North Carolina Department of Environmental Quality
Policy and Innovation Group
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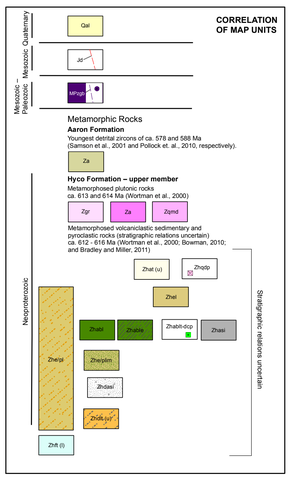
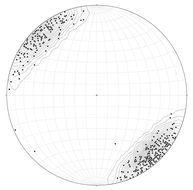
This Geologic map was funded in part by the USGS National Cooperative Geologic Mapping Program

North Carolina Geological Survey
Open File Report 2017-10

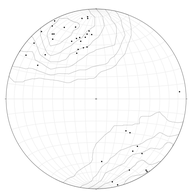


Equal-Area Schmidt Net Projections and Rose Diagram

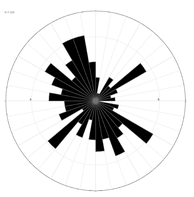
Plots and calculations created using Stereonet v. 8.6.0 based on Allmendinger et al. (2013) and Cardozo and Allmendinger (2013).



Equal Area Schmidt Net Projection of Contoured Poles to Foliation and Cleavage
Contour Interval = 2 sigma N =396



Equal Area Schmidt Net Projection of Contoured Poles to Primary Bedding, Layering, and Welding Compaction/Foliation
Contour Interval = 2 sigma N = 39



Unidirectional Rose Diagram of Joints N = 329
Outer Circle = 7%
Mean vector = 253.2° ± 21.3°
Max value = 5.2% between 121° and 130°

INTRODUCTION

The Crutchfield Crossroads 7.5-minute Quadrangle lies in the east central portion of the North Carolina Piedmont. The Rocky River crosses the southwestern corner of the quadrangle; the Chatham – Alamance County line crosses the quadrangle from west to east. Portions of the Town of Siler City (population approximately 8,200) occupies the southwest corner of the quadrangle. Impounded portions of the Rocky River within the quadrangle serve as the water supply source for the Town of Siler City. The quadrangle is crossed by northwest-southeast US Highway 421. Hwy 64, a major east-west corridor for the central Piedmont, is located immediately to the south of the quadrangle.

The majority of the quadrangle drains to the Rocky River along drainages that include Lacy's Creek, Nick Creek, North Prong, Greenbrier Creek, Johnson Creek, Mud Lick Creek, Varnell Creek and unnamed creeks. The northeast portion of the quadrangle drains to the Haw River along drainages that include South Fork, Reedy Branch and Pine Hill Branch. A small area in the southwest corner of the quadrangle drains to the Deep River. The drainage divide between the Rocky and Deep Rivers is locally controlled by a ridge that marks a major geologic contact (Hyco and Aaron Formations). Natural exposures of crystalline rocks occur mainly along these and numerous unnamed creeks. Rock exposure at road cuts, ridges, resistant finned-shaped outcrops and pavement outcrops occur locally outside of drainages. The elevations in the map area range from about 740 feet above sea level north of the intersection of Piney Grove Church road and Fellowship Church Road (on the ridge that defines the drainage divide between the Rocky and Deep Rivers) in the southwest corner of the quadrangle, to less than 500 feet along Pine Hill Branch near the northeastern corner of the quadrangle.

Geologic Background and Past Work

Pre-Mesozoic crystalline rocks in the Siler City Quadrangle are part of the redefined Hyco Arc (Hibbard et al., 2013) within the Neoproterozoic to Cambrian Carolina terrane (Hibbard et al., 2002; and Hibbard et al., 2006). In the region of the map area, the Carolina terrane can be separated into two lithotectonic units: 1) the Hyco Arc and 2) the Aaron Formation of the redefined Virgilina sequence (Hibbard et al., 2013). The Hyco Arc consists of the Hyco Formation which include ca. 612 to 633 Ma (Wortman et al., 2000; Bowman, 2010; Bradley and Miller, 2011) metamorphosed layered volcaniclastic rocks and plutonic rocks. Available age dates (Wortman et al., 2000; Bradley and Miller, 2011) indicate the Hyco Formation may be divided into lower (ca. 630 Ma) and upper (ca. 615 Ma) members (informal) with an apparent intervening hiatus of magmatism. In northeastern Chatham County, Hyco Formation units are intruded by the ca. 579 Ma (Tadlock and Loewy, 2006) East Farrington pluton and associated West Farrington pluton. The Aaron Formation consists of metamorphosed layered volcaniclastic rocks with youngest detrital zircons of ca. 578 and 588 Ma (Samson et al., 2001 and Pollock, 2010, respectively).

The Hyco Arc and Aaron Formation lithologies were folded and subjected to low grade metamorphism during the ca. 578 to 554 Ma (Pollock, 2007; Pollock et al., 2010) Virgilina deformation (Glover and Sinha, 1973; Harris and Glover, 1985; Harris and Glover, 1988; and Hibbard and Samson, 1995). In the map area, original layering of Hyco and Aaron Formation lithologies are interpreted to range from shallowly to steeply dipping due to open to isoclinal folds that are locally overturned to the southeast.

Map units of metavolcanic and metavolcaniclastic rocks include various lithologies that when grouped together are interpreted to indicate general environments of deposition. The dacitic lavas and tuffs unit is interpreted to represent dacitic domes and proximal pyroclastics. The andesitic to basaltic lavas (with tuffs or conglomerates) units are interpreted to represent eruption of intermediate to mafic lava flows and associated pyroclastic and/or epiclastic deposits. The epiclastic/pyroclastic units are interpreted to represent deposition from the erosion of dormant and active volcanic highlands. Some of the metavolcaniclastic units within the map area display lithologic relationships similar to dated units present in northern Orange and Durham Counties. Due to these similarities, the metavolcanic and metavolcaniclastic units have been tentatively separated into upper and lower portions of the Hyco Formation; geochronologic data in the map area is needed to confirm this interpretation. A review of the regional lithologies is summarized in Bradley (2013).

Abundant evidence of brittle faulting at the outcrop scale and large-scale lineaments (as interpreted from hillshade LiDAR data) are present in the map area. The brittle faulting and lineaments are interpreted to be associated with Mesozoic extension. The Colon cross-structure (Reinemund, 1955), located to the southeast of the study area, is a constriction zone in the Deep River Mesozoic basin and is characterized by crystalline rocks overprinted by complex brittle faulting. Dikes of Jurassic aged diabase intrude the crystalline rocks of the map area. Quaternary aged alluvium is present in most major drainages.

Mineral Resources

There are no active mining activities currently in the quadrangle. One historic flagstone quarry associated with an abandoned grist mill site was identified along the Rocky River in the south of the quadrangle. The northern portion of the quadrangle was mapped at reconnaissance-scale as part of the Schmidt et al. (2006) study. The area was identified as containing large zones of high-sulfidation alteration with the potential for pyrophyllite and gold resources. The quadrangle has 4 identified prospect and/or mine areas including: 1) "Ore Hill", 2) Hinshaw pyrophyllite prospect, 3) Snow Camp Pyrophyllite Mine, and the 4) Snow Camp South pyrophyllite prospect.

Schmidt et al. (2006) identified "Ore Hill" as a location of a small shaft at the top of a knob. The rock is magnetite bearing and it is speculated that the shaft was sunk in search of iron ore. A site visit to "Ore Hill" in 2016 did not encounter the shaft; several shallow (prospect-like) openings are present. The reported shaft may have collapsed. The Hinshaw pyrophyllite prospect is described by Stuckey (1967) and Schmidt et al. (2006). The Snow Camp Pyrophyllite Mine is abandoned. Schmidt (1985) described the mine as an important former producer of high-grade pyrophyllite in North Carolina active from the mid-1930's to the mid-1960's. Additional descriptions of the Snow Camp Mine are provided in Broadhurst and Councill (1953), Espenshade and Potter (1960), Stuckey (1967), and Hughes (1987). The Snow Camp South pyrophyllite prospect is located on the southern end of the ridge that includes the Snow Camp Mine location.

DESCRIPTION OF MAP UNITS

All pre-Mesozoic rocks in the map area have been metamorphosed to at least the chlorite zone of the greenschist metamorphic facies. Many of the rocks display a weak or strong metamorphic foliation. Although subjected to metamorphism, the rocks retain relict igneous, pyroclastic, and sedimentary textures and structures that allow for the identification of protolith rocks. As such, the prefix "meta" is not included in the nomenclature of the pre-Mesozoic rocks described in the quadrangle. Jurassic diabase dikes are unmetamorphosed.

A preliminary review of the area geology is provided in Bradley (2013). Unit descriptions common to Hanna et al. (2014) and Bradley et al. (2017) from the Silk Hope and Siler City geologic maps, respectively, were used for conformity with on strike units in neighboring quadrangles. Unit descriptions and stratigraphic correlations were maintained from adjacent mapping in Orange County Bradley (Bradley et al., 2016). The nomenclature of the International Union of Geological Sciences subcommission on igneous and volcanic rocks (IUGS) after Le Maitre (2002) is used in classification and naming of the units. The classification and naming of the rocks is based on relict igneous textures, modal mineral assemblages, or normalized mineral assemblages when whole-rock geochemical data is available. Pyroclastic rock terminology follows that of Fisher and Schminke (1984).

SEDIMENTARY UNIT

Qal

Qal – Alluvium: Unconsolidated poorly sorted and stratified deposits of angular to subrounded clay, silt, sand and gravel- to boulder-sized clasts. In stream drainages. May include point bars, terraces and natural levees along larger stream floodplains. Structural measurements depicted on the map within Qal represent outcrops of crystalline rock inliers surrounded by alluvium.

INTRUSIVE AND METAINTRUSIVE UNITS

Jd

Jd – Diabase: Black to greenish-black, fine- to medium-grained, dense, consists primarily of plagioclase, augite and may contain olivine. Occurs as dikes up to 100 ft wide. Diabase typically occurs as spheroidally weathered boulders with a grayish-brown weathering rind. Red station location indicates outcrop or boulders of diabase.

MPzgb

MPzgb – Gabbro: Melanocratic (CI greater than 50), fine-grained gabbro. Distinctive brown weathering. Occurs as a small map scale body closely associated with a diabase dike, and as isolated boulders along the trend of a diabase dike. Appears unmetamorphosed. Purple station locations indicate outcrop or boulders of MPzgb.

Zgmd

Zqmd - Quartz monzodiorite: Composite pluton of mesocratic, coarse- to medium-grained, equigranular, quartz monzodiorite, diorite and granodiorite. Major minerals include plagioclase and amphiboles with lesser amounts of quartz. Amphiboles appear altered to chlorite and actinolite masses. Feldspars have a light pinkish-hue locally. Includes a distinctive plagioclase porphyritic granodiorite to diorite on South Fork Cane Creek. Unit identified as the Lindley Farms Quartz Monzonite by Schmidt et al. (2006). Schmidt et al. (2006) whole rock and modal analyses were replotted on IUGS tertiary diagrams and plot in the quartz monzodiorite field.

Zdi

Zdi – Diorite: Mesocratic (CI~50), greenish-gray to grayish-green, fine- to medium-grained, metamorphosed, hypidiomorphic granular diorite. Major minerals include plagioclase and amphibole. Plagioclase crystals are typically sericitized and saussuritized. Amphiboles are typically altered to chlorite and actinolite masses. Gabbro intermingled locally.

Zgr

Zgr – Granite: Leucocratic, medium- grained, equigranular metamorphosed, granite or tonolite

METAVOLCANIC AND METAVOLCANICLASTIC UNITS

Aaron Formation

Za

Za – Aaron Formation: Distinctive metasedimentary package that ranges from fine-grained siltstones to coarse-grained sandstones, pebbly sandstones and conglomerates. Siltstones are similar in appearance to Hyco Formation lithologies. The sandstones, pebbly sandstones and conglomerates (classified as litharenite, feldspathic litharenite and lithic feldsarenite by Harris (1984)) are distinctive and commonly contain rounded to subrounded clasts of quartz ranging from sand- to gravel-sized. In the sandstones, feldspar is the most prominent mineral grain; quartz varies from sparse to abundant in hand sample. Lithic clasts are typically prominent and range from sand- to gravel-size. Harris (1984), performed a detailed sedimentary study of the Aaron Formation to the immediate west of the map area. Harris (1984) interpreted the Aaron Formation to have been deposited by turbidity currents in a retrogradational submarine fan setting. Mirabile (2010) interpreted an approximate 35 million year unconformity between the Aaron and underlying Hyco Formation. This interpretation is based in part on detrital zircon age date data from an Aaron conglomerate sample collected in the adjacent Liberty Quadrangle.

Hyco Formation – Upper Portion

Zhat (u)

Zhat (u) – Altered tuffs: Very light gray to light greenish gray (whitish in areas) with red and yellow mottling, altered volcaniclastic rocks. Alteration consists of silicified, sericitized and pyrophyllitized rock. Sericite phyllite, pods of pyrophyllite, and quartz + phyrophyllite rock all with less than 1 mm to 2 mm diameter weathered sulfides are common. Relict lithic clasts and kaolinized feldspar crystal shards are visible in some exposures. Relict structures are obliterated in heavily altered rocks. Map area contains boulders (up to several feet in diameter) and outcrop of massive milky quartz and quartz + sericite rock.

Zhel

Zhel - Epiclastic rocks and lavas: Metamorphosed conglomerate, conglomeratic sandstone, sandstone, siltstone and mudstone. Siltstones and mudstones typically display bedding ranging from mm-scale up to 10 cm, bedding layers traceable for several feet locally, may exhibit soft sediment deformation. Locally tuffaceous with a relict vitric texture. Locally contain interbedded dacitic to basaltic lavas. Conglomerates and conglomeratic sandstones typically contain subrounded to angular clasts of dacite in a clastic matrix. Deposition interpreted as distal from volcanic center, in deep water (?), and via turbidite flows.

Zhelplm

Zhelplm - Mixed epiclastic-pyroclastic rocks with interlayered intermediate to basaltic lavas: Grayish-green to greenish-gray, locally with distinctive reddish-gray or maroon to lavender coloration; metamorphosed: conglomerate, conglomeratic sandstone, sandstone, siltstone, mudstone, and felsic fine- to coarse tuff and lapilli tuff. Siltstones are locally phyllitic. Locally contain interbedded andesitic to basaltic lavas identical to Zhabl unit. Silicified and/or sericitized altered rock are locally present. Interpreted to be in gradational contact with unit Zhe/pl and identified by increase in intermediate to mafic lavas and decrease and/or absence of dacites.

Zhe/pl

Zhe/pl - Mixed epiclastic-pyroclastic rocks with interlayered dacitic lavas: Grayish-green to greenish-gray, locally with distinctive reddish-gray or maroon to lavender coloration; metamorphosed: conglomerate, conglomeratic sandstone, sandstone, siltstone and mudstone. Lithologies are locally bedded; locally tuffaceous with a cryptocrystalline-like groundmass. Siltstones are locally phyllitic. Locally contain interbedded dacitic lavas identical to Zhdt unit. Contains lesser amounts of fine- to coarse tuff and lapilli tuff with a cryptocrystalline-like groundmass. Pyroclastics, lavas, and epiclastics are mainly felsic in composition. Minor andesitic to basaltic lavas and tuffs present. Silicified and/or sericitized altered rock are locally present and increase in occurrence toward the north. Conglomerates and conglomeratic sandstones typically contain subrounded to angular clasts of dacite in a clastic matrix. Fine- to medium-grained diorite is locally present. Portions of the Zhe/pl unit are interpreted to have been deposited proximal to active volcanic centers represented by the Zhdt unit but are also interpreted to record the erosion of proximal volcanic centers after cessation of active volcanism.

Zhdt (u)

Zhdt (u) – Dacitic lavas and tuffs of the upper portion of the Hyco Formation: Greenish-gray to dark gray, siliceous, metamorphosed: aphanitic dacite, porphyritic dacite with plagioclase phenocrysts, and flow banded dacite. Dacite with hyalaclastic textures are common. Welded and non-welded tuffs associated with the lavas include: greenish-gray to grayish-green, fine tuff, coarse plagioclase crystal tuff and lapilli tuff. Locally, interlayers of immature crystalline sandstone and conglomeratic sandstone with abundant dacite clasts are present. The dacites are interpreted to have been coherent extrusives or very shallow intrusions associated with dome formation. The tuffs are interpreted as episodic pyroclastic flow deposits, air fall tuffs or reworked tuffs generated during formation of dacite domes. The unit occurs as map scale pods surrounded by clastic rocks of Zhe/pl unit. Wortman et al. (2000) reports an age of 615.7+3.7/-1.9 Ma U-Pb zircon date for a dacitic tuff from the unit in the Rougemont quandrangle.

Zhdasi

Zhdasi – Dacitic to andesitic shallow intrusive: Gray to greenish-gray; dacite to andesite. Aphanitic groundmass with plagioclase and acicular amphibole phenocrysts. Weak relict cryptocrystalline texture present (less than dacites). Aphanitic dacite to andesite clasts present locally likely indicating hyaloclastic texture.

Zhabl

Zhabl - Andesitic to basaltic lavas: Green, gray-green, gray, dark gray and black; typically unfoliated, amygdaloidal, plagioclase porphyritic, amphibole/pyroxene porphyritic and aphanitic; metamorphosed: andesitic to basaltic lavas and shallow intrusions. Hyaloclastic texture is common and imparts a fragmental texture on some outcrops and float boulders. Conglomeratic rocks consisting of angular clasts of andesite and/or basalt occur locally and are interpreted as resedimented hyaloclastite. Map-scale body within Sheeprock alteration zone is siliceous and magnetic.

Zhable

Zhable – Andesitic to basaltic lavas with interlayered epiclastic rocks: Light green, gray-green, gray, and dark gray; typically unfoliated, amygdaloidal, plagioclase porphyritic, amphibole/pyroxene porphyritic and aphanitic; metamorphosed: andesitic to basaltic lavas and shallow intrusions. Hyaloclastic texture is common and imparts a fragmental texture on some outcrops and float boulders. Contains lesser amounts of grayish-green, light green, and gray to light gray; metamorphosed conglomerate, conglomeratic sandstone, sandstone, siltstone and mudstone.

Zhqdp

Zhqdp - Quartz dacite porphyry: Porphyritic with aphanitic groundmass and sub- to euhedral phenocrysts (2-6 mm) of white to salmon plagioclase and gray to dark gray (beta-) quartz; phenocrysts typically constitute 20 to 25% of the rock. Foliated and likely altered. Present in a few outcrops and boulders in the vicinity of Johnson creek. Similar to quartz dacite porphyry unit within the Bynum Quadrangle (Bradley et al., 2013).

Zhasi

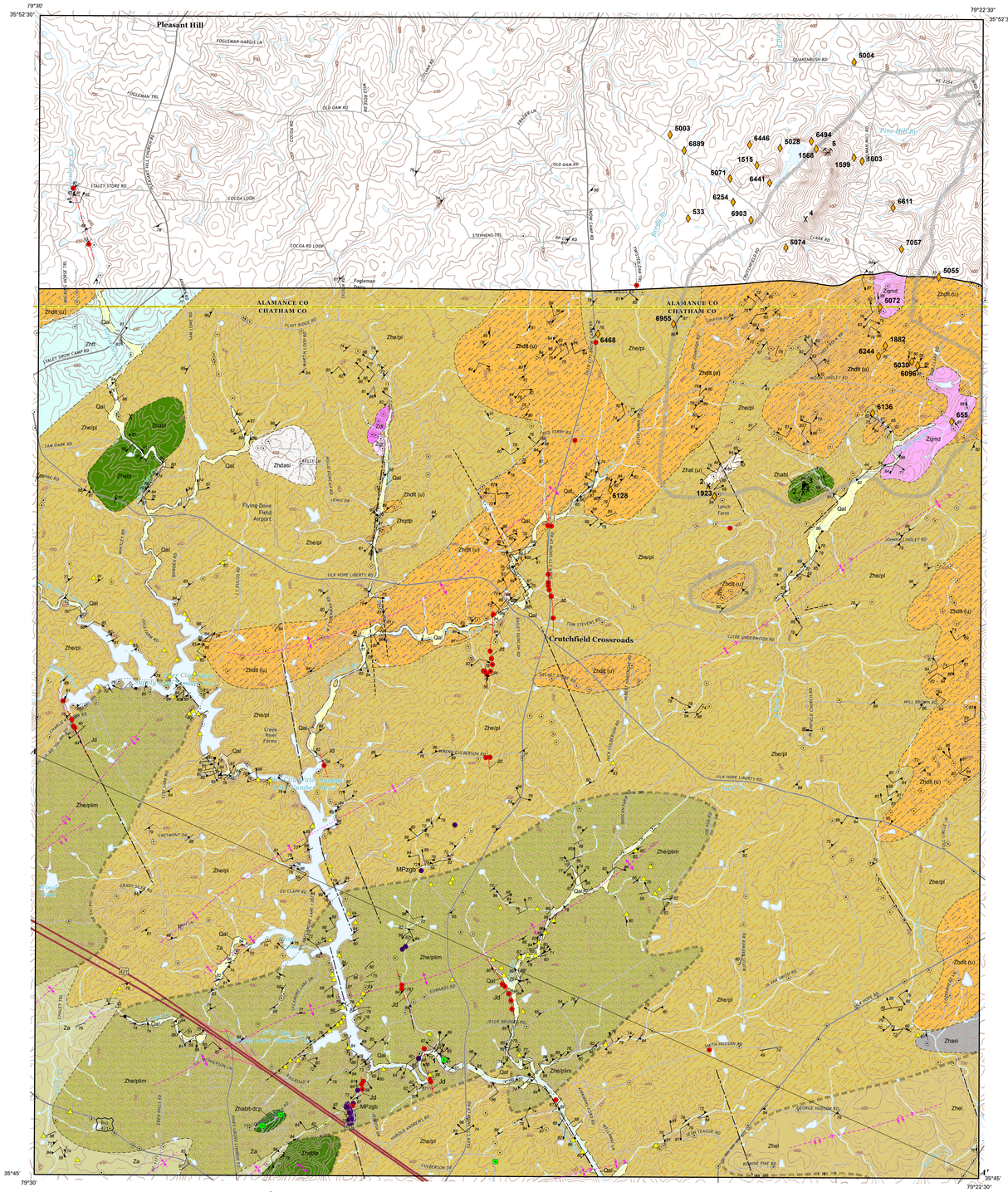
Zhasi - Andesitic shallow intrusive: Grayish-green to light green, metamorphosed: plagioclase porphyritic andesite with a granular-textured groundmass to very fine-grained diorite (with intrusive texture visible with 7x hand lens – microdiorite-like). Contains lesser amounts of fine- to medium grained diorite. Plagioclase phenocrysts typically range from 1 mm to 4 mm. Dark green to black colored amphibole, when present, occurs as phenocrysts (less than 1 mm to 1 mm) and as intergrowths with plagioclase.

Zhabl-dcp

Zhabl-dcp – Andesite to basalt porphyry of the Dry Creek area: Distinctive, green to dark green, metamorphosed andesite porphyry with aphanitic groundmass and euhedral phenocrysts (up to 10 mm) of greenish-white plagioclase; phenocrysts typically constitute 20 to 50% of the rock; local alignment of plagioclase; lesser pyroxene/amphibole phenocrysts. Green to dark green basalt porphyry with abundant pyroxene (altered to amphibole) phenocrysts with minor plagioclase phenocrysts. Andesite and basalt porphyries locally amygdaloidal (up to 2 cm), amygdules in filling include calcite, quartz, chlorite, and epidote. Same as Dry Creek Porphyry complex of Hauck (1977). Present as isolated outcrops or boulders as designated by green station locations.

Zhft

Zhft - Felsic tuffs: Grayish-green to greenish-gray and silvery-gray; massive to foliated volcaniclastic pyroclastic rocks consisting of fine- to coarse tuffs, lapilli tuffs and minor welded tuffs. Tuffs are differentiated from other volcaniclastic rocks by the presence of zones of crystoorystalline texture that exhibit conchoidal-like fractures in between foliation domains. Layering ranges from massive to thinly bedded. Contains lesser amounts of volcaniclastic sedimentary rocks consisting of volcanic sandstones, and greywackes with minor siltstones and phyllite.



Topographic base produced by the United States Geological Survey.
Altered by the North Carolina Geological Survey for use with map.

North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and
1 000-meter grid: Universal Transverse Mercator, Zone 17S
10 000-foot ticks: North Carolina Coordinate System of 1983

Imagery.....NAIP, May 2012
Roads.....©2006-2012 TomTom
Names.....GNIS, 2012
Hydrography.....National Hydrography Dataset, 2012
Contours.....National Elevation Dataset, 2008
Boundaries.....Census, IBWC, BLC, USGS, 1972 - 2012

Base map is from USGS 2013 GeoPDF of the Crutchfield Crossroads 7.5-minute quadrangle. Air photo, map collar and select features removed. Bounds of GeoPDF based on 7.5-minute grid projection in UTM 17S; North American Datum of 1983 (NAD83).

UTM GRID AND 2013 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

U.S. National Grid
100,000-m Square ID
PV
Grid Zone Designation
17S

SCALE 1:24 000

1 0.5 0 KILOMETERS 1 2
1000 500 0 METERS 1000 2000
1 0.5
1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000
FEET

CONTOUR INTERVAL 10 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988

This map was produced to conform with the National Geospatial Program US Topo Product Standard, 2011.
A metadata file associated with this product is draft version 0.6.11

ROAD CLASSIFICATION

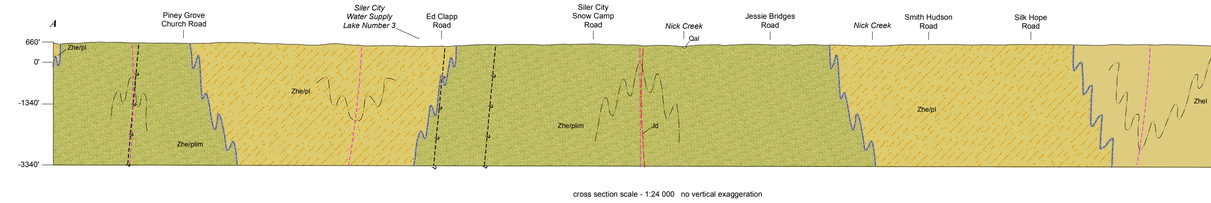
Expressway		Local Connector	
Secondary Hwy		Local Road	
Ramp		4WD	
Interstate Route		US Route	State Route

QUADRANGLE LOCATION

Kimesville	Snow Camp	Saxapahaw
Liberty	Crutchfield Crossroads	Silk Hope
Coleridge	Siler City	Siler City NE

ADJOINING 7.5' QUADRANGLES

CRUTCHFIELD CROSSROADS, NC



cross section scale - 1:24 000 no vertical exaggeration

EXPLANATION OF MAP SYMBOLS

CONTACTS, FAULTS, AND OTHER FEATURES

- inferred contact
- concealed contact
- gradational contact - inferred; dotted where concealed
- quaternary alluvium contact
- inferred brittle fault; dotted where concealed
- linear geomorphic feature interpreted from hillshade LiDAR - origin uncertain
- A A' cross section
- zone of alteration associated with the Sheeprock area (Schmidt, et. al. 2006)
- interpreted fold hinge of anticline; question mark where existence is questionable; dotted where concealed
- interpreted fold hinge of syncline; question mark where existence is questionable; dotted where concealed
- interpreted fold hinge of overturned anticline
- interpreted fold hinge of overturned syncline, existence questionable
- inferred diabase dike; dotted where concealed
- MPzgb dike - inferred

IN CROSS SECTION

- inferred contact
- inferred gradational contact
- interpretive fold form lines
- brittle fault, identity or existence questioned, inferred from LiDAR lineament
- inferred fold axis
- diabase dike - inferred

PLANAR FEATURES

- 65 Strike and dip of primary bedding and/or layering
- 79 45 Strike and dip of primary bedding and/or layering (multiple observations at one location)
- 78 Strike and dip of inclined regional foliation
- 85 77 Strike and dip of inclined regional foliation (multiple observations at one location)
- 84 Strike and dip of cleavage
- 87 80 Strike and dip of cleavage (multiple observations at one location)
- 81 Strike and dip of inclined joint surface
- Strike of vertical Joint surface
- 88 79 Strike and dip of inclined joint surface (multiple observations at one location)
- Strike of vertical Joint surface (multiple observations at one location)
- 82 Strike and dip of primary volcanic compaction and/or welding foliation

PROSPECTS AND QUARRIES

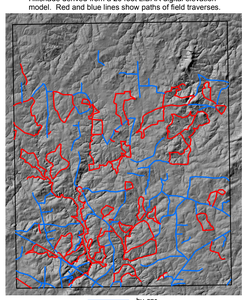
- X Prospect (pit or small open cut)
  - 2 Hinshaw Prospect (pyrophyllite) - abandoned
  - 3 "Ore Hill" (Iron?) - abandoned
  - 4 Snow Camp South Prospect (pyrophyllite) - abandoned
- quarry or mine - abandoned
  - 1 quarry (flagstone) - abandoned
  - 5 Snow Camp Pyrophyllite Mine
- mine shaft - abandoned
  - 3 "Ore Hill" shaft (Iron?) - abandoned - not found in 2016; location from Schmidt, et. al. (2006)

OTHER FEATURES

- Observation station location
- Diabase station location
- Indicates location of vuggy quartz or siliceous breccia float
- Indicates location of Zhabit-dcp boulders or outcrop
- Indicates location of MPzgb boulders or outcrop
- 533 Schmidt et al. (2006) geochem location

TRAVERSE MAP

Hillshade derived from a 20 foot LiDAR digital elevation model. Red and blue lines show paths of field traverses.



by car
by foot

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Environmental Quality

Geologic Map of the Chatham County Portion of the Crutchfield Crossroads 7.5-Minute Quadrangle, Chatham and Alamance Counties, North Carolina

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