Map Unit Properties Table: Shenandoah National Park

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Age	Map Unit (Symbol)	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
QUATERNARY (Holocene)	Alluvium (Qa)	**Qa** consists of unconsolidated (not solidified) deposits of (by increasing grain size) silt, sand, cobbles, and boulders with a total thickness up to 12 m (40 ft). This unit is associated with fluvial processes and is deposited along streams, floodplains, riparian areas, and alluvial plains. At higher elevations, coarser grain sizes such as boulders dominate units of **Qa**. Further downslope, the alluvium mixes with debris fans (see **Qdf** and **Nf**).	**Surficial Deposits**—Deposited by flowing water. Alluvium is ubiquitous along park streams and rivers reflecting the most recent part of the park's geologic history.	**Slope Movements**—unconsolidated units such as **Qa** are prone to erosion when exposed on slopes or undercut by streams. **Surface Water and Sediment Loading**—**Qa** is associated with surface water features such as streams and rivers. **Groundwater Quantity and Quality**—surface water percolates through **Qa** to recharge underlying aquifers. **Disturbed Lands**—sand and gravel resources occur within **Qa**. Locally, thick deposits of alluvium resulted from increased erosion during deforestation and agriculture of the 1800s.	**Appalachian Mountain Erosion and Ice Age Glaciation**—youngest geologic map units occurring on the landscape at Shenandoah National Park. These units reflect the ongoing processes of weathering and erosion within the Appalachian Mountains as sediments are transported downslope toward the Coastal Plain.
	Debris-flow deposits (Qdf)	**Qdf** consists of boulders and finer-grained matrix material deposited in chutes within bedrock and unconsolidated regolith. Tracks and scars scratched by the flow of these deposits occur in the Blue Ridge highlands. Flows of **Qdf** are triggered by high rainfall events.	**Surficial Deposits**—**Qdf** occurs at the base of coves and hollows on the upper to lower slopes of the Blue Ridge highlands. Deposited by slope movements.	**Slope Movements**—**Qdf** forms via mass wasting processes of debris flows and slides. When located in areas of infrastructure, debris flows can cause serious damage and threat to human safety. Measured velocities from 1995 debris flows were as much as 24 m/sec (79 ft/sec). Climate models predict more frequent and intense storm events for the park area; strong storms may trigger additional debris flows. Scars associated with the formation of **Qdf** can remain unvegetated for decades. **Surface Water and Sediment Loading**—heavy precipitation triggers debris flows on steep slopes of the Blue Ridge Mountains. **Earthquakes**—could trigger mass movements on steep slopes, particularly in wet conditions.	
QUATERNARY (Holocene and Pleistocene)	Quartzite block-field deposits (Qb)	**Qb** contains rather angular block and boulders of lichen-covered quartzite with very little interstitial (matrix) material between the blocks. Deposits of **Qb** tend to accumulate on nonvegetated slopes of ridges composed of erosion resistant quartzite of the Chilhowee Group (see **Ccw**, **Cchs**, **Cch**, and **Cca**). Thickness of **Qb** is variable.	**Surficial Deposits**—block fields are concentrated in the highland slopes of the park. They are well-developed on ridges underlain by metamorphosed sandstone and quartzite such as the Chilhowee Group (**Ccw**, **Cch**, and **Cca**). Typically formed by frost-wedging. **Periglacial Features**—**Qb** likely formed during cooler climates as frost wedging created quartzite blocks. **Paleontological Resources**—may contain Pleistocene-age fossils. **Connections with Park Stories**—quartzite was used by American Indians for tools. Only scant vegetation can develop on **Qb** and the unit was largely undisturbed during early settlement.	**Slope Movements**—**Qb** forms through mass wasting processes such as frost weathering. Rockfall and topples proceed as blocks are weathered from the bedrock outcrop and fall downslope. **Bedrock Outcrop Management**—the erosion-resistant quartzites that weather to produce deposits of **Qb** tend to form cliffs and ridges. **Earthquakes**—could trigger mass movements of blockfall- and topple-prone deposits on steep slopes.	**Appalachian Mountain Erosion and Ice Age Glaciation**—units reflect colder climatic conditions during the Pleistocene ice ages when frost weathering dislodged millions of blocks of rock from bedrock outcrops to litter the slopes below. Process continues at a subdued rate today.

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Age	Map Unit (Symbol)	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
QUATERNARY (Holocene and Pleistocene)	Colluvium (Qc)	Colluvium is similar to **Qb** in that it contains clast-supported, rather angular to slightly rounded cobbles and boulders. As with **Qa**, **Qc** grades downslope into debris-fan deposits (see **Qdf** and **Nf**). Thickness of **Qc** can reach up to 30 m (100 ft).	**Surficial Deposits**—colluvium is concentrated in the highlands of the park. Typically formed by frost-wedging. **Periglacial Features**—most **Qc** is a relict deposit from the periglacial climates of the Pleistocene formed by forces and processes such as gravity, solifluction, freeze-thaw cycles, ice wedging, and frost heaving. **Paleontological Resources**—may contain Pleistocene-age fossils.	**Slope Movements**—**Qc** is formed by myriad mass wasting processes and is present at the base of slopes throughout the park area. **Bedrock Outcrop Management**—**Qc** collects at the base of steep slopes and cliffs. **Earthquakes**—could trigger mass movements on steep slopes.	**Appalachian Mountain Erosion and Ice Age Glaciation**—units reflect colder climatic conditions during the Pleistocene ice ages when frost weathering dislodged millions of blocks of rock from bedrock outcrops to litter the slopes below. Process continues at a subdued rate today.
NEOGENE	Terrace deposits (Nt)	**Nt** comprises unconsolidated, sorted sand, gravel, cobbles, and boulders. It is associated with major rivers in the park area. Deposits of **Nt** can reach 9 m (30 ft) in thickness. Terraces frequently occur as much as 9 m (30 ft) above the modern floodplain, but **Nt** also includes older terraces as much as 60 m (197 ft) in elevation above the active floodplain.	**Surficial Deposits**—deposited by flowing water. Terrace deposits are located along major rivers in the valleys of the park area. **Periglacial Features**—terraces may have formed as material destabilized from upland surfaces during following the colder climates of the Ice Age; frost-bound debris provided a pulse of increased sediment load of which the terraces are remnants. **Paleontological Resources**—may contain Neogene-age fossils.	**Slope Movements**—elevated terraces, perched some 60 m (197 ft) above modern floodplains may be prone to mass wasting. Much of the finer, unconsolidated material has already eroded away, leaving boulders and cobbles. **Surface Water and Sediment Loading**—**Nt** is associated with major rivers, flanking the sides of the valley. These are left perched along stretches of the valley to record previous, higher river levels.	**Appalachian Mountain Erosion and Ice Age Glaciation**—units reflect a long history of erosion and landscape change within the park area. These units formed through earth surface processes active from 23 to 2.6 million years ago.
	Alluvial-plain deposits (Np)	**Np** covers broad areas of coalescing terraces (**Nt**) along major rivers in the lowlands east of the Blue Ridge highlands. As such, it contains similar deposits and records the former locations of the major rivers meandering across the landscape.	**Surficial Deposits**—deposited by flowing water. Alluvial-plain and alluvial-fan deposits are located on the lower slopes and valleys on the western and eastern flanks of the Blue Ridge, respectively. **Paleontological Resources**—may contain Neogene-age fossils.	**Surface Water and Sediment Loading**—**Np** records the previous locations of major rivers meandering across the lowland topography. **Disturbed Lands**—sand and gravel resources occur within **Np**.	
	Debris-fan deposits (Nd)	**Nd** forms fans and sheets as much as 30 m (98 ft) thick on lower slopes and valleys. The deposits consist of a jumbled mixture of pebbles, cobbles, and boulders that are only partially rounded by weathering. These coarse components are supported in a matrix of unstratified and unconsolidated clay, silt, sand, and pebbles. All the deposits come from local bedrock, and their morphology and topographic setting vary with bedrock type. Some portions of **Nd** are actually terraces of debris fans as much as 36 m (118 ft) above adjacent fans and alluvium (**Qa**).	**Surficial Deposits**—deposited by slope movements. Debris-fan deposits are concentrated in coves and hollows on the upper to lower slopes within the park, particularly where underlain by gneiss of metabasalts. **Type Sections, Reference Locations, and Radiometric Ages**—radiocarbon (C^{14}) ages from fans along Kinsey Run ranged from 51,000 to 2,000 years before present, individual flow events recur on average of every 2,500 years. Cosmogenic Be^{10} and Al^{26} dates from exposed boulders in the same area suggest the fan surfaces are older than 500,000 years before present. **Periglacial Features**—**Nd** formed during glacial and interglacial transitions as warm and cold cycles fluctuated and severe storms were common. **Paleontological Resources**—may contain Neogene-age fossils.	**Slope Movements**—**Nd** forms downslope from debris flows and slides. This unit contains a valuable record of the history of mass wasting in the park area and is the dominant Cenozoic deposit of the unglaciated highlands of the Appalachians. **Disturbed Lands**—early settlers, while developing land for pasture, removed the boulders and cobbles making conical piles, terraces, and/or fences.	

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NEOGENE	Alluvial-fan deposits (Nf)	**Nf** contains unconsolidated sand, pebbles, cobbles, and boulders of quartzite and sandstone (derived from **Cca**, **Cch**, and **Cchs**). Fans and sheets of coalesce to form aprons extending from the lower west slope of Blue Ridge to the South Fork of the Shenandoah River. Thickness of **Nf** is variable, but can exceed 150 m (500 ft) in areas where the deposits have not been significantly reworked by later alluvial (stream) processes.	**Surficial Deposits**—deposited by flowing water. Alluvial-plain and alluvial-fan deposits are located on the lower slopes and valleys on the western and eastern flanks of the Blue Ridge, respectively. Commonly mantles carbonate (limestone or dolomite/dolostone) bedrock **Paleontological Resources**—may contain Neogene-age fossils. **Cave and Karst Features**—**Nf** has surface expressions of sinkholes and water-filled depressions.	**Slope Movements**—unconsolidated units such as **Nf** are prone to erosion when exposed on slopes or undercut by streams. **Groundwater Quantity and Quality**—surface water percolates through **Nf** to recharge underlying aquifers. These fans host the only aquifer of unconsolidated sediments west of the Coastal Plain province in Virginia. **Disturbed Lands**—sand and gravel resources occur within **Nf**. **Nf** also forms a "trap" for manganese deposits weathering out of carbonate units (**Ct** and **Cca**) along the western slope of the Blue Ridge (Page Valley area). **Cave and Karst Hazards**—sinkholes and water-filled depressions in **Nf** attest to karst formation in underlying bedrock.	**Appalachian Mountain Erosion and Ice Age Glaciation**—units reflect a long history of erosion and landscape change within the park area. These units formed through earth surface processes active from 23 to 2.6 million years ago.
JURASSIC (Late)	Peridotite dike (Jpd)	Peridotite is a silica-poor rock composed of olive and other mafic minerals with virtually no feldspar. Dikes are igneous intrusions that cut across the fabric of the local bedrock. **Jpd** occurs in a discrete, 182-m (597-ft) long, 46-m (151-ft) wide, elliptical igneous intrusion into **Om** west of Front Royal, Virginia. This localized unit contains olivine and pyroxene minerals which have altered to chlorite, phlogopite, biotite, ankerite, and talc.	**Ancient Bedrock**—molten material that would become dikes was emplaced in fractured rock, which formed as Pangaea rifted apart.	**Disturbed Lands**—peridotites often contain unusual minerals that may be targets for mining.	**Pangaea Separation, Atlantic Ocean Formation, and Appalachian Mountains Erosion**—of these units, the only Mesozoic rocks in the park are diabase dikes, **Jd**. They represent a shift in tectonic setting from plates coming together to the supercontinent Pangaea rifting apart. At this time, extension of Earth's crust was occurring along the eastern side of North America.
	Alkalic dikes (Jad)	**Jad** occurs in a series of discrete, northwest-trending vertical dikes consisting of nepheline syenite, teschenite, and teschenite-picrite. Similar to **Jpd**, **Jad** intrudes **Om**, but west of the Grottoes.	**Ancient Bedrock**—molten material that would become dikes was emplaced in fractured rock, which formed as Pangaea rifted apart. **Type Sections, Reference Locations, and Radiometric Ages**—**Jad** yielded an age of 157±8 to 148±7 million years ago.	None reported.	
JURASSIC (Early)	Diabase dikes (Jd)	**Jd** consists of medium to dark gray, crystalline (visible crystals) and equigranular (crystals of similar grain size), massive diabase (see **Zmd**) dikes. The diabase varies in composition between olivine-bearing and quartz-bearing and has clusters of calcic plagioclase feldspar in a fine-grained groundmass (matrix) of pyroxene and plagioclase. Weathering of **Jd** produces characteristic orange-brown surfaces.	**Ancient Bedrock**—molten material that would become dikes was emplaced in fractured rock, which formed as Pangaea rifted apart. **Type Sections, Reference Locations, and Radiometric Ages**—**Jd** yielded an age of 200 million years ago.	**Slope Movements**—**Jd** weathers to produce boulders that may tumble downslope. **Bedrock Outcrop Management**—**Jd** weathers to produce staircases.	

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DEVONIAN and SILURIAN	Devonian and Silurian rocks, undivided (DSu)	Mahantango Formation	Unit consists of gray mudstone, sandstone, and shale that is locally fossiliferous.	**Ancient Bedrock**—these units contain mudcracks, cross laminations, and turbidite sedimentary structures. **Blue Ridge-South Mountain Anticlinorium and Regional Structures**—exposed in core of synclinorium. **Paleontological Resources**—some units contain fossils. **Cave and Karst Features**—karst topography is well-developed in the Great and Page valleys. **Connections with Park Stories**—although extraction was primarily focused north and west of the park in the northern Shenandoah Valley, chert nodules in these units may have provided tool and trade material for American Indians.	**Slope Movements**—dissolution of calcareous portions of these units may render them susceptible to mass wasting and undercutting. **Groundwater Quantity and Quality**—dissolution-enlarged conduits within the calcareous portions of this unit may more readily transmit groundwater than adjacent units. **Disturbed Lands**—American Indians extracted chert from **DSu**. Ferruginous (iron-bearing) rocks may have been targeted for iron mining. **Cave and Karst Hazards**—calcareous layers and limestones are prone to dissolution.	**Acadian–Neoacadian Orogeny**—influx of clastic sediment from Acadian Orogeny. Ash beds in the Tioga Ash Bed mark the eruption of island-arc volcanoes associated with the Acadian Orogeny, north of the park area, 390 to 374 million years ago. The Mahantango Formation is the youngest formation preserved in the core of the Massanutten synclinorium. It is exposed in Fort Valley.
		Needmore Shale	Unit contains greenish gray shale and calcareous (containing calcium carbonate) mudstone that are fossiliferous with a base of black shale.			
		Tioga Ash Bed	Unit includes a distinctive brown-biotite bearing calcareous ash bed; gray shale and siltstone; and black, fissile (easily parted) shale.			
		Marcellus Shale, undivided	Unit contains dark gray to black, fissile shale with some gray, silty limestone and calcareous shale beds interlayered.			
		Ridgeley Sandstone	Unit is primarily calcareous and fossiliferous sandstone appearing light gray in outcrop with fine- to coarse-grained (locally conglomeratic) textures and cross-laminated sedimentary structures.			
		Helderberg Group	An upper sandy portion of this unit grades downward into light gray, laminated to thick-bedded limestone with black nodular chert and white blocky chert.			
		Keyser Limestone	Unit is mostly gray limestone, some of which is fossiliferous and some contains black, nodular chert and white blocky chert.			
		Tonoloway Limestone	Unit is gray, laminated limestone with mudcracks as sedimentary features.			
		Wills Creek Formation	Unit contains gray limestone with greenish gray siltstone and mudstone that is calcareous.			
		Bloomsburg Formation	Distinctive unit of red mudstone interlayered with red, ferruginous (iron-bearing) sandstone and shale.			
		McKenzie Formation	Unit consists of gray, calcareous shale.			
SILURIAN	Massanutten Sandstone (Sm)		**Sm** consists of light gray sandstone. The unit is fine to coarse grained and in places considered conglomeratic. **Sm** exhibits cross lamination sedimentary structures. **Sm** crops out as ridges of Massanutten Mountain. Correlative with the Tuscarora Sandstone, named for exposures in Pennsylvania.	**Ancient Bedrock**—**Sm** contains cross-lamination sedimentary structures. **Blue Ridge-South Mountain Anticlinorium and Regional Structures**—exposed in core of synclinorium.	**Slope Movements**—where unit is exposed on slopes, it may be prone to rockfall.	None reported.
ORDOVICIAN (Upper and Middle)	Martinsburg Formation (Om)		**Om** contains light brown shale, calcareous shale, and siltstone. The upper portions of this unit contain layers of sandstone and metagraywacke, whereas the basal portions of the unit contain argillaceous (clay-rich) limestone. **Jpd** and **Jad** intrude this unit locally.	**Ancient Bedrock**—**Om** contains turbidite deposits with typical Bouma cycles and load casts. **Blue Ridge-South Mountain Anticlinorium and Regional Structures**—transported westward along thrust faults, exposed in Valley and Ridge province. **Paleontological Resources**—may contain bioturbated beds, algal bioherms, and algal limestone. **Cave and Karst Features**—karst topography is well-developed in the Great and Page valleys. Sinkholes developed in this unit.	**Slope Movements**—dissolution of calcareous portions of this unit may render certain layers susceptible to mass wasting and undercutting. **Groundwater Quantity and Quality**—dissolution-enlarged conduits within the calcareous portions of this unit may more readily transmit groundwater than adjacent units. **Cave and Karst Hazards**— calcareous layers and limestones are prone to dissolution, but probably not enough limestone is present to cause significant issues.	**Taconic Orogeny**—siliciclastic rocks in **Om** records an inundation of the continental margin as sea level was rising—shallow-water carbonates were shifting towards deepwater clastic sediments.

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ORDOVICIAN (Middle)	Edinburg Formation, Lincolnshire Limestone, and New Market Limestone, undivided (Oeln)	**Oeln** consists of three components: (1) gray to black, fossiliferous limestone and black shale; (2) gray, fossiliferous, and cherty limestone; and (3) bluish gray, micritic (extremely fine-grained) limestone. **Oeln** is only exposed as a narrow band on limestone within the Great Valley section	**Ancient Bedrock**—the Edinburg Formation contains yellowish brown volcanic ash or bentonite beds. **Type Sections, Reference Locations, and Radiometric Ages**—similar volcanic ash beds elsewhere were dated at 470±1.4 and 451±4 million years ago. **Paleontological Resources**—some units contain fossils. **Cave and Karst Features**—karst topography is well-developed in the Great and Page valleys. Sinkholes developed in this unit. **Connections with Park Stories**—although extraction was primarily focused north and west of the park in the northern Shenandoah Valley, chert nodules in these units may have provided tool and trade material for American Indians.	**Groundwater Quantity and Quality**—dissolution-enlarged conduits within the limestone portions of this unit may more readily transmit groundwater than adjacent units. **Cave and Karst Hazards**—limestones are prone to dissolution. **Disturbed Lands**—American Indians extracted chert from **Os**.	**Passive Margin**—**Ob** and **Oeln** are separated by an angular unconformity marking a shift from passive margin deposition to an active margin (convergent margin) as the Taconic Orogeny was beginning.
ORDOVICIAN (Lower and Middle)	Beekmantown Group, undivided (Ob)	**Ob** consists of light gray dolostone layered with thinly laminated dolostone that contains white and light gray chert nodules. Collapse breccia and paleokarst occur in the upper portions of the unit.	**Ancient Bedrock**—**Ob** features paleokarst features in the upper portions including collapse breccia. This indicates the unit was once exposed near the surface before being buried again during mountain building and re-exposed. Weathered joints in **Ob** render a "butcher-block" pattern on the surface. **Ob** contains a paleorecord of karst features and processes. **Blue Ridge-South Mountain Anticlinorium and Regional Structures**—transported westward along thrust faults, exposed in Valley and Ridge province. **Paleontological Resources**—may contain bioturbated beds, algal bioherms, and algal limestone. **Cave and Karst Features**—karst topography is well-developed in the Great and Page valleys. Hosts Luray Caverns and Skyline Caverns. Sinkholes developed in this unit. **Connections with Park Stories**—although extraction was primarily focused north and west of the park in the northern Shenandoah Valley, chert nodules in this unit may have provided tool and trade material for American Indians. **Ob** was locally altered to yellow jasper beneath the Front Royal Fault. This was quarried by American Indians at the Flint Run Archeological District.	**Groundwater Quantity and Quality**—dissolution-enlarged conduits within the dolostone portions of this unit may more readily transmit groundwater than adjacent units. **Disturbed Lands**—American Indians extracted chert and jasper from **Ob**. **Cave and Karst Hazards**—calcareous dolostones are prone to dissolution though less soluble than limestone.	**Passive Margin**—**Ob** and **Oeln** are separated by an angular unconformity marking a shift from passive margin deposition to an active margin (convergent margin) as the Taconic Orogeny was beginning.
ORDOVICIAN (Lower)	Stonehenge Limestone (Os)	**Os** contains dark gray, fossiliferous limestone with fine- to medium-grained textures. Minor black chert occurs within the limestone as do interlayers of light gray, laminated, silty limestone; platy limestone; coarse-grained bioclastic (contains fragments of fossil organisms) limestone; gray fossiliferous limestone and crystalline dolostone with fine- to medium-grained textures; and dark gray chert nodules.	**Paleontological Resources**—**Os** includes algal bioherms, and bioclastic layers. **Cave and Karst Features**—karst topography is well-developed in the Great and Page valleys. Sinkholes developed in this unit. **Connections with Park Stories**—although extraction was primarily focused north and west of the park in the northern Shenandoah Valley, chert nodules in this unit may have provided tool and trade material for American Indians.	**Groundwater Quantity and Quality**—dissolution-enlarged conduits within this unit may more readily transmit groundwater than adjacent units. **Cave and Karst Hazards**—limestones and dolostones are prone to dissolution. **Disturbed Lands**—American Indians extracted chert from **Os**.	**Passive Margin**—**Os** contains a record of the abundant life flourishing along the passive margin prior to the onset of the Taconic Orogeny.

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ORDOVICIAN (Lower) and CAMBRIAN (Upper)	Conococheague Limestone (OCc)	**OCc** contains light gray, sandstone that ranges in composition from calcareous to dolomitic; gray, fine-grained limestone and intraformational, coarse-grained conglomerate; light gray, fine-grained dolostone with gray laminated algal limestone; dolomitic limestone; and light brown dolostone with calcareous sandstone.	**Ancient Bedrock**—bioturbated beds **Blue Ridge-South Mountain Anticlinorium and Regional Structures**—transported westward along thrust faults, exposed in Valley and Ridge province. **Paleontological Resources**—**OCc** contains algal limestone and bioturbated beds. **Cave and Karst Features**—karst topography is well-developed in the Great and Page valleys. Sinkholes developed in this unit.	**Groundwater Quantity and Quality**—dissolution-enlarged conduits within the calcareous, limestone, and dolostone portions of this unit may more readily transmit groundwater than adjacent units. **Cave and Karst Hazards**—limestones and dolostones are prone to dissolution.	**Passive Margin**—**OCc** records the conditions locally present during the transition from Cambrian to Ordovician time as cyclic incursions of sandy sediment spread onto the carbonate platform.
CAMBRIAN (Upper and Middle)	Elbrook Limestone (Ce)	**Ce** consists of gray limestone with white marble interlayered throughout. Some light brown, laminated dolostone, and thin, calcareous shale and shaly dolostone are interlayered locally as well.	**Blue Ridge-South Mountain Anticlinorium and Regional Structures**—transported westward along thrust faults, exposed in Valley and Ridge province. **Paleontological Resources**—**Ce** elsewhere contains trilobite fossils. **Cave and Karst Features**—karst topography is well-developed in the Great and Page valleys. Sinkholes developed in this unit.	**Groundwater Quantity and Quality**—dissolution-enlarged conduits within the calcareous, limestone, and dolostone portions of this unit may more readily transmit groundwater than adjacent units. **Cave and Karst Hazards**—limestones and dolostones are prone to dissolution.	**Passive Margin**—marble in **Ce** records metamorphism affecting this unit.
CAMBRIAN (Lower)	Waynesboro Formation (Cwa)	**Cwa** includes three distinct subunits: (1) light olive-gray shale interbedded with light gray, fine-grained sandstone and darker gray, sandy, dolomitic limestone; (2) gray, bioturbated dolostone interlayered with dolomitic limestone, laminated limestone, and some scant sandy limestone beds in the middle portions of the subunit; and (3) dusky red shale, mudstone, and argillaceous (clay-rich) sandstone interlayered with light gray sandstone and light-brown, sandy, dolomitic limestone and dolostone.	**Paleozoic Sedimentary Rocks and Metamorphism**—contains bioturbated layers, and sedimentary features such as ripple marks, cross-beds, and mudcracks. **Blue Ridge-South Mountain Anticlinorium and Regional Structures**—transported westward along thrust faults, exposed in Valley and Ridge province. **Paleontological Resources**—may contain bioturbated beds, algal bioherms, and algal limestone. **Cave and Karst Features**—karst topography is well-developed in the Great and Page valleys. Sinkholes developed in this unit.	**Slope Movements**—dissolution of carbonate-rich portions of **Cwa** may render certain layers susceptible to mass wasting and undercutting particularly in cases where shales or sandstones are undercut on slopes. **Groundwater Quantity and Quality**—dissolution-enlarged conduits within the carbonate portions of this unit may more readily transmit groundwater than adjacent units. **Cave and Karst Hazards**—carbonate layers (limestones, dolostones, and calcareous portions) within **Cwa** are prone to dissolution.	**Passive Margin**—siliciclastic rocks in **Cwa** may record a pulse of continental sediment or a marine regression.
CAMBRIAN (Lower)	Tomstown Formation (Ct)	In general, **Ct** contains gray limestone, dolostone, and marble. During mapping, four subunits were combined: (1) dark gray, fine-grained limestone exhibiting wispy dolomitic burrow traces that increase towards the top of the subunit, and some gray to white, mylonitic (highly deformed) marble; (2) dark gray, burrowed dolostone; (3) light gray, sugary (texture resembles sugar crystals) dolostone with cross-bedding sedimentary features; (4) dark gray, bioturbated dolostone with limestone underlying dark gray, bioturbated, oolitic (containing tiny pearl-like balls of sediment) dolostone interlayered with limestone and silty dolostone.	**Blue Ridge-South Mountain Anticlinorium and Regional Structures**—transported westward along thrust faults, exposed in Valley and Ridge province. **Paleontological Resources**—unit contains metamorphosed remnants of burrows and bioturbated (rummaged through by bottom feeders) sediments. **Cave and Karst Features**—karst topography is well-developed in the Great and Page valleys. Sinkholes developed in this unit.	**Groundwater Quantity and Quality**—dissolution-enlarged conduits within the carbonate portions of this unit may more readily transmit groundwater than adjacent units. **Disturbed Lands**—manganese deposits from **Ct** and its contact with **Cca** were mined on the western slope of the Blue Ridge. **Cave and Karst Hazards**—carbonate layers (limestones, dolostones, and calcareous portions) within **Ct** are prone to dissolution.	**Passive Margin**—**Ct** records the passive continental margin that existed along the eastern coast of the ancient continent Laurentia—a change from a shallow, carbonate shelf to a deepwater shelf, then to a carbonate bank.

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Age	Map Unit (Symbol)		Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
CAMBRIAN (Lower)	Chilhowee Group	Antietam Formation (Cca)	**Cca** is locally olive gray, medium- to coarse-grained silty metasandstone and quartzite with very fine-grained, silty layers present. Some layers are ferruginous (iron-bearing) and micaceous (contain flashy, platy minerals).	**Ancient Bedrock**—**Cca** contains a coarsening-upward sequence, bioturbated beds, and cross-bedding sedimentary features. **Cch** contains upward-coarsening sequences and wavy lamination sedimentary features. **Ccw** contains upward-coarsening sequences, wavy laminations, and cross-bedding sedimentary features. **Blue Ridge-South Mountain Anticlinorium and Regional Structures**—exposed on flanks of anticlinorium. **Bedrock Outcrop Habitats**—**Cca:** Central Appalachian acidic boulderfield. **Cch** and **Cchs**: Sweet-birch-chestnut oak talus woodland; Central Appalachian heath barren; Central Appalachian acidic boulderfield; Central Appalachian high-elevation boulderfield forest; and Central Appalachian xeric chestnut oak-Virginia pine woodland. **Paleontological Resources**—trace fossils, most prevalently the worm burrow, *Skolithos linearis*, occur in quartzite beds within **Cca**. Elsewhere **Cca** may contain other trace fossils and rare body fossils. trace fossils, most commonly the worm burrow, *Skolithos linearis*, occur in pure quartzite beds in the upper part of **Cch**. These are the oldest fossils in the park and the Mid-Atlantic Inventory and Monitoring Network. Metasiltstone and, locally, quartzite within **Ccw** is heavily bioturbated. **Cave and Karst Features**—Sinkholes developed in this unit. **Connections with Park Stories**—quartzite was used by American Indians for tools. Trace fossils are visible in some of the guardrails along Skyline Drive. Blocks of **Cca** were used in park infrastructure such as guardrails, retaining walls, building foundations, and fences. May have been used as flagstones in front of The Byrd's Nest. Dark quartzite at Blackrock is **Cch**. **Cch** is well-exposed along Big Run.	**Slope Movements**—erosion-resistant metasandstones and quartzites underlie local ridges and could be prone to rockfall and topple. **Bedrock Outcrop Management**—these units tend to form mixtures of isolated outcrops, ledges, and open talus fields. Examples of Rock Outcrop Management Project sites include Blackrock South District, Calvary Rocks-Chimney Rock, Rocky Mountain, Trayfoot Saddle boulderfields west, Trayfoot Saddle boulderfields east, and Brown Mountain. **Surface Water and Sediment Loading**—Chilhowee Group rocks with lesser pyroxene and feldspar minerals lack acid-neutralizing capabilities. Chilhowee Group (e.g., **Cchs** and **Ccw**) may locally contain high amounts of iron sulfide minerals that would increase the acidification of a stream or watershed, especially in areas that were disturbed by mining. **Disturbed Lands**—ferruginous (iron-bearing) rocks may have been targeted for iron mining. Manganese deposits from the contact between **Cca** and **Ct** were mined locally on the western slope of the Blue Ridge.	**Continued Opening of the Iapetus Ocean and Transition to a Passive Margin**—the Chilhowee Group is mostly restricted to the western slope of Blue Ridge, but locally occurs along Skyline Drive near the crest in the southern and northern parts of the park. It unconformably overlies the Catoctin Formation indicating a period of erosion following volcanism. The pure quartzite within **Cca** suggests a beach or bar depositional environment with occasional sea level fluctuations represented by silty layers. The trace fossils and sand- and silt-rich composition of these units suggest the depositional environment was a beach or nearshore marine setting. They reflect fluvial to shallow-marine transgressive and regressive environments as the tectonic setting shifted from rifting into a passive margin along the eastern side proto-North America (Laurentia) as the Iapetus Ocean basin continued to widen.
		Harpers Formation (Cch) Harpers Formation, ferruginous metasandstone (Cchs)	**Cch** is greenish to bluish gray phyllite and metasiltstone. The phyllite contains quartz, chlorite, and sericite as the definitive mineral constituents. Interlayered in the phyllite and metasiltstone are thin gray metasandstones, quartzite, and meta-arkose (a feldspar-rich sandstone). Locally, lower portions of **Cch** include green and brown metasiltstone and some metasandstones. In the northern areas of the park some coarse, pebbly metasandstones and metaconglomerate occur in the lower part beneath vitreous (glassy) quartzite and ferruginous, arkosic metasandstones. **Cchs** is maroon to dark blue to black, ferruginous (iron-bearing) metasandstones. It occurs only locally.			
		Weverton Formation (Ccw)	**Ccw** contains maroon and gray phyllite and discrete beds of pebbly quartzite interlayered with siltstone and metaconglomerate in the basal portions of the unit. In the southern part of the park, light tan to brown, pebbly and maroon, ferruginous metasandstones overlie the phyllite. In the northern part of the park, the metasiltstone is heavily bioturbated and blocky quartzite beds occur throughout beneath a cap of pebbly metasandstones and metaconglomerate. The coarse metasedimentary rocks exhibit cross-bedding sedimentary features.			

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Age	Map Unit (Symbol)		Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
NEOPROTEROZOIC ERA	Catoctin Formation	Metavolcanic phyllite (Zcp)	Phyllite is a metamorphic rock rich in flaky minerals—micas. **Zcp** is dark, multi-colored (gray, blue, reddish) phyllite exhibiting relict white to green elongated (deformed) vesicles and smeared blebs of sericite and chlorite. In outcrop the exposures appear mottled to lustrous.	**Ancient Bedrock**—the Catoctin Formation is an important widespread geologic unit in the area. It exhibits abundant relict igneous features including vesicles (bubbles), amygdules, flow patterns, ashfall, polygonal columnar cooling joints, and submarine pillows. Volcanic breccias mark the base of the individual flows. Where molten lava altered the surface of the basement rocks (contact metamorphism), the underlying rocks (sands and gneisses) were bleached and changed to unakite (containing pink potassium feldspar, quartz, and yellowish green epidote), which is the unofficial state stone of Virginia. Flows as much as 82 m (269 ft) thick locally flowed across the landscape filling valleys and covering adjacent hills. **Type Sections, Reference Locations, and Radiometric Ages**—**Zcr** yielded an age of approximately 569 million years ago. The Catoctin Formation is well-exposed throughout the park with particular study locations at Stony Man, North and South Marshall, Compton Peak, roadcuts along U.S. Interstate Route 64, Big Meadows, and the Hawksbill-Spitler Hill area. **Blue Ridge-South Mountain Anticlinorium and Regional Structures**—exposed on flanks of anticlinorium. **Bedrock Outcrop Habitats**— Central Appalachian basic woodland; Central Appalachian acidic boulderfield; Central Appalachian mafic boulderfield; Central Appalachian circumneutral barren; sweet-birch-chestnut oak talus woodland; Central Appalachian high-elevation boulderfield forest; high-elevation outcrop barren; Central Appalachian mafic barren; high-elevation greenstone barren; and Central Appalachian xeric chestnut oak-Virginia pine woodland. **Zcm** caps some of the highest points of the park, including Hawksbill Mountain (peregrine falcon habitat). Weathering of the Catoctin Formation contributes to magnesium- and iron-rich soils. Chestnut oak and red oak are common on ridgetops and higher elevation locations underlain by Catoctin Formation greenstones. Greenstone typically forms cliffs and ledges with some open talus areas. **Connections with Park Stories**—greenstone was used by American Indians for tools.	**Slope Movements**—the Catoctin Formation features prominently in the upland areas of the park and is prone to rockfall and topple. **Bedrock Outcrop Management**—these units tend to form mixtures of outcrops of cliffs and ledges, and some open talus fields. Examples of Rock Outcrop Management Project sites include Bettys Rock, Big Devils Stairs, Blackrock Central District, Browntown Valley Overlook, Crescent Rock Overlook, Crescent Rock South, Dean Mountain Ridge, Dickey Hill, Dickey Ridge, Franklin Cliffs North, Franklin Cliffs South, Goat Ridge, Gooney Manor overlook, Halfmile Cliff, Hawksbill north slope outcrops, Hawksbill Summit, Hightop, Little Devils Stairs, Little Stony Man, Stony Man Summit, Loft Mountain Summit, North Marshall Summit, Overall Run Falls south, Overall Run Falls north, Pass Mountain, Sawlog Ridge, Stony Man north slope, South Marshall Cliff, Hawksbill North slope talus, Field Hollow Cliff, Bearfence Mountain, Rose River Cliffs, and Whiteoak Canyon. **Surface Water and Sediment Loading** —carbonate rocks (limestones) and the pyroxene and feldspar-rich (greenstones or altered basalts) Catoctin Formation neutralize acid precipitation. Some sedimentary units in the Catoctin Formation may also contain significant amounts of sulfides and contribute to increased acidification. **Disturbed Lands**—Ferruginous (iron-bearing) rocks may have been targeted for iron mining. Copper oxides, sulfides, and native copper occur sporadically in **Zcm**.	**Rifting of Rodinia and Opening of the Iapetus Ocean**—these units record an extensional, rifting event following the Neoproterozoic Grenville Orogeny that ultimately opened the Iapetus Ocean basin. It underlies most of the highlands of the Blue Ridge. Flows decrease in thickness and number toward the southwest, away from the feeder dikes.
		Metasandstone and laminated phyllite (Zcs)	**Zcs** includes light greenish gray, medium- to coarse-grained metasandstones and multi-colored, laminated quartz-muscovite (mica mineral) phyllite. **Zcs** only occurs locally in the southwestern park area for about 17 km (10 mi) .			
		Metarhyolite (Zcr)	Metarhyolite is a metamorphosed extrusive igneous rock similar in composition to a granite (silica rich). **Zcr** contains light gray to pinkish white, very fine-grained metarhyolite and tuff. The tuff layers contain feldspar crystals (phenocrysts) and cm-wide clots of white quartz crystals and pale green epidote. **Zcr** occurs near the base of the Catoctin Formation in the northeastern park area for only 5 km (8 mi) in a 10 m (33 ft) thick layer.			
		Metabasalt (Zcm)	Metabasalt is a metamorphosed extrusive igneous rock that is relatively poor in silica and flows easily. **Zcm** consists of light green to dark greenish gray to bluish gray, fine-grained to aphanitic (no discernible grains) metabasalt. Outcrops may appear massive to platy (schistose). The metabasalt includes remnant amygdules (mineral-filled bubbles). Major mineral constituents include actinolite, chlorite, epidote, albite, and some quartz. Locally contains lenses and layers of light green, fine-grained epidosite (primarily epidote and quartz), phyllite, and metasandstones.			
	Metadiabase dikes (Zmd)		Metadiabase is a metamorphosed intrusive igneous rock with a relatively low silica content whose original primary mineral constituents were labradorite and pyroxene. **Zmd** is dark greenish gray, fine- to medium-grained metadiabase that may appear massive or schistose in outcrop. The primary mineral constituents are chlorite, albite, epidote, and actinolite. Coarse-grained exposures have large (nearly 1 cm [0.5 in.]) actinolite crystals that formed as pseudomorphs after clinopyroxene. Relict plagioclase crystals occur within the finer grained (aphanitic) exposures. Dikes change in composition toward the northeastern part of the park becoming more amphibole rich and porphyritic (having large crystals in a finer-grained matrix). Similar in composition to **Zcm**.	**Ancient Bedrock**—**Zmd** were likely the feeder dikes for the Catoctin Formation. **Type Sections, Reference Locations, and Radiometric Ages**—**Zmd** is aged dated at 567±4 and 555±4 million years ago. **Zmd** is well-exposed along Skyline Drive at northeast of Mount Marshall, north tunnel portal at Marys Rock, and north of Stony Man.	**Bedrock Outcrop Management**—dikes tend to form linear chutes (often used as trails, staircases) within older granites and gneisses.	**Rifting of Rodinia and Opening of the Iapetus Ocean**—these units record an extensional, rifting event following the Neoproterozoic Grenville Orogeny. **Zmd** intruded the Mesoproterozoic gneisses (**Ybg** through **Ylg**), Neoproterozoic Robertson River Igneous Suite (**Zra** through **Zrr**), and **Zmr** in the park area taking advantage of preexisting cracks and normal faults. **Zmd** was metamorphosed (foliated) during the Paleozoic.

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Age	Map Unit (Symbol)	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
NEOPROTEROZOIC ERA	Swift Run Formation (Zsr)	**Zsr** is highly variable with pink to gray, very coarse- to medium-grained metasandstones and quartzite with cross-bedding sedimentary structures. Pebbles and cobbles within **Zsr** include quartz phyllite and sandstone. Some areas of **Zsr** contain brownish green metagraywacke and lustrous, silvery schist (mica-rich rock), whereas other areas include multi-colored phyllite and dark gray slate. The slate exhibits fining upward sequences.	**Ancient Bedrock**—Similar to **Zmr** as sedimentary rock deposited atop the Mesoproterozoic rocks prior to the emplacement of the Catoctin Formation, **Zsr** occurs on the west limb and at the nose of the Blue Ridge anticlinorium. **Bedrock Outcrop Habitats**—Central Appalachian heath barren; Central Appalachian acidic boulderfield; sweet-birch- chestnut oak talus woodland; Central Appalachian high-elevation boulderfield forest; and Central Appalachian xeric chestnut oak-Virginia pine woodland. **Type Sections, Reference Locations, and Radiometric Ages**—The age of **Zsr** is poorly constrained, but likely older than 555±4 million years ago. The type locality for **Zsr** are exposures on U.S. Highway 33, just east of Swift Run Gap and on the Skyline Drive just north of the gap. **Blue Ridge-South Mountain Anticlinorium and Regional Structures**—exposed on flanks of anticlinorium. **Connections with Park Stories**—quartzite was used by American Indians for tools.	**Slope Movements**—erosion resistant quartzites and metasandstones underlie local ridges and could be prone to rockfall and topple. **Bedrock Outcrop Management**—this unit tends to form mixtures of isolated outcrops, ledges, and open talus fields. Examples of Rock Outcrop Management Project sites include Powell Gap Cliff.	**Rifting of Rodinia and Opening of the Iapetus Ocean**—rocks of **Zsr** are mostly fluvial (alluvial fan and floodplain) with minor lake (lacustrine) sediments. The uppermost sedimentary rocks of **Zsr** are largely interbedded with the volcanic rocks of the Catoctin Formation. Notable locations for this relationship occur: (1) northwest of Big Meadows; (2) along the West Branch of Naked Creek in Weaver Hollow; (3) East of Compton Gap; and (4) Sugar Hollow. **Zsr** was either deposited in isolated basins on a landscape of considerable topographic relief or the rocks experienced an erosional event prior to the deposition of the Catoctin Formation.
	Hornblende metagabbro dike and (or) sill (Zhg)	Dikes are igneous intrusions that cut across the fabric of the local bedrock whereas sills intruded parallel to preexisting bedrock fabrics. Metamorphosed gabbro is the result of heat and pressure changing a mafic (silica-poor), intrusive (extrusive equivalent is basalt) metaigneous rock. **Zhg** is greenish black, medium- to fine-grained, altered mafic (silica-poor) rock. The original mineral components include hornblende, plagioclase, epidote, and quartz. Locally, altered ultramafic rocks consisting of actinolite, epidote, chlorite, and magnetite occur beneath **Zhg** east of Graves Mill.	None reported.	None reported.	**Rifting of Rodinia and Opening of the Iapetus Ocean**—**Zhg** is likely older than **Zmd** and intrudes **Zmr**.
	Mechum River Formation (Zmr)	**Zmr** is subdivided into four distinctive units: (1) laminated metasiltstone, metamudstone, and minor arkosic (feldspar-rich) metawacke; (2) fine- to coarse-grained arkosic metasandstones and metawacke with minor metasiltstone and metaconglomerate interlayers; (3) arkosic metasandstones and metaconglomerate with relict cross-bedding sedimentary structures; and (4) laminated metasiltstone, metagraywacke, and arkosic metawacke also with cross-bedding.	**Ancient Bedrock**—**Zmr** contains graded and scoured beds representing subaqueous gravity-flow deposits (turbidites) as well as glaciomarine deposits in the form of boulder conglomerates. **Zmr** occurs in the middle part of the Blue Ridge anticlinorium. **Type Sections, Reference Locations, and Radiometric Ages**—**Zmr** is between 700 and 575 million years old. **Zmr** was named for exposures along the railroad cuts and banks of the Mechums River. The formation is a narrow band that extends for nearly 100 km (60 mi) northeast from near Batesville to near Ben Venue and U.S. Route 211. Metaconglomerates of **Zmr** are well-exposed on Bessie Bell Mountain.	**Slope Movements**—metasandstones and metaconglomerates may weather in blocks prone to falls and topples.	**Rifting of Rodinia and Opening of the Iapetus Ocean**—The boulders and cobbles of the conglomerates were derived mostly from Mesoproterozoic rocks with some from the Robertson River Igneous Suite. The boulder conglomerates are glaciomarine deposits from proglacial outwash fans. Much of the rest of the unit occurs from near Charlottesville to as far north as U.S. Route 33. The metawackes and arkosic rocks were deposited as submarine fans with some fluviodeltaic (nonmarine) input. **Zmr** was intruded by metadiabase dikes likely related to Catoctin Formation volcanism. **Zmr** may be part of a footwall syncline beneath a Paleozoic thrust fault that shoved older, Mesoproterozoic rocks above them.

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Age	Map Unit (Symbol)		Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
NEOPROTEROZOIC ERA	Robertson River Igneous Suite	Amissville Alkali Feldspar Granite (Zra)	Granite denotes a specific intrusive igneous rock composition characterized by relatively high silica contents, rich in quartz (10 to 50%) and alkali feldspars. **Zra** is gray, medium-grained alkali feldspar granite. The mineral components of **Zra** include mesoperthite (a feldspar), quartz, and larger, characteristic quartz crystals (phenocrysts).	**Ancient Bedrock**—small cavities within **Zra** contain protruding quartz crystals. Such "miarolitic" cavities may contain unusual minerals. **Type Sections, Reference Locations, and Radiometric Ages**—**Zra** yielded a uranium-lead radiometric age of 700 million years ago.	None reported.	**Failed Rifting**—the Robertson River Igneous Suite is a compound batholith that extends continuously for 110 km (66 mi) between Charlottesville and Markham. The entire suite intruded a fracture zone during crustal extension—analogous to a large dike. Rocks of the Robertson River Igneous Suite are similar to others in the Blue Ridge of southern Virginia and western North Carolina. **Zra** and **Zrbd** are roughly contemporaneous with igneous volcanism of units **Zrbr** and **Zrbf**. **Zrbr** crops out near Battle Mountain; the cobbles of rhyolite, Mesoproterozoic granitoids, and sedimentary rocks are isolated from and not contiguous with those of **Zmr**. The presence of conglomerate within **Zrbr** records a history of igneous activity (volcanism) intermittent with mass wasting and weathering. These two units are roughly contemporaneous with igneous intrusions **Zra** and **Zrbd**. **Zrbd** intruded Mesoproterozoic gneisses as well as granites of the Robertson River Igneous Suite. **Zra** and **Zrbd** are roughly contemporaneous with igneous volcanism of units **Zrbr** and **Zrbf**. **Zrqt** is the extrusive volcanic equivalent of **Zrc**. **Zrqt** occurs between older Mesoproterozoic rocks (**Yod** and **Yom**) and the Catoctin Formation. **Zrqt** is in turn intruded by metadiabase dikes associated with the Catoctin Formation.
		Battle Mountain Alkali Feldspar Granite (Zrb)	Similar to **Zra**, **Zrb** is gray, medium-grained alkali feldspar granite. Compositionally, **Zrb** is missing the distinctive quartz phenocrysts of **Zra**.	**Ancient Bedrock**—small cavities within **Zrb** contain protruding quartz crystals. Such "miarolitic" cavities may contain unusual minerals. **Type Sections, Reference Locations, and Radiometric Ages**—**Zrb** yielded a uranium-lead radiometric age of 705±2 million years ago.	None reported.	
		Rhyolite and metaconglomerate (Zrbr)	Rhyolite is an extrusive igneous rock similar in composition to a granite (silica rich). **Zrbr** consists of light gray, aphanitic (extremely fine-grained) felsic (silica-rich) metarhyolite formed during volcanic eruptions. Larger crystals (phenocrysts) within **Zrbr** include fluorite and feldspar. Interlayered with the metarhyolite are metaconglomerates including pebbles of metarhyolite and conglomerate of granite boulders.	**Type Sections, Reference Locations, and Radiometric Ages**—the rocks of the Robertson River Igneous Suite are well-exposed along the Robinson River and along Mill Run just south of Laurel Mills, Hitt Mountain, Battle Mountain, and the north side of U.S. Route 211 northwest of Amissville.	None reported.	
		Felsite (Zrbf)	Felsite is similar to rhyolite, almost entirely composed of quartz and feldspar (silica-rich). Similar to **Zrbr**, **Zrbf** consists of light gray, aphanitic (extremely fine-grained) (silica-rich) felsite formed during volcanic eruptions. Larger crystals (phenocrysts) within **Zrbf** include alkali feldspar (mesoperthite) and quartz.	**Ancient Bedrock**—small cavities within **Zrbf** contain protruding quartz crystals. Such "miarolitic" cavities may contain unusual minerals. **Zrbf** also contains lithophysae, which are hollow, bubble-like features exhibiting concentric shells of finely crystalline minerals. **Type Sections, Reference Locations, and Radiometric Ages**—**Zrbf** yielded a uranium-lead radiometric age of approximately 702 million years ago. **Zrbf** is well-exposed on the west side of Battle Mountain and along U.S. Route 522 near Boston.	None reported.	
		Felsic dikes (Zrbd)	Dikes are igneous intrusions that cut across the fabric of the local bedrock. **Zrbd** consists of light gray, aphanitic (very fine-grained), felsic dikes.	None reported.	None reported.	

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Age	Map Unit (Symbol)		Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
NEOPROTEROZOIC ERA	Robertson River Igneous Suite	Hitt Mountain Alkali Feldspar Syenite (Zrh)	Syenite is similar to granite (see **Zra**), but with less quartz and a variety of feldpsars—alkali feldspar and minor plagioclase. **Zrh** is gray, coarse-grained alkali feldspar syenite. Primarily the unit is equigranular (crystals are roughly the same size) composed of microcline (mesoperthite), quartz, plagioclase, hastingsite, and scant garnets. Locally, the unit is pegmatitic (very coarse-grained).	**Type Sections, Reference Locations, and Radiometric Ages**—**Zrh** yielded an age of 706±2 million years ago.	None reported.	**Failed Rifting**—the Robertson River Igneous Suite is a compound batholith that extends continuously for 110 km (66 mi) between Charlottesville and Markham. The entire suite intruded a fracture zone during crustal extension—analogous to a large dike. Rocks of the Robertson River Igneous Suite are similar to others in the Blue Ridge of southern Virginia and western North Carolina. **Zra** and **Zrbd** are roughly contemporaneous with igneous volcanism of units **Zrbr** and **Zrbf**. **Zrbr** crops out near Battle Mountain; the cobbles of rhyolite, Mesoproterozoic granitoids, and sedimentary rocks are isolated from and not contiguous with those of **Zmr**. The presence of conglomerate within **Zrbr** records a history of igneous activity (volcanism) intermittent with mass wasting and weathering. These two units are roughly contemporaneous with igneous intrusions **Zra** and **Zrbd**. **Zrbd** intruded Mesoproterozoic gneisses as well as granites of the Robertson River Igneous Suite. **Zra** and **Zrbd** are roughly contemporaneous with igneous volcanism of units **Zrbr** and **Zrbf**. **Zrqt** is the extrusive volcanic equivalent of **Zrc**. **Zrqt** occurs between older Mesoproterozoic rocks (**Yod** and **Yom**) and the Catoctin Formation. **Zrqt** is in turn intruded by metadiabase dikes associated with the Catoctin Formation.
		Quartz trachyte (Zrqt)	Trachyte is the extrusive volcanic equivalent of syenite (see **Zrh**) with alkali feldspar and some dark minerals (biotite, amphibole, or pyroxene) as the primary mineral constituents.**Zrqt** consists of dusky red to gray, aphanitic (extremely fine-grained) to fine-grained quartz trachyte. Mineral constituents include mesoperthite and quartz. Larger crystals (phenocrysts) of light gray mesoperthite occur. **Zrqt** only occurs southeast of Jenkins Gap in the park area.	**Type Sections, Reference Locations, and Radiometric Ages**—**Zrqt** was uranium-lead age dated at 719±6 to 714±5 million years ago.	None reported.	
		Cobbler Mountain Alkali Feldspar Quartz Syenite (Zrc)	**Zrc** is gray, medium-grained alkali feldspar quartz syenite. The unit has conspicuous stubby, 2 to 4 mm (0.1 to 0.2 in.) diameter, well-formed mesoperthite crystals intergrown with poorly formed quartz grains.	**Type Sections, Reference Locations, and Radiometric Ages**—**Zrc** yielded an age of 722±3 million years ago. **Zrc** crops out in the northeast part of the park area northeast of Cresthill and along Interstate Route 66 on Little Cobbler Mountain, east of the map area.	None reported.	
		White Oak Alkali Feldspar Granite (Zrw)	**Zrw** consists of gray, coarse-grained, alkali feldspar granite. The crystals are not the same size throughout the unit. The primary mineral constituents are mesoperthite (microcline, a feldspar), quartz, and hastingsite.	**Type Sections, Reference Locations, and Radiometric Ages**—**Zrw** yielded a uranium-lead radiometric age dated of 724±3 million years ago.	None reported.	
		Laurel Mills Granite (Zrl)	Similar to **Zrw**, **Zrl** contains gray, coarse-grained granite. The dominant mineral is alkali feldspar (microperthite, chiefly microcline). Other mineral constituents include characteristic pale blue quartz, hastingsite, biotite, magnetite, and titanite.	**Type Sections, Reference Locations, and Radiometric Ages**—**Zrl** yielded a uranium-lead radiometric age of 729±1 million years ago.	None reported.	

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Age	Map Unit (Symbol)		Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
NEOPROTEROZOIC ERA	Robertson River Igneous Suite	Arrington Mountain Alkali Feldspar Granite (Zram)	Similar to **Zrw** and **Zrl**, **Zram** consists of gray, medium-grained alkali feldspar granite. The texture of **Zram** is roughly equigranular; most of the visible crystals are of a similar size. Primary mineral components include mesoperthite, quartz, hastingsite, biotite, fluorite, and scant garnet and muscovite.	**Type Sections, Reference Locations, and Radiometric Ages**—**Zram** yielded a uranium-lead radiometric age of 730±4 million years ago.	None reported.	**Failed Rifting**—the Robertson River Igneous Suite is a compound batholith that extends continuously for 110 km (66 mi) between Charlottesville and Markham. The entire suite intruded a fracture zone during crustal extension—analogous to a large dike. Rocks of the Robertson River Igneous Suite are similar to others in the Blue Ridge of southern Virginia and western North Carolina. **Zra** and **Zrbd** are roughly contemporaneous with igneous volcanism of units **Zrbr** and **Zrbf**. **Zrbr** crops out near Battle Mountain; the cobbles of rhyolite, Mesoproterozoic granitoids, and sedimentary rocks are isolated from and not contiguous with those of **Zmr**. The presence of conglomerate within **Zrbr** records a history of igneous activity (volcanism) intermittent with mass wasting and weathering. These two units are roughly contemporaneous with igneous intrusions **Zra** and **Zrbd**. **Zrbd** intruded Mesoproterozoic gneisses as well as granites of the Robertson River Igneous Suite. **Zra** and **Zrbd** are roughly contemporaneous with igneous volcanism of units **Zrbr** and **Zrbf**. **Zrqt** is the extrusive volcanic equivalent of **Zrc**. **Zrqt** occurs between older Mesoproterozoic rocks (**Yod** and **Yom**) and the Catoctin Formation. **Zrqt** is in turn intruded by metadiabase dikes associated with the Catoctin Formation.
		Rivanna Granite (Zrr)	**Zrr** is white, medium-grained granite with quartz, plagioclase, alkali feldspar (microcline), biotite, fluorite, and scant muscovite mineral constituents. The texture is largely equigranular.	**Ancient Bedrock**—small cavities within **Zrr** contain protruding quartz and pyrite crystals. Such "miarolitic" cavities may contain unusual minerals. **Type Sections, Reference Locations, and Radiometric Ages**—**Zrr** yielded an age of 735±4 million years ago.	None reported.	
	Garnet-graphite paragneiss (Zp)		The word gneiss refers to a metamorphic rock in which the minerals segregated into bands of alternating composition—commonly marked by bands of flaky or elongate minerals. The prefix para- refers to a metamorphic rock of sedimentary origin. **Zp** consists of rusty brown, medium- to fine-grained, graphite-garnet-biotite-plagioclase-quartz gneiss. The gneiss has a layered appearance due to compositionally different bands formed in the rock during metamorphism. Some bands are garnetiferous (contain abundant garnets), others are quartzofeldspathic (quartz and feldspar), and some contain only quartz. Coarse-grained pegmatites locally cut exposures of **Zp**. Some portions of **Zp** are changed (retrograde metamorphism) to chlorite schist.	**Ancient Bedrock**—**Zp** has almandine garnets as much as 1 cm (0.4 in.) in diameter occurring as aggregates whereas graphite occurs as disseminated flakes. **Type Sections, Reference Locations, and Radiometric Ages**—**Zp** yielded a uranium-lead radiometric age of less than 812 million years ago. **Zp** is well-exposed along Buck Mountain Creek, Lickinghole Creek, and Garth Run.	None reported.	**Neoproterozoic Era**—**Zp** displays conspicuous deformation fabrics (schistosity) that records conditions during Paleozoic mountain-building events. **Zp** occurs in isolated bodies surrounded by Mesoproterozoic rocks. Geochemistry suggests the parent material for **Zp** were impure sandstone or greywacke. **Zp** may represent the erosional remnants of the missing rock record between the emplacement of **Ybg** (1,028 million years ago) and the intrusion of the Robertson River Igneous Suite ("Zr" units) 730 million years ago.
MESOPROTEROZOIC ERA	Biotite monzogranite-quartz monzodiorite (Ybg)		Monzogranite is a variety of granite (see**Zra**) wherein the plagioclase and alkali feldspar contributions to composition are roughly equal. Monzodiorite is a dark rock that contains more alkali feldspar (sodic plagioclase) than diorite (an igneous rock with moderate silica content).**Ybg** is very dark gray, medium- to coarse-grained biotite monzogranite and quartz monzodiorite. The grain sizes of the various mineral constituents are not equal and the unit has very little if any planar or banded fabrics (foliation). Biotite content can reach 25%.	**Ancient Bedrock**—these rocks are some of the oldest and most complex (structurally and lithologically) in eastern North America. **Type Sections, Reference Locations, and Radiometric Ages**—**Ybg** yielded a uranium-lead radiometric age of 1,040±9 to 1,028±9 million years ago. The reference locality is on the west side of a parsonage driveway along Virginia Route 670 in Criglersville.	None reported.	**Grenville Orogeny and the Supercontinent Rodinia**—**Ybg** is the youngest rock mapped in the Mesoproterozoic Blue Ridge suite of Virginia.

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Age	Map Unit (Symbol)	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
MESOPROTEROZOIC ERA	Orthopyroxene monzogranite-quartz monzodiorite (Yom)	**Yom** is dark green to black, medium- to coarse-grained orthopyroxene monzogranite and quartz monzodiorite. The monzogranite is rich in amphibole, orthopyroxene, and clinopyroxene minerals in unequal grain sizes. In outcrop, the unit appears massive without distinct banding (foliation).	**Ancient Bedrock**—these rocks are some of the oldest and most complex (structurally and lithologically) in eastern North America. **Bedrock Outcrop Habitats**—Central Appalachian basic woodland; Central Appalachian heath barren; sweet-birch-chestnut oak talus woodland; Central Appalachian high-elevation boulderfield forest; high-elevation outcrop barren; Central Appalachian mafic barren; and Central Appalachian xeric chestnut oak-Virginia pine woodland. **Type Sections, Reference Locations, and Radiometric Ages**—**Yom** yielded a uranium-lead radiometric age of 1,050±8 to 1,044±6 million years ago. The reference locality is on the east side of Bluff Mountain, approximately 3 km (2 mi) northwest of Graves Mill. **Blue Ridge-South Mountain Anticlinorium and Regional Structures**—exposed in core of anticlinorium.	**Bedrock Outcrop Management**—this unit tends to form mixtures of flat or rounded outcrops and barrens. Examples of Rock Outcrop Management Project sites include Millers Head, Nakedtop, and Upper Devils Ditch.	**Grenville Orogeny and the Supercontinent Rodinia**—**Yom** occurs as both a massive pluton and discrete dikes in the Swift Run Gap area to north of Skyland. Intrusive relationships yield relative timing of geologic events.
	Megacrystic quartz monzonite (Ybp)	Monzonite contains even more alkali feldspar than monzodiorite (see **Ygb**).**Ybp** contains light to medium gray, medium-grained quartz monzonite. In places this unit has very large crystals and some weak banding texture (foliation). Characteristic of **Ybp**, are large crystals (porphyroblasts) of pink microcline (alkali feldspar).	**Ancient Bedrock**—these rocks are some of the oldest and most complex (structurally and lithologically) in eastern North America. **Type Sections, Reference Locations, and Radiometric Ages**—**Ybp** yielded an age of 1,049±6 million years ago. **Ybp** is well-exposed in the extreme northeast part of the map area.	None reported.	**Grenville Orogeny and the Supercontinent Rodinia**—**Ybp** intruded **Yfh** and was in turn intruded by **Zrc** of the Robertson River Igneous Suite.
	Megacrystic biotite monzogranite (Ybm)	**Ybm** consists of light to medium gray, very coarse-grained, biotite monzogranite. Major mineral constituents include biotite and blue quartz. Outcrop exposures show weak to moderate banding textures (foliation). In places, dikes of pegmatite and biotite monzogranite intrude **Ybm**. Compositionally similar, those rocks are likely from the same magma source as **Ybm**.	**Ancient Bedrock**—these rocks are some of the oldest and most complex (structurally and lithologically) in eastern North America. **Type Sections, Reference Locations, and Radiometric Ages**—**Ybm** yielded a uranium-lead radiometric age dated of 1,057±8 to 1,057±7 million years ago. **Ybm** underlies a broad area from Etlan north to Sperryville and is well-exposed along the Covington River west of Rock Mills. **Blue Ridge-South Mountain Anticlinorium and Regional Structures**—exposed in core of anticlinorium.	**Bedrock Outcrop Management**—this unit tends to form mixtures of flat or rounded outcrops and barrens.	**Grenville Orogeny and the Supercontinent Rodinia**—**Ybm** forms part of the foundation of the Appalachian Mountains as an igneous intrusion.
	Crozet Granite (Ycg)	**Ycg** is light gray, very coarse-grained, biotite- and clinopyroxene-bearing monzogranite. Large megacrysts of euhedral (well-formed crystal faces) feldspar and anhedral (poorly-formed crystal faces) quartz may reach up to 10 cm (4 in.) in length. In places the unit appears massive, whereas elsewhere it may be nonfoliated to moderately foliated (banded). This type of texture formed during deformation. Undeformed pegmatite dikes intrude **Ycg**.	**Ancient Bedrock**—these rocks are some of the oldest and most complex (structurally and lithologically) in eastern North America. **Type Sections, Reference Locations, and Radiometric Ages**—**Ycg** yielded a uranium-lead radiometric age of 1,0460±7 million years ago. The reference locality for **Ycg** is along the Moormans River downstream of the dam at the Charlottesville Reservoir in Sugar Hollow. **Blue Ridge-South Mountain Anticlinorium and Regional Structures**—exposed in core of anticlinorium.	**Bedrock Outcrop Management**—this unit tends to form mixtures of flat or rounded outcrops and barrens.	**Grenville Orogeny and the Supercontinent Rodinia**—this unit records three geologic events: (1) major igneous intrusions; (2) deformation of the Crozet Granite; and (3) renewed igneous activity as pegmatite dikes intrude.

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Age	Map Unit (Symbol)	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
MESOPROTEROZOIC ERA	Old Rag Granite (Yor)	A leucogranite is a granite (see **Zra**) generally lacking in dark, mafic (silica poor) minerals, whereas a syenogranite is a granite with more alkali feldspar than plagioclase in composition. **Yor** consists of white to light gray, medium- to coarse-grained leucogranite and syenogranite. The leucogranite contains some biotite, orthopyroxene, and garnet. The syenogranite also contains garnets. Both granites contain gray and blue quartz grains. Grain sizes are not equal. **Yor** appears massive in outcrop with some areas of weak foliation (banding) evident.	**Ancient Bedrock**—these rocks are some of the oldest and most complex (structurally and lithologically) in eastern North America. **Bedrock Outcrop Habitats**—Central Appalachian basic woodland; Central Appalachian heath barren; sweet-birch-chestnut oak talus woodland; Central Appalachian high-elevation boulderfield forest; high-elevation outcrop barren; Central Appalachian mafic barren; and Central Appalachian xeric chestnut oak-Virginia pine woodland. **Type Sections, Reference Locations, and Radiometric Ages**—**Yor** yielded a uranium-lead radiometric age of 1,063±8 to 1,060±5 million years ago. **Yor** extends from Whiteoak Canyon north to near Front Royal. The reference locality is along the lower slope of Buck Mountain above the north bank of Gooney Run. Old Rag Mountain is another reference locality for the more leucogranitic component of this unit. **Blue Ridge-South Mountain Anticlinorium and Regional Structures**—exposed in core of anticlinorium. **Connections with Park Stories**—**Yor** was used in the construction of The Byrd's Nest.	**Bedrock Outcrop Management**—this unit tends to form mixtures of flat or rounded outcrops and barrens. Examples of Rock Outcrop Management Project sites include Old Rag southside, Old Rag summit east, Old Rag summit west, Oventop, and Whiteoak Canyon. **Disturbed Lands**—Copper mining prospects occur in **Yor**.	**Grenville Orogeny and the Supercontinent Rodinia**—Old Rag Granite and the Pedlar Formation were the two primary units previously recognized as the bulk of Mesoproterozoic rocks exposed within the park until more detailed mapping.
	Porphyroclastic metagranitoid (Yml)	**Yml** is light gray, very coarse-grained, alkali-feldspar granite. **Yml** is strongly foliated (banded in outcrop) and contains abundant biotite that in part aligns to form the banded texture.	**Ancient Bedrock**—these rocks are some of the oldest and most complex (structurally and lithologically) in eastern North America. **Type Sections, Reference Locations, and Radiometric Ages**—**Yml** yielded a uranium-lead radiometric age dated of 1,078±9 million years ago. Unit is well-exposed along the east bank of the Conway River, 1.5 km (0.9 mi) north of Fletcher.	None reported.	**Grenville Orogeny and the Supercontinent Rodinia**—**Yml** occurs as a large xenolith within **Yom** indicating a relative timing of emplacement (**Yml** predates **Yom**).
	Orthopyroxene granite-monzogranite (Yog)	**Yog** includes dark gray, medium- to coarse-grained, orthopyroxene granite-monzogranite. Major mineral constituents include orthopyroxene, biotite, and garnet. The grain sizes amongst the major minerals are similar. In outcrop the unit is weakly to strongly foliated.	**Ancient Bedrock**—these rocks are some of the oldest and most complex (structurally and lithologically) in eastern North America. **Blue Ridge-South Mountain Anticlinorium and Regional Structures**—exposed in core of anticlinorium. **Type Sections, Reference Locations, and Radiometric Ages**—**Yog** yielded a uranium-lead radiometric age of 1,120±12 to 1,111±16 million years ago. **Yog** underlies rugged, northwest slopes of Stony Man and Skyland. The reference locality is on the east side of The Peak, northwest of the county road between Washington and Flint Hill.	**Bedrock Outcrop Management**—this unit tends to form mixtures of flat or rounded outcrops and barrens.	**Grenville Orogeny and the Supercontinent Rodinia**—xenoliths of **Yog** occur within **Yomg** indicating a relative timing of emplacement (**Yog** predates **Yomg**).

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Age	Map Unit (Symbol)	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
MESOPROTEROZOIC ERA	Flint Hill Gneiss (Yfh)	**Yfh** is dark to medium gray, medium-grained, quartzofeldspathic (contains quartz and feldspar) syenogranite to monzogranite forming compositional layers separated by biotite flakes. **Yfh** contains distinctive gray and blue quartz grains and veins of blue quartz.	**Ancient Bedrock**—these rocks are some of the oldest and most complex (structurally and lithologically) in eastern North America. **Type Sections, Reference Locations, and Radiometric Ages**—**Yfh** yielded a uranium-lead radiometric age of dated at 1,444±8 million years ago. This unit also contains partially melted, in situ zones (migmatites) indicative of extreme heating during metamorphism. The reference locality for **Yfh** is a collection of roadcuts along U.S. Route 522, approximately 0.9 km (0.6 mi) south of Flint Hill.	None reported.	**Grenville Orogeny and the Supercontinent Rodinia**—gneisses record deformation and metamorphic conditions during crustal compression as part of the construction of geologic foundation of the Appalachian Mountains.
	Lineated leucogranite gneiss (Yll)	**Yll** consists of light gray to tan, medium- to coarse-grained, leucogranite gneiss. In outcrop the unit is strongly banded (foliated) and lineated with lineations defined by aligned biotite flakes. This yields a distinctive stripped appearance.	**Ancient Bedrock**—these rocks are some of the oldest and most complex (structurally and lithologically) in eastern North America. **Type Sections, Reference Locations, and Radiometric Ages**—**Yll** yielded a uranium-lead radiometric age of 1,150±23 million years ago. **Yll** is well-exposed on the south side of Roundtop, along Skyline Drive, about 0.5 km (0.3 mi) east of Powell Gap. **Blue Ridge-South Mountain Anticlinorium and Regional Structures**—exposed in core of anticlinorium.	**Bedrock Outcrop Management**—this unit tends to form mixtures of flat or rounded outcrops and barrens.	
	Orthopyroxene monzogranite-quartz monzodiorte gneiss (Yomg)	**Yomg** contains greenish gray to black, orthopyroxene monzogranite and quartz monzodiorite gneiss. The monzogranite bears orthopyroxene, clinopyroxene, and biotite. Weathered outcrops of **Yomg** are rusty colored and show ribbed surfaces due to differential weathering of the compositional layering.	**Ancient Bedrock**—these rocks are some of the oldest and most complex (structurally and lithologically) in eastern North America. **Type Sections, Reference Locations, and Radiometric Ages**—**Yomg** yielded a uranium-lead radiometric age of 1,158±13 million years ago. **Yomg** is a compound unit occurring in the southern part of the park with exposures along the south side of Virginia State Route 810 north of Nortonsville, or along Virginia State Route 674 north of the Moormans River.	None reported.	
	Megacrystic orthopyroxene syenogranite-monzogranite gneiss (Yos)	**Yos** consists of dark gray to dark greenish gray, very coarse–grained, megacrystic (large crystals) orthopyroxene syenogranite-monzogranite gneiss. **Yos** contains orthopyroxene, amphibole, and clinopyroxene. The unit appears strongly banded (foliated). Alkali feldspar crystals may reach up to 12 cm (5 in.) in length.	**Ancient Bedrock**—these rocks are some of the oldest and most complex (structurally and lithologically) in eastern North America. **Bedrock Outcrop Habitats**—Central Appalachian basic woodland, Central Appalachian heath barren, sweet-birch-chestnut oak talus woodland, Central Appalachian high-elevation boulderfield forest, high-elevation outcrop barren, Central Appalachian mafic barren, Central Appalachian xeric chestnut oak-Virginia pine woodland. **Type Sections, Reference Locations, and Radiometric Ages**—**Yos** yielded a uranium-lead radiometric age of 1,166±14 to 1,159±14 million years ago. Reference localities include highland areas from near Stony Man north to near Pignut Mountain, on Slaughter Mountain, and the south portal of the tunnel at Marys Rock south of Thornton Gap. **Blue Ridge-South Mountain Anticlinorium and Regional Structures**—exposed in core of anticlinorium.	**Bedrock Outcrop Management**—this unit tends to form mixtures of flat or rounded outcrops and barrens. Examples of Rock Outcrop Management Project sites include Hogback Mountain spur, Marys Rock, Pinnacles **Disturbed Lands**—copper mining prospects occur in **Yos**.	**Grenville Orogeny and the Supercontinent Rodinia**—**Yos** is a compound unit which occurs as xenoliths in **Ybm** and **Yor**. This indicates it is older than both of those units.

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Age	Map Unit (Symbol)	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
MESOPROTEROZOIC ERA	Granodiorite gneiss (Ygd)	A granodiorite is an intrusive igneous rock with an intermediate composition between a quartz diorite (see **Ybg**) and a quartz monzonite (see **Ybp**).**Ygd** is light gray, granodiorite gneiss. The unit is strongly banded (foliated) with characteristic compositional layering. Lineations defined by aligned biotite flakes and clots of biotite are distinctive for this unit.	**Ancient Bedrock**—these rocks are some of the oldest and most complex (structurally and lithologically) in eastern North America. **Type Sections, Reference Locations, and Radiometric Ages**—**Ygd** yielded a uranium-lead radiometric age of 1,161±9 million years ago. The reference locality for **Ygd** is on the southwest side of Turkey Mountain north of Fletcher Mill.	None reported.	None reported.
	Orthopyroxene quartz diorite gneiss (Yoq)	**Yoq** is greenish gray to black, medium-grained, quartz diorite-gneiss. Primary mineral constituents include orthopyroxene, biotite, garnet, and quartz. **Yoq** is strongly compositionally layered and banded (foliated) in outcrop.	**Ancient Bedrock**—these rocks are some of the oldest and most complex (structurally and lithologically) in eastern North America. **Type Sections, Reference Locations, and Radiometric Ages**—**Yoq** yielded a uranium-lead radiometric age of 1,161±10 million years ago. The reference locality is along the east side of Virginia State Route 649, approximately 1.5 km (1 mi) north of Boyd's Mill.	None reported.	**Grenville Orogeny and the Supercontinent Rodinia**—**Yoq** occurs as a large xenolith within **Yor** indicating it predates Old Rag Granite intrusive event. Geochemical tests suggest this unit originated from a melt with a significant island-arc component.
	Orthopyroxene syenogranite and monzogranite gneiss (Yon)	Similar to **Yos**, **Yon** consists of gray, medium- to coarse-grained, orthopyroxene syenogranite and monzogranite gneiss. Primary mineral constituents include orthopyroxene, biotite, garnet, and clinopyroxene. **Yon** displays compositional layering and strong foliation (banded appearance). Some layers are garnetiferous.	**Ancient Bedrock**—these rocks are some of the oldest and most complex (structurally and lithologically) in eastern North America. **Type Sections, Reference Locations, and Radiometric Ages**—**Yon** yielded a uranium-lead radiometric age of 1,164±8 million years ago. The reference locality for **Yon** is Skinners Ridge, opposite the Buck Hollow Overlook, just 2 km (1 mi) southeast of Thornton Gap. **Blue Ridge-South Mountain Anticlinorium and Regional Structures**—exposed in core of anticlinorium.	**Bedrock Outcrop Management**—this unit tends to form mixtures of flat or rounded outcrops and barrens.	**Grenville Orogeny and the Supercontinent Rodinia**—gneisses record deformation and metamorphic conditions during crustal compression, often accompanied by igneous pluton intrusions as part of the construction of geologic foundation of the Appalachian Mountains
	Orthopyroxene granodiorte gneiss (Yod)	**Yod** is dark gray, medium- to coarse-grained, granodiorite gneiss. The unit is strongly foliated with compositional layering. Mineral constituents include amphibole and orthopyroxene. Some layers of leucocratic composition also present locally, transposed.	**Ancient Bedrock**—these rocks are some of the oldest and most complex (structurally and lithologically) in eastern North America. **Bedrock Outcrop Habitats**—Central Appalachian basic woodland; Central Appalachian heath barren; sweet-birch-chestnut oak talus woodland; Central Appalachian high-elevation boulderfield forest; high-elevation outcrop barren; Central Appalachian mafic barren; and Central Appalachian xeric chestnut oak-Virginia pine woodland. **Type Sections, Reference Locations, and Radiometric Ages**—**Yod** yielded a uranium-lead radiometric age of 1,165±7 million years ago. **Yod** occurs only in the northern end of the park with diagnostic roadcut exposures along Skyline Drive on the south side of Carson Mountain between Lands Run Gap and Compton Gap. **Blue Ridge-South Mountain Anticlinorium and Regional Structures**—exposed in core of anticlinorium.	**Bedrock Outcrop Management**—this unit tends to form mixtures of flat or rounded outcrops and barrens. Examples of Rock Outcrop Management Project sites include Gooney Manor Overlook.	

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Age	Map Unit (Symbol)	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
MESOPROTEROZOIC ERA	Foliated, garnetiferous, porphyroblastic monzogranite (Ypg)	**Ypg** consists of medium gray, medium- to coarse-grained, monzogranite. The major mineral constituents are biotite, garnet, microcline, and blue quartz. The microcline frequently occurs in megacrysts or crystal aggregates as much as 3 cm (1 in.) in diameter and the quartz displays distinctive clots within the rock.	**Ancient Bedrock**—these rocks are some of the oldest and most complex (structurally and lithologically) in eastern North America. **Type Sections, Reference Locations, and Radiometric Ages**—**Ypg** yielded an age of 1,172±8 million years ago. **Ypg** occurs in the eastern part of the park area, east of portions of the Robertson River Igneous Suite (**Zrr**) with a reference locality immediately east of the boundary between the Flint Hill and Jeffersonton 7.5-minute quadrangles.	None reported.	**Grenville Orogeny and the Supercontinent Rodinia**—gneisses record deformation and metamorphic conditions during crustal compression, often accompanied by igneous pluton intrusions as part of the construction of geologic foundation of the Appalachian Mountains
	Leucogranite gneiss (Ylg)	**Ylg** is light gray, coarse-grained to megacrystic (with very large crystals), leucogranite gneiss. The foliated (banded) texture is weakly to strongly expressed in outcrop. The rock composition varies between alkali-feldspar granite, syenogranite, and monzogranite. Dikes of leucogranite cut the main body of **Ylg**. These dikes are medium gray, medium-grained, and contain biotite. Their mineral constituents have similar grain sizes and in outcrop, the dikes are folded. Leucocratic pegmatites in turn intrude the main body of **Ylg** and the aforementioned dikes.	**Ancient Bedrock**—these rocks are some of the oldest and most complex (structurally and lithologically) in eastern North America. **Type Sections, Reference Locations, and Radiometric Ages**—**Ylg** yielded a uranium-lead radiometric age of 1,183±11 to 1,171±22 million years ago. The reference locality for **Ylg** is in Deep Hollow, west of Virginia State Route 651. **Blue Ridge-South Mountain Anticlinorium and Regional Structures**—exposed in core of anticlinorium.	**Bedrock Outcrop Management**—this unit tends to form mixtures of flat or rounded outcrops and barrens.	**Grenville Orogeny and the Supercontinent Rodinia**—**Ylg** records several igneous and deformational events: (1) intrusion of the main body of **Ylg**; (2) foliation of **Ylg** formed through deformation; (3) intrusion of leucogranite dikes; (4) isoclinal folds in the dikes formed through deformation of the entire body; and (5) intrusion of leucocratic pegmatites during renewed igneous activity.