# GEOLOGIC MAP OF THE EFLAND 7.5-MINUTE QUADRANGLE, ORANGE COUNTY, 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**

**NORTH CAROLINA GEOLOGICAL SURVEY**
**OPEN FILE REPORT 2006-02**

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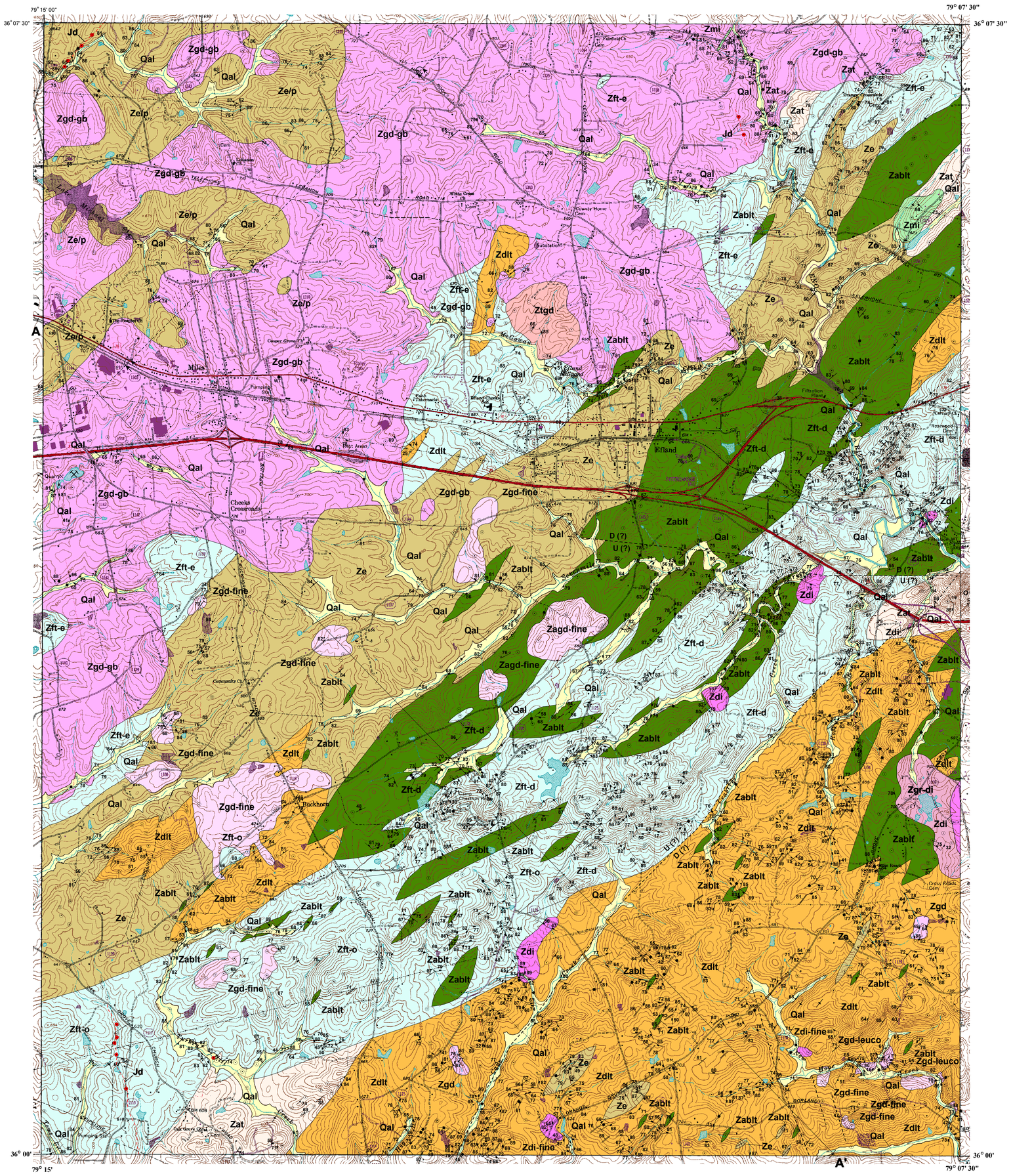
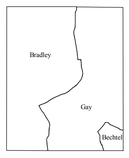
*Digital representation by Michael A. Medina, Philip J. Bradley, and Norman K. Gay*

**2006**

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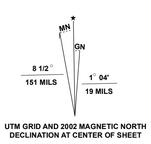
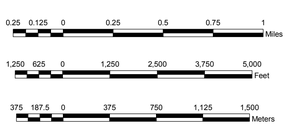
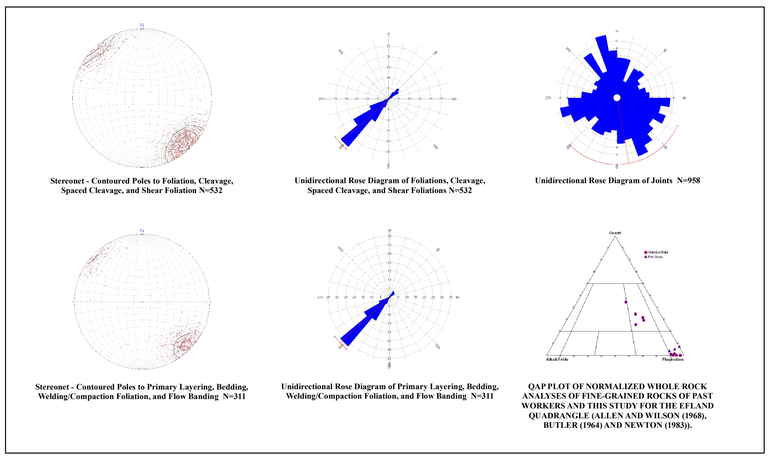



UTM GRID AND 2002 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET



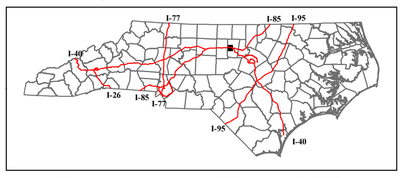




QAP PLOT OF NORMALIZED WHOLE ROCK ANALYSES OF FINE-GRAINED ROCKS OF PAST WORKERS AND THIS STUDY FOR THE EFLAND QUADRANGLE (ALLEN AND WILSON (1968), BUTLER (1964) AND NEWTON (1983)).

1:24,000 SCALE
CONTOUR INTERVAL 10 FEET

Base topographic map is digital raster graphic image of the Efland 7.5 minute USGS quadrangle (1994), North Carolina State Plane NAD 83 meters coordinate system.

**LOCATION OF THE EFLAND 7.5-MINUTE QUADRANGLE, NORTH CAROLINA**




Geology mapped from August 2005 through May 2006.

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.

Research supported by the U.S. Geological Survey, National Cooperative Geologic Mapping Program, under USGS award number 05HQAG0082. 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.

**CONTACTS**

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

- geologic contact
- concealed geologic contact
- Quaternary alluvium contact
- D (?) / U (?) — fault - D (?) indicates suspected downthrown side, U (?) indicates suspected upthrown side
- major / minor — inferred fold axis of major- and minor-scale overturned syncline
- major / minor — inferred fold axis of minor-scale overturned anticline

**STRUCTURAL SYMBOLS**

Observation sites are centered on the strike bar or are at the intersection point of multiple symbols.

- 23 strike and dip of primary bedding and layering
- 19 strike and dip of normal bedding
- 34 strike and dip of primary volcanic compaction and/or welding
- 17 strike and dip of primary volcanic flow banding
- 41 strike and dip of cleavage
- 34 strike and dip of foliation
- 22 strike and dip of joint
- 22 strike and dip of shear foliation
- 41 trend and plunge of crenulation lineation
- 19 trend and plunge of mineral lineation
- station location
- active quarry location
- vertical primary bedding and layering
- 70 strike and dip of overturned bedding
- vertical strike of primary volcanic compaction and/or welding
- 51 strike and dip of spaced cleavage
- vertical cleavage
- vertical foliation
- vertical joint
- vertical shear foliation
- 44 trend and plunge of clast lineation
- 36 trend and plunge of slickenline lineation
- 11 trend and plunge of lineation
- inactive quarry location

## DESCRIPTION OF MAP UNITS

All pre-Mesozoic rocks of the Efland 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 Efland quadrangle (Butler, 1964; Allen and Wilson, 1968; and Newton, 1983) 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** - **Olivine diabase**: Black to greenish-black, fine- to medium-grained, dense, consists primarily of plagioclase, augite, and olivine. Occurs as dikes up to 80 ft wide. Diabase typically occurs as spheriodally weathered boulders with a grayish-brown weathering rind. Red station location indicates outcrop or boulders of diabase.

**Zmi** - **Porphyritic mafic intrusive**: Grayish-green to dark-green, very hard, plagioclase porphyritic mafic rock. Greenish-white, euhedral, plagioclase phenocrysts (up to 8 mm) and black amphibole/pyroxene? phenocrysts (up to 2 mm) are present in a green and yellow mottled, very fine-grained (less than 1 mm) matrix. Typically weathers to rounded boulders and outcrops. The plagioclase phenocrysts weather in positive relief, creating a distinctive bumpy or pustulate surface. Newton (1983) identified this unit as an amphibole-porphyry lamprophyre dike.

**Zgr-di** - **Granite to diorite**: Composite pluton exhibiting a variety of rock types ranging from granite to diorite. Lithologies include grayish pink, medium- to coarse-grained granite; pinkish-white, medium-grained hornblende granodiorite; and dark-gray, fine- to coarse-grained diorite.

**Zgd** - **Granodiorite**: Exhibits a variety of colors and textures ranging from yellowish-gray to grayish-white, medium- to coarse-grained hornblende granodiorite; contains dark-gray to light gray, fine to coarse-grained diorite.

**Zgd-fine** - **Fine-grained granodiorite**: Light-gray to green; ranges from equigranular fine-grained (less than 1 mm) granodiorite to very fine-grained porphyritic granodiorite with plagioclase phenocrysts (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.

**Zgd-leuco** - **Fine-grained leucocratic granodiorite**: Small pods of tan to light-gray, fine-grained (less than 1 mm), leucocratic granodiorite. Mafics present in rock are commonly biotite clusters up to 1 mm in diameter. Plagioglase mineral grains have a light greenish tint from epidote growth.

**Zagd-fine** - **Fine-grained altered granodiorite**: Light-green, fine-grained (less than 1 mm), altered intrusive rock interpreted as a granodiorite. Rock is primarily a fine-grained mass of heavily saussuritized plagioclase and quartz with no visible mafic minerals in hand sample. Unit occurs as angular boulders in two small map bodies.

**Zgd-gb** - **Granodiorite to gabbro**: Composite pluton of dominantly medium-grained, hornblende granodiorite; lesser amounts of medium-grained hornblende diorite, plagioclase porphyritic granodiorite, fine-grained granodiorite, and diorite; minor amounts of fine-grained gabbro. Fine-grained granodiorite and diorite are typically green in hand sample from sausseritization of plagioclase. Hornblende is typically altered to chlorite and actinolite masses.

**Ztgd** - **Tonolitic granodiorite**: Small stock of distinctive, white to light gray, medium-grained leucocratic tonolitic granodiorite. Quartz content is greater than 15%. Mafics present in rock are most commonly biotite. Weathering of rock produces a very coarse sand.

**Zdi** - **Diorite**: Greenish-gray to gray, medium-grained, equigranular, hornblende diorite. Major minerals include plagioclase and hornblende. Greenish-white plagioclase crystals compose up to 50% of the rock and are typically sericitized and saussuritized. Hornblende is typically altered to chlorite and actinolite masses.

**Zdi/gd** - Composite pluton of dominantly medium-grained hornblende diorite; lesser amounts of medium-grained hornblende granodiorite, fine-grained granodiorite, porphyritic diorite with plagioclase phenocrysts; minor amounts of porphyritic granodiorite with plagioclase phenocrysts.

**Zdi-fine** - **Fine-grained diorite**: Small plutonic bodies of green, very fine-grained diorite. The rock is green in hand sample from saussuritization of plagioclase.

### Metavolcanic Units

**Zat** - **Altered tuffs**: Very light-gray, light-greenish-gray to white, mottled red and yellow, altered, tuffs. Alteration of felsic tuffs have produced sericite-quartz phyllite, pods of pyrophyllite, and quartz + pyrophyllite rock; all with common less than 1 mm to 2 mm diameter cubic pyrite aggregates and goethite-lined molds of pyrite crystals. Fine-grained porphyoblasts of chloritoid (less than 1 mm) and andalusite (up to 4 mm) are present in some pyrophyllite bearing rocks. Relict lithic clasts and kaolinitized feldspar crystal shards are visible in some outcrops. Relict structures are obliterated in heavily altered rocks. A steep hill, west of Occoneechee Mountain, is capped with a well-bedded, nodular, siliceous sinter mixed with pyrophyllite and massive quartzite-like rock interpreted to be a hydrothermal deposit.

**Ze/p** - **Mixed epiclastic-pyroclastics**: Grayish-green to greenish-gray; tuffaceous sandstones, conglomeratic sandstones, siltstones and minor phyllite. The siltstones typically are weakly phyllitic. Unit contains lesser amounts of coarse tuff and lapilli tuff. Abundant silicified and/or sericitized altered rock similar to Zat unit is present near contacts with plutonic rocks.

**Ze** – **Epiclastics**: Mixed unit of metasedimentary rocks. Lithologies present include mudstone, siltstone, sandy siltstone, sandstone, pebbly sandstone, and conglomerate. Mudstones are greenish-gray to gray, typically silicified, with continuous, parallel to slightly wavy, very thin to medium lamina occasionally with small-scale loading structures. Siltstones are light green-gray to gray, with continuous, parallel to slightly wavy, thin lamina to very thin beds, occasionally with small-scale loading structures. The 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. Textures range from fine-grained, and well sorted to very coarse-grained, and moderately poorly sorted. Bedding in the sandstones is continuous, parallel to inclined, thin lamina to thin beds; also massive bedding and cross-beds are present. Individual beds are sometimes graded from sand-size to silt-size with abrupt upper surfaces. Conglomerates include matrix supported and clast supported polymictic conglomerate composed of angular to rounded, pebbles to large cobbles (up to 30 cm). Conglomerates are generally massive bedded, rarely with any imbrication of the clasts. Clast types include: dark-gray to gray, angular to subangular, microcrystalline volcanic rock fragments; black, subangular to subrounded, plagioclase-porphyritic dacite; black to dark gray, subrounded, flow-banded dacite; and greenish-gray to grayish-green, rounded to well rounded, fine to coarse plagioclase crystal tuff. Rare clast types include: white, subangular to rounded, granite and granodiorite (up to 12 cm); dark-brown, rounded, vesicular basalt (up to 2.5 cm); and gray, angular siltstone (up to 25 cm). Sandstone and conglomerate beds often fill scour channels in the siltstones. Metasedimentary units are interpreted to be correlative with the Aaron Formation of Glover and Sinha (1973). The Aaron Formation has been interpreted as a submarine-fan deposit in a deep marine basin marginal to or superimposed on a formerly active volcanic arc (Harris, 1984).

**Zft-e** - **Felsic tuff of the Efland area**: Light-green to grayish-green and greenish-gray to gray; massive to strongly foliated; fine to coarse felsic tuffs. Coarse plagioclase crystal tuff, and welded tuffs are common with lesser amounts of lapilli tuff with clasts up to 12.5 cm. Interlayers of tuffaceous sandstones are locally present.

**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.

**Zft-d** - **Felsic tuffs of the Duke quarry area**: Unit consists of massive to strongly foliated: greenish-gray to grayish-green, coarse plagioclase crystal tuff; light-green, welded, lapilli-bearing, plagioclase + quartz crystal tuff; greenish-gray to grayish-green, matrix supported lithic tuff; and gray microcrystalline ash tuff with pyrite. Minor lithologies include interlayers of amygdaloidal basalt, fine-grained mafic tuffs that have been altered to epidote/chlorite, and epiclastic rocks.

In the Duke quarry area the unit is characterized by foliated phyllitic tuffs, matrix supported lapilli tuff, tuffaceous sandstone, and siltstones. Relict sedimentary structures preserved in the Duke quarry area include lamina and beds, small-scale load structures, and normally graded bedding. Lithic clasts display an apparent flattening parallel to foliation and are commonly altered to quartz and sericite. Chloritoid porphyroplasts are locally present. Southwest of Duke quarry, in the Carrington Farm and Chestnut Ridge Church area, the rocks are strongly foliated, dark gray, very resistant, with or without apparently flattened clasts, siliceous phyllites. All primary structures have been obliterated.

**Zdlt** - **Dacitic lavas and tuffs**: Distinctive dark-gray to black, siliceous, cryptocrystalline dacite, porphyritic dacite with plagioclase 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. Welded lapilli tuff often contains black-colored fiamme, up to 10 cm, interpreted as flattened pumice and coarse plagioclase crystal fragments. Massive, matrix supported lithic tuff contains angular to rounded, polymictic clasts up to 8 cm. Clast types include: gray and green, microcrystalline to coarse-grained volcanic rock fragments; black porphyritic lava with plagioclase phenocrysts; and black flow-banded dacite. Minor interlayers of microcrystalline ash tuff are present. Small map-scale bodies of mafic tuff and lava; coarse-grained, cross-bedded, litharenite sandstone; and polymictic, pebble and small cobble conglomerate are present in unit. 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.

**Zablt** - **Andesitic to basaltic lavas and tuffs**: Green, gray-green, black; amygdaloidal basalt, porphyritic basalt with plagioclase phenocrysts, porphyritic basalt with amphibole/pyroxene phenocrysts, and microcrystalline basalt. Tuffs associated with the lavas include: coarse plagioclase crystal tuff, with suassseritized pale green, angular to subrounded plagioclase crystal fragments (up to 3 mm) in a fine-grain matrix of epidote and chlorite; coarse amphibole/pyroxene crystal tuff with black, prismatic amphibole/pyroxene crystal fragments (up to 3 mm) in a fine-grain matrix of epidote and chlorite. Rounded weathering patterns of outcrops and amoeboid shaped structures in outcrop of some mafic lavas are interpreted as possible pillow structures. Basalts are interpreted to be lava flows or shallow intrusions.

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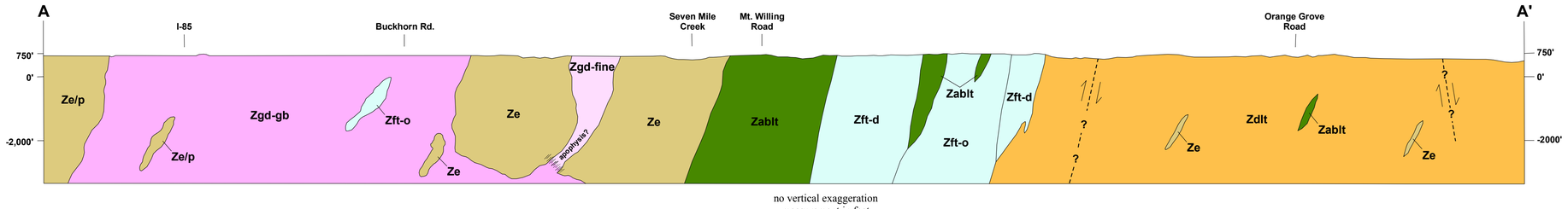


no vertical exaggeration
measurement in feet
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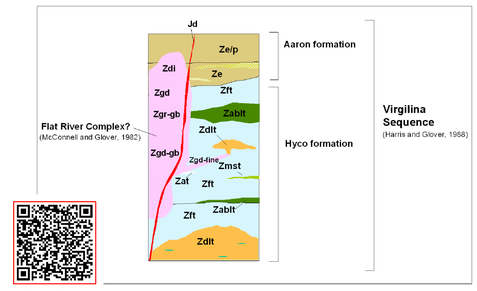


*Scan with smartphone for link to GeoPDF of map. Third party App required.*

Schematic representation of relationships of geologic units in the Efland quadrangle

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