GEOLOGIC MAP OF THE WHITE CROSS 7.5-MINUTE QUADRANGLE, ORANGE AND CHATHAM COUNTIES, NORTH CAROLINA

This geologic map was funded in part by the USGS National Cooperative Geologic Mapping Program

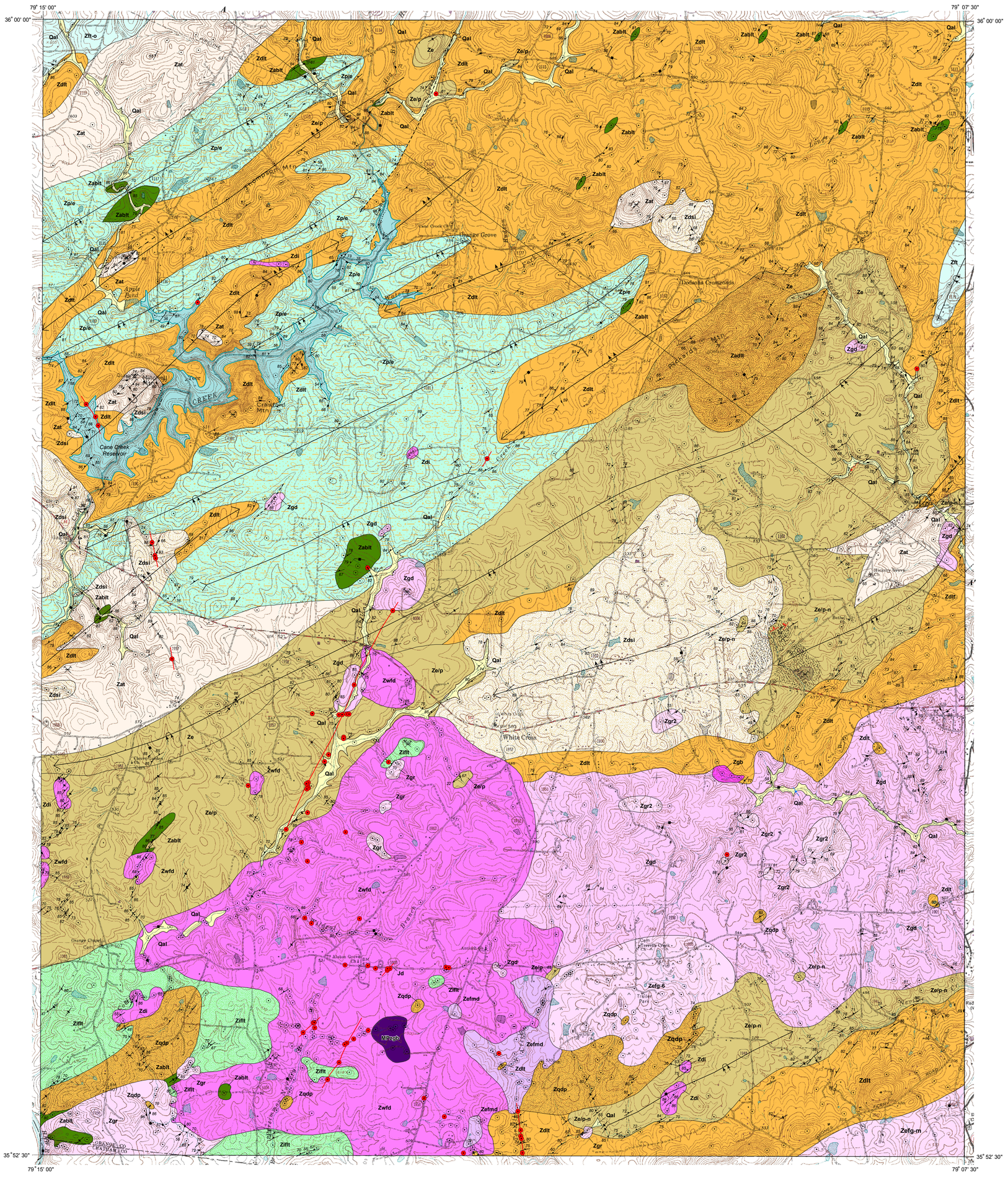
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
DIVISION OF LAND RESOURCES
JAMES D. SIMONS, DIRECTOR AND STATE GEOLOGIST

NORTH CAROLINA GEOLOGICAL SURVEY
OPEN FILE REPORT 2008-01

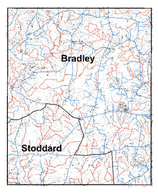
BY PHILIP J. BRADLEY AND
EDWARD F. STODDARD

Digital representation by Michael A. Medina and Philip J. Bradley

2008

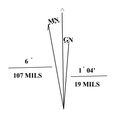


Geology mapped from August, 2007 through May, 2008.



INDEX TO GEOLOGIC MAPPING AND TRAVERSE MAP

traverse by car



UTM GRID AND 1981 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

0.25 0 0.25 0.5 0.75 1 Miles

1,250 0 1,250 2,500 3,750 5,000 Feet

375 0 375 750 1,125 1,500 Meters

1:24,000 SCALE

CONTOUR INTERVAL 10 FEET

Base topographic map is digital raster graphic image of the White Cross 7.5-minute quadrangle (1968, photorevised 1981), North Carolina State Plane NAD 83 meters coordinate system.

This geologic map was funded in part by the USGS National Cooperative Geologic Mapping Program, award number 07HQAG0140.
The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

Disclaimer:
This Open-File report is preliminary and has not been reviewed for conformity with the North Carolina Geological Survey editorial standards or with the North American Stratigraphic Code. Further revisions or corrections to this preliminary map may occur prior to its release as a North Carolina Geological Survey map.

Description of Map Units

All pre-Mesozoic rocks of the White Cross quadrangle 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.

The nomenclature of the International Union of Geological Sciences subcommission on igneous and volcanic rocks (IUGS) after Streckeisen (1973 and 1979) 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. Past workers in the White Cross quadrangle and adjacent areas (Chuilli, 1987; Black, 1977; Hauck, 1977; Allen and Wilson, 1968 and Wagener, 1964 and 1965) have used various nomenclature systems for the igneous rocks. The raw data of these earlier workers was recalculated and plotted on ternary diagrams and classified based on IUGS nomenclature. Pyroclastic rock terminology follows that of Fisher and Schminke (1984).

Sedimentary Units

Qal – **Alluvium**: Unconsolidated clay, silt, sand and gravel to cobble-sized clasts, subrounded to angular, deposited in drainages.

Intrusive and Meta-Intrusive Units

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 spheriodally weathered boulders with a grayish-brown weathering rind. Red station location indicates outcrop or boulders of diabase.

MPzgb – **Olivine gabbronorite**: Unfoliated, black, medium- to coarse-grained gabbronorite. In thin section, olivine, plagioclase, orthopyroxene and clinopyroxene are present with no apparent metamorphic overprint. In field, rock is similar in appearance to coarse-grained diabase.

East Farrington pluton: The East Farrington pluton is composed of several distinct granitoid facies based on mineral and textural characteristics. U-Pb zircon geochronologic data (Tadlock and Loewy, 2006) indicate that the East Farrington pluton is ca. 579 Ma.

Zefg-m – **East Farrington pluton main facies**: Unfoliated, orange pink to pinkish-gray to gray, medium- to coarse-grained, equigranular to slightly porphyritic, amphibole (va. hornblende?) granite. Amphibole content varies from approximately 5 to 10% by volume and occurs locally as dark green, elongate crystals up to 1.5 cm long and amorphous intergrowths with feldspar and quartz up to 0.5 cm diameter. Dark gray xenoliths/enclaves up to 8 cm in diameter are common. Grain size becomes finer and xenolithsenclaves larger near the pluton edge. Cavities, less than 1 mm in diameter, with euhedral terminating crystals are common in some specimens. In thin section the main facies can be separated into two groups: 1) rocks with a porphyritic texture with orthoclase and plagioclase phenocryts in a groundmass of intergrown orthoclase, plagioclase and quartz with a granophyric texture (micrographic texture) and 2) porphyritic and equigranular rocks consisting of orthoclase, plagioclase and quartz without a granophyric texture in matrix. The two varieties appear to be intermingled throughout the study area and within the adjacent Farrington Quadrangle (Bradley et al., 2008).

Zefg-6 – **East Farrington pluton satellite granitoid**: White, creamy, pale pink, or pale greenish; fine- to medium-grained, locally plagioclase-porphyritic granite, granodiorite, leucogranite, leucogranodiorite, and quartz monzodiorite. Contains distinctive prismatic amphibole crystals, locally acicular and up to one cm. Amphibole-rich enclaves to 2 cm are present locally. At western contact in Heron Pond subdivision, contains enclaves of and cuts fine-grained gray diorite and monzodiorite porphyry of the Zefmd unit.

Zefmd – **East Farrington monzodiorite porphyry of Terrells Creek area**: Light gray to dark grayish-green where fresh, olive drab weathering, plagioclase-phyric monzodiorite and diorite, typically with very low color index. Fine- to medium-grained groundmass, with phenocrysts to 8 mm. Quartz phenocrysts very rare. Commonly has a cloudy, splotchy, or mottled appearance. Locally contains salmon-colored feldspar phenocrysts and/or orange ovoids interpreted as cavity filling or weathered phenocrysts. May have a thin light beige outer weathering rind. Weathered surface may be pitted. Locally sulfide-bearing, saussuritized, or streaked with tiny epidote veins. Fine-grained near margins.

Zwfd – **West Farrington pluton diorite**: White to cream-colored, unfoliated, medium- to coarse-grained, with dark green amphibole (actinolite after hornblende) diorite. Locally with chlorite/biotite; dominantly equigranular but locally weakly plagioclase porphyritic; includes quartz diorite, granodiorite, quartz monzodiorite, and tonalite; commonly contains ovoid enclaves of green to black micro-diorite to 0.5 m; grades to local patches of more mafic diorite and gabbro; fine dense to slabby hornfelsed country rocks occur locally as enclaves and near contacts; locally strongly saussuritized and pale greenish; white weathering with plagioclase occurring in positive relief giving "bumpy" texture.

Zdi – **Diorite**: Greenish-gray to gray, fine- to medium-grained, hornblende diorite. Major minerals include plagioclase and hornblende. Plagioclase crystals are typically sericitized and saussuritized. Hornblende is typically altered to chlorite and actinolite masses. May be foliated.

Zgr – **Granite**: Light brownish to beige or creamy, and locally pale pink or green; medium- to coarse-grained, equigranular metamorphosed leucocratic granodiorite and granite; locally weakly porphyritic with beta-quartz forms; grades to quartz porphyry in zones of cleavage development; quartz may be bluish; locally reddish weathering; locally contains epidote and/or chlorite clots possibly pseudomorphic after a hornblende; feldspar and quartz grains resist weathering and produce a bumpy surface; plagioclase and quartz phenocrysts sit in a granophyric matrix of alkali feldspar and quartz. Correlative to the Chatham granite of Hauck 1977 in Bynum Quadrangle.

Zgr2 – **Granite**: Light pink to pink and orange; fine- to coarse-grained granite. May be foliated.

Zdsi – **Dacitic shallow intrusive**: Gray-green, light green to green; plagioclase porphyritic dacite with a granular-textured groundmass to very fine-grained granodiorite (with intrusive texture visible with 7x hand lens). Contains lesser amounts of fine- to medium grained granodiorite. Plagioclase phenocrysts typically range from 1 mm to 4 mm. Black colored amphibole, when visible, occurs as phenocrysts (less than 1 mm to 1 mm) and as intergrowths with plagioclase. Amphibole intergrowths distinguish rock from fine-grained tuffs. Enclaves of dark gray, plagioclase porphyritic dacite are common and at times give rock a psuedo-clastic appearance. Locally xenoliths of tuffs are present.

Zgd – **Granodiorite**: Leucoractic to mesocratic, fine- to medium-grained, equigranular to porphyritic granodiorite. May contain quartz diorite and diorite. Typically contains dark green to black less than 1 mm to 4 mm clots of actinolitic (?) amphibole and chlorite masses. Plagioclase grains are often sericitized and saussuritized and may exhibit a greenish color.

Zgb – **Gabbro**: Dark green, melanocratic, fine-grained gabbro.

Metavolcanic Units

Zat – **Altered tuffs**: Very light gray to light greenish gray (whitish in areas) with red and yellow mottling. 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. Fine-grained chloritoid porphyroblasts (less than 1 mm) are present in some pyrophyllite bearing rocks. Relict lithic clasts and kaolinitized 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.

Ze – **Epiclastics**: Mixed unit of metasedimentary rocks. Includes mudstone, siltstone, sandy siltstone, sandstone, conglomeratic sandstone, and conglomerate. Minor interlayers of fine tuff to vitric tuff are present. Mudstones and siltstones are sometimes phyllitic or silicified. The mudstones and siltstones are composed of quartz, sericite, and traces of a black detrital heavy minerals (less than 1 mm in diameter). Siltstones are typically interbedded with the sandstones. Sandstones are dark-gray, gray, greenish-gray, grayish-green, litharenites and feldspathic litharenites composed of volcanic rock fragments, feldspar, quartz, and rare intrusive rock fragments. Conglomerates include matrix supported and clast supported polymictic conglomerate composed of angular to rounded pebble to gravel-size sediment.

Ze/p - **Mixed epiclastic-pyroclastic rocks**: Green, grayish-green to greenish-gray; tuffaceous sandstones, conglomeratic sandstones, siltstones and minor phyllite. The siltstones typically are weakly phyllitic. Contains lesser amounts of coarse tuff and lapilli tuff. Silicified and/or sericitized altered rock similar to Zat unit are present near contacts with other units. Minor andesitic to basaltic lavas and tuffs.

Ze/p-n - **Mixed epiclastic-pyroclastic rocks of Neville Creek area**: Heterogeneous unit of felsic to intermediate composition tuffs and lavas, mudstone, siltstone, tuffaceous sandstones and conglomeratic sandstones. Unit appears to contain more andesitic to basaltic lavas and tuffs than Ze/p unit.

Zp/e – **Mixed pyroclastic-epiclastics**: Gray to green, felsic tuffs interlayed with mudstone, siltstone, and sandstone and distinctive immature, monomictic, conglomeratic sandstone to conglomerate containing subangular to angular clasts of plagioclase porphyritic dacite. Minor andesitic to basaltic lavas and tuffs.

Zabit – **Andesitic to basaltic lavas and tuffs**: Typically unfoliated, green, gray-green, gray, dark gray and black; amygdaloidal, plagioclase porphyritic, amphibole/pyroxene porphyritic and aphanitic; andesitic to basaltic lavas and shallow intrusions. Hyaloclastic texture is common and imparts a fragmental texture similar to a lithic tuff on some outcrops. Tuffs associated with the lavas are weakly foliated to foliated, green to gray to silvery-gray, coarse tuff and lapilli tuff.

Zft - **Felsic tuffs**: Greenish-gray, silvery-gray, and gray, massive to foliated, lithic, lithic-crystal, crystal, and minor welded tuffs. Layering ranges from massive to thinly bedded.

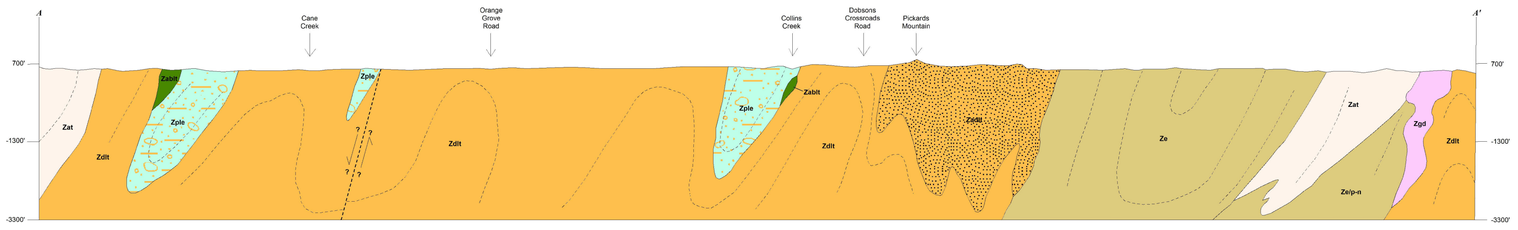
Zft-o – **Felsic tuff of Oak Grove Church area**: Gray, greenish-gray, grayish-green; massive to strongly foliated; fine to coarse felsic tuffs. Plagioclase crystal fragment-rich coarse tuff, lithic tuff and welded tuff are common. Minor quartz crystal tuff. Minor amounts of interlayered epiclastic rocks are present.

Zlflt – **Intermediate to felsic lavas and tuffs**: Heterogenous unit of felsic to intermediate composition tuffs and with lesser interlayers of andesitic to basaltic lavas and epiclastic rocks. Porphyritic andesitic to basaltic lithologies may be shallow intrusions. Felsic tuffs are locally phyllitic. On strike with the Collins Creek and Collins Mountain units of Hauck 1977 in Bynum Quadrangle.

Zdlt - **Dacitic lavas and tuffs**: Distinctive dark-gray to black, siliceous, cryptocrystalline dacite, porphyritic dacite with plagioclase +- quartz phenocrysts, and flow banded dacite. Tuffs associated with the lavas include welded and non-welded: greenish-gray to grayish-green, coarse plagioclase crystal tuff; lapilli tuff; lithic tuff. The dacites are interpreted to have been coherent magma that were extrusive 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. A sample, identified as a flow-banded rhyolite, collected from a location immediately west of University Lake on the Chapel Hill quadrangle, yielded an upper intercept date from single zircons of 632.9 +2.6/-1.9 Ma (Wortman et al. 2000).

Zqdp - **Quartz dacite porphyry**: Strongly 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; local weak alignment of plagioclase; interpreted as either lava flows or shallow intrusives possibly associated with domes.

Zadlt – **Andesitic to dacitic lavas and tuffs**: Distinctive black to dark gray; porphyritic lava with plagioclase phenocrysts (up to 4 mm), and flow banded lava with local amygdules. Interlayed with the lavas are gray to black; welded and non-welded; coarse tuff, lapilli tuff, and tuff breccia.



approximately 1:24,000 scale
no vertical exaggeration

EXPLANATION OF MAP SYMBOLS

CONTACTS

Lithologic contacts - Distribution and concentration of structural symbols indicates degree of reliability.

- geologic contact
- concealed geologic contact
- inferred brittle fault
- inferred ductile fault
- A — A' cross section line
- interpreted fold hinge of large scale plunging anticline
- interpreted fold hinge of large scale plunging syncline
- interpreted fold hinge of large scale doubly plunging syncline
- in cross section, interpreted fold form lines

LINEAR FEATURES

47 Bearing and plunge of lineation

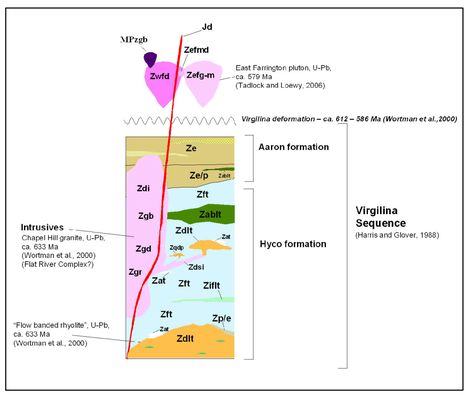
7 fold axis

PLANAR FEATURES

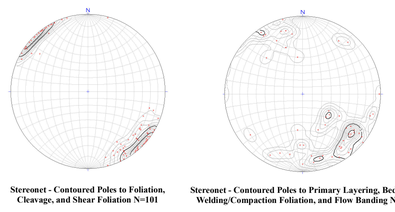
Observation sites are centered on the strike bar or are at the intersection point of multiple symbols. Planar feature symbols may be combined with linear features.

- 85 strike and dip of foliation
- vertical foliation
- vertical cataclastic foliation
- 89 strike and dip of shear foliation
- 84 strike and dip of joint
- vertical joint
- 74 strike and dip of primary bedding and layering
- vertical bedding
- 81 strike and dip of cleavage
- 72 strike and dip of spaced cleavage
- 75 strike and dip of primary volcanic compaction and/or welding
- 84 overturned bedding
- 50 fault plane
- diabase station location
- 77 fold axial plane
- observation station location

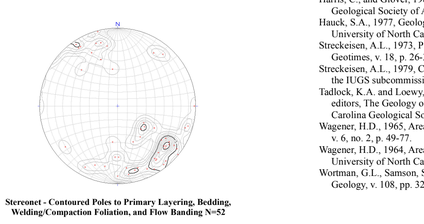
The banks of Cane Creek reservoir were traversed from November 2007 through March 2008. The water level of the reservoir was at a record low allowing the collection of data from outcrops typically underwater. Stations indicated within blue polygon of reservoir were collected at that time.



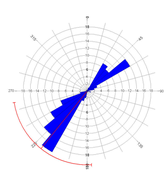
Schematic representation of relationships of geologic units in the White Cross and adjacent quadrangles.



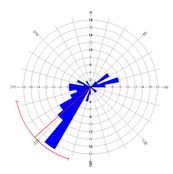
Stereonet - Contoured Poles to Foliation, Cleavage, and Shear Foliation N=101



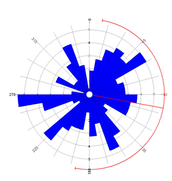
Stereonet - Contoured Poles to Primary Layering, Bedding, Welding/Compaction Foliation, and Flow Banding N=52



Unidirectional Rose Diagram of Foliations, Cleavage, and Shear Foliations N=101



Unidirectional Rose Diagram of Primary Layering, Bedding, Welding/Compaction Foliation, and Flow Banding N=52



Unidirectional Rose Diagram of Joints N=217

MAP LOCATION

Scan with smartphone for link to GeoPDF of map. Third party App required.

References:

Allen, E.P., and Wilson, W.F., 1968, Geology and mineral resources of Orange County, North Carolina: Division of Mineral Resources, North Carolina Department of Conservation and Development, Bulletin 81, 58 p.
Black, W.W., 1977, The geochronology and geochemistry of the Carolina Slate belt of north-central North Carolina, Ph.D. thesis, University of North Carolina, Chapel Hill, 118 p.
Bradley, P.J., Gay, N.K., Bechtel, R. and Clark, T.W., 2007, Geologic map of the Farrington 7.5-minute quadrangle, Chatham, Orange and Durham Counties, North Carolina: North Carolina Geological Survey Open-file Report 2007-03, scale 1:24,000, in color.
Chiulli, A.T., 1987, The geology and stratigraphy of the northeast portion of White Cross quadrangle, Orange County, North Carolina, M.S. thesis, University of North Carolina at Chapel Hill, 70 p.
Fisher, R.V. and Schmincke H.-U., 1984, Pyroclastic rocks, Berlin, West Germany, Springer-Verlag, 472 p.
Harris, C., and Glover, 1988, The regional extent of the ca. 600 Ma Virgilina deformation: implications of stratigraphic correlation in the Carolina terrane, Geological Society of America Bulletin, v. 100, pp. 200-217.
Hauck, S.A., 1977, Geology and petrology of the northwest quarter of the Bynum quadrangle, Carolina slate belt, North Carolina, unpublished M.S. thesis, University of North Carolina at Chapel Hill, 146 p.
Streckeisen, A.L., 1973, Plutonic rocks: Classification and nomenclature recommended by the IUGS subcommission on the systematics of igneous rocks: Geotimes, v. 18, p. 26-31.
Streckeisen, A.L., 1979, Classification and nomenclature of volcanic rocks, lamprophyres, carbonatites, and melilitic: Recommendations and suggestions of the IUGS subcommission on the systemics of igneous rocks, Geology, v. 7, p. 331-335.
Tadlock, K.A. and Loewy, S.L., 2006, Isotopic characterization of the Farrington pluton: constraining the Virgilina orogeny, in Bradley, P.J., and Clark, T.W., editors, The Geology of the Chapel Hill, Hillsborough and Efland 7.5-minute Quadrangles, Orange and Durham Counties, Carolina Terrane, North Carolina, Carolina Geological Society Field Trip Guidebook for the 2006 annual meeting, pp. 17-21.
Wagener, H.D., 1965, Areal modal variation in the Farrington igneous complex, Chatham and Orange Counties, North Carolina, Southeastern Geology, v. 6, no. 2, p. 49-77.
Wagener, H.D., 1964, Areal modal variation in the Farrington igneous complex, Chatham and Orange counties, North Carolina, unpublished M.S. thesis, University of North Carolina at Chapel Hill, 51 p.
Wortman, G.L., Samson, S.D., and Hibbard, J.P., 2000, Precise U-Pb zircon constraints on the earliest magmatic history of the Carolina terrane, Journal of Geology, v. 108, pp. 321-338.

GEOLOGIC MAP OF THE WHITE CROSS 7.5-MINUTE QUADRANGLE, ORANGE AND CHATHAM COUNTIES, NORTH CAROLINA
NCGGS OPEN FILE REPORT 2008-01