National Park Service
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Natural Resource Program Center

Shenandoah National Park

Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory Digital Geologic Data for Shenandoah National Park

shen_geology.pdf

Version: 11/4/2009

Geologic Resources Inventory Map Document for Shenandoah National Park

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Geologic Resources Inventory Map Document

Shenandoah National Park, Virginia

Document to Accompany Digital Geologic-GIS Data

shen_geology.pdf

Version: 11/4/2009

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Shenandoah National Park, Virginia (SHEN)

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/publications.

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

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

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

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

Map Unit List

The geologic units present on digital geologic-GIS data produced for Shenandoah National Park, Virginia (SHEN) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qal - Alluvium). Units are listed from youngest to oldest. No description for water is provided. Information about each geologic unit is also presented in the Geologic Unit Information (UNIT) table included with the GRI geology-GIS data.

Geologic Map Units

Geologic Period

CENOZOIC ERA
Quaternary Period
Qa - Alluvium
Qdf - Debris-flow deposits
Qb - Quartzite block-field deposits
Qc - Colluvium

Tertiary Period
Neogene
Nt - Terrace deposits
Np - Alluvial-plain deposits
Nd - Debris-fan deposits
Nf - Alluvial-fan deposits

MESOZOIC ERA
Jurassic Period
Jpd - Peridotite dike
Jad - Alkalic dikes
Jd - Diabase dikes

PALEOZOIC ERA
Devonian and Silurian Periods
DSu - Devonian and Silurian rocks, undivided

Silurian Period
Sm - Massanutten Sandstone

Ordovician Period
Om - Martinsburg Formation
Oeln - Edinburg Formation, Lincolnshire Limestone, and New Market Limestone, undivided
Ob - Beekmantown Group, undivided
Os - Stonehenge Limestone

Ordovician and Cambrian Periods
OCc - Conococheague Limestone

Cambrian Period
Ce - Elbrook Limestone
Cwa - Waynesboro Formation
Ct - Tomstown Formation
Cca - Antietam Formation
Cch - Harpers Formation
Cchs - Harpers Formation, ferruginous metasandstone

Ccw - Weverton Formation

PROTEROZOIC ERA
Neoproterozoic
Zcp - Catoctin Formation, metavolcanic phyllite
Zcs - Catoctin Formation, metasandstone and laminated phyllite
Zcr - Catoctin Formation, metarhyolite
Zcm - Catoctin Formation, metabasalt
Zmd - Metadiabase dikes
Zsr - Swift Run Formation
Zhg - Hornblende metagabbro dike and (or) sill
Zmr - Mechum River Formation
Zra - Amissville Alkali Feldspar Granite
Zrb - Battle Mountain Alkali Feldspar Granite
Zrbr - Rhyolite and metaconglomerate
Zrbf - Felsite
Zrbd - Felsic dikes
Zrh - Hitt Mountain Alkali Feldspar Syenite
Zrqt - Quartz trachyte
Zrc - Cobbler Mountain Alkali Feldspar Quartz Syenite
Zrw - White Oak Alkali Feldspar Granite
Zrl - Laurel Mills Granite
Zram - Arrington Mountain Alkali Feldspar Granite
Zrr - Rivanna Granite
Zp - Garnet-graphite paragneiss

Mesoproterozoic
Ybg - Biotite monzogranite-quartz monzodiorite
Yom - Orthopyroxene monzogranite-quartz monzodiorite
Ypb - Megacrystic quartz monzonite
Ybm - Megacrystic biotite monzogranite
Ycg - Crozet Granite
Yor - Old Rag Granite
Yml - Porphyroclastic metagranitoid
Yog - Orthopyroxene granite-monzogranite
Yfh - Flint Hill Gneiss
Yll - Lineated leucogranite gneiss
Yomg - Orthopyroxene monzogranite-quartz monzodiorite gneiss
Yos - Megacrystic orthopyroxene syenogranite-monzogranite gneiss
Ygd - Granodiorite gneiss
Yoq - Orthopyroxene quartz diorite gneiss
Yon - Orthopyroxene syenogranite and monzogranite gneiss
Yod - Orthopyroxene granodiorite gneiss
Ypg - Foliated, garnetiferous, porphyroblastic monzogranite
Ylg - Leucogranite gneiss

Map Unit Descriptions

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

Qa - Alluvium (Holocene)

Unconsolidated silt, sand, cobbles, and boulders. Located along streams, flood plains, and alluvial plains. Thickness is as much as 12 m. Alluvium in the highlands is mostly boulders and is transitional with debris fans on lower slopes. (Open File Report 2009-1153)

Qdf - Debris-flow deposits (Holocene)

Debris flow scars and tracks in the Blue Ridge highlands resulted from high rainfall associated with a tropical storm in June 1995. Consists of boulder deposits on chutes in bedrock and residuum. (Open File Report 2009-1153)

Qb - Quartzite block-field deposits (Holocene and Pleistocene)

Clast-supported, open framework of subangular, lichen-covered quartzite blocks and boulders. Commonly located on nonvegetated slopes of ridges underlain by quartzite of the Chilhowee Group. Thickness is variable. (Open File Report 2009-1153)

Qc - Colluvium (Holocene and Pleistocene)

Clast-supported diamicton of subangular to subrounded cobbles and boulders. Grades downslope and is transitional into debris-fan deposits. Thickness ranges from a thin veneer to 30 m. (Open File Report 2009-1153)

Nt - Terrace deposits (Neogene)

Unconsolidated sand, gravel, cobbles, and boulders along major rivers. Deposits range from 0 to 9 m thick on terraces to as much as 9 m above present flood plains. Includes elevated terraces as much as 60 m above present flood plains. (Open File Report 2009-1153)

Np - Alluvial-plain deposits (Neogene)

Broad areas of coalescing terraces along major rivers in the lowlands east of the Blue Ridge highlands. Little to no transported material preserved. Older alluvial plains shown by pattern. (Open File Report 2009-1153)

Nd - Debris-fan deposits (Neogene)

Diamicton consisting of subrounded pebbles, cobbles, and boulders, of local rocks supported in a matrix of unstratified clay, silt, sand, and pebbles. Forms fans and sheets on lower slopes and valleys. Includes terraces of debris fans as much as 36 m above the adjacent debris fans and alluvium. Thickness is as much as 30 m. (Open File Report 2009-1153)

Nf - Alluvial-fan deposits (Neogene)

Unconsolidated sand, pebbles, cobbles, and boulders of quartzite and sandstone, mostly derived from the Harpers and Antietam Formations. Forms coalescing fans and sheets that extend from the lower west slope of Blue Ridge to the South Fork of the Shenandoah River. Thicknesses are highly variable as a function of the weathered state of the underlying bedrock and subsequent alluvial modification. Bedrock residuum is locally exposed beneath a thin veneer of gravel but drill-hole data and mining operations show fan thicknesses may locally exceed 150 m. (Open File Report 2009-1153)

Jpd - Peridotite dike (Late Jurassic)

Elliptical peridotite dike 182 m long and 46 m wide intruding the Martinsburg Formation west of Front Royal. Consists of olivine and pyroxene altered to chlorite, phlogopite, biotite, ankerite, and talc (Young and Bailey, 1955). (Open File Report 2009-1153)

Jad - Alkalic dikes (Late Jurassic)

Northwest-trending vertical alkalic dikes consisting of nepheline syenite, teschenite, and teschenite-picrite intruding the Martinsburg Formation west of Grottoes (Johnson and others, 1971). (Open File Report 2009-1153)

Jd - Diabase dikes (Early Jurassic)

Medium- to dark-gray, moderately crystalline and equigranular, massive diabase dikes that weather to subrounded boulders with characteristic orange-brown-surface. Dikes consist of olivine-normative (olivine-plagioclase-pyroxene) tholeiitic diabase and low-titanium, quartz-normative tholeiitic diabase containing centimeter-sized clusters of calcic plagioclase phenocrysts in a fine-grained groundmass of pyroxene and plagioclase. (Open File Report 2009-1153)

DSu - Devonian and Silurian rocks, undivided (Devonian and Silurian)

Includes the formations listed below:

Mahantango Formation (Middle Devonian)—Gray mudstone, sandstone, and fossiliferous shale
Needmore Shale (Middle and Lower Devonian)—Greenish-gray, fossiliferous shale and calcareous mudstone; black shale at the base
Tioga Ash Bed (Middle and Lower Devonian)—Gray shale and siltstone; brown-biotite-bearing, calcareous ash; and black, fissile shale
Marcellus Shale, undivided (Middle and Lower Devonian)—Dark-gray to black, fissile shale with interbeds of gray, silty limestone and calcareous shale
Ridgeley Sandstone (Lower Devonian)—Light-gray fine- to coarse-grained, cross-laminated,

calcareous, fossiliferous, locally conglomeratic sandstone
Helderberg Group (Lower Devonian)—Light-gray, laminated to thick bedded limestone; black, nodular chert; and white, blocky chert. Upper part is sandy
Keyser Limestone (Lower Devonian and Upper Silurian)—Gray, fossiliferous limestone and gray, laminated limestone with black, nodular chert and white, blocky chert
Tonoloway Limestone (Upper Silurian)—Gray, laminated limestone with mudcracks
Wills Creek Formation (Upper Silurian)—Gray limestone and greenish-gray, calcareous siltstone and mudstone
Bloomsburg Formation (Upper Silurian)—Red mudstone interbedded with red, ferruginous sandstone and shale
McKenzie Formation (Upper and Middle Silurian)—Gray, calcareous shale
(Open File Report 2009-1153)

Sm - Massanutten Sandstone (Silurian)

Light-gray, fine- to coarse-grained, cross laminated, locally conglomeratic sandstone.
(Open File Report 2009-1153)

Om - Martinsburg Formation (Upper and Middle Ordovician)

Light-brown shale, calcareous shale, and siltstone. Contains thin to medium beds of sandstone and metagraywacke in the upper part; gray, argillaceous limestone at the base.
(Open File Report 2009-1153)

Oeln - Edinburg Formation, Lincolnshire Limestone, and New Market Limestone, undivided (Middle Ordovician)

Gray to black, fossiliferous limestone and black shale; gray, fossiliferous and cherty limestone; and bluish-gray, micritic limestone. (Open File Report 2009-1153)

Ob - Beekmantown Group, undivided (Middle and Lower Ordovician)

Light-gray, medium- to thick-bedded dolostone and laminated dolostone containing white and light-gray chert nodules. Weathered surface characterized by “butcher-block” of cross-hatched joints. Irregular bedding at top is due to collapse breccia and paleokarst. (Open File Report 2009-1153)

Os - Stonehenge Limestone (Lower Ordovician)

Dark-gray, fine- to medium-grained, thick-bedded, fossiliferous limestone with minor black chert. Contains algal bioherms, intraformational conglomerates, and bioclastic and dolostone beds. Also contains minor light-gray, laminated, silty limestone with thin interbeds of platy limestone and coarse-grained bioclastic limestone; and light- to dark-gray, fine- to medium-grained, thin- to medium-bedded, fossiliferous limestone and crystalline dolostone containing gray chert nodules.
(Open File Report 2009-1153)

OCc - Conococheague Limestone (Lower Ordovician and Upper Cambrian)

Light-gray, calcareous to dolomitic sandstone; medium-gray, fine-grained limestone with intraformational conglomerate; and light-gray, fine-grained dolostone interbedded with dark- to light-gray, laminated, algal limestone; dolomitic limestone; and light-brown dolostone and calcareous sandstone. (Open File Report 2009-1153)

Ce - Elbrook Limestone (Upper and Middle Cambrian)

Medium-gray, thinly bedded limestone interbedded with white marble; light-brown, laminated dolostone; and thin, calcareous shale and shaly dolostone. (Open File Report 2009-1153)

Cwa - Waynesboro Formation (Lower Cambrian)

Consists of three units too thin to map separately, in ascending order: (1) interbedded light-olive-gray shale; light-gray, fine-grained sandstone; and medium- to dark-gray, sandy, dolomitic limestone; (2) interbedded gray, bioturbated dolostone, dolomitic limestone, and laminated limestone, with a few thin, sandy limestone beds near the middle; and (3) interbedded dusky-red shale, mudstone, and argillaceous sandstone; light-gray sandstone; and light-brown, sandy, dolomitic limestone and dolostone. (Open File Report 2009-1153)

Ct - Tomstown Formation (Lower Cambrian)

Light- to dark-gray limestone, dolostone, and marble. Includes four subdivisions too thin to map separately, in ascending order: (1) dark-gray, fine-grained, thin-bedded limestone with wispy dolomitic burrows that increase in abundance upsection; may include a basal 15-m-thick interval of gray to white, mylonitic marble; (2) dark-gray, thick-bedded, burrow-mottled dolostone; (3) light-gray, very thick bedded to massive, sugary dolostone with faint cross-bedding with a base that is gradational with the underlying bioturbated dolostone; and (4) a unit consisting of a lower dark-gray, bioturbated dolostone interbedded with intervals of dark-gray, laminated dolostone and dark-gray limestone, and an upper dark-gray, bioturbated, oolitic dolostone interbedded with laminated limestone and silty dolostone.
(Open File Report 2009-1153)

Cca - Antietam Formation (Lower Cambrian)

Light-olive- to olive-gray, medium- to coarse-grained, medium-bedded, locally ferruginous, micaceous, silty metasandstone interbedded with very fine grained, silty metasandstone to sandy metasiltstone. Local ferruginous horizons with abundant botryoidal hematite and limonite are located near contact with overlying Tomstown Formation. (Open File Report 2009-1153)

Cch - Harpers Formation (Lower Cambrian)

Greenish- to bluish-gray quartz-chlorite-sericite phyllite and metasiltstone interbedded with thin gray metasandstone, quartzite, and meta-arkose; also includes interbedded layers of quartzite, metasandstone, and metasiltstone. Lower part locally consists of green and brown metasiltstone interbedded with fine metasandstone, but dark quartzite occurs at Blackrock. In northern part of the map, characterized by upward-coarsening sequences of bioturbated phyllite with intervals of wavy, thick laminations that grade into blocky beds of metasiltstone and fine sandstone that contain abundant burrows. Top of the lower part consists of quartzite with interbeds of metasandstone and thin dolomite. Local beds of pebbly metasandstone and metaconglomerate are in the lower part and vitreous quartzite and ferruginous arkosic metasandstone are in the upper part. The trace fossil *Skolithos linearis* appears to be limited to clean quartzite beds in the upper part. (Open File Report 2009-1153)

Cchs - Harpers Formation, ferruginous metasandstone (Lower Cambrian)

Maroon and dark-blue to black, ferruginous metasandstone. (Open File Report 2009-1153)

Ccw - Weverton Formation (Lower Cambrian)

Maroon and gray, laminated phyllite that includes beds of pebbly quartzite interbedded with siltstone, and metaconglomerate at the base. Coarse-grained, sandy and pebbly metasandstone interbedded with silvery-green, quartzose phyllite and reddish-purple, coarse-grained, thick-bedded, ferruginous metasandstone. Locally capped by light-tan to brown, pebbly metasandstone and maroon ferruginous metasandstone in the southern part of the Shenandoah National Park. In the northern part of the park, consists of upward-coarsening sequences of heavily bioturbated metasiltstone and phyllite with intervals of wavy, thick laminations; blocky, fine-grained quartzite that is commonly bioturbated with flat and wavy laminations; and a cap of crossbedded, pebbly metasandstone and metaconglomerate. (Open File Report 2009-1153)

Zcp - Catoctin Formation, metavolcanic phyllite (Neoproterozoic)

Dark, variegated (gray, blue, dusky-red), mottled to lustrous phyllite containing white to green, elongated vesicles and smeared sericite and chlorite blebs. (Open File Report 2009-1153)

Zcs - Catoctin Formation, metasandstone and laminated phyllite (Neoproterozoic)

Light-greenish-gray, medium- to coarse-grained metasandstone and variegated, finely laminated quartz-muscovite phyllite. Occurs within metabasalt in the upper part of the formation from the extreme southwest part of the map area northeast for about 17 km. (Open File Report 2009-1153)

Zcr - Catoctin Formation, metarhyolite (Neoproterozoic)

Light-gray to pinkish-white, very fine grained metarhyolite and tuff containing feldspar phenocrysts and centimeter-wide clots of white quartz and pale-green epidote. Occurs as a layer about 10 m thick and 5 km long in metabasalt near the base of the formation in the extreme northeast part of the map area (Lukert and Nuckols, 1976). (Open File Report 2009-1153)

Zcm - Catoctin Formation, metabasalt (Neoproterozoic)

Light-green to dark-greenish-gray to medium-bluish-gray, fine-grained to aphanitic, massive to schistose, amygdaloidal metabasalt composed of actinolite, chlorite, epidote, albite, and rare quartz. Contains lenses and layers of light-green, fine-grained, massive epidosite, which consists of epidote and quartz. Locally contains thin layers of phyllite and metasandstone. (Open File Report 2009-1153)

Zmd - Metadiabase dikes (Neoproterozoic)

Dark-greenish-gray, fine- to medium-grained, massive to schistose metadiabase composed predominantly of chlorite, albite, epidote, and actinolite. Coarse-grained variety has 2- to 8-mm-long actinolite pseudomorphs after clinopyroxene, and aphanitic variety has relict euhedral laths of plagioclase. Similar in composition to metabasalt of the Catoctin Formation; interpreted to be feeder dikes to those metabasalt flows. Includes augite-bearing porphyritic and actinolite-rich amphibolite dikes in the northeastern part of the map area (Lukert and Nuckols, 1976; Lukert and Halladay, 1980). (Open File Report 2009-1153)

Zsr - Swift Run Formation (Neoproterozoic)

Pink to gray, very coarse to medium-grained, crossbedded metasandstone and quartzite containing pebbles and cobbles of quartz phyllite and sandstone; brownish-green chlorite-sericite-feldspar-quartz metagraywacke; and lustrous, silvery quartz-sericite schist. Also includes grayish-reddish-purple phyllite; grayish-green, finely laminated phyllite; dark-greenish-gray to brownish-gray, sandy, sericitic phyllite; and medium-dark-gray slate in fining-upward sequence. (Open File Report 2009-1153)

Zhg - Hornblende metagabbro dike and (or) sill (Neoproterozoic)

Greenish-black, medium- to fine-grained, massive to foliated dike or sill consisting of hornblende, plagioclase, epidote, and quartz. An altered ultramafic rock consisting of actinolite, epidote, chlorite, and magnetite is found locally beneath hornblende metagabbro east of Graves Mill (Bailey and others, 2003). (Open File Report 2009-1153)

Zmr - Mechum River Formation (Neoproterozoic)

Consists of four units (Bailey, Peters, and others, 2007) not differentiated on the map: (1) laminated metasiltstone and metamudstone with minor arkosic metawacke; (2) fine- to coarse-grained, graded arkosic metasandstone and metawacke interbedded with minor metasiltstone and metaconglomerate; (3) crossbedded arkosic metasandstone and metaconglomerate; and (4) laminated metasiltstone, metagraywacke, and crossbedded, arkosic metawacke. (Open File Report 2009-1153)

Zra - Amissville Alkali Feldspar Granite (Neoproterozoic)

Gray, medium-grained alkali feldspar granite composed of mesoperthite, quartz, and diagnostic quartz phenocrysts. Small, irregular (miarolitic) cavities contain protruding quartz crystals. (Open File Report 2009-1153)

Zrb - Battle Mountain Alkali Feldspar Granite (Neoproterozoic)

Gray, medium-grained alkali-feldspar granite composed of alkali-feldspar-dominant mesoperthite, and quartz; local small, irregular (miarolitic) cavities contain protruding quartz crystals. (Open File Report 2009-1153)

Zrbr - Rhyolite and metaconglomerate (Neoproterozoic)

Light-gray, aphanitic, extrusive metarhyolite containing fluorite and feldspar phenocrysts; interlayered with metaconglomerate consisting of pebbles of metarhyolite and conglomerate comprised granite boulders. (Open File Report 2009-1153)

Zrbf - Felsite (Neoproterozoic)

Light-gray, aphanitic, extrusive felsic volcanic rock composed of phenocrysts of alkali-feldspar-dominant mesoperthite and quartz; locally displays flow banding, lithophysae (hollow, bubblelike structures composed of concentric shells of finely crystalline minerals), and small, irregular (miarolitic) cavities containing protruding quartz crystals. (Open File Report 2009-1153)

Zrbd - Felsic dikes (Neoproterozoic)

Light-gray, aphanitic, felsic dikes; intruded Mesoproterozoic gneisses as well as granites of the Robertson River Igneous Suite. (Open File Report 2009-1153)

Zrh - Hitt Mountain Alkali Feldspar Syenite (Neoproterozoic)

Gray, coarse-grained, inequigranular, locally pegmatitic alkali-feldspar syenite composed of mesoperthite (chiefly microcline), quartz, saussuritized plagioclase, hastingsite, and rare garnet. (Open File Report 2009-1153)

Zrqt - Quartz trachyte (Neoproterozoic)

Dusky-red to gray, aphanitic to fine-grained quartz trachyte composed of mesoperthite and quartz with light-gray mesoperthite phenocrysts; occurs in one locality in the park, southeast of Jenkins Gap, between Mesoproterozoic rocks and Catoctin Formation. Locally layered and fragmented; interpreted to be the extrusive volcanic equivalent of Cobbler Mountain Alkali Feldspar Quartz Syenite. (Open File Report 2009-1153)

Zrc - Cobbler Mountain Alkali Feldspar Quartz Syenite (Neoproterozoic)

Gray, medium-grained, and massive alkali-feldspar quartz syenite composed of conspicuous stubby, euhedral mesoperthite grains that are 2 to 4 mm in diameter and are intergrown with anhedral quartz. (Open File Report 2009-1153)

Zrw - White Oak Alkali Feldspar Granite (Neoproterozoic)

Gray, coarse-grained, inequigranular alkali-feldspar granite composed of mesoperthite (chiefly microcline), quartz, and hastingsite. (Open File Report 2009-1153)

Zrl - Laurel Mills Granite (Neoproterozoic)

Gray, coarse-grained, inequigranular granite composed of alkali-feldspar-dominant mesoperthite, diagnostic pale-blue quartz, hastingsite, biotite, magnetite, and titanite. (Open File Report 2009-1153)

Zram - Arrington Mountain Alkali Feldspar Granite (Neoproterozoic)

Gray, medium-grained, equigranular alkali-feldspar granite composed of mesoperthite (chiefly microcline), quartz, and hastingsite, biotite, fluorite, and rare garnet and muscovite. (Open File Report 2009-1153)

Zrr - Rivanna Granite (Neoproterozoic)

White, medium-grained, and equigranular granite composed of quartz, plagioclase, and alkali-feldspar-dominant mesoperthite (chiefly microcline), biotite, fluorite, and rare muscovite. Local small, irregular (miarolitic) cavities contain protruding quartz and pyrite crystals. (Open File Report 2009-1153)

Zp - Garnet-graphite paragneiss (Neoproterozoic)

Rusty-brown, medium- to fine-grained, compositionally layered graphite-garnet-biotite-plagioclase-quartz gneiss. Includes garnetiferous, quartzofeldspathic, and quartzitic layers that are several millimeters thick. Almandine garnets 0.1 to 1 cm in diameter occur as aggregates; graphite occurs as small disseminated flakes. Exhibits foliation parallel to layering. Locally cut by pegmatite. Commonly retrograded to chlorite schist with Paleozoic schistosity. (Open File Report 2009-1153)

Ybg - Biotite monzogranite-quartz monzodiorite (Mesoproterozoic)

Very dark gray, medium- to coarse grained, inequigranular, nonfoliated to weakly foliated biotite monzogranite and quartz monzodiorite. Biotite content is as much as 25 percent. (Open File Report 2009-1153)

Yom - Orthopyroxene monzogranite-quartz monzodiorite (Mesoproterozoic)

Dark-green to black, medium- to coarse-grained, inequigranular, massive and nonfoliated, orthopyroxene-, amphibole-, and clinopyroxene-bearing orthopyroxene monzogranite and quartz monzodiorite. (Open File Report 2009-1153)

Ypb - Megacrystic quartz monzonite (Mesoproterozoic)

Light- to medium-gray, medium-grained to megacrystic, weakly foliated quartz monzonite containing porphyroblasts of pink microcline. (Open File Report 2009-1153)

Ybm - Megacrystic biotite monzogranite (Mesoproterozoic)

Light- to medium-gray, very coarse grained, inequigranular, weakly to moderately foliated, megacrystic biotite monzogranite. Includes variable amounts of biotite; quartz is typically blue. Intruded by comagmatic dikes of pegmatite and biotite monzogranite. (Open File Report 2009-1153)

Ycg - Crozet Granite (Mesoproterozoic)

Light-gray, very coarse grained, massive, nonfoliated to moderately foliated, biotite- and clinopyroxene-bearing monzogranite. Includes megacrysts of euhedral feldspar and anhedral quartz as much as 10 cm long. Intruded by undeformed pegmatite dikes. (Open File Report 2009-1153)

Yor - Old Rag Granite (Mesoproterozoic)

White- to light-gray, medium- to coarse-grained, inequigranular, massive, nonfoliated to weakly foliated, biotite-, and orthopyroxene-bearing, garnetiferous leucogranite and garnetiferous syenogranite containing gray and blue quartz grains. (Open File Report 2009-1153)

Yml - Porphyroclastic metagranitoid (Mesoproterozoic)

Light-gray, very coarse grained, strongly foliated, biotite-bearing alkali-feldspar granite. (Open File Report 2009-1153)

Yog - Orthopyroxene granite-monzogranite (Mesoproterozoic)

Dark-gray, medium- to coarse-grained, equigranular, weakly to strongly foliated, orthopyroxene-, amphibole-, biotite-, and garnet-bearing orthopyroxene granite-monzogranite. (Open File Report 2009-1153)

Yfh - Flint Hill Gneiss (Mesoproterozoic)

Dark- to medium-gray, medium-grained, inequigranular, strongly foliated, locally migmatitic quartzofeldspathic syenogranite to monzogranite in compositional layers separated by biotite. Includes gray and blue quartz grains and blue quartz veins. (Open File Report 2009-1153)

Yll - Lineated leucogranite gneiss (Mesoproterozoic)

Light-gray to tan, medium-to coarse-grained, strongly foliated, lineated leucogranite gneiss. Exhibits diagnostic stripped texture due to lineations of biotite. (Open File Report 2009-1153)

Yomg - Orthopyroxene monzogranite-quartz monzodiorite gneiss (Mesoproterozoic)

Greenish-gray to black, strongly foliated, orthopyroxene-, clinopyroxene, and biotite-bearing orthopyroxene monzogranite and quartz monzodiorite gneiss. Exhibits rusty-weathered, ribbed surface and transposed leucocratic layers. (Open File Report 2009-1153)

Yos - Megacrystic orthopyroxene syenogranite-monzogranite gneiss (Mesoproterozoic)

Dark-gray to dark-greenish-gray, very coarse grained, strongly foliated, orthopyroxene-, amphibole-, and clinopyroxene-bearing megacrystic orthopyroxene syenogranite-monzogranite gneiss; alkali-feldspar megacrysts are as much as 12 cm long. (Open File Report 2009-1153)

Ygd - Granodiorite gneiss (Mesoproterozoic)

Light-gray, equigranular, compositionally layered, strongly foliated granodiorite gneiss that includes clots and lineations of biotite. (Open File Report 2009-1153)

Yoq - Orthopyroxene quartz diorite gneiss (Mesoproterozoic)

Greenish-gray to black, medium-grained, compositionally layered, strongly foliated, orthopyroxene-, biotite-, and garnet-bearing orthopyroxene quartz-diorite gneiss. (Open File Report 2009-1153)

Yon - Orthopyroxene syenogranite and monzogranite gneiss (Mesoproterozoic)

Gray, medium- to coarse-grained, compositionally layered, strongly foliated orthopyroxene-, biotite-, garnet-, and clinopyroxene-bearing orthopyroxene syenogranite and monzogranite gneiss. Exhibits transposed garnetiferous leucocratic layers. (Open File Report 2009-1153)

Yod - Orthopyroxene granodiorite gneiss (Mesoproterozoic)

Dark-gray, medium- to coarse-grained, compositionally layered, strongly foliated, amphibole-bearing orthopyroxene granodiorite gneiss. Exhibits transposed leucocratic layers. (Open File Report 2009-1153)

Ypg - Foliated, garnetiferous, porphyroblastic monzogranite (Mesoproterozoic)

Medium-gray, variegated, medium- to coarse-grained, biotite-bearing, moderately foliated, garnetiferous, porphyroblastic monzogranite. Contains microcline megacrysts or aggregates as much as 3 cm in diameter and distinctive clots of blue quartz. (Open File Report 2009-1153)

Ylg - Leucogranite gneiss (Mesoproterozoic)

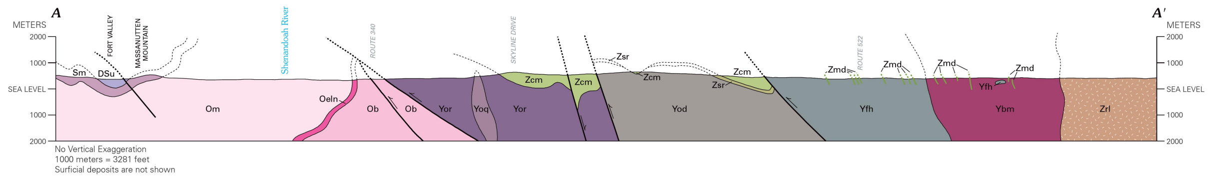
Light-gray, coarse-grained to megacrystic, weakly to strongly foliated leucogranite gneiss. Composition varies and includes alkali-feldspar granite, syenogranite, and monzogranite. Intruded by medium-gray, medium-grained, equigranular, biotite-bearing, isoclinally folded leucogranite dikes. Both gneiss and dikes are in turn intruded by leucocratic pegmatites. (Open File Report 2009-1153)

Geologic Cross Sections

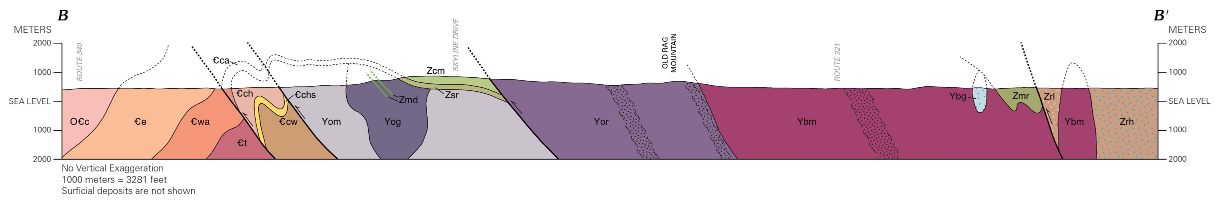
The geologic cross sections present in the GRI digital geologic-GIS data produced for Shenandoah National Park, Virginia (SHEN) are presented below.

All cross section images extracted from (Open File Report 2009-1153)

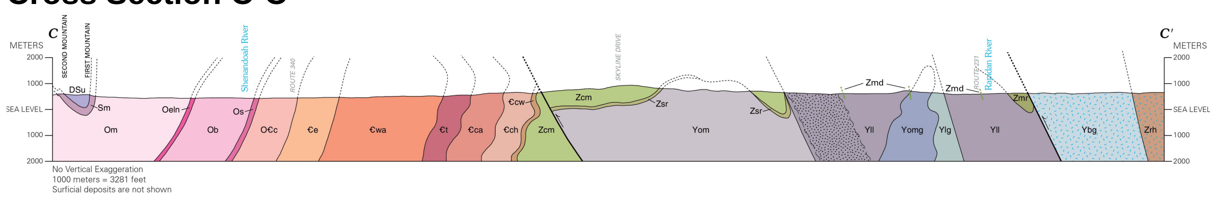
Cross Section A-A'



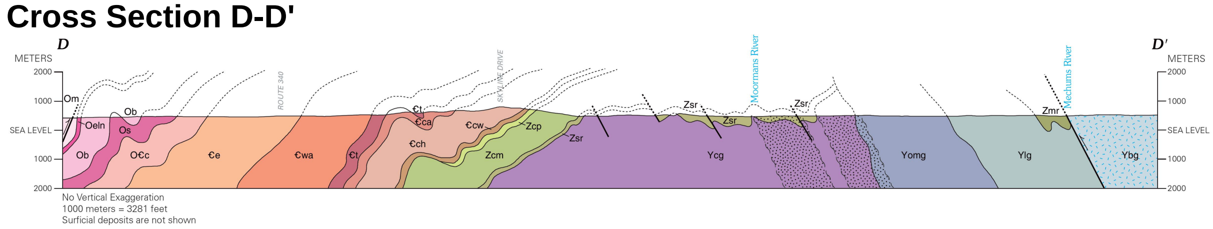
Cross Section B-B'



Cross Section C-C'



Cross Section D-D'



GRI Source Map Citations

The GRI digital geologic-GIS map for Shenandoah National Park, Virginia (SHEN) was compiled from the following source:

Southworth, Scott, Aleinikoff, John N., Bailey, Christopher M., Burton, William C., Crider, E.A., Hackley, Paul C., Smoot, Joseph P., and Tollo, Richard P., 2009, Geologic Map of the Shenandoah National Park Region, Virginia: U.S. Geological Survey, Open File Report 2009-1153, 1:100,000 scale. (Open File Report 2009-1153) (*GRI Source Map 75180)*

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

Southworth, et. al., 2009 (OFR 2009-1153)

Southworth, Scott, Aleinikoff, John N., Bailey, Christopher M., Burton, William C., Crider, E.A., Hackley, Paul C., Smoot, Joseph P., and Tollo, Richard P., 2009, Geologic Map of the Shenandoah National Park Region, Virginia: U.S. Geological Survey, Open File Report 2009-1153, 1:100,000 scale. (Open File Report 2009-1153) (*GRI Source Map 75180)*

To view information about this digital source and other related products, go to the Publication Warehouse page on the U.S. Geological Survey website at: http://pubs.usgs.gov/of/2009/1153/

Unit Correlation

Index Map and Declination

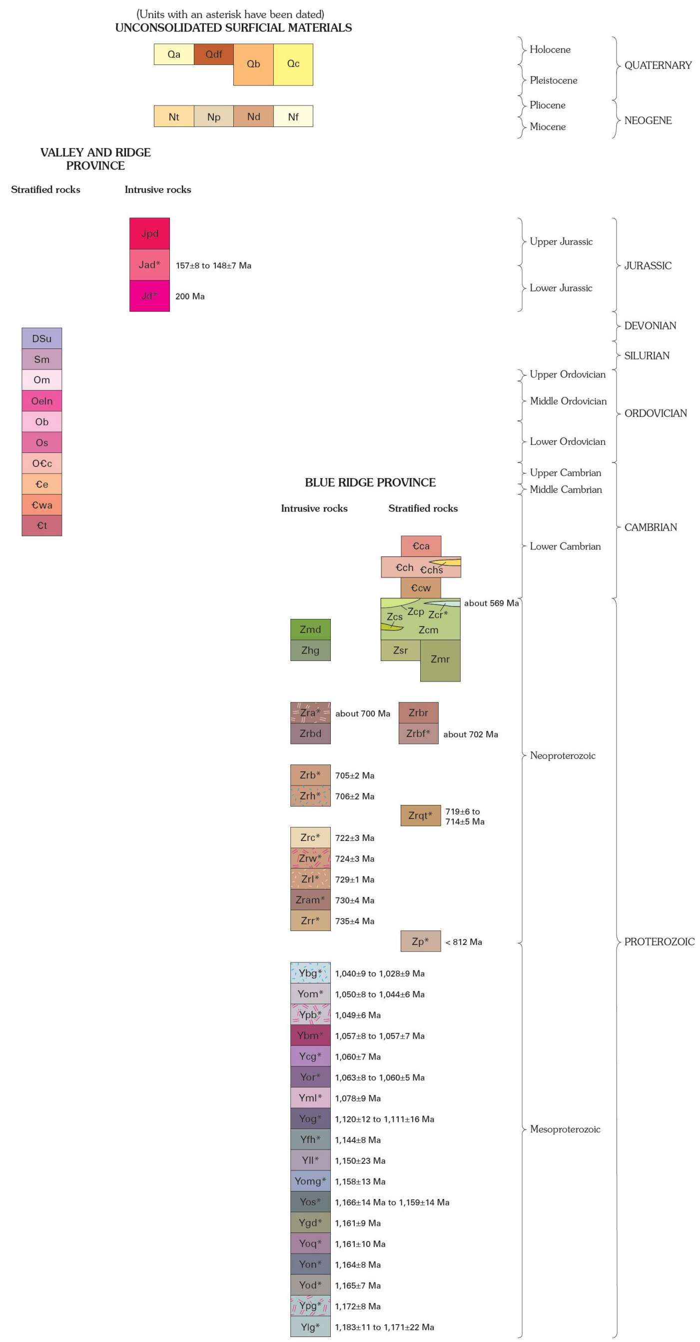
Isotopic Age Date Localities

Physiographic Provinces and Structural Features

Map Legend

References

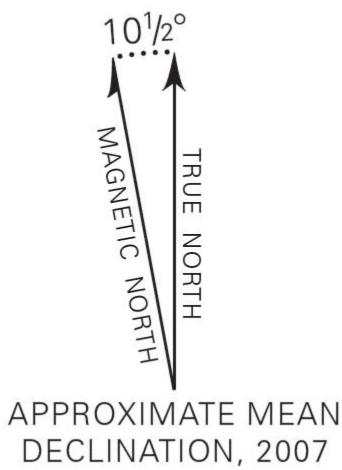
Unit Correlation - Southworth, et al., 2009



Extracted from (Open File Report 2009-1153).

Index Map and Declination - Southworth, et al., 2009

Extracted from ([Open File Report 2009-1153]*)*



Extracted from ([Open File Report 2009-1153]*).*

Isotopic Age Date Localities - Southworth, et al., 2009

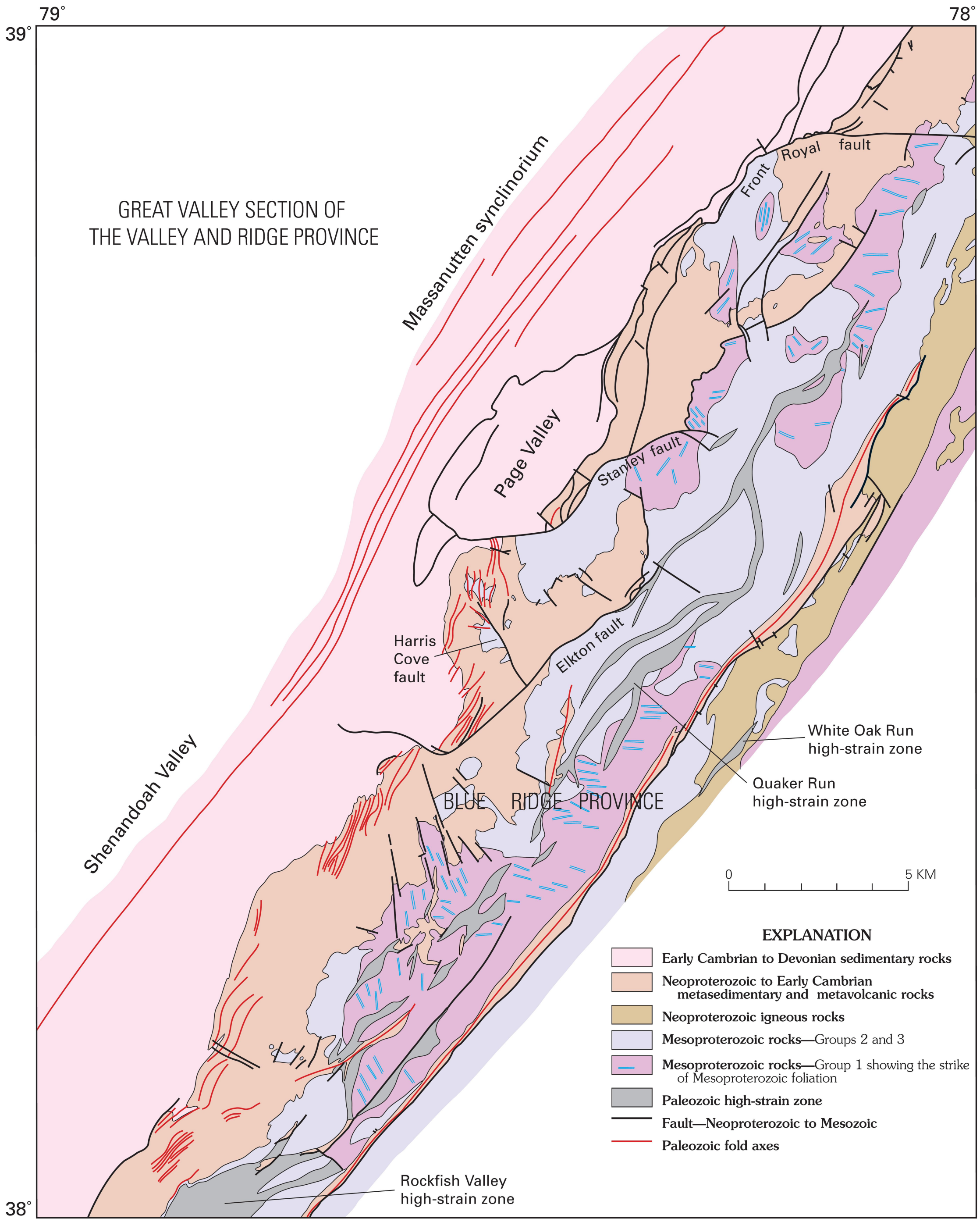
Table 1. Location of isotopically dated rocks in the Shenandoah National Park Region.

[Uranium-lead (U-Pb) dating techniques are abbreviated as follows: TIMS, thermal ionization mass spectrometry; SHRIMP, sensitive high-resolution ion microprobe. Ages given in millions of years (mega-annum, Ma)]

Sample number	Map symbol	Technique	Age, in Ma
1	Zra	TIMS	700
2	Zrbf	TIMS	702
3	Zrbg	TIMS	705±2
4	Zrqt	SHRIMP	714±5
5	Zrqt	SHRIMP	719±6
6	Zrw	TIMS	724±3
7	Zrl	TIMS	729±1
8	Zram	TIMS	730±4
9	Zp	SHRIMP	<812
10	Zp	SHRIMP	<959
11	Zp	SHRIMP	<997
12	Ybg	SHRIMP	1,028±9
13	Ybm	SHRIMP	1,030±11
14	Ybg (xenolith)	SHRIMP	1,032±10
14	Ybg	SHRIMP	1,040±9
15	Yom	SHRIMP	1,044±6
16	Yom	SHRIMP	1,049±9
17	Yom	SHRIMP	1,050±8
18	Ybm	SHRIMP	1,057±7
19	Ybm	SHRIMP	1,057±8
20	Yor	SHRIMP	1,060±5
21	Ycg	SHRIMP	1,060±7
22	Yor	SHRIMP	1,063±8
23	Yml	SHRIMP	1,078±9
24	Yog	SHRIMP	1,111±16
25	Yog	SHRIMP	1,120±12
26	Yfh	SHRIMP	1,144±8
27	Yll	SHRIMP	1,150±23
28	Yomg	SHRIMP	1,158±13
29	Yos	SHRIMP	1,159±14
30	Ygd	SHRIMP	1,161±9
31	Yoq	SHRIMP	1,161±10
32	Yőn	SHRIMP	1,164±8
33	Yod	SHRIMP	1,165±7
34	Yos	SHRIMP	1,166±14
35	Ylg	SHRIMP	1,171±22
36	Ylg (dikes)	SHRIMP	1,175±11
36	Ylg	SHRIMP	1,183±11

Extracted from (Open File Report 2009-1153). Sample localities are present in the GRI GIS data in the Geologic Sample Localities (SHENGSL) data layer.

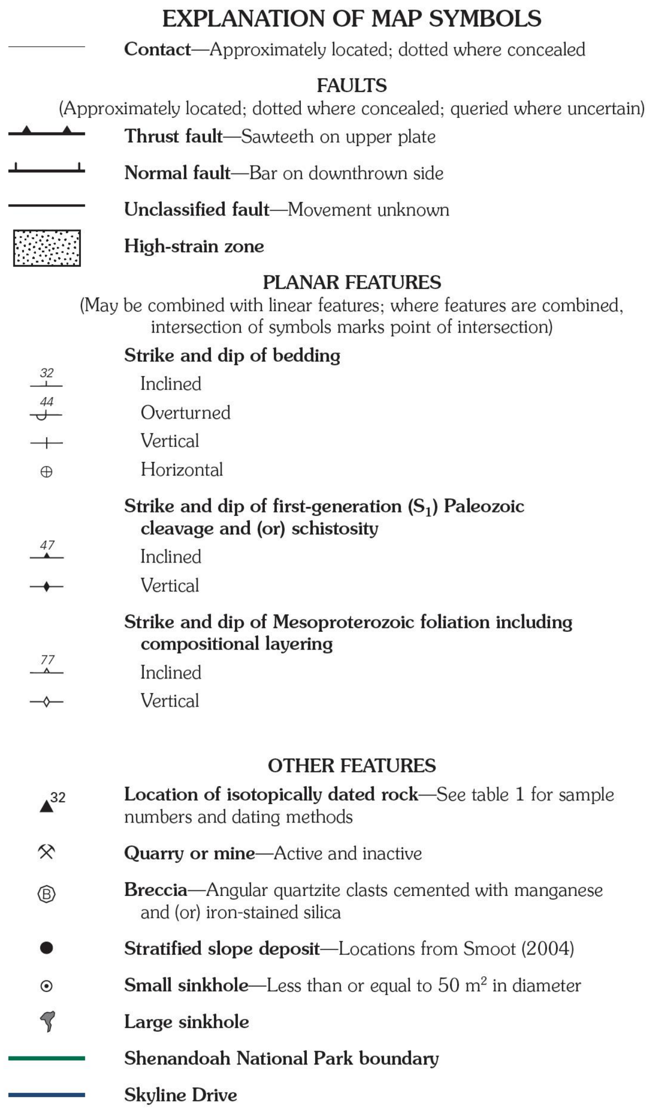
Physiographic Provinces and Structural Features - Southworth, et al., 2009



Map showing the major physiographic provinces and structural features of the Shenandoah National Park region

Extracted from (Open File Report 2009-1153).

Map Legend - Southworth, et al., 2009



Extracted from (Open File Report 2009-1153). Non-geologic features (i.e., Shenandoah National Park Boundary and Skyline Drive) were not included in the GRI digital geologic-GIS map for Shenandoah National Park Boundary and vicinity).

References - Southworth, et al., 2009

Geology mapped by Christopher Bailey (1996-2008), William Burton (2006-2008), Paul Hackley (1996-1998), Joseph Smoot (2003-2008), Scott Southworth (2005-2008), and Richard Tollo (1985-1992, 1996-2007)
Geochronology by John Aleinikoff (1995-2009)
Compiled by Scott Southworth (2008)
Cartography and digital compilation by E.A. Crider (2008-2009)
Manuscript approved for publication July 24, 2009

*Extracted from (*Open File Report 2009-1153).

GRI Digital Data Credits

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

The information contained here was compiled to accompany the digital geologic-GIS map(s) and other digital data for Shenandoah National Park, Virginia (SHEN) developed by Philip Reiker (NPS GRD, Lakewood, Colorado) from U.S. Geological Survey digital data and map (Southworth, 2009).

Quality Control (QC) by Jim Chappell (Colorado State University).

GRI finalization by Stephanie O'Meara (Colorado State University).

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