DEPARTMENT OF ENVIRONMENTAL PROTECTION
WATER RESOURCE MANAGEMENT
NEW JERSEY GEOLOGICAL SURVEY

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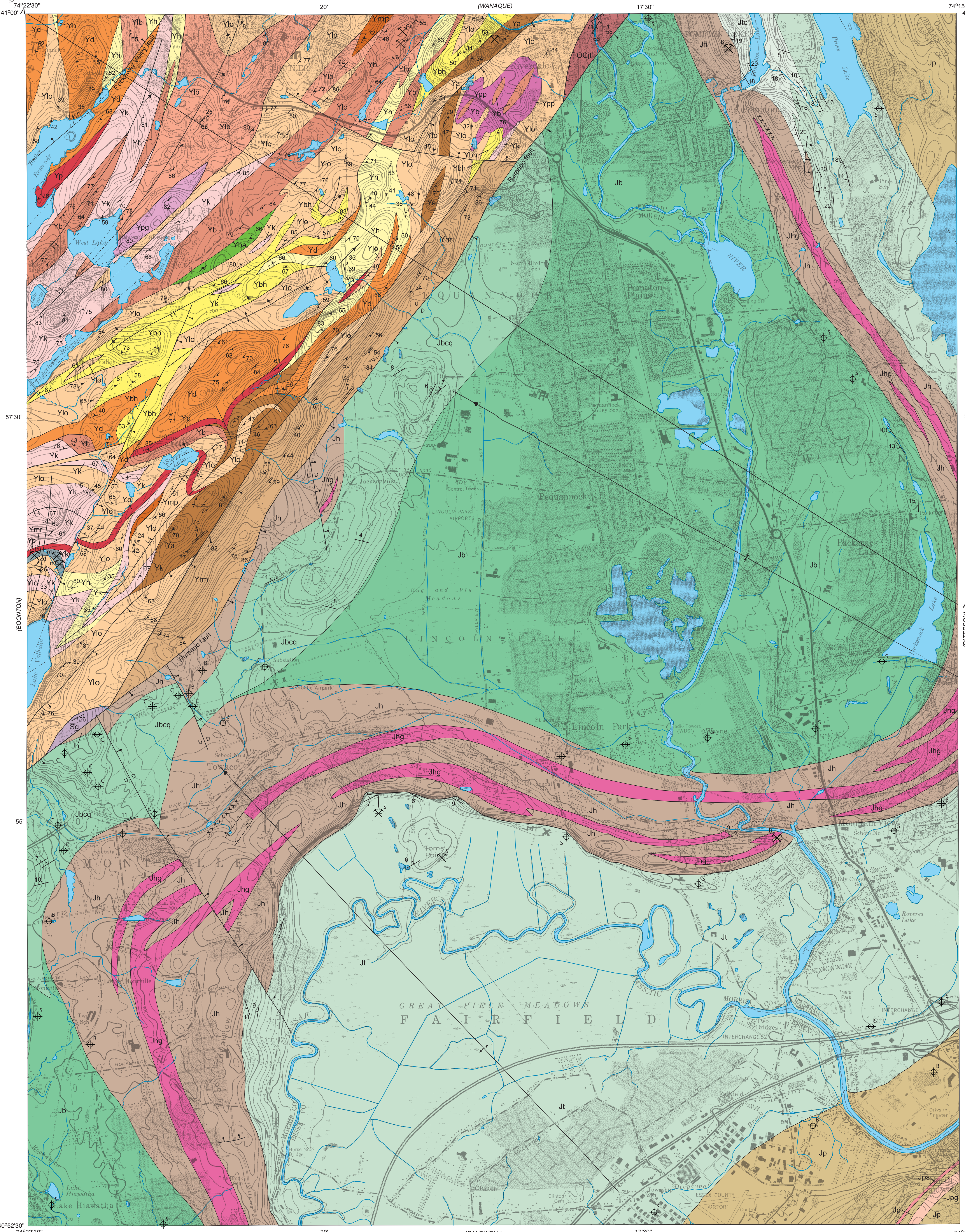
BEDROCK GEOLOGIC MAP OF THE POMPTON PLAINS QUADRANGLE PASSAIC, MORRIS, BERGEN, AND ESSEX COUNTIES, NEW JERSEY
GEOLOGIC MAP SERIES GMS 10-1



Base map U.S. Geological Survey, 1981

SCALE 1:24 000

Bedrock geology mapped by R.A. Volkert in 1999, 2000
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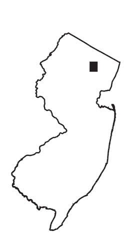


LOCATION IN NEW JERSEY

BEDROCK GEOLOGIC MAP OF THE POMPTON PLAINS QUADRANGLE
PASSAIC, MORRIS, BERGEN, AND ESSEX COUNTIES, NEW JERSEY

by
Richard A. Volkert

2010

INTRODUCTION

The Pompton Plains 7.5-minute quadrangle is located in Passaic, Morris, Bergen and Essex Counties within a mixed commercial, industrial and residential setting. The quadrangle is in the central part of the Passaic River drainage basin, and the Pompton and Passaic Rivers form the dominant drainages in the map area. The Pompton River drains the eastern part of the quadrangle from north to south, and the Passaic River drains its southern part from west to east. The southern and central parts of the map are underlain by large tracts of natural wetland areas, of which the largest is Great Piece Meadows that lies in Fairfield Township north of Interstate 80. The Bog and Vly Meadows underlie Lincoln Park. These poorly drained areas are underlain by unconsolidated sediments of Pleistocene age that are remnants of Glacial Lake Passaic.

The quadrangle straddles the Highlands and Piedmont Physiographic Provinces but is predominantly in the latter. The Ramapo fault traverses the quadrangle northeastward from Montville to Riverdale and provides a structural and physiographic boundary between the two provinces. Mesoproterozoic rocks of the Highlands underlie the northwestern part of the area, whereas Mesozoic rocks of the Piedmont underlie the remainder.

STRATIGRAPHY

The youngest bedrock in the quadrangle is Mesozoic in age and constitutes part of the Newark basin, a northeast-trending half-graben in northern and central New Jersey that contains approximately 24,600 ft. of interbedded Upper Triassic to Lower Jurassic sedimentary and igneous rocks. These consist of conglomerate, sandstone, siltstone, and shale of fluvial and lacustrine origin, and three interbedded tholeiitic basalt flows. However, only the upper part of this stratigraphic succession occurs in the quadrangle.

The general stratigraphic order of the Mesozoic units is one of progressively younger beds from east to west, although the stratigraphy is locally complicated by faults and broad regional folds. Sedimentary units from oldest to youngest are the Towaco and Boonton Formations of Lower Jurassic age. These form a muted topographic surface that is now largely covered by glacial sediments. Conglomeratic facies of the Boonton Formation crops out from the vicinity of Riverdale southwest to Montville. Conglomeratic facies of the Towaco Formation crops out west of Pines Lake. Mesozoic igneous units from oldest to youngest include Preakness Basalt and Hook Mountain Basalt of Lower Jurassic age. Both contain coarse-grained layers and local basaltic pegmatite at several stratigraphic intervals that are mapped as gabbroid. Gabbroid and pegmatite layers within the Preakness Basalt are interpreted by Puffer and Volkert (2001) to have formed through fractionation from finer-grained basalt. Gabbroid layers within the Hook Mountain Basalt likely formed through a similar process. The Hook Mountain and Preakness Basalts form the dominant topography within the Piedmont in the quadrangle.

Sedimentary rocks of probable Ordovician to Cambrian age that are tentatively correlated with rocks of the Jutland Klippe Sequence (Drake et al., 1996) are locally preserved along the Pequannock River at Riverdale. These highly deformed dark gray phyllonitic shale and thin, discontinuous siltstone beds occur as tectonic lenses on the footwall of the Ramapo fault. They are inferred to project into the Wanaque quadrangle to the immediate north, and a few miles to the northeast, in the Ramsey quadrangle, similar highly deformed phyllonitic shale is preserved on the footwall of the Ramapo fault along the west side of the Ramapo River north of Crystal Lake (Volkert, 2003).

Brittly deformed quartzite crops out along a small prominent ridge east of Lake Valhalla, where it is in fault contact with mylonitic Mesoproterozoic rocks in the west and with Hook Mountain Basalt in the east. The quartzite is lithologically similar to the Silurian Green Pond Conglomerate in the Green Pond Mountain Region to the west and is tentatively correlated with that unit.

Mesoproterozoic rocks in the quadrangle are intruded by thin diabase dikes of Neoproterozoic age (Volkert and Puffer, 1995) that strike toward the northeast. These dikes have sharp contacts and chilled margins against enclosing Mesoproterozoic country rocks. Diabase dikes in the New Jersey Highlands are interpreted to have an age of about 600 Ma and were emplaced during breakup of the supercontinent Rodinia (Volkert and Puffer, 1995).

The oldest rocks in the quadrangle are Mesoproterozoic in age and are part of the New Jersey Highlands. They include various granites, gneisses and marble metamorphosed under conditions of granulite facies at 1090 to 1030 Ma (Volkert, 2004). The oldest and volumetrically most abundant of these are calc-alkaline, plagioclase-rich gneisses mapped as quartz-oligoclase gneiss, biotite-quartz-oligoclase gneiss, or hypersthene-quartz-plagioclase gneiss, and plutonic rock mapped as diorite, all of which constitute the Losee Metamorphic Suite (Drake, 1984; Volkert and Drake, 1999). Rocks of the Losee Suite are spatially associated with a layered sequence of metasedimentary rocks that include potassic feldspar gneiss, biotite-quartz-feldspar gneiss, clinopyroxene-quartz-feldspar gneiss, pyroxene gneiss, and marble. These Mesoproterozoic rocks are intruded by hornblende-bearing granite and related rocks of the Byram Intrusive Suite (Drake et al., 1991) and clinopyroxene-bearing granite and related rocks of the Lake Hopatcong Intrusive Suite (Drake and Volkert, 1991), both of which constitute the Vernon Supersuite (Volkert and Drake, 1998).

The youngest Mesoproterozoic rocks in the quadrangle are unfoliated granite pegmatites and coarse-grained granite referred to informally as Pompton Pink Granite (Lewis, 1908). The latter cuts across other Mesoproterozoic rocks in the Riverdale area and contains xenoliths of foliated gneiss country rock.

STRUCTURE

Mesozoic bedding

Bedding in the Mesozoic rocks is somewhat variable in orientation and is influenced by the location of the outcrops in relation to folds that extend through the central part of the map area. In general, beds in the southwestern and northeastern parts of the quadrangle strike about N.30°W., and in the central part of the quadrangle N.60°E. (Fig. 1). Beds on either limb of these folds dip gently from 3° to 11°. However, dips on the east limb of the syncline near Pines Lake are steeper and range from 8° to 22°.

Proterozoic foliation

Crystallization foliation (the parallel alignment of mineral grains) in the Mesoproterozoic rocks is an inherited feature resulting from compressional stresses during high-grade metamorphism in the Grenville Orogeny at 1090 to 1030 Ma. Foliation in the Mesoproterozoic rocks is somewhat variable in strike due to deformation by regional folds and also to drag along faults. In general, foliation strikes about N.40°E. (Fig. 2) and dips toward the southeast and less often toward the northwest, at 26° to 90°.

Folds

The Mesozoic rocks are deformed into a broad, upright syncline and anticline pair that plunges toward the northwest and dominates the structural geology of the Piedmont part of the map area. The Boonton Formation cores the syncline and Towaco Formation cores the anticline, with thickening of both units due to folding. The Mesoproterozoic rocks have been deformed by at least two phases of folding. The earlier folds have north-striking axial surfaces and are predominantly northeast-plunging upright to overturned antiforms and synforms. These folds have been refolded by northeast-plunging, upright to northwest-overturned antiforms and synforms that have east-northeast-striking axial surfaces.

Faults

The Ramapo fault is the dominant structural feature in the region, extending northeastward from the Peapack-Gladstone area (Houghton and Volkert, 1990; Drake et al., 1996) into New York State. The Ramapo fault has a complex and protracted history of movement that began in the Proterozoic. Multiple episodes of subsequent reactivation have left overprinting brittle and ductile fabrics that record kinematic indicators consistent with normal, reverse, and strike-slip movement. In the Pompton Plains quadrangle the Ramapo fault trends N.40°E. to N.45°E. The fault dips about 50° to 55° toward the southeast as indicated by borings drilled to the southwest at Bernardsville (Ratcliffe et al., 1990) and by a series of borings drilled for Route 287 between Montville and Riverdale (Woodward-Clyde Consultants, 1983). However, outcrops of ductilely deformed Mesoproterozoic rocks on the footwall proximal to, and west of, the fault consistently record mylonitic foliation of probable Paleozoic age that dips steeply toward the southeast at 60° to 85°.

Several northwest-striking, steeply northeast-dipping brittle faults of Mesozoic age that may be splays of the Ramapo fault cut the Boonton and Towaco Formations and Hook Mountain Basalt in the central and southwestern part of the map area. These faults are characterized by breccia and eroded gaps in basalt outcrops, and by close-spaced fracture cleavage in outcrops of sedimentary rock.

Mesoproterozoic rocks throughout the map area are deformed by a series of northeast-trending and, less commonly, by east-northeast-trending or northwest-trending faults. The fault just west of, and subparallel to, the Ramapo fault is characterized by a pervasive, steeply southeast-dipping mylonitic fabric. The rest of the faults cutting Mesoproterozoic rocks are characterized by brittle fabric that includes retrogression of mafic mineral phases, chlorite or epidote-coated fractures or slickensides, and close-spaced fracture cleavage.

Joints

Joints are a ubiquitous feature in all of the bedrock units in the quadrangle. Joints in outcrops of Mesozoic sedimentary rock tend to be better developed in outcrops of sandstone and siltstone than joints developed in finer-grained lithologies such as shale. All joints formed proximal to faults are spaced much closer, typically on the order of <1 ft. Two joint sets occur in the Mesozoic sedimentary rocks. The dominant set strikes N.07°W. (Fig. 3) and dips steeply toward the northeast and less commonly toward the southwest. All joints are characteristically planar, moderately well formed, and unmineralized, except close to faults where they may contain quartz or calcite. Joint surfaces typically are smooth and less commonly irregular. All joints are variably spaced from <1 ft. to several ft.

Joints in the Mesozoic igneous rocks consist of two types, columnar (cooling) and tectonic. Columnar joints are present in all of the basalt formations in the map area. They are characteristically polygonal, arrayed radially and are variable in height and spacing. A comprehensive study of cooling joints in the Watchung basalts was performed by Faust (1978). Tectonic joints occur in all of the basalt formations but are commonly obscured by the more pervasive cooling joints. Tectonic joints are typically planar, moderately to well formed, smooth to slightly irregular, steeply dipping, unmineralized, and variably spaced from a few ft. to tens of ft. However, in outcrops that are near faults, joint spacing is typically 1 foot or less.

Joints developed in Mesoproterozoic rocks are characteristically planar, moderately well formed, moderately to widely spaced, and moderately to steeply dipping. Surfaces of joints are typically unmineralized, except where proximal to faults, and are smooth and less commonly slightly irregular. Joints are variably spaced from a foot to tens of feet. Those developed in massive-textured rocks such as granite tend to be more widely spaced, irregularly formed and discontinuous than joints developed in the layered gneisses and finer-grained crystalline rocks. However, those formed proximal to faults are more closely spaced, typically 2 feet or less.

The dominant joint orientation at any given place within the Mesoproterozoic rocks is nearly orthogonal to the trend of the crystallization foliation, and this orthogonal relationship of the principal joint set to foliation is a consistent feature that has been observed in Mesoproterozoic rocks throughout the Highlands (Volkert, 1996). Consequently, joint trends are not uniform because of the variable orientation of foliations in the map area due to folding. The dominant joint set strikes about N.44°W. (Fig. 4) and dips steeply toward the southwest and less commonly toward the northeast.

ECONOMIC RESOURCES

Graphite was mined during the 19th century from Mesoproterozoic rusty, sulfidic gneiss and metaquartzite west of Riverdale at the Bloomingdale mine. Descriptions of this and other graphite mines in the Highlands are summarized in Volkert (1997). Marble was formerly quarried for serpentine and also for use as lime from several quarries north of Lake Valhalla. Granite and gneiss are currently quarried for crushed stone at Riverdale. Mesozoic Hook Mountain Basalt was formerly quarried for crushed stone and aggregate from locations near Mountain View and Pompton Lakes. Sandstone of the Towaco Formation was formerly quarried from two locations southeast of Towaco.

Background levels of naturally occurring radioactivity were measured in Mesozoic bedrock outcrops using a hand-held Micro R meter and the results are given under the individual rock unit descriptions. In general, basalt yields consistently low readings of about 6 Micro R/Hr regardless of stratigraphic position, texture, or composition. Sedimentary units yield higher and somewhat more variable readings ranging from 11 to 21 Micro R/Hr that appear to be influenced mainly by grain size. Values recorded from sandstone and conglomerate are lower than from finer-grained siltstone and shale, suggesting that clay minerals are principal hosts of the radiogenic mineral phases. This relationship applies on a regional basis as well, based on measurements of various lithofacies of the Mesozoic sedimentary formations from 7.5-minute quadrangles in the Newark basin from New Brunswick north to Ramsey (R.A. Volkert, unpublished data).

DESCRIPTION OF MAP UNITS

NEWARK BASIN

Jb, Jbcq — Boonton Formation (Lower Jurassic) (Olsen, 1980) - Reddish-brown to brownish-purple, fine-grained, commonly micaceous sandstone, siltstone, and shale, in fining-upward sequences mostly 5 to 13 ft. thick. Red, gray, and brownish-purple siltstone and black, blocky, partly dolomitic siltstone and shale are common in the lower part of unit. Irregular mudcracks, symmetrical ripple marks, hummocky and trough cross-laminated beds, burrows, and evaporite minerals are abundant in red siltstone and shale. Gray, fine-grained sandstone may have carbonized plant remains, and reptile footprints occur in middle and upper parts of unit. Conglomerate and conglomeratic sandstone (Jbcq) containing subangular to subrounded pebble to boulder clasts of Mesoproterozoic rocks, less abundant Paleozoic quartzite, shale, dolomite, and Jurassic basalt within a matrix of coarse brown sand interfinger with unit along the Ramapo fault. Maximum thickness of the unit regionally is about 1,640 ft. Levels of natural radioactivity range from 13 to 15 (mean=14) Micro R/Hr in reddish-brown lithologies, 15 to 17 (mean=16) Micro R/Hr in gray lithologies, and 11 to 13 (mean=12) Micro R/Hr in conglomerate (Jbcq).

Jh, Jhg — Hook Mountain Basalt (Lower Jurassic) (Olsen, 1980) - Dark greenish-gray to black, generally fine-grained, amygdaloidal basalt composed of plagioclase, clinopyroxene, and opaque oxides. Contains small spherical to tubular gas-escape vesicles, some filled by zeolite minerals or calcite, typically above flow contacts. Dark-gray, coarse-grained gabbroid (Jhg) composed of clinopyroxene and plagioclase grains up to 0.5 in. long occurs at several stratigraphic intervals in the unit but is most abundant in the lowest flow. Gabbroid has sharp upper contacts and gradational lower contacts with more typical finer-grained basalt. Unit consists of at least two, and possibly three major flows. Base of lowest flow is intensely vesicular. Tops of flows are weathered and vesicular. Maximum thickness regionally is 361 ft. Levels of natural radioactivity range from 4 to 10 (mean=6) Micro R/Hr. and show no variability between basalt and gabbroid.

Jt, Jtc — Towaco Formation (Lower Jurassic) (Olsen, 1980) - Reddish-brown to brownish-purple, buff, olive-tan, or light olive-gray, fine- to medium-grained, micaceous sandstone, siltstone, and shale in fining-upward sequences 3 to 10 ft. thick. Unit consists of at least eight sequences of gray, greenish-gray, or brownish-gray, fine-grained sandstone, siltstone, and calcareous siltstone, and black microlaminated calcareous siltstone and shale with diagnostic pollen, fish, and dinosaur tracks. Gray fine-grained sandstone at Pines Lake has carbonized plant remains. Irregular mudcracks and symmetrical ripple marks are present locally. Sandstone is often hummocky and trough cross-laminated, and siltstone commonly planar laminated or bioturbated and indistinctly laminated to massive. Several feet of unit have been thermally metamorphosed along contact with Hook Mountain Basalt. Conglomerate and conglomeratic sandstone (Jtc) with subangular to subrounded clasts of Mesoproterozoic rocks, Paleozoic quartzite and quartz, dolomite, and shale in matrix of coarse brown sand to silt interfinger with unit near Pines Lake. Maximum thickness of the Towaco Fm. regionally is about 1,250 ft. Levels of natural radioactivity range from 12 to 21 (mean=15) Micro R/Hr in reddish-brown lithologies, 13 to 20 (mean=16) Micro R/Hr in gray lithologies, and 9 to 13 (mean=11) Micro R/Hr in conglomerate (Jtc).

Jp, Jpg, Jps — Preakness Basalt (Lower Jurassic) (Olsen, 1980) - Dark greenish-gray to black, fine-grained, dense, hard basalt composed mainly of intergrown calcic plagioclase and clinopyroxene. Contains small spherical to tubular gas-escape vesicles, some filled by zeolite minerals or calcite, just above scoriaceous flow contacts. Dark-gray, coarse- to very-coarse-grained gabbroid (Jpg) composed of clinopyroxene grains up to 0.5 in. long and plagioclase grains up to 1.0 in. long occurs at several stratigraphic intervals in the unit but is most abundant in the lowest flow. Gabbroid has sharp upper contacts and gradational lower contacts with more typical finer-grained basalt. Unit consists of at least three major flows, the tops of which are marked by prominant vesicular zones up to 8 ft. thick. Radiating slender columns 2 to 24 in. wide, due to shrinkage during cooling, are abundant near the base of the lowest flow. A thin, 6 to 25 ft.-thick sequence of interbedded reddish-brown siltstone and shale (Jps) separates the lowest flows. It is well exposed immediately south of the quadrangle in North Caldwell (Volkert, 2006) and is known elsewhere from water well record data. Maximum thickness is about 1,040 ft. Levels of natural radioactivity measured from 14 outcrops range from 3 to 8 (mean=6) Micro R/Hr.

GREEN POND MOUNTAIN REGION

Sg — Green Pond Conglomerate (Middle and Lower Silurian) (Rogers, 1836) - Light-gray weathering, pale pinkish-white to light-gray orthoquartzite locally containing quartz pebbles. Unit crops out southeast of Lake Valhalla where it is in fault contact with Mesoproterozoic rocks on the west and Lower Jurassic rocks on the east. Thickness of unit in the map area is unknown.

JUTLAND KLIPPE SEQUENCE

O€jt — Jutland klippe sequence undivided (Middle Ordovician to Upper Cambrian?) (Perissoratis et al., 1979) - Gray-weathering, dark-gray phyllonitic shale containing thin, discontinuous siltstone lenses. Unit is in fault contact with Mesoproterozoic rocks in the west and Lower Jurassic rocks in the east. Thickness of unit is unknown. Levels of natural radioactivity range from 11 to 15 (mean=14) Micro R/Hr.

NEW JERSEY HIGHLANDS

Zd — Diabase dikes (Neoproterozoic) (Volkert and Puffer, 1995) - Light gray- or brownish-gray-weathering, dark-greenish-gray, aphanitic to fine-grained rocks. Composed principally of plagioclase (labradorite to andesine), augite, and ilmenite and (or) magnetite. Locally occurring pyrite blebs are common. Contacts are typically chilled and sharp against enclosing Mesoproterozoic country rock. Dikes are as much as 10 ft. thick.

Ypp — "Pompton Pink Granite" (Mesoproterozoic) - Pink weathering, pinkish-white, locally green-mottled, coarse-grained, unfoliated granite composed of microcline microperthite, quartz, oligoclase, and minor amounts of epidote, biotite and opaque oxides. Contains xenoliths of, and discordantly cuts across contacts of, foliated country rock. Unit is confined to a single body north of Route 23 at Riverdale. Field relations suggest post-orogenic emplacement and an age of approximately 1 Ga.

Yrm — Ramapo Mylonite (Mesoproterozoic) - Heterogeneous sequence of dark-gray, light-green, whitish-tan, or pinkish-white altered and retrogressively metamorphosed rocks with mylonitic to ultramylonitic fabric. Interpreted to be deformed equivalents of amphibolite, mafic-rich and mafic-poor variants of quartz-plagioclase gneiss, hornblende granite and microperthite alaskite. Rocks are too highly deformed to be mapped separately.

Vernon Supersuite (Volkert and Drake, 1998)

Byram Intrusive Suite (Drake et al., 1991)

Ybh — Hornblende granite (Mesoproterozoic) - Pinkish-gray or buff-weathering, pinkish-white or light-pinkish-gray, medium- to coarse-grained, foliated granite composed of microcline microperthite, quartz, oligoclase, and hornblende. Minor variants contain much less quartz and are quartz monzonite or monzonite. Unit includes small bodies of pegmatite and amphibolite too small to be shown on map.

Yba — Microperthite alaskite (Mesoproterozoic) - Pale pinkish-white to buff-weathering, pinkish-white, medium- to coarse-grained, moderately foliated granite composed of microcline microperthite, quartz, oligoclase, and trace amounts of hornblende and magnetite.

Lake Hopatcong Intrusive Suite (Drake and Volkert, 1991)

Ypg — Pyroxene granite (Mesoproterozoic) - Gray to buff or white weathering, greenish-gray, medium- to coarse-grained, massive, moderately foliated granite composed of mesoperthite to microantiperthite, quartz, oligoclase, and clinopyroxene. Common accessory minerals include titanite, apatite, magnetite, and trace amounts of pyrite. Locally includes small bodies of amphibolite too small to be shown on map.

Metasedimentary Rocks

Yk — Potassic feldspar gneiss (Mesoproterozoic) - Light-gray or pinkish-buff weathering, pinkish-white or light-pinkish-gray, medium-grained, moderately foliated gneiss composed of quartz, microcline microperthite, oligoclase, and biotite.

Yb — Biotite-quartz-feldspar gneiss (Mesoproterozoic) - Pale pinkish-white to gray weathering, or rusty weathering, pinkish-gray, tan, or greenish-gray, fine- to medium-grained, moderately layered and foliated gneiss containing microcline microperthite, oligoclase, quartz, biotite, garnet, sillimanite, graphite and pyrrhotite. Rusty variant commonly interlayered with thin, moderately foliated to well-layered quartzite that contains biotite, feldspar, and graphite.

Yp — Clinopyroxene-quartz-feldspar gneiss (Mesoproterozoic) - Pinkish-gray or pinkish-buff-weathering, white to pale-pinkish-white, medium-grained, massive, moderately foliated to well-layered gneiss composed of microcline, quartz, oligoclase, clinopyroxene, and trace amounts of titanite and opaque minerals.

Ymp — Pyroxene gneiss (Mesoproterozoic) - White-weathering, greenish-gray, medium-grained, well-layered gneiss containing oligoclase, clinopyroxene, variable amounts of quartz, and trace amounts of opaque minerals and titanite. Some phases contain scapolite and calcite. Commonly spatially associated with amphibolite (Ya), rusty biotite-quartz-feldspar gneiss (Yb) and marble (Ymr).

Ymr — Marble (Mesoproterozoic) - White-weathering, white, light gray, or pale pink, medium-grained, calcitic to dolomitic marble containing calcite, antigorite, phlogopite, and trace amounts of graphite and pyrrhotite. Chrysotile is locally developed along shear surfaces. Unit is spatially associated with pyroxene gneiss (Yp) with which it commonly has a gradational contact.

Losee Metamorphic Suite (Drake, 1984; Volkert and Drake, 1999)

Ylo — Quartz-oligoclase gneiss (Mesoproterozoic) - White-weathering, light-greenish-gray, medium- to coarse-grained, moderately layered and foliated gneiss composed of oligoclase or andesine, quartz, hornblende and (or) biotite. Locally contains layers of amphibolite (Ya) too thin to be shown on map.

Ylb — Biotite-quartz-oligoclase gneiss (Mesoproterozoic) - White or light-gray weathering, medium-gray or greenish-gray, medium- to coarse-grained, moderately well layered and foliated gneiss composed of oligoclase or andesine, quartz, biotite, and local garnet. Some outcrops contain hornblende. Locally contains thin layers of amphibolite (Ya) not shown on map.

Yh — Hypersthene-quartz-plagioclase gneiss (Mesoproterozoic) - Gray or tan weathering, greenish-gray or greenish-brown, medium-grained, moderately layered and foliated, greasy-lustered gneiss composed of andesine or oligoclase, quartz, clinopyroxene, hornblende, and hypersthene. Commonly contains conformable layers of amphibolite (Ya) and mafic-rich quartz-plagioclase gneiss (Ylo) too thin to be shown on map.

Yd — Diorite (Mesoproterozoic) - Gray or tan weathering, greenish-gray or greenish-brown, medium- to coarse-grained, greasy-lustered, massive, moderately foliated rock containing andesine or oligoclase, clinopyroxene, hornblende, and hypersthene. Thin mafic layers or schlieren having the composition of amphibolite (Ya) are common.

Other Rocks

Ya — Amphibolite (Mesoproterozoic) - Gray to grayish-black, medium-grained foliated gneiss composed of hornblende and andesine. Some variants contain biotite, clinopyroxene, or local hypersthene. Unit is commonly associated with rocks of the Losee Suite and also is intercalated with metasedimentary gneisses.

EXPLANATION OF MAP SYMBOLS

Contact - Dotted where concealed

Faults - Dotted where concealed

High angle fault - U, upthrown side; D, downthrown side. Ball and bar show dip of fault plane where known

Thrust fault - Sawteeth on upper plate

Folds

Folds in Mesoproterozoic rocks - Folds in foliation and layering

- Antiform - Showing crestline and direction of plunge
- Overturned antiform - Showing trace of axial surface, direction of dip of limbs, and direction of plunge
- Overturned synform - Showing trace of axial surface, direction of dip of limbs, and direction of plunge

Folds in Mesozoic rocks - Folds in bedding

- Anticline - Showing crestline and direction of plunge
- Syncline - Showing troughline and direction of plunge

Planar Features

Strike and dip of crystallization foliation

- 10 Inclined
- Vertical

10 Strike and dip of mylonitic foliation

12 Strike and dip of inclined beds

20 Strike and dip of parallel bedding and slaty cleavage in Paleozoic rocks

Linear Features

20 Bearing and plunge of mineral lineation in Proterozoic rocks

80 Bearing and plunge of crenulation lineation in Paleozoic rocks

Other Features

x x x x Scoriaceous flow contact in Jurassic basalt

B Active rock quarry

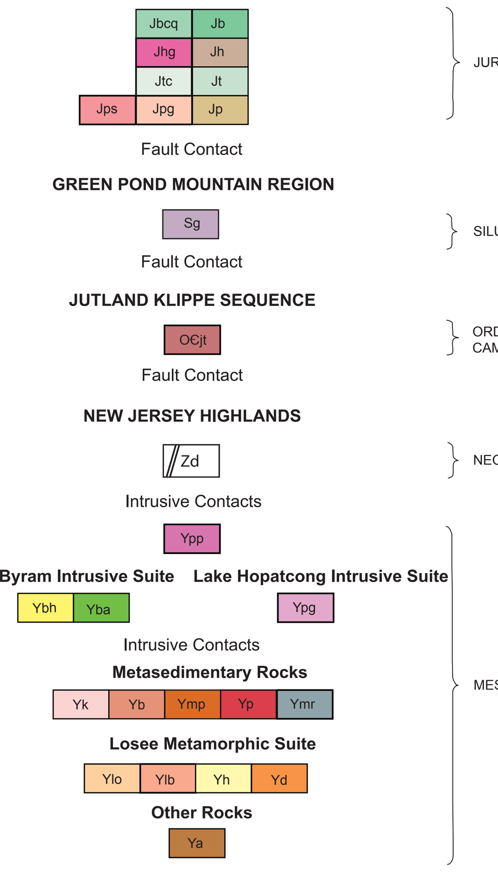
B Abandoned rock quarry: B, basalt; S, sandstone; M, marble

Gr Abandoned graphite mine

B Water well- Rock type at bottom: B, basalt; S, sandstone, siltstone, shale C, conglomerate

Form line - Shown in cross section to indicate foliation in Proterozoic rocks

CORRELATION OF MAP UNITS



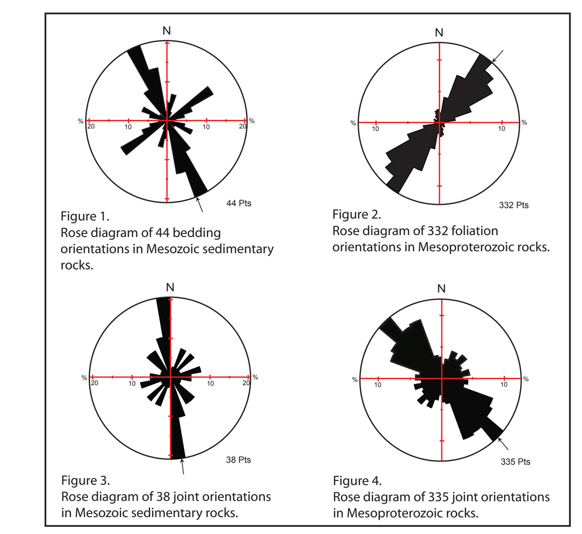
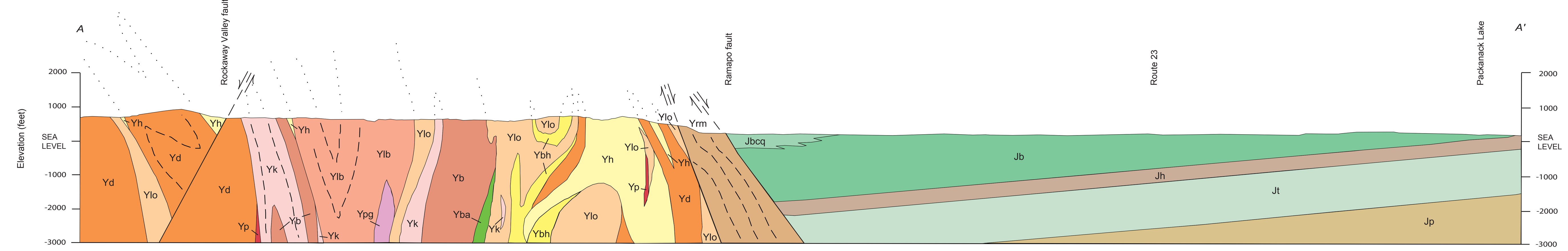


Figure 1. Rose diagram of 44 bedding orientations in Mesozoic sedimentary rocks.

Figure 2. Rose diagram of 332 foliation orientations in Mesoproterozoic rocks.

Figure 3. Rose diagram of 38 joint orientations in Mesozoic sedimentary rocks.

Figure 4. Rose diagram of 335 joint orientations in Mesoproterozoic rocks.



REFERENCES CITED AND USED IN CONSTRUCTION OF MAP

Drake, A.A., Jr., 1984, The Reading Prong of New Jersey and eastern Pennsylvania-An appraisal of rock relations and chemistry of a major Proterozoic terrane in the Appalachians, in Bartholomew, M.J., ed., The Grenville event in the Appalachians and related topics: Geological Society of America Special Paper 194, p. 75-109.

Drake, A.A., Jr., Aleinikoff, J.N., and Volkert, R.A., 1991, The Byram Intrusive Suite of the Reading Prong-Age and tectonic environment, in Drake, A.A., Jr., ed., Contributions to New Jersey Geology: U.S. Geological Survey Bulletin 1952, p. D1-D14.

Drake, A.A., Jr., and Volkert, R.A., 1991, The Lake Hopatcong Intrusive Suite (Middle Proterozoic) of the New Jersey Highlands, in Drake, A.A., Jr., ed., Contributions to New Jersey Geology: U.S. Geological Survey Bulletin 1952, p. A1-A9.

Drake, A.A., Jr., Volkert, R.A., Monteverde, D.H., Herman, G.C., Houghton, H.F., Parker, R.A., and Dalton, R.F., 1996, Bedrock Geologic Map of Northern New Jersey: U.S. Geological Survey Miscellaneous Investigations Series Map I-2540-A, scale 1:100,000.

Faust, G.T., 1978, Joint systems in the Watchung basalt flows, New Jersey: U.S. Geological Survey Professional Paper 864-B, 46p.

Houghton, H.F., and Volkert, R.A., 1990, Bedrock geologic map of the Gladstone quadrangle, Morris, Hunterdon, and Somerset Counties, New Jersey: New Jersey Geological Survey Geologic Map Series GMS 89-4, scale 1:24,000.

Kummel, H.B., ca. 1900, unpublished data on file in the office of the New Jersey Geological urvey, Trenton, New Jersey.

Lewis, J.V., 1908, Building stones of New Jersey: New Jersey Geological Survey, Annual Report of the State Geologist, p. 53-124.

Olsen, P.E., 1980, The Latest Triassic and Early Jurassic formations of the Newark Basin (Eastern North America Newark Supergroup): Stratigraphy, structure and correlation: New Jersey Academy of Science Bulletin, v. 25, no. 2, p. 25-51.

Perissoratis, C., Brock, P.W.G., Brueckner, H.K., Drake, A.A., Jr., and Berry, W.B.N., 1979, The Taconides of western New Jersey: New evidence from the Jutland Klippe: Geological Society of America Bulletin, Part II, v. 90, p. 154-177.

Puffer, J.H., and Volkert, R.A., 2001, Pegmatoid and gabbroid layers in Jurassic Preakness and Hook Mountain Basalts, Newark basin, New Jersey: Journal of Geology, v. 109, p. 585-601.

Ratcliffe, N.M., Burton, W.C., and Pavich, M.J., 1990, Orientation, movement history, and cataclastic rocks of Ramapo fault based on core drilling and trenching along the western margin of the Newark basin near Bernardsville, New Jersey: U.S. Geological Survey Miscellaneous Investigations Series Map I-1982, 1 sheet, no scale.

Rogers, H.D., 1836, Report on the geological survey of the State of New Jersey: Philadelphia, Desilver, Thomas & Co., 174p.

Volkert, R.A., 1996, Geologic and engineering characteristics of Middle Proterozoic rocks of the Highlands, northern New Jersey, in Engineering geology in the metropolitan environment: Field Guide and Proceedings of the 39th Annual Meeting of the Association of Engineering Geologists, p. A1-A33.

_______, 1997, Graphite mines and mining history in the New Jersey Highlands, in Benimoff, A.I. and Puffer, J.H., eds., The economic geology of northern New Jersey: Field Guide and Proceedings of the 14th annual meeting of the Geological Association of New Jersey, p. 21-32.

_______, 2003, Bedrock geologic map of the Ramsey quadrangle, Bergen and Passaic Counties, New Jersey: New Jersey Geological Survey Open-File Map, scale 1:24,000.

_______, 2004, Mesoproterozoic rocks of the New Jersey Highlands, north-central Appalachians: petrogenesis and tectonic history, in Tollo, R.P., Corriveau, L., McLelland, J., and Bartholomew, J., eds., Proterozoic tectonic evolution of the Grenville orogen in North America: Geological Society of America Memoir 197, p. 697-728.

_______, 2006, Bedrock geologic map of the Caldwell quadrangle, Essex and Morris Counties, New Jersey: New Jersey Geological Survey Geologic Map Series GMS 06-3, scale 1:24,000.

Volkert, R.A., and Drake, A.A., Jr., 1998, The Vernon Supersuite: Mesoproterozoic A-type granitoid rocks in the New Jersey Highlands: Northeastern Geology and Environmental Sciences, v. 20, p. 39-43.

_______, 1999, Geochemistry and stratigraphic relations of Middle Proterozoic rocks of the New Jersey Highlands, in Drake, A.A., Jr., ed., Geologic Studies in New Jersey and eastern Pennsylvania: U.S. Geological Survey Professional Paper 1565C, 77p.

Volkert, R.A., and Puffer, J.H., 1995, Late Proterozoic diabase dikes of the New Jersey Highlands- A remnant of Iapetan rifting in the north-central Appalachians, in Drake, A.A., Jr., ed., Geologic studies in New Jersey and eastern Pennsylvania: U.S. Geological Survey Professional Paper 1565-A, 22p.

Woodward Clyde Consultants, 1983, Logs of borings from the Ramapo fault. On file in the office of the New Jersey Geological Survey, Trenton, New Jersey.