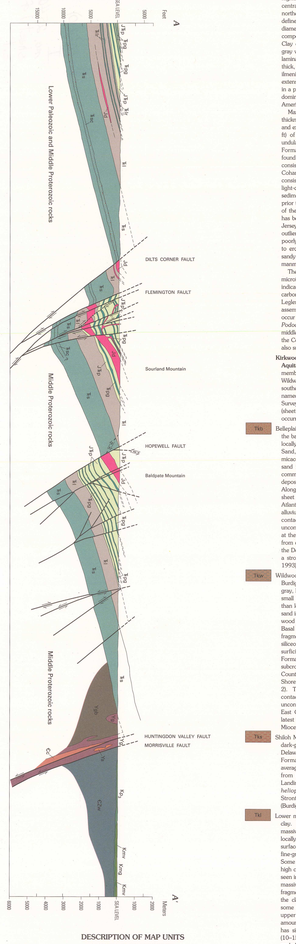
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
NEW JERSEY GEOLOGICAL SURVEY

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I-2540-B (SHEET 1 OF 4)



DESCRIPTION OF MAP UNITS

COASTAL PLAIN SEDIMENTS

Tc **Unnamed unit at Cape May (upper Pliocene)**—Interbedded gravel, sand, and clay, massive to thick-bedded. Informal unit described from a core hole at the Cape May Airport. The lower 18.3 m (60 ft) consists of interbedded gravel; medium- to very coarse grained, poorly sorted sand; and thin to thick beds of medium- to dark-gray, very woody clay. Gravel clasts are typically less than 0.64 mm (0.025 in) in diameter. The upper 12.2 m (40 ft) consists of a thick-bedded, medium-gray, extensively bioturbated clay-silt, which is overlain by an extensively burrowed, fine- to medium-grained glauconitic (about 5 percent) quartz sand. Quartz and siliceous rock fragments compose most sand grains. Feldspar is present in most samples but usually constitutes less than 10 percent of the sand fraction. No calcareous macrofossils were found in the burrowed intervals. Unit is known only to occur on the Cape May peninsula where it lies within a large channel. The unit is about 60 m (197 ft) in maximum thickness. The contact with the underlying Belleplain Member of the Kirkwood Formation is sharp and unconformable; a basal gravel bed as much as 1 m (3 ft) thick is present along the contact.

The pollen assemblage in the lower part of the unit is dominated by pine and oak with somewhat lesser amounts of hickory and basswood. Spruce, hemlock, beech, alder, and black gum are minor constituents. Traces of fir, willow, birch, and sweet gum are present, as is exotic *Engelhardia*. The non-arboreal pollen are a *Multisia*-type composite of the present-day Andean provenance which indicate an exotic cool climate. The lower assemblage suggests a cool-temperate climatic regimen. The pollen assemblage in the upper beds is dominated by oak and hickory with minor amounts of basswood, sweet gum, pine, and *Multisia*-type composite. Traces of cedar, willow, birch, alder, grass, and *Sphagnum* spores also are present. This assemblage probably represents a temperate climatic regimen (Les Sirkin, Adelphi University, written commun., 1991). The low percentage of exotic species is characteristic of the late Pliocene, and therefore, the unnamed unit at Cape May may be equivalent to the Beaverdam Formation of the Delmarva Peninsula of Delaware, Maryland, and Virginia

Tch **Cohansey Formation (middle Miocene, Serravallian)**—Sand, white to yellow with local gravel and clay. Locally stained red or orange brown by iron oxides and (or) cemented into large blocks of ironstone. Unweathered clay is typically dark gray, but commonly weathers white where interbedded with thin beds of ironstone. Unit is a complex of interfingering marine and nonmarine facies. Sand is typically medium grained and moderately sorted although it ranges from fine to very coarse grained and from poorly to well sorted. Sand consists of quartz and siliceous rock fragments. Some beds are locally micaceous, and in the Lakehurst area, Ocean County, some beds have high concentrations of "black" sand (pseudorutile) that was once extensively mined. In general, the sand is crossbedded, although the style of crossbedding varies significantly with the paleoenvironment. Trough crossbedding predominates, especially in the nonmarine channel fill deposits, and the scale of the crossbeds varies from small to large. In some areas, planar bedding is well developed in sections that have abundant marine burrows (mostly the clay-lined trace fossil *Ophiomorpha nodosa*). Such marine-influenced beds (largely foreshore deposits) occur on the central sheet west of Asbury Park, near Adelphia, Monmouth County, north of the Lakehurst Naval Air Station, Ocean County, and at Jullustown, Burlington County (Owens and Sohl, 1969), and on the southern sheet as far north as Salem, Salem County. Gravel beds occur locally, especially in updip areas such as near New Egypt, Ocean County, in the Atlantic Highlands and in the Asbury Park quadrangle (Sugarman and Owens, 1994). Most outcrops are small, less than 3 m (10 ft) in height. The contact with the underlying Manasquan Formation was not observed. The Shark River is about 18 m (59 ft) thick and consists of two fining-upward cycles: a glauconite sand is present at the base and a clay or silt is present at the top of each cycle. Calcareous nannofossils in subsurface Shark River sections indicate Zones NP 14 through NP 18 (Martini, 1971) (middle Eocene and early late Eocene)

Tmg **Manasquan Formation (lower Eocene, Ypresian)**—Consists of several lithologies. In the northern part of the central sheet, unit consists of a lower, clayey, quartz-glauconite sand, which is exposed intermittently along the Manasquan River near Farmingdale, Monmouth County, and an upper, fine-grained quartz sand or silt, which is exposed along Hog Swamp Brook west of Deal, Monmouth County. The Farmingdale Member and the Deal Member (of Enright, 1969) are not used on this map because they are not continuous through the outcrop belt or in the subsurface.

The formation is best exposed in the central sheet from the Fort Dix Military Reservation, Burlington County, southwestward to the Medford Lakes quadrangle. Here the lower part of the formation consists of 5 m (16 ft) of medium- to coarse-grained, massive, dark-grayish-green, glauconite-quartz sand. The lowest 1 m (3 ft) mostly contains calcareous debris and phosphatized internal (cast) molds reworked from the underlying Vincentown Formation. The upper part of the formation is approximately 8 m (26 ft) thick and is mostly a very clayey, blue-green to pale-gray, quartz-glauconite (about 20 percent glauconite) sand. Locally, the glauconite content of this interval is variable, and the unit becomes almost a blue-green clay-silt, especially near Pemberton, Burlington County (sheet 1) (Owens and Minard, 1964a). Casts and molds of mollusks (especially *Venericardia perversipicata*) occur in outcrop. The age of the formation was determined from microfauna in unweathered subsurface beds. Calcareous nannofossils indicate upper Zone NP 9 to mid Zone NP 14 (early Eocene)

Tmf **Vincentown Formation (upper Paleocene, Selandian)**—Sand, quartz, medium-grained, well- to poorly sorted, dusky-yellow to pale-gray, weathers orange brown or red brown, typically very glauconitic and clayey near base; glauconite decreases up section. Feldspar and mica are minor sand constituents. Unit best exposed in the Pemberton, New Egypt, and Mount Holly quadrangles of the central sheet where the overlying formations have been stripped away. The Vincentown Formation is as much as 30 m (98 ft) thick and averages 3 to 15 m (10–49 ft) in its subcrop belt. Where unweathered the unit is generally a shelly sand, where weathered the unit is largely a massive quartz sand. The unweathered sand of the Vincentown is exposed intermittently along the Manasquan River near Farmingdale, Monmouth County. The calcareous nature of the unweathered Vincentown was observed in several coreholes in the vicinity of Farmingdale. The contact with the underlying Hornerstown Formation is disconformable; locally shell beds (biohermal) up to 1.5 m (5 ft) thick are found along the contact. Shells in the bioherms are typical of a restricted environment and contain the brachiopod *Oleneothyris harlani* (Morton) in the lower beds and the oyster *Pycnodonte dissimilaria* in the upper beds. The basal contact and the *Oleneothyris* bioherms are exposed along Crosswicks and Lahaway Creeks and their tributaries (sheet 1). Where bioherms are absent, the basal contact is difficult to place within a sequence of glauconite beds. In general, glauconite beds of the Vincentown are darker gray than glauconite beds of the Hornerstown, and the Vincentown has more quartz sand. Upper beds of the Vincentown are as much as 12 m (39 ft) thick and are mostly silty, dark-gray to green-gray, massive, glauconite sand that contains a small percentage of quartz. Calcarenite or coquina, characterized by an abundance of bryozoans, occurs locally along the western belt. These fossiliferous beds, 6 to 7.5 m (20–25 ft) thick, are best exposed along Shingle Run in the New Egypt quadrangle area and in streams that cross the Vincentown outcrop belt in the Pemberton quadrangle.

Calcareous nannofossils, present in some Vincentown outcrops, are from Zones NP 5 (the *Oleneothyris* beds) and NP 9 (late Paleocene). Vincentown sediments are much more fossiliferous in the subsurface and contain Zones NP 5 through NP 9, inclusive. Therefore, the Vincentown corresponds in age with the Aquia Formation of Virginia and Maryland. Numerous studies of the foraminifera of the Vincentown from calcareous beds in the western outcrop belt indicate that the Vincentown includes the planktic foraminifera Zones P3b through P4a (Olsson and others, 1988). A potassium-argon age of 56.4±1.8 Ma was determined for basal beds near New Egypt, Ocean County (Owens and Sohl, 1973)

Thd **Hornerstown Formation (lower Paleocene, Danian)**—Sand, glauconite, fine- to medium-grained, locally clayey, massive, dark-gray to dusky-green; weathers dusky yellow or red brown, extensively bioturbated, locally has a small amount of quartz at base. Glauconite grains are typically dark green and have botryoidal shapes. The Hornerstown weathers readily to iron oxide because of its high glauconite content. The Hornerstown in most areas is nearly pure glauconite greensand. The Hornerstown crops out in a narrow belt throughout most of the western outcrop area. In the northern part of the central sheet, it is extensively dissected and occurs as several outliers. Throughout its outcrop belt in the central sheet, the Hornerstown unconformably overlies several formations: the Tinton Formation in the extreme northern area; the Red Bank Formation in the northwestern and west-central areas; and the Navesink Formation in the west-central and southern areas. In the southern sheet, it unconformably overlies the Mount Laurel Formation. The unconformable basal contact locally contains a bed of reworked phosphatic vertebrate and invertebrate fossils. For the most part, however, the basal contact is characterized by an intensely bioturbated zone in which many burrows filled with bright green glauconite sand from the Hornerstown Formation project down into the dark-gray matrix of the underlying Navesink Formation. In a few exposures, a thin layer of medium- to coarse-grained quartz sand separates the Hornerstown from the underlying unit. The Hornerstown is 1.5 to 7 m (5–23 ft) thick.

A Cretaceous age was assigned to this unit by Koch and Olsson (1977) based, in part, on a vertebrate fauna found at Sewell, Gloucester County (sheet 1). However, early Paleocene calcareous nannofossil Zones NP 2–4 were found in a core at Allaire State Park, Monmouth County. This is the only locality in New Jersey where Zone NP 2 was observed; otherwise, the Hornerstown is confined to Zones NP 3 and NP 4. Lowermost Paleocene Zone NP 1 was not identified, and it is thought that the Cretaceous-Tertiary boundary in New Jersey may be unconformable. A complete Cretaceous-Tertiary boundary section was recovered at the Bass River borehole (ODP Leg 174AX). It contained the uppermost Maastrichtian calcareous nannofossil *Micula prinsii* Zone below a sphaerule layer and the basal Danian planktonic foraminiferal *Guembelitria cretacea P0* Zone just above the layer (Olsson and others, 1997)

Kt **Tinton Formation (Upper Cretaceous, upper Maastrichtian)**—Sand, quartz, and glauconite in varying proportions, very clayey and locally indurated by siderite into hard, massive ledges. Sand is dark gray to dark yellow where unweathered; where weathered, siderite changes color of unit to orange brown because of iron oxides, and the formation is stained or cemented in exotic patterns. The Tinton crops out in the northern part of the central sheet from Sandy Hook, Monmouth County, to the northernmost part of the Roosevelt quadrangle, near Perrineville. Unit unconformably overlies the Red Bank Formation in the high hills of the northern Coastal Plain, most notably near Perrineville and Morganville, Monmouth County (sheet 1). In these updip areas, fine gravel, 1 cm (0.4 in) maximum diameter, or large shell concentrations are found along the basal contact. The typical basal bed is a massive, glauconitic (10–35 percent), fine- to medium-grained quartz sand with scattered gravel. The massive character of the basal bed is the result of extensive bioturbation. Burrows, filled with glauconite sand of the Tinton, project down into the quartz sand of the underlying Red Bank Formation.

At lower elevations downdip, the Tinton is less weathered, much darker, more glauconitic, and typically indurated. The type locality on Pine Brook at Tinton Falls, Monmouth County, is in this downdip area. At Tinton Falls, 7 to 8 m (23–26 ft) of the Tinton is exposed and has a higher glauconite content than in the updip area. Glauconite at Tinton Falls is light green to pale yellow, and many of the grains have a smooth polished surface that is almost lustrous. Thin sections of the Tinton reveal that many of the grains are oolitic (Owens and Sohl, 1973). X-ray analyses indicate the presence of mixed clay minerals; therefore, the unit is not pure glauconite.

The Tinton Formation at Tinton Falls has scattered molds of calcitic fossils and aragonitic shells. Richards (1958) recorded 30 species of mollusks from the Tinton in this area. Of importance are *Sphenodiscus lobatus*, *Cucullaea (Idonearca) littlei*, and *Scabrotrigonia carsilia*. In New Jersey, *Scabrotrigonia carsilia* is restricted to the Tinton. All three species are common to the upper Maastrichtian *Hoplitoplacenticeras billingsi* Zone of Sohl (in Owens and others, 1977). Strontium-isotope analysis on calcareous shells from the Tinton yielded ages of 66.2 to 65.6 Ma or a late Maastrichtian age (Sugarman and others, 1995)

Tht **Shark River Formation (upper and middle Eocene, Priabonian through Lutetian)**—Glauconite sand, silt, and clay, medium- to coarse-grained, light-brown to medium-gray, locally indurated at top and noncalcareous throughout. Mollusk impressions (mainly *Venericardia perversipicata*) were observed in the Farmingdale quadrangle (sheet 1). The Shark River is exposed only at a few localities in the central sheet near Farmingdale, Monmouth County, along the Manasquan and Shark Rivers and in several tributaries to Deal Lake near Asbury Park in the

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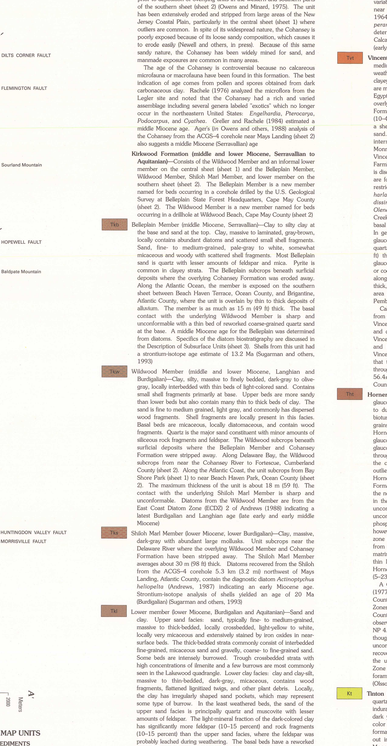
CORRELATION OF MAP UNITS


COASTAL PLAIN
SURFACE
SUBSURFACE
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