U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science Directorate
Geologic Resources Division

Bluestone National Scenic River

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic Data for Bluestone National Scenic River

blue_geology.pdf

Version: 7/21/2015

Geologic Resources Inventory Map Document for Bluestone National Scenic River

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Geologic Resources Inventory Map Document

Bluestone National Scenic River, West Virginia

Document to Accompany Digital Geologic-GIS Data

blue_geology.pdf

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This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Bluestone National Scenic River, West Virginia (BLUE).

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 Search Application: http://irma.nps.gov/App/Reference/Search. To find GRI data for a specific park or parks select the appropriate park

(s), enter “GRI” as a Search Text term, and then select the Search Button.

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) Division.

GRI Digital Maps and Source Map Citations

The GRI digital geologic-GIS maps for Bluestone National Scenic River, West Virginia (BLUE):

Digital Bedrock Geologic Map of Bluestone National Scenic River and Vicinity, West Virginia (*GRI MapCode BLUE*)

Map produced from the following West Virginia Geological and Economic Survey source map,

Matchen, David L., Allen, Joseph L., Peck, Robert C., and Mercier, David (Digital Cartography and Map Compilation by Sarah E. Gooding and Paula J. Hunt), 2011, Bedrock Geologic Map of the Bluestone National Scenic River, Flat Top and Pipestem 7.5' Quadrangles, West Virginai: West Virginia Geological and Economic Survey, (Bedrock Geologic Map), Open-File Report 1101, scale 1: 24000. (*GRI Source Map ID 75598*).

Digital Surficial Geologic Map of Bluestone National Scenic River and Vicinity, West Virginia (*GRI MapCode BLUS*)

Map produced from the following West Virginia University and West Virginia Geological and Economic Survey source map,

Yates, Marla K and Kite, Stephen J. (Digital Cartography and Map Compilation by Gooding, Sarah E.), 2014, Surficial Geologic Map of the Bluestone National Scenic River Area, West Virginia: WVU and WVGES, (Surficial Geologic Map), Open File Map 1401, scale 1:12,000. (*GRI Source Map ID 76008*).

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

Digital Bedrock Geologic Map of Bluestone National Scenic River

Bedrock Map Unit List

The bedrock geologic units present in the digital bedrock geologic-GIS data produced for Bluestone National Scenic River, West Virginia (BLUE) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., PNnr - New River Formation, undifferentiated). Units are listed from youngest to oldest. Information about each geologic unit is also presented in the Bedrock Geologic Unit Information (BLUEUNIT) table included with the GRI geologic-GIS data.

Bedrock Geologic Map Units

Paleozoic

Pennsylvanian Period
Pottsville Group
Approximately 1000 feet (300 meters) of the lower Pottsville Group are exposed in the two-quadrangle area.
PNnr - New River Formation, undifferentiated
    PNnrfc - New River Formation, Fire Creek coal
    PNnrp9 - New River Formation, Pocahontas No. 9 Coal
PNp - Pocahontas Formation, undifferentiated
    PNpp6 - Pocahontas Formation, Pocahontas No. 6 Coal
    PNpp3 - Pocahontas Formation, Pocahontas No. 3 Coal

Mississippian Period
Mauch Chunk Group
The Upper Mississippian Mauch Chunk Group in southern West Virginia is subdivided into the Bluefield, Hinton, Princeton [Sandstone] and Bluefield Formations, with a maximum aggregate thickness of approximately 1,050 feet (320 meters), of which approximately 2,100 feet (635 meters) are exposed in the map area.
Mbs - Bluestone Formation, undifferentiated
Mbsuc - Bluestone Formation, unnamed conglomeratic sandstone
Mbsgf - Bluestone Formation, Glady Fork Sandstone Member
Mbspd - Bluestone Formation, Pride Shale Member
Mpn - Princeton Formation
Mhu - Upper Hinton Formation
Mhlsg - Hinton Formation, Little Stone Gap (Avis) Member
Mhl - Lower Hinton Formation
Mhsg - Hinton Formation, Stony Gap Sandstone Member
Mbf - Bluefield Formation
Mg - Greenbrier Group

Bedrock Map Unit Descriptions

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

PNnr - New River Formation, undifferentiated (Pennsylvanian)

360 ft (110 m), partial section
The youngest rocks occurring in the map area are assigned to the New River Formation, a coal-bearing sequence of quartzose and lithic sandstone, siltstone, shale, mudstone, coal, and siderite. Sandstones are mainly very fine- to fine-grained quartz arenites, commonly conglomeratic, and white with tan staining on weathered surfaces. Finer grained lithologies are shades of gray. Pebbles are predominantly quartz with lesser siderite and minor lithic fragments. Lithic sandstones contain varying amounts of metamorphic rock fragments, mica, and various heavy mineral grains. Heterolithic sequences of thinly interbedded or laminated sandstone, siltstone and shale layers often intergrade between lenticular and flaser bedding, occasionally with low-diversity trace fossil assemblages. Mudstones are internally massive, often arenaceous, and generally occur below coal beds (seatrocks) or are laterally correlative to absent coal beds. Siderite occurs as nodules and layers in marine-influenced mudrock sequences. Coal beds are generally thin and non-economic. A massive quartz arenite, the Pineville Sandstone Member, occurs in the map area but poor exposures precluded mapping the unit. Named coal beds include the Pocahontas 8 and 9 (PC9, PNnrp9 in NPS version), Little Fire Creek, Fire Creek (FCK, PNnrfc in NPS version), and Beckley. Due to poor exposures and the thin, discontinuous nature of these coal beds in the map area, only the Pocahontas No. 9 and Fire Creek coal bed outcrops are shown and are dotted on the map to indicate their inferred position. Plant fossils are common throughout the formation, ranging from well-preserved specimens to poorly-preserved comminuted plant debris draping beds. Lycopsid rootlets are abundant throughout. No invertebrate fossils were noted while mapping, although Henry and Gordon (1979) noted the uncommon occurrence of margin-marine bivalves from some levels, notably the roof shales of the Fire Creek coal bed. Only the lower 360 feet (110 meters) of the New River Formation are present in the map area; the upper part being removed by erosion. The formation's basal contact is arbitrarily placed at the base of the Pocahontas No. 8 coal bed (Englund, 1979). However, this coal has been removed by erosion in the map area; thus necessitating the placement of the basal formation contact at the base of the Pineville Sandstone Member. *GRI Source Map ID 75598* (Bedrock Geologic Map).

****Note: The following coal beds are mapped as linear features within the GRI GIS data for this park.*

PNnrfc - New River Formation, Fire Creek Coal (Pennsylvanian)

See above for lithologic descriptions.

PNnrp9 - New River Formation, Pocahontas No. 9 Coal (Pennsylvanian)

See above for lithologic descriptions.

PNp - Pocahontas Formation, undifferentiated (Pennsylvanian)

620 ft (190 m)
The Pocahontas Formation is a coal-bearing sequence of sandstone, siltstone, shale, mudstone, and siderite. Sandstones are mainly fine- to coarse-grained, micaceous, light gray, and trough-crossbedded lithic arenites. White-weathering feldspars have been noted (Englund, 1979). Sandstones often contain thin shale streaks, coal fragments, and ironstone (siderite, limonite, goethite) concretions. Siltstones and shales are light- to dark-gray, black, often arenaceous, carbonaceous in places, fissile, and platy. Mudstone and claystone occur mainly as medium gray seatrocks with carbonized lycopsid rootlets. Plant fossils are common throughout the formation. Non-marine bivalves have been reported from several beds in surrounding areas (Henry and Gordon, 1979; Englund and Randall, 1981; Meisner, 1981) but were not observed within the mapped area. Named coal beds include the Pocahontas Nos. 1, 2, 3, 4, 5, 6, and 7, but exposures are poor. The Pocahontas No. 6 (PC6, PNpp6 in NPS version) and Pocahontas No. 3 (PC3, PNpp3 in NPS version) coal beds are the most laterally continuous Pocahontas Formation

coals in the adjacent area and were the only coal beds included on the map. These coals are thinner and less continuous in the map area, and therefore, their outcrops were estimated from adjacent areas and are dotted on the map to show their inferred position. *GRI Source Map ID 75598* (Bedrock Geologic Map).

PNpp6 - Pocahontas Formation, Pocahontas No. 6 Coal (Pennsylvanian)

See above for lithologic descriptions.

PNpp3 - Pocahontas Formation, Pocahontas No. 3 Coal (Pennsylvanian)

See above for lithologic descriptions.

Mbs - Bluestone Formation, undifferentiated (Mississippian)

500 to 750 ft (150 to 230 m)
The Bluestone Formation is up to 750 feet (230 meters) thick in the map area and is notable due to its conspicuous red color. Mudstone, shale, siltstone, and sandstone are the main rock types with discontinuous beds of coalesced authigenic limestone and siderite nodules. A few thin, discontinuous, impure coal beds are present. Bluestone marine zones contain a typical Upper Mississippian (Chesterian) fauna of brachiopods, bryozoans, corals, bivalves, gastropods, ostracodes, trilobites, pelmatazoans and cephalopods (Reger, 1926; Cooper, 1948, 1961; Henry and Gordon, 1979, 1992; Hoare, 1993). The Bluestone is subdivided into the marine Pride Shale Member, the Glady Fork Sandstone Member, the informal gray and red members of Englund (1968), the marine Bramwell Member, and the informal upper member of Englund (1968). The Pride Shale and the Glady Fork Sandstone were the only continuous, recognizable Bluestone units mapped. A discontinuous conglomerate was mapped in the upper Bluestone and used as a marker bed. The informal upper member of Englund (1968) is not always present due to erosion associated with the mid-Carboniferous Eustatic Event (Beuthin and Neal, 1998; Blake and Beuthin, 2008).

The informal upper member of Englund (1968) overlies the Bramwell Member and contains the youngest Mississippian rocks in the Central Appalachian Basin. Where present, the upper member consists of stacked red, calcareous mudstones (vertisols), poorly-laminated grayish-green alluvial plain mudrocks, and thin sandstones. Organic-rich layers (possible O-horizons) cap some paleosols, but discontinuous coal zones are uncommon. White-gray claystones (gleysols) underlie organic-rich horizons (histosols, O horizons). Beuthin (1997) demonstrated that a 3 feet (9 meter) thick, well-developed complex of stacked paleovertisols, the Green Valley Paleosol Complex (GVPC), represented soil formation on a Late Mississippian and Early Pennsylvanian landscape. The upper member contains the stratigraphically highest red beds in the study area. Well-exposed sections are uncommon due to erosion during the mid-Carboniferous eustatic event and modern weathering of incompetent, clay-rich strata. The upper member is unconformably overlain by the Lower Pennsylvanian Pocahontas Formation (Blake and Beuthin, 2008).

The Bramwell Member is a coarsening-upward unit consisting of green to gray shale, calcareous siltstone, and ripple-bedded sandstone. Bioturbation is common but beds are rarely homogenized. The Bramwell attains a maximum thickness of approximately 11 feet (35 meters) and depositionally thins to the north and west (Beuthin, 1997). Black, carbonaceous shale containing ostracodes and Lingula occurs at the base of the member and is exposed along Interstate 77. This suggests deepening during a gradual transgression. The Bramwell contains a diverse shelly fauna that is often concentrated as pavements. The fauna is dominated by brachiopods and bivalves, but bryozoans, crinoids, blastoids, bivalves, trilobites, cephalopods and corals have been noted (Beuthin, 1997), although exposures in the study area are less fossiliferous. The Bramwell is poorly exposed within the map area, but has been

identified in surrounding areas.

A lenticular unnamed conglomeratic sandstone (Mbsuc) 0 to 100 feet (0 to 30 meters) thick caps ridges in the eastern portion of the Flat Top quadrangle. This medium- to coarse-grained sandstone may be confused with the overlying Pennsylvanian sandstones. Angular to subangluar pebbles 1 inch (2.5 centimeters) in diameter occur in a basal lag up to 2 feet (0.6 meter) thick. The sandstone is crossbedded but may appear massive on weathered surfaces. Ironstone clasts weather out leaving a pockmarked appearance.

The middle part of the Bluestone Formation has been informally subdivided into the red and gray members that are dominated by mudstones (paleovertisols; Blake and Beuthin, 2008) (red above, and gray below). The upper part of this interval is conspicuously red. Subordinate lithologies include sandstones, siltstone, shales, and limestones. A few discontinuous, impure coal beds are present in the red and gray members and a widespread coaly zone presages the overlying marine Bramwell Member transgression.

The informal gray member is gray to green-gray and contains several ostracode and myalinid bivalve-bearing, black carbonaceous shales and impure limestone beds. Lycopsid rootlets are common and evidence of paleopedogenesis is widespread. Red beds are uncommon and the top of this unit is arbitrarily placed where red beds become dominant. This unit likely correlates with the Pipestone Shale of Reger (1926). *GRI Source Map ID 75598* (Bedrock Geologic Map).

Mbsuc - Bluestone Formation, unnamed conglomeratic sandstone (Mississippian)

0 to 100 feet (0 to 30 meters)
A lenticular unnamed conglomeratic sandstone (Mbsuc) 0 to 100 feet (0 to 30 meters) thick caps ridges in the eastern portion of the Flat Top quadrangle. This medium- to coarse-grained sandstone may be confused with the overlying Pennsylvanian sandstones. Angular to subangluar pebbles 1 inch (2.5 centimeters) in diameter occur in a basal lag up to 2 feet (0.6 meter) thick. The sandstone is crossbedded but may appear massive on weathered surfaces. Ironstone clasts weather out leaving a pockmarked appearance. *GRI Source Map ID 75598* (Bedrock Geologic Map).

Mbsgf - Bluestone Formation, Glady Fork Sandstone Member (Mississippian)

0 to 40 feet (0 to 12 m)
This unit ranges from silty, ripple-bedded sandstone to coarse, conglomeratic sublitharenite and is most commonly a light gray to light brown, fine- to coarse-grained, thin-bedded to trough-crossbedded sandstone. It weathers light-brown to brown, is slightly micaceous, contains carbonaceous films and flakes, and locally forms cliffs. The Glady Fork Sandstone is present throughout most of the map area except in the southwestern portion of the Flat Top quadrangle. This unit is sometimes confused with the Pipestem Shale of Reger (1926), a cross-laminated, fine-grained sandstone and siltstone found at the top of the Pride Shale Member. This relationship can best be observed in the vicinity of McKeever Lodge at Pipestem State Park. *GRI Source Map ID 75598* (Bedrock Geologic Map).

Mbspd - Bluestone Formation, Pride Shale Member (Mississippian)

160 to 240 ft (48 to 72 m)
The basal member of the Bluestone Formation is the dark gray, lithologically distinct Pride Shale. In the study area the Pride exhibits a distinctive corrugated appearance on weathered surfaces from a rhythmic alternation of shale, siltstone and sandstone laminae due to reported multiple hierarchies of tidal cyclicity (Miller and Eriksson, 1997). A ravinement (transgressive) surface erosionally separates coastal

plain and estuarine beds from overlying marine beds, and in some areas, Princeton paleovalley interfluves. A 0 to 12-inch (0 to 30-centimeter) thick basal transgressive lag (ravinement bed) consisting of an arenaceous mudstone overlies the ravinement surface. Extensive bioturbation homogenized the lag and siderite cementation is locally pervasive. Trilobites, articulate and inarticulate brachiopods, bivalves and gastropods have been identified in the lag (B.M. Blake, Jr., personal communication, December 2011). A finely-laminated, dark gray to black, clay-rich, carbonaceous shale containing, ellipsoidal limestone concretions, bivalves and ostracodes overlies the lag. This shale bed exhibits a characteristic high gamma ray log signature in the subsurface (Schalla, 1984; Wrightstone, 1984, 1985), which is interpreted as a condensed section that marks the maximum extent of the Pride transgression. The shales of the condensed section grade upward into the more typical laminated regressive facies containing rare bivalves and the inarticulate brachiopod Lingula. In northern parts of the study area, a full marine fauna is present (B.M. Blake, Jr., personal communication, December 2011). Where not truncated by the Glady Fork Sandstone of Reger (1926), the Pride grades upward into poorly-drained coastal plain sediments informally named the gray member by Englund (1968) or the Pipestem Shale after Reger (1926). Where arenaceous, these beds have been misidentified as the overlying Glady Fork Sandstone. The entire Pride Shale sequence is well exposed in roadcuts at the Camp Creek Exit on Interstate 77. *GRI Source Map ID 75598* (Bedrock Geologic Map).

Mpn - Princeton Formation (Mississippian)

0 to 100 ft (0 to 30 m)
The Princeton Formation (Miller and Eriksson, 1997) represents a conceptual expansion of the original "type" Princeton Sandstone (Campbell, 1896) named for exposures around Princeton, West Virginia. The Princeton Formation [Sandstone] is a fine- to medium-grained, quartzose sandstone to quartz arenite. In outcrop, the Princeton Sandstone is conspicuous in containing extrabasinal quartz pebbles and intrabasinally derived polymictic conglomerate beds. *GRI Source Map ID 75598* (Bedrock Geologic Map).

Mhu - Upper Hinton Formation (Mississippian)

Hinton Formation, 800 to 1350 ft (244 to 592 m)
Blake and Beuthin (2004) informally subdivided the Hinton Formation into upper and lower divisions for mapping and discussion purposes, a scheme adopted herein.

Upper Hinton, 450 ft (135 m)
The upper Hinton Formation (after Beuthin and Blake, 2004) is up to 450 feet (135 meters) thick and extends from the top of Avis Limestone of Reger (1926) to the base of the Pride Shale Member of the overlying Bluestone Formation. The upper Hinton comprises a variable succession of mudstone, sandstone, and limestone with limited occurrences of coal. Autogenic limestone, siderite and hematite nodules are common in some beds. Mudstones are mainly red and green, less commonly gray-green. Sandstones are generally very fine- to medium-grained and lithic; quartz arenites are rare. Conglomeratic lenses within sandstones consist of intrabasinally-derived clasts of limestone, siderite and mudrocks. Sandstones in the area around Pipestem, Dunns, and Streeter are often thick enough to resemble the Princeton and may be a source of confusion during mapping. In contrast to past reports (Reger, 1926; Englund, 1968; Miller and Eriksson, 2000), geologic mapping at 1:24,000 scale (Beuthin et al., 2000; Blake et al., 2000, 2001; Beuthin and Blake, 2001, 2002a; Blake and Beuthin, 2002) demonstrated that upper Hinton sandstones are limited in lateral continuity and should not be afforded member rank. Limestones include marine shell beds, thin bivalve-dominated bioherms, and argillaceous calcareous mudstones with ostracodes, myalinid bivalves, fish scales and vertebrate bone fragments. Calcareous glaebules, locally coalesced into nodular beds (caliches), occur within some red mudstones. Evidence of pedogenesis is widespread in upper Hinton strata. Pedogenic features (Mack et al., 1993; Beuthin and Blake, 2002b) in red mudstones include shrink-swell structures, pedogenic slickensides,

clastic dikes filling desiccation cracks, reduction features (burial gleys; drab-haloed root traces) and caliches (vertisols and calcisols). Coal beds (histosols) are generally thin (centimeter-scale) and impure, grading laterally and vertically into carbonaceous shale (Beuthin and Blake, 2002b, 2004). Beuthin and Blake (2004) suggested these coal beds formed as peat accumulated in muck puddles as water tables rose prior to the cyclic marine transgressions. Carbonaceous beds (histosols) are associated commonly with white-gray mudstones (gleyols) that contain carbonized lycopsid roots and pyrite nodules (Beeler, 1999; Miller and Eriksson, 1999; Beuthin and Blake, 2002b, 2004; B.M. Blake, Jr., West Virginia Geological and Economic Survey, personal communication, December 2011). The two regionally-extensive marine members present in the upper Hinton, the Fivemile and Eads Mill members (Beuthin and Blake, 2004), have been attributed to glacioeustatic transgressions (Miller and Eriksson, 2000; Beuthin and Blake, 2004). These marine zones contain a typical Chesterian fauna of brachiopods, bryozoans, corals, bivalves, gastropods, ostracodes, trilobites, pelmatazoans and cephalopods (Reger, 1926; Cooper, 1948, 1961; Henry and Gordon, 1979, 1992). While these units assist in identifying stratigraphic position, they were not exposed well enough for consistent mapping in the study area. *GRI Source Map ID 75598* (Bedrock Geologic Map).

Mhlsg - Hinton Formation, Little Stone Gap (Avis) Member (Mississippian)

50 to 65 ft (15 to 20 m)
A widespread and currently unnamed marine unit comprised of the Paynes Branch Sandstone, Lower Avis Shale, Avis Limestone (equivalent to the Little Stone Gap Member), Upper Avis Shale and Upper Avis Sandstone (Neal Sandstone of Englund, 1968) (after Reger, 1926) occurs near the middle of the Hinton Formation throughout the mapping area. These units are currently under investigation and a formal nomenclature will be advanced in the near future (B.M. Blake, Jr., West Virginia Geological and Economic Survey, personal communication, December 2011). The member consists of a basal, lenticular, laminated to thinly bedded, highly bioturbated, very fine- to fine-grained sandstone (Paynes Branch Sandstone of Reger 1926) overlain by discontinuous calcareous, marine invertebrate-bearing shale beds (Lower Avis Shale of Reger, 1926) that intergrade laterally and vertically with limestone. The most distinctive and mappable part of the unnamed member is the Avis Limestone of Reger (1926; Little Stone Gap Member) which has been identified throughout the central Appalachian region. The Avis Limestone is predominately micritic and argillaceous and contains a typical Chesterian fauna of bryozoans, corals, bivalves, gastropods, ostracodes, trilobites, pelmatazoans and cephalopods. Stromatolitic beds were identified at the base of the Avis Limestone in Pipestem Creek south of the falls (B.M. Blake, Jr., West Virginia Geological and Economic Survey, personal communication, December 2011). Bedding varies from laminated to massive. The more argillaceous beds appear nodular on weathered surfaces. Minor karstic weathering is common and small caves were noted along Indian Ridge. The Upper Avis Shale of Reger (1926) is a heterolithic sequence of shales, mudstones, siltstones, and very fine sandstones exhibiting minor bioturbation (burrowing and rooting) and locally containing limited diversity bivalve and ostracode assemblage. Plant fossils are also common locally. Limestone beds ranging in thickness from inches to feet (centimeter to meters) and containing a diverse marine invertebrate assemblage are not uncommon. Dolomitic limestone beds generally occur within the upper Avis shale and rarely contain identifiable fossils. The Upper Avis Sandstone of Reger (1926) was not noted in the study area. Because of its distinct nature and regional distribution, the Avis Limestone of Reger (1926) is an important marker horizon for the eastern portion of the map area where it is the most consistently identifiable bed. As a result, the Avis Limestone was used as a structural datum to assist in the construction of contacts in areas of poor exposure. *GRI Source Map ID 75598* (Bedrock Geologic Map).

Mhl - Lower Hinton Formation (Mississippian)

700 ft (210 m)
According to Beuthin and Blake (2004) the Lower Hinton Formation is lithologically similar to the upper

Hinton, but without the regionally identifiable marine units. It is a variable succession of mudstone, sandstone, and limestone with limited occurrences of coal. Autogenic limestone, siderite and hematite nodules are common in some beds. Mudstones are mainly red and green, less commonly gray-green. Sandstones are generally brownish violet to grayish green, very fine- to medium-grained, well-sorted and lithic; quartz arenites are rare. Sandstones display trough crossbeds, planar crossbeds, and ripple-scale cross-lamination. Conglomeratic lenses within sandstones consist of intrabasinally-derived clasts of limestone, siderite and mudrocks. *GRI Source Map ID 75598* (Bedrock Geologic Map).

Mhsg - Hinton Formation, Stony Gap Sandstone Member (Mississippian)

40 ft (12 m)
The Stony Gap Sandstone, informally called the Upper Maxon Sand by drillers, is the basal member of the Hinton Formation. It is mainly a white, fine- to medium-grained quartz arenite although it changes locally to a light gray, fine-grained, lithic arenite. The unit is typically crossbedded, with both trough and planar crossbeds present. The Stony Gap is highly variable across the map area, ranging from thick, cliff-forming sandstones, to thinner, flaggy sandstones. The Stony Gap is sometimes subdivided into upper and lower members separated by a conglomerate zone. The basal part of the unit often has log clasts while the upper part is ripple to trough cross laminated. The basal contact is sharp but variable, demonstrating erosion (potential valley incisement), and resulting in an unconformable contact with the underlying Bluestone Formation. *GRI Source Map ID 75598* (Bedrock Geologic Map).

Mbf - Bluefield Formation (Mississippian)

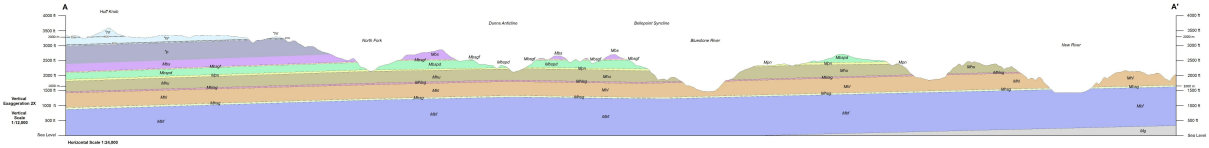
120 ft (36 m), partial section
The upper 120 feet (36 meters) of the Bluefield Formation is poorly exposed in the eastern map area along the New River Gorge. This part of the formation comprises gray calcareous shales and blocky reddish mudstones. An unnamed, fossiliferous limestone occurs in this area, often directly underlying the Stony Gap Sandstone. The basal contact with the underlying Greenbrier Group is not exposed. Reger (1926) reported a total thickness of up to 1350 feet (412 meters) for the Bluefield Formation. *GRI Source Map ID 75598* (Bedrock Geologic Map).

Mg - Greenbrier Group (Mississippian)

Shown in cross-section only. No description provided. *GRI Source Map ID 75598* (Bedrock Geologic Map).

Bedrock Geologic Cross Sections

The geologic cross section present in the GRI digital geologic-GIS data produced for Bluestone National Scenic River, West Virginia (BLUE) is presented below. Cross section graphics were scanned at a high resolution and can be viewed in more detail by zooming in (when viewing the digital format of this document).



Extracted from: (GRI Source Map 75598) (Bedrock Geologic Map).

Bedrock Ancillary Source Map Information

The GRI digital geologic-GIS map for Bluestone National Scenic River, West Virginia (BLUE) was compiled from the following source.

Matchen, David L., Allen, Joseph L., Peck, Robert C., and Mercier, David (Digital Cartography and Map Compilation by Sarah E. Gooding and Paula J. Hunt), 2011, Bedrock Geologic Map of the Bluestone National Scenic River, Flat Top and Pipestem 7.5' Quadrangles, West Virginai: West Virginia Geological and Economic Survey, (Bedrock Geologic Map), Open-File Report 1101, scale 1: 24000. (*GRI Source Map ID 75598*).

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

Open File Report 1101

Matchen, David L., Joseph L. Allen, Robert C. Peck, and David Mercier, (Digital Cartography and Map Compilation by Sarah E. Gooding and Paula J. Hunt), 2011, Bedrock Geologic Map of the Bluestone National Scenic River, Flat Top and Pipestem 7.5' Quadrangles, West Virginai: West Virginia Geological and Economic Survey, (Bedrock Geologic Map), Open-File Report 1101, scale 1: 24000. (*GRI Source Map ID 75598*).

Report

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Matchen, David L., Joseph L. Allen, Robert C. Peck, and David Mercier, (Digital Cartography and Map Compilation by Sarah E. Gooding and Paula J. Hunt), 2011, Bedrock Geologic Map of the Bluestone National Scenic River,
Flat Top and Pipestem 7.5' Quadrangles, West Virginia, West Virginia Geological and Economic Survey, Open-File Report 1101, 1: 24,000 scale.

Introduction
This map of the bedrock geology in and around the National Park Service's Bluestone National Scenic River covers the Flat Top and Pipestem 7½-minute United States Geological Survey topographic quadrangles in Summers, Mercer, and Raleigh counties, West Virginia. Surficial deposits were also mapped within the National Park Service property boundary in these quadrangles as part of a separate publication. The study area is located in the Kanawha River drainage basin in the relatively horizontal to

gently folded rocks of the Appalachian Plateau physiographic province.

According to common lore, the Native American name for the Bluestone River translates into “Big Stone River.” The river ostensibly received its present name from the blue-colored limestone in the river bed. The spectacular scenery of the Bluestone River Gorge is the result of erosion through the Princeton and Glady Fork Sandstones. The National Park Service has protected 10.5 miles (17 km) of the Bluestone River upstream of the New River and Bluestone Lake. Bluestone State Park, Pipestem Resort State Park, and a portion of Camp Creek State Park are also located in the map area.

Adjacent Bedrock Mapping

Quadrangles previously mapped by the West Virginia Geological and Economic Survey include Athens and Lerona (Beuthin and Blake, 2001; 2002a), located south of the present map area. Bedrock of the Shady Spring quadrangle, located north of the Flat Top quadrangle, was mapped by the United States Geological Survey (Meissner, 1981). The Pineville Sandstone Member of the New River Formation was mapped separately by Meissner (1981) in the Shady Spring quadrangle, but was not separated from the New River Formation on the Flat Top quadrangle due to lack of exposure. In the Athens and Lerona quadrangles, Beuthin and Blake (2001; 2002a) mapped members that were too poorly exposed in the Bluestone map area to break out as separate map units. Likewise, some of the units on the Bluestone bedrock map were not mapped separately on the Athens and Lerona quadrangles.

Overview of Stratigraphy

Rock units exposed at the surface in the study area include the Upper Mississippian Mauch Chunk Group, which is subdivided into (ascending) the Bluefield and Hinton formations, the Princeton Formation (Princeton Sandstone), and the Bluestone Formation. Pennsylvanian rock units exposed include the Pocahontas Formation and the lower New River Formation (Pottsville Group). In general, bedrock consists of intercalated sandstones, siltstones, shales, mudstones limestones, and coals. These units are shown on the stratigraphic column along with their estimated thicknesses in the map area. Except for resistant sandstones, rock exposures are limited by soil cover, colluvium, and vegetation. Where concealed, contacts between rock units were inferred from cores, gas well records, aerial photography, digital elevation models, and data from adjacent areas.

The oldest rocks exposed in the study area are the shales, limestone, and mudstones of the upper 120 feet (36 meters) of the Bluefield Formation observed along the New River in the Pipestem quadrangle. The base of the Bluefield Formation is not exposed in the map area.

The youngest rocks exposed in the map area belong to the lower New River Formation and cap the plateaus in the northwestern portion of the Flat Top quadrangle. The thickest remnant of the New River Formation is poorly exposed on Huff Knob, where up to 360 feet (110 meters) of coals, shales, and sandstones are present. Although thick quartz arenites were observed across the Flat Top area, the prominent and continuous sandstones mapped farther to the north are less discontinuous in the map area. Where these sandstones were observed they typically cap isolated ridge crests and were mapped as separate units. An example of this is an unnamed quartz conglomerate in the upper Bluestone Formation along Ellison Ridge in the Flat Top quadrangle. Mapping this unit separately provided stratigraphic control that would otherwise have been lacking in this part of the map area.

Structural Geology and Tectonics

The general strike of rocks in the Appalachian Plateau is northeast-southwest, at approximately N30°E. The original geologic maps of the area (Krebs and Teets, 1916; Reger, 1926) included a relatively large anticline, the Dunns Anticline, plunging to the southwest around Dunns in the Flat Top quadrangle. Preliminary field mapping for this study indicated that this structure was not as prominent as earlier maps suggested. Because the units dip so gently, a structure contour map was constructed on the base of the persistent and identifiable Princeton Sandstone. The structure map, which uses observed outcrop data and is supplemented in the western map area by limited gas-well data, indicates that the

Dunns Anticline and Bellepoint Syncline are present, but very subtle.

Coal Resources, Building Materials, and Gas Resources
New River and Pocahontas coal beds are generally thin, laterally discontinuous, and have no documented commercial mining in the study area (West Virginia Geological and Economic Survey, 2011a, 2011b, and 2011c). The regionally important Pocahontas Formation coal horizons present in the map area include the Pocahontas No. 3 and the Pocahontas No. 6 coals. The New River Formation coal beds mapped in the study area are the Pocahontas No. 9 and Fire Creek coals.

Reger (1926) reported a quarry in the Avis (Little Stone Gap) limestone between the Bluestone River and the New River on the Pipestem quadrangle, but in general, quarrying of this unit was on a small scale. A quarry or "gravel pit" is shown on the Flat Top Mountain quadrangle in the New River Formation southeast of Flat Top Lake.

Oil and gas wells have been drilled in the study area since the late 1800s, with most drilling activity occurring since the 1940s. Successful natural gas wells were drilled in the western portion of the map area in the Flat Top quadrangle, with a handful of less successful wildcat wells attempted in the eastern portion of the map area in the Pipestem quadrangle. Three named gas fields are present in the study area: Mabscott, Rhodell, and Hinton. Most of the successful wells were completed in Mississippian rocks, with a few producing wells completed in Upper Devonian units (Cardwell and Avary, 1982; West Virginia Geological and Economic Survey, 2011d). The oil and natural gas potential of deeper strata was not assessed for the Bluestone bedrock map.

Recreation
Many recreation opportunities are available in the area. The National Park Service's Bluestone National Scenic River, the U.S. Army Corps of Engineers' Bluestone Lake, and three West Virginia State Parks (Bluestone, Pipestem Resort, and Camp Creek) are popular destinations for whitewater paddling, rock climbing, motor boating, fishing, camping, hunting, hiking, mountain biking, and skiing (West Virginia Division of Natural Resources, 2011a, 2011b, 2011c, and 2011d). The 10.5-mile (17 km) gorge between the Bluestone and Pipestem Resort State Parks is preserved by the National Park Service as the Bluestone National Scenic River (NPS, 2011).

The two state parks are connected by a trail along the river called the Bluestone Turnpike. Bluestone State Park, located near the confluence of the New and Bluestone Rivers, offers views of the lower Hinton Formation, including ledges and cliffs of the Stony Gap Sandstone. Within Pipestem State Park, the Glady Fork Sandstone forms the cliffs at the top of the gorge. Downstream toward the confluence with the New River, the Princeton Sandstone forms the rim of the gorge. Pipestem State Park's aerial tramway provides riders a chance to descend rapidly from the resistant Princeton Sandstone at the edge of the gorge down to the softer limestone and mudstone of the Hinton Formation at the bottom of the gorge. Land along the shore of Bluestone Lake is managed as Bluestone Wildlife Management Area, a popular area for hunting in the region. The southwest corner of the Flat Top quadrangle includes portions of Camp Creek State Park and Forest. The park and forest preserve land at the base of Flat Top Mountain, and include two scenic waterfalls developed on the Princeton Sandstone.

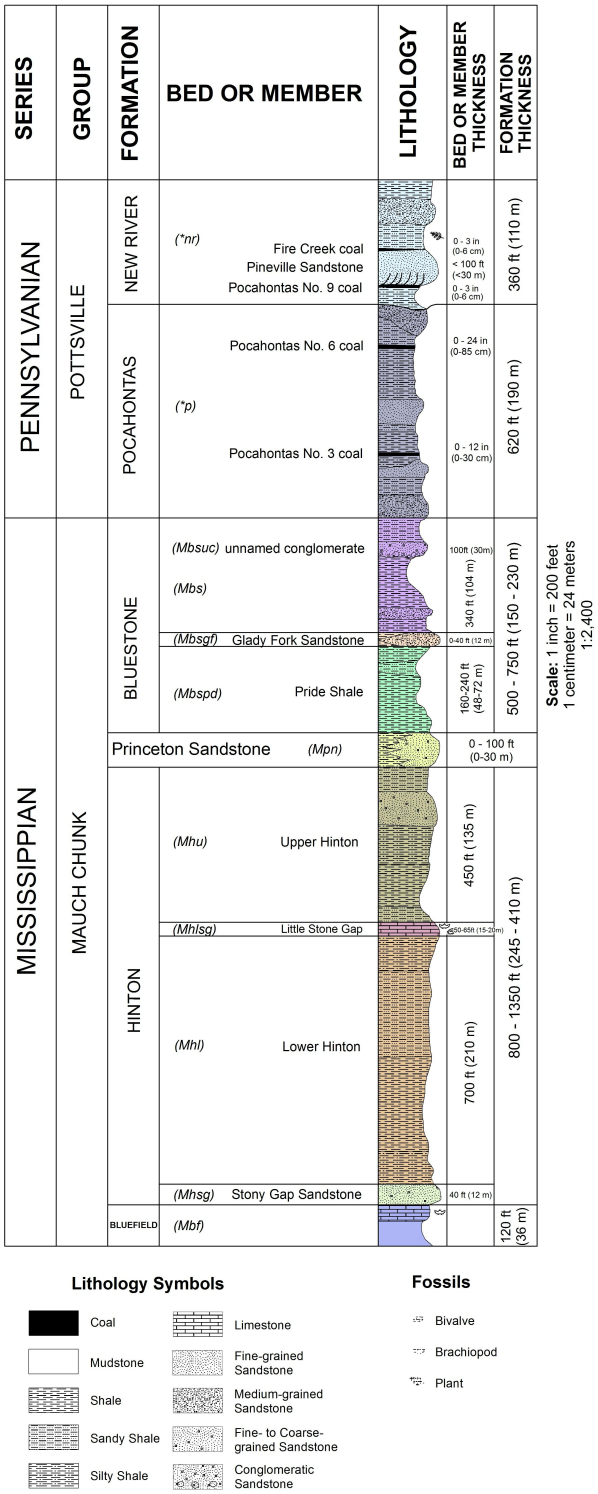
Acknowledgements
Bedrock was mapped by David L. Matchen, Joseph L. Allen, Robert C. Peck, and David Mercier of Concord University in 2010 and 2011. Concord University geoscience students Kenneth Stanley and Aaron Owens provided GIS and field assistance. West Virginia Geological and Economic Survey (WVGES) cartographer and geologist Sarah Gooding was assisted by geologists Paula Hunt and Philip Dinterman in producing the final map, map text, cross section, and geodatabase. Andy Steele of the National Park Service provided technical and field support. Mitch Blake of WVGES provided guidance, internal agency map review, and extensive unit-description editing. Ronald McDowell of WVGES also provided internal agency map review. Thomas Whitfield and William Kochanov of the Pennsylvania

Department of Environmental Resources Bureau of Topographic and Geologic Survey, and Jaime Toro of West Virginia University provided external map and geodatabase review. All reviewers are thanked for their time; their helpful suggestions made this a much better map. The authors acknowledge the hard work of the WVGES geologists who came before them and laid the foundation that is continually being built upon and refined. Most of the funding for this mapping project was provided by the National Park Service under Contract #C236009073, with remaining funds provided by the West Virginia Geological and Economic Survey.

Extracted from: (GRI Source Map 75598) (Bedrock Geologic Map).

Stratigraphic Column

This stratigraphic column graphic is at a high resolution and can be viewed in more detail by zooming in (when viewing the digital format of this document).



Extracted from: (GRI Source Map 75598) (Bedrock Geologic Map).

Map Symbols

Contact, Certain

Contact, Approximately Located

Contact, Inferred

A - A' Cross Section Location Line

PC6 Coal Bed, Inferred

Coal Beds:

FCK: Fire Creek Coal bed
PC9: Pocahontas No. 9 Coal bed
PC6: Pocahontas No. 6 Coal bed
PC3: Pocahontas No. 3 Coal bed

Structure:

2400 Princeton Sandstone Structure Contour, Location Certain

1200 Princeton Sandstone Structure Contour, Location Approximate

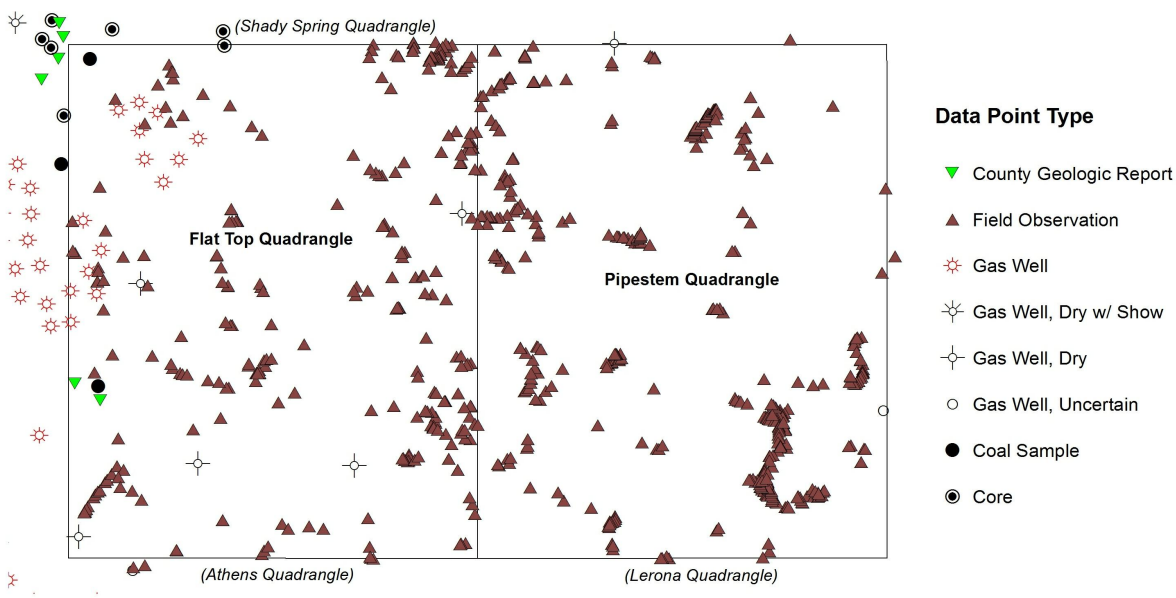
Anticline, Plunging, Inferred

Syncline, Inferred

State and National Park Boundaries

Extracted from: (GRI Source Map 75598) (Bedrock Geologic Map).

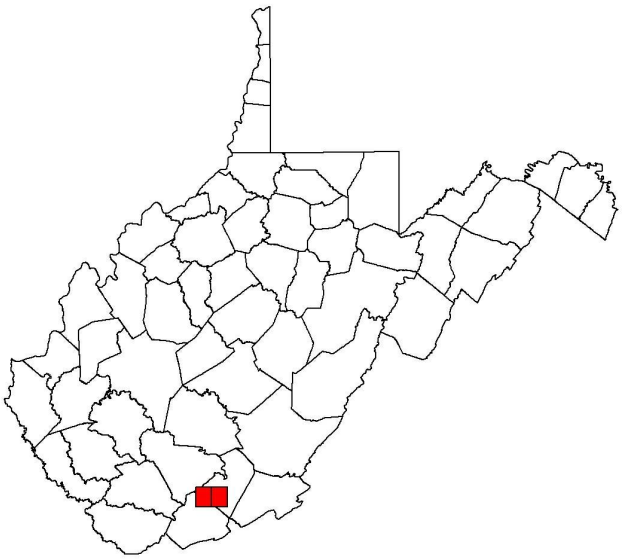
Data Point Map



Data Point Locations

Extracted from: (GRI Source Map 75598) (Bedrock Geologic Map).

Location Map



Location Map

Extracted from: (GRI Source Map 75598) (Bedrock Geologic Map).

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Extracted from: (GRI Source Map 75598) (Bedrock Geologic Map).

County Geologic Report

The six features in the Geologic Observation Localities feature class are from County Geologic Report No. 81, pages 504, 507 and 622. The location IDs include the report number, page number and which paragraph (A-F) on that page the description is located. The relevant text from three pages of the report that relate to this dataset are provided below. The full report, Raliegh County and the Western Portions of Mercer and Summer Counties, is available on Google Books here.

Very little Sewell Coal is found in Shady Spring District, there being small disconnected patches in the western and southern parts of the same. A few sections were measured, as follows :

081-504A

Price Heirs Local Fuel Opening—No. 402 on Map II.
One mile almost due weft, of Ghent; Sewell Coal; elevation, 3025' B.; section by Teets; butts, N. 25° W.;

faces, N. 65° E.; greatest rise, southeast.

			Ft.	In.
Coal, gas (with slate roof)	2'	2"		
Shale, gray	1'	7"		
Coal (to slate floor)	1'	1"	4	10

081-504B

Fink Local Fuel Opening—No. 403 on Map II.
On the waters of Oak Creek of Glade Creek, 1.0 mile northwest of Ghent; Sewell Coal; elevation, 3070' B.; butts, N. 25° W.; faces, N. 65° E.; section by Krebs.

			Ft.	In.
Coal, gas (with slate roof)	2'	2"		
Shale, gray	0	11		
Coal, gas (to slate floor)	1	1	4	2

081-504C

Glade Creek & Raleigh R. R. Co. Local Fuel Opening—No. 404 on Map II.
On waters of Oak Creek of Glade Creek, one mile northwest of Ghent; Sewell Coal; elevation, 3080' B.; section by Teets.

			Ft.	In.
Coal (with shale roof and slate floor)	2'	9"	2	9

081-507F

Coal Exposure—No. 414 on Map II.
In county road, 0.7 mile northwest of Ghent; Little Raleigh Coal; elevation, 2960' B.; section by Teets.

			Ft.	In.
Coal (with shale roof and slate floor)	1'	0"	1	0

081-622D

Coal Exposure—No. 703 on Map II.
In county road, 0.7 mile south of Fairview School; No. 3 Pocahontas Coal; elevation, 2780' B.; section by Teets.

			Ft.	In.
Coal (with shale roof and slate floor)	1'	6"	1	6

081-622E

Ed. Lilly Prospect—No. 704 on Map II.
On west side of road leading to Bear Creek, 0.5 mile southwest of Fairview School; No. 3 Pocahontas Coal; elevation, 2750' B.; section by Krebs.

			Ft.	In.

Dark shale (with sandstone cover)	1'			
Coal, soft	1	6"		
Concealed by water	1	0	2	6

Provided by: Paula Hunt, Geologist, West Virginia Geological and Economic Survey (WVGES)

Cores and Coal Samples

Cores were used to identify coal or other marker beds at depth so they maybe more than one geologic unit related with these point locations.

Coal Samples were collected by the West Virginia Geological and Economic Survey (WVGES) in the late 1970s at of near the land surface (approximately between 3 to 10 feet below). The ID numbers associated with these features refers to the notebook number and page number. For example, "27-011" would be coal notebook 27, page 11. The public is invited to go to the WVGES office to view the notebooks.

Provided by: Paula Hunt, Geologist, West Virginia Geological and Economic Survey (WVGES)

Digital Surficial Geologic Map of Bluestone National Scenic River

Surficial Map Unit List

The surficial geologic units present in the digital surficial geologic-GIS data produced for Bluestone National Scenic River, West Virginia (BLUE) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Hfp - Floodplain). Units are listed from youngest to oldest. Information about each geologic unit is also presented in the Bedrock Geologic Unit Information (BLUSUNIT) table included with the GRI geologic-GIS data.

Surficial Geologic Map Units

Cenozoic Era

Quaternary Period

Hfp - Floodplain
Hfc - Fluvial channel
Haf - Alluvial fan
Hls - Landslide
Ht - Terrace
Hbt - Bouldery tributary deposits
Hcf - Colluvial fan
Hca - Colluvial apron
Hcm - Colluvial mantle
Hcv - Colluvial veneer

Late Cenozic Era
CZr - Residuum

Surficial Map Unit Descriptions

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

Hfp - Floodplain (Active, late Holocene)

Relatively flat river bottom land, episodically inundated by floods. Surface may be dissected by secondary stream channels active during high flows and floods. Includes some very rarely inundated low terraces. Composed of alluvium sediments ranging from silts and clays to boulders. *GRI Source Map ID 76008* (Surficial Geologic Map).

Hfc - Fluvial channel (Active, Holocene)

Very steep, highly entrenched, >30 m wide intermittent or perennial stream channels. Some may be debris flow tracks. Coarse to extremely coarse bed material may include bedrock outcrops and waterfalls. Banks in steep narrow canyons are commonly composed of boulder or block lag derived from very coarse colluvial diamictons. *GRI Source Map ID 76008* (Surficial Geologic Map).

Haf - Alluvial fan (Active, Holocene and late Pleistocene)

Gently sloping fan emanating from, and typically dissected by, one or two source tributary streams. Composed of alluvial sediments ranging from sand to boulders. Fans with steep source basins may include debris flow deposits. Varied soil profile development, reflecting complex age and genesis. *GRI Source Map ID 76008* (Surficial Geologic Map).

Hls - Landslide (Anthropocene, Holocene and late Pleistocene)

Discrete slope failure, differentiated from adjacent landforms by distinct morphology, such as scarps, intact blocks, hummocks, or depositional toes. Slumps are most common landslide type. Lower portions of most landslides have been removed by mitigation along roadways and railroads, or erosion adjacent to streams. Surficial materials vary greatly, reflecting source areas. *GRI Source Map ID 76008* (Surficial Geologic Map).

Ht - Terrace (Holocene and late Pleistocene)

Relatively flat to gently sloping bottom land, seldom or never inundated by floods, and rarely displaying old inactive stream channels. Composed of alluvial sediments ranging from silts and clays to boulders, and commonly showing significant soil profile development. Locally mantled by thin colluvial deposits derived from adjacent slopes. *GRI Source Map ID 76008* (Surficial Geologic Map).

Hbt - Bouldery tributary deposits (Holocene and late Pleistocene)

Irregular narrow bottomlands along steep confined tributary stream valleys, typically entrenched by a channel with steep banks. Composed of coarse bouldery deposits and extremely coarse lag. Complex origins may include colluvial, debris flow, and alluvial deposition, modified by fluvial erosion. *GRI Source Map ID 76008* (Surficial Geologic Map).

Hcf - Colluvial fan (Holocene and late Pleistocene)

Fan- or cone-shaped landforms that can be traced to one or more confined sources, such as coves or hill-slope hollows. Composed primarily of colluvial diamicton, but may include debris flow deposits or tributary alluvium. *GRI Source Map ID 76008* (Surficial Geologic Map).

Hca - Colluvial apron (Holocene and Pleistocene)

Footslope landforms with slope gradient generally decreasing downslope and no surface expression of underlying bedrock stratigraphy and structure. Composed of colluvial diamicton derived from unconfined sources. Underlying bedrock structure is not apparent because colluvium thickness exceeds 2 m. *GRI Source Map ID 76008* (Surficial Geologic Map).

Hcm - Colluvial mantle (Holocene and Pleistocene)

Very steep to moderately steep slopes lacking surface expression of underlying bedrock stratigraphy and structure. Generally composed of thick (>2 m) colluvial diamictons reflecting upslope bedrock lithologies. Colluvium may include deposits created by sheet-flow and local fluvial processes. *GRI Source Map ID 76008* (Surficial Geologic Map).

Hcv - Colluvial veneer (Holocene and Pleistocene)

Very steep to steep slopes with ribbed topography reflecting underlying bedrock stratigraphy and structure. Generally composed of thin (<2 m) colluvial diamicton derived from in situ and upslope bedrock lithologies, interspersed with local outcrops of resistant bedrock, patches of residual soils, and pockets of thick diamicton that may include local fluvial and sheet-flow deposits. *GRI Source Map ID 76008* (Surficial Geologic Map).

CZr - Residuum (Late Cenozoic)

Low-relief uplands, typically rolling topography, lithologically controlled benches, or crests and shoulders of ridges and spurs. Composed of in situ or nearly in situ weathering products of varying textures and thicknesses, with properties inherited from underlying bedrock lithologies. May include local colluvial deposits. *GRI Source Map ID 76008* (Surficial Geologic Map).

Surficial Ancillary Source Map Information

The GRI digital geologic-GIS map for Bluestone National Scenic River, West Virginia (BLUE) was compiled from the following source.

Yates, Marla K and Kite, Stephen J. (Digital Cartography and Map Compilation by Gooding, Sarah E.), 2014, Surficial Geologic Map of the Bluestone National Scenic River Area, West Virginia: WVU and WVGES, Open File Map 1401, scale 1:12,000. (*GRI Source Map ID 76008*).

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

Open File Map 1401

Yates, Marla K and Kite, Stephen J. (Digital Cartography and Map Compilation by Gooding, Sarah E.), 2014, Surficial Geologic Map of the Bluestone National Scenic River Area, West Virginia: WVU and WVGES, (Surficial Geologic Map), Open File Map 1401, scale 1:12,000. (*GRI Source Map ID 76008*).

Abstract

LIDAR AND FIELD-BASED SURFICIAL GEOLOGY AND GEOMORPHOLOGY MAPPING OF BLUESTONE NATIONAL SCENIC RIVER AND PIPESTEM STATE PARK, SOUTHERN WEST VIRGINIA

LiDAR-based "bare earth" DEMS and slope-shade maps were used to guide field work and surficial geology mapping in the Bluestone National Scenic River and adjacent portions of Pipestem State Park. Local bedrock is dominated by gently dipping shale, siltstone, sandstone, conglomerate and limestone of the Mississippian Mauch Chunk Group, lithologies that have yielded a complex variety of surficial deposits and landforms. Bluestone River has carved a steep canyon with over 350 m of local relief. Floodplains are of modest extent in the narrow valleys of the Bluestone and it largest tributaries, and are marked by numerous secondary high-flow channels. LiDAR reveals low terraces have significantly less dissected surfaces, even though they may be inundated during extreme floods. High-terrace deposits contain well-rounded alluvial cobbles and boulders, including quartz sandstones from headwaters Pennsylvanian strata; high-terrace clasts tend to be more weathered with increased distance above modern drainage. Most exposures of high-terrace alluvium lie buried under colluvium, and colluviated terraces and slip-off terraces are very difficult to differentiate from colluvial landforms on LiDAR

imagery. LiDAR DEMS are very noisy for bouldery deposits of mixed colluvial and alluvial origins in low-order tributary valleys that drain resistant sandstone. Bouldery surfaces in many of these low-order valleys show significant incision: some of which appears to be ongoing. The most widespread surficial geology map units are steep "smooth" colluvial aprons and very steep "ribbed" colluvial-residual veneers. Bedrock cliffs are common within veneer map units. Upland benches are loosely associated with resistant sandstone layers, particularly the Princeton Sandstone, although bench regolith ranges from deeply weathered reddish-yellow shaley residuum to yellow-brown colluvial diamicton derived from adjacent slopes; the yellow-brown colluvium lies above the residuum in several poor outcrops. Residual soils on moderate relief uplands generally reflect underlying bedrock.

Extracted from: GRI Source Map ID 76008 (Surficial Geologic Map).

Map Symbols

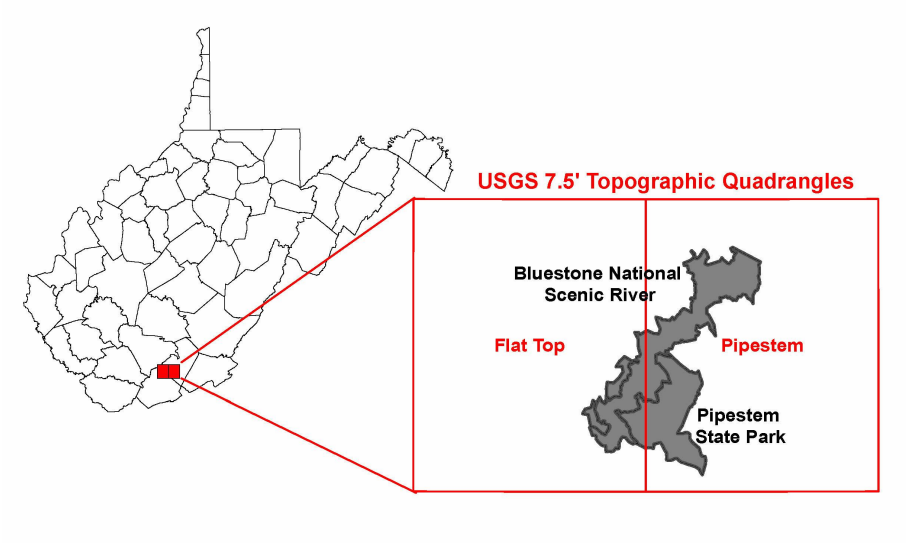
- National/State Park Boundary
- Mapped Area Boundary
- Surficial Unit Contact

Surficial Map Units

- R — River Channel
- A_Fan — Alluvial Fan
- B_Trib_Dep — Bouldery Tributary Terrace
- C_Apr — Colluvial Apron
- C_Fan — Colluvial Fan
- C_Man — Colluvial Mantle
- C_Ven — Colluvial Veneer
- Flp — Floodplains
- FC — Fluvial Channel
- Ls — Landslides
- T — Terraces
- Res — Residuum

Extracted from: GRI Source Map ID 76008 (Surficial Geologic Map).

Location Map



Extracted from: GRI Source Map ID 76008 (Surficial Geologic Map).

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Yates, Marla K. and Kite, J. Steve n, 2012. LiDAR and field -base d surficial geology and geomorphology mapping of Bluestone National Scenic River and Pipestem State Park, southern West Virginia: Geologic al Society of America Abstracts with Programs, v. 44, no. 7, p. 257.

Extracted from: GRI Source Map ID 76008 (Surficial Geologic Map).

GRI Digital Data Credits

This document was developed and completed by Andrea Croskrey (NPS GRD), Stephanie O'Meara and James Winter (Colorado State University) for the NPS Geologic Resources Division (GRD) Geologic Resources Inventory(GRI) Program. Quality control of this document by Jim Chappell (Colorado State University), than later by Stephanie O'Meara (updated and inclusion of surficial map).

The information contained here was compiled to accompany the digital geologic-GIS maps and other digital data for Bluestone National Scenic River, West Virginia (BLUE) developed by Andrea Croskrey and Jim Chappell (bedrock map) and Derek Witt (Colorado State University) and Stephanie O'Meara (surficial map). See the GRI Digital Maps and Source Map Citations section of this document for all sources used by the GRI in the completion of this document and related GRI digital geologic-GIS maps.

GRI finalization by Stephanie O'Meara.

GRI program coordination and scoping provided by Bruce Heise (NPS GRD, Lakewood, Colorado).