BEDROCK GEOLOGY OF THE ZEBULON 7.5-MINUTE QUADRANGLE, FRANKLIN, JOHNSTON, NASH, AND WAKE COUNTIES, NORTH CAROLINA

by

P. Albert Carpenter III

North Carolina Geological Survey
512 North Salisbury Street
Raleigh, NC 27604-1148

Robert H. Carpenter

North Carolina Geological Survey
512 North Salisbury Street
Raleigh, NC 27604-1148

J. Alexander Speer

Mineralogical Society of America
1718 M Street, N. W.
Washington, DC 20036

Edward F. Stoddard

Department of Marine, Earth and Atmospheric Sciences
North Carolina State University
Raleigh, NC 27695-8208

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ABSTRACT

The Zebulon 7.5-minute quadrangle includes portions of Franklin, Johnston, Nash, and Wake Counties. It is located in the east-central portion of the Raleigh 30 X 60-minute quadrangle.

The western two-thirds of the quadrangle is underlain by the Rolesville batholith, a composite Alleghanian intrusive ranging in age from 298 to 312 Ma. The Rolesville batholith in the Zebulon quadrangle consists of four medium to coarse grained granitoids that are distinguished on the basis of texture, mineralogy, and chemical composition.

Two geologic belts that can be distinguished by regional metamorphic grade comprise the eastern one-third of the quadrangle. The western of these belts consists mainly of amphibolite-grade biotite and muscovite gneiss. These rocks are considered to be equivalent to 620 Ma biotite gneiss exposed along Mill Creek in the Flowers 7.5-minute quadrangle, and to Raleigh gneiss exposed on the west side of the Rolesville batholith. The eastern of the two belts consists of greenschist-grade metavolcanic and metasedimentary rocks of the Eastern slate belt. A preliminary discordant Pb/Pb age of 590 Ma has been determined for an equivalent quartz-feldspar crystal tuff unit in the Bunn East quadrangle. Near the margin of the Rolesville batholith, garnet, staurolite, and sillimanite have been identified in metamorphic rocks. This suggests local contact metamorphic overprinting associated with intrusion of the Rolesville batholith.

The Zebulon quadrangle lies between the Wake-Warren antiform to the west and an antiform whose axis lies just east of the quadrangle. Within the quadrangle, this study identifies a synform whose axial trace lies at the center of a metasedimentary unit (argillite) in the Eastern slate belt. Based on the contrast of metamorphic grade between the gneisses and low-grade metavolcanic and metasedimentary units, and evidence of shearing along the contact, we propose that these two units are separated by a thrust fault. Additional studies are required to

confirm this. Although previous studies suggest that these units belong to different structural blocks or terranes, recent geochronological and geochemical data indicate that both units probably belong to the Carolina terrane. Differences are attributed to crustal levels of origin and/or tectonothermal overprinting.

Unconsolidated Tertiary sediment, consisting of sand, gravel, and clay, covers older crystalline rocks. These sediments formerly covered most, if not all, of the quadrangle shortly after they were deposited. However, they have been largely eroded away. Remnants are best preserved at higher elevations along stream divides.

No mines or quarries are active in the Zebulon quadrangle. Rolesville granite was quarried for crushed stone about one mile east of Wendell at the Rockton Quarry from the early 1920's to about 1950. Manganese oxide minerals in the argillite unit were prospected by two companies during the 1940's.

INTRODUCTION

The Zebulon 7.5-minute quadrangle includes portions of Franklin, Johnston, Nash, and Wake Counties (fig. 1). It is located in the east-central portion of the Raleigh 100K quadrangle. Previous geologic mapping by Parker (1979) delineated rock units in the Wake County portion of the quadrangle. Wilson and Carpenter (1975) carried out reconnaissance geologic mapping in Wake and Johnston Counties and McDaniel (1980) conducted reconnaissance geologic mapping in Franklin County.

Geologic mapping in the Zebulon quadrangle was conducted as part of a cooperative effort (COGEOMAP and STATEMAP) between the North Carolina Geological Survey and the U. S. Geological Survey. Field mapping at the 1:24,000 scale is being compiled into a 1:100,000-scale geologic map compilation of the Raleigh 100K quadrangle. Delineation of rock units and structural features of the quadrangle should assist future planning and assessments such as: 1) location of adequate sites for municipal landfills or hazardous waste disposal; 2) planning for highway construction, 3) evaluation of groundwater resources; 4) general construction site assessments; and 5) exploration for mineral resources.

LITHOLOGIC UNITS

Metamorphic Rocks

Regional stratigraphic relationships for the Eastern slate belt are summarized by Carpenter and others (1995). Two geologic belts comprise the eastern one-third of the quadrangle. The western, a stratigraphically lower belt, consists mainly of

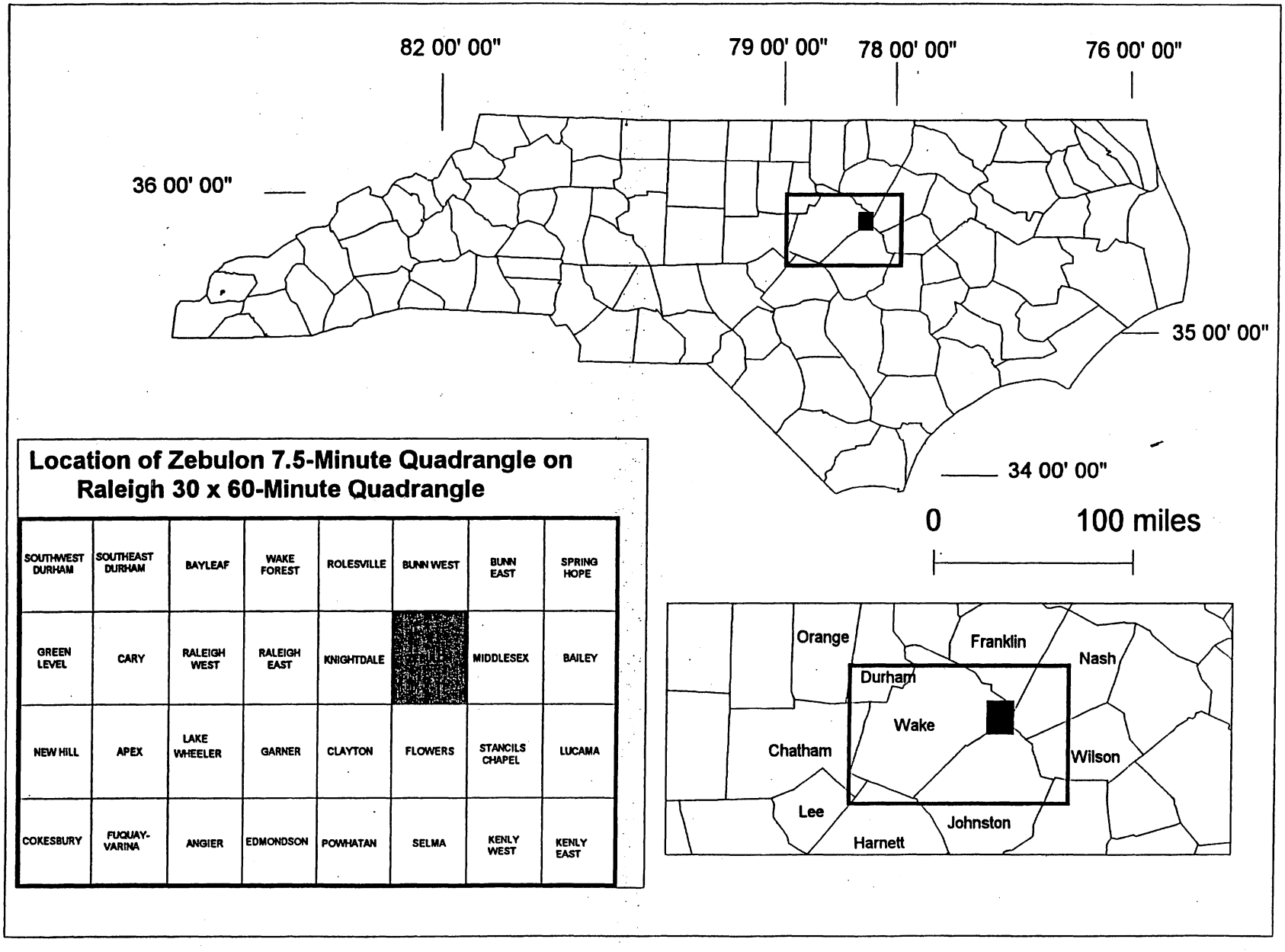

Figure 1. Location of the Zebulon 7.5-Minute Quadrangle in the Raleigh 30 x 60-Minute Quadrangle

biotite and muscovite gneiss. These rocks are considered to be equivalent to 620 Ma biotite gneiss exposed along Mill Creek in the Flowers 7.5-minute quadrangle, and to Raleigh gneiss exposed on the west side of the Rolesville batholith. The eastern, and stratigraphically upper belt, consists of metavolcanic and metasedimentary rocks of the Eastern slate belt. A preliminary discordant Pb/Pb age of 590 Ma has been determined for an equivalent quartz-feldspar crystal tuff unit in the Bunn East quadrangle .

Amphibolite-grade gneiss and schist

Quartzofeldspathic Gneiss

A band of quartzofeldspathic gneiss occurs along the eastern margin of the Rolesville batholith in the Zebulon quadrangle. It is fine to medium grained, and light gray to gray in color. It is composed primarily of quartz, plagioclase, potash feldspar, biotite, and muscovite. Locally, biotite is absent where the gneiss is leucocratic and fine-grained. Locality 7 (plate 1) is a strongly foliated quartzofeldspathic rock with sparse biotite and opaque minerals. Pegmatite and granite dikes, probably derived from differentiation of the Rolesville batholith, occur west of NC Highway 96 (locality 6, plate 1). Outcrop and float of gneiss and schist along Little River, east of NC Highway 96, show contact metamorphic effects from the granite. Thin sections of these rocks contain staurolite, garnet, and tourmaline, and biotite retrograded to chlorite. Sillimanite was tentatively identified in other samples collected in this area.

The quartzofeldspathic gneiss was mapped by Parker (1979) for the Wake County portion of the Zebulon quadrangle. Our mapping agrees with his delineation of this unit. Comparable gneisses are reported to occur on the west side of the Rolesville granite (Parker, 1979) and are included in the Raleigh terrane by Farrar (1985), and Stoddard and others (1991). We consider these rocks to be equivalent to 620 Ma biotite gneiss exposed along Mill Creek in the Flowers 7.5-minute quadrangle (Goldberg, 1994). Based on both geochronological and geochemical evidence, Stoddard and others (1996) conclude that these gneisses belong to the Carolina terrane and are equivalent to rocks in the Carolina slate belt.

Greenschist-grade rocks of the Eastern Slate Belt

Regional stratigraphic relationships for the Eastern slate belt have been summarized by Carpenter and others (1995). A sequence of metavolcanic rocks is overlain by a sequence of metasedimentary rocks. Both of these sequences are exposed in the Zebulon quadrangle.

Metavolcanic rocks

Metavolcanic rocks include quartz-feldspar crystal tuff and phyllite. Crystal

tuffs are dense, medium-grained, and light gray in color, with phenocrysts of plagioclase , and locally quartz, up to 1 mm in size. Faint bedding is locally present. These rocks are exposed along Moccasin Creek and its tributaries (localities 2 and 3, plate 1). A thin section from locality 2 consists of plagioclase and potassium feldspar in equal proportions, with quartz, muscovite, and biotite in decreasing order of abundance.

Phyllite is fine grained and white to light-gray in color and composed primarily of muscovite and quartz. Phenocrysts of quartz are present locally as well as black opaque minerals. East of NC Highway 39 (locality 4, plate 1) the phyllite contains interbeds of chlorite phyllite and a chlorite-epidote rock, probably representing interbedded mafic to intermediate metavolcanic rocks. The phyllite is interpreted as hydrothermally altered (sericitized) felsic volcanic rock.

Metasedimentary rocks

This unit contains both laminated argillite and massive siltstone. These rocks are fine grained, and dark to light gray in fresh outcrops, but varying shades of tan and brown in weathered exposures. Laminated argillite consists of thin mica-rich layers which alternate with thicker quartzose layers. Crenulations are conspicuous in the phyllitic layers. Fresh dark gray exposures appear to contain fine disseminated graphite. Massive siltstone is somewhat coarser, and lacks the mica-rich layers. Most exposures of the metasedimentary rocks are deeply weathered to reddish or yellowish clay saprolite. Leisegang banding is common. An outcrop of fresh argillite on NC Highway 97 east of Moccasin Creek (locality 1, plate 1) consists mainly of alternating mica-rich and quartz rich layers. Chlorite, chloritoid, tourmaline, zircon, monazite (?), and opaque minerals are also present.

Intrusive Rocks

Rolesville batholith

The Rolesville batholith is a composite body composed of granitoids differing in mineralogy, texture, modal composition, or combinations of these characteristics (Speer, 1994). In the Zebulon quadrangle, four granitoid lithologies were observed but not mapped separately on plate 1.

Rolesville granitoid

The Rolesville granitoid is a pinkish gray, medium- to coarse-grained biotite monzogranite. It varies in appearance as a result of the range in both color index, from 2 to 10, and of grain size, as well as the presence or absence of subhedral, moderate orange pink alkali feldspar megacrysts up to 3 cm long. Foliation is generally absent in the Rolesville granitoid in the Zebulon quadrangle. Enclaves

within the Rolesville batholith are rare, but biotite gneiss and biotite amphibolite xenoliths are present at locality 14 (plate 1).

Outcrops of Rolesville granitoid are scattered throughout the quadrangle with some large pavement outcrops. This rock type dominates the Rolesville batholith in the Zebulon quadrangle. The largest pavement is located on the south bank of a tributary of Little River crossing SR 2329 on the northwestern border of the Zebulon quadrangle (locality 8, plate 1). The pavement extends into the adjacent Knightdale quadrangle. This pavement was prospected for crushed stone, but now is "The Rocks Preserve" managed by the Triangle Land Conservancy.

Archers Lodge granitoid

The Archers Lodge granitoid in the Zebulon quadrangle is a coarse-grained biotite granite with moderate orange pink K-feldspar megacrysts up to 3 cm long. The Archers Lodge granitoid has very limited occurrence in the Zebulon quadrangle. It occurs as enclaves in the Rockton Quarry (locality 9, plate 1) and at the edge of the Rolesville batholith adjacent to NC Highway 96 near the southern border of the quadrangle (locality 10, plate 1). At both locations the Archers Lodge granitoid is intermixed with rocks of the Rolesville granitoid, suggesting that the Archers Lodge granitoid may occur only as enclaves within the Rolesville granitoid.

Wakefield granitoid

The Wakefield granitoid occurs in the vicinity of Wakefield in the north-central portion of the Zebulon quadrangle (locality 12, plate 1). It is a massive, medium-grained, equigranular biotite ± muscovite granite with a grain size range smaller than Rolesville granitoid.

Mafic granitoid

The mafic granitoid is a massive, medium dark-gray granodiorite. The rock is medium grained, with an average grain size of between 1 and 2 mm, and a few alkali feldspar megacrysts up to 1 cm. The mafic minerals are amphibole + biotite and the color index is 20. Other varietal minerals include muscovite, epidote, and titanite. This granitoid was found at only one location: where NC Highway 96 crosses Little River at the southern boundary of the Zebulon quadrangle (locality 10, plate 1). This is at the contact of the Rolesville batholith with biotite gneiss.

Diabase

North- to slightly northwest-trending dikes are composed of fine-grained, dense, black to greenish-black diabase. Although exposures of diabase are generally poor, linear magnetic anomalies on aeromagnetic maps indicate there are more dikes than can be mapped at the surface.

Unconsolidated Sediments

Alluvium

Unconsolidated clay, silt, sand, and gravel occur as flood plain deposits along streams and rivers throughout the quadrangle. The widest alluvial deposits are associated with Moccasin Creek and Little River.

Coastal Plain Sediments

Unconsolidated sedimentary rocks of the Coastal Plain cover higher elevations in the Zebulon quadrangle. Thickness is generally less than 10 meters. Unconsolidated sediments consist locally of coarse clayey sands. Basal layers of gravel are present in some areas. The sands are generally present above 290 to 300 feet south of Zebulon and above 320 feet in the vicinity of Wakefield.

The Coastal Plain Office of the North Carolina Geological Survey is conducting a detailed geomorphic and subsurface study of the Coastal Plain in the eastern half of the Raleigh 30 X 60-minute quadrangle as part of the STATEMAP program. That study will evaluate Coastal Plain units throughout the Zebulon and other quadrangles and will be incorporated into revised maps.

STRUCTURE

The area lies between the Wake-Warren antiform to the west (Parker, 1979; Farrar, 1985), and an antiform whose axis lies just east of the Zebulon quadrangle (Farrar, 1985). The dominant structural fabric in the Zebulon quadrangle is a N 0° E to N 30° E foliation that parallels the trend of the rock units. The foliation dips steeply, primarily to the southeast, but some dips are northwest. The northeast trend parallels the eastern contact of the Rolesville batholith, and also parallels the axis of a synform whose axial plane trace lies in the center of the metasedimentary unit in the eastern part of the quadrangle. This synform has not been previously recognized. A crenulation cleavage is locally present that trends N 5° E to N 35° E. Bedding in the metasedimentary rocks parallels the strike and dip of the regional foliation.

We propose that a thrust fault separates the quartzofeldspathic gneiss from rocks of the Eastern slate belt. Principal evidence for the fault is the apparent break in metamorphic grade between coarse-grained gneisses and fine-grained phyllites. At locality 11 (plate 1) a small creek crosses the contact between biotite gneiss and muscovite phyllite. Both rock types are highly sheared and contain thin, quartzose, locally tourmaline bearing layers that are interpreted to be silicified mylonite. If a thrust fault is present, it probably corresponds to the D2 thrust fault recognized by Farrar (1985) in the eastern Piedmont. Further investigation of this contact is

needed to substantiate the existence of a thrust fault.

MINERAL RESOURCES

No mines or quarries are currently active in the Zebulon quadrangle. Rolesville granite was quarried for crushed stone about one mile east of Wendell at the Rockton Quarry from the early 1920's to about 1950 (Parker, 1979). Manganese oxide minerals in the argillite unit, formed by weathering of spessartine garnet, were prospected by two companies during the 1940's (Parker, 1979). The U.S. Bureau of Mines drilled the site in 1944 and 1945 (Thompson, 1950), but the deposit was too small for commercial production. No evidence of the deposit was seen during the current mapping but it is in the vicinity of locality 13 (plate 1).

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