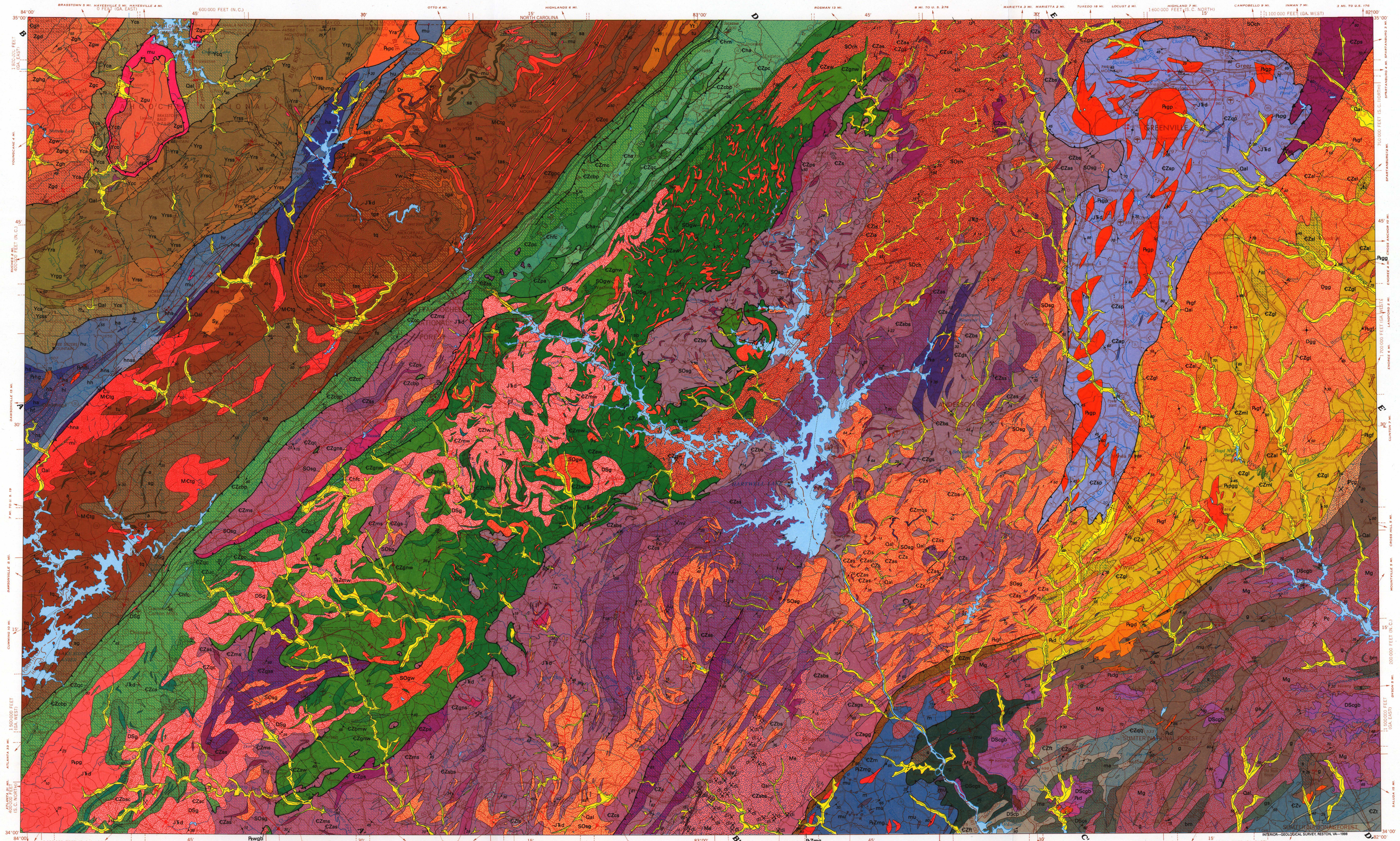
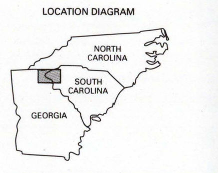
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I-2175 (SHEET 1 OF 2)
Explanatory pamphlet accompanies map





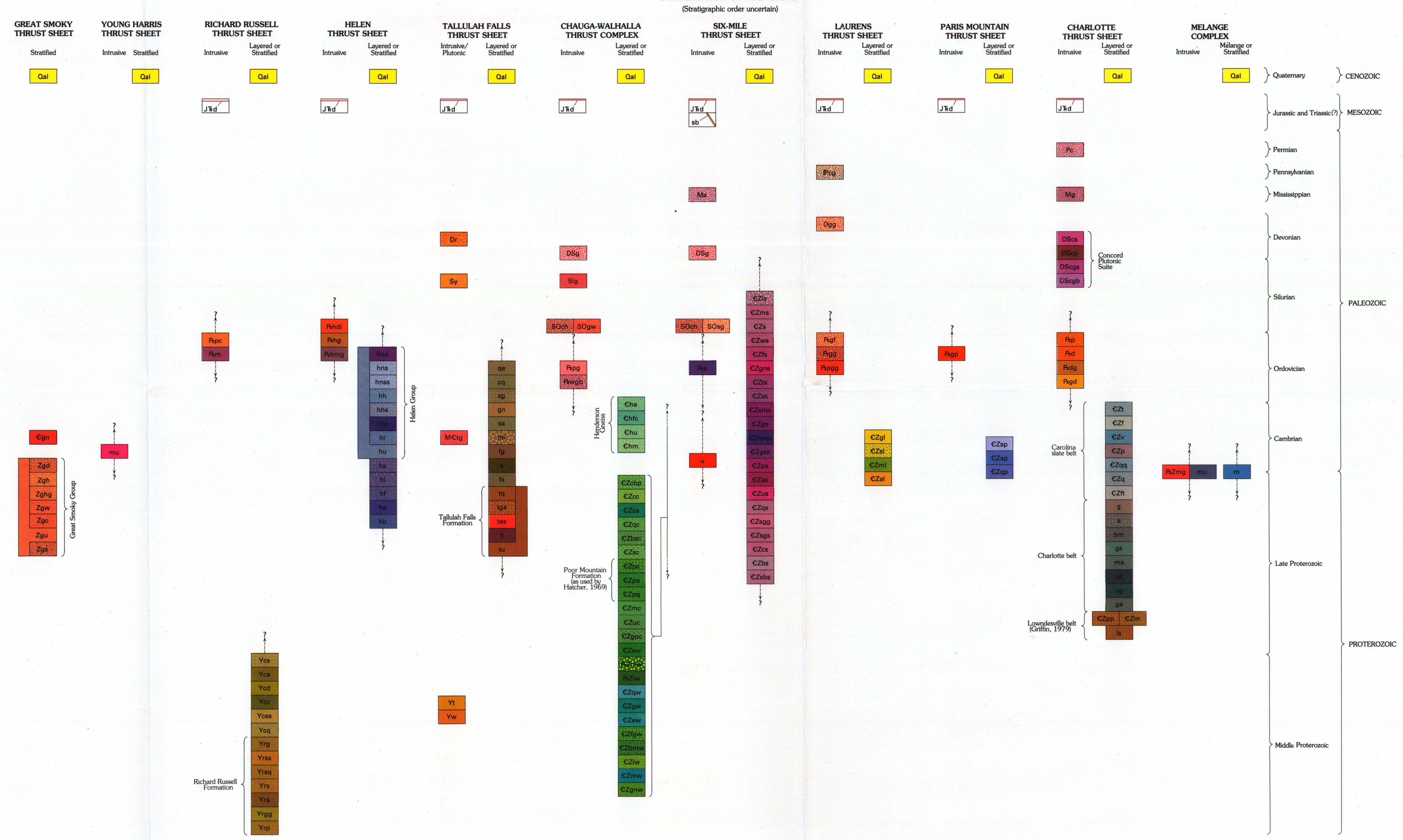
Base from U.S. Geological Survey 1954
Limited revision 1964

100,000-foot grids based on South Carolina coordinate system, north zone, Georgia coordinate system, west and east zones, and North Carolina coordinate system

SCALE 1:250 000

Mapped in 1976-1986
Compiled in 1988
Manuscript approved for publication April 12, 1990

CORRELATION OF MAP UNITS
(Stratigraphic order uncertain)



DESCRIPTION OF MAP UNITS

Qal **Alluvium (Quaternary)**—Unconsolidated, coarse- to fine-textured bouldery and cobbly gravels, sand, and clay. Streams in the Blue Ridge are commonly choked with bouldery debris; alluvial deposits are present in all stream valleys but only the most extensive deposits are mapped; the thickest deposits are in broader stream valleys; locally along steep valley walls colluvium is mixed with alluvium

JTRd **Diabase dikes (Jurassic and Triassic?)**—Medium-dark-gray to black, fine- to medium-grained, massive diabase. Very hard and resistant. Dikes range from a few centimeters to several meters thick

sb **Silicified breccia**—Cohesive, silicified fault breccia, composed mostly of fine-grained quartz. Vugs lined with drusy quartz crystals are common. Occurs as tabular, steeply dipping bodies

GREAT SMOKY THRUST SHEET

Murphy syncline

Ꞓgn **Nantahala Slate (Cambrian)**—Dark-gray slate and mica schist with laminae and thin beds of light-colored, fine-grained quartzose metasandstone

Great Smoky Group (Late Proterozoic)

Zgd **Dean Formation**—Interlayered muscovite schist, mica schist, sericite schist, and argillaceous to feldspathic metasandstone. Schists are medium gray, mostly thickly bedded, and contain garnet, sillimanite, magnetite, quartz, sericite, biotite, and muscovite. Sandstones are medium gray, medium to coarse grained, moderately to thickly bedded, and contain mostly quartz, biotite, and plagioclase, minor microcline, tourmaline, and titanite

Zgh **Hothouse Formation**—Metasandstone, interlayered with mica schist and minor metaconglomerate. Medium to dark gray, thin to moderately thick and evenly bedded; metasandstone is argillaceous to feldspathic; schists contain mostly biotite, quartz and muscovite; some minor calc-silicate beds

Zghg **Hughes Gap Formation**—Aluminous schist interlayered with conglomeratic argillaceous metasandstone, and abundant thin calc-silicate beds. Schists are mostly silver gray, thickly bedded, and contain staurolite, garnet, sillimanite, chlorite, biotite, sericite and muscovite; metasandstones are light gray, medium grained, thinly to thickly bedded, and contain mostly plagioclase, biotite, quartz, and minor muscovite

Zgw **Wehutty Formation**—Interlayered sillimanite-graphite-muscovite schist and argillaceous and feldspathic metasandstone containing pods and lenses of calc-silicate granofels

Zgc **Copperhill Formation**—Interlayered argillaceous metasandstone (locally conglomeratic), sillimanite-biotite-muscovite schist, and minor calc-silicate beds. Metasandstones are reddish gray to gray, thickly bedded, fine to medium grained, and contain mostly quartz, plagioclase, biotite, and muscovite; schists are gray to dark gray, medium to coarse grained, thinly to thickly layered, and contain chiefly muscovite, quartz, and biotite

Zgu **Undivided rocks of the Great Smoky Group**—Mostly sillimanite-garnet-biotite-muscovite schist interbedded with lesser amounts of feldspathic to argillaceous metasandstone, and some calc-silicate beds. Metasandstone is dark gray, medium grained, and contains mostly quartz, plagioclase, and biotite; schists are silver gray, coarse grained, with muscovite dominant over biotite, and garnet and sillimanite locally abundant

Zgs **Interbedded argillaceous metasandstone and garnet-muscovite-biotite schist**—Fine to coarse grained, thin to medium bedded

YOUNG HARRIS THRUST SHEET

Intrusive rocks

mu **Ultramafic-mafic complex near Lake Chatuge**—Undivided dark-greenish-brown, medium- to coarse-grained, two-pyroxene rock rich in magnetite; and dark-greenish-gray, medium- to coarse-grained, deeply weathered rock that may represent metamorphosed gabbro or olivine troctolite; some amphibolite that is black and fine grained is included with these rocks. Includes minor amounts of dark-greenish-gray, fine- to medium-grained talc-chlorite schist; some altered greenish-gray, medium-grained dunite; rare dark-gray wehrlite; and a weathered, coarse-grained rock that contains garnet and pyroxene (possibly an eclogite). Rocks of this complex are locally chaotically mixed and form a tectonic melange

Note—All thrust sheets structurally higher than the Great Smoky thrust sheet contain variably sized lenses and pods of ultramafic-mafic rocks, including some chlorite-talc-tremolite schist, talc-anthophyllite schist, and actinolite-chlorite-antigorite schist, most of which are too small to be mapped. Accessory and trace minerals locally include magnetite, ilmenite, anthophyllite, dolomite, and calcite. Contact aureoles have not been observed and these ultramafic-mafic rocks are believed to be tectonically emplaced fragments of a larger ultramafic-mafic source that might be represented by mu in the Young Harris thrust sheet; some of these mapped bodies in higher thrust sheets carry the letter symbol mu

RICHARD RUSSELL THRUST SHEET

Layered or stratified rocks
(Stratigraphic order uncertain)

Schist of Crooked Creek (Middle? Proterozoic)

Ycs Garnet-mica-quartz-feldspar schist—Medium to dark gray, medium to coarse grained; interlayered with quartz-feldspar-mica gneiss, amphibolite, hornblende gneiss, calc-silicate layers, quartzofeldspathic gneiss and (or) metagraywacke; contains minor diamictite and quartzite; irregularly layered to form heterogeneous rock assemblage; ranges from thinly to thickly layered, and from fine to coarse grained

Yca Amphibolite—Dark greenish gray, fine to medium grained, thinly to thickly layered; containing plagioclase, hornblende, biotite, minor quartz, and some opaque minerals

Ycd Diamictite—Olive gray, medium to coarse grained; contains lithic rock fragments in a matrix rich in quartz, plagioclase, biotite, opaque minerals, and some garnet

Ycc Calc-silicate gneiss—Pinkish gray, fine to medium grained, mostly very thinly layered, and locally present as discontinuous lenses or pods; consists of alternating mafic and felsic layers of garnet-amphibole-plagioclase-quartz granofels, garnet-plagioclase-quartz amphibolite, and garnet-mica-quartz-plagioclase schist

Ycss Quartzofeldspathic gneiss and biotite gneiss—Quartzofeldspathic gneiss grading into biotite gneiss; quartzofeldspathic gneiss is medium to dark gray, fine to medium grained, thickly layered, and locally very thinly laminated; bedding commonly transposed; biotite gneiss is well foliated and contains quartz, plagioclase, biotite, garnet and locally muscovite, sillimanite, epidote, opaque minerals, minor sulfides

Ycq **Quartzite (Middle? Proterozoic)**—Almost pure massive quartzite, mostly white except where variably stained by iron oxide; contains quartz, minor but widely disseminated pyrite, and rare feldspar and mica

Richard Russell Formation (Middle? Proterozoic)

Yrg Biotite gneiss—Medium gray to brownish gray, medium to coarse grained, locally porphyroblastic, irregularly layered to massive; contains mostly biotite, feldspar, quartz, and garnet, with lesser amounts of muscovite, sillimanite, epidote, sphene, and sulfides. Many exposures consisting largely of gneiss containing light (felsic) and dark (biotite-rich) segregations. Gneiss is irregularly interlayered with and gradational into lesser amounts of quartzofeldspathic gneiss. Contains alternating thin to thick layers of biotite schist, muscovite-biotite schist, hornblende gneiss, amphibolite, and calc-silicate granofels; includes minor gabbroic, dioritic, and granitic gneiss. Pegmatite and granite pods and veins common

Yrss Quartzofeldspathic gneiss—Light green to brownish gray, fine to medium grained (locally contains pebble layers), thinly to thickly layered, well foliated, containing mostly plagioclase, quartz, and brown to green biotite with minor garnet, chlorite, epidote, sphene, opaque minerals, and sulfides; sillimanite common to the southwest and kyanite and staurolite to the northeast. Locally, very thin quartzofeldspathic segregations alternate with very thin, dark, biotite streaks; irregularly interlayered with and gradational into biotite gneiss; interlayered with biotite schist, muscovite-biotite schist, quartzite, thin calc-silicate layers, hornblende gneiss, and amphibolite; discontinuous pegmatite and quartz veins and pods are common. Probably correlates with Coleman River Formation of Hatcher (1979) in North Carolina

Yrgg Mixed biotite gneiss and granitic gneiss—Complex of biotite and granitic gneisses mixed in all proportions from small granite veins and pods in biotite gneiss to massive granite to granodioritic gneiss containing only thin wisps of biotite gneiss; also includes minor quartzofeldspathic gneiss, biotite schist, and amphibolite. Granite to granodiorite gneiss is light gray to white, fine to coarse grained, equigranular to porphyroblastic, and contains principally quartz, microcline, plagioclase, muscovite, and biotite; locally garnetiferous; commonly associated with pegmatite pods and veins, and quartzofeldspathic lenses. A light-gray, equigranular, medium- grained, granitic gneiss in this complex has a preliminary concordant $^{207}Pb/^{206}Pb$ age for zircons of 1,035 Ma (T.W. Stern and A.E. Nelson, U.S. Geological Survey, unpub. data, 1984)

Yra Amphibolite—Dark greenish gray to black, fine to medium grained, thinly laminated and locally with thin black mafic and light felsic stripes; contains mostly plagioclase and hornblende, with some garnet, biotite, epidote, chlorite, and quartz. Locally grades into hornblende gneiss and in places is associated with metagabbro

Yrsq Quartzite and interlayered quartzofeldspathic gneiss—Quartzite is light tan to light gray and characteristically fine grained; locally contains muscovite and in places is rich in epidote. Quartzofeldspathic gneiss is light gray, thin layered, and quartz rich

Yrs Biotite schist and muscovite-biotite schist—Gray to dark brown, medium to coarse grained, irregularly layered to massive, containing biotite, feldspar, quartz, sillimanite, and locally abundant garnet; in places muscovite nearly equal to biotite; contains clusters of sericite. Locally has some chlorite and graphite; calc-silicate layers, felsic segregations, granite, and pegmatite veins and pods are all common; interlayered with quartzofeldspathic gneiss, biotite gneiss, and some granite gneiss

Yrp Irregularly interlayered and commonly well-foliated biotite-garnet schist, mica schist, quartzofeldspathic gneiss, and quartzite that is locally muscovitic—Biotite schist is dark gray and coarse grained; contains biotite, muscovite, plagioclase, quartz, garnet, and chlorite. Mica schist is silvery gray to light gray, thinly to thickly layered; contains muscovite, biotite, quartz, plagioclase, garnet, and minor chlorite, kyanite, staurolite, and opaque minerals. Quartzite is white to tan and contains quartz, muscovite, biotite, plagioclase, garnet, epidote, and some staurolite, chlorite, and opaque minerals. Metasandstone is light to medium gray, fine to medium grained, thin to thick layered (in places thinly laminated); bedding is commonly transposed; contains quartz, plagioclase, biotite, muscovite, garnet, epidote, with minor staurolite, biotite and opaque minerals. This unit may correlate with the Ridgepole Mountain Formation of Hatcher (1979) in North Carolina

Intrusive rocks

Pzpc **Quartz diorite to tonalitic gneiss (Paleozoic)**—Generally massive, dark to medium gray, and equigranular; contains some discontinuous, generally thin layers of quartzofeldspathic gneiss and mica schist. Quartz diorite gneiss is medium to coarse grained, and massive; consists principally of plagioclase, quartz, biotite, and some epidote, garnet, muscovite, and chlorite. May correlate with the Persimmon Creek Formation of Hatcher (1979) in North Carolina

Pzm **Metagabbro (Paleozoic)**—Dark gray, mostly medium to coarse grained, massive; contains subequal amounts of plagioclase (andesine-labradorite) and green to blue-green amphibole, and minor quartz; accessories include epidote, serpentine, chlorite, magnetite, ilmenite, and titanite

HELEN THRUST SHEET

Layered or stratified rocks
(Stratigraphic order uncertain)

Helen Group (lower Paleozoic and (or) Late Proterozoic)

Nacoochee Formation

hna Amphibolite—Dark gray to black, mostly medium grained, thinly layered to massive; consists of black hornblende and (or) actinolite, plagioclase, quartz, epidote, and minor biotite, chlorite, tremolite, tourmaline, and garnet

hns Aluminous schist—Silver gray to dark metallic gray, mostly thickly layered, coarse to medium grained; consists mostly of muscovite, biotite, quartz, plagioclase, with minor graphite, staurolite, and chlorite

hnss Metasandstone and metasiltstone—Light to medium gray, thinly layered, fine to medium grained; consists mostly of quartz, plagioclase, biotite, and muscovite with minor chlorite, epidote, and opaque minerals. Metasandstones are argillaceous; metasiltstones are feldspathic and locally sulfidic

Horton Formation

hh Argillaceous and feldspathic metasandstone and metasiltstone—Light bluish gray, thinly to thickly layered (in places thinly laminated, fine to medium grained; major constituents are quartz, plagioclase, muscovite, and biotite, minor constituents include pyrite and opaques; sulfides are commonly present

hhs Aluminous schist—Silver gray, coarse to medium grained, thinly to thickly layered, consisting mostly of muscovite (greater than biotite), quartz, and feldspar; minor amounts of staurolite, garnet, some graphite, and chlorite

hha Amphibolite locally mixed with metagabbro—Dark gray, medium grained, thinly to thickly layered, consisting of hornblende and (or) actinolite, saussuritized plagioclase, magnetite, chlorite, and minor epidote, calcite, and quartz

hr **Robertstown Formation**—Metasandstone, blue gray, mostly thick layered but in some places a thinly layered, medium to coarse grained; characteristically has thin muscovite schist partings. Principal minerals are quartz, plagioclase, biotite, muscovite, with minor microcline, opaque minerals, and zircon

hu **Undivided rocks of the Helen Group**—Metasandstone, metasiltstone, aluminous schist, amphibolite, and minor mica schist, metagraywacke, and quartzite. Metasandstone is thinly to thickly layered, commonly medium blue gray, fine to medium grained with thin muscovite partings between sandstone layers; principal minerals are quartz, biotite, plagioclase, muscovite, and minor chlorite, garnet, epidote, sphene, and opaque minerals. Mica schist is medium to dark gray, coarse grained, and contains biotite and muscovite (either of which can be dominant), and quartz, plagioclase, garnet, and opaque minerals

Other metasedimentary rocks (lower Paleozoic or Late Proterozoic)

hi **Interlayered metasiltstone, metasandstone, mica schist, phyllite, amphibolite, and rare slate**—Light gray to blue gray to black, characteristically thinly layered, mostly fine to very fine grained. Metasandstone is mostly feldspathic. Metasiltstone consists of quartz, variable amounts of plagioclase, muscovite, biotite, and lesser amounts of garnet, sphene, calcite, chlorite, and opaque minerals; layering ranges between 1 and 5 cm in thickness, muscovite-rich partings are common in metasandstone layers. Phyllite is very fine grained, thinly layered (commonly between 3 and 10 cm); alternating lamellae of muscovite, biotite, and quartz are common; also includes feldspar, garnet, chlorite, calcite, and opaque minerals. Mica schists include variably textured and layered biotite-rich and muscovite-rich schists and some dark-gray to black, manganiferous schists; also includes quartz, plagioclase, garnet, calcite, chlorite, and opaque minerals. Amphibolite is dark gray to black, fine to medium grained, mostly thinly layered; consists of amphibole, biotite, plagioclase, and minor quartz characterized by weathering to thin slabby and blocky fragments

hs **Mica and aluminous schist interlayered with fine-grained metasandstone**—Schists are silvery gray, coarse grained, thickly to thinly layered, consisting of biotite greater than muscovite (which commonly forms large crystals), quartz, feldspar, and minor graphite and garnet

hf **Garnet felsic gneiss or schist**—Light to medium gray, fine grained, indistinctly layered, containing poikiloblastic garnet, sericitized plagioclase, muscovite, biotite, quartz, some opaque minerals, and chlorite; locally garnet has chlorite rims

ha **Amphibolite**—Black to dark gray, generally medium to coarse grained; in thin layers, massive, or as pods or lenses; contains some thin alternating layers of black amphibole and light zones of plagioclase and quartz; also contains epidote, opaque minerals, biotite, garnet, calcite, chlorite, and rare sulphide minerals

hb **Biotite-plagioclase-quartz gneiss**—Mostly fine grained, medium gray. Interlayered with lesser amounts of dark-gray, fine-grained amphibolite; medium-gray sericite schist; and light-gray, quartz-rich rock containing dark, thin layers of magnetite and quartz

Intrusive rocks

Pzhdi **Hornblende diorite (Paleozoic)**—Light gray to light olive gray, fine to medium grained; consists mostly of equigranular plagioclase, quartz, and crystals of hornblende aligned in the foliation; associated with medium-grained granodiorite

Pzhg **Tonalitic gneiss (Paleozoic)**—Light gray, generally massive, variably foliated, and locally porphyritic with large microcline megacrysts; consists mainly of plagioclase, microcline, quartz, and biotite; locally contains some hornblende diorite

Pzhmg **Metagabbro (Paleozoic)**—Dark gray to black, medium grained; composed mainly of hornblende, plagioclase, and minor quartz

TALLULAH FALLS THRUST SHEET

Layered or stratified rocks
(Except for Tallulah Falls Formation, stratigraphic order uncertain)

sg **Biotite schist and muscovite-biotite schist**—Gray to dark brown, medium to coarse grained, irregularly layered to massive, containing biotite, plagioclase commonly as porphyroblasts, quartz, garnet, minor muscovite, rare sillimanite, and chlorite; some plagioclase has sericitic alteration. Interlayered with lesser amounts of biotite gneiss, minor quartzofeldspathic gneiss or graywacke, some granitic gneiss, and rare amphibolite. Variably sized pods and veins of pegmatite and quartz common

gn **Biotite gneiss and schist containing irregularly spaced layers of granite to granodiorite gneiss and migmatite**—Biotite gneiss is medium gray to brownish gray, medium to coarse grained, locally porphyritic with large feldspar grains, thinly to thickly layered to massive; contains quartz, biotite, plagioclase, microcline, muscovite, and lesser amounts of garnet, epidote, titanite, magnetite, and zircon. Light (felsic) and dark (biotite) segregations form major parts of some exposures. Includes minor metasandstone that is locally gneissic, mica schist, and amphibolite. Variably sized veins and pods of both pegmatite and quartz are widespread, as are stringers of granitic material

sa **Interlayered amphibolite, biotite schist, biotite-muscovite schist, and quartzofeldspathic gneiss**—Amphibolite is dark greenish gray to black, fine to medium grained, thinly laminated and locally striped in thin black mafic and light felsic bands; contains mostly plagioclase and hornblende with quartz, garnet and biotite; generally thinly layered and weathers to thin slabs. Assemblage includes some granite gneiss, many irregular lenses and stringers of quartzofeldspathic segregations, and quartz and pegmatite pods and veins

a **Amphibolite**—Dark greenish gray to black, medium to coarse grained, thinly layered to massive, commonly laminated into thin black hornblende layers and light felsic layers. Consists chiefly of hornblende and plagioclase with massive biotite, garnet, quartz, and chlorite. Occurs also as small pods and lenses in other rock types

qe **Quartzite**—Fine to medium grained, characterized by widely disseminated epidote

cq **Calc-silicate quartzite**

mi **Migmatite**—Biotite gneiss, quartzofeldspathic gneiss, and granitic gneiss mixed in all proportions from small granite veins and pods in biotite gneiss to massive granite gneiss containing only thin wisps of biotite gneiss; also includes minor biotite schist and amphibolite

fg **Gray mica gneiss**—Fine grained, occurs in thin layers. Three varieties present are quartz-rich, muscovite-rich, and microcline-biotite rich. Principal minerals are quartz, plagioclase, muscovite, (microcline and biotite); less common are garnet, epidote, titanite, zircon, apatite, and opaque minerals

fs **Mylonitized rocks of the Tallulah Falls thrust sheet**—Variably mylonitic; unit includes button schists

Tallulah Falls Formation (lower Paleozoic and (or) Late Proterozoic)

tq Quartzite-schist member—Very light gray to pale greenish yellow, coarse grained, thickly bedded with graded bedding, and locally conglomeratic. Contains quartz with minor biotite, plagioclase, muscovite, and microcline; in places, epidote is dispersed in the quartzite; interlayered with coarse-grained muscovite-biotite-quartz-plagioclase schist

tga Graywacke-schist member—Medium-gray to bluish-gray, medium- to coarse-grained quartz-biotite-plagioclase-muscovite metagraywacke interlayered with coarse-grained, medium-silver-gray muscovite-biotite-quartz schist

tas Garnet-aluminous schist member—Silver gray to medium brown, medium to coarse grained, irregularly layered to massive. Contains abundant muscovite and low biotite, garnet, quartz, locally high in plagioclase; locally contains kyanite or sillimanite. Interlayered with mica schist and metagraywacke or quartzofeldspathic gneiss and rare light-tan quartzite

tl Graywacke-schist-amphibolite member—Interlayered medium-gray, medium-grained quartz-oligoclase-biotite-muscovite graywacke; medium- to coarse-grained muscovite (biotite-quartz plagioclase) schist; and coarse-grained hornblende-andesine (biotite) amphibolite

tu Undivided rocks of the Tallulah Falls Formation

Plutonic rocks

Yt **Toxaway Gneiss (Middle Proterozoic)**—Light to medium gray, massive to well layered, equigranular to inequigranular, characterized by coarse eyes or knots of quartz and feldspar enclosed by folia of medium-grained biotite; microcline commonly occurs as coarse blocky porphyroblasts. Quartz, plagioclase, biotite, and microcline are chief minerals; less common minerals are muscovite, epidote, titanite, magnetite, apatite, and zircon. Fullagar and others (1979) reported a whole-rock age of 1,203±54 Ma

Yw **Informal Wiley gneiss of Hatcher (1974) (Middle Proterozoic)**—Light to medium gray, generally massive, coarse grained; contains principally microcline, plagioclase, quartz, biotite, and muscovite

Intrusive rocks

Dr **Informal Rabun gneiss of Hatcher (1974) (Devonian)**—Light-gray to pinkish-gray, moderately well foliated granodiorite gneiss; fine- to medium-grained groundmass with large porphyroblasts of microcline; principal minerals are plagioclase, microcline, quartz, biotite, with lesser amounts of epidote, magnetite, and muscovite. Preliminary concordant $^{207}Pb/^{206}Pb$ age for zircons is 373 Ma (T.W. Stern and A.E. Nelson, U.S. Geological Survey, unpub. data, 1987)

Sy **Informal Yonah Gneiss of Gillon (1982) (Silurian)**—A complex of layered felsic gneiss, microcline porphyroblastic gneiss, and tonalite gneiss. Layered felsic gneiss, the dominant rock type, is light to medium gray, coarse to medium grained, and variably layered. Light-gray quartzofeldspathic bands and darker biotite-rich zones consist mostly of quartz, plagioclase, biotite, muscovite, and microcline. Microcline porphyroblastic gneiss is a light- to medium-gray granodiorite gneiss with a coarse- to medium-grained, equigranular to inequigranular groundmass with microcline augen; consists mostly of plagioclase, microcline, quartz, biotite, and muscovite, with lesser amounts of epidote, sericite, apatite, and zircon. Tonalite gneiss is light-gray, fine-grained, mostly equigranular aggregate of plagioclase and quartz with prominent hornblende crystals; also contains epidote, microcline, titanite, opaque minerals, and zircon. These rocks have a preliminary concordant $^{207}Pb/^{206}Pb$ zircon age of 431 Ma (T.W. Stern and A.E. Nelson, U.S. Geological Survey, unpub. data, 1987)

MꞒtg **Undifferentiated granite, granodiorite, and quartz diorite gneisses (Cambrian to Mississippian)**—Granitic gneisses are light gray to white, medium to coarse grained, variably foliated; they consist mostly of quartz, microcline and plagioclase (locally as large porphyroblasts), plus muscovite and biotite; pods and veins of quartz and pegmatite common. Pegmatites chiefly contain plagioclase, microcline, biotite and (or) muscovite. Quartz diorite gneiss is medium light gray to greenish gray, fine to medium grained, and consists of oligoclase, quartz, hornblende, minor biotite, garnet, epidote, and zircon. Unit includes some unmapped trondhjemite dikes and contains small layers and lenses of biotite gneiss, mica schist and quartzofeldspathic gneiss. Two separate granodiorite bodies have preliminary discordant $^{207}Pb/^{206}Pb$ zircon ages of 353 Ma and 561 Ma, respectively (T.W. Stern and A.E. Nelson, U.S. Geological Survey, unpub. data, 1987)

CHAUGA-WALHALLA THRUST COMPLEX

Layered or stratified rocks
(Stratigraphic order uncertain)

The Chauga belt part of the Chauga-Walhalla thrust complex

Ꞓha **Henderson Gneiss (Cambrian)**—Includes an augen gneiss and an equigranular granite gneiss, principally a medium- to dark-gray, medium- to coarse-grained, massive to well-layered, strongly foliated granitoid augen gneiss; consists of quartz, plagioclase, microcline, and biotite with minor calcite, sericite, epidote, titanite, hornblende, chlorite, apatite, and zircon; mylonitized near Brevard fault zone

Ꞓhfc **Fine-grained, light- to medium-gray, variably layered quartz-plagioclase-microcline-epidote-biotite-gneiss (Cambrian)**—In places, has small augen of feldspar and locally is sheared

Ꞓhu **Undivided Henderson Gneiss (Ꞓha) and an unnamed fine- to medium-grained quartz-feldspar-mica gneiss (Ꞓhfc) (Cambrian)**

Ꞓhm **Mylonitic Henderson Gneiss (Cambrian)**

Chauga River Formation of Hatcher (1969) (Lower Cambrian or Late Proterozoic)

ꞒZcbp Lower and upper phyllonitic schist members—Fine- to medium-grained, medium-greenish-gray muscovite-chlorite-plagioclase-quartz phyllonite and button schist; some metallic-gray graphite-muscovite-chlorite-plagioclase phyllonite and button schist; and some thin metagraywacke beds southwest of Cornelia, Ga. Phyllonite button schist consists mainly of muscovite, graphite, biotite, plagioclase, and minor garnet that is locally chloritized; unit includes some thinly layered metasandstone, metasiltstone, and some amphibolite layers

ꞒZcc Carbonate member—Light-gray, fine- to medium-grained marble containing mostly calcite and minor quartz, plagioclase, and microcline; also includes light-gray, calcareous quartzite. Locally contains buttons of white mica

ꞒZca Amphibolite—Dark gray to black, very fine grained, thinly layered, thinly laminated with alternating black hornblende lamellae and white lamellae of feldspar and quartz; may correlate with ꞒZpc

ꞒZqc Quartzite—White to light gray, fine to medium grained, and thinly to thickly layered; consists chiefly of quartz with variable smaller amounts of biotite, muscovite, plagioclase, microcline, garnet, and opaque minerals. Locally mylonitic; in places, contains thin granitic gneiss layers and pods

ꞒZbsc Muscovite-biotite schist containing variable amounts of interlayered biotite schist, metasandstone, quartzite, thinly laminated amphibolite, and minor gondite—Muscovite-biotite schist is medium to coarse grained and contains mostly biotite, muscovite, plagioclase, quartz, garnet, (staurolite), and opaque minerals; gondite mostly consists of garnet (spessartine) and quartz

ꞒZsc Interlayered button mica schist, biotite schist, amphibolite, and minor metasandstone, undivided

ꞒZgpc Muscovite-chlorite phyllonitic schist and metallic-gray, graphitic muscovite-chlorite button phyllonitic schist

ꞒZuc Fine- to medium-grained, medium- to dark-gray quartz-feldspar-biotite gneiss and (or) feldspathic quartzite

ꞒZmc Undifferentiated mylonitic and cataclastic rocks

Poor Mountain Formation as used by Hatcher (1969) (Lower Cambrian and (or) Late Proterozoic)

ꞒZpa Amphibolite—Thinly laminated, very fine grained, alternating quartzofeldspathic and amphibole lamellae, interlayered with minor thinly bedded biotite schist, metasiltstone, metasandstone, and quartzite

ꞒZpc Interlayered mica schist, metasiltstone, metasandstone, quartzite, biotite schist, amphibolite, and granite, undifferentiated—Thickly to thinly layered schists locally have button textures. Quartzites range from epidote-rich to muscovite-quartz schists to garnet (spessartine) quartzites (gondite). Also present are thinly laminated amphibolite (ꞒZpcu), minor biotite schist, and minor metasandstone

ꞒZpq Quartzite to calcareous quartzite—Quartzite is mostly light gray, fine grained, thinly to thickly layered; contains mostly quartz, plagioclase, muscovite, local garnet, some opaque minerals, and local minor calcite

Walhalla metamorphic suite (informal name) (lower Paleozoic and (or) Late Proterozoic)

ꞒZgnw **Alternating biotite feldspathic gneiss, amphibolite, and hornblende gneiss**—Gneiss is medium to dark gray, mostly medium grained and irregularly layered to massive; principal minerals are biotite, plagioclase, quartz, and microcline; contains some porphyroblasts of microcline and plagioclase, and in places, hornblende, epidote, titanite, sillimanite, garnet and opaque minerals. Amphibolite is dark gray to black, fine grained, and consists mostly of plagioclase, hornblende, quartz, and garnet. Hornblende gneiss is dark gray and medium to coarse grained; it consists mostly of plagioclase, hornblende and minor quartz. Major rock types are variably interlayered with fine-grained, mostly equigranular plagioclase-quartz-biotite (-garnet-microcline-muscovite) metasandstone, quartzite, migmatite, biotite-muscovite gneiss and schist, and fine-grained biotite schist

ꞒZaw **Hornblende gneiss and amphibolite**—Medium-gray to dark-gray, fine- to medium-grained, thinly to thickly layered, locally flaggy, hornblende-plagioclase gneiss and amphibolite composed mainly of hornblende and plagioclase (typically andesine) in heterogeneous proportions, with smaller amounts of quartz and epidote-clinozoisite. Locally contains minor garnet, biotite, and traces of titanite, chlorite, pyroxene, and opaque minerals. Minor epidote-rich layers and clots up to a few millimeters thick are common. Hornblende gneiss and amphibolite grade into one another and differ only in percentage of hornblende (10 to 75 percent). Minor interlayers of biotite-granitoid gneiss are widespread; interlayers of biotite-muscovite gneiss and schist (ꞒZbmw) and muscovitic schist (ꞒZmw) are sporadic

PzZmw **Migmatite**—Mixed granitoid gneiss and amphibolite or hornblende gneiss or granitoid gneiss and biotite feldspathic gneiss, commonly thinly layered and discontinuous within hornblende gneiss and amphibolite (ꞒZaw)

PzZiw **Injected hornblende gneiss**—Migmatite composed of hornblende gneiss or amphibolite (ꞒZaw) pervasively injected by abundant layers and irregular masses of biotite granitoid gneiss (SOgw)

ꞒZqw **Quartzite**—Cream white to light gray, irregularly layered, generally fine grained; consists mostly of quartz but is locally feldspathic and (or) micaceous and may contain epidote interlayered with hornblende gneiss and amphibolite (ꞒZaw)

ꞒZgw **Garnet-quartz rock (gondite)**—Fine- to medium-grained, equigranular rock composed mainly of quartz, garnet (spessartine-almandine), and, in some cases, magnetite. Locally contains minor hornblende and (or) biotite. Sporadically interlayered in hornblende gneiss and amphibolite (ꞒZaw); thicknesses range from a few centimeters to map scale. Weathered rock and soil are dusky brown to reddish black

ꞒZew **Epidosite**—Medium-grained equigranular rock composed mainly of epidote and quartz

ꞒZfgw **Fine-grained biotite gneiss and schist**—Pale yellowish brown to yellowish gray, fine grained, equigranular, commonly thinly layered; composed mostly of biotite, plagioclase, quartz (muscovite, garnet, epidote), and opaque minerals; interlayered with hornblende gneiss and amphibolite (ꞒZaw) and with feldspathic gneiss (ꞒZgnw)

ꞒZbmw **Biotite-muscovite gneiss and schist**—Light- to dark-gray, fine- to medium-grained, equigranular to porphyroblastic, thinly to thickly layered gneiss and schist composed mainly of plagioclase, quartz, biotite, and muscovite in heterogeneous proportions; locally contains microcline and (or) epidote-clinozoisite. Minor constituents may include hornblende, garnet, and opaque minerals. Interlayered with hornblende gneiss and amphibolite (ꞒZaw) and biotite granitoid gneiss (SOgw)

ꞒZlw **Leucocratic plagioclase-quartz gneiss**—Very light gray, fine-grained, equigranular, almost massive leucocratic gneiss composed mainly of plagioclase, quartz, and smaller amounts of epidote-clinozoisite. Local minor constituents include orthoclase and hornblende. Occurs sporadically as layers in hornblende gneiss and amphibolite (ꞒZaw). Interpreted as metamorphosed dacitic volcanic rock

ꞒZmw **Muscovitic schist**—Gray, fine- to coarse-grained, muscovite-quartz schist, locally garnetiferous. Composed mainly of muscovite and quartz in heterogeneous proportions, commonly with smaller amounts of biotite, garnet, plagioclase, and, in some cases, pyrite. Occurs locally as layers in hornblende gneiss and amphibolite (ꞒZaw)

Intrusive rocks

DSg **Undifferentiated granodiorite gneiss and granitic gneiss (Devonian and Silurian)**—Medium to light gray, moderately well foliated, fine to medium grained; contains mostly biotite, (muscovite), microcline, plagioclase and quartz; includes minor amounts of epidote, sericite, garnet, and opaque minerals. Locally crosses boundary between Six Mile thrust sheet and the Chauga-Walhalla thrust complex. Equivalent, at least in part, to rocks mapped as Lithonia Gneiss in Georgia. Two preliminary concordant $^{207}Pb/^{206}Pb$ zircon ages have been determined for these rocks at different locations of 419 Ma and 385 Ma (T.W. Stern and A.E. Nelson, U.S. Geological Survey, unpub. data, 1987)

Slg **Lineated leucogranite (Silurian)**—Very light gray, generally medium-grained, muscovite-biotite leucogranite (monzogranite); strongly lineated but weakly foliated. Composed of plagioclase, quartz, and microcline with small amounts of biotite (3 to 5 percent), muscovite (2 to 4 percent), and garnet (1 to 2 percent). Trace amounts of epidote are common; opaque minerals are rare. Well exposed in quarries near Toccoa, Ga. Preliminary concordant $^{207}Pb/^{206}Pb$ zircon age is 424 Ma (T.W. Stern and A.E. Nelson, U.S. Geological Survey, unpub. data, 1987)

SOch **Caesars Head Granite (Early Silurian to Ordovician?)**—Light-gray, inequigranular, medium-grained, discontinuously banded to nonbanded biotite granitoid gneiss or gneissic granitoid. Mainly granodioritic but composition ranges from quartz monzonite and monzogranite to quartz diorite. Epidote and titanite are common and locally abundant. Magnetite, allanite, zircon, and apatite are common accessories. Chlorite and calcite occur locally. Discontinuous black, biotite-rich bands, 2 to 10 mm thick, alternating with white, biotite-poor bands are common and typically folded. Interlayered and crosscutting bodies of light-gray, fine-grained, massive to foliated, garnet-bearing muscovite-biotite granite are too small to portray at this scale. Preliminary discordant $^{207}Pb/^{206}Pb$ age of zircons is about 435 Ma (T.W. Stern and J.W. Horton, Jr., U.S. Geological Survey, unpub. data, 1984). Pluton cuts boundary of Six Mile and Walhalla thrust sheets

SOgw **Biotite granitoid gneiss (Early Silurian to Ordovician?)**—White to light-gray, fine- to medium-grained, equigranular, coarsely foliated biotite granite to granodiorite gneiss composed mainly of plagioclase (oligoclase), microcline, quartz, and smaller amounts of biotite. Locally contains minor muscovite, epidote-clinozoisite, and trace amounts of hornblende, garnet, titanite, and magnetite. Widespread throughout Walhalla thrust sheet as map-scale bodies and discontinuous layers too small to map. Includes some alaskite dikes and pegmatites as veins and pods; locally forms migmatite with other rocks. Overlying soils are sandy. Probably correlative with granitic gneisses (DSg and Slg)

Pzpg **Porphyritic granite gneiss (Paleozoic)**—Same mineralogy as DSg but characterized by megacrysts of microcline

Pzwgb **Mixed dark-gray hornblende gabbro and light-gray granitoid (Paleozoic)**—Medium to coarse grained with megacrysts of hornblende

SIX MILE THRUST SHEET

Layered or stratified rocks (Lower Cambrian and (or) Late Proterozoic)
(Stratigraphic order uncertain)

ꞒZis **Injected gneiss and schist (migmatite)**—Biotite-plagioclase-quartz gneiss (ꞒZsbs) or biotite-muscovite schist (ꞒZs) pervasively injected by granitoid rock as layers, pods, or irregular bodies that range in thickness from less than 1 cm to tens of meters. Common adjacent to mapped granitoid bodies

ꞒZms **Mica schist**—Biotite-muscovite schist and biotite schist. Minerals are chiefly biotite, muscovite, quartz, plagioclase (sericitized), locally microcline, with lesser amounts of epidote, garnet, sillimanite, and tourmaline; includes some interlayered amphibolite, porphyroblastic schist and gneiss, and quartzofeldspathic gneiss and quartzite. Quartzite is epidote rich locally, and in some places has a high muscovite content to form a quartzite schist. In some places, quartzite consists of nearly equal amounts of quartz and garnet (spessartine) and forms gondite; variably sized pods and lenses of granitoid and pegmatite are widespread. Commonly exposed in the Alto allochthon

ꞒZs **Biotite-muscovite schist**—Generally medium grained but locally coarse-grained biotite-muscovite schist; locally garnetiferous. Composed mostly of quartz, muscovite, biotite, and plagioclase in varied proportions; either mica may predominate. Local accessories include garnet, sillimanite, epidote, tourmaline, opaque minerals, and rarely microcline. Interlayered with and gradational into biotite-plagioclase-quartz gneiss (ꞒZbs); unit contains subordinate layers of sillimanite-mica schist (ꞒZss) and some amphibolite layers

ꞒZws **White-mica schist**—Highly muscovitic, medium- to coarse-grained white-mica schist. Composed mainly of muscovite, quartz, and lesser amounts of plagioclase; biotite is minor. Commonly associated with abundant pegmatite

ꞒZfs **Fine-grained felsic gneiss**—Very light gray, fine-grained, equigranular, thinly layered epidote-quartz-feldspar gneiss composed mainly of plagioclase, quartz, microcline, epidote-clinozoisite, and sericite; commonly graphitic and pyritic. A porphyroblastic phase contains large feldspar crystals in fine- to medium-grained matrix of quartz, plagioclase, and biotite. Weathered rock is white and rusty reddish brown, commonly in alternating bands. Interpreted as calcareous metatuff. Interlayered with minor amounts of fine-grained amphibolite, biotite schist, biotite-muscovite schist, and irregular bodies of granitoid. Equivalent, at least in part, to Ison Branch Formation (Higgins and others, 1988)

ꞒZgns **Felsic gneiss**—Light gray, fine to medium grained, variably layered, equigranular to unequigranular. Contains mostly plagioclase, quartz, biotite, muscovite, microcline, garnet, chlorite, epidote, and opaque minerals; locally has porphyroblasts of plagioclase and microcline

ꞒZts **Staurolite-mica schist**—Gray schist composed mainly of muscovite, biotite, quartz, and staurolite with garnet in lesser amounts. Staurolite is abundant as euhedral porphyroblasts averaging about 1 cm but ranging to 3 cm long. Residual crystals in soil delineate unit between outcrops east of Royston, Ga.

ꞒZss **Sillimanite-mica schist**—Medium-gray sillimanite-mica schist, variably garnetiferous, locally pyritic. Composed of muscovite, biotite, quartz, sillimanite, and commonly garnet. Accessories may include graphite, plagioclase, pyrite, and, in some cases, tourmaline. Sillimanite is abundant as fibrolitic mats and as needle-like prisms parallel to schistosity. Unit is heterogeneous in texture and proportions of minerals. Weathers white, pale purple, yellow, and reddish orange

ꞒZsms **Megacrystic sillimanite-mica schist**—Light-gray, generally fine grained sillimanite-mica schist containing coarse bundles of sillimanite prisms up to 1 cm long; sillimanite also occurs as mats of fibrolite parallel to foliation. Composed of muscovite, quartz, and sillimanite in heterogeneous proportions, with minor biotite and graphite. Splintery texture is common. Unit is a conspicuous marker unit similar to the Kalves Creek Formation (Higgins and others, 1988)

ꞒZgs **Garnet-quartz rock (gondite)**—Gray, thinly layered, fine- to medium-grained, equigranular rock (gondite or coticule) composed mainly of quartz and garnet (spessartine-almandine); minor magnetite and amphibole (actinolite or cummingtonite) may be present. Locally gradational into garnet-bearing quartzite. Weathered rock and soil are dusky brown to black

ꞒZmqs **Magnetite-quartz rock**—Dark-gray, medium-grained, equigranular magnetite-quartz rock or magnetite "quartzite" composed of quartz (greater than 50 percent), smaller amounts of magnetite, and commonly garnet. Epidote-clinozoite and anthophyllite have also been recognized. Interpreted as metamorphosed iron formation. Largest occurrence near Starr, S.C.

ꞒZgss **Mica schist**—Containing relatively high amounts of interlayered gondite, quartzite, quartzite schist, and some manganiferous schist

ꞒZps **Megacrystic biotite (muscovite) gneiss**—Dark-gray, thickly layered biotite gneiss (or, locally, biotite-muscovite gneiss) containing microcline porphyroblasts (typically 5 to 10 mm in diameter). Composed mainly of quartz, plagioclase (mainly oligoclase), microcline, biotite, and local muscovite. May include minor garnet and sillimanite; traces of epidote, chlorite, sericite; and opaque minerals. Interlayered with and gradational into biotite-plagioclase-quartz gneiss (ꞒZbs) and biotite-muscovite schist (ꞒZs); locally contains minor layers of amphibolite (ꞒZas)

ꞒZas **Amphibolite**—Dark-gray, fine- to medium-grained, thinly to thickly layered amphibolite composed mainly of plagioclase and hornblende; smaller amounts of epidote, quartz, and garnet may be present. Common accessory and trace minerals include diopside, titanite, chlorite, magnetite, pyrite, calcite, and leucoxene. Bodies are generally concordant

ꞒZus **Biotite-muscovite schist and gneiss, undivided**—Similar to ꞒZs and ꞒZms but without amphibolite

ꞒZqs **Quartzite**—Light-tan, fine- to medium-grained quartzite and muscovite-quartz schist; locally rich in sillimanite and (or) sulfides, especially pyrite

ꞒZsgg **Microcline gneiss, biotite schist, and mixed granitoid**—Granitoid is light to medium gray, fine to medium grained, locally porphyritic. Includes some irregular bodies of undivided Elberton Granite (Me). Locally deformed to microbreccia, protocataclasite, and mylonite series rock close to and in the Lowndesville shear zone

ꞒZsgs **Undifferentiated biotite schist and biotite felsic gneiss with interlayered amphibolite, biotite-muscovite schist, quartzofeldspathic gneiss, granitoid, and pegmatite**—Biotite schist and biotite felsic gneiss dominant over other rock types. Layering is irregular; textures range from fine to coarse grained. Locally, schists contain sillimanite. Granitoid ranges from granodiorite to quartz diorite and is present as irregular bodies, layers, lenses, and pods; pegmatites are widespread as lenses, pods, and veins

ꞒZcs **Calc-silicate gneiss and schist**—Biotite-muscovite schist (ꞒZs) and biotite-plagioclase-quartz gneiss (ꞒZbs), intergradational with characteristic interlayers (0.5 to 30 cm thick) of slabby calc-silicate granofels. Calc-silicate granofels is gray, fine to medium grained, and composed mainly of quartz, labradorite, epidote, and smaller amounts of hornblende; accessories include titanite, pyrrhotite, apatite, zircon, garnet, and, less commonly, calcite and diopside. Unit may represent metamorphosed altered volcanic sediments. Lithologically similar to Wahoo Creek Formation (Higgins and Atkins, 1981) but commonly more schistose

ꞒZbs **Biotite-plagioclase-quartz gneiss**—Gray to dark-gray, medium-grained, generally equigranular, thinly to thickly layered gneiss composed mostly of plagioclase (mainly oligoclase), quartz, and biotite. Minor amounts of muscovite, microcline, garnet, sillimanite, and epidote-clinozoisite may be present. Contains subordinate layers of biotite-muscovite schist (ꞒZs), megacrystic biotite gneiss (ꞒZps), amphibolite (ꞒZas), rare garnet-quartz rock (ꞒZgs), and irregular bodies of granitoid (SOsg)

ꞒZsbs **Interlayered biotite gneiss and biotite-muscovite schist**—Biotite-plagioclase-quartz gneiss (ꞒZgs) and biotite-muscovite schist (ꞒZs) undivided. Includes subordinate layers of megacrystic biotite gneiss (ꞒZps), sillimanite-mica schist (ꞒZss), and minor amphibolite (ꞒZas)

Intrusive rocks

Me **Elberton Granite (Mississippian)**—Very light gray, locally pinkish gray, equigranular, homogeneous, fine- to medium-grained, massive biotite monzogranite. Titanite, zircon, allanite, apatite, magnetite, and ilmenite-hematite are common accessories; secondary muscovite and chlorite occur locally. Flow foliation is poorly defined; contacts are discordant to foliation of country rock. Rb-Sr whole-rock age is 350±11 Ma (Ellwood and others, 1980); U-Pb zircon age is 320±20 Ma (Ross and Bickford, 1980)

DSg **Undifferentiated granodiorite gneiss and granitic gneiss (Devonian and Silurian)**—See description under Chauga-Walhalla thrust sheet

SOch **Caesars Head Granite (Early Silurian to Ordovician?)**—See description under heading of Chauga-Walhalla thrust complex

SOsg **Biotite granitoid gneiss (Early Silurian to Ordovician?)**—Light-gray, medium-grained, equigranular, coarsely foliated biotite granite to granodiorite (and rarely diorite) gneiss composed mainly of plagioclase (oligoclase), microcline, quartz, and smaller amounts of biotite. Locally contains minor muscovite, epidote-clinozoisite, and traces of garnet, titanite, and magnetite. Overlying soils are sandy. Widespread throughout Six Mile thrust sheet as map-scale bodies including plutons at Starr, S.C., and Antreville, S.C., and as discontinuous layers too small to map that alternate with metasedimentary rocks or as irregular lenses and pods; commonly contains inclusions of variably sized metasedimentary rocks. Pluton at Antreville overlaps boundary between Six Mile and Laurens thrust sheets

Pza **Metagabbro of Anderson (Paleozoic?)**—Metagabbro, amphibolite, and variably foliated transitional rocks. Metagabbro phase is dark gray to medium gray, equigranular, medium to coarse grained, and massive to weakly foliated. Composed of plagioclase (labradorite to anorthite), hornblende, and commonly garnet, ferrohypersthene, clinopyroxene, and quartz; accessories include epidote-clinozoisite, ilmenite-magnetite, and apatite. Subophitic to hypidiomorphic. Garnet coronas are common. Amphibolite phase is medium to dark gray, fine to coarse grained, nematoblastic, and nonlayered to thinly banded. Composed mainly of plagioclase (andesine to labradorite), hornblende, and quartz; accessories may include clinopyroxene, garnet, biotite, epidote, opaque minerals, titanite, chlorite, and white mica

u **Altered ultramafic rocks of Inner Piedmont**—Dominantly chlorite-tremolite schist, greenish gray, strongly foliated, composed of chlorite and tremolite with smaller amounts of olivine or serpentine plus talc. Sieve texture suggests metamorphic olivine; serpentine and talc are most abundant where olivine is absent. Accessory and trace minerals include magnetite, ilmenite, anthophyllite, dolomite, and calcite. Scattered bodies in Six Mile and Walhalla thrust sheets lack contact aureoles and are interpreted as tectonic slices

LAURENS THRUST SHEET

Layered or stratified rocks (Lower Cambrian and (or) Late Proterozoic)
(Stratigraphic order uncertain)

ꞒZgl **Biotite (hornblende-sillimanite-microcline-muscovite) gneiss**—Chiefly medium to dark gray to pale yellowish brown, variably textured and layered. Contains chiefly plagioclase, quartz, biotite, (hornblende, sillimanite, microcline, and muscovite) and, locally, some feldspar porphyroblasts. Interlayered with dark biotite (-muscovite-sillimanite-manganiferous) schist, that, in places grades, to a sillimanite schist; locally has persistent biotite-rich and biotite-poor layers. Included are minor quartzofeldspathic gneiss; thin layers of quartzite or quartz-muscovite schist; thin layers, lenses, and pods of biotite granite gneiss or granodiorite gneiss; and some thin layers of amphibolite and metagabbro. Deformed to cataclastic and mylonitic rock close to Lowndesville shear zone

ꞒZsl **Biotite sillimanite schist**—Gray, fine grained, laminated; occurs as lenses in ꞒZgl

ꞒZml **Marble**—White to light-gray, fine- to medium-grained calcite marble; moderately well foliated; contains phlogopite, tremolite, scapolite, and diopside at contact with intrusive granite

ꞒZal **Amphibolite**—Black to dark-green, fine- to coarse-grained, ocher-weathering amphibolite interlayered with minor biotite schist and biotite felsic gneiss. Composed of about equal amounts of hornblende and plagioclase with minor quartz. Occurs as small lenses and boudins as well as large mappable bodies

Intrusive rocks

IPcg **Granite of Cold Point (Pennsylvanian)**—Fine-grained leucocratic biotite granite. Horizontal foliation due to flat quartz and feldspar grains; biotite has no preferred orientation. Xenoliths have biotite rims. Some myrmekitic intergrowth of microcline and plagioclase grains. Crops out as low, rounded exposures that extend one or two meters above the ground. Cuts across Lowndesville shear zone and straddles boundary between Laurens and Charlotte thrust sheets. Preliminary discordant $^{207}Pb/^{206}Pb$ zircon age is 312 Ma (T.W. Stern and A.E. Nelson, U.S. Geological Survey, unpub. data, 1987)

Dgg **Granite gneiss of Gray Court (Devonian)**—Medium-grained megacrystic granite. Megacrysts are blocky, 1 to 3 cm in length, and make up 25 to 40 percent of the rock. Horizontal and steeply southeast-dipping foliations are common in the same rock. Biotite-rich schlieren are common but xenoliths are uncommon. Preliminary concordant $^{207}Pb/^{206}Pb$ zircon age of 359 Ma (T.W. Stern and A.E. Nelson, U.S. Geological Survey, unpub. data, 1987)

Pzgf **Biotite granite gneiss (Paleozoic)**—Fine- to coarse-grained, both horizontal and steeply dipping foliation commonly present, intersecting one another. Biotite gneiss (ꞒZgl) xenoliths are in varying degree assimilated, whereas amphibolite (ꞒZal) xenoliths appear unaltered

Pzgg **Undifferentiated granite gneiss and granodiorite gneiss (Paleozoic)**—Light- to medium-gray, fine- to medium-grained, equigranular gneiss containing mostly plagioclase, quartz, biotite, and muscovite. Widespread throughout the Laurens thrust sheet

Pzpgg **Porphyritic granite gneiss (Paleozoic)**—Very light gray, medium to coarse grained, weakly foliated. Consists mostly of plagioclase, microcline, quartz, and minor biotite; phenocrysts of feldspar generally blocky and 1 to 2 cm in length

PARIS MOUNTAIN THRUST SHEET

Layered or stratified rocks (Lower Cambrian and (or) Late Proterozoic)
(Stratigraphic order uncertain)

ꞒZsp **Sillimanite-mica schist**—Medium grained, composed mostly of sillimanite, biotite, muscovite, and smaller amounts of quartz; local accessory minerals include garnet, hematite, and graphite. Sillimanite is generally matted in the foliation plane and deformed by crenulations; elsewhere sillimanite is parallel to crenulation axes. Weathers reddish brown

ꞒZap **Amphibolite**—Black to dark gray, fine to medium grained; contains hornblende, plagioclase, (biotite), and quartz as principal minerals, with minor magnetite and garnet; commonly thinly layered

ꞒZqp **Quartzite**—Light tan, fine grained; includes thin layers of garnet quartzite

Intrusive Rocks

Pzgp **Granite gneiss (Paleozoic)**—Medium- to coarse-grained; principal minerals are biotite, feldspar, and quartz; intrudes the sillimanite schist (ꞒZsp)

CHARLOTTE THRUST SHEET

Layered or stratified rocks
(Stratigraphic order uncertain)

Rocks commonly assigned to the Carolina slate belt (Cambrian and (or) Late Proterozoic)

ꞒZt **Siliceous crystal-lithic metatuff**—Light medium gray to pale yellow gray, fine grained, thinly bedded; crystals and lithic fragments in very fine matrix of quartz and feldspar; interlayered with some phyllite

ꞒZf **Interlayered crystal-lithic metatuff, phyllite, graded crystal metatuff, and very fine grained, commonly thickly bedded siliceous rocks**—Interpreted as metamorphosed lava

ꞒZv **Interlayered, very fine grained, light-pinkish-gray, rhyolitic crystal metatuff, fine-grained crystal-lithic metatuff; fine-grained, siliceous, metamorphosed glomeroporphyritic lava; fine-grained, greenish-gray greenstone; and light-gray, thinly bedded, fine-grained phyllite**

ꞒZp **Phyllite**—Light creamy gray, fine grained and mostly thinly bedded; contains quartz, plagioclase, muscovite, and local chlorite

ꞒZqq **Quartzite and quartz-muscovite schist**—Interbedded creamy white to light-gray, thinly bedded to massive quartzite, quartz-muscovite schist, and very fine grained phyllite that locally grades to muscovite schist containing minor biotite. Includes minor (weathered) fine-grained crystal-lithic metatuff, and (weathered) fine-grained, dark-gray, metamorphosed intermediate to mafic lava(?)

ꞒZq **Quartzite**—Light gray to creamy white, fine grained; locally grades into a muscovite-quartz schist

ꞒZft **Phyllite and tuff**—Thinly layered to massive, light creamy gray phyllite, interlayered massive crystal tuff, and minor fine-grained, dark-gray, metamorphosed lava; locally intruded(?) by hornblende gabbro (DScgb)

Rocks commonly assigned to the Charlotte belt (lower Paleozoic and (or) Late Proterozoic)

g **Biotite gneiss**—Medium-gray to pale-yellowish-gray, medium- to coarse-grained gneiss consisting mostly of quartz, plagioclase, biotite and muscovite. Interlayered with thin layers of hornblende gneiss; fine- to medium-grained muscovite-chlorite-schist; fine-grained, equigranular quartz-feldspar-biotite gneiss or metasandstone. Contains stringers, lenses, pods, and layers of granitoid gneiss ranging in composition from granite to diorite and local lenses of pyroxene gabbro

s **Biotite schist**—Medium gray, medium to coarse grained, thinly to thickly layered; contains chiefly quartz, plagioclase, biotite, muscovite, (kyanite, sillimanite) interlayered with variably sized layers and lenses of granitoid (granitic to granodioritic) gneiss

bm **Muscovite-biotite schist**—Light gray, mostly medium grained; contains plagioclase, muscovite, quartz, and biotite. Schist locally includes some amphibolite, biotite gneiss, and equigranular microcline granite with perthite, plagioclase, quartz, biotite, garnet, (epidote), and a trace of muscovite and sericite

gs **Quartz-feldspar gneiss**—Light gray, fine to medium grained, equigranular, mixed with layers, lenses, and pods of granitoid gneiss

ma **Muscovite schist**—Pale grayish yellow, medium grained, thinly to thickly layered; contains mostly quartz, plagioclase, muscovite, biotite, and local sillimanite; interlayered with thinly layered amphibolite (ca), and thin to thick layers, pods, and lenses of granitoid rock

ca **Amphibolite**—Dark greenish gray, fine to medium grained; consists mostly of hornblende, plagioclase, epidote, minor quartz, and opaque minerals, commonly weathers to thin slabs

ug **Undifferentiated greenstone, amphibolite, metagabbro, and granitoid gneiss**

ga **Undifferentiated granitoid gneiss, amphibolite, and biotite schist**

Rocks commonly included in the Lowndesville belt of Griffin (1979)

ꞒZpp **ꞒZm** **Mostly phyllonite**—Light cream white to yellowish tan and commonly stained by iron oxides, fine grained, characterized by button texture; consists principally of quartz, muscovite-sericite, and opaque minerals. Interlayered with thin layers of phyllitic (chloritic) schist, quartzite, metasiltstone, and thin layers of amphibolite; contains some zones of blastomylonite, mylonite, and cataclastic rock; resembles Blacksburg Formation of Kings Mountain belt (Goldsmith and others, 1988) but lacks marble; where polydeformed mylonites, blastomylonites, and cataclastic rocks are widespread, they are mapped as ꞒZm

ls **Undifferentiated cataclastic and mylonitic rocks of the Lowndesville shear zone**—Includes some less-deformed rock lenses. Derived from adjacent rock units including fine-grained biotite gneiss, biotite schist, porphyroblastic biotite gneiss, porphyroblastic biotite gneiss, hornblende gabbro (DScgb), equigranular granite, amphibolite; zones of whitish-yellow clay are present along veins of blocky quartz

Intrusive rocks

Pc **Coronaca Granite (Permian?)**—Light gray to pale pinkish gray, massive, medium to coarse grained, equigranular to inequigranular to porphyritic, mainly quartz monzonite to quartz syenite; consists of microcline, oligoclase, quartz, biotite, magnetite, titanite, and chlorite; includes unmapped norite consisting of plagioclase, pyroxene, minor hornblende, biotite, and opaque minerals. Rb-Sr whole-rock age is about 278 Ma (Fullagar and Butler, 1979)

Mg **Granitic to dioritic gneiss (Mississippian)**—Light to dark gray, medium to coarse grained, xenomorphic granular to porphyritic texture; contains principally varying amounts of quartz, plagioclase, (microcline perthite, microcline), biotite commonly dominant over muscovite, hornblende, epidote, opaque minerals, titanite, and zircon; contains some layers of biotite gneiss and thin, discontinuous biotite-rich zones; locally, granitoid is highly mixed with metasedimentary rocks to form migmatite zones. A preliminary concordant $^{207}Pb/^{206}Pb$ zircon age is 338 Ma (T.W. Stern and A.E. Nelson, U.S. Geological Survey, unpub. data, 1987)

Concord Plutonic Suite (Devonian and Silurian)

DScs **Syenite**—Medium-grained hornblende syenite containing mostly saussuritized plagioclase, microcline, microperthite, chloritized hornblende, clinopyroxene, biotite, and some quartz; occurs in the Mount Carmel complex of Griffin (1978)

DScp **Pyroxenite**—Dark gray to greenish black, coarse to medium grained, equigranular; locally thin pyroxene is chloritized; includes some hornblendite. Occurs in Calhoun Falls complex of Griffin (1978)

DScgs **Undivided gabbro and syenite**—Occurs in the Trotters Shoals complex of Griffin (1978)

DScgb **Hornblende gabbro**—Mostly medium to coarse grained, medium to dark gray, undeformed, commonly with xenomorphic granular texture, locally porphyritic with large hornblende crystals. Contains chiefly plagioclase (locally sericitized), hornblende, (pyroxene), biotite, rare quartz, some opaque minerals, and epidote. Includes some fine-grained pyroxene gabbro and hornblende diorite. Commonly deeply weathered. Occurs within the Abbeville, Calhoun Falls, and Mount Carmel complexes of Griffin (1978, 1979) and elsewhere as unnamed bodies

Pzp **Porphyritic granite to granodiorite gneiss (Paleozoic)**—Creamy white to light gray, mostly medium grained, commonly equigranular; widely dispersed as layers of different thicknesses or as discontinuous lenses and pods in different types of metasedimentary rock

Pzd **Quartz diorite (Paleozoic)**—Medium gray, fine to medium grained, equigranular; contains mostly sericitized plagioclase, quartz, biotite (locally chloritized), minor muscovite, and some opaque minerals

Pzdg **Diorite and gabbro (Paleozoic)**

Pzgd **Mixed diorite gneiss and granite gneiss (Paleozoic)**—Occurs in both the Laurens thrust sheet and the Charlotte thrust sheet

MELANGE COMPLEX

m **Mafic-ultramafic complex**—Heterogeneous assemblage of undifferentiated mafic and ultramafic rocks. Includes ultramafic rocks, gabbro, diorite, amphibolite, mafic dikes, and granitic bodies in a gabbroic(?) saprolite matrix. Saprolite is mostly light to grayish olive and clay rich, containing altered plagioclase laths, widespread incompletely altered hornblende, and tiny gabbro and metatuff fragments. Most of the rocks are highly fractured, locally sheared, commonly weathered, and seldom present in fresh exposures. One of three rock bodies informally referred to by Higgins and others (1988) as the "Juliette slice" of the "Macon melange"

Intrusive rocks

mu **Undifferentiated ultramafic rocks**—Small bodies or lenses; mostly talc-chlorite schist and some serpentinite

PzZmg **Granitic gneiss (Paleozoic and (or) Late Proterozoic)**—Present as isolated bodies in mafic-ultramafic complex (m)

EXPLANATION OF MAP SYMBOLS

See structure map (sheet 2) for complete portrayal of structural features

Contact—Approximately located, dotted where concealed

Fault

Approximate outline of dome

Approximate outline of basin

Thrust fault—Approximately located, dashed where inferred, dotted where concealed, queried where uncertain; sawteeth on upper plate. On overturned thrust faults, sawteeth in direction of dip, bar on side of tectonically higher plate. Direction of movement indicated by arrows in cross section

FOLDS
(Direction of plunge shown where known)

Trace of axial surface of second generation fold (folded foliation)—Folds typically isoclinal with variably dipping axial surfaces. Axial surfaces of first generation folds are not shown; possible locations may be inferred from pattern of map units

- Upright antiform
- Overturned antiform
- Upright synform
- Overturned synform

Trace of axial surface of third and later generation upright fold—Folds close to open and have moderately to steeply dipping axial surfaces

- Antiform
- Synform

PLANAR FEATURES
(May be combined with other planar or linear features)

Strike and dip of inclined bedding

Strike and dip of foliation and compositional layering not clearly seen as bedding

- Inclined
- Vertical
- Horizontal

Strike and dip of foliation—May include flow foliation in intrusive rocks

Strike and dip of slaty cleavage, slip cleavage, or crenulation cleavage

- Inclined
- Vertical

Strike and dip of inclined mylonitic foliation or fluxion structure

Strike and dip of inclined axial surface of minor fold

LINEAR FEATURES
(May be combined with planar features)

Bearing and plunge of fold axis—Bearing only shown where amount of plunge not determined

Bearing of horizontal fold axis

Bearing and plunge of lineation (elongation or alignment of mineral grains or intersection of two planar features)

- Inclined
- Horizontal

OTHER SYMBOLS

Sand and gravel pit

Selected mine or quarry—Unlabeled, aggregate (mostly crushed rock); ol, olivine; mi, mica; di, dimension stone; Cu, copper; mb, marble; Au, gold; Fe, iron; gp, granite pegmatite. Numerous abandoned gold mines in Dahlonega area are not shown

- Active
- Inactive

GEOLOGIC MAP OF THE GREENVILLE 1°×2° QUADRANGLE, SOUTH CAROLINA, GEORGIA, AND NORTH CAROLINA

By

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1998

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