Paleozoic bedding

Bedding in the Paleozoic formations of the Green Pond Mountain Region is fairly uniform and strikes at an average of N.42°E. (fig. 2). Most beds are upright and dip northwest and less commonly southeast. Locally beds are overturned steeply southeast. Beds range in dip from 9° to 90° and average 60°.

The Dover quadrangle is located in northern New Jersey in a mixed commercial, industrial and residen-

remain undeveloped. The quadrangle is in the Rockaway River watershed which constitutes the primary

The Dover quadrangle is situated in the central part of the New Jersey Highlands Physiographic

Province and it is divided into western and eastern segments by the northeast-trending Green Pond

to the uniform trend of the bedrock. The rest of the quadrangle is characterized by variably oriented

and composition of unconsolidated glacial deposits in the map area is discussed by Stanford (1989).

STRATIGRAPHY

Paleozoic rocks

The youngest bedrock in the map area is in the Green Pond Mountain Region, a northeast-trending

block of downfaulted and folded sedimentary rocks of Paleozoic age that extends diagonally through the

central part of the map. From oldest to youngest, Paleozoic formations include the Hardyston Quartzite

and Leithsville Formation of Cambrian age, Green Pond Conglomerate, Longwood Shale, Poxino Island,

age. The Hardyston and Leithsville are rarely exposed in the quadrangle but are known from borings and

water-well records. These formations also crop out to the immediate southwest of the map area. The origin and stratigraphic relationships of the Paleozoic formations in the Green Pond Mountain Region is

Neoproterozoic rocks

near Woodport, at Hurdtown, and along the southern end of Mase Mountain. The dikes range in width

from a few inches to as much as 30 ft., and they strike toward the east, northeast, or northwest. They have coarse-grained interiors and fine-grained to aphanitic chill margins and sharp contacts against

enclosing Mesoproterozoic rocks. Locally the dikes display columnar jointing and contain xenoliths of

Mesoproterozoic rocks. Diabase dikes are interpreted as having been emplaced in a rift-related, exten-

sional tectonic setting in the Highlands at about 600 Ma during breakup of the supercontinent Rodinia

Mesoproterozoic rocks

Most of the quadrangle is underlain by rocks of Mesoproterozoic age of the New Jersey Highlands.

These include a heterogeneous assemblage of granites and gneisses that were metamorphosed to

granulite facies at ca.1050 to 1030 Ma (Volkert et al., 2010). Temperature estimates for this high-grade

metamorphism are constrained from regional calcite-graphite thermometry to ~769°C (Peck et al., 2006)

Among the oldest map units in the quadrangle are calc-alkaline, plagioclase-rich rocks of the Losee

Suite (Drake, 1984; Volkert and Drake, 1999) that were formed in a continental-margin magmatic arc

(Volkert, 2004). These include rocks mapped as quartz-oligoclase gneiss, biotite-quartz-oligoclase

gneiss, hypersthene-quartz-plagioclase gneiss, amphibolite, diorite, and albite-oligoclase alaskite

formed from plutonic and volcanic protoliths (Volkert and Drake, 1999; Volkert, 2004). Representative

samples of the Losee Suite from elsewhere in the Highlands yield sensitive high-resolution ion micro-

Magmatic arc rocks of the Losee Suite are spatially and temporally associated with a succession of

supracrustal rocks formed in a back-arc basin (Volkert, 2004). These include a bimodal suite of rhyolitic

gneiss mapped as potassic feldspar gneiss and mafic volcanic rock mapped as amphibolite, as well as

metasedimentary rocks mapped as biotite-quartz-feldspar gneiss, hornblende-quartz-feldspar gneiss,

clinopyroxene-quartz-feldspar gneiss, and pyroxene gneiss. Supracrustal rocks from elsewhere in the

Other Mesoproterozoic rocks in the quadrangle of uncertain age include biotite-plagioclase gneiss and

interpreted as sills formed from an anorthosite protolith (Young, 1969; Young and Icenhower, 1989).

Hornblende-plagioclase gneiss crops out in two bodies southwest of Mase Mountain. This unit is also

The quadrangle also contains voluminous granite and related rocks of the Byram and Lake Hopatcong

Intrusive Suites that comprise the Vernon Supersuite (Volkert and Drake, 1998). Rocks of these suites

include monzonite, quartz monzonite, granite, and alaskite. These suites are well exposed throughout

the map area where they have intruded rocks of the Losee Suite and supracrustal rocks. Byram and

Lake Hopatcong rocks have a characteristic A-type geochemical composition (Volkert et al., 2000).

The youngest Mesoproterozoic rocks are small, irregular, bodies of granite pegmatite that are unfoliated

and have intruded other Mesoproterozoic rocks. Most of these occur in bodies that are too small to be

Other Mesoproterozoic rock in the quadrangle includes amphibolite of several different origins. Most

amphibolite associated with the Losee Suite is metavolcanic, whereas amphibolite intercalated with the

supracrustal gneisses may be metavolcanic or metasedimentary in origin. All types of amphibolite are

undifferentiated on the map, and most occurrences are too small to be shown.

Granite of both suites yields similar SHRIMP U-Pb ages of 1188 to 1182 Ma (Volkert et al., 2010).

discussed in Darton (1894), Kummel and Weller (1902), and Barnett (1970).

probe (SHRIMP) U-Pb zircon ages of 1282 to 1248 Ma (Volkert et al., 2010).

Highlands yield SHRIMP U-Pb zircon ages of 1299 to 1251 Ma (Volkert et al., 2010).

interpreted as formed from a anorthosite protolith (Young, 1969; Gorring and Volkert, 2004).

level on Mase Mountain, east of Beaver Brook.

(Volkert and Puffer, 1995).

(Volkert et al., 2005).

and from biotite thermometry to ~754°C (Volkert, 2006).

Proterozoic foliation Crystallization foliation in the Mesoproterozoic rocks (formed by the parallel alignment of constituent mineral grains) strikes predominantly northeast at an average of N.39°E. (fig. 3). Foliations locally are somewhat varied in strike, especially in the west-central part of the quadrangle, owing to the folds of all scale, from outcrop to major regional extent. Foliations dip mainly southeast and very locally dip northwest, although in the hinge areas of fold structures dips are gentle to moderate toward the north. Dips range from 20° to 90° and average 62°.

Folds in the Paleozoic rocks are dominated by a major regional synclinorium in the Green Pond Mountain Region. Beds on Copperas Mountain form an asymmetric, northeast-plunging upright syncline (Herman and Mitchell, 1991), the axis of which extends just west of the ridge crest. Beds on the west limb dip gently to moderately, whereas beds on the east limb dip steeply to vertically. The pattern of folding on Green Pond Mountain is more complex and consists of both upright and overturned synclines

Characteristic fold styles in the Mesoproterozoic rocks consist of northeast-plunging and northwestoverturned to northeast-plunging and upright antiforms and synforms. The plunge of mineral lineations and fold axes is parallel and averages 18°. The plunge trend ranges from N.23°E. to N.76°E. and averages N.52°E., with nearly 60 percent of all lineations plunging from N.45°E. to N.54°E. No southwest plunging lineations or folds were recognized. The overall sequence of folding is uncertain. It may be a continuum of the same fold phase that resulted from differences in the vector of compressional stress. Regardless, the folds clearly predate the development of folds in the Paleozoic rocks of the quadrangle and thus are of Mesoproterozoic age.

Northeast-trending faults are the most common in the Dover quadrangle and they deform both Mesoproterozoic and Paleozoic rocks. Some of the wider fault zones are possibly due to the interaction of several smaller parallel or anastomosing faults, rather than consisting of a single, discrete fault. From the northwest, the major faults are the Reservoir, Ledgewood, Longwood Valley, Berkshire Valley, Picatinny, Tanners Brook-Green Pond, and Gorge fault, that partition the map area into a series of structural blocks (fig. 1). In the Mesoproterozoic rocks, these faults are characterized by brittle deformation fabric that consists of breccia, gouge, retrogression of mafic mineral phases, chlorite or epidote-coated fractures or slickensides, and (or) close-spaced fracture cleavage.

The Reservoir fault has a strike length of about 37 miles, extending from New York State southwest to Schooleys Mountain (Drake et al., 1996). Along its northern end, the fault has Paleozoic rocks on the hanging wall and Mesoproterozoic rocks on the footwall, but in the map area, and along strike to the south, it contains Mesoproterozoic rocks on both the hanging wall and footwall blocks. The Reservoir fault strikes about N.40°E. and ranges in dip from steep northwest or southeast to 90°. The fault records a history of multiple reactivations dating from the Mesoproterozoic involving normal, strike slip, and reverse movement, with latest movement having been normal (east side down). The Reservoir fault is characterized by ductile deformation fabric in the center of the fault zone, overprinted by a pervasive brittle deformation fabric that envelops the mylonite on both sides of the fault zone over a total width of as much as 1,000 ft.

The Ledgewood fault has a strike length of about 10 miles. South of the map area it merges with, or is cut off by, the Longwood Valley fault, and within the area it is cut off by the Reservoir fault north of Lake

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Shawnee. The Ledgewood fault strikes about N.25°E. and dips steeply southeast at about 70°. It contains Mesoproterozoic rocks on both sides along its entire length. Latest movement on the fault appears to have been dip-slip normal. The Ledgewood fault is characterized by a zone of brittle deformation fabric that is tial setting. Development is fairly extensive south of Route 80, whereas large tracts of land to the north

The Longwood Valley fault has a strike length of nearly 40 miles, extending from Oak Ridge Reservoir south to the vicinity of High Bridge where it is cut off by a segment of the border fault (Drake et al., 1996). Along much of its length the fault contains Mesoproterozoic rocks on the footwall and Paleozoic rocks on the hanging wall. In the map area, the fault strikes about N.45°E. and dips steeply northwest to vertically. Mountain Region (fig. 1). The topography of the central part of the quadrangle is dominated by a series The fault is characterized by brittle deformational fabric along its entire length. Kinematic indicators suggest that latest movement on the Longwood Valley fault was predominantly reverse, although south of of broad, linear, northeast-trending ridges (Green Pond and Copperas Mountains) and intervening stream valleys that are underlain by rocks of Paleozoic age. The linearity of the ridges and valleys is due the map area the fault dips southeast and dip-slip normal movement is predominant.

ridges and stream valleys that reflect the greater structural complexity and nonlinear trend of the under-The northeast-trending Berkshire Valley fault is not exposed in the map area, and its occurrence was lying Mesoproterozoic bedrock. The maximum elevation in the map area is about 1,320 feet above sea inferred by Herman and Mitchell (1991) on the basis of missing stratigraphic units between the Green Pond Conglomerate and Cornwall Shale in the Berkshire Valley. This fault has a strike length of more than 8 miles, extending along the northwest side of Green Pond Mountain southwestward where it is cut off by All of the bedrock in the map area has been affected by the effects of Pleistocene-age glaciation. The the Longwood Valley fault. The Berkshire Valley fault contains Paleozoic rocks on both sides along its terminal moraine, which records the southernmost advance of glacial ice, trends roughly east-west entire length. It strikes about N.40°E. and dips southeast at about 45°. The latest movement appears to through the southern part of the quadrangle, nearly coincident with Route 80. The distribution, thickness have been reverse. The fault is characterized by a zone of brittle fabric of indeterminate width.

> The northeast-trending Picatinny fault has a strike length of more than 11 miles, extending along the southeast side of Green Pond Mountain (Herman and Mitchell, 1991). The fault contains Paleozoic rocks on both sides along most of its length except for a short segment near Picatinny Lake, where Mesoproterozoic rocks are on the hangingwall. Leithsville Formation is on the hanging wall and Green Pond Conglomerate on the footwall along most of the length of the fault. The Picatinny fault strikes N.40°E. and dips southeast at about 50°. Latest movement appears to have been reverse. The fault is characterized by a zone of brittle fabric that has a total width of as much as a few hundred feet.

and Berkshire Valley Formations of Silurian age, and the Connelly Conglomerate, Esopus Formation, The Tanners Brook-Green Pond fault is a structure resulting from the merger of the Green Pond fault, that Kanouse Sandstone, Cornwall Shale, Bellvale Sandstone and Skunnemunk Conglomerate of Devonian extends along the northwest side of Copperas Mountain from near Newfoundland to Picatinny Lake (Kummel and Weller, 1902; Barnett, 1976; Herman and Mitchell, 1991), and the Tanners Brook fault that extends from Picatinny Lake southwest to Califon where it bounds the south side of Long Valley (Volkert et al., 1990). The combined fault has a length of about 30 miles. It contains mainly Paleozoic rocks on both sides to the north and Mesoproterozoic rocks on both sides from Chester southwest to Califon. The fault strikes N.40°E. and dips northwest at about 75°. Latest movement on the fault in the map area was predominantly reverse. The Tanners Brook-Green Pond fault is characterized by a zone of brittle fabric Diabase dikes of Neoproterozoic age intrude Mesoproterozoic rocks in the northwest part of the map 300 to 400 ft, wide.

> The Gorge fault is a newly recognized structure that is named for the prominent gorge at Picatinny Arsenal. The fault has a strike length of about 6 miles, extending along the southeast side of Green Pond Mountain north to Newfoundland. The Gorge fault appears to be cut off on both ends by the Tanners Brook-Green Pond fault. The Gorge fault contains Mesoproterozoic rocks on the hanging wall and Green Pond Conglomerate on the footwall. The fault strikes N.40°E. and dips about 60° southeast. Latest movement appears to have been reverse. The fault is characterized by ductile deformation fabric that is overprinted by strong brittle fabric over a total width of about 500 ft.

> Mesoproterozoic rocks throughout the map area are also deformed by smaller, more localized faults. These northeast-trending or northwest-trending faults have widths of not more than a few tens of feet. Northwest-trending cross faults dip toward the south at about 50° to nearly vertical. Most of these faults are not exposed and are known from the subsurface offset of the orebodies in magnetite mines (Bayley,

> Joints are a common feature in the Paleozoic and Mesoproterozoic rocks of the quadrangle. They are characteristically planar, moderately well formed, and moderately to steeply dipping. Their surfaces are typically unmineralized, except near faults, and are smooth, and less commonly, slightly irregular. Joints are variably spaced from a ft. to tens of ft. Those developed in massive rocks such as Mesoproterozoic granite or Paleozoic conglomerate and quartzite tend to be more widely spaced, irregularly formed and discontinuous than joints developed in the Mesoproterozoic layered gneisses and finer-grained Paleozoic rocks. Joints formed near faults have a spacing of 2 ft. or less.

> The dominant joint trend in the Mesoproterozoic rocks is nearly perpendicular to the strike of crystallization foliation, and this relationship is a consistent feature in Mesoproterozoic rocks throughout the Highlands (Volkert, 1996). Consequently, joint trends in the map area are somewhat varied because of folding of Mesoproterozoic rocks. The dominant joint set strikes northwest at an average of N.54°W. (fig. 4). Joints of this set dip southwest at an average of 73 . A subordinate joint set strikes about N.42°E. (fig. 4) and dips gently to moderately northwest.

Within the Paleozoic rocks, northwest-trending cross joints are the most common. These joints strike at an average of N.40°W. (fig. 5) and dip nearly equally northwest and southeast at about 50°.

ECONOMIC RESOURCES

Some Mesoproterozoic rocks in the quadrangle were host to economic deposits of magnetite (iron ore) mined predominantly during the 19th century. Detailed descriptions of the mines are given in Bayley (1910) and Sims (1958). Iron mines are distributed throughout the guadrangle, but the most economically important ones are in the south-central part in the Mount Hope district. The Mount Hope and Scrub Oaks mines were among the largest of these. The latter was especially notable for the presence of rare-earth elements in the deposit (Klemic et al., 1959).

the Cornwall Shale and placed where beds thicken and volume of shale and siltstone is about

Esopus Formation (Vanuxem, 1842; Boucot, 1959) - Light to dark-gray, laminated to

thin-bedded siltstone interbedded with dark-gray to black mudstone, dusky-blue sandstone

and siltstone, and yellowish-gray, fossiliferous siltstone and sandstone. Lower contact prob-

Connelly Conglomerate (Chadwick, 1908) - Grayish-orange-weathering, very light gray to

greenish-gray calcareous siltstone and silty dolomite, medium-gray to light-gray dolomite

Poxino Island Formation (White, 1882; Barnett, 1970) - Very thin to medium-bedded

sequence of medium-gray, greenish-gray, or yellowish-gray, mud-cracked dolomite; light-

green, pitted, medium-grained calcareous sandstone, siltstone, and edgewise conglomerate

containing gray dolomite; and quartz-pebble conglomerate containing angular to subangular

Longwood Shale (Upper and Middle Silurian) (Darton, 1894) - Dark reddish-brown, thin to

very thick-bedded shale interbedded with cross-bedded, very dark-red, very thin to

thin-bedded sandstone and siltstone. Lower contact is conformable with Green Pond

pebbles as much as 0.8 in. long. Interbedded grayish-green shale at lower contact is transi-

tional into underlying Longwood Shale. Unit ranges in thickness from 160 to 275 ft.

conglomerate, and grayish-black thinly laminated shale. Lower contact conformable with

ably conformable with Connelly Conglomerate. Unit is about 180 ft. thick.

well rounded, well sorted, and as much as 0.8 in. long. Unit is about 36 ft. thick.

Berkshire Valley and Poxino Island Formations, undivided (Upper Silurian)

Poxino Island Formation. Unit ranges in thickness from 90 to 125 ft.

equal. Unit is 1,750 to 2,000 ft. thick.

(Lower Devonian)

tional. Unit is about 46 ft. thick.

Conglomerate. Unit is 330 ft. thick.

Mesoproterozoic rocks in the map area are currently being quarried for crushed stone at Woodport and weathering, white, pale-pinkish-white or light-gray, medium to coarse-grained, foliated gneiss Mount Hope, and were formerly quarried for crushed stone on a small scale at Picatinny Arsenal. Green composed of microcline, quartz, oligoclase, diopside, and trace amounts of titanite, magne-Pond Conglomerate was formerly quarried at Roxbury. Deposits of sand and gravel are being mined at shown on the map. Pegmatites elsewhere in the Highlands yield U-Pb zircon ages of 1004 to 987 Ma

Kenvil, and were formerly worked at various locations (Stanford, 1989).

DESCRIPTION OF MAP UNITS Losee Metamorphic Suite (Drake, 1984; Volkert and Drake, 1999) **GREEN POND MOUNTAIN REGION**

Bellvale Sandstone (Middle Devonian) (Bellvale Flags of Darton, 1894; Willard, 1937) – Upper beds are grayish-red to grayish-purple sandstone containing quartz pebbles as much as 1 in. in diameter. Lower beds are light-olive-gray to yellowish-gray- and greenish-blackweathering, medium-gray to medium-bluish-gray, very thin to very thick-bedded siltstone and sandstone crossbedded, graded, and interbedded with black to dark-gray shale. More sandthin, conformable layers within diorite. stone occurs in upper beds and becomes finer downward. Lower contact conformable with

Cornwall Shale (Middle Devonian) (Hartnagel, 1907) - Black to dark-gray, very thin to thick-bedded, fossiliferous, fissile shale, interbedded with medium-gray and light-olive-gray to yellowish-gray, laminated to very thin bedded siltstone that increases in upper part. Lower contact with Kanouse Sandstone probably conformable. Unit is about 950 ft. thick.

Kanouse Sandstone, Esopus Formation and Connelly Conglomerate, undivided Kanouse Sandstone (Kummel, 1908) – Medium-gray, light-brown, and grayish-red, fine- to coarse-grained, thin to thick-bedded sandstone and pebble conglomerate. Basal conglomerate is interbedded with siltstone and contains well-sorted, subangular to subrounded, gray and white quartz pebbles less than 0.4 in. long. Lower contact with Esopus Formation grada-

amphibolite and leucocratic to mafic layers of quartz-oligoclase gneiss occur locally.

yellowish-gray, thin-bedded quartz-pebble conglomerate. Quartz pebbles are subrounded to Berkshire Valley Formation (Barnett, 1970) – Yellowish-gray-weathering, medium-gray to metavolcanic or metasedimentary. All types are undifferentiated on the map. pinkish-gray, very thin to thin-bedded fossiliferous limestone interbedded with gray to

of hornblende, clinopyroxene, and garnet.

Mesoproterozoic rocks, undifferentiated – Shown in cross section only.

EXPLANATION OF MAP SYMBOLS

----- Contact - Dotted where concealed ------ Faults - Dotted where concealed. Arrow indicates dip direction and attitude, where known. Normal fault - U, upthrown side; D, downthrown side

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

lar to subrounded white quartz pebbles as much as 1 in. long. Lower contact unconformable with Mesoproterozoic rocks. Unit ranges from 0 to 30 ft. thick regionally. NEW JERSEY HIGHLANDS

rocks but not Paleozoic cover rocks. Composed principally of labradorite to andesine, augite, and ilmenite and (or) magnetite. Pyrite blebs are common. Contacts are chilled and sharp against enclosing Mesoproterozoic rocks. Dikes are as much as 30 ft. wide and a mile or

Green Pond Conglomerate (Middle and Lower Silurian) (Rogers, 1836) - Medium to

parse-grained quartz-pebble conglomerate, quartzitic arkose and orthoquartzite, and thin to

thick-bedded reddish-brown 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 red shale, siltstone, sandstone, and chert; yellowish-gray

sandstone and chert; dark-gray shale and chert; and white-gray and pink milky quartz. Quartz

cobbles are as much as 4 in. long. Unconformably overlies the Leithsville Formation or Meso-

Leithsville Formation (Middle and Lower Cambrian) (Wherry, 1909) – Light to dark-gray

ward through medium-gray, grayish-yellow, or pinkish-gray dolomite and dolomitic sand-

stone, siltstone, and shale to medium-gray, medium-grained, medium-bedded dolomite

containing quartz sand grains as stringers and lenses near the base. Lower contact grada-

and light-olive-gray, fine to medium-grained, thin to medium-bedded dolomite. Grades down-

proterozoic rocks in the map area. Unit is about 1,000 ft. thick.

tional with Hardyston Quartzite. Approximately 800 ft thick regionally.

gneiss composed of mesoperthite, microcline microperthite, quartz, oligoclase, and hastingsite. Common accessory minerals include zircon, apatite and magnetite. Contains small podies of pegmatite too small to be shown. Microperthite alaskite (Mesoproterozoic) - Pale pinkish-white- or buff-weathering,

Hornblende granite (Mesoproterozoic) – Pinkish-gray or buff-weathering, pinkish-white or

pinkish-white, medium- to coarse-grained, massive, foliated rock composed of microcline nicroperthite, quartz, oligoclase, and trace amounts of hastingsite, biotite, zircon, apatite, and magnetite. Lake Hopatcong Intrusive Suite (Drake and Volkert, 1991)

Pyroxene granite (Mesoproterozoic) - Buff or white-weathering, greenish-gray, medium to parse-grained, foliated granite containing mesoperthite to microantiperthite, quartz, oligoclase, and hedenbergite. Common accessory minerals include titanite, magnetite, apatite, and trace amounts of zircon and pyrite.

Pyroxene monzonite (Mesoproterozoic) - Gray, buff, or tan-weathering, greenish-gray, nedium to coarse-grained, massive, moderately to indistinctly foliated syenite to monzonite. Composed of mesoperthite, microantiperthite to microcline microperthite, oligoclase, hedenbergite, titanite, magnetite, and apatite. Locally contains sparse quartz and (or) hornblende.

> pinkish-gray, medium- to coarse-grained, massive, foliated rock composed of mesoperthite to microantiperthite, quartz, oligoclase, and sparse amounts of hedenbergite. Common accessory minerals include titanite, magnetite, apatite, and zircon.

Biotite-quartz-feldspar gneiss (Mesoproterozoic) – Pale pinkish-white, pinkish-gray, or gray-weathering, locally rusty-weathering, pinkish-gray, tan, or greenish-gray, fine to coarsegrained, moderately layered and foliated gneiss containing microcline microperthite, bligoclase, quartz, biotite, and garnet. Very locally contains kornerupine. Graphite and pyrrhotite are confined to the variant that weather rusty. The rusty variant is commonly associated with thin, layered quartzite containing biotite, feldspar, graphite, and pyrrhotite.

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

yroxene gneiss (Mesoproterozoic) - Light-gray or white-weathering, greenish-gray or ght-greenish-gray, medium-grained, layered and foliated gneiss containing oligoclase, diopside, varied amounts of quartz and titanite, and trace amounts of magnetite and epidote.

gray or light greenish-gray, layered and foliated quartz-epidote gneiss. Magmatic Arc Rocks

Biotite-quartz-oligoclase gneiss (Mesoproterozoic) - Light-gray-weathering, lightgreenish-gray, medium to coarse-grained, layered and foliated gneiss composed of oligoclase or andesine, quartz, biotite, and local hornblende. Locally contains conformable

Albite-oligoclase alaskite (Mesoproterozoic) - Pale pink, or white-weathering, lightgreenish-gray or light-pinkish-green, medium to coarse-grained, foliated rock composed of Locally contains rutile. Commonly contains conformable layers of amphibolite.

foliated, greasy lustered gneiss composed of andesine or oligoclase, quartz, augite, hornblende, hypersthene, and magnetite. Commonly contains conformable layers of amphibolite and quartz-plagioclase gneiss containing hornblende and augite.

gray, medium-grained, foliated gneiss composed of biotite, plagioclase, and varied amounts

and local clinopyroxene, apatite, and magnetite.

and bluish-gray conglomeratic sandstone. Varies from pebble conglomerate, to fine-grained, well-cemented quartzite, to arkosic or dolomitic sandstone. Conglomerate contains subangulimbs, and direction of plunge

Diabase dikes (Neoproterozoic) (Volkert and Puffer, 1995) - Light-gray to brownish-grayweathering, dark-greenish-gray, aphanitic to fine-grained dikes that intrude Mesoproterozoic

Vernon Supersuite (Volkert and Drake, 1998) Byram Intrusive Suite (Drake, 1984)

light-pinkish-gray, medium- to coarse-grained, massive, foliated granite and sparse granite

Pyroxene alaskite (Mesoproterozoic) - Buff or white-weathering, greenish-buff or light

Supracrustal Rocks

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, biotite, and magnetite. Garnet and sillimanite

Clinopyroxene-quartz-feldspar gneiss (Mesoproterozoic) – Pinkish-gray or pinkish-buff-

Locally interlayered with clots and layers of dark-green, medium to coarse-grained diopsidite composed almost entirely of diopside. West of Longwood Lake unit is interlayered with light-

Quartz-oligoclase gneiss (Mesoproterozoic) - White-weathering, light-greenish-gray, medium to coarse-grained, layered to massive, foliated gneiss composed of oligoclase or andesine, quartz, and varied amounts of hornblende, augite, biotite, and magnetite. Locally contains layers of amphibolite too thin to be shown. Commonly has gradational contacts with biotite-quartz-oligoclase gneiss and hypersthene-quartz-plagioclase gneiss. Locally forms

albite or oligoclase, quartz, and variable amounts of hornblende, augite and magnetite. Hypersthene-quartz-plagioclase gneiss (Mesoproterozoic) – Light-gray or tan-weathering, greenish-gray or greenish-brown, medium-grained, moderately layered and

Diorite (Mesoproterozoic) - Light-gray or tan-weathering, greenish-gray or greenish-brown, medium-grained, greasy lustered, massive, foliated rock containing andesine or oligoclase, augite, hornblende, hypersthene, and magnetite. Thin mafic layers having the composition of

Biotite-plagioclase gneiss (Mesoproterozoic) – White or light-gray-weathering, greenish-

Amphibolite (Mesoproterozoic) - Grayish-black-weathering, black or grayish-black, nedium-grained gneiss composed of hornblende, andesine, and magnetite. Some variants contain biotite and others contain augite and local hypersthene. Amphibolite associated with the Losee Suite is metavolcanic in origin and that associated with supracrustal rocks may be

Hornblende-plagioclase gneiss (Mesoproterozoic) - White or light-gray-weathering, greenish-gray, medium- to coarse-grained, foliated rock containing hornblende, plagioclase,

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

Hardyston Quartzite (Lower Cambrian) (Wolff and Brooks, 1898) – Light to medium-gray Folds in Proterozoic rocks showing trace of axial surface, direction of dip of

Overturned Synform

Strike and dip of beds

─ Vertical Overturned

Overturned Antiform

→ 20 Bearing and plunge of mineral lineation in Proterozoic rocks

Strike and dip of crystallization foliation

Strike and dip of mylonitic foliation LINEAR FEATURES

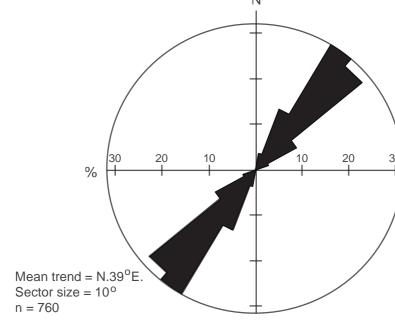
Abandoned magnetite mine

Active rock quarry Abandoned rock quarry

Stanhope block

Drill hole – Rock type at bottom: G, granite; D, dolomite; Q, quartzite = = = = Form lines showing foliation in Proterozoic rocks. Shown in cross section

OTHER FEATURES



% | | | |

Sector size = 10^c

Mean trend = N.54⁰V

Mean trend = N.40°V

Sector size = 10

Sector size = 10^o

n = 861

n = 116

Figure 3. Rose diagram of 760 crystallization foliation orientations in Mesoproterozoic rocks

Figure 4. Rose diagram of 861 joint orientations in Mesoproterozoic rocks

Figure 2. Rose diagram of 116 bedding orientations in Paleozoic rocks

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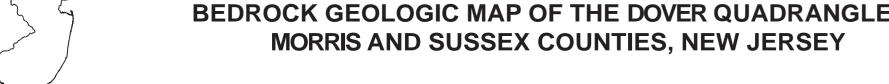
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LOCATION IN

NEW JERSEY

Base map U.S. Geological Survey, 1981



Richard A. Volkert 2012

SCALE 1:24 000

HHH H



Bedrock geology mapped by R.A. Volkert in 1988, 2001, and 2002 Paleozoic geology adapted from G.C. Herman and J.P. Mitchell (1991)

Research supported by the U. S. Geological Survey, National Cooperative

Geological Mapping Program, under USGS award number 99HQAG0141

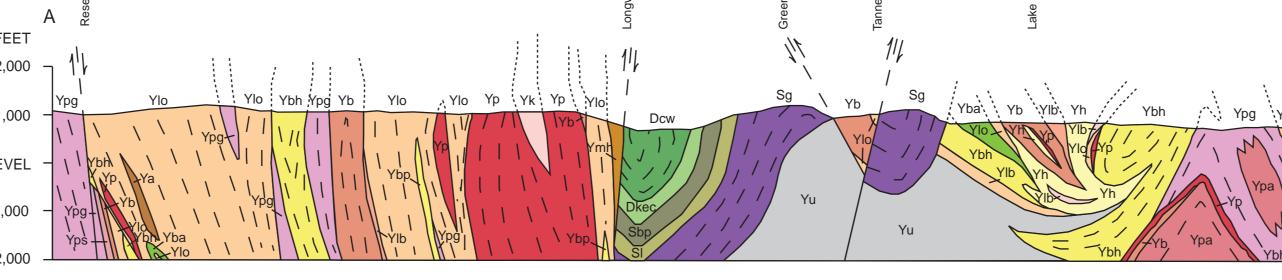
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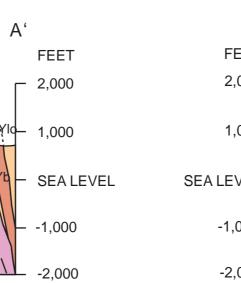
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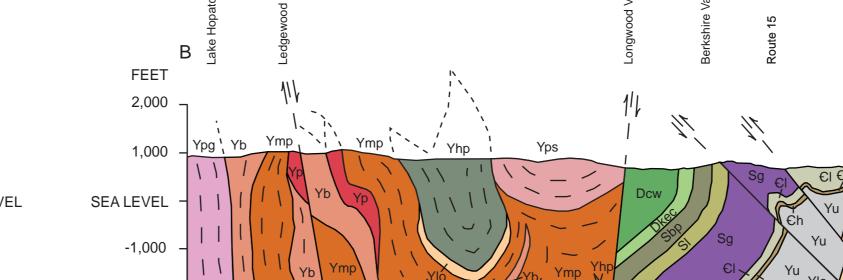
APPROXIMATE MEAN DECLINATION, 1999

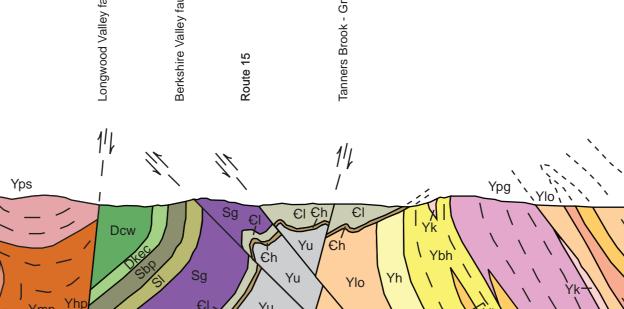
The views and conclusions contained in this document are those of the author

Digital cartography by M.W. Girard









Dover block

Figure 1. Simplified map of the Dover quadrangle showing locations of the principal

structural blocks and the faults that bound them.

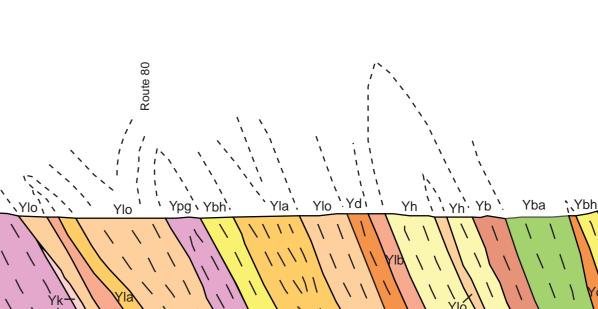
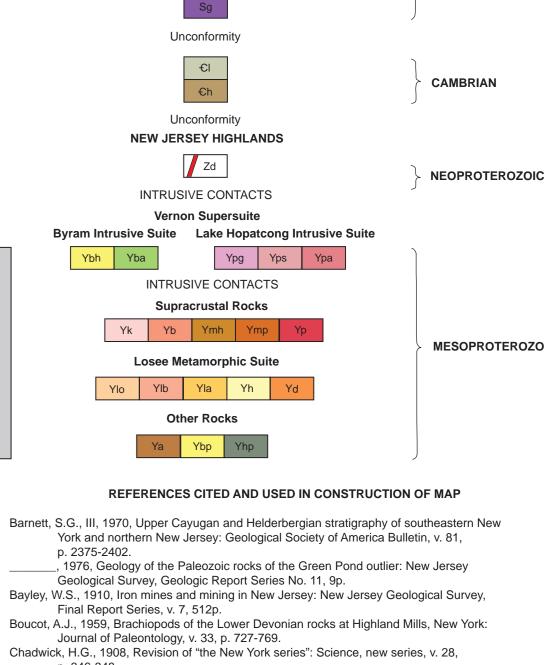


Figure 5. Rose diagram of 138 joint orientations in Paleozoic rocks

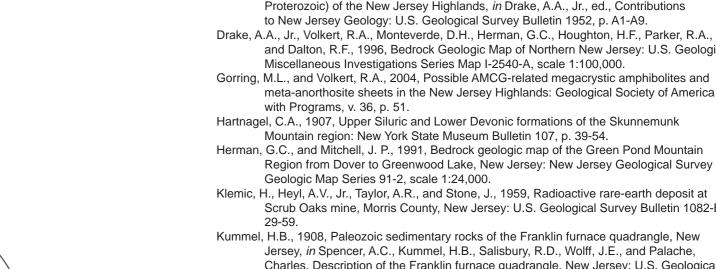


BEDROCK GEOLOGIC MAP OF THE DOVER QUADRANGLE

CORRELATION OF MAP UNITS

GREEN POND MOUNTAIN REGION

MORRIS AND SUSSEX COUNTIES, NEW JERSEY



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