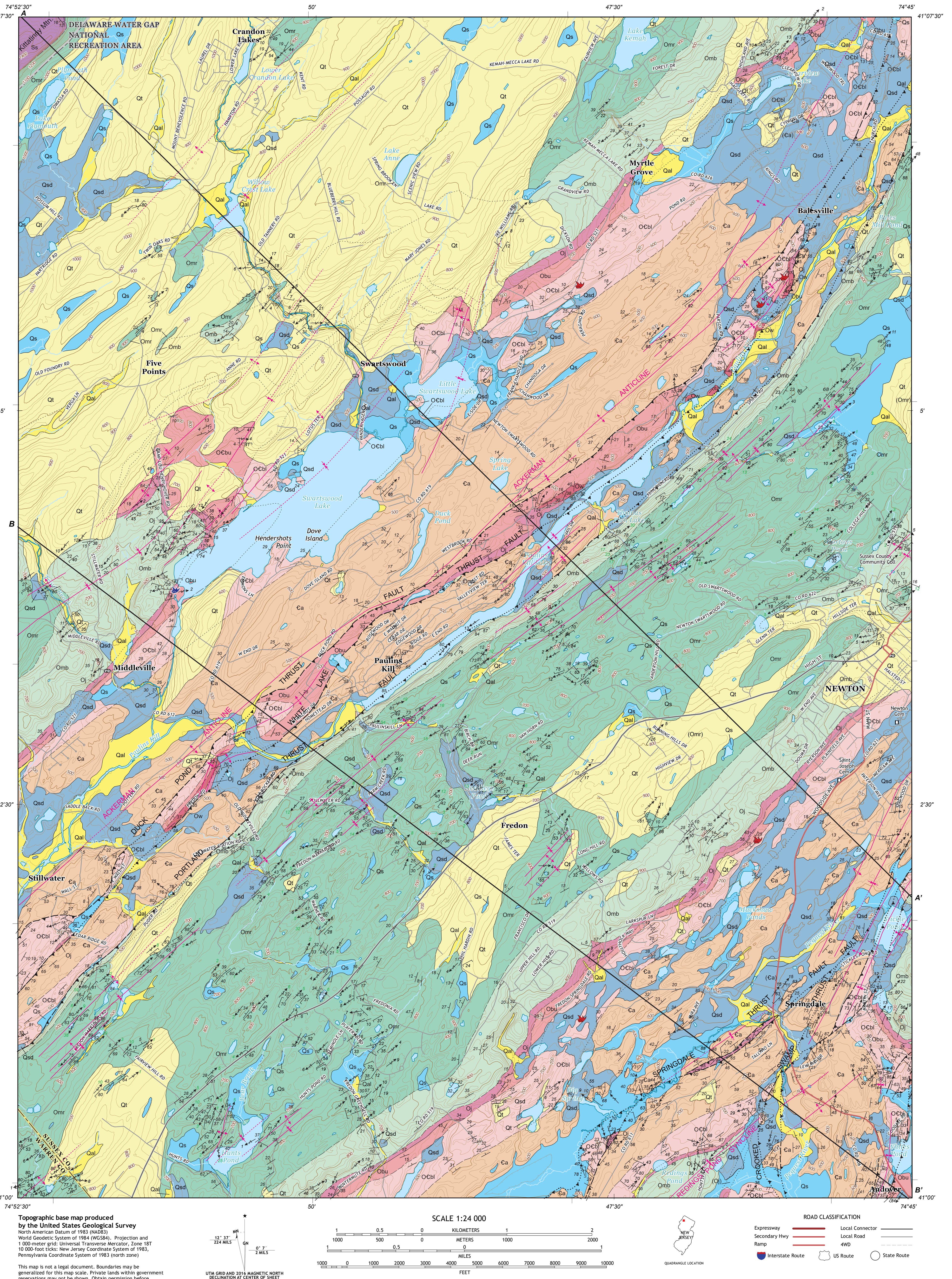
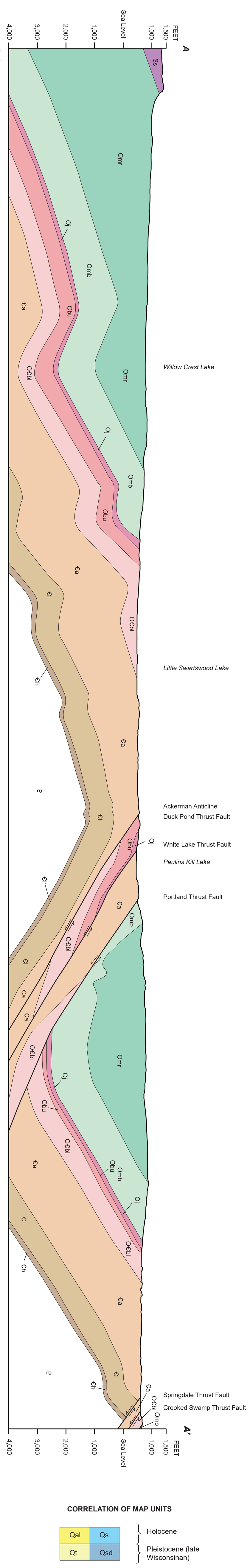
DEPARTMENT OF ENVIRONMENTAL PROTECTION
WATER RESOURCES MANAGEMENT
NEW JERSEY GEOLOGICAL AND WATER SURVEY

Prepared in cooperation with the
U.S. GEOLOGICAL SURVEY
NATIONAL GEOLOGIC MAPPING PROGRAM





EXPLANATION OF MAP SYMBOLS

Contact - Long dashed where approximately located; short dashed where inferred; dotted where concealed.

Fault - Long dashed where approximately located; short dashed where inferred; dotted where concealed.

Thrust fault - Sawteeth on upper plate.

Fold - Shows trace of axial surface. Long dashed where approximately located; short dashed where inferred; dotted where concealed

Anticline

Syncline

PLANAR FEATURES

Strike and dip of bedding

- Inclined
- Vertical
- Horizontal
- Overturned

Strike and dip of slaty cleavage

- Inclined
- Vertical

Strike and dip of crenulation cleavage

- Inclined
- Vertical

LINEAR FEATURES

Bearing and plunge of intersection of bedding and slaty cleavage

- Inclined
- Horizontal

Bearing and plunge of intersection of slaty cleavage and crenulation cleavage

- Inclined
- Horizontal

OTHER FEATURES

Location of conodont age date equivalent to Stonehenge Formation (Harris and others, 1995)

Location of conodont age date equivalent to Jacksonburg Limestone (Harris and others, 1995)

National Park Service boundary

(Oj) Formation shown in parenthesis represents bedrock unit below surficial material

INTRODUCTION

The Newton West quadrangle is in southwestern Sussex County and northern Warren County, all within the Valley and Ridge Physiographic Province. Northeast-trending ridges dominantly controlled by bedrock are separated by southwest draining rivers, the largest of which is the Paulins Kill. Paulins Kill essentially bisects the quadrangle into a northwestern and southeastern part. Pleistocene glaciation has further sculpted the landscape, leaving behind local thick blankets of till and meltwater sediment (Witte, 2012). Continued weathering, erosion and fluvial processes have led to a changing landscape.

The Delaware Water Gap National Recreation Area (DEWA) just crosses the far northwestern corner of the quadrangle along Kittatinny Mountain. Swartswood State Park covers a large amount of land and includes both Swartswood and Little Swartswood Lakes as well as several smaller water bodies in the region. Kittatinny Valley State Park occupies land along the southeast quadrangle boundary. DEWA with NJ State Parks and other preserved lands under the New Jersey Division of Fish and Wildlife as well as local municipalities comprise a large region of the quadrangle, all of which together offer many opportunities for hiking, camping, hunting, fishing and boating.

STRATIGRAPHY

See Witte (1997, 2012) for discussion on Pleistocene and younger age sediments.

Cambrian and Ordovician age rocks cover the entire quadrangle except for Kittatinny Mountain where Silurian age rocks crop out. These rocks mark the initial breakup of the Supercontinent Rodinia, creation of a broad carbonate passive margin and subsequent collision with an island arc complex of the Taconic orogenic event. Rodinia's breakup led to an initial transgression and deposition of the Hardyston Quartzite, the basal clastic sedimentary unit with clasts commonly sourced by local Mesoproterozoic gneisses. Lying above the Hardyston is the Leithsville Formation, a dolomite-rich unit that marks the initial transition into the carbonate-dominated passive margin. The Leithsville, Hardyston and Mesoproterozoic rocks are only shown in cross section. Allentown Dolomite overlies the Leithsville and contains abundant stromatolites, oolites, and quartz sand beds marking a shallow marine carbonate environment. The Leithsville, Allentown formations and Beekmantown Group units, have been completely dolomitized except for several limestone layers within the Beekmantown Group lower part. These limestone beds can be traced along strike into a dolomite facies. This dolomitization has led to an evolving stratigraphic interpretation of the Beekmantown Group carbonates (figure 1). The difference in interpretation began with the introduction of conodont dating across the dolomitized terrain between Reading, Pennsylvania and the northern New Jersey-New York border. In Pennsylvania, Hobson (1963) subdivided the Beekmantown Group rocks and projected these units to the Delaware River and into New Jersey. Initially Hobson (1963) suggested the basal Beekmantown unit in the Reading area, named the Stonehenge Limestone, pinched out toward New Jersey into the overlying Rickenbach Dolomite. Drake (1965, 1967) followed this interpretation on early geologic maps of the southwestern Valley and Ridge Province in New Jersey. Markewicz and Dalton (1977) further subdivided the Beekmantown Group rocks into various members traceable across northwestern New Jersey. These authors placed the few limestone beds found within the Beekmantown into either the Epler Formation, which Hobson (1963) described as an alternating interbedded limestone and dolomite unit that rests atop the Rickenbach, or within the younger limestone and dolomite within the Ontelaunee Formation.

Conodont-based age dating first used by Anita Harris and John Repetski, U. S. Geological Survey, (Harris and others, 1995, Repetski and others, 1995) in eastern Pennsylvania and New Jersey showed that New Jersey units mapped as Rickenbach and overlying Epler Formation were age equivalent with the Stonehenge Limestone type area in Reading, Pennsylvania (Karklins and Repetski, 1989). Drake and Lyttle (1985) started mapping the Stonehenge Limestone but changed it to a Formation due to its degree of dolomitization. Markewicz and Dalton (1977) used a more lithostratigraphic approach. Drake and others (1996) used a mutually agreed subdivision of Beekmantown Group upper part and lower part. Both Drake and others (1996) and Markewicz and Dalton (1977) recognize the contact between the upper and lower parts, though each use this boundary differently. Drake and others (1996) suggest the boundary lies between the Stonehenge and Rickenbach whereas, Markewicz and Dalton (1977) and Dalton and others (2014) suggest the boundary lies between the Epler and younger Ontelaunee Formation. The current map returns to the subdivision of Drake and others (1996). Drake and Lyttle (1980) placed the Leithsville, Allentown, Stonehenge, Rickenback, Epler and Ontelaunee formations into the Kittatinny Valley Supergroup. These formations represent the passive margin phase of sedimentation preceding the Taconic Orogeny.

The passive margin ends with the approach of an island arc and beginning of the Taconic Orogeny which resulted in the closing of the Iapetus Ocean in this region. A peripheral bulge formed due to thrust loading caused by the approaching island arc on an eastward-dipping (modern orientation) subduction zone (Jacobi, 1981; Quinlan and Beaumont, 1984). The westward migrating peripheral bulge uplifted, exposed and eroded the carbonate passive margin. This erosion accounts for the variable thickness of the Beekmantown Group upper part and local paleokarst features observed across the quadrangle. With the passing of the bulge, the region subsided. Sediments of the Sequence at Wantage, a locally preserved unit of reworked residual material, marks the initial phases of a transgression. Marine waters deepened leading to the deposition of the Jacksonburg Limestone. Facies of the Jacksonburg carbonates record the continued deepening of the margin. The cement-lime facies containing highly fossiliferous limestone marks shallow to moderate water depths. Argillaceous limestone of the cement-rock facies transitions upsection to deepening conditions that leads into a deep foreland basin filled by down slope turbidity flows of the Martinsburg Formation. Two members of the Martinsburg, one distal (Bushkill Member) and one more proximal (Ramseyburg Member), comprise the thick turbidite deposition in the foreland basin. Continued closing of the Iapetus Ocean led to the deformational features that mark the Taconic orogeny.

Post-orogenic uplift led to subaerial erosion of the Martinsburg Formation. Westward erosion of the Taconic Mountains moved sediment across and over the eroded Martinsburg. These sediments were deposited in braided steams and transitional marine-continental environments (Epstein and Epstein, 1972). Gray and Zeitler (1997) studied zircon minerals within quartz-rich rocks within conglomerate pebbles and boulders of the Shawangunk Formation. These zircons yielded U/Pb ages ranging from 950-1200 Million years ago indicating an older Grenville-aged event. The source of these zircon-bearing clasts probably originated in the belt of Grenville rocks to the east. Chert and shale clasts suggest provenance of some materials to be Lower Paleozoic in origin.

STRUCTURE

Rocks of the Newton West quadrangle show evidence of both the Taconic and Alleghanian Orogenic events. To date there is no deformational data that has been attributed to the Acadian Orogeny though it my be coaxial with the Alleghanian structural trends. Previous workers who studied rocks immediately across the New York border (Offield, 1967) and across the New Jersey region (Merchant and Teet, 1954; Herman and Monteverde, 1988, 1989; Herman and others, 1997) suggested that the Taconic signature was only broad open folds in northern New Jersey and southern New York. Folds steepened and became overturned to the south in Warren and Hunterdon Counties and closer to the Taconic deformational front. Taconian thrusting was limited to the more southern regions of Hunterdon County, New Jersey. Later Alleghanian deformation developed northwest-verging thrust faults that subsequently deformed the Taconic folded cover sequence. These Alleghanian thrust faults include the Duck Pond, White Lake and Portland thrust faults. They form the eastern section of the Paulins Kill Valley carbonate belt. Due to the previous Taconic deformational signature, these Alleghanian thrust faults further deformed and offset the older Taconic terrain generally bringing younger rocks over older. The White Lake Thrust Fault places older Allentown Dolomite rocks over younger units ranging from Beekmantown lower part to Jacksonburg Limestone. The Portland Thrust Fault marks the eastern boundary of the Paulins Kill Valley. Drake (1992) notes the continuation of this fault for about 30 miles from eastern Pennsylvania (Epstein, 1973). It terminates near Branchville, New Jersey (Drake and Monteverde, 1992) in the quadrangle to the immediate northeast of the Newton West quadrangle. The Ackerman Anticline (Drake and Lyttle, 1985) represents a probable Taconic-aged structure that continues approximately parallel to the Alleghanian thrust faults. A series of smaller scale folds to the west of the Ackerman Anticline deform the carbonates and continue through the western Martinsburg structural block (figure 2). The proposed Alleghanian faults appear to climb the south-dipping limb of the Ackerman Anticline. Stereonets of poles to bedding of the carbonate rocks (Figure 3) within the Paulins Kill Valley block display a dominant northwest dip as most outcrops lie west of the Ackerman Anticline. Using the Cylindrical Best Fit option on the Stereonet software of Allmendinger and others (2013) and Cardozo and Allmendinger (2013) a fold axis with a trend and plunge of 045/1 best fits the girdle of poles to bedding. Bedding in the western Martinsburg block shows a stronger northwestern dip and a fold axis to the poles to bedding girdle of 228/2. Though the twofold axes plunge almost 180° away, the plunges are so shallow that there is little difference in the calculated fold axes between the two.

Eastward of the Portland Fault lies a wide belt of Martinsburg turbidites that defines a broad synclinal structure cored by the Ramseyburg Member of the Martinsburg Formation. Abundant smaller scaled folds that parallel the Portland Fault occur within the Ramseyburg. The Portland Thrust Fault cuts the Bushkill Member of the Martinsburg Formation along the east-dipping limb of the syncline. Carbonates from the Jacksonburg Limestone to the Allentown Dolomite are part of the west-dipping limb of this Ramseyburg-cored synclinal structure. Similar to the Paulins Kill Valley block, stereonets of poles to bedding (figure 3) display a dominant northwest dip. Again, using the Cylindrical Best Fit program, a fold axis with a trend and plunge of 228/2 best fits the girdle of poles to bedding, identical to that of the western Martinsburg block. Farther eastward in the southeast corner of the quadrangle lie another series of thrust faults including the Springdale and Crooked Swamp faults and several other smaller, unnamed thrust faults. Several of these unnamed faults form small horse structures. As in the Paulins Kill Valley, depending on location along the structure either younger or older units can be in the hanging wall block. Calculated fold axis defined by the poles to bedding girdle of the carbonate rocks in the Crooked Swamp block structural block has a trend and plunge of 040/8.

Ordovician Martinsburg turbidite sediments have a well-developed cleavage. The development of this cleavage has been attributed to either Taconic (Rowlands, 1980; Ratcliffe, 1981, 2012), or Alleghanian compressive regimes (Epstein and Epstein, 1969; Wintsch and others, 1996), or a possible continuum across both events (Drake and Lyttle, 1980; Drake and Monteverde, 1993). Drake and Lyttle (1980) and Monteverde and Witte (2012) provide a review of the variety of data regarding this question. Cleavage is best developed in Martinsburg Formation structural blocks as shown by well-defined girdles (figure 3). Paulins Kill Valley cleavage is not as definitive due to the low number of readings compared to the Martinsburg data. Nonetheless, there is a strong correlation of the calculated fold axes for the Western and Eastern Martinsburg blocks, and Paulins Kill Valley block. Trend and plunge of the calculated cylindrical best fit for the three structural blocks are from west to east: 054/1, 051/3, and 052/2. The Crooked Swamp block is an outlier, with a trend and plunge fold axis at 030/12. Bedding-cleavage intersection lineations appear quite complimentary (figure 3). Martinsburg blocks display both northeast and southwest plunge directions. The Paulins Kill Valley block has similar trends with a higher concentration to the southwest. Data from the Crooked Swamp block shows the opposite with a stronger trend to the northeast than the southwest, but still in agreement with the other three blocks.

All northeast trending faults are suspected to have been reactivated as normal faults during the breakup of Pangea in the Mesozoic (Ratcliffe and others, 1986). Therefore, the most recent motion would have been normal or down to the southeast.

Drake (1965,1967)		Markewicz and Dalton (1977)	Drake and Lyttle (1985), Volkert and others (1989)	Drake and others (1996)	Dalton and others (2014)	This study	
Ob	Oe	Oo	Or	Obu	Oo	Obu	Ordovician
Ob	Oe	Oe	Os	Obl	O€e	O€bl	
Ob	Or*	Or			€r		
€a		€a**	O€a	O€a	€a**	€a	Cambrian
€l		€l	€l	€l	€l	€l	

Oo - Ontelaunee Formation
Oe - Epler Formation
Or - Rickenbach Formation
Or* - Rickenbach Dolomite
Os - Stonehenge Formation
Ob - Beekmantown Group
Obu - Beekmantown Group, upper part
O€bl - Beekmantown Group, lower part
O€e - Epler Formation
€r - Rickenbach Formation
O€a - Allentown Dolomite
€a** - Allentown Formation
€a - Allentown Dolomite
€l - Leithsville Formation

Figure 1. Evolution of Paleozoic carbonate rock nomenclature. This map follows the units of Drake and others (1996) with the inclusion of the revised age correlations due to changes in the International Stratigraphic Time Scale (U.S. Geological Survey, 2010) which raised the Cambrian-Ordovician boundary. Red dashed lines indicates the evolving placement of the Cambrian-Ordovician boundary. Symbols * and ** differentiates among different authors using the same formation name.

DESCRIPTION OF MAP UNITS

Postglacial Deposits - descriptions and mapped units simplified from Witte (2012)

Qal — **Stream deposits (Holocene and Pleistocene, late Wisconsinan)** - Stratified, moderately- to poorly-sorted, yellowish-brown, brown, and brownish-gray sand, gravel, silt, and minor dark gray clay and dark brown organic material deposited by streams. Locally bouldery. Can form narrow, sheet like deposits on the floors of modern valleys and higher stream terraces that flank the course of modern streams. Includes stratified, moderately to poorly sorted sand, gravel, and silt in fan deposits that lie at the mouth of tributaries. As much as 40 feet thick.

Qs — **Swamp and bog deposits (Holocene and Pleistocene, late Wisconsinan)** – Peat, (dark brown to black, partially decomposed remains of mosses, sedges, trees and other plants, and muck underlain by laminated organic-rich silt and clay. Accumulated in kettles, shallow postglacial lakes, glacially scoured bedrock basins, poorly-drained areas in uplands, in abandoned stream channels on alluvial plains, and hollows in ground moraine. Locally interbedded with alluvium and thin colluvium. In areas underlain by limestone and dolomite, may contain calcareous marl. As much as 25 feet thick.

Glacial Deposits - descriptions and mapped units simplified from Witte (2012)

Qt — **Till (Pleistocene, late Wisconsinan)** – yellowish-, reddish-, olive-brown, and grayish brown sandy, sandy-silty, and clayey-silty diamicton consisting of a very poorly sorted matrix of sand, silt, and clay and containing 5 to 35 percent pebbles, cobbles, and boulders. Deposited directly by or from glacial ice. Till is widespread, generally less than 20 feet thick and lies on bedrock. In areas of thin till (shown as bedrock formations on this map), bedrock outcrops are abundant and most of these exhibit signs of glacial erosion. Thicker till forms aprons on the north facing hillslopes, drumlins, and ground and recessional moraines. In places overlain by thin till (shown as unit Qt), noncompact, poorly sorted silty sand to sand containing as much as 35 percent pebbles, cobbles, boulders, and interlayered with lenses of sorted sand, gravel, and silt. May be as much as 100 feet thick.

Qsd — **Meltwater deposits (Pleistocene, late Wisconsinan)** - Stratified, well- to moderately-sorted sand, yellowish-brown, brown, and brownish-gray boulder-cobble to pebble gravel, pebbly sand and minor silt deposited by meltwater streams in valleys as outwash plains and fans and meltwater terraces and in small glacial lakes as deltaic and lacustrine-fan deposits. In places includes light to dark gray, parallel-laminated, irregularly to rhythmically-bedded silt, clay, and very fine sand; and minor cross-laminated silt, fine sand, and minor clay deposited on the floor of glacial lakes. As much as 150 feet thick.

Bedrock Formations

Ss — **Shawangunk Formation (Middle and Lower Silurian)** - Very light to medium dark gray, and greenish gray to medium greenish gray, very fine to coarse grained, thin to thick bedded, planar bedded, cross-bedded, and ripple bedded, light gray to light- olive gray and moderate-yellowish brown to moderate-reddish orange and moderate-brown weathering, conglomeratic quartzite with rounded to subangular quartz and lesser chert pebbles as much as 2.25 inches long, but averaging about 0.25 inches long, and dark gray to grayish black silty shale pebbles averaging about 2 inches long, but as much as 10 inches long. Medium dark to dark gray, thin to thick bedded siltstone and shale is interbedded with the sandstone and conglomerate in a zone about 300 feet thick lying about 350 feet above the base of the formation in the western part of the quadrangle. These shales and siltstones may be the Lizard Creek Member of the Shawangunk Formation separating the Tammany Member above from the Minsi Member below as exposed at Delaware Water Gap, 11 miles to the southwest (Epstein, 1973). These shales and siltstones are found in scattered outcrops along Kittatinny Mountain at about this stratigraphic level, but the members are not readily mapped in this quadrangle. The scattered outcrops do show, however, that the shales and siltstones ascribed to the Lizard Creek Member in eastern Pennsylvania thin northeastward through New Jersey and are represented by thin scattered intervals in southeastern New York (Epstein, 1993). The lower unconformable contact is covered by talus along the south slope of Kittatinny Mountain. About 1,400 feet thick.

Omr — **Ramseyburg Member of Martinsburg Formation (upper Middle Ordovician)** – Interbedded medium- to dark-gray to brownish-gray, fine- to medium-grained, thin- to thick-bedded quartzose to graywacke sandstone and siltstone and medium- to dark-gray, laminated to thin-bedded shale and slate. Unit forms fining upward sequences characterized by basal cross-bedded sandstone to siltstone grading upward through planar laminated siltstone into shale or slate. Locally, fining upward cycles may have a lower, medium- to thick-bedded, graded-bedded sandstone overlain by planar laminated sandstone to siltstone beneath the cross-bedded layer. Complete cycles may be an inch to several feet thick. Basal scour, sole marks, and soft-sediment distortion of beds are common in quartzose and graywacke sandstones. Lower contact placed at bottom of lowest thick- to very-thick-bedded graywacke, but contact locally grades through sequence of dominantly thin-bedded slate and minor thin- to medium-bedded discontinuous and lenticular graywacke beds in the Bushkill Member. Parris and Cruikshank (1992) correlate unit with *Orthograptus ruedemanni* zone to lowest part of *Climacograptus spiniferus* zone of Riva (1969, 1974) indicating Shermanian age (Caradocian). Regionally, unit is as much as 3,500 feet thick.

Omb — **Bushkill Member of Martinsburg Formation (upper Middle Ordovician)** – Medium- to medium-dark-gray-weathering, dark-gray to black, thinly laminated to medium-bedded shale and slate; less abundant medium-gray- to brownish-gray-weathering, dark-gray to black, laminated to thin-bedded, greywacke siltstone. Unit forms fining upward sequences characterized by basal cross-bedded siltstone grading upward through planar laminated siltstone into a cross-bedded siltstone that grades upward into slate. Complete cycles may be an inch to several feet thick with slate comprising the thickest part. Lower contact with the Jacksonburg Limestone is gradational, but commonly disrupted by thrust faulting. Parris and Cruikshank (1992) show that regionally the unit contains graptolites of zones *Diplograptus multidens* to *Corynoides americanus* (Riva, 1969; 1974), indicating Shermanian (Caradocian) age. Thicknesses ranges from 1,000 to 1,500 feet regionally.

Oj — **Jacksonburg Limestone (Middle Ordovician)** – 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 basal sequence. Lower contact unconformable on the 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). Thickness ranges from 150 feet to 1,000 feet regionally.

Ow — **"Sequence at Wantage" (Upper Ordovician)** – Interbedded, very-thin- to medium-bedded limestone, dolomite, siltstone, and argillite. Upper carbonate facies is moderate-yellowish-brown to olive-gray weathering, medium- to dark-gray, very-fine- to fine-grained, laminated to medium-bedded limestone and dolomite. Rounded quartz sand occurs locally as floating grains and in very thin lenses. Lower clastic facies contains medium-gray, grayish-red to grayish-green, thin- to medium-bedded mudstone, siltstone, and fine-grained to pebbly sandstone. Fine-grained beds commonly contain minor disseminated subangular to subrounded, medium-grained quartz sand and pebble-sized chert. Some coarse-grained beds are cross-stratified. Unit is restricted to lows on the surface of the Middle Ordovician unconformity. North American Midcontinent province conodonts within the carbonate facies, identified by Harris and others (1995) limit a range in age from no older than Rocklandian to no younger than Kirkfieldian. Unit may be as much as 150 feet thick in the quadrangle.

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 surface, 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. Lower contact 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) age as used by Sweet and Bergstrom (1986). In the map area, unit correlates with the Epler and Rickenbach Dolomite of Drake and others (1985) and the Ontelaunee Formation of Markewicz and Dalton (1977). Thickness averages about 200 feet. but locally is as much as 800 feet.

O€bl — **Beekmantown Group, lower part (Upper Cambrian - 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 with 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), which dates the unit to Ibexian (Tremadocian) age. 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 feet thick.

€a — **Allentown Dolomite (lowest Lower Ordovician to Upper Cambrian)** - 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 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 feet thick regionally.

€l — **Leithsville Formation (Middle to Lower Cambrian)** - 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 the Hardyston Quartzite. Archaeocyathids of Early Cambrian age are present in the formation at Franklin, New Jersey, suggesting an intraformational disconformity between Middle and Early Cambrian time (Palmer and Rozanov, 1967). Unit also contains *Hyolithellus micans* (Offield,1967; Markewicz, 1968). Approximately 800 feet thick regionally. Only on cross sections.

€h — **Hardyston Quartzite (Lower Cambrian)** - 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 absent to a maximum 100 feet regionally. Only on cross sections.

Ꝑ — **Proterozoic Undivided** – Predominantly high-grade metamorphic rocks shown in section only.

CORRELATION OF MAP UNITS

Qal, Qs — Holocene
Qt, Qsd — Pleistocene (late Wisconsinan)
unconformity
Ss — Silurian
unconformity
Omr, Omb, Oj — Ordovician
unconformity
Ow
unconformity
Obu, O€bl
€a, €l, €h — Cambrian
nonconformity
Ꝑ — Proterozoic

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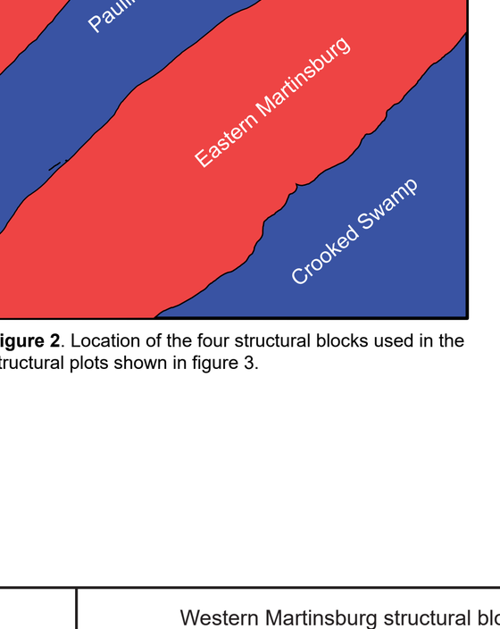

Figure 2. Location of the four structural blocks used in the structural plots shown in figure 3.

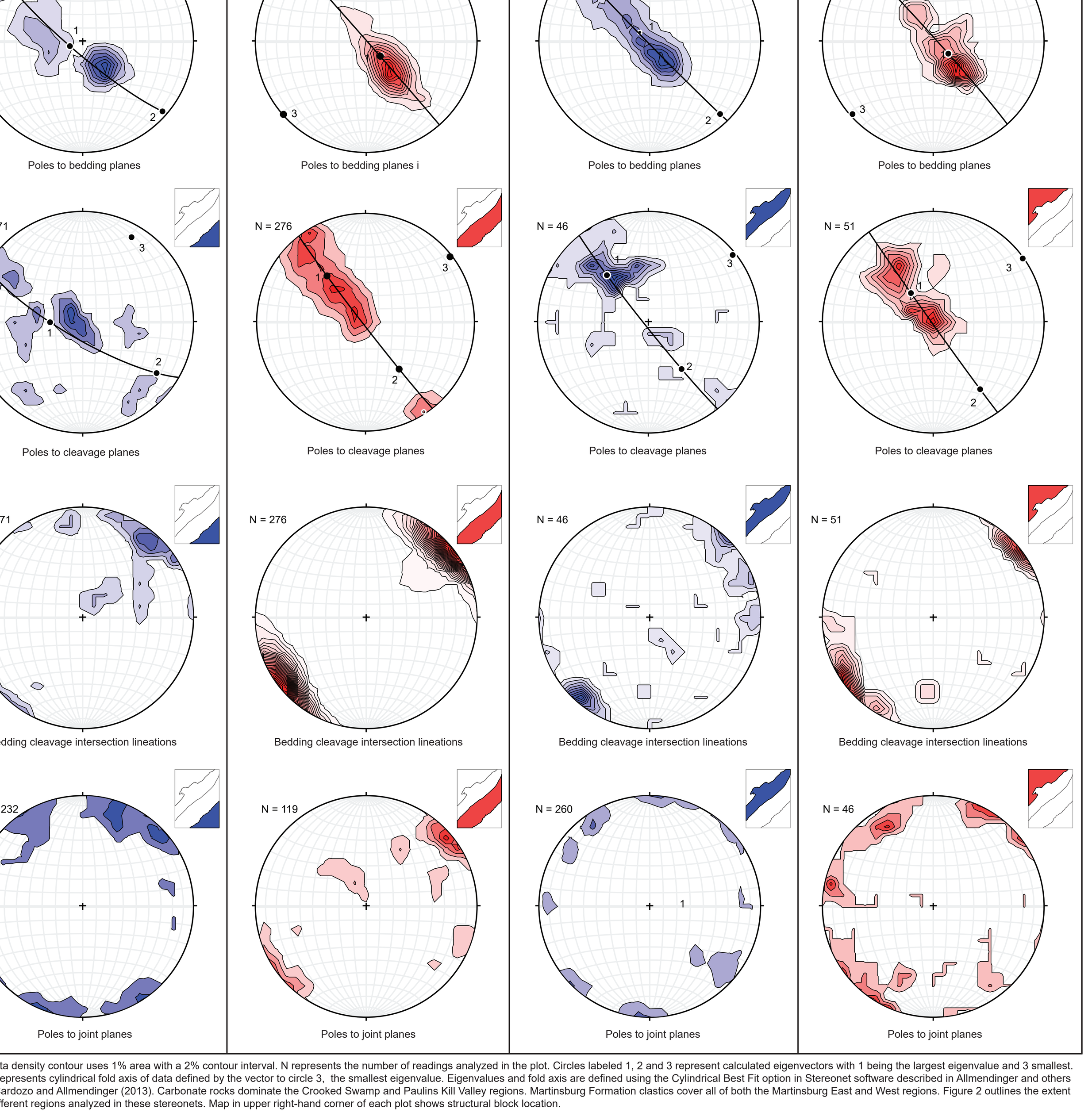

Figure 3. Data density contour uses 1% area with a 2% contour interval. N represents the number of readings analyzed in the plot. Circles labeled 1, 2 and 3 represent calculated eigenvectors with 1 being the largest eigenvalue and 3 smallest. Great circle represents cylindrical fold axis of data defined by the vector to circle 3, the smallest eigenvalue. Eigenvalues and fold axis are defined using the Cylindrical Best Fit option in Stereonet software described in Allmendinger and others (2013) and Cardozo and Allmendinger (2013). Carbonate rocks dominate the Crooked Swamp and Paulins Kill Valley regions. Martinsburg Formation clastics cover all of both the Martinsburg East and West regions. Figure 2 outlines the extent of the four different regions analyzed in these stereonets. Map in upper right-hand corner of each plot shows structural block location.

Topographic base map produced by the United States Geological Survey
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 (north 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, September 2015
Roads.... U.S. Census Bureau, 2015 - 2016
Names....GNIS, 2016
Hydrography....National Hydrography Dataset, 2015
Contours....National Elevation Dataset, 2013
Boundaries....Multiple sources; see metadata file 1972 - 2016
Wetlands....FWS National Wetlands Inventory 1977 - 2014

UTM GRID AND 2016 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET
12° 37' 224 MILS
0° 7' 2 MILS

U.S. National Grid
100,000-m Square ID
WL
Grid Zone Designation
18T

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

QUADRANGLE LOCATION

1 Lake Maskenozha
2 Culvers Gap
3 Branchville
4 Flatbrookville
5 Newton East
6 Blairstown
7 Tranquility
8 Stanhope
ADJOINING QUADRANGLES

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

Geology mapped by D.H. Monteverde and G.C. Herman[1] in 1985-88,
D.H. Monteverde in 2017-18
Digital cartography by D.H. Monteverde and R.S. Pristas
[1] retired from New Jersey Geological and Water Survey

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Geologic Map of the Newton West Quadrangle
Sussex County New Jersey

by
Donald H. Monteverde and Gregory C. Herman[1]
2021