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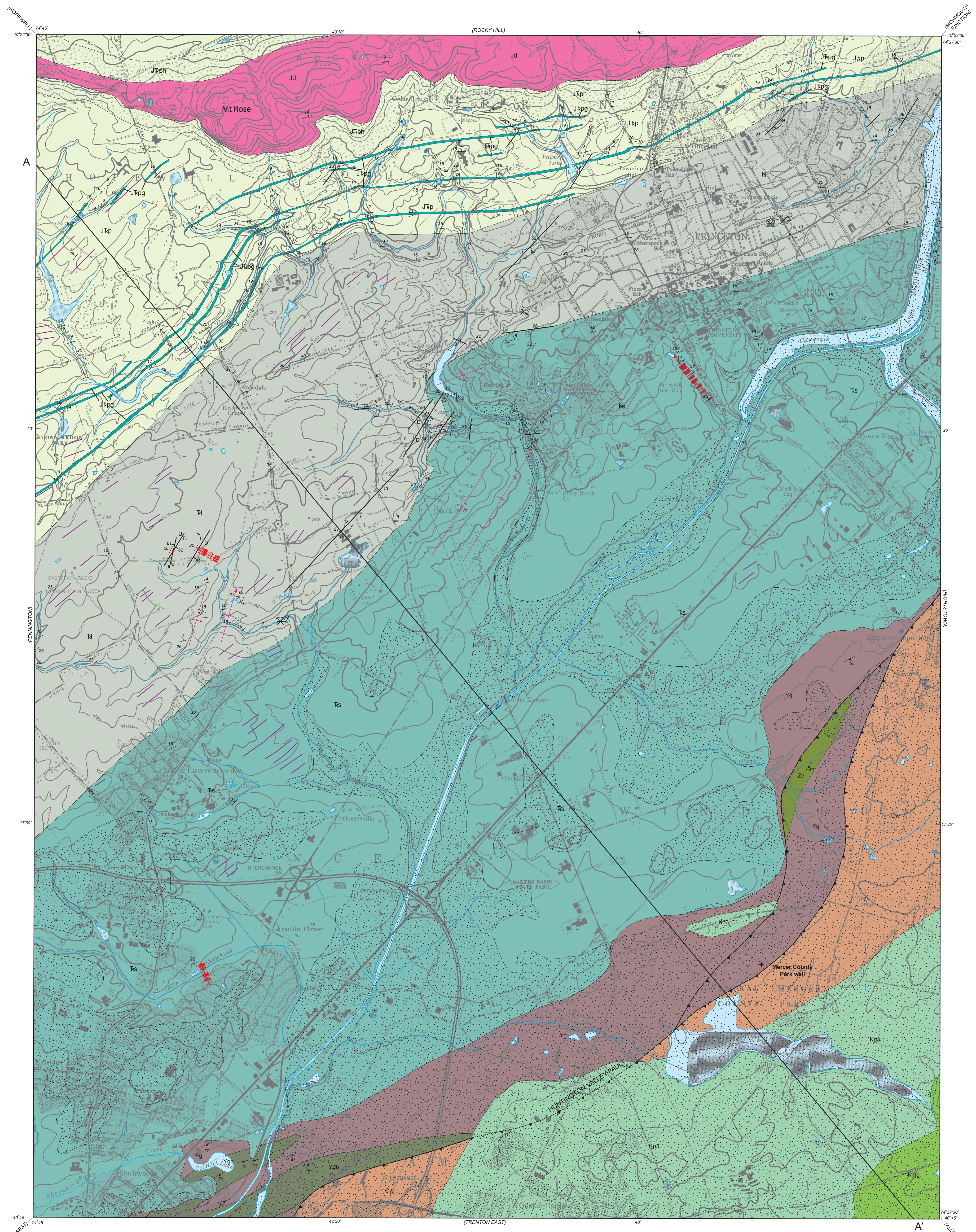

Base from US Geological Survey, 1954
Photorevised 1981

LOCATION IN NEW JERSEY

APPROXIMATE MEAN DECLINATION, 1981

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Bedrock Geologic Map of the Princeton Quadrangle, Mercer and Middlesex Counties, New Jersey

By
Donald H. Monteverde, Gregory C. Herman, Richard A. Volkert and Scott D. Stanford
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Bedrock geology mapped by D.H. Monteverde in 2005-2006, 2011
G.C. Herman in 1999,2005-2006
R.A. Volkert in 1992, 2005-2006
S.D. Stanford in 1990-1991, 2005-2006
H.F. Houghton in 1987-1988
S.D. Fankhauser in 1999
Limited field data used from H. Kummel
Digital cartography by D.H. Monteverde
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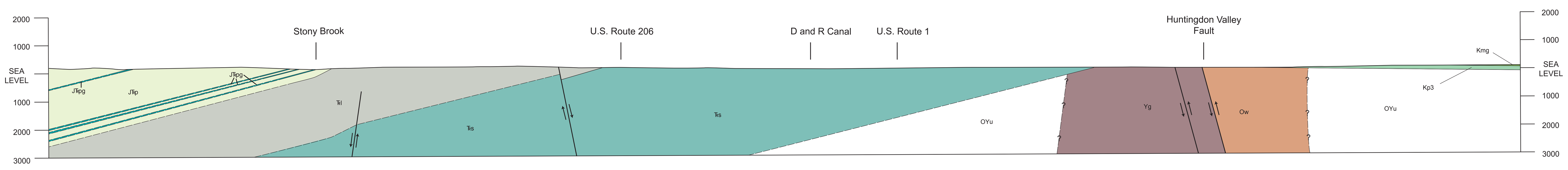


Introduction

The Princeton 7½-minute quadrangle is in west-central New Jersey, where it covers parts of Mercer and Middlesex Counties. Topographic elevations range from approximately 400 ft in the north to 80 ft in the south. The highest elevations are on Mount Rose, a prominent ridge of igneous diabase, commonly called trap rock, lying along the northern quadrangle boundary. Less resistant shale and mudstone that have been metamorphosed to hornfels surrounds the diabase and forms slightly lower elevations. Elevations remain fairly uniform with several small, broad hills in the northwestern third of the quadrangle where Stony Brook cuts through sedimentary rock units. South of Princeton elevation drops slightly forming a broad flat landscape that is underlain by some less resistant sandstones. Crystalline metamorphic rocks create a slight positive landscape in the southwest corner of the the quadrangle. Unlithified sediment underlies the gentle landscape morphology on the southeastern third of the quadrangle up to 100 ft in elevation.

The Delaware and Raritan Canal is a prominent physical feature in the quadrangle. It runs northeast southwest, close to, and approximately parallel to, US Route 1, a major northeast-southwest transportation corridor. The canal connects the Delaware and Raritan Rivers, and it facilitated commerce between Philadelphia and New York in the 1800's. It now serves as a local water-supply source. The Route 1 corridor roughly separates areas of good to moderate bedrock exposures in the northwest from areas of less common and more deeply weathered exposures in the southeast. The Fall line separates bedrock of the Piedmont Province from the unconsolidated material of the Coastal Plain Province.

Stratigraphy

The Princeton quadrangle straddles the contacts between three primary bedrock groups. From the northwest to the southeast, these groups are: 1) Early Mesozoic sedimentary and igneous rocks of the Newark Basin, 2) Proterozoic and Paleozoic metamorphic crystalline rocks of the Trenton Prong, and 3) Upper Cretaceous semiconsolidated to unconsolidated bedrock of the Coastal Plain. Rocks of the Newark Basin unconformably overlie the Trenton Prong rocks which form the geological basement for all the younger materials in the study area. Coastal Plain deposits also unconformably overlie Trenton Prong units in the Princeton quadrangle. Outside the study area Coastal Plain units completely blanket the Trenton Prong and onlap rocks of the Newark Basin.

Early Mesozoic rocks include sedimentary and igneous varieties that were deposited in the Newark Basin, a regional half graben, fault-bounded on its northern boundary, that extends from eastern Pennsylvania through New Jersey and into southeastern New York. The basin was filled with as much as 20,000 feet of Late Triassic through Early Jurassic rocks. Fluvial systems developed between border-fault segments and deposited Proterozoic and Paleozoic sediment into the basin from the Highlands to the north and west. Additional sediment came from the Trenton Prong metamorphic rocks in the south through north-draining rivers and streams (Glaeser, 1966; Van Houten, 1969). Extensive lakes periodically developed in the basin throughout much of its depositional history.

Sedimentary rocks of the Newark Basin include fluvial and lacustrine deposits that are locally intruded with diabase and interbedded with basaltic rocks that are approximately 201 my in age (McHone and others, 2003). The basal sedimentary unit in the Newark Basin is the Stockton Formation, a fluvial conglomerate and arkosic sandstone with red, light brown, gray and white interbeds. Conglomerate is more common near its base and the basin margins whereas sandstone, siltstone and mudstone are more common in the upper half of the unit and in areas away from the basin margins (McLaughlin, 1945, 1959; Glaeser, 1966). Smoot (1991) and Smoot and Olsen (1994) suggest that the Stockton was deposited by high-gradient, braided streams that cut down through a residual surface mantled by gravel and colluvium. Infilling toward the basin center eventually reduced stream gradients and resulted in deposition of an overall, fining-upward, fluvial sequence. The uppermost units gradually grade into cyclical lacustrine beds of the Lockatong Formation. The Lockatong is mostly gray and black siltstone and argillte and lesser, interbedded red shale and siltstone. Smoot (1991) described the Lockatong as cyclic deepwater deposits that shortly grade upward into desiccated features and subaerial deposits with little to no associated fluvial facies. The Passaic Formation overlies the Lockatong. The Passaic is a thick sequence of red-brown and reddish-purple mudstone, siltstone and sandstone, and lesser cycles of gray and black siltstone, mudstone and rare sandstone. Its coarser grain size, marginal alluvial facies, and broader lateral extent compared to the Lockatong, suggest a broadening of the basin through time (Smoot, 1991).

Cyclic color variations in beds of the Lockatong and Passaic formations indicate deposition during alternating, wet and dry, climatic periods (Olsen and Kent, 1996, Olsen and others 1996). Vast, deep lakes developed in the basin during wetter periods when the gray and black units of the deeper water environments were deposited. Red and brown units correlate to dryer climatic periods marker by shallow lakes and subaerial mud-flat deposits. Outcrops of the Lockatong formation in the Princeton quadrangle are too few to enable mapping of individual beds or color sequences like those defined by Olsen and others (1996). In the Passaic Formation more numerous outcrops make some subdivision possible. Here gray-bed sequences have been mapped where possible within the red and brown beds. These thin, gray to black interbeds form distinctive marker horizons that may be mappable for miles along strike. These beds help depict fold patterns. A sequence of three gray beds in the northwest corner of the quadrangle are thought to correlate with part of the Perkasie member of the Passaic Formation, based on comparison of mapped units with the subsurface coring results of Olsen and others (1996), and on unpublished, detailed bedrock mapping of units in the adjacent Pennington quadrangle to the west.

The northern edge of the Princeton quadrangle consists of a large diabase body intruded into Triassic sedimentary rocks. It forms an east-west ridge that includes Mount Rose and Rocky Hill farther to the east. The thickest part of the body forms a sill which has been injected subparallel to bedding. Along strike to the west, the diabase thins dramatically, and cuts across bedding to form a dike. Much of it was delineated by mapping diabase float. Thermally metamorphosed sedimentary rocks (hornfels) surround the diabase intrusion. A topographic break separates low-lying, unaltered Passaic Formation rocks from more resistant hornfels and diabase at higher elevations. Dunning and Hodych (1990) and Husch (1990) proposed that the Mount Rose – Rocky Hill diabase body is a lateral continuation of the Palisades sill.

The Trenton Prong in the Princeton area is part of a larger metamorphic rock belt that plunges northeastward from Pennsylvania into New Jersey, where It pinches out at the surface directly to the east, in the bordering Hightstown 7½-minute quadrangle. Trenton Prong rocks include felsic, intermediate and mafic metamorphic varieties of probable Ordovician, Mesoproterozoic, and Neoproterozoic ages (Volkert and Drake, 1993). The Wissahickon is dated at ~480 Ma based on U-Pb radioisotopes (Bosbyshell and others, 2001). Fine-grained diabase dikes locally intrude the older metamorphic rocks. These dikes are similar in composition and petrography to diabase dikes in the New Jersey Highlands. They may have been emplaced during rifting and breakup of the Rodinian supercontinent about 600 Ma (Volkert and Puffer, 1995; Volkert, 2004). Weathered float at the land surface and a limited number of natural outcrops and excavated exposures faciliated delineation of its contact with older rocks of the Trenton Prong.

Erosion of rocks of the Newark Basin and Trenton Prong since the Cretaceous has supplied sediment to the Atlantic Coastal Plain. These sediments include the Potomac Formation and the overlying Magothy Formation. The Potomac Formation consists of interbedded sand and clay laid down in a coastal river system in the Late Cretaceous, about 95 Ma. The Potomac sand and clay are typically red and white in color, due to weathering and soil development on the river plains in which they were deposited. The Magothy Formation also consists of interbedded sand, silt, and clay, although its sand is generally finer than that of the Potomac, and its clay and silt are more thinly bedded and less abundant. The Magothy is more commonly gray because it was not exposed to weathering and soil development. It was laid down in nearshore marine settings in the Late Cretaceous, about 85 Ma. Additional marine deposits were laid down during numerous sea-level highstands through the Cretaceous and Tertiary periods, probably until the Middle Miocene (about 10 Ma). These deposits almost certainly covered the entire Princeton quadrangle and extended well to the north and west of the present Coastal Plain. Subsequently they were completely eroded by rivers, except for the remaining Magothy and Potomac sediments, during the late Miocene and Pliocene (10 to 2 Ma).

Surficial deposits, shown here by an overprint pattern where thicker than 10 feet, include alluvial, wetland, hillslope, and windblown sediments of Pliocene through Quaternary age (Stanford, 1993).

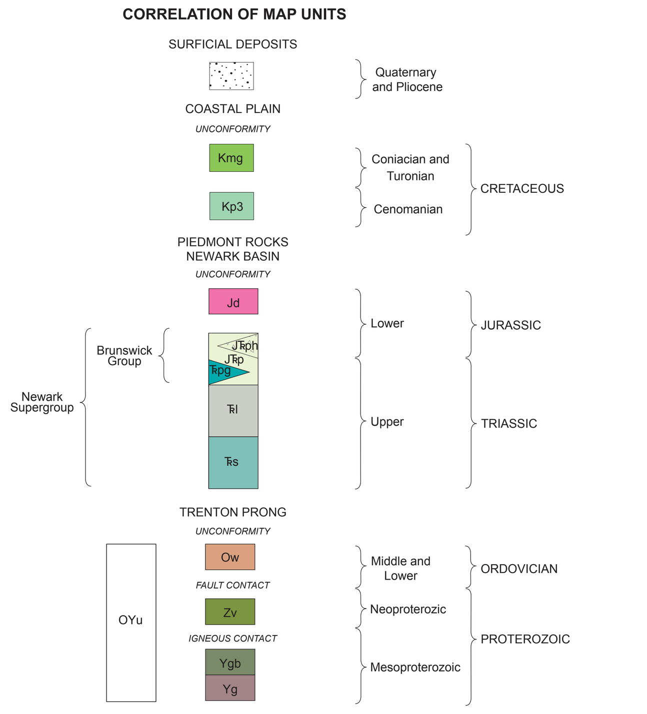
Structure

In the Trenton Prong, the Huntingdon Valley Fault is a major thrust fault interpreted to be of Paleozoic age. It strikes southwest-northeast and separates the Ordovician Wissahickon Formation in the hanging wall from Mesoproterozoic and Neoproterozoic (?) rocks in the footwall. The footwall rocks are in a secondary thrust-fault slice that splays off the Huntingdon fault to the east. The Huntingdon Valley Fault plunges eastward beneath rocks of the Newark basin and is interpreted to correlate with the Cameron's Line thrust fault in the Manhattan Prong (Volkert and others, 1996).

Rocks in the Newark basin have been tilted, fractured, folded, and faulted (Schlische, 1992; Olsen and others, 1996). Most tectonic deformation is probably of Late Triassic to Middle Jurassic age (Lucas and others, 1988; de Boer and Clifford, 1988). In the Princeton quadrangle, these rocks chiefly dip gently and uniformly to the north and northwest, except near faults where they dip moderately to steeply, or where they are locally folded into southeast-dipping beds. Faults within the Mesozoic rocks in the Princeton quadrangle are enigmatic. Abundant, complex fault movements are evident at stratigraphic levels in and near the Lockatong Formation, but outcrops are scarce enough to obscure evidence as to whether these faults link with larger faults in adjacent areas that are covered with surficial material. Normal fault slip is seen in borehole-televiewer images of the Lockatong Formation north of Lawrenceville, but complex, reverse slip is documented at other nearby faults near Princeton, where the Stockton through Passaic formations are arched and locally faulted and folded. Herman and others (2010) interpreted these structures as part of a larger, regional oblique-slip transform-fault system that probably developed during late stages of basin extension. However it is also possible that some of these faults were reactivated during late compression and inversion of the basin.

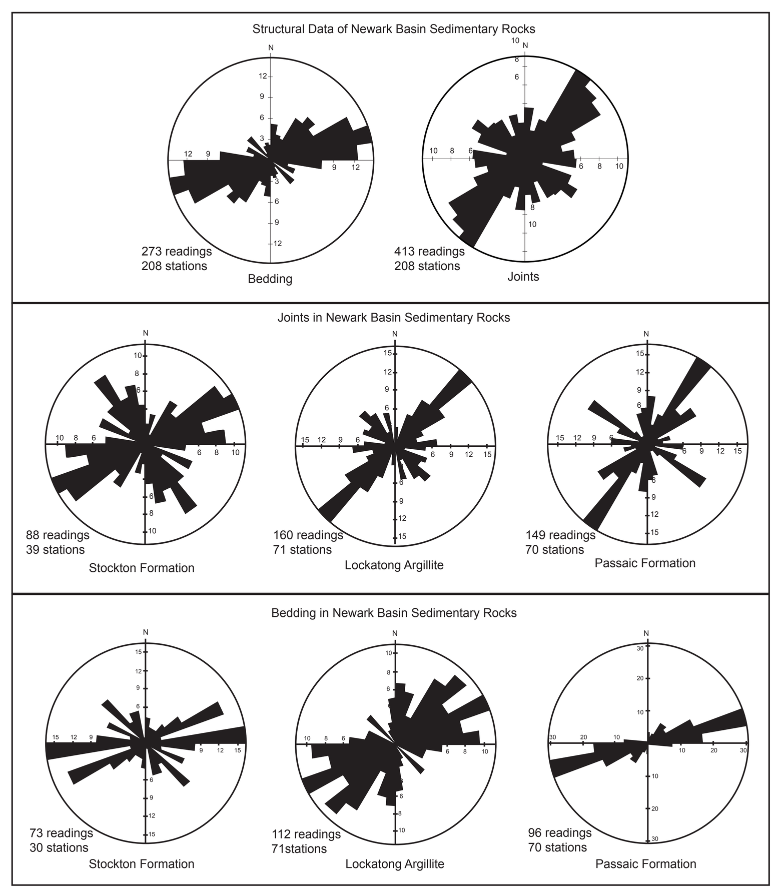
Rocks of the Trenton Prong and Newark basin are highly fractured. Three sets of systematic extension fractures (joints) cut through the New Jersey part of the basin (Herman, 2005 and 2009). Together they record a counterclockwise rotation of the extensional stress field from northwest-southeast to west-east which developed during the extensional phases of basin development. The earliest of these joint sets, striking northeast southwest and complimentary cross joints, are most abundant in the Princeton quadrangle. The latest set, striking north south with complimentary east-west cross joints is less common.

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

EXPLANATION OF MAP SYMBOLS



Rose diagrams of structural data within the map area. Data depicted consist of strike orientation of bedding and fracture planes. Bins are 10º sectors and numbers on X and Y axes represent per cent of total data population. Trenton Prong rocks are not shown due to paucity of outcrop locations.

REFERENCES CITED