OPEN-FILE MAP OFM 73

INTRODUCTION

Surficial materials in the New Jersey part of the Bristol quadrangle include artificial fill and fluvial, glaciofluvial, eolian, estuarine, and salt-marsh deposits. They are as much as 70 feet thick beneath and adjacent to the Delaware River but are generally less than 30 feet thick elsewhere. They record seven main periods of deposition, separated by six episodes of valley erosion. The deposits are described below. The age of the deposits and the episodes of valley erosion are shown on the correlation chart. The underlying bedrock and Coastal Plain formations were mapped by Owens and Minard (1964).

DESCRIPTION OF MAP UNITS

- ARTIFICIAL FILL--Sand, silt, gravel, clay; gray to brown; demolition debris (concrete, brick, wood, metal, etc.), cinders, ash, slag, glass. Unstratified to weakly stratified. As much as 20 feet thick. Chiefly in highway and railroad embankments and filled marshes and flood plains. Many small areas of fill, particularly along streams in urban areas, are not mapped. Extent of fill based in part on position of shorelines and salt marshes shown on topographic manuscript map sheets 54 and 58 (N. J. Geological Survey, c. 1880).
- DREDGE SPOILS--Fine-to-medium sand, silty fine-to-medium sand, minor and white clay, and fragments of schist and gneiss. Gravel consists chiefly of white to gray quartz and quartzite, gray siltstone and sandstone, minor gray chert and gneiss, and minor red siltstone and sandstone. Unstratified to weakly stratified, locally thinly bedded to laminated. May contain minor amounts of demolition debris. As much as 30 feet thick. In disposal cells along the Delaware River. Consist largely of sediment excavated from units Qm and Qwf, and from the underlying Potomac Formation of Cretaceous age, and from schist and gneiss bedrock, during dredging of ship channels.
- TRASH FILL--Trash mixed and covered with silt, clay, sand, and minor gravel.

 As much as 60 feet thick is colid assets by 1811 and 1811 an As much as 60 feet thick. In solid-waste landfills. Small areas of trash fill may be included within artificial fill.
- Qal ALLUVIUM--Sand, silt, minor clay and peat; brown, yellowish-brown, gray; and pebble gravel. Contains varied amounts of wood and fine organic matter. Sand and silt are unstratified to weakly stratified. Gravel occurs in unstratified to weakly stratified beds generally less than 2 feet thick. Sand consists chiefly of quartz with some glauconite, gray siltstone fragments, and mica. Gravel consists chiefly of white, gray, and yellow-stained quartz and quartzite, and a trace of gray siltstone and chert. Sand and gravel beds may be locally cemented with iron. Total thickness of deposit as much as 15 feet. Deposited in modern flood plains and stream channels, and in former flood plains and channels now covered by salt-marsh and estuarine deposits. Beneath the Delaware River, alluvium underlies estuarine deposits (unit Qm) but cannot be distinguished lithically from the underlying and adjoining glaciofluvial deposit (unit Qwf) and so is included with Qwf on sections AA' and BB'.
- SALT-MARSH AND ESTUARINE DEPOSITS--Silt, sand, peat, clay; brown, dark-brown, gray, black; and minor pebble-to-cobble gravel. Contain abundant organic matter. As much as 30 feet thick. Deposited in salt marshes, tidal flats, and tidal channels during Holocene sea-level rise, chiefly within the past 10,000
- Qst POSTGLACIAL STREAM-TERRACE DEPOSIT--Fine-to-medium sand, minor coarse sand and silt; yellowish-brown, brown, grayish-brown. May include pebble-to-cobble gravel at base. Sand and gravel composition as in unit Qwf. As much as 20 feet thick (estimated). Forms terrace at Newbold Island with a surface 5-10 feet above the Delaware estuary. Deposited by the Delaware River as it downcut into deposit Qwf in postglacial time, about 15,000 to 10,000 years ago. Deposit is a veneer on a strath cut into unit Qwf.

This deposit was mapped as part of "Graywacke 1" by Owens and Minard (1975) and was included with the "Van Sciver Lake beds" by Owens and Minard (1979), who considered the beds to be interglacial estuarine deposits of Sangamonian age. Newell and others (2000) also mapped the deposit as the "Van Sciver Lake beds" but considered it to be a fluvial or glaciofluvial deposit of late Wisconsinan age. Because this deposit lies upon a terrace eroded into the glaciofluvial deposits, and is in turn overlain by the modern estuarine deposit, it is a postglacial alluvial deposit. Because the age and origin of the deposit differ from those proposed for the "Van Sciver Lake beds", that name is not used here.

- Qe EOLIAN DEPOSITS--Fine-to-medium sand, yellowish-brown to very pale brown. Sand consists chiefly of quartz with some glauconite and gray siltstone fragments, and minor mica. As much as 15 feet thick. These are windblown sediments forming low dunes, derived from underlying and adjacent surficial
- GLACIOFLUVIAL DEPOSIT--Fine-to-medium sand, minor coarse sand; yellowish-brown, light reddish-brown, grayish-brown; pebble gravel, minor cobble gravel. Sand consists chiefly of quartz and gray siltstone fragments with a little glauconite, feldspar, and a few red siltstone fragments. Gravel consists chiefly of white and gray quartz and quartzite, gray siltstone and sandstone, minor red siltstone and sandstone, and minor gray chert and gneiss. As much as 50 feet thick. Laid down by glacial meltwater descending the Delaware Valley during the late Wisconsinan glaciation, about 20,000 to 15,000 years ago. Forms a terrace along the Delaware River with a surface elevation of 25 feet in the Florence area, declining to 15 feet in the Burlington area.

This deposit was informally termed the "Trenton Gravel" by Cook (1880) and Lewis (1880). It was later mapped as "Graywacke 1" and "Graywacke 2" by Owens and Minard (1975) and named the "Van Sciver Lake" and "Spring Lake" beds by Owens and Minard (1979). "Graywacke 1" and "Van Sciver Lake beds" refer to deposits forming the lowest terrace in the Trenton area, which is equivalent to unit Qst here. "Graywacke 2" and "Spring Lake beds" refer to deposits forming the higher terrace in the Trenton area, which is equivalent to unit Qwf here. Lewis (1880), Owens and Minard (1979), Berg and others (1980), and Newell and others (2000), applied the names "Trenton Gravel", "Spring Lake beds", and "Van Sciver Lake beds" to sediments now known to include glaciofluvial, interglacial estuarine, and postglacial alluvial deposits. Because these deposits are mapped separately here as units Qwf, Qcm2, and Qst, respectively, the names "Trenton Gravel", "Spring Lake beds", and "Van Sciver Lake beds" are not used.

LOWER STREAM-TERRACE DEPOSITS--Fine-to-coarse sand, minor silt; yellow, yellowish-brown light grave pebble gravel. Sand consists ships and consists ships are consists and consists ships and consists ships are consists and consists are consists are consists and consists are consists and consists are consists and consists are consists and consists are consists and consists are consists are consists are consists and consists are consists are consists and consists are consists are consists are consists and consists are consists are consistent and consists are consists and consists are consistent and consists are consistent are consistent and consists are consistent are consistent are consistent and consists are consistent are consistent are consistent are consistent and consists are consistent and consists are consistent are consistent are consistent and consists are consistent are consistent and consists are consistent and consistent are consis yellow, yellowish-brown, light gray; pebble gravel. Sand consists chiefly of quartz, with some glauconite, and minor gray siltstone fragments and mica. Gravel consists chiefly of white, gray, and yellow-stained quartz and quartzite. As much as 40 feet thick in the East Burlington area, generally less than 10 feet thick elsewhere. Form stream terraces with surfaces 5 to 15 feet above modern

flood plains.

UPPER STREAM-TERRACE DEPOSITS--Fine-to-medium sand, minor silt and coarse sand; yellow, reddish-yellow, brownish-yellow, light-gray, locally olive-yellow; pebble gravel. Sand consists chiefly of quartz with some glauconite, gray siltstone fragments, minor mica and a trace of red siltstone fragments and feldspar. Gravel consists chiefly of white, gray, and yellowstained quartz and quartzite. As much as 40 feet thick. The deposits form a fluvial plain in the Delaware Valley between Kinkora and East Burlington, with a surface elevation of 55 to 35 feet, and form stream terraces in tributary valleys that are on grade with the plain in the Delaware Valley. The surfaces of the tributary terraces are 15 to 30 feet above modern flood plains. The plain and terraces grade downvalley to, or are onlapped by, the Cape May Formation, unit 2 (unit Qcm2), and so are contemporaneous with, or slightly older than, the Cape May 2.

minor coarse sand and silt; yellow, brownish-yellow, reddish-yellow, very pale brown, light gray; minor pebble gravel, trace of cobble gravel. Unstratified to well-stratified. Sand consists of quartz with a little glauconite and a trace of mica, feldspar, and gray siltstone fragments. Gravel consists chiefly of white, gray, and yellow-stained quartz and quartzite, and a trace of gray and red siltstone and sandstone. As much as 30 feet thick. The Cape May Formation, unit 2 (Qcm2) (Newell and others, 2000) forms a terrace with a maximum surface elevation of about 35 feet. Fossils, pollen, and amino-acid racemization ratios in shells from this unit elsewhere in the Delaware estuary and Delaware Bay area indicate that it is an estuarine or fluvial-estuarine deposit of Sangamon age (about 125,000 years ago), when sea level was 20 to 30 feet higher than at present in this region (Woolman, 1897; Newell and others, 1995; Lacovara, 1997; Wehmiller, 1997). The Cape May Formation, unit 1 (Qcm1) (Newell and others, 1995) is an older estuarine or fluvial-estuarine deposit of uncertain age that forms an extensively eroded terrace with a top elevation of about 70 feet. Patches of slightly glauconitic yellowish-brown fine-to-medium sand occur as veneers on surfaces higher than this terrace, at elevations as high as 100 feet. These are included in unit Qcm1 but they may consist of windblown or slopewash deposits rather than estuarine and fluvial-estuarine sediments. Because unit Qcm1 is at higher elevation than Sangamon-age deposits, it was laid down during a pre-Sangamon interglacial sea-level highstand and is of early or middle Pleistocene age (Lacovara, 1997; O'Neal and McGeary, 2002). Areas symboled as "Qe-Qcm1/Tp" indicate extent of Cape May Formation, unit 1, and eolian deposits, less than 5 feet thick overlying Pensauken Formation.

CAPE MAY FORMATION (Salisbury and Knapp, 1917)--Fine-to-medium sand,

Salisbury and Knapp (1917) included stream-terrace and glaciofluvial deposits within the Cape May Formation; here they are mapped separately as the upper and lower stream-terrace deposits (units Qtl and Qtu) and glaciofluvial deposit (unit Qwf) because they differ in age and origin from the Cape May Formation. In Pennsylvania, deposits correlative with the Cape May are mapped as "Trenton Gravel" (Berg and others, 1980). As described above for unit Qwf, the "Trenton Gravel" at its type area is a glaciofluvial deposit, not an interglacial estuarine deposit. Because the glaciofluvial and interglacial estuarine deposits are mapped

PENSAUKEN FORMATION (Salisbury and Knapp, 1917)--Fine-to-coarse sand to clayey sand, minor silt and very coarse sand; reddish-yellow to yellow; pebble gravel. Unstratified to well stratified, commonly with tabular, planar cross-beds in sand. Pebble gravel occurs as thin layers (generally less than 3 inches thick) within the sand and as thicker, unstratified beds in places at the base of the formation, where it may include cobble gravel. Sand consists chiefly of quartz

separately here, the name "Trenton Gravel" is not used.

VERTICAL EXAGGERATION 40X

with some feldspar, mica, and glauconite, and a few rock fragments (chert and shale) (Bowman and Lodding, 1969; Owens and Minard, 1979). The feldspar is partially or fully weathered to white clay. Gravel consists chiefly of yellow, reddish-yellow (from iron-staining), white, or gray quartz and quartzite; a little brown to gray chert and reddish-brown ironstone; and a trace of brown, reddishbrown, and gray sandstone and shale, and white-to-gray gneiss. The chert, sandstone, shale, and gneiss commonly are partially weathered or fully decomposed. As much as 40 feet thick. Occurs as erosional remnants capping uplands. Elevation of the base of the deposit ranges from 90 to 100 feet in the Jacksonville area to 60 to 70 feet in the belt trending southwestward from Kinkora through Bustleton, Springside, and Deacons, to Willingboro, with a channel as low as 30 feet at Rancocas. The variation in basal elevation records thickening of the deposit towards the axis of the Delaware Valley, which roughly coincides with the former axis of the Pensauken river valley, and northeastsouthwest-trending fluvial channeling into the underlying substrate of Coastal Plain formations. Regional paleoflow data (Owens and Minard, 1979; Martino, 1981; Stanford and others, 2002), and the provenance of the sand and gravel in the formation, indicate that the Pensauken was deposited by a large river flowing southwesterly from the New York City area to the Delmarva Peninsula. The map area is in the southeastern part of the former river valley.

The age of the Pensauken is not firmly established. Berry and Hawkins (1935) describe plant fossils from the Pensauken near New Brunswick, New Jersey that they consider to be of early Pleistocene age. Owens and Minard (1979) assign a late Miocene age based on correlation with units in the Delmarva Peninsula. Pollen from a black clay bed within the Pensauken near Princeton, New Jersey, includes cool-temperate species and a few pre-Pleistocene taxa. This assemblage suggests a Pliocene age (Stanford and others, 2002). The Pensauken is overlain by late Pliocene or early Pleistocene till in Somerset County, New Jersey, and lies in a valley deeply eroded into middle and late Miocene marine and fluvial deposits. These relationships indicate a Pliocene age (Stanford, 1993).

- UPLAND GRAVEL—Medium-to-coarse sand, reddish-yellow to reddish-brown, and pebble gravel. Unstratified, iron-cemented in places. Sand and gravel consist of quartz. As much as 10 feet thick. Caps summit of Mount Holly, above an elevation of 160 feet. Erosional remnant of a fluvial deposit older than the Pensauken Formation.
- Qwcp OUTCROP OF COASTAL PLAIN FORMATIONS--Exposed formations of Cretaceous age. Soil zone generally includes some lag pebbles from eroded surficial deposits. May include thin, patchy colluvial, alluvial, or eolian sediments less than 3 feet thick.

MAP SYMBOLS

- Contact--Solid where well-defined by landforms; dashed where approximate; short-dashed where featheredged or gradational; dotted where exposed in former
- •27-5069 Thickness of surficial material in well or boring--Location accurate to within 200 feet. Upper number is identifier; lower number is thickness in feet of surficial material, inferred from driller's or engineer's log. Where multiple surficial units were penetrated, the depth (in feet below land or water surface) of the base of the unit is indicated next to the unit symbol. A ">" indicates that base of unit was not reached at depth shown. Identifiers of the form 27-xxxx or 28xxxx are well permits issued by the N. J. Department of Environmental Protection, Bureau of Water Allocation. Identifiers prefixed by P, R, and NJ are test borings for the Pennsylvania Turnpike bridge. Identifiers prefixed by CB and TP are test borings for channel dredging made by the U. S. Army Corps of Engineers. Identifiers prefixed by B and BC are test borings on file at the N. J. Geological Survey. Identifiers of the form 27-xx-xxx are N. J. Atlas Sheet coordinates of records of wells or borings in the permanent note collection of the N. J. Geological Survey.
- 27-4750 Thickness of surficial material in well or boring--Location accurate to within 500 feet. Identifiers and thickness values as above
- A20 Thickness of surficial material in power-auger boring--From Owens and Minard (1964).
- 100 Thickness of surficial material in former sand and gravel pit--From Owens and Minard (1964).
- Surficial material observed in exposure, excavation, or hand-auger hole.
- 15▲ Thickness of surficial material observed in former exposure--From permanent note collection of the N. J. Geological Survey.
- Fluvial scarp--Line at top, ticks on slope. Marks late Wisconsinan channel cut into upper stream terrace deposits by Assicunk Creek near Burlington.
- **Excavation perimeter--**Line at limit of large excavation.
- Slump scarp and block--Line at base of scarp, barbs on slope. Slump block lies between base of scarp and river. Slump is in Potomac Formation clay along Delaware River in Florence.
- **★ Sand pit**--Inactive in 2004.
- Shallow topographic basin--Line at rim, pattern in basin. Depth generally less than 5 feet. Most were formed by melting of permafrost about 18,000 to 15,000 years ago. Some may have formed from wind erosion. Drawn from air photos taken in 1979.

REFERENCES

Berg, T. W., Edmunds, W. E., Geyer, A. R., Glover, A. D., Hoskins, D. M., MacLachlan, D. B., Root, S. I., Sevon, W. D., and Socolow, A. A., compilers, 1980, Geologic map of Pennsylvania: Pennsylvania Geologic Survey, Fourth Series, scale 1:250,000, 2 sheets.

Berry, E. W., and Hawkins, A. C., 1935, Flora of the Pensauken Formation in New Jersey: Geological Society of America Bulletin, v. 46, p. 245-252.

Bowman, J. F., and Lodding, William, 1969, The Pensauken Formation--a Pleistocene fluvial deposit in New Jersey, in Subitzky, Seymour, ed., Geology of selected areas in New Jersey and eastern Pennsylvania and guidebook of excursions: New Brunswick, N. J., Rutgers University Press, p. 3-6.

Cook, G. H., 1880, Surface geology--report of progress: N. J. Geological Survey Annual Report for 1880, p. 14-97.

Lacovara, K. J., 1997, Definition and evolution of the Cape May and Fishing Creek formations in the middle Atlantic Coastal Plain of southern New Jersey: unpublished PhD dissertation, University of Delaware, Newark, Delaware, 243 p.

Lewis, H. C., 1880, The Trenton Gravel and its relation to the antiquity of man: Proceedings of the Academy of Natural Sciences of Philadelphia, Part 2, April to September 1880, p. 296-309.

Pensauken formations in southern New Jersey: unpublished PhD dissertation, Rutgers University, New Brunswick, N. J., 299 p.

Newell, W. L., Powars, D. S., Owens, J. P., and Schindler, J. S., 1995, Surficial

Martino, R. L., 1981, The sedimentology of the late Tertiary Bridgeton and

geologic map of New Jersey: southern sheet: U. S. Geological Survey Open File Map 95-272, scale 1:100,000.

Newell, W. L., Powars, D. S., Owens, J. P., Stanford, S. D., and Stone, B. D.,

2000, Surficial geologic map of central and southern New Jersey: U. S.

Geological Survey Miscellaneous Investigations Map I-2540-D, scale 1:100,000. New Jersey Geological Survey, c. 1880, Topographic map sheets 54 and 58:

unpublished maps on file at N. J. Geological Survey: scale 1:21,120.

Quaternary Science Reviews, v. 21, p. 929-940.

O'Neal, M. L., and McGeary, S., 2002, Late Quaternary stratigraphy and sealevel history of the northern Delaware Bay margin, southern New Jersey, USA: a ground penetrating radar analysis of composite Quaternary coastal terraces:

Owens, J. P., and Minard, J. P., 1964, Pre-Quaternary geology of the Bristol quadrangle, New Jersey-Pennsylvania: U. S. Geological Survey Geologic Quadrangle Map GQ-342, scale 1:24,000.

the Trenton area, New Jersey and Pennsylvania: U. S. Geological Survey Miscellaneous Investigations Map I-884, scale 1:48,000.

Owens, J. P., and Minard, J. P., 1979, Upper Cenozoic sediments of the lower Delaware valley and northern Delmarva Peninsula, New Jersey, Pennsylvania, Delaware, and Maryland: U. S. Geological Survey Professional Paper 1067D,

Salisbury, R. D., and Knapp, G. N., 1917, The Quaternary formations of southern New Jersey: N. J. Geological Survey Final Report, v. 8, 218 p.

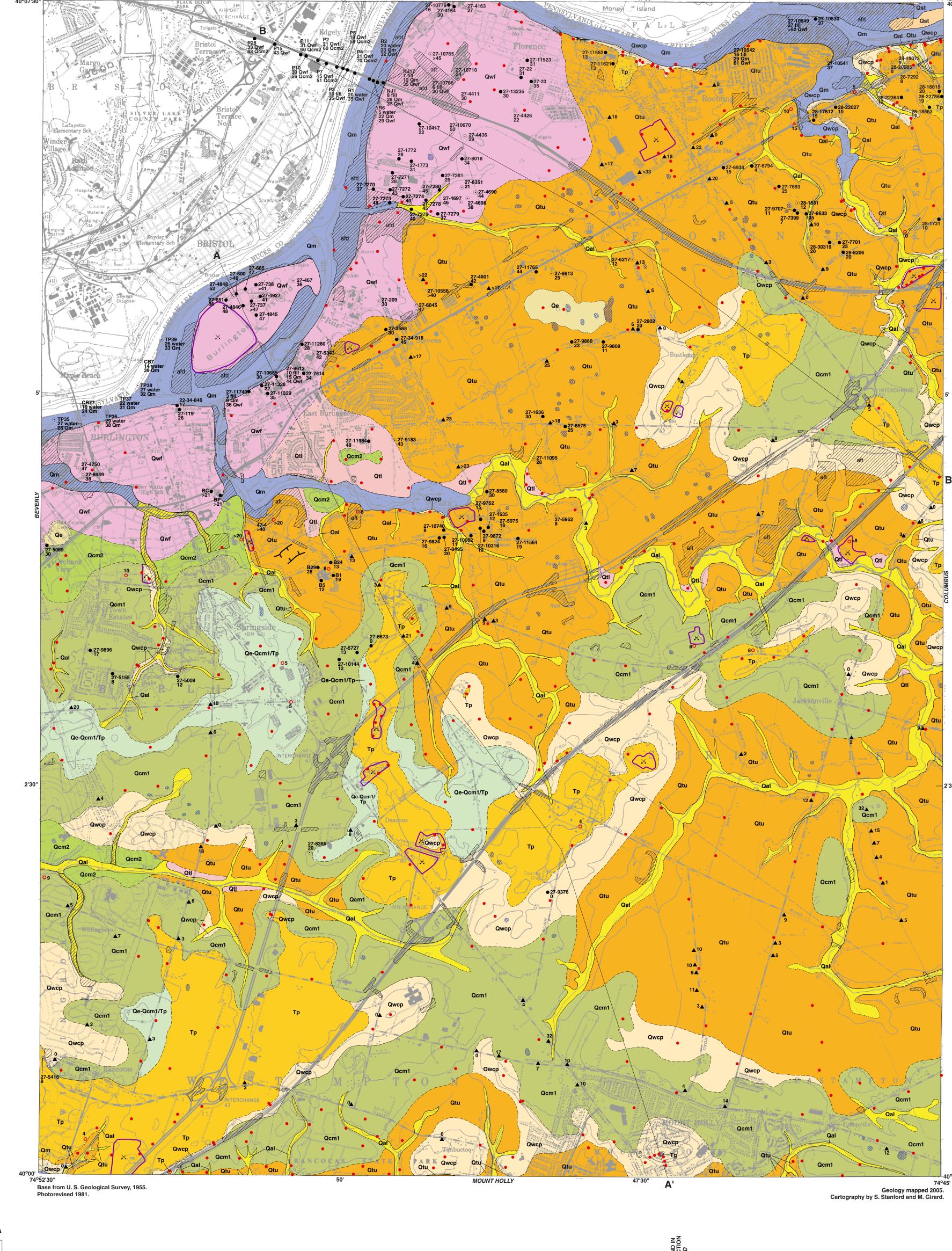
Stanford, S. D., 1993, Late Cenozoic surficial deposits and valley evolution of unglaciated northern New Jersey: Geomorphology, v. 7, p. 267-288. Stanford, S. D., Ashley, G. M., Russell, E. W. B., and Brenner, G. J., 2002, Rates

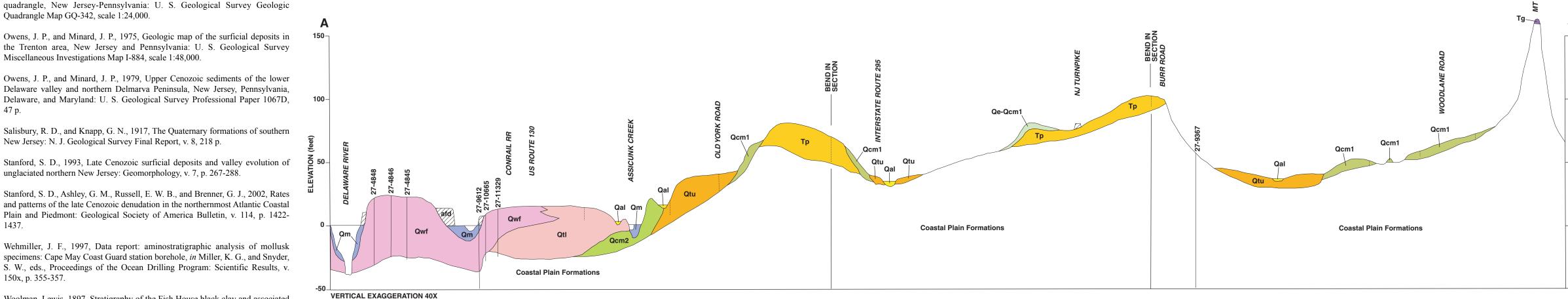
and patterns of the late Cenozoic denudation in the northernmost Atlantic Coastal

Plain and Piedmont: Geological Society of America Bulletin, v. 114, p. 1422-

Wehmiller, J. F., 1997, Data report: aminostratigraphic analysis of mollusk specimens: Cape May Coast Guard station borehole, in Miller, K. G., and Snyder, S. W., eds., Proceedings of the Ocean Drilling Program: Scientific Results, v.

Woolman, Lewis, 1897, Stratigraphy of the Fish House black clay and associated

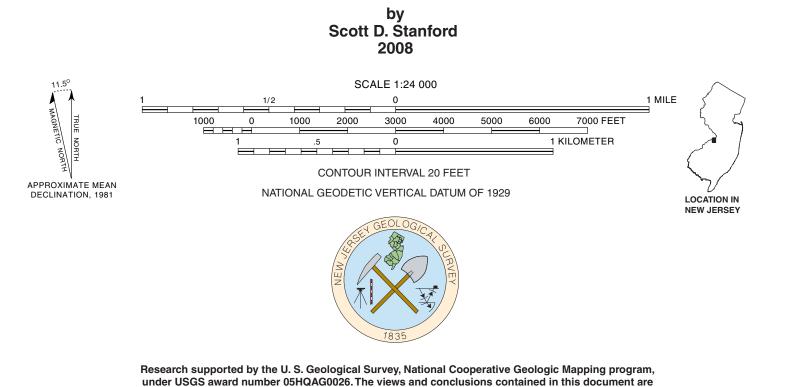




gravels: N. J. Geological Survey Annual Report for 1896, p. 201-254. **Coastal Plain Formations Coastal Plain Formations**

150x, p. 355-357.

SURFICIAL GEOLOGY OF THE BRISTOL QUADRANGLE **BURLINGTON COUNTY, NEW JERSEY**



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