DEPARTMENT OF ENVIRONMENTAL PROTECTION
WATER RESOURCES MANAGEMENT
NEW JERSEY GEOLOGICAL AND WATER SURVEY

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U. S. GEOLOGICAL SURVEY
NATIONAL GEOLOGIC MAPPING PROGRAM

SURFICIAL GEOLOGY OF THE CASSVILLE QUADRANGLE
OCEAN AND MONMOUTH COUNTIES, NEW JERSEY
OPEN-FILE MAP OFM 129

## INTRODUCTION

The Cassville quadrangle is on the northwestern edge of the Pine Barrens region of the New Jersey Coastal Plain, in the south-central part of the state. Surficial deposits in the quadrangle include river, wetland, estuarine, hillslope, and windblown sediments of late Miocene to Holocene age. The surficial deposits overlie Coastal Plain bedrock formations (fig. 1), which are unconsolidated to semi-consolidated marine and coastal sediments that dip gently (10-50 feet/mile) to the southeast (Sugarman and others, in preparation). Most of the quadrangle is underlain by the Cohansey Formation. The Cohansey is a middle Miocene quartz sand with a few thin clay beds. The Kirkwood Formation, a silty-clayey fine sand of early and middle Miocene age, underlies the Cohansey and crops out in the northern and western parts of the quadrangle. The Vincentown Formation, a glauconitic quartz sand of late Paleocene age, and the Hornerstown Formation, a glauconite clay of early Paleocene age, underlie the Kirkwood and crop out in the Lahaway Creek valley in the northwestern corner of the quadrangle. The Cohansey is permeable and forms dry uplands vegetated by pine and oak forest and wet seepage-fed lowlands vegetated by maple and cedar forest. The other formations are less permeable and support hardwood forest, or mixed hardwood and pine forest, and some crop farming.

The Cohansey Formation includes beach, nearshore, bay, and marsh sediments deposited when sea level was, at times, more than 200 feet higher than at present in this region. As sea level lowered after the Cohansey was laid down, rivers flowing on the emerging Coastal Plain deposited the Beacon Hill Gravel, forming a broad regional river plain. With continued lowering of sea level, the regional river system shifted to the west of the quadrangle, and local streams began to erode into the Beacon Hill plain and rework the Beacon Hill Gravel. Through the latest Miocene, Pliocene, and Quaternary, stream and hillslope sediments were deposited in several stages as valleys were progressively deepened by stream incision, and widened by seepage erosion.

A summary of the geomorphic history of the quadrangle as recorded by surficial deposits and landforms is provided below. The age of the deposits and episodes of valley erosion are shown on the correlation chart. Surficial sand and gravel, and sand in the underlying Cohansey Formation, have been dug for aggregate and fill in many pits in the quadrangle. These pits are shown by outline and symbol on the map. Only one was active at the time of mapping.

## SURFICIAL DEPOSITS AND GEOMORPHIC HISTORY

Sea level in the New Jersey region began a long-term decline following deposition of the Cohansey Formation. As sea level lowered, the inner continental shelf emerged as a coastal plain. River drainage was established on this plain. The Beacon Hill Gravel is the earliest record of this drainage. The Beacon Hill is weathered quartz-chert gravel that caps the highest hills in the Coastal Plain. It has been entirely eroded away in the Cassville quadrangle. The base of the Beacon Hill is at an elevation of 320 feet near Clarksburg (Stanford, 2000a), about 10 miles north of Colliers Mills, and at an elevation of 190 feet near Woodmansie, 12 miles south of Colliers Mills (Stanford, 2010a). This descending grade places the Beacon Hill above an elevation between 290 and 250 feet from north to south across the quadrangle, above the height of the highest hills. Regionally, cross-beds, slope of the deposit, and gravel provenance indicate that the Beacon Hill was deposited by rivers draining southward from the Valley and Ridge province in northwestern New Jersey and southern New York (Owens and Minard, 1979; Stanford, 2010b).

Also indicative of southward flow are rare chert pebbles containing coral, brachiopod, and pelecypod fossils of Devonian age found in the Beacon Hill Gravel and in upland gravels reworked from the Beacon Hill. These fossils indicate that some of the rivers feeding the Beacon Hill drained from north of what is now Kittatinny and Shawangunk Mountains in northwestern New Jersey and adjacent New York state, where chert-bearing Devonian rocks crop out.

Continued decline of sea level through the late Miocene and early Pliocene (approximately 8 to 3 Ma; “Ma” = million years ago) caused the regional river system to erode into the Beacon Hill plain. As it did, it shifted to the west of the Cassville quadrangle. The area of the quadrangle became an upland from which local streams drained eastward to the Atlantic Ocean or westward to what is now the Delaware River valley. These local streams eroded shallow valleys into the Beacon Hill Gravel. Groundwater seepage, slope erosion, and channel erosion reworked the gravel and deposited it in floodplains, channels, and pediments, between 20 and 50 feet below the level of the former Beacon Hill plain. These deposits are mapped as upland gravel, high phase (unit Tg). Today, owing to topographic inversion, they cap hilltops on the Delaware-Toms River divide above elevations of 190 to 200 feet. On the broad part of this upland on the southern edge of the quadrangle, the gravel is more continuous and in places its base descends to 140-150 feet in elevation. Overall, the base of the gravel descends in a southerly direction, indicating a southerly paleoflow like that in the Beacon Hill (purple arrows on figure 1).

A renewed period of lowering sea level in the Pliocene and early Pleistocene (approximately 3 Ma to 800 ka; “ka” = thousand years ago) led to another period of valley incision. Groundwater seepage and channel and slope erosion reworked the upland gravel and deposited the upland gravel, lower phase (unit TQg) in shallow valleys 20 to 50 feet below the upland gravel, high phase. These deposits today cap interfluves and, on the Delaware-Toms River divide upland, form extensive mantles in head-of-valley areas and upper slopes. The base of these deposits descends from an elevation of 180 to 190 feet on the divide upland to an elevation of 90 to 120 feet in valleys on the east and west edges of the quadrangle. Stream drainage at this time, inferred from the elevation of the interfluve deposits, is shown by red arrows on figure 1. This drainage shows that the general location of present-day valleys was established by the early Pleistocene.

Continuing stream incision in the middle and late Pleistocene (about 800 to 20 ka) formed the modern valley network. Sediments laid down in modern valleys include upper and lower terrace deposits (units Qtuo, Qtu, and Qtl), upper and lower colluvium (Qcu, Qcl) inactive deposits in dry valleys (unit Qald), and active floodplain and wetland (Qal, Qals) deposits in valley bottoms. Like the upland gravels, the terrace and floodplain deposits represent erosion, transport, and redeposition of sand and gravel reworked from older surficial deposits and the Coastal Plain bedrock formations by streams, groundwater seepage, and slope processes. Wetland deposits are formed by accumulation of organic matter in swamps and bogs.

Upper terrace deposits form terraces and pediments 5 to 30 feet above modern valley-bottom wetlands. They include sediments laid down during periods of cold climate, and possibly during periods of temperate climate when sea level was high, in the middle and late Pleistocene. During cold periods, permafrost formed an impermeable layer at shallow depth, which increased runoff and slope erosion, which in turn increased the amount of sediment entering valleys. Aprons of colluvium (Qcu) along the base of steep slopes that grade to the upper terraces were also deposited primarily during periods of permafrost. During periods of high sea level, the lower reaches of streams downstream from the Cassville quadrangle were close to sea level, favoring deposition. This deposition may have extended upvalley into the map area.

In the Shannae Brook and Bordens Mill Branch lowland two phases of the upper terrace are mapped: an older phase (Qtuo) forming erosional remnants with tops 15 to 20 feet higher than the more extensive main terrace (Qtu). Abundant groundwater seepage in this lowland, where the fine-grained Kirkwood Formation is at shallow depth below the permeable Cohansey, creates more active lateral erosion than elsewhere in the quadrangle, favoring the formation and incision of terraces.

In a few places, the upper terrace deposits cross drainage divides, or occupy abandoned valleys, indicating drainage changes during downcutting from the upper to lower terraces. These locations (green arrows on fig. 1) include 1) upper terraces that cross the Delaware-Toms River divide at two places west and south of Colliers Mills, 2) an upper terrace that crosses the Toms River-Shannae Brook divide in two spots southwest of Cassville, and 3) an upper terrace that crosses a divide between the Toms River and an unnamed tributary north of Cassville. In each of these places streams that formerly flowed to the west or south were captured or diverted by easterly flowing streams. In the case of the two diversions near Colliers Mills, south-trending segments of two valleys between Archers Corners and Colliers Mills align with the upper terraces crossing the Delaware-Toms River divide, suggesting that they formerly drained into the Delaware basin before being captured by a Shannae Brook tributary and Bordens Mill Branch. The two diversions near Cassville suggest capture by the Toms River of drainage that formerly was southward into the Ridgeway Branch valley. In both the Colliers Mills and Cassville cases, the capture may be the result of the shallow depth of the Kirkwood in the Shannae Brook-Bordens Mill Branch lowland and in the Toms River valley at Cassville, which accelerated seepage erosion and downcutting at these sites.

Lower terrace deposits (unit Qtl) form low, generally wet, terraces less than 5 feet above modern floodplains, except in the Lahaway Creek valley where the terraces are more deeply incised and are as much as 15 feet above the floodplain. They are of much smaller extent than the upper terraces except in the Shannae Brook-Bordens Mill Branch and Jumping Brook-Hartshorne Mill Stream lowlands, where they are extensive. Here they are only 1 to 3 feet higher than the active floodplain and seepage wetlands and are separated from them by low scarps. The scarps are visible on LiDAR imagery in places (fig. 2). The terraces are also identifiable from vegetation patterns, with pine or mixed pine and cedar on the terraces and hardwood (chiefly maple) and cedar on the active wetlands (fig. 2). The lower terraces formed from stream and seepage erosion of the upper terrace deposits, probably during or slightly after the last period of cold climate around 25 ka. Radiocarbon dates on organic silt at the base of the lower terrace deposits at Siloam and Farmingdale, 5 and 12 miles, respectively, northeast of Cassville, yielded ages of 33.7-32.8 calibrated ka and 45.4-33.4 calibrated ka (Stanford and others, 2002, 2018; age range is 95% confidence interval), confirming a late Wisconsinan age for the overlying deposit. Braided channels (blue solid lines on map) scribe the lower terraces in a few places (fig. 2). These braided networks indicate that streams were choked with sand and gravel during deposition of the terraces, causing channels to aggrade and split. The high sediment supply indicates increased erosion by groundwater seepage and runoff, most likely when permafrost impeded infiltration. Dry-valley alluvium (unit Qald) and lower colluvium (Qcl), which grade to the lower terraces, were likely also laid down at this time.

Eolian deposits (Qe) form narrow, linear dune ridges as much as 4,000 feet long (dark yellow lines on map) and dunefields (figs. 1 and 3). Individual dunes are up to 15 feet high but are commonly 3 to 6 feet high. Their long axes are oriented east-west to northwest-southeast. A few have crescentic form, with the axes of the crescents also oriented east-west to northwest-southeast. These orientations indicate that winds were blowing from the north and northwest during deposition of the dunes. Most dunes occur on the upper terraces or on upland surfaces above the upper terraces. Some occur on the lower terraces, including several long dune ridges in the Shannae Brook-Bordens Mill Branch lowland. One of the largest dunes in the quadrangle was blown across, and blocked, a valley incised into the upper terrace (fig. 3). Based on this distribution, the windblown deposits were laid down after deposition of the upper terraces, and also during, and in places after, deposition of the lower terraces, principally during the period of intermittently cold climate between about 80 and 15 ka known as the Wisconsinan in North American glacial-stage terminology. The presence of a few dunes on the lower terrace suggests that some eolian deposition continued in the Holocene, perhaps when sand was exposed by intense forest fires. A radiocarbon date of 4.6-4.8 calibrated ka (95% confidence range) on organic clay beneath eolian sand just south of the map area (Stanford, 2016) also indicates a Holocene age for some dunes. Modern floodplain and wetland deposits (units Qal, Qals) were laid down within the past 10 ka, based on radiocarbon dates on basal peat in other alluvial wetlands in the Pine Barrens (Buell, 1970; Florer, 1972; Stanford, 2000b).

During cold climate at glacial maxima in the middle and late Pleistocene, permafrost was present in the Pine Barrens region (Wolfe, 1953; French and others, 2005, 2007). During thaws, permafrost at depth acted as an impermeable layer and supported the water table at a higher elevation than in temperate climate. Seepage features, including dry channels and amphitheater-shaped valley heads (fig. 3), were developed in landscape positions that are dry today. These are indicated by brown and dashed blue lines, respectively, on the map. Another permafrost-related feature is thermokarst basins, which are shallow depressions that form when subsurface ice lenses melt (Wolfe, 1953). These basins (blue cross-hatched pattern on map) typically form in sandy deposits in lowlands with high water table, or, more rarely, in upland settings where shallow low-permeability layers provide a perched water table. Basins within, or bordered by, eolian deposits (for example, several areas of large basins in the Jumping Brook valley) tend to be larger than other thermokarst basins and were likely formed or enlarged by wind erosion (French and Demitroff, 2001).

## DESCRIPTION OF MAP UNITS

▨ ARTIFICIAL FILL—Sand, pebble gravel, minor clay and organic matter; gray, brown, very pale brown, white. In places includes minor amounts of man-made materials such as concrete, asphalt, brick, cinders, and glass. Unstratified to poorly stratified. As much as 15 feet thick. In road and runway embankments, dams, berms, dikes around cranberry bogs, and filled low ground.

**aft** TRASH FILL—Trash mixed and covered with sand, silt, clay, and gravel. As much as 20 feet thick.

**Qals** WETLAND AND ALLUVIAL DEPOSITS—Fine-to-medium sand and pebble gravel, minor coarse sand; light gray, yellowish-brown, brown, dark brown; overlain by brown to black peat and gyttja. Peat is as much as 8 feet, but generally less than 4 feet, thick. Sand and gravel are chiefly quartz and are generally less than 3 feet thick. Sand and gravel are stream-channel deposits; peat and gyttja form from the vertical accumulation and decomposition of plant debris in swamps and marshes. In floodplains and wetlands on modern valley bottoms.

**Qal** ALLUVIUM—Fine-to-medium sand and pebble gravel, silt, fine sand, minor coarse sand and silty clay; gray, brown, yellowish-brown. As much as 10 feet thick. Sand is quartz with some (5-10%) glauconite and mica; gravel is quartz with a trace (<1%) ironstone. Contains some wood and peat but peat is not as thick and continuous as in unit Qals. Silty fine sand and clay are overbank deposits and typically overlie sand and gravel channel deposits.

**Qald** DRY-VALLEY ALLUVIUM—Fine-to-medium sand and pebble gravel, minor coarse sand; very pale brown, white, brown, dark brown, light gray. As much as 5 feet thick. Sand and gravel are quartz. In dry valley bottoms forming headwater reaches of streams. These valleys lack channels or other signs of surface-water flow. They may have formed under cold-climate conditions when permafrost impeded infiltration, increasing surface runoff. The deposits are therefore largely relict. Narrow, erosional dry channels without mappable alluvium are shown by line symbol.

**Qe** EOLIAN DEPOSITS—Fine-to-medium quartz sand; very pale brown, white. As much as 15 feet thick. Sand includes few (1-5%) opaque minerals and fine mica in places. Form dune ridges and dune fields. Sand is from wind erosion of the Cohansey, Kirkwood, and Vincentown formations, upper terrace deposits, and, less commonly, lower terrace and upland surficial deposits.

**Qtl** LOWER TERRACE DEPOSITS—Fine-to-medium sand, pebble gravel, minor coarse sand; gray, brown, dark brown, yellowish-brown, brownish-yellow. As much as 10 feet thick. Sand and gravel are quartz. Sand includes some glauconite and fine mica in the Lahaway Creek valley, and few to some opaque minerals elsewhere. Gravel includes traces of ironstone in places. Form terraces and pediments in valley bottoms with surfaces 2 to 15 feet above modern floodplains. Include both stratified stream-channel deposits and unstratified pebble concentrates formed by seepage erosion of older surficial deposits. Sand includes gyttja in places, and peat less than 2 feet thick overlies the sand and gravel in places. The gyttja and peat are younger than the sand and gravel and accumulate due to poor drainage. Gravel generally is more abundant in lower terrace deposits than in upper terrace deposits due to winnowing of sand by seepage erosion during formation of the lower terrace deposits.

**Qcl** LOWER COLLUVIUM—Sand and gravel as in unit Qtl forming footslope aprons on grade with lower terraces and the modern floodplain. As much as 10 feet thick. Weakly subhorizontally stratified to nonstratified. Includes sheetwash, alluvial-fan, and solifluction deposits and seepage lags.

**Qtu** UPPER TERRACE DEPOSITS—Fine-to-medium sand, pebble gravel, minor coarse sand; very pale brown, brownish-yellow, yellow. As much as 20 feet thick, generally less than 10 feet thick. Sand and gravel are quartz. Sand includes some glauconite and fine mica in the Lahaway Creek valley and few to some opaque minerals elsewhere. Gravel includes traces of ironstone in places. Form terraces and pediments with surfaces 5 to 25 feet above modern floodplains. Include stratified stream-channel deposits and poorly stratified to unstratified deposits laid down by groundwater seepage on pediments.

**Qcu** UPPER COLLUVIUM—Sand and gravel as in unit Qtu forming footslope aprons on grade with upper terraces. As much as 10 feet thick. Weakly subhorizontally stratified to nonstratified. Includes sheetwash, alluvial-fan, and solifluction deposits and seepage lags.

**Qtuo** UPPER TERRACE DEPOSITS, OLDER PHASE—Sand and gravel as in unit Qtu forming eroded terraces as much as 20 feet higher than adjacent upper terraces.

**TQg** UPLAND GRAVEL, LOWER PHASE—Fine-to-medium sand, minor coarse sand, slightly clayey in places, and pebble gravel; yellow, very pale brown, reddish-yellow. Sand and gravel are quartz with a few quartzite pebbles and a trace of white weathered chert in the coarse-sand-to-fine pebble gravel fraction. Sand and gravel are iron-cemented in places. Clay is chiefly from weathering of chert. As much as 15 feet thick. Occurs as erosional remnants on lower interfluves and hilltops, and as more continuous deposits on broad parts of the Delaware-Toms River divide upland, between 90 and 180 feet in elevation. Includes stratified stream-channel deposits, poorly stratified deposits laid down by groundwater seepage on pediments, and pebble concentrates formed by winnowing of sand from older surficial deposits and the Cohansey Formation by groundwater sapping or surface runoff (fig. 4).

**Tg** UPLAND GRAVEL, HIGH PHASE—Fine-to-medium sand, some coarse sand, clayey in places, and pebble gravel; yellow, brownish-yellow, reddish-yellow, very pale brown. Sand and gravel are quartz, with a few quartzite pebbles and a trace of chert and weathered feldspar in the coarse-sand-to-fine pebble gravel fraction. Sand and gravel are iron-cemented in places. Most chert is weathered to white and yellow clay; some chert pebbles are gray to dark gray and unweathered to partially weathered. Clay-size material chiefly is from weathering of chert and feldspar. As much as 15 feet thick. Occurs as erosional remnants on hilltops on the Delaware-Toms River divide in northern and central parts of the quadrangle, between 180 and 220 feet in elevation, and as a more continuous deposit on the broad plateau-like part of the divide in the southern part of the quadrangle, between 140 and 200 feet in elevation. Includes stratified and cross-bedded stream-channel deposits and poorly stratified to unstratified pebble concentrates formed by washing of sand and clay from the Beacon Hill Gravel by groundwater sapping or surface runoff.

**Qwcp** WEATHERED COASTAL PLAIN BEDROCK FORMATIONS—Exposed sand, clay, silty sand, glauconitic sand, and glauconite clay of Coastal Plain bedrock formations, variably oxidized during weathering in the Quaternary and Neogene. Upper several feet may include quartz pebbles left from erosion of surficial deposits, and patchy colluvial, alluvial, or eolian deposits less than 3 feet thick.

## MAP SYMBOLS

Contact—Solid where well-defined by landforms as visible on 1:12,000 stereo airphotos and LiDAR imagery, long-dashed where approximately located, short-dashed where gradational or featheredged, dotted where excavated.

● 
● 4
● Qe4/Qtu
● g2/Qtu
● e2/Qtu

Material penetrated by hand-auger hole or observed in exposure or excavation—Number indicates thickness of surficial material, in feet, where penetrated. Symbols without a thickness value within surficial deposits indicate that the surficial material is more than 5 feet thick. Where more than one unit was penetrated, the thickness (in feet) of the upper unit is indicated next to its symbol and the lower unit is indicated following the slash. A “g” followed by number indicates thickness of silt and fine sand (loess or gley) overlying the mapped unit. An “e” followed by a number indicates thickness of eolian sand overlying the mapped unit in isolated occurrences outside of map unit Qe.

● 28-4710 10/50 Well or test boring with thickness of surficial deposit—Location accurate to within 200 feet. Identifiers of the form 28-xxxx are N. J. Department of Environmental Protection well permit numbers. Identifiers of the form “Cassville x” or “CS x” are power-auger borings with logs on file at the N. J. Geological and Water Survey. Number before slash is thickness of surficial deposit as inferred from well log. Number following slash is total depth of well.

⊙ 28-147 5/40 Well or test boring with thickness of surficial deposit—Location accurate to within 500 feet. Identifiers and numbers as above.

**figure 4** ● Photograph location

Head of seepage valley—Line at top of slope. Marks head of small valleys and hillslope embayments formed by seepage erosion during times when the water table was higher than present.

Dry channel—Line in channel axis. Marks inactive channels on dry uplands.

Abandoned channel—Line in channel axis. Marks braided-channel network on lower terraces.

Fluvial scarp—Line at top, ticks on slope.

Dune ridge—Line on crest.

Paleocurrent direction—Arrow indicates direction of streamflow inferred from dip of cross-beds observed at point marked by “x”.

Iron-cemented sand—Extensive iron cementation in Cohansey Formation (fig. 5).

Shallow topographic basin—Line at rim, pattern in basin. Includes thermokarst basins formed from melting of permafrost, and deflation basins formed or enlarged by wind erosion.

Excavation perimeter—Line at limit of excavated area. Topography within these areas differs from that on the base map. Contacts show units as restored to topography as shown on base map.

⚔ Sand pit—Active in 2019.

⚔ Sand pit—Inactive in 2019.

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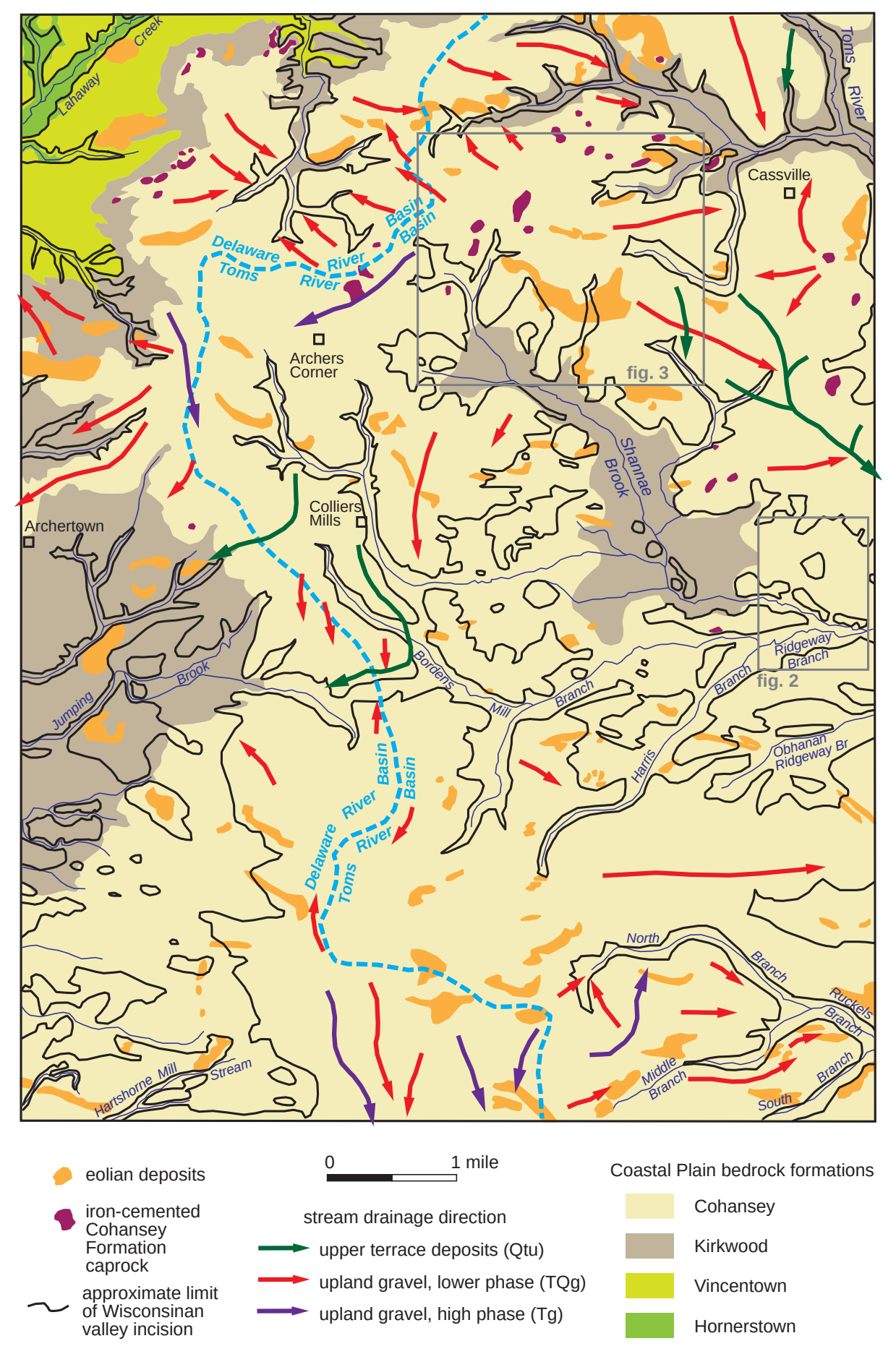

Figure 1. Coastal Plain bedrock formations, eolian deposits, areas of ironstone caprock, paleodrainage directions, and extent of Wisconsinan valley incision in the Cassville quadrangle (incised areas are on the streamward side of the line). Note extensive areas of seepage-induced Wisconsinan valley incision in the Shannae Brook-Bordens Mill Branch and Jumping Brook-Hartshorne Mill Stream lowlands, where silt and fine sand of the Kirkwood Formation is at shallow depth. Areas of figures 2 and 3 shown in gray outline. Bedrock formations are from Sugarman and others (in preparation).

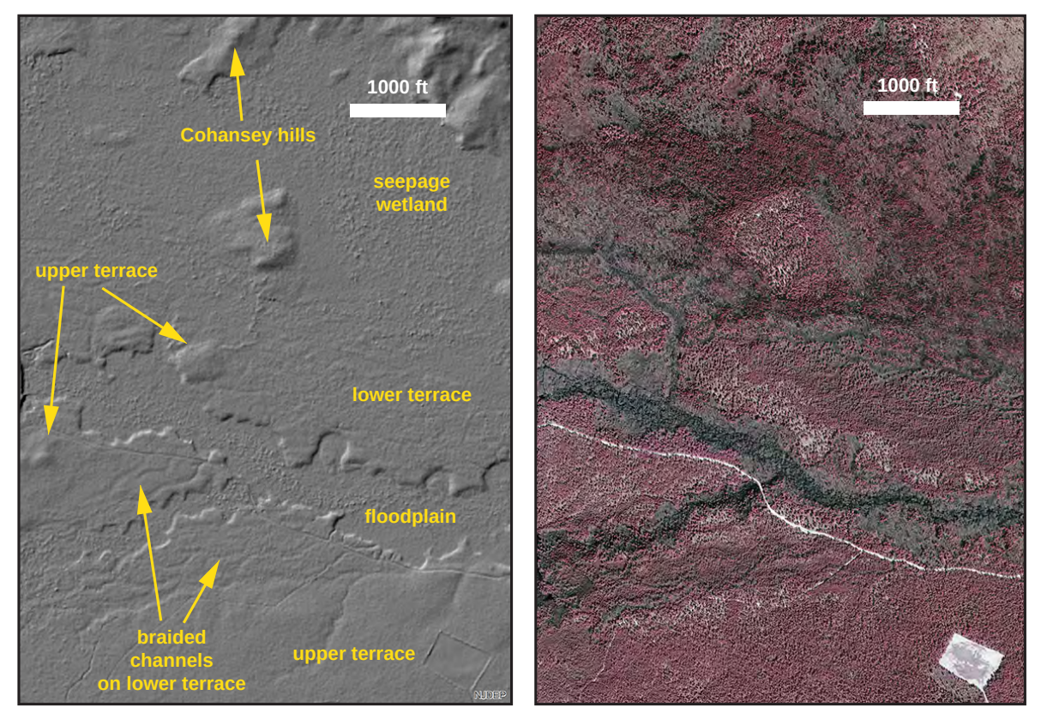

Figure 2. LiDAR hillshade image (left) and infrared aerial photograph taken in 2002 (right) of a part of the Shannae Brook valley. LiDAR image shows scarps separating the lower terrace and floodplain, braided paleochannels on lower terrace, erosional remnants of the upper terrace, and hills of Cohansey Formation higher than the upper terrace. On the infrared photo note that cedar (dark red) and maple (gray) grow on the floodplain and seepage wetland and in some paleochannels on the lower terrace. Pine (light red) grows on both the lower and upper terraces, with sparser pine and scrub oak (whitish gray) on the drier parts of upper terraces and hills of Cohansey Formation, and mixed pine and cedar on the wetter parts of the lower terrace. Location shown on figure 1.

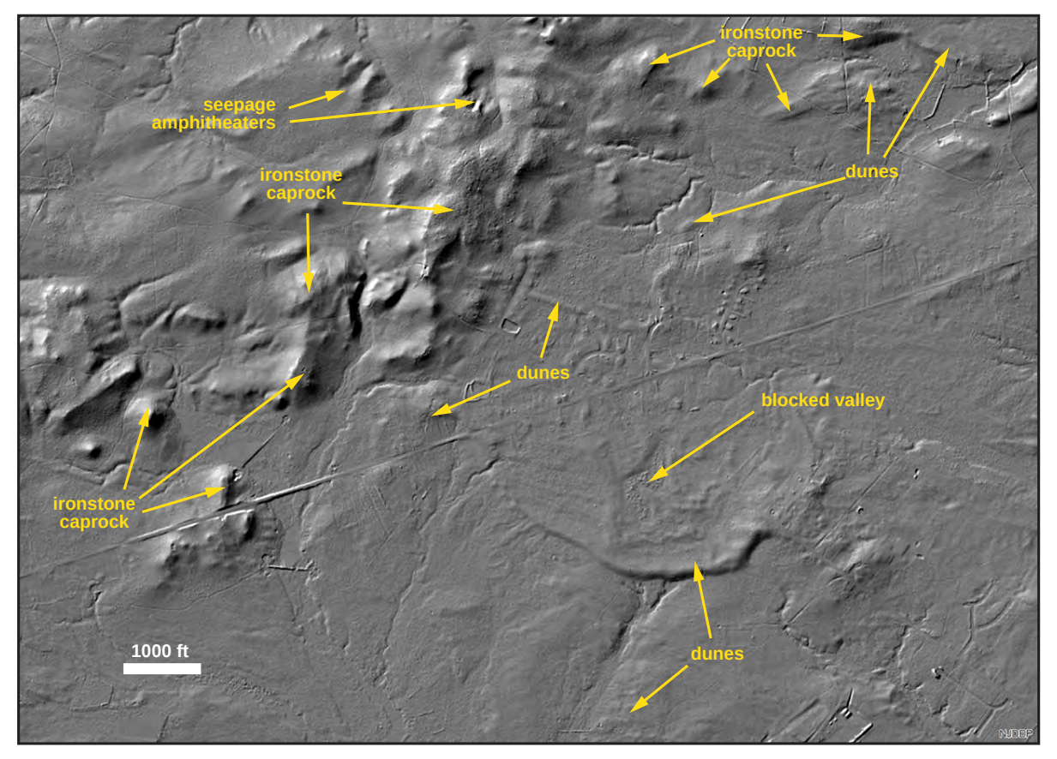

Figure 3. LiDAR hillshade image showing paleodunes, mesas and ridges formed on ironstone caprocks in the Cohansey Formation (fig. 5), and paleoseepage amphitheaters. Note that the large dune in the lower right has blocked a small valley. Location shown on figure 1.

Figure 4. Upland gravel, lower phase (above line) over Cohansey Formation. Note faint horizontal bedding in the upland gravel. Location shown on inset.

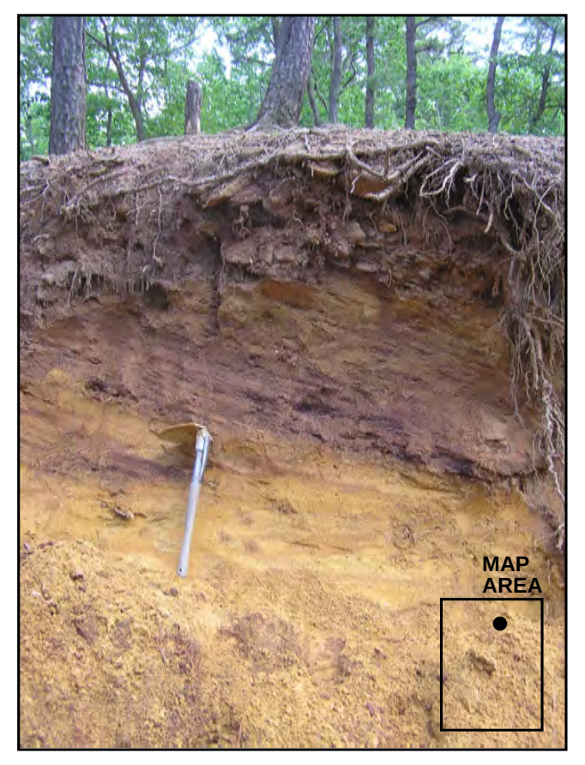

Figure 5. Ironstone (tabular blocks below tree roots and reddish sand above shovel) developed in Cohansey Formation. Note planar cross bedding in the Cohansey. Ironstone forms resistant caprocks on hilltops in the northern part of the quadrangle. Location shown on inset.

Base map from U. S. Geological Survey Cassville quadrangle, 1957.
Topography from aerial photographs by photogrammetric methods.
Aerial photographs taken 1947.
Planimetric detail revised from aerial photographs taken 1956.
Photorevised from aerial photographs taken 1970-71.
North American Datum of 1927.

# SURFICIAL GEOLOGY OF THE CASSVILLE QUADRANGLE
# OCEAN AND MONMOUTH COUNTIES, NEW JERSEY

by
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2020

Geology mapped 2018-2019
Cartography by S. Stanford

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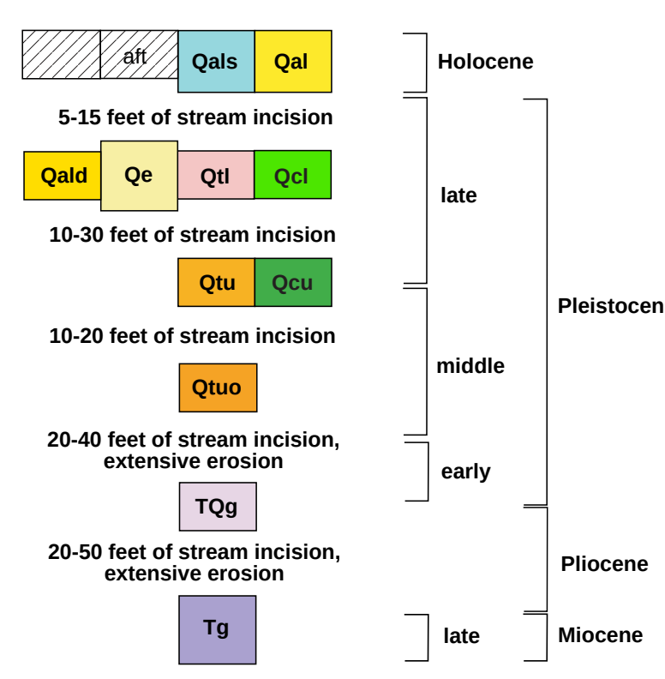
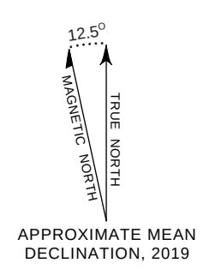
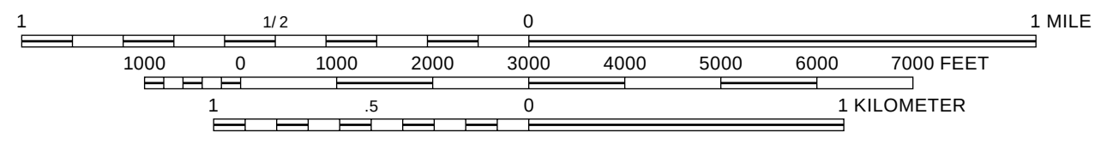
## CORRELATION OF MAP UNITS





SCALE 1:24 000



CONTOUR INTERVAL 10 FEET

NATIONAL GEODETIC VERTICAL DATUM OF 1929


LOCATION IN NEW JERSEY