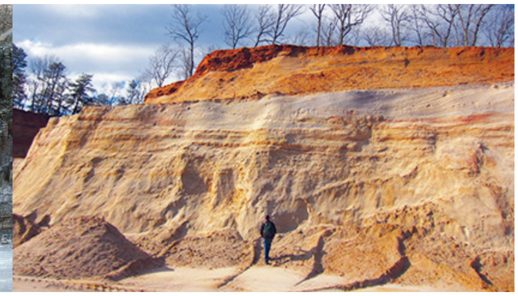




Generalized Stratigraphic Table for New Jersey

New Jersey stratigraphic units are commonly grouped into surficial sediments resulting from coastal, alluvial, colluvial, glacial, and periglacial processes of the past 10 million years (fig. 1) and older, generally thicker units within structural and physiographic regions resulting from major tectonic events of the past 1.6 billion years (fig. 2).

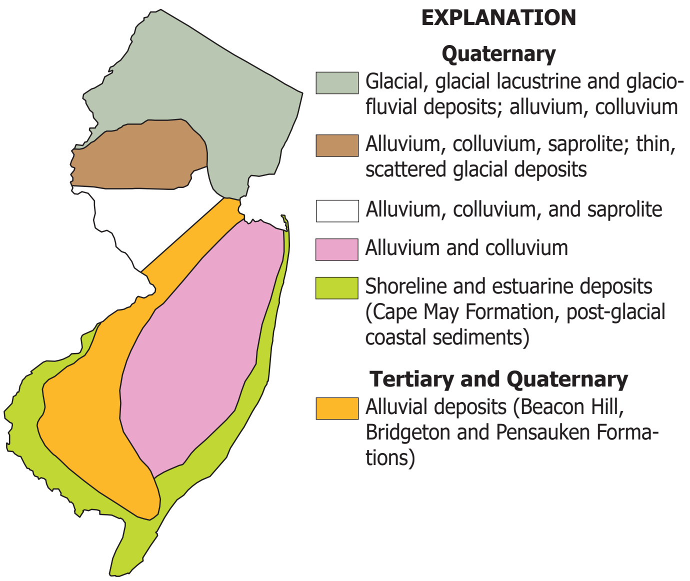


Figure 1. Predominant surficial materials.

The oldest rocks in New Jersey are granulite-facies metamorphic and granitic igneous rocks exposed in the Highlands and Trenton prong (Drake, 1984; Volkert and Drake, 1986). These form the crystalline basement northwest of the limit of highly metamorphosed Paleozoic rocks (fig. 3). They are part of the Grenville terrane, which accreted to older rocks during the Grenville orogenic cycle (table 1) to form the North American craton.

Unconformably above the Grenville rocks are sedimentary rocks of the Iapetus Ocean, which opened in the Late Precambrian and closed during the Taconic orogeny. Stratigraphic units shown here are from Drake and others (1997), and Markewicz and Dalton (1980). Rocks of the western margin of Iapetus are exposed in the Valley and Ridge and in linear belts within the Highlands. The Hardyston Quartzite shows initial clastic sedimentation. Subsequent development of a carbonate platform resulted in deposition of the Kittatinny Supergroup. Contemporaneous deeper-water continental margin and oceanic environments are represented to the east by the Jutland sedimentary units and metasedimentary and metaigneous rocks within the Manhattan and Trenton prongs (Perissoratis and others, 1979; Drake and others, 1997.

Change from a trailing margin to a convergent margin in the late Early Ordovician led first to uplift and unconformity, then to submergence and deposition of the shallow marine and submarine slope Jacksonburg and deeper-water Martinsburg. The Taconic orogeny led to closing of the Martinsburg foreland basin, uplift, low-grade metamorphism in northwestern New Jersey, amphibolite facies metamorphism to the east, and to folding and northwestward thrusting.

From the Taconic orogeny into the Middle Devonian, shallow marine sediments and alluvial clastics indicate that northwestern New Jersey was near the eastern margin of a shifting interior sea. Middle Paleozoic units shown here are from Drake and others (1997) and Herman and Mitchell (1991). Above these units is an unconformity representing Middle Devonian to Upper Triassic time.

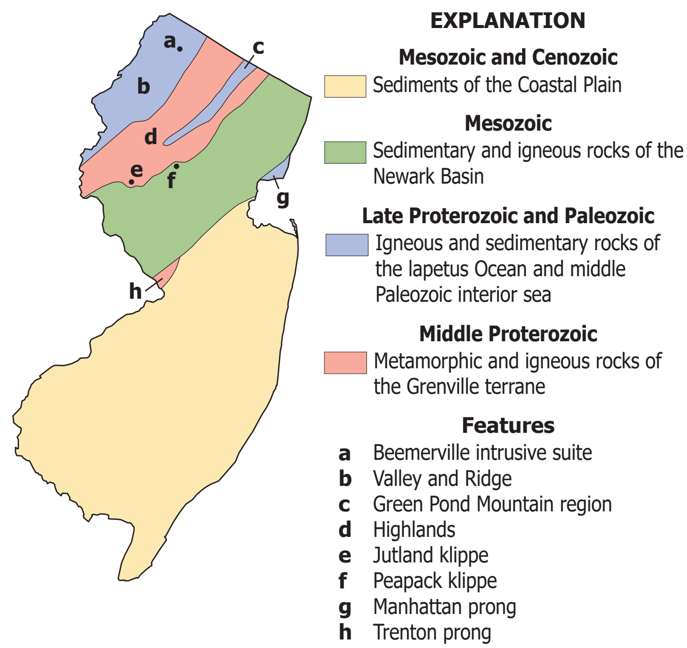
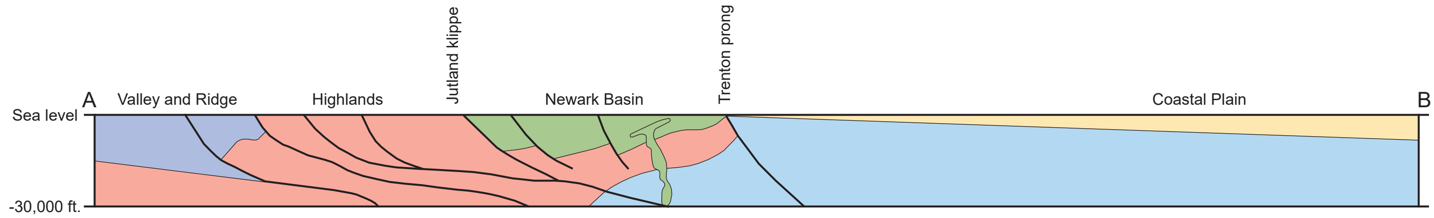
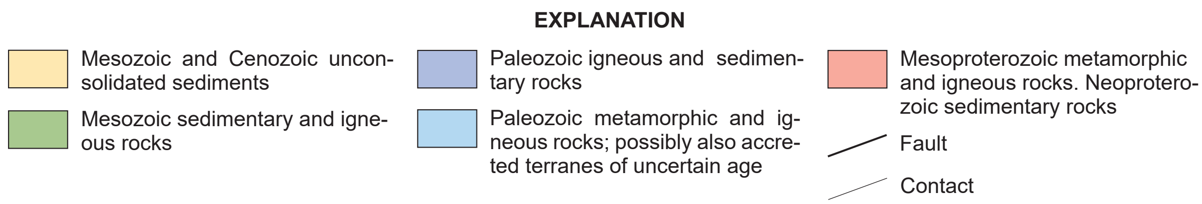


Figure 2. Generalized geologic map.

The late Paleozoic Alleghanian orogeny, the result of collision between the North American and African continental plates, was expressed in New Jersey through uplift and renewed faulting and folding of Taconic structures (Herman and Monteverde, 1989).

Triassic and Jurassic crustal extension and shearing associated with early stages of the formation of the Atlantic Ocean created continental fault-block basins. The Newark Basin was filled with





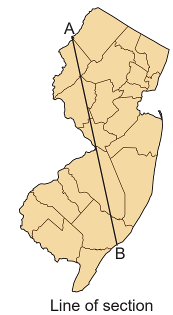


Figure 3. Geologic cross section through New Jersey.

Table 1. Ages of geologic events.

Era	System/ Epoch	Time (millions of years before present)	Geologic Events
CENOZOIC	Holocene	present-0.001	Postglacial rise of sea level; shoreline, alluvial, and marsh sedimentation
	Pleistocene	0.001-2.6	Cyclic glaciation, associated rise and fall of sea level
	Pliocene	2.6-5.3	
	Miocene	5.3-23	Alluvial sedimentation (Beacon Hill, Bridgeton, Pensauken)
	Oligocene	23-33.9	Sedimentation on subsiding Atlantic continental margin
	Eocene	33.9-56	
	Paleocene	56-66	
MESOZOIC	Cretaceous	66-145	unconformity
	Jurassic	145-201	Rifting, deformation of Newark basin, opening of Atlantic Ocean basin
	Triassic	201-252	Basaltic magmatism, sedimentation (Newark Supergroup) Shear and extension prior to opening of Atlantic
PALEOZOIC	Permian	252-299	
	Pennsylvanian	299-323	unconformity Alleghanian orogeny
	Mississippian	323-359	
	Devonian	359-419	
	Silurian	419-444	Epicontinental sea to west; clastic sedimentation from east
	Ordovician	444-485	unconformity Taconic orogeny Submergence of continental margin; carbonate sedimentation (Jacksonburg) followed by deeper-water clastic deposition (Martinsburg) unconformity Iapetus continental margin changes from passive to convergent
	Cambrian	485-541	Continental margin sedimentation in west (Hardyston, Kittatinny), deeper-water and oceanic sedimentation to east (Jutland, protoliths of Manhattan and Wissahickon)
PROTEROZOIC	Neo-Proterozoic	541-1,000	unconformity Sedimentation, volcanism (?) (Chestnut Hill)
	Meso-Proterozoic	1,000-1,600	unconformity Grenville orogenic cycle (metamorphism, plutonism, several phases of tectonism, post-kinematic emplacement of Mount Eve Granite) Emplacement of protoliths of layered metasedimentary rocks (graywacke, arkose and carbonate) unconformity Emplacement of losee protolith (probably dacite, keratophyre and spilite)

GENERALIZED STRATIGRAPHIC TABLE FOR NEW JERSEY

Era	Period	Series	Stratigraphic unit		Predominant lithology	Aquifer name or hydrogeologic characteristics
CENOZOIC	Quaternary	Holocene	alluvial, coastal, marsh and eolian deposits		sand, gravel, silt, mud and peat	under water-table conditions at most locations
		Pleistocene	COASTAL AREAS Wisconsinan alluvium, Cape May Formation, colluvium	INLAND, NORTHERN NEW JERSEY Wisconsinan and pre-Wisconsinan alluvial, colluvial, glacial, lacustrine, and eolian deposits	sand, gravel, silt, clay (statewide), till and till-like deposits (northern New Jersey)	includes glacial valley-fill aquifers and Cape May aquifer system/Holly Beach aquifer
	Neogene	Pliocene	Pensauken Formation		sand, gravel	under water-table conditions at most locations
		Miocene	Bridgeton Formation			
			Beacon Hill Gravel		gravel, sand	
			Stone Harbor Formation		interbedded gravel, sand and clay	Kirkwood-Cohansey aquifer system
			Cohansey Sand		sand, some clayey silt	
			Kirkwood Formation	Belleplain Member	sand, gravel, clayey silt	confining unit
				Wildwood Member		Rio Grande water-bearing zone
				Shiloh Marl Member		confining unit
				Brigantine Member		Atlantic City 800-foot sand
	Paleogene	Oligocene	Atlantic City Formation		sand, some glauconitic sand	composite confining unit: Piney Point Aquifer
			Sewell Point Formation			
		Eocene	Shark River Formation		clayey silt, fine quartz sand, glauconite sand	
			Manasquan Formation			
			Absecon Inlet Formation			
		Paleocene	Vincentown Formation		sand, clayey silt, glauconitic sand, calcarenite	Vincentown Aquifer
			Hornerstown Formation		glauconite sand	
MESOZOIC	Cretaceous	Upper Cretaceous	Tinton Sand		sand, glauconite sand	
			Red Bank Sand		sand, clayey silt, some glauconitic sand	Red Bank Sand
			Navesink Formation		glauconitic sand	
			Mount Laurel Formation		sand	Wenonah-Mount Laurel aquifer
			Wenonah Formation		silty sand, some glauconite	Marshalltown-Wenonah confining unit
			Marshalltown Formation		clayey silt, glauconitic sand	
			Englishtown Formation		sand, clayey silt	Englishtown aquifer system
			Woodbury Clay		clayey silt	Merchantville-Woodbury confining unit
			Merchantville Formation		clayey silt, glauconitic sand	
			Cheesequake Formation		clayey silt	
			Magothy Formation		sand, clayey silt	Potomac-Raritan-Magothy aquifer system: upper aquifer
						confining unit
			Raritan Formation			middle aquifer
		Lower Cretaceous	Potomac Formation	Unit 3	gravel, sand, silt, clay	confining unit
				Unit 2		lower aquifer
				Unit 1		
	Jurassic	Lower Jurassic	Newark Supergroup, Brunswick Group: Boonton Formation		sandstone, siltstone, shale, conglomerate	groundwater occurs along bedding surfaces, joints, faults, intergranular spaces, and other openings
			Hook Mountain Basalt	diabase	basalt	
			Towaco Formation		sandstone, siltstone, shale, conglomerate	
			Preakness Basalt	diabase	basalt, intercalcated sedimentary rock	
			Feltville Formation		sandstone, siltstone, shale, conglomerate, limestone	
	Triassic	Upper Triassic	Orange Mountain Basalt	diabase intrusives	basalt / diabase	
			Passaic Formation		sandstone, siltstone, shale, conglomerate	
			Newark Supergroup: Lockatong Formation		siltstone, mudstone, sandstone	
			Stockton Formation		arkosic sandstone, siltstone, shale, conglomerate	

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Era	Period	Series	VALLEY AND RIDGE Stratigraphic unit	VALLEY AND RIDGE Predominant lithology	GREEN POND MOUNTAIN REGION Stratigraphic unit	GREEN POND MOUNTAIN REGION Predominant lithology	Hydrogeologic characteristics
PALEOZOIC	Devonian	Middle Devonian			Skunnemunk Conglomerate	conglomerate	groundwater occurs along bedding surfaces, joints, faults, intergranular spaces, solution cavities, and other openings
					Bellvale Sandstone	sandstone, siltstone, shale	
			Marcellus Shale	shale, siltstone	Cornwall Shale	shale, siltstone	
					unconformity	unconformity	
			Buttermilk Falls Limestone / Onondaga Formation	argillaceous limestone / limestone	Kanouse Sandstone	conglomeratic sandstone, siltstone	
		Lower Devonian	Schoharie Formation	calcareous siltstone			
			Esopus Formation	sandstone	Esopus Formation	sandstone	
					unconformity	unconformity	
			Oriskany Group: Ridgely Sandstone	sandstone	Connelly Conglomerate	conglomeratic quartzite	
			Oriskany Group: Shriver Chert	shale, siltstone, chert			
			Oriskany Group: Glenerie Limestone	limestone			
			Helderberg Group: Port Ewen Shale	calcareous shale, siltstone	unconformity	unconformity	
			Helderberg Group: Minisink Limestone	limestone, calcareous shale			
			Helderberg Group: New Scotland Formation	calcareous silty shale			
			Helderberg Group: Kalkberg Limestone	limestone			
			Helderberg Group: Coeymans Limestone	limestone, sandstone, conglomerate	Berkshire Valley Formation	calcareous siltstone, dolomite	
			Helderberg Group: Manlius Limestone	limestone			
			Helderberg Group: Rondout Formation	limestone, calcareous shale, dolomite			
	Silurian	Upper Silurian	Decker Formation	calcareous sandstone, limestone			
			Bossardville Limestone	argillaceous limestone			
			Poxono Island Formation	calcareous shale, dolomite	Poxono Island Formation	calcareous shale, dolomite	
			Bloomsburg Red Beds	shale, siltstone sandstone	Longwood Shale	shale	
		Middle Silurian	Shawangunk Formation	conglomeratic quartzite	Green Pond Conglomerate	conglomeratic quartzite, siltstone	

Era	Period	Series	Stratigraphic unit		Predominant lithology		Hydrogeologic characteristics
PALEOZOIC	Ordovician	Upper Ordovician	Nepheline syenite, Ouachitite breccia		intrusive and extrusive alkalic igneous rocks		groundwater occurs along bedding surfaces, joints, faults, intergranular spaces, solution cavities, and other openings
			Martinsburg Formation: High Point Member		shale, siltstone, sandstone		
			Martinsburg Formation: Ramseyburg Member		slate, graywacke		
			Martinsburg Formation: Bushkill Member				
			Jacksonburg Limestone	Jutland klippe units (not part of the Kittatinny Supergroup)	limestone	shale, limestone, chert (Jutland)	
		Mid.Ordovician	unconformity		unconformity		
		Lower Ordovician	Kittatinny Supergroup: Beekmantown Group: Upper: Ontelaunee Formation		dolomite, limestone		
			Kittatinny Supergroup: Beekmantown Group: Lower: Epler Formation				
	Cambrian	Upper Cambrian	Kittatinny Supergroup: Beekmantown Group: Lower: Rickenback Dolomite		dolomite		
				?—?—?		?—?—?	
			Kittatinny Supergroup: Allentown Dolomite		dolomite		
		Middle Cambrian	Kittatinny Supergroup: Leithsville Formation		dolomite, calcareous shale		
		Lower Cambrian	Hardyston Quartzite		arkosic quartzite, conglomerate		
	Ordovician and Cambrian		Wissahickon Formation	Manhattan Schist serpentinite	schist, metagraywacke, amplibolite, altered ultramafics (Wissahickon); sillmanite-garnet-muscovite-biotite schist (Manhattan); serpentinite		groundwater occurs in joints, faults, foliation surfaces, solution cavities, and other openings
PROTEROZOIC	Neo-Proterozoic		Chestnut Hill Formation		metasedimentary and metavolcanic (?) rock		
	Meso-Proterozoic		Bryam Instrusive Suite, Lake Hopatcong Intrusive Suite, Mount Eve Granite		granite, quartz syenite, syenite, monzonite and granodiorite		
			metasedimentary rocks		metasedimentary rocks including Franklin and Wildcat Marble		
			Losee Metamorphic Suite		highly sodic gneissic and granitoid rocks; amphibolite		

clastic fluvial and lacustrine sediments, and basalt and diabase magma. During final separation of the North American and African continental plates, the Newark Supergroup rocks were tilted to roughly their present attitude (Manspeizer and Cousminier, 1988).

Coastal Plain sediments, predominantly deltaic, shallow marine, and continental shelf clastics, record several major transgressive cycles. Units are generally thicker and reflect deeper water to the southeast. The units shown here are from Owens and others (1998), and Johnson (1950).

Surficial deposits of New Jersey are generally no more than a few feet, rarely as much as 300 feet, thick. The Bridgeton and Pensauken reflect a persistent drainage pattern: to the southwest along the inner margin of the Coastal Plain, then to the southeast parallel to the Delaware River (Owens and Minard, 1979).

Pleistocene and Holocene deposits record fluctuating conditions related to cyclic glaciation. Alluvial, coastal and estuarine deposits of the Cape May Formation record rise and fall of sea level due to changes in global ice volume (Newell and others, 2000). Northern New Jersey glacial deposits record at least three ice advances (Stone and others, 2002). Colluvial, residual and eolian deposits formed most rapidly under periglacial conditions, but also date from interglacial and postglacial times.

Postglacial sediments include lake and marsh deposits (most extensive in areas of glacially-disrupted drainage), estuarine and shoreline deposits post-dating rapid sea-level rise, alluvial sands and gravels, and anthropogenic materials.

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Banner Photos *(left to right)*:

Looking across Kittatinny Valley (Cambrian and Ordovician, 444 to 541 million years old, carbonate rock and sandstone, siltstone and shale) from Kittatinny Mountain (Silurian, 419 to 444 million years old, quarzite and quartz-pebble conglomerate) to the New Jersey Highlands (Middle Proterozoic, 1,000 to 1,600 million years old, metamorphic rock), Sussex County. *Photo by R. Witte*

Basal contact of the Orange Mountain Basalt (Triassic, basalt, approximately 201 million years old) with the Passaic Formation (Triassic, sandstone, siltstone and shale, 201 to 217 million years old) in the Chimney Rock Quarry, Somerset County. *Photo by D. Monteverde*

Sand and gravel pit (Cohansey Formation, Middle Miocene, sand, silt and clay, 14 million years old) overlain by Bridgeton Formation (Miocene, sand, gravel, 8 to 5 million years old), Monmouth County. *Photo by P. Sugarman*

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