Virginia Department of Mines, Minerals and Energy

Open File Report 10-06
Geologic Map of the Chesterfield Quadrangle
Virginia Division of Geology and Mineral Resources

GEOLOGIC MAP OF THE CHESTERFIELD QUADRANGLE, VIRGINIA

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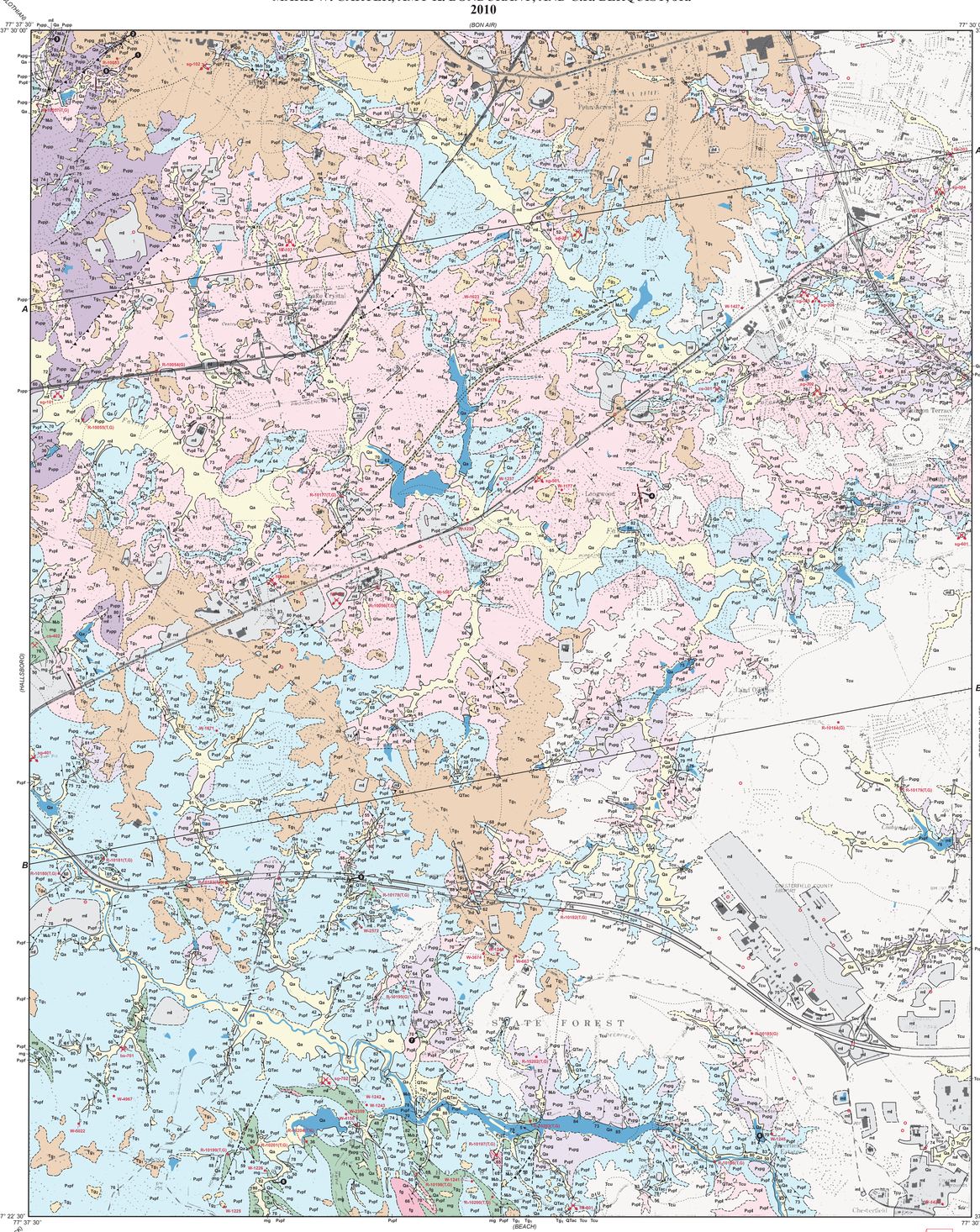
2010



Basemap, scanned image (300 dpi) of U.S. Geological Survey 1963, Revised 1994, Chesterfield, Virginia topographic map
Projection of original map: Virginia coordinate system, south zone (Lambert conformal conic)
Digital Cartography by Mark W. Carter

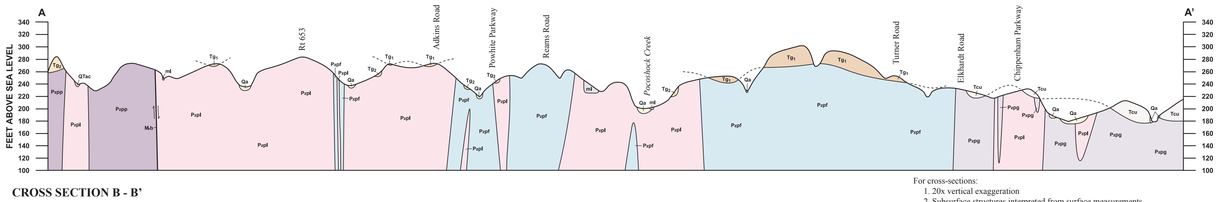
1994 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET ANNUAL VARIATION: 0° 1' West per year

SCALE 1:24000

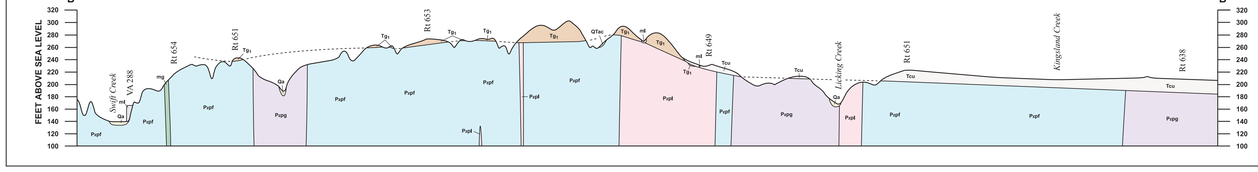
CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Geology mapped from November 2005 to February 2008

CROSS SECTION A - A'



CROSS SECTION B - B'



For cross-sections:
1. 20x vertical exaggeration
2. Subsurface structures interpreted from surface measurements

DESCRIPTION OF MAP UNITS

SURFICIAL UNITS

md — **Modified Land** – Extensive cut and/or fill related to grading and excavation. Widespread modified land in heavily urbanized areas not shown. Holocene. Variable thickness.

Qa — **Alluvium** – Floodplain deposits ranging from clay to gravel. Holocene to Pleistocene. Variable thickness.

cb — **Carolina Bay** – Elliptical depressions occurring above Tertiary sand and gravel of the upper Chesapeake Group (T_{cu}) in the eastern part of the quadrangle. Interpreted to be equivalent to Carolina Bays of the central and southern outer Atlantic Coastal Plain (Goodwin and Johnson, 1970). On the adjacent Bon Air quadrangle to the north, similar depressions are filled with 5 to 10 feet (1.5 to 3.0 meters) of massive, brownish-gray silty clay, with scattered rounded quartz pebbles, surrounded by a low ridge or rim of fine sand.[1] Located and mapped using both remote sensing and soil survey data[2] (Coxville and Rains Soil Series typically occur on Carolina Bays[3]).

QTac — **Quaternary-Tertiary Alluvial and Colluvial Valley Fill** – Channel fill and side-slope deposits of alluvium and colluvium in drainageways, at elevations ranging from 150 to 250 feet above present sea level. Variably lithified pebbly feldspathic sand, which is very light-gray to pinkish-gray to yellowish-gray, fine- to medium-grained quartz and feldspar sand, characterizes sediments of the unit. The unit is highly indurated to lithified. Subangular to well-rounded pebbles, cobbles, and boulders of quartz, quartzite (many containing the trace fossil *Skolithos*), and granite are scattered throughout. The matrix contains very few mica minerals. Feldspar is variably weathered to clay, which, with hematite, carbonate, and silica, contributes to cementation. Sediment consists of quartz, plagioclase, potassium feldspar, clay minerals, hematite, ilmenite/magnetite, and carbonate. Locally bedded; basal gravel lag deposit, up to about 1 foot (0.3 meter) thick, typically occurs at the contact with underlying Paleozoic granite, and is commonly iron-oxide cemented (ferricrete). Lithification and generally higher elevation distinguish this unit from younger Holocene to Pleistocene surficial alluvium. The unit is interpreted to be remnants of periodic debris flows that mixed granite saprolite with reworked gravels from older or more distal units. Pleistocene to Pliocene. Maximum thickness about 10 feet (3 meters).

COASTAL PLAIN UNITS

T_{g3} — **Low-Level Tertiary Gravels** – Gravel and sand deposits that cap hills at elevations ranging from 140 to 240 feet above present sea level, along Pocoshock, Falling, and Swift creeks. Rounded quartz and quartzite pebbles, cobbles, and boulders, many with the trace fossil *Skolithos*, comprise the gravel. Commonly, the base of the unit is lithologically similar to Quaternary-Tertiary alluvial and colluvial valley fill (QTac). Correlates with at least part of the upper Pliocene Bacons Castle Formation (Coch, 1965) to the east (Mixon and others, 1989; Carter and others, 2007a). Maximum thickness about 10 feet (3 meters).

T_{g2} — **Mid-Level Tertiary Gravels** – Gravel and sand deposits that cap hills and mantle slopes at elevations ranging from about 225 to 245 feet above present sea level along Pocoshock, Falling, and Swift creeks and their major tributaries. Gravel consists of rounded quartz and quartzite pebbles, many containing the trace fossil *Skolithos*, in a sandy to clayey sand matrix, locally stained and cemented with iron-oxide (ferricrete); locally bedded. Commonly, the base of the unit is lithologically similar to Quaternary-Tertiary alluvial and colluvial valley fill (QTac). The sediment consists of quartz, sericite and other clay minerals, hematite, potassium feldspar, plagioclase, carbonate, with traces of biotite, muscovite (both as detrital grains), and ilmenite/magnetite. Slightly younger than upper Chesapeake Group sediments (T_{cu}), and interpreted to have been deposited during Pliocene sea-level regression (Carter and others, 2007b). Maximum thickness about 50 feet (15 meters).

Tcu — **Upper Chesapeake Group Sand and Gravel** – Grayish-yellow to moderate reddish-brown silty sand and gravel occurs on the low, relatively flat topographic surface along the eastern edge of the quadrangle, to an average elevation of about 245 feet above present sea level (up to 260 feet above present sea level in the southern part of the quadrangle). Fine sand, with scattered, rounded quartz granules and pebbles, is the dominant lithology. Locally, sand is finely laminated, cross-bedded, or bedded with gravel stringers and layers, up to several feet (about 1 meter) thick. Gravel consists of well-rounded, clast-supported quartz and quartzite pebbles and cobbles. Iron-oxide mottling and cement (ferricrete) is common. Base of unit is locally lithologically similar to Quaternary-Tertiary alluvial and colluvial valley fill (QTac). Fine (pea-size) gravel typically mantles the surface, distinguishing this unit from the T_{g3} gravels that typically contain coarser cobbles and boulders. Overlies, and younger than high-level Tertiary gravels (T_{g1}). This unit is interpreted to have been deposited in fluvial, nearshore, and strandline environments (Daniels and Onuschak, 1974; Goodwin, 1980). Most likely correlates with the Pliocene upper Chesapeake Group, as the nearshore equivalent of the down-dip marine Yorktown Formation (Newell and Rader, 1982). Maximum thickness about 30 feet (10 meters).

T_{g1} — **High-Level Tertiary Gravels** – Gravel and sand deposits that cap hills in the central and southern parts of the quadrangle and underly the relatively flat upland topographic surface in the north-central part of the quadrangle, at elevations ranging from about 250 to 350 feet above present sea level. Yellowish-brown to reddish-brown sediment consists of abundant, well rounded pebbles and cobbles in a sandy to clayey sand matrix; gravel composition dominantly vein quartz and quartzite (a few clasts contain the trace fossil *Skolithos*), with few metamorphic and igneous clasts; quartzite clasts commonly deeply weathered to decomposed; partially iron-oxide cemented (ferricrete) matrix; locally bedded. Commonly, the base of unit is lithologically similar to Quaternary-Tertiary alluvial and colluvial valley fill (QTac). Unconformably overlies lower Chesapeake Group sediments (Tcl) in the northern part of the quadrangle, and interpreted to have been deposited during Pliocene to Miocene sea-level regression. Maximum thickness about 30 feet (10 meters) in the northern part of the quadrangle, but mostly comprises a thin (less than 10 feet, or 3 meters thick) mantle of gravel and sand on hills and high topographic surfaces in the central and southern parts of the quadrangle.

Tcl — **Lower Chesapeake Group Clayey Silt** – Dark greenish-gray to medium bluish-gray fresh, moderate yellowish-brown weathered clayey silt and very fine sand with abundant flakes of mica; unconformably underlies gravel and sand (T_{g1}) in the northernmost part of the quadrangle. Locally, subangular to subrounded quartz granules are common within a finer-grained clayey silt and very fine sand matrix. Iron oxide mottling and staining from disseminated iron sulfide is common. Massive to finely laminated; locally bedded with gravel stringers up to about 3 inches (approximately 8 centimeters) thick, consisting of well-rounded, clast-supported quartz pebbles; sparsely fossiliferous; locally jointed. Easternmost exposures of map unit consist of grayish-yellow to grayish-orange, finely laminated sandy silt. Basal gravel lag deposit, up to about 1 foot (0.3 meter) thick, locally occurs at the unconformable contact with the underlying Paleozoic rocks; consists of clast-supported subangular to well-rounded pebbles, cobbles, and boulders of quartz and granite; commonly iron cemented; where gravel is not present, basal lithology consists of fine- to medium-grained quartz and feldspar sand. Unit interpreted to be marine; most likely correlates with the Miocene lower Chesapeake Group. Maximum thickness about 5 feet (1.5 meters).

CATACLASTIC ROCKS

Mzb — **Silicified Cataclasite** – White to very light-gray brecciated quartz is the dominant rock type of this unit. Quartz fragments range from pebble- to cobble-size; fractures and voids between fragments filled with botryoidal masses, concentric growths, and vugs of drusy quartz crystals. Slickensides are common on some fracture surfaces. Locally, fragments of country rock are also common within brecciated quartz. Silicified cataclasite is resistant to weathering and erosion, and occurs as outcrops or abundant float that caps many hills within the outcrop belt. Also included within this unit are zones of intensely fractured country rock, cross-cut by abundant swarms of approximately 0.1-inch-(2.5-millimeters-) thick chalcedony- and quartz-filled joints and fractures. In these zones, granule- to boulder-size fragments of country rock dominate. Locally, chalcedony- and quartz-filled fracture swarms grade into thicker zones of brecciated quartz. Several silicified cataclasite zones portrayed on the geologic map are exaggerated, and many more are too small to map separately at this scale. Age of formation and deformation of at least one silicified cataclasite zone is well constrained: on the adjacent Bon Air quadrangle to the north, a 2 foot (0.6 meter) thick silicified breccia zone cross-cuts and brecciates Jurassic diabase. Several silicified breccia zones appear to be reactived and potentially much younger; at one locality in the northwestern part of the Chesterfield quadrangle, a reactived silicified breccia zone appears to offset Miocene clayey silt (T_{cl}).

IGNEOUS INTRUSIVE ROCKS

Jd — **Diabase** – Dark-green to black, weathers to dark reddish-brown; fine-grained; aphanitic; occurs as dikes ranging from several feet to about 10 feet (1 to 3 meters) thick; commonly weathers to spheroidically rounded, dense boulders or punky cobbles that can be traced along strike when outcrop is absent. Several dikes portrayed on the geologic map are exaggerated for clarity, and several more dikes are too small to map separately at this scale. Jurassic (Sutter, 1988).

NEWARK SUPERGROUP

Tns — **Newark Supergroup, Undivided** – Triassic Newark Supergroup sedimentary rocks of the Richmond basin include arkosic, micaceous, and carbonaceous sandstone, laminated to thin-bedded shale, and coal, which unconformably overlie Paleozoic rocks (Goodwin and others, 1986). In the northwestern part of the Chesterfield quadrangle, two areas of Newark Supergroup rocks are shown. Their distribution was mapped on soil survey data[2] (Creedmoor, Mayodan and Pinkston Soil Series form from weathered Triassic residuum[3]); outcrop data in the vicinity of these areas are lacking. Additional detailed (1:12,000- or larger-scale) geologic and soil mapping should be conducted to confirm or accurately delineate this unit.

IGNEOUS INTRUSIVE ROCKS

PETERSBURG GRANITE

The Petersburg Granite underlies a large region of east-central Virginia, from near Ashland in Hanover County in the north, to Dinwiddie in Dinwiddie County in the south. Its outcrop belt is bounded to the north and west by the Richmond-Taylorsville Mesozoic basins, and is covered by Coastal Plain sediments to the south and east. Dated at approximately 330 MA (Mississippian) by Wright and others (1975), and approximately 315 MA (Pennsylvanian) by Lee and Williams (1993). On the Chesterfield quadrangle, the Petersburg Granite is subdivided into four phases, from youngest to oldest:

Pzpg — **Subidiomorphic Granite** – Light bluish-gray; fine- to medium-grained, locally coarse-grained; homogenous, uniform subidiomorphic texture; locally foliated. Consists of quartz, plagioclase, potassium feldspar, muscovite, biotite, hornblende, zircon, epidote, carbonate, and traces of ilmenite/magnetite, apatite and garnet. Locally porphyritic, with pale-pink potassium feldspar phenocrysts less than 0.5 inch (1 centimeter) in length; locally contains pods, lenses, zones, and enclaves of foliated granite and layered granite gneiss; cross-cut by aplite and pegmatite dikes; well jointed.

Pzpp — **Porphyritic Granite** – Grayish-blue, medium- to coarse-grained, porphyritic, with pale-pink potassium feldspar phenocrysts over 1 inch (2.5 centimeters) in length, commonly oriented and aligned subparallel to a weak to strong biotite foliation within the matrix. Consists of quartz, plagioclase, potassium feldspar, biotite, muscovite, zircon, epidote, carbonate, and traces of hornblende, hematite, and ilmenite/magnetite. Quartz and plagioclase dominate the matrix; quartz is typically medium-gray to light bluish-gray; locally, potassium feldspar phenocrysts deformed to porphyroclasts; commonly associated with coarse- to very coarse-grained medium-gray to light bluish-gray quartz and pale-pink potassium feldspar pegmatite, which also cross-cuts older phases; also cross-cut by grayish-yellow aplite dikes; locally contains pods and lenses of subidiomorphic granite, and rarely, layered granite gneiss and foliated granite; well jointed.

Pzpf — **Foliated Granite** – Light bluish-gray granite; medium- to coarse-grained, locally fine-grained; weakly to strongly foliated. Phyllosilicate and quartz-feldspar alignment defines foliation; unit locally contains pods, lenses, zones, and enclaves of layered granite gneiss, subidiomorphic granite, and rarely porphyritic granite; cross-cut by aplite and pegmatite dikes; well jointed.

Pzpl — **Layered Granite Gneiss** – Light bluish-gray to medium bluish-gray to medium-gray granite; compositionally layered; layering ranges from 0.5 inch to several inches (1 centimeter to 1 decimeter) thick; composition ranges from quartz-feldspar- to biotite-quartz-feldspar-rich layers; individual layers are fine- to coarse-grained, subidiomorphic to locally porphyritic (potassium feldspar phenocrysts are less than 0.5 inch, or 1 centimeter in length); unit locally contains pods, lenses, zones, and enclaves of subidiomorphic granite and foliated granite; cross-cut by aplite and pegmatite dikes; well jointed.

METAMORPHIC ROCKS

Felsic and mafic metamorphic rocks occur as enclaves or xenoliths within Petersburg Granite. These rocks are older than Petersburg Granite, but maximum age constraints are lacking. Larger bodies are shown on the geologic map; several more bodies were observed, but are too small to map separately at this scale.

fg — **Felsic Gneiss** – Biotite-muscovite granitic gneiss; compositionally layered rock consisting of contrasting quartz-feldspar- and phyllosilicate-rich layers, 0.5 inch (1 centimeter) thick. Quartz-feldspar-rich layers are bluish-white to yellowish-gray; medium- to coarse-grained; granoblastic to locally porphyroclastic. Phyllosilicate-rich layers are medium dark-gray to dusky-brown to very dusky-red; fine- to medium-grained; lepidoblastic, strongly foliated.

mg — **Mafic Gneiss** – Muscovite-biotite gneiss, amphibole-biotite gneiss and schist, amphibolite and talc-amphibole schist. These rocks range from dark-gray to dark greenish-gray to dusky yellowish-green to olive-gray to dusky yellowish-brown; fine- to medium-grained; lepidoblastic to nematoblastic to locally granoblastic. Interlayered locally with felsic gneiss, described above. South of Swift Creek, mafic gneiss is intricately interlayered with panels and screens of foliated granite that range from from less than 1 foot (0.3 meter) to more than 200 feet (60 meters) in thickness. Easily distinguished from younger diabase (Jd) by foliation and metamorphic overprint.

MAP SYMBOLS

For all line symbols: lines are solid where the location is exact (located in field to within 50 feet or 15 meters), long-dashed where the location is approximate (located to within 200 feet or 60 meters), short-dashed where the location is inferred, dotted where covered. For geologic observation symbols, observation sites are centered on the strike bar, or are at the intersection point of multiple symbols.

Line Symbols

Contacts

Fault Contacts
Faults labeled "Mzb" are Mesozoic silicified cataclasites; Faults not labeled are Cenozoic brittle structures.

Reverse - "U" on upthrown block; ornaments show dip direction

Normal - "D" on downthrown block; ornaments show dip direction

Structural contact - displacement known; dip-direction unknown

Structural contact - displacement and dip-direction unknown

Line Symbols in Cross Sections

Contact

Eroded contact

Mineral Resources

Commodity letter symbol precedes identification number (identification numbers are preceded by "100A-" in Mineral Resources of Virginia database). Commodity letter symbols: bs - building and dimension stone; cs - crushed stone; fill - saprolite or earth material; sg - sand and gravel.

Abandoned or reclaimed borrow pit

Abandoned or reclaimed mine or quarry

Active mine or quarry

Geologic Observations

Strike and dip of inclined beds in Coastal Plain sediments and Triassic sedimentary rocks

Strike and dip of inclined foliations in Petersburg Granite and gneiss units

Strike and dip of inclined aplite and pegmatite dikes

Strike and dip of inclined joints

Strike and dip of inclined chalcedony-filled fractures or joints

Trend and plunge of mineral lineations

Trend and plunge of mesoscale fold hinges

Geologic References

R-9947 — Rock repository sample

R-9957(T) — Rock repository sample and thin section

R-9942(G) — Rock repository sample and geochemical analysis

R-9967(T,G) — Rock repository sample, with both thin section and geochemical analysis

W-6133 — Water well drill cuttings

Other boreholes used to construct map and cross sections

Location of Geologic Reference Photographs (location at tip of arrow)

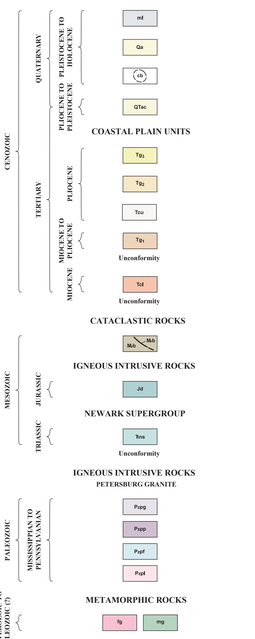
FOOTNOTES

[1]Description of map unit modified from Goodwin (1980).

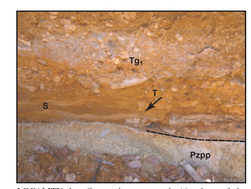
[2]United States Department of Agriculture, Natural Resources Conservation Service, 2006, Soil Survey Geographic (SSURGO) database for Chesterfield County, Virginia: U.S. Department of Agriculture, Natural Resources Conservation Service, Fort Worth, Texas (Available at http://SoilDataMart.nrcs.usda.gov).

[3]Soil Survey Staff, 2004, Official Soil Series Descriptions: U. S. Department of Agriculture, Natural Resources Conservation Service (Available at http://soils.usda.gov/technical/classification/osd/index.html).

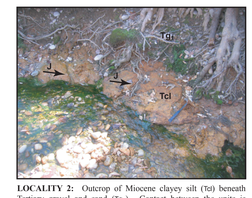
CORRELATION OF MAP UNITS



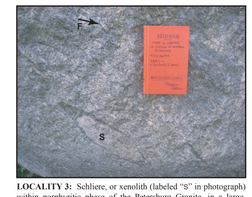
GEOLOGIC REFERENCE PHOTOGRAPHS



LOCALITY 1: Contact between porphyritic phase of the Petersburg Granite (Pzpp) and high-level Tertiary gravel and sand (T_{g1}), marked by a dashed line. High-level Tertiary gravel and sand here consists of a thin (less than 1-foot or 0.3-meter), discontinuous section of laminated clayey sand (marked "S" in photograph) that is cut out by thicker gravel in the center of the photograph (truncation is marked by an arrow and "T" in photograph). Note the deeply weathered, red and yellow, iron-stained coloration of the gravel and sand. Hammer head is about 8 inches (20 centimeters) long.

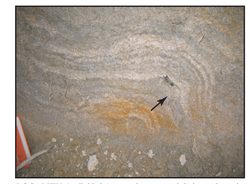


LOCALITY 2: Outcrop of Miocene clayey silt (Tcl) beneath Tertiary gravel and sand (T_{g1}). Contact between the units is beneath tree roots in the upper right of the photograph. Differentially weathered joints (marked by arrows and "J" in photograph) are present in the clayey silt. Hammer is approximately 15 inches (38 centimeters) long.

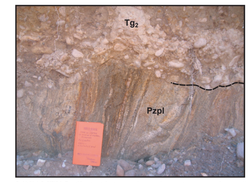


LOCALITY 3: Schliere, or xenolith (labeled "S" in photograph) within porphyritic phase of the Petersburg Granite, in a large, out-of-place boulder in an alluvial floodplain. Large (up to 1.5 inches, or 4 centimeters) potassium feldspar phenocrysts (marked by an arrow and "F" in photograph) are approximately aligned with the long axis of the schliere. Long edge of fieldbook is about 7.5 inches (19 centimeters).

GEOLOGIC REFERENCE PHOTOGRAPHS

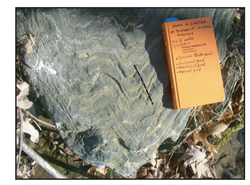


LOCALITY 4: Folded (magmatic or tectonic?) layered granite gneiss phase of the Petersburg Granite (Pzpl). Layering is about 0.5 inch (1 centimeter) thick, and consists of quartz-feldspar and biotite-quartz-feldspar-rich bands. Pencil (indicated by arrow) marks the bearing and plunge of the fold axis. Edge of fieldbook is about 7.5 inches (19 centimeters) long.



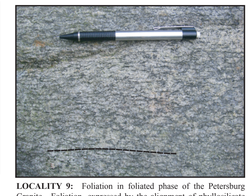
LOCALITY 5: Contact between layered granite gneiss phase of the Petersburg Granite (Pzpl) and mid-level Tertiary gravel and sand (T_{g2}), marked by a dashed line. Notice the well-layered fabric of the Petersburg Granite at this locality. Compare the deeply weathered, red and yellow iron-stained coloration of the gravel and sand of high-level Tertiary gravel and sand at locality 1 with the much less intensely weathered mid-level Tertiary gravel at this locality. Long edge of fieldbook is about 7.5 inches (19 centimeters) long.

LOCALITY 6: Strong foliation in foliated phase of the Petersburg Granite. Foliation is marked by a dashed line in the photograph. Long edge of fieldbook is about 7.5 inches (19 centimeters) long.



LOCALITY 7: Folded amphibolite xenolith within Petersburg Granite. Axial planes of the tight folds in the amphibolite are marked by secondary crenulation cleavage (shown by a dashed line in the photograph), which mirrors the orientation of foliation in Petersburg Granite surrounding the xenolith. Edge of fieldbook is about 7.5 inches (19 centimeters) long.

LOCALITY 8: Tight to isoclinal folds (some shown by dashed lines in the photograph), with fold axes parallel to the pen, in a xenolith of layered biotite gneiss within Petersburg Granite. Axial planes of the isoclines mirror the orientation of foliation in Petersburg Granite surrounding the xenolith. Pen is 5.4 inches (13.7 centimeters) long.



LOCALITY 9: Foliation in foliated phase of the Petersburg Granite. Foliation, expressed by the alignment of phyllosilicate minerals, is marked by a dashed line in the photograph. Pencil is 5.4 inches (13.7 centimeters) long.

ACKNOWLEDGEMENTS

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Carter M.W., Bondurant, A.K., and Berquist, C.R., 2010, Geologic map of the Chesterfield quadrangle, Virginia: Virginia Department of Mines, Minerals and Energy, Division of Geology and Mineral Resources Open File Report 10-06, Map Scale 1:24,000.

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