Highlands: Geological Society of America Abstracts with Programs, v. 22,

map of the Stanhope quadrangle, Sussex and Morris Counties, New Jersey:

U.S. Geological Survey Geologic Quadrangle Map GQ-1671, scale

New Jersey Highlands: a remnant of Iapetan rifting in the north-central

Appalachians, in Drake, A.A., Jr., editor, Geologic studies in New Jersey

Volkert, R.A., Monteverde, D.H., and Drake, A.A., Jr., 1989, Bedrock geologic

Volkert, R.A., and Puffer, J.H., in press, Late Proterozoic diabase dikes of the

and eastern Pennsylvania: U.S. Geological Survey Professional Paper.

Weller, Stuart, 1903, The Paleozoic faunas: Geological Survey of New Jersey

Report on Paleontology, v. 3, 462 p.

SEA LEVEL

2,000

map area.

and Allamuchy Mountains.

Lake Hopatcong Intrusive Suite

Pyroxene granite (Middle Proterozoic) - Gray to buff- or white-

weathering, greenish-gray, medium- to coarse-grained,

massive, gneissoid to indistinctly foliated granite containing mesoperthite to microantiperthite, quartz, oligoclase, and

clinopyroxene. Common accessories include titanite,

magnetite, apatite, and trace amounts of pyrite. Some phases

are quartz monzonite, quartz monzodiorite or granodiorite.

Locally includes small bodies of amphibolite not shown on map. Mainly exposed on County House, Upper Pohatcong,

NEW JERSEY GEOLOGICAL SURVEY INTRODUCTION DESCRIPTION OF MAP UNITS VALLEY AND RIDGE STRUCTURAL GEOLOGY Warren County occupies about 364 square miles in northwestern New The northwestern half of Warren County, from the southeastern side Deformation in the Paleozoic rocks includes jointing, cleavage, Bloomsburg Red Beds (Upper Silurian) (High Falls Formation Yps Pyroxene syenite (Middle Proterozoic) - Gray- to buff- or tan-Jersey. It straddles two physiographic regions, the Valley and Ridge and of Kittatinny Valley to the Delaware River in the north, lies within the veining, folding and faulting. Jointing is common in the more massive the New Jersey Highlands (fig. 1). Elevations range from 1,560 feet above of previous usage) - Grayish-red, thin- to thick-bedded, weathering, greenish-gray, medium- to coarse-grained, Valley and Ridge Province. Bedrock ranges in age from Lower Cambrian rocks such as limestone, dolomite, sandstone and conglomerate and less sea level on Kittatinny Mountain to 160 feet above sea level along the massive, indistinctly foliated rock composed of mesoperthite massive siltstone, sandstone, and local quartz-pebble to Upper Silurian. Formations from Cambrian through Ordovician in age common in shale and slate. Joint spacing varies, becoming closer near fold to microantiperthite, oligoclase and clinopyroxene. Contains Delaware River. conglomerate, poorly to moderately well sorted, containing make up the Kittatinny Valley Sequence. These rocks were previously local planar to trough cross-bedded laminations. sparse accessory quartz, titanite, magnetite, and trace considered part of the Lehigh Valley Sequence of MacLachlan (1967), but Middle and Late Proterozoic rocks of the Highlands underlie a series were reassigned by Drake and others (in press). The Kittatinny Valley Conglomerate consists of matrix-supported quartz pebbles in amounts of pyrite. Unit occurs mainly in the Allamuchy of northeast-trending ridges. These are, from northwest to southeast, Jenny grayish-red, fine-grained sandstone matrix. Locally, near Mountain area, but has been mapped as far south as Oxford Sequence includes the Kittatinny Supergroup, the "Sequence at Wantage," Jump Mountain, Marble Mountain, Scotts Mountain, County House base of unit, consists of greenish-gray, light-gray, or grayishon County House Mountain. the Jacksonburg Limestone, and the Martinsburg Formation. This Mountain, Pohatcong Mountain, Upper Pohatcong Mountain, and orange, massive, planar tabular to trough cross-bedded assemblage consists of thin basal clastics overlain by carbonates, in turn Allamuchy Mountain. These ridges are separated by broad, northeast-Pyroxene alaskite (Middle Proterozoic) - Light-gray or tanquartz siltstone to sandstone; grains are subrounded. Lower overlain by a thick assemblage of flysch to molasse clastic rocks. The trending valleys underlain by Paleozoic dolomite, limestone, sandstone, weathering, greenish-buff to light-pinkish-gray, medium- to **ENVIRONMENTAL GEOLOGY OF WARREN COUNTY, NEW JERSEY:** part of formation marked by several fining-upward Taconic unconformity, at the base of Kittatinny Mountain, separates the and shale of the Kittatinny Valley Sequence. The Kittatinny Valley sequences of light-gray sandstone grading through grayishcoarse-grained, massive, moderately foliated granite Kittatinny Valley Sequence from the Lower to Upper Silurian Shawangunk Sequence also underlies Kittantinny Valley, the large, open lowland of composed of mesoperthite to microantiperthite, oligoclase, Formation and Bloomsburg Red Beds. These younger units consist of basal red, fine sandstone to siltstone to grayish-red, mud-cracked press) shows detailed information on the joints and cleavage in the **BEDROCK GEOLOGY** moderate topographic relief that lies between the Highlands and Kittatinny and quartz. Common accessories are clinopyroxene, titanite siltstone to mudstone. Each sequence is 3-9 ft. thick. Lower quartzite and conglomerate that grade upward into interbedded sandstone Paleozoic rocks. Mountain. Kittatinny Mountain is a prominent northeast-trending ridge and magnetite. Locally includes small bodies of amphibolite contact placed at bottom of lowermost red sandstone. and shale. The Kittatinny Valley Sequence rocks were deformed during the underlain by dense and resistant Paleozoic conglomerate and quartzite. not shown on map. Unit occurs sporadically on County Thickness approximately 1,500 ft. Locally exploited for Taconic and Alleghanian orogenies. The Shawangunk and Bloomsburg by
Donald H. Monteverde, <sup>1</sup> Richard A. Volkert, <sup>1</sup> Gregory C. Herman, <sup>1</sup>
Avery Ala Drake, Jr., <sup>2</sup> Jack B. Epstein, <sup>2</sup> and Richard Dalton <sup>1</sup> House and Upper Pohatcong Mountains. copper at the Pahaquarry Mine. Unit occupies northwest experienced only the Alleghanian orogeny. The purpose of this map is to provide detailed geologic information on the distribution and lithologic character of the various bedrock types in Metasedimentary Rocks NEW JERSEY HIGHLANDS Warren County and the structures, such as folds and faults, that affect these Shawangunk Formation (Middle and Lower Silurian) - Upper Yk Potassic feldspar gneiss (Middle Proterozoic) - Light-gray to Rocks of the Highlands are predominently of Middle and Late part is medium- to medium-dark-gray, or dark-greenish-gray, Musconetcong Valley and the Riegelsville and Alpha areas. pinkish-buff-weathering, pinkish-white to light-pinkish-gray, Proterozoic age. Rocks of the Kittatinny Valley Sequence underlie valleys medium- to thick-bedded sandstone and pebble fine- to medium-grained, moderately foliated gneiss and within the Highlands. The Middle Proterozoic rocks consist of conglomerate having well rounded grains; some limonite lesser granofels composed of quartz, microcline, microcline heterogeneous metasedimentary and metavolcanic gneisses and granofels staining. Conglomerate consists of matrix-supported quartz microperthite and local accessory biotite, garnet, sillimanite, intruded by two suites of syn-kinematic granite (Drake, 1984; Volkert and and subordinate shale pebbles as long as 2 in. in poorly- to and opaque minerals. Locally contains thin, layered well-sorted, planar tabular to trough cross-bedded sandstone. Drake, 1990). These are Lake Hopatcong Intrusive Suite of Drake and metaquartzite which may be garnetiferous. Unit is most Volkert (1991) and the Byram Intruive Suite of Drake (1984). The oldest Locally, black to dark-greenish-gray, thin-bedded shale abundant on Scotts Mountain. rocks are plagioclase-rich gneiss and associated amphibolite of the Losee occurs near upper contact. Middle part, occurring in Metamorphic Suite of Drake (1984), a metamorphosed sequence of southwest and sporadically in northeast, is light- to medium-Microcline gneiss (Middle Proterozoic) - Light-gray to pinkishdark-gray, to greenish-gray, interbedded thin- to mediumextrusive (dacite, basalt) and intrusive (tonalite, trondhjemite) rocks (Puffer white-weathering, tan to pinkish-white, fine- to mediumand unmineralized, and dip moderately to steeply. As in the Paleozoic and Volkert, 1991). These rocks are associated with charnockitic gneiss bedded shale and sandstone, planar tabular to trough crossgrained, well-layered rock composed principally of quartz, rocks, two sets dominate: northeast-trending strike joints and northwestand granulite that have metavolcanic and intrusive protoliths, respectively. bedded. Grains are well rounded and moderately to well microcline, and lesser oligoclase. Common accessories trending cross joints. Subordinate poorly developed sets occur also. The sorted. Contains sparse graphite flakes. Lower part is light-Unconformably overlying the Losee and charnockitic rocks are include biotite, garnet, magnetite, and local sillimanite. quartzofeldspathic gneiss of arkosic and graywacke sandstone to medium-gray to light-olive-gray, thin- to thick-bedded Confined to several areas near Allamuchy Mountain west composition, quartzite, calc-silicate gneiss, and marble. Rocks of the quartz and feldspathic sandstone, quartzite, and quartzand north of Allamuchy Pond. the Middle Proterozoic rocks. Byram and Lake Hopatcong Intrusive Suites intrude all the previously pebble conglomerate, matrix-supported, poorly- to wellsorted, cross- to planar-bedded. Clasts are primarily quartz, described Proterozoic rocks. Middle Proterozoic rocks were regionally Yb Biotite-quartz-feldspar gneiss (Middle Proterozoic) - Graymetamorphosed under conditions of upper amphibolite to hornblende lesser dark-gray argillite and black chert. Sandstone is weathering, locally rusty, gray to tan or greenish-gray, finegranulite facies. The Late Proterozoic Chestnut Hill Formation (Drake, feldspathic and locally approaches an arkose in composition. to medium-coarse-grained, moderately layered and foliated 1984) is a weakly to non-metamorphosed sequence of interbedded clastic Lower contact is unconformable and locally faulted. gneiss that is variable in texture and composition. Composed **CONTOUR INTERVAL 10 FEET** of oligoclase, microcline microperthite, quartz, and biotite. and metavolcanic rocks and metasaprolite locally preserved as erosional Thickness approximately 1,400 ft. Unit underlies crest of NATIONAL GEODETIC VERTICAL DATUM OF 1929 remnants and as small slices along faults. Diabase dikes of probable Late Kittatinny Mountain. Locally contains garnet, graphite, sillimanite, and opaque Proterozoic age (Volkert and Puffer, in press) intrude Middle Proterozoic minerals. May be layered with thin metaquartzite containing Kittatinny Valley Sequence rocks of the Highlands in Warren County, but are absent in Cambrian and graphite and biotite. Unit occurs throughout the Highlands in younger rocks. the map area. Ramseyburg Member of Martinsburg Formation (Upper and Middle Ordovician) - Interbedded medium- to dark-gray to Ymh Hornblende-quartz-feldspar gneiss (Middle Proterozoic) - Pinkishgray to buff-weathering, light-pinkish-white to pinkish-gray, brownish-gray, fine- to medium-grained, thin- to thickbedded quartzose to graywacke sandstone and siltstone and fine- to medium-grained, massive to moderately well-layered New Jersey Geological Survey medium- to dark-gray, laminated to thin-bedded slate. Unit gneiss containing microcline, quartz, oligoclase, hornblende, forms fining upward sequences characterized by basal cross-<sup>2</sup> U.S. Geological Survey and magnetite. Locally contains garnet and biotite. Confined bedded sandstone to siltstone grading upward through planar Pohatcong, Upper Pohatcong, and Allamuchy Mountains are bordered to two small exposures on County House Mountain east of laminated siltstone into slate. Locally, fining upward cycles Oxford and south of Vienna. on the southeast by Kennedys fault, a steeply southeast-dipping reverse may have a lower graded bedded sandstone to siltstone Clinopyroxene-quartz-feldspar gneiss (Middle Proterozoic) overlain by planar laminated siltstone beneath the crossbedded layer. Complete cycles may be an inch to several feet Pinkish-gray or pinkish-buff-weathering, white to pale pinkish-white or light-gray, fine- to medium-grained, thick. Basal scour, sole marks, and soft-sediment distortion massive to moderately well-layered gneiss composed of of beds are common in graywacke. Lower contact placed at microcline, quartz, oligoclase, clinopyroxene, and trace bottom of lowest thick- to very thick-bedded graywacke, but contact locally grades through sequence of dominantly amounts of epidote, biotite, titanite, and opaque minerals. Commonly interlayered with amphibolite or pyroxene thin-bedded slate and minor thin- to medium-bedded amphibolite. Unit dominantly occurs on Allamuchy discontinuous and lenticular graywacke beds in the Bushkill Mountain and on Jenny Jump Mountain. member. Parris and Cruikshank (1992) correlate unit with Orthograptus ruedemanni zone to lowest part of Yp Pyroxene gneiss (Middle Proterozoic) - White to tan-weathering, Climacograptus spiniferus zone of Riva (1969, 1974) indicating Shermanian age (Caradocian). Thickness greenish-gray, fine- to medium-grained, well-layered gneiss approximately 2,400 ft. in Delaware Valley. Unit restricted containing oligoclase, clinopyroxene, variable amounts of to Kittatinny Valley. quartz, and trace amounts of opaque minerals and titanite. Some phases contain scapolite and calcite. May be Bushkill Member of Martinsburg Formation (upper Middle interlayered with pyroxene amphibolite, marble, and less Ordovician) - Medium- to medium-dark-gray weathering, commonly with thin metaquartzite. Unit is most abundant on dark-gray to black, thinly laminated to medium-bedded shale Allamuchy Mountain, Jenny Jump Mountain, and the and slate; less abundant medium-gray to brownish-gray northeastern part of Scotts Mountain. weathering, dark-gray to black, laminated to thin-bedded, Franklin Marble (Middle Proterozoic) - White to light-graygraywacke siltstone. Unit forms fining upward sequences weathering, white, grayish-white, or less commonly pinkishcharacterized by either basal cross-bedded siltstone grading upward through planar laminated siltstone into slate, or orange, coarse- to locally finely-crystalline, calcitic marble laminated siltstone grading upward into slate. Locally, fining with accessory graphite, phlogopite, chondrodite, upward cycles may have a lower graded sandstone to clinopyroxene, serpentine and trace amounts of molybdenite. Contains pods and layers of clinopyroxene-garnet skarn, siltstone overlain by planar laminated siltstone beneath the merges with the Harmony-Jenny Jump fault system. cross-bedded layer. Complete cycles may be an inch to hornblende skarn, and clinopyroxene-rich rock. Thin layers of metaquartzite occur locally. Exploited for talc and several feet thick with slate comprising the thickest part. Lower contact with Jacksonburg Limestone gradational, but asbestiform minerals near Easton, Pennsylvania. Mainly commonly disrupted by thrust faulting. Parris and occurs on Marble, northern Scotts, and Jenny Jump Cruikshank (1992) show that regionally the unit contains graptolites of zones Diplograptus multidens to Corynoides Ype Pyroxene-epidote gneiss (Middle Proterozoic) - White to lightamericanus (Riva 1969, 1974), which they correlate to the gray-weathering, light-greenish-gray or greenish-buff, fine-Climacograptus bicornis zone to Corynoides americanus to medium-grained, moderately layered and foliated gneiss subzone of Orthograptus amplexicaulis (Berry 1960, 1971, composed principally of quartz, microcline, plagioclase, 1976) indicating Shermanian (Caradocian) age. Thickness epidote, and sparse titanite. Some phases are quartz-rich and ranges from 1,500 ft. near Johnsonburg, 3,000 ft. near Port grade into metaquartzite. Probably related to pyroxene gneiss Murray, to a maximum of approximately 4,100 ft. near with which it is locally interlayered. Unit is dominantly Belvidere. Unit located in Kittatinny and Musconetcong exposed on High Rock Mountain south of Mountain Lake and on Allamuchy Mountain west of Allamuchy. Jacksonburg Limestone (Middle Ordovician) - Medium-dark-Losee Metamorphic Suite gray weathering, medium-dark to dark-gray, laminated to thin-bedded, argillaceous limestone (cement-rock facies) and Ylo Quartz-oligoclase gneiss (Middle Proterozoic) - White minor arenaceous limestone. Grades downward into weathering, light-greenish-gray, medium- to coarse-grained, medium-bluish-gray weathering, dark-gray, very thin- to moderately layered to indistinctly foliated gneiss and lesser medium-bedded, commonly fossiliferous, interbedded finegranofels composed of quartz and oligoclase, or andesine and medium-grained limestone and pebble-and-fossil and local biotite, hornblende, and/or clinopyroxene. Contains limestone conglomerate (cement-limestone facies). thin amphibolite layers. Unit is most abundant on Scotts Elsewhere, thick- to very thick-bedded dolomite cobble conglomerate occurs within basal sequence. Lower contact unconformable on Beekmantown Group, and on clastic Albite-oligoclase granite (Middle Proterozoic) - White facies of "Sequence at Wantage," and conformable on weathering, light-greenish-gray, medium- to coarse-grained carbonate facies of "Sequence at Wantage." Unit contains granite composed of albite or oligoclase, quartz, and sparse North American Midcontinent province conodont zones accessory hornblende or clinopyroxene. Petrogenetically Phragmodus undatus to Aphelognathus shatzeri which range related to quartz-oligoclase gneiss (Ylo), but has a more from Rocklandian to Richmondian ages (Sweet and granulitic texture. Includes small bodies of pegmatite not Bergstrom, 1986). Approximately 150 ft. thick in shown on map. Occurs sporadically in small bodies Musconetcong Valley and Paulins Kill; maximum thickness, throughout the Highlands in the map area. near Alpha, is 1,000 ft. Individual conodont species Biotite-quartz-oligoclase gneiss (Middle Proterozoic) - White to morphology suggests within this age range, Kirfieldian (Caradocian) best approximates the age of the unit. light-gray-weathering, light- to medium-gray or greenishgray, fine- to coarse-grained, massive to moderately well-"Sequence at Wantage" (Middle Ordovician) - Interbedded, layered and foliated gneiss composed of oligoclase or very thin- to medium-bedded limestone, dolomite, siltstone, andesine, quartz, biotite, and local garnet. Commonly and argillite. Upper carbonate facies, locally present outside interlayered with amphibolite. Unit is confined to a few small areas on Jenny Jump Mountain and a single exposure of Warren County, is moderate-yellowish-brown to olivegray weathering, light- to dark-gray, very fine- to fineon northeastern Scotts Mountain east of Buttzville. grained, laminated to medium-bedded limestone and Rocks of Uncertain Origin dolomite. Rounded quartz sand occurs locally as floating grains and very thin lenses. Clastic facies contains medium-Hypersthene-quartz-plagioclase gneiss (Middle Proterozoic) gray, grayish-red to grayish-green, thin- to medium-bedded Gray to tan-weathering, greenish-gray to greenish-brown, mudstone, siltstone and fine-grained to pebbly sandstone. medium-grained, moderately well-layered and foliated, CORRELATION OF MAP UNITS Fine-grained beds commonly contain minor disseminated greasy lustered gneiss of charnockitic affinity composed of subangular to subrounded, medium-grained quartz sand and andesine or oligoclase, quartz, clinopyroxene, hornblende, pebble-sized chert. Some coarse-grained beds are cross-VALLEY AND RIDGE and sparse hypersthene. Commonly interlayered with stratified. Unit is restricted to lows on surface of amphibolite and mafic-rich quartz-plagioclase gneiss. Unit Beekmantown unconformity. Regional relations and North occurs sporadically and is best exposed on northeastern American Midcontinent province conodonts within Pohatcong Mountain southwest of Washington. carbonate facies, identified by Anita Harris (U.S. Geological Survey, written communication, 1990) limits Amphibolite (Middle Proterozoic) - Gray to grayish-black, UNCONFORMITY age range from no older than Rocklandian to no younger medium-grained rock composed of hornblende and andesine. than Kirkfieldian. May be as much as 150 ft. thick. Unit is Some phases contain biotite and/or clinopyroxene. well exposed in vicinity of Asbury. Ubiquitous and associated with almost all other Middle Proterozoic units. Some amphibolite is clearly metavolcanic BEEKMANTOWN GROUP in origin, some is metasedimentary, and some appears to be Beekmantown Group undivided - Shown in cross section only. metagabbro. Unit occurs throughout the Highlands in the ORDOVICIAN Beekmantown Group, upper part (Lower Ordovician) - Light-Yam Migmatite (Middle Proterozoic) - Mixed rock consisting of UNCONFORMITY to medium-gray- to yellowish-gray-weathering, mediumamphibolite containing veins, lenses, layers, and irregular light to medium-gray, aphanitic to medium-grained, thinclots of albite-oligoclase granite or microperthite alaskite. to thick-bedded, locally laminated, slightly fetid dolomite. Occurs throughout Scotts Mountain, Pohatcong Mountain, Locally light-gray to light-bluish-gray weathering, mediumand the Silver Hill area in Pohatcong Township. to dark-gray, fine-grained, medium-bedded limestone occurs Yma Microantiperthite alaskite (Middle Proterozoic) - White near the top of unit. Grades downward into medium- to weathering, locally rusty, light-greenish-gray, medium- to dark-gray on weathered surface, medium-dark to dark-gray where fresh, medium- to coarse-grained, medium- to thickcoarse-grained, gneissoid granite and alaskite containing bedded, strongly fetid dolomite. Contains pods, lenses and microantiperthite, quartz, oligoclase, and sparse hornblende, layers of dark-gray to black rugose chert. Lower contact clinopyroxene, biotite, and magnetite. Unit is confined to UNCONFORMITY conformable and grades into the fine-grained, laminated several areas on Scotts Mountain and the Silver Hill area in Pohatcong Township, and one small exposure on Allamuchy dolomite of Beekmantown Group, lower part. Contains NEW JERSEY HIGHLANDS conodonts of North American Midcontinent province Mountain south of Allamuchy. Rossodus manitouensis zone to Oepikodus communis zone (Karklins and Repetski, 1989; J.E. Repetski, U.S. Geological LATE PROTEROZOIC Survey, oral communication, 1992), so unit is Ibexian docian to Arenigian) as used by Sweet and Bo MAP SYMBOLS (1986). In map area, unit correlates with the Epler Formation and Rickenbach Dolomite of Drake and others (1985) and ----- Contact - Dotted where concealed. Dashed where uncertain the Ontelaunee Formation of Markewicz and Dalton (1977). Faults - Dotted where concealed, Dashed where uncertain Unit thickens to the southwest where it attains a maximum 800 ft. thick. Unit averages 200 ft. in thickness. Normal fault - U, upthrown side; D, downthrown side Beekmantown Group, lower part (Lower Ordovician) - Upper Reverse fault - U, upthrown side; D, downthrown side sequence is light- to medium-gray to dark-yellowish-orange Yk Ym Yb Ymh Ymp Yp Ymr Ype Inclined thrust fault - Teeth on upper plate MIDDLE PROTEROZOIO weathering, light-olive-gray to dark-gray, fine- to medium-UNCONFORMITY grained, very thin- to medium-bedded, locally laminated dolomite. Middle sequence is olive-gray, light-brown and Losee Metamorphic Suite dark-yellowish-orange weathering, medium- to dark-gray, Folds in Proterozoic rocks showing trace of axial surface, aphanitic to medium-grained, thin-bedded, locally well Ylo Yla Ylb direction and dip of limbs, and direction of plunge. Folds in laminated dolomite which grades into discontinuous lenses foliation and layering. Dotted where concealed Rocks of Uncertain Origin of light-gray to light-bluish-gray weathering, medium- to dark-gray, fine-grained, thin- to medium-bedded limestone. Yh Ya Yam Yma Limestone has "reticulate" mottling characterized by <del>\*</del> anastomosing, light-olive-gray to grayish-orange weathering, silty dolomite laminae surrounding lenses of limestone. Overturned antiform Limestone may be completely dolomitized locally. Grades down into medium-dark- to dark-gray, fine-grained, well Overturned synform laminated dolomite having local pods and lenses of black to Folds in Paleozoic rocks showing trace of axial surface, white chert. Lower sequence consists of medium- to medium-dark-gray, aphanitic to coarse-grained, thinlydirection and dip of limbs, and direction of plunge. Folds in laminated to thick-bedded, slightly fetid dolomite having bedding and/or cleavage. Dotted where concealed quartz-sand laminae and sparse, very thin to thin, black chert beds. Individual bed thickness decreases and floating quartz sand content increases toward the lower gradational contact. **←** ‡ In Phillipsburg, near the Route 22 bridge, thin discontinuous pegmatite dikelets occur and consist of quartz, feldspar and Overturned anticline **←** lesser apatite, tourmaline, and magnetite or hematite (Markewicz and Dalton, 1977). Contains conodonts of < ++ Overturned syncline North American Midcontinent province Cordylodus proavus Gently inclined to recumbent anticline to Rossodus manitouensis zones (Karklins and Repetski, 1989; J.E. Repetski, U.S. Geological Survey, oral Gently inclined to recumbent syncline communication, 1992) as used by Sweet and Bergstrom (1986), so unit is Ibexian (Tremadocian). Entire unit is Cleavage arch Stonehenge Limestone of Drake and others (1985) and Cleavage trough Stonehenge Formation of Volkert and others (1989). Markewicz and Dalton (1977) correlate upper and middle PLANAR FEATURES sequences as Epler Formation and lower sequence as Rickenbach Formation. Unit is about 600 ft. thick. Best Strike and dip of crystallization foliation exposure of limestone is along Paulins Kill near Hainesburg. Allentown Dolomite (lowest Lower Ordovician to Upper Cambrian) - Upper sequence is light- to medium-gray weathering, medium-light to medium-dark-gray, fine- to Strike and dip of beds medium-grained, locally coarse-grained, medium- to very thick-bedded dolomite; local shaly dolomite near the bottom. Floating quartz sand and two series of medium-light- to very light-gray, fine- to medium-grained, thin-bedded quartzite and discontinuous dark-gray chert lenses occur directly below upper contact. Lower sequence is medium- to very light-gray weathering, light- to medium-dark-gray, fine- to Strike and dip of cleavage in Paleozoic rocks medium-grained, thin- to medium-bedded dolomite and shaly dolomite. Weathered exposures characterized by Strike and dip of parallel bedding and cleavage alternating light- and dark-gray beds. Ripple marks, oolites, algal stromatolites, cross-beds, edgewise conglomerate, mud LINEAR FEATURES cracks, and paleosol zones occur throughout, but are more abundant in lower sequence. Lower contact gradational into 27← Bearing, plunge of mineral lineation in Proterozoic rocks Leithsville Formation. In Delaware Valley, lowest part 5 ← Hearing, plunge of intersection of bedding and cleavage contains a trilobite fauna of Dresbachian (early Late Cambrian) age (Weller, 1903; Howell, 1945). Unit OTHER FEATURES approximately 1,900 ft. thick. Leithsville Formation and Hardyston Quartzite undivided -Shown in cross section only. conglomerate, sandstone, and quartzite Leithsville Formation (Middle to Lower Cambrian) - Upper sequence, rarely exposed, is mottled, medium-light to REFERENCES CITED slate, shale, and sandstone medium-dark-gray weathering, medium- to medium-dark-Berry, W.B.N., 1960, Graptolite faunas of the Marathon region, West Texas: gray, fine- to medium-grained, medium- to thick-bedded, locally pitted and friable. Middle sequence is grayish-orange University of Texas Publication 6005, 179 p. dolomite and limestone to light-gray to dusky-red to grayish-green-weathering, \_, 1971, Late Ordovician graptolites from southeastern New York: aphanitic to fine-grained, thin- to medium-bedded shaly granite, gneiss, marble, diabase dikes, and sedimentary and volcanic rocks Journal of Paleontology, v. 45, p. 633-640. dolomite, dolomitic shale, quartz sandstone, siltstone and shale. Lower sequence is medium-light to medium-gray 1976, Aspects of correlation of North American shelly and weathering, medium-gray, fine- to medium-grained, thin- to graptolite faunas: in Bassett, M.G., editor, The Ordovician System, 7.5 minute quadrangle boundary medium-bedded dolomite. Quartz sand lenses occur near Proceedings of a Paleontological Association Symposium, Birmingham, lower gradational contact with Hardyston Quartzite. University of Wales Press, p. 153-169. physiographic province boundary Archaeocyathids of Early Cambrian age are present in Drake, A.A., Jr., 1984, The Reading Prong of New Jersey and eastern formation elsewhere in New Jersey, suggesting an Figure 1. Index map. Pennsylvania - An appraisal of rock relations and chemistry of a major intraformational disconformity between Middle and Early Proterozoic terrane in the Appalachians, in Bartholomew, M.J., editor, The Cambrian rock (Palmer and Rozanov, 1967). Unit also Grenville event in the Appalachians and related topics: Geological Society contains Hyolithellus micans (Markewicz, 1968). Thickness 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, Ch Hardyston Quartzite (Lower Cambrian) - Medium- to light-A.A., Jr., editor, Contributions to New Jersey Geology: U.S. Geological gray, fine- to coarse-grained, medium- to thick-bedded Survey Bulletin 1952, p. D1-D14. quartzite, arkosic sandstone and dolomitic sandstone. Contains fragments of the trilobite Olenellus thompsoni of Drake, A.A., Jr., Kastelic, R.L., Jr., and Lyttle, P.T., 1985, Geologic map of the Early Cambrian age elsewhere in New Jersey (Nason, 1891; eastern parts of the Belvidere and Portland quadrangles, Warren County, New Jersey: U.S. Geological Survey Miscellaneous Investigations Map I-Weller, 1903). Thickness ranges from 2 ft. near Mountain 1530, scale 1:24,000. Lakes to maximum of 200 ft. regionally. Well exposed on ridge between Springtown and Warren Glen. 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., Middle and Late Proterozoic rocks, undivided - Shown in editor, Contributions to New Jersey geology: U.S. Geological Survey cross section only. Diabase dikes (Late Proterozoic) - Medium- to dark-greenish-Drake, A.A., Jr., Volkert, R.A., Monteverde, D.H., Herman, G.C., Houghton, gray, fine-grained to aphanitic dikes that are dense and hard. H.F., Parker, R.A., and Dalton, Richard, in press, Geologic map of New Contacts are typically chilled and sharp against enclosing Jersey: northern bedrock sheet: U.S. Geological Survey, scale 1:100,000. country rock. Tholeiitic to alkalic in composition and hypersthene normative. Composed principally of plagioclase Herman, G.C., Monteverde, D.H., Volkert, R.A., Drake, A.A., Jr., and Dalton, FEET (labradorite to andesine), augite, and ilmenomagnetite. R.F., in press, Bedrock fracture map of Warren County, New Jersey: New 4,000 -Locally occurring pyrite blebs are ubiquitous. Dikes range Jersey Geological Survey Open-File Map, scale 1:48,000. from a few feet to 65 ft. in thickness and are as much as 3 Howell, B.F., 1945, Revision of Upper Cambrian faunas of New Jersey: mi. long. Occur mainly in Jenny Jump Mountain where they Geological Society of America Memoir 12, 46 p. are widespread, but intrude only Middle Proterozoic rocks. 2,000 Karklins, O.L., and Repetski, J.E., 1989, Distribution of selected conodont Chestnut Hill Formation (Late Proterozoic) - Interbedded faunas in northern New Jersey: U.S. Geological Survey Miscellaneous arkose, ferruginous quartzite, quartzite conglomerate, The interpretations presented here are provisional pending peer review. Field Studies Map MF-2066, scale 1:185,000. SEA LEVEL metarhyolite, and metasaprolite. Confined to a few small There may be revisions prior to publication. areas north and east of Phillipsburg. MacLachlan, D.B., 1967, Structure and stratigraphy of thelinestone and dolomites of Dauphin County, Pennsylvania: Pennsylvania Geological Middle Proterozoic rocks, undivided - Shown in cross section Survey, 4th ser., General Geology Report 44, 168 p. Markewicz, F.J., 1968, The Hardyston-Leithsville contact and significance of Byram Intrusive Suite "Hyolithellus micans" in the lower Leithsville Formation [abstract]: Bulletin New Jersey Academy of Science, v. 13, p. 96. Ybh Hornblende granite (Middle Proterozoic) - Pinkish-gray to buffweathering, pinkish-white or light-pinkish-gray, medium- to Markewicz, F.J., and Dalton, Richard, 1977, Stratigraphy and applied geology coarse-grained, gneissoid to indistinctly foliated granite and of the Lower Paleozoic carbonates in northwestern New Jersey: sparse granite gneiss composed principally of microcline Harrisburg, Pennsylvania, 42nd Annual Field Conference of Pennsylvania microperthite, quartz, oligoclase, and hornblende. Some Geologists, Guidebook, 117 p. phases are quartz syenite or quartz monzonite. Includes small Nason, F.L., 1891, The Post-Archean age of the white limestones of Sussex bodies of pegmatite and amphibolite not shown on map. Has County, New Jersey: Annual Report of the State Geologist for the Year an U-Pb age of approximately 1090 m.y. (Drake and others, 1890, Geological Survey of New Jersey, p. 25-50. 1991). Unit occurs throughout the Highlands in the map area, but is best exposed on Danville, Upper Pohatcong, and Palmer, A.R., and Rozanov, A.Y., 1967, Archaeocyatha from New Jersey; Allamuchy Mountains. evidence for an intra-Cambrian unconformity in the north-central Appalachians: Geology, v. 4, p. 773-774. Hornblende syenite (Middle Proterozoic) - Tan to buffweathering, pinkish-gray or greenish-gray, medium- to Parris, D.C., and Cruikshank, K.M., 1992, Graptolite biostratigraphy of the coarse-grained, gneissoid syenite and lesser quartz syenite Ordovician Martinsburg Formation in New Jersey and contiguous areas: containing microcline microperthite, oligoclase, quartz, and New Jersey Geological Survey, Geological Survey Report 28, 18 p. hornblende. Some phases are monzonite or monzodiorite. Occurs sporadically throughout the northern part of the Puffer, J.H., and Volkert, R.A., 1991, Generation of trondhjemite from partial Highlands in the map area. melting of dacite under granulite facies conditions: an example from the New Jersey Highlands, USA: Precambrian Research, v. 51, p. 115-125. Ybb Biotite granite (Middle Proterozoic) - Pink to buff-weathering, light-pinkish-gray, medium-grained, massive, moderately Riva, John, 1969, Middle and Upper Ordovician graptolite faunas of St. foliated granite composed of microcline microperthite, Lawrence Lowlands of Quebec, and of Anticosti Island, in Kay, Marshall, quartz, oligoclase, and biotite. Confined to a few areas on editor, North Atlantic geology and continental drift: American Association County House and Upper Pohatcong Mountains south and of Petroleum Geologists Memoir 12, p. 513-556. east of Great Meadows. , 1974, A revision of some Ordovician graptolites of eastern North America: Paleontology, v. 17, p. 1-40. Yba Microperthite alaskite (Middle Proterozoic) - Pink to buffweathering, light-pinkish-gray or pinkish-white, medium- to Sweet, W.C., and Bergstrom, S.M., 1986, Conodonts and biostratigraphic coarse-grained, gneissoid to indistinctly foliated granite correlation: Annual Review of Earth and Planetary Science, v. 14, p. 85composed principally of microcline microperthite, quartz, 2,000 and oligoclase. Includes small bodies of amphibolite not shown on map. Unit occurs throughout the Highlands in the Volkert, R.A., and Drake, A.A., Jr., 1990, New geologic map of the New Jersey

**OPEN-FILE MAP OFM 15A** 

BEDROCK GEOLOGY

ENVIRONMENTAL GEOLOGY OF WARREN COUNTY, NEW JERSEY:

axes and faults. Veins commonly occur in close proximity to faults. Two joint sets dominate; one strikes parallel to the regional grain, the other crosses strike (Herman and others, in press). Cleavage (closely spaced parallel partings developed by pressure) can occur in all Paleozoic rocks but is best developed in finer-grained rocks such as the slate and shale of the Martinsburg Formation. Cleavage in finer-grained rocks is closely spaced and termed slaty cleavage. Cleavage generally parallels the structural trend of the beds and generally dips moderately to the southeast. The "Bedrock fracture map of Warren County" (Herman and others, in

Folds are open to tight throughout the Paleozoic rocks; they range from upright through overturned, and gently inclined to recumbent. Folds and faults trend dominantly northeast-southwest, following the regional structural grain. The intensity of the folding and degree of overturning generally increases southeastward; the strongest deformation occurs in the

Within Kittatinny Valley, gently-dipping to high-angle faults are commonly exposed at the surface. Along Kittatinny Mountain, northwest of the Taconic unconformity, only small scale, local faults cut the present

The major structures affecting the Proterozoic rocks in Warren County are joints, folds, and faults. Joints are ubiquitous in all of the Proterozoic rocks. They are dominantly moderately to widely spaced, open

"Bedrock fracture map of Warren County" (Herman and others, in press) shows detailed information on the strike and dip of joints and fractures in Folds in the Middle Proterozoic rocks are ascribed to the Grenville orogeny, and are mainly open and upright to isoclinal and overturned to the northwest. They plunge gently to moderately to the northeast and less

commonly to the southwest. Much less abundant are folds that are upright to overturned to the southwest, and plunge to the north-northwest or to the south-southeast. Other folds are upright and plunge predominantly to the

Major northeast-trending thrust and reverse faults were active during the Taconic and Alleghanian, and possibly at other times as well. They partition the Highlands in the county into structural blocks (fig. 1). Discrete structural blocks include Silver Hill, Pohatcong Mountain, Upper Pohatcong Mountain, Allamuchy Mountain, Scotts Mountain, County House Mountain, High Rock Mountain, and Jenny Jump Mountain.

fault. Kennedys fault also borders the Silver Hill area on the northwest. Pohatcong Mountain is flanked on the northwest by the moderately southeast-dipping Pohatcong thrust fault. Kennedys fault and Pohatcong thrust fault separate the Middle Proterozoic rocks from rocks of Lower Paleozoic age in Musconetcong and Pohatcong Valleys, respectively. Scotts Mountain and County House Mountain are flanked on the southeast by the moderately southeast-dipping Brass Castle thrust fault.

This fault, forming the northwest boundary of the Paleozoic rocks in Pohatcong Valley, is cut off by Kennedys fault just west of Hackettstown. The moderately southeast-dipping Pequest-Allamuchy thrust fault cuts across Allamuchy Mountain, and then forms the northern end of County House Mountain on the northwest. Along strike to the southwest, this fault crosses Pequest Valley, and then marks the southeast side of High

Along strike to the northeast, this fault system bounds High Rock Mountain on the west, then trends eastward where it bounds Jenny Jump Mountain on the southeast. The moderate-to-steeply southeast-dipping the Paleozoic rocks of the Delaware Valley; along strike to the northeast, it separates Jenny Jump Mountain on the northwest from the Paleozoic rocks in Kittatinny Valley. At the northern end of Jenny Jump Mountain, the Lower Harmony-Shades of Death fault system loses displacement and

Scotts Mountain is abutted on the northwest by the moderately southeast-dipping Lower Harmony-Shades of Death thrust fault system.