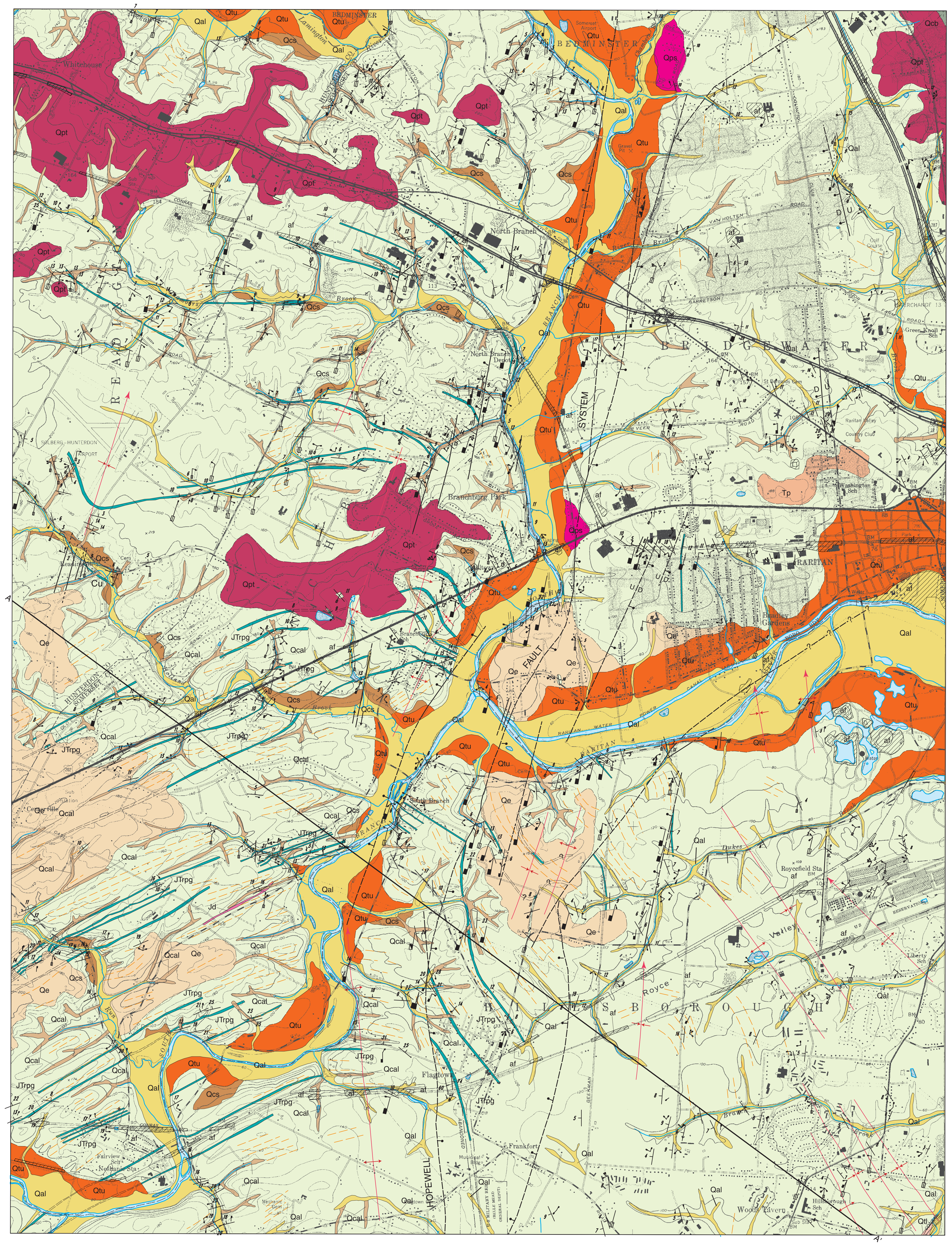
DEPARTMENT OF ENVIRONMENTAL PROTECTION
LAND USE MANAGEMENT
NEW JERSEY GEOLOGICAL SURVEY

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



Base from U.S. Geological Survey, Raritan, N.J. 7 1/2-minute quadrangle 1955
Photorevised 1988

GIS application and digital cartography by:
Donald H. Monteverde and Scott D. Stanford

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

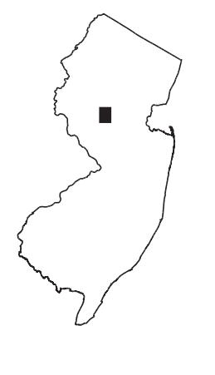
Surficial geology by S.D. Stanford, 1990
Bedrock geology by D.H. Monteverde and R.A. Volkert, 1997
Reviewed by R.W. Schlische and M.O. Withjack (Rutgers Univ.)
and R. Dalton, I.G. Grossman, K. Muessig and D. Pasicznyk (NJGS)

GEOLOGY OF THE RARITAN QUADRANGLE, HUNTERDON AND SOMERSET COUNTIES, NEW JERSEY

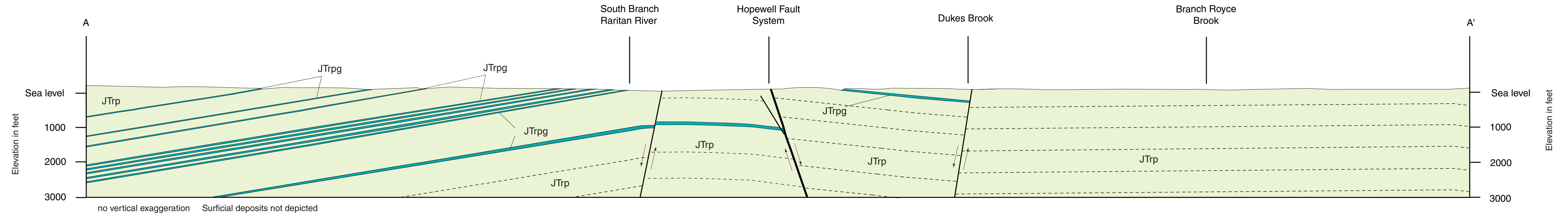
by

Donald H. Monteverde, Scott D. Stanford and Richard A. Volkert

2003

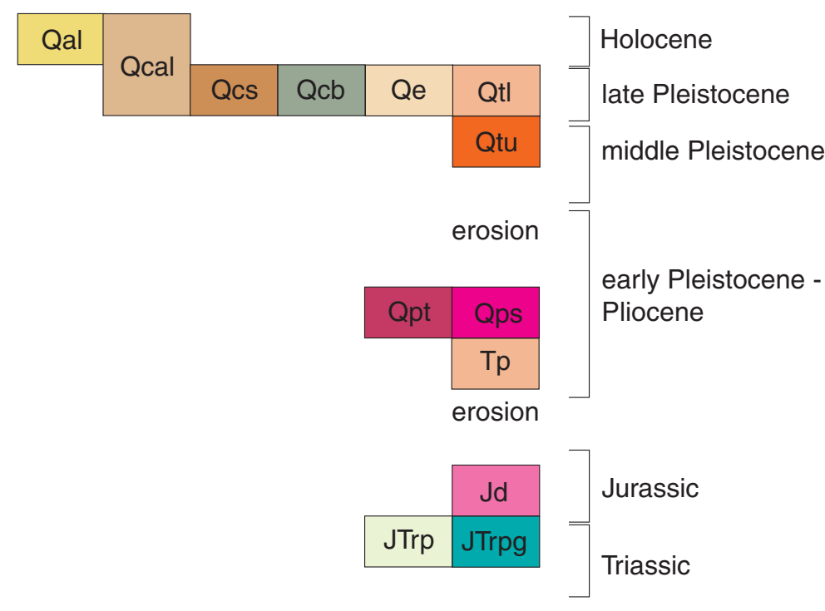


LOCATION IN
NEW JERSEY



no vertical exaggeration   Surficial deposits not depicted

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

af Artificial fill--Silt, clay, sand, gravel, rock and man-made materials including bricks, cinders, ash, and construction debris. Includes railroad and road embankment materials and manmade land. As much as 20 feet thick. Many small areas of fill not mapped. Extent of fill based on aerial photographs,1979.

Qal Alluvium--Reddish-brown silt, with some sand and clay, and minor amounts of pebble gravel. Contains variable amounts of organic matter. Gravel is chiefly rounded chips of reddish-brown to gray shale and mudstone, with lesser white, gray, and purple quartz and quartzite and gray to white gneiss. As much as 20 feet thick along the Raritan River; generally less than 10 feet thick along tributary streams. Deposited in modern floodplains and channels.

Qtl Lower Terrace deposits--Reddish-brown silt, sand, and pebble gravel. Gravel is chiefly rounded chips of reddish-brown shale, with minor white to yellow quartz. As much as 10 feet thick. Forms terraces with surfaces 5 to 10 feet above modern floodplains in southeastern corner of the quadrangle. Low terraces within the Raritan floodplain are regularly inundated by large floods and are included with the floodplain alluvium on this map.

Qe Eolian deposits--Reddish-yellow silt and very fine sand. As much as 5 feet thick; generally less than 3 feet thick.

Qcs Shale colluvium--Reddish-yellow to reddish-brown silt with angular red shale chips and, in places, a few gray quartzite and chert pebbles. As much as 10 feet thick. Forms aprons at the base of hillslopes.

Qcb Basalt colluvium--Reddish-yellow clayey silt with subangular pebbles and cobbles of basalt and some angular red shale chips. As much as 10 feet thick.

Qcal Colluvium and Alluvium, undivided--Interbedded alluvium and shale colluvium, as described above, in small headwater valleys. As much as 10 feet thick.

Qtu Upper Terrace deposits--Reddish-brown to reddish-yellow sand, silt, pebble gravel; minor clay and cobble gravel. Gravel is chiefly gray to white gneiss and reddish-brown shale, sandstone, and mudstone, with lesser amounts of white, purple, and gray quartzite and quartz, gray to black chert, gray shale and sandstone. Gneiss clasts are generally iron-stained, pitted, or have a thin weathering rind. As much as 20 feet thick. Form terraces with surfaces 20 to 30 feet above modern floodplains.

Qps Pre-Illinoian Fluvial deposits--Reddish-yellow silt and clay with some pebbles and cobbles. Gravel is chiefly gray quartzite, quartzite conglomerate, and chert, with minor gray to brown sandstone. Quartzite, conglomerate, and chert clasts are iron-stained, pitted, and have thin weathering rinds; sandstone clasts are deeply weathered. As much as 5 feet thick. Occur as erosional remnants on shale straths 5 to 10 feet above the surface of the upper terrace deposits.

Qpt Pre-Illinoian till (Jerseyan till of previous usage)--Reddish-yellow to reddish-brown clayey silt with some sand, pebbles, and cobbles, and an occasional boulder. Gravel is chiefly gray, white, and purple quartzite and quartzite-conglomerate and gray to white gneiss, with some gray to black chert and reddish-brown to gray shale and sandstone. Some basalt clasts occur in the till in the northeastern corner of the quadrangle. Gneiss, basalt, sandstone, and some chert clasts are decomposed or deeply weathered; quartzite, conglomerate, and most chert clasts may have thin weathering rinds. As much as 20 feet thick. Occurs as erosional remnants on hilltops and divides.

Tp Pensauken Formation (Salisbury and Knapp, 1917)--Reddish-yellow to yellow silty fine to medium sand with some pebbles. Pebbles are chiefly rounded yellow-stained white quartz, with some gray chert, quartzite, and sandstone, and gray to white gneiss. The gneiss clasts, and some of the chert clasts, are deeply weathered. As much as 15 feet thick. Occurs as an erosional remnant on the hilltop in northern Raritan Borough, just at the southern limit of the pre-Illinoian glaciation.

Jd Diabase (Lower Jurassic) - Dark-gray to dark greenish-gray, fine-grained to aphanitic, subophitic diabase. Massive-textured, hard, and sparsely fractured. Composed dominantly of calcic plagioclase, clinopyroxene, and opaque minerals. Material at contacts with sedimentary rocks are typically fine-grained, display chilled, sharp margins and may be vesicular adjacent to enclosing sedimentary rock.

JTrp
JTrpg Passaic Formation - (Lower Jurassic and Upper Triassic) (Olsen, 1980) - Interbedded sequence of reddish-brown to maroon and purple, fine-grained sandstone, siltstone, shaly siltstone, silty mudstone and mudstone, separated by interbedded olive-gray, dark-gray, or black siltstone, silty mudstone, shale 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-lamination, root casts and load casts. Shaly siltstone, silty mudstone, and 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, locally bioturbated, and locally contain evaporite minerals. Gray bed sequences (JTrpg) are medium- to fine-grained, thin- to medium-bedded, planar to cross-bedded siltstone and silty mudstone. Gray to black mudstone, shale and argillite are laminated to thin-bedded, and commonly grade upward into desiccated purple to reddish-brown siltstone to mudstone. Thickness of gray bed sequences ranges from less than 1 foot to approximately 40 feet. Gray beds are continuous across the mapped area but only shown where identified during field mapping. Copper mineralization (mainly malachite and lesser azurite) is associated with gray siltstone in several stratigraphic intervals in the map area. It occurs as thin laminae along bedding in layers that range in thickness from less than 1 inch to several feet. Unit is approximately 8,100 feet thick in the map area.

EXPLANATION OF MAP SYMBOLS

Contact - Dashed where approximately located; queried where uncertain.

Bedrock strike ridge - Developed along strike of resistant bedrock mapped from air photos

U D Faults - U, upthrown side; D, downthrown side. Ball and post indicates direction of dip
Dashed where approximately located; queried where uncertain

Fault - Arrows show relative motion

Fault - Motion is unknown

Fold axes -
Anticline - Showing crestline
Syncline - Showing trough line

Strike and dip of beds
Inclined beds

Strike and dip of joints - symbol frequency weighted using normalized percentage values from table 1. See text for explanation.
0-29°
30-59°
60-89°
90°

⚒ Abandoned rock quarry

Cu Copper mineralization observed

Introduction

The Raritan 7.5 minute topographic quadrangle lies within the Piedmont Physiographic Province in north-central New Jersey. Somerset County covers most of the quadrangle except for the northwest corner that is in Hunterdon County. The region has a long history of agricultural use but is changing to a more suburban environment. Three State and federal highways cross the quadrangle and focus land usage changes. The well developed road network allows easy access between bedroom communities and business/industrial locations.

The Raritan River dominates the quadrangle topography. Elevation ranges from 220 feet in the north to 40 feet in the east, where the Raritan River exits the quadrangle. The North and South Branches of the Raritan River effectively bisect the quadrangle, along a north-south trend. These two rivers converge into the Raritan River proper near the center of the quadrangle. The Raritan River continues with an eastward flow and exits along the eastern border of the map area. Branching feeder streams drain the landscape into the various branches of the Raritan River.

Surficial Geology

Surficial deposits in the Raritan quadrangle include stream, hillslope, glacial, and windblown sediments. The oldest sediments are preserved on hilltops and divides, where they have been protected from erosion. These older units include the Pensauken Formation (unit Tp), a stream deposit laid down between 2 to 3 million years ago, and the pre-Illinoian till (unit Qpt), glacial sediment laid down during the first glaciation of New Jersey sometime between 800,000 and 2.2 million years ago. Old, deeply weathered and eroded stream deposits (unit Qps) may also date from around the time of this glaciation. The Raritan quadrangle includes the southernmost limit of this glaciation in New Jersey, roughly marked by the present location of Route 202.

A long period of erosion followed the glaciation. The present location of the Raritan River valley and tributary valleys was established during this period, which lowered the land surface as much as 150 feet below its level at the end of the pre-Illinoian glaciation. Younger surficial deposits occur within these valleys. Younger stream sediments include upper and lower terrace deposits (units Qtu and Qtl) and modern alluvium (Qal). The upper terrace deposits extend along the Raritan River about 20 to 30 feet above the modern floodplain. Gravel clasts within these deposits are as deeply weathered as those in glacial deposits of Illinoian age (about 150,000 years old), suggesting that these sediments are of similar age. The lower terrace deposits and modern alluvium were laid down within the past 20,000 years. The modern floodplain of the Raritan River includes fragments of low terraces no more than 5 feet above the principal floodplain surface. These may be the remnants of a terrace deposit laid down during the late Wisconsinan glaciation (about 20,000 years ago), which is now mostly eroded and covered by the postglacial floodplain. Lower terrace deposits, distinct from the floodplain, along the Raritan just to the east of the Raritan quadrangle (Stanford, 1992) may be downstream equivalents of these erosional remnants. Colluvial sediments laid down along the base of steep hillslopes (units Qcs, Qcb, and Qcal) were probably also deposited primarily during the late Wisconsinan. Although neither the Illinoian nor the late Wisconsinan glaciers reached the Raritan quadrangle, the cold climate during these glacial periods increased downslope movement of soil on hillslopes and delivery of sediment into streams. Windblown silt (unit Qe), blown from the terraces in the Raritan Valley onto the adjacent uplands by predominantly westerly winds, was also deposited primarily during glacial periods when the terraces were alluviating and unvegetated.

Bedrock Geology

The regional bedrock units were deposited within the Newark rift basin during initial Atlantic Ocean opening approximately 230 million years ago (Olsen and others, 1996). Southeast-dipping normal faults form the western margin of the basin. Episodic faulting and associated folding along this margin were a major influence on the volume and rate of sediment input to the developing basin. Intrabasinal faulting and folding also occurred during deposition (Schlische, 1992, 1993). The principal bedrock unit in the mapped area is the Upper Triassic to Lower Jurassic (219 - 202 Ma; Olsen and others, 1996) Passaic Formation (Olsen, 1980). This 8,100-foot-thick unit (figure 1, composite thickness of Olsen and others, 1996) consists predominantly of playa and perennial lake deposits (Van Houten, 1969; Olsen and others, 1996). Red-brown fluvial and lacustrine sandstone, siltstone and mudstone are more abundant than gray to black siltstone and mudstone (gray beds) that formed in a deeper lacustrine setting than the red units. Gray beds are important stratigraphic markers for Passaic Formation member identification (figure 1). The north trending Hopewell fault system dominates the structural geology of the quadrangle (figure 2). It is a major intrabasinal assemblage of dominantly southeast-dipping faults exhibiting dip-slip and minor right-lateral motion that merges with the Ramapo Fault, a major basin-bounding normal fault, towards the northeast. Offset on the Hopewell system in the Rocky Hill quadrangle to the south exceeds 11,000 feet (Parker and Houghton, 1990). There is a decrease in offset towards the north into the Raritan quadrangle as Passaic Formation is present in both the Hopewell's footwall and hanging wall (figure 1). Less common northwest-dipping faults have also been interpreted within the Hopewell system. Numerous small-scale faults that parallel the dominant Hopewell trend also were identified. Visual estimates of fracture density proved an effective method of small-scale fault delineation. As bed thickness has been shown to correlate to fracture spacing (Huang and Angelier, 1989; Narr and Suppe, 1991; Rives and others, 1992; Gillespie and others, 1993), care was taken to compare similar bed thickness and sediment grain size. Fracture spacings were estimated perpendicular to the fracture surface. Similar increases in fracture density exist at known or observable fault locations.

The Newark Basin Coring Project (NBCP) attempted to collect a complete stratigraphic section of the Triassic and Jurassic sediments and basaltic flows of the Newark basin (figure 1; Olsen and others, 1996). The NBCP set up offset core locations that contain a stratigraphic overlap of select member horizons, thereby allowing reconstruction of the composite stratigraphic sequences. NBCP drilled three coreholes, the Martinsville, Weston and Somerset coreholes (figure 1), in the Bound Brook quadrangle, directly east of the map area (Olsen and others, 1996). Units intersected by these coreholes project into the Raritan quadrangle, but due to the region's structural complexity it was not possible to delineate individual members with certainty. This map only marks the locations of gray bed cycles observed during field mapping and attempts to project them as far as accurately possible. Difficulties arose connecting gray bed cycles over long distances, leading to the map depiction of short "apparently" discontinuous units that actually do project across the entire mapped area. Olsen and others (1996) suggest that gray units traverse the basin except where cut by structural breaks. Therefore, the cross section portrays the gray sequences as continuous units. Good examples of gray bed sequences occur at an abandoned quarry along the South Branch of the Raritan River in the South Branch area of Hillsborough Township and on the east side of the South Branch of the Raritan River opposite Neshanic Station.

The Brunswick aquifer underlies the entire Raritan quadrangle, encompasing shale, siltstone and sandstone of the Passaic Formation. Ground water flows in the bedrock aquifer through openings from sedimentary and tectonic processes including bed-parallel (low-angle) fractures (Michalski and Britton, 1997; Brown and dePaul, 2000; Carleton and others 1999), tectonic (high-angle) fractures (Spayd, 1985), and mineralized strata containing solution cavities (Herman, 2001). Fracture-orientation analysis can help to understand how fractured-bedrock heterogeneity relates to uneven ground water flow conditions (anisotropy) within the aquifer. Circular histograms from a fracture-trend analysis are shown in figures 3, 4 and 5. They show the strike trend of bedding parallel fractures in 10° sectors (figs. 3a, 4a and 5a). The strike trend and fracture dip-azimuth frequencies for any fracture sets within an eastern or western structural domain (fig. 6) as divided by the Hopewell Fault system are also shown (figs. 3b, 3c, 4b, 4c, and 5b, 5c). These fracture trends are uniform throughout the area, but bed-parallel fractures show considerable variation in trend on either side of the Hopewell Fault system (compare figs. 4 and 5). Fault strike orientation parallels the nonbedding fracture trends, which agrees with results from the New Brunswick quadrangle (Stanford and others, 1998). Frequency statistics for all the joints were calculated (fig. 3c, and table 1) and used for weighting joint-symbol length according to methods in Stanford and others (1998). The most common fracture trend (dip azimuth 280-289, Table 1) is plotted with the longest symbol length. Lower frequency fractures have correspondingly shorter symbol length according to statistics in Table 1. Each fracture trend, shown at its recorded outcrop location is compared to all other mapped fractures.

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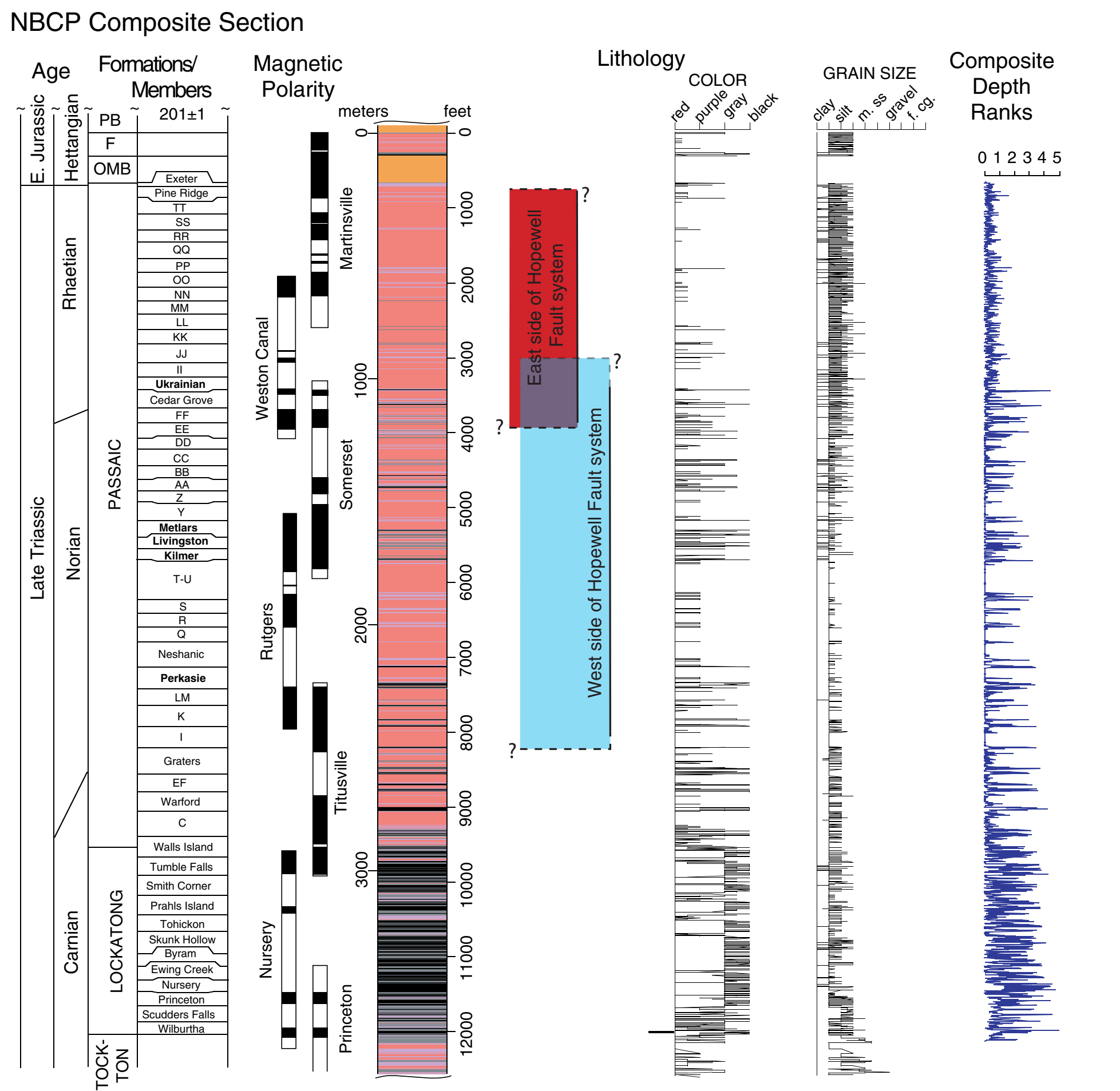
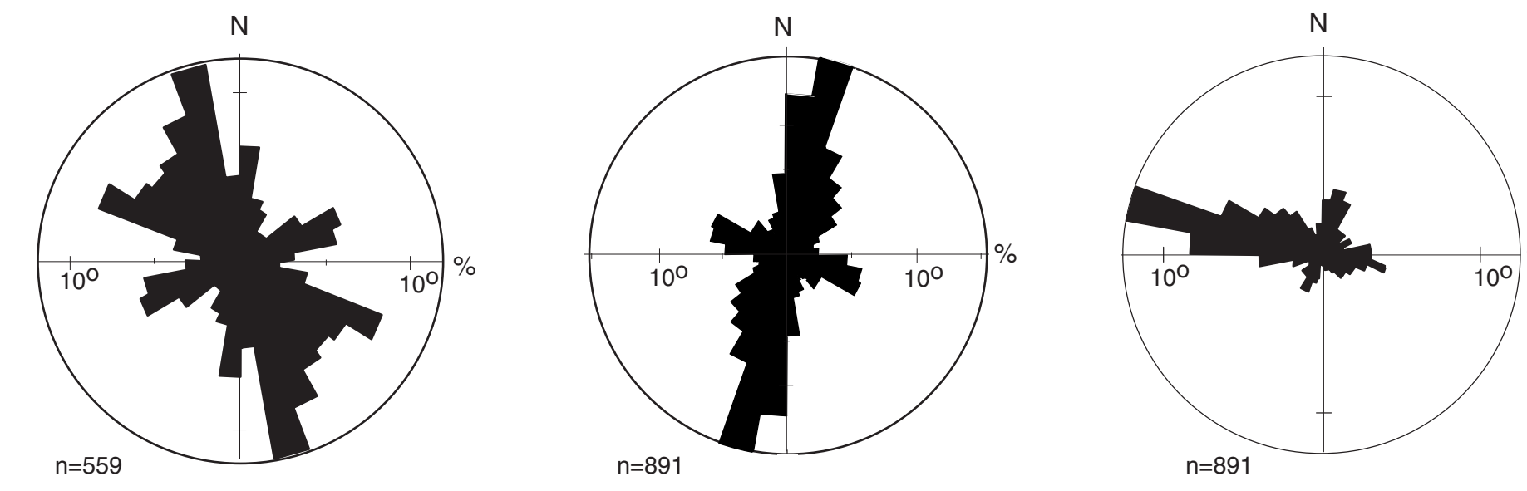


Figure 1. Newark Basin Coring Project composite section (modified from Olsen and others (1996) and Olsen and Kent (1996). The Martinsville, Somerset and Weston Canal coreholes are in the adjoining Bound Brook quadrangle to the east. Colors on the composite section correlate to the actual rock colors with the exception of orange used for the basalt units. The approximate sections encountered on either side of the Hopewell Fault system are indicated by the red and blue boxes, and correlate with colored data in figures 4 and 6. Limit of stratigraphic units on either side of the Hopewell are interpolated from Olsen and others (1996) and Parker and Houghton (1990). Compositie depth ranks indicate relative lake depth with 0 shallowest and 5 deepest based on sediment structures and fabrics (Olsen and Kent, 1996).

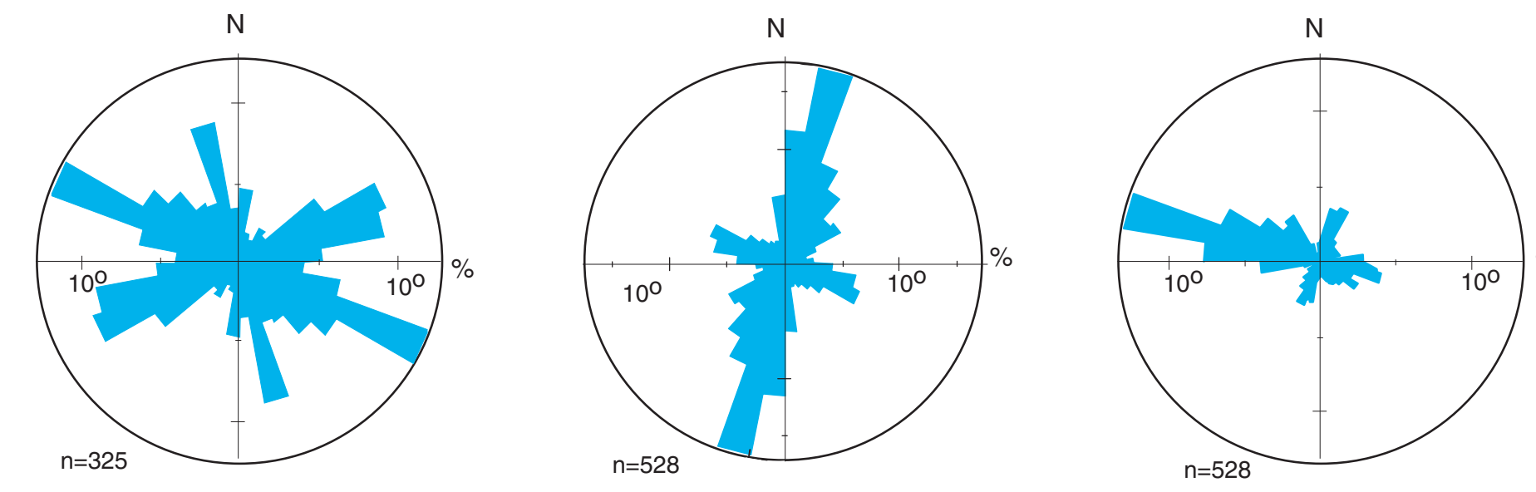
ALL DATA



a. Strike of bedding b. Strike of joints c. Joint dip azimuth

Figure 3. Structural trends of bedding and joints (n=number of readings).

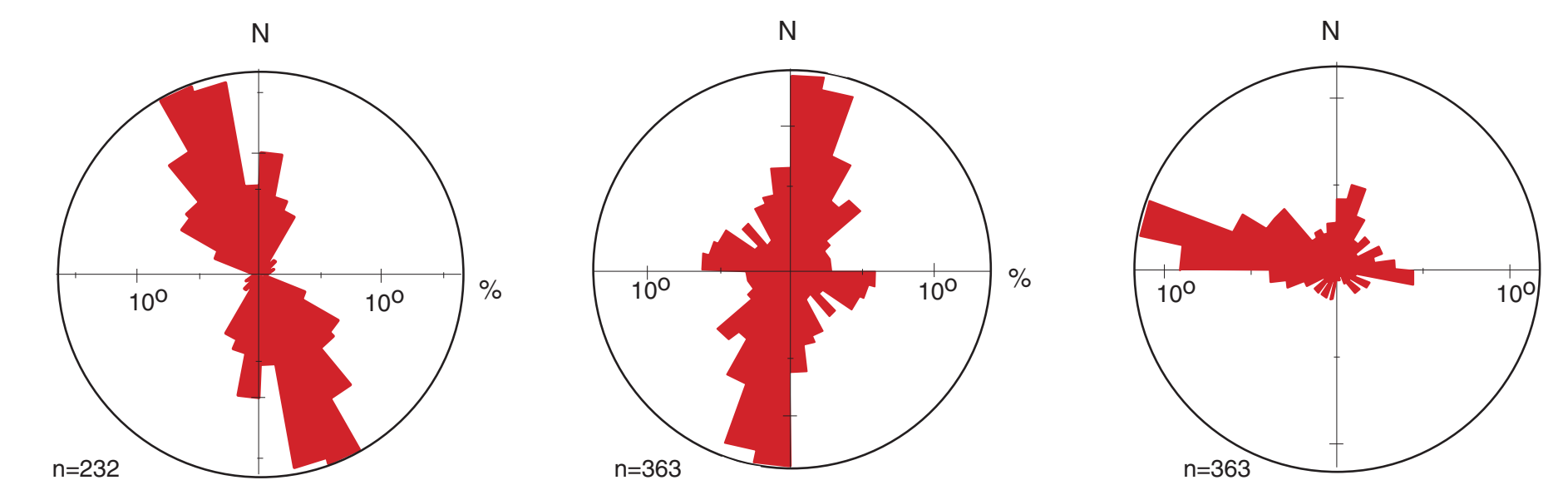
WESTERN BLOCK



a. Strike of bedding b. Strike of joints c. Joint dip azimuth

Figure 4. Structural trends of bedding and joints (n=number of readings).

EASTERN BLOCK



a. Strike of bedding b. Strike of joints c. Joint dip azimuth

Figure 5. Structural trends of bedding and joints (n=number of readings).

Rose sector, in degrees (°)	Dip-Azimuth Percentages	Average Dip (°)
0-9	3	87
10-19	4	88
20-29	4	88
30-39	2	88
40-49	1	87
50-59	2	85
60-69	2	89
70-79	2	83
80-89	3	82
90-99	4	79
100-109	3	80
110-119	2	78
120-129	2	80
130-139	2	73
140-149	1	73
150-159	1	75
160-169	1	77
170-179	1	78
180-189	1	81
190-199	2	79
200-209	2	77
210-219	2	76
220-229	1	79
230-239	1	77
240-249	1	71
250-259	2	77
260-269	3	74
270-279	8	85
280-289	13	83
290-299	7	84
300-309	4	83
310-319	4	81
320-329	3	83
330-339	2	85
340-349	1	86
350-359	2	87

Table 1. Joint-orientation statistics, calculated from figure 3c, used to frequency weight the length of joint symbols on geologic map.

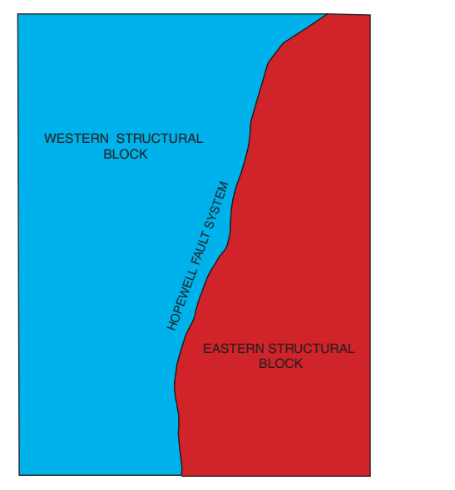


Figure 6. Division of mapped area into western and eastern structural blocks by the Hopewell Fault system.

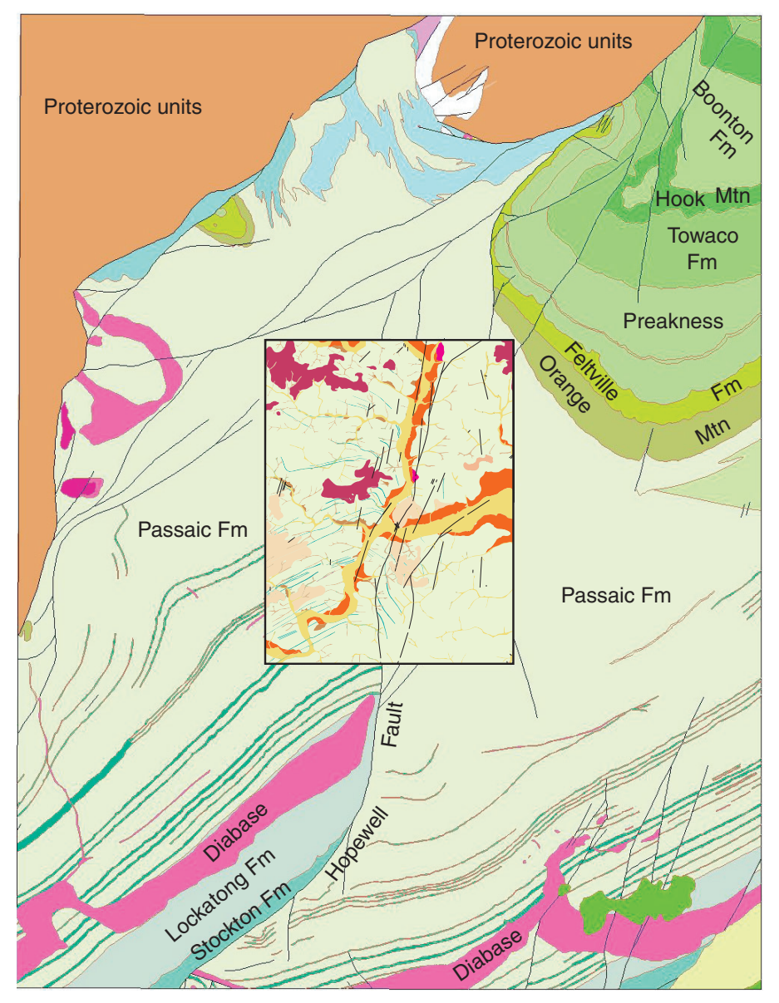


Figure 2. Regional geology surrounding the Raritan quadrangle (from Drake and others, 1996) showing the location and lithologic contact relationshps of the Hopewell Fault. Greater offset is evident on the Hopewell south of the Raritan quadrangle