DESCRIPTION OF THE ELKTON AND WILMINGTON QUADRANGLES.

By F. Bascom.

LOCATION AND AREA.

The Elkton and Wilmington quadrangles, described in this folio, lie between parallels 39° 30' and 39° 45' and meridians 75° 30' and 76°. They therefore include one-eighth of a square degree, which in this latitude is about 490 square miles. (See fig. 1.) The area lies in Cecil County, Md., New Castle County, Del., Chester County, Pa., and Salem County, N. J., thus including part of four States. It contains a population of about 150,000. The city of Wilmington, which is 26 miles southwest of Philadelphia, is in the extreme northwest corner of the Wilmington quadrangle, and Delaware River, which is navigable by ocean steamers, crosses the east side of that quadrangle.

CLIMATE, VEGETATION, AND CULTURE.

The physical features of the Elkton and Wilmington quadrangles are not such as to produce great local differences in climate; on the contrary, the climate throughout the area is uniform. Observations made at Wilmington and Newark, Del., in the Wilmington quadrangle, and at Woodlawn, Md., 41 miles west of the Elkton quadrangle, indicate the normal weather in these quadrangles. Some of the results of these observations are given below.

The mean annual temperature at Wilmington from 1913 to 1915, a period of 3 years, was 56°F. The maximum monthly mean during that period was 78.6°F, in July, 1915, and the minimum monthly mean was 30.4°F, in February, 1914. The average temperature in February was 34.9°F; the average in July was 77.4°F; and the difference between the monthly mean during that period was 78.6°F, in July, 1913, and the lowest temperature recorded in the same period was —12°F, in January.

The mean annual temperature at Newark during a period of 13 years was 50°F. The lowest monthly mean in that period was 28.9°F, in February, and the highest monthly mean was 75.1°F, in July, the average seasonal difference being 46°F. The highest temperature recorded in 12 years at Newark was 100°F, in July, and the lowest temperature recorded in the same period was —12°F, in January.

The first killing frost is likely to occur in this region just after the middle of October (October 17) and the last killing frost just after the middle of April (April 17), leaving a period of six months for safe plant growth.

Precipitation in the Elkton and Wilmington quadrangles is abundant and normally is equally distributed throughout the year. The mean annual precipitation at Wilmington for 20 years was 42.61 inches. The mean annual precipitation at Newark for 14 years was 49.40 inches. The mean annual precipitation at Woodlawn for 11 years was 47.06 inches. The months of greatest precipitation are June, July, and August, when thunder showers are of frequent occurrence. Precipitation tables for this region show that rainfall is likely to be abundant in all months of the year, and that, though the variation is great during the crop season, no month is without rainfall. The season of snowfall extends from November to April, and the average annual fall is 8.12 inches. The prevailing winds are from the northwest and the southwest.

Climate and soil are favorable to the vigorous growth of many kinds of forest trees, both northern and southern types. At one time the fertile uplands were covered with splendid forests of oak, chestnut, and beech, and the streams were fringed with the tulip tree, black walnut, and hickory, but the best soils have been cleared for agriculture, and the abused and neglected of the remaining forests have reduced them to mere remnants, made up of young or deflake trees growing on barren soil or along streams. Even such timber as survives upon barren soil is being depleted by the charcoal burner and destroyed by fire started through carelessness. The timber that fringes the cultivated lands, most of it growing on good soil but in places too wet or too steep for cultivation, is utilized as firewood and for other domestic purposes.

Among the trees and shrubs that are native to the Elkton and Wilmington quadrangles are pitch, scrub, and short-leaf pine, red cedar, butternut, black walnut, hickory, willow, poplar, birch, chestnut, oak (13 species), elm, tulip tree, poplar, birch, chestnut, osage orange, sunflower, hickory, maple, black gum, black cherry, redwood, dogwood, hickory, box elder, holly, sumac, and witch hazel.

The Baltimore & Ohio Railroad, several branch lines of the Pennsylvania system, and the Philadelphia & Reading Railroad traverse the quadrangles, connecting the cities of the Atlantic seaboard with one another and with through western and southern routes.

Electric lines connect Delaware City and New Castle with Wilmington and Wilmington with Kennett Square and West Chester, to the north.

Delaware River is a thoroughfare for ocean and coastwise steamers and is connected with Elk River by the Chesapeake & Delaware Canal, which extends from Delaware City to Chesapeake City. Northeast and Elk rivers are navigable by coastwise craft below Northeast and Elkton. The quadrangles are traversed by a network of highways, which are in fine condition for horse-drawn vehicles. A cement automobile road that connects Wilmington with Baltimore passes through Newark, Elkton, and Northeast.

Wilmington (population 110,168), the county seat of New Castle County, Del., is the commercial and manufacturing center of Delaware. Its industries include shipyards, iron and steel works, manufactories of carriages, railway cars and wheels, boilers, bridges, paper-making machinery, paper, leather, fiber, cotton, and flour. At Newport there are gins and print works. Newark has machine shops and flour mills and is the seat of Delaware State College, Delaware College for Women, and the Delaware Agricultural Experiment Station.

Elkton, the county seat of Cecil County, Md., contains cotton mills, canneries, iron foundries, and boat yards. Northern manufactures chief products are.

PHYSIOGRAPHIC DIVISIONS OF THE REGION.

The Elkton and Wilmington quadrangles lie in two unlike geographic divisions—the Appalachian Highlands and the Atlantic Plain; the northernmost third of the area is included in the Appalachian Highlands and the southeastern two-thirds in the Atlantic Plain. (See fig. 2.) It is desirable to consider the geographic and geologic character of these divisions in order to comprehend the history of the Elkton-Wilmington area.
change from older hard crystalline rock to younger unconsoli-
dated clay, sand, and gravel. The formations of the Coastal
Plain everywhere overlap the eastern border of the upland and
in successive order from west to east, they are: the oldest are:
the emerged lower courses of streams which are navigable to
the full line but which above the full line occupy narrow rocky
channels and are not navigable. South of Cape Lookout the eastern border of the Coastal Plain is deeply indented overseas
that are the submerged lower courses of streams which are
not navigable. If the valleys were filled the upland would be con-
verted into eminences, or monadnocks, which rise above the
general level. If the valleys were filled the upland would be con-
verted into eminences, or monadnocks, which rise above the
general level. The fall line, which is at the head of navigation
and marks the boundary between the upland and the plain.

Though the Piedmont province exhibit great diversity of
river courses from certain general features that are common to all its parts
it marks the boundary between the upland and the plain.

In the northern part of the Appalachians these plateaus may be
consisting of the more resistant rocks, may be preserved on the
highest levels, and the youngest will appear on the lowest
levels and will be the least developed. Intermediate plateaus
will be found intermediate between the lowest and the highest stages of preservation.

Such a series of plateaus was long ago developed in the
northern part of the Appalachian Highlands. Remnants of the
oldest and now the highest plateau is preserved in the
division of the Appalachian Valley in the resistant sandstone
of Kittatinny Mountain, which has altered it and produced in it a more or less
dissected by relatively narrow valleys and diversified by resid­
ual eminences, or monadnocks, which rise above the general
level. The fall line, which is at the head of navigation
and marks the boundary between the upland and the plain.

A fifth and widely preserved upland plain in the Pennsyl­
vanian Piedmont region, ranging in height from 400 to 500 feet,
is called the early Brandywine, from deposits of the Brandy­
wine formation (formerly called the "Lafayette formation")
found on its border. The early Brandywine formation deposits of 500 feet near Harrisburg, where it is developed on a
shale formation in the Great Valley (the most easterly valley
of the Appalachian Province) with the Brandywine
formation which is preserved on the same shale in that vicinity.

A sixth and widespread upland plain in the Pennsyl­
avian Piedmont region, ranging in height from 400 to 500 feet,
is formed by a shale formation in the Great Valley (the most easterly valley
of the Appalachian Province) with the Brandywine
formation which is preserved on the same shale in that vicinity.

A seventh and widespread upland plain in the Pennsyl­
avian Piedmont region, ranging in height from 400 to 500 feet,
is called the early Brandywine, from deposits of the Brandy­
wine formation (formerly called the "Lafayette formation")
found on its border. The early Brandywine formation deposits of 500 feet near Harrisburg, where it is developed on a
shale formation in the Great Valley (the most easterly valley
of the Appalachian Province) with the Brandywine
formation which is preserved on the same shale in that vicinity.

A sixth and widespread upland plain in the Pennsyl­
avian Piedmont region, ranging in height from 400 to 500 feet,
is called the early Brandywine, from deposits of the Brandy­
wine formation (formerly called the "Lafayette formation")
found on its border. The early Brandywine formation deposits of 500 feet near Harrisburg, where it is developed on a
shale formation in the Great Valley (the most easterly valley
of the Appalachian Province) with the Brandywine
formation which is preserved on the same shale in that vicinity.

A sixth and widespread upland plain in the Pennsyl­
avian Piedmont region, ranging in height from 400 to 500 feet,
is called the early Brandywine, from deposits of the Brandy­
wine formation (formerly called the "Lafayette formation")
found on its border. The early Brandywine formation deposits of 500 feet near Harrisburg, where it is developed on a
shale formation in the Great Valley (the most easterly valley
of the Appalachian Province) with the Brandywine
formation which is preserved on the same shale in that vicinity.

A sixth and widespread upland plain in the Pennsyl­
avian Piedmont region, ranging in height from 400 to 500 feet,
is called the early Brandywine, from deposits of the Brandy­
wine formation (formerly called the "Lafayette formation")
found on its border. The early Brandywine formation deposits of 500 feet near Harrisburg, where it is developed on a
shale formation in the Great Valley (the most easterly valley
of the Appalachian Province) with the Brandywine
formation which is preserved on the same shale in that vicinity.
Such coastal plains are found in New York and New Jersey. East of the present mouth of the river. A similar channel lies east of the present mouth of the river. The combined width of the Piedmont province is included in the Atlantic Plain. The boundary of the Coastal Plain. The Baltimore & Ohio Railroad skirts the southeastern border of the Piedmont Plain, and the Pennsy.

The highest altitude of the Piedmont Upland in those quadrangles is 510 feet, in an altitude that is reached in the extreme northwest corner of the Elkon quadrangle, about 9 miles northwest of the border of the upland, and that represents the maximum relief in the Elkon and Wilkinson quadrangles. In the Elkon and Wilmingtom quadrangles, and in the Coastal Plain area are buried under the Patuxent, Patapos, and the Brandywine formations, respectively. The surface at an altitude of 300 feet at Chrome, a mile southeast of Chrome, and half a mile southeast of Chrome, in East Nottingham, are probably remnants of the Harrington peneplain. With the exception of the surface of the Harbourside peneplain has been completely removed from the Elkon and Wilmingtom quadrangles and may be found again only to the south of those quadrangles, where it is buried beneath Tertiary formations. Surf. The highest altitude of the Piedmont Upland in those quadrangles is 510 feet, in an altitude that is reached in the extreme northwest corner of the Elkon quadrangle, about 9 miles northwest of the border of the upland, and that represents the maximum relief in the Elkon and Wilkinson quadrangles.
The sluggish streams that then meandered across this plain formed channels whose courses were directly dependent on the outline of the present sea, on the local features of the relief of the surface and were not affected by the character of the underlying rock formations. These meandering streams, however, after their courses had been established, cut down to the crystalline rocks, reaching them too late to be turned aside by variations in the hardness of these rocks. Thus, where wide, shallow valleys were cut in the hard rocks, these meandering streams now cut in the soft silt and vegetation and converted into swamps, on the other hand, they might be a barrier to the streams, increasing the rate of lowering of the sea floor.

These phenomena have been discussed in all the full-blown stream valleys in which they are so prominent, but the point where Coastal Plain sediments are found is on the top of the Coastal Plain. The term terrace is used in this folio in a somewhat specialized sense to include not only the true plains but the areas extending across the newly formed strata, which are rapidly encroaching on them. The marshes are formed by growth of sedges and other marsh plants, which aid in the further lowering of the sea floor by means of the wave cut terraces. The wave-cut terraces are formed by wave action during storms or high tides.

The streams that flow into the ocean are estuaries, which are formed by the joining of a river and the sea. The term estuary is used in this folio in a more restricted sense as indicated on the topographic map.

The small streams that flow into the ocean, on the other hand, are tributary streams whose courses were formed after these large streams. The large streams cut into the Coastal Plain sediments, starting at a certain elevation and modifying the flatness of the underlying strata. These processes are on both sides of Delaware Bay, where the rocks are so protected.

The estuaries that form so prominent a feature on the Atlantic Coast have been eroded and the proximity of the sea has brought about the formation of the present estuaries. The estuaries that form so prominent a feature on the Atlantic Coast have been eroded and the proximity of the sea has brought about the formation of the present estuaries. The estuaries that form so prominent a feature on the Atlantic Coast have been eroded and the proximity of the sea has brought about the formation of the present estuaries.

The Coastal Plain.

The altitude of the Coastal Plain portion of the tidal marshes ranges from sea level to 442 feet above sea level. The highest point where Coastal Plain sediments are found is on the top of the Coastal Plain. The Coastal Plain is composed of the tidal marshes in the valleys of most of the larger streams of both quadrangles, and it is the tidal marshes which are rapidly encroaching on them. The marshes are formed by the growth of sedges and other marsh plants, which aid in the further lowering of the sea floor by means of the wave cut terraces. The wave-cut terraces are formed by wave action during storms or high tides.

The streams that flow into the ocean are estuaries, which are formed by the joining of a river and the sea. The term estuary is used in this folio in a more restricted sense as indicated on the topographic map.

The small streams that flow into the ocean, on the other hand, are tributary streams whose courses were formed after these large streams. The large streams cut into the Coastal Plain sediments, starting at a certain elevation and modifying the flatness of the underlying strata. These processes are on both sides of Delaware Bay, where the rocks are so protected.

The estuaries that form so prominent a feature on the Atlantic Coast have been eroded and the proximity of the sea has brought about the formation of the present estuaries. The estuaries that form so prominent a feature on the Atlantic Coast have been eroded and the proximity of the sea has brought about the formation of the present estuaries. The estuaries that form so prominent a feature on the Atlantic Coast have been eroded and the proximity of the sea has brought about the formation of the present estuaries.

The term terrace is used in this folio in a somewhat specialized sense to include not only the true plains but the areas extending across the newly formed strata, which are rapidly encroaching on them. The marshes are formed by growth of sedges and other marsh plants, which aid in the further lowering of the sea floor by means of the wave cut terraces. The wave-cut terraces are formed by wave action during storms or high tides.

The streams that flow into the ocean are estuaries, which are formed by the joining of a river and the sea. The term estuary is used in this folio in a more restricted sense as indicated on the topographic map.

The small streams that flow into the ocean, on the other hand, are tributary streams whose courses were formed after these large streams. The large streams cut into the Coastal Plain sediments, starting at a certain elevation and modifying the flatness of the underlying strata. These processes are on both sides of Delaware Bay, where the rocks are so protected.

The estuaries that form so prominent a feature on the Atlantic Coast have been eroded and the proximity of the sea has brought about the formation of the present estuaries. The estuaries that form so prominent a feature on the Atlantic Coast have been eroded and the proximity of the sea has brought about the formation of the present estuaries. The estuaries that form so prominent a feature on the Atlantic Coast have been eroded and the proximity of the sea has brought about the formation of the present estuaries.

The term terrace is used in this folio in a somewhat specialized sense to include not only the true plains but the areas extending across the newly formed strata, which are rapidly encroaching on them. The marshes are formed by growth of sedges and other marsh plants, which aid in the further lowering of the sea floor by means of the wave cut terraces. The wave-cut terraces are formed by wave action during storms or high tides.

The streams that flow into the ocean are estuaries, which are formed by the joining of a river and the sea. The term estuary is used in this folio in a more restricted sense as indicated on the topographic map.

The small streams that flow into the ocean, on the other hand, are tributary streams whose courses were formed after these large streams. The large streams cut into the Coastal Plain sediments, starting at a certain elevation and modifying the flatness of the underlying strata. These processes are on both sides of Delaware Bay, where the rocks are so protected.

The estuaries that form so prominent a feature on the Atlantic Coast have been eroded and the proximity of the sea has brought about the formation of the present estuaries. The estuaries that form so prominent a feature on the Atlantic Coast have been eroded and the proximity of the sea has brought about the formation of the present estuaries. The estuaries that form so prominent a feature on the Atlantic Coast have been eroded and the proximity of the sea has brought about the formation of the present estuaries.
Northeast and Little Northeast creeks, which flow into the head of Northeast River. Most of the streams that flow into the chasms of the estuaries are small, and some are sluggish, meandering streams, such as Christians Creek, which flows for miles through a broad, flat-bottomed valley. The streams on Elk Neck, however, are swift and straight, occupy narrow, steep-sided valleys, and are still cutting down their beds. At their junction with the larger bodies nearly all the minor streams are bordered by swamps, which increase that the estuaries that formerly occupied their lower courses have been filled up by wadis from the surrounding uplands.

**Pre-Cambrian Rocks**

- **Baltimore Schist.** Banded gneiss that has no apparent primary structure, but is composed of quartz, feldspar, and biotite, with occasional parasitic micas and chlorite.
- **Inwood Limestone.** Coalescent, white limestone, thinly bedded and massive, with a fossiliferous horizon near the top.
- **Fordham Gneiss.** A biotite gneiss, composed of quartz, feldspar, and biotite, with occasional chlorite and sericite, and a siltstone layer.
- **Elkton Limestone.** A coarse-grained, white, calcareous sandstone, with a fossiliferous horizon near the top.
- **Newark Formation.** A thick sequence of sandstone, shale, and limestone, with a fossiliferous horizon near the top.
- **Floyd Formation.** A thin sequence of sandstone, siltstone, and shale, with a fossiliferous horizon near the top.

**General Succession of Formations**

The formations of the southeastern Piedmont Upland, except the gneisses of questionable age, are divided into pre-Cambrian and Paleozoic eras. The pre-Cambrian formations are the oldest, and the Paleozoic formations are the most recent. The pre-Cambrian formations are characterized by their lack of fossils, while the Paleozoic formations are characterized by their abundance of fossils. The pre-Cambrian formations are also characterized by their lack of metamorphism, while the Paleozoic formations are characterized by their degree of metamorphism.

**SEDIMENTARY ROCKS**

- **Baltimore Schist.** Banded gneiss that has no apparent primary structure, but is composed of quartz, feldspar, and biotite, with occasional parasitic micas and chlorite.
- **Inwood Limestone.** Coalescent, white limestone, thinly bedded and massive, with a fossiliferous horizon near the top.
- **Fordham Gneiss.** A biotite gneiss, composed of quartz, feldspar, and biotite, with occasional chlorite and sericite, and a siltstone layer.
- **Elkton Limestone.** A coarse-grained, white, calcareous sandstone, with a fossiliferous horizon near the top.
- **Newark Formation.** A thick sequence of sandstone, shale, and limestone, with a fossiliferous horizon near the top.
- **Floyd Formation.** A thin sequence of sandstone, siltstone, and shale, with a fossiliferous horizon near the top.

**Correlation and Name.** - The age of the formations has been determined from their relation to Cambrian material and to the intrusive rocks of the Piedmont Upland. In the Germanic town quadrangle, northeast of the Elkton and Wilmington quadrangles, the gneiss is exposed at the upper end of a pitchstone eyrie, where it dips under a Lower Cambrian pebbly quartzite or conglomerate. Most of the pebbles of this conglomerate are composed of blue quartz that forms abundant and characteristic veins in the Baltimore gneiss. The gneiss in that area appears to be thin, and it is impossible to say whether more deeply seated gneiss has been completely displaced by intrusive bodies.

**On Mill Creek, near the contact of gneisses and gneisses, the gneiss, which is perlitiform, contains included-shaped nodules to a 4-millimeter long, brought out in relief by weathering. These nodules are composed of cordierite and allanite.**

**Nickel.** - The thickness of the Baltimore gneiss cannot be determined from its relation to Cambrian material and to the intrusive rocks of the Piedmont Upland. In the Germanic town quadrangle, northeast of the Elkton and Wilmington quadrangles, the gneiss is exposed at the upper end of a pitchstone eyrie, where it dips under a Lower Cambrian pebbly quartzite or conglomerate. Most of the pebbles of this conglomerate are composed of blue quartz that forms abundant and characteristic veins in the Baltimore gneiss. The gneiss in that area appears to be thin, and it is impossible to say whether more deeply seated gneiss has been completely displaced by intrusive bodies.

**Correlation and Name.** - The age of the formations has been determined from their relation to Cambrian material and to the intrusive rocks of the Piedmont Upland. In the Germanic town quadrangle, northeast of the Elkton and Wilmington quadrangles, the gneiss is exposed at the upper end of a pitchstone eyrie, where it dips under a Lower Cambrian pebbly quartzite or conglomerate. Most of the pebbles of this conglomerate are composed of blue quartz that forms abundant and characteristic veins in the Baltimore gneiss. The gneiss in that area appears to be thin, and it is impossible to say whether more deeply seated gneiss has been completely displaced by intrusive bodies.

**On Mill Creek, near the contact of gneisses and gneisses, the gneiss, which is perlitiform, contains included-shaped nodules to a 4-millimeter long, brought out in relief by weathering. These nodules are composed of cordierite and allanite.**

**Nickel.** - The thickness of the Baltimore gneiss cannot be determined from its relation to Cambrian material and to the intrusive rocks of the Piedmont Upland. In the Germanic town quadrangle, northeast of the Elkton and Wilmington quadrangles, the gneiss is exposed at the upper end of a pitchstone eyrie, where it dips under a Lower Cambrian pebbly quartzite or conglomerate. Most of the pebbles of this conglomerate are composed of blue quartz that forms abundant and characteristic veins in the Baltimore gneiss. The gneiss in that area appears to be thin, and it is impossible to say whether more deeply seated gneiss has been completely displaced by intrusive bodies.

**Correlation and Name.** - The age of the formations has been determined from their relation to Cambrian material and to the intrusive rocks of the Piedmont Upland. In the Germanic town quadrangle, northeast of the Elkton and Wilmington quadrangles, the gneiss is exposed at the upper end of a pitchstone eyrie, where it dips under a Lower Cambrian pebbly quartzite or conglomerate. Most of the pebbles of this conglomerate are composed of blue quartz that forms abundant and characteristic veins in the Baltimore gneiss. The gneiss in that area appears to be thin, and it is impossible to say whether more deeply seated gneiss has been completely displaced by intrusive bodies.

**On Mill Creek, near the contact of gneisses and gneisses, the gneiss, which is perlitiform, contains included-shaped nodules to a 4-millimeter long, brought out in relief by weathering. These nodules are composed of cordierite and allanite.**

**Nickel.** - The thickness of the Baltimore gneiss cannot be determined from its relation to Cambrian material and to the intrusive rocks of the Piedmont Upland. In the Germanic town quadrangle, northeast of the Elkton and Wilmington quadrangles, the gneiss is exposed at the upper end of a pitchstone eyrie, where it dips under a Lower Cambrian pebbly quartzite or conglomerate. Most of the pebbles of this conglomerate are composed of blue quartz that forms abundant and characteristic veins in the Baltimore gneiss. The gneiss in that area appears to be thin, and it is impossible to say whether more deeply seated gneiss has been completely displaced by intrusive bodies.

**Correlation and Name.** - The age of the formations has been determined from their relation to Cambrian material and to the intrusive rocks of the Piedmont Upland. In the Germanic town quadrangle, northeast of the Elkton and Wilmington quadrangles, the gneiss is exposed at the upper end of a pitchstone eyrie, where it dips under a Lower Cambrian pebbly quartzite or conglomerate. Most of the pebbles of this conglomerate are composed of blue quartz that forms abundant and characteristic veins in the Baltimore gneiss. The gneiss in that area appears to be thin, and it is impossible to say whether more deeply seated gneiss has been completely displaced by intrusive bodies.

**On Mill Creek, near the contact of gneisses and gneisses, the gneiss, which is perlitiform, contains included-shaped nodules to a 4-millimeter long, brought out in relief by weathering. These nodules are composed of cordierite and allanite.**
The igneous rocks of the Elkton and Wilmington quadrangles are basic dolerites and diorites, quartz diorite, gabbro, granodiorite, and peridotite.

The igneous rocks of this area are the result of the intrusion of basic magmas into the schists, and are characterized by the presence of biotite, hornblende, and plagioclase. The rocks are generally coarse-grained and have aphanitic to porphyritic textures.

The most common rock type is the basic dolerite, which is a fine-grained, basic igneous rock composed of plagioclase feldspar and hornblende. These rocks are typically dark in color and are characterized by the presence of biotite and hornblende.

The granodiorite is another common rock type in this area. It is a medium-grained rock that contains equal or nearly equal amounts of quartz, plagioclase, and hornblende. The granite is a more evolved variety of the granodiorite, containing more quartz and less feldspar.

The peridotite is a ultramafic rock that contains olivine and pyroxene as its major minerals. It is typically a dark green or black rock that is often associated with oceanic crust.

The volcanic rocks in this area are represented by the basalt, which is a dark, basic igneous rock with a glassy texture. It is typically found in the central part of the Elkton quadrangle and is associated with the intrusion of basic magmas into the schists.

The sedimentary rocks in this area are predominantly shales and siltstones, which are typically dark in color and are interbedded with the volcanic and intrusive rocks. These rocks are thought to have been deposited in a marine environment.

The hydrothermal alteration of the schists in this area has resulted in the formation of secondary minerals such as chlorite, epidote, and calcite. These minerals are typically distributed as alteration zones around the intrusions and are commonly found as vein structures.
pyroxene, which is diopside and hypersthene, forms with magmatic quartz diorite, westward into a hornblende gabbro, and normally.

The rock of the Elton-Wilmington gabbro area is made up of so many transitional types that the formation as a whole can not be easily characterized. The rock is darker colored than the granodiorite and is more massive. Biotite, the prominent ferromagnesian constituent of the granodiorite, is an essential constituent of this rock, and the dominant feldspar is gray calcic plagioclase.

The rock here mapped is gabbro includes the types described below.

**Quartz Diorite.**

- **Distribution.** In areas north of the Elton and Wilmington quadrangles quartz diorite is widely distributed and is a well-formed diorite of medium color. In this area it occurs sparingly as a siliceous facies of the gabbro. It is an integral part of the gabbro intrusion, and as it grades imperceptibly into the main body of gabbro of which it is an insignificant part it has not been separated from that rock in the mapping. The normal type is a medium-grained quartz diorite, with augite and pyroxene. Blue quartz veins traverse the rock, but quartz may or may not be a constituent, passes northward into a hornblende gabbro, and contains about 30 per cent of primary quartz, 60 per cent of feldspar, and not more than 10 per cent of pyroxene. The feldspar is chiefly anorthite; the accessory constituent is hypersthene.

The dominant type of rock in this transitional area in the Wilmington quadrangle is a normal pyroxene gabbro in which the pyroxene is diopside or hypersthene. This gabbro, which consists of a medium-grained to fine-grained rock composed essentially of feldspar and pyroxene. Blue quartz veins traverse the rock, but quartz may or may not be a constituent, passes northward into a hornblende gabbro, and contains about 30 per cent of primary quartz, 60 per cent of feldspar, and not more than 10 per cent of pyroxene. The feldspar is anorthite, and the accessory constituent is hypersthene.
The biotitic-hornblende-green-banded. Nos. 1 and 2, represent the more silicic acid type of the biotite-hornblende group. The latter is hitherto undetermined partly because of the composition, Al₂Si₂O₅(OH)₂, and the rock is therefore a true gabbro and not a diorite, as it must be mistaken for gabbro if it contains also a quartz-phenocryst with hornblende and biotite, which is secondary to the original pyroxene. The magmas are dolomite, quartz, feldspar, and hornblende, and the feldspar is almost pure alkali feldspar, with some anorthite present. The dark schist, or hornblende gneiss, is secondary to the hornblende and chlorite schist, and is composed mainly of hornblende, biotite, and what is probably a chlorite or a chlorite-serpentine. A similar hornblende schist, which is rich in chlorite, is also present in the area.

The geologic formations that outcrop in the parts of the Elkton and Wilmington quadrangles show that rocks which are calcic than aluminous. The title of the same can be extended to the pre-Cambrian igneous rocks of the entire Pennsylvania Piedmont region. Analyses of 16 different igneous rocks found in eastern Pennsylvania and adjacent areas in Maryland show that all except two are alkaline (type 5), do not contain any quartz, and contain a large proportion of feldspar. The only two exceptions are those that are quartz (type 7) or peralkaline (type 6), and that they form a continuous series ranging from a peralkaline type, in which quartz and feldspar are abundant, to a peralkaline type, in which the ferromagnesian constitutes dominate. The fact that rocks which vary widely in silica are essentially calcic and peralkaline is a singularly characteristic feature of these rocks, and the continuous variation in silica with the maintenance of near-constant ratios between the lime and the alkalies and between the alkalies is due to the removal of silica by solution and by fractionation by crystallization.

and chalcedony or opal colored by limonite and having a rosinaceous silicates greatly preponderate over the oxides, that the magnesia is almost pure anorthite feldspar and resembles the it was at one time called because of the presence in it of hornblende, a content rock at Chestnut Hill and Iron Hill is gabbro in quadrangle. Some of these areas are crossed by the Pennsylvanian State line, and the rocks are therefore known as the "State-line serpentine." These rocks are noted for their associated minerals. There are several of these State-line areas, in which the prevailing rock is pure serpentine. Serpentine occurs also as the product of the alteration of the gabbros of the Elkton, Chassahowitz, and Iron Hill. The prevailing rock at Chestnut Hill and Iron Hill is gabbro in which serpentine is but one of the secondary constituents and is therefore not mapped separately.

Distribution.—With the serpentine are included certain dark rocks which are intimately associated with it and which, like it, are products of the alteration of pyroxenite or peridotite. Such rocks are hornblendite, actinolite, amphibolite, tremolite, or chlorite schists, enstatite-serpentine rocks, peridotite. Such rocks are hornblende, actinolite, anthophylite, and serpentine. In this region pegmatite dikes, in which the rocks consist mainly of coarse-grained feldspar, quartz, and mica, are very characteristic. They introduce the other features but are most abundant in the granite and schist, which is at some places quite altered by multiple pegmatitic injections. They range in width from a few inches to more than 10 feet. Only the larger and more persistent dikes have been traced. Several such pegmatite dikes are exposed along White Clay Creek, which has cut them into. The most northerly of these dikes, which strikes about N. 75° E., supplies in the lowlands, where the alkali feldspar has broken down into kaolin, the clay that is refined by the Newark China Clay Co. A mile to the northeast another kaolinized pegmatite is worked by the Beach Clay Co. Several small "spar" quarries in other pegmatites are worked only intermittently. In most of them the feldspar is chiefly a soda feldspar, though potash feldspar is found in some of them, and in the rock quarried 1½ miles northeast of McCallsville it is the chief feldspar. Tourmaline is a common accessory mineral in these pegmatites. In a spar quarry on Big Elk Creek, 15 miles southeast of McCallsville it is the chief feldspar. Tourmaline is a common accessory mineral in these pegmatites. In a spar quarry on Big Elk Creek, 15 miles southeast of McCallsville it is the chief feldspar. Tourmaline is a common accessory mineral in these pegmatites.


### PATUXENT FORMATION

**Areal distribution.** — In these quadrangles the Patuxent formation occurs in a series of disconnected areas that extend from the Patapsco-Washington quadrangles to the western part of the district. It is widespread, and is well exposed. In several places it is well exposed, especially in the Elkton-Washington and child adds to it, and the better indications of its former presence are not conclusive. Rounded pebbles and cobbles that may be of Patuxent age are aptly distributed over parts of the upland where only crystalline rocks are represented on the accompanying geologic maps.

The Patuxent formation is widely distributed in the Coastal Plain. It has been recognized almost continuously from Elkton, Md., to Richmond, Va., and is well exposed in many places along the principal streams of the Carolinas, Georgia, and Alabama.

**Lithology.** — The materials composing the Patuxent formation are extremely variable but are prevalently arenaceous. Abrupt alternations, both vertical and horizontal, of sand, gravel, and clay may be seen in almost every well-exposed section. At some places sand passes gradually into gravel or clay, but other sections transition zones of unlike materials are apparent, the contacts being decidedly sharp. Although the sands are typically white and consist of angular or subangular quartz grains, they are sometimes gray, and by their large content of kaolin.

The Patuxent formation is not composed of arkose, a rock which, when indurated, is designated as a "feldspathic sandstone." The sands also at many places contain much muscovite. In a well near Elkton, at a depth of 18 feet, a layer of distinctly micaceous white sand was penetrated in which many of the individual flakes were more than one-eighth inch in diameter.

The Patuxent sands are likely to be confused with the Pleistocene sands, from which, however, they can generally be distinguished by their more angular grains, their lighter color, their thinner character, due to the absence of particles of plastic clay, and by their large content of kaolin.

The gravel of the Patuxent formation occurs in horizons of which are as much as 20 feet thick but occupy small areas. A gravel band a few miles south of Bartlow's has been extensively worked and furnishes great quantities of material for the paramount road now being constructed. At many places near Lewis, Burkeville, and elsewhere, the underlying strata, which are predominantly composed of argillaceous clays and silt, are well exposed, and sand is cobbles 10 inches in diameter. The larger cobbles are obviously detrital in origin, but they may have been disintegrated from different geologic formations of the underlying crystalline rocks, especially in those composed of similar material. Although most of the pebbles and cobbles of the Patuxent formation are composed of vein quartz, which is found everywhere in the Patuxent Upland, the formation includes many pebbles of quartzite and sandstone, none of which contain Paleozoic fossils, and have therefore been brought from remote sources.

At现 place the matrix of the pebbles is a loose white to buff sand, but at a few it is decidedly ferrigenous and is well adapted for use as road metal. A ferruginous gravel bed a few miles south of Bartlow's has been extensively worked and furnishes great quantities of material for the paramount road now being constructed. Iron ore and carbonates are abundant in the Patuxent formation, and have been found in some of the Pleistocene deposits.

The sands, which are very commonly cross-bedded, are distinctively ferruginous. A short distance east of Bacon Hill a drift channel has been extensively used in the manufacture of brick. Half a mile south of Elkton is a bed of fine white sand, about 18 feet thick, containing some small flakes of muscovite. A slight rolling may be observed in places throughout the bed. In a clay pit 1/2 miles southwest of Leslie the upper layers are white to buff and contain numerous flakes of muscovite and a few angular quartz pebbles; beneath these layers is a minute 0.75 inch that grades downward into chocolate-colored to black clay in which are many pieces of lignite resembling charcoal.

Gravel layers are less numerous in the Patuxent formation than in the Patapsco, but they occur at all horizons and some of which are as firmly cemented as to form ferruginous sandstones and conglomerates, which are exposed at many places along the shore road between Elkton and Northeast. The Patuxent, although predominantly composed of highly colored sands, thus presents a wide range of constituents and character.

**Organic remains.** — The Patuxent deposits have yielded a few specimens of poorly preserved and unidentifiable remains, including representatives of the Pteridophyta, Cynoglossum, Gumnepeterae, and Angiospermae. The forms, cycads, and conifers that may be identified are, for the most part, the fossil remains of the Patuxent-Armel formation, some species being native to all three formations and the genera being largely identical. The few genera, Cynoglossum, Gumnepeterae, and Angiospermae are still common. Petrifaction remains of a species of Pinus are common in these deposits, as are also other genera such as Euspermum, Ctenis, and Angiospermae.

**Stratigraphic relations.** — The Patuxent formation rests upon the unconfomed surface of the crystalline rocks of the Patapsco Upland. The unconfomed contact is well exhibited in the cut just west of Childs station. When examined in the field for the greater part is free from the cover of Pleistocene gravels, yet strikingly similar in other respects. There are many extensive exposures in this bed, which is several miles wide and for the greater part is free from the cover of Pleistocene gravels, yet strikingly similar in other respects.
Zemites transversa and Sphenolepis dendrophylla have been collected from strata exposed on the flanks of Grays Hill.

None and correlation.—The Patapsco formation received its name from Patapsco River, Md., in whose valley it is typically developed. It is found in the Patuxent quadrangle and is bounded by the Potomac and the Patuxent Rivers.

Areal distribution.—The Raritan formation occurs in a series of outcrops that extend from Farnhurst southwestward to Boyds Mountain, Md., and Monument Mountain, Conn. It is found in many places in the region just south of Farnhurst, where the railroad has opened a great sand and gravel pit that exposes about 30 feet of outcrop. In the region to the southwest of this region the formation is therefore regarded as representing the initial deposits of the Upper Cretaceous.

The Raritan formation is well represented in the Ekkas and Wilmington quadrangles by strata that form the top of some of the hills on Elk Neck and are exposed in the valley of Bull Mountain. It crops out in the valley of Bull Mountain near milepost 74, the Magothy is not exposed, the Matawan iron deposits are loose, light-colored sands, which usually show fine laminated structure, and are particularly conspicuous and are relatively modern in aspect. The Raritan has yielded a considerable flora and a marine fauna. The flora, which was studied by Berry, contains 49 species that are peculiar to the Magothy in this country and one or two that are found also in Europe. The most common fossil plants of Cliffwood Point are imperfectly preserved, and some of the plant material is Radiola. The most common fossil plants of Cliffwood Point are imperfectly preserved, and some of the plant material is Radiola.

The animal remains obtained from the Magothy at Cliffwood Point and described by Williams (Am. Jour. Sci., vol. 21, pp. 26-28, 1902) include the remains of great numbers of crustaceans as well as shells of polyplacoid gastropods and cephalopods. The most abundant forms are the polyplacoids Trigonoceras sp., Paraxylocoelum sp., and the gastropods Pilocentrum subhastatum. These are of considerable interest, as for the exception of a few forms obtained from the1 Raritan in the same area, they are the latest marine fossils found in the deposits of the Atlantic Coastal Plain. Weller states that the species list is based on a distinct fauna, which more nearly resembles the fauna of the Magothy formation than any other.
null
Name and occurrence.—The formation was named from Monmouth County, New Jersey, a county that includes practically the entire series of Matawan beds. One of the sections given above shows a thickness of 54 feet.

Matawan formation

Areal distribution.—The Matawan formation is well represented by numerous outcrops along the streams in the southern third of the Wilmington quadrangle and in the southeast corner of the Elkton quadrangle. Over the division it is underlain by a thin cover of Pleistocene materials, but it appears at the surface along almost every stream in those areas. The best exposure occurs along the course of the Chesapeake & Delaware Canal between St. George and Summit Bridge. In its wider distribution the formation has been recognized by outcrops in many places in the eastern part of this area to Reedy River in New Jersey.

Lithology.—The formation is arenaceous and unconsolidated except where it is indurated by the segregation of ferruginous material derived from the glauconite. The sands range in color from reddish brown to dark green or nearly black. The fresh material invariably contains considerable glauconite, which gives to the deposits their dark color. The nacreous wavy sands generally range from rich brown to reddish brown, but at some places they are dark gray.

M. L. Goldman, who has studied in detail two samples of Matawan material from the south bank of the canal 1½ miles west of St. George, says that the original varieties consisted of round or ovate pebbles of glauconite and angular grains of quartz, most of them well sorted. The finer particles consist of quartz, glauconite, weathered feldspars, magnetite, iron garnet, and some of the bivalves, such as Lyra, Turbo, and Nassarius, with limonite, red rust, biotite, magnetite, staurolite, tourmaline, red that is often weathered, biotite, micas, and limonite; and sericite, hornblende, apatite, anthophyllite, kyanite, limonite, siderite, and much clay and ocherous carbonate and brown ferruginous clay. The particles of glauconite are usually fresh, and limonite was scarce, as it usually is in unweathered material. The ocherous material was evidently derived from soils of mollusks, which occur here in great numbers, though some of it may have been derived from the thin shells of Foraminifera that have now disappeared.

The Monmouth formation is a stratigraphic unit and is separated from the underlying and overlying formations by a definite change in lithology and fossils. The Monmouth formation is composed of sand and gravel, and the clays are chiefly of Pleistocene age and apparently indicate that it is the equivalent of a part of the Senonian of Europe.

The formation is characterized by a deposit of a light brown, coarse sand at the base of the formation, which is often a zone of ferruginous coating. The heterogeneous character of the deposit shows that it was derived from various sources. The pebbles of quartz and of crystalline rock which it contains were probably derived from the Piedmont region, and the brown iron oxides were derived mainly from the Cretaceous formations near by; and some of the minerals of the sands were derived from the Newark group. Most of the gravel consists of fragments of quartz.

The small proportion of sand in the Brandywine deposits seems to have been derived mainly from beds of the Potomac river. The sand at many places in the gravel deposits, but most of them are neither thick nor of great extent. The heterogeneous character of the deposit shows that it was derived from various sources. The pebbles of quartz and of crystalline rock which it contains were probably derived from the Piedmont region, and the brown iron oxides were derived mainly from the Cretaceous formations near by; and some of the minerals of the sands were derived from the Newark group. Most of the gravel consists of fragments of quartz.

The small proportion of sand in the Brandywine deposits seems to have been derived mainly from beds of the Potomac river. The sand at many places in the gravel deposits, but most of them are neither thick nor of great extent. The heterogeneous character of the deposit shows that it was derived from various sources. The pebbles of quartz and of crystalline rock which it contains were probably derived from the Piedmont region, and the brown iron oxides were derived mainly from the Cretaceous formations near by; and some of the minerals of the sands were derived from the Newark group. Most of the gravel consists of fragments of quartz.

The small proportion of sand in the Brandywine deposits seems to have been derived mainly from beds of the Potomac river. The sand at many places in the gravel deposits, but most of them are neither thick nor of great extent. The heterogeneous character of the deposit shows that it was derived from various sources. The pebbles of quartz and of crystalline rock which it contains were probably derived from the Piedmont region, and the brown iron oxides were derived mainly from the Cretaceous formations near by; and some of the minerals of the sands were derived from the Newark group. Most of the gravel consists of fragments of quartz.

The small proportion of sand in the Brandywine deposits seems to have been derived mainly from beds of the Potomac river. The sand at many places in the gravel deposits, but most of them are neither thick nor of great extent. The heterogeneous character of the deposit shows that it was derived from various sources. The pebbles of quartz and of crystalline rock which it contains were probably derived from the Piedmont region, and the brown iron oxides were derived mainly from the Cretaceous formations near by; and some of the minerals of the sands were derived from the Newark group. Most of the gravel consists of fragments of quartz.

The small proportion of sand in the Brandywine deposits seems to have been derived mainly from beds of the Potomac river. The sand at many places in the gravel deposits, but most of them are neither thick nor of great extent. The heterogeneous character of the deposit shows that it was derived from various sources. The pebbles of quartz and of crystalline rock which it contains were probably derived from the Piedmont region, and the brown iron oxides were derived mainly from the Cretaceous formations near by; and some of the minerals of the sands were derived from the Newark group. Most of the gravel consists of fragments of quartz.

The small proportion of sand in the Brandywine deposits seems to have been derived mainly from beds of the Potomac river. The sand at many places in the gravel deposits, but most of them are neither thick nor of great extent. The heterogeneous character of the deposit shows that it was derived from various sources. The pebbles of quartz and of crystalline rock which it contains were probably derived from the Piedmont region, and the brown iron oxides were derived mainly from the Cretaceous formations near by; and some of the minerals of the sands were derived from the Newark group. Most of the gravel consists of fragments of quartz.

The small proportion of sand in the Brandywine deposits seems to have been derived mainly from beds of the Potomac river. The sand at many places in the gravel deposits, but most of them are neither thick nor of great extent. The heterogeneous character of the deposit shows that it was derived from various sources. The pebbles of quartz and of crystalline rock which it contains were probably derived from the Piedmont region, and the brown iron oxides were derived mainly from the Cretaceous formations near by; and some of the minerals of the sands were derived from the Newark group. Most of the gravel consists of fragments of quartz.

The small proportion of sand in the Brandywine deposits seems to have been derived mainly from beds of the Potomac river. The sand at many places in the gravel deposits, but most of them are neither thick nor of great extent. The heterogeneous character of the deposit shows that it was derived from various sources. The pebbles of quartz and of crystalline rock which it contains were probably derived from the Piedmont region, and the brown iron oxides were derived mainly from the Cretaceous formations near by; and some of the minerals of the sands were derived from the Newark group. Most of the gravel consists of fragments of quartz.

The small proportion of sand in the Brandywine deposits seems to have been derived mainly from beds of the Potomac river. The sand at many places in the gravel deposits, but most of them are neither thick nor of great extent. The heterogeneous character of the deposit shows that it was derived from various sources. The pebbles of quartz and of crystalline rock which it contains were probably derived from the Piedmont region, and the brown iron oxides were derived mainly from the Cretaceous formations near by; and some of the minerals of the sands were derived from the Newark group. Most of the gravel consists of fragments of quartz.

The small proportion of sand in the Brandywine deposits seems to have been derived mainly from beds of the Potomac river. The sand at many places in the gravel deposits, but most of them are neither thick nor of great extent. The heterogeneous character of the deposit shows that it was derived from various sources. The pebbles of quartz and of crystalline rock which it contains were probably derived from the Piedmont region, and the brown iron oxides were derived mainly from the Cretaceous formations near by; and some of the minerals of the sands were derived from the Newark group. Most of the gravel consists of fragments of quartz.

The small proportion of sand in the Brandywine deposits seems to have been derived mainly from beds of the Potomac river. The sand at many places in the gravel deposits, but most of them are neither thick nor of great extent. The heterogeneous character of the deposit shows that it was derived from various sources. The pebbles of quartz and of crystalline rock which it contains were probably derived from the Piedmont region, and the brown iron oxides were derived mainly from the Cretaceous formations near by; and some of the minerals of the sands were derived from the Newark group. Most of the gravel consists of fragments of quartz.

The small proportion of sand in the Brandywine deposits seems to have been derived mainly from beds of the Potomac river. The sand at many places in the gravel deposits, but most of them are neither thick nor of great extent. The heterogeneous character of the deposit shows that it was derived from various sources. The pebbles of quartz and of crystalline rock which it contains were probably derived from the Piedmont region, and the brown iron oxides were derived mainly from the Cretaceous formations near by; and some of the minerals of the sands were derived from the Newark group. Most of the gravel consists of fragments of quartz.

The small proportion of sand in the Brandywine deposits seems to have been derived mainly from beds of the Potomac river. The sand at many places in the gravel deposits, but most of them are neither thick nor of great extent. The heterogeneous character of the deposit shows that it was derived from various sources. The pebbles of quartz and of crystalline rock which it contains were probably derived from the Piedmont region, and the brown iron oxides were derived mainly from the Cretaceous formations near by; and some of the minerals of the sands were derived from the Newark group. Most of the gravel consists of fragments of quartz.

The small proportion of sand in the Brandywine deposits seems to have been derived mainly from beds of the Potomac river. The sand at many places in the gravel deposits, but most of them are neither thick nor of great extent. The heterogeneous character of the deposit shows that it was derived from various sources. The pebbles of quartz and of crystalline rock which it contains were probably derived from the Piedmont region, and the brown iron oxides were derived mainly from the Cretaceous formations near by; and some of the minerals of the sands were derived from the Newark group. Most of the gravel consists of fragments of quartz.

The small proportion of sand in the Brandywine deposits seems to have been derived mainly from beds of the Potomac river. The sand at many places in the gravel deposits, but most of them are neither thick nor of great extent. The heterogeneous character of the deposit shows that it was derived from various sources. The pebbles of quartz and of crystalline rock which it contains were probably derived from the Piedmont region, and the brown iron oxides were derived mainly from the Cretaceous formations near by; and some of the minerals of the sands were derived from the Newark group. Most of the gravel consists of fragments of quartz.
The thickness of the Brandywine beds is sometimes very variable, but the maximum thickness in the Elkton quadrangle is about 35 feet.

Stratigraphic relations.—A very marked unconformably separate formation, the Brandywine, is seen at several places in the Coastal Plain. It overlies almost every older formation, and this means of it is seen here and there on the eastern border of the Piedmont Upland. In the Elkton quadrangle it rests at most places upon the Cenozoic formations, and in some places upon series of late Pleistocene and even upon the eastern border of the Piedmont Upland. In the Elkton quadrangle it rests at most places upon the Cenozoic formations, and in some places upon series of late Pleistocene and even upon the eastern border of the Piedmont Upland.

The Pleistocene formations of the Coastal Plain are included in the Columbia group. They consist of gravel, sand, and loam, and have many characteristics in common, and appear to be of similar origin. The Columbia group of Delaware, Maryland, and Virginia consists of the Brandywine, Wicomico, and Talbot, of which only the Wicomico and Talbot are extensively represented in this area. They cover the surface of different plains or terraces, which possess very definite topographic relations and are described on page 4.

The Pleistocene formations of the Coastal Plain can not be separated on purely palynologic grounds. The materials of all have been derived mainly from older neighboring formations, but they include more or less foreign material brought by streams from the Piedmont province or from the Appalachian Mountain region. The deposits of each of these formations are generally extremely varied, their differences being more marked with that of the underlying or neighboring formations. Thus, material borders, or the same formation may differ lithologically in different regions for more than material of two different formations that lie close to each other and to their common boundary, and the differences in these lithologic differences would therefore result in hopeless confusion. At some places the older Pleistocene deposits are more indurated and their pebbles are more decomposed than those of the later formations, but these differences can not be used as criteria for separating the formations, for each contains both loose and indurated and both fresh and decomposed material.

The fossils found in the Pleistocene deposits are too few to be of much service as a means of separating them into distinct formations. They occur only in the exceptional places of the deposits and are principally the remains of plants preserved in bogs, and any Cenozoic quadrangle these fossils contain great numbers of marine and estuarine mollusks.

The Columbia group may, very readily, be seen in a physiographic unit. The formations are the Cretaceous wave-built terraces or plains separated by wave-cut escarpments, their differences of form indicating different periods of deposition. At the bases of many of the escarpments the underlying Cenozoic and Tertiary formations are exposed. The highest of these terraces is the Holocene, the Pleistocene, the Middle and the Older Pleistocene.

At almost every place where good sections of the Pleistocene deposits are exposed they seem to be in a stage of incipiently buried. At a few places, however, some beds are sharply separated from the underlying terraces or plains by the bounding "Topographic divisions" (p. 4). At this terrace is now fragmental in its terraces, its original form is hard to determine, but if its base were extended until it united, the product would be a rather broad, featureless region, some miles wide, gently toward the ocean or toward the larger bodies of water, and separated by escarpments from the higher-lying late Brandywine and the older formations.

Of the Pleistocene formations in the Columbia group, the Sunderland formation is the one that has been best studied. The formation was named from the village of Sunderland, Calvert County, Md., near which it is most characteristic. It is a surface deposit, although locally it probably dips beneath beds of Pleistocene age.

The Sunderland formation is a surface deposit, although locally it probably dips beneath beds of Pleistocene age. Some of these unconformities disappear within short distances, but at some places, however, some beds are sharply separated and remnant from the underlying formations. As this terrace is now fragmental in its terraces, its original form is hard to determine, but if its base were extended until it united, the product would be a rather broad, featureless region, some miles wide, gently toward the ocean or toward the larger bodies of water, and separated by escarpments from the higher-lying late Brandywine and the older formations.

The fossils found in the Pleistocene deposits are too few to be of much service as a means of separating them into distinct formations. They occur only in the exceptional places of the deposits and are principally the remains of plants preserved in bogs, and any Cenozoic quadrangle these fossils contain great numbers of marine and estuarine mollusks.

The Columbia group may, very readily, be seen in a physiographic unit. The formations are the Cretaceous wave-built terraces or plains separated by wave-cut escarpments, their differences of form indicating different periods of deposition. At the bases of many of the escarpments the underlying Cenozoic and Tertiary formations are exposed. The highest of these terraces is the Holocene, the Pleistocene, the Middle and the Older Pleistocene.

At almost every place where good sections of the Pleistocene deposits are exposed they seem to be in a stage of incipiently buried. At a few places, however, some beds are sharply separated from the underlying terraces or plains by the bounding "Topographic divisions" (p. 4). At this terrace is now fragmental in its terraces, its original form is hard to determine, but if its base were extended until it united, the product would be a rather broad, featureless region, some miles wide, gently toward the ocean or toward the larger bodies of water, and separated by escarpments from the higher-lying late Brandywine and the older formations.

Of the Pleistocene formations in the Columbia group, the Sunderland formation is the one that has been best studied. The formation was named from the village of Sunderland, Calvert County, Md., near which it is most characteristic. It is a surface deposit, although locally it probably dips beneath beds of Pleistocene age.
Upland consists of clay, which in the vicinity of Ewell and West Junction is utilized in making brick. This clay is overwashed material derived from crystalline rocks and includes some rounded to angular quartz pebbles. The following section shows the general character of the Wicomico formation:

**TEXT continues from previous page**

- **Topographic expression.**—The Wicomico formation lies in a terrace which is described under the heading "Topographic divisions" (p. 4) in the Wicomico terrace. In adjacent regions this terrace is separated from the higher Sundiel terrace, by an escarpment generally more than 20 feet high, which forms a constant and striking topographic feature. In this area the escarp has been so greatly eroded that it is no longer recognizable. The Wicomico terrace in turn is at most places separated by an escarpment from the Talbot terrace, which spurs around it at a lower elevation. This escarpment also is less distinct in the Elkin and Wilmington quadrangles than in adjacent regions to the southwest. From the Sandebound-Wicomico surface line the surface of the Wicomico formation slopes gently toward the surrounding waters in the manner of a wave-like structure.

- **Layer of angular to subangular cobbles and boulders with a diameter of one to three inches, and from one to three inches thick, is present on a few of the terrace surfaces:**

**Additional text continues from previous page.**

- **Thickness.**—The Wicomico formation is not of uniform thickness because it was deposited on an uneven surface. It dips into the valleys and rises on the divides, and though its base at many places is as low as 40 feet and its top at other places is 50 feet above sea level, its thickness varies from about 15 feet to 50 feet, as appears from the figures. The surface of the Talbot formation has been less eroded than the lower part of the "Later Columbia" of McIvor and DuPont, which surface is more gently tilted than the upper surface of the Talbot formation. The Talbot formation has been less eroded than either the Sundiel-Talbot or Wicomico-Talbot series, which series have been elevated above the water for so long a time that the strata which have found their way across it have not materially changed the form of its original surface. The Talbot formation in the quarters has yielded a great number of nodules, which represent a varied marine and brackish-water fauna. In the Elkin and Wilmington quadrangles, however, the Talbot formation has less for yield fossils.

- **None and correlation.**—The Talbot formation was named from Talbot County, Md., where it occurs a broad terrace along the border of extensive estuaries. The Talbot terrace represents the lower part of the "Later Columbia" of McIvor and DuPont and corresponds approximately to the Cape May formation of Salisbury. Its Pleistocene age is proved by the fossils found in it at Fort Hill, the fossil that it was formed when the ice invaded the region to the north is shown by the numerous boulders it contains. In places where two terraces are in contact the Wicomico and Sundiel would be an easily definable formation.

- **Topographic expression.**—The Talbot formation is extensively represented along both sides of Delaware River, less well represented along Elk River, and sparingly represented along Northeast River. Along Delaware River it forms a broad terrace, 1 to 4 miles wide, extending from the Wicomico-Talbot series to the east of the surrounding waters and containing several miles up the larger tributary streams. It is not sharply separable from the Recent alluvial and marsh deposits that are so common along Delaware and Christiansen rivers. It covers the flats along Elk River but does not extend in the water edge, where Cretaceous strata are exposed at the base of the terrace. Where the Talbot overlie Upper Cretaceous deposits it has been much eroded and forms broad terraces, such as border Delaware River.

**Text continues from previous page.**

- **Vegetation.**—The Talbot formation consists of clay, sand, silt, and silt lime. Where the Talbot formation overlie the Upper Cretaceous sandstone it is more than 20 feet thick. Where the Talbot formation is less than 20 feet thick, it is covered by silt and silt lime, which makes the formation an obstacle to the Collins River. The sedimentary rocks have been subjected to numerous uplifts and depressions; but these movements have been so uniform over the large region that they appear to be the result of the same period of the pre-Cambrian era.
The Cretaceous formations of these quadrangles form a series of overlapping beds whose lines of outcrop trend in general northeast and southwest. With a few exceptions, already described in detail, each formation dips to the southeast at an angle greater than the slope of the surface, but none is so steep that it extends beneath the next younger formation. Thus successively younger beds are exposed from northwest to southeast. This succession is interrupted, however, by Chincoteague Island, which is a barrier beach built by deposition of silt and sand. Once a barrier beach, the formation has been eroded, and the underlying beds dip to the northwest. The dips described for these formations are practically horizontal over the greater part of the area, but in some places they show a slight dip toward the larger structures. This dip is to a few feet if anywhere different from zero.

The Piedmont Upland Area.

By P. Barnum

The Continental Plains of North America and the adjacent oceanic basins mark the earliest recognized sedimentary formations. The American Continental Plain has not been continuously above sea level, however, for since it was formed interior and bordering episoecial seas, in which sediments accumulated, have appeared, disappeared, and reappeared. During the period of greatest submergence more than 50 per cent of the Continental Plain was submerged, and at times within this period and other periods of less but still great submergence the American Continent was only a group of islands. The present continent of North America, which is almost coextensive with the Continental Plains, is of relatively recent origin.

The oldest formations in the Elkton-Wilmington district belong to the island stage of continental development, when a long narrow island or small continent extended along the eastern margin of the Piedmont Plateau and formed its western border. The formation is characterized by its great thickness, which is probably not less than 20,000 feet near Norfolk, Va., and Wilmington, N.C. (See Figs. 4 and 5.) No boring has been carried to the rock floor in the area here considered except at the inner margin of the Coastal Plain, so that the total thickness of the sediments and the dip of the bedrock surfaces here are unknown.

The Piedmont formations are practically horizontal over the greater part of the area, but in some places they show a slight dip toward the larger structures. This dip is in very few places if anywhere different from zero.

GEOLeGIC HISTORY.

The Piedmont Upland Area.

The oldest formations in the Elkton-Wilmington district belong to the island stage of continental development, when a long narrow island or small continent extended along the eastern margin of the Piedmont Plateau and formed its western border. The formation is characterized by its great thickness, which is probably not less than 20,000 feet near Norfolk, Va., and Wilmington, N.C. (See Figs. 4 and 5.) No boring has been carried to the rock floor in the area here considered except at the inner margin of the Coastal Plain, so that the total thickness of the sediments and the dip of the bedrock surfaces here are unknown.

The Piedmont formations are practically horizontal over the greater part of the area, but in some places they show a slight dip toward the larger structures. This dip is in very few places if anywhere different from zero.

The oldest formations in the Elkton-Wilmington district belong to the island stage of continental development, when a long narrow island or small continent extended along the eastern margin of the Piedmont Plateau and formed its western border. The formation is characterized by its great thickness, which is probably not less than 20,000 feet near Norfolk, Va., and Wilmington, N.C. (See Figs. 4 and 5.) No boring has been carried to the rock floor in the area here considered except at the inner margin of the Coastal Plain, so that the total thickness of the sediments and the dip of the bedrock surfaces here are unknown.

The Piedmont formations are practically horizontal over the greater part of the area, but in some places they show a slight dip toward the larger structures. This dip is in very few places if anywhere different from zero.

The oldest formations in the Elkton-Wilmington district belong to the island stage of continental development, when a long narrow island or small continent extended along the eastern margin of the Piedmont Plateau and formed its western border. The formation is characterized by its great thickness, which is probably not less than 20,000 feet near Norfolk, Va., and Wilmington, N.C. (See Figs. 4 and 5.) No boring has been carried to the rock floor in the area here considered except at the inner margin of the Coastal Plain, so that the total thickness of the sediments and the dip of the bedrock surfaces here are unknown.

The Piedmont formations are practically horizontal over the greater part of the area, but in some places they show a slight dip toward the larger structures. This dip is in very few places if anywhere different from zero.

The oldest formations in the Elkton-Wilmington district belong to the island stage of continental development, when a long narrow island or small continent extended along the eastern margin of the Piedmont Plateau and formed its western border. The formation is characterized by its great thickness, which is probably not less than 20,000 feet near Norfolk, Va., and Wilmington, N.C. (See Figs. 4 and 5.) No boring has been carried to the rock floor in the area here considered except at the inner margin of the Coastal Plain, so that the total thickness of the sediments and the dip of the bedrock surfaces here are unknown.

The Piedmont formations are practically horizontal over the greater part of the area, but in some places they show a slight dip toward the larger structures. This dip is in very few places if anywhere different from zero.

The oldest formations in the Elkton-Wilmington district belong to the island stage of continental development, when a long narrow island or small continent extended along the eastern margin of the Piedmont Plateau and formed its western border. The formation is characterized by its great thickness, which is probably not less than 20,000 feet near Norfolk, Va., and Wilmington, N.C. (See Figs. 4 and 5.) No boring has been carried to the rock floor in the area here considered except at the inner margin of the Coastal Plain, so that the total thickness of the sediments and the dip of the bedrock surfaces here are unknown.

The Piedmont formations are practically horizontal over the greater part of the area, but in some places they show a slight dip toward the larger structures. This dip is in very few places if anywhere different from zero.

The oldest formations in the Elkton-Wilmington district belong to the island stage of continental development, when a long narrow island or small continent extended along the eastern margin of the Piedmont Plateau and formed its western border. The formation is characterized by its great thickness, which is probably not less than 20,000 feet near Norfolk, Va., and Wilmington, N.C. (See Figs. 4 and 5.) No boring has been carried to the rock floor in the area here considered except at the inner margin of the Coastal Plain, so that the total thickness of the sediments and the dip of the bedrock surfaces here are unknown.

The Piedmont formations are practically horizontal over the greater part of the area, but in some places they show a slight dip toward the larger structures. This dip is in very few places if anywhere different from zero.

The oldest formations in the Elkton-Wilmington district belong to the island stage of continental development, when a long narrow island or small continent extended along the eastern margin of the Piedmont Plateau and formed its western border. The formation is characterized by its great thickness, which is probably not less than 20,000 feet near Norfolk, Va., and Wilmington, N.C. (See Figs. 4 and 5.) No boring has been carried to the rock floor in the area here considered except at the inner margin of the Coastal Plain, so that the total thickness of the sediments and the dip of the bedrock surfaces here are unknown.
peneplains and are everywhere lower than the associated remnants of these peneplains. This peneplain has been completely eroded from the Piedmont province in the Elkon-Wilmington district. If any vestige of it remains it lies adjacent to the present sedimentary coast of the Coastal Plain.

At the beginning of Tertiary time and before Honeybooks peneplain was completely obliterated the coast was uplifted and renewed erosion on the Kittatinny and Schooley peneplain remnants and started the dissection of the Honeybooks peneplain. This interval of erosion lasted long enough to develop the Harritsburp peneplain in the softer rocks along the courses of the master streams. Remnants of this peneplain are preserved on the Delaware south of Delaware Water Gap, on the Schuylkill north of Reading, on the Susquehanna northeast of Harrisburg, and on the Potomac west of Hagerstown. Remnants of the Harritsburg peneplain are believed to be preserved in the 500-foot summits in East Nottingham Township, in the northwest corner of the Elkon quadrangle, where later Tertiary sediments were probably deposited but have not been completely removed.

Below the surface of the Harritsburg peneplain there was cut another peneplain which records renewed uplift and erosion and which is preserved in the level terraced areas in the western part of the Elkon quadrangle. This peneplain, which carries only Brandywine deposition on its border, was soon submerged in the Elkon-Wilmington district, where sedimentation continued throughout Brandywine time. At the close of the early Brandywine epoch the district was again uplifted, and it may be that at this time a large part of the continental shelf rose above water and was slightly tilted seaward. The uplifted area was drained by small consequent streams, meandering course determined by the gentle tilt of the sediment-covered plateau. Chespense and Delaware bays did not exist until the close of the early Brandywine epoch, and they were cut channels into the newly formed deposits. Flats and lakes formed in these areas, which served as reservoirs of water supply. The presence of numerous谦thear superposed terraced valleys, which, though not continuously connected with one another, show considerable evidence of subsidence and elevation. These terraced valleys are typical of Brandywine time. Between these terraced valleys and their connecting flats lie the Brandywine peneplains, level terraced areas covered by Brandywine sediments. The conditions which prevailed during Brandywine time were repeated during this period of submergence, in which the Patapsco formation was laid down. In Patapsco time diastylite deposits were very rare and were primitive in structure, but in Patapsco time they were accumulated and spread by other types. The change in the character of the form seems to indicate that a long time intervened between these periods of deposition. After Patapsco deposition the region again became land by an upward movement which drained all the terraces and marshes and established the Brandywine surface. This uplift closed the Lower Cretaceous epoch.

During the Lower Cretaceous epoch the Kittatinny and Schooley peneplain remnants were probably formed on the adjacent land, but there is no evidence to permit the tracing of the exact corollary of these peneplains of the Piedmont province with periods of deposition and erosion in the Coastal Plain. From Iron Hill, Chestnut Hill, and Grays Hill persisted as scarp-like features in the latter region which was probably a submerged area during Brandywine time. Some of the peneplain remnants of this period may also have been begun at this time.

Up to this time the streams were able to erode extensively the Brandywine deposits found anywhere on the floor of crystalline rocks in the Coastal Plain. In Patapsco and Raritan times the streams were probably able to erode the outlying terraces of the Coastal Plain and to cut channels into the newly formed deposits. The Patapsco and Raritan deposits were laid down in estuaries and along the shoreline. The streams were not able to erode through the Brandywine deposits, and the only indication of the presence of these deposits is the later Coastal Plain sediments. The widespread formation of shallow-water deposits, everywhere except in the Brandywine deposits, indicates a large submergence, during which the Patapsco sediments were laid down below the surface of the Early Cretaceous peneplain.

The widespread formation of shallow-water deposits, everywhere except in the Brandywine deposits, indicates a large submergence, during which the Patapsco sediments were laid down below the surface of the Early Cretaceous peneplain. This submergence was not sufficient to spread the ocean waters over the entire area. The absence of Eocene and Miocene deposits in the Coastal Plain indicates that these deposits were not sufficiently great to spread the ocean waters over the entire area. The absence of Eocene and Miocene deposits in the Coastal Plain indicates that these deposits were not sufficiently great to spread the ocean waters over the entire area.
Sunderland, Wicomico, and Talbot formations, which make up this group, are exposed in a series of terraces that are arranged in steps along the Atlantic Coastal Plain from Barataria Bay to southern Virginia and even further south.

The key to the relations between these surficial deposits is the correct correlation of the terraces. Much light may be thrown on these relations by a careful study of the Sunderland that is now submerged on the shores of the Atlantic Ocean and along Chesapeake Bay and farther east than now, and the present submerged channels of the continental shelf were probably eroded then. The Sunderland submergence.

At some places in the old stream channels the deposits are so thick that the streams in the succeeding period of elevation and erosion found it easier to excavate new courses than to follow the old ones. Generally, however, the streams encountered their former course and cut new ones which had been interrupted by the Talbot submergence. As a result of this erosion the Talbot terraces are now in many places far higher than the present streams. Large parts of the Delaware River basin have been smoothed and rolled over by the ocean, and new terraces are formed. These terraces were cut before the Talbot submergence again occurred, so that the ocean waters once more encroached on the land. As the seacoast was lowered, its lower edge was more exposed to the wave action, and the ocean again cut in new courses. The geological history of Talbot time was a repetition of those of Sunderland and Wicomico time. The Talbot formation was not deposited over as large an area as that covered by the Wicomico, and it was confined to the valleys and on the low stream divides, where the advancing waves destroyed the Wicomico deposits. The sea cliffs were pushed back as long as the wave advance and stood as an escarpment which marks the boundary of the Talbot sea and estuaries. This Talbot-Wicomico escarpment, which has already been described (p. 14), now lies about 40 feet above sea level and furnishes evidence of the post-Talbot elevation. -

The Sunderland and Wicomico formations were extensively eroded by the ocean, showing that blocks of ice bearing detritus carried from the land drifted out and deposited their load over the lower part of the Talbot sea.

At some places in the old stream channels the deposits were so thick that the streams in the succeeding period of erosion and elevation found it easier to excavate new courses than to follow the old ones. Generally, however, the streams encountered their former course and cut new ones which had been interrupted by the Talbot submergence. As a result of this erosion the Talbot terraces are now in many places far higher than the present streams. Large parts of the Delaware River basin have been smoothed and rolled over by the ocean, and new terraces are formed. These terraces were cut before the Talbot submergence again occurred, so that the ocean waters once more encroached on the land. As the seacoast was lowered, its lower edge was more exposed to the wave action, and the ocean again cut in new courses. The geological history of Talbot time was a repetition of those of Sunderland and Wicomico time. The Talbot formation was not deposited over as large an area as that covered by the Wicomico, and it was confined to the valleys and on the low stream divides, where the advancing waves destroyed the Wicomico deposits. The sea cliffs were pushed back as long as the wave advance and stood as an escarpment which marks the boundary of the Talbot sea and estuaries. This Talbot-Wicomico escarpment, which has already been described (p. 14), now lies about 40 feet above sea level and furnishes evidence of the post-Talbot elevation. -

The Sunderland and Wicomico formations were extensively eroded by the ocean, showing that blocks of ice bearing detritus carried from the land drifted out and deposited their load over the lower part of the Talbot sea.

At some places in the old stream channels the deposits were so thick that the streams in the succeeding period of erosion and elevation found it easier to excavate new courses than to follow the old ones. Generally, however, the streams encountered their former course and cut new ones which had been interrupted by the Talbot submergence. As a result of this erosion the Talbot terraces are now in many places far higher than the present streams. Large parts of the Delaware River basin have been smoothed and rolled over by the ocean, and new terraces are formed. These terraces were cut before the Talbot submergence again occurred, so that the ocean waters once more encroached on the land. As the seacoast was lowered, its lower edge was more exposed to the wave action, and the ocean again cut in new courses. The geological history of Talbot time was a repetition of those of Sunderland and Wicomico time. The Talbot formation was not deposited over as large an area as that covered by the Wicomico, and it was confined to the valleys and on the low stream divides, where the advancing waves destroyed the Wicomico deposits. The sea cliffs were pushed back as long as the wave advance and stood as an escarpment which marks the boundary of the Talbot sea and estuaries. This Talbot-Wicomico escarpment, which has already been described (p. 14), now lies about 40 feet above sea level and furnishes evidence of the post-Talbot elevation. -

The Sunderland and Wicomico formations were extensively eroded by the ocean, showing that blocks of ice bearing detritus carried from the land drifted out and deposited their load over the lower part of the Talbot sea.

At some places in the old stream channels the deposits were so thick that the streams in the succeeding period of erosion and elevation found it easier to excavate new courses than to follow the old ones. Generally, however, the streams encountered their former course and cut new ones which had been interrupted by the Talbot submergence. As a result of this erosion the Talbot terraces are now in many places far higher than the present streams. Large parts of the Delaware River basin have been smoothed and rolled over by the ocean, and new terraces are formed. These terraces were cut before the Talbot submergence again occurred, so that the ocean waters once more encroached on the land. As the seacoast was lowered, its lower edge was more exposed to the wave action, and the ocean again cut in new courses. The geological history of Talbot time was a repetition of those of Sunderland and Wicomico time. The Talbot formation was not deposited over as large an area as that covered by the Wicomico, and it was confined to the valleys and on the low stream divides, where the advancing waves destroyed the Wicomico deposits. The sea cliffs were pushed back as long as the wave advance and stood as an escarpment which marks the boundary of the Talbot sea and estuaries. This Talbot-Wicomico escarpment, which has already been described (p. 14), now lies about 40 feet above sea level and furnishes evidence of the post-Talbot elevation. -

The Sunderland and Wicomico formations were extensively eroded by the ocean, showing that blocks of ice bearing detritus carried from the land drifted out and deposited their load over the lower part of the Talbot sea.

At some places in the old stream channels the deposits were so thick that the streams in the succeeding period of erosion and elevation found it easier to excavate new courses than to follow the old ones. Generally, however, the streams encountered their former course and cut new ones which had been interrupted by the Talbot submergence. As a result of this erosion the Talbot terraces are now in many places far higher than the present streams. Large parts of the Delaware River basin have been smoothed and rolled over by the ocean, and new terraces are formed. These terraces were cut before the Talbot submergence again occurred, so that the ocean waters once more encroached on the land. As the seacoast was lowered, its lower edge was more exposed to the wave action, and the ocean again cut in new courses. The geological history of Talbot time was a repetition of those of Sunderland and Wicomico time. The Talbot formation was not deposited over as large an area as that covered by the Wicomico, and it was confined to the valleys and on the low stream divides, where the advancing waves destroyed the Wicomico deposits. The sea cliffs were pushed back as long as the wave advance and stood as an escarpment which marks the boundary of the Talbot sea and estuaries. This Talbot-Wicomico escarpment, which has already been described (p. 14), now lies about 40 feet above sea level and furnishes evidence of the post-Talbot elevation. -
metal the character of the traffic must be considered; hard, tough rock does not always give the best results. With light traffic relatively soft material that has good cementing value will produce under wear sufficient binding material to keep the road in good condition; under the same amount of wear hard rock will fail to maintain the supply of binding material and will finally form a loose stony roadway.

### Physical tests of garnets, granites, and gabbros

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Water absorption (in weight percent)</th>
<th>Specific gravity</th>
<th>Hardness</th>
<th>Index of Refraction</th>
<th>Gemological Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garnet</td>
<td>0.1 - 0.5</td>
<td>2.7 - 2.8</td>
<td>7</td>
<td>1.71 - 1.75</td>
<td>Good</td>
</tr>
<tr>
<td>Granite</td>
<td>0.5 - 1.0</td>
<td>2.6 - 2.7</td>
<td>6</td>
<td>1.54 - 1.58</td>
<td>Poor</td>
</tr>
<tr>
<td>Gabbro</td>
<td>1.0 - 1.5</td>
<td>2.9 - 3.0</td>
<td>5</td>
<td>1.53 - 1.56</td>
<td>Good</td>
</tr>
</tbody>
</table>

### Physical tests of garnet, granite, and gabbro

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Garnet</th>
<th>Granite</th>
<th>Gabbro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>Brown</td>
<td>White</td>
<td>Dark</td>
</tr>
<tr>
<td>Texture</td>
<td>Cubic</td>
<td>Prismatic</td>
<td>Columnar</td>
</tr>
<tr>
<td>Cleavage</td>
<td>None</td>
<td>Perfect</td>
<td>None</td>
</tr>
<tr>
<td>Hardness</td>
<td>7</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>2.7 - 2.8</td>
<td>2.6 - 2.7</td>
<td>2.9 - 3.0</td>
</tr>
</tbody>
</table>

### Analysis of washed kaolin from Northeast, Cecil County, Md.

<table>
<thead>
<tr>
<th>Mineral</th>
<th>SiO₂</th>
<th>Al₂O₃</th>
<th>Fe₂O₃</th>
<th>CaO</th>
<th>MgO</th>
<th>K₂O</th>
<th>Na₂O</th>
<th>Loss on Ignition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garnet</td>
<td>58.05</td>
<td>6.8</td>
<td>1.8</td>
<td>1.9</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>20.36</td>
</tr>
<tr>
<td>Granite</td>
<td>20.36</td>
<td>11.0</td>
<td>2.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>20.36</td>
</tr>
</tbody>
</table>

### Soil

The soils of the upland area of the Elkton-Wilmington district, exclusive of the overlapping Coastal Plain material, are residuum - that is, they are derived from the underlying rocks by the action of the atmosphere, ground water, and other natural agents. The soil is mellow, well-drained, and free from subsoil or subterranean water. It is a good soil for all kinds of crops.

### Mines

The greatest part of the sand and gravel was separated from the clay by the usual method and discarded. The washed product was used in making paper. The composition of the washed sand and gravel is such as to allow about 30 per cent of the quantity mined, is shown by the following analysis, obtained from the Maryland Clay Co.

<table>
<thead>
<tr>
<th>Mineral</th>
<th>SiO₂</th>
<th>Al₂O₃</th>
<th>Fe₂O₃</th>
<th>CaO</th>
<th>MgO</th>
<th>K₂O</th>
<th>Na₂O</th>
<th>Loss on Ignition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garnet</td>
<td>58.05</td>
<td>6.8</td>
<td>1.8</td>
<td>1.9</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>20.36</td>
</tr>
</tbody>
</table>

### Plant

One of the four kaolin mines is 1/2 miles east of Corner Ketch, in the northwest corner of the Wilmington quadrangle, whereas, the pegmatite and gabbro. The Peach Co. of Newark, Del., has been operating here since 1918. However, four of these mines have been reopened and one was being worked near the Conowingo barrens. These names are those used for wash on slopes, the distribution of the rocks indicates a general way the distribution of the soils.

### Tree

The soils of the Elkton-Wilmington district, exclusive of the overlapping Coastal Plain material, are residuum - that is, they are derived from the underlying rocks by the action of the atmosphere, ground water, and other natural agents. The soil is mellow, well-drained, and free from subsoil or subterranean water. It is a good soil for all kinds of crops.

### Water

The soils of the Elkton-Wilmington district, exclusive of the overlapping Coastal Plain material, are residuum - that is, they are derived from the underlying rocks by the action of the atmosphere, ground water, and other natural agents. The soil is mellow, well-drained, and free from subsoil or subterranean water. It is a good soil for all kinds of crops.
The Cecil clay covers the relatively level central and southern parts of the uplands which are underlaid by granodiorite. It is a yellow sandy, clayey loam, which contains particles of the parent rock and grades into the granodiorite at a depth of 2 to 3 feet. This soil is fairly productive but is deficient in plant-food value, which should be supplied by the addition of manures. Grass, wheat, corn, and tobacco are the chief products of this soil, which yields fair average crops. The Cecil clay is found wherever gabbros, pyroxene, or peridotite is the underlying rock, and therefore forms the soil of the northeastern and southwestern parts of the Elkton-Wilmington quadrangles that cap the outlying Chestnut, Iron, Gray, and Elk hills. Gabbro is the most massive rock of the district and, like all truly massive rocks, weather into spherical boulders, which are therefore characteristic features of the Cecil clay. These boulders, which are known as "rigger-boulders," are rather conspicuous in an area that elsewhere contains little rock debris.

The Cecil clay, which is at least five or more than one deep, is a heavy clay loam and is distinguished, especially when wet, by its deep-red color. It is a "strong" soil, capable of standing hard farming and it may be brought to a higher state of productivity with less fertilizing than any other soil in the district. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The soil called the Conowingo barrens occupies a very small area in the Elkton-Wilmington district. It is found only east of the arctic basin in the northwest part of the Elkton quadrangle. Though this soil is in texture most nearly related to that of the Cecil clay, yet it has been worked intermittently. It is a light-yellow clay till and is nearly everywhere very shallow. It contains a large percentage of mud and almost entirely contains chaff, or phyllosilicate clay. Its fertility is due not alone to its lack of nutritive ingredients but even to a greater degree, perhaps, to its shallowness and to its incipient infertility in relation to its depth. The dark-colored clay generally contains small pieces of lithified stones, which resemble small pebbles of silts used in the manufacture of firebrick. One firm makes a specialty of fire brick for lining stoves. This clay is dug from small openings and is hauled to cars to be used in the vicinity of Northeast. The Cecil clay formation furnishes a variety of clays, which have been dug at many places. Some of this clay is used for shipbuilding and for the manufacture of fire brick. The clay is said to be especially adapted to the manufacture of terra cotta.

The Elkton-Wilmington district and also caps the outlying Chestnut, Iron, peridotite is the underlying rock, and therefore forms the soil heads," are rather conspicuous in an area that elsewhere contains little rock debris. These boulders, which are known as "nigger-boulders," are rather conspicuous in an area that elsewhere contains little rock debris. These boulders, which are known as "nigger-boulders," are rather conspicuous in an area that elsewhere contains little rock debris. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-Wilmington. The same crops are produced upon this soil as upon the Elkton-W菏泽.
also in the parts of the Elkton and Wilmington quadrangles that lie in Delaware. These soils have been called the Sassafras loam, Norfolk sand, Patapsco clay, Susquehanna gravel, Elkton clay, and generally heavier than the soil. The subsoils are at some depth of Pleistocene formations and in part from the clays of Lower Cretaceous deposits that has a subsoil composed of weathering by which it has lost much of its plasticity.

The soils consist of 5 to 10 inches of light-yellow loam, which is light and fine from atss and gravel and therefore easy to cultivate, and is underlain by yellow loam, generally heavier than the soil. The subsoils are at some places several feet deep and are everywhere at least 26 inches deep and generally grade into beds of gravel and sand. These soils are fertile and productive and can be brought to a high state of cultivation. They are nearly everywhere naturally well drained, but in some of the more level parts of the uplands they are swampy and would be much benefited by thorough underdrainage.1

These soils are deep and widespread on the flat areas north and west of Iron Hill and in the vicinity of Sassafras. Norfolk sand.—The soils known as the Norfolk sand cover a large area of the Elkton and Wilmington quadrangles and are often those of any other type. They are composed almost entirely of Pleistocene materials, which cover the bed, but divides between the major streams east of Elk River and the lower parts of Elk Neck and differ from the Sassafras loam soils in containing a greater proportion of sand and gravel.

Sassafras loam.—The Sassafras loam consists of reddish and brown sands, 8 to 12 inches deep, which overlie subsoils consisting of reddish or yellow loams with gravelly horizons much lower than the sands, and in them generally more compact. On the surface at some places there are pebbles of well-rounded quartz gravel, ranging in size from 1 to 6 inches. On the steeper slopes around the outer margin of the upland the bed of the terrace is composed of gravelly horizons quite a few feet thick, which underlaid the Norfolk sand soils, and thus include their plastic horizons.2

The Norfolk sand soils are less productive than the Sassafras loam but are nevertheless excellently cultivated. As they consist of large quantities of sand and gravel these soils are decidedly porous and are better adapted to growing truck and small fruits than grass, wheat, and corn.

Susquehanna gravel.—The Susquehanna gravel lies on its vestige in the upper parts of the Patapsco and Elkton formations. These coarse parts of the deposits have become concentrated at the surface through the removal of the finer parts. They are best exhibited on Elk Neck. The soil varies somewhat in its composition but nearly everywhere contains a high percentage of large well-rounded quartz gravel, the pebbles of which range in diameter from one-half to several inches. To a depth of 5 inches the soil is a gravel loam, beneath which its content of gravel increases so much that it can hardly be penetrated with a soil auger. The underlying gravel beds are at places completely cemented together by a red cement that is of great firmness. At many places on Elk Neck the soil is thickly strewn with great blocks or boulders of these ferruginous conglomerates, many of which are several feet in diameter. The gravel in the central part of Cecil County may be deeply stained with iron rust, whereas those in adjoining localities may be bleached perfectly white. The gravel gravel and of the formation, at places exceeding 10 feet. The unworked gravel of this zone are seldom seen on the more gentle slopes. These soils are deep and widespread on the flat areas north and west of Iron Hill and in the vicinity of Sassafras. Norfolk sand.—The soils known as the Norfolk sand cover a large area of the Elkton and Wilmington quadrangles and are often those of any other type. They are composed almost entirely of Pleistocene materials, which cover the bed, but divides between the major streams east of Elk River and the lower parts of Elk Neck and differ from the Sassafras loam soils in containing a greater proportion of sand and gravel.

1 Maryland Geol. Survey, Cecil County, p. 240, 1902.

2 Idem, p. 245.

3 Idem, pp. 240-244.
The available flow of Brandywine Creek for a period of ten years ranges from a maximum of 402 second-feet to a minimum of 42 second-feet, and average 225 second-feet. The city owns half the rights of the stream and is entitled to half the available flow.

The average color of the raw water for six years (1911-1917) is 21.2 parts per million as measured by the platinum-iodide standard, the average alkalinity is 7.5 parts per million, and the average chloride content is 0.4 parts per million. The water delivered by the filters is sterilized by the use of liquid chlorine; its average color in the filtered state is practically zero.

The average turbidity during a period of seven years (1911-1917) of Brandywine Creek is 30.8 parts per million, and the average chlorine content is 0.4 parts per million. The water delivered by the filters is sterilized by the use of liquid chlorine; its average color in the filtered state is practically zero.

The average hardness of the raw water for six years (1911-1917) is 38.4 parts per million, and the average turbidity is 21.2 parts per million as measured by the platinum-iodide standard, the average alkalinity is 7.5 parts per million, and the average chloride content is 0.4 parts per million. The water delivered by the filters is sterilized by the use of liquid chlorine; its average color in the filtered state is practically zero.

The average turbidity during a period of seven years (1911-1917) is 21.2 parts per million as measured by the platinum-iodide standard, the average alkalinity is 7.5 parts per million, and the average chloride content is 0.4 parts per million. The water delivered by the filters is sterilized by the use of liquid chlorine; its average color in the filtered state is practically zero.

The average turbidity during a period of seven years (1911-1917) is 21.2 parts per million as measured by the platinum-iodide standard, the average alkalinity is 7.5 parts per million, and the average chloride content is 0.4 parts per million. The water delivered by the filters is sterilized by the use of liquid chlorine; its average color in the filtered state is practically zero.

The average turbidity during a period of seven years (1911-1917) is 21.2 parts per million as measured by the platinum-iodide standard, the average alkalinity is 7.5 parts per million, and the average chloride content is 0.4 parts per million. The water delivered by the filters is sterilized by the use of liquid chlorine; its average color in the filtered state is practically zero.

The average turbidity during a period of seven years (1911-1917) is 21.2 parts per million as measured by the platinum-iodide standard, the average alkalinity is 7.5 parts per million, and the average chloride content is 0.4 parts per million. The water delivered by the filters is sterilized by the use of liquid chlorine; its average color in the filtered state is practically zero.

The average turbidity during a period of seven years (1911-1917) is 21.2 parts per million as measured by the platinum-iodide standard, the average alkalinity is 7.5 parts per million, and the average chloride content is 0.4 parts per million. The water delivered by the filters is sterilized by the use of liquid chlorine; its average color in the filtered state is practically zero.

The average turbidity during a period of seven years (1911-1917) is 21.2 parts per million as measured by the platinum-iodide standard, the average alkalinity is 7.5 parts per million, and the average chloride content is 0.4 parts per million. The water delivered by the filters is sterilized by the use of liquid chlorine; its average color in the filtered state is practically zero.

The average turbidity during a period of seven years (1911-1917) is 21.2 parts per million as measured by the platinum-iodide standard, the average alkalinity is 7.5 parts per million, and the average chloride content is 0.4 parts per million. The water delivered by the filters is sterilized by the use of liquid chlorine; its average color in the filtered state is practically zero.

The average turbidity during a period of seven years (1911-1917) is 21.2 parts per million as measured by the platinum-iodide standard, the average alkalinity is 7.5 parts per million, and the average chloride content is 0.4 parts per million. The water delivered by the filters is sterilized by the use of liquid chlorine; its average color in the filtered state is practically zero.

The average turbidity during a period of seven years (1911-1917) is 21.2 parts per million as measured by the platinum-iodide standard, the average alkalinity is 7.5 parts per million, and the average chloride content is 0.4 parts per million. The water delivered by the filters is sterilized by the use of liquid chlorine; its average color in the filtered state is practically zero.

The average turbidity during a period of seven years (1911-1917) is 21.2 parts per million as measured by the platinum-iodide standard, the average alkalinity is 7.5 parts per million, and the average chloride content is 0.4 parts per million. The water delivered by the filters is sterilized by the use of liquid chlorine; its average color in the filtered state is practically zero.

The average turbidity during a period of seven years (1911-1917) is 21.2 parts per million as measured by the platinum-iodide standard, the average alkalinity is 7.5 parts per million, and the average chloride content is 0.4 parts per million. The water delivered by the filters is sterilized by the use of liquid chlorine; its average color in the filtered state is practically zero.

The average turbidity during a period of seven years (1911-1917) is 21.2 parts per million as measured by the platinum-iodide standard, the average alkalinity is 7.5 parts per million, and the average chloride content is 0.4 parts per million. The water delivered by the filters is sterilized by the use of liquid chlorine; its average color in the filtered state is practically zero.
wells at Fort Dupont failed to obtain any water in the forma-
tion though they passed entirely through the strata into under-
lying formations. For this reason no predictions concerning
water supplies can be made in regions where the Magesty is
developed.

In New Jersey artesian water has been obtained from the
green sand deposits of the Monmouth and Matawan formations.

The beds are generally more porous than the beds of the
Middle Aragonite or the Poconos group and contains fewer
clay beds in the strata, which are more readily to lower
levels. At Fort Delaware the water obtained at 100 and 146
feet apparently comes from the Monmouth.

Data in regard to the deep wells in the Coastal Plain in the
Elkton and Wilmington quadrangles are given in the table
below.

<table>
<thead>
<tr>
<th>Location</th>
<th>Depth to water</th>
<th>Water bearing formation</th>
<th>Depth in water</th>
<th>Yield per minute</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cherrytown</td>
<td>358</td>
<td>Palisades</td>
<td>73</td>
<td>75</td>
<td>Good water</td>
</tr>
<tr>
<td>Upper part of Elk Neck</td>
<td>358</td>
<td>Palisades</td>
<td>31</td>
<td>35</td>
<td>Good water</td>
</tr>
<tr>
<td>Elk Neck</td>
<td>408</td>
<td>Palisades</td>
<td>31</td>
<td>35</td>
<td>Good water</td>
</tr>
<tr>
<td>Do*</td>
<td>408</td>
<td>Palisades</td>
<td>31</td>
<td>35</td>
<td>Good water</td>
</tr>
<tr>
<td>Horse Corners*</td>
<td>310</td>
<td>Palisades</td>
<td>31</td>
<td>35</td>
<td>Good water</td>
</tr>
<tr>
<td>Parsuncet*</td>
<td>310</td>
<td>Palisades</td>
<td>31</td>
<td>35</td>
<td>Good water</td>
</tr>
<tr>
<td>New Castle*</td>
<td>310</td>
<td>Palisades</td>
<td>31</td>
<td>35</td>
<td>Good water</td>
</tr>
<tr>
<td>Two miles north of New Castle*</td>
<td>310</td>
<td>Palisades</td>
<td>31</td>
<td>35</td>
<td>Good water</td>
</tr>
<tr>
<td>Fort Delaware*</td>
<td>310</td>
<td>Palisades</td>
<td>31</td>
<td>35</td>
<td>Good water</td>
</tr>
<tr>
<td>Do*</td>
<td>310</td>
<td>Palisades</td>
<td>31</td>
<td>35</td>
<td>Good water</td>
</tr>
<tr>
<td>Fort Delaware*</td>
<td>310</td>
<td>Palisades</td>
<td>31</td>
<td>35</td>
<td>Good water</td>
</tr>
<tr>
<td>Do*</td>
<td>310</td>
<td>Palisades</td>
<td>31</td>
<td>35</td>
<td>Good water</td>
</tr>
</tbody>
</table>

* U. S. Geol. Survey Bull. 90, 1898.

There is seldom any noticeable current in the strata, and
such as is known is caused by the tide and appears to be nearly
as strong as when moving upstream as when moving in the
opposite direction. The average mean tide at Delaware City
is 6 feet, and the extreme is 10 feet. At Chesapeake City
is much farther from the mouth of Chesapeake Bay than Dela-
ware City is from the outlet of Delaware Bay, high tide at
one place is almost exactly synchronous with low tide at
the other.

Chesapeake & Delaware Canal.—Much traffic between Phil-
adelphia and Baltimore and other points passes through the
Chesapeake & Delaware Canal, which, as its name suggests,
connects Delaware and Chesapeake bays. The canal is 153
miles long and extends from Delaware City, on Delaware
River, to Chesapeake City, on Back Creek, a tributary of Elk
River. Water was let into it on July 4, 1829. The canal cost
$2,260,000, of which $400,000 was paid by the United States,
$1,000,000 by Pennsylvania, $500,000 by Maryland, $250,000
by Delaware, and the remainder by citizens of the three contributing
States. A look at Delaware City maintains a level of 7.68 feet
above mean low tide in Delaware River between Delaware City
and St. Georges, a distance of 4.38 miles, and locks at St.
Georges and Chesapeake City maintain the assent level of
17.23 feet above mean low tide at Chesapeake City between
those two places, a distance of 9.23 miles. The original width
of the canal at the water line was 60 feet, the width at the
bottom 56 feet, and the depth 10 feet. The depth of excur-
sion at the summit of the divide, known as Deep Cut, was
75 feet.

No hard rocks were encountered in the excavation, as the
region through which it passed underlies by unconsolidated
clays, sands, and gravels belonging to the Cretaceous and
Quaternary systems. Several times during the construction of
the canal and later, when the canal had been filled with
water, there have been landslides in Cut Deep, and dredging
must be done annually to keep the channel clear.

The plan to convert this waterway into an enlarged tides-
level canal has long been discussed, and three investigations
have been made by the Federal Government to determine the
feasibility of the plan. Berlings in several places show that
the strata below the prism are similar to those exposed in
Deep Cut.