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WATER RESOURCES MANAGEMENT
NEW JERSEY GEOLOGICAL AND WATER SURVEY

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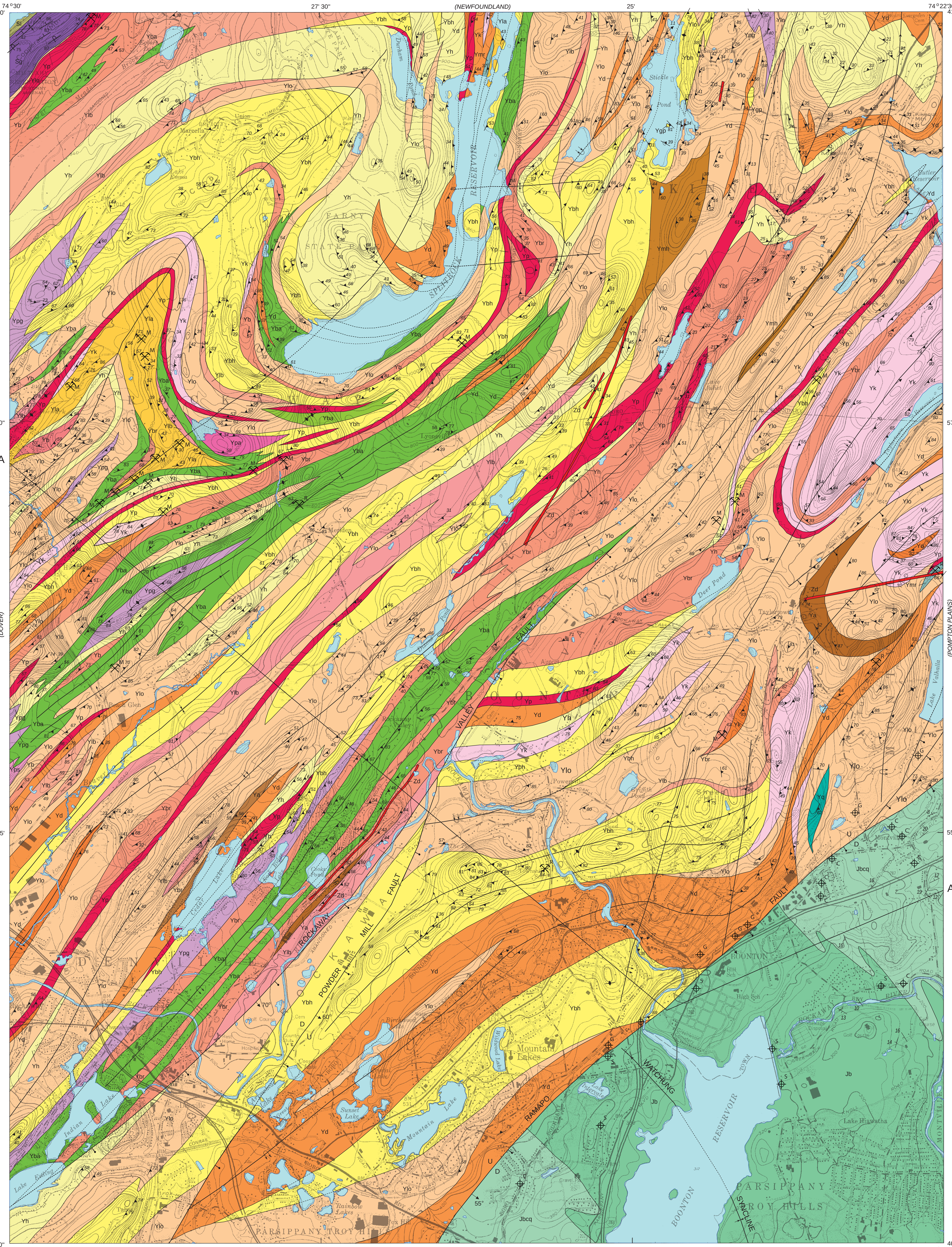

Base map from U.S. Geological Survey, 1981

SCALE 1:24 000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

Bedrock geology mapped by R.A. Volkert in 1987 and 2000
Paleozoic geology adapted from G.C. Herman and J.P. Mitchell (1991)
Digital cartography by M.W. Girard
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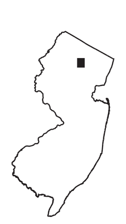
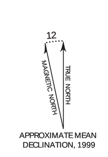

LOCATION IN
NEW JERSEY

BEDROCK GEOLOGIC MAP OF THE BOONTON QUADRANGLE MORRIS COUNTY, NEW JERSEY

by

Richard A. Volkert

2012



INTRODUCTION

The Boonton quadrangle is located in northern New Jersey, in Morris County, within a mixed commercial, industrial and residential setting. Large tracts of land adjacent to Splitrock Reservoir remain undeveloped through management by the Jersey City Water Department, the New Jersey Department of Environmental Protection and various public and private groups. The quadrangle is in the Rockaway River drainage basin which constitutes an important part of the regional groundwater and surface-water supply. Impoundment of the Rockaway River in Parsippany Troy Hills Township created the Boonton Reservoir which, along with Splitrock, Butler, and Taylortown Reservoirs, is a major water source for residents of the northern part of the state.

The quadrangle straddles the boundary between the Highlands and Piedmont Physiographic Provinces, but is predominantly in the Highlands. Rocks of Mesoproterozoic and Neoproterozoic age of the Highlands underlie all but the southeastern area, which is underlain by Mesozoic sedimentary rocks of the Piedmont. The Ramapo Fault is a structural and physiographic boundary between rocks of the two provinces.

STRATIGRAPHY

Mesozoic Rocks

The youngest bedrock in the quadrangle is Mesozoic in age and is part of the Newark basin, a northeast-trending half-graben that contains approximately 24,600 ft. of interbedded Upper Triassic to Lower Jurassic sedimentary and igneous rocks. Only the Boonton Formation, in the upper part of this stratigraphic succession, is exposed in the quadrangle. It crops out along, and south of, the Rockaway River. Conglomeratic lithofacies of the unit support the moderate relief north of the Rockaway River near Montville, and similar rocks have also been recovered from water wells drilled west of Boonton Reservoir. The Boonton Formation is in fault contact with Mesoproterozoic rocks northwest of Boonton Reservoir.

Paleozoic Rocks

Paleozoic sedimentary rocks underlie Copperas Mountain in the northwest part of the map: they consist of the Longwood Shale and Green Pond Conglomerate of Silurian age. These formations are part of a stratigraphic succession of Paleozoic rocks of the Green Pond Mountain Region, a northeast-trending block of downfaulted and folded rocks. Green Pond Conglomerate is in unconformable contact with Mesoproterozoic rocks along the southeast side of Copperas Mountain.

Neoproterozoic Rocks

Numerous diabase dikes of Neoproterozoic age intrude Mesoproterozoic rocks in the quadrangle but not Paleozoic or younger rocks. They were emplaced about 600 Ma during rifting of the eastern Laurentian continental margin in response to breakup of the supercontinent Rodinia (Volkert and Puffer, 1995). Dikes strike mainly northeast and have sharp contacts and chilled margins with enclosing Mesoproterozoic rocks. They are best exposed west of Lake Juliet, in the northeast part of the map, and east of Cooks Pond in the southwest part.

Mesoproterozoic Rocks

The oldest rocks in the quadrangle are Mesoproterozoic and are part of the New Jersey Highlands. They include various granites, gneisses, quartzite, and marble metamorphosed to granulite facies about 1050 Ma during the Ottawan phase of the Grenville orogeny (Volkert, 2004). Temperature estimates for this high-grade metamorphism are 769°C from calcite-graphite thermometry (Peck et al., 2006) and 754°C from biotite thermometry (Volkert, 2006).

The youngest Mesoproterozoic rocks are small, irregular bodies of granite pegmatite that are undeformed and have discordantly intruded most other Mesoproterozoic rocks. Except for two of large bodies east of Splitrock Reservoir, pegmatites are too small to be shown on the map. Regionally, they yield U-Pb zircon ages of 1004 to 987 Ma (Volkert et al., 2005).

Granitic rocks are widely distributed and abundant in the quadrangle. They include hornblende granite, alaskite and monzonite of the Byram Intrusive Suite (Drake et al., 1991) and clinopyroxene granite and alaskite of the Lake Hopatcong Intrusive Suite (Drake and Volkert, 1991) that comprise the Vernon Supersuite (Volkert and Drake, 1998). Rocks of these suites have a similar A-type geochemical composition (Volkert et al., 2000), and they yield overlapping sensitive high-resolution ion microprobe (SHRIMP) U-Pb zircon ages of 1188 to 1182 Ma (Volkert et al., 2010). Byram rocks are best exposed in the northwest part of the map and also east of the Rockaway Valley. Lake Hopatcong rocks are much less abundant, but are well exposed in the northwest part of the map and also in the southwest, near Cedar Lake.

Among the oldest Mesoproterozoic rocks are those of the Losee Suite, interpreted as a sequence of metamorphosed volcanic and plutonic rocks of calc-alkaline composition formed in a continental-margin magmatic arc (Volkert, 2004). They include quartz-oligoclase gneiss, albite-oligoclase granite, biotite-quartz-oligoclase gneiss, hypersthene-quartz-plagioclase gneiss, and diorite gneiss. Rocks of the Losee Suite are spatially associated with a sequence of supracrustal rocks formed in a back-arc basin inboard of the Losee magmatic arc (Volkert, 2004). They include potassic feldspar gneiss, biotite-quartz-feldspar gneiss, hornblende-quartz-feldspar gneiss, pyroxene gneiss, quartzite, marble, and amphibolite. Losee Suite and supracrustal rocks yield similar SHRIMP U-Pb zircon ages of 1299 to 1248 Ma (Volkert et al., 2010).

STRUCTURE

Bedding

The strike of bedding in the Boonton Formation is somewhat varied and reflects its position west of a large, regional anticline, and the Watchung Syncline that extends through the southeast corner of the area. In general, beds strike about N.30°W. and dip 10° to 16° southwest. In the hinge areas of folds, beds strike about N.49°E. and dip 8° to 20° northwest. The average dip of all beds is 14°.

Bedding in the Green Pond Conglomerate is fairly uniform and strikes about N.58°E. Most beds dip northwest, although locally they are overturned and dip steeply southeast. (Barnett, 1976; Herman and Mitchell, 1991). The average dip of all beds is 81°.

Proterozoic Foliation

Crystallization foliation (the parallel alignment of mineral grains) in Mesoproterozoic rocks is inherited from compressional stresses that deformed the rocks during high-grade metamorphism. Foliation is fairly uniform throughout most of the area and strikes northeast at an average of N.40°E. (fig. 1). However, locally it is varied, especially in the central and northern part of the quadrangle, owing to folds of all scale from outcrop to regional in extent. Foliations dip mainly southeast and, less commonly, northwest from 11° to 90° and average 56°.

Folds

Mesozoic rocks in the quadrangle are on the west limb of a broad, upright, northwest-plunging anticline. Its fold axis is to the east in the Pompton Plains quadrangle (Volkert, 2010). The axis of the broad, upright Watchung Syncline is in the southeast part of the map.

Paleozoic rocks have been folded into an asymmetric, northeast-plunging upright to locally northwest-overturned syncline. Beds on the west limb dip steeply southeast and on the east limb dip steeply northwest or are locally overturned to the southeast.

Folds in the Mesoproterozoic rocks are dominated by a large northeast-plunging antiform and synform pair in the northwest part of the map. Characteristic fold styles include: 1) antiforms and synforms that are northeast-plunging and northwest overturned; 2) northeast-plunging and upright; and 3) east-northeast-plunging and upright. The plunge of mineral lineations is parallel to the axes of folds and ranges from 10° to 54° with nearly equal abundance from N.20°E. to N.80°E. East-plunging folds are interpreted to be the youngest because they refold northeast-plunging folds.

Faults

The Ramapo Fault is a dominant structural feature in the region, extending northeast from the Peapack-Gladstone area (Drake et al., 1996) into New York State. The fault has a complex and protracted history of movement that began in the Proterozoic. Multiple episodes of reactivation since then have left overprinting brittle and ductile fabrics that record kinematic indicators consistent with normal, reverse, and strike-slip movement. In the quadrangle the fault strikes about N.40°E. It dips about 50° southeast, and it is well constrained by borings drilled to the southwest at Bernardsville (Ratcliffe et al., 1990) and by a series of borings drilled for Interstate Route 287 between Montville and Riverdale (Woodward Clyde Consultants, 1983). However, outcrops of ductilely deformed Mesoproterozoic rocks on the footwall of the fault, especially to the north in the Pompton Plains and Ramsey quadrangles, record mylonitic foliations of probable Proterozoic and Paleozoic age that dip steeply southeast at 60° to 85° (Volkert, 2010; 2011a).

The Rockaway Valley fault extends through the central part of the map area and is another major regional structural feature. It strikes about N.40°E. and dips about 70° southeast. It records a dip-slip normal sense of movement, and it is characterized mainly by brittle deformation fabric that overprints an earlier, steeply-dipping ductile deformation fabric.

The Powder Mill Fault extends through the central part of the quadrangle where it is cut off by the Rockaway Valley Fault. The Powder Mill Fault strikes about N.40°E. and dips about 60° southeast. It records dip-slip reverse movement sense and is characterized by brittle deformation fabric along its length.

Mesoproterozoic rocks are also deformed by smaller northeast- or northwest-trending faults, some of which are at outcrop scale. These faults are characterized by brittle deformation fabric that consists of retrograded mafic mineral phases, chlorite or epidote-coated fractures or slickensides, and (or) closely-spaced fracture cleavage. The faults are typically tens of ft. wide, although some wider fault zones may reflect the merging of smaller parallel faults.

Joints

Joints are a common feature in all rocks of the quadrangle. They are characteristically planar, moderately well formed, and moderately to steeply dipping. Surfaces are typically smooth and, less commonly, slightly irregular and unmineralized except near faults. Joints are spaced from 1 ft. to several ft. apart, except near faults where they are commonly spaced less than 1 ft. apart.

Northwest-trending cross joints are the most common in Mesozoic rocks. They strike about N.12°W. and dip predominantly northeast at an average of 83°. The small number of joints measured prevents their tabulation and display on a structural plot. However, joints measured in Mesozoic sedimentary rocks in the adjacent Pompton Plains quadrangle have a similar strike of about N.10°W (Volkert, 2010).

The dominant joint orientation in Mesoproterozoic rocks is nearly perpendicular to the strike of crystallization foliation, and this relationship is a consistent feature observed in Mesoproterozoic rocks throughout the Highlands (Volkert, 1996). Joints are typically unmineralized except near faults where they are coated by chlorite and (or) epidote. Those developed in massive rocks such as diorite gneiss or granite are more widely spaced, irregularly formed and discontinuous than those in layered gneisses and fine-grained rocks. Northwest-trending cross joints are the most common and they strike about N.45°W. (fig. 2) and dip nearly equally southwest and northeast at an average of 75°.

ECONOMIC RESOURCES

Some Mesoproterozoic rocks in the quadrangle host economic deposits of magnetite that were mined intermittently mainly during the 19th century. Detailed descriptions of most mines are in Bayley (1910) and Sims (1958). The largest and economically most important mines are in the west-central part of the area, at Beach Glen and Hibernia. Diorite gniess was quarried for use as aggregate and dimension stone at Turkey Mountain, west of Lake Valhalla, and granite and alaskite were quarried at Meriden. Marble was extracted locally from a small quarry at Turkey Mountain, north of Lake Valhalla, for its serpentine content and for its use as a flux during the roasting of magnetite from local mines.

NATURALLY OCCURRING RADIATION

Background levels of naturally occurring radioactivity were measured at Mesozoic and Paleozoic 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, more varied readings that range from 9 to 21 Micro R/Hr and appear to be related mainly to grain size. Values recorded from conglomerate, pebbly sandstone and sandstone are lower than those from fine-grained rocks such as siltstone and shale, suggesting that clay minerals may be hosts for the radiogenic mineral phases.

DESCRIPTION OF MAP UNITS

NEWARK SUPERGROUP

Jb
Jbcq

Boonton Formation (Lower Jurassic) (Olsen, 1980) – Reddish-brown to brownish-purple, fine-grained, commonly micaceous sandstone, siltstone, and mudstone (Jb), 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 mud cracks, symmetrical ripple marks, hummocky and trough cross-laminated beds, burrows, and evaporite minerals are abundant in red siltstone and mudstone. 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) that contains subangular to subrounded pebble-to- boulder clasts of Mesoproterozoic rocks and less abundant Paleozoic quartzite, shale, and dolomite, and Jurassic basalt within a matrix of coarse brown sand interfinger with upper part of unit along the Ramapo Fault. Maximum thickness is about 1,640 ft. Levels of natural radioactivity range from 13 to 15 (mean=14) Micro R/Hr in reddish-brown, fine-grained lithologies, 15 to 17 (mean=16) Micro R/Hr in gray lithologies, and 11 to 13 (mean=12) Micro R/Hr in conglomerate and conglomeratic sandstone.

Jh

Hook Mountain Basalt (Lower Jurassic) (Olsen, 1980) – Dark greenish-gray to black, generally fine-grained, amygdaloidal basalt composed of plagioclase, clinopyroxene, and iron-titanium oxides. Contains small spherical to tubular gas-escape vesicles above flow contacts, some of which are filled by zeolite minerals or calcite. Dark-gray, coarse-grained gabbroid composed of clinopyroxene and plagioclase grains as much as 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 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 is 360 ft. Levels of natural radioactivity range from 4 to 10 (mean=6) Micro R/Hr. Unit is not exposed in the map area and is shown in cross section only.

Jt

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 silty mudstone 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 mudstone with diagnostic pollen, fish, and dinosaur tracks. Gray fine-grained sandstone has carbonized plant remains. Irregular mud cracks and symmetrical ripple marks may be present. Sandstone is commonly hummocky and trough cross-laminated, and siltstone is planar laminated or bioturbated and indistinctly laminated to massive. Several ft. of unit have been thermally metamorphosed along the contact with Hook Mountain Basalt. Maximum thickness is about 1,250 ft. Levels of natural radioactivity range from 12 to 21 (mean=15) Micro R/Hr in reddish-brown lithologies and 13 to 20 (mean=16) Micro R/Hr in gray lithologies. Unit is not exposed in the map area and is shown in cross section only.

GREEN POND MOUNTAIN REGION

Sl

Longwood Shale (Upper and Middle Silurian) (Darton, 1894) – Dark reddish-brown, thin- to very thick-bedded shale interbedded with very dark-red, very thin- to thin-bedded, cross-bedded sandstone and siltstone near the base. Thickness is about 325 ft. Unit does not crop out in the map area but is exposed to the north, along strike.

Sg

Green Pond Conglomerate (Middle and Lower Silurian) (Rogers, 1836) – Red, medium- to coarse-grained quartz-pebble conglomerate, quartzitic arkose and orthoquartzite, and reddish-brown, thin- to thick-bedded siltstone. Grades downward into less abundant gray, very dark-red, or grayish-purple, medium- to coarse-grained, thin- to very thick-bedded pebble-to-cobble conglomerate containing clasts of whitish-gray and pink milky quartz and (or) shale, siltstone, sandstone, and chert. Thickness is about 1,000 ft. Levels of natural radioactivity range from 4 to 7 (mean=6) Micro R/Hr in conglomerate and orthoquartzite and from 8 to 10 (mean=9) Micro R/Hr in arkosic sandstone.

NEW JERSEY HIGHLANDS

Zd

Diabase dikes (Neoproterozoic) (Volkert and Puffer, 1995) – Light-gray to brownish-gray-weathering, dark-greenish-gray, aphanitic to fine-grained rocks. Composed principally of plagioclase (labradorite to andesine), augite, and ilmenite and (or) magnetite. Pyrite blebs are common. Contacts are typically chilled and sharp against enclosing Mesoproterozoic rock. Dikes are as much as 40 ft. wide and a mile or more long.

Ygp

Granite pegmatite (Mesoproterozoic) - Pinkish-gray or buff-weathering, pinkish-white or light-pinkish-gray, very coarse-grained, massive, unfoliated granite composed of microcline microperthite, quartz, oligoclase, and hornblende. Locally contains zircon, apatite and magnetite. Commonly spatially associated with hornblende granite, but intrudes most Mesoproteroic rocks on the map.

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, massive, foliated granite composed of mesoperthite, microcline microperthite, quartz, oligoclase, and hornblende. Locally contains zircon, apatite and magnetite.

Yba

Microperthite alaskite (Mesoproterozoic) – Pale pinkish-white or buff-weathering, pinkish-white, medium- to coarse-grained, massive, moderately foliated granite composed of microcline microperthite, quartz, oligoclase, and trace amounts of hornblende and (or) biotite, zircon, apatite, and magnetite.

Lake Hopatcong Intrusive Suite (Drake and Volkert, 1991)

Ypg

Pyroxene granite (Mesoproterozoic) – Gray or buff-weathering, greenish-gray to greenish-buff, medium- to coarse-grained, massive, foliated granite containing mesoperthite, microcline microperthite, quartz, oligoclase, and clinopyroxene. Common accessory minerals include titanite, zircon, apatite, magnetite, and pyrite.

Ypa

Pyroxene alaskite (Mesoproterozoic) – Tan or buff-weathering, greenish-buff, medium-grained, massive, moderately foliated granite composed of microcline microperthite, oligoclase, and quartz. Common accessory minerals include clinopyroxene, titanite and magnetite.

Back Arc Supracrustal Rocks

Yk

Potassic feldspar gneiss (Mesoproterozoic) – Buff or pale pinkish-white-weathering, buff, pale pinkish-white or light-pinkish-gray, medium-grained, massive, foliated gneiss composed of quartz, microcline microperthite, oligoclase, and biotite. Garnet, sillimanite, and magnetite are less common.

Yb
Ybr

Biotite-quartz-feldspar gneiss (Mesoproterozoic) – Pale pinkish-white, pinkish-gray or gray-weathering (Yb), locally rusty weathering (Ybr), pinkish-gray, tan, or greenish-gray, medium- to coarse-grained, moderately layered and foliated gneiss containing microcline microperthite, oligoclase, quartz, biotite, garnet, and sillimanite. Graphite and pyrrhotite are confined to the variant that weathers rusty. This variant is commonly associated spatially with thin, moderately layered quartzite that contains accessory biotite, feldspar and graphite.

Ymh

Hornblende-quartz-feldspar gneiss (Mesoproterozoic) – Pinkish-gray or buff-weathering, light pinkish-white to pinkish-gray, medium-grained, moderately layered and foliated gneiss composed of microcline, quartz, oligoclase, hornblende, and magnetite. Locally contains biotite and (or) garnet.

Yq

Quartzite (Mesoproterozoic) – Light-gray-weathering, light-gray, vitreous, medium-grained, massive, foliated to layered rock composed predominantly of quartz and locally abundant clinopyroxene. Unit is spatially associated with pyroxene gneiss and rusty biotite-quartz-feldspar gneiss.

Yp

Pyroxene gneiss (Mesoproterozoic) – Light-gray or white-weathering, greenish-gray, medium-grained, layered and foliated gneiss containing oligoclase, clinopyroxene, variable amounts of quartz, and trace amounts of titanite, magnetite and epidote. Locally contains thin layers and lenses of green or brownish-green diopsidite composed predominantly of clinopyroxene not shown on the map. Unit is commonly spatially associated with pyroxene amphibolite, marble, and rusty-weathering biotite-quartz-feldspar gneiss.

Ymr

Marble (Mesoproterozoic) – White-weathering, white, light-gray, or pale-pink, medium-grained, calcitic to locally dolomitic marble containing calcite, antigorite, phlogopite, and trace amounts of graphite and pyrrhotite. Unit is spatially associated with pyroxene gneiss, with which it may have a gradational contact.

Magmatic Arc Rocks
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 to foliated gneiss composed of oligoclase or andesine, quartz, and varied amounts of hornblende, clinopyroxene, and (or) biotite. Commonly contains layers of amphibolite too thin to be shown on the map. Locally grades into hypersthene-quartz-plagioclase gneiss.

Yla

Albite-oligoclase granite (Mesoproterozoic) – Pale pink or white-weathering, light-greenish-gray to light-pinkish-green, massive, medium- to coarse-grained granite composed of pink albite or oligoclase, quartz, hornblende and (or) clinopyroxene, magnetite, and locally abundant rutile.

Ylb

Biotite-quartz-oligoclase gneiss (Mesoproterozoic) – Light-gray-weathering, light-greenish-gray, medium- to coarse-grained, moderately layered and foliated gneiss composed of oligoclase or andesine, quartz, biotite, and local garnet and (or) hornblende. Locally contains thin layers of biotite amphibolite too thin to be shown on the map.

Yh

Hypersthene-quartz-plagioclase gneiss (Mesoproterozoic) – Light-gray or tan-weathering, greenish-gray or greenish-brown, medium-grained, moderately layered and foliated gneiss composed of andesine or oligoclase, quartz, clinopyroxene, hornblende, and hypersthene. Commonly contains conformable layers of amphibolite and mafic-rich quartz-plagioclase gneiss.

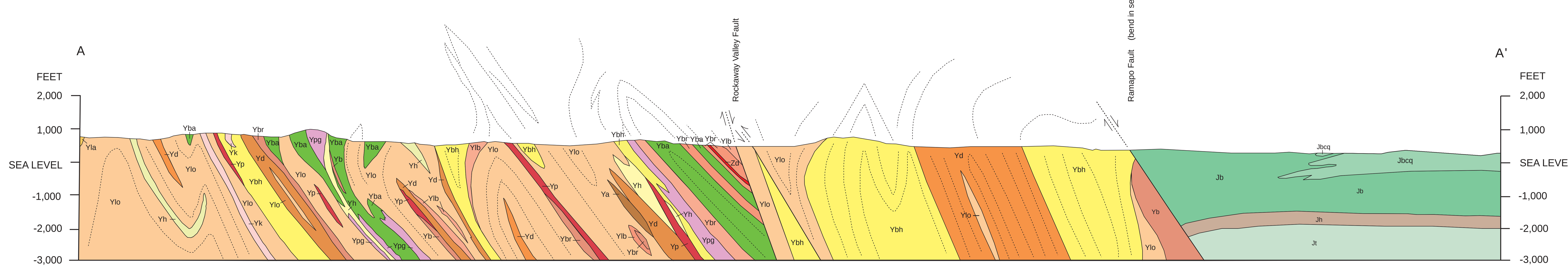
Yd

Diorite gneiss (Mesoproterozoic) – Light-gray or tan-weathering, greenish-gray or greenish-brown, medium-grained, massive, foliated rock containing andesine or oligoclase, clinopyroxene, hornblende, and hypersthene. Thin mafic layers composed of amphibolite are common.

Other Rocks

Ya

Amphibolite (Mesoproterozoic) – Gray to grayish-black, medium-grained gneiss composed of hornblende and andesine. Some variants contain biotite or clinopyroxene. Amphibolite associated with the Losee Suite is metavolcanic in origin. Amphibolite associated with supracrustal rocks may be metavolcanic or metasedimentary in origin. All types are shown undifferentiated on the map.



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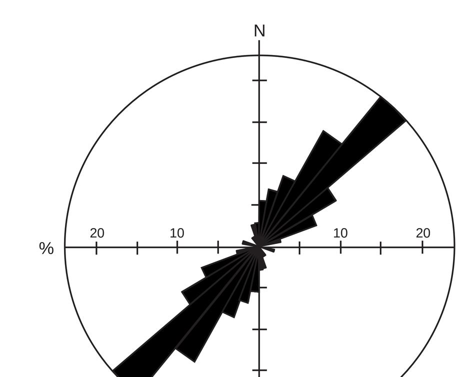
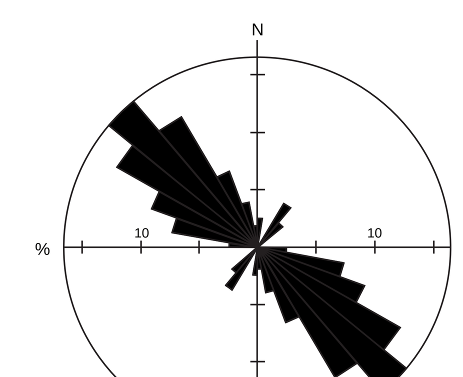


Mean trend = N40°E
Sector size = 10°
n = 888

Figure 1. Rose diagram of 888 crystallization foliation orientations in Mesoproterozoic rocks.



Mean trend = N48°W
Sector size = 10°
n = 895

Figure 2. Rose diagram of 895 joint orientations in Mesoproterozoic rocks.

EXPLANATION OF MAP SYMBOLS

Contact - Dotted where concealed

Fault - Dotted where concealed. Bar and ball show dip of fault plane and arrow indicates dip direction and attitude, where known.

D U 80° Normal fault - U, upthrown side; D, downthrown side

U D 80° Reverse fault - U, upthrown side; D, downthrown side

FOLDS

Fold in Mesozoic and Paleozoic rocks showing trace of axial surface, direction of dip of limbs, and direction of plunge

Syncline

Fold in Mesoproterozoic and Paleozoic rocks showing trace of axial surface, direction of dip of limbs, and direction of plunge

Synform

Antiform

Overturned Synform

Overturned Antiform

PLANAR FEATURES

Strike and dip of beds

50 Inclined

80 Overturned

Strike and dip of crystallization foliation

50 Inclined

50 Strike and dip of mylonitic foliation

LINEAR FEATURES

20° Bearing and plunge of mineral lineation in Mesoproterozoic rocks

OTHER FEATURES

R Abandoned rock quarry

M Abandoned magnetite mine

Drill hole – Rock type at bottom: G, gneiss, granite; C, conglomerate; S, shale

Form lines showing foliation in Mesoproterozoic rocks. Shown in cross section only.

CORRELATION OF MAP UNITS

NEWARK BASIN

Jbcq Jb
Jh
Jt
} JURASSIC

GREEN POND MOUNTAIN REGION

Sl
Sg
} SILURIAN

Unconformity

NEW JERSEY HIGHLANDS

Zd } NEOPROTEROZOIC

Intrusive Contacts

Ygp

Intrusive Contacts

Vernon Supersuite

Byram Intrusive Suite: Ybh Yba
Lake Hopatcong Intrusive Suite: Ypg Ypa

Intrusive Contacts

Back Arc Supracrustal Rocks

Yk, Yb Ybr, Ymh, Yq, Yp, Ymr

Magmatic Arc Rocks

Losee Metamorphic Suite

Ylo, Yla, Ylb, Yh, Yd

Other Rocks

Ya
} MESOPROTEROZOIC