National Park Service
U.S. Department of the Interior

Natural Resource Program Center

National Capital Area Parks

Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory Digital Geologic Data for National Capital Area Parks

ncap_geology.pdf

Version: 7/15/2010

Geologic Resources Inventory Map Document for National Capital Area Parks

Table of Contents

Geologic Resources Inventory Map Document

National Capital Area Parks, Washington D.C., Virginia, Maryland and West Virginia

Document to Accompany Digital Geologic-GIS Data

ncap_geology.pdf

Version: 7/15/2010

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Catoctin Mountain Park (CATO), Greenbelt Park (GREE), George Washington Memorial Parkway (GWMP), Manassas National Battlefield Park (MANA), Monocacy National Battlefield (MONO), National Capital Parks-East (NACE), Prince William Forest Park (PRWI), Rock Creek Park (ROCR) and Wolf Trap Farm Park (WOTR), as well as Antietam National Battlefield (ANTI).

Attempts have been made to reproduce all aspects of the original source products, including the geologic units and their descriptions, geologic cross sections, the geologic report, references and all other pertinent images and information contained in the original publication.

National Park Service (NPS) Geologic Resources Inventory (GRI) Program staff have assembled the digital geologic-GIS data that accompanies this document.

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About the NPS Geologic Resources Inventory Program

Background

Recognizing the interrelationships between the physical (geology, air, and water) and biological (plants and animals) components of the Earth is vital to understanding, managing, and protecting natural resources. The Geologic Resources Inventory (GRI) helps make this connection by providing information on the role of geology and geologic resource management in parks.

Geologic resources for management consideration include both the processes that act upon the Earth and the features formed as a result of these processes. Geologic processes include: erosion and sedimentation; seismic, volcanic, and geothermal activity; glaciation, rockfalls, landslides, and shoreline change. Geologic features include mountains, canyons, natural arches and bridges, minerals, rocks, fossils, cave and karst systems, beaches, dunes, glaciers, volcanoes, and faults.

The Geologic Resources Inventory aims to raise awareness of geology and the role it plays in the environment, and to provide natural resource managers and staff, park planners, interpreters, researchers, and other NPS personnel with information that can help them make informed management decisions.

The GRI team, working closely with the Colorado State University (CSU) Department of Geosciences and a variety of other partners, provides more than 270 parks with a geologic scoping meeting, digital geologic-GIS map data, and a park-specific geologic report.

Products

Scoping Meetings: These park-specific meetings bring together local geologic experts and park staff to inventory and review available geologic data and discuss geologic resource management issues. A summary document is prepared for each meeting that identifies a plan to provide digital map data for the park.

Digital Geologic Maps: Digital geologic maps reproduce all aspects of traditional paper maps, including notes, legend, and cross sections. Bedrock, surficial, and special purpose maps such as coastal or geologic hazard maps may be used by the GRI to create digital Geographic Information Systems (GIS) data and meet park needs. These digital GIS data allow geologic information to be easily viewed and analyzed in conjunction with a wide range of other resource management information data.

For detailed information regarding GIS parameters such as data attribute field definitions, attribute field codes, value definitions, and rules that govern relationships found in the data, refer to the NPS Geology-GIS Data Model document available at:
http://science.nature.nps.gov/im/inventory/geology/GeologyGISDataModel.cfm

Geologic Reports: Park-specific geologic reports identify geologic resource management issues as well as features and processes that are important to park ecosystems. In addition, these reports present a brief geologic history of the park and address specific properties of geologic units present in the park.

For a complete listing of Geologic Resource Inventory products and direct links to the download site visit the GRI publications webpage http://www.nature.nps.gov/geology/inventory/gre_publications.cfm

GRI geologic-GIS data is also available online at the NPS Data Store site http://science.nature.nps.gov/nrdata/. To find GRI data select “geology” as a Category, and use “GRI” as a Word Search term.

For more information about the Geologic Resources Inventory Program visit the GRI webpage: http://www.nature.nps.gov/geology/inventory, or contact:

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The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) program. For more information on the Inventory and Monitoring (I&M) program visit: http://science.nature.nps.gov/im/index.cfm

For more information on this and other Inventory and Monitoring (I&M) Natural Resource inventories visit: http://science.nature.nps.gov/im/inventory/index.cfm

Map Unit List

CENOZOIC

Quaternary
- Qdgf - Disturbed ground and artificial fill
- Qa - Alluvium
- Qs - Sinkhole
- Qt - Terrace deposits, low level
- Qc - Colluvium
- Qd - Debris
- Ql - Landslide
- Qte - Low-level fluvial and estuarine deposits
- Qfe - Upper-level fluvial and estuarine deposits

Pleistocene and Tertiary
- QTt - Terrace deposits, upper level

Tertiary
- Tt - Terrace deposits
- Ttu - Highest level upland terrace deposits
- Tyb - Yorktown Formation and Bacons Castle Formation, undivided
- Tc - Calvert Formation
- Tn - Nanjemoy Formation

Eocene and Paleocene
- Tm - Marlboro Clay

Paleocene
- Ta - Aquia Formation

Paleocene and Cretaceous
- TKb - Brightseat Formation and Monmouth Formation, undivided

MESOZOIC ERA

Cretaceous
- Km - Monmouth Formation
- Ks - Severn Formation
- Kp - Potomac Formation, undivided
- Kpc - Potomac Formation, Clay-dominated lithofacies
- Kps - Potomac Formation, Sand-dominated lithofacies

Early Jurassic and Late Triassic
- JTRd - Diabase dikes and sills

Late Jurassic and Early Triassic
- JTRtm - Thermally metamorphosed rocks

Triassic
- TRbg - Chatham Group, Groveton Member of the Bull Run Formation

PALEOZOIC ERA

- PZq - Vein quartz bodies

Devonian
- Dl - Lamprophyre dike

Silurian
- Si - Felsic igneous rocks

Ordovician
- Op - Pegmatite
- Ocw - Chopawamsic Formation, Metavolcanic and metasedimentary rocks
- Ocg - Chopawamsic Formation, Breccia and metabasalt
- Olr - Lunga Reservoir Formation
- Oq - Quantico Formation
- Oc - Clarendon Granite
- Ok - Kensington Tonalite
- Olj - Lake Jackson pluton
- Odm - Dalecarlia Intrusive Suite, Biotite monzogranite and lesser granodiorite
- Odt - Dalecarlia Intrusive Suite, Muscovite trondhjemite
- Ogh - Georgetown Intrusive Suite, Biotite-hornblende tonalite
- Ogg - Georgetown Intrusive Suite, Quartz gabbro
- Ogb - Georgetown Intrusive Suite, Biotite tonalite
- Ogr - Georgetown Intrusive Suite, Garnetiferous biotite-hornblende tonalite
- Ogus - Georgetown Intrusive Suite, Soapstone and talc schist
- Ogu - Georgetown Intrusive Suite, Ultramafic rocks
- Ogp - Georgetown Intrusive Suite, Pyroxenite
- Ob - Bear Island Granodiorite
- Ombg - Massive muscovite-biotite granite
- Ogl - Granite

Ordovician and Cambrian
- OCp - Phyllite
- OCc - Conococheague Limestone
- Ccbs - Conococheague Limestone, Big Spring Station Member

Cambrian
- Cfl - Frederick Formation, Lime Kiln Member
- Cfa - Frederick Formation, Adamstown Member
- Cfr - Frederick Formation, Rocky Springs Station Member
- Cfrs - Frederick Formation, Rocky Springs Station Member (shale)
- Ce - Elbrook Limestone
- Car - Araby Formation
- Cs - Sykesville Formation, Diamictite
- Cst - Sykesville Formation, Diamictite tectonite
- Csg - Sykesville Formation, Metagraywacke and schist
- Csp - Sykesville Formation, Chlorite-sericite phyllonite
- Cl - Laurel Formation
- Cwac - Waynesboro Formation, Chewsville Member
- Cwak - Waynesboro Formation, Cavetown Member
- Cwar - Waynesboro Formation, Red Run Member
- Ctd - Tomstown Formation, Dargan Member
- Ch - Chilhowee Group, Harpers Formation
- Cwo - Chilhowee Group, Weverton Formation, Owens Creek Member
- Cwm - Chilhowee Group, Weverton Formation, Maryland Heights Member
- Cwb - Chilhowee Group, Weverton Formation, Buzzard Knob Member
- Clc - Loudoun Formation, Conglomerate
- Clp - Loudoun Formation, Phyllite

Cambrian and (or) Neoproterozic

CZum - Mafic and ultramafic rocks
CZd - Diamictite
CZms - Mather Gorge Formation, Schist
CZmg - Mather Gorge Formation, Metagraywacke
CZmm - Mather Gorge Formation, Migmatite
CZmmg - Mather Gorge Formation, Migmatitic metagraywacke
CZmms - Mather Gorge Formation, Migmatitic schist
CZmmp - Mather Gorge Formation, Migmatitic phyllonite
CZmss - Mather Gorge Formation, Sheared migmatitic schist and migmatitic phyllonite

Cambrian and Neoproterozic

CZu - Metavolcanic and meta-igneous rocks of uncertain origin, Ultramafic rocks
CZa - Metavolcanic and meta-igneous rocks of uncertain origin, Amphibolite
CZg - Metavolcanic and meta-igneous rocks of uncertain origin, Metagabbro and metapyroxenite
CZt - Metavolcanic and meta-igneous rocks of uncertain origin, Soapstone, talc schist, and actinolite
CZi - Ijamsville Phyllite

PROTEROZOIC

Ediacarian

Zc - Catoctin Formation, Metabasalt
Zcr - Catoctin Formation, Metarhyolite
Zcp - Catoctin Formation, Porphyritic

Map Unit Descriptions

Descriptions of all geologic map units, generally listed from youngest to oldest, are presented below.

Qdgf - Disturbed ground and artificial fill (Recent)

Disturbed ground and artificial fill (OF 2005-1331).

Qa - Alluvium (Holocene)

Alluvium and broad alluvial deposits (OF 2005-1331)

Qs - Sinkhole (Holocene)

Sinkholes that have formed as the result of dissolution of the underlying carbonate rocks (OF 2005-1331)

Qt - Terrace deposit, low level (Holocene and Pleistocene)

Terrace deposits of alluvium and reworked colluvium. Concentrated where small creeks empty into the larger creeks (OF 2005-1331).

Qc - Colluvium (Holocene and Pleistocene)

Colluvial deposits and fine colluvium of variable thickness. Fills broad hollows in meadows (OF 2005-1331).

Qd - Debris (Holocene and Pleistocene)

An unsorted mixture of fine and coarse debris that fills hillslope depressions. The debris is material that was deposited by gravity, water, and debris-flow processes (OF 2005-1331).

Ql - Landslide (Holocene and Pleistocene)

Landslide deposits (OF 2005-1331).

Qte - Low-level fluvial and estuarine deposits (Pleistocene)

Consist of sand, gravel, peat, sand interbedded with thin silt, and clay beds that locally contain wood fragments. Sandy clay beds contain scattered pebbles and cobbles, and limonite-filled root zones capped by sand. Low-level terrace alluvium and estuarine deposits that are incised into the fluvial and estuarine deposits (OF 2005-1331).

Qfe - Upper-level fluvial and estuarine deposits (Pleistocene)

Consist of swamps that overlie bedrock and Tertiary sediments near the mouth of Rock Creek Park. Part of the National Mall is situated on these deposits. Underlies the high ground of Capitol Hill (OF 2005-1331).

QTt - Terrace deposits, upper level (Pleistocene and Tertiary)

Terrace deposits that consist of gravel and sand as much as 50 ft thick. Relates to different episodes of downcutting that probably relate to changes in climate and (or) tectonic uplift. A series of dissected upland deposits on either side of the George Washington Memorial Parkway. Locally incised into the Potomac Formation (Kp) in some areas (OF 2005-1331).

Tt - Terrace deposits (Tertiary)

Lower-level and upper-level terrace deposits. Meridian Hill Park is situated on these terrace deposits that overlie the Potomac Formation (Kp). Montrose Park is situated on these low-level terrace deposits above biotite-hornblende tonalite of the Georgetown Intrusive Suite (Ogh). Whitehaven Park crosses rocks of the Georgetown Intrusive Suite that are overlain by terraces. In the area west of Rock Creek Park, near Walter Reed Army Medical Center, are at least three lower-level terraces of this unit (OF 2005-1331).

Ttu - Highest level upland terrace deposits (Tertiary)

Upland terrace deposits consisting of gravel and sand. Sandy gravel and gravelly quartz sand contain large pebbles and cobbles of vein quartz and quartzite. Occurs on a flat bench at an altitude of about 360 ft above sea level, west of Rock Creek Park near Walter Reed Army Medical Center. Fort Totten is located on these deposits at 310 ft asl. Fort Reno also sits on these upper level terrace deposits at 400 ft asl, as does Battery Kemble at 370 ft asl (OF 2005-1331).

Tyb - Yorktown Formation and Bacons Castle Formation, undivided (upper Pliocene)

Yorktown Formation and Bacons Castle Formation, undivided. Fort Washington is built on a late Pliocene terrace of the Yorktown Formation and Bacons Castle Formation (OF 2005-1331).

Tc - Calvert Formation (middle Miocene)

Consists of grayish-olive quartz sand and sandy clay, with brown layers of phosphatic grains, shells, and pebbles, and diatoms. Occurs only on the west side of Rock Creek Park in Cleveland Park (OF 2005-1331).

Tn - Nanjemoy Formation (lower Eocene)

A dark-grayish-green, glauconitic quartz sand and silty clay containing fossiliferous beds with abundant mollusk shells (OF 2005-1331).

Tm - Marlboro Clay (lower Eocene and upper Paleocene)

Unit consists of a distinctive layer of gray clay and yellow silty clay with lenses of silt. The thickness of the clay ranges from 0 to 40 ft, but typically it is 10 to 20 ft thick (OF 2005-1331).

Ta - Aquia Formation (upper Paleocene)

Unit consists of olive to black, micaceous, glauconitic, extensively burrowed quartz sand with silty clay and sandy silt layers. The sediments contain molds and clasts of pelecypods and gastropods, and locally abundant ilmenite (OF 2005-1331).

TKb - Brightseat Formation and Monmouth Formation, undivided (lower Paleocene and Upper Cretaceous)

Brightseat Formation and Monmouth Formation, undivided. These marine deposits consist of dark-gray, micaceous sand in the lower part and greenish-gray, clayey sand in the upper part. The base of the unit is a gravel layer a few feet thick (OF 2005-1331).

Km - Monmouth Formation (Upper Cretaceous)

Unit consists of a basal gravel of vein-quartz pebbles overlain by sand, clayey sand, and silty sand (OF 2005-1331).

Ks - Severn Formation (Upper Cretaceous)

Late Cretaceous marine deposits (OF 2005-1331).

Kp - Potomac Formation, undivided (Lower Cretaceous)

Alluvial deposits consisting of massive, mottled, silty clay with minor sand and thin beds of tan, clayey sand. Quartz- and feldspar- sand and pebbles that grade into silty sand, clayey silt, and silty clay as well. The clay contains rare stems of plants that were replaced with silica and coal. Locally, consists of unconsolidated coarse sand composed of feldspar and quartz grains, quartz gravel, montmorillonite and illite, clayey sand, and sandy silt with lignite. The Potomac Formation was deposited in channels, bars, and flood plains by rivers that flowed eastward. Regionally, the sediment tapers to a feathered edge to the west. The Potomac Formation is the oldest Coastal Plain unit. Fort Slocum is situated on the Potomac Formation at 250 ft asl. Fort Stevens sits on both an upper-level terrace (Tu) and on the Potomac Formation (OF 2005-1331).

Kpc - Potomac Formation, Clay-dominated lithofacies (Lower Cretaceous)

A clay-dominated lithofacies (Fleming and others, 1994) of the Potomac Formation (Kp) that contains leaf and stem impressions and rare silicified tree trunks. Both the sand-dominated facies (Kps) and the clay-dominated facies of the Potomac Formation are found on the east side of Rock Creek Park (OF 2005-1331).

Kps - Potomac Formation, Sand-dominated lithofacies (Lower Cretaceous)

Sand-dominated lithofacies of the Potomac Formation (Kp). Both the sand-dominated facies and the clay-dominated facies (Kpc) of the Potomac Formation are found on the east side of Rock Creek Park. Fort DeRussy is located on the unit at 400 ft asl. (OF 2005-1331).

JTRd - Diabase dikes and sills (Early Jurassic and Late Triassic)

Linear, near-vertical dikes and near-horizontal sheets (sills) intruded the sedimentary rocks at about 200 Ma. The hard, black, igneous diabase is found in Manassas National Battlefield Park. The hot, molten diabase metamorphosed the red siltstone to a gray hornfels (JTRtm) at its contact. The diabase in the western part of the park has two geometries. The easternmost body is a near-vertical dike that intrudes a near horizontal sill. Normal faults cut both of them. Fractures in the stratified rocks trend northeast and northwest and the drainage patterns parallel both sets. The occurance of the diabase is characterized by a float of light-gray, subrounded cobbles and boulders commonly with a rusty weathering rind. The diabase underlies the ridge that trends northeast through Battery Heights to near Sudley Springs, where abundant float can be seen along Bull Run. Appropriately, diabase also underlies Stony Ridge in the western part of the park. Amphibole crystallized in diabase dikes and sills has an 40 Argon/ 39 Argon age of ~200 Ma (Late Triassic and Early Jurassic) (Kunk and others, 1992). The diabase and hornfels (JTRtm) are resistant rocks that are aquitards (confining beds), therefore ground water in fractures has facilitated their breakdown. The area of diabase sills and hornfels in the west part of the park underlies swamp, as the rocks impede the flow of ground water (OF 2005-1331).

*** Unit geologic symbol is Jd on source map, yet is also listed as being Early Jurassic and Late Triassic in age on source map and in the accompanying map report.

JTRtm - Thermally metamorphosed rocks (Late Jurassic and Early Triassic)

Siltstone, shale and sandstone that was metamorphosed to hornfels where it came into contact with the hot, molten diabase (JTRd). The hornfels are light-grayish green, very finegrained, brittle rock with porphyroblasts of minerals that grew as the result of the heat. Siltstone and shale were altered to cordierite-spotted hornfels in the inner aureole, and epidote-chlorite hornfels characterizes the outer aureole. Sandstone was metamorphosed to tourmaline granofels and quartzite. Thin belts of hornfels are also found adjacent to narrow diabase dikes. The lowland between Stuarts Hill and Stony Ridge in the southwestern part of Manassas National Battlefield Park is underlain by hornfels (OF 2005-1331).

TRbg - Chatham Group, Groveton Member of the Bull Run Formation (Upper Triassic)

The oldest rocks in Manassas National Battlefield Park are gray-brown, and red siltstone and sandy shale of the Upper Triassic Groveton Member of the Bull Run Formation of the Chatham Group (Weems and Olson, 1997). The Groveton Member is predominately a thin-bedded, silty and sandy shale interbedded with clayey and sandy siltstone in cyclic sequences as much as 33 feet thick. Dark-gray lacustrine shale locally contains fish fossils. These stratified rocks are poorly exposed but weather to reddish or gray soil that contains abundant shale chips. Good exposures of the red shale occur along Bull Run. Several historic houses in the park and the Route 29 stone bridge at Bull Run were constructed of this red slab-like rock as it makes good dimension stone (OF 2005-1331).

PZq - Vein quartz bodies (Paleozoic)

Veins, lenses, and irregular bodies of white and clear, massive, jointed, and locally foliated vein quartz of several different ages intruded all of the rocks along the gorge. Loose boulders of quartz commonly litter the Piedmont province because the silica is very resistant to weathering (OF 2005-1331).

Dl - Lamprophyre dike (Late Devonian)

A lamprophyre dike that has an argon biotite cooling age of about 360 Ma (Late Devonian) (Reed and others, 1980) (OF 2005-1331).

Si - Felsic igneous rocks (Silurian)

Well-foliated biotite metatonalite and hornblende-quartz diorite. Biotite metatonalite has a zircon U-Pb SHRIMP age of 434±6 Ma (Horton and others, 1998), which makes it one of the youngest dated rocks in the park. These rocks are exposed along Quantico Creek along the Quantico Falls Trail (OF 2005-1331).

*** Unit geologic symbol is Oi on source map, yet is also listed as being Silurian in age on source map and in the accompanying map report. Zircon U-Pb SHRIMP age of 434±6 Ma is Silurian in age.

Op - Pegmatite (Ordovician)

Light gray pegmatite composed of coarse grains of muscovite, microperthitic microcline, albite, and quartz. It is non-foliated and crosscuts schistosity and foliation in the Sykesville Formation (Cs) along the bluffs of the Potomac River between Donaldson Run and Windy Run (OF 2005-1331).

Ocw - Chopawamsic Formation, Metavolcanic and metasedimentary rocks (Upper Ordovician)

The only rocks in Prince William Forest Park that have been isotopically dated are part of the Ordovician Chopawamsic Formation (Oc) (Pavlides, 1980). These are metavolcanic and metasedimentary rocks derived from an island arc. The metavolcanic rocks include porphyritic volcanic flows, breccias, and tuffs that range in composition from rhyolite to andesite to basalt. The metavolcanic rocks are interbedded and interlayered with dark-gray slate, phyllite, schist, and metasandstone that were derived from weathering of volcanic rocks. The rocks of the Chopawamsic Formation (oc) are exposed along the North Valley Trail along Quantico Creek and South Fork Quantico Creek along the South Valley Trail. Metarhyolite of the Chopawamsic Formation (Oc) has an age of 454±5 Ma (Late Ordovician) (OF 2005-1331).

Ocg - Chopawamsic Formation, Breccia and metabasalt (Upper Ordovician)

Coarse breccias and thin metabasalts interlayered with slate and metasiltstone. The metabasalts are exposed along Quantico Creek downstream of the Cabin Branch pyrite mine. Metabasalt of the Chopawamsic Formation from central Virginia is 470±1.4 Ma (Coler and others, 2000). The rocks of the Chopawamsic Formation (Oc) are exposed along the North Valley Trail along Quantico Creek and South Fork Quantico Creek along the South Valley Trail (OF 2005-1331).

Olr - Lunga Reservoir Formation (Middle Ordovician)

The dominant rock in Prince William Forest Park is a sedimentary mélange that was named the Lunga Reservoir Formation by Pavlides (1980). The diamictite resembles a granitic rock with xenoliths, as it contains a mixture of pebbles and cobbles of other rock types. The matrix is composed of rounded grains of quartz and plagioclase feldspar that eroded from a granitic rock. The pebbles and cobbles within the matrix consist of clear and milky white quartz, mica schist, calc-silicate rocks, and mafic and ultramafic rocks. The diamictite is a deep-water deposit of debris shed from the island arc during the Ordovician (Pavlides, 1980). Locally near the fault contact with the Chopawamsic Formation, the Lunga Reservoir Formation contains rock fragments that look similar to the Chopawamsic and may be derived from it. The Lunga Reservoir Formation is exposed along South Fork Quantico Creek. The Lunga Reservoir Formation may contain clasts of Chopawamsic Formation, thus it may be older than 454±5 Ma (OF 2005-1331).

Oq - Quantico Formation (Middle Ordovician)

In the eastern part of Prince William Forest Park, a dark-gray slate, metagraywacke, and tuffaceous metavolcanic rocks constitute the Quantico Formation (Oq) (Pavlides, 1980). The dark- gray slate is graphitic and sulfidic. Pyrite was mined from 1889 to 1919 at the Cabin Branch mine along the southwest side of Quantico Creek. The pyrite was mined for sulfur as an ingredient in gunpowder, especially during World War I. There is recent interest in reclamation of the mining area (Seal and others, 1998a,b). A metamorphosed lapilli-tuff layer in the lower part of the formation yielded a zircon U-Pb SHRIMP age of 451±6 Ma (Horton and others, 1998). These rocks are exposed along Quantico Creek and its tributaries north of the visitor center and immediately east of the park. About 5.6 miles north of the park entrance, Pavlides and others (1980) found crinoids and a cephalopod in slate of the Quantico Formation (OF 2005-1331).

Oc - Clarendon Granite (Middle Ordovician)

The Clarendon Granite is a leucocratic, foliated biotite-muscovite monzogranite that intrudes diamictite of the Sykesville Formation (Cs) along Turkey Run in Turkey Run Park and Claude Moore Colonial Farm (OF 2005-1331).

Ok - Kensington Tonalite (Middle Ordovician)

The Kensington Tonalite (Cloos and Cooke, 1953; Fleming and others, 1994) intruded rocks of the Sykesville Formation (Cs) and Georgetown Intrusive Suite (Og) in the Rock Creek shear zone. Within this 1.8-mile-wide shear zone, it consists of foliated mylonitic granodiorite gneiss that contains augen and coarse porphyroblasts of microcline. The tonalite is light gray, coarse-grained, and well foliated, with muscovite and biotite and locally garnet. It has a SHRIMP U-Pb zircon age of 463±8 Ma (Aleinikoff and others, 2002) (OF 2005-1331).

Olj - Lake Jackson Pluton (Middle Ordovician)

Biotite and muscovite metatonalite of the Lake Jackson pluton (Pavlides, 1980) is composed of albite, quartz, and perthite, with inclusions of phyllite (OCp). The area underlain by the poorly exposed metatonalite has abundant boulders of metamorphic vein quartz that litter the surface. Metatonalite yielded a zircon U-Pb SHRIMP age of 461±7 Ma (Aleinikoff and others, 2002) (OF 2005-1331).

Odm - Dalecarlia Intrusive Suite, Biotite monzogranite and lesser granodiorite (Early and Middle Ordovician)

Associated biotite monzogranite of the Dalecarlia Suite has a zircon U-Pb SHRIMP age of 478±6 Ma (Aleinikoff and others, 2002) (OF 2005-1331).

Odt - Dalecarlia Intrusive Suite, Muscovite trondhjemite (Early and Middle Ordovician)

Muscovite trondhjemite of the Dalecarlia Intrusive Suite (Drake and Fleming, 1994) intruded the diamictite of the Sykesville Formation (Cs) along the Potomac River near Little Falls and along Pimmit Run. The muscovite trondhjemite is light gray to white, and fine grained with a sugary texture. Associated biotite monzogranite of the Dalecarlia Suite has a zircon U-Pb SHRIMP age of 478±6 Ma (Aleinikoff and others, 2002). The unit crops out east of where the Potomac Heritage National Scenic Trail climbs from the flood plain up to the parkway (OF 2005-1331).

Og - Georgetown Intrusive Suite (Early Ordovician)

The Georgetown Intrusive Suite consists of the following mapped units:

Ogh - Georgetown Intrusive Suite, Biotite-hornblende tonalite
Ogg - Georgetown Intrusive Suite, Quartz gabbro
Ogb - Georgetown Intrusive Suite, Biotite tonalite
Ogr - Georgetown Intrusive Suite, Garnetiferous biotite-hornblende tonalite
Ogus - Georgetown Intrusive Suite, Soapstone and talc schist
Ogu - Georgetown Intrusive Suite, Ultramafic rocks
Ogp - Georgetown Intrusive Suite, Pyroxenite

The Georgetown Intrusive Suite consists of tonalite with biotite (Ogb), tonalite with biotite and hornblende (Ogh), and ultramafic rocks and soapstone (Ogus), all of which intrude rocks of the Sykesville Formation. The igneous rocks contain many xenoliths of ultramafic, mafic, and metasedimentary rocks. Superficially, especially in Turkey Run Park, it is difficult to distinguish between the meta-igneous rocks and the diamictite of the Sykesville Formation (from which they were partially derived). The mafic rocks were altered during metamorphism. Biotite-hornblende tonalite has a U-Pb zircon SHRIMP age of 472±4 Ma (Aleinikoff and others, 2002). On the bluffs northeast of the George Washington Memorial Parkway headquarters at Turkey Run Park, dark-greenish-gray, foliated pyroxenite and serpentinite (Ogu), and talc schist and soapstone (Ogus) were quarried (Keith and Darton, 1901) (OF 2005-1331).

Ob - Bear Island Granodiorite (Early Ordovician?)

The Bear Island Granodiorite (Cloos and Cooke, 1953) is a leucocratic muscovite-biotite granodiorite composed of quartz, albite, and microcline. The granodiorite and related pegmatite form small- to moderate-sized sheets, sills, and dikes within diamictite of the Sykesville Formation (Cs) east of Turkey Run Park (OF 2005-1331).

Ombg - Massive muscovite-biotite granite (Ordovician)

Large blocks of light-gray massive muscovite-biotite granite were excavated along a sewer and water line along Wolf Trap Creek (OF 2005-1331).

*** Unit geologic symbol is Og on source map, yet was changed so as to not conflict with the geologic symbol (Og) for the Georgetown Intrusive Suite.

Ogl - Granite (Ordovician?)

Small dikes, sheets, and irregular bodies of fine- to coarse-grained, well-foliated muscovite monzogranite and granodiorite occur near National Zoo and north of Military Road on the east side of Rock Creek. This intrusive rock contains as much as 3 percent biotite and hornblende and is probably related to rocks of the Georgetown Intrusive Suite (Og) and Kensington Tonalite (Ok) (OF 2005-1331).

OCp - Phyllite (Ordovician and (or) Cambrian)

Phyllite and metasiltstone were interpreted by Pavlides (1980) to be Ordovician and (or) Cambrian. These fine-grained rocks are poorly exposed in the extreme northwest part of Prince William Forest Park (OF 2005-1331).

OCc - Conococheague Limestone (Lower Ordovician and Upper Cambrian)

Conococheague Limestone consists of light-gray limestone interbedded with dolostone and sandstone (Brezinski, 1992). The lower 328 feet of the formation consists of coarse-grained, calcareous sandstone, fine-grained limestone, and fine-grained dolostone of the Big Spring Station Member (Ccbs). Above the Big Spring Station Member, the Conococheague Limestone consists of conglomerates, algal bioherms, ribbon rock, and oolites, arranged in cycles. These rocks represent a shallowing-upward, peritidal marine deposit. The Conococheague Limestone underlies the higher grounds of the park, whereas the clastic rocks underlie low ridges. The unit contains some trilobites and conodonts, and abundant snails, brachiopods, echinoderms, bryozoans, and cephalopods. The high ground of the Antietam battlefield is on Conococheague Limestone in the core of a syncline that coincides with the local drainage divide between the Potomac River to the west and Antietam Creek to the east. The lower part of the Conococheague Limestone forms a swale between the Big Spring Station Member and more resistant strata. Strike belts of limestone, dolostone, and sandstone generally have trees and brush growing along them. This ridge and swale topography provided good cover for troops during the Civil War (OF 2005-1331).

Ccbs - Conococheague Limestone, Big Spring Station Member (Lower Ordovician and Upper Cambrian)

The lower 328 feet of the Conococheague Limestone consists of coarse-grained, calcareous sandstone, fine-grained limestone, and fine-grained dolostone of the Big Spring Station Member. The Big Spring Station Member underlies the National Cemetery (OF 2005-1331).

Cf - Frederick Formation (Upper Cambrian)

The Frederick Formation consists of the following mapped members:

Cfl - Frederick Formation, Lime Kiln Member
Cfa - Frederick Formation, Adamstown Member
Cfr - Frederick Formation, Rocky Springs Station Member 1
Cfrs - Frederick Formation, Rocky Springs Station Member 2 (shale)

The Upper Cambrian Frederick Formation (Reinhardt, 1974, 1977; Brezinski, 2004) is a thick interval of thin- to medium-bedded limestone and dolostone with thin intervals of shale and sandstone. The Rocky Springs Station Member (Cfr) is characterized by intervals of polymictic limestone breccia that resulted when off-shelf submarine slide deposits accumulated at the toe of a paleo-slope (Reinhardt, 1974). An interval of gray to black shale (Cfrs) locally is interbedded. A small borrow pit exposes the black shale along the trail to the Worthington House. The Adamstown Member (Cfa) consists of thinly bedded limestone with thin intervals of shale that were probably deposited as the basin became larger (Reinhardt, 1974). The Lime Kiln Member (Cfl) consists of thinly bedded limestone interbedded with algal limestone at the top of the formation. This upper member records depositional aggradation as the basin filled and became a shallow shelf (Reinhardt, 1974). The best exposures of the Frederick Formation are along the Monocacy River and within creek beds (OF 2005-1331).

Ce - Elbrook Limestone (Upper and Middle Cambrian)

The Elbrook Limestone mostly consists of gray limestone interbedded with dolostone (Brezinski, 1992). The lower part of the formation consists of cyclic intervals of limestone, shale, and shaly dolostone. The middle part of the formation is largely thin-bedded, bioturbated limestone. The upper part of the formation is a thick sequence of medium-bedded algal limestone, dolostone, and dolomitic shale. These rocks are a shallowing-upward, peritidal marine deposit. The rocks are exposed between Sharpsburg and Antietam Creek, and underlying a hill in the western part of Antietam National Battlefield (OF 2005-1331).

Car - Araby Formation (Middle and Lower Cambrian)

The Lower and Middle Cambrian Araby Formation (Reinhardt, 1974, 1977) consist of light-brownish-gray, burrow-mottled, sandy metasiltstone and graphitic metashale. Bedding is obscured by cleavage. The metasiltstone and metashale are deepwater slope facies of a starved clastic basin (Reinhardt, 1974). The Araby Formation is conformably overlain by limestone and limestone breccia of the Rocky Springs Station Member of the Frederick Formation. In the northeast part of the Frederick Valley within the map area, metashale beds thicken near the top of the unit and are mapped as the Cash Smith Formation (not on the map). The Araby is exposed along the Monocacy River (where the river has cut into the ridges) in cuts along the railroad bed in the northeast part of Monocacy National Battlefield, and in the road cuts in the southeast part of Monocacy National Battlefield (OF 2005-1331).

Cs - Sykesville Formation (Lower Cambrian)

The Sykesville Formation consists of the following mapped units:

Csd - Sykesville Formation, Diamictite
Cst - Sykesville Formation, Diamictite tectonite
Csg - Sykesville Formation, Metagraywacke and schist
Csp - Sykesville Formation, Chlorite-sericite phyllonite

The Sykesville Formation (Hopson, 1964) is a sedimentary mélange consisting of a gray matrix of quartz and feldspar that contains distinctive round and tear-shaped cobbles of white and clear quartz. There are also larger boulders of dark-gray phyllonite, light-gray migmatite and metagraywacke, and greenish-black mafic and ultramafic rocks; metagabbro; and light-gray metafelsite and plagiogranite. The diamictite is massive gneiss that extends from Theodore Roosevelt Island west to the Turkey Run Park area, but it is sheared from Turkey Run Park west to the American Legion Bridge.

Near the contact with the Mather Gorge Formation (CZm) along the Plummers Island fault near the American Legion Bridge, the Sykesville Formation locally contains 50 percent or more cobbles of phyllonite and schist that Drake (1989) and Muller and others (1989) thought were derived from the Mather Gorge Formation. Kunk and others (2004, 2005) alternatively suggest that the Sykesville and Mather Gorge Formations were at different crustal depths and geographically separate until the Devonian; therefore, the clasts in the diamictite probably could not have come from the rocks of the Mather Gorge Formation. The massive gneiss exposed along the bluff of the Potomac below Chain Bridge was quarried for building stone in the late 1800s (Darton and Keith, 1901).

The Sykesville Formation (Hopson, 1964) sedimentary mélange may also consist of a gray matrix of quartz and feldspar that supports distinctive rounded and elliptical white and clear quartz cobbles, as well as blocks of dark gray phyllonite, light gray migmatite and metagraywacke, and dark greenish black mafic, ultramafic, and metagabbro rocks, and light gray metafelsite and plagiogranite. The Sykesville Formation occurs at the mouth of Rock Creek Park and as a large northerly trending xenolith within the Kensington Tonalite (Ok) in Woodley Park. The contact of the Laurel and Sykesville Formations along Rock Creek is interpreted to be the Rock Creek fault that has been overprinted by the Rock Creek shear zone. The body of Laurel Formation in Woodley Park is probably a xenolith within metatonalite. Diamictite (Csd) of the Sykesville Formation is exposed along the northern perimeter of the 91-acre Theodore Roosevelt Island (OF 2005-1331).

*** The geologic symbol of the Diamictite unit was Cs on source map, yet was changed to Csd so as to not conflict with the geologic symbol assigned to an undivided Sykesville Formation.

Cl - Laurel Formation (Lower Cambrian)

The Laurel Formation is a sedimentary mélange that is similar to the diamictite of the Sykesville Formation (Cs). Rocks of the Laurel Formation have a matrix of quartz and feldspar that support fragments, elongate cobbles, and bodies of meta-arenite and muscovite-biotite schist. Unlike the Sykesville Formation, the Laurel Formation locally consists of more than 50 percent meta-arenite clasts. This unique rock is exposed in the drainage at Klingle Park. Some exposures of Laurel Formation show pegmatites and leucosomes indicative of partial melting and migmatization (OF 2005-1331).

Cwa - Waynesboro Formation (Lower Cambrian)

Waynesboro Formation consists of the following mapped units:

Cwac - Waynesboro Formation, Chewsville Member
Cwak - Waynesboro Formation, Cavetown Member
Cwar - Waynesboro Formation, Red Run Member

The Waynesboro Formation is subdivided into the three members: the Red Run Member (base), the Cavetown Member, and the Chewsville Member (top) (Brezinski, 1992). These members have distinctive physiographic expression. Sandstone of the Red Run (Cwar) and Chewsville Members (Cwac) underlie low hills with the intervening carbonate rock of the Cavetown Member (Cwak) underlying a swale between the hills. The Red Run Member consists of interbedded light-brown calcareous sandstone and laminated, ribbony, sandy dolostone and light-green, silty, calcareous shale.

The Cavetown Member typically is not well exposed. It consists of thick-bedded, massive limestone and bioturbated dolostone (lower); bioturbated dolomitic limestone and dolostone and thin calcareous sandstone and shale (middle); and thick-bedded, bioturbated dolostone with laminated, ribbony dolostone at the top (upper). The Chewsville Member is distinctive with its dusky red siltstone, sandstone, and shale. The siltstone generally has ripple marks and mudcracks; the sandstone is crossbedded and contains Skolithos linearis burrows. These rocks were deposited in a shallow subtidal to supratidal environment. Exposures occur along the valley of Antietam Creek on the east side of the park, and in roadcuts along Maryland Highway 34 (OF 2005-1331).

Ctd - Tomstown Formation, Dargan Member (Lower Cambrian)

The oldest rock in Antietam National Battlefield is the Dargan Member of the Tomstown Formation, which consists of light-gray limestone interbedded with dolostone (Brezinski, 1992). A lower bioturbated dolostone alternates with intervals of laminated dolostone. In the upper part, bioturbated and oolitic dolostone is interbedded with laminated limestone and silty dolostone. These rocks are the first carbonate-platform deposits of the evolving passive margin. The vertical sequence of rocks suggests a change from shallow carbonate shelf to deep shelf to bank-edge carbonate sand shoal. These rocks are exposed in the extreme northeast corner of Antietam National Battlefield (OF 2005-1331).

Ch - Chilhowee Group, Harpers Formation (Lower Cambrian)

Harpers Formation consists of greenish-to-brownish-gray phyllite and metasiltstone interbedded with light-gray to brown, thin metasandstone. These rocks are transitional above the Owens Creek Member of the Weverton Formation and are found in the easternmost part of Catoctin Mountain Park; they are also exposed along Big Hunting Creek. The environment of deposition was probably a delta and tidal flat (OF 2005-1331).

Cw - Chilhowee Group, Weverton Formation (Lower Cambrian)

The Weverton Formation consists of the following mapped members:

Cwo - Weverton Formation, Owens Creek Member
Cwm - Weverton Formation, Maryland Heights Member
Cwb - Weverton Formation, Buzzard Knob Member

The Lower Cambrian Weverton Formation consists of three members (Brezinski, 1992): the Buzzard Knob Member, the Maryland Heights Member, and the Owens Creek Member. The basal Buzzard Knob Member (Cwb) consists of light-gray metagraywacke, quartzite, meta-arkose, and metasiltstone and are transitional above conglomeratic rocks of the Loudoun Formation. The unit underlies the high ridge north of the Catoctin Mountain Park visitor center and can be seen along the trails to Thurmont Vista. The Maryland Heights Member (Cwm) consists of gray quartzite interbedded with metasiltstone. Rocks of the Maryland Heights Member underlie Chimney Rock and Wolf Rock and are accessible by trail. Dark-gray quartzite and pebble conglomerate of the Owens Creek Member (Cwo) is transitional above the Maryland Heights Member. These rocks are interpreted as alluvial-plain deposits. They are named after exposures along Owens Creek at the north margin of Catoctin Mountain Park where they are well exposed; they are also exposed in the eastern region of the park (OF 2005-1331).

Clo - Loudoun Formation (Lower Cambrian)

The Loudoun Formation consists of the following mapped units:

Clc - Loudoun Formation, Conglomerate
Clp - Loudoun Formation, Phyllite

Rocks of the Lower Cambrian Loudoun Formation consist of conglomerate (Clc) and phyllite (Clp). The basal conglomerate is dark, variegated, and consists of quartz and red jasper. Most of the quartz is milky white but some is gray or dusky red. The discontinuous conglomerate probably represents local channel and fan deposits. Interbedded with the conglomerate is dark, variegated, tuffaceous, locally vesicular and amygdaloidal phyllite that also contains sand grains. The phyllite is probably a fine-grained volcaniclastic fluvial deposits derived from the weathered volcanic rocks of the Catoctin Formation (Zc). The rocks of the Loudoun Formation are transitional between the dominantly volcanic environment and fluvial environment at the boundary between the Neoproterozoic and Cambrian. The conglomerate of the Loudoun Formation in contact with the Weverton Formation (Cw) on the south bank of Big Hunting Creek. The phyllite of the Loudoun Formation can be seen along the slopes on the north side of Maryland Highway 77, east of the Catoctin Mountain Park visitor center (OF 2005-1331).

CZum - Mafic and ultramafic rocks (Cambrian and (or) Neoproterozoic)

The oldest rocks in the park are mafic and ultramafic rocks that include epidote-hornblende gneiss and amphibolite. Pavlides (1980) interpreted these as Neoproterozoic and (or) Cambrian rocks deposited in the diamictite of the Lunga Reservoir Formation. The rocks are poorly exposed in the north-central part of Prince William Forest Park (OF 2005-1331).

CZd - Diamictite (Lower Cambrian and (or) Neoproterozoic)

Diamictite (OF 2005-1331).

CZm - Mather Gorge Formation (Lower Cambrian and (or) Neoproterozoic)

The Mather Gorge Formation consists of the following mapped units:

CZms - Mather Gorge Formation, Schist
CZmg - Mather Gorge Formation, Metagraywacke
CZmm - Mather Gorge Formation, Migmatite
CZmmg - Mather Gorge Formation, Migmatitic metagraywacke
CZmms - Mather Gorge Formation, Migmatitic schist
CZmmp - Mather Gorge Formation, Migmatitic phyllonite
CZmss - Mather Gorge Formation, Sheared Migmatitic schist and migmatitic phyllonite

Metamorphosed sedimentary rocks of the Mather Gorge Formation include schist interbedded with thin metagraywacke (CZms) and meta-arenite and metagraywacke interbedded with schist (CZmg). These rocks originally were impure sandstones and shales deposited as turbidites in a submarine fan. These coarse- and fine-grained rocks were deposited in a complex depositional setting that was further complicated by metamorphism and deformation. The metagraywacke contains graded beds, soft-sediment slump folds, and clastic dikes. Metagraywacke is best exposed at the falls where the water drops about 80 ft over the resistant, near-vertical beds. The dominant rocks in Great Falls Park are schists that are well exposed along the river trail and in the bluffs of Mather Gorge. The lustrous

muscovite-rich schist was intruded by thin quartz veins. Both the schist and quartz veins have been more complexly deformed and folded than the more resistant metagraywacke. The metagraywacke and schist were metamorphosed to staurolite-kyanite grade during the Ordovician when they partially melted to form migmatite (CZmmg and CZmms). Migmatite is confined to a narrow belt between the boat landing and Difficult Run. The partially melted schist and gneiss has a soupy appearance of swirly layers of white vein quartz and light-gray granite. Metagraywacke (CZmg) and schist (CZms) of the Mather Gorge Formation are exposed along Wolf Trap Creek (OF 2005-1331).

CZmvmi - Metavolcanic and meta-igneous rocks of uncertain origin, Ultramafic rocks (Lower Cambrian and Neoproterozoic)

Lower Cambrian and Neoproterozoic metavolcanic and meta-igneous rocks of uncertain origin consists of the following mapped units:

CZu - Metavolcanic and meta-igneous rocks of uncertain origin, Ultramafic rocks
CZa - Metavolcanic and meta-igneous rocks of uncertain origin, Amphibolite
CZg - Metavolcanic and meta-igneous rocks of uncertain origin, Metagabbro and metapyroxenite
CZt - Metavolcanic and meta-igneous rocks of uncertain origin, Soapstone, talc schist, and actinolite

The oldest rocks exposed in Rock Creek Park are metamorphosed, mafic and ultramafic volcanic and igneous rocks that occur as bodies within the diamictite of the Laurel Formation (Cl). These are intruded by Ordovician plutonic rocks. The ultramafic rocks are metagabbro and metapyroxenite (CZg) that have been further altered to soapstone, talc schist, serpentinite, or amphibolite (CZu). Soapstone, talc schist, and actinolite (CZt) are greenish-gray and fine- to coarse-grained; the schist is foliated. They are found near Connecticut Avenue at the head of Soapstone Branch, where Native Americans quarried them to make implements. Although many quarries and outcrops have been filled in and buildings constructed on them, there are abundant cobbles of greasy-textured soapstone and talc schist in the lower flood plain of Soapstone Branch. The soapstone and talc schist were likely derived from the mafic rocks by hydrothermal alteration during metamorphism and deformation. Amphibolite (CZa) is dark green and black, medium to coarse grained, foliated and composed of hornblende, plagioclase, and epidote. Elongate bodies of amphibolite extend from Broad Branch south to the National Zoo. Dark-greenish-black metagabbro and metapyroxenite (CZg) composed mostly of pyroxene occur at the southeastern end of the National Zoo (OF 2005-1331).

CZi - Ijamsville Phyllite (Lower Cambrian? and Neoproterozoic?)

The oldest geologic unit in Monocacy National Battlefield is the Ijamsville Phyllite, which consists of blue, purple, and green phyllite, slate, and phyllonite that contains pods and stringers of folded white vein quartz. The fine-grained rocks are rich in hematite and probably were deposited in deep water in the Iapetus Ocean. The rocks are undated but interpreted as Neoproterozoic and Early Cambrian. These soft rocks were readily deformed, especially during movement along the Martic fault, so that the map unit is expressed as a broad shear zone (Southworth, 1996). The Ijamsville Phyllite is exposed in the extreme southeastern part of Monocacy National Battlefield (OF 2005-1331).

Zc - Catoctin Formation, Metabasalt (Ediacarian)

The Catoctin Formation consists of the following mapped units:

Zc - Catoctin Formation, Metabasalt
Zcr - Catoctin Formation, Metarhyolite
Zcp - Catoctin Formation, Porphyritic

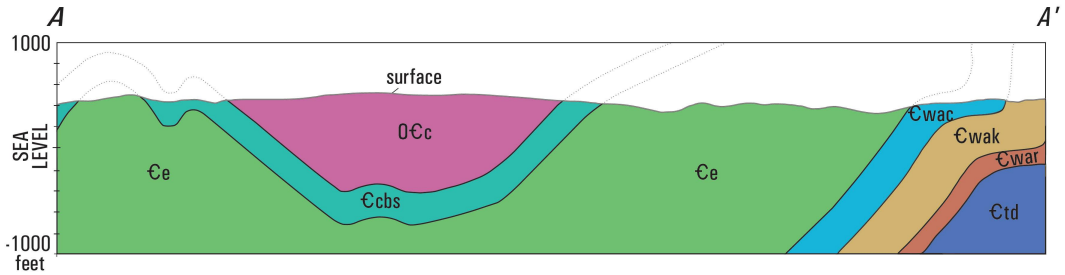
The oldest rocks in the park are the Neoproterozoic metavolcanic rocks of the Catoctin Formation, named after the rocks exposed on Catoctin Mountain in Maryland (Keith, 1894). From central Virginia to Pennsylvania, metamorphosed basalt (greenstone) is the dominant volcanic rock. In Maryland, however, quartz-rich volcanic rock (metarhyolite) is dominant. Catoctin Mountain Park has varieties of both metabasalt and metarhyolite (Fauth, 1977). The metabasalt consists of green, massive, and schistose, metamorphosed basalt flows containing vesicles (gas bubbles). Some vesicles are filled with secondary minerals and others are void. The metabasalt is rich in calcium and magnesium and weathers to an orange, clay-rich soil. Locally, the metabasalt contains light-green masses of quartz and epidote (epidosite) that formed during hydrothermal alteration. Metabasalt can be seen along Park Central Road and at Cunningham Falls. Metarhyolite is a dark-bluish-black, fine-grained, foliated rock that weathers to light-gray slabs. Tan phyllite and quartz-sericite schist are locally intercalated with the metarhyolite. The cryptocrystalline metarhyolite was prized by native Americans who made tools and projectile points from it. Zircon from a sample of the same metarhyolite from approximately 9.3 miles north in Pennsylvania was dated by the U-Pb SHRIMP technique at ~560 Ma (John Aleinikoff, USGS, written commun., 2005). In addition, a metarhyolite dike that intruded gneiss dated at 1 Ga (billion years) along the Potomac River in Virginia yielded a 571±4 Ma U-Pb zircon age (Aleinikoff and others, 1995). Metarhyolite can be seen in the western part of the park on the hills and creek valley along Foxville-Deerfield Road (OF 2005-1331).

Geologic Cross Sections

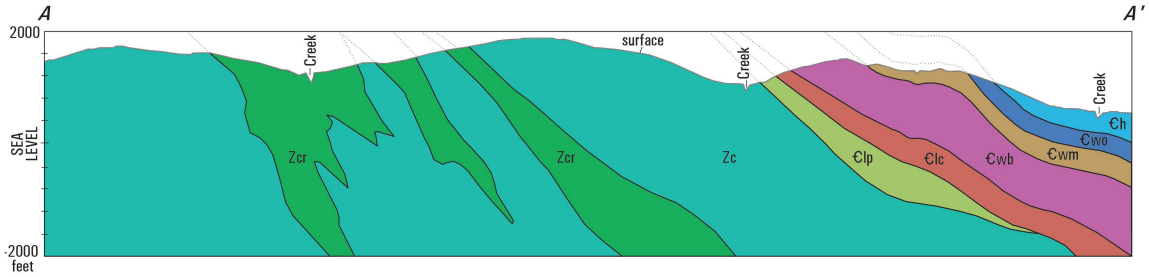
The geologic cross sections present in the GRI digital geologic-GIS data produced for Catoctin Mountain Park (CATO), Greenbelt Park (GREE), George Washington Memorial Parkway (GWMP), Manassas National Battlefield Park (MANA), Monocacy National Battlefield (MONO), National Capital Parks-East (NACE), Prince William Forest Park (PRWI), Rock Creek Park (ROCR) and Wolf Trap Farm Park (WOTR), as well as Antietam National Battlefield (ANTI) are presented below. Note that some cross section abbreviations (e.g., A - A') may have been changed from their source map abbreviation in the GRI data so that each GRI cross section abbreviation is unique.

All cross section images extracted from (OF 2005-1331)

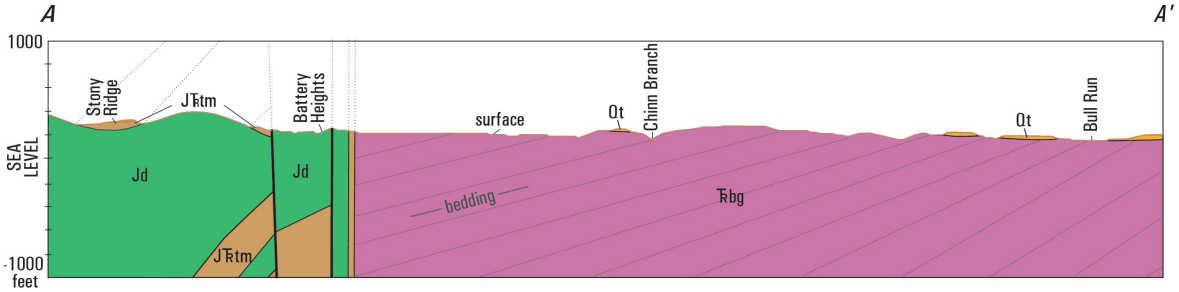
Antietam National Battlefield - Cross Section A-A'



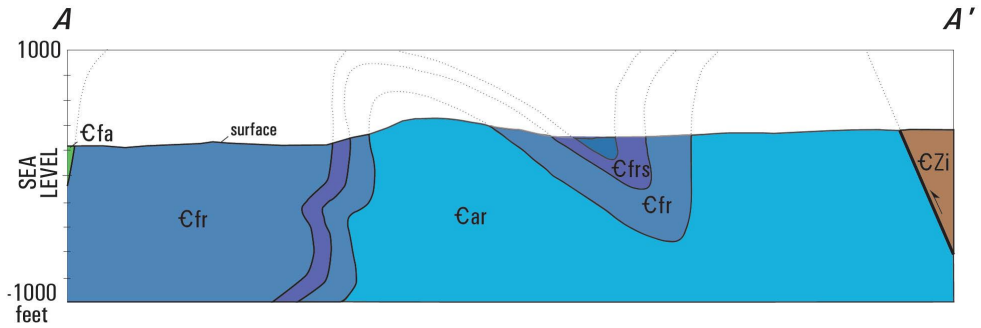
Catoctin Mountain Park Map - Cross Section A-A'



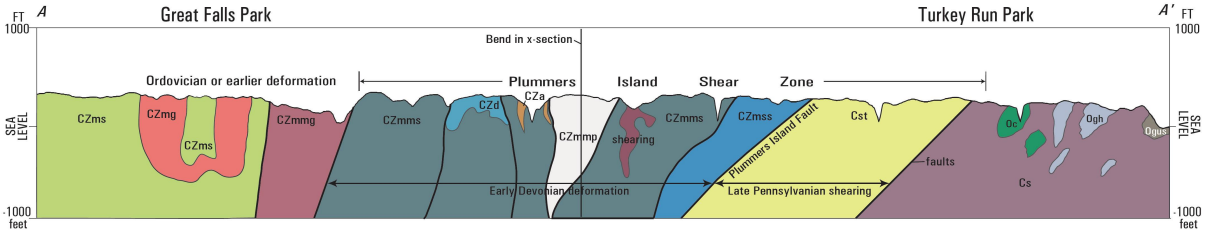
Manassas National Battlefield Park - Cross Section A-A'



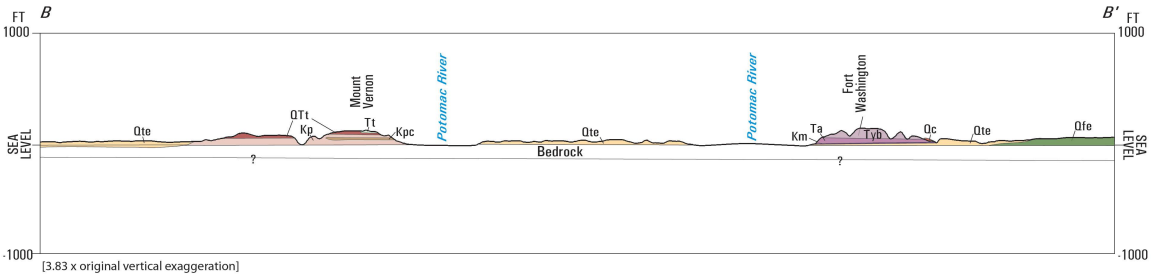
Monocacy National Battlefield - Cross Section A-A'



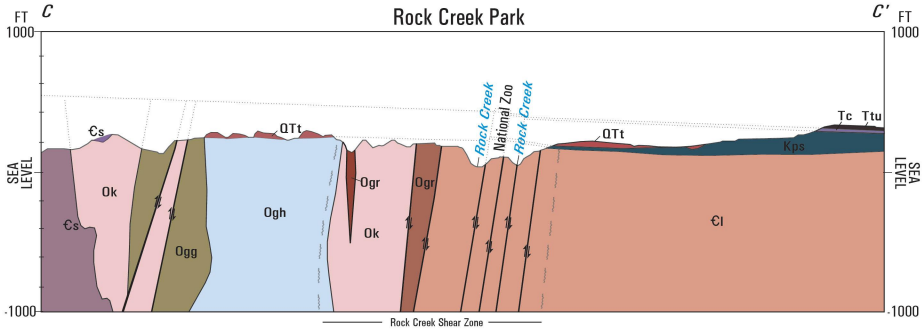
Parks in the District of Columbia and Potomac River Corridor Cross Section A-A'



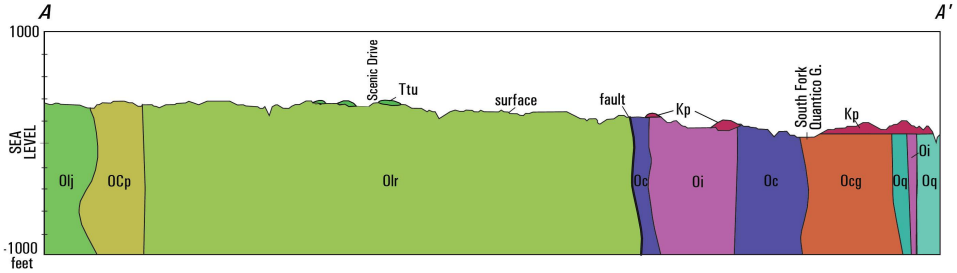
Parks in the District of Columbia and Potomac River Corridor Cross Section B-B'



Parks in the District of Columbia and Potomac River Corridor Cross Section C-C'



Prince William Forest Park - Cross Section A-A'



GRI Source Map Citations

The GRI digital geologic-GIS map for Catoctin Mountain Park (CATO), Greenbelt Park (GREE), George Washington Memorial Parkway (GWMP), Manassas National Battlefield Park (MANA), Monocacy National Battlefield (MONO), National Capital Parks-East (NACE), Prince William Forest Park (PRWI), Rock Creek Park (ROCR) and Wolf Trap Farm Park (WOTR) was compiled from the following source:

Scott Southworth and Danielle Denenny, 2006, Geologic Map of the National Parks in the National Capital Region, Washington D.C., Virginia, Maryland and West Virginia, US Geological Survey, Open File Report 2005-1331, OF 2005-1331*, 1:24,000 scale. (GRI Source Map 4165)*

The following source (available on-line) is also of interest to NPS parks in the National Capital region:

Southworth, Scott and William Burton, 2004, Geology of the National Capital Region: Field Trip Guidebook, USGS and Geologic Society of America, Circular 1264, http://pubs.usgs.gov/circ/2004/1264/title.html

Additional information pertaining to each source map is also presented in the Source Map Information (MAP) table included with the GRI geology-GIS data.

USGS Open File Report 2005-1331

Scott Southworth and Danielle Denenny, 2006, Geologic Map of the National Parks in the National Capital Region, Washington D.C., Virginia, Maryland and West Virginia, US Geological Survey, Open File Report 2005-1331, OF 2005-1331, 1:24,000 scale. (GRI Source Map 4165)

To view and download information about this digital source and other related products, go to the Publication Warehouse page on the U.S. Geological Survey website at:
http://pubs.usgs.gov/of/2005/1331/

Map Report (pdf)
Map Legend
Index Map - Physiographic Provinces

ANTIETAM NATIONAL BATTLEFIELD
Map Graphic
Correlation of Map Units
Geologic Cross Section A-A'

CATOCTIN MOUNTAIN PARK
Map Graphic
Correlation of Map Units
Geologic Cross Section A-A'

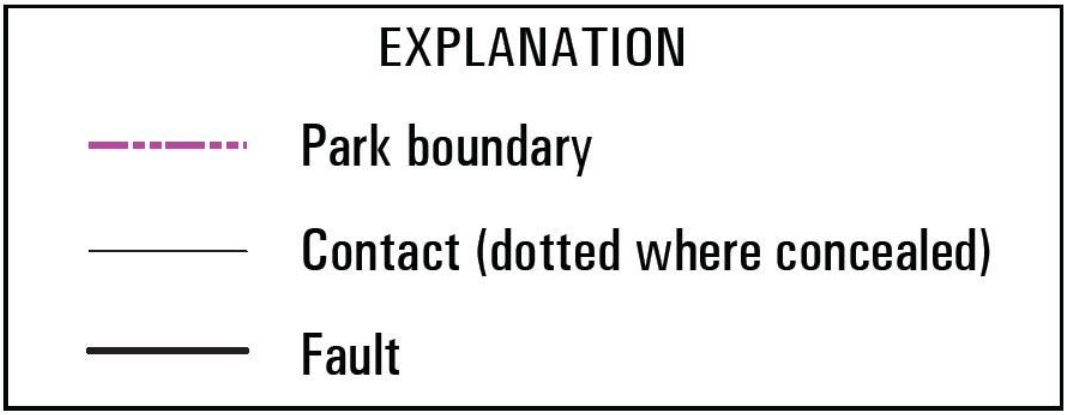
MANASSAS NATIONAL BATTLEFIELD
Map Graphic
Correlation of Map Units
Geologic Cross Section A-A'

MONOCACY NATIONAL BATTLEFIELD
Map Graphic
Correlation of Map Units
Geologic Cross Section A-A'

PARKS in the DISTRICT OF COLUMBIA and POTOMAC RIVER CORRIDOR
Map Graphic
Correlation of Map Units
Geologic Cross Section A-A'
Geologic Cross Section B-B'
Geologic Cross Section C-C'

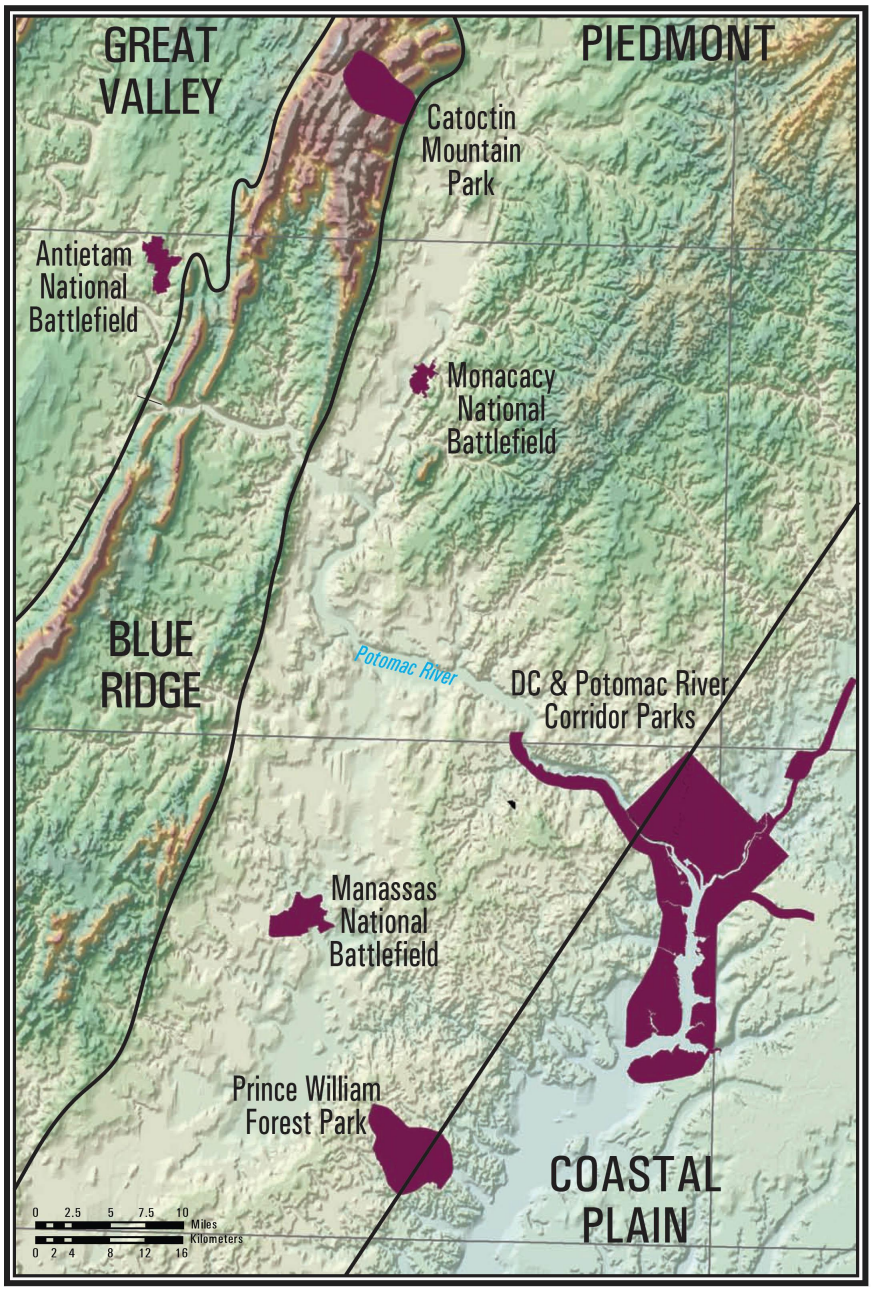
PRINCE WILLIAM FOREST PARK
Map Graphic
Correlation of Map Units
Geologic Cross Section A-A'

Map Legend - USGS Open File Report 2005-1331



Extracted from: (OF 2005-1331)

Index Map & Physiographic Provinces - USGS Open File Report 2005-1331



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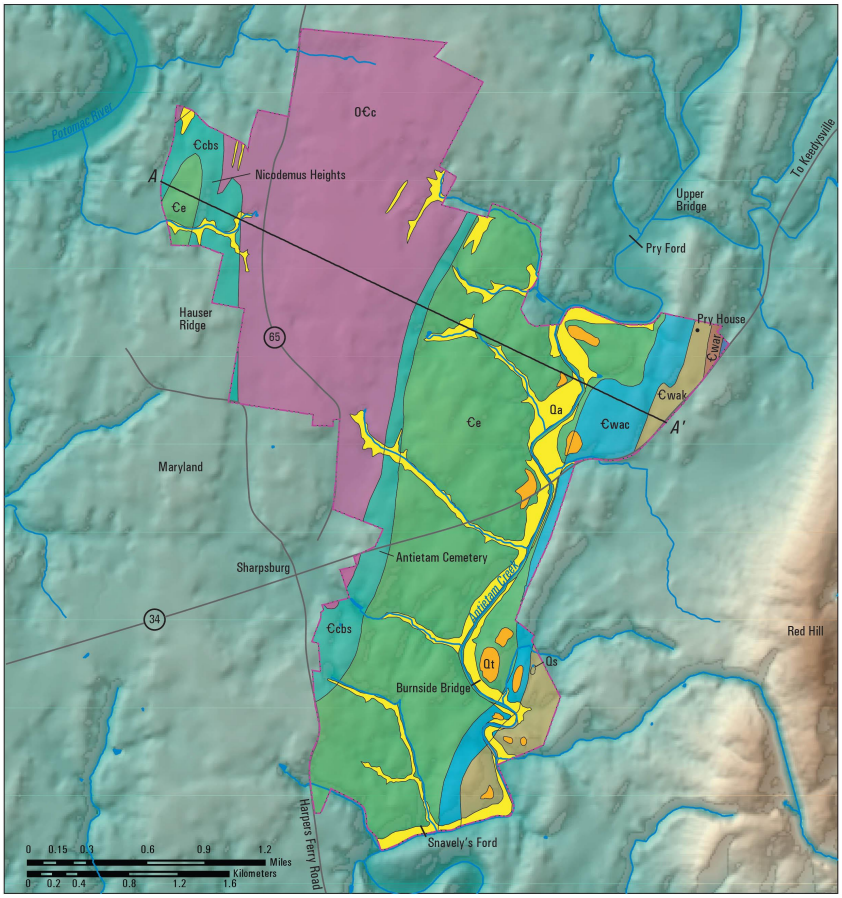
Antietam National Battlefield Map - USGS Open File Report 2005-1331



Extracted from: (OF 2005-1331)

Antietam National Battlefield Correlation - USGS Open File Report 2005-1331

QUATERNARY SURFICIAL MATERIALS

- Qa — Alluvium (Holocene)
- Qs — Sinkhole (Holocene)
- Qt — Terrace deposit, low level (Holocene and Pleistocene)

PALEOZOIC ROCKS

- O€c — Conococheague Limestone (Lower Ordovician and Upper Cambrian)
- €cbs — Big Spring Station Member (Upper Cambrian)
- €e — Elbrook Limestone (Upper and Middle Cambrian)

Waynesboro Formation (Lower Cambrian)

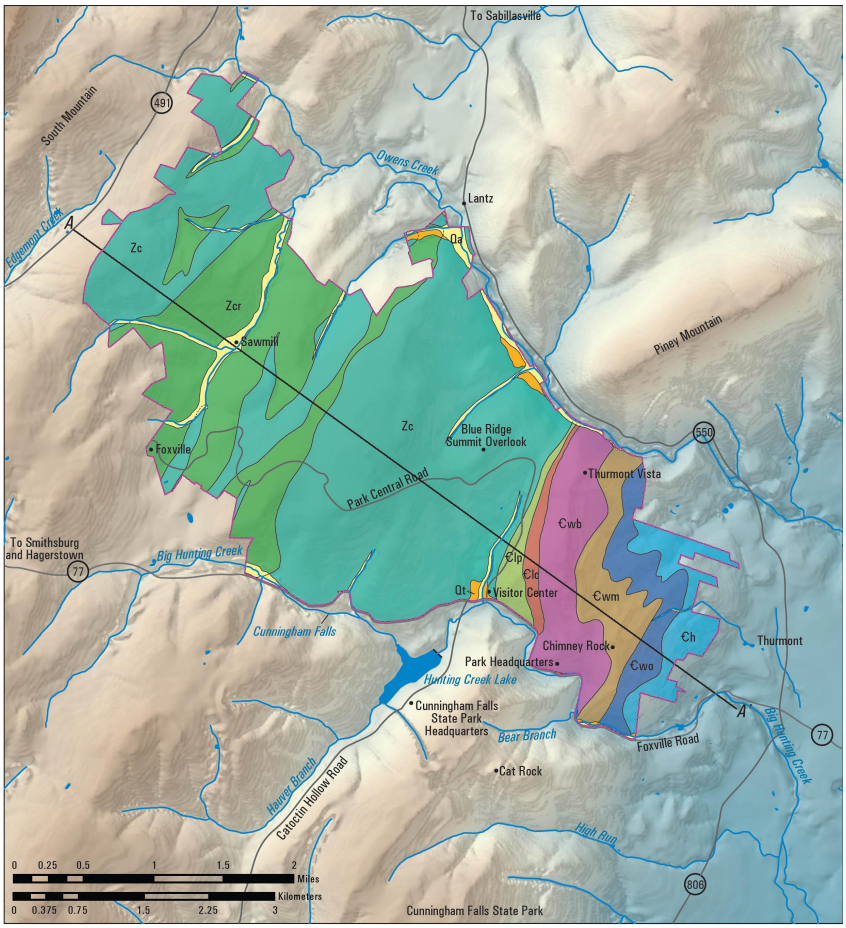
- €wac — Chewsville Member
- €wak — Cavetown Member
- €war — Red Run Member

Tomstown Formation (Lower Cambrian)

- €td — Dargan Member

Extracted from: (OF 2005-1331)

Catoctin Mountain Park Map - USGS Open File Report 2005-1331



Extracted from: (OF 2005-1331)

Catoctin Mountain Park Correlation - USGS Open File Report 2005-1331

QUATERNARY SURFICIAL MATERIALS

- Qa — Alluvium (Holocene)
- Qt — Terrace deposit, low level (Holocene and Pleistocene)

PALEOZOIC ROCKS

Chilhowee Group

- Ꞓh — Harpers Formation (Lower Cambrian)

Weverton Formation (Lower Cambrian)

- Ꞓwo — Owens Creek Member
- Ꞓwm — Maryland Heights Member
- Ꞓwb — Buzzard Knob Member

Loudoun Formation (Lower Cambrian)

- Ꞓlc — Conglomerate
- Ꞓlp — Phyllite

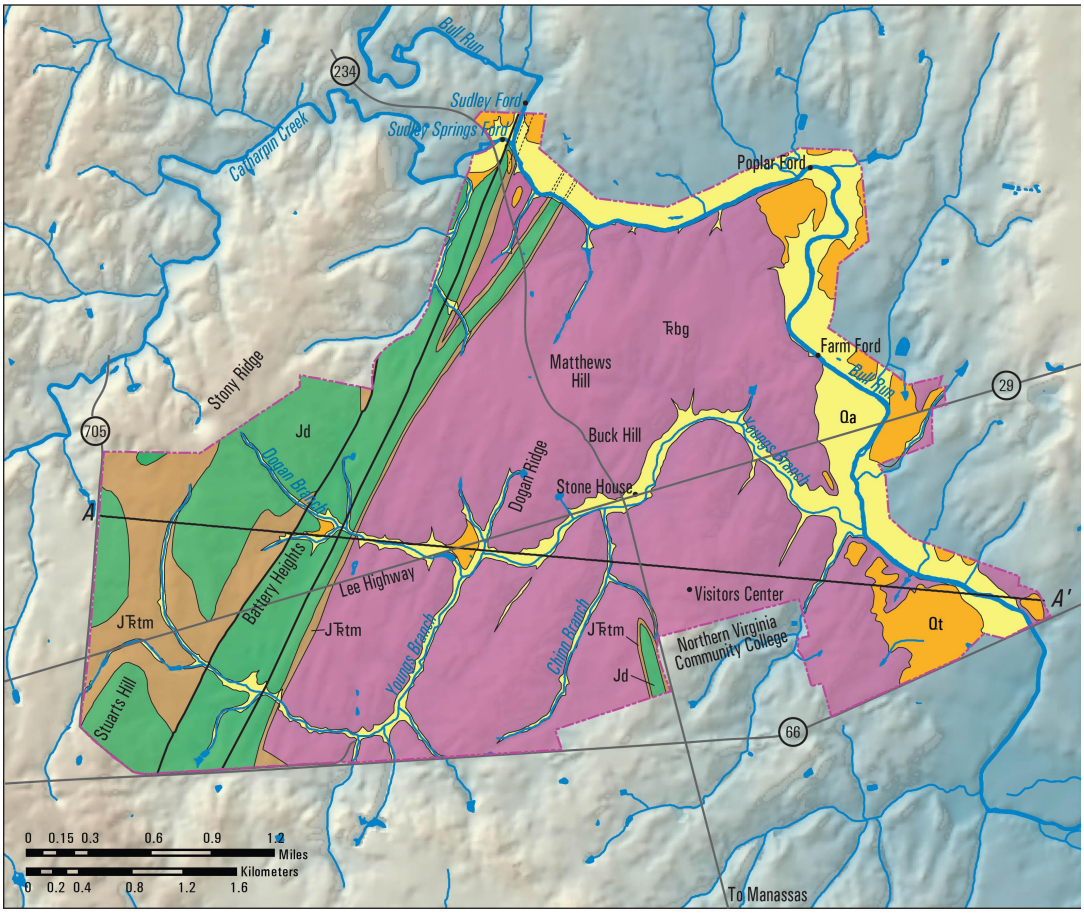
NEOPROTEROZOIC ROCKS

Catoctin Formation (Ediacaran)

- Zc — Metabasalt
- Zcr — Metarhyolite

Extracted from: (OF 2005-1331)

Manassas National Battlefield Map - USGS Open File Report 2005-1331



Extracted from: (OF 2005-1331)

Manassas National Battlefield Correlation - USGS Open File Report 2005-1331

QUATERNARY SURFICIAL MATERIALS

Qa — Alluvium (Holocene)

Qt — Terrace deposit, low level (Holocene and Pleistocene)

EARLY MESOZOIC ROCKS

Jd — Diabase dikes and sills (Early Jurassic and Late Triassic)

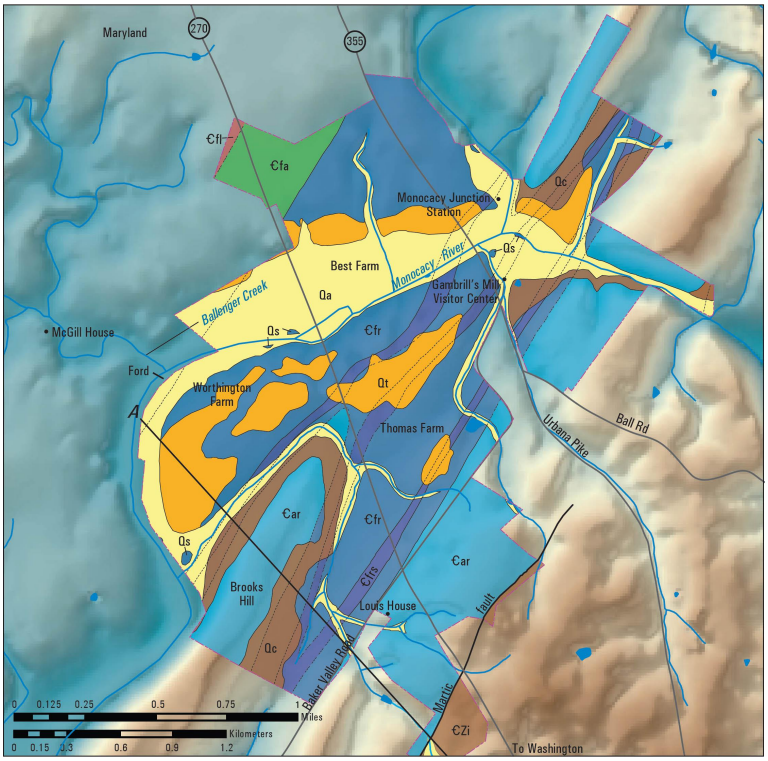
JTRtm — Thermally metamorphosed rocks (Lower Jurassic and Upper Triassic)

Chatham Group

TRbg — Groveton Member of the Bull Run Formation (Upper Triassic)

Extracted from: (OF 2005-1331)

Monocacy National Battlefield Map - USGS Open File Report 2005-1331



Extracted from: (OF 2005-1331)

Monocacy National Battlefield Correlation - USGS Open File Report 2005-1331

QUATERNARY SURFICIAL MATERIALS

Qa	Alluvium (Holocene)
Qs	Sinkhole (Holocene)
Qt	Terrace deposit, low level (Holocene and Pleistocene)
Qc	Colluvium (Holocene and Pleistocene)

PALEOZOIC ROCKS

Frederick Formation (Upper Cambrian)

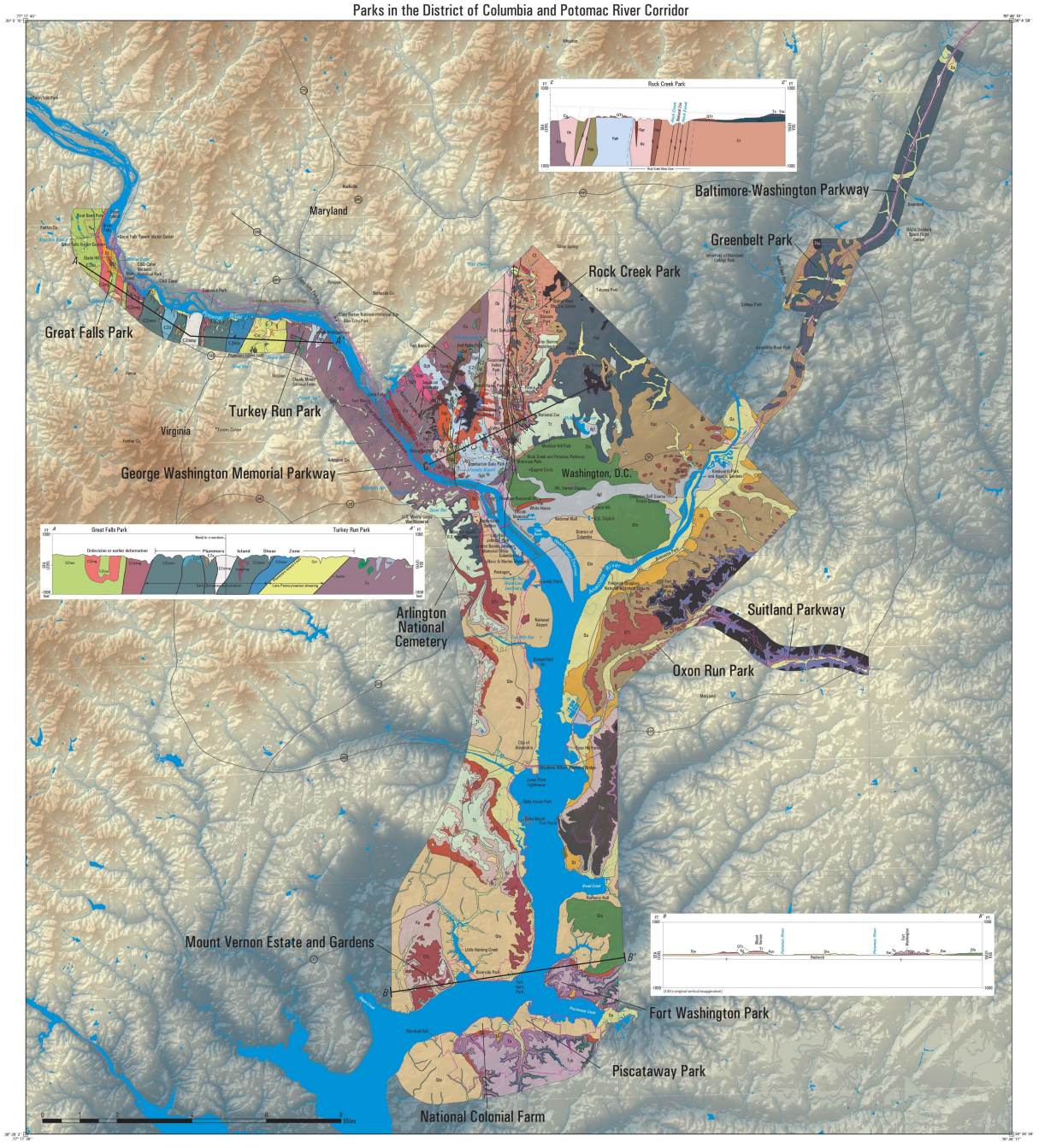
Cfl	Lime Kiln Member
Cfa	Adamstown Member
Cfr / Cfrs	Rocky Springs Station Member
Car	Araby Formation (Middle and Lower Cambrian)

PALEOZOIC AND NEOPROTEROZOIC ROCKS

CZi	Ijamsville Phyllite (Lower Cambrian? and Neoproterozoic?)

Extracted from: (OF 2005-1331)

Parks in the District of Columbia and Potomac River Corridor Map - USGS Open File Report 2005-1331

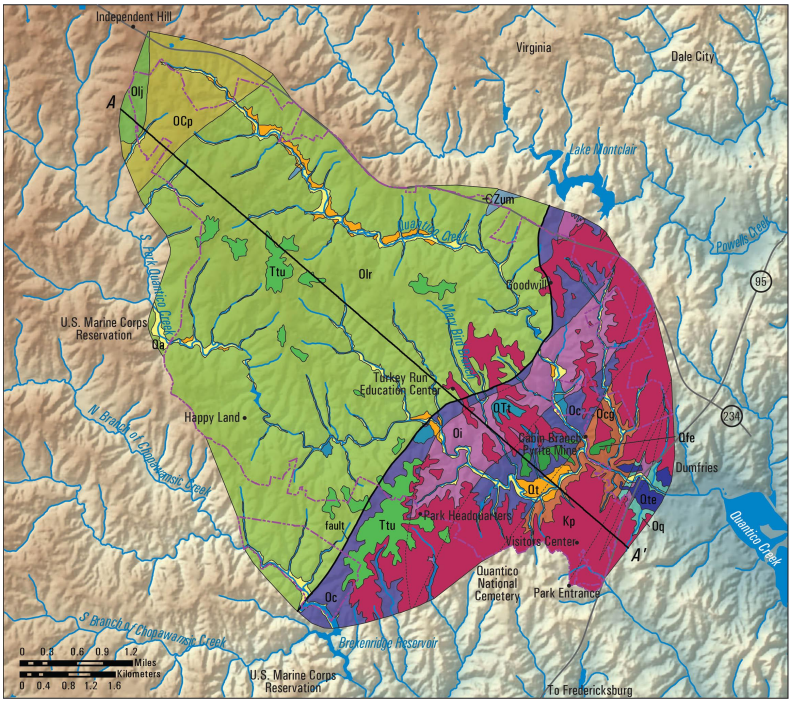


Extracted from: (OF 2005-1331)

Parks in the District of Columbia and Potomac River Corridor Correlation - USGS Open File Report 2005-1331

Extracted from: (OF 2005-1331)

Prince William Forest Park Map - USGS Open File Report 2005-1331



Extracted from: (OF 2005-1331)

Prince William Forest Park Correlation - USGS Open File Report 2005-1331

QUATERNARY SURFICIAL MATERIALS

- Qa — Alluvium (Holocene)
- Qt — Terrace deposit, low level (Holocene and Pleistocene)
- QTt — Terrace deposit, high level (Pleistocene)

CENOZOIC AND CRETACEOUS COASTAL PLAIN DEPOSITS

Fluvial and estuarine deposits (Pleistocene)

- Qte — Lower level
- Qfe — Upper level
- Ttu — Upper level upland terrace deposits (Miocene)
- Kp — Potomac Formation (Upper and Lower Cretaceous)

PALEOZOIC ROCKS

- Oi — Felsic igneous rocks (Silurian)
- Oq — Quantico Formation (Upper Ordovician)
- Olr — Lunga Reservoir Formation (Ordovician)

Chopawamsic Formation (Upper Ordovician)

- Ocw — Metavolcanic and metasedimentary rocks
- Ocg — Breccia and metabasalt
- Olj — Lake Jackson pluton (Middle Ordovician)
- OCp — Phyllite (Ordovician and (or) Cambrian)

PALEOZOIC AND NEOPROTEROZOIC ROCKS

- €Zum — Mafic and ultramafic rocks (Cambrian and (or) Neoproterozoic)

Extracted from: (OF 2005-1331)

GRI Digital Data Credits

This document was developed and completed by Philip Reiker (NPS GRD, Lakewood, Colorado) and Stephanie O'Meara (Colorado State University) for the NPS Geologic Resources Division (GRD) Geologic Resources Inventory(GRI) Program.

The information contained here was compiled to accompany the digital geologic-GIS map(s) and other digital data for National Capital Area Parks, Washington D.C., Virginia, Maryland and West Virginia (NCAP) compiled by Philip Reiker (NPS GRD, Lakewood, Colorado); developed by Stephanie O'Meara (Colorado State University), Heather Stanton (Colorado State University Research Associates), and Jason Isherwood (Colorado State University-NPS Intern).

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