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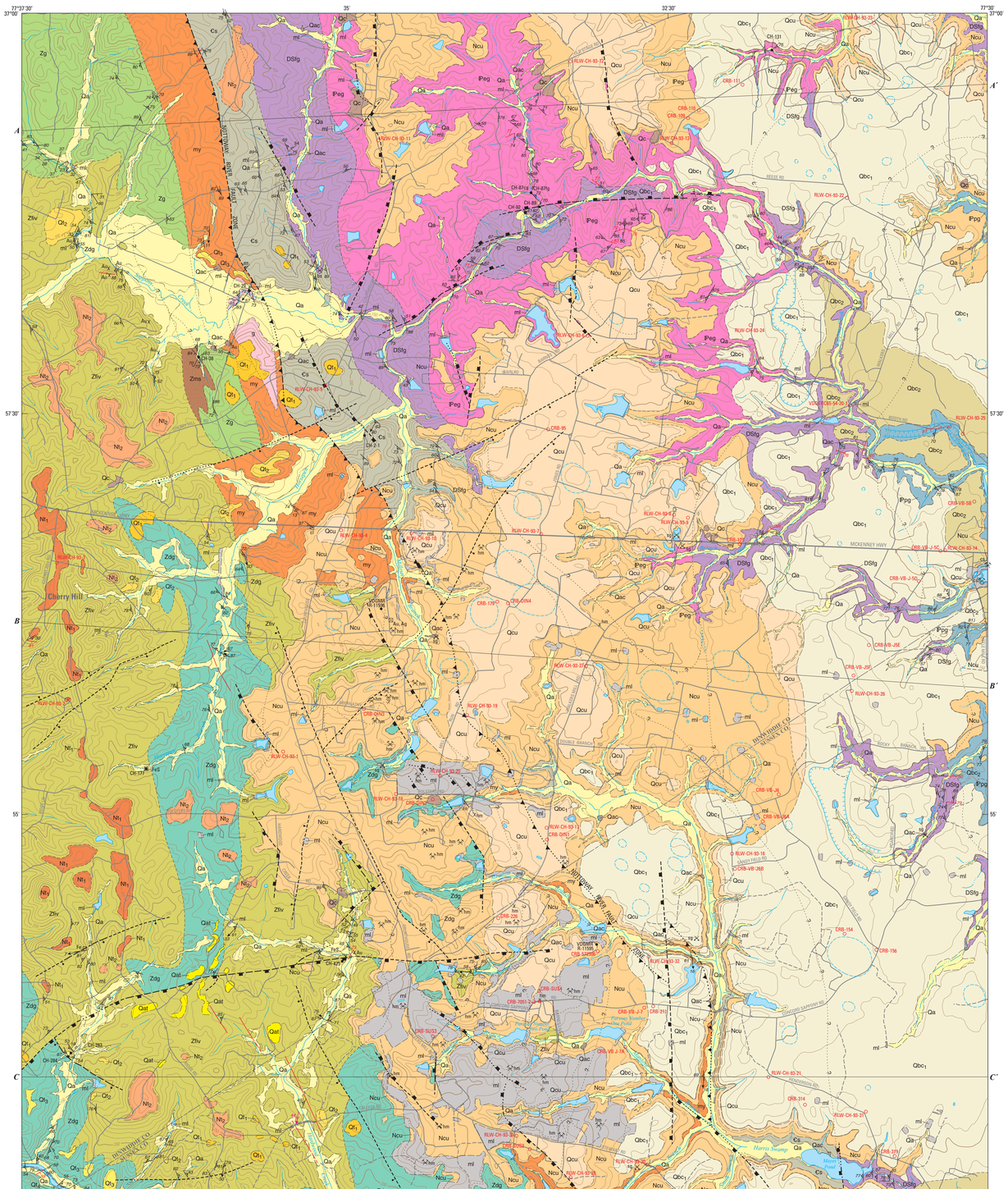
Open-File Report 2021–1106



Base from Geological Survey Cherry Hill quadrangle map, 1:24,000, 2019

SCALE 1:24000

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

2019 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

MAP LOCATION

Geology mapped and compiled by Mark W. Carter from March 2018 to February 2020

GIS Database and cartography by Benjamin R. Weinmann and E. Allen Crider, Jr. (2020-2022)

Edited by Natalie Juda; digital cartographic production by Linda M. Masonic

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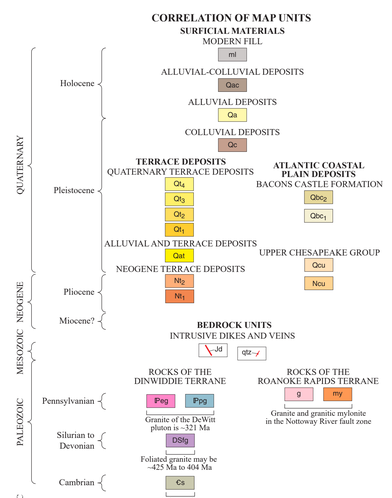
CORRELATION OF MAP UNITS



EXPLANATION OF MAP SYMBOLS

Contact—Long-dashed where location is approximately located to within 50 meters (m); short-dashed (inferred) where located within 100 meters; dotted where concealed by water or surficial materials; queried where location is questionable and (or) greater than 100 meters

Internal contact—Distinct surfaces that occur at the head of second order and higher order branch streams within alluvium, and in permanently abandoned stream channels. Internal contacts were constructed from both field observation and hillshade raster images derived from 1-m light detection and ranging (lidar) Digital Elevation Models

Abandoned channel—Three abandoned channels and associated scarps defined on 1-m lidar-derived hillshade raster images, and on the 1:24,000-scale topographic map of the quadrangle (10-foot contour interval)

Carolina bay—Elliptical depressions interpreted to be Carolina bay of the Atlantic Coastal Plain

Jurassic diabase dike (dashed where concealed by surficial materials)

Quartz vein

FAULTS

[Long-dashed where location is approximately located to within 50 meters; short-dashed (inferred) where located within 100 meters; dotted where concealed by water and (or) surficial materials]

Fault—Unspecified movement or orientation

High-angle reverse fault—Marked by zones of silicified cataclasite; latest Paleozoic to Mesozoic in age; some reactivated during the Cenozoic. Rectangles on upthrown block

Normal fault—Marked by zones of silicified cataclasite; latest Paleozoic to Mesozoic in age; some reactivated during the Cenozoic. Ball and bar on downthrown block

Thrust fault—Paleozoic ductile faults delineated by highly-strained rocks within or on either side of contact. Sawteeth on upper plate

PLANAR AND LINEAR FEATURES

[Observation sites are centered on the strike bar, or are at the intersection point of multiple symbols]

Strike and dip of inclined primary bedding in sedimentary rock or layering in volcanic rock

Strike and dip of inclined cleavage in low-grade metamorphic rocks

Strike and dip of inclined generic (origin not known or not specified) foliation or layering

Strike and dip of inclined mylonitic foliation

Strike and dip of inclined clay-filled, chalcedony-filled, manganese-filled, epidote-filled, or zeolite-filled fracture

Strike and dip of inclined joint

Bearing and plunge of outcrop-scale fold axes

Bearing and plunge of inclined generic (origin or type not known or not specified) lineation or linear structure

Strike and dip of inclined outcrop-scale metagranitoid dike, aplite dike, pegmatite, diabase, or quartz vein

Strike and dip of inclined outcrop-scale fault or fracture

MINERAL RESOURCES

Mineral resources shown on this map were located in the field or compiled from lidar analysis and the Mineral Resources of Virginia (MRV) database, available from the Virginia Division of Geology and Mineral Resources (undated). Some of the mines and prospects interpreted from hillshade raster images derived from 1-m lidar Digital Elevation Models were verified in the field or crosschecked with the MRV database. The location of some mines and prospects have been slightly adjusted on the topographic basemap from their actual location for cartographic representation. Areas of modified land related to extensive mining of heavy minerals are shown in the 2019 U.S. Department of Agriculture, Natural Resources Conservation Service 1-m lidar dataset; most mined areas were reclaimed prior to lidar data aquisition and are shown by mine symbols only. Commodity abbreviations: Au, gold; bs, building stone; cl, clay minerals; cs, crushed stone; Fe, iron; FeS, massive sulfides; hm, heavy minerals; sg, sand and gravel

Prospect pit

Abandoned borrow pit

Abandoned mine or open-pit quarry

Economic mineral occurrence

OTHER FEATURES

Borehole—Location and reference label abbreviations: RLW, compiled from Weems and others (2010); CRB, compiled from Virginia Division of Geology and Mineral Resources (2018); VDOT, borehole data from the Virginia Department of Transportation

Thin section and (or) geochemical sample locality

EXPLANATION

[Cross sections only]

Stratigraphic and igneous contact

Eroded contact

Brittle fault—Marked by zones of silicified cataclasite; latest Paleozoic to Mesozoic in age and some reactivated during the Cenozoic (U–up; D–down where determined)

Paleozoic ductile fault—Delineated by highly-strained rocks within or on either side of contact (arrow shows relative offset)

Jurassic dike

Interpretive form line of foliation—In Piedmont rocks constructed from surface structural data and projected at depth

Interpretive form line of primary bedding or layering—In Piedmont rocks constructed from surface structural data and projected at depth

DESCRIPTION OF MAP UNITS

SURFICIAL MATERIALS

MODERN FILL

ml **Artificial fill (Holocene)**—Unconsolidated rock, sand and gravel, soil, and debris of local origin used for land modification and grading; includes spoil from mining, fill material for roadway creek crossings, and earthen dams and ponds. Thickness is variable; locally up to 15 meters (m) thick

ALLUVIAL-COLLUVIAL DEPOSITS

Qac **Alluvial-colluvial material (Holocene)**—Unconsolidated clay, silt, sand, and gravel deposited as hillslope, toe slope, and stream channelway colluvium, and in alluvial-colluvial fan deposits overlying floodplain alluvium at stream mouths. These deposits are interpreted to have been formed by extensive erosion of topsoil and saprolite since European settlement. Thickness is typically no more than 3 m

ALLUVIAL DEPOSITS

Qa **Alluvium (Holocene to Pleistocene)**—Unconsolidated clay, silt, sand, gravel, and organic material mostly deposited in floodplains along modern stream courses. Gravel occurs in active and abandoned channelways and consists of angular to subrounded pebbles, cobbles, and boulders; much of the alluvial gravel throughout the quadrangle is recycled from Quaternary to Neogene coastal plain and fluvial terrace deposits but, in the western portion of the quadrangle, gravel also consists of locally sourced vein quartz, with some bedrock clasts. Locally, alluvial sediments are consolidated to semi-lithified by clay and iron-oxide precipitation. Soil developed above alluvium is typically olive gray (5*Y* 4/1) to brownish gray (5*YR* 4/1) or dark yellowish brown (10*YR* 4/2) loam. Thickness of alluvium is variable, but likely no more than 10 m. Contacts were constructed from both field observation and hillshade images derived from light detection and ranging (lidar). Locally within areas mapped as alluvium are distinctly elevated morphologic terraces within the modern floodplains; scarps separating these older alluvial surfaces from younger deposits are up to about 1 m in height. Other distinct surfaces occur at the head of second-order and higher order branch streams, and in permanently abandoned stream channels. These surfaces are underlain by unconsolidated clay, silt, sand, gravel, and organic material identical to that beneath the nearby floodplain. Although the mode of deposition of these sediments was dominantly alluvial, significant colluvial transport and mixing has also occurred. Internal contacts bounding these surfaces were constructed from both field observation and lidar images derived from lidar. Unlike the sharp contact between the modern floodplain and hillslopes underlain by bedrock or coastal plain deposits, contacts between these higher morphologic surfaces and the adjacent hillslopes are gentler and topographically subdued

COLLUVIAL DEPOSITS

Qc **Colluvial material (Pleistocene)**—Deposits of unconsolidated clay, silt, sand, and gravel; hummocky surface morphology from field observation and lidar analysis suggests deposits are mostly of colluvial origin and likely older than Holocene. Several areas mapped as colluvial material morphologically resemble landslide deposits, with distinct head scarps and toes consisting of transported material. Soil developed above colluvium is typically olive gray (5*Y* 4/1) to brownish gray (5*YR* 4/1) or dark yellowish brown (10*YR* 4/2) loam. Thickness is variable, but likely no more than 5 m

TERRACE DEPOSITS

QUATERNARY TERRACE DEPOSITS

Deposits of sand and gravel occur west of the outcrop belt of Chesapeake Group deposits along the Nottoway River and major creeks at three distinct landscape elevations. The deposits are interpreted to be up-dip fluvial equivalents of fluvial, estuarine, and marine deposits of the coastal plain. Distinguishing lithologic characteristics, location and elevations of occurrences, possible correlations and thicknesses are given below for each suite of deposits.

Qt_4 **Lowest-level terrace deposit (Pleistocene)**—A small deposit of mostly sand with some pebbles caps a hill on the south bank of the Nottoway River at an elevation of about 150 feet (ft; 46 m) above sea level. This deposit may be equivalent to the Pleistocene Windsor Formation (Coch, 1968). Thickness is less than 3 m

Qt_3 **Lower-level terrace deposits (Pleistocene)**—Deposits of gravel and sand cap hills and mantle side slopes at elevations ranging from 170 to 195 ft (52 to 59 m) above sea level on the north bank of the Nottoway River, and from 175 to 185 ft (53 to 56 m) above sea level on the north bank of Sappony Creek. The deposits are interpreted to be equivalent to the Pleistocene Windsor Formation (Coch, 1968). Thickness is up to 6 m

Qt_2 **Low-level terrace deposits (Pleistocene)**—Deposits of gravel consisting of very pale-orange vein quartz pebbles; cobbles and boulders of quartzite and cross-bedded sandstone are also common. Sandy matrix is light brown (5*YR* 6/4). These deposits cap hills and mantle sideslopes at elevations ranging from 185 to 200 ft (56 to 61 m) above sea level on the east bank of Hardwood Creek, from 190 to 200 ft (58 to 61 m) above sea level on the west bank of Sappony Creek, from 200 to 205 ft (61 to 62.5 m) above sea level on the south bank of the Nottoway River, from 200 to 210 ft (61 to 64 m) above sea level on the north bank of the Nottoway River, and from 205 to 225 ft (62.5 to 68.5 m) above sea level on the northwest bank of Horsepen Branch. The deposits are interpreted to be equivalent to the Varina Grove member of the Bacons Castle Formation. Thickness is up to 6 m

Qt_1 **High-level terrace deposits (Pleistocene)**—Deposits of gravel and sand cap hills and mantle sideslopes at elevations ranging from 215 to 225 ft (65.5 to 68.5 m) above sea level on the north bank of Sappony Creek, from 210 to 235 ft (64 to 71.5 m) above sea level on the interfluve between Sappony Creek and Horsepen Branch, and from 220 to 235 ft (67 to 71.5 m) above sea level on the west bank of the mid-section of Horsepen Branch, on the east bank of Hardwood Creek, and on the north bank of the Nottoway River, mostly on the interfluve between the river and Hardwood Creek. All of the deposits are distinctly higher topographically than low-level terrace deposits. These deposits are interpreted to be equivalent to younger unit 2 deposits of the upper part of the Chesapeake Group to the east (Qcu). Thickness is up to 5 m

ALLUVIAL AND TERRACE DEPOSITS

Qat **Sand and gravel (Pleistocene?)**—Deposits of sand and gravel mostly occur along the interfluve between Hardwood Creek and an unnamed tributary of the Nottoway River to the west. Sand in these deposits is typically grayish orange-pink (10*R* 8/2) and medium to coarse; rounded pebbles of very pale orange (10*YR* 8/2) vein quartz and silicified cataclasite, and moderate reddish-brown (10*R* 4/6) clasts of ironstone, are also common. The character of the sand and gravel deposits, and their morphologic setting, suggest alluvial deposition in stream channelways, which were later abandoned, erosionally stranded, and dissected following a period of significant stream capture and re-organization, possibly due to uplift along local faults. The age of these deposits is unknown but is likely equivalent to high-level terrace deposits (Qt_1). Thickness is less than 3 m

NEOGENE TERRACE DEPOSITS

Deposits of sand and gravel occur west of the outcrop belt of Chesapeake Group deposits along the Nottoway River and major creeks at two distinct landscape elevations. The deposits are interpreted to be up-dip fluvial equivalents of fluvial, estuarine, and marine deposits of the coastal plain. Distinguishing lithologic characteristics, location and elevations of occurrences, possible correlations and thicknesses are given below for each suite of deposits.

Nt_2 **Higher-level terrace deposits (Pliocene)**—Deposits of gravel and sand; gravel consists of very pale orange (10*YR* 8/2) vein quartz pebbles and moderate reddish-brown (10*R* 4/6) clasts of ironstone, in a matrix of coarse sand. Sand is commonly fine to medium, contains thin centimeter-thick, discontinuous beds of gravel and very coarse sand, and exhibits moderate red (5*R* 4/6) to pale yellowish-orange (10*YR* 8/6) reticulated mottling. Locally, cobbles and small boulders of moderate reddish-brown (10*R* 4/6) to dark reddish-brown (10*R* 3/4) ironstone and ferricrete occur at the contact with underlying bedrock. These deposits cap hills and mantle side slopes at elevations ranging from 260 to 265 ft (79 to 81 m) above sea level north of Sappony Creek, 255 to 260 ft (77.5 to 79 m) above sea level on the interfluve between Horsepen Branch and Hardwood Creek, 245 to 275 ft (74.5 to 84 m) above sea level south of Sappony Creek and west of Horsepen Branch, and 235 to 255 ft (71.5 to 77.5 m) west of Hardwood Creek and north of the Nottoway River. Variability in basal elevations of deposits south of Horsepen Branch are due to vertical movement along Cenozoic faults, but all of the deposits are distinctly higher topographically than high-level terrace deposits. These deposits are interpreted to be equivalent to older unit 1 deposits of the upper part of the Chesapeake Group to the east (Ncu). Thickness is up to 7 m

Nt_1 **Highest-level terrace deposits (Pliocene to Miocene)**—Deposits of gravel mostly consisting of very pale orange (10*YR* 8/2) vein quartz pebbles, cobbles, and few boulders; cobbles of *Skolithos*-bearing, grayish orange (10*YR* 7/4) quartzite are rare. Gravel occurs in a clayey sand matrix that is typically grayish red (5*R* 4/2) to moderate red (5*R* 4/6); cobbles and small boulders of moderate reddish-brown (10*R* 4/6) to dark reddish-brown (10*R* 3/4) ironstone and ferricrete at the contact with underlying bedrock are common. These deposits cap hills at elevations ranging from 300 to 320 ft (91.5 to 97.5 m) above sea level west of Horsepen Branch, and 260 to 290 ft (79 to 88 m) above sea level west of Hardwood Creek. Variability in basal elevations of deposits south of Horsepen Branch may be due to vertical movement along Cenozoic faults, but all of the deposits are distinctly higher topographically than higher-level terrace deposits. Regionally, these deposits are equivalent to the Midlothian gravels west of Richmond (Mathews and others, 1965; Goodwin and Johnson, 1970) of possible late middle Miocene age (Weems and Edwards, 2007). Thickness is less than 4 m

ATLANTIC COASTAL PLAIN DEPOSITS

BACONS CASTLE FORMATION

The Bacons Castle Formation (Coch, 1965; Johnson and others, 1987; Mixon and others, 1989) is separated into two units on the basis of morphologic position and lithologic differences. Unit descriptions were constructed from field observation (including unpublished Virginia Department of Mines, Minerals and Energy, Division of Geology and Mineral Resources field data) and sediment descriptions from borehole analysis (Weems and others, 2010).

Qbc_2 **Upper part of the Bacons Castle Formation (Pleistocene)**—An upward-fining sequence of gravel and sand. Basal gravel consists of well-rounded pebbles and cobbles up to 3 centimeter (cm) in diameter that mostly consist of very pale orange (10*YR* 8/2) vein quartz and grayish orange (10*YR* 7/4) quartzite, in a coarse to very coarse clayey sand matrix. Basal gravel is up to 1 m thick, but locally a distinct gravel bed is absent, and the base of the unit consists of coarse to very coarse pebbly sand. Basal gravel is gradational with overlying sand, which is fine and silty, but locally medium to coarse. Heavy minerals in the sand are sparse. This unit rests with marked unconformity on older coastal plain units or granitic rocks of the Dinwiddie terrane. The surface of the deposit is typically mantled by light brown (5*YR* 6/4) sandy silt. This unit underlies the Norge uplands of Johnson and others (1980) to an elevation of approximately 137 ft (42 m) above sea level and are separated from deposits of the lower part of the Bacons Castle Formation (Qbc_1) by the Parler scarp (Weems and others, 2010). Internal to this unit is an abandoned channelway east of Sappony Creek where sediments of this unit have been completely eroded away and granitic bedrock is exposed at the surface. This unit is likely equivalent to the Bahrampsville member of the Bacons Castle Formation (Johnson and others, 1987). Sediments are likely estuarine (Mixon and others, 1989). Thickness is up to 6 m

Qbc_1 **Lower part of the Bacons Castle Formation (Pleistocene)**—An upward-fining sequence of gravel and sand. Basal gravel consists of subrounded to well-rounded pebbles, cobbles, and boulders up to 0.3 m in diameter that consist of very pale orange (10*YR* 8/2) vein quartz and grayish orange (10*YR* 7/4) quartzite in a medium to coarse sandy matrix; a few cobbles of quartzite preserve *Skolithos*. Basal gravel is up to 2 m thick, but locally a distinct gravel bed is absent, and the base of the unit consists of coarse to very coarse pebbly sand. Basal gravel is gradational with overlying sand, which is fine to very coarse and sparsely pebbly. Heavy minerals in the sand are sparse. Locally, discontinuous beds of sandy silt, up to 0.3 m thick, are interbedded with sand. This unit rests with marked unconformity on older coastal plain units or rocks of the Dinwiddie terrane and Nottoway River fault zone. The surface of the deposit is typically mantled by very pale orange (10*YR* 8/2) medium to coarse sand. This unit underlies the Essex plain of Weems and others (2010), to an elevation of approximately 182 ft (55 m) above sea level and are separated from deposits of the Chesapeake Group (Qcu and Ncu) by the Broad Rock scarp (Johnson and others, 1987). Internal to this unit is an abandoned channelway west of Rocky Branch, and several topographic scarps, including an abandoned meander bend west of Sappony Creek and north of its confluence with Double Branch. This unit is likely equivalent to the Varina Grove member of the Bacons Castle Formation (Johnson and others, 1987). Sediments are likely fluvial to estuarine (Ramsey, 1988). Thickness is up to 14 m

UPPER PART OF THE CHESAPEAKE GROUP

Sand and gravel deposits above the Broad Rock scarp are assigned to two units, a lower unit 1 and an upper unit 2 of the upper part of the Chesapeake Group (Darton, 1891; Ward and Blackwelder, 1980), on the basis of subtle but recognizable lithologic differences. Unit descriptions were constructed from sediment descriptions from borehole analysis (Weems and others, 2010) and supplemented with field observations.

Qcu **Unit 2, upper part of the Chesapeake Group (Pleistocene)**—An upward-fining sequence of gravel, sand, and silt. Basal gravel consists of well-rounded to subrounded pebbles, generally 2 to 3 cm in diameter, that mostly consist of very pale orange (10*YR* 8/2) vein quartz; a few clasts are moderate reddish-brown (10*R* 4/6) ironstone, in a fine to coarse sandy matrix. This unit rests with marked unconformity on older Chesapeake Group deposits; the basal contact is locally marked by quartz pebbles, and cobbles and small boulders of moderate reddish-brown (10*R* 4/6) to dark reddish-brown (10*R* 3/4) ironstone and ferricrete. Basal gravel is up to 1 m thick, but locally a distinct gravel bed is absent, and the base of the unit consists of coarse to very coarse pebbly sand. Basal gravel is overlain by very fine to very coarse silty sand. Heavy minerals in the sand are locally abundant, particularly along western faulted and depositional contacts with underlying sediments of unit 1 of the upper part of the Chesapeake Group (Newton and Romeo, 2006). Sand is locally kaolinitic. Locally, discontinuous beds of silt, up to 0.2 m thick, are interbedded with sand. Sand grades upward to sandy silt, which is locally micaceous. Sediment of the unit is locally heavily oxidized. The surface of the deposit is typically mantled by pale yellowish-brown (10*YR* 6/2) sand containing small, very pale orange (10*YR* 8/2) vein quartz pebbles. This unit occurs to an elevation of approximately 235 ft (72 m) above sea level and where present, overlie sand and gravel of unit 1 of the upper part of the Chesapeake Group (Ncu). Weems and others (2010) interpret sediments of this unit to be equivalent to the Chowan River Formation of Blackwelder (1981). The Chowan River Formation has been dated at 2.4 Ma to 1.9 Ma (Cronin and others, 1984; Weems and others, 2010, 2011). Farrell and Thornton (2020) report that the Chowan River Formation in eastern North Carolina occurs above a transgressive lag deposit dated at 2.65 Ma to 1.7 Ma. Berquist and others (2015) assign these sediments to the informal Cold Harbor formation of Berquist and Gilmer (2014). Sediments are likely marginal marine (Weems and others, 2010). Thickness is up to 6 m

Ncu **Unit 1, upper part of the Chesapeake Group (Pliocene)**—An upward-fining sequence of gravel, sand, and silt. Basal gravel consists of well-rounded to sub-rounded pebbles, generally 2 to 3 cm in diameter but locally up to 5 cm in diameter, that consist of medium dark-gray (*N* 8) "smoky" vein quartz, very pale orange (10*YR* 8/2) vein quartz, and clasts of moderate reddish-brown (10*R* 4/6) ironstone, in a fine to very coarse sandy matrix. This unit rests with marked unconformity on bedrock; the basal contact with underlying bedrock is commonly marked by quartz pebbles, and cobbles and small boulders of moderate reddish-brown (10*R* 4/6) to dark reddish-brown (10*R* 3/4) ironstone and ferricrete. Basal gravel is up to 1.2 m thick, but locally a distinct gravel bed is absent, and the base of the unit consists of coarse to very coarse pebbly sand. Basal gravel is typically overlain by very fine to very coarse silty sand, but locally almost 4 m of silt overlies gravel. Sand is locally arkosic, kaolinitic, and commonly micaceous. Heavy minerals in the sand are locally very abundant. Zones of angular cobbles to boulders locally occur as discontinuous lenses intercalated with heavy mineral sands (Newton and Romeo, 2006). Locally, discontinuous beds of silt, up to 2.7 m thick, are interbedded with sand. Where preserved, micaceous clayey sand caps the unit. Sediment of the unit is locally heavily oxidized. The surface of the deposit is typically mantled by pale red (10*R* 6/2) to moderate reddish orange (10*R* 6/6) sand containing small pebbles of moderate reddish-brown (10*R* 4/6) ironstone. Where heavy minerals are abundant, sand is brownish gray (5*YR* 4/1). This unit occurs to an elevation of approximately 275 ft (84 m) above sea level and underlies (with sand and gravel of unit 2 of the upper part of the Chesapeake Group) the Richmond plain of Johnson and others (1982). Weems and others (2010) interpret sediments of this unit to be equivalent in part to the Yorktown Formation (Clark and Miller, 1906; Ward and Blackwelder, 1980). Sediments are likely marine to marginal marine (Weems and others, 2010). Thickness is up to 12.5 m

BEDROCK UNITS

INTRUSIVE VEINS AND DIKES

Jd **Diabase (Jurassic)**—Grayish olive-green (5*GY* 3/2) to greenish black (5*GY* 2/1) fresh, weathers olive gray (5*Y* 3/2) with local surface coloration of dusky red (5*R* 3/4); aphanitic to phaneritic; ophitic, subophitic, subidiomorphic to porphyritic; mostly consists of plagioclase and orthopyroxene, with some clinopyroxene, quartz, and biotite; chlorite is an alteration mineral; typically contains abundant magnetite, and locally pyrite. In ophitic-textured rocks, plagioclase laths up to 3-millimeter (mm) long are common. Joint density in diabase is moderately to widely spaced (30 cm to 1 m, or 1 to 3 ft); joints are typically oriented parallel or orthogonal to the walls of the dike. Rocks commonly weather to dense, spheroidally rounded boulders, which can be easily traced along strike where outcrop is absent. Diabase weathers to a dusky red (5*R* 3/4), dense clay-rich soil; soil and saprolite cover is up to 2 m. Diabase occurs as nearly vertical dikes that locally intrude older units in the Dinwiddie and Roanoke Rapids terranes

qtz - y **Vein quartz (Mesozoic to Paleozoic)**—White (*N* 9) to bluish-white (5*B* 9/1) fresh, weathers very pale orange (10*YR* 8/2); fine- to very coarse-grained, idiomorphic; consists of quartz, with minor amounts of sericite and muscovite, and locally chlorite, ilmenite, and magnetite. Joint density in vein quartz is moderately spaced (30 cm to 1 m, or 1 to 3 ft); joints are typically oriented parallel or orthogonal to the walls of the vein. Rocks commonly weather to pebbles, cobbles, and boulders of angular to subrounded fragments, and white (*N* 9) to very pale orange (10*YR* 8/2) sand, which mantles the surface above quartz veins; soil and saprolite cover is typically less than 1 m. Vein quartz occurs as dikes and sills that locally intrude older units throughout map area; most are too small to map accurately at 1:24,000-scale. Brittle faults are marked by zones of brecciated and recemented veins of quartz, which consist of clasts of vein quartz and rare lithic fragments cemented by quartz and chalcedony. Locally, silicified cataclasite mostly consists of quartz that has been brecciated and recemented with quartz and chalcedony multiple times. Vugs are typically filled with fine-grained terminated crystals of quartz or locally zeolite. Many quartz veins and silicified cataclasite zones are mineralized with sulfides, and several have been prospected for gold. Quartz veins likely crystallized from regional metamorphic fluids during late Paleozoic high-grade metamorphism and deformation, or hydrothermal fluids during Mesozoic rifting. Re-activation of silicified cataclasite zones occurred during the Pliocene, as many of these brittle-deformed faults deform and offset sediments of the upper part of the Chesapeake Group and equivalent deposits; younger Quaternary deposits are not offset

ROCKS OF THE DINWIDDIE TERRANE

Granite of the De Witt pluton

Granite east of the Nottoway River fault was once assigned to the Petersburg Granite of Jonas (1928, 1932). Modern geochronology, however, indicates a suite of wide-ranging ages for rocks of the Dinwiddie terrane. In the southern part of the outcrop belt, granite in the vicinity of De Witt and at the Vulcan Materials Jack Quarry near Sutherland have been dated using the Sensitive High-Resolution Ion Microprobe-Reverse Geometry (SHRIMP-RG) U-Pb zircon technique at 321±5 Ma (Carter and others, 2019) and 318±4 Ma (McAleer and others, 2020), respectively, and are part of the De Witt-Sutherland pluton (McAleer and others, 2020). Comparatively, massive and porphyritic granite near Richmond, also assigned to the Petersburg Granite (Virginia Division of Mineral Resources, 1993) have been dated using the Isotope Dilution-Thermal Ionization Mass Spectrometry (ID-TIMS) U-Pb zircon technique at 296±0.11 Ma and 299±0.13 Ma, respectively (Buchwaldt and Owens, 2012; Owens and others, 2017, 2019). On the Cherry Hill 7.5-minute quadrangle, rocks assigned to the granite of the ca. 321 Ma De Witt-Sutherland pluton of McAleer and others (2020) are separated into two units.

Ꝑeg **Equigranular granite (Pennsylvanian)**—Light bluish-gray (5*B* 7/1) fresh, weathers grayish orange-pink (10*R* 8/2); medium- to coarse-grained; typically equigranular, with uniform hypidiomorphic to allotriomorphic granular texture, but locally porphyritic; consists of quartz, potassium feldspar, and plagioclase. Biotite is the major mafic mineral but is locally altered to chlorite; epidote is also common. Quartz is commonly "smoky," or medium gray (*N* 5) in color. Myrmekite and muscovite are locally minor mineral constituents; some chlorite replaces biotite. Where porphyritic, pinkish gray (5*YR* 8/1) potassium feldspar phenocrysts are less than 1.2-cm long. Granite is locally massive to weakly foliated; foliation is defined by 0.5- to 2-cm-thick bands of mostly quartz and tabular feldspar, locally separated by thin (0.5-mm) selvages of biotite; foliation is locally broadly folded. Equigranular granite locally contains enclaves of foliated metagranite and is cross-cut by numerous muscovite-quartz-potassium feldspar pegmatite dikes ranging in thickness from less than 1 cm up to 1.5 m. Joint density in granite is typically widely to very widely spaced (30 cm to 3 m, or 1 to 10 ft). Rocks of this unit weather to a very pale orange (10*YR* 8/2) sandy soil containing coarse-grained, angular fragments of quartz and feldspar; soil and saprolite cover is typically less than 2 m. Equigranular granite is lithologically identical to ca. 321 Ma rocks dated by Carter and others (2019) on the northwest adjacent De Witt 7.5-minute quadrangle

Ꝑpg **Porphyritic granite (Pennsylvanian)**—Light greenish-gray (5*G* 8/1) fresh, weathers yellowish gray (5*Y* 8/1); medium- to very coarse grained; porphyritic to porphyroclastic; consists of quartz, plagioclase, and potassium feldspar, with biotite as the major mafic mineral. Quartz is locally "smoky," or medium gray (*N* 5) in color. Pinkish gray (5*YR* 8/1) potassium feldspar phenocrysts are up to 3-cm long. Granite is locally foliated; foliation is defined by aligned feldspar phenocrysts or deformed feldspar porphyroclasts and thin (0.5-mm) selvages of biotite; foliation is locally broadly folded. Porphyritic granite is cross-cut by numerous muscovite-quartz-potassium feldspar pegmatite dikes ranging in thickness from less than 1 cm up to 1.5 m. Joint density in granite is typically widely to very widely spaced (30 cm to 3 m, or 1 to 10 ft). Rocks of this unit weather to a light brown (5*YR* 6/4) loamy soil containing scattered flakes of mica; soil and saprolite cover is typically less than 3 m. Foliated metagranite was once thought to be a phase of the late Paleozoic Petersburg Granite (for example, Carter and others, 2007a, b), but recently, similar rocks in the Richmond area have been dated using both laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) and SHRIMP-RG U-Pb zircon techniques at ca. 425 Ma to ca. 404 Ma (Carter and others, 2019; McAleer and others, 2020). Foliated metagranite in this area has not been dated

Cs **Mica schist (Cambrian)**—Medium bluish-gray (5*B* 5/1) fresh, weathers pale brown (5*YR* 5/2); fine- to medium-grained; lepidoblastic, porphyroclastic, and porphyroblastic; mostly consists of muscovite and quartz, with locally biotite, graphite, and chlorite as mineral constituents. Bluish white (5*B* 9/1) quartz occurs as discontinuous layers and boudins up to several centimeters thick. Porphyroblasts of garnet and staurolite are common; kyanite porphyroblasts occur locally. Staurolite is also locally porphyroclastic, rotated in the plane of foliation, and preserves an earlier foliation as inclusion trails. Schist is strongly foliated, locally lineated and crenulated. Joint density in mica schist is closely spaced (30 mm to 10 cm, or 1.2 to 3.9 inches [in.]) where joints are parallel to foliation, and very widely spaced (1 to 3 m, or 3 to 10 ft) where joints are orthogonal to foliation. Mica schist weathers to a pale brown (5*YR* 5/2) clayey soil containing abundant grains of garnet, staurolite, and flakes of mica; soil and saprolite cover is locally up to 6 m. Detrital zircons from similar rocks in the Richmond area have been dated as young as Cambrian 527 Ma or younger) using the LA-ICP-MS U-Pb technique and provide a maximum depositional age for this unit (McAleer and others, 2020)

ROCKS OF THE ROANOKE RAPIDS TERRANE

Granite and granitic mylonite in the Nottoway River fault zone

g **Granite (Paleozoic)**—Grayish pink (5*R* 8/2) to grayish orange-pink (10*R* 8/2) fresh, weathers light brown (5*YR* 6/4); fine- to medium-grained; equigranular, porphyritic, protomylonitic to locally mylonitic; contains potassium feldspar phenocrysts up to 0.5 cm in length in a finer grained matrix of quartz and sparse plagioclase. Muscovite is the major phyllosilicate mineral; biotite is very sparse and mostly replaced by chlorite. Magnetite is also a mineral constituent. Granite is locally strongly foliated and lineated; joint density in granite is typically widely spaced (30 cm to 1 m, or 1 to 3 ft). Rocks of this unit weather to a light brown (5*YR* 6/4) loamy soil; soil and saprolite cover is typically less than 2 m. Granite occurs in a map-scale body along Sappony Creek and as smaller boudins within granitic mylonite of the Nottoway River fault zone and is the less deformed equivalent of those rocks

my **Granitic mylonite (Paleozoic)**—Pale olive (10*Y* 6/2) fresh, weathers moderate yellowish-brown (10*YR* 5/4) to dark yellowish brown (10*YR* 4/2); very fine to fine-grained, locally medium-grained; lepidoblastic, mylonitic to ultramylonitic. Granitic mylonite consists of quartz, plagioclase, potassium feldspar, and sericite; chlorite and epidote are also common mineral constituents; quartz and feldspar porphyroclasts, several millimeters in diameter, are common. Granitic mylonite is strongly foliated, lineated, and locally crenulated; abundant sericite occurs on foliation surfaces. Recrystallized quartz and feldspar, and aligned sericite grains, define subhorizontal lineation on foliation surfaces. Kinematic indicators such as rotated feldspar porphyroclasts consistently preserve dextral transpression. Cross-cutting, millimeter-thick fractures filled with chalcedony are locally common, as are meter-thick zones of highly sheared greenstone and amphibolite. Joint density in granitic mylonite is closely spaced (30 mm to 10 cm, or 1.2 to 3.9 in.); the dominant joint set is parallel to foliation. Rocks of this unit weather to a light brown (5*YR* 6/4) loamy soil with abundant flakes of mica; soil and saprolite cover is locally up to 4 m. Granitic mylonite occurs within the Nottoway River fault zone, a major tectonic boundary within the eastern Piedmont fault system (Hatcher and others, 1977) that separates rocks of the Roanoke Rapids terrane from those of the Dinwiddie terrane to the east (Carter and others, 2020)

Meta-igneous intrusive rocks

Zdg **Metadiorite and metagabbro (Neoproterozoic)**—Rock types of this unit include metadioritic and metagabbro, amphibolite, and metagranodiorite. Metadioritic and metagabbro are the most common rock types and are dusky yellow-green (10*GY* 3/2) fresh, weather dark greenish-gray (5*G* 4/1); medium-grained; nematoblastic, granoblastic, locally poikilitic; mostly consist of hornblende and plagioclase in varying amounts, with some quartz and a minor amount of potassium feldspar. Composition ranges from dioritic to gabbroic. Locally, some quartz is "smoky," or medium dark-gray (*N* 4) in color. Yellowish gray (5*Y* 8/1) plagioclase grains contrast with the darker greenish black (5*GY* 2/1) color of the mafic-mineral-rich groundmass. Epidote is a very common mineral, either as an alteration from plagioclase and hornblende, or in thin (several millimeter-thick) fracture fills throughout the rock. Pyrite is locally common, as is hematite, which stains other mineral grains dusky red (5*R* 3/4). Metadiorite is foliated, but locally massive or compositionally layered; compositional layering consists of centimeter-thick bands of mostly feldspar, alternating with similarly thick bands of mostly hornblende. Where strongly deformed, metadiorite is altered to amphibolite, which is dusky green (5*G* 3/2) fresh, but weathers to dusky yellowish-green (10*GY* 3/2); fine- to medium-grained; nematoblastic to locally granoblastic; consists of hornblende and plagioclase, with minor amounts of quartz. Yellowish gray (5*Y* 8/1) plagioclase grains contrast with the darker greenish black (5*GY* 2/1) color of the mafic-mineral-rich groundmass, giving the rock a "salt and pepper" appearance. Amphibolite is foliated, but locally massive, and weakly compositionally layered; compositional layering, where present, consists of millimeter-thick bands of mostly plagioclase feldspar and some amphibole, alternating with similarly thick bands of mostly hornblende, with some plagioclase. Hornblende locally forms garbenschiefer, or "turkey-track" texture on foliation surfaces. Joint density in metadiorite is widely to very widely spaced (30 cm to 3 m, or 1 to 10 ft); the dominant joint set parallel to foliation. Metadior