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

Kennesaw Mountain National Battlefield Park

GRI Ancillary Map Information Document

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

kemo_geology.pdf

Version: 3/16/2022

Geologic Resources Inventory Map Document for Kennesaw Mountain National Battlefield Park

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Geologic Resources Inventory Map Document

Kennesaw Mountain National Battlefield Park, Georgia

Document to Accompany Digital Geologic-GIS Data

kemo_geology.pdf

Version: 3/16/2022

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Kennesaw Mountain National Battlefield Park, Georgia (KEMO).

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.

This document contains the following information:

1) **About the NPS Geologic Resources Inventory Program** – A brief summary of the Geologic Resources Inventory (GRI) Program and its products. Included are web links to the GRI GIS data model, and to the GRI products page where digital geologic-GIS datasets, scoping reports and geology reports are available for download. In addition, web links to the NPS Data Store and GRI program home page, as well as contact information for the GRI coordinator, are also present.

2) **GRI Digital Map and Source Citation** – A listing of all GRI digital geologic-GIS map produced for this project along with source map used in its completion. In addition, a brief explanation of how the source map was used is provided.

3) **Map Unit List** – A listing of all geologic map units present on maps for this project, generally listed from youngest to oldest.

4) **Map Unit Descriptions** – Descriptions for all geologic map units.

5) **Geologic Cross Sections** – Geologic cross section graphics with source geologic cross section abbreviations.

6) **Ancillary Source Map Information** – Additional source map information presented by source map.

7) **GRI Digital Data Credits** – GRI digital geologic-GIS data and ancillary map information document production credits.

For information about using GRI digital geologic-GIS data contact:

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About the NPS Geologic Resources Inventory Program

Background

The Geologic Resources Inventory (GRI) provides geologic map data and pertinent geologic information to support resource management and science-informed decision making in more than 270 natural resource parks throughout the National Park System. 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 GRI is one of 12 inventories funded by the National Park Service (NPS) Inventory and Monitoring Program. The Geologic Resources Division of the NPS Natural Resource Stewardship and Science Directorate administers the GRI. The NPS Geologic Resources Division partners with the Colorado State University Department of Geosciences to produce GRI products. Many additional partners participate in the GRI process by contributing source maps or reviewing products.

The GRI team undertakes three tasks for each park in the Inventory and Monitoring program: (1) conduct a scoping meeting and provide a summary document, (2) provide digital geologic map data in a geographic information system (GIS) format, and (3) provide a GRI report. These products are designed and written for nongeoscientists.

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: https://www.nps.gov/articles/gri-geodatabase-model.htm

Geologic Reports: GRI reports synthesize discussions from the original scoping meeting, follow up conference call(s), and subsequent research. Chapters of each report discuss the geologic setting of the park, distinctive geologic features and processes within the park, highlight geologic issues facing resource managers, and describe the geologic history leading to the present-day landscape. Each report also includes a poster illustrating these GRI digital geologic-GIS data.

For a complete listing of GRI products visit the GRI publications webpage: https://go.nps.gov/gripubs. GRI digital geologic-GIS data is also available online at the NPS Data Store: https://irma.nps.gov/DataStore/Search/Quick. 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: https://www.nps.gov/subjects/geology/gri.htm. At the bottom of that webpage is a “Contact Us” link if you

need additional information. You may also directly contact the program coordinator:

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The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) Division. Learn more about I&M and the 12 baseline inventories at the I&M webpage: https://www.nps.gov/im/inventories.htm.

GRI Digital Map and Source Map Citation

The GRI digital geologic-GIS map for Kennesaw Mountain National Battlefield Park, Georgia (KEMO) is listed below.

Digital Geologic-GIS Map of Kennesaw Mountain National Battlefield Park and Vicinity, Georgia (*GRI MapCode KEMO*)

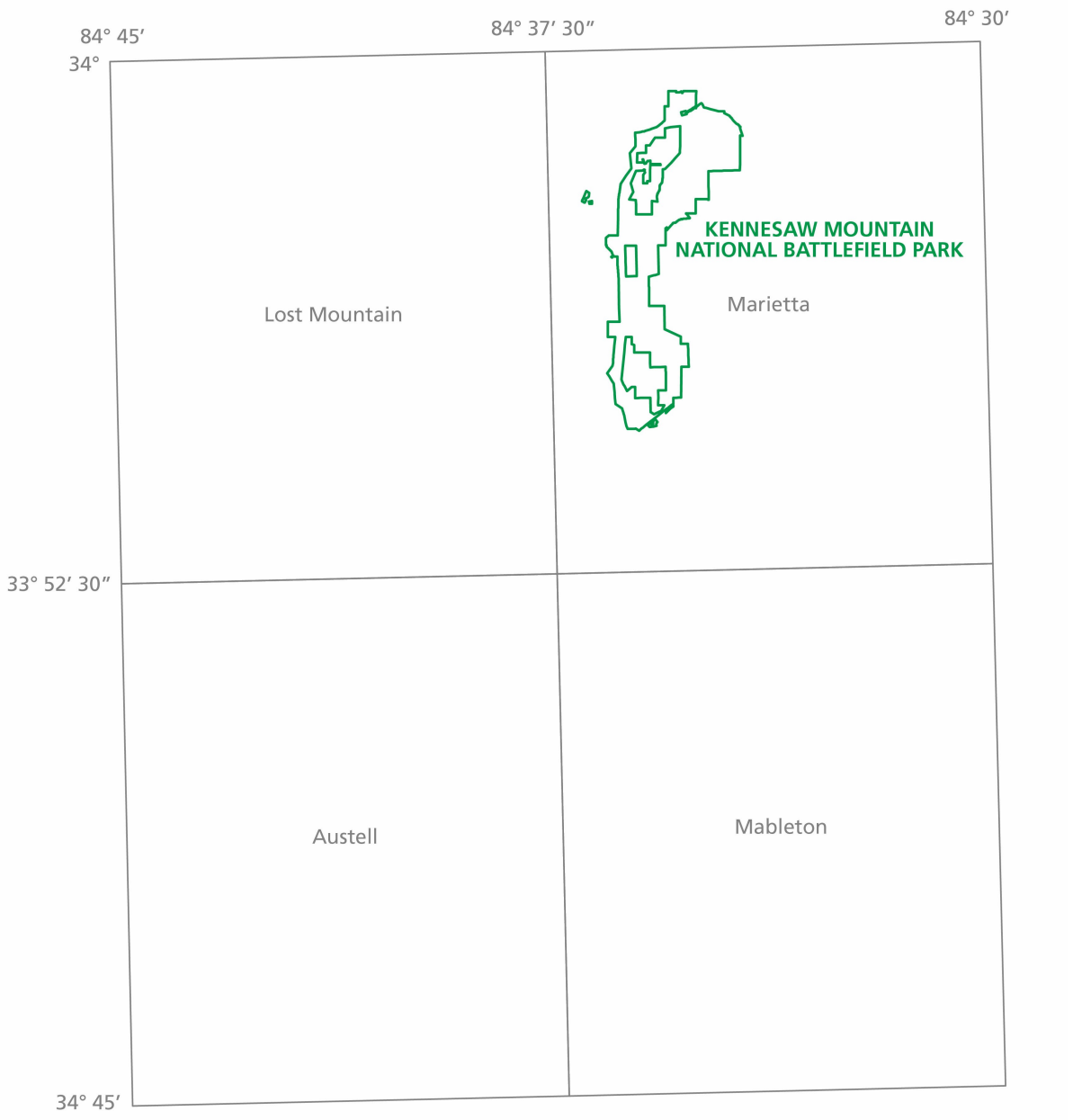
The source map used to produce the above GRI digital geologic-GIS map is listed below. Only a partial extent of the source map, that of the Austell, Lost Mountain, Mableton and Marietta 7.'5 quadrangles, was used, however, all geologic features within this extent were captured.

> Higgins, M.W., Crawford, T.J., Atkins, R.L., and Crawford, R.F., 2003, Geologic Map of the Atlanta 30 x 60 Quadrangle, Georgia: U.S. Geological Survey, Geologic Investigations Series Map I-2602, scale 1:100,000 (Atlanta 30' x 60'). (*GRI Source Map ID 68679*).

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

Index Map

The following index map displays the extent of the GRI digital geologic-GIS maps produced for Kennesaw Mountain National Battlefield Park (KEMO). The extent is defined by the extent of the four 7.5' quadrangles: Austell, Lost Mountain, Mableton and Marietta. The boundary for Kennesaw Mountain National Battlefield Park (as of March, 2022) is outlined in green.



Index map by Stephanie O'Meara (Colorado State University).

Map Unit List

The geologic units present in the digital geologic-GIS data produced for Kennesaw Mountain National Battlefield Park, Georgia (KEMO) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qg - Gossan). 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 (KEMOUNIT) table included with the GRI digital geologic-GIS data.

Cenozoic Era

Quaternary Period?
Qg - Gossan

Paleozoic Era? to Mesozoic Era?

Mississippian? to Jurassic?
JMb - Metatrondhjemite breccia

Paleozoic Era(?)

Mississippian to Permian?
PCmb - Mylonitized Ben Hill Granite

Upper Ordovician? to Permian?)
POb - Button schist
POcm - Mylonitized Chattahoochee Palisades Quartzite
POgm - Mylonitized garnet schist
POms - Button schist and sheared amphibolite derived by shearing of mixed unit (OZm)
POpa - Rocks of the Pine Mountain alteration zone
Pos - Garnet Hill type altered rocks
POag - Chlorite schist
POuc - Silicified schist and metagraywacke

Proterozoic? to Paleozoic Era?

Middle Proterozoic? to Permian?
PYl - Long Island Creek Gneiss

Paleozoic Era

Pennsylvanian and Mississippian
PNMb - Ben Hill Granite

Devonian
Dl - Lithonia Gneiss, undivided

Silurian
Sa - Austell Gneiss

Proterozoic? to Paleozoic Era?

Middle Proterozoic? to Silurian?
SYg - Gothards Creek Gneiss

Paleozoic Era?

Cambrian? to Ordovician?
OCb - Bill Arp Formation
OCbh - Bill Arp Formation, informal schist of Hulett facies

Proterozoic? to Paleozoic Era?

Late Proterozoic? to Ordovician?
OZp - Paulding Volcanic-Plutonic Complex of the Paulding allochthon
OZmp - Metapyroxenite
OZu - Altered meta-ultramafic rock
OZs - Stonewall Gneiss
OZsp - Stonewall Gneiss, Powers Ferry Member
OZsi - Stonewall Gneiss, weathers to slabs
OZa - Amphibolite
OZr - Ropes Creek Metabasalt
OZrk - Ropes Creek Metabasalt, kyanite quartzite
OZrt - Ropes Creek Metabasalt, amphibolite
OZrf - Ropes Creek Metabasalt, plagioclase-hornblende gneiss
OZcr - Crider Gneiss
OZmq - Magnetite quartzite
OZmt - Unmapped metatrondhjemite gneisses
OZkm - Informal migmatite of Kennesaw Mountain
OZrs - Spheroidally weathering amphibolite
OZm - Informal mixed unit
OZmgs - Informal mixed unit, garnet-rich schist
OZmn - Manganiferous schist and gondite

Paleozoic Era

Cambrian and Cambrian?
Ccf - Crawfish Creek Formation
Ccq - Crawfish Creek Formation, clean quartzite unit

Cambrian?
Ccp - Chattahoochee Palisades Quartzite
Cas - Aluminous schist unit
Caq - Aluminous schist unit, muscovite quartzite

Map Unit Descriptions

Descriptions of all geologic map units, generally listed from youngest to oldest, are presented below. All unit descriptions were taken from the source map Atlanta 30' x 60'. See the source map publication for units referenced in unit descriptions but that are not on the GRI digital geologic-GIS map. The unit symbol for unit the Ben Hill Granite was changed from Cb to PNMb with PNM being used to represent Pennsylvanian (PN) and Mississippian (M) periods of geologic time and not the C for the Carboniferous period of geologic time. A change from the source map in the GRI digital geologic-GIS data was to list ages with a range using "to" to be "older to younger" (e.g., "Mississippian? to Jurassic?") and not "younger to older" (e.g., Jurassic? to Mississippian?). The format change was done to every unit age using "to" in its age.

Qg - Gossan (Holocene?)

Dark brown, iron-rich, siliceous, porous-textured, weathering product of massive sulfide bodies. Found in fault zones in Ropes Creek Metabasalt (OZr), in mixed unit of the oceanic assemblage, and in sheared and altered rocks in fault zones, generally near magnetite quartzite.

JMb - Metatrondhjemite breccia (Mississippian? to Jurassic?)

Light-gray breccia composed of angular fragments of metatrondhjemite as large as 3 cm. Holds up a low ridge.

PCmb - Mylonitized Ben Hill Granite (Mississippian to Permian?)

Generally fine-grained , light-gray to white mylonite and mylonite gneiss that contain a few scattered porphyroclasts of potassium feldspar as large as about 1 cm in most outcrops and many porphyroclasts as large as 1.5 cm in some outcrops. Contact with unmylonitized Ben Hill Granite has not been observed but is thought to be within the solid contact line at 1:100,000 scale.

POb - Button schist (Upper Ordovician? to Permian?)

Gray to silvery, tan-weathering (±chlorite)-plagioclase-quartz-sericite button schist (Higgins, 1971) with C-S texture (Berthé and others, 1979); S-C mylonite of Lister and Snoke (1984) with fish-scale texture and locally displaying fish-flash (Simpson, 1986, p. 252); locally manganiferous; in many places including (±chlorite)-sericite-quartz-plagioclase phyllonite with mica-fish and fish-flash, and, locally, lenses and slivers of sheared chlorite-actinolite (±hornblende)-plagioclase and chlorite-actinolite-plagioclase-hornblende amphibolites. Weathers to a red soil with buttons (mica porphyroclasts, mica-fish) scattered on the ground surface. Probably derived by shearing mostly of mixed unit (OZm).

POcm - Mylonitized Chattahoochee Palisades Quartzite (Upper Ordovician? to Permian?)

Gray to greenish tan, schistose mylonite with abundant thin stringers of mylonitized quartz and local lenses of mylonitized quartz and local lenses of mylonitized quartz rock as thick as 0.5 m. Locally has buttony S-C mylonite texture but more commonly has schist texture probably due to more laminar mylonitization.

POgm - Mylonitized garnet schist (Upper Ordovician? to Permian?)

Buttony, mylonitic garnet-biotite-muscovite-plagioclase-quartz schist with S-C mylonite texture, generally containing small (4mm or less), pinkish-red garnets that are commonly porphyroclasts, and knots and stringers of quartz.

POms - Button schist and sheared amphibolite derived by shearing of mixed unit (OZm) (Upper Ordovician? to Permian?)

Derived by shearing of mixed unit (OZm) - Gray to silvery, tan-weathering (±chlorite)-quartz-sericite button schist (Higgins, 1971) with C-S texture (Berthé and other, 1979); S-C mylonite of Lister and Snoke (1984) with fish-scale texture and commonly displaying fish-flash (Simpson, 1986, p. 252), with lenses and slivers of chlorite-actinolite (±hornblende)-plagioclase and sheared chlorite-actinolite-plagioclase-hornblende amphibolites. Locally contains fine-grained, blocky and sooty weathering (±magnetite)-spessartine quartzite (gondite, coticule rock) (OZmm) in beds about 0.3 to 1 m thick indicating that the protolith was the mixed unit (OZm) of the allochthonous assemblage.

POpa - Rocks of the Pine Mountain alteration zone (Upper Ordovician? to Permian?)

Light-gray to greenish-white, epidote-rich granofels and light-green to epidote-green, epidote-rich, chlorite-rich amphibolites that resemble Paulding Volcanic-Plutonic Complex but are less chaotic.

POs - Garnet Hill type altered rocks (Upper Ordovician? to Permian?)

Named for Garnet Hill in the south-central part of the Dallas 7.5-min quadrangle where they can be seen along the road that crosses the hill and along the north-south road just west of the hill, especially where that road crosses Mill Creek. They are pervasively sheared, buttony, coarse-grained, well-foliated, green, greenish- to reddish weathering, actinolite-chlorite schist and slightly graphitic to graphitic button schists and generally contain abundant euhedral garnets as large as 2 to 4 cm, but commonly less than 1 cm, and locally contain radiating clusters of actinolite on S-planes (generally on S-planes parallel to wavy shear-planes). Thin layers of chlorite-quartz-sericite schist, generally with small euhedral magnetite crystals, are intercalated with the actinolite-chlorite schist. Large garnets are commonly flattened and (or) sheared euhedra that can be flaked apart; subhedral garnets are commonly sheathed in wavy chlorite bundles. In many outcrops garnets are conspicuously elongated. Locally there are layers and lenses of light-colored, greatly leached, chalky-weathering, pyritiferous, euhedral magnetite crystal-bearing platy quartzite and (or) felsite and highly pyritiferous quartz rocks. The unit contains gossan , ferrous quartzites, and massive sulfide deposits.

POag - Chlorite schist (Upper Ordovician? to Permian?)

Green, generally contoured, (±garnet)-quartz-plagioclase-actinolite-chlorite schist derived from shearing and alteration of amphibolite along faults.

POuc - Silicified schist and metagraywacke (Upper Ordovician? to Permian?)

Garnet-biotite-muscovite-plagioclase-quartz schist and (±garnet)-biotite-plagioclase-quartz metagraywacke derived from silicification and thermal alteration of Bill Arp Formation phyllite and metagraywacke adjacent to faults.

PYl - Long Island Creek Gneiss (Middle Proterozoic? to Permian?)

Light- to dark gray, well-layered (layers generally about 8-40 cm thick), medium-grained, generally blastomylonitic epidote-biotite-plagioclase-quartz gneiss, with tiny crystals of sphene, interlayered with biotite-epidote-muscovite-quartz-plagioclase-microcline gneiss; microcline content quite variable. Mylonite gneiss with porphyroclasts of potassium feldspar in many outcrops. Locally forms pavement outcrops. Characteristically cut by numerous 6- to 20-cm-thick quartz veins and sills and aplite dikes and sills. Weathers to a characteristic yellowish soil.

PNMb - Ben Hill Granite (Pennsylvanian and Mississippian)

Cb - Ben Hill Granite (unit symbol as per source map, changed to PNMb)
Massive, poorly foliated to unfoliated, light-gray, porphyritic, muscovite-biotite-quartz-microcline granite, in which blocky, commonly zoned, microcline phenocrysts, locally as long as 5 cm, make up 10 to 70 percent, but most commonly 25 to 40 percent, of the rock. Tends to form pavement outcrops and large pedestal-boulder outcrops (as at Utoy Boulder Park and along Shiprock Road in southwestern Atlanta). Weathers initially to a tan-yellow saprolite with weathered microcline phenocrysts and quartz grains and finally to a light-red soil with quartz grains. Lithologically identical to Palmetto Granite (Cp). Higgins and Atkins (1981) interpreted the Ben Hill and Palmetto Granites to be two cupolas on a batholith, but construction of cross sections for this map, using down-plunge projections that show deeper structural levels to the southwest, indicate that the two granite bodies are at different structural levels and are not part of the same batholith, unless they were detached from one another during faulting.

Dl - Lithonia Gneiss, undivided (Devonian)

Lithonia Gneiss is a complex of metagranites and granitic gneisses. The most common rock type is a light-gray to grayish-white, medium-grained, poorly foliated metagranite that is cut by numerous pegmatite and aplite dikes and sills in several generations; dikes of different generations crosscut older dikes. This rock type probably forms about 80 to 90 percent of all rocks mapped as Lithonia Gneiss in the Athens quadrangle, whereas in the Atlanta and Griffin quadrangles, it may form only about 40 to 50 percent. The remainder of rocks mapped as Lithonia Gneiss are migmatite gneiss that belong to the Mount Arabia Migmatite of Grant of other (1980; also see Covert, 1986; and Size and Khairallah, 1989), which is included in this unit on this map. The Mount Arabia Migmatiite of Grant and others (1980) is a light-gray to whitish-gray, medium-grained muscovite-biotite-microcline-oligoclase-quartz gneiss with well-defined, contorted, generally 3-mm- to 1-cm-thick gneissic layering. The migmatite gneiss is the prevalent rock type in Lithonia Gneiss near its edges, whereas the metagranite is far more prevalent away from the edges of most outcrop areas of Lithonia Gneiss. Garnet segregations in lenses as large as 2 m by 2 m are locally present in the migmatite gneiss. Scattered xenoliths, mainly of amphibolites, are present in the migmatite and the migmatite gneiss, but are probably more abundant in the migmatite gneiss. Pavement outcrops are characteristic of both the metagranite and the migmatite gneiss, and where deeply weathered both from light-whitish-yellow sandy soils. Both the metagranite and the migmatite gneiss are extensively quarried for crushed-stone

aggregate and curbstone, and the migmatite gneiss is extensively quarried for monumental stone.

Sa - Austell Gneiss (early Silurian)

Medium- to-course-grained, light- to medium-gray, well-foliated, biotite (±muscovite)-oligoclase-quartz-microcline (quartz monzonite) orthogneiss with megacrysts of microcline that make up 20 to 50 percent, but commonly 25 to 30 percent, of the rock. Accessories are garnet, ilmenite, sphene, tourmailine, magnetite, allanite, apatite, and zircon in general order of abundance. Microcline megacrysts, as long as 4 cm, but more commonly 1 to 2 mm, and biotite define the foliation, which is an f_e foliation modified by f_{en} folding associated with dextral slip on the Chattahoochee fault at the northwestern edge of the Brevard fault zone. Near its contacts the gneiss is mylonitized in many exposures and the feldspar megacrysts are augen. Forms extensive pavement outcrops and weathers to a yellowish, sandy soil. Early Silurian age based on nearly concordant U-Pb_Th age on zircon of 430 Ma and 5 point Rb-Sr isochron of 432±8 Ma with initial 87Sr/86Sr ratio of 0.07073±.0.0005 to give interpreted age of about 430 Ma (Higgens and others, 1997). Extensively quarried for crushed stone.

SYg - Gothards Creek Gneiss (Middle Proterozoic? to lower Silurian?)

Light-gray, medium- to coarse-grained, pervasively sheared, schistose and finely layered biotite-quartz-potassium feldspar-plagioclase gneiss that is generally rich in biotite and weathers to a uniform, almost featureless, light-orange saprolite. Age assigned is based on appearance and structural and stratigraphic position (see section on Early Silurian Austell Gneiss), which suggest the possibility that the Gothards Creek could belong with the southern Appalachian basement.

OCb - Bill Arp Formation (Cambrian? to Lower Ordovician?)

In the Austell-Frolona anticlinorium the Bill Arp consists of dark-brown the dark-gray, medium-grained, locally feldspathic, generally slightly calcareous, biotite-metagraywacke beds, about 0.3 to 3 m thick, interbedded with fine- to medium-grained, locally slightly graphitic, biotite-muscovite phyllite/schist rarely containing widely scattered, small pink garnets and, locally, small "cross-biotite" crystals. Fine-grained disseminated ilmenite and magnetite are common, and vein quartz characteristically contains platy ilmenite as large as 5 cm. In streams the metagraywacke beds stand as riffles separated by troughs where pelite beds have weathered out; this can be seen in the Dog River. In the Mulberry Rock structure and between the Mulberry Rock structure and the Emerson fault, the Bill Arp consists of about the same thickness; scattered blue-quartz granules and rounded subhedral microcline grains are found in the metagraywackes and are interpreted to indicate a Middle(?) to Late Proterozoic Corbin Metagranite (ZYc) basement source.

OCbh - Bill Arp Formation, informal schist of Hulett facies (Cambrian? to Lower Ordovician?)

Tan-weathering, finely schistose, (±garnet)-biotite-plagioclase-muscovite-quartz schist that contains abundant small red garnets in many outcrops and no garnets in others. The schist generally contains at least two schistosities and original layering has been transposed; the finely spaced schistosity, although a secondary feature, is characteristic. May be equivalent with garnetiferous Bill Arp rocks (OCbc, OCbb, OCba).

OZp - Paulding Volcanic-Plutonic Complex of the Paulding allochthon (Late Proterozoic? to Middle Ordovician?)

A chaotic mixture of mafic and felsic rocks marked by an overall meta-igneous, veined, faulted, disrupted, gray to epidote-green appearance. Consists mainly of light-green-weathering, epidote-rich, generally chloritic, green or blue-green hornblende- and (or) actinolite-plagioclase amphibolites (~50-60 percent) intimately interlayered with light-gray to nearly white, amphibolite-bearing granofels, biotite-bearing gneisses, and biotite- and feldspar-rich schists (~20-30 percent). Dikes, sills, and small plutons of potassium feldspar-poor granitic rocks and potassium feldspar-bearing granitic rocks are ubiquitous and numerous (~15-20 percent), and pods of epidosite are common. Thin layers and lenses of vermiculitic mica are also common. Pods of ultramafic rocks are common and in places make up 60 to 80 percent of exposures. At Soapstone Ridge in southeastern Atlanta, pods of ultramafic rocks are so abundant that the unit was once thought to be a mafic-ultramafic sheet (Higgens and others, 1980); areas of high concentrations of residual/colluvial boulders of ultramafic rock are outlined by dashed lines in the Soapstone Ridge outcrop area of Paulding Volcanic-Plutonic Complex. The most common ultramafic rocks are course, altered metapyroxenite and soapstone, but altered metadunite, metaperidotite, and serpentinite also are found. Serpentinite (OZus) is most commonly found adjacent to faults. Siliceous "hardpan" is locally found above the rocks. At Soapstone Ridge the most common ultramafic rock is dark-green, coarse- to very coarse grained, highly altered metapyroxenite. The large (4-6 cm) euhedral and subhedral pyroxene crystals generally are completely altered to fibrous meshes of chlorite, talc, tremolite, and actinolite.

OZmp - Metapyroxenite (Late Proterozoic? to Middle Ordovician?)

Commonly composed of large (>4 mm), subhedral to euhedral pyroxenite crystals that have been partially to totally replaced by a mesh of chlorite and serpentine minerals. Tents to occur as rounded boulders in or over a dark-red soil. Large bodies support sparse vegetation.

OZu - Altered meta-ultramafic rock (Late Proterozoic? to Middle Ordovician?)

A wide variety of chloritized and (or) serpentinized ultramafic rocks generally in small bodies, tens of meters in diameter. Commonly found as cobbles and boulders. Includes soapstone and light-green to emerald-green, but mostly chlorite-schist, generally with blue black manganese-stained joint facies/S-planes.

OZs - Stonewall Gneiss (Late Proterozoic? to Middle Ordovician?)

Gray to grayish-brown to dark-gray, medium- to coarse-grained, commonly schistose, generally pegmatitic biotite-muscovite-quartz-potassium feldspar gneiss with generally rare but locally fairly common layers, lenses, and pods of hornblende-plagioclase amphibolites. Locally contains small, red garnets. Characteristically and commonly contains small pods and lenses of altered ultramafic rocks, now mostly soapstones and serpentinites, but originally probably pyroxenites, dunites, and peridotites. Some have original crystal textures of pyroxenites, but the crystals of pyroxene have been completely serpentinized and (or) uralitized, and many rocks are now soapstones. Intensely deformed in most

outcrops. Fresh outcrops are relatively rare because unit weathers deeply; fresh rock exposed along large streams. Weathers to a uniform, slightly micaceous, dark-red saprolite and clayey, dark-red soil; vermiculitic mica is characteristic of soils formed from the Stonewall Gneiss. Lack of outcrops and the dark-red soil also are characteristic; outcrops are even rare on steep hillsides of secondary streams. Most ultramafic bodies in the Stonewall are archaeological sites because of its ease in sculpting bowls, cooking utensils, and heat-retaining devices thought to have been used as bed/shelter/food warmers. Bowl fragments can be found at many sites; occasionally bowls blanks can be found still attached to the rock.

OZsp - Stonewall Gneiss, Powers Ferry Member (Late Proterozoic? to Middle Ordovician?)

Biotite gneiss identical to that in the undivided Stonewall Gneiss interlayered with biotite-muscovite-feldspar-quartz schist (~20-35 percent of unit) and minor scattered amphibolite.

OZsi - Stonewall Gneiss, weathers to slabs (Late Proterozoic? to Middle Ordovician?)

Stonewall Gneiss that has been extensively intruded by poorly foliated to unfoliated biotite-quartz-potassium feldspar-plagioclase granite, so that soil has characteristics of undivided Stonewall Gneiss, but the presence of many residual boulders makes weathered areas resemble those of Crider Gneiss.

OZa - Amphibolite (Late Proterozoic? to Middle Ordovician?)

Generally fine- to medium-grained, hornblende-plagioclase and (or) plagioclase-hornblende amphibolites, commonly with nematoblastic or, less commonly, salt and pepper textures.

OZr - Ropes Creek Metabasalt (Late Proterozoic? to Middle Ordovician?)

Fine- to medium-grained, dark-green to greenish-black, ocher-weathering, massive to finely layered, locally laminated, locally pillowed, locally chloritic, commonly garnetiferous, locally magnetite-bearing, generally pyrite-bearing, generally epidotic, hornblende-plagioclase and plagioclase-hornblende amphibolites with insignificant amounts (generally less than a very small fraction of a percent) of fine- to medium-grained, generally amphibole-bearing granofels. The final weathering product of the amphibolites is a characteristic dark-red, clayey soil. Thinly layered, medium-grained, magnetite quartzite (OZmq), in units about 0.3 to 6 m thick, is common in and characteristic of the Ropes Creek Metabasalt.

OZrk - Ropes Creek Metabasalt, kyanite quartzite (Late Proterozoic? to Middle Ordovician?)

Kyanite quartzite, 5 to 20 m thick, containing as much as 30 percent blue and green kyanite and 10 to 15 percent sulfide

OZrt - Ropes Creek Metabasalt, amphibolite (Late Proterozoic? to Middle Ordovician?)

Amphibolite containing ~5 to 15 percent interlayered, light-gray to white, white-weathering, biotite (<10 percent)-quartz-plagioclase gneiss that strongly resembles metatrondhjemite gneiss (OZmt) and the Villa Rica Gneiss (OZv).

OZrf - Ropes Creek Metabasalt, plagioclase-hornblende gneiss (Late Proterozoic? to Middle Ordovician?)

Plagioclase-hornblende gneiss composed of blackish-green, ochre-weathering, flaggy to massive, medium- to coarse-grained plagioclase-hornblende, with little or no felsic material.

OZcr - Crider Gneiss (Late Proterozoic? to Middle Ordovician?)

Gray to nearly white, massive to slabby, medium- to coarse-grained, poorly to well-foliated biotite-muscovite-quartz-plagioclase gneiss that is locally contorted and generally weathers to a light-tan to dark-yellowish-tan soil containing corestones of gneiss. The gneiss commonly is found as residual boulders where the unit is deeply weathered.

OZmq - Magnetite quartzite (Late Proterozoic? to Middle Ordovician?)

Thinly layered (<1 cm) to laminated, medium-grained, magnetite quartzite in units about 0.3 to 6 m thick. Commonly has thin (~1-4 cm) quartz-magnetite layers, with magnetite crystals as much as 1 cm in size, but commonly about 1 mm, that alternate with 4- to 8-cm-thick quartz layers with or without a small percentage of magnetite. Magnetite clumps that generally disrupt the layering are locally as large as 20 cm but are commonly about 1 cm. The magnetite quartzites are locally associated with thin (<0.5 m) gondites and magnetite-spessartine quartzites, and manganiferous schist, and locally with thin (~15 cm) layers of fibrous dravite tourmaline and with pyritiferous quartzite inunits of about 1.5 to 4 m thick. Where there is a considerable amount of manganiferous rocks with the magnetite quartzite, the quartzite has been mapped as OZmn.

OZmt - Unmapped metatrondhjemite gneisses (Late Proterozoic? to Middle Ordovician?)

A complex of several varieties of potassium feldspar-poor gneisses and metatrondhjemites. The most common variety, which probably makes up 85 to 90 percent of the unit, is identical to Villa Rica Gneiss. Other varieties include a coarse-grained, poorly foliated biotite (generally less than 2 percent)-quartz-plagioclase gneiss/granofels with minor amounts of a dark-green amphibole; and a biotite-quartz-plagioclase gneiss that weathers to a dark-pink saprolite. Fresh rocks are rare enough to be anomalous. Most structural measurements are on amphibolites within the gneisses.

OZkm - Informal migmatite of Kennesaw Mountain (Late Proterozoic? to Middle Ordovician?)

Massive, light-gray to nearly white, medium-grained, potassium feldspar-poor, biotite-quartz-plagioclase gneiss identical to metatrondhjemite gneisses (OZmt) and Villa Rica Gneiss (OZv), but with abundant xenoliths of Ropes Creek Metabasalt (OZr).

OZrs - Spheroidally weathering amphibolite (Late Proterozoic? to Middle Ordovician?)

Dark-green, medium- to coarse-grained, salt-and-pepper-textures, massive and flaggy, spheroidally weathering amphibolite. Holds up low ridges and knobs. Weathers to a dark-red soil with residual cobbles and boulders or flags.

OZm - Informal mixed unit (Late Proterozoic? to Middle Ordovician?)

Lustrous, medium- to coarse-grained (±garnet)-sillimanite-biotite-muscovite schist that is locally slightly graphitic and is commonly slightly manganiferous; medium- to coarse-grained, locally porphyroblastic biotite-quartz-plagioclase and biotite-quartz-potassium feldspar-plagioclase gneisses; light-gray, medium-grained granite gneisses; and fine- to medium-grained, dark-green, ocher-weathering hornblende-plagioclase and plagioclase-hornblende amphibolites. Locally contains garnet (±chlorite)-biotite-muscovite-quartz-feldspar gneisses. Generally contains pods and lenses of chlorite, hornblende, and actinolite schists. Characteristic of the mixed unit is the presence of scattered 0.3- to-1-m-thick beds of fine-grained, blocky and sooty weathering, (±magnetite)-spessartine quartzite (gondite, coticule rock) (OZmm), commonly interbedded with medium-grained, pink- to purple-weathering garnet-sillimanite-biotite-quartz-muscovite schist and fine- to medium-grained, dark-green to blackish-green, ocher-weathering hornblende-plagioclase amphibolite. Brown- to blackish-weathering manganiferous schists commonly are interbedded with the manganiferous quartzite, and manganiferous schists also occur without the quartzite.

OZmgs - Informal mixed unit, garnet-rich schist (Late Proterozoic? to Middle Ordovician?)

Gray, lustrous, tan- to yellowish-weathering, quartzose, garnet-rich muscovite-biotite schist containing medium to large (6 mm-1.5 cm) garnets. Garnets are so abundant that they cover the ground in most places. Kyanite is locally present.

OZmn - Manganiferous schist and gondite (Late Proterozoic? to Middle Ordovician?)

Gray to brown manganiferous schist containing layers and lenses of blocky, sooty-weathering spessartine quartzite (gondite, coticule rock), manganiferous magnetite quartzite, and interbedded hornblende-plagioclase amphibolite. Locally contains magnetite quartzite (OZmq).

Ccf - Crawfish Creek Formation (Cambrian and Cambrian?)

Garnet-muscovite-biotite-plagioclase-quartz schist with abundant quartz stringers and pods that contains relatively abundant medium-size (~0.5 mm to ~1 cm, but locally larger) garnets. Generally contains lenses and stringers of clean quartzite as thick as several meters, but more commonly less than 2 m.

Ccq - Crawfish Creek Formation, clean quartzite unit (Cambrian and Cambrian?)

Clean quartzite units that are locally mappable within some units of the Chilhowee Group.

Ccp - Chattahoochee Palisades Quartzite (Cambrian?)

White to yellowish, sugary to vitreous, slightly graphitic to nongraphitic quartzite with accessory muscovite garnet (generally flattened and elongated), and aluminosilicate minerals, in layers and beds about 0.3 to 1.2 m thick, interbedded with feldspathic quartzite and garnetiferous quartz-muscovite schist. Commonly adjacent tot and gradational into the aluminous schist unit (Cas). Chattahoochee Palisades Quartzite holds up low ridges that stand 30 to 60 m above intervening valleys and weathers to a quartz-sand saprolite/soil that is locally mineable for quartz sand where the unit is stratigraphically and (or) tectonically thickened. Within the Brevard fault zone, where it was originally named and where the type locality and type section are located (Higgins and McConnell, 1978), the quartzite is generally massive, vitreous, white to bluish, and generally continuous for many kilometers.

Cas - Aluminous schist unit (Cambrian?)

Consists of light-gray to silvery gray, generally reddish-weathering kyanite or staurolite-garnet-biotite-plagioclase (generally oligoclase)-muscovite-quartz schist, locally with abundant aluminosilicate minerals, locally with abundant garnets. Contains layers of quartz-muscovite schist, thinly layered, red, micaceous quartzite, and lenses of clean quartzite. Commonly contains abundant pegmatites. Commonly found adjacent to Chattahoochee Palisades Quartzite.

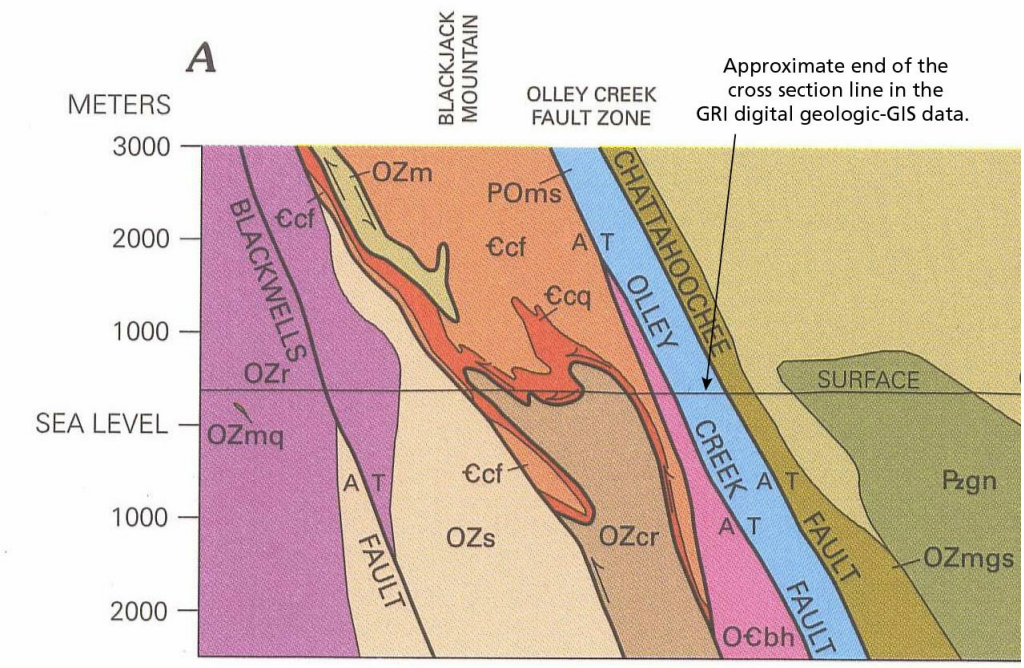
Caq - Aluminous schist unit, muscovite quartzite (Cambrian?)

Thin (<2 m thick) mappable units of muscovite quartzite that may be fault slices of Chattahoochee Palisades Quartzite (Ccp).

Geologic Cross Section

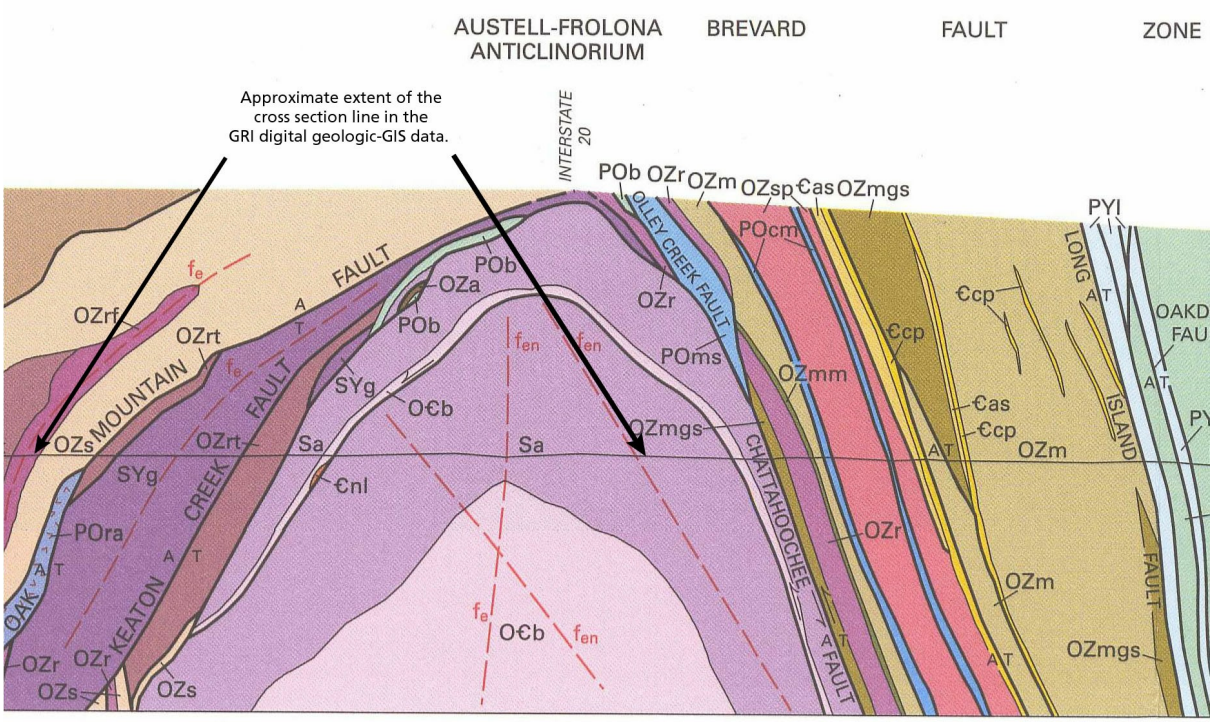
The geologic cross sections present in the GRI digital geologic-GIS data produced for Kennesaw Mountain National Battlefield Park, Georgia (KEMO) are presented below. Cross section graphics were scanned at a high resolution and can be viewed in more detail by zooming in (when viewing the digital format of this document). Only a portion, that of the extent within the GRI digital geologic-GIS data, is presented. See the source map publication for each full cross section.

Cross Section A-A'



Graphic from source map: Atlanta 30' x 60'. Note that the horizontal line in the middle of the graphic denotes the approximate surface of the earth.

Cross Section C-C'



Graphic from source map" Atlanta 30' x 60'. Note that the horizontal line in the middle of the graphic denotes the approximate surface of the earth.

Ancillary Source Map Information

The following sections present ancillary source map information associated with sources used for this project.

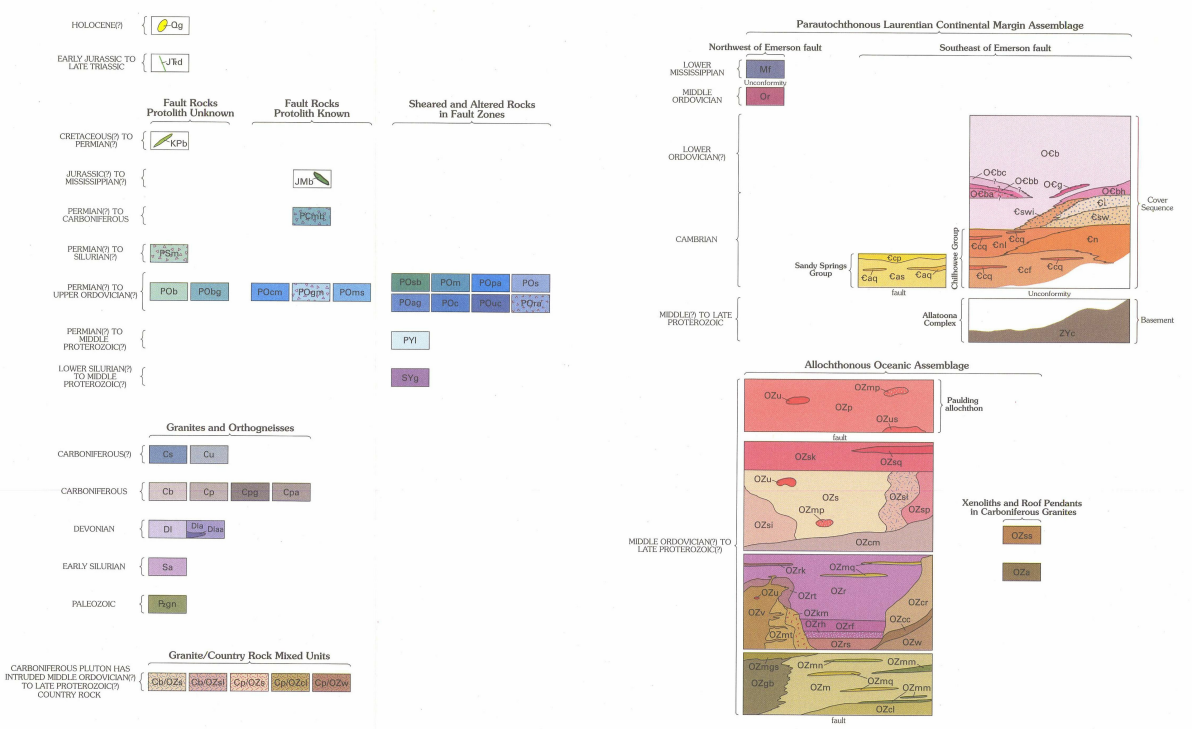
Atlanta 30' x 60'

The formal citation for this source.

> Higgins, M.W., Crawford, T.J., Atkins, R.L., and Crawford, R.F., 2003, Geologic Map of the Atlanta 30 x 60 Quadrangle, Georgia: U.S. Geological Survey, Geologic Investigations Series Map I-2602, scale 1:100,000 (*GRI Source Map ID 68679*).

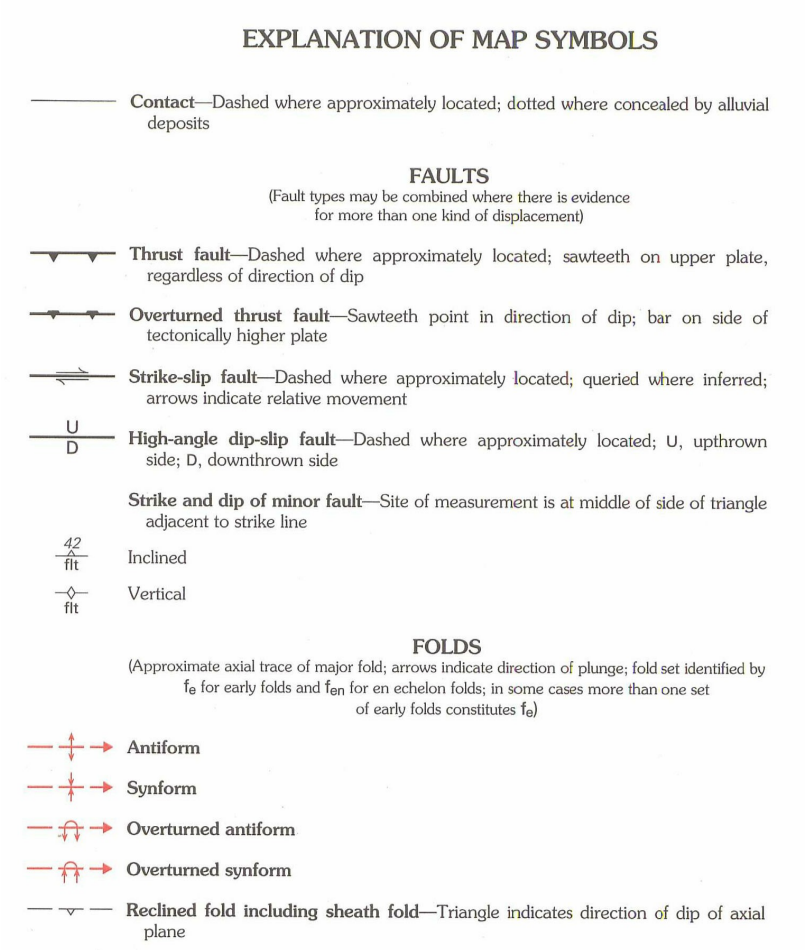
Prominent graphics and text associated with this source.

Correlation of Map Units



Graphic from source map: Atlanta 30' x 60'. Note that as only a portion of the source map was used for the GRI digital geologic-GIS map, only a subset of units present in the above correlation are present on the GRI digital geologic-GIS map.

Legend



EXPLANATION OF MAP SYMBOLS

Contact—Dashed where approximately located; dotted where concealed by alluvial deposits

FAULTS

(Fault types may be combined where there is evidence for more than one kind of displacement)

Thrust fault—Dashed where approximately located; sawteeth on upper plate, regardless of direction of dip

Overturned thrust fault—Sawteeth point in direction of dip; bar on side of tectonically higher plate

Strike-slip fault—Dashed where approximately located; queried where inferred; arrows indicate relative movement

U / D **High-angle dip-slip fault**—Dashed where approximately located; U, upthrown side; D, downthrown side

Strike and dip of minor fault—Site of measurement is at middle of side of triangle adjacent to strike line

42 / flt Inclined

flt Vertical

FOLDS

(Approximate axial trace of major fold; arrows indicate direction of plunge; fold set identified by f_e for early folds and f_{en} for en echelon folds; in some cases more than one set of early folds constitutes f_e)

Antiform

Synform

Overturned antiform

Overturned synform

Reclined fold including sheath fold—Triangle indicates direction of dip of axial plane

PLANAR FEATURES

(May be combined with linear features)

27 — **Strike and dip of bedding in unmetamorphosed Fort Payne Chert**—Site of measurement at junction of dip line with strike line

Strike and dip of foliation parallel to bedding or original compositional layering— Foliation characterized by alignment of micas and (or) amphiboles and (or) feldspars and (or) quartz; ball indicates top known from sedimentary structures; site of measurement is at middle of side of triangle adjacent to strike line

77 — Inclined

Vertical

63 — Overturned

Strike and dip of main schistosity, foliation, or cleavage where compositional layering is absent—Foliation characterized by alignment of micas and (or) amphiboles and (or) feldspars and (or) quartz; site of measurement is at middle of side of triangle adjacent to strike line

26 — Inclined

Vertical

Strike and dip of second cleavage or schistosity characterized by alignment of micas and (or) amphiboles and generally parallel to axial plane of fold—Sometimes cuts across compositional layering and (or) schistosity in the closure of the fold; site of measurement is at middle of side of triangle adjacent to strike line

42 — Inclined

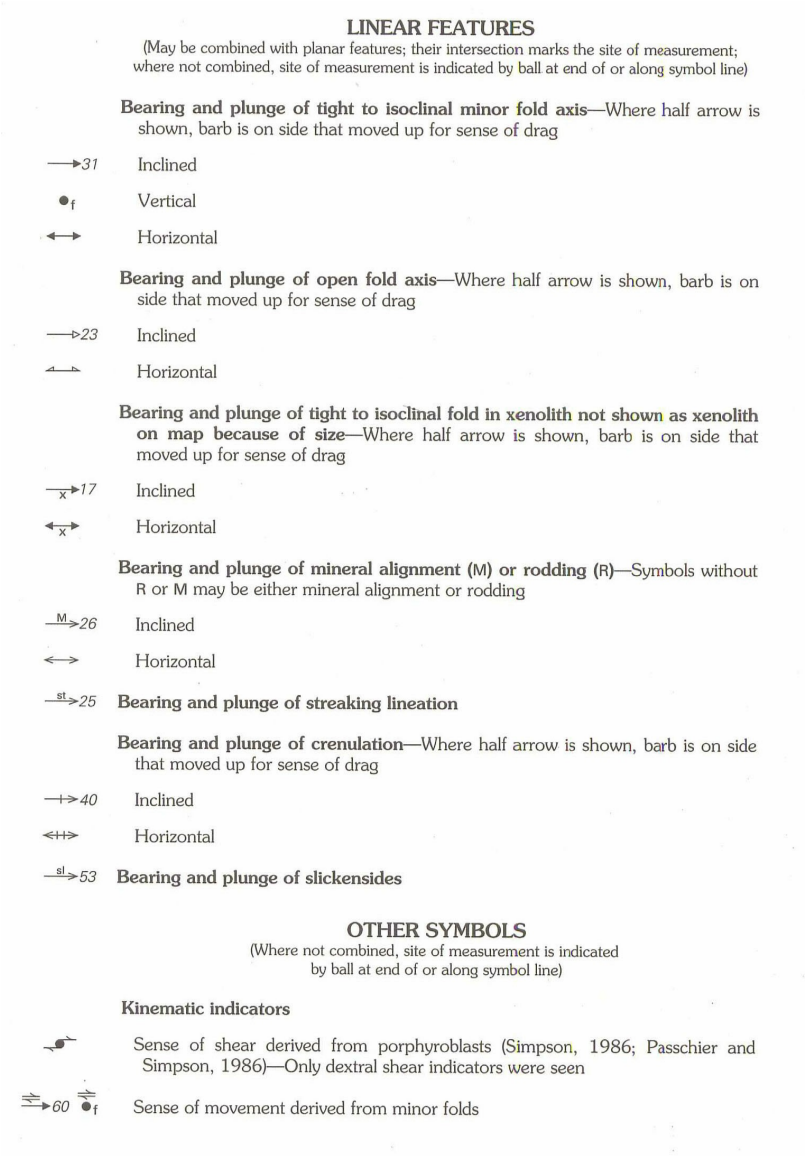
Vertical

Strike and dip of schistosity caused by shearing—Site of measurement is at middle of side of triangle adjacent to strike line

67 s — Inclined

s — Vertical

80 my — **Strike and dip of mylonitic layering**—Site of measurement is at middle of side of triangle adjacent to strike line



LINEAR FEATURES

(May be combined with planar features; their intersection marks the site of measurement; where not combined, site of measurement is indicated by ball at end of or along symbol line)

Bearing and plunge of tight to isoclinal minor fold axis—Where half arrow is shown, barb is on side that moved up for sense of drag

31 Inclined

f Vertical

Horizontal

Bearing and plunge of open fold axis—Where half arrow is shown, barb is on side that moved up for sense of drag

23 Inclined

Horizontal

Bearing and plunge of tight to isoclinal fold in xenolith not shown as xenolith on map because of size—Where half arrow is shown, barb is on side that moved up for sense of drag

x 17 Inclined

x Horizontal

Bearing and plunge of mineral alignment (M) or rodding (R)—Symbols without R or M may be either mineral alignment or rodding

M 26 Inclined

Horizontal

st 25 **Bearing and plunge of streaking lineation**

Bearing and plunge of crenulation—Where half arrow is shown, barb is on side that moved up for sense of drag

40 Inclined

Horizontal

sl 53 **Bearing and plunge of slickensides**

OTHER SYMBOLS

(Where not combined, site of measurement is indicated by ball at end of or along symbol line)

Kinematic indicators

Sense of shear derived from porphyroblasts (Simpson, 1986; Passchier and Simpson, 1986)—Only dextral shear indicators were seen

60 f Sense of movement derived from minor folds

Graphic from source map: Atlanta 30' x 60'. Note that as only a portion of the source map was used for the GRI digital geologic-GIS map only a subset features presented in the above legend are present on the GRI digital geologic-GIS map.

Report

The report/pamphlet associated with this source map is presented here as an embedded document, USGS_I-2602_report.pdf (double-click link to access the document). Note that as only a portion of the source map was used for the GRI digital geologic-GIS map, only some of the information within the report is directly related to the GRI digital geologic-GIS map. The report does, however, present a more regional perspective concerning the geology related to the map and park.

GRI Digital Data Credits

This document was developed and completed by Stephanie O'Meara (Colorado State University) for the NPS Geologic Resources Division (GRD) Geologic Resources Inventory (GRI) Program. Quality control of this document by Jim Chappell (Colorado State University). An earlier version of this document was produce by Ian Hageman, Georgia Hybels and Stephanie O'Meara (Colorado State University).

The information in this document was compiled from GRI source map, and is intended to accompany the GRI digital geologic-GIS map and other digital data for Kennesaw Mountain National Battlefield Park, Georgia (KEMO) developed by Georgia Hybels and Stephanie O'Meara (see the GRI Digital Map and Source Map Citation section of this document for all sources used by the GRI in the completion of this document and related GRI digital geologic-GIS map).

GRI finalization by Stephanie O'Meara.

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