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BEDROCK GEOLOGIC MAP OF THE NEW JERSEY PORTIONS OF THE EASTON QUADRANGLE
WARREN AND HUNTERDON COUNTIES, NEW JERSEY
OPEN FILE MAP OFM 161

INTRODUCTION

The Easton 7.5-minute quadrangle is located in western New Jersey, in the west-central part of Warren County. The quadrangle is underlain by rocks of two physiographic provinces, the New Jersey Highlands and the Valley and Ridge, but is predominantly in the former. The highest point is approximately 920 feet (280 meters) above sea level on Scotts Mountain in the northeastern corner of the quadrangle, and the lowest point is approximately 160 feet (50 meters) above sea level on the Delaware River where it flows into the Riegelsville quadrangle to the south. The Delaware River constitutes the dominant drainage in the map area, and the Musconetcong River and Lopatcong and Pohatcong Creeks are the principal tributary drainages in the New Jersey parts of the map.

The interpretations presented here, unless stated otherwise, supersede those shown on the bedrock geologic maps of Drake (1967) and Drake and others (1996). This report provides new geologic information on the stratigraphy, structure, geochronology, and description of geologic units in the map area. Cross sections show a vertical profile of the geologic units and their structure. Stereonets and rose diagrams provide a directional analysis of selected structural features. Surficial deposits are mapped by Witte (2021).

STRATIGRAPHY

Paleozoic Rocks

Lower Paleozoic rocks of Cambrian through Ordovician age of the Kittatinny Valley Sequence underlie the valleys and lowland areas throughout the map area. The Kittatinny Valley Sequence was previously considered part of the Lehigh Valley Sequence but was reassigned by Drake and others (1996). It includes the Kittatinny Supergroup, Jacksonburg Limestone, “Sequence at Wantage”, and Martinsburg Formation. All of these units are exposed in the map area except the “Sequence at Wantage” and Martinsburg Formation. In ascending age, the Kittatinny Supergroup includes the Hardyston Quartzite, Leithsville Formation, Allentown Dolomite, and lower and upper parts of the Beekmantown Group.

Neoproterozoic Rocks

A single diabase dike of Neoproterozoic age intrudes Mesoproterozoic rocks, but not Cambrian or younger rocks, along the southeast side of Marble Mountain. The dike strikes about N.40°E. and is as much as 1.5 miles long. It has a coarse-grained interior and fine-grained to aphanitic chilled margins against Mesoproterozoic rocks. The dike is part of a widespread swarm of similar dikes that were emplaced in a rift-related extensional tectonic setting in the New Jersey Highlands about 600 Ma (million years ago) during the breakup of the supercontinent Rodinia (Volkert and Puffer, 1995). Neoproterozoic-age siliciclastic rocks of the Chestnut Hill Formation unconformably overlie Mesoproterozoic rocks mainly on the southwestern side of Marble Mountain. The Chestnut Hill Formation is, in turn, unconformably overlain by the Lower Cambrian Hardyston Quartzite. Rocks of the Chestnut Hill Formation were formed from alluvial, fluvial, and lacustrine sediments, and possible volcanic rocks of felsic composition, that were deposited in a series of small sub-basins in the western Highlands during breakup of the supercontinent Rodinia (Volkert and others, 2010a).

Mesoproterozoic Rocks

Mesoproterozoic rocks that are part of the New Jersey Highlands underlie Marble Mountain, Scotts Mountain, and Musconetcong Mountain. They include a heterogeneous assemblage of granites, gneisses, and marble that were metamorphosed to granulite facies conditions during the Grenville orogeny approximately 1045 Ma (Volkert and others 2010b). The peak temperature during this high-grade metamorphism is 769°C based on calcite-graphite geothermometry (Peck and others, 2006).

Among the oldest units in the map area are calc-alkaline rocks of the Losee Suite formed from volcanic and plutonic protoliths in a continental-margin magmatic arc (Volkert, 2004). The Losee Suite yielded U-Pb zircon ages of 1282 to 1248 Ma (Volkert and others, 2010b). Magmatic arc rocks of the Losee Suite are spatially and temporally associated with a succession of supracrustal rocks that were formed in a back-arc basin (Volkert, 2004). Supracrustal rocks include felsic volcanic rocks mapped as potassic feldspar gneiss and mafic volcanic rocks mapped as amphibolite, as well as quartzofeldspathic gneisses, calc-silicate rocks, and marble. Felsic volcanic rocks yielded U-Pb zircon ages of 1299 to 1240 Ma (Volkert and others, 2010b) that closely overlap the age of the Losee Suite.

The map area also contains granite and related rocks of the Byram Intrusive Suite that comprise part of the Vernon Supersuite (Volkert and Drake, 1998). Rocks of this suite have intruded the Losee Suite and supracrustal rocks. Byram granite yielded U-Pb zircon ages of 1185 to 1182 Ma (Volkert and others, 2010b).

The youngest Mesoproterozoic rocks in the map area are small, irregular bodies of granite pegmatite that are too small to be shown on the map. Pegmatites are undeformed and have contacts that cut across other Mesoproterozoic rocks. Elsewhere in the Highlands, pegmatites have yielded U-Pb zircon ages of 1004 to 986 Ma (Volkert and others, 2005).

STRUCTURE

Paleozoic Bedding and Cleavage

Most beds in the map area dip toward the northwest and less commonly toward the southeast, although locally they are overturned steeply toward the southeast (Fig. 1). Bedding in the Paleozoic rocks is fairly uniform and strikes northeastward at about N.65°E. (Fig. 2a). Bedding ranges in dip from 5° to vertical and averages about 41°.

Figure 1. Locally overturned Allentown Dolomite steeply dipping to the southeast.
Photo by J. Weremeichik.

Cleavage (closely-spaced parallel partings) in the Paleozoic rocks generally trends toward the northeast and averages about N.60°E. (Fig. 2b), subparallel to the bedding trend. Cleavage dips predominantly toward the southeast at 2° to 80° and averages about 59°.

Proterozoic Foliation

Crystallization foliation (the parallel alignment of mineral grains) in the Mesoproterozoic rocks is an inherited feature resulting from compressional stresses during high-grade metamorphism that deformed these rocks during the Grenvillian Orogeny at about 1045 Ma. The strike of foliations is reasonably uniform throughout most of the area but varies locally because of folding. Foliations strike northeast at an average of N.58°E. (Fig. 2c). The dip of all foliations ranges from 24° to 84° and averages 54°. Foliations dip southeast and, less commonly, northwest, although northwest-striking foliations that dip southwest are present along Scotts Mountain.

Folds

Folds in the Paleozoic rocks formed during the Taconic and Alleghenian orogenies at about 450 Ma and 250 Ma, respectively, and they postdate the development of bedding. These folds are open to tight, upright to locally overturned, and gently inclined to recumbent. Larger Paleozoic folds in the map area trend toward the northeast and plunge predominantly toward the northeast. Taconic-aged folds are cut by younger Alleghenian faults (Herman and Monteverde, 1989; Herman and others, 1997). These folds formed in the hinterland of emergent Taconic thrusting. Fold intensity and overturning increase toward this Taconic structural culmination in the southwest.

Folds that deform earlier-developed planar metamorphic fabrics in Mesoproterozoic rocks formed from compressional stresses during the Grenvillian Orogeny and these folds postdate the development of crystallization foliation. Characteristic fold patterns on Marble Mountain include northeast-plunging upright antiforms and synforms. Rocks on Scotts Mountain are folded into a southwest-plunging, southeast-overturned antiform. Folds on Musconetcong Mountain are mainly northeast-plunging upright antiforms and synforms.

Faults

The structure of the map area is dominated by a series of northeast-trending faults that deform both Mesoproterozoic and Paleozoic rocks. These faults were active during the Taconic and Alleghenian orogenies and possibly the Mesozoic as well. From the northwest to southeast they include the Marble Mountain fault, Lower Harmony thrust fault, Merrill Creek fault, Whippoorwill fault, Brass Castle thrust fault, Kennedys fault, Musconetcong thrust fault, and Warren Glen fault.

The Marble Mountain fault trends northeast in the northern part of the map area and dips steeply to southeast. It places Mesoproterozoic rocks on both the hanging wall and the footwall, as well as rocks of the Leithsville Formation and the Hardyston Quartzite on the footwall. It continues northeast into the Belvidere quadrangle and southeast across the Delaware River into the Pennsylvania portions of the quadrangle.

The Lower Harmony thrust fault lies within the southern boundary of Phillipsburg where it exposes Allentown Dolomite on the hanging wall over the Middle Ordovician-aged Jacksonburg Limestone and the Lower Ordovician-aged Beekmantown Group. The fault continues eastward and swings into a more northeasterly trend where it bounds the northwestern side of Scotts Mountain. There, Mesoproterozoic-aged rocks ramp up and over lower Paleozoic rocks to the northwest. This interpretation differs from Herman and Monteverde (1989) who show the thrust fault continuing farther to the northeast before merging with the Shades of Death Fault in the Bloomsbury quadrangle. A moderate south-southeasterly dip and down dip lineations where the Allentown overrides the Jacksonburg suggest the thrust relations of this fault.

The Merrill Creek fault on Scotts Mountain trends northeast and dips steeply toward the southeast. It places Mesoproterozoic rocks on both the hanging wall and footwall along most of its length, and then Paleozoic rocks on both the hanging wall and footwall futher west. Kinematic indicators suggest components of both reverse and left-lateral strike-slip movement but the relative timing of each is not well constrained. Fault fabric is consistently brittle and includes close-spaced fracture cleavage, recrystallization, and low-temperature retrogression of mineral phases. Good fault exposures are seen in the Bloomsbury quadrangle to the east, along a small drainage north of Lows Hollow, and along the gorge south of Merrill Creek Reservoir.

The Whippoorwill fault trends subparallel to the Merrill Creek fault on Scotts Mountain and dips steeply southeast to vertical. Drake (1967) interpreted this fault as a moderately southeast-dipping thrust fault, whereas Kümmel (ca. 1900), Bayley (1941), and Monteverde and others (1994) interpreted it as a normal fault. Recent mapping by the authors recognized kinematic indicators consistent with a normal movement sense. The fault displays consistent brittle fault fabric much like that of the Merrill Creek fault. The fate of both faults along strike to the northeast is uncertain because of poor exposure. They likely lose displacement to the southwest and terminate just west of Scotts Mountain.

The moderately southeast-dipping Brass Castle thrust fault contains Paleozoic rocks on the hanging wall and footwall. It continues northeastward into the adjacent Bloomsbury quadrangle where it bounds Scotts Mountain along the southeast side and it places Allentown Dolomite onto Mesoproterozoic rocks, (Drake and others, 1994; Monteverde and others, 1994).

Kennedys fault borders the southeast side of Pohatcong Mountain in the Bloomsbury quadrangle and the north side of Silver Hill in the Easton quadrangle. It is a steeply southeast-dipping reverse fault that places Paleozoic rocks of the hanging wall onto Mesoproterozoic rocks of the footwall throughout most of its length, except in the map area where it contains Mesoproterozoic and Paleozoic rocks on both sides. The fate of Kennedys fault is uncertain; it may terminate south of Springtown, or it may extend beneath cover into Paleozoic rocks.

The moderately southeast-dipping Musconetcong thrust fault borders the northwest side of Musconetcong Mountain placing Mesoproterozoic rocks onto Paleozoic rocks along most of its length. At Warren Glen it bifurcates, with the fate of the northern segment uncertain. It may terminate on Silver Hill, but more likely extends beneath cover into Paleozoic rocks. The southern segment extends southward into the Riegelsville quadrangle. Both segments contain Mesoproterozoic and Paleozoic rocks on the hanging wall and footwall.

The moderately to steeply southeast-dipping Warren Glen fault trends along the northwest side of Musconetcong Mountain, where it contains Mesoproterozoic and Paleozoic rocks on both the hanging wall and footwall. Drake (1967) recognized this fault but ended it within the Bloomsbury quadrangle. Our current mapping extends the fault across Easton into the Riegelsville quadrangle. A mylonitic fabric characterizes the Warren Glen fault that is well exposed in a stream valley south of Bloomsbury in the Bloomsbury quadrangle and in the Musconetcong River gorge near Warren Glen.

Mesoproterozoic rocks throughout the map area are also deformed by small faults, some of which are confined to outcrops that strike east, north, or northwest. These faults are characterized by brittle fabrics consisting of brecciation, the retrogression of mafic mineral phases, chlorite or epidote-coated fractures or slickensides, and close-spaced fracture cleavage. Fault widths typically are a few feet to tens of feet and some of the wider fault zones likely are due to the merging of parallel or anastomosing faults.

Paleozoic faults ascend fold limbs of similar dip direction and often decapitate the fold hinge (Herman and Monteverde, 1989; Herman and others, 1997). These structures relate to deflection of the dip of the Jenny Jump thrust fault, the northeastern continuation of the Marble Mountain fault, to locally northwest, as shown by a series of klippen composed of Lower Paleozoic and minor Mesoproterozoic rocks that are exposed northeast of the Easton quadrangle (Drake and Lyttle, 1985; Herman and Monteverde, 1989; Herman and others, 1997).

Joints

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

Joints are developed in all Paleozoic rocks but are more common in massive-textured rocks such as limestone, dolomite, and sandstone. They display a dominant northeast-striking set and two subordinate cross-strike sets. The dominant northeast set strikes at an average of N.63°E. (Fig. 2d) and has average dips of 51° northwest or 61° southeast. The southeast dip mimics the strike and dip of the dominant cleavage. Some joints may actually be cleavage planes but were classified as joints due to poor outcrop exposure.

The dominant strike of joints in the Mesoproterozoic rocks is nearly orthogonal to the strike of crystallization foliation, and this relationship has been observed in Mesoproterozoic rocks throughout the New Jersey Highlands (Volkert, 1996). The dominant set strikes an average of N.37°W. (Fig. 2e) and dips moderately to steeply northeast and, less commonly, southwest. Other minor joint sets strike east-west and also northeast and dip steeply to vertically south or southeast. The average dip of all joints in the Mesoproterozoic rocks is 72°.

ECONOMIC RESOURCES

Bedrock in the map area is the source deposits of iron ore mined predominantly during the 19th century. Descriptions of most mines are given in Bayley (1910; 1941). Mesoproterozoic rocks host magnetite deposits at the Carter mine on Scotts Mountain east of Uniontown and a small, previously unreported prospect pit on the north side of Marble Mountain. Hematite was mined from the Late Neoproterozoic Chestnut Hill Formation at the Marble Mountain (Fulmer) mine on the southwest crest of Marble Mountain and from a small prospect north of Marble Hill Road. Limonite was mined from Paleozoic rocks at three locations near Carpentersville and Port Warren.

Mesoproterozoic marble was quarried for talc and serpentine at three locations along the west side of Marble Mountain. Descriptions of these occurrences are given in Peck (1904). Marble was also quarried for dimension stone and lime near Lower Harmony. Paleozoic dolomite was quarried at numerous locations throughout the map area and is currently being quarried in Carpentersville. The cement-rock facies of the Paleozoic Jacksonburg Formation was quarried at two locations near Alpha. Deposits of sand and gravel were mined at numerous locations in the quadrangle, mainly along the Delaware River.

DESCRIPTION OF MAP UNITS

VALLEY AND RIDGE

Kittatinny Valley Sequence

Oj **Jacksonburg Limestone (Middle Ordovician)** (Spencer and others, 1908, Miller, 1937) – Medium-dark-gray-weathering, medium-dark to dark-gray, laminated to thin-bedded, argillaceous limestone (cement-rock facies) and minor arenaceous limestone. Grades downward into medium-bluish-gray-weathering, dark-gray, very thin- to medium-bedded, commonly fossiliferous, interbedded fine- and medium-grained limestone and pebble-and-fossil limestone conglomerate (cement-limestone facies). Elsewhere, thick- to very thick-bedded dolomite cobble conglomerate occurs within the basal sequence. Lower contact unconformable on Beekmantown Group, and on clastic facies of “Sequence at Wantage,” and conformable on carbonate facies of “Sequence at Wantage.” Unit contains North American Midcontinent province conodont zones *Phragmodus undatus* to *Aphelognathus shatzeri* indicating Rocklandian to Richmondian and possibly Kirkfieldian (Caradocian) ages (Sweet and Bergstrom, 1986). Regionally unit ranges in thickness from 150 ft. to 1,000 ft.

Obu **Beekmantown Group, upper part (Lower Ordovician)** – Light- to medium-gray- to yellowish-gray-weathering, medium-light to medium-gray, aphanitic to medium-grained, thin- to thick-bedded, locally laminated, slightly fetid dolomite. Locally light-gray- to light-bluish-gray- weathering, medium- to dark-gray, fine-grained, medium-bedded limestone occurs near the top of unit. Grades downward into medium- to dark-gray on weathered surfaces, medium- to dark-gray where fresh, medium- to coarse-grained, medium- to thick-bedded, strongly fetid dolomite. Contains pods, lenses, and layers of dark-gray to black rugose chert. The lower contact is conformable and grades into the fine-grained, laminated dolomite of Beekmantown Group, lower part. Contains conodonts of North American Midcontinent province *Rossodus manitouensis* zone to *Oepikodus communis* zone (Karklins and Repetski, 1989), so that unit is Ibexian (Tremadocian to Arenigian) as used by Sweet and Bergstrom (1986). In the map area, the unit correlates with the Epler and Rickenbach Dolomite of Drake et al. (1985) and the Ontelaunee Formation of Markewicz and Dalton (1977). Unit averages about 200 ft. in thickness but is as much as 800 ft. thick.

Obl **Beekmantown Group, lower part (Lower Ordovician)** – Upper sequence is light- to medium-gray- to dark-yellowish-orange-weathering, light-olive-gray to dark-gray, fine- to medium-grained, very thin- to medium-bedded locally laminated dolomite. Middle sequence is olive-gray- to light-brown- and dark-yellowish-orange-weathering, medium- to dark-gray, aphanitic to medium-grained, thin-bedded, locally well laminated dolomite which grades into discontinuous lenses of light-gray- to light-bluish-gray-weathering, medium- to dark-gray, fine-grained, thin- to medium-bedded limestone. Limestone has “reticulate” mottling characterized by anastomosing light-olive-gray- to grayish-orange-weathering, silty dolomite laminae surrounding lenses of limestone. Limestone may be completely dolomitized locally. Grades downward into medium dark- to dark-gray, fine-grained, well laminated dolomite having local pods and lenses of black to white chert. Lower sequence consists of medium- to medium-dark-gray, aphanitic to coarse-grained, thinly-laminated to thick-bedded, slightly fetid dolomite having quartz-sand laminae and sparse, very thin to thin, black chert beds. Individual bed thickness decreases and floating quartz sand content increases toward lower gradational contact. Contains conodonts of North American Midcontinent province *Cordylodus proavus* to *Rossodus manitouensis* zones (Karklins and Repetski, 1989) as used by Sweet and Bergstrom (1986), so that unit is Ibexian (Tremadocian). Entire unit is Stonehenge Limestone of Drake and others (1985) and Stonehenge Formation of Volkert and others (1989). Markewicz and Dalton (1977) correlate upper and middle sequences as Epler Formation and lower sequence as Rickenbach Formation. Unit is about 600 ft. thick.

Ꞓa **Allentown Dolomite (Upper Cambrian)** (Wherry, 1909) – Upper sequence is light-gray- to medium-gray-weathering, medium-light- to medium-dark-gray, fine- to 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, 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 medium-grained, thin- to medium-bedded dolomite and shaly dolomite. Weathered exposures are characterized by alternating light- and dark-gray beds. Ripple marks, oolites, algal stromatolites, cross-beds, edgewise conglomerate, mud cracks, and paleosol zones occur throughout but are more abundant in lower sequence. Lower contact gradational into Leithsville Formation. Unit contains a trilobite fauna of Dresbachian (early Late Cambrian) age (Weller, 1903; Howell, 1945). Approximately 1,800 ft. thick regionally.

Ꞓl **Leithsville Formation (Middle and Lower Cambrian)** (Wherry, 1909) – Upper sequence, rarely exposed, is mottled, medium-light- to medium-dark-gray-weathering, medium- to medium-dark-gray, fine- to medium-grained, medium- to thick-bedded, locally pitted and friable dolomite. Middle sequence is grayish-orange or light- to dark-gray, grayish-red, light-greenish-gray- or dark-greenish-gray-weathering, aphanitic to fine-grained, thin- to medium-bedded dolomite, argillaceous dolomite, dolomitic shale, quartz sandstone, siltstone, and shale. Lower sequence is medium-light- to medium-gray-weathering, medium-gray, fine- to medium-grained, thin- to medium-bedded dolomite. Quartz-sand lenses occur near lower gradational contact with Hardyston Quartzite. Archaeocyathids of Early Cambrian age are present in formation at Franklin, New Jersey, suggesting an intraformational disconformity between Middle and Early Cambrian (Palmer and Rozanov, 1967). Unit also contains *Hyolithellus micans* (Offield, 1967; Markewicz, 1968). Approximately 800 ft. thick regionally.

Ꞓh **Hardyston Quartzite (Lower Cambrian)** (Wolff and Brooks, 1898) – Medium- to light-gray, fine- to coarse-grained, medium- to thick-bedded quartzite, arkosic sandstone and dolomitic sandstone. Contains *Scolithus linearis* (?) and fragments of the trilobite *Olenellus thompsoni* of Early Cambrian age (Nason, 1891; Weller, 1903). Thickness ranges from 0 ft. to a maximum of 200 ft. regionally.

NEW JERSEY HIGHLANDS

Zch **Chestnut Hill Formation (Late Neoproterozoic)** (Drake, 1984) – Lower part of the unit is characterized by fairly coarse clastic material that includes matrix-supported pebble conglomerate, lithic sandstones, and arkose derived from a Mesoproterozoic source. Conglomerate and pebbly sandstone contain subangular to subrounded quartz and feldspar clasts in near equal proportion and locally abundant lithic fragments of Mesoproterozoic lithologies. The middle part is dominated by feldspathic and quartzose sandstone, quartz pebble conglomerate, quartz arenite and less common siltstone and shale. Interbedded coarser-grained lithologies as thick as six feet are not laterally continuous and likely represent channel deposits. Graded beds, tabular cross beds, rip-up clasts, slump folds, load casts, and clastic dikes are common. The upper part consists of cobble to pebble conglomerate, feldspathic sandstone, quartzite, siltstone, phyllite, very thin limestone beds less than six-feet thick, possible tuffaceous sediments, and banded hematite layers. Unit is exposed as very thin remnants that unconformably overlie Mesoproterozoic rocks.

Zd **Diabase dike (Late Neoproterozoic)** (Volkert and Puffer, 1995) – Light-gray- or brownish-gray-weathering, dark greenish-gray, aphanitic to fine-grained dike. Composed principally of plagioclase (labradorite to andesine), augite, ilmenite, and (or) magnetite. Locally contains pyrite blebs. Contacts are typically chilled and sharp against enclosing Mesoproterozoic rocks.

Ygp **Granite pegmatite (Mesoproterozoic)** – Pinkish-gray- to buff-weathering, pinkish-white or light-pinkish-gray, coarse- to very-coarse-grained, unfoliated granite. Intrusive into most other Mesoproterozoic rocks in the map area as tabular to irregular bodies of varied thickness that are discordant to crystallization foliation. Composed principally of microcline microperthite, quartz, and oligoclase. Hornblende and/or magnetite are present locally.

Ymag **Microantiperthite granite (Mesoproterozoic)** – Tan- to buff-weathering, light-greenish-gray, medium- to coarse-grained, massive, indistinctly foliated granite composed of microantiperthite, oligoclase, quartz, and hornblende. Locally contains biotite, altered clinopyroxene, and magnetite.

Yma **Microantiperthite alaskite (Mesoproterozoic)** – Tan- to buff-weathering, light-greenish-gray, medium- to coarse-grained, massive, indistinctly foliated alaskite composed of microantiperthite, brown rust-stained quartz, and oligoclase. Locally contains biotite, hornblende, altered clinopyroxene, and magnetite.

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

Yba **Microperthite alaskite (Mesoproterozoic)** – Pinkish-gray- to buff-weathering, pinkish-white or light-pinkish-gray, medium- to coarse-grained, moderately foliated alaskite composed principally of microcline microperthite, quartz, and oligoclase. Locally contains small clots and disseminated grains of magnetite.

Back-Arc Basin Supracrustal Rocks

Yk **Potassic feldspar gneiss (Mesoproterozoic)** – Light-gray- or pinkish-buff-weathering, pinkish-white or light-pinkish-gray, medium-grained, moderately foliated gneiss composed of quartz, microcline microperthite, and varied amounts of biotite, garnet, tourmaline, sillimanite, and magnetite.

Yb **Biotite-quartz-feldspar gneiss (Mesoproterozoic)** – Gray-weathering, locally rusty, gray, tan, or greenish-gray, medium-grained, moderately layered and foliated gneiss containing microcline microperthite, oligoclase, quartz, biotite, and local garnet, sillimanite, and magnetite. Commonly contains interlayers of light-gray, vitreous, medium-grained, massive to well-foliated feldspathic quartzite composed of quartz and local black tourmaline too thin to be shown on the map.

Ymp **Clinopyroxene-quartz-feldspar gneiss (Mesoproterozoic)** – Pinkish-gray- or pinkish-buff- weathering, white, pale-pinkish-white, or light-gray, medium- to coarse-grained, foliated gneiss composed of quartz, microcline, oligoclase, clinopyroxene, and trace amounts of epidote, biotite, titanite, and magnetite. Commonly interlayered with amphibolite or pyroxene amphibolite.

Yp **Pyroxene gneiss (Mesoproterozoic)** – White- or tan-weathering, greenish-gray, fine- to medium-grained, layered and foliated gneiss containing oligoclase and clinopyroxene. Quartz content is highly variable. Locally contains epidote, titanite, scapolite, or calcite. Commonly interlayered with pyroxene amphibolite, marble, or less commonly quartzite too thin to be shown on the map.

Ymr **Marble (Mesoproterozoic)** – White- or light-gray-weathering, white, grayish-white, or less commonly pale pink, fine- to medium-crystalline, calcitic to dolomitic marble with accessory graphite, phlogopite, serpentine, clinopyroxene, and magnetite. Contains abundant talc and serpentine along the west side of Marble Mountain, and pods and lenses of hornblende skarn near Lower Harmony. Unit locally displays relict karst features in the form of bedrock pinnacles and solution joints and openings.

Magmatic Arc Rocks
Losee Metamorphic Suite (Drake, 1984; Volkert, 2004)

Ylo **Quartz-oligoclase gneiss (Mesoproterozoic)** – White-weathering, light-greenish-gray, medium- to coarse-grained, moderately layered and foliated gneiss composed of oligoclase or andesine, quartz, and varied amounts of hornblende, biotite, and clinopyroxene. Locally contains thin, conformable layers of amphibolite.

Ylb **Biotite-quartz-oligoclase gneiss (Mesoproterozoic)** – White- or light-gray-weathering, medium-gray or greenish-gray, medium- to coarse-grained, moderately layered and foliated gneiss composed of oligoclase or andesine, quartz, biotite, and local garnet. Some outcrops contain hornblende. Locally interlayered with amphibolite.

Ylh **Hornblende-quartz-oligoclase gneiss (Mesoproterozoic)** – White- or light-gray-weathering, greenish-gray, medium- to coarse-grained, foliated gneiss composed of oligoclase or andesine, quartz, hornblende, and magnetite. Some outcrops contain clinopyroxene. Locally interlayered with amphibolite.

Other Rocks

Ya **Amphibolite (Mesoproterozoic)** – Grayish-black, medium-grained, moderately foliated rock composed of hornblende and andesine. Some amphibolite contains biotite and/or clinopyroxene. Spatially associated with most Mesoproterozoic rocks in the map area. Much of the unit is interpreted to be metavolcanic, although some amphibolite layers within metasedimentary rocks may be metasedimentary in origin.

Yu **Mesoproterozoic rocks, undifferentiated** – Shown in cross section only.

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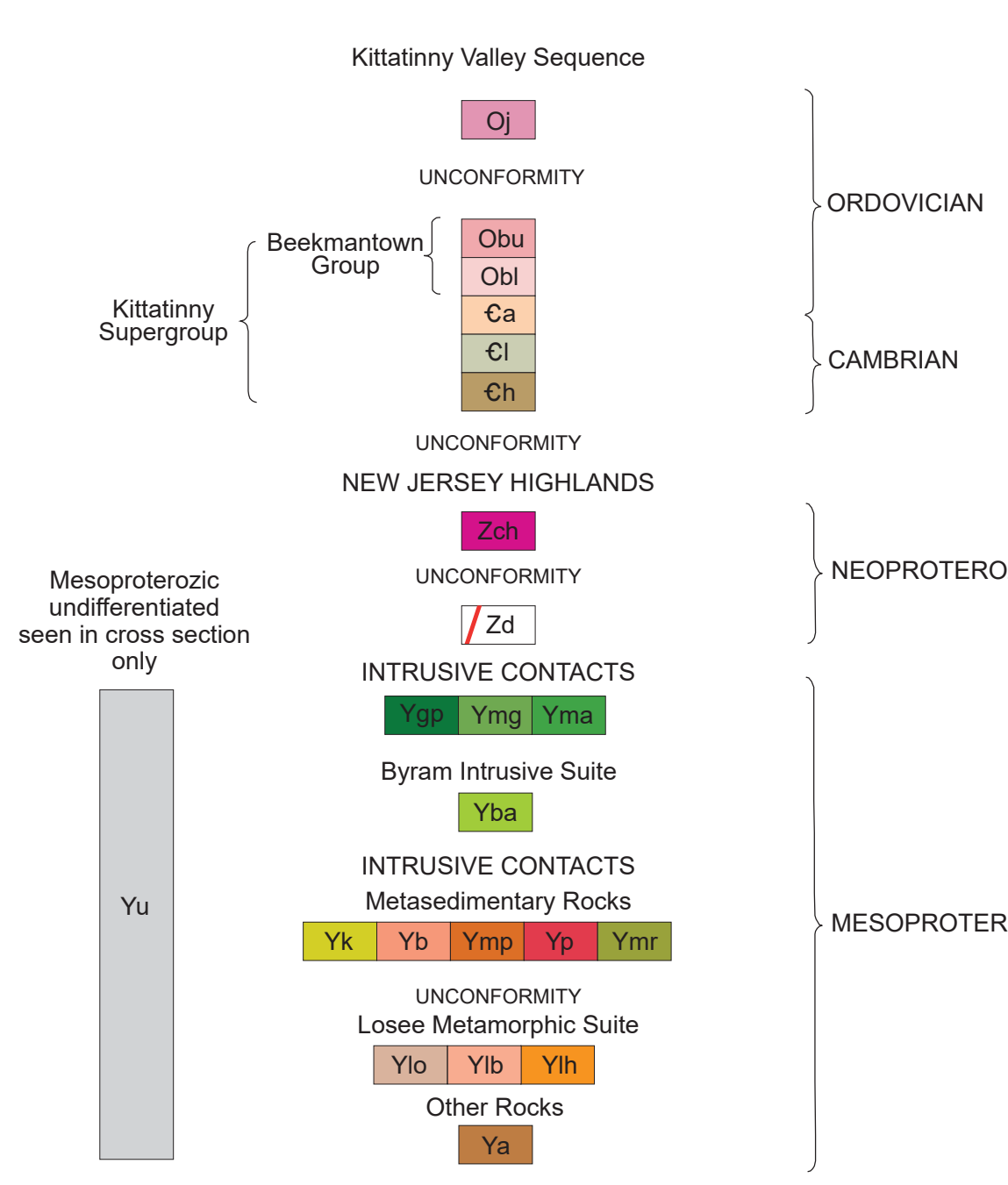
CORRELATION OF MAP UNITS



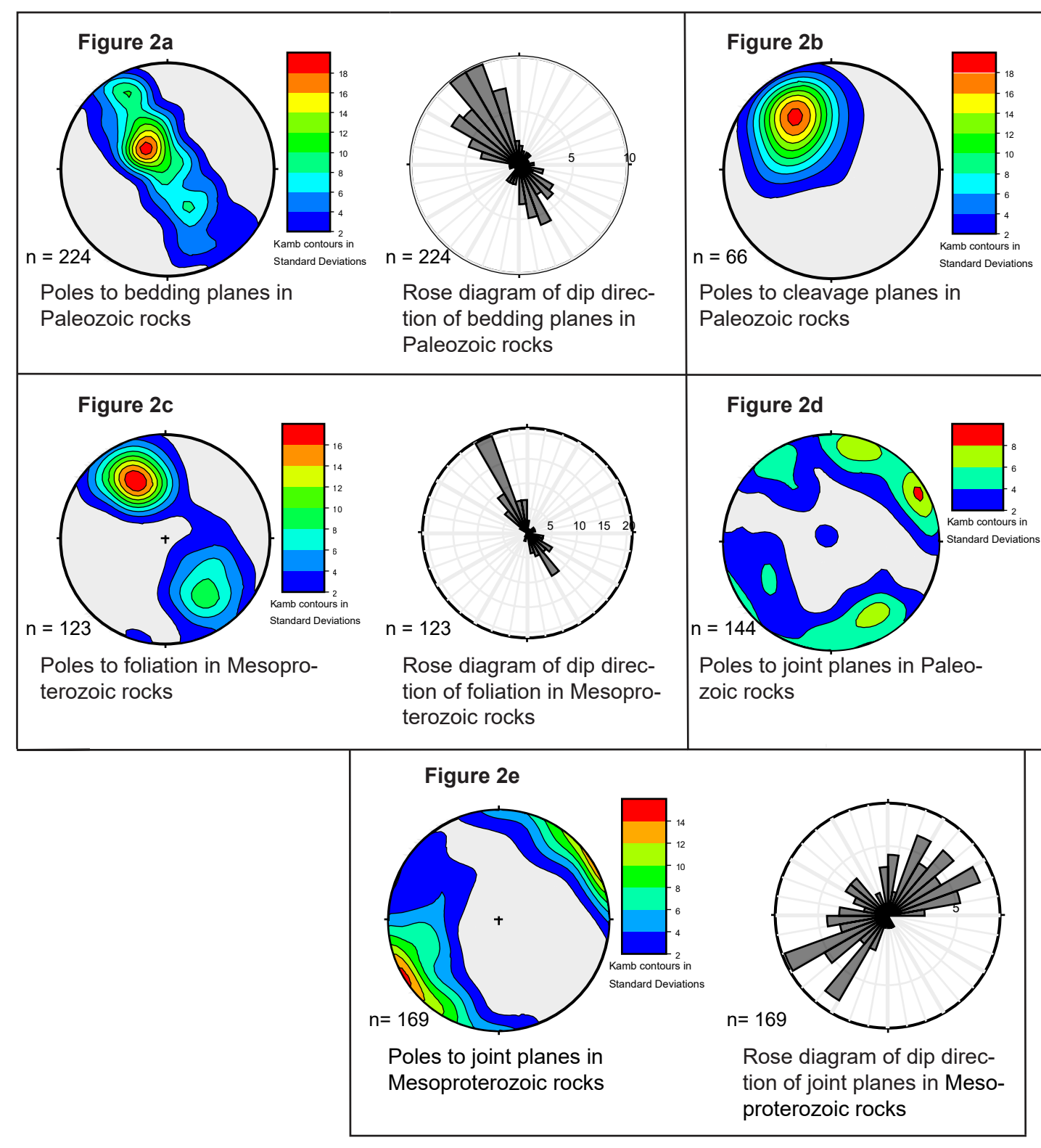


Figure 2a: Poles to bedding planes in Paleozoic rocks; Rose diagram of dip direction of bedding planes in Paleozoic rocks

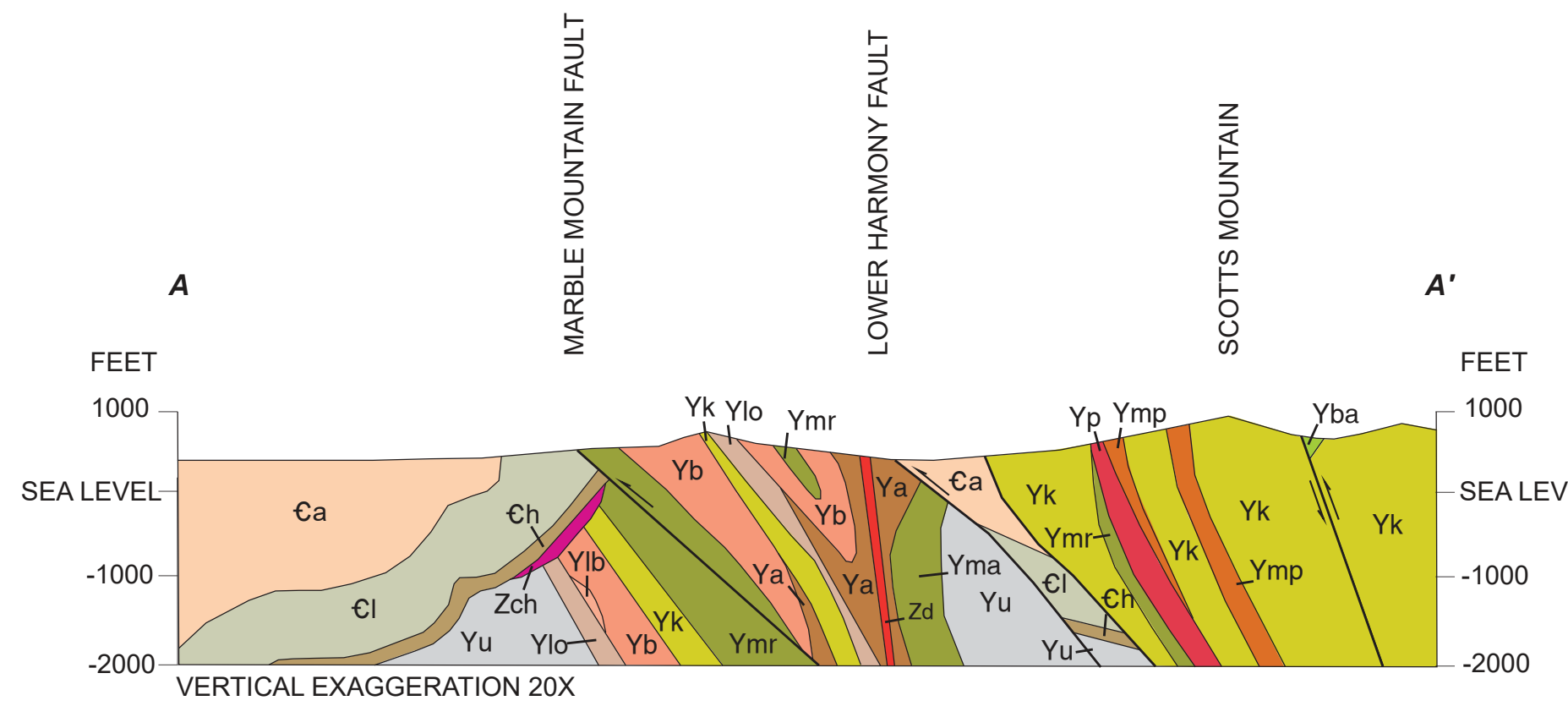
Figure 2b: Poles to cleavage planes in Paleozoic rocks; Rose diagram of dip direction of cleavage planes in Paleozoic rocks

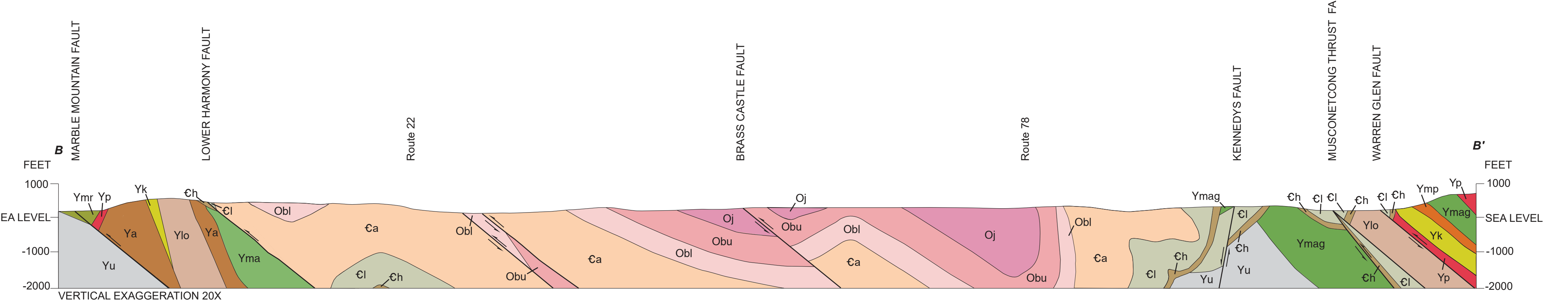
Figure 2c: Poles to foliation in Mesoproterozoic rocks; Rose diagram of dip direction of foliation in Mesoproterozoic rocks

Figure 2d: Poles to joint planes in Paleozoic rocks; Rose diagram of dip direction of joint planes in Paleozoic rocks

Figure 2e: Poles to joint planes in Mesoproterozoic rocks; Rose diagram of dip direction of joint planes in Mesoproterozoic rocks

Figure 2. Contour plots and rose diagrams showing dip direction of bedding planes, cleavage planes, and joint planes within Paleozoic rocks (2a, 2b, 2d), and dip direction of foliation and joint planes within Mesoproterozoic rocks (2c, 2e).





EXPLANATION OF MAP SYMBOLS

Contact - Dashed where approximately located

Faults - Queried where uncertain

Inclined thrust fault - teeth on upper plate. Queried where uncertain.

FOLDS

Folds in Paleozoic rocks showing trace of axial surface, direction and dip of limbs, and direction of plunge. Folds in bedding and/or cleavage.

Syncline

Anticline

Recumbent anticline

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

Antiform

Synform

PLANAR FEATURES

Strike and dip of beds

40 **Inclined**

Vertical

Overturned

20 **Strike and dip of cleavage in Paleozoic rocks**

Strike and dip of crystallization foliation

62 **Inclined**

Vertical

LINEAR FEATURES

18 **Bearing and plunge of intersection of bedding and cleavage**

OTHER FEATURES

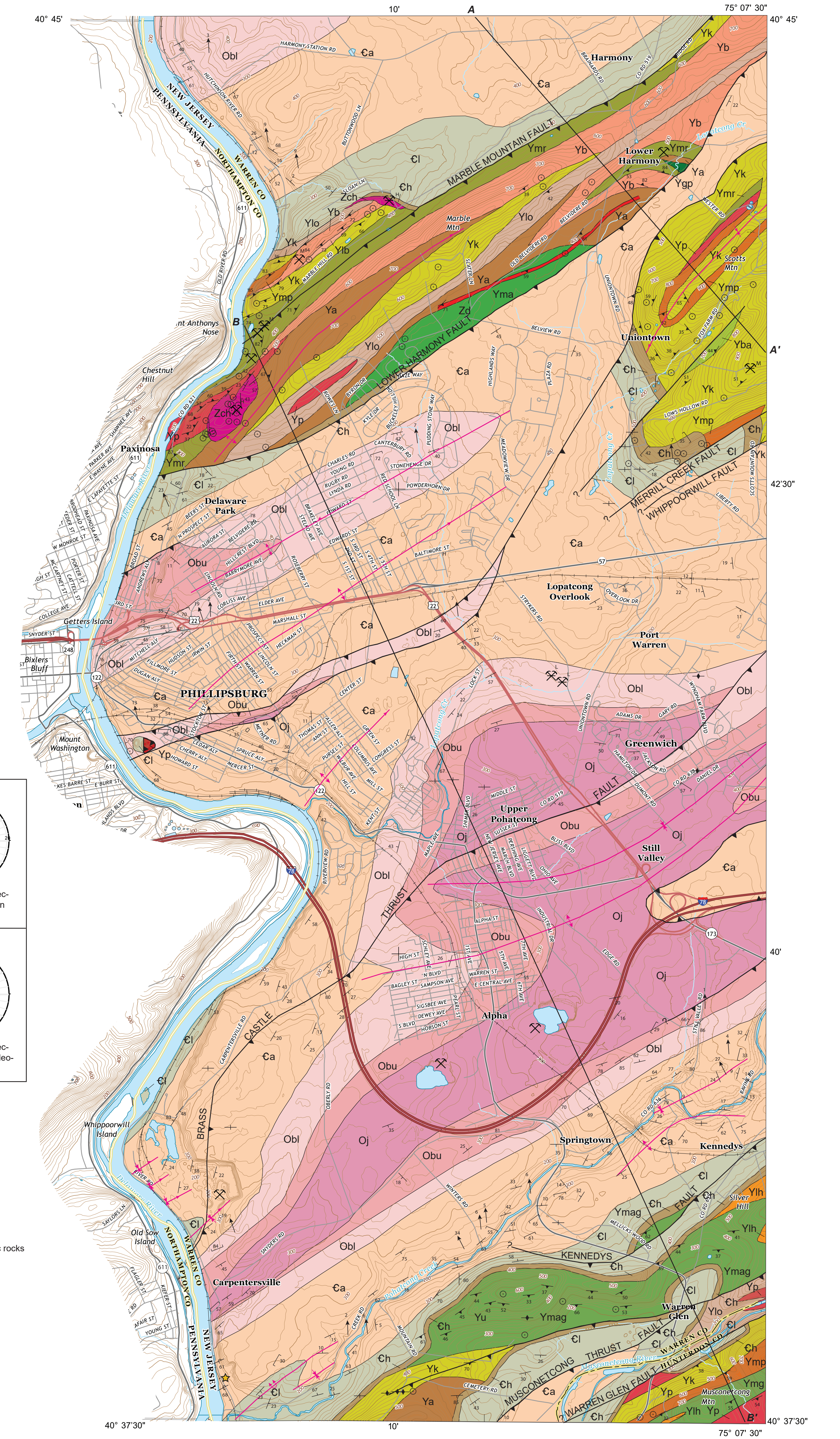
Relative motion along faults in cross-section

★ **Figure 1 location**

M **Abandoned mine; noted in 2024; M, magnetite; H, hematite; L, limonite**

Active quarry

⊙ **Bedrock float station**



North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and
1 000-meter grid: Universal Transverse Mercator, Zone 18T
10 000-foot ticks: New Jersey Coordinate System of 1983,
Pennsylvania Coordinate System of 1983 (south zone)

This map is not a legal document. Boundaries may be generalized for this map scale. Private lands within government reservations may not be shown. Obtain permission before entering private lands.

Imagery..........NAIP, July 2013
Roads..........U.S. Census Bureau, 2015 - 2016
Names..........GNIS, 2016
Hydrography..........National Hydrography Dataset, 2013
Contours..........National Elevation Dataset, 2011
Boundaries..........Multiple sources; see metadata file 1972 - 2016

Wetlands..........FWS National Wetlands Inventory 1977 - 2014

SCALE 1:24 000
1 0.5 0 KILOMETERS 1 2
1000 500 0 METERS 1000 2000
1 0.5 0 1
MILES
1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000
FEET

CONTOUR INTERVAL 20 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988

Bedrock geology mapped in 1986, 2003-04.
Digital cartography by Z.C. Schagrin.
Prepared in cooperation with the U. S. Geological Survey
National Geologic Mapping Program.
This geologic map was funded in part by the USGS National Cooperative Geologic Mapping Program under STATEMAP award number 04HQAG0043, 2004. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U. S. Government.
[1]retired, NJGWS

MN
GN
13°
219 MILS
0° 7´
2 MILS
UTM GRID AND 2003 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

1	2	3
4		5
6	7	8

ADJOINING QUADRANGLES

1 Wind Gap
2 Bangor
3 Belvidere
4 Nazareth
5 Bloomsbury
6 Hellertown
7 Riegelsville
8 Frenchtown

ROAD CLASSIFICATION

Expressway
Secondary Hwy
Ramp
Local Connector
Local Road
4WD
Interstate Route
US Route
State Route

BEDROCK GEOLOGIC MAP OF THE NEW JERSEY PORTIONS OF THE EASTON QUADRANGLE, WARREN AND HUNTERDON COUNTIES, NEW JERSEY

By

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2024