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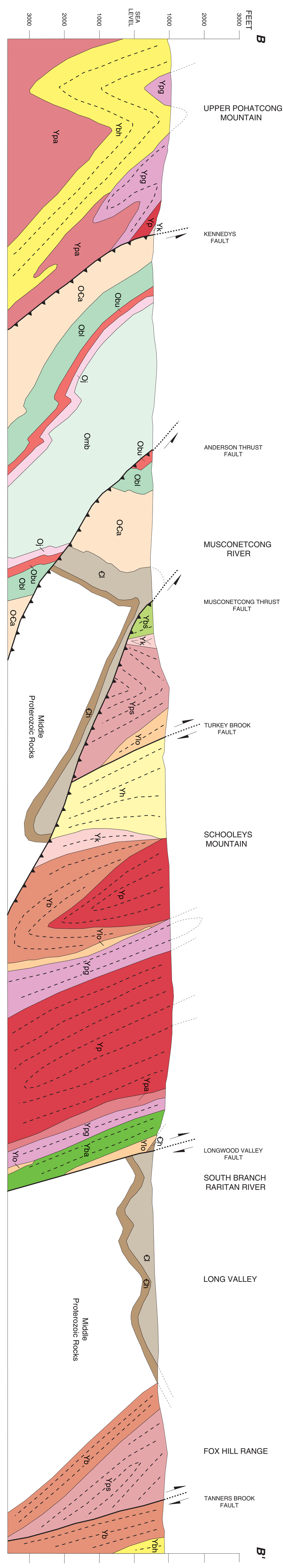
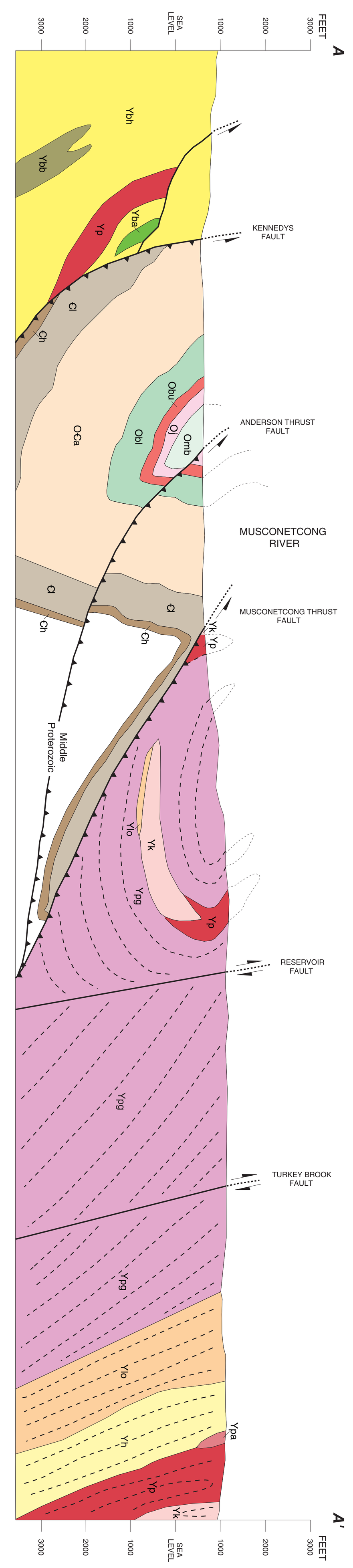
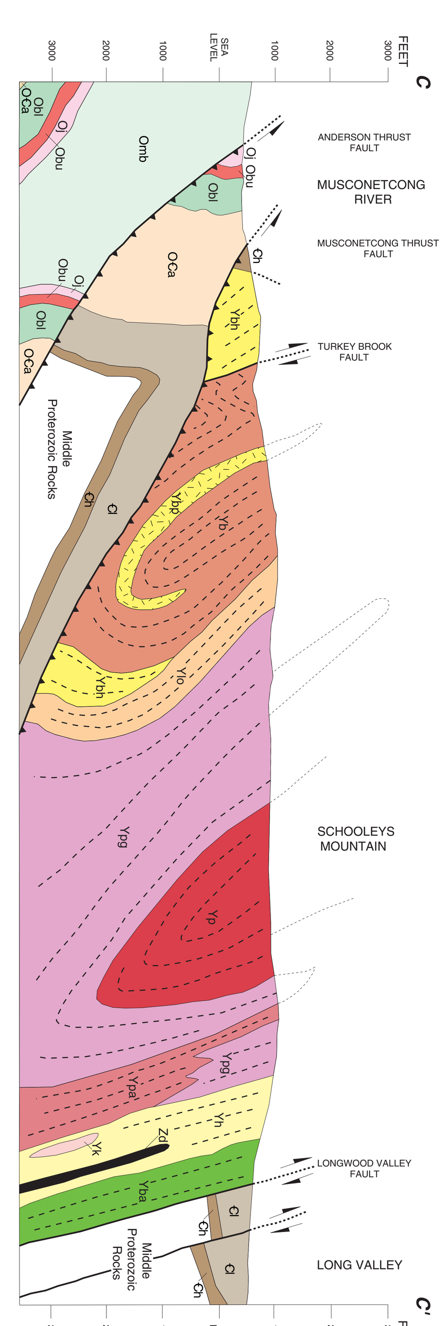
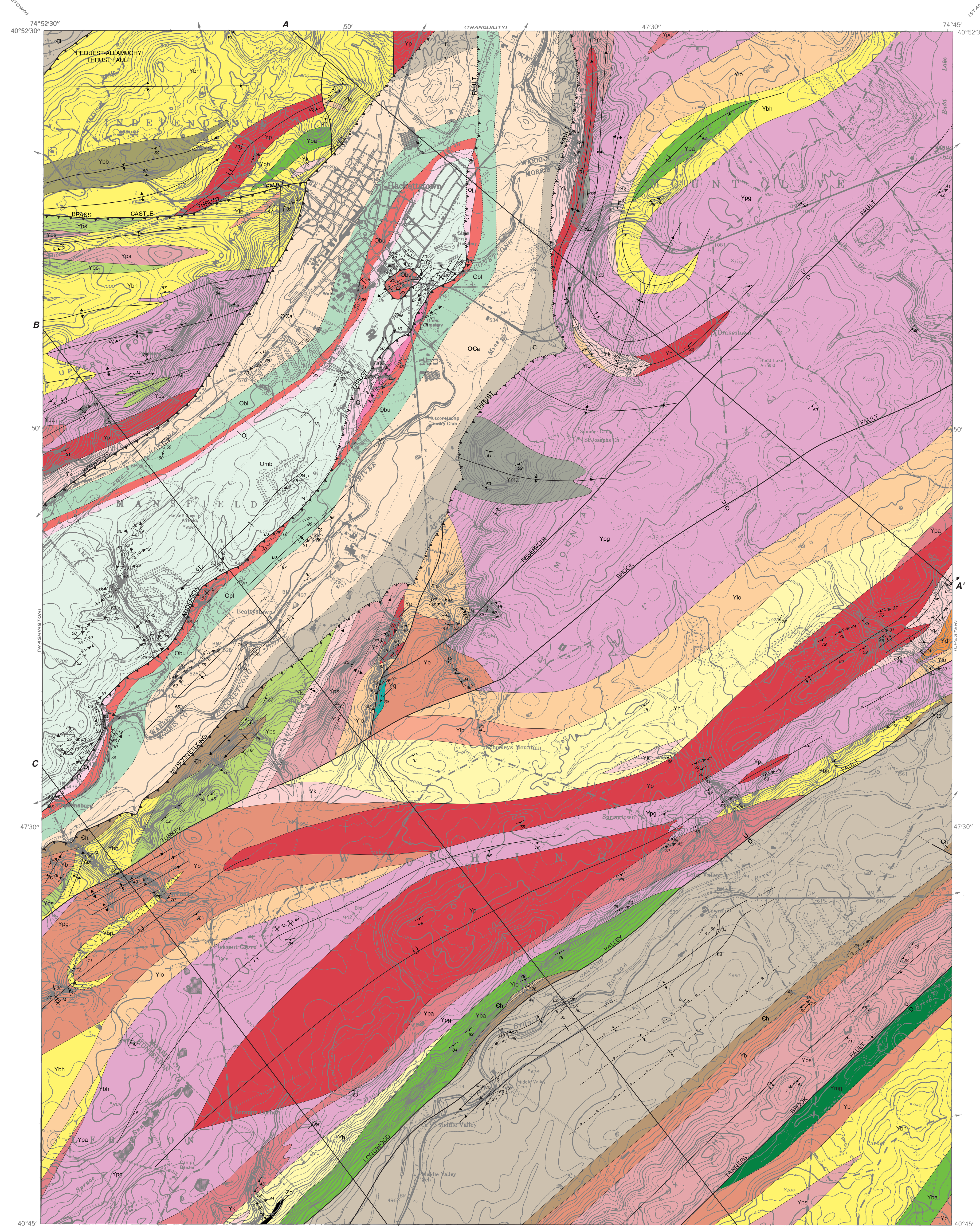
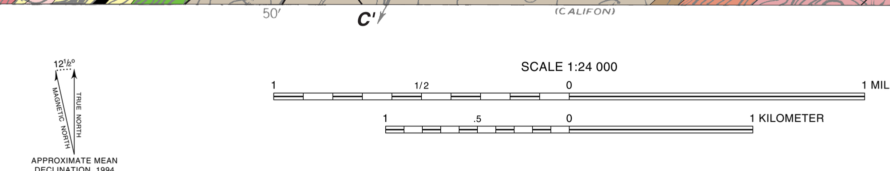








Base map from U.S. Geological Survey, 1953
Photorevised 1971



[1] New Jersey Geological Survey
[2] U.S. Geological Survey

Geologic interpretations supported by data in Andreasen and others, 1963; Banino, 1968; Bayley and others, 1914; Drake and others, 1985; Drake and others, 1994; Ghatge, unpublished data; Kummel, ca.1900; Markewicz, ca.1965; Markewicz and Dalton, unpublished data; Volkert, 1989; Volkert and others, 1989, and Volkert and others, 1990.

Digital Cartography by Ronald Pristas, Donald Monteverde, and Maryann Scott.

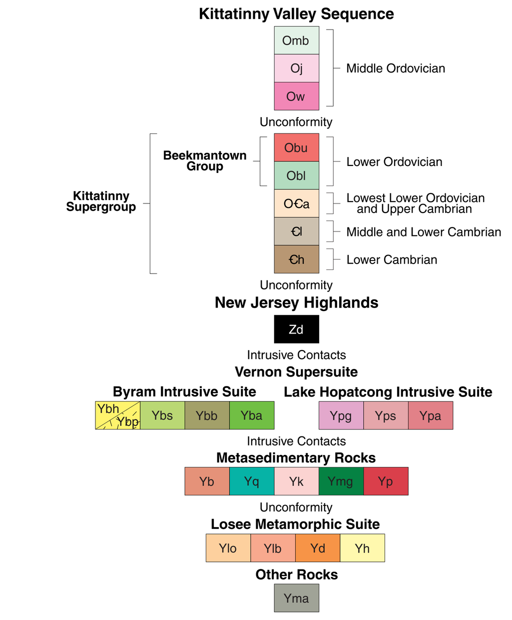
BEDROCK GEOLOGIC MAP OF THE HACKETTSTOWN QUADRANGLE MORRIS, WARREN, AND HUNTERDON COUNTIES, NEW JERSEY

By

Richard A. Volkert, [1] Donald H. Monteverde, [1] and Avery Ala Drake, Jr., [2]

2002

CORRELATION OF MAP UNITS



Kittatinny Valley Sequence

Omb **Bushkill Member of the Martinsburg Formation (Upper Middle Ordovician)**
Interbedded laminated to medium-bedded, dark-gray to black shale and slate, and less abundant laminated to thin-bedded, dark-gray to black siltstone. Complete Bouma (1962) turbidite sequences (Tabcde) are present, but basal cut-out sequences (Tcde and Tde) are the most common and compose the bulk of the rock. Some beds contain sparse graptolites and brachiopods. Lower contact with the Jacksonburg Limestone is gradational, but commonly disrupted by thrust faulting. Parris and Cruikshank (1992) show that regionally this unit contains graptolites of the *Diplograptus multidens* to *Corynoides americanus* zones of Riva (1969, 1974), which they correlate to the *Climacograptus bicornis* zone to the *Corynoides americanus* subzone of the *Orthograptus amplexicaulis* zone of Berry (1960, 1971, 1976). Maximum thickness of unit in Musconetcong Valley is approximately 3,000 feet.

Oj **Jacksonburg Limestone (Middle Ordovician)**
Laminated to thin-bedded, medium-dark- to dark-gray, shaly limestone with less abundant arenaceous limestone (cement rock facies). Grades downward into a fossiliferous, very thin to medium-bedded, interbedded mudstone, wackestone, and pebble-and-fossil packstone (cement limestone facies). Elsewhere, thick to very thick bedded dolomite cobbleconglomerate occurs within the basal sequence. Lower contact is unconformable with the Beekmantown Group and the clastic facies of the locally occurring sequence at Wantage. Unit contains conodonts of the North American Midcontinent province,is Rocklandian to Richmondian and possible Kirkfieldian (Caradocian) (Karklins and Repetski, 1989). Unit is approximately 150 feet thick.

Ow **Sequence at Wantage (Middle Ordovician)**
Interbedded very thin to medium-bedded limestone, dolomite, siltstone, and argilite. Upper carbonate facies, where present, is conformable with the Jacksonburg Limestone and grades downward into the clastic facies. The carbonate rocks are medium-bedded to laminated, medium- to dark-gray,very fine to fine-grained limestone and dolomite, and may have a very thin, moderate yellowish-brown to olive-gray alteration rind. Rounded quartz sand may occur as floating grains and in very thin lenses. The clastic facies ranges from mudstone to siltstone with minor disseminated subangular to subrounded chert pebbles and medium-grained quartz sand. A coarse-grained quartz and white chert sandstone to pebbly conglomerate occurs in the Musconetcong Valley. Commonly thin- to medium-bedded. Some coarser-grained beds are cross stratified. Unit is restricted to lows on the Beekmantown unconformity surface. Based on identification of North American Midcontinent province conodonts within the carbonate facies, the unit age limit is Rocklandian-medial Shermanian and possible Kirkfieldian (Caradocian) (A. Harris, written commun., 1990). Unit ranges from 0 to approximately 150 feet thick.

Obu **Beekmantown Group upper part (Lower Ordovician)**
Locally preserved, thin- to thick-bedded, aphanitic to medium-grained, medium light- to medium-gray dolomite; weathers light- to medium-gray to yellowish-gray,locally laminated, slightly fetid. Grades downward into medium- to thick-bedded, medium- to coarse-grained, medium-dark- to dark-gray dolomite; strongly fetid, mottled weathered surface contains pods and lenses of dark-gray to black chert. Contains conodonts of the North American Midcontinent province so unit is Ibexian (Tremadocian to Arenigian) as used by Sweet and Bergstrom (1986). In map area the unit includes the Richenback Dolomite of Drake and others (1985) and is the Ontelaunee Formation of Markewicz and Dalton (1977). Thickness varies from 0 to 200 feet because of erosion on the Beekmantown unconformity.

Obl **Beekmantown Group lower part (Lower Ordovician)**
Very thin to thick-bedded interbedded dolomite and minor limestone. Consists of three lithologic sequences. Upper sequence is laminated, fine- to medium-grained dolomite, very thin to thick-bedded, light-olive-gray to dark-gray, at places weathers dark-yellowish-orange. Middle sequence is fine-grained dolomite having silty dolomite laminae, and thin- to medium-bedded, fine-grained limestone which grades laterally into fine-grained dolomite having silty dolomite laminae. Grades down into a fine-grained, laminated dolomite. The dolomite is aphanitic to fine-grained, dark-gray, weathers light-gray to light-bluish-gray, typically has dolomitic "reticulate" mottling, and is characterized by a pattern of anastomosing, light-olive-gray to grayish-orange laminae surrounding lenses of limestone. Lower sequence consists of thinly laminated to thick-bedded, medium-grey to medium-dark gray, locally mottled, aphanitic to coarse-grained dolomite having quartz sand laminae, local very thin to thin, black chert beds; slightly fetid. Quartz sand increases toward the lower contact. Lower contact gradational. Contains conodonts of the North American Midcontinent province (Bergstrom 1986), so unit is Ibexian (Tremadocian). Entire unit is the Stonehenge Limestone of Drake and others (1985) and the Stonehenge Formation of Volkert and others (1989). Upper and middle sequences are the Epler Formation of Markewicz and Dalton (1977) and lower sequence is the Rickenbach Formation of Markewicz and Dalton (1977). Unit is about 600 feet thick.

O-Ca **Allentown Dolomite (Lowest Lower Ordovician to Upper Cambrian)**
Very thin to very thick bedded, interbedded dolomite and shale. The dolomite includes minor interbeds of orthoquartzite and shale. An upper dolomite, at most places, is medium to very thick bedded, fine- to medium-grained, contains local coarse-grained beds, and is medium-dark- to medium-light-gray. Floating quartz sand and two sequences of medium light to very light gray, thin bedded quartzite and discontinuous dark gray chert lenses occur directly below the upper contact. A rhythmically bedded lower dolomite sequence contains abundant medium-to very light-gray-weathering grainstones, algal stromatolites, and light-gray weathering beds. Weathered exposures are characterized by alternating light and dark-gray beds. Ripple marks, cross beds, edgewise conglomerate, mud cracks, and paleosol zones occur in the lower unit. Interbedded shaly dolomite increases downward towards the lower contact with the Leithsville Formation. Lower contact conformable. In the Delaware Valley the lowest part of the unit contains a trilobite fauna of Dresbachian (Lower Upper Cambrian) age (Weller, 1903; Howell, 1945). In the Musconetcong Valley unit is approximately 1,900 feet thick.

Cl **Leithsville Formation (Middle to Lower Cambrian)**
Thin- to thick-bedded dolomite containing subordinate clastic rocks. Dolomite in the upper part is massive, fine- to medium-grained, pitted, friable, mottled and medium- to medium-dark-gray. A lower dolomite sequence is thin- to medium-bedded, stylolitic, fine-grained, and medium gray. Shaly dolomite and clastic interbeds of varicolored quartz sandstone, siltstone, and shale occur throughout, but are most abundant in the middle of the unit. The lower dolomite sequence contains quartz sand interbeds near the lower contact with the Hardyston Quartzite. Archaeocyathids of Early Cambrian age occur in the formation elsewhere in New Jersey, suggesting an intraformational disconformity so that both Middle and Early Cambrian are represented by the unit (Palmer and Rozanov, 1976). Unit also contains *Hyolithellus micans* (Markewicz and Dalton, 1977). Thickness is approximately 800 feet in the Musconetcong Valley.

Ch **Hardyston Quartzite (Lower Cambrian)**
Medium-to thick-bedded, fine-grained, medium- to light-gray quartzite, arkosic sandstone and dolomitic sandstone. Elsewhere in New Jersey contains fragments of the trilobite of Early Cambrian age (Nason, 1891; Weller, 1903). Maximum thickness of unit is 200 feet.

Zd **Diabase dike (Late Proterozoic)**
Medium- to dark-greenish-gray, fine-grained to aphanitic, dense, hard dike south-southeast of Scrappy Corner. Has chilled margins and is in sharp, conformable contact with enclosing country rock. Tholeiitic is slightly alkalic in composition, hypersthene normative. Composed principally of labradorite to andesine, clinopyroxene (augite), and ilmeno-magnetite. Sparse pyrite blebs are ubiquitous. Chemically similar to other Highlands diabase dikes that have been assigned a Late Proterozoic age by Volkert and Puffer (1995). Maximum thickness of dike is about 35 feet.

NEW JERSEY HIGHLANDS

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

Ybh **Hornblende granite (Middle Proterozoic)**
Pinkish-gray- to buff-weathering, pinkish-white or light-pinkish-gray, medium- to medium-coarse-grained, moderately foliated granite and sparse granite gneiss composed of mesoperthite, microcline microperthite, quartz, oligoclase, hornblende, and variable amounts of magnetite. Locally includes a pegmatite phase (Ybp) that is best exposed west of Pleasant Grove. Small amphibolite bodies too small to be shown on map are common. Unit has an Rb-Sr isochron age of about 1116 Ma (Volkert and others, 2000).

Ybs **Hornblende syenite (Middle Proterozoic)**
Tan- to buff-weathering, pinkish-gray or greenish-gray, medium- to medium-coarse-grained, moderately foliated rock of syenitic to monzonitic and less abundant quartz syenitic to quartz monzonitic composition. Composed of mesoperthite, microcline microperthite, oligoclase, hornblende, and magnetite.

Ybb **Biotite granite (Middle Proterozoic)**
Pink- to buff-weathering, light-pinkish-gray or pinkish-white, medium- to medium-coarse-grained, moderately foliated granite composed of microcline microperthite, quartz, oligoclase, biotite, and magnetite.

Yba **Microperthite alaskite (Middle Proterozoic)**
Pale pinkish-white- to buff-weathering, light-pinkish-gray or pinkish-white, medium- to medium-coarse-grained, moderately foliated granite composed of microcline microperthite, quartz, oligoclase, and trace amounts of hornblende and magnetite. Includes small bodies of amphibolite too small to be shown on map. Formerly quarried for dimension stone in the southern part of the map area.

Lake Hopatcong Intrusive Suite (Drake and Volkert, 1991)

Ypg **Pyroxene granite (Middle Proterozoic)**
Gray- to buff- or white-weathering, greenish-gray, medium-to medium-coarse-grained, moderately foliated granite and sparse granite gneiss containing mesoperthite to microantiperthite, quartz, oligoclase, clinopyroxene, magnetite, and trace amounts of titanite, apatite, and pyrite. Contains sparse hornblende where in contact with rocks of the Byram Intrusive Suite. Locally includes small bodies of amphibolite too small to be shown on map. Unit has an Rb-Sr isochron age of about 1095 Ma (Volkert et al., 2000).

Yps **Pyroxene syenite (Middle Proterozoic)**
Gray- to buff- or tan-weathering, greenish-gray, medium- to medium-coarse-grained, moderately foliated rock of syenitic to monzonitic and less abundant quartz syenitic to quartz monzonitic composition. Composed of mesoperthite, microcline microperthite, oligoclase, clinopyroxene, magnetite, and trace amounts of titanite and pyrite.

Ypa **Pyroxene alaskite (Middle Proterozoic)**
Light-gray- or tan-weathering, greenish-buff to light-pinkish-gray or pinkish-white, medium- to coarse-grained, moderately foliated granite composed of mesoperthite, microcline microperthite, quartz, oligoclase, and trace amounts of clinopyroxene, titanite, pyrite, and magnetite.

Metasedimentary Rocks

Yb **Biotite-quartz-feldspar gneiss (Middle Proterozoic)**
Pale pinkish-gray- to rusty-weathering, gray, tan, or greenish-gray, fine-to medium-coarse-grained, moderately layered and foliated gneiss containing microcline microperthite, oligoclase, quartz, biotite, garnet, and (or) sillimanite, and magnetite. Graphite and pyrrhotite are confined to the variant that weathers rusty. This variant is commonly spatially associated with thin, moderately foliated to well-layered quartzite (Yq) that is too thin to be shown on map.

Yq **Quartzite (Middle Proterozoic)**
Light-gray-weathering, light-gray to grayish-buff, vitreous, medium-grained, massive-textured to well-layered rock composed predominantly of quartz and variable amounts of biotite, microcline, and graphite.

Yk **Potassic feldspar gneiss (Middle Proterozoic)**
Light-gray- to pinkish-buff- weathering, pale pinkish-white to light-pinkish-gray, medium-grained, massive, moderately foliated gneiss composed of quartz, microcline microperthite, oligoclase, biotite, and less common garnet, sillimanite, and magnetite.

Ymg **Monazite gneiss (Middle Proterozoic)**
Buff-weathering, light-greenish-gray or greenish-buff, medium-grained, moderately foliated gneiss containing microcline microperthite, quartz, oligoclase, biotite, and locally abundant monazite. Accessory minerals include hornblende, zircon, and magnetite. Interpreted by Volkert and Drake (1999) to represent a metamorphosed placer deposit. Unit occurs in a thin belt along Tanners Brook.

Yp **Pyroxene gneiss (Middle Proterozoic)**
Two distinct variants of this unit are recognized in the map area, but they are shown together because of poor exposure. One variant is white- to tan-weathering, light-greenish-gray, medium-fine- to medium-grained, well-layered and foliated gneiss containing oligoclase, clinopyroxene, variable amounts of quartz, and trace amounts of titanite, magnetite and epidote. The other variant is pinkish-gray- to pinkish-buff-weathering, pinkish-white or pinkish-gray, medium-grained, moderately foliated gneiss containing microcline, quartz, oligoclase, clinopyroxene, and trace amounts of titanite and magnetite. The latter variant is the clinopyroxene-quartz-microcline gneiss of Volkert and others (1989) and clinopyroxene-quartz-feldspar gneiss of Volkert and others (1990) and Drake and others (1996). Both variants are commonly interlayered with amphibolite or pyroxene amphibolite in the map area.

LOSEE METAMORPHIC SUITE (Drake, 1984; Volkert and Drake, 1999)

Ylo **Quartz-oligoclase gneiss (Middle Proterozoic)**
White-weathering, light-greenish-gray, medium- to coarse-grained, massive-textured, moderately foliated to moderately layered gneiss composed of oligoclase or andesine, quartz, and variable amounts of hornblende, clinopyroxene, and (or) biotite. Locally contains layers of amphibolite too thin to be shown on map. Unit commonly has gradational contacts with biotite-qyartz-oligoclase gneiss (Ylb) and with hypersthene-quartz-plagioclase gneiss (Yh) and occurs as conformable layers within bodies of diorite (Yd).

Ylb **Biotite-quartz-oligoclase gneiss (Middle Proterozoic)**
Light-gray-weathering, medium-gray or greenish-gray, medium- to medium-coarse-grained, moderately well layered and foliated gneiss composed of oligoclase or andesine, quartz, biotite, and local garnet. Some outcrops contain hornblende. Locally contains thin layers of amphibolite too thin to be shown on map.

Yd **Diorite (Middle Proterozoic)**
Gray- to tan-weathering, greenish-gray or brownish-gray, medium-grained, greasy lustered, moderately foliated rock containing andesine or oligoclase, clinopyroxene, hornblende, hypersthene, and local accessory biotite quartz, and magnetite. Commonly contains thin layers of amphibolite (Ya) and leucocratic to mafic layers of quartz-oligoclase gneiss (Ylo). Unit is interpreted to be petrogenetically related to rocks of the Losee Metamorphic Suite (Volkert, 1993; Volkert and Drake, 1999).

Yh **Hypersthene-quartz-plagioclase gneiss (Middle Proterozoic)**
Gray- to tan-weathering, greenish-gray or greenish-brown, medium-grained, moderately layered and foliated, greasy-lustered gneiss composed of andesine or oligoclase, quartz, clinopyroxene, hornblende, hypersthene, and sparse biotite, and magnetite. Commonly contains conformable layers of amphibolite (Ya) and mafic-rich quartz-plagioclase gneiss (Ylo) too thin to be shown on map. Unit is interpreted to be petrogenetically related to rocks of the Losee Metamorphic Suite (Volkert, 1993; Volkert and Drake, 1999).

OTHER ROCKS

Yma **Microantiperthite alaskite (Middle Proterozoic)**
White-weathering, locally rusty, light-greenish-gray, medium-to medium-coarse-grained, moderately foliated alaskite and sparse granite gneiss containing microantiperthite, quartz, oligoclase, and less abundant clinopyroxene, hornblende, biotite, and magnetite. Unit may be petrogenetically related to pyroxene granite (Ypg) with which it is spatially associated.

MAP SYMBOLS

Contact - Dashed where concealed; queried where uncertain.

Faults - Dashed where concealed; queried where uncertain.

Fault - Showing uncertain attitude and movement sense

High angle fault - U, upthrown side; D, downthrown side

Thrust fault - Sawteeth on upper plate

FOLDS

Folds in Middle Proterozoic rocks - Folds in foliation and layering.

Antiform - Showing crestline and direction of plunge

Synform - Showing troughline and direction of plunge

Overturned antiform - Showing trace of axial surface, direction of dip of limbs, and direction of plunge

Overturned synform - Showing trace of axial surface, direction of dip of limbs, and direction of plunge

Folds in Paleozoic rocks - Folds in bedding and cleavage. Dashed where concealed; queried where uncertain.

Anticline - Showing crestline and direction of plunge

Syncline - Showing troughline and direction of plunge

Syncline, gently inclined to recumbent - Showing trace of troughline, direction of dip of limbs, and direction of plunge

Cleavage trough - Showing troughline and direction of plunge

MINOR FOLDS

Minor fold axis - Showing bearing and plunge

Anticline or antiform - Showing bearing and plunge

PLANAR FEATURES

Strike and dip of beds - Dot indicates top of bed known from sedimentary features

Inclined

Vertical

Overturned

Strike and dip of crystallization foliation

Inclined

Vertical

Strike and dip of mylonitic foliation

Strike and dip of slaty cleavage

Strike and dip of parallel bedding and slaty cleavage

Strike and dip of spaced cleavage

Strike and dip of crenulation cleavage

LINEAR FEATURES

Bearing and plunge of mineral lineation in Proterozoic rocks

Bearing and plunge of intersection of bedding and slaty cleavage

Bearing and plunge of crenulation lineation

OTHER SYMBOLS

Abandoned dolomite quarry

Abandoned magnetite mine

Drill hole - Bottoming in Jacksonburg Limestone

Form line - Shown in cross section to indicate foliation in Proterozoic rock

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