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Geologic Map of the Kings Mountain and Grover Quadrangles, Cleveland and Gaston Counties, North Carolina, and Cherokee and York Counties, South Carolina

DESCRIPTION OF MAP UNITS

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[Intrusive rocks are classified according to IUGS nomenclature using normalized values of modal quartz, alkali feldspar, and plagioclase (Streckeisen, 1976). Mineral modifiers are listed in order of increasing abundance for both igneous and metamorphic rocks. In descriptions, minerals are listed in order of decreasing abundance.]

af **Artificial fill—**Unconsolidated material in areas filled for construction of roads, dams, and buildings

d **Mine dump**

SURFICIAL DEPOSITS

Qal **Alluvium (Holocene)—**Unconsolidated stream deposits of gravel, sand, silt, and clay

Qc **Colluvium (Holocene and Pleistocene)—**Coarse cobbles, boulders, and blocks of quartzite that were transported by gravity and modified by freeze-thaw cycles on the slopes of Kings Mountain and Crowders Mountain

INTRUSIVE ROCKS

Jd **Olivine diabase (Early Jurassic)—**Unmetamorphosed, dark-gray, fine- to medium-grained diabase having uniform composition and texture. Composed of labradorite, augite, olivine, and accessory disseminated magnetite. Ophitic texture is common. Dikes parallel north to northwest joint pattern and range up to 5 m in thickness. Mapped largely on float; map thickness increased to show on map

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

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

Mp **Granite pegmatite (Mississippian)—**White, coarse-grained pegmatite composed mainly of microcline, oligoclase, quartz, muscovite, and biotite. Euhedral garnet as much as 1 cm in diameter is a common accessory.

Other accessories include magnetite-ilmenite, zircon, apatite, beryl, and chlorite. Composition is similar to Cherryville Granite but muscovite is more abundant and biotite is less abundant. Large books of mica are undeformed. Textures visible in hand samples include graphic intergrowths of feldspar and quartz, overgrowths of muscovite on biotite, and plumose cones of muscovite intergrown with quartz. Whole-rock Rb-Sr age is 341 ± 40 Ma (2_) (Kish and Fullagar, 1996). Occurs as swarms of irregular dikes, sills, and pods up to a few meters thick near southeastern contact of Cherryville Granite. Pegmatite swarms shown by overprint symbol

Cherryville Granite (Mississippian)

Mcp Coarse-grained granite and pegmatite—Very-light-gray, coarse-grained biotite-muscovite granite grading into pegmatite and crosscut by pegmatite dikes; granite composed mainly of microcline, oligoclase, quartz, muscovite, and biotite; includes graphic granite; weakly foliated

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

Otg **Toluca Granite (Ordovician?)—**Very-light-gray, medium- to coarse-grained, strongly foliated, biotite granite and subordinate granodiorite composed of oligoclase, microcline, quartz, biotite, and minor muscovite. Accessories include garnet, monazite, ilmenite, rutile, sillimanite, apatite, and zircon. Bodies are generally conformable to regional foliation in surrounding muscovite-biotite gneiss; foliation within the granite is not always parallel to contacts, perhaps due to rheological differences. A provisional Ordovician(?) age is inferred from discordant U-Pb dates as discussed in the text

Pzgd **Metadiorite and metagabbro (Paleozoic?)—**Dark-gray, medium- to coarse-grained hornblende-quartz gabbro and hornblende-quartz diorite. Textures range from massive to strongly foliated and gneissic. Composed mainly of labradorite or andesine, green hornblende, and quartz, with variable amounts of epidote, accessory biotite, and magnetite. Small bodies crop out in the southern part of the Kings Mountain quadrangle. Dikes of similar rock crosscut the metatonalite (Zto)

Zts **Silicified metatrondhjemite (Neoproterozoic)—**White to tan to pale-green, massive metatrondhjemite; composed mainly of plagioclase and quartz; accessory minerals include magnetite (0-3 percent), disseminated pyrite

(1-2 percent), sericitic white mica, and chlorite. Contains abundant crosscutting quartz veins and gold-bearing mineralized zones. Occurs as a single body previously described as silicified porphyry (LaPoint, 1992). Interpreted as hypabyssal(?) intrusion into metadacite of undivided metadacite and metatrondhjemite unit (Zbdt)

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

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

INNER PIEDMONT LAYERED METAMORPHIC ROCKS

~~C~~Za **Amphibolite (Cambrian or Neoproterozoic)—**Dark-gray, fine-grained, equigranular, layered amphibolite composed of a metamorphic mineral assemblage of plagioclase and hornblende with smaller amounts of diopside, calcite, epidote, and quartz. Accessories include sphene, apatite, and pyrrhotite. Biotite and chlorite are present adjacent to schist layers. Calcite-rich layers occur locally

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

~~C~~Zbg **Muscovite-biotite gneiss (Cambrian or Neoproterozoic)—**Light-gray to dark-gray, fine- to medium-grained, muscovite-biotite gneiss composed of quartz, oligoclase, biotite, muscovite, and lesser amounts of sillimanite and garnet; accessory magnetite is common. The gneiss is inequigranular, well foliated and layered, locally mylonitic, and it contains minor schist interlayers. Equivalent to "unit 6" of Overstreet, Yates, and Griffitts (1963)

KINGS MOUNTAIN SEQUENCE OF CAROLINA TERRANE

Blacksburg Formation (Neoproterozoic)—The Blacksburg Formation is composed mostly of phyllitic metasiltstone (Zbls) with discontinuous lenses of hornblende gneiss and amphibolite (Zbla), marble at two stratigraphic levels (Zblg, Zblm), and discontinuous beds and lenses of laminated micaceous quartzite (Zblq) at different stratigraphic levels

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

Zbls Phyllitic metasiltstone—Light-gray to dark-gray, fine-grained, variably phyllitic metasiltstone, composed mainly of quartz and white mica, smaller amounts of biotite; local accessory minerals include garnet, chloritoid, chlorite, calcite, graphite, and opaque minerals. Quartz grains average about 0.1 mm in diameter. Generally well foliated but locally blocky and quartz-rich. Contacts with other members of the Blacksburg

are gradational and interfingering. Generally, quartz-rich metasiltstone is near quartzite and micaceous phyllite is near marble and amphibolite. Locally shows composite planar fabrics and "mica fish" texture

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

Zblg Gaffney Marble Member—Very-light-gray to medium-bluish-gray, fine- to coarse-grained calcite marble and dolomitic marble; commonly banded and locally schistose. Similar to "Dixon Branch marble member" (Zblm) but generally thinner and not as well exposed in these quadrangles

Zblq Laminated micaceous quartzite—White to yellowish-gray, fine- to medium-grained, equigranular, laminated micaceous quartzite with phyllite (schist) layers. Composed of anhedral quartz and disseminated white mica with variable amounts of accessory biotite and magnetite. Laminated appearance is caused partly by foliation banding and partly by rhythmic layering with phyllite (schist). Individual quartzite and phyllite layers typically have a thickness of a few meters or less. Crops out as discontinuous beds which are no thicker than 140 m

Zbla Hornblende gneiss and amphibolite—Dark-gray, fine- to coarse-grained, essentially equigranular hornblende gneiss and amphibolite. Composed of hornblende, plagioclase, quartz, epidote, opaque minerals, and in some places augite. Occurs sporadically as discontinuous, foliation-parallel lenticular sheets

Battleground Formation (Neoproterozoic)—The lower part of the formation consists of metamorphosed pyroclastic and epiclastic rocks (Zbht, Zbfs, Zbct, Zbmps, Zbvc, and Zbmp) interlayered with the biotite-muscovite schist (Zbms). The upper part of the formation consists of interlayered metasedimentary rocks, including quartz-sericite phyllite and schist (Zbs), quartz-pebble metaconglomerate (Zbc, Zbd, Zbmc), aluminous quartzite (Zbaq), micaceous quartzite (Zbmq), manganifererous schist (Zbj), and smaller amounts of felsic metavolcanic rock (part of Zbdt)

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

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

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

Zbmq Micaceous quartzite—White to yellowish-gray, fine- to medium-grained, equigranular, micaceous quartzite (metasandstone) with phyllite or schist layers. Composed mostly of quartz and disseminated white mica with variable amounts of accessory biotite and magnetite. Schist and phyllite layers are generally a few meters thick or less. Individual beds, including schist layers, are no thicker than 50 m. Occurs as discontinuous beds and lenses at several stratigraphic levels. Micaceous quartzite (Zbmq) at Yellow Ridge is interpreted to be stratigraphically higher than the Jumping Branch manganiferous member (Zbj) and lower than the Crowders Creek Metaconglomerate Member

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

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

Zbc Dixon Gap Metaconglomerate Member—Very-light-gray to medium-light-gray, coarse-grained quartz-pebble metaconglomerate. Approximately 90 percent of the clasts are white quartz pebbles. Other clasts include medium dark gray magnetite-bearing or ilmenite-bearing quartzite,

hornblende gneiss, and quartz-rich phyllite. Pebbles average about 1 cm in diameter and are moderately sorted. They are flattened in the plane of foliation, which is commonly at an angle to bedding, and elongated with length-width ratios from 1 to 5. The medium-light-gray matrix is composed of poorly sorted quartz grains averaging 1.5 mm in diameter with white mica and variable smaller amounts of chloritoid, kyanite, and opaque minerals. Typically clast-supported but locally grades into matrix-supported layers with fewer clasts. Poorly developed graded beds at several places, notably in the vicinity of Dixon Gap and on both limbs of the Sherrars Gap synform, provide stratigraphic tops. Estimated thickness ranges from 10 to 40 m. Relatively thick segments commonly crop out along ridges. Described at the type locality by Horton and Butler (1977, p. 130-132) and Horton and Butler (1986, p. 241-242) and more generally under the informal name "bed C" by France and Brown (1981). Although previously lumped with the "Draytonville Conglomerate Member" by Keith and Sterrett (1931) the Dixon Gap Metaconglomerate Member (unlike the Draytonville Metaconglomerate Member) is stratigraphically lower than the Jumping Branch Manganiferous Member

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

Zbmp Mottled phyllitic metatuff—Light-bluish-gray to medium-dark-gray, stratified, well-foliated, mottled sericite schist and phyllite. A metamorphosed pyroclastic rock (lapilli metatuff) composed of lithic and crystal (plagioclase) clasts in a fine-grained matrix of quartz, plagioclase, sericitic white mica, and finely disseminated iron-titanium oxides with variable smaller amounts of chloritoid, chlorite, epidote, and unidentified opaque minerals. The mica is interlayered paragonite and muscovite or a mica of intermediate composition; margarite has also been reported.

Angular, matrix-supported clasts, which are lapilli-size or smaller, are poorly-sorted, heterolithologic, and flattened in the plane of foliation. The distinctive mottled appearance is caused by finely disseminated iron-titanium oxides which are generally more abundant in the matrix than in the clasts. Most clasts are nearly white but dark-gray clasts also occur. Some resemble rocks in the underlying massive metatuff (Zbct) unit. Others having flattened tuning-fork shapes and bubble-wall texture that suggest relict pumice fragments. Individual layers are well-sorted with some possible graded bedding. Locally interbedded with quartz-sericite phyllite and schist (Zbs). Unit equivalent to "mottled phyllite (lapilli metatuff)" of Howard (2004)

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

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

Zbct Plagioclase-crystal metatuff—Medium-gray to dark-gray, massive to schistose, andesitic to dacitic metamorphosed volcaniclastic rock. Composed of plagioclase phenocrysts up to 6 mm long in a very fine grained matrix. The matrix consists of quartz and plagioclase with smaller amounts of white mica, epidote, chlorite, calcite, biotite, pyrite, and other opaque minerals. Trace minerals include green amphibole, zircon, and apatite. Locally contains as much as 10 percent calcite. Plagioclase phenocrysts are euhedral to subhedral and they commonly have cavities and embayments. Angular lapilli-size lithic clasts similar in composition to the matrix are locally recognizable. Grain sizes averaging less than 0.01 mm commonly give the matrix a cherty appearance. Equivalent to "crystal metatuff" of Howard (2004)

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

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

Zbht Metavolcanic hornblende gneiss—Medium-dark-gray to dark-greenish-gray metavolcanic gneiss, composed primarily of hornblende (10-45 percent), plagioclase (andesine to oligoclase), and quartz. Common accessories include biotite, epidote, microcline, sphene, opaque minerals, garnet, and apatite. Hornblende laths range from 0.1 to 3 mm in length. Quartz and much of the plagioclase is equigranular and fine grained, averaging about 0.1 mm. Euhedral to subhedral plagioclase phenocrysts up to 5 mm long are common. Angular lithic clasts up to 4 mm long are less abundant than phenocrysts. Crystal and lithic clasts make up as much as 40 percent of some layers and most rocks appear to have been andesitic and dacitic crystal tuff or lithic crystal tuff. Largest bodies are on eastern side of map area