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

Kings Mountain National Military Park

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic Data for Kings Mountain National Military Park

kimo_geology.pdf

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Geologic Resources Inventory Map Document for Kings Mountain National Military Park

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Geologic Resources Inventory Map Document

Kings Mountain National Military Park, South Carolina

Document to Accompany Digital Geologic-GIS Data

kimo_geology.pdf

Version: 4/27/2015

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Kings Mountain National Military Park, South Carolina (KIMO).

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.

For information about the status of GRI digital geologic-GIS data for a park contact:

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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 Map and Source Map Citations

The GRI digital geologic-GIS <maps/map> for Kings Mountain National Military Park, South Carolina (KIMO):

GRI Digital Geologic Map of Kings Mountain National Military Park and Vicinity, South Carolina (*GRI MapCode KIMO*)

Horton, J.W., Jr., 2008, Geologic map of the Kings Mountain and Grover quadrangles, Cleveland and Gaston Counties, North Carolina, and Cherokee and York Counties, South Carolina: U.S. Geological Survey Scientific Investigations Map SIM-2981, 1 sheet, scale 1:24,000. (Kings Mountain and Grover Quadrangles) (*GRI Source Map ID 75063*)

Howard, Scott, 2005, Geologic Map of the Kings Creek Quadrangle, Cherokee and York Counties, South Carolina: South Carolina Geological Survey Geologic Quadrangle Map GQM-16, 1:24,000 scale. (Kings Creek Quadrangle) (GRI Source Map ID 74617)

Nystrom, Paul G., Jr., 2003, Geologic Map of the Filbert Quadrangle, York County, South Carolina: South Carolina Geological Survey Geologic Quadrangle Map GQM-25, 1:24,000 scale. (Filbert Quadrangle) (GRI Source Map ID 74616)

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

Map Unit List

The geologic units present in the digital geologic-GIS data produced for Kings Mountain National Military Park, South Carolina (KIMO) 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 GRI Geologic Unit Information (KIMOUNIT) table included with the GRI geology-GIS data. Some source unit symbols, names and/or ages may have been changed in this document and in the GRI digital geologic-GIS data. This was done if a unit was considered to be the same unit as one or more units on other source maps used for this project, and these unit symbols, names and/or ages differed. In this case a single unit symbol and name, and the unit's now recognized age, was adopted. Unit symbols, names and/or ages in a unit descriptions, or on a correlation of map units or other source map figure were not edited. If a unit symbol, name or age was changed by the GRI the unit's source map symbol, name and/or age appears with the unit's source map description.

Cenozoic Era

Quaternary Period

Qdm - Dam material
Qaf - Artificial fill
Qal - Alluvium
Qc - Colluvium

Mesozoic Era

Jurassic Period

Jd - Olivine diabase dike

Paleozoic Era

Pennsylvanian Period

PNhs - High Schoals Granite
PNy - York Pluton
PNyf - York Pluton, fine grained leucocratic facies

Mississippian Period

Mc - Muscovite-biotite granite
Mcp - Coarse grained granite and pegmatite
Mp - Granite pegmatite
Ms - Spodumene pegmatite

Devonian Period

Dtg - Toluca Granite

Paleozoic Era - Proterozoic Eon

PZPCgd - Metadiorite and metagabbro

Inner Piedmont Layered Metamorphic Rocks
- CPCbg - Muscovite, biotite gneiss
- CPCs - Muscovite schist
- CPCa - Amphibolite

Proterozoic Eon

Neoproterozoic Era

Charlotte Belt Units of the Carolina Terrane
- PCambgn - Amphibolite and biotite gneiss
- PCms - Mica schist
- PCq - Quartzite
- PCmto - Metatonalite

**Note: The following rock units from PCtrs through PCto have been moved above the Kings Mountain Sequence in order to group the Blacksburg and Battleground Formations together for this list. Correlation diagrams suggest units PCtrs through PCto were deposited either before or during deposition of the Blacksburg Formation.*

PCtrs - Interlayered mafic and felsic gneiss - south
PCtr - Metatrondhjemite and amphibole gneiss
PCts - Silicified metatrondhjemite
PCtom - Metatonalite with mafic layers
PCto - Metatonalite and volcaniclastic rocks

Kings Mountain Sequence of the Carolina Terrane

Blacksburg Formation
- PCbls - Phyllitic metasiltstone
- PCblq - Laminated micaceous quartzite
- PCblm - Marble member of Dixon Branch
- PCblg - Gaffney Marble Member
- PCbla - Hornblende gneiss and amphibolite
- PCblc - Chlorite phyllonite

Battleground Formation
- PCbdt - Metadacite and metatrondhjemite
- PCbs - Quartz sericite phyllite and schist
- PCbmc - Crowders Creek Metaconglomerate Member
- PCbmq - Micaceous quartzite
- PCbd - Draytonville Metaconglomerate Member
- PCbj - Jumping Branch Manganiferous Member
- PCbmp - Mottled phyllitic metatuff
- PCbc - Dixon Gap Metaconglomerate Member
- PCbaq - Aluminous quartzite
- PCkq - Kyanite quartzite
- PCbms - Biotite muscovite schist
- PCbvc - Volcanic metaconglomerate
- PCbmps - Siliceous metatuff
- PCbct - Plagioclase crystal metatuff

PCbgs - Greenstone
PCbfs - Felsic schist and gneiss (metafelsite)
PCbht - Metavolcanic hornblende gneiss

Map Unit Descriptions

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

Qdm - Dam material (Holocene)

me - Dam Material (Holocene) - Ninetynine Island Dam. (*GRI Source Map ID 4149)* (Kings Creek Quadrangle).

Qaf - Artificial fill (Holocene)

af - Artificial fill (Holocene)
Unconsolidated material in areas filled for construction of roads, dams, and buildings. (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

Qal - Alluvium (Holocene)

Qal - Quaternary Alluvium (Quaternary)
Alluvial sediments deposited in the flood plains of streams. The sediments are mainly poorly sorted, fine- to very coarse-grained quartz sand with lesser amounts of silt and clay, and with sporadically distributed gravel lenses. These deposits are locally 600 to 800 feet wide along the larger streams and may be 20 feet thick. Such deposits have the potential for commercial sand and gravel production. (*GRI Source Map ID 4147).* (Filbert Quadrangle).

al - Alluvium (Quaternary)
Deposits of sand and gravel with lesser amounts of silt and clay accumulated in flood plains of major stream. (*GRI Source Map ID 4149)* (Kings Creek Quadrangle).

Qal - Alluvium (Holocene)
Unconsolidated stream deposits of gravel, sand, silt, and clay. (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

Qc - Colluvium (Holocene and Pleistocene)

Qc - Colluvium (Holocene and Pleistocene)
Coarse cobbles, boulders, and blocks of quartzite that were transported by gravity and modified by freeze-thaw cycles on the slopes of Kings Mountain and Crowders Mountain. (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

Jd - Olivine diabase dike (Early Jurassic)

Jd - Olivine diabase dikes (Early Jurassic, 200 Ma)
Unmetamorphosed, dark-gray, fine- to medium-grained rock composed of labradorite, augite, olivine, and accessory disseminated magnetite. The characteristic ophitic texture is marked by narrow labradorite laths partly enclosed by augite and olivine. The dikes are near vertical and in Filbert quadrangle trend N30E to N50E. One dike was traced for 6 miles and several others for 1 to 2 miles. They were mapped from the angular to rounded boulders produced from weathering. The boulders range in size from 6 inches to several feet in diameter. The mantle-derived basaltic dikes were conduits that fed structurally higher sills or basalt flows that have long since been removed by erosion. They are part of the Central

Atlantic Magmatic Province (CAMP), the most extensive igneous province on earth. Included within the province are sills, flows, and dike swarms in eastern North America, Brazil, western Africa, Spain, and France. The magmatic province marks the rifting of the supercontinent Pangea and the initial formation of the Atlantic Ocean basin. The magmatism closely coincides in age with the Triassic-Jurassic extinction boundary and has been proposed as the cause of that worldwide extinction. (*GRI Source Map ID 4147)* (Filbert Quadrangle).

Jd - Diabase (Jurassic)
Mostly fine to very fine crystalline mafic igneous rock. Composed of pyroxene and plagioclase; ophitic textures present in coarse-grained varieties. Found as meter-thick layers at high angle to main foliation. Although not always traceable, outcrops occur along strike for several hundred meters. Most dikes trend northwest with near-vertical dips. (*GRI Source Map ID 4149)* (Kings Creek Quadrangle).

Jd - Olivine diabase (Early Jurassic)
Unmetamorphosed, dark-gray, fine- to medium-grained diabase having uniform composition and texture. Composed of labradorite, augite, olivine, and accessory disseminated magnetite. Ophitic texture is common. Dikes strike northwest and generally range up to 5 m in thickness. Mapped largely on the basis of float; dike thickness increased on map to enhance legibility. (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

PNhs - High Schoals Granite (Pennsylvanian)

PNhs - High Schoals Granite (Pennsylvanian)
Very-light-gray, coarse-grained, porphyritic, gneissic biotite granite or granitic augen gneiss. Consists of oligoclase and albite (35 percent), microcline (25 percent), quartz (22 percent), brown biotite (13 percent), myrmekite (3 percent), sphene (1 percent), magnetite-ilmenite and pyrite (1 percent), and trace amounts of epidote, allanite, zircon and apatite (Horton and Butler, 1977, p. 137). White, euhedral to subhedral microperthitic (5 percent albite) microcline phenocrysts average about 1.5 cm in length. Carlsbad twinning is common. Phenocrysts are subparallel to foliation as defined by biotite. Oligoclase occurs as zoned, euhedral to subhedral crystals which are 1 to 5 mm long. Sodic oligoclase or albite occurs as small grains, some of which are myrmekitic, and as rims around larger oligoclase crystals. Myrmekite also occurs as embayments in microcline where oligoclase is in contact. Lenticular inclusions (screens) of country rock characterize the High Schoals in the Kings Mountain quadrangle. (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

PNy - York Pluton (Early Pennsylvanian, 321 +/-2 Ma.)

Pny - York Pluton (Early Pennsylvanian, 321+/-2Ma ; Samson, 2001)
The York pluton, one of the oldest Alleghanian granites, is an unmetamorphosed, coarse-grained, porphyritic, light-gray adamellite composed of microcline, plagioclase, quartz, biotite, muscovite, and opaque minerals. Residual boulders 10 to 30 feet in diameter are common, as are spectacular pedestal rocks and large pavement outcrops. A light-colored, porous, well-drained sandy soil develops on the adamellite, and much of the land is used for pasture and peach orchards. In contrast, the surrounding country-rock terrain yields clayey soils, and most of that is forest land. The pluton underlies most of the eastern part of the Filbert quadrangle. Butler (1966) mapped a single pluton underlying the town of York and extending north about 7 miles. This map shows that there are two plutons separated by several thousand feet of older country rock along Turkey Creek south of Filbert community. The two plutons appear to be composed of the same rock and may or may not be connected at depth. (*GRI Source Map ID 4147)* (Filbert Quadrangle).

PNyf - York Pluton, fine grained leucocratic facies (Early Pennsylvanian, 321 +/-2 Ma.)

PNyf - York Pluton (Early Pennsylvanian, 321+/-2Ma ; Samson, 2001)
Finer grained and more leucocratic facies of the pluton. (*GRI Source Map ID 4147)* (Filbert Quadrangle).

Mc - Muscovite-biotite granite (Mississippian)

Mc - Muscovite-biotite granite (Mississippian)
Very-light-gray, medium- to coarse-grained, and weakly-foliated granite. Consists of microcline, oligoclase, quartz, biotite, and muscovite. Accessories include magnetite-ilmenite, apatite, zircon, chlorite, epidote, and rarely beryl. Contacts are mostly concordant but locally discordant to country rock foliation. Whole-rock Rb-Sr age is 351 ± 20 Ma (2σ) (Kish and Fullagar, 1996) (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

Mcp - Coarse grained granite and pegmatite (Mississippian)

Mcp - Coarse-grained granite and pegmatite (Mississippian)
Very-light-gray, coarse-grained biotite-muscovite granite grading into pegmatite and crosscut by pegmatite dikes; granite composed mainly of microcline, oligoclase, quartz, muscovite, and biotite; includes graphic granite; weakly foliated. (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

Mp - Granite pegmatite (Mississippian)

Mp - Granite pegmatite (Mississippian)
White, coarse-grained pegmatite composed mainly of micro-cline, oligoclase, quartz, muscovite, and biotite. Euhedral garnet as much as 1 cm in diameter is a common accessory. Other accessories include magnetite-ilmenite, zircon, apatite, beryl, and chlorite. Composition is similar to that of the Cherryville Granite, but muscovite is more abundant and biotite is less abundant. Large books of mica are undeformed. Textures visible in hand samples include graphic intergrowths of feldspar and quartz, overgrowths of muscovite on biotite, and plumose cones of muscovite intergrown with quartz. Whole-rock Rb-Sr age is 341±40 Ma (2σ) (Kish and Fullagar, 1996). Occurs as swarms of irregular dikes, sills, and pods up to a few meters thick near southeastern contact of Cherryville Granite. Pegmatite swarms shown by overprint pattern. (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

Ms - Spodumene pegmatite (Mississippian)

Ms - Spodumene pegmatite (Mississippian)
White, medium-to coarse-grained, and generally unzoned pegmatite. Composed of spodumene, microcline, quartz, albite, and muscovite. Trace amounts of beryl, manganapatite, ferrocolumbite, cassiterite, and zircon are present. Secondary minerals such as vivianite, fluorapatite, and siderite occur in fractures and vugs. Only spodumene and microcline commonly exceed 2 cm in size, which defines a pegmatite; these crystals are rarely longer than 30 cm. Spodumene and microcline are commonly fractured and the fractures are filled with a sugary matrix of albite and quartz. Yellowish-white muscovite crystals, commonly twisted, are typically less than 2 cm long. Whole-rock Rb-Sr age is 340±10 Ma (2σ) (Kish and Fullagar, 1996). Pegmatites occur as dikes and sills in a narrow belt in and just west of the Kings Mountain shear zone, and are most abundant in and near bodies of amphibolite. Pegmatites range from nonfoliated to strongly foliated, and locally crosscut foliation in the Kings Mountain shear zone. Locally, particularly near wall-rock contacts, blastomylonitic or augen-gneiss texture is developed . (*GRI*

Source Map ID 75063) (Kings Mountain and Grover Quadrangles).

Dtg - Toluca Granite (Devonian)

Dtg - Toluca Granite (Devonian)
Very-light-gray, medium- to coarse-grained, strongly foliated biotite granite and subordinate granodiorite composed of oligoclase, microcline, quartz, biotite, and minor muscovite. Accessories include garnet, monazite, ilmenite, rutile,sillimanite, apatite, and zircon. Bodies are generally conformable to regional foliation in surrounding muscovite-biotite gneiss; foliation within the granite is not always parallel to contacts, perhaps due to rheological differences. Recent ion-microprobe U-Pb geochronology of zircons indicates a Devonian age of ~378 Ma for the Toluca Granite (Mapes, 2002). (GRI Source Map ID 75063) (Kings Mountain and Grover Quadrangles).

PZPCgd - Metadiorite and metagabbro (Paleozoic? or Neoproterozoic)

mdi - Metadiorite (Neoproterozoic)
Several northeast-trending belts of coarse-grained metadiorite alternate with belts of metatonalite in the Charlotte belt part of the map area. This map unit is mainly composed of hornblende metadiorite with lesser biotite metagranodiorite. The rock has a speckled appearance due to the dark grains of hornblende or biotite in a light-colored background of plagioclase and quartz. The metadiorite is composed of andesine and hornblende with lesser biotite and less than 10 percent quartz. The metagranodiorite has more biotite than hornblende and more than 10 percent quartz. In creek beds the massive to weakly foliated metadiorite is well exposed as large rounded boulders or as pavement exposures. Because the rock tends to weather deeply, outcrops are uncommon away from creek beds, but the unit yields a distinctive greenish-brown clayey soil that is an aid to mapping. (*GRI Source Map ID 4147)* (Filbert Quadrangle).

mgb - Metagabbro (Neoproterozoic)
Dark greenish-gray to greenish-black, fine- to coarse-crystalline mafic rock, composed of hornblende and plagioclase, some mafic grains may be relict pyroxene. Variable amounts of plagioclase control color index of rock. Near contact with adjacent unit, the metagabbro is commonly interlayered with epidosite, fine-grained hornblende gneiss, and felsic schist. Faint compositional layering visible in places, which may be vestiges of original igneous layering. Possibly correlative with Horton's (2000) metagabbro and metadiorite. (*GRI Source Map ID 4149)* (Kings Creek Quadrangle).

Pzgd - Metadiorite and metagabbro (Paleozoic?)
Darkgray, medium- to coarse-grained hornblende-quartz gabbro and hornblende-quartz diorite. Textures range from massive to strongly foliated and gneissic. Composed mainly of labradorite or andesine, green hornblende, and quartz, with variable amounts of epidote, accessory biotite, and magnetite. Small bodies crop out in the southern part of the Kings Mountain quadrangle. Dikes of similar rock (too small to show on the map) crosscut the metatonalite (Zto) . (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

CPCbg - Muscovite, biotite gneiss (Cambrian or Neoproterozoic)

Czbg - Muscovite-biotite gneiss (Cambrian or Neoproterozoic)
Light-gray to dark-gray, fine- to medium-grained, muscovite-biotite gneiss composed of quartz, oligoclase, biotite, muscovite, and lesser amounts of sillimanite and garnet; accessory magnetite is common. The gneiss is inequigranular, well foliated and layered, and locally mylonitic, and it contains minor schist interlayers. Equivalent to “unit 6” of Overstreet and others (1963). (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

CPCs - Muscovite schist (Cambrian or Neoproterozoic)

Czs - Muscovite schist (Cambrian or Neoproterozoic)
Yellowish-gray, medium-grained schist composed mainly of muscovite, quartz, minor biotite, and locally oligoclase. Garnet, staurolite, and kyanite are locally present; secondary chlorite is a common accessory. Muscovite flakes average 2 mm in length and quartz grains average 1 mm in diameter. Weathered schist is grayish pink to pale red. Composition indicates metamorphosed pelitic sediment. Coarse-grained and quartz-rich near Cherryville Granite and associated pegmatites. Radial clusters of tourmaline are common in schist near spodumene pegmatite. (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

CPCa - Amphibolite (Cambrian or Neoproterozoic)

Cza - Amphibolite (Cambrian or Neoproterozoic)
Darkgray, fine-grained, equigranular, layered amphibolite composed of a metamorphic mineral assemblage of plagioclase and hornblende with smaller amounts of diopside, calcite, epidote, and quartz. Accessories include sphene, apatite, and pyrrhotite. Biotite and chlorite are present adjacent to schist layers. Calcite-rich layers occur locally. (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

PCambgn - Amphibolite and biotite gneiss (Neoproterozoic)

Zambgn - Amphibolite and biotite gneiss (Neoproterozoic)
Composed of thinly layered, fine grained amphibolite and thinly foliated, medium-grained biotite gneiss. Fine-grained, gray, felsic rocks with contorted layering and disrupted amphibolite layers also occur in the map unit. It is located in the southern part of the quadrangle and is bounded on the northwest and southeast by belts of metatonalite. (*GRI Source Map ID 4147)* (Filbert Quadrangle).

PCms - Mica schist (Neoproterozoic)

Zms - Mica schist (Neoproterozoic)
Somewhat silicified sericite phyllite stained purple and brown. Indistinguishable from some of the phyllite in the hydrothermal alteration zone near Henry Knob.. (*GRI Source Map ID 4147)* (Filbert Quadrangle).

PCq - Quartzite (Neoproterozoic)

q - Quartzite (Neoproterozoic)
Small bodies of fine-grained, granular, purple- and brown-stained quartzose rock with poorly defined foliation characterized by numerous small voids or pits from the weathering of pyrite. (*GRI Source Map ID 4147)* (Filbert Quadrangle).

PCmto - Metatonalite (Neoproterozoic)

Zto - Metatonalite (Neoproterozoic)
Medium-gray or tan, coarse- to very coarse-grained rock mainly composed of oligoclase, blue quartz, biotite, muscovite, and locally hornblende. Accessory minerals include epidote, chlorite, apatite, calcite, sphene, zircon, pyrite, and magnetite. Exposures are massive to moderately well foliated. Elongate lens-shaped inclusions of sericite phyllite can be seen in some outcrops. At a number of localities, mafic inclusions several inches in diameter are evident. An intrusive origin is indicated by the inclusions of phyllite and mafic rocks and the coarse-grained granitic textures. Probably originated as shallow intrusions associated with volcanism in the Kings Mountain belt. This metatonalite is exposed in the

western and northwestern parts of the map area along the trace of the South Fork antiform. Correlative with Horton's(2000) metatonalite (Zto). (*GRI Source Map ID 4147)* (Filbert Quadrangle).

Zto - Metatonalite and volcaniclastic rocks (Neoproterozoic) Felsic rock of mixed origin and consisting of intrusive tonalite, dacitic flows, and epiclastic byproducts of both. The distinction between intrusive, extrusive, and sedimentary rocks is virtually indistinguishable in places. Metatonalite is coarse-grained with quartz, feldspar, biotite, and blue quartz granules. It has a homogeneous fabric with poorly developed, discontinuous biotite folia. Mafic inclusions, xenoliths, are common. Weathered rock produces granule-rich soil with blocky feldspar and rounded quartz. Correlative in part with Horton's (2000) metatonalite (intrusive). Flows and epiclastic rocks are schists and poorly foliated gneisses, fine to medium grained. Rock matrix is composed of quartz and feldspar with rounded blue quartz granules (2-4 mm); accessory chlorite, pyrite, and magnetite. Folia consist of white mica and chlorite. Within a sample, grain size ranges from very fine to coarse, and the overall appearance of the rock is referred to as "garbage can." Sedimentary portions are probably equivalent to biotite-chlorite-muscovite schist (Zbms). (*GRI Source Map ID 4149)* (Kings Creek Quadrangle).

Zto - Metatonalite (Neoproterozoic)
Largely verylight-gray to medium-gray, medium- to coarse-grained metatonalite composed of oligoclase and quartz with minor albite, biotite, muscovite, and locally hornblende. Common accessories include epidote, sphene, chlorite, magnetite, pyrite, zircon, and apatite. Microcline and orthoclase are present in some places. Unit is predominantly biotite tonalite but contains minor amounts of hornblende tonalite, trondhjemite, and granodiorite. Textures range from weakly foliated to schistose. Angular xenoliths and granitic textures indicate an intrusive origin. May have originated as shallow intrusions associated with volcano-genic deposits of the Battleground Formation. Unit equivalent, in part, to “metatonalite and volcaniclastic rocks” of Howard (2004). (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

PCbls - Phyllitic metasiltstone (Neoproterozoic)

Zbls - Phyllitic metasiltstone and Quartzite (Neoproterozoic)
Very pale orange, micaceous metasiltstone with very fine to fine grained and lineated quartzite float. Rock is composed chiefly of quartz, feldspar, and white mica. Compositional layering consists of quartz layers and fine white mica domains, less than 1 cm. Scattered pieces of dark-greenish-gray phyllonite are probably interlayered. Correlative with Horton's (2000) phyllitic metasiltstone and laminated micaceous quartzite members of the Blacksburg Formation. (*GRI Source Map ID 4149)* (Kings Creek Quadrangle).

Zbls - Phyllitic metasiltstone (Neoproterozoic)
Light-gray to dark-gray, fine-grained, variably phyllitic metasiltstone, composed mainly of quartz and white mica, and smaller amounts of biotite; local accessory minerals include garnet, chloritoid, chlorite, calcite, graphite, and opaque minerals. Quartz grains average about 0.1 mm in diameter. Generally well foliated but locally blocky and quartz-rich. Contacts with other members of the Blacksburg Formation are gradational and interfingering. Generally, quartz-rich metasiltstone is near quartzite and micaceous phyllite is near marble and amphibolite. Locally shows composite planar fabrics and “mica fish” texture. (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

PCblq - Laminated micaceous quartzite (Neoproterozoic)

Zblq - Laminated micaceous quartzite (Neoproterozoic)
White to yellowish-gray, fine- to medium-grained, equigranular, laminated micaceous quartzite with phyllite (schist) layers. Composed of anhedral quartz and disseminated white mica with variable amounts of accessory biotite and magnetite. Laminated appearance is caused partly by foliation banding

and partly by rhythmic layering with phyllite (schist). Individual quartzite and phyllite layers typically have a thickness of a few meters or less. Crops out as discontinuous beds that are not thicker than 140 m. (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

PCblm - Marble member of Dixon Branch (Neoproterozoic)

Zblm - Marble member at Dixon Branch (informal name) (Neoproterozoic)
Very-light-gray to medium-bluish-gray, fine- to coarse-grained calcite marble and dolomitic marble. Composed of calcite or dolomite (80–90 percent), phlogopite, and locally tremolite. Graphite is a common accessory. Compositional banding is well defined by layers of pale-olive calc-silicate rock composed of tremolite, quartz, and phlogopite with smaller amounts of calcite or dolomite, epidote, and pyrite. Layers of schistose marble contain white mica and chlorite as major constituents. Layers of dark-gray, fine-grained amphibolite composed of hornblende and quartz with minor epidote, calcite, and biotite are also present. Contacts between amphibolite layers and marble are sharp. Maximum thickness 200 m. Unit is well exposed in open-pit quarries. (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

PCblg - Gaffney Marble Member (Neoproterozoic)

Zblg - Gaffney Marble Member (Neoproterozoic)
Very-light-gray to medium-bluish-gray, fine- to coarse-grained calcite marble and dolomitic marble; commonly banded and locally schistose. Similar to marble member at Dixon Branch (Zblm) but generally thinner and not as well exposed as that unit in these quadrangles. (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

PCbla - Hornblende gneiss and amphibolite (Neoproterozoic)

Zbla - Hornblende gneiss and amphibolite (Neoproterozoic)
Dark-gray, fine- to coarse-grained, essentially equigranular hornblende gneiss and amphibolite. Composed of hornblende, plagioclase, quartz, epidote, opaque minerals, and in some places augite. Occurs sporadically as discontinuous, foliation-parallel lenticular sheets. (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

PCblc - Chlorite phyllonite (Neoproterozoic)

Zblc - Chlorite phyllonite (Neoproterozoic)
Light-greenish-gray, fine- to medium-grained chlorite phyllonite. Composed primarily of chlorite (20–40 percent), quartz, and plagioclase. Common accessory minerals are epidote, hornblende, opaque minerals, white mica, and graphite. Texture is phyllonitic or blastomylonitic. Plagioclase porphyroclasts up to 4 mm in diameter are subrounded to rounded and strongly saussuritized. The abundance of chlorite and plagioclase with smaller amounts of hornblende and epidote suggests a retrogressively altered hornblende gneiss. Lenses of light-bluish-gray, banded dolomitic marble lie within the chlorite phyllonite at the Kings Mountain gold mine (Keith and Sterrett, 1931, fig. 4; LaPoint, 1992). (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

PCtrs - Interlayered mafic and felsic gneiss - south (Neoproterozoic)

Ztrs - Interlayered mafic and felsic gneiss (Neoproterozoic)
White to very light gray, medium to finely crystalline felsic gneiss with seriate texture. Felsic gneiss composed of feldspar, quartz, and muscovite. Scattered clasts of feldspar 2-3 mm, and accessory biotite, chlorite, and epidote(?). Dark phyllosilicates define streaky lineation. Mafic gneiss is dark greenish-gray to greenish-black, medium- to coarse-grained hornblende gneiss; composed of hornblende and feldspar; hornblende needles up to 4mm long. Strong, near-horizontal mineral lineation is found along sheared northwestern and southeastern contacts in Ztrn, excellent L-tectonite fabric. Mafic and felsic interlayering occurs on a variety of scales, usually visible within an outcrop, meters to tens of meters. Preliminary interpretation at the time of mapping suggests that, based on similar scale of layering and outward appearance, the northern and southern units are the same, possibly connected by folding. The southern unit (Ztrs) is exposed in the core of the South Creek antiform. The northern unit (Ztrn) is correlative with Horton's Metatrondhjemite. (*GRI Source Map ID 4149)* (Kings Creek Quadrangle).

PCtr - Metatrondhjemite and amphibole gneiss (Neoproterozoic)

Ztrn - Interlayered mafic and felsic gneiss (Neoproterozoic)
White to very light gray, medium to finely crystalline felsic gneiss with seriate texture. Felsic gneiss composed of feldspar, quartz, and muscovite. Scattered clasts of feldspar 2-3 mm, and accessory biotite, chlorite, and epidote(?). Dark phyllosilicates define streaky lineation. Mafic gneiss is dark greenish-gray to greenish-black, medium- to coarse-grained hornblende gneiss; composed of hornblende and feldspar; hornblende needles up to 4mm long. Strong, near-horizontal mineral lineation is found along sheared northwestern and southeastern contacts in Ztrn, excellent L-tectonite fabric. Mafic and felsic interlayering occurs on a variety of scales, usually visible within an outcrop, meters to tens of meters. Preliminary interpretation at the time of mapping suggests that, based on similar scale of layering and outward appearance, the northern and southern units are the same, possibly connected by folding. The southern unit (Ztrs) is exposed in the core of the South Creek antiform. The northern unit (Ztrn) is correlative with Horton's Metatrondhjemite. (*GRI Source Map ID 4149)* (Kings Creek Quadrangle).

Ztr - Metatrondhjemite and amphibole gneiss (Neoproterozoic)
Metatrondhjemite (felsic gneiss of trondhjemite composition) and less abundant amphibole gneiss interlayers. Metatrondhjemite is very light gray to yellowish gray, fine to medium grained, weakly foliated to schistose to gneissic, and composed mainly of plagioclase (oligoclase and albite) and quartz with accessory biotite, muscovite, and chlorite. Amphibole gneiss is dark greenish gray, mostly medium grained, and composed mainly of plagioclase, actinolite, hornblende, and chlorite. Interlayering at centimeter-to-meter scales is mostly concordant, but metatrondhjemite locally crosscuts amphibole gneiss (Murphy and Butler, 1981). Previously mapped as “metatrondhjemite” (Goldsmith and others, 1988); coextensive with rocks to the southwest mapped as “interlayered mafic and felsic gneiss” (Howard, 2004), “metatrondhjemite-amphibolite complex” (Murphy and Butler, 1981), and “metatrondhjemite with numerous mafic dikes” (Butler, 1981b)). (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

PCts - Silicified metatrondhjemite (Neoproterozoic)

Zts - Silicified metatrondhjemite (Neoproterozoic)
White to tan to pale-green, massive metatrondhjemite; composed mainly of plagioclase and quartz; accessory minerals include magnetite (0–3 percent), disseminated pyrite (1–2 percent), sericitic white mica, and chlorite. Contains abundant crosscutting quartz veins and gold-bearing mineralized zones. Occurs as a single body previously described as silicified porphyry (LaPoint, 1992). Interpreted as

hypabyssal(?) intrusion into metadacite of undivided metadacite and metatrondhjemite unit (Zbdt). (GRI Source Map ID 75063) (Kings Mountain and Grover Quadrangles).

PCtom - Metatonalite with mafic layers (Neoproterozoic)

Ztom - Metatonalite with mafic layers (Neoproterozoic)
Areas of metatonalite with greater proportion of mafic enclaves or xenoliths, enough to map. Large (meters) mafic inclusions of hornblende gneiss and epidosite are found throughout the unit, sometimes as layers continuous for tens of meters. (*GRI Source Map ID 4149)* (Kings Creek Quadrangle).

PCto - Metatonalite and volcaniclastic rocks (Neoproterozoic)

Zto - Metatonalite (Neoproterozoic)
Medium-gray or tan, coarse- to very coarse-grained rock mainly composed of oligoclase, blue quartz, biotite, muscovite, and locally hornblende. Accessory minerals include epidote, chlorite, apatite, calcite, sphene, zircon, pyrite, and magnetite. Exposures are massive to moderately well foliated. Elongate lens-shaped inclusions of sericite phyllite can be seen in some outcrops. At a number of localities, mafic inclusions several inches in diameter are evident. An intrusive origin is indicated by the inclusions of phyllite and mafic rocks and the coarse-grained granitic textures. Probably originated as shallow intrusions associated with volcanism in the Kings Mountain belt. This metatonalite is exposed in the western and northwestern parts of the map area along the trace of the South Fork antiform. Correlative with Horton's (2000) metatonalite (Zto). (*GRI Source Map ID 4147)* (Filbert Quadrangle).

Zto - Metatonalite and volcaniclastic rocks (Neoproterozoic)
Felsic rock of mixed origin and consisting of intrusive tonalite, dacitic flows, and epiclastic byproducts of both. The distinction between intrusive, extrusive, and sedimentary rocks is virtually indistinguishable in places. Metatonalite is coarse-grained with quartz, feldspar, biotite, and blue quartz granules. It has a homogeneous fabric with poorly developed, discontinuous biotite folia. Mafic inclusions, xenoliths, are common. Weathered rock produces granule-rich soil with blocky feldspar and rounded quartz. Correlative in part with Horton's (2000) metatonalite (intrusive). Flows and epiclastic rocks are schists and poorly foliated gneisses, fine to medium grained. Rock matrix is composed of quartz and feldspar with rounded blue quartz granules (2-4 mm); accessory chlorite, pyrite, and magnetite. Folia consist of white mica and chlorite. Within a sample, grain size ranges from very fine to coarse, and the overall appearance of the rock is referred to as "garbage can." Sedimentary portions are probably equivalent to biotite-chlorite-muscovite schist (Zbms). (*GRI Source Map ID 4149)* (Kings Creek Quadrangle).

Zto - Metatonalite (Neoproterozoic)
Largely verylight-gray to medium-gray, medium- to coarse-grained metatonalite composed of oligoclase and quartz with minor albite, biotite, muscovite, and locally hornblende. Common accessories include epidote, sphene, chlorite, magnetite, pyrite, zircon, and apatite. Microcline and orthoclase are present in some places. Unit is predominantly biotite tonalite but contains minor amounts of hornblende tonalite, trondhjemite, and granodiorite. Textures range from weakly foliated to schistose. Angular xenoliths and granitic textures indicate an intrusive origin. May have originated as shallow intrusions associated with volcano-genic deposits of the Battleground Formation. Unit equivalent, in part, to “metatonalite and volcaniclastic rocks” of Howard (2004). (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

PCbdt - Metadacite and metatrondhjemite (Neoproterozoic)

Zbdt - Metadacite and metatrondhjemite (Neoproterozoic)
Very-light-gray to yellowish-gray, fine- to medium-grained, felsic muscovite-biotite-quartz-plagioclase gneiss interpreted as metadacite and metatrondhjemite (undivided). Consists of plagioclase, blue quartz, and minor biotite; common accessories include sericitic white mica and chlorite. Locally mylonitic. Metadacite of this unit is intruded by silicified metatrondhjemite (Zts). Relicts of primary structures in drill core from the Kings Mountain gold mine area suggest that dacite of this uppermost unit within the Battleground Formation is stratigraphically overlain by the Blacksburg Formation (LaPoint, 1992), although contacts are highly sheared. Unit includes rocks previously mapped as Bessemer Granite (Keith and Sterrett, 1931), felsic gneiss (Horton, 1977), metatrondhjemite (Goldsmith and others 1988), and metadacite (LaPoint, 1992). (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

PCbs - Quartz sericite phyllite and schist (Neoproterozoic)

Zbs - Quartz schist, metasiltstone, and phyllite (Neoproterozoic)
Very pale orange and grayish-yellow, fine-to medium-grained quartzofeldspathic rock, includes quartz schist, meta-arenite, metasiltstone, and metaconglomerate. Phyllite is darker: gray, pale red purple, and brownish-gray. Thin compositional layering of metasiltstone and phyllite is common. Correlative with Horton's (2000) metasedimentary unit of the Battleground Formation. (*GRI Source Map ID 4149)* (Kings Creek Quadrangle).

Zbs - Quartz-sericite phyllite and schist (Neoproterozoic)
Very-light-gray to light-bluish-gray, light-brown, or yellowish- Zbd gray, very-fine- to medium-grained phyllite and schist, composed mainly of quartz and sericitic white mica (muscovite and (or) paragonite). Local accessory and trace minerals include plagioclase (oligoclase or albite), biotite, garnet, chloritoid or staurolite, kyanite, andalusite, chlorite, graphite, tourmaline, zircon, pyrite, and hematite, depending in part on metamorphic grade. Chloritoid porphyroblasts, 0.1 to 10 mm long, are common but not in association with biotite. Unit is locally quartzose; high-alumina minerals are most abundant near aluminous quartzite. Disseminated hematite is responsible for the bluish-gray color in parts of the unit. Contacts with interlayered metavolcanic facies are gradational and interfingering. Unit generally equivalent to “quartz schist, metasiltstone, and phyllite” of Howard (2004) and “metasedimentary rocks” (“msd”) of Murphy and Butler (1981); includes “chloritoid schists” (“csu” and “csl”) of Espenshade and Potter (1960, pl. 7) and informal “Lake Montonia sequence” of LaPoint (1992). (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

PCbmc - Crowders Creek Metaconglomerate Member (Neoproterozoic)

Zbmc - Crowders Creek Metaconglomerate Member (Neoproterozoic)
Very-light-gray to yellowish-gray, coarse-grained, schistose quartz-pebble metaconglomerate. Quartz pebbles average about 1 cm in diameter and are moderately well sorted, generally subrounded, and flattened in the plane of schistosity. The matrix is composed of quartz, white mica, chlorite, and accessory magnetite and pyrite. Ranges from clast-supported metaconglomerate, to matrix-supported pebbly metasandstone with fewer clasts, to flaggy micaceous metasandstone. Maximum thickness about 15 m. Described by France and Brown (1981, p. 96) as “bed E” and previously mapped as the Draytonville Conglomerate Member (Keith and Sterrett, 1931) or “schistose conglomerate” (Espenshade and Potter, 1960). (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

PCbmq - Micaceous quartzite (Neoproterozoic)

Zbmq - Micaceous quartzite (Neoproterozoic)
White to yellowish-gray, fine- to medium-grained, equigranular, micaceous quartzite (metasandstone) with phyllite or schist layers. Composed mostly of quartz and disseminated white mica with variable amounts of accessory biotite and magnetite. Schist and phyllite layers are generally a few meters thick or less. Individual beds, including schist layers, are not thicker than 50 m. Occurs as discontinuous beds and lenses at several stratigraphic levels. Micaceous quartzite (Zbmq) at Yellow Ridge is interpreted to be stratigraphically higher than the Jumping Branch Manganiferous Member (Zbj) and lower than the Crowders Creek Metaconglomerate Member (Zbmc). (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

PCbd - Draytonville Metaconglomerate Member (Neoproterozoic)

Zbd - Draytonville Metaconglomerate Member (Neoproterozoic)
Very-light-gray to medium-light-gray, coarse-grained, quartz-pebble metaconglomerate and pebbly metasandstone; matrix-supported. Quartz pebbles are moderately sorted, rarely larger than 1 cm, and flattened in the plane of foliation (commonly at an angle to bedding). The medium-light-gray matrix is composed of poorly sorted quartz grains averaging 1.5 mm in diameter, white mica, and variable smaller amounts of chloritoid and opaque minerals. Metaconglomerate grades laterally into massive to friable metasandstone northeast of State Route 161. Unit is crudely sorted, with poorly developed graded bedding observed in a few places. Thickness ranges from about 10 to 34 m. Described at Draytonville Mountain, S.C. (Hatcher and Morgan, 1981), at another locality in South Carolina (Horton and others, 1981, p. 239–240), and in North Carolina under the informal name “bed D” (France and Brown, 1981). Stratigraphically higher than the Jumping Branch Manganiferous Member (Zbj). (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

PCbj - Jumping Branch Manganiferous Member (Neoproterozoic)

Zbjp - Jumping Branch member (Neoproterozoic)
Brownish-gray or "chocolate" phyllite with manganese oxides is correlative with Horton's Jumping Branch member. Additional locations of manganiferous phyllite are described in Murphy and Butler (1981). (*GRI Source Map ID 4149)* (Kings Creek Quadrangle).

Zbj - Jumping Branch Manganiferous Member (Neoproterozoic)
Light-gray to light-brown, fine-grained, equigranular garnet (50–70 percent)-quartz rock (coticule or gondite) closely interlayered with light-gray to light-brown, fine-grained, quartz-sericite phyllite and schist. Accessories include biotite, hematite, and locally hornblende and white mica. The garnet is spessartine-almandine; grains are rounded, average 0.1 mm in diameter, and although widely disseminated, are concentrated in rhythmic bands less than 1 cm thick. Quartz grains are polygonal and average 0.15 mm in diameter. Unlike the relatively massive coticule or gondite, the quartz-sericite phyllite and schist interlayered with it is strongly foliated. It is composed of quartz, white mica, biotite, and variable amounts of spessartine-almandine. Unweathered rock (rarely exposed) resembles the adjacent quartz-sericite phyllite and schist (Zbs). Weathered rock, saprolite, and soil are readily distinguished by the characteristic dusky-brown stain of manganese oxides such as pyrolusite and psilomelane. (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

PCbmp - Mottled phyllitic metatuff (Neoproterozoic)

Zbmp - Mottled phyllite (lapilli metatuff) (Neoproterozoic)
Dark, spotted phyllitic rock, medium bluish-gray, and light to medium gray. Distinctive rounded and

elliptical clast and lapilli component flattened in major foliation plane, which is the cause of the mottled appearance. Clasts have elliptical shapes up to several centimeters long and 1-2 mm thick, and they are composed of fine felsic grains. Lapilli are finely crystalline or microcrystalline, composed of felsic and mafic material, and form discontinuous layers parallel to the main foliation. Phyllite is a dark-colored micaceous rock, which may be caused by very fine disseminated oxides scattered throughout the micaceous matrix. Scattered fine feldspar crystals, approximately 1 mm; the rock has a fine-pitted appearance where feldspar crystals are weathered. Correlative with Horton's (2000) mottled phyllitic metatuff of the Battleground Formation. Kyanite is common around Jefferson Mountain, where it occurs as kyanite quartzite. Tourmaline quartzites are also found in the area. Two other rock types are white metatuff and chloritoid schist. White metatuff is fine grained with a splintery texture and is common around Jefferson Mountain. Chloritoid schist is very pale orange with silky luster; dark-colored chloritoid crystals are 2-4 mm, and minor magnetite octahedra are 1 mm. The hilltop along George road, northeast of Kings Creek and approximately on strike with Jefferson Mountain, has excellent exposure of chloritoid schist. These exotic rocks may represent a siliceous alteration zone, and the zone of alteration is denoted by the red-stippled pattern. Espenshade and Potter (1960, p. 64-95) give a detailed description of the aluminosilicate mineralogy found in the Kings Mountain Sequence. (*GRI Source Map ID 4149)* (Kings Creek Quadrangle).

Zbmp - Mottled phyllitic metatuff (Neoproterozoic)
Light-bluish-gray to medium-dark-gray, stratified, well-foliated, mottled sericite schist and phyllite. Unit is a metamorphosed pyroclastic rock (lapilli metatuff) composed of lithic and crystal (plagioclase) clasts in a fine-grained matrix of quartz, plagioclase, sericitic white mica, and finely disseminated iron-titanium oxides with variable smaller amounts of chloritoid, chlorite, epidote, and unidentified opaque minerals. The mica is interlayered paragonite and muscovite or a mica of intermediate composition; margarite has also been reported. Angular, matrix-supported clasts, which are lapilli-size or smaller, are poorly sorted, heterolithologic, and flattened in the plane of foliation. The distinctive mottled appearance is caused by finely disseminated iron-titanium oxides which are generally more abundant in the matrix than in the clasts. Most clasts are nearly white, but dark-gray clasts also occur. Some clasts resemble rocks in the underlying massive metatuff (Zbct) unit; others have flattened tuning-fork shapes and bubble-wall texture that suggest relict pumice fragments. Individual layers are well-sorted with some possible graded bedding. Locally interbedded with quartz-sericite phyllite and schist (Zbs). Unit equivalent to “mottled phyllite (lapilli metatuff)” of Howard (2004). (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

PCbc - Dixon Gap Metaconglomerate Member (Neoproterozoic)

Zbc - Metaconglomerate (Neoproterozoic)
Contains rounded pebbles and cobbles, partially flattened, of quartzite and occasional clasts of mottled phyllite and occurs in discontinuous ridges along the contact with the mottled phyllite. Clasts are slightly aligned in the major foliation; foliation of white mica anastomoses around wedge-shaped clasts. (*GRI Source Map ID 4149)* (Kings Creek Quadrangle).

Zbc - Dixon Gap Metaconglomerate Member (Neoproterozoic)
Very-light-gray to medium-light-gray, coarse-grained quartz-pebble metaconglomerate. Approximately 90 percent of the clasts are white quartz pebbles. Other clasts include medium-dark-gray magnetite-bearing or ilmenite-bearing quartzite, hornblende gneiss, and quartz-rich phyllite. Pebbles average about 1 cm in diameter and are moderately sorted. They are flattened in the plane of foliation, which is commonly at an angle to bedding, and elongated, having length-to-width ratios ranging from 1:1 to 5:1. The medium-light-gray matrix is composed of poorly sorted quartz grains averaging 1.5 mm in diameter, with white mica and variable smaller amounts of chloritoid, kyanite, and opaque minerals. Unit is typically clast-supported but locally grades into matrix-supported layers having fewer clasts. Poorly developed graded beds at several places, notably in the vicinity of Dixon Gap and on both limbs of the Sherrars Gap synform, provide stratigraphic tops. Estimated thickness ranges from 10 to 40 m. Relatively thick

segments commonly crop out along ridges. Described at the type locality by Horton and Butler (1977, p. 130–132) and Horton and Butler (1986, p. 241–242) and more generally under the informal name “bed C” by France and Brown (1981). Although previously lumped with the “Draytonville Conglomerate Member” by Keith and Sterrett (1931), the Dixon Gap Metaconglomerate Member (unlike the Draytonville Metaconglomerate Member, (Zbd) is stratigraphically lower than the Jumping Branch Manganiferous Member (Zbj). (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

PCbaq - Aluminous quartzite (Neoproterozoic)

Zbaq - Aluminous quartzite (Neoproterozoic)
Includes kyanite quartzite and sillimanite quartzite depending on metamorphic rank. The kyanite quartzite is light gray to medium gray and composed of aggregates or blades of kyanite up to 1 cm long in a matrix of fine-grained quartz Common accessory minerals include andalusite, biotite, white mica, magnetite, and pyrite. Kyanite is typically poikiloblastic with quartz inclusions; it occurs as mats of crystals parallel to foliation or as radial clusters crossing foliation. Where present, andalusite has alteration rims of clay minerals and is cut by unaltered kyanite. Kyanite quartzite crops out as long discontinuous beds and lenses, most of which are stratigraphically equivalent to the Dixon Gap Metaconglomerate Member (Zbc). Two thin beds of sillimanite quartzite crop out near McGill Branch within 500 m of the High Shoals Granite. The medium-gray rock is composed of sillimanite (up to 40 percent) and fine-grained equigranular quartz. Minor constituents include kyanite, andalusite, biotite, white mica, magnetite, and pyrite. Sillimanite occurs as tabular blades up to 4 mm long as well as radial and matted aggregates of fibrolite. Kyanite and andalusite, where present, are rimmed by fibrolitic sillimanite. (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

PCkq - Kyanite quartzite (Neoproterozoic)

Kq - Kyanite Quartzite (Neoproterozoic)
Occurs as well-defined, steeply dipping lenticular beds in the hydrothermal alteration zone southwest of Henry Knob that is within the biotite–muscovite schist. The rock is coarse grained, granular, medium-gray, commonly stained brown or purple from the weathering of pyrite, and with a poorly defined to well-defined foliation. The kyanite occurs as subhedral blades 1 cm long. Delineation of this unit was modified from the mapping of Espenshade and Potter (1960, Plate 7). (*GRI Source Map ID 4147)* (Filbert Quadrangle).

PCbms - Biotite muscovite schist (Neoproterozoic)

Zbms - Biotite-muscovite schist (Neoproterozoic)
Mainly very fine to medium grained light - tan, quartz sericite phyllite. The unit is heterogeneous, however, and includes layers of tan to light-gray fine-grained phyllite, medium-gray to blue-gray plagioclase and quartz crystal metatuff, blue quartz crystal metatuff, some greenstones, and white phyllite with brown and purple staining, locally silicified and derived from hydrothermal alteration. The hydrothermally altered phyllites are prominent at the north border of the map area near Henry Knob. Local bodies of kyanite quartzite (kq) occur with these rocks. Similar layers of hydrothermally altered volcanics occur sporadically in this unit to the southwest as far as the western border of the quadrangle. Correlative with Horton's (2000) biotite-muscovite schist (Zbms). (*GRI Source Map ID 4147)* (Filbert Quadrangle).

Zbms - Biotite-chlorite-muscovite schist (Neoproterozoic)
Fine- to coarse-grained mica schist and phyllite. Fine psammitic quartzofeldspathic domains with granules of blue quartz and feldspar, mica folia defined by white mica and minor chlorite (probably an alteration product), scattered fine biotite are lepidoblastic in quartzofeldspathic domains. Phyllite is a very fine grained micaceous rock lacking a coarse domainal fabric. Interlayers of fine and coarse layers

(phyllite and schist) resemble graded bedding. Probably an epiclastic product of metatonalite and equivalent to unmapped metasedimentary rocks found in the mixed plutonic and volcaniclastic unit. Layers of crystal metatuff, not necessarily equivalent to the main body, are found in the southeastern unit. Correlative with Horton's (2000) biotite-muscovite schist. (*GRI Source Map ID 4149)* (Kings Creek Quadrangle).

Zbms - Biotite-muscovite schist (Neoproterozoic)
Very-light-gray to light-bluish-gray, light-brown, or yellowish-gray, very fine to medium-grained schist and phyllite, composed mainly of quartz, sericitic white mica (muscovite and (or) paragonite), and minor biotite. Local accessory minerals, depending in part on metamorphic grade, include oligoclase and albite, garnet, chloritoid or staurolite, kyanite or sillimanite locally overgrowing andalusite, chlorite, tourmaline, pyrite, and hematite. Kyanite, sillimanite, and andalusite are most abundant near aluminous quartzite. Contacts with metamorphosed pyroclastic and epiclastic rocks are gradational and interfingering. Near Henry Knob the schist contains round granules and small pebbles of quartz. Unit equivalent to “biotitechlorite-muscovite schist” of Howard (2004); includes “biotite schist and gneiss” (“bs”) of Espenshade and Potter (1960, pl. 7) and “feldspathic biotite-muscovite schist” (“fbms”) of Horton (1977, pl. 1). (GRI Source Map ID 75063) (Kings Mountain and Grover Quadrangles).

PCbvc - Volcanic metaconglomerate (Neoproterozoic)

Zbvc - Volcanic metaconglomerate (Neoproterozoic)
Yellowish-gray to medium-gray, metamorphosed polymict volcanic conglomerate. Contains clasts, mostly pebbles, of (1) gray ferruginous quartz rock with abundant disseminated iron-titanium oxides, (2) white polycrystalline quartz, (3) biotite-muscovite schist (Zbms), (4) mottled schistose pyroclastic rock (Zbmp), and (5) massive metatuff (Zbct). The clasts are angular to subrounded and poorly sorted with a continuous gradation in size from 0.1 mm to 8 cm. Quartz grains, which range in size from fine sand to small pebbles, are typically more rounded than the schistose and metavolcanic clasts. Relict (flow?) layering is preserved in some metavolcanic fragments. Clasts are flattened in the plane of schistosity, which is generally not parallel to bedding. The matrix is composed of quartz, white mica, and commonly biotite. Crude graded bedding was observed in a few places. (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

PCbmps - Siliceous metatuff (Neoproterozoic)

Zbmps - Siliceous metatuff (Neoproterozoic)
Very-light-gray to medium-gray, fined-grained, quartzose equivalent of mottled phyllitic metatuff (Zbmp). Disseminated pyrite suggests volcanogenic hydrothermal silicification and epiclastic mixing with quartzose sediment is also possible. Resistant unit underlies linear ridges, including the site of the 1780 Battle of Kings Mountain in Kings Mountain National Military Park. (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

PCbct - Plagioclase crystal metatuff (Neoproterozoic)

Zbct - Plagioclase-crystal metatuff (Neoproterozoic)
Medium-gray to medium blue-gray, poorly foliated to moderately well foliated, dacitic metamorphosed volcaniclastic rock. Composed of euhedral to subhedral plagioclase crystals or plagioclase and rounded quartz crystals in a very fine grained matrix. The matrix mainly consists of quartz, plagioclase, and white mica. Pyrite and other opaque minerals are visible locally. Angular lithic clasts from lapilli size to several inches across are recognizable in some exposures. This unit occurs in the northwest corner of the map area. Correlative with Horton's (2000) plagioclase-crystal metatuff (Zbct). (*GRI Source Map ID 4147)* (Filbert Quadrangle).

Zbct - Crystal metatuff (Neoproterozoic)
Light greenish-gray, greenish-gray, pale gray, and light bluish-gray schist and gneiss. Microcrystalline to finely crystalline rock composed primarily of quartz and feldspar. Fine-grained white mica (sericite) and lesser amounts of muscovite are the dominant mica in folia. Folia in metatuff are characteristically poorly developed, discontinuous, or strongly anastomosing. Accessory minerals include magnetite, pyrite, chlorite, and biotite. Distinct white plagioclase phenocrysts 1-2 mm with blocky shapes, some with zoning textures; characteristically, plagioclase crystals weather, leaving pits (1-4 mm) with a light-brown weathering stain. There are rare greenstone layers conformable with the main foliation. In the past, economic deposits of barite were mined from this unit. Several occurrences of barite were located through the literature, particularly at abandoned mine in the town of Kings Creek. At this locality, rootless, tight to isoclinal folds of barite layers were observed tucked between the main foliation. Hornig's map pattern also suggests that the barite was emplaced prior to the isoclinal folding event (1973, Plate III). Correlative with Horton's (2000) plagioclase-crystal metatuff. (*GRI Source Map ID 4149)* (Kings Creek Quadrangle).

Zbct - Plagioclase-crystal metatuff (Neoproterozoic)
Medium-gray to dark-gray, massive to schistose, andesitic to dacitic metamorphosed volcaniclastic rock. Composed of plagioclase phenocrysts up to 6 mm long in a very fine grained matrix. The matrix consists of quartz and plagioclase with smaller amounts of white mica, epidote, chlorite, calcite, biotite, pyrite, and other opaque minerals. Trace minerals include green amphibole, zircon, and apatite. Locally contains as much as 10 percent calcite. Plagioclase phenocrysts are euhedral to subhedral and they commonly have cavities and embayments. Angular lapilli-size lithic clasts similar in composition to the matrix are locally recognizable. Grain sizes averaging less than0.01 mm commonly give the matrix a cherty appearance. Equivalent to “crystal metatuff” of Howard (2004). (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

PCbgs - Greenstone (Neoproterozoic)

Zbgs - Greenstone (Neoproterozoic)
One occurrence of greenstone is noted in Kings Creek quadrangle, in the streambed of Kings Creek on the north side of Route 5. Pale green, fine-grained schist composed of chlorite, epidote, quartz, feldspar, and magnetite; it has a rounded and knobby surface appearance. (*GRI Source Map ID 4149)* (Kings Creek Quadrangle).

PCbfs - Felsic schist and gneiss (metafelsite) (Neoproterozoic)

Zbfs - Felsic schist and gneiss (metafelsite) (Neoproterozoic)
White to light-gray, fine- to medium-grained feldspathic biotite schist and gneiss. Composed of calcic oligoclase and albite, quartz, biotite, white mica, and rarely microcline or orthoclase. Sillimanite, garnet, and staurolite occur locally. Foliation is weakly to strongly developed. Euhedral to subrounded plagioclase phenocrysts up to 2 mm long are common. Brown biotite is evenly disseminated or in clusters along foliation planes. Unit probably is metamorphosed dacitic tuff and mudstone. Crops out as lenticular and interfingering bodies in the eastern part of the map area. (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

PCbht - Metavolcanic hornblende gneiss (Neoproterozoic)

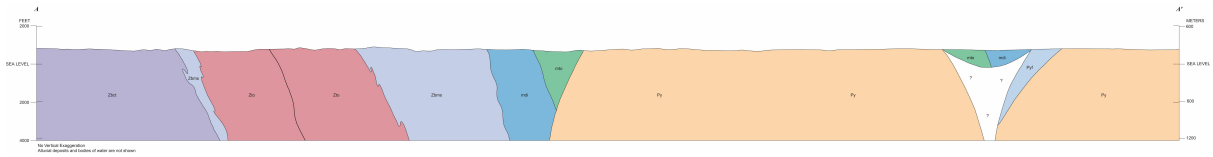
Zbht - Metavolcanic hornblende gneiss (Neoproterozoic)
Medium-dark-gray to dark-greenish-gray metavolcanic gneiss, composed primarily of hornblende (10–45 percent), plagioclase (andesine to oligoclase), and quartz. Common accessories include biotite, epidote, microcline, sphene, opaque minerals, garnet, and apatite. Hornblende laths range from 0.1 to 3 mm in

length. Quartz and much of the plagioclase is equigranular and fine grained, averaging about 0.1 mm. Euhedral to subhedral plagioclase phenocrysts up to 5 mm long are common. Angular lithic clasts up to 4 mm long are less abundant than phenocrysts. Crystal and lithic clasts make up as much as 40 percent of some layers, and most rocks appear to have been andesitic and dacitic crystal tuff or lithic crystal tuff. Largest bodies are on the eastern side of the map area. (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

Geologic Cross Sections

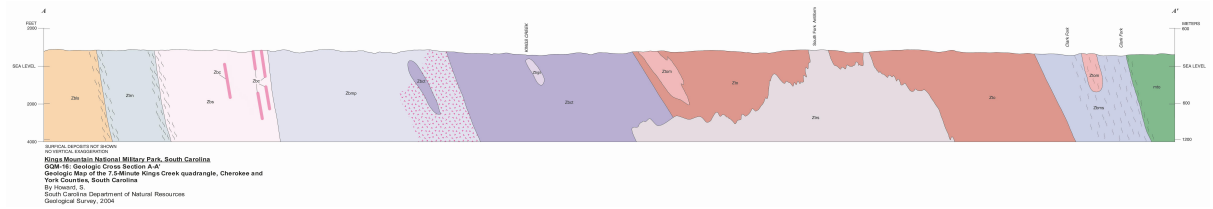
The geologic cross sections present in the GRI digital geologic-GIS data produced for Kings Mountain National Military Park, South Carolina (KIMO) are presented below. Note that some cross section abbreviations (e.g., A - A') may have been changed from their source map abbreviation in the GRI data so that each cross section abbreviation in the GRI data is unique. Cross section graphics were scanned at a high resolution and can be viewed in more detail by zooming in (if viewing the digital format of this document).

Cross Section A-A'



Extracted from: (GRI Source Map ID 4147) (Filbert Quadrangle).

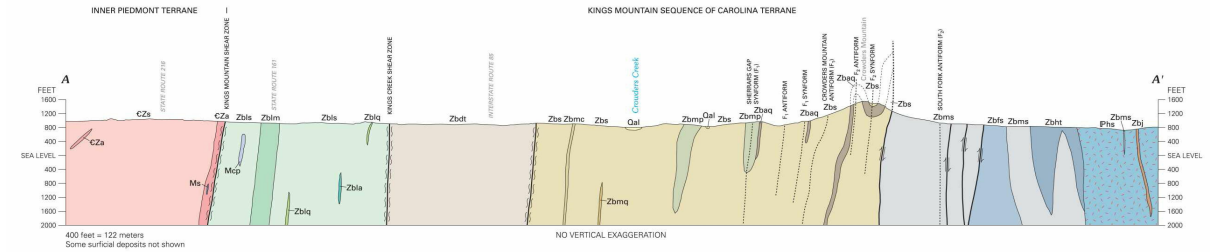
Cross Section B-B'



Extracted from: (Kings Creek Quadrangle) (*GRI Source Map ID 4149*)

*Note this cross section was A-A' on the source map.

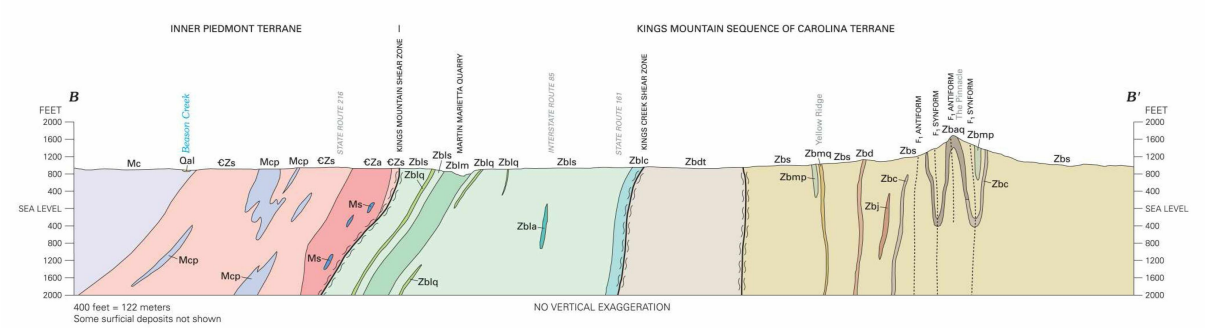
Cross Section C-C'



Extracted from: (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

*Note this cross section was A-A' on the source map.

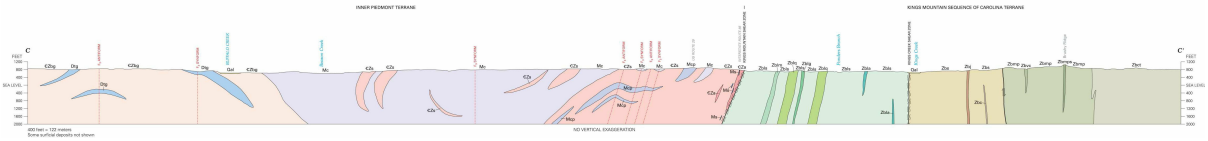
Cross Section D-D'



Extracted from: (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

*Note this cross section was B-B' on the source map.

Cross Section E-E'



Extracted from: (*GRI Source Map ID 75063)* (Kings Mountain and Grover Quadrangles).

*Note this cross section was C-C' on the source map.

GRI Source Map Information

Filbert Quadrangle (GQM-25)

South Carolina Geological Survey, 2007, Digital Geologic Map of the Filbert Quadrangle, York County, South Carolina: South Carolina Geological Survey Digital Geologic Dataset DGD-13, 1:24,000 scale. (*GRI Source Map ID 74616*)

Note: The abaove source is the digital equivalent of GQM-25 below. The majority of data presented in Geology-GIS Geodatabase for Kings Mountain National Military Park and Vicinity was derived from this digital data source and checked against the paper map (GQM-25) for accuracy and consistency.

Nystrom, Paul G., Jr., 2003, Geologic Map of the Filbert Quadrangle, York County, South Carolina: South Carolina Geological Survey Geologic Quadrangle Map GQM-25, 1:24,000 scale. (*GRI Source Map ID 4147*)

Filbert Index Map



QUADRANGLE LOCATION

1	2	3	1	Grover NC
4		5	2	Kings Mountain
6	7	8	3	Gastonia South
			4	Kings Creek
			5	Clover
			6	Hickory Grove
			7	Sharon
			8	Tirzah

ADJOINING 7.5' QUADRANGLE NAMES

Extracted from: Filbert Quadrangle.

Filbert Map Legend

Contact – Dotted where concealed. Distribution and concentration of structural symbols indicates degree of reliability

Overturned antiform – Showing crest line and direction of plunge, dotted where concealed

PLANAR FEATURES

86 Strike and dip of schistosity

Granite outcrop

Diabase outcrop

Extracted from: Filbert Quadrangle.

Filbert References

REFERENCES

Butler, J.R., 1966, Geology and mineral resources of York County, South Carolina: South Carolina Division of Geology Bulletin 33, 65 p.

Espenshade, G. H., and Potter, D. B., 1960, Kyanite, sillimanite, and andalusite deposits of the southeastern states: United States Geological Survey Professional Paper 336, 121 p.

Horton, J. W., Jr., 2000, Geologic map of the Kings Mountain and Grover quadrangles, Cleveland and Gaston Counties, North Carolina, and Cherokee and York Counties, South Carolina: United States Geological Survey, unpublished Open-File Report.

Samson, S. D., 2001, Timing of Alleghanian magmatism revisited: Geological Society of America Abstracts with Programs, v. 33, no. ?, p. ?.

Extracted from: Filbert Quadrangle.

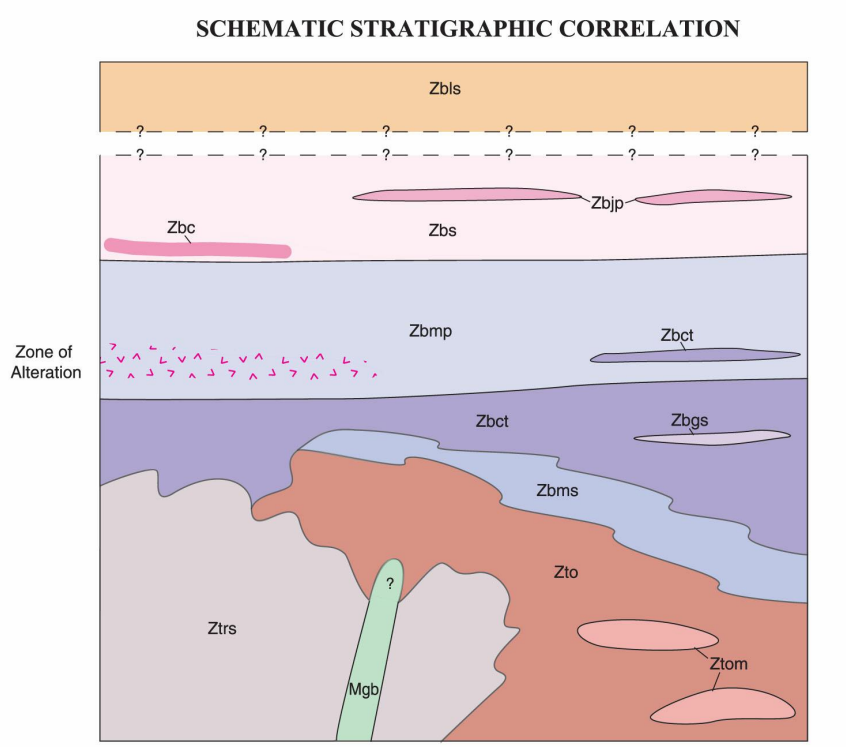
Kings Creek Quadrangle (GQM-16)

South Carolina Geological Survey, 2007, Digital Geologic Map of the Kings Creek Quadrangle, Cherokee and York Counties, South Carolina: South Carolina Geological Survey Digital Geologic Dataset DGD-14, 1:24,000 scale. (*GRI Source Map ID 74617*)

Note: The above source is the digital equivalent of GQM-16 below. The majority of data presented in Geology-GIS Geodatabase for Kings Mountain National Military Park and Vicinity was derived from this digital data source and checked against the paper map (GQM-16) for accuracy and consistency.

Howard, Scott, 2004, Geologic Map of the Kings Creek quadrangle, Cherokee and York Counties, South Carolina: South Carolina Geological Survey Geologic Quadrangle Map GQM-16, 1:24,000 scale. (*GRI Source Map ID 4149*)

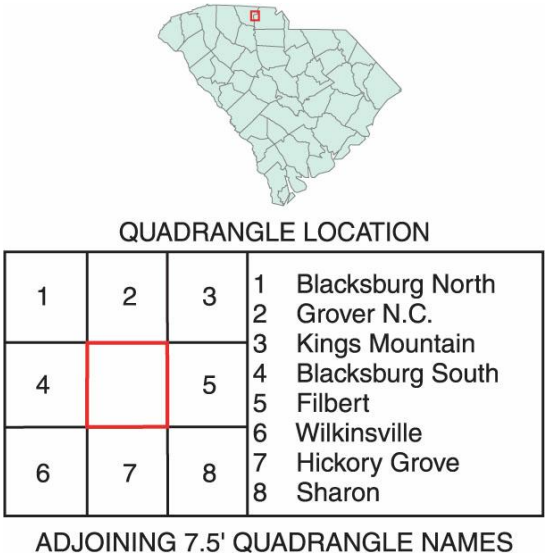
Kings Creek Correlation



Schematic diagram of stratigraphic relations in Kings Mountain sequence prior to earliest deformation. Not all units are depicted in this graphic.

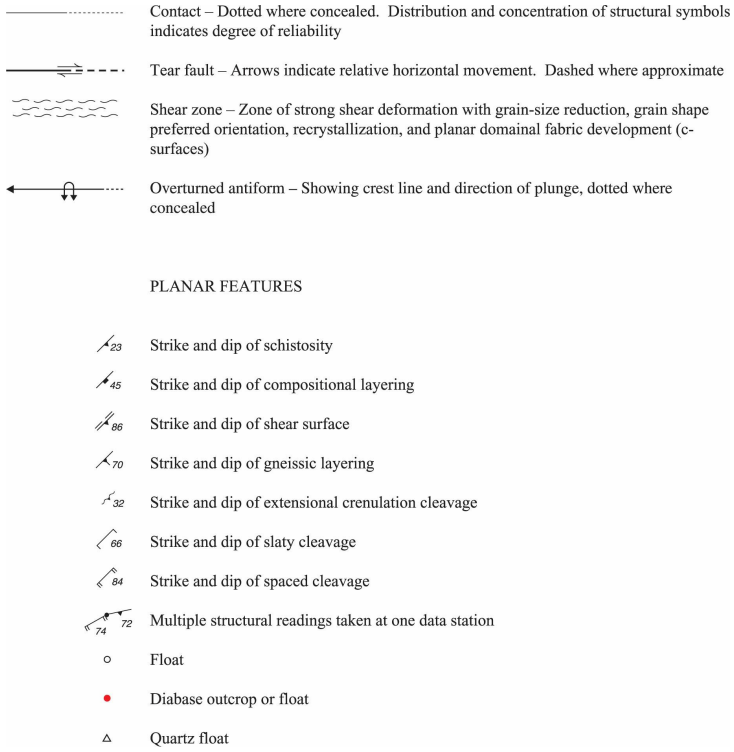
Extracted from: Kings Creek Quadrangle.

Kings Creek Index Map



Extracted from: Kings Creek Quadrangle.

Kings Creek Map Legend



Extracted from: Kings Creek Quadrangle.

Kings Creek References

REFERENCES

Espenshade, G. H. and D. B. Potter, 1960, Kyanite, sillimanite, and andalusite deposits of the southeastern states: U. S. Geological Survey Professional Paper 336, 121 p.

Hornig, C. A., 1973, The barite deposits at Kings Creek, South Carolina: M.S. Thesis, University of South Carolina, Columbia, South Carolina.

Horton, J. W., Jr., 2000, Geologic map of the Kings Mountain and Grover quadrangles, Cleveland and Gaston Counties, North Carolina, and Cherokee and York Counties, South Carolina: United States Geological Survey, unpublished Open-File Report.

Murphy, C. F. and J. R. Butler, 1981, Geology of the northern half of Kings Creek quadrangle, South Carolina in Horton, J. W., Jr., J. R. Butler, and D. J. Milton, eds., Geological investigations of the Kings Mountain belt and adjacent areas in the Carolinas, Carolina Geological Society, Field Trip Guidebook: Columbia, South Carolina Geological Survey, p. 49-64.

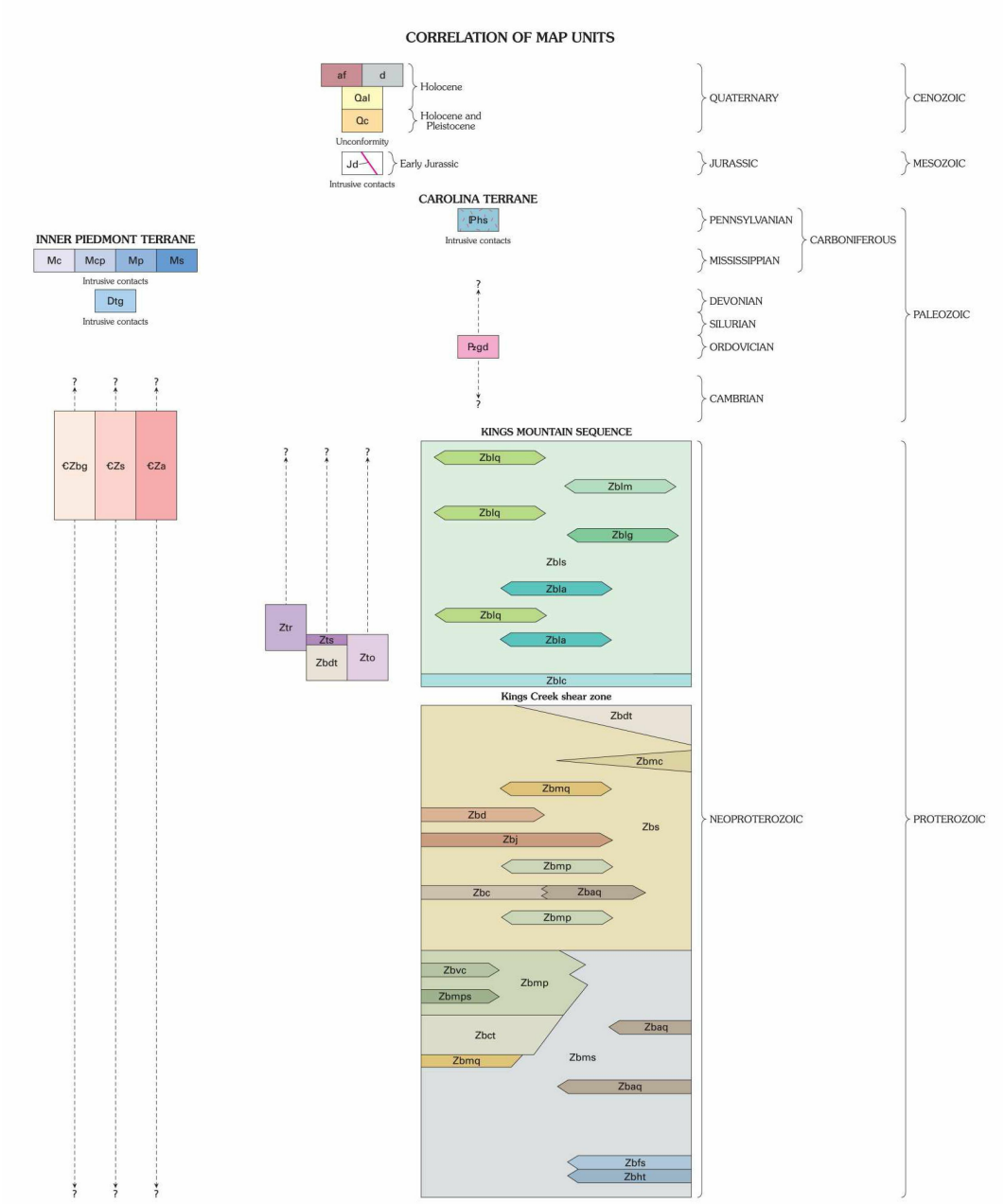
Nystrom, P. G., Jr., in review, Geology of the Filbert 7.5-minute quadrangle, York County, South Carolina: South Carolina Geological Survey, Geologic Quadrangle Map, scale 1:24000.

Extracted from: Kings Creek Quadrangle.

Kings Mountain and Grover Quadrangles (SIM 2981)

Horton, J.W., Jr., 2008, Geologic map of the Kings Mountain and Grover Quadrangles, Cleveland and Gaston Counties, North Carolina, and Cherokee and York Counties, South Carolina: U.S. Geological Survey Scientific Investigations Map SIM-2981, 1 sheet, scale 1:24,000. (*GRI Source Map ID 75063*)

Kings Mountain and Grover Correlation



Extracted from: Kings Mountain and Grover Quadrangles.

Kings Mountain and Grover Index Map

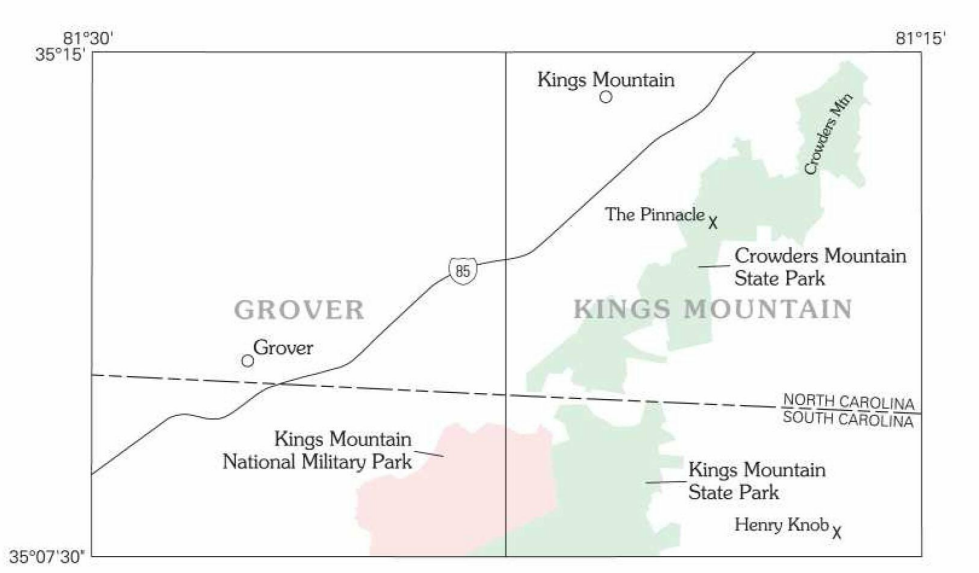
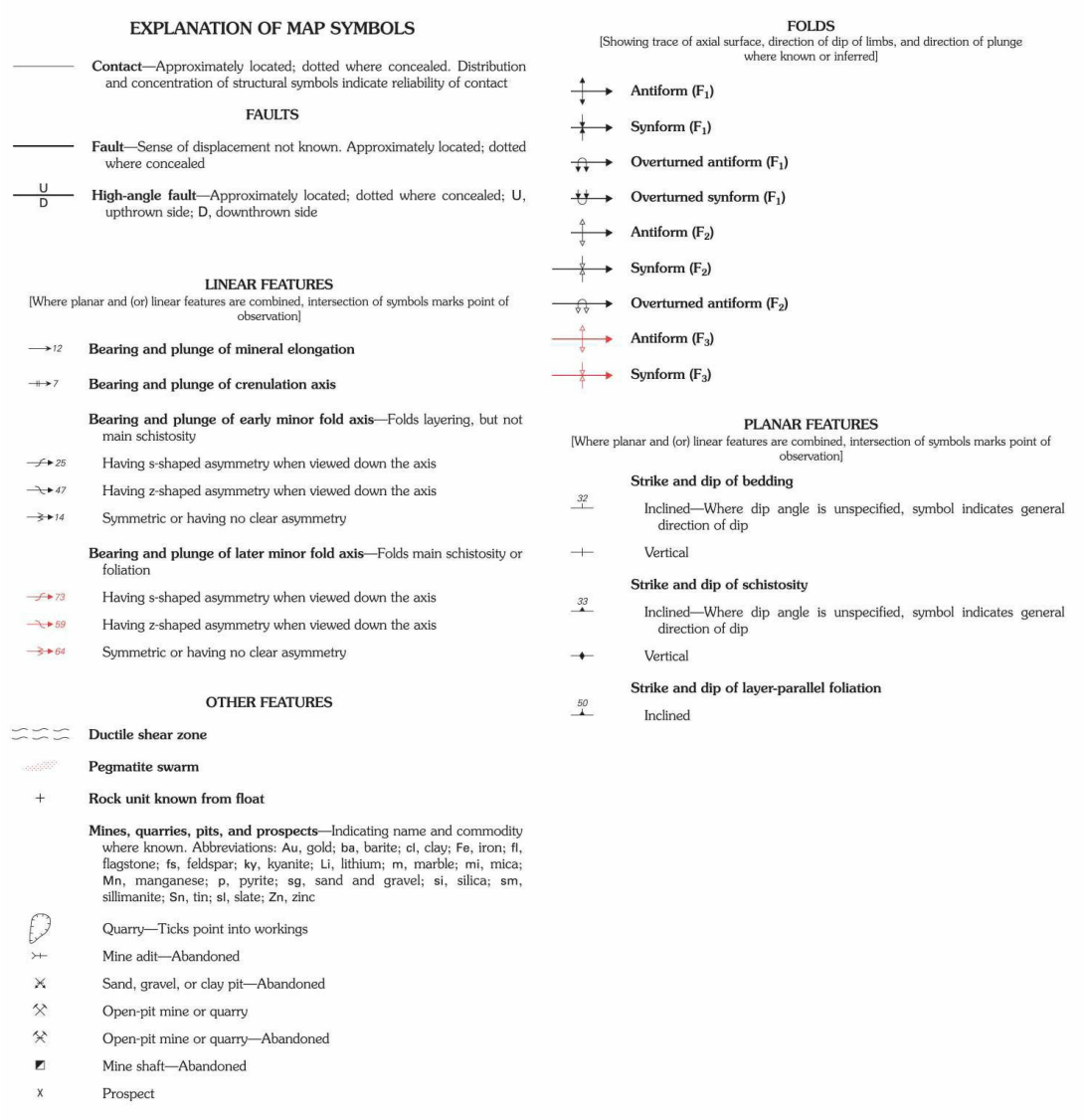


Figure 1.—Location map showing selected features of the Kings Mountain and Grover quadrangles.

Extracted from: Kings Mountain and Grover Quadrangles.

Kings Mountain and Grover Map Legend



EXPLANATION OF MAP SYMBOLS

Contact—Approximately located; dotted where concealed. Distribution and concentration of structural symbols indicate reliability of contact

FAULTS

Fault—Sense of displacement not known. Approximately located; dotted where concealed

U / D **High-angle fault**—Approximately located; dotted where concealed; U, upthrown side; D, downthrown side

LINEAR FEATURES

[Where planar and (or) linear features are combined, intersection of symbols marks point of observation]

12 **Bearing and plunge of mineral elongation**

7 **Bearing and plunge of crenulation axis**

Bearing and plunge of early minor fold axis—Folds layering, but not main schistosity

25 Having s-shaped asymmetry when viewed down the axis

47 Having z-shaped asymmetry when viewed down the axis

14 Symmetric or having no clear asymmetry

Bearing and plunge of later minor fold axis—Folds main schistosity or foliation

73 Having s-shaped asymmetry when viewed down the axis

59 Having z-shaped asymmetry when viewed down the axis

64 Symmetric or having no clear asymmetry

OTHER FEATURES

Ductile shear zone

Pegmatite swarm

Rock unit known from float

Mines, quarries, pits, and prospects—Indicating name and commodity where known. Abbreviations: Au, gold; ba, barite; cl, clay; Fe, iron; fl, flagstone; fs, feldspar; ky, kyanite; Li, lithium; m, marble; mi, mica; Mn, manganese; p, pyrite; sg, sand and gravel; si, silica; sm, sillimanite; Sn, tin; sl, slate; Zn, zinc

Quarry—Ticks point into workings

Mine adit—Abandoned

Sand, gravel, or clay pit—Abandoned

Open-pit mine or quarry

Open-pit mine or quarry—Abandoned

Mine shaft—Abandoned

Prospect

FOLDS

[Showing trace of axial surface, direction of dip of limbs, and direction of plunge where known or inferred]

Antiform (F_1)

Synform (F_1)

Overturned antiform (F_1)

Overturned synform (F_1)

Antiform (F_2)

Synform (F_2)

Overturned antiform (F_2)

Antiform (F_3)

Synform (F_3)

PLANAR FEATURES

[Where planar and (or) linear features are combined, intersection of symbols marks point of observation]

Strike and dip of bedding

32 Inclined—Where dip angle is unspecified, symbol indicates general direction of dip

Vertical

Strike and dip of schistosity

33 Inclined—Where dip angle is unspecified, symbol indicates general direction of dip

Vertical

Strike and dip of layer-parallel foliation

50 Inclined

Extracted from: Kings Mountain and Grover Quadrangles.

Kings Mountain and Grover Report

A report discussing the geology of the Kings Mountain and Grover Quadrangles is available with SIM 2981 and be viewed here: USGS pubs website (SIM 2981).

Extracted from: Kings Mountain and Grover Quadrangles.

GRI Digital Data Credits

This document was developed and completed by James Chappell, James Winter, Philip Reiker and Jason Isherwood (Colorado State University) for the NPS Geologic Resources Division (GRD) Geologic Resources Inventory (GRI) Program. Quality control of this document by James Chappell (Colorado State University).

The information in this document was compiled from GRI source maps, and intended to accompany the digital geologic-GIS map and other digital data for Kings Mountain National Military Park, South Carolina (KIMO) developed by James Chappell, James Winter, Max Jackl and Jason Isherwood (Colorado State University) (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 the related GRI digital geologic-GIS map).

GRI finalization by James Chappell (Colorado State University).

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