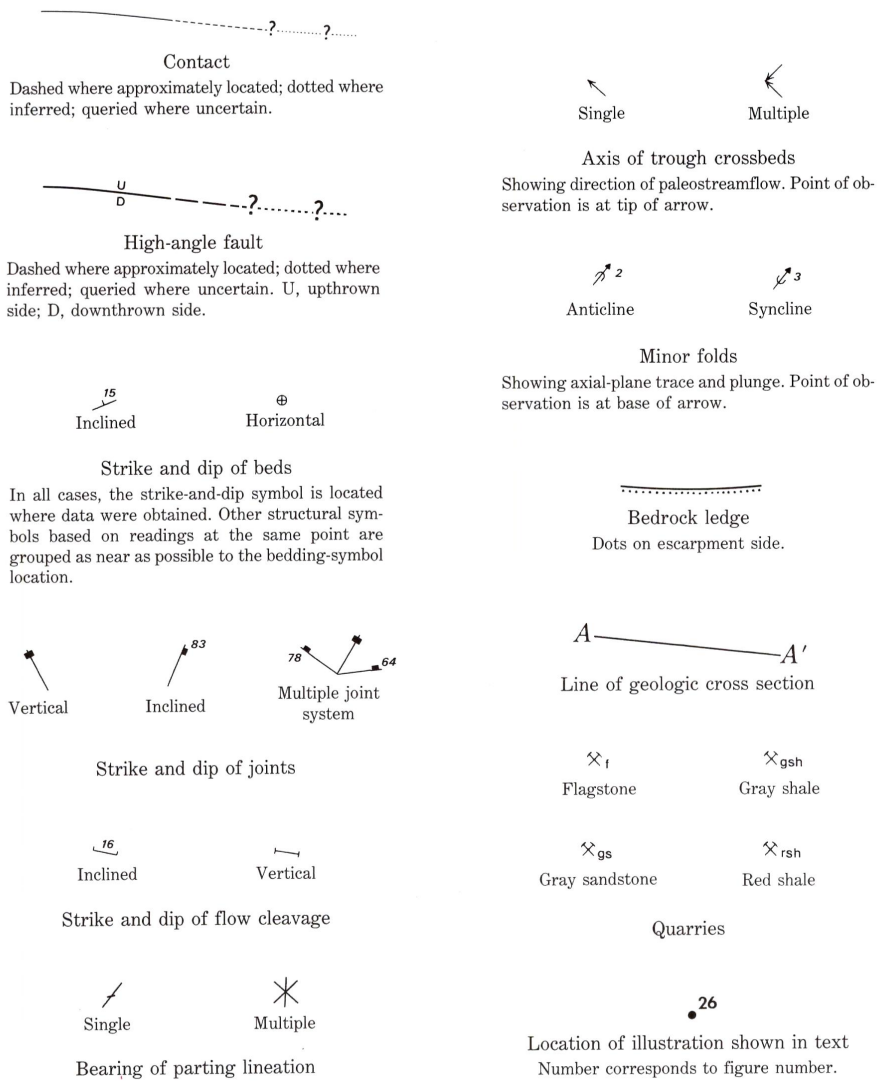
Location Map



LOCATION OF AREA

Extracted from: (County Report C52, plate1)

Legend



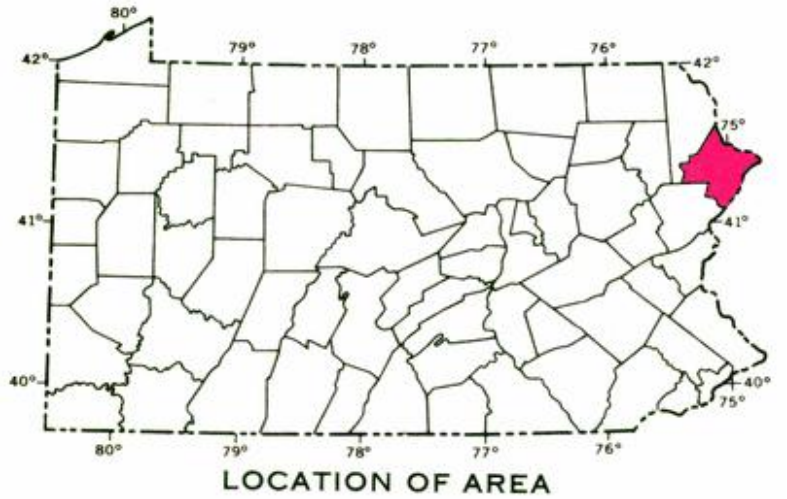
Extracted from: (County Report C52, plate1)

Geology and Mineral Resources of Pike County, Plate 2 - Surficial Geology (County Report C 52)

Sevon, W.D., Berg, Thomas M., Schultz, Lane D., and Crowl, G.H., 1989, Geology and Mineral Resources of Pike County, Pennsylvania (Plate 2, Surficial Geology), Pennsylvania Geological Survey, County Report C 52, 1:50,000 scale. (*GRI Source Map ID 4794*)

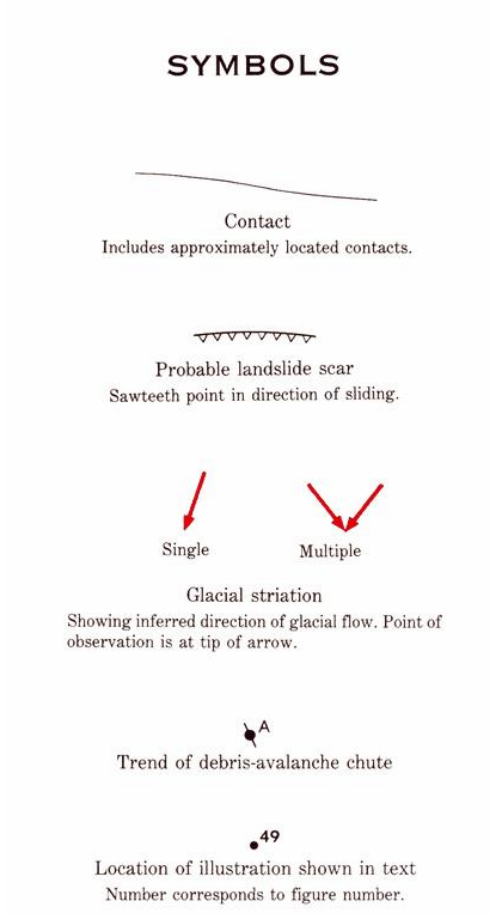
***Note: Only a portion of this map was used for this GIS dataset; some graphics such as correlations and cross sections may contain more data that what depicted in the GIS dataset.*

Location Map



Extracted from: (County Report C52, plate2)

Legend

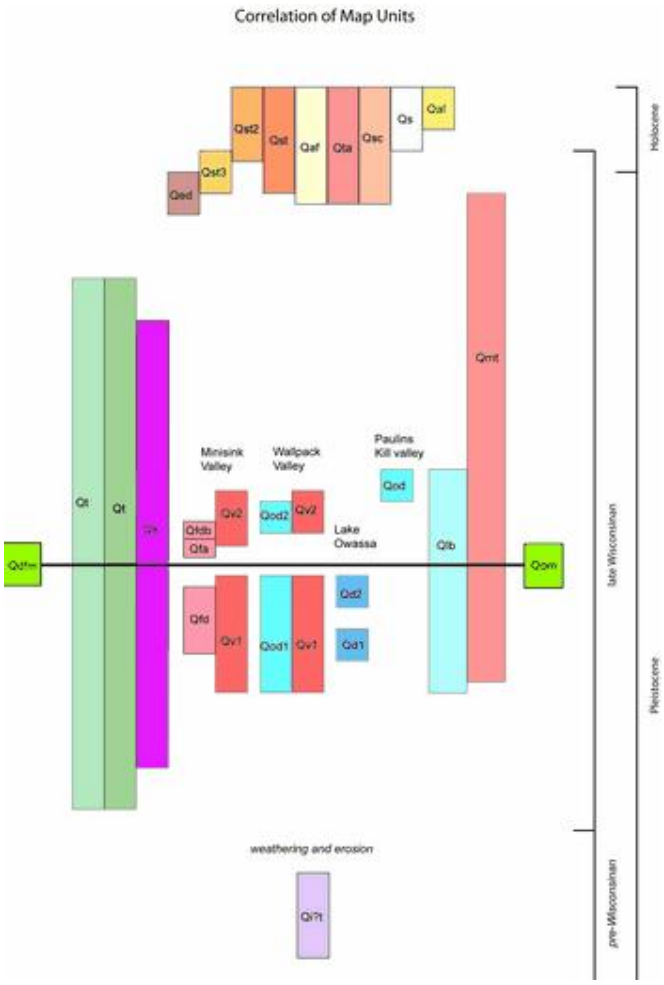


Extracted from: (County Report C52, plate2)

Surficial Geologic Map of the Culvers Gap Quadrangle (GMS 04-1)

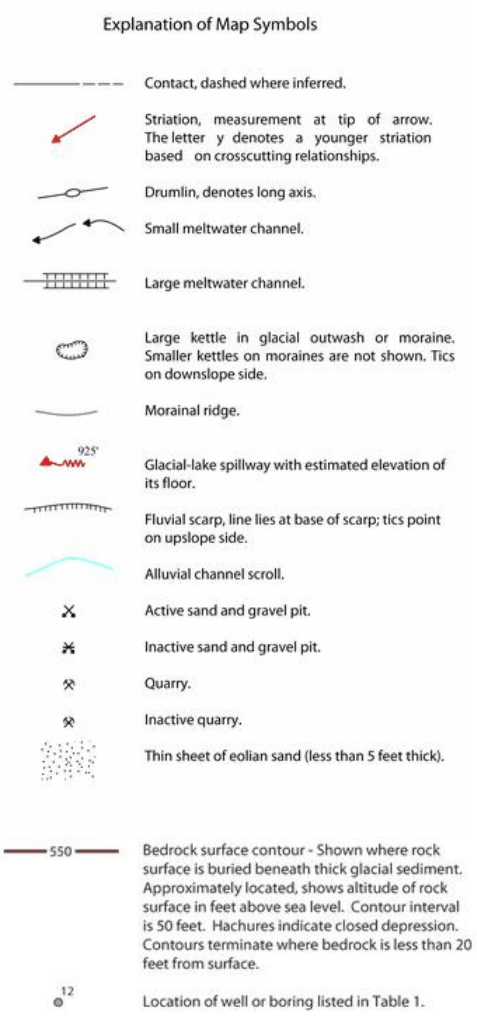
Witte, R.W. and Epstein, J.B., 2005, Surficial Geologic Map of the Culvers Gap Quadrangle, Sussex County, New Jersey, New Jersey Geological Survey, Geologic Map Series GMS 04-1, 1:24,000 scale. (*GRI Source Map ID 73984*)

Correlation of Units



Extracted from: [(GMS 04-1)]

Legend



Extracted from: (GMS 04-1)

Table 1

Table 1. Records of selected wells in the Culvers Gap quadrangle, Sussex County, New Jersey, and Pike County, Pennsylvania. The d wells were drilled for private and public water supply, and exploration. Wells with a NJDEP permit number are from the files of the Bureau of Water Allocation, Division of Water Resources, New Jersey Department of Environmental Protection. Well records from Davis (1989) are noted in the table as "Pike" followed by an identification number that was used in that report. The location of wells listed with NJDEP are based on property maps, and they are generally accurate to 500 feet of their actual location. A few geologic records were compiled from New Jersey Geological Survey Permanent Notes, which are on file at the New Jersey Geological Survey, PO Box 427, Trenton, New Jersey. "?" indicates incomplete geologic log.

well number	NJDEP permit number	Discharge in gallons per minute	Depth in feet below land surface	Driller's log
1	21-915	15	0-241	sand and siltstone
			241-285	bluestone
2	21-90	20	0-80	depth of casing
3	21-155	20	0-60	depth of casing
4	21-611	30	0-179	depth of casing
5	Pike 163	--	0-40	depth of casing
6	21-1016	30	0-180	depth of casing
7	21-2071	30	0-171	depth of casing
8	21-6539	100	0-185	sand, clay, and gravel
			185-205	sand and gravel
9	21-627	8	0-22	depth of casing
			22-80	rock
10	21-1292	20	0-37	depth of casing
			37-141	rock
11	Pike 165	--	0-130	depth of casing
12	Pike 170	--	0-170	depth of casing
13	Pike 167	15	0-95	depth of casing
14	Pike 234	15	0-40	depth of casing
15	Pike 235	50	0-180	depth of casing
16	Pike 419	20	0-80	depth of casing
17	Pike 236	20	0-165	depth of casing
18	21-1203	13	0-131	depth of casing
			131-258	rock
19	21-586	40	0-60	depth of casing
			60-420	rock
20	21-3343	21	0-25	hardpan and boulders
			25-35	sand, gravel, and water
			35-47	broken rock, limestone
			47-124	lime rock
			124-137	sandstone
21	21-6071	6	0-18	gravel
			18-145	limestone
22	21-5176	1	0-60	clay, gravel, and boulders
			60-105	clay
			105-120	clay and gravel
			120-395	shale
			395-415	hard red sandstone
			415-450	blue shale
23	21-65	9	0-45	glacial drift
			45-70	limestone
			70-110	limestone and limey shale
			110-155	limestone
24	21-5283	60	0-30	bouldery overburden
			30-105	limestone
25	21-5152	20	0-58	overburden with big boulders
			58-123	red rock
26	21-5113	20	0-50	overburden with clay, gravel, and boulders
			50-123	red, blue, and yellow shale
27	22-5569	5	0-20	overburden
			20-175	red rock
28	21-5282	35	0-15	overburden
			15-250	red rock
29	21-52	15	0-23	hardpan
			23-131	pink rock
30	21-5653	20	0-30	boulders and gravel
			30-105	red rock
31	21-2486	5	0-45	overburden
			45-106	red shale
32	21-5976	20	0-40	overburden
			40-125	red rock
33	21-4932	25	0-35	clay and gravel
			35-180	slate rock
34	21-6323	20	0-50	sand and gravel
			50-188	limestone
35	21-6510	3	0-8	large gravel
			8- 301	red rock
36	21-503	20	0-25	hardpan and boulders
			25-50	sand, gravel, and water
			50-60	quicksand
			60-94	red rock
37	21-5569	5	0-20	overburden
			20-175	red rock
38	21-4637	10	0-30	large gravel and loam
			30-208	red rock
39	21-249	25	0-16	depth of casing
			16-211	rock
40	21-600	45	0-35	hardpan, boulders, and gravel
			35-100	red sandstone
			100-120	blue rock
			120-125	red sandstone
41	21-1934	12	0-123	clay and sand
			123-132	clay
			132-238	slate
42	21-6330	50	0-10	gravel and sand
			10-270	red rock
43	21-2380	4	0-25	hardpan and boulders
			25-50	hardpan
			50-75	large boulders and hardpan
			75-100	clay, sand, gravel, and water
			100-110	sand and water
			110-225	red shale
			225-233	green shale
44	21-3364	18	0-20	hardpan and boulders
			20-30	boulders, clay, and gravel
			30-40	gravel and water
			40-50	sand, water, and clay
			50-60	blue clay
			60-70	blue shale
			70-80	shale with clay pockets
			80-129	hard gray rock
			129-162	blue shale
			162-175	soft black shale
45	21-6142	8	0-78	overburden
			78-208	shale
46	21-6491	20	0-18	sand and gravel
			18-145	red rock
47	21-5628	--	0-74	sand and gravel
			74-?	red shale
48	21-6154	30	0-75	gravel and sand
			75-125	limestone
49	21-6298	15	0-52	sand, clay, and gravel overburden
			52-150	shale
50	21-4625	30	0-57	sand, clay, and gravel overburden
			57-75	shale
51	21-5975	20	0-40	overburden
			40-125	red rock
52	21-6643	10	0-60	gravel and sand
		(artesian)	60-75	shale and limestone
53	22-18407	2	0-20	gravel, hardpan, and boulders
			20-349	red slate
54	21-4233	4	0-53	sand, clay, and gravel overburden
			53-280	red slate
55	21-6999	9	0-20	sand, clay, and gravel overburden
			20-125	red shale
56	21-5471	3	0-11	clay overburden
			11-300	red slate
57	21-5314	4	0-14	clay overburden
			14-225	red slate
58	21-6262	15	0-40	sand, clay, and gravel overburden
			40-150	red slate
59	21-927	35	0-50	hardpan and boulders
			50-89	red sandstone
60	21-814	20	0-25	red hardpan
			25-75	red sand, gravel, and boulders
			75-96	quicksand
			96-200	red sandstone
61	21-822	20	0-25	hardpan
			25-52	hardpan, gravel, and sand
			52-130	red sandstone
62	21-1314	16	0-25	boulders and hardpan
			25-50	boulders, hardpan, and gravel
			50-63	gravel, sand, and water
			63-120	red shale
63	21-545	25	0-60	depth of casing
			60-144	rock
64	21-3444	20	0-30	gravel and gray clay
			30-50	sand and gravel
			50-85	gray clay and gravel
			85-95	layer of limestone
			95-102	gray clay
			102-110	sand, clay, and gravel
			110-115	gravel and water
65	21-1371	--	0-25	hardpan and boulders
			25-32	gravel and sand
			32-45	blue clay
			45-?	rock
66	21-7170	2	0-15	sand, clay, and gravel overburden
			15-500	slate
67	21-6982	80	0-65	red loam, boulders, and gravel
			65-535	red rock
68	21-478	--	0-10	gravel and sand
			10-20	sand and pea gravel
			20-60	sand
			60-?	rock
69	21-1592	42	0-25	boulders and hardpan
			25-40	boulder
			40-60	large boulders and sand
			60-75	boulders, gravel, and sand
			75-83	red clay
			83-90	gravel with water
70	21-5037	30	0-120	boulders and gravel
			120-205	shale
71	21-7082	11	0-212	sand, clay, and gravel overburden
			212-600	red slate
72	21-4927	25	0-2	overburden
			2-125	clay, heavy gravel, and boulders
			125-135	rotten red rock
			135-173	soft red rock
73	21-5886	20	0-127	sand, gravel, and boulders
			127-175	shale
74	21-760	25	0-25	hardpan and boulders
			25-50	sand, red gravel, and water
			50-82	red quicksand
			82-115	red sandstone
75	21-6686	20	0-52	sand, clay, and gravel overburden
			52-174	red slate
76	21-5429	15	0-121	clay overburden
			121-233	slate
77	21-274	20	0-50	boulders, gravel, and sand
			50-75	hardpan and gravel
			75-100	hardpan and clay
			100-125	gravel and boulders
			125-155	quicksand
			155-175	red sandstone
78	21-2335	6	0-108	sand and gravel (depth of casing)
			108-122	red rock
79	21-4887	32	0-2	overburden
			2-10	heavy gravel and boulders
			10-100	heavy gravel, sand, and some clay
			100-180	clay and gravel
			180-190	soft red rock
			190-295	hard red rock
			295-300	soft red rock
80	21-3201	32	0-42	sand and gravel (depth of casing)
			42-299	quartzite
81	21-2379	25	0-160	gravel and boulders
			160-179	gravel, boulders, and water
82	permanent notes	--	0-82	glacial drift
83	21-4711	30	0-160	sand, gravel, clay, and hardpan on red shale
84	21-4328	15	0-180	clay, gravel, and hardpan
			180-200	red slate
85	21-3798	15	0-70	sand and gravel (depth of casing)
			70-185	red slate
86	21-4570	10	0-25	clay and gravel overburden
			25-80	soft red slate
			80-125	red slate
87	21-4931	10	0-55	clay and gravel overburden
			55-130	red slate
88	21-5368	20	0-14	overburden
			14-58	boulders and rock
			58-126	granite (quartzite)
89	permanent notes		0-163	sand, gravel, and hardpan on red shale
90	21-4537	20	0-20	muck and boulders
			20-45	gravel, sand, and small boulders
			45-50	clay and gravel
			50-222	red shale
91	21-4588	3	0-8	overburden with boulders
			8-23	clay and gravel
			23-43	sand and gravel
			43-51	clay, and gravel
			51-298	granite (quartzite)
92	21-5315	4	0-51	clay and gravel
			51-?	red slate
93	21-4345	7	0-65	gravel and hardpan
			65-174	red slate
94	21-5680	3	0-27	clay and gravel
			27-275	red slate
95	21-3554	2	0-32	sand and gravel (depth of casing)
			32-272	red slate
96	21-4763	50	0-100	sand, gravel, and hardpan
			100-199	slate
97	21-5049	3	0-54	clay and gravel
			54-250	slate
98	21-5141	2	0-46	clay, gravel, and boulders
			46-273	blue shale
99	21-5038	20	0-25	gravel and sand
			25-?	shale
100	21-5039	8	0-43	sand and gravel
			43-198	shale
101	21-799	25	0-50	hardpan and boulders
			50-75	boulders
			75-100	blue clay and boulders
			100-140	blue clay, boulders, and gravel
			140-163	gravel, sand, and water
			163-220	blue shale
102	21-4618	25	0-85	sand and gravel
			85-175	slate
103	21-4807	30	0-180	sand, gravel, and hardpan
			180-300	slate
104	21-431	15	0-140	yellowish-gray silt and minor clay
			140-180	medium-gray clay, angular shale fragments
105	21-5454	30	0-61	clay and gravel
			61-250	slate
106	21-2964	38	0-25	hardpan and boulders
			25-50	hardpan, boulders, and gravel
			50-75	gravel, clay, and water
			75-100	clay and water
			100-111	blue clay and broken rock
			111-175	blue shale
			175-253	hard gray rock
			253-275	brown sandstone
107	21-6861	3	0-25	hardpan and boulders
			25-50	gravel, sand, and water
			50-100	black shale
			100-112	hard gray rock
			112-135	soft brown sandstone
108	22-19221	6	0-32	sand and boulders
			32-152	shale
109	22-18217	10	0-105	sand and gravel
			105-199	slate
110	22-22617	10	0-118	clay and gravel
111	22-21462	1	0-25	clay
		(artesian)	25-75	hardpan and gravel
			75-125	hardpan, boulders, and gravel
			125-144	brown silt
			144-477	shale
112	22-8491	1	0-166	boulders and gravel
			166-446	gray shale
113	22-21248	5	0-42	clay and boulders
			42-120	shale
114	22-20195	45	0-2	overburden
			2-30	clay and gravel
			30-35	boulder
			35-70	clay and gravel
			70-76	brown shale
			76-231	blue shale
115	21-5032	11	0-118	clay and gravel
			118-225	slate
116	21-1027	32	0-50	hardpan and boulders
			50-75	gravel, sand, and cobbles
			75-100	boulder
			100-125	large boulders and clay
			125-150	gravel, sand , and clay
			150-175	gravel, sand, and water
			175-200	sand and water
			200-225	sand and clay
			225-300	quicksand
			300-325	quicksand, red clay, and blue shale
			325-412	blue shale
117	22-18925	10	0-180	clay, gravel, boulders, and sand
			180-273	shale
118	22-18652	20	0-26	hardpan and boulders
			26-116	sand, gravel, and clay
			116-210	quicksand
			210-238	gravel
			238-262	sand
			262-294	clay
			294-333	gravel (tight)
119	21-5122	--	0-2	overburden
			2-30	clay and gravel
			30-35	boulder
			35-115	clay and gravel
			115-118	boulder
			118-220	clay and gravel
			220-235	red sand
			235-242	red gravel
120	21-4912	10	0-2	overburden
			2-20	sand, clay, and gravel
			20-23	boulder
			23-50	sand, clay, and gravel
			50-52	boulder
			52-60	sand, clay, and gravel
			60-63	boulder
			63-100	sand, clay, and gravel
			100-120	sand and water
			120-138	sand and clay
			138-150	sand and gravel
121	22-8909	2	0-25	hardpan and boulders
			25-50	hardpan, gravel, and water
			50-61	blue clay
			61-148	blue shale
			148-193	hard gray rock
			193-267	blue shale
			267-299	hard gray rock
			299-328	blue shale
122	22-21777	3	0-46	clay and gravel
			46-225	slate
123	22-20886	8	0-40	clay and hardpan
			40-75	clay and sand
			75-150	clay and gravel
			150-235	slate
124	22-6026	6	0-50	hardpan and boulders
			50-75	hardpan
			75-125	hardpan and boulders
			125-140	blue clay
			140-150	blue clay, sand, and water
			150-155	blue clay
			155-200	blue shale
			200-237	hard gray rock
			237-248	brown sandstone
			248-279	blue shale
			279-300	brown sandstone
125	22-22350	3	0-140	clay and gravel
			140-650	slate
126	22-18051	15	0-100	clay and gravel
			100-160	gravel
			160-197	red clay and gravel
127	22-18451	1	0-20	gravel
			20-50	sand
			50-155	clay and gravel
			155-180	red clay
			180-400	gray slate
128	22-22578	2	0-60	clay and gravel
			60-450	slate
129	21-2102	10	0-25	hardpan and boulders
			25-50	boulders, gravel, and sand
			50-75	gravel, sand, and water
			75-103	blue shale
130	21-5207	30	0-30	clay and hardpan
			30-45	gravel and clay
			45-100	slate
131	22-17861	5	0-14	clay and gravel
			14-224	slate
132	21-3263	10	0-20	overburden
			20-25	boulder
			25-95	clay and gravel
			95-115	sand and gravel
			115-150	clay and gravel
			150-175	sand and gravel
			175-182	gravel
			182-183	boulder
			183-206	sand and gravel
			206-225	blue shale
133	21-2973	25	0-160	gravel and boulders
			160-179	gravel, boulders, and water
134	21-1434	45	0-25	hardpan and boulders
			25-50	boulders, gravel, and water
			50-75	blue clay and gravel
			75-100	blue clay
			100-125	blue clay, sand, and water
			125-130	blue clay and shale
			130-176	shale
135	21-1260	22	0-50	hardpan and boulders
			50-75	hardpan, gravel, sand, and water
			75-100	gravel, sand, and water
			100-115	blue clay
			115-120	broken shale
			120-195	shale
136	21-5011	5	0-2	overburden
			2-15	sand, gravel, and boulders
			15-52	sand, gravel, clay and boulders
			52-53	boulder
			53-80	clay, sand, and gravel
			80-81	boulder
			81-88	clay, sand, and gravel
			88-190	clay, sand, and big gravel
			190-208	clay and sand
			208-280	clay, sand, and gravel
			280-423	blue shale
137	21-2133	3	0-25	sand
			25-75	sand, gravel, and clay
			75-100	sand and gravel
			100-140	clay seams
			140-275	shale
138	21-4673	10	0-25	sand and gravel
			25-248	blue shale
139	21-1966	3	0-45	clay and hardpan
			45-80	clay
			80-146	shale
140	21-1131	12	0-25	hardpan, gravel, and boulders
			25-50	hardpan and sandy loam
			50-75	blue clay and gravel
			75-100	blue clay, gravel, and water
			100-125	gravel
			125-220	blue shale
141	21-925	10	0-20	clay and hardpan
			20-45	hardpan
			45-65	clay and sand
			65-81	clay
			81-148	slate
142	21-599	10	0-100	hardpan and gravel
			100-150	hardpan and red clay
			150-200	red clay and sand
			200-215	very fine sand and water
			215-230	blue shale
143	21-1821	9	0-50	clay and gravel
			50-90	clay and hardpan
			90-116	clay
			116-160	slate
144	21-5521	--	0-61	overburden
			61-400	shale
145	21-5220	2	0-100	overburden
			100-175	black shale
			175-350	blue shale
146	21-5466	50	0-20	gravel and boulders
			20-125	shale

Extracted from: (GMS 04-1)

Figure 1

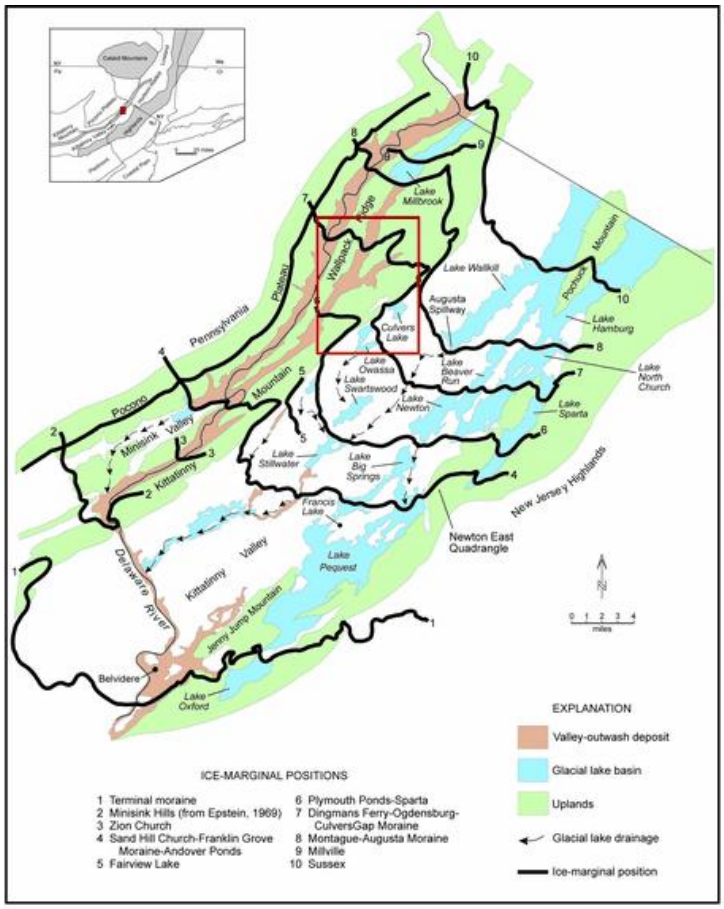


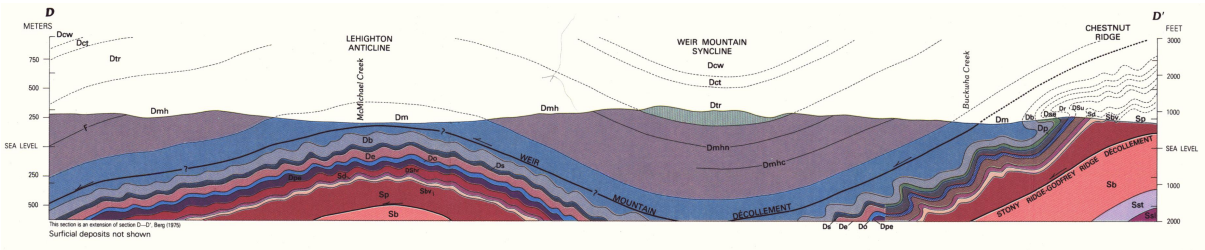
Figure 1. Physiography of Kittatinny Valley and surrounding area. Location of late Wisconsinan ice-margin positions of the Kittatinny and Minisink Valley ice lobes, large glacial lakes, extensive valley-outwash deposits, and Culvers Gap topographic quadrangle. Modified from Crowl (1971), Epstein (1969), Minard (1961), Ridge (1983), and Witte (1997a).

Extracted from: (GMS 04-1)

Geologic Cross Sections

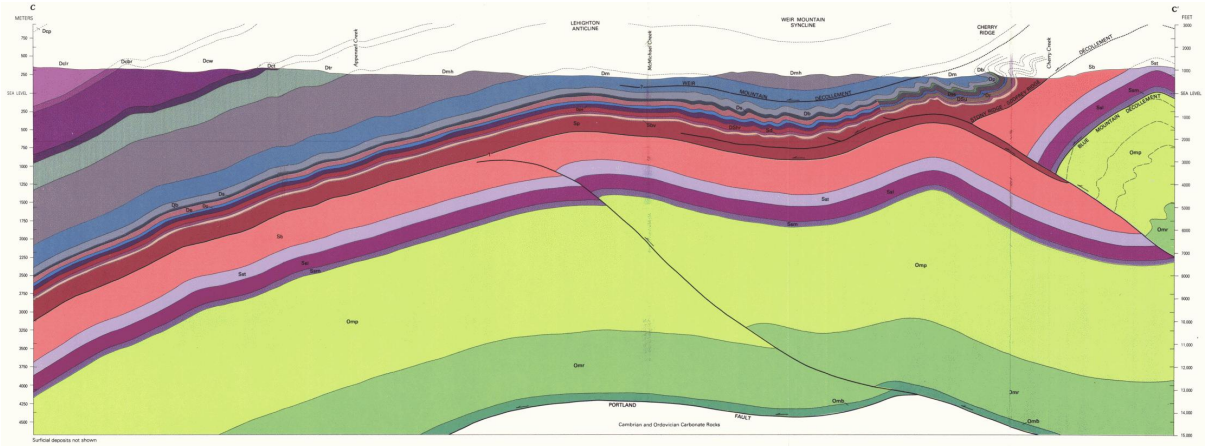
The geologic cross sections present in the GRI digital geologic-GIS data produced for Delaware Water Gap, NJ, PA (DEWA) are presented below. Note that some cross section abbreviations (e.g., A - A') may have been changed from their source map abbreviation in the GRI data so that each GRI cross section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

A-A'



Displayed as A-A' in digital geologic data. *Extracted from:* (GQ-1638)

B-B'



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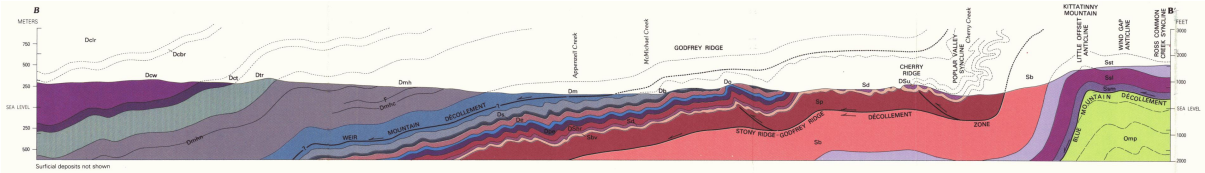
C-C'



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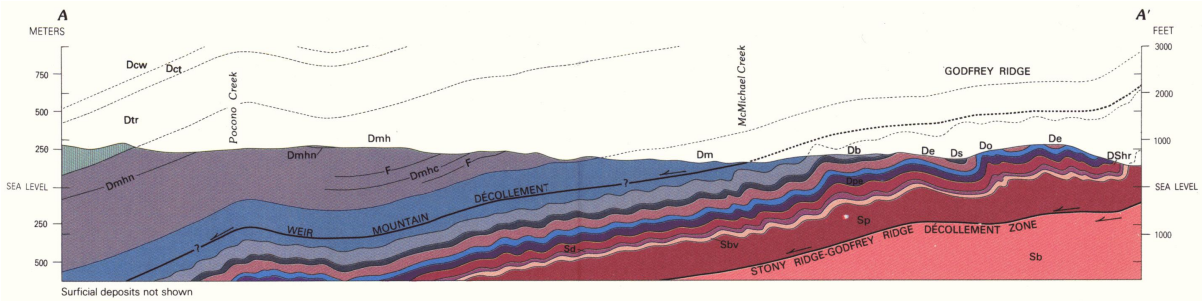
D-D'



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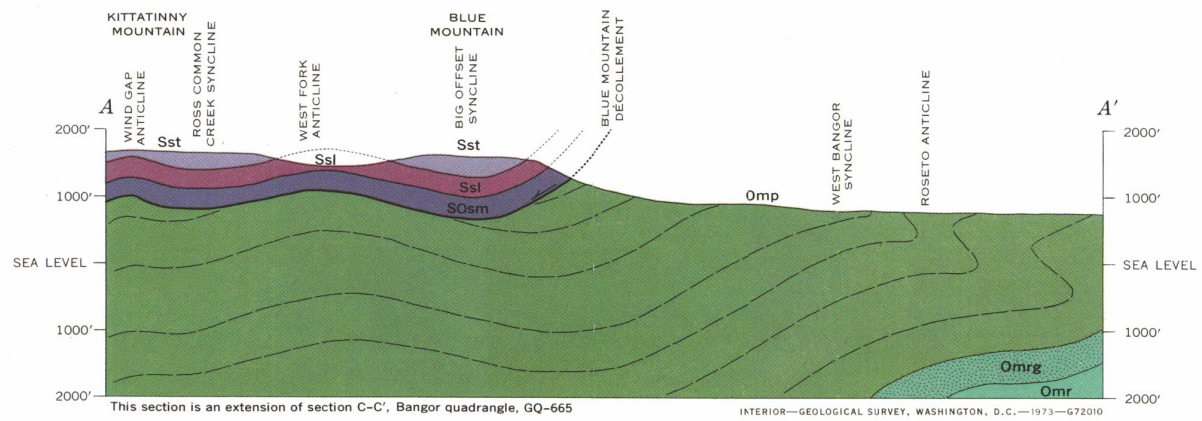
E-E'



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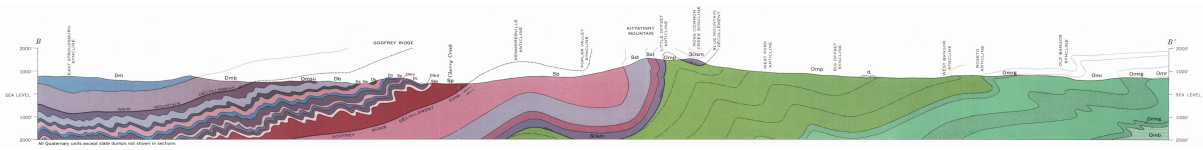
F-F'



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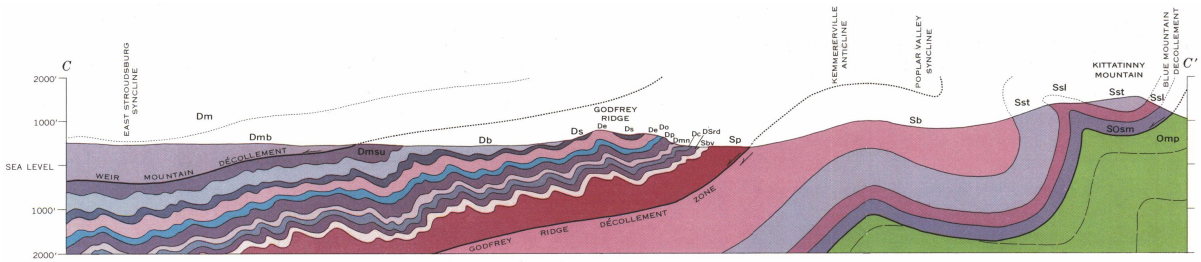
G-G'



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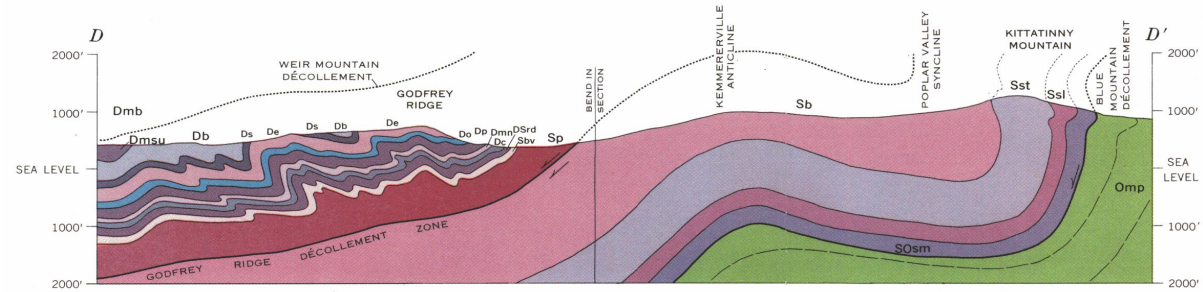
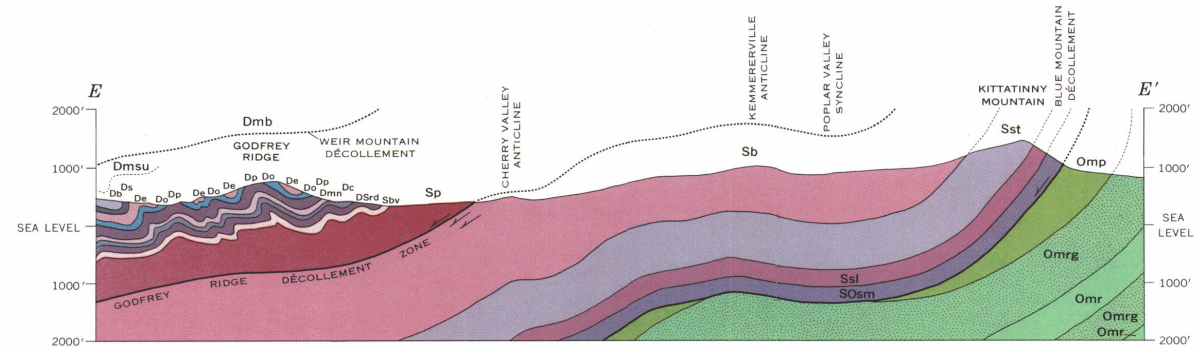
H-H'



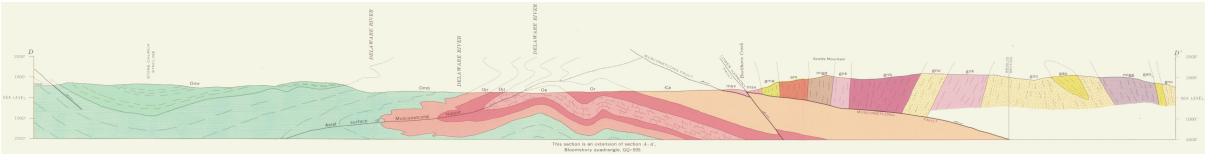
Displayed as H-H' in digital geologic data. *Extracted from:* (GQ-1047)

I-I'



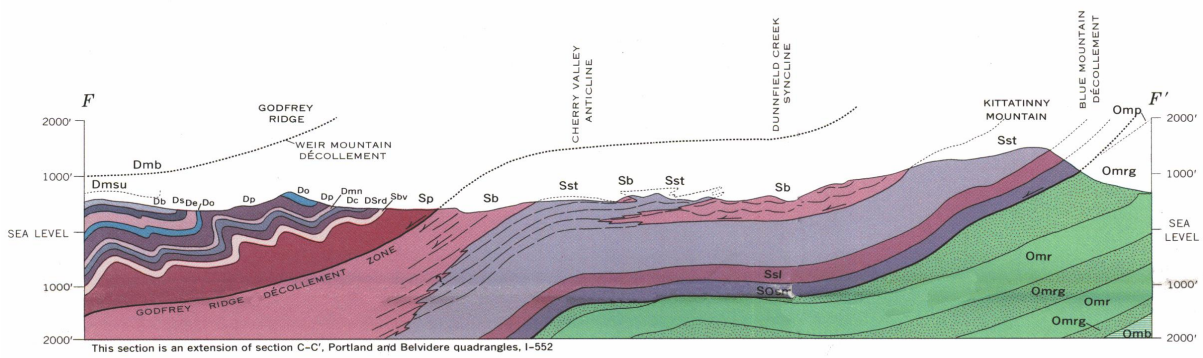
Displayed as I-I' in digital geologic data. *Extracted from:* (GQ-1047)

J-J'



Displayed as J-J' in digital geologic data. *Extracted from:* (I-552)

K-K'



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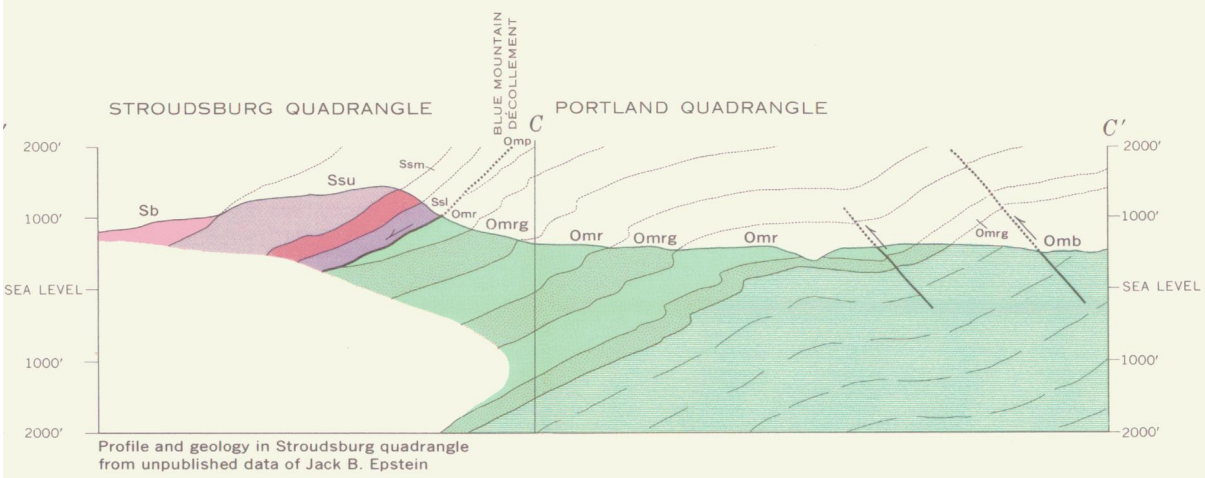
L-L'



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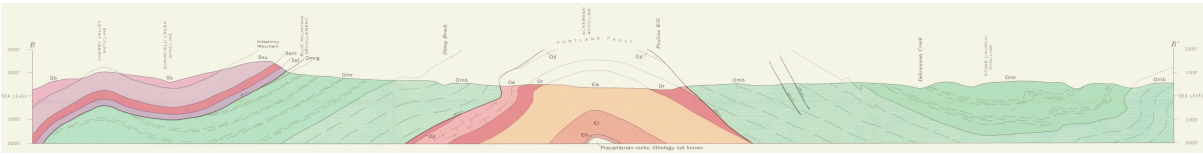
M-M'

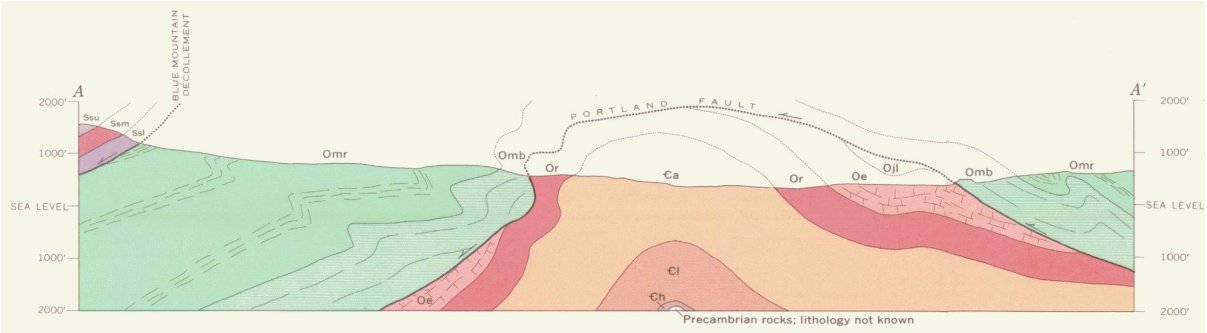


Displayed as M-M' in digital geologic data. *Extracted from:* (I-552)

N-N'

Displayed as N-N' in digital geologic data. *Extracted from:* (I-1530)

O-O'



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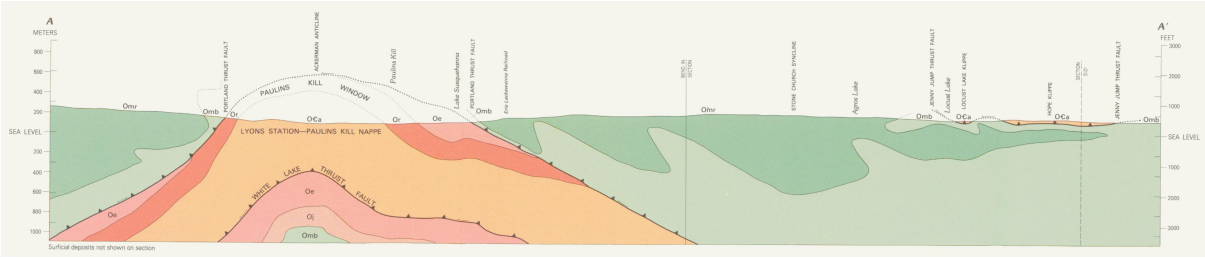
P-P'



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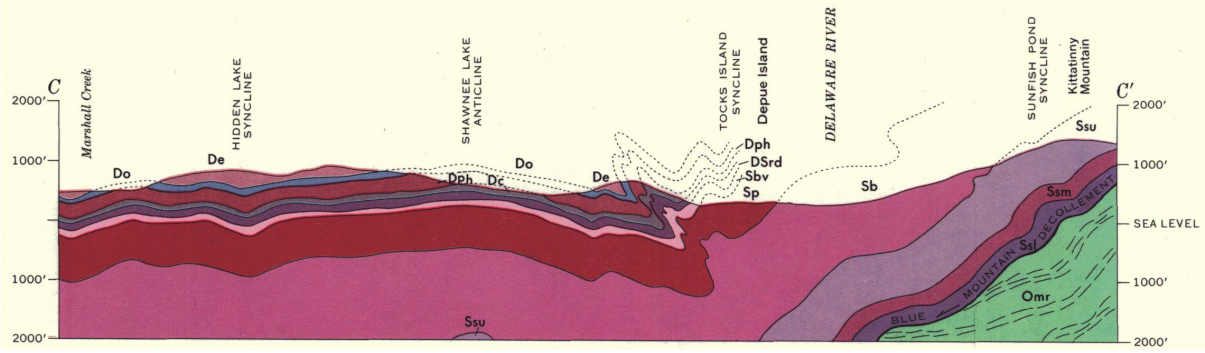
Q-Q'



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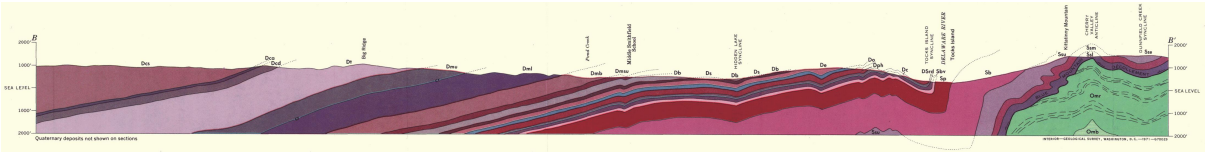
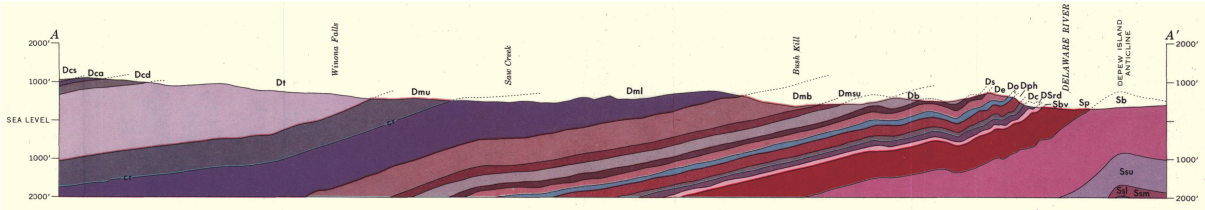
R-R'



Displayed as R-R' in digital geologic data. *Extracted from:* (GQ-908)

S-S'



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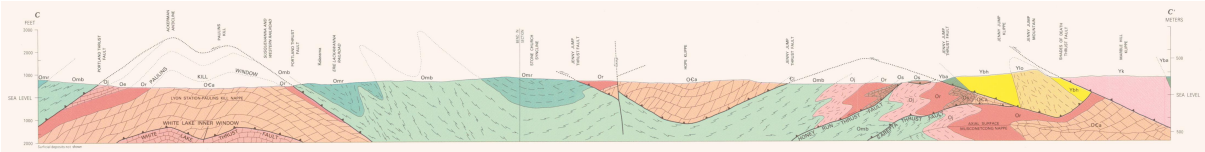
T-T'



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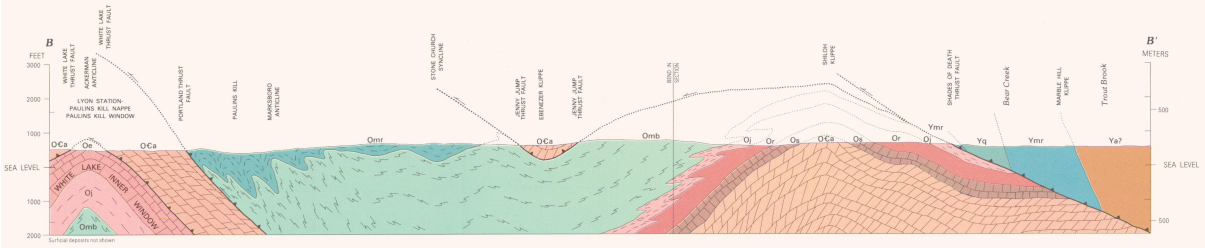
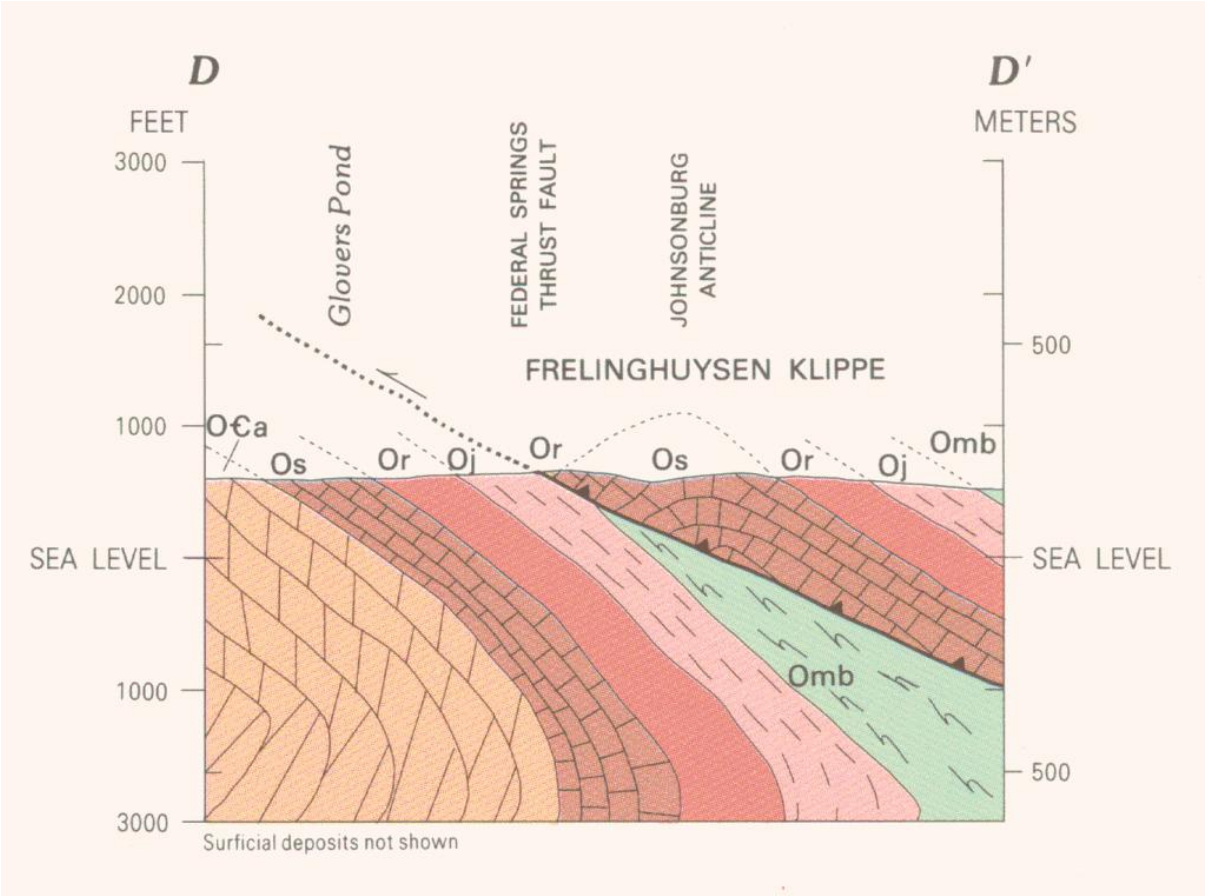
U-U'



Displayed as U-U' in digital geologic data. *Extracted from:* (GQ-1585)

V-V'



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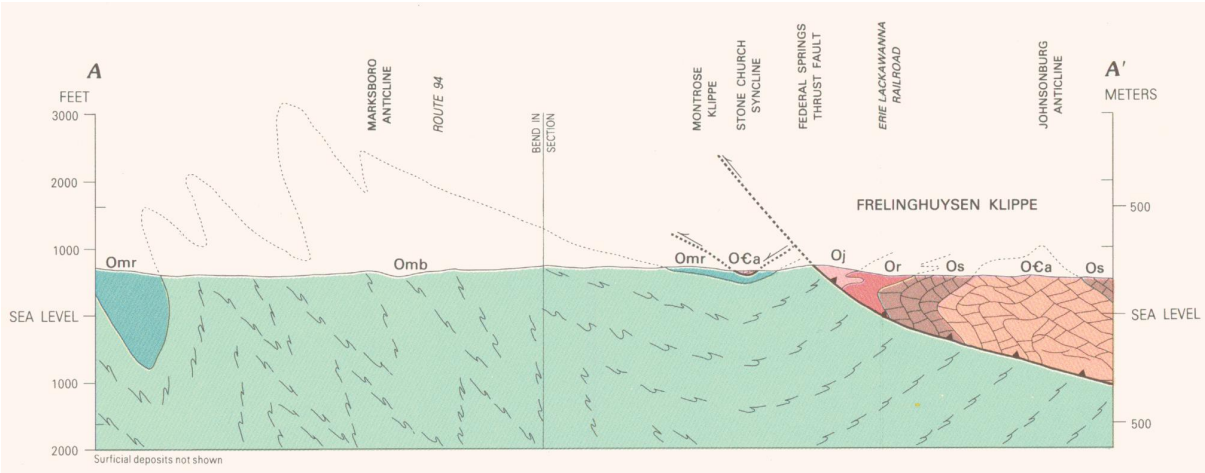
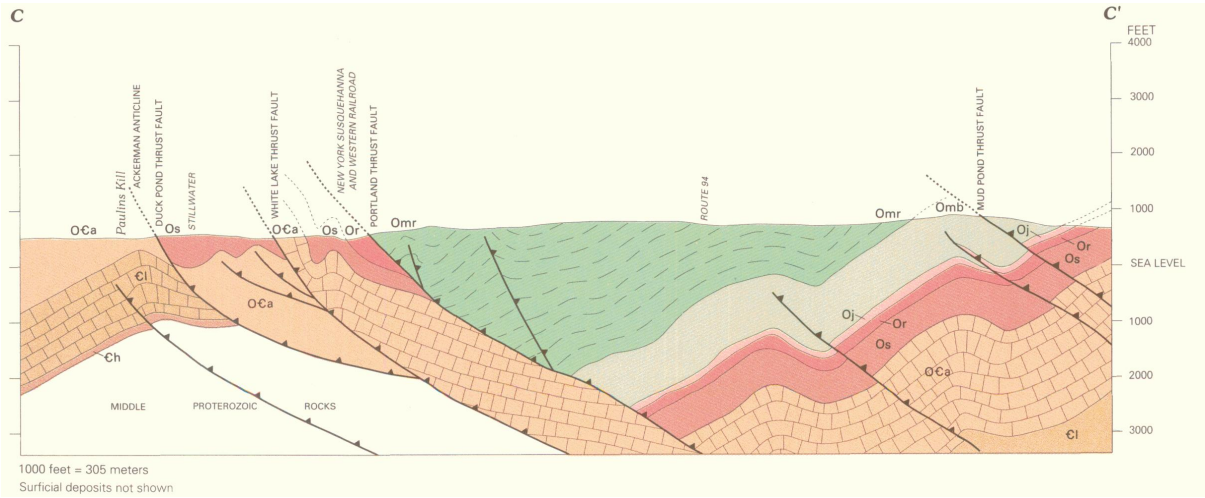
W-W'



Displayed as W-W' in digital geologic data. *Extracted from:* (GQ-1585)

X-X'



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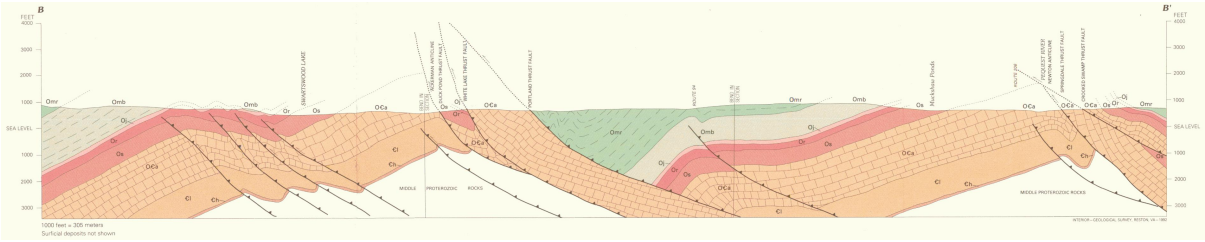
Y-Y'



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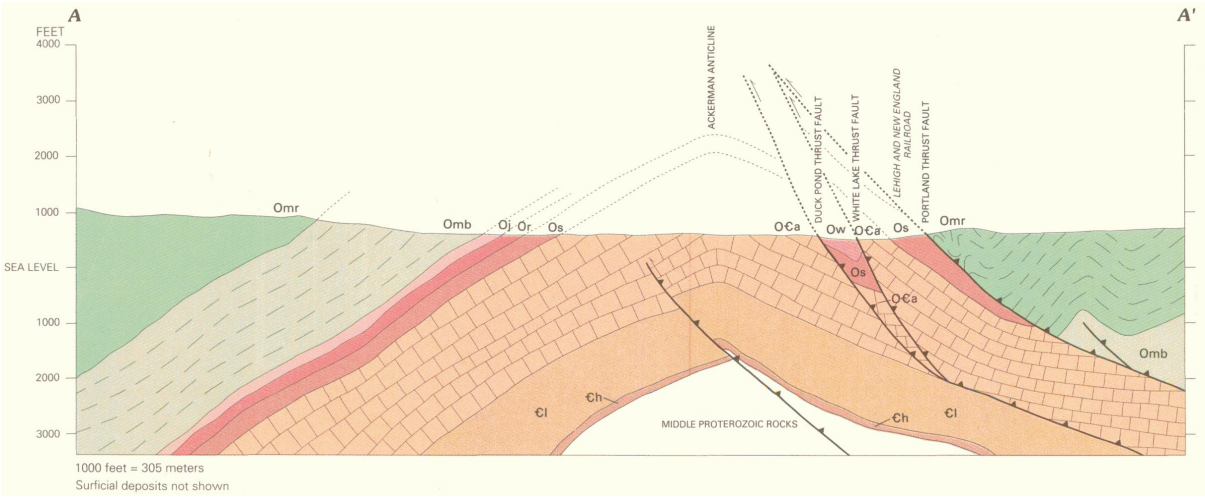
Z-Z'



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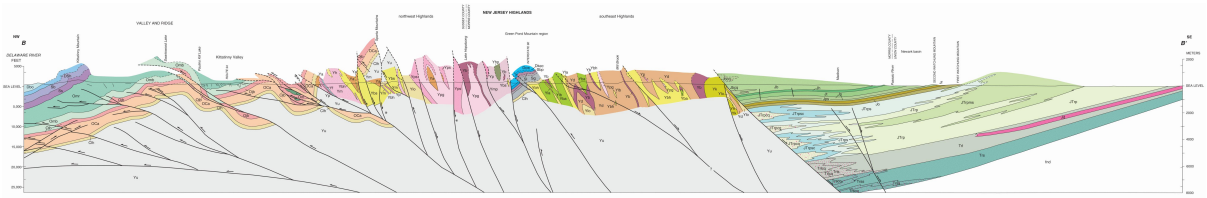
AA-AA'



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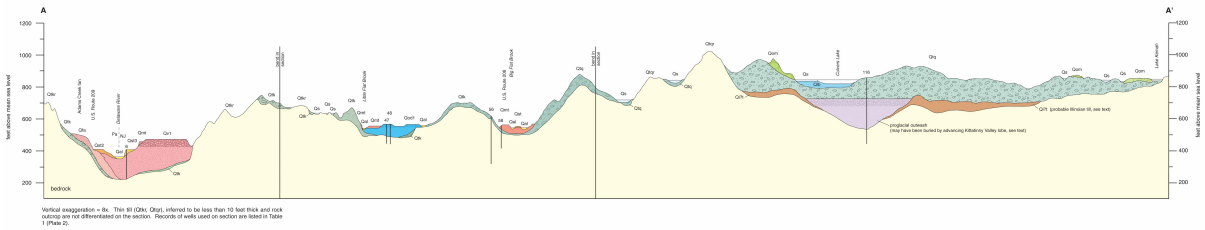
BB-BB'



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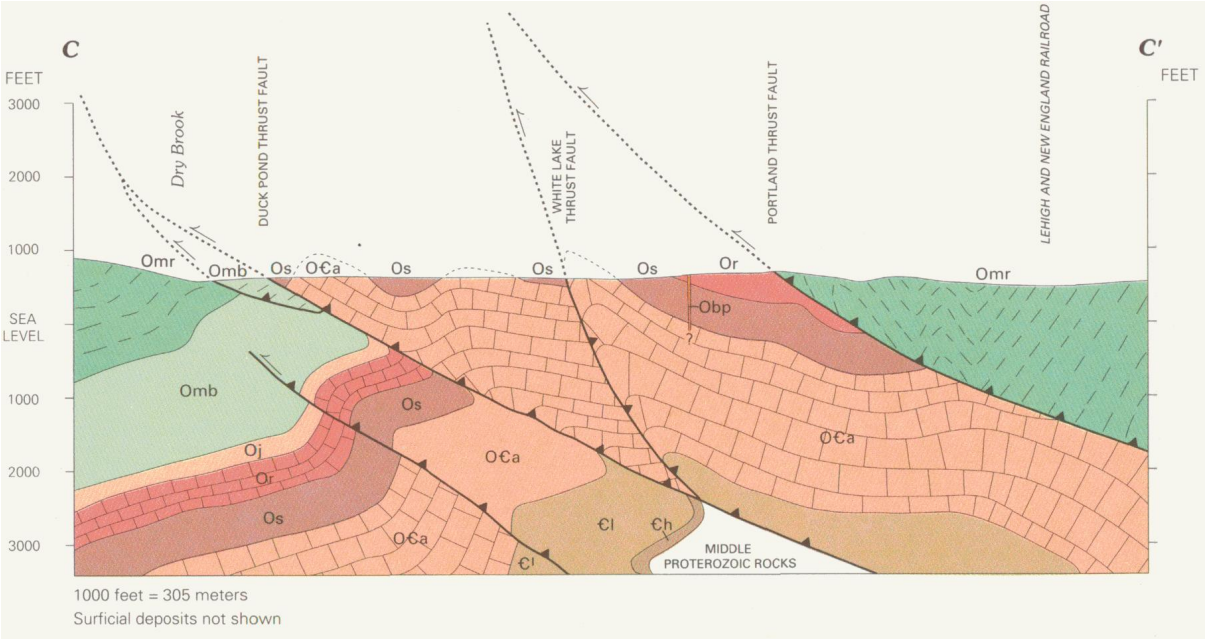
CC-CC'



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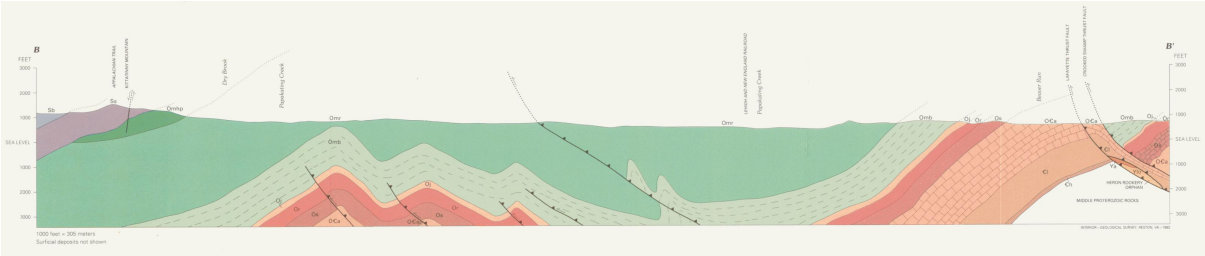
DD-DD'



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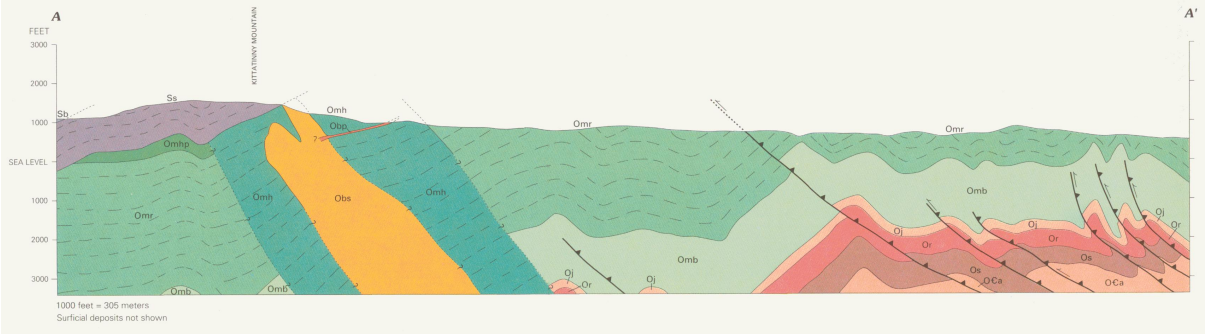
EE-EE'



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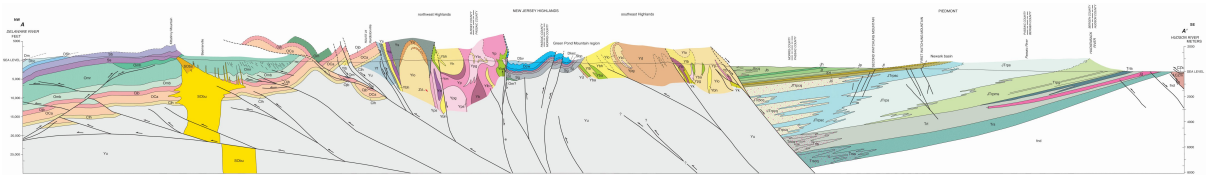
FF-FF'



Displayed as FF-FF' in digital geologic data. *Extracted from:* (DGS 04-6)

GRI Digital Data Credits

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

The information contained here was compiled to accompany the digital geologic-GIS map(s) and other digital data for Delaware Water Gap, NJ, PA (DEWA) developed by Derek Witt and James Chappell (Colorado State University) using source data (see the GRI Source Map Citations section of this document for all sources used by the GRI in the completion of this map).

GRI finalization by James Chappell (Colorado State University).

GRI program coordination and scoping provided by Bruce Heise and Tim Connors (NPS GRD, Lakewood, Colorado).