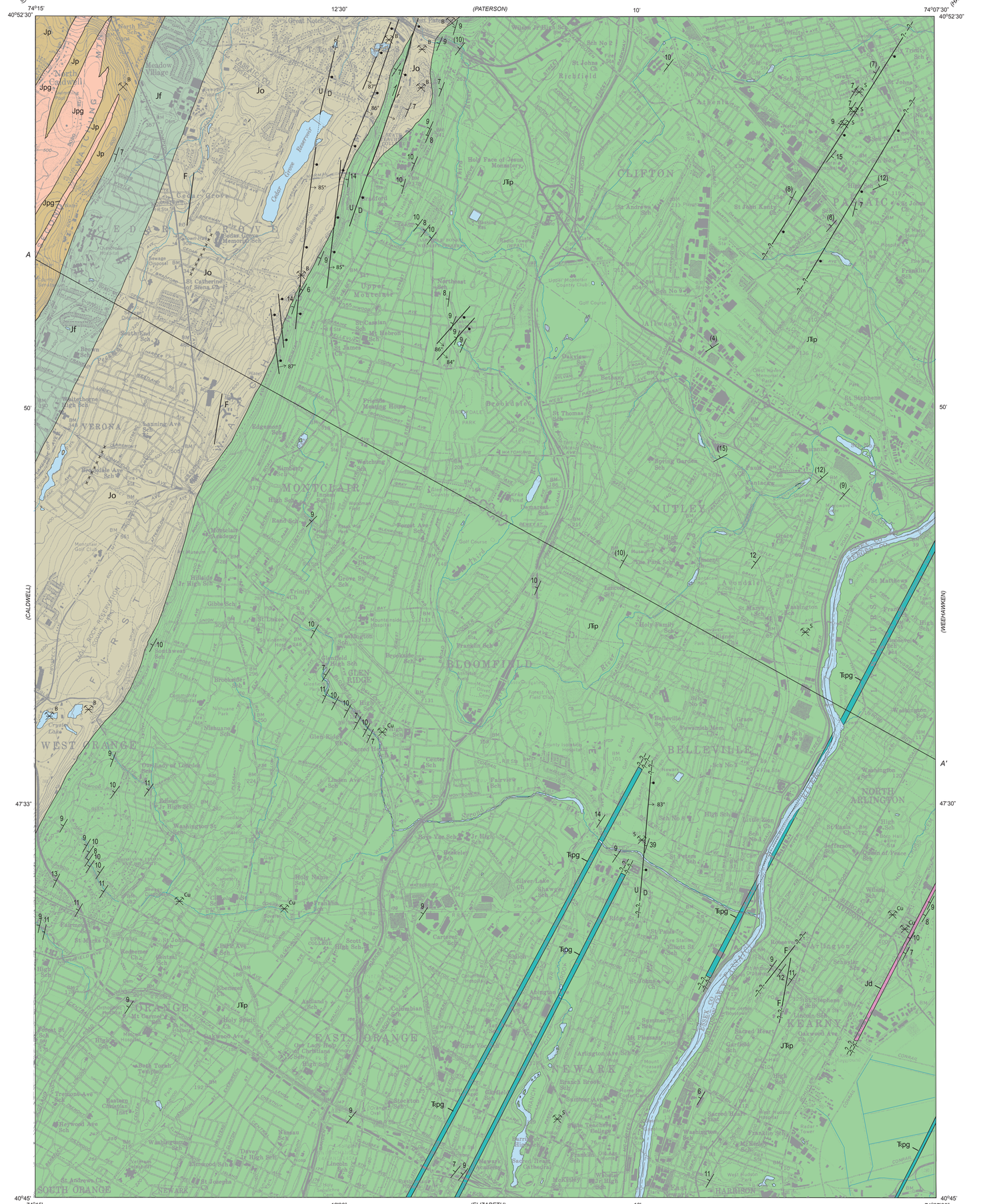
DEPARTMENT OF ENVIRONMENTAL PROTECTION
LAND USE MANAGEMENT
NEW JERSEY GEOLOGICAL SURVEY

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

BEDROCK GEOLOGIC MAP OF THE ORANGE QUADRANGLE ESSEX, PASSAIC, BERGEN AND HUDSON COUNTIES, NEW JERSEY GEOLOGIC MAP SERIES GMS 07-1



SCALE 1:24,000

1 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 .5 0 1 KILOMETER

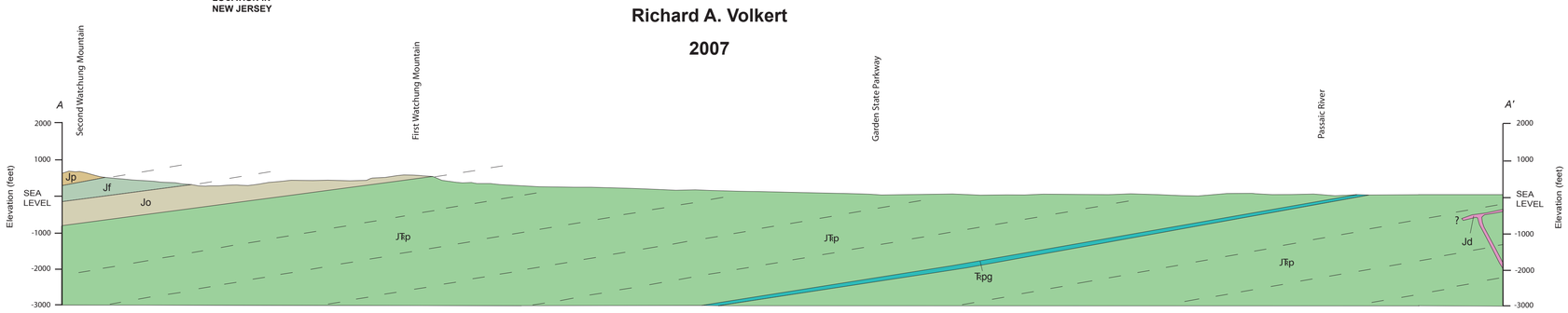
LOCATION IN NEW JERSEY

BEDROCK GEOLOGIC MAP OF THE ORANGE QUADRANGLE ESSEX, PASSAIC, BERGEN, AND HUDSON COUNTIES, NEW JERSEY

by

Richard A. Volkert

2007



DESCRIPTION OF MAP UNITS

Jd — Diabase (Lower Jurassic) (Olsen, 1980a) - Dark greenish-gray to black, fine- to medium-grained diabase composed of plagioclase (An_{50-70}), clinopyroxene (mainly augite), and magnetite ± ilmenite. Olivine is rare. Diabase is dense, hard, sparsely fractured, and has chilled margins against the bounding Passaic Formation. Maximum thickness of sill in the map area is approximately 20 ft. (Woodward, 1944).

Jp, Jpg — Preakness Basalt (Lower Jurassic) (Olsen, 1980a) - Dark-greenish-gray to black, fine-grained, dense, hard basalt composed mainly of intergrown calcic plagioclase and clinopyroxene. Contains small spherical tubular gas-escape vesicles, some filled by zeolite minerals or calcite, just above flow contacts. Dark-gray, coarse- to very coarse-grained gabbroid (Jpg) composed of clinopyroxene grains as much as 0.5 in. long and plagioclase grains as much as 1.0 in. long occurs at several stratigraphic intervals but is thickest in the middle and upper part of the first flow. It has been described in detail by Puffer and Volkert (2001) from exposures in the Chatham quadrangle. Gabbroid has sharp upper contacts and gradational lower contacts with finer-grained basalt. Unit consists of at least three major flows, the tops of which are marked by prominant vesicular zones as much as 8 ft. thick. The first flow ranges in thickness from 415 to 475 ft. in the area, but is as much as 514 ft. thick regionally. It is overlain by a thin, 6-to-25 ft.-thick sequence of interbedded reddish-brown siltstone, shaly siltstone and shale that is well exposed to the west in North Caldwell (Volkert, 2007a,) and is known elsewhere from water well record data. The second flow is about 192 ft. thick in the area. It is overlain by 2.5 ft. or more of thin-bedded, reddish-brown sandstone to siltstone known only from drill core in the Paterson and Caldwell quadrangles (Fedosh and Smoot, 1988; Volkert, 2007a,b). Radiating slender columns 2 to 24 in. wide, due to shrinkage during cooling, are abundant near the base of the first flow. Maximum thickness of unit is about 1,040 ft. Levels of natural radioactivity measured in outcrops range from 5 to 7 Micro R/Hr (mean = 6) and show no variability between basalt and gabbroid.

Jf — Feltville Formation (Lower Jurassic) (Olsen, 1980a) – Reddish-brown or light-grayish-red, fine- to-coarse-grained sandstone, siltstone, shaly siltstone, and silty shale, and light- to-dark-gray or black, locally calcareous siltstone, silty shale, and carbonaceous limestone. Upper part of unit is predominantly thin- to-medium-bedded, reddish-brown siltstone and locally cross-bedded sandstone. They grade upward into massive-bedded, medium-grained sandstone with thin pebbly sandstone interbeds that occur directly beneath the contact with the Preakness Basalt (Jp). Reddish-brown sandstone and siltstone are moderately well sorted, commonly cross-laminated, and interbedded with reddish-brown, planar-laminated silty shale and shale. Two thin, laterally continuous sequences, each as much as 10 ft. thick, of dark-gray to black, carbonaceous limestone, light-gray limestone, and medium-gray, calcareous siltstone, and gray or olive, dessicated shale to silty shale occur near the base and, along with the red beds between them, comprise the Washington Valley Member of Olsen (1980b). Gray beds contain fish, reptiles, arthropods, and diagnostic plant fossils. As much as 2 ft. of unit have been thermally metamorphosed along the contact with the Preakness Basalt (Jp). Thickness of unit ranges from 450 to 510 ft. regionally. Levels of natural radioactivity measured in outcrops of reddish-brown sandstone and siltstone range from 9 to 12 Micro R/Hr (mean = 11).

Jo — Orange Mountain Basalt (Lower Jurassic) (Olsen, 1980a) – Dark-greenish-gray to black, fine-grained, dense, hard basalt composed mostly of calcic plagioclase and clinopyroxene. Locally contains spherical to tubular gas-escape vesicles, some filled by zeolite minerals or calcite, or lined with prehnite, and amygdular zones typically near flow tops and above base of flow contacts. Unit consists of three major flows that are separated in places by a weathered zone, a bed of thin reddish-brown siltstone, or by volcaniclastic rock. Lower part of upper flow, (average thickness of 244 ft.), is locally pillowed; upper part has pahoehoe flow structures. Middle flow, (average thickness of 153 ft.), is massive to columnar jointed. Lower flow, (average thickness of 251 ft.), is generally massive, with widely spaced curvilinear joints, and is pillowed near the top and locally at the base along the contact with Passaic Fm. Spaces between pillows are commonly lined with zeolites, quartz, calcite, and prehnite. Individual flow contacts are characterized by vesicular zones as much as 8 ft. thick. Thickness of unit ranges from about 650 to 590 ft. Levels of natural radioactivity measured in outcrops range from 4 to 8 Micro R/Hr (mean = 5).

JTRp, TRpg — Passaic Formation (Lower Jurassic and Upper Triassic) (Olsen, 1980a) – Interbedded sequence of reddish-brown, and less common maroon or purple, sandstone and pebbly sandstone, pebble conglomerate, siltstone, shaly siltstone, silty shale, and shale. Middle and lower parts of unit contain interbedded olive-gray, dark-gray, or black siltstone, silty shale, shale, and less common argillite (TRpg). Reddish-brown sandstone and pebbly sandstone are thin- to-thick-bedded, medium-to-coarse-grained, planar to cross-bedded with local lensoidal interbeds of pebble conglomerate. Clasts in pebbly sandstone and conglomerate are mainly white or purple quartzite, but contain locally abundant carbonate clasts beneath Orange Mountain Basalt contact to the north, at North Haledon (Volkert, 2007b). Siltstone and shaly siltstone are thin-bedded, planar to cross-bedded, and locally mudcracked and ripple cross-laminated. Shaly siltstone, silty shale, and shale are fine-grained, very-thin- to thin-bedded, planar to ripple cross-laminated, locally fissile, bioturbated, and contain evaporite minerals, root casts and load casts. About 0.5 to 1.5 ft. of unit have been thermally metamorphosed and locally mineralized with sulfides along contact with the Orange Mountain Basalt and also along the upper and lower contacts with diabase at North Arlington. Maximum thickness regionally is about 11,500 ft. but an incomplete thickness of approximately 5,900 ft. occurs in the quadrangle. Levels of natural radioactivity measured in outcrops range from 7 to 18 Micro R/Hr (mean = 12) in reddish-brown sandstone and pebbly sandstone and from 13 to 26 Micro R/Hr (mean = 19) in reddish-brown siltstone, shaly siltstone and shale.

EXPLANATION OF MAP SYMBOLS

- Contact - Dotted where concealed; queried where uncertain
- Faults - queried where uncertain. U, upthrown side; D, downthrown side. Ball shows direction of dip. Arrows show relative horizontal movement where known.
- F — Fault with unknown dip direction

PLANAR FEATURES

- 11 (15) — Strike and dip of inclined beds. Dip numbers in parenthesis are from historical records of bedrock outcrops no longer exposed

OTHER FEATURES

- Cu — Abandoned Copper mine
- B — Abandoned rock quarry - B, basalt; S, sandstone
- B — Active rock quarry
- x x x x — Exposed basalt flow contact

INTRODUCTION

The Orange 7.5-minute quadrangle, in northern New Jersey, is located in Essex, Passaic, Bergen, and Hudson Counties, within a mixed commercial, industrial and residential setting. However, two tracts of land along the First Watchung Mountain (Mills Reservation and Eagle Rock Reservation) and one in Newark (Branch Brook Park) remain undeveloped. The Orange quadrangle is situated in the Passaic River drainage basin, within the southern part of New Jersey Department of Environmental Protection Watershed Management Area 4.

The Orange quadrangle falls entirely within the Piedmont Physiographic Province. The dominant topography in the map area consists of two subparallel, northeast-trending ridges, First Watchung Mountain (known locally as South Mountain) and Second Watchung Mountain. First Watchung Mountain attains a maximum elevation of 660 ft. at Verona, east of Crestmont Road, and Second Watchung Mountain 660 ft., at Verona west of Fairview Avenue. Separating these mountains is a northeast-trending valley (known locally as Pleasant Valley) that has an elevation of 360 ft. at Verona, and 180 ft. toward the northeast, at Little Falls. The valley is drained by the north-flowing Peckman River that discharges into the Passaic River just north of the map area.

The remainder of the quadrangle east of First Watchung Mountain consists of a gently eastward-dipping plain with elevations of slightly less than 400 ft. above sea level at the base of First Watchung Mountain and just a few feet above sea level toward the east at Kearny.

STRATIGRAPHY

The Orange quadrangle is underlain entirely by bedrock of Mesozoic age (Upper Triassic and Lower Jurassic). Bedrock occurs in the Newark basin, a northeast trending extensional basin in northern and central New Jersey that contains a total of approximately 24,600 ft. of interbedded sedimentary and igneous rocks. These consist of conglomerate, sandstone, siltstone, and shale of fluvial and lacustrine origin, and three interbedded tholeiitic basalt formations. However, only the upper part of this stratigraphic succession occurs in the quadrangle.

The general stratigraphic order of the bedrock is one of progressive younging from east to west. Sedimentary units in order of ascending age are the Passaic Formation of Lower Jurassic and Upper Triassic age and the Feltville Formation of Lower Jurassic age. The Passaic and Feltville Formations weather to form a muted topographic surface that is now largely covered by unconsolidated glacial sediments. The distribution, thickness, and composition of the glacial deposits in the Orange quadrangle are discussed elsewhere (Stanford, 2001).

Igneous rocks in order of ascending age are the Orange Mountain Basalt and the Preakness Basalt, both of Lower Jurassic age. The Preakness Basalt contains massive-textured, coarse-grained layers at several stratigraphic intervals (Monteverde and Volkert, 2004; Volkert, 2007,a,b) that are mapped as gabbroid. In addition, the Preakness Basalt contains very thin layers of locally developed, very-coarse-grained basaltic pegmatite. Gabbroid and pegmatite layers are interpreted by Puffer and Volkert (2001) to have formed through fractionation from finer-grained Preakness basalt.

Diabase of Lower Jurassic age intrudes the Passaic Formation as a thin, conformable sill that is exposed at North Arlington. The sill ranges in thickness from 5 ft. to as much as 20 ft. and is approximately 1.25 mi. long (Woodward, 1944). It is likely an offshoot from the much thicker Palisades diabase sill that occurs about 4 miles to the east.

STRUCTURE

Bedding of the Mesozoic rocks displays a maxima at about N.32°E. (Fig. 1) with only very slight variability in trend. Beds dip gently toward the west between 4° and 15° and average about 9°. However, proximal to faults beds locally steepen in dip to as much as 69°.

Small, generally north-northwest to northeast-trending, brittle faults of Mesozoic age and of apparent limited displacement cut the Orange Mountain Basalt and Passaic Formation in the map area. Northeast-trending faults strike N.23°E. to N.34°E. and north-trending faults strike N.11°E. to N.13°W. The latter appear to be younger as they cut the northeast-trending faults in the northern part of the quadrangle. All of the mapped faults dip steeply toward the east or southeast at 83° to 90°. Faults range in width from <1 ft. to about 25 ft., with the wider faults often consisting of zones of multiple thin faults. All faults are characterized by the following: very close-spaced jointing; thin zones of breccia and (or) clayey-silt gouge; slickensides locally coated with chlorite and (or) calcite; and eroded gaps in outcrops. Kinematic indicators that consist of subhorizontal to gently north-plunging slip lineations on fault surfaces constrain the predominant movement to right-lateral strike-slip.

Joints are a ubiquitous feature in all of the bedrock units. In the sedimentary units, northeast-trending joints are the most abundant and display a maxima at about N.22°E. (Fig. 1). These joints are characteristically planar, moderately well formed, and dip at an average of 83° mainly toward the southeast. A second, relatively minor set strikes about N.75°W. Joint surfaces are typically unmineralized except where proximal to faults, where they may contain calcite, and are smooth and less commonly slightly irregular. Joints are variably spaced from <1 ft. to several feet. Those in massive textured rocks such as sandstone tend to be better developed and more continuous than joints in the finer-grained lithologies such as shaly siltstone and shale. Joints in finer-grained lithologies are commonly less well developed and are discontinuous over short distances in outcrop. All joints formed proximal to faults are spaced much closer, typically 2 ft. or less.

Joints in the igneous rocks consist of two predominant types, columnar (cooling) and tectonic. Columnar joints are present in all of the basalts in the map area. They are characteristically polygonal and are variable in height and spacing. A comprehensive study of the characteristics of cooling joints in the Watchung basalts was performed by Faust (1978). Tectonic joints occur in all of the basalt formations but they are commonly obscured by the more prevasive cooling joints. Tectonic joints are best developed in the Orange Mountain Basalt where they are typically planar, well formed, smooth to slightly irregular, steeply dipping, unmineralized, and variably spaced, from a few feet to tens of feet. However, where fault proximal, joint spacing is on the order of 1 foot or less. Northeast-trending strike joints are the most common and display a maxima at about N.15°E. (Fig. 1). A minor variant of this set displays a maxima at about N.82°E. Both sets dip steeply at an average of 87° mainly toward the northeast, and less commonly toward the southwest.

ECONOMIC RESOURCES

Copper was mined in the 18th and 19th centuries (Woodward, 1944) at four locations in the southern part of the Orange quadrangle. These include the Dodd and Wigwam Brook mines at East Orange, Glen Ridge mine at Glen Ridge, and Schuyler mine at North Arlington. All of these mines were developed in the Passaic Formation. The Schuyler mine was developed on an ore body that occurred along the contact between a Lower Jurassic diabase sill and the Passaic Formation, whereas the rest of the copper mines appear to lack an obvious association with basalt or diabase.

Orange Mountain Basalt was formerly quarried for use as aggregate and dimension stone from locations at Little Falls, Great Notch and West Orange, and is currently being quarried near Little Falls. Preakness Basalt was formerly quarried from small workings at Cedar Grove along the west side of Pompton Avenue. Sandstone of the Passaic Formation was formerly quarried from locations in Passaic, Nutley, North Arlington, and Newark for use in the brownstone industry.

NATURALLY OCCURRING RADIATION

Background levels of naturally occurring radioactivity were measured in bedrock outcrops using a hand-held Micro R meter and the results are given under the individual rock unit descriptions. In general, basalts yield consistently low Micro R/Hr readings regardless of stratigraphic position, texture, or degree of fractionation. Sedimentary units yield higher and somewhat more varied readings that appear to be influenced mainly by grain size. In general, readings from sandstones and pebbly sandstones are lower than from finer-grained siltstones and shales, suggesting that clay minerals are principal hosts of the radiogenic mineral phases. This appears to be true on a regional basis as well, based on measurements of various lithofacies of the Mesozoic sedimentary formations from 7.5-minute quadrangles in the Newark basin from New Brunswick north to Ramsey (R.A. Volkert, unpublished data).

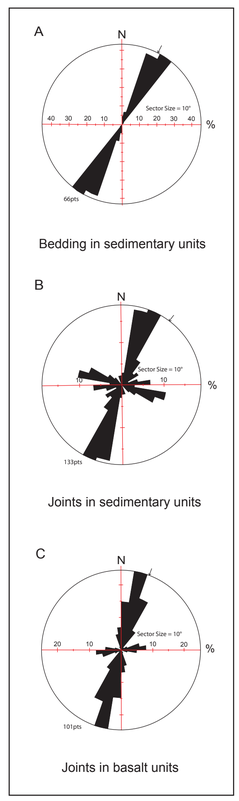
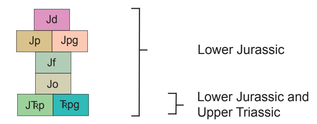


Figure 1. Bedrock structural features measured in outcrop. Arrow points to mean of dataset.

CORRELATION OF MAP UNITS



REFERENCES CITED AND USED IN CONSTRUCTION OF MAP

Drake, A.A., Jr., Volkert, R.A., Monteverde, D.H., Herman, G.C., Houghton, H.F., Parker, R.A., and Dalton, R.F., 1996, Bedrock Geologic Map of Northern New Jersey: U.S. Geological Survey Miscellaneous Investigations Series Map I-2540-A, scale 1:100,000.

Faust, G.T., 1978, Joint systems in the Watchung basalt flows, New Jersey: U.S. Geological Survey Professional Paper 864-B, 46p.

Fedosh, M.S., and Smoot, J.P., 1988, A cored stratigraphic section through the northern Newark Basin, New Jersey, *in* Froelich, A.J., and Robinson, G.R., Jr., eds., Studies of the Early Mesozoic Basins of the eastern United States: U.S. Geological Survey Bulletin 1776, p. 19-24.

Houghton, H.F., ca. 1990, unpublished data on file in the office of the New Jersey Geological Survey, Trenton, New Jersey.

Kummel, H.B., ca. 1900, unpublished data on file in the office of the New Jersey Geological Survey, Trenton, New Jersey.

Monteverde, D.H., and Volkert, R.A., 2004, Bedrock geologic map of the Chatham quadrangle, Morris, Union, and Somerset Counties, New Jersey: New Jersey Geological Survey, Geologic Map Series GMS 04-2, scale 1:24,000.

Olsen, P.E., 1980a, The Latest Triassic and Early Jurassic formations of the Newark Basin (Eastern North America Newark Supergroup): Stratigraphy, structure and correlation: New Jersey Academy of Science Bulletin, v. 25, no. 2, p. 25-51.

_____, 1980b, Fossil great lakes of the Newark Supergroup in New Jersey, *in* Manspeizer, Warren, ed., Field Studies of New Jersey geology and guide to field trips: 52nd Annual Meeting of New York State Geological Association, p. 352-398.

Parker, R.A., ca. 1990, unpublished data on file in the office of the New Jersey Geological Survey, Trenton, New Jersey.

_____, 1993, Stratigraphic relations of the sedimentary rocks below the Lower Jurassic Orange Mountain Basalt, northern Newark basin, New Jersey and New York: U.S. Geological Survey Miscellaneous Field Studies Map MF-2208, scale 1:100,000.

Puffer, J.H., and Volkert, R.A., 2001, Pegmatoid and gabbroid layers in Preakness and Hook Mountain Basalts, Newark Basin, New Jersey: Journal of Geology, v. 109, p. 585-601.

Stanford, S.D., 2001, Surficial geology of the Orange quadrangle, Essex, Passaic, Hudson, and Bergen Counties, New Jersey: New Jersey Geological Survey, Open-File Map OFM 41, scale 1:24,000.

U.S. Army Corps of Engineers, 1995, Passaic River Flood Damage Reduction Project, Appendix E, Design Tunnel and Shafts, unpaginated.

Volkert, R.A., 2007a, Bedrock geologic map of the Caldwell quadrangle, Essex and Morris Counties, New Jersey: New Jersey Geological Survey Open-File Map, scale 1:24,000.

_____, 2007b, Bedrock geologic map of the Paterson quadrangle, Passaic, Essex, and Bergen Counties, New Jersey: New Jersey Geological Survey Open-File Map, scale 1:24,000.

Woodward, H.P., 1944, Copper mines and mining in New Jersey: Department of Conservation and Development, State of New Jersey, Bulletin 57 Geologic Series, 156p.