DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF SCIENCE AND RESEARCH
NEW JERSEY GEOLOGICAL SURVEY

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

CORRELATION OF MAP UNITS

Artificial fill, Trash fill, Qs, Qal, Qm	Holocene	Quaternary
5-20 feet of downcutting in main valleys		
Qcs, Qcsg, Qtl, Qrt	Pleistocene, late	Quaternary
10-50 feet of downcutting in main and tributary valleys		
Qtu	Pleistocene, early to middle	Quaternary
new drainage established, 50-100 feet of downcutting in main and tributary valleys extensive erosion		
Tp	Pliocene	Tertiary
unconformity		
Kmg	Turonian-Coniancian to Santonian	Cretaceous
unconformity		
Krw, Krf	Cenomanian	Cretaceous
unconformity		
Jd	Early	Jurassic
intrusive contact		
JTrph, JTrp, JTrpg, Trl, Trlh, Trs	Late	Triassic
unconformity		
CZYu		Cambrian to Middle Proterozoic

MAP UNITS
(for description, see Sheet 3)

SURFICIAL DEPOSITS

- Artifical Fill
- Trash Fill
- Qal Alluvium
- Qm Estuarine Deposits
- Qs Swamp Deposits
- Qtl Lower Terrace Deposits
- Qcsg Sand and Gravel Colluvium
- Qsc Shale Colluvium
- Qrt Raritan Terrace Deposit
- Qtu Upper Terrace Deposits
- Tp Pensauken Formation

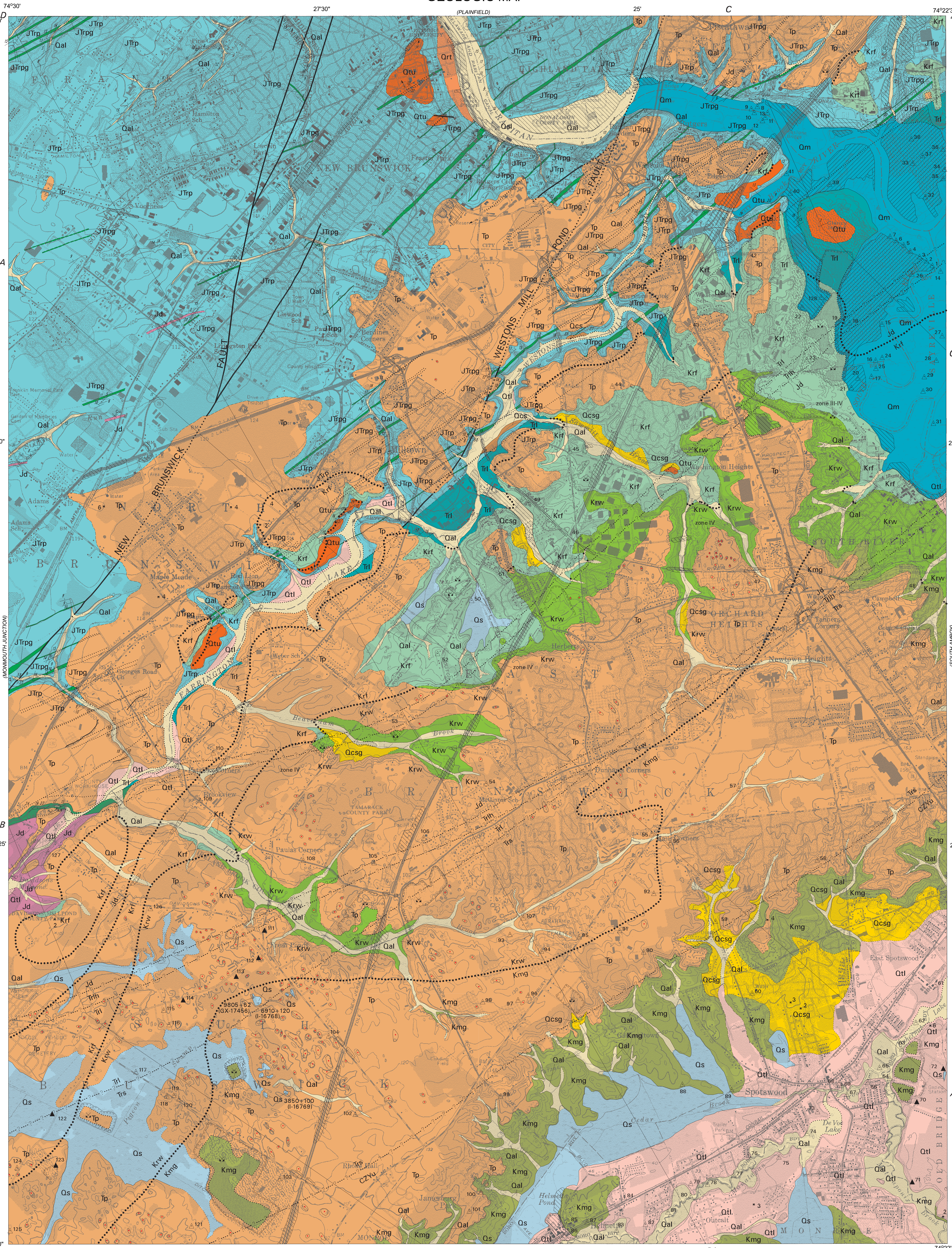
COASTAL PLAIN FORMATIONS

- Kmg Magothy Formation
- Krw Raritan Formation, Woodbridge Clay
- Krf Raritan Formation, Farrington Sand

BEDROCK FORMATIONS

- Jd Diabase
- JTrp Passaic Formation
- JTrpg Passaic Formation gray bed
- JTrph Passaic Formation, hornfels
- Trl Lockatong Formation
- Trlh Lockatong Formation, hornfels
- Trs Stockton Formation
- CZYu Undifferentiated pre-Mesozoic basement

GEOLOGIC MAP



Base from U.S. Geological Survey, 1954
Photorevised 1970

GIS application and digital cartography by:
Donald H. Monteverde, Maryann Scott
and Ronald Pristas

[1] New Jersey Geological Survey
[2] State University of N.Y., at New Paltz, N.Y.

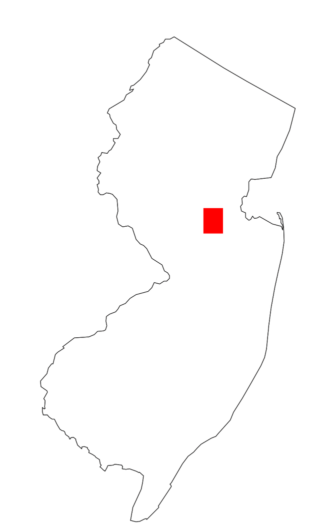
SCALE 1:24 000
1 1/2 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 .5 0 1 KILOMETER

Surficial geology by S.D. Stanford, 1991
Cretaceous geology by S.D. Stanford and P.J. Sugarman, 1991
Cretaceous paylnology by G.J. Brenner, 1992-94
Bedrock geology by D.H. Monteverde and R.A. Volkert, 1993-95
The interpretations presented here are provisional pending peer review.
There may be revisions prior to publication

EXPLANATION

GEOLOGIC MAP SYMBOLS

- Contacts of surficial deposits - solid where well-defined by landforms; short-dashed where featheredged, gradational, or interfingered; long-dashed where approximate; dotted where covered by fillor water where exposed bye excavation.
- Contacts of Cretacrous formations - dashed where approximate or gradational; bold-dotted where concealed by surficial deposits.
- Contacts of bedrock formations - solid where well-defined; dashed where approximate; dotted where concealed by surficial deposits; dashed and queried where inferred beneath thick Createaceous and surficial deposits.
- Fault - solid where known: dotted where concealed; dashed and queried where uncertain.
- 27 Strike and dip of beds
- Limit of excavated area - line at perimeter, tick marks inside. Contacts within these areas are drawn to reflect their approximate location in the excavated topography at the time of mapping. In many places this topography is substantially different from that on the base map.
- Fluvial scarp - line at top of scarp, ticks on slope. Cut into unit Tp during early to middle Pleistocene dissection.
- Paleocurrent measurement - arrow indicates paleoflow direction, "x" indicates location of measurement. Measurements made on tabular, planar cross beds.
- Sand, gravel or clay pit - active in 1991
- Sand, gravel or clay pit - inactive in 1991
- Quarry - inactive in 1991
- Cu Abandoned copper mine
- 123 Boring with log in Table 1 - location accurate to within 100 feet
- 91 Boring with log in Table 1 - location accurate to within 500 feet
- 4 Hand-auger hole penetrating underlying Coastal Plain formation - number is thichkness, in feet, of overlying surficial deposit.
- 9805±62 (GX-17456) Radiocarbon-dated sample - upper two numbers are age and error, respectively in years before present. Lower number is laboratory reference number.
- zone IV Sample analyzed for pollen - pollen zone indicated by roman numerals.
- Shallow topographic basin - line at rim of basin; dot in the bottom of basin. May contain thin swamp deposits in places, although larger swamp deposits in the basins are mapped with unit Qs. Drawn where clearly visible on 1:12,000-scale aerial photographs taken in 1979. Other basins, now destroyed by urbanization or obscured by thick vegetation, are shown by the base-map topography. These basins are likely of late Wisconsinan periglacial origin (Wolfe, 1953).



LOCATION MAP

GEOLOGY OF THE NEW BRUNSWICK QUADRANGLE, MIDDLESEX AND SOMERSET COUNTIES, NEW JERSEY

By:

Scott D. Stanford[1], Donald H. Monteverde[1],
Richard A. Volkert[1], Peter J. Sugarman[1]
And Gilbert J. Brenner[2]

1998

(for cross sections, see Sheet 2)

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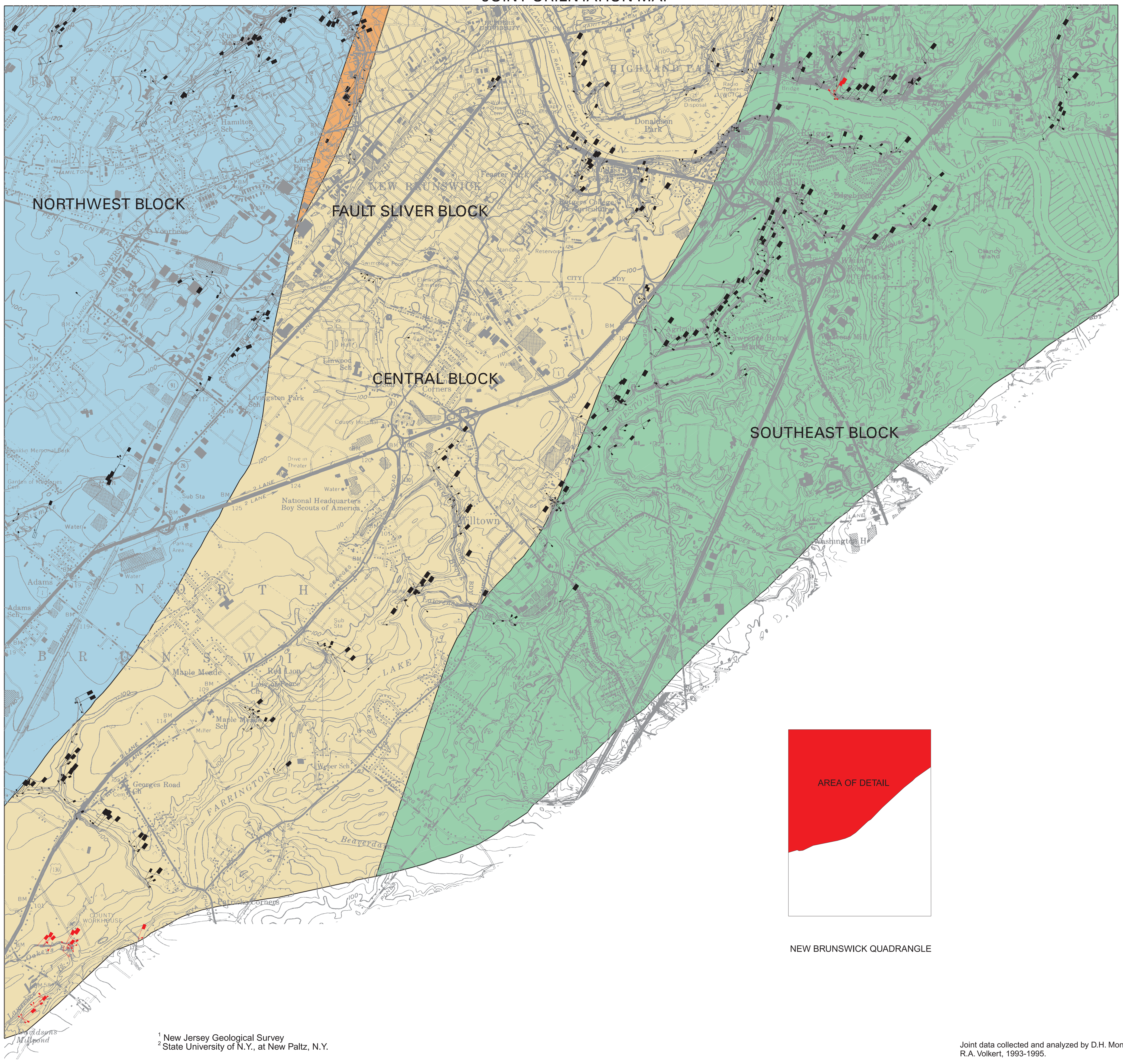
JOINT ORIENTATION MAP



JOINT ORIENTATION MAP UNITS

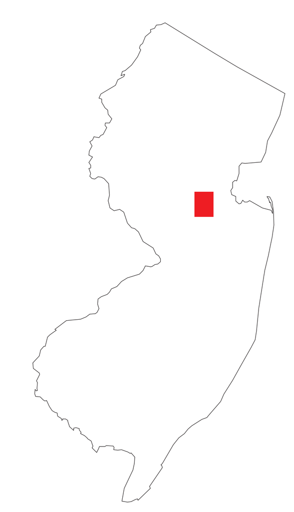
- Northwest block
- Fault sliver block
- Central block
- Southeast block

JOINT ORIENTATION MAP SYSMBOLS

Joints in sedimentary rock
- dipping between 0-29 degrees
- dipping between 30-59 degrees
- dipping between 60-89 degrees
- dipping 90 degrees

Joints in diabase
- dipping between 0-29 degrees
- dipping between 30-59 degrees
- dipping between 60-89 degrees
- dipping 90 degrees

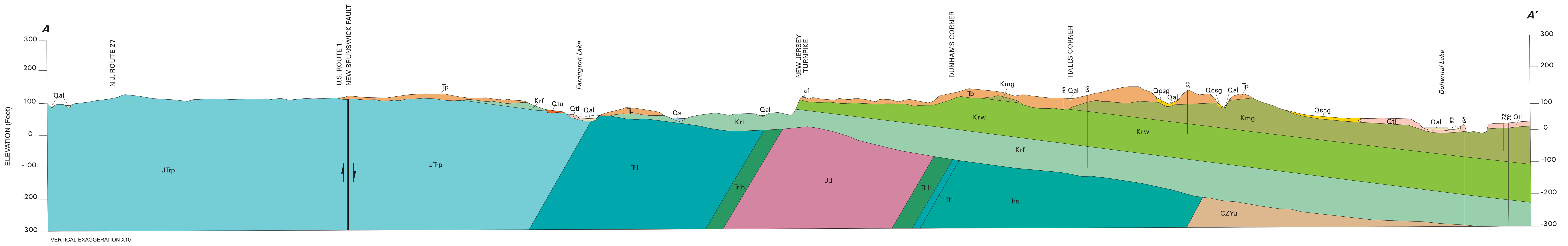
NEW BRUNSWICK QUADRANGLE

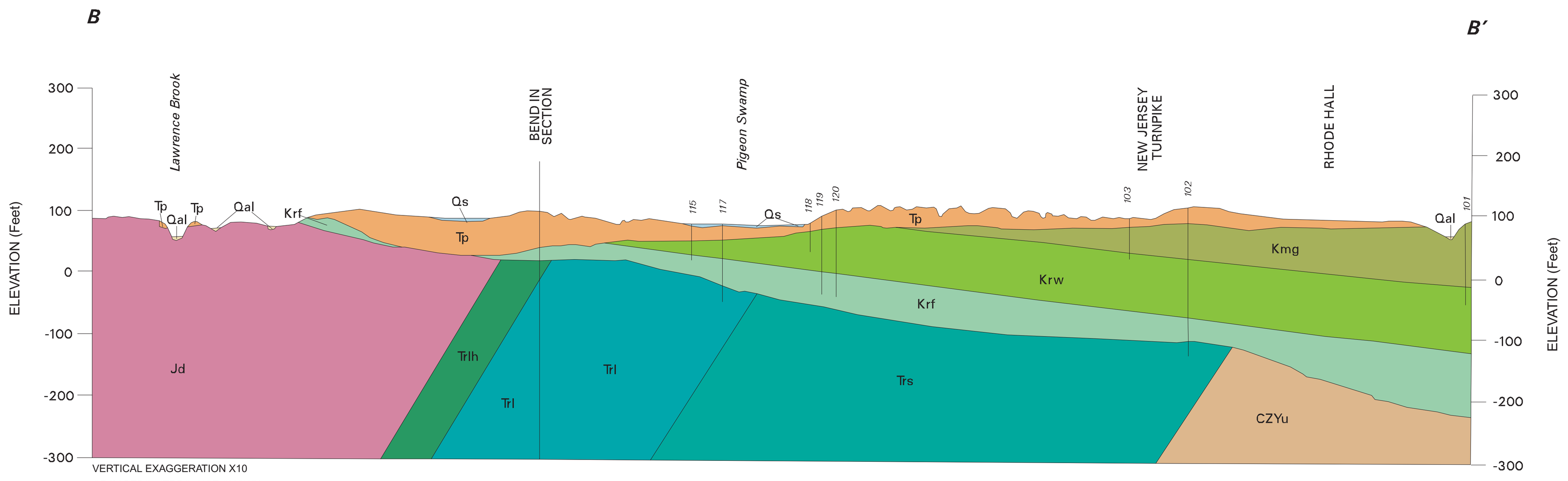


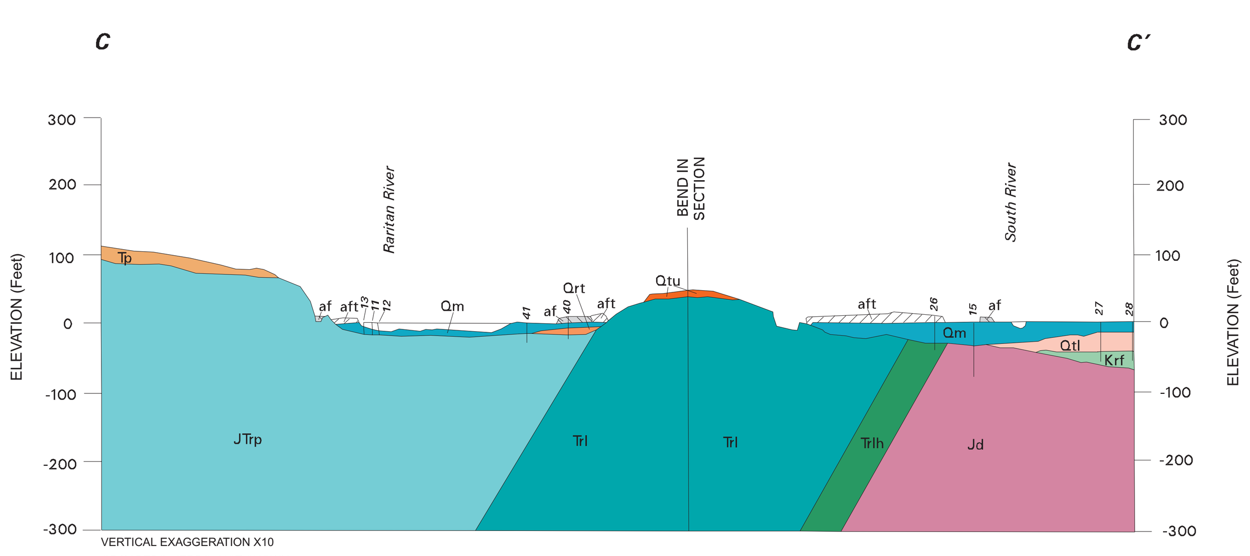
LOCATION MAP

[1] New Jersey Geological Survey
[2] State University of N.Y., at New Paltz, N.Y.

Joint data collected and analyzed by D.H. Monteverde and R.A. Volkert, 1993-1995.







GEOLOGY OF THE NEW BRUNSWICK QUADRANGLE, MIDDLESEX AND SOMERSET COUNTIES, NEW JERSEY

By:

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And Gilbert J. Brenner[2]

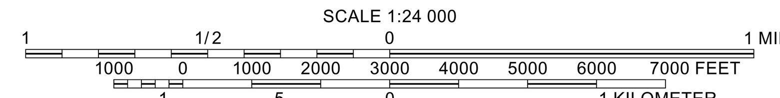
1998

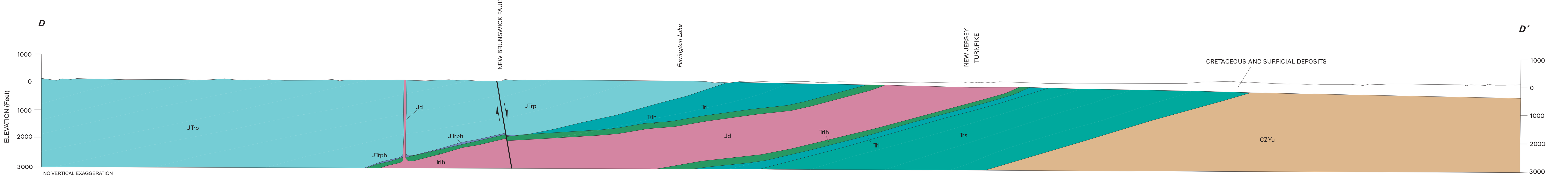
(for description of cross sections units, see Sheet 3)

(for location of cross sections, see Sheet 1)

(for discussion of joint data, see Sheet 3)

SCALE 1:24 000





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INTRODUCTION

Bedrock in the New Brunswick quadrangle includes shale and mudstone of Triassic age, intruded by diabase of Jurassic age. These rocks dip gently to the northwest, and crop out in the northwestern part of the quadrangle. They unconformably overlie schist and gneiss of Middle Proterozoic to Cambrian age, which occur in the subsurface in the southeastern part of the quadrangle. The bedrock formations are onlapped to the southeast by sand and clay of Cretaceous age. The Cretaceous sediments dip very gently to the southeast and crop out in the central and southeastern parts of the quadrangle. The bedrock and Cretaceous sediments are discontinuously overlain by surficial deposits of sand, gravel, mud, and peat of late Tertiary and Quaternary age.

These rocks and sediments are described in detail below. Table 1 provides drillers' logs of selected wells and test borings. These data show the thickness of surficial deposits and the underlying bedrock or Cretaceous formation. Figures 1 and 2 provide data on joints in the bedrock units.

DESCRIPTION OF MAP UNITS

Surficial Deposits

Surficial deposits are mapped where they are generally continuous and greater than 3 feet thick. Where no surficial deposits are mapped, discontinuous colluvium and alluvium, generally less than 3 feet thick, may overlie the mapped bedrock or Cretaceous formations. Bedrock units generally have a mantle of weathered material overlying unweathered rock. This material is not mapped separately from the bedrock formation. On the Passaic and Lockatong Formations, the weathered material is a reddish brown, reddish yellow, and gray clayey silt with variable amounts of angular rock fragments. It is generally less than 10 feet thick. On diabase, it is a reddish yellow sandy clay with many angular rock fragments and some to many rounded diabase boulders, also generally less than 10 feet thick. The Cretaceous deposits are oxidized and mineralogically altered but weathering has not significantly changed their grain size. Throughout the quadrangle, gravel and matrix material derived from the Pensauken Formation have been mixed into the upper several feet of the weathered material by soil processes.

ARTIFICIAL FILL--Excavated sand, silt, clay, gravel, rock and man-made materials (bricks, cinders, ash, construction debris). In railroad and road embankments, dams, and made land. As much 60 feet thick. Many small areas of fill are not mapped. Extent of fill based on aerial photographs taken in 1979 and 1986.

TRASH FILL--Trash and construction debris mixed and covered with clay, silt, and sand. As much as 100 feet thick.

Qal **ALLUVIUM**--Sand, silt, pebble-to-cobble gravel, minor clay and peat. Contains variable amounts of organic matter. Matrix is reddish brown, yellowish brown, dark brown, light gray. The sand is predominantly quartz, shale fragments, and mudstone fragments; with variable but minor glauconite, mica, and feldspar. The gravel consists of shale, mudstone, quartz, quartzite, ironstone; and chert, diabase, and sandstone. As much as 15 feet thick (estimated). Alluvium along streams draining shale terrain has reddish brown fine sediment with much shale in both the sand and gravel fraction. Alluvium along streams draining Cretaceous sediments is brown to light gray and contains chiefly quartz and mica in the sand fraction. Older surficial deposits (units Tp, Qtu, and Qtl) contribute glauconite and feldspar to the sand fraction, and quartz, quartzite, ironstone, chert, and sandstone to the gravel fraction.

Qm **ESTUARINE DEPOSITS**--Peat and organic-rich clay and silt, brown to dark gray; minor sand and shells. As much as 35 thick.

Qs **SWAMP DEPOSITS**--Peat and organic-rich clay and silt, minor sand, brown to dark gray. As much as 10 feet thick. Wood and peat from the base of swamp deposits in a basin near Fresh Ponds yielded radiocarbon dates of 9805±62 yrs B. P. (GX-17456), and 6910±120 yrs B. P. (I-16768) from depths of 5.5 and 3.5 feet respectively. Peat from the base of swamp deposits in a second basin half a mile to the south yielded a radiocarbon date of 3850±100 yrs B. P. (I-16769) from a depth of 4 feet. Peaty sand at a depth of about 6 feet at the bottom of organic sediments in the bog around Helmetta Pond (exact location unknown) yielded a date of 9649±60 yrs B. P. (QL-1082) (Watts, 1979). These dates indicate that swamp deposits have been gradually accumulating since at least the early Holocene.

Qtl **LOWER TERRACE DEPOSITS**--Sand, silt, pebble gravel, and minor clay forming stream terraces with surfaces 5 to 20 feet above modern alluvial surfaces. Matrix is reddish brown, yellow, brownish yellow, and reddish yellow. Sand and gravel composition is similar to unit Qal, although organic matter is absent. The dependence of color and sand and gravel composition on source terrain is also similar to that of Qal. As much as 40 feet thick. In the Matchaponix and Manalapan Brook valleys, the lower terrace deposits are chiefly sand. Here, they are particularly rich in glauconite because they are derived, in part, from glauconitic Cretaceous sediments to the south and southeast of the quadrangle.

Qtl is on grade with Qrt, which, in turn, is on grade with glaciofluvial deposits of late Wisconsinan age both upstream and downstream in the Raritan Valley. These relationships indicate that Qtl is, in part, of late Wisconsinan age. The Qtl deposits were assigned to the Cape May Formation by Lewis and Kummel (1910) and Salisbury and Knapp (1917). The name is not used here because the Cape May has been subdivided and redefined in its type area (Newell and others, 1989) and correlation of Qtl to the redefined Cape May deposits has not been established.

Qcsg **SAND-AND-GRAVEL COLLUVIUM**--Sand, pebble gravel, minor silt and clay. Matrix is light gray, very pale brown, yellow and yellowish brown. Sand is chiefly quartz, with some mica and feldspar, and minor glauconite. Gravel is chiefly quartz, quartzite, ironstone; with minor chert, sandstone, and mudstone. As much as 20 feet thick. Forms aprons with surfaces that grade distally to elevations 5 to 20 feet above modern alluvial surfaces. Contemporaneous with unit Qtl.

Qcs **SHALE COLLUVIUM**--Silt, clay, pebble gravel, minor sand. Matrix is reddish brown to brown. Sand is chiefly quartz, shale fragments, and feldspar. Gravel is shale, quartz, quartzite; with minor ironstone, chert, and sandstone. As much as 10 feet thick (estimated). Topographic and age relationships as in unit Qcsg.

Qrt **RARITAN TERRACE DEPOSIT**--Sand, silt, pebble gravel, minor clay and cobble gravel. Matrix is gray, brown, and reddish brown. Sand is predominantly quartz, with some shale fragments and feldspar, and minor glauconite and mica. Gravel is predominantly quartz and quartzite; with some red and gray mudstone and shale; and minor chert, gneiss, and sandstone. As much as 20 feet thick.

Unit Qrt is on grade with late Wisconsinan glaciofluvial deposits both upstream and downstream in the Raritan Valley and so is, in part, of late Wisconsinan age. It likely includes some glacially derived sediment from bedrock to the north and east of the Raritan basin, in addition to nonglacially derived sediment from bedrock, Coastal Plain formations, and surficial deposits within the basin. The deposit was assigned to the Cape May Formation by Darton and others (1908) and Lewis and Kummel (1910). The name is not used here because the Cape May has been subdivided and redefined in its type area (Newell and others, 1989) and correlation of Qrt to the redefined Cape May deposits has not been established.

Qtu **UPPER TERRACE DEPOSITS**--Sand, yellow to reddish yellow; pebble gravel; minor cobble gravel. On terrace remnants with bases that are 20 to 40 feet above modern alluvial and salt-marsh surfaces. Sand and gravel composition similar to that of unit Tp. As much 20 feet thick. Topographic position indicates that unit Qtu is older than units Qtl and Qrt but younger than unit Tp, and so may range in age from Early to Middle Pleistocene.

Tp **PENSAUKEN FORMATION**--Sand, reddish yellow to yellow; pebble gravel; minor cobble gravel. Sand is predominantly quartz; with some feldspar; and minor glauconite, mica, and red shale. Gravel is predominantly quartz, quartzite, and ironstone; with chert, red to gray mudstone, and sandstone; and minor gneiss, schist, and diabase. As much as 80 feet thick. Cobble-gravel channel deposits are common in the basal few feet of the deposit, where they are commonly iron-cemented and contain abundant clasts of sandstone and mudstone, and scattered clasts of gneiss, schist, and diabase. These clasts generally have thick weathering rinds or are fully decomposed. Iron-petrified wood also occurs in the basal few feet of the deposit in places. Tabular, planar cross-bedded sand with minor pebble gravel dominates the deposit above the basal gravel. The pebble gravel is chiefly quartz, quartzite, and ironstone with some chert and minor mudstone. A red-colored soil is developed in the Pensauken on flat surfaces above about 140 feet in elevation in the Lawrence-Brook-Manalapan-Brook divide area. These upland flats may be remnants of the original aggradation surface. Other surfaces on the Pensauken are not flat and do not exhibit a red soil, indicating that they were formed by stream dissection and slope erosion during the Pleistocene.

Salisbury and Knapp (1917) defined and mapped the Pensauken Formation. Owens and Minard (1979) reassigned the Pensauken deposits north of Trenton to the Bridgeton Formation (a higher fluvial sand and gravel in southern New Jersey), based on projection of the elevations of the deposits from their type areas in southern New Jersey. This usage was followed by Martino (1981) and Stanford (1993, 1995). However, the deposits north of Trenton are continuous in both extent and elevation with those at the Pensauken type locality, so the original nomenclature is used here. The age of the Pensauken is not firmly established. Berry and Hawkins (1935) describe plant fossils in the Pensauken from the Ireland Brook valley near Beth Abraham Cemetery that they consider to be of early Pleistocene age. Owens and Minard (1979) assign a late Miocene age based on correlation to units in the Delmarva Peninsula. Pollen from a black clay bed within the Pensauken near Plainsboro, New Jersey, about 12 miles southwest of Old Bridge, includes cool-temperate to cold-temperate species and a few pre-Pleistocene species. This assemblage suggests a Pliocene age (Gilbert J. Brenner, written communication, December 1991). This age is also consistent with the geomorphic and stratigraphic relation of the Pensauken to late Pliocene or early Pleistocene till and to middle to late Miocene marine and fluvial deposits (Stanford, 1993).

Coastal Plain Formations

Kmg **MAGOTHY FORMATION** (Darton, 1893)--Quartz sand, white to yellow, micaceous, commonly interbedded with thin to thick, gray carbonaceous clay and silt. In places the clay is oxidized to white, red, and pink. Locally, the clay contains pyrite and lignite. Sand is typically cross-stratified, although laminated beds are common. In the Sayreville-South Amboy area, just east of the New Brunswick quadrangle, extensive clay-pit exposures permitted the naming and mapping of clay beds within this sequence, which was formerly included in the Raritan Formation (Cook, 1878; Ries and others, 1904). Later, intervening sands in the same area were named as part of an aquifer investigation (Barksdale and others, 1943). Berry (1905) correlated the uppermost beds of the Raritan with the Magothy Formation of Maryland, based on their fossil flora. Owens and Sohl (1969), Wolfe and Pakiser (1971), Owens and others (1977), and Christopher (1979) provide more detailed bio-stratigraphic control for these units, and redefined additional beds of the former Raritan as Magothy. In the South Amboy area the Magothy now includes, from oldest to youngest, the following informal members: South Amboy Fire Clay, Old Bridge Sand, Amboy Stoneware Clay, Morgan beds, and Cliffwood beds (Owens and others, 1977). These members may extend into the New Brunswick quadrangle but exposure and subsurface data are not sufficient to map them. The Magothy is Turonian-Coniacian (?) to Santonian in age (Christopher, 1979, 1982). It is as much as 180 feet thick in this quadrangle.

RARITAN FORMATION (Cook, 1868)--Includes two informal members in this quadrangle: the Farrington Sand and the Woodbridge Clay. Another member, the "Raritan fire and potter's clay" of Cook (1878) and Ries and others (1904), underlies the Farrington Sand and was mapped by Cook (1878) and Ries and others (1904) in the northeastern part of the quadrangle. This unit includes a lower clay (the "potter's clay") which is predominantly a red, white, and gray clay derived from weathering of shale and mudstone of the Passaic and Lockatong Formations, and is included in those formations on this map; and an upper, discontinuous, gray sandy clay (the "fire clay") which is near the base of the Farrington Sand and is included in that member on this map.

Krw **WOODBRIDGE CLAY**--Clay and silt, dark gray, massive, with mica, lignite (typically fine grained), and pyrite. Locally interlaminated with white to yellow quartz sand. Small (less than 1 foot thick) lense-like masses and slabs of gray to brown siderite are common. The Woodbridge Clay is as much as 120 feet thick in this quadrangle.

The Woodbridge has been assigned to the Complexiopollis-Atlanto-pollis pollen assemblage zone of Cenomanian age (Christopher, 1979), or Pollen Zone IV. It has also been assigned to the upper Cenomanian based on the ammonites *Metoicoceras bergquisti* and *Metengonoceras* sp. (Cobban and Kennedy, 1990). Samples in this quadrangle (locations plotted on map) yielded Zone IV pollen and cysts of the dinoflagellates *Cyclonephelium distinctum*, *Hystrichosphaeridium recurvatum*, and *Cleistosphaeridium* sp.

Krf **FARRINGTON SAND**--Quartz sand, white, yellow, and pink, micaceous, commonly interbedded with thin beds of angular granule gravel and minor, thin to thick gray clay and silt beds. It rests unconformably on weathered rocks of Mesozoic age, and is as much as 100 feet thick in this quadrangle. Lower parts of the Farrington may be time-equivalent to the Potomac Formation.

The Farrington is Cenomanian in age (Christopher, 1979). It has been assigned to the upper part of Pollen Zone III by Christopher (1979). Samples of the Farrington from the adjacent South Amboy and Perth Amboy quadrangles yielded Zone IV pollen assemblages (written communication, Leslie A. Sirkin, Adelphi University, 1989). One sample collected within the quadrangle near South River from laminated gray silt and white to yellow fine sand in the transitional contact zone between the Woodbridge and the Farrington had species generally associated with older palynomorphs than typically seen in the Woodbridge Clay, and is assigned to Zone III-IV.

Bedrock Formations

Jd **DIABASE** (Lower Jurassic)--Fine-grained to aphanitic dikes (?) and sills and medium-grained, discordant, sheet-like intrusion of dark-gray to dark greenish-gray, sub-ophitic diabase. Massive-textured, hard, and sparsely fractured. Composed dominantly of plagioclase, clinopyroxene, and opaque minerals. Contacts are typically fine-grained, display chilled, sharp margins and may be vesicular adjacent to enclosing sedimentary rock. Exposed in map area in sills along the Raritan River east of Highland Park, in a dike approximately 1.9 miles south-southeast of Voorhees, and in the Rocky Hill diabase sheet along Oakeys Brook immediately north of Davidsons Millpond County Park. This sheet may be the southern extension of the Palisades sill. Beneath Cretaceous deposits it is weathered to a white, gray, or olive clay as much as 20 feet thick. The thickness of the Rocky Hill diabase in the quadrangle, known mainly from drill-hole data, is approximately 1,325 feet.

JTrp, JTrpg, JTrph **PASSAIC FORMATION** (Lower Jurassic and Upper Triassic) (Olsen, 1980)--Interbedded sequence of reddish-brown to maroon and dusky grayish-red siltstone, reddish-brown shaly siltstone to mudstone, separated by interbedded olive-gray to dark-gray siltstone and lesser silty argillite. Reddish-brown siltstone is medium- to fine-grained, thin- to medium-bedded, planar to cross-bedded, micaceous, locally containing mud cracks, ripple cross-laminations, root casts, load casts, and evaporite minerals. Shaly siltstone to mudstone form rhythmically fining upward sequences as much as 15 feet thick. They are fine-grained, very thin- to thin-bedded, planar to ripple cross-laminated, fissile, and locally bioturbated. Reddish-brown beds are thermally altered to olive-gray to black hornfels where intruded by diabase (JTrph, in cross section only). Thickness of alteration directly related to thickness of intruded diabase. Copper minerals (chalcocite and secondary copper carbonate) were mined from the "red shales" at the Raritan mine during the 1800's (Woodward, 1944). It is uncertain whether the ore zones are related to diabase intrusions. Gray bed sequences (JTrpg) are medium- to fine-grained, thin- to medium-bedded, planar to cross-bedded. Finer-grained beds commonly laminated to thinly laminated, platy, with local desiccation features and disseminated pyrite. Thickness of gray bed sequences ranges from less than 1 foot to approximately 40 feet. Lower contact gradational into Lockatong Formation and placed where proportion of gray beds is greater than reddish-brown beds (Van Houten, 1969). Beneath Cretaceous deposits the Passaic Formation is weathered to a red, reddish-brown, gray, or olive clay as much as 20 feet thick. This material was mapped as the "fire and potter's clay" member of the Raritan Formation by Cook (1878) and Ries and others (1904) but is included here with the Passaic Formation. Approximately 5,422 feet to 5,475 feet of Passaic Formation is exposed in this quadrangle. Best exposed along the Raritan River and Westons Mill Pond.

Trl, Trlh **LOCKATONG FORMATION** (Upper Triassic) (Kummel, 1897)--Cyclically deposited sequences of mainly gray to greenish-gray, and in upper part of unit, locally reddish-brown siltstone to silty argillite and dark-gray to black shale and mudstone. Siltstone is medium- to fine-grained, thin-bedded, planar to cross-bedded with mud cracks, ripple cross-laminations and locally abundant pyrite. Shale and mudstone are very thin-bedded to thinly-laminated, platy, locally containing desiccation features. Thermally altered to dark-gray to black hornfels (Trlh) where intruded by diabase. Thickness of hornfels directly related to thickness of intruded diabase. Lower contact gradational into Stockton Formation and placed at base of lowest continuous black siltstone bed (Olsen, 1980). Beneath Cretaceous deposits the Lockatong Formation is weathered to a gray, white, or olive clay as much as 20 feet thick. This material was mapped as the "Raritan fire and potter's clay" member of the Raritan Formation by Cook (1878) and Ries and Kummel (1904) but is included here with the Lockatong Formation. Maximum thickness of unit regionally is about 2,200 feet (Parker and Houghton, 1990). Approximately 1,800 feet thick in this quadrangle, including about 160 feet of hornfels. Best exposed southeast of Farrington Lake.

Trs **STOCKTON FORMATION** (Upper Triassic) (Kummel, 1897)--Regionally unit is interbedded sequence of gray, grayish-brown, or reddish-brown, medium- to fine-grained, thin- to thick-bedded, planar to cross-bedded arkosic conglomerate, sandstone, and reddish-brown shaly siltstone to mudstone. Lower contact is an erosional unconformity. Conglomerate and sandstone units are deeply weathered; siltstone and mudstone are generally less weathered. Maximum thickness of unit regionally may be as much as 3,000 feet (Parker and Houghton, 1990). Interpreted to be approximately 2,550 feet thick in this quadrangle. Not exposed in map area but known from water well records and drill-hole data.

CZYu **UNDIFFERENTIATED PRE-MESOZOIC BASEMENT** (Cambrian to Middle Proterozoic (?)) (Volkert and others, in press) -- Gray, medium- to coarse-grained schist and gneiss dominantly composed of quartz, feldspar, and mica (biotite and/or muscovite), deeply weathered; may be associated with green micaceous saprolite. Not exposed in map area but known from water well records and drill-hole data.

BEDROCK JOINTS

The distribution and orientation of joints in the bedrock units are shown on the "Joint Orientation Map" on sheet 1 and on figures 1 and 2. Joints are fractures that show no visible movement parallel to the surface of the fracture. Bedding partings are not considered. All joints were measured on outcrops. Strike and dip data were grouped by structural block. Structural blocks were delineated by identifying lithologic units that have undergone a similar deformational history. Because the lithology of the sedimentary rocks is similar, the structural blocks are delineated mainly by the major faults rather than by formation contacts. Diabase is classed separately because it is mechanically distinct from the sedimentary rocks. Joint orientations were analyzed by plotting rose diagrams of all joints within each structural block according to dip azimuth in 10-degree sectors (figure 1). The percentage of data in each sector as compared to the total domain database was then calculated using Field Data Management (FMS) software (G. C. Herman, Field Data Management System v. 2.1; an upgrade of Kaeding and Herman, 1988, on file at the N. J. Geological Survey). Percentage values were rounded off to whole numbers. Sectors without readings are omitted. Sectors showing 0 percent contain data but comprise less than 1 percent of the total. A module of the FMS software creates files for ARC/INFO Geographic Information Systems (GIS) programs, which assign a statistical weight factor according to the sector percentage values. The GIS programs recalculate the dip azimuth values back to strike and dip, then plot user-defined structural symbols using the weighting factor at specified locations on maps (Herman and others, 1993; M. A. French and G. C. Herman, MesoPlot v. 1.0, unpublished program on file at the N. J. Geological Survey). The longer the length of the symbol the more dominant the joint orientation. All plotted data on the map show strike trend. The bottom of the flag symbol marks the location of the outcrop. Dip values are divided into 30-degree sectors. Dips of 1 to 29 degrees are marked by open flags; half-filled flags mark dips of 30 to 59 degrees; filled flags marks dips of 60 to 89 degrees. Flag placement shows direction of dip. Some joints with identical strike trends and opposite dip direction will have different symbol lengths because the statistics were calculated on dip azimuth.

Joint data are important to fully characterize the water-bearing properties of the bedrock. Because the bedrock generally lacks primary porosity, joints and other fractures control the occurrence and movement of ground water. Models invoke either bedding-parallel fractures (Vecchioli and others, 1969; Michalski, 1990) or vertical fractures (Vecchioli, 1967; Spayd, 1985) as the dominant control on ground-water movement. Hybrid models suggest that either flow cannot be defined by bedding fractures or vertical joints alone but that both must be considered (Houghton, 1990; Lewis, 1992). All models show that the bedrock aquifers are anisotropic and ground-water flow is generally parallel rather than perpendicular to bedding strike direction. The same models characterize dominant joint trends as either parallel to the strike of bedding or perpendicular to it. The data presented here suggest that the dominant joint trends more closely parallel the strike of the major faults rather than strike of bedding (figure 2).

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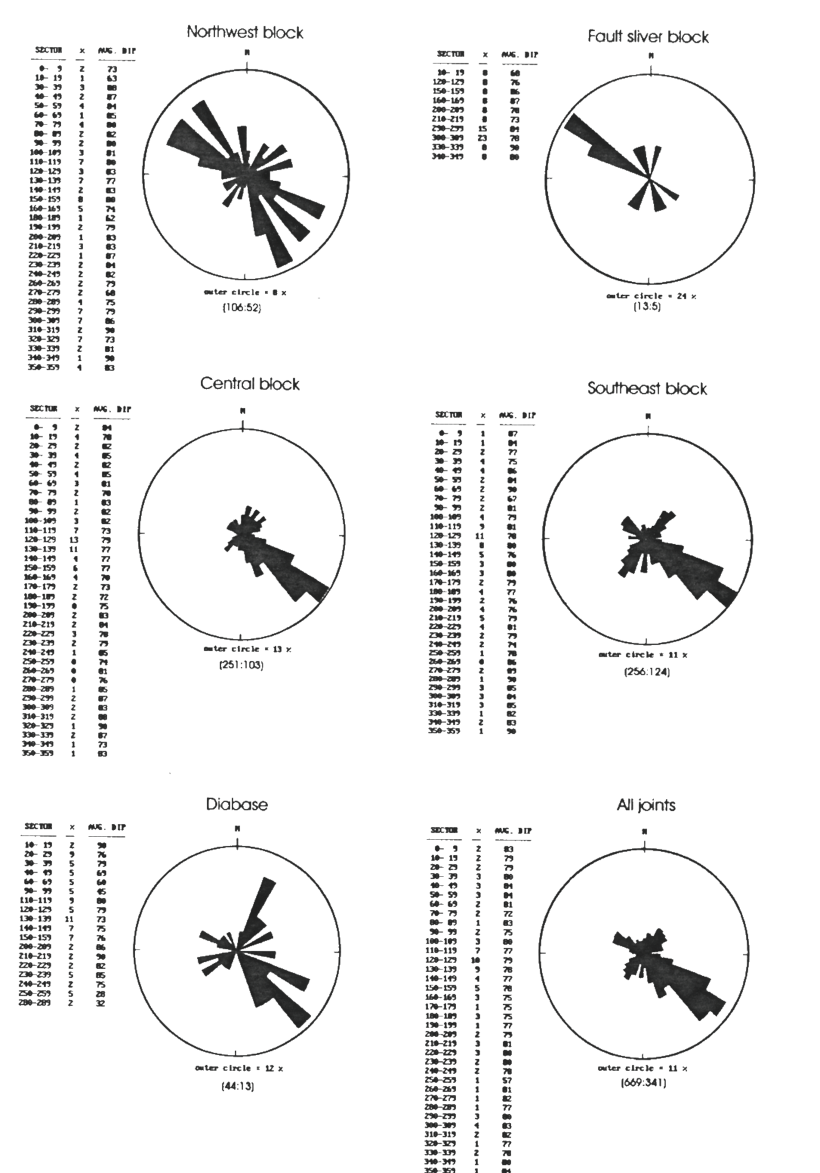

Figure 1.--Rose diagrams of bedrock joints, grouped by structural block. See joint orientation map on sheet 1 for location of structural blocks. Numbers in parentheses below the diagrams are the number of measured joints and number of outcrops, respectively, for each block.

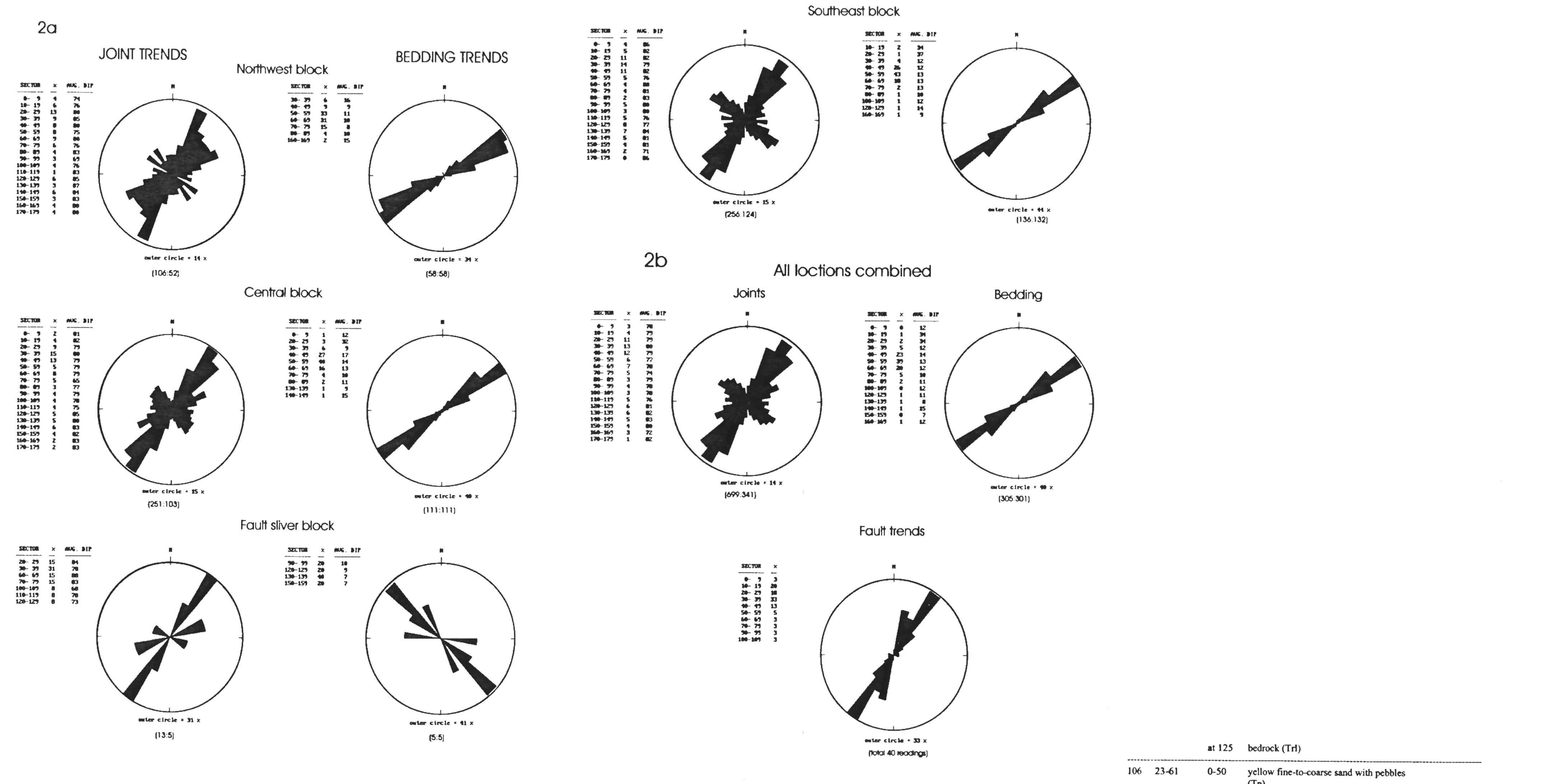

Figure 2.--(a) Rose diagrams showing the comparison of strike trends of joints and bedding for each structural block. (b) Comparison of all joints against bedding and fault trends. Fault data include 24 digitally identified linear segments tracing all mapped faults on the quadrangle and 16 outcrop-scale structures measured in the field.

Table 1.--Selected well logs

Well No.	Identifier[1]	Depth (feet)	Description[2]
1	NJGS files	0-19	river mud and meadow bog (Qm)
		19-25	brown and green fine-to-medium sand and gravel (Qrt)
2	NJGS files	0-6	fill
		6-8	black fine sand, river mud and meadow bog (Qm)
		8-33	brown fine-to-medium sand, gravel (Qrt)
3	NJGS files	0-23	meadow bog and river mud (Qm)
		23-38	brown and green medium-to-coarse sand and gravel (Qrt)
4	NJGS files	0-15	meadow bog (Qm)
		15-25	brown and green medium-to-coarse sand and gravel, trace clay (Qrt)
5	NJGS files	0-4	meadow bog (Qm)
		4-15	river mud with some bog (Qm)
		15-20	brown and green medium-to-coarse sand and gravel, trace clay (Qrt)
6	NJGS files	0-11	meadow bog (Qm)
		11-16	meadow bog and black fine sand (Qm)
		16-20	brown and green medium-to-coarse sand (Qrt)
7	NJGS files	0-9	meadow bog (Qm)
		9-18	brown and green fine sand (Qrt)
		18-20	brown and green medium-to-coarse sand and gravel (Qrt)
8	25-44-539 boring 49	0-8	water
		8-13	sand, broken shale (Qm over shale)
		at 13	shale (JTrp)
9	25-44-539 boring 50	0-12	water
		12-14	sand, broken shale (Qm over shale)
		at 14	shale (JTrp)
10	25-44-539 boring 51	0-12	water
		12-13	clay, sand (Qm)
		at 13	shale (JTrp)
11	25-44-539 boring 53	0-11	water
		11-13	sand, broken shale (Qm over shale)
		at 13	shale (JTrp)
12	25-44-539 boring 54	0-6	water
		6-14	sand, broken shale (Qm over shale)
		at 14	shale (JTrp)
13	25-44-539 boring 52	0-8	water
		8-14	sand, broken shale (Qm over shale)
		at 14	shale (JTrp)
14	NJGS files	0-16	meadow bog (Qm)
		16-23	green fine-to-medium sand and gravel (Qrt)
		23-28	brown medium-to-coarse sand and gravel (Qrt)
15	25-11772		log by H. F. Kasabach, NJGS
		0-5	light-gray organic silty sandy clay (Qm)
		5-10	olive-brown organic clayey silt and fine sand (Qm)
		10-35	gray clay with lignite and diatoms (Qm)
		35-50	white clay with angular diabase fragments and pyrite crystals--diabase is altering to white clay (weathered Jd)
		50-53	dark-gray clay, white clay streaks
		53-69	black diabase, slightly weathered (Jd)
		69-75	diabase (Jd)
16	25-11773		log by H. F. Kasabach, NJGS
		0-5	fill
		5-25	gray clay, lignite (Qm)
		25-40	light-gray to brownish-gray fine-to-very coarse sand and gravel (Qtl)
		40-50	light-gray fine-to-coarse sand, little fine gravel, rose quartz grains (Krf)
		50-60	light-gray to white clay (weathered Jd)
		60-70	weathered diabase
		70-75	fresh diabase (Jd)
17	25-11774		log by H. F. Kasabach, NJGS
		0-5	fill
		5-30	brown to gray silty clay with wood and lignite (Qm)
		30-40	brownish-gray silty fine-to-medium sand, grains subrounded to subangular (Qtl)
		40-54	light-gray fine-to-very coarse sand, rose quartz and a few chert grains (Krf)
		54-68	white to green clay (weathered Jd)
		68-74	diabase (Jd)
18	28-5267		log by H. F. Kasabach, NJGS
		0-15	fill and organic silt and clay (af over Qm)
		15-30	yellowish-brown to grayish-yellow fine-to-coarse sand, some gravel, including red shale and ironstone clasts, some pink quartz (Qtl, possibly over Krf)
		30-35	pure white clay (weathered Jd or Trl?)
19	28-5268		log by H. F. Kasabach, NJGS
		0-10	dark-brown organic silty clay (Qm)
		10-20	brownish-yellow fine-to-coarse sand and gravel, some glauconite (Qtl)
		20-25	pure white clay (weathered Jd or Trl?)
		25-30	clay with fragments of diabase and baked sandstone (weathered Jd or Trl?)
20	28-5269		log by H. F. Kasabach, NJGS
		0-30	fill over dark-gray organic silty clay (af over Qm)
		30-35	light-yellowish-brown fine-to-coarse sand (Qtl)
		35-50	yellowish-brown to light-gray fine-to-coarse sand and some clay, with pink, blue, and milky quartz grains (Krf)
		50-55	white kaolinite clay, a few diabase and sandstone fragments (weathered Jd)
		55-60	greenish-gray clay (weathered Jd)
21	28-5270		log by H. F. Kasabach, NJGS
		0-20	fill over brown to dark-gray clay (Qm)
		20-35	brownish-orange to yellowish-gray sand and gravel (Qtl)
		35-40	light-gray medium-to-very coarse sand with blue and pink quartz grains (Krf)
		40-45	white kaolinite clay (weathered Jd)
		45-50	white and gray clay (weathered Jd)
22	NJGS files	0-2	fill (af)
		2-8	meadow muck (Qm)
		8-10	sand (Krf)
		10-25	clay (weathered Trl)
		at 25	shale (Trl)
23	NJGS files	0-27	sand (Krf)
		27-43	clay (weathered Trl)
		at 43	shale (Trl)
24	23-77	0-25	fill over black clay and silt (af over Qm)
		25-30	gray fine-to-medium sand and silt (Qm)
		30-35	gray coarse sand and fine gravel (Qtl)
		35-40	light-gray clay (Krf)
		40-50	medium-to-coarse sand (Krf)
		50-60	light-gray to green clay (weathered Jd)
		60-74	black partly weathered diabase (Jd)
25	28-9469	0-4	fill (af)
		4-7	peat (Qm)
		7-27	dark-brown organic clay (Qm)
		27-37	brown to light-gray coarse-to-fine sand and gravel, some clayey silt at base (Qtl)
26	SC--H1	0-30	soft gray clay (Qm)
		30-37	one or two pebbles (Qrt lag) and greenish-gray weathered baked shale (Trl)
		37-39	dark-gray baked shale (Trl)
27	SC--21E	0-16	gray organic clay to clayey sand (Qm)
		16-38	brown fine-to-medium sand (Qtl)
		38-56	white to light-gray fine-to-coarse sand (Krf)
28	SC--E20	0-13	reddish organic sand and clay (Qm)
		13-38	brown fine-to-medium sand (Qtl)
		38-56	white to light-gray fine-to-coarse sand (Krf)
29	SC--E19	0-12	brownish-gray organic clay and sand (Qm)
		12-23	brown clayey coarse sand and gravel (Qtl)
		23-55	light-gray to tan fine-to-medium sand (Krf)
30	SC--E18	0-15	brownish-gray organic clay (Qm)
		15-25	greenish-gray to yellowish-brown medium-to-coarse sand and gravel (Qtl)
		25-56	light-gray medium-to-coarse sand (Krf)
31	SC--E17	0-18	brownish-gray clay (Qm)
		18-29	yellowish-brown clayey sand and gravel (Qtl)
		29-59	yellow to light-gray arkosic fine-to-coarse sand (Krf)
32	25-19303	0-18	fill (aft)
		at 18	green clay (Qm)
33	25-19308	0-21	trash (aft)
		21-23	sand and mud (Qm)
		23-43	stones (Qrt)
		at 43	rock (Trl)
34	25-19307	0-21	trash (aft)
		21-23	mud and sand (Qm)
		23-41	stones (Qrt)
		at 41	rock (Trl)
35	25-19304	0-10	trash (aft)
		10-20	sand and stones (Qrt)
36	25-19302	0-19	trash (aft)
		19-21	mud and sand (Qm)
		21-25	sand and stones (Qrt)
37	25-19305	0-20	trash (aft)
		20-21	mud and sand (Qm)
		21-26	sand and stones (Qrt)
38	25-24477	0-15	trash (aft)
		15-20	peat (Qm)
		20-23	red clay (Qm)
		23-26	fine sand (Qm)
		26-38	sand and gravel (Qrt)
		38-42	stones, weathered zone (Qrt over weathered Trl)
		42-43	gray rock (Trl)
		43-58	rock (Trl)
39	23-963	0-10	gray-brown clayey silt with argillite pieces and sand (af over Qm)
		10-17	organic clay and silt (Qm)
		17-20	gray highly weathered argillite (Trl)
		20-30	hard gray argillite (Trl)
40	23-969	0-6	fill (af)
		6-10	dark-brown organic clayey silt (Qm)
		10-20	brown sand and gravel (Qrt)
		20-23	weathered red-brown shale (JTrp)
		23-33	soft to medium hard red-brown shale (JTrp)
41	23-971	0-5	fill
		5-11	brown silt and sand (Qm)
		11-14	black peat (Qm)
		14-28	medium hard purple-brown shale (JTrp)
42	23-82	0-12	brown sand and gravel (Krf)
		12-25	red clay (weathered shale)
		25-38	brown, white, green clay (weathered shale)
		38-109	black, green bedrock (Trl)
43	SC--3H	0-7	light-brown clayey loam (Tp)
		7-47	light-gray and yellow fine-to-coarse sand (Krf)
		47-62	gray clay (weathered Trl)
		62-80	hard gray shale (Trl)
44	SC--4H	0-15	yellow medium sand (Tp)
		15-72	light-gray to light-yellow fine-to-medium sand (Krf)
		72-77	gray to olive-gray clay (weathered Trl)
		77-79	gray baked shale (Trl)
45	SC--5H	0-7	gritty light-gray clay (Krf)
		7-15	yellow clayey medium-to-coarse sand (Krf)
		15-30	stiff gray to greenish-gray clay (weathered Trl)
		30-40	gray baked shale (Trl)
46	23-73	0-49	sand and clay (Krw over Krf)
		49-60	white fine sand (Krf)
		60-82	white coarse sand and gravel (Krf)
47	23-72	0-15	sand (Tp)
		15-97	light-brown and gray clay (Krw)
		97-138	sand (Krf)
		138-149	clay and sand (Krf and weathered Jd)
		149-150	bedrock (Jd)
48	23-790	0-20	brown medium-to-coarse sand, some gravel (Qal)
		20-45	clayey brown sand and gray clay (Kmg)
		45-75	interbedded grayish-white fine sand and gray clay (Krw)
		75-115	gray clay (Krw)
		115-147	gray to grayish-white sand (Krf)
49	SC--6H	0-21	light-yellow fine-to-coarse sand (Krf)
		21-26	light-gray clay (Krf)
		26-30	light-gray coarse sand (Krf)
		30-39	light-gray and white clay (weathered Trl)
		39-41	brownish-gray hard clay (weathered Trl)
		41-46	gray baked shale (Trl)
50	SC--8H	0-7	soft black peaty clay (Qs)
		7-29	light-gray to white fine sand (Krf)
		29-39	white clay with some coarse sand and gravel (Krf)
		39-41	dark-gray clayey sand (weathered Trl?)
		41-42	dark-gray baked shale (Trl)
51	SC--7H	0-15	yellowish to light-gray clayey sand and gravel (Tp)
		15-26	compact dark-gray clay (Krw)
		26-70	light-gray fine-to-coarse sand (Krf)
		70-86	hard olive-gray clay and weathered baked shale (weathered Trl)
		86-91	light-gray baked shale (Trl)
52	SC--9H	0-60	gray to white medium-to-coarse sand, some clay and gravel, including chert and quartz pebbles (Krf)
		60-70	compact white clay (weathered Trl)
		70-75	dark-gray baked shale (Trl)
53	SC--10H	0-9	yellowish-brown fine sand and gravel (Tp)
		9-20	dark-gray sandy and lignitic clay (Krw)
		20-28	gray fine sand and interbedded dark-gray clay (Krf)
		28-62	white to light-gray fine-to-medium sand (Krf)
		62-70	white and gray clay and weathered baked shale (Trl)
		70-72	dark-gray baked shale (Trl)
54	23-65	0-122	clay, streaks of sand and gravel (Tp over Krw)
		122-158	sand, gravel, clay streaks (Krf)
		158-160	clay (weathered Jd)
		at 160	bedrock (Jd)
55	23-609	0-35	brown to tan fine-to-coarse sand with fine gravel (Tp)
		35-45	dark-gray clay, some fine sand (Krw)
56	23-59	0-18	yellow sand and gravel, some clay (Tp)
		18-36	sand, streaks of gray clay (Kmg or Tp)
		36-164	gray, blue clay (Krw)
		164-172	fine sand with clay streaks (Krf)
		172-220	white coarse sand, a little white clay and gravel (Krf)
57	23-66	0-36	loam, sand, gravel (Tp)
		36-73	yellow clayey sand (Kmg)
		73-105	gray clay (Krw)
		105-165	clay and sand (Krw)
		165-221	gray to brown fine-to-coarse sand, a little gravel and clay (Krf)
58	23-585	0-18	brown medium-to-coarse sand and gravel (Tp)
		18-61	gray, yellow, brown clay (Kmg)
		61-111	interbedded brown sand and white to gray clay (Kmg)
		111-213	gray clay, a little sand (Krw)
		213-248	brown to gray fine-to-coarse sand, some clay and gravel (Krf)
59	23-610	0-20	brown medium-to-coarse sand and gravel (Qcsg)
		20-40	gray to tan fine-to-coarse sand, some clay (Kmg)
		40-45	multicolored clay (Kmg?)
		45-85	dark-gray silt, some fine sand and clay (Krw)
60	23-170	0-77	red, white, gray, brown sand, a little gravel and clay (Kmg)
		77-201	blue clay (Krw)
		201-304	gray medium-to-coarse sand (Krf)
		304-317	clay (weathered CZYu?)
		317-337	mica and fine sand, bedrock (weathered CZYu?)
61	23-453	0-18	yellow sand, streaks of clay (Qtl over Kmg)
		18-81	yellow coarse sand, some gravel (Kmg)
		81-229	blue clay (Krw)
		229-269	sand and clay streaks (Krf)
		269-284	coarse sand, some gravel (Krf)
		284-312	blue clay (weathered CZYu?)
		312-354	green clay with streaks of silica and mica (weathered CZYu?)
		at 354	hard bedrock (CZYu)
62	SC--42	0-2	clayey brown peat (Qal)
		2-39	brown medium-to-coarse sand (Qtl)
		39-61	white to yellow medium-to-coarse sand, a little gray to white clay (Kmg)
63	SC--43	0-7	reddish-brown sand and gravel (Qtl)
		7-63	interbedded white to gray fine-to medium sand and clay (Kmg)
64	23-127	0-33	sand (Qtl over Kmg)
		33-77	sand, some clay (Kmg)
		77-210	clay (Krw)
		210-257	sand (Krf)
		257-269	clay (Krf)
		269-307	sand (Krf)
		307-312	clay (weathered CZYu?)
65	SC--44	0-13	gray and brown organic clay and sand (Qal)
		13-63	interbedded light- to dark-gray fine-to-coarse sand and clay (Kmg)
66	SC--45	0-22	brown sand and gravel (Qtl)
		22-78	white, yellow, light-gray lignitic fine sand with a trace of clay (Kmg)
67	SC--46	0-6	brown clayey fine sand and gray organic clay (Qal)
		6-68	interbedded gray clay and light-gray fine sand (Kmg)
68	23-443	0-15	gravel and sand (Qtl)
		15-60	gray interbedded sand and clay (Kmg)
		60-79	coarse sand, some gravel (Kmg)
		79-99	gray clay (Krw)
69	23-445	0-15	brown sand and pebbles (Qtl)
		15-79	gray sand, some white clay (Kmg)
		79-193	gray clay (Krw)
		193-324	white medium-to-coarse sand with some clay (Krf)
		324-328	weathered zone (weathered CZYu)
70	23-114	0-18	brown sand (Qtl)
		18-101	clay and sand (Kmg)
		101-167	clay and shale (Krw)
		167-172	sand (Krw)
		172-210	clay (Krw)
		210-316	sand with some interbedded clay (Krf)
		316-325	clay (weathered CZYu?)
71	23-107	0-13	red sand and gravel (Qtl)
		13-48	blue clay with fine sand streaks (Kmg)
		48-109	gray coarse sand (Kmg)
		109-175	blue clay (Krw)
		175-228	fine sand with streaks of clay (Krw)
		228-273	clay (Krw)
		273-345	gray coarse sand and gravel, some interbedded clay (Krf)
		345-349	clay (weathered CZYu?)
		349-351	hard shale (CZYu?)
		351-365	fine sandy clay with mica (weathered CZYu?)
72	23-131	0-15	yellow and brown sand and gravel (Qtl)
		15-80	white fine-to-coarse sand, some interbedded white and gray clay (Kmg)
		80-87	blue tough clay (Krw?)
73	SC--47	0-11	yellow to brown clayey sand, some gravel (Qtl)
		11-72	light-gray to white sand, a little interbedded clay (Kmg)
74	SC--48	0-3	dark-brown clayey peat (Qal)
		3-5	yellow and gray slightly clayey sand (Qal)
		5-70	light-gray lignitic fine sand (Kmg)
75	SC--49	0-10	brown sand and gravel (Qtl)
		10-70	interbedded gray clay and fine lignitic sand (Kmg)
76	SC--50	0-13	reddish-brown to yellowish-brown fine sand (Qtl)
		13-82	gray to yellow micaceous, lignitic fine-to-medium sand (Kmg)
77	SC--51	0-13	dark-brown peaty clay and sand (Qal)
		13-71	light-gray to white lignitic fine-to-medium sand (Kmg)
78	SC--52	0-6	brown to black peaty clay (Qal)
		6-12	dark-brown clayey sand and gravel (Qal or Qtl)
		12-73	light-gray to white lignitic fine-to-medium sand (Kmg)
79	23-442	0-10	white clay and sand (Qtl)
		10-25	brown and white sand, some wood (Qtl)
		25-89	interbedded gray to white clay and fine-to-coarse sand, with lignite (Kmg)
80	SC--53	0-7	brown clayey fine sand (Qal)
		7-72	light-gray fine-to-medium sand (Kmg)
81	SC--54	0-4	black to brown peaty clay (Qal)
		4-15	yellow clayey sand and small pebbles (Qtl)
		15-74	yellow to light-gray fine-to-medium sand, a little lignite and clay (Kmg)
82	SC--55	0-5	rusty brown fine sand with pebbles (Qtl)
		5-86	light-gray to white lignitic fine-to-medium sand (Kmg)
83	SC--56	0-11	brown to dark-gray organic clay and sand (Qal)
		11-31	gray sandy lignitic clay (Kmg)
		31-78	light-gray fine sand (Kmg)
84	23-97	0-48	red sand (Qtl, possibly over Kmg)
		48-83	gray sand, some clay (Kmg)
		83-117	gray clay (Krw)
		117-127	white fine sand (Krw)
		127-180	tough clay, hard streaks (Krw)
		180-320	fine-to-coarse sand and some interbedded clay (Krf)
85	23-94	0-83	gray to white fine-to-coarse sand, streaks of clay (Kmg)
		83-183	gray sandy clay (Krw)
		183-206	gray medium-to-coarse sand with some layers of gray clay (Krf)
86	SC--58	0-11	yellow sand and pebbles (Qtl)
		11-80	white, yellow, gray fine-to-medium sand, some clay, mica, and lignite (Kmg)
		80-97	gray sandy clay (Krw)
87	SC--57	0-80	white, yellow, gray fine-to-medium sand, some lignite, mica, and clay (Kmg)
		80-102	gray sandy clay (Krw)
88	23-626	0-55	tan to gray fine-to-coarse sand, some lignite and clay (Kmg)
		55-57	dark-gray silty clay (Krw?)
89	23-613		gamma-ray log indicates sandy unit (Kmg) over clayey unit (Krw), transition occurs between 60 and 80 feet, total depth about 100 feet
90	23-44	0-27	orange sand (Tp)
		27-108	gray, brown, white sand and clay, some lignite (Kmg)
		108-206	clay, some sand (Krw)
		206-289	fine-to-coarse sand (Krf)
		289-292	red clay (weathered Trs?)
		292-299	hard-packed sand, weathered zone (weathered Trs?)
		299-316	clay (weathered Trs?)
		316-319	hardpan (Trs?)
91	23-46	0-50	brown and yellow sand (Tp)
		50-96	white and gray clay (Kmg over Krw)
		96-100	gray fine sand (Krw)
		100-155	black clay (Krw)
		155-250	fine-to-coarse sand and gravel, some clay (Krf)
		250-255	red clay and sand (weathered Trs?)
		255-265	red clay or shale (weathered Trs)
92	23-57	0-49	brown sand and gravel (Tp)
		49-187	gray clay (Krw)
		187-241	sand and gravel, streaks of clay (Krf)
93	28-4-574	0-NR	yellow sand and gravel (Tp)
		NR-NR	gray clay (Krw)
		NR-260	white medium-to-coarse sand (Krf)
		260-565	red shale (Trs)
94	23-40	0-79	brown sand and pebbles (Tp)
		79-90	clay (Krw)
		90-108	white sand (Krw)
		108-178	black clay, some interbedded sand (Krw)
		178-251	pink and white sand, some gravel, a little clay (Krf)
		251-261	hardpan (weathered Trs or Trs)
95	23-42	0-38	clayey sand and pebbles, iron stained (Tp)
		38-118	sandy clay (Krw)
		118-231	sand, some clay (Krf)
		231-247	red sand (Krf or weathered Trs)
		247-269	sand and gravel, weathered zone (weathered Trs)
		269-279	rock, weathered zone (Trs)
96	23-598		electric log indicates (depths approximate):
		0-60	high resistance material (Tp sand and gravel)
		60-110	slightly lower resistance material (Kmg sand and clay)
		110-220	low resistance material (Krw)
		220-250	higher resistance material (Krf)
		250-270	low resistance material (weathered Trs and Trs?)
97	23-611	0-50	brown to tan fine-to-coarse sand and gravel (Tp)
		50-86	gray to tan fine-to-coarse sand, some white clay (Kmg)
		86-110	dark gray clay (Krw)
98	23-506	0-85	yellow sand (Tp over Kmg)
		85-115	dark gray sand (Kmg)
		115-215	white to gray clay, a little fine sand (Krw)
		215-225	water-bearing sand (Krf)
		225-230	white clay (weathered Trs?)
		230-255	red clay (weathered Trs)
		at 255	red bedrock (probable Trs)
99	23-612	0-35	tan to rust fine-to-coarse sand, some gravel (Tp)
		35-104	tan, red, rust fine-to-coarse sand, some white to gray clay (Kmg)
		104-115	dark-gray clay (Krw)
100	23-619	0-119	gray, tan, yellow, brown fine-to-coarse sand and some interbedded clay and lignite (Kmg)
		119-130	yellow, gray clay (Krw)
101	23-623	0-15	tan clayey sand and gravel (Tp)
		15-118	gray to tan fine-to-coarse sand, some white to yellow clay (Kmg)
		118-149	gray clay with fine sand and lignite (Krw)
102	23-332	0-24	yellow sand (Tp)
		24-80	yellow fine sand (Kmg)
		80-125	gray solid clay (Krw)
		125-178	white fine sand and clay (Krw or Krf)
		178-208	coarse sand and gravel (Krf)
		208-240	red clay (weathered Trs)
103	28-12522	0-15	reddish-brown sand and gravel (Tp)
		15-47	brown medium-to-coarse sand, some clay (Kmg)
		47-61	gray clay, some interbedded sand (Krw)
104	23-501	0-20	yellow medium-to-coarse clayey sand (Tp)
		20-40	yellow sand with streaks of white clay (Kmg)
		40-154	gray and white clay, some sand and lignite (Krw)
		154-175	gray medium-to-coarse sand and gravel (Krf)
		175-178	gray hard clay (Krf or weathered Trs?)
105	23-58	0-23	coarse gravel, some clay and hardpan (Tp)
		23-81	gray solid clay, some sand (Krw)
		81-107	gray coarse sand (Krf)
		107-125	multicolored solid clay (weathered Trl)
		at 125	bedrock (Trl)
106	23-61	0-50	yellow fine-to-coarse sand with pebbles (Tp)
		50-102	gray clay (Krw)
		102-108	gray fine-to-coarse sand (Krf)
		108-114	gray, white, pink clay (weathered Jd?)
		114-151	diabase bedrock (Jd)
107	23-47	0-25	yellow, orange, brown sand (Tp)
		25-69	gray clay and some sand (Krw)
		69-201	white, orange, gray fine-to-coarse sand, some clay and lignite (Krf)
		at 201	red hard clay (weathered Trs)
108	SC--11H	0-7	yellow clayey sand (Tp)
		7-15	light-gray clay (Krw)
		15-44	light-gray fine sand (Krf)
		44-56	light-gray clay and a little coarse sand (Krf or weathered Jd)
		56-59	coarse-grained diabase (Jd)
109	28-1563	0-35	coarse yellow sand and gravel (Tp)
		35-52	gray clay and sand (Krf)
		at 52	rock (Jd)
110	28-1775	0-58	brown and yellow sand and gravel, a little yellow and white clay (Tp)
111	28-9270	0-15	gray and green medium sand (Tp)
		15-26	brown coarse sand (Tp)
		26-74	gray clay and lignite (Krw)
		74-80	gray medium sand (Krf?)
		80-83	gray clay (Krf or weathered Trl?)
112	28-19179	0-15	yellow to red clayey fine sand and gravel (Tp)
		15-75	light-gray clay, some wood and sand (Krw)
		75-105	white fine-to-coarse sand (Krf)
113	28-18450	0-33	brown medium-to-coarse sand (Tp)
		33-65	gray clay (Krw)
		65-95	gray fine-to-coarse sand (Krf)
		at 95	white clay (Krf or weathered Trl?)
114	28-12475	0-24	yellow clay and sand (Tp)
		24-55	blue and black clay (Krw)
		55-69	black clay and sand (Krw over Krf)
		69-75	gray sand and wood (Krf)
115	28-12084	0-40	yellow coarse sand (Tp)
		40-55	gray hard clay, some white sand (Krw)
		55-60	gray-white medium sand (Krf)
116	28-18366	0-40	brown clayey coarse sand with some gravel (Tp)
		40-75	salmon, gray, white clay, some fine sand (Krw)
		75-107	fine-to-coarse sand (Krf)
117	SC--12H	0-30	yellow to light-gray fine-to-coarse sand and gravel (Tp)
		30-102	white to light-gray fine-to-coarse sand (Krf)
		102-109	compact light-gray to black clay (weathered Trl)
		109-126	hard, gray baked shale (Trl)
118	28-425	0-16	sand and gravel, a little white clay (Tp)
		16-24	blue clay (Krw)
		24-44	yellow to white medium-to-coarse sand (Krw)
119	28-12037	0-15	red sand and gravel (Tp)
		15-100	gray, white, red clay (Krw)
		100-126	coarse white sand (Krf)
120	28-1195	0-25	yellow sand and gravel (Tp)
		25-100	gray, white, red, black clay, some fine sand (Krw)
		100-143	white fine-to-coarse sand , some clay (Krf)
121	23-71	0-58	yellow sand (Tp over Kmg)
		58-130	brown and white clay, some interbedded sand (Krw)
		130-172	coarse sand (Krf)
122	28-13794	0-15	gravel (Tp)
		15-65	yellow, white, red sand (Krf)
123	28-6628	0-13	brown silty sandy clay with gravel (Tp)
		13-60	brown fine-to-coarse sand with some clay (Krf)
124	28-3585		log by "J. A. P", NJGS
		0-30	tan to brown fine-to-coarse quartz sand, some pea gravel, sand grains are subrounded and frosted, trace of chert and glauconite (Tp)
		30-40	brown fine-to-very coarse quartz sand, grains mostly subangular and clear, much white feldspar and granitic particles, some chert and Triassic particles (Krf or Tp)
125	28-11360	0-48	brown fine-to-coarse sand and gravel (Tp)
		48-50	gray clay (Krw)
126	28-875	0-18	yellow sand, some clay and boulders (Tp)
		18-42	gray to white clay (Krw)
		42-53	gray, yellow, white sand, some clay and gravel (Krf)
127	28-7973A	0-60	sand, gravel (weathered Jd?)
		60-250	trap rock (Jd)
128	SC--H2	0-16	yellow to light-gray fine-to-coarse clayey sand, a little gravel (Krf)
		16-30	white to dove-gray clay (weathered Trl?)
		30-34	hard, gray baked shale (Trl)

[1]Numbers of the form 25-xxxx or 28-xxxx (for example, 28-6628) are well permit numbers issued by the N. J. Department of Environmental Protection, Bureau of Water Allocation.

Numbers of the form 23-xxx (for example 23-71) are well numbers from Gronberg and others (1989).

Numbers of the form xx-xx-xxx (for example, 25-44-539) are N. J. Atlas Sheet grid locations of entries in the N. J. Geological Survey permanent note collection.

Identifiers of the form SC--xx (for example SC--47) are reference codes for borings made for a proposed ship canal in the 1930s. Logs of these borings are on file at the N. J. Geological Survey.

The notation "NJGS files" indicates logs of borings or wells that are on file at the N. J. Geological Survey but that are not entered in the permanent note collection.

[2]Depths are in feet below land or water surface. Inferred map units and comments in parentheses. "NR" indicates "not reported". In most cases the logs have been condensed for brevity, but the descriptive terminology is as it appears in the original source. Map units were assigned by the authors based on comparison of log descriptions to known lithologic and geophysical properties of the unit (Sandberg and others, 1996). No samples were examined except as noted.