GEOLOGY OF THE STANCILS CHAPEL 7.5-MINUTE QUADRANGLE, JOHNSTON, NASH, AND WILSON COUNTIES, NORTH CAROLINA

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DIVISION OF LAND RESOURCES
DEPARTMENT OF ENVIRONMENT, HEALTH
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CONTENTS

ILLUSTRATIONS

GEOLOGY OF THE STANCILS CHAPEL 7.5-MINUTE QUADRANGLE, JOHNSTON, NASH, AND WILSON COUNTIES, NORTH CAROLINA

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ABSTRACT

Two metamorphosed rock sequences of late Precambrian or early Cambrian age underlie most of the Stancils Chapel 7.5-minute quadrangle. A lower sequence of metavolcanic rocks is stratigraphically overlain by a sequence of fine-grained metasedimentary rocks. Prior to intrusion of the Sims pluton during the Pennsylvanian period, these rocks were deformed and metamorphosed to chlorite grade. Earliest folds (F_1) are at outcrop scale. The axes of two regional-scale F_2 folds are located within the quadrangle. These are the Smithfield synform, whose axis is located in the east central portion of the quadrangle, and an unnamed antiform, whose axis is located in the northwest corner of the quadrangle.

The Sims pluton, located in the northeast corner of the quadrangle, is dated at 287 ± 9 Ma and intruded during the Alleghanian orogeny. It is a composite pluton consisting of a megacrystic phase (Conner granitoid) and an equigranular phase (Sims granitoid). Only the Conner phase crops out in the Stancils Chapel quadrangle.

The metasedimentary and metavolcanic rocks are overlain by Coastal Plain sediments. These Coastal Plain sediments consist of an upper and lower unit. The lower unit consists of medium to coarse sands and gravels. They are poorly sorted, and sand grains are generally angular to subangular in shape. Sands of the overlying upper unit are finer grained, better sorted, and show greater rounding of

quartz grains.

No mines or quarries are currently active in the Stancils Chapel quadrangle. The Sims granitoid is currently quarried for crushed stone near the town of Sims (outside the Stancils Chapel quadrangle). A large reserve of heavy minerals (ilmenite, rutile, and leucoxene) is located south of Bailey, North Carolina, in Coastal Plain sediments. A portion of the deposit is located in the northeast corner of the quadrangle. Other mineral occurrences and/or geologic mineral anomalies include molybdenum, copper, mica, and gold.

INTRODUCTION

Geologic mapping in the Stancils Chapel quadrangle was conducted as part of a cooperative effort (COGEOMAP) 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 30 X 60-minute quadrangle. Delineation of rock units and structural features of the quadrangle should assist future planning and assessments such as the following: 1) location of adequate sites for municipal landfills or hazardous waste disposal; 2) planning for highway construction, 3) evaluation of ground-water resources; 4) general construction site assessments; and, 5) exploration for mineral resources.

The Stancils Chapel 7.5-minute quadrangle includes portions of Johnston, Nash, and Wilson Counties (fig. 1). It is located in the east-central portion of the Raleigh 30 X 60-minute quadrangle. Crystalline rocks in the quadrangle are deeply weathered and covered extensively by Coastal Plain sediments. The best exposures of fresh rocks are in stream valleys.

Northeast-trending metavolcanic and metasedimentary rocks of the Eastern slate belt underlie a thin veneer of Coastal Plain sediments. The metamorphic rocks are exposed primarily in outcrops along streams that have cut through the cover sediments. Some of the best outcrops of crystalline rock are along Moccasin Creek in the northern portion of the quadrangle (plate 1), and along Little River in the southwest corner of the quadrangle (plate 1). Other crystalline rock exposures occur in smaller drainages and in roadcuts.

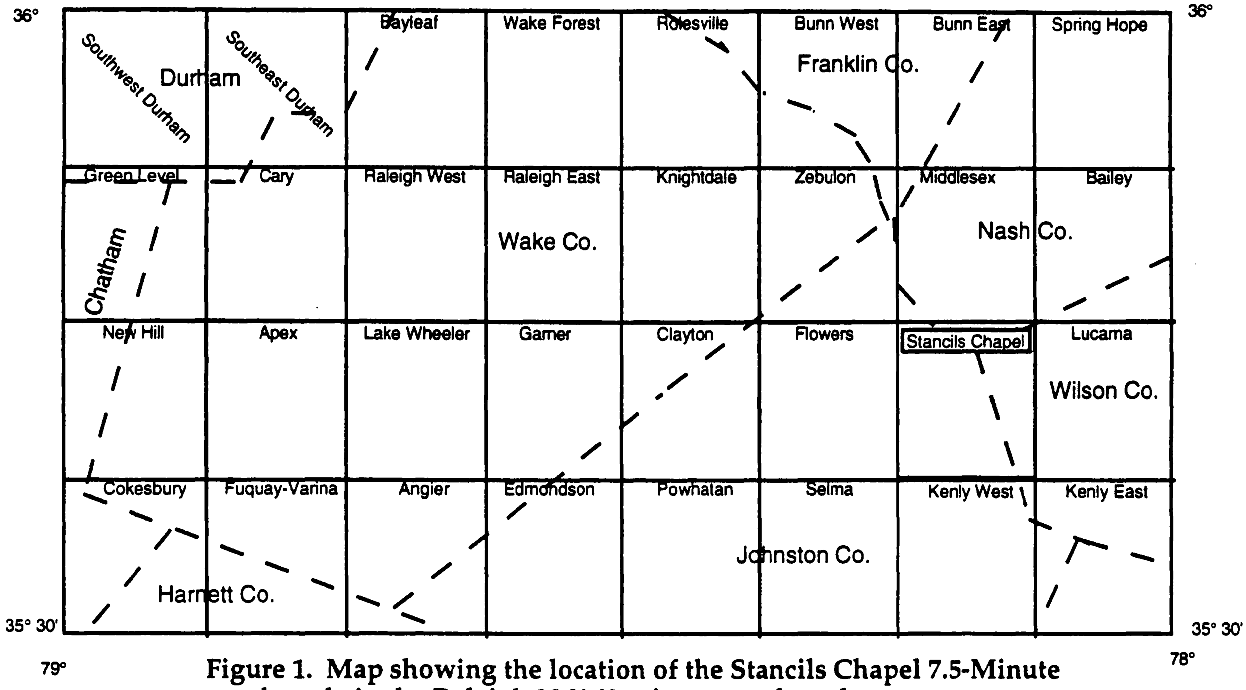

Figure 1. Map showing the location of the Stancils Chapel 7.5-Minute quadrangle in the Raleigh 30 X 60-minute quadrangle.

The Sims pluton is exposed in the northeast corner of the quadrangle north of Buckhorn Reservoir (plate 1). Both pavement outcrops and boulder occurrences are present in this area.

Diabase dikes are common in the Eastern slate belt. On the Stancils Chapel quadrangle, however, diabase was found only as a single boulder in the southwest corner of the quadrangle west of Little River (plate 1).

Coastal plain units cover most of the quadrangle. More detailed studies are being conducted to refine the understanding of the stratigraphic framework for the Coastal Plain sedimentary units in the Raleigh 1:100,000 quadrangle. These studies will combine surface and subsurface geologic information to aid in delineating the Coastal Plain units.

PREVIOUS INVESTIGATIONS

Previous geologic maps of this area are only of reconnaissance scale (i.e., smaller than 1:100,000). Parker (1968) compiled a reconnaissance map of the eastern Piedmont and divided the metamorphic rocks into high- and low-rank rocks on the east flank of the Wake-Warren anticlinorium. Wilson and Carpenter (1975) compiled the geology of Region J, which included Johnston County, at a scale of 1:125,000. This mapping was primarily a compilation of existing mapping supplemented by geologic mapping of road cut exposures. Reconnaissance geologic maps of Wilson and Nash Counties at a scale of 1:125,000 were prepared by Wilson (1979) and by Wilson and Spence (1979), respectively. Detailed soil mapping for Johnston County was completed in 1986 by the U. S. Department of Agriculture, Soil Conservation Service (unpublished). Soil survey reports and maps are available for Nash County (Allison, 1989) and Wilson County (Sink, 1983).

Farrar (1985a, 1985b) proposed a tectonic and lithostratigraphic interpretation of the region based on reconnaissance mapping of the northeastern North Carolina Piedmont. Stoddard and others (1991) presented a modified interpretation of the Eastern Piedmont. Tectonic models (Farrar, 1985b; Stoddard and others, 1991) for the Eastern Piedmont involve thrusting of the metavolcanic/metavolcaniclastic/meta-sedimentary sequence (Carolina slate belt and the Eastern slate belt) onto older basement (the Raleigh belt). The thrust that separates slate belt rocks from basement is Farrar's (1985b) D_2 decollement. Locally, it has been folded and is crosscut by granitoid bodies similar in age to the Pennsylvanian age Sims pluton. D_2 thrusting occurred prior to the Alleghanian orogeny and may have been related to the Taconic orogeny (Middle Ordovician). In the Stancils Chapel quadrangle, only the Eastern slate belt sequence is exposed.

The eastern Piedmont is also cut by steeply dipping, regional-scale D_3 shear zones that strike approximately N10°E with dextral kinematic indicators. One of these, the Hollister mylonite zone, lies about ten kilometers east of the Stancils Chapel quadrangle, where it has been interpreted to separate two different blocks of volcanogenic rocks (Farrar 1985a, 1985b).

Horton and others (1989) divided the eastern Piedmont, along with all of the central and southern Appalachians, into tectonostratigraphic terranes. These terranes, which are separated by D_2 and D_3 faults, are distinguished by differences in their lithologic types and intrusive, structural, and metamorphic history. The Stancils Chapel quadrangle lies within their Spring Hope terrane.

LITHOLOGIC UNITS

Metamorphic Rocks

Metamorphic rocks in the Stancils Chapel quadrangle consist of a lower sequence of metavolcanic rocks and an upper sequence of metasedimentary rocks. The lower sequence includes portions of Farrar's Spring Hope and Stanhope formations. The upper sequence corresponds to the Smithfield formation of Farrar (1985). Both sequences are considered to be of Late Proterozoic or early Cambrian age. The principal metamorphic event (M_1) affecting these rocks occurred during the Taconic orogeny (Farrar, 1985b). Metamorphic grade is within the greenschist facies (chlorite and biotite zones).

Metavolcanic Sequence

Metavolcanic units in the Stancils Chapel quadrangle are subdivided into a lower and upper group based on characteristic texture and mineralogy of unaltered metavolcanic rocks. The lower group consists of relatively coarse vitric and crystal-vitric tuffs (qft) and laminated epiclastic rocks and felsic lithic-crystal (ls) tuffs. Minor quantities of fine muscovite flakes are disseminated in the quartzo-feldspathic matrix, but phyllite occurrences are rare in felsic crystal tuff. Goldberg (1994) reported a discordant zircon age of 590±3 Ma for these metavolcanic rocks in the Bunn East quadrangle. The upper group of unaltered felsic metavolcanic rocks is aphanitic and texturally similar to the Princeton volcanics and felsic volcanic rocks informally termed bluestone (Stoddard, 1991) that occur elsewhere in the Eastern slate belt. Zircon from the "Princeton volcanics yielded a preliminary Pb/Pb age of 544 Ma. (Horton and Stern, 1994). The upper volcanic group is extensively sericitized and locally silicified. Thin intermediate (cms1) to mafic (cms2) metavolcanic units are present in the upper group (plate 1).

Lower metavolcanic group

The lower group of metavolcanic rocks is exposed in the northwestern portion of the quadrangle. Saprolite of felsic quartz crystal tuff (qft) is present at locality 1(plate 1) where the saprolite is massive and lacks stratification or foliation. Small, equant quartz phenocrysts (0.5 mm) occur in a matrix of fine quartz and clay, along with minor concentrations of fine, disseminated muscovite and black opaques. Northwest of locality 1 (plate 1), a saprolite exposure along SR 2106 on the adjacent Flowers quadrangle (fig. 1) consists of similar crystal tuff in which quartz phenocrysts are consistently 2-4 mm in size. Feldspar phenocrysts, where present, are not discernible in the clay-rich saprolite.

Laminated lithic and lithic-crystal tuffs (ls) are exposed at Localities 2 and 5 (plate 1). At locality 2, these rocks are weathered to a clay-rich saprolite, which locally has a phyllitic character. Laminations and bluish quartz phenocrysts, however, are prominent in the saprolite. Fresh boulders and outcrops of this unit are exposed at locality 5 in a number of small pits. According to local landowners, these rocks were excavated for use as footings, fireplaces, and chimneys in early home construction in this area. At locality 5, the foliation is formed by flattened clasts of fine-grained quartz and feldspar in a matrix that contains a higher content of muscovite. Foliation is defined by alignment of mica flakes and 1-2 mm-thick flattened clasts which commonly exceed 5 cm in length. They are interpreted to represent flattened pumice lapilli. Equant quartz phenocrysts 3-4 mm in size are also common. Some masses of mica are stained red, probably from iron oxide formed by the weathering of pyrite.

Upper metavolcanic Group

This unit consists mainly of felsic volcanics with interbedded meta-andesite (cms1) and metabasalt (cms2). The felsic unit consists of several lithologies based on outcrop and thin section analyses. These include the following:

1. Unaltered vitric and vitric-crystal tuffs (ffv) characterized by the assemblage quartz + plagioclase + potassium feldspar which comprises an aphanitic groundmass.

2. Sericitized tuffs in which feldspar has been replaced by muscovite. The dominant assemblage is muscovite + quartz. Minor amounts of chlorite and black opaque minerals are common. These rocks are typically fine-grained, light-gray- to

silvery, crenulated, sericite phyllites (ph).

3. Sericitized and silicified tuffs (sp). These rocks are similar to the sericite phyllites (ph), but contain more quartz and less muscovite. Chloritoid and pyrite are common accessory minerals. Gold and possibly base metal mineralization is associated with this lithology.

The basal unit of the upper group consists of sericitized volcanic rock (qxp) comprised of flattened quartz phenocrysts in light-gray, crenulated, sericite phyllite (Localities 3 and 4, plate 1). Locality 4 is a pile of well cuttings adjacent to a domestic well. At both localities, flattened quartz phenocrysts, 2-3 mm in maximum length, occur along the foliation. The length-to-thickness ratio of the quartz phenocrysts is approximately 2 to 1. Phyllite (ph) overlying this unit is of similar lithology, but lacks quartz phenocrysts.

Basal phyllites (qxp and ph) are overlain by an intermediate mafic rock consisting of actinolite, epidote, quartz, and untwinned plagioclase. It is interpreted as an andesitic metatuff (locality 13, plate 1). Saprolite along strike tends to be mainly chlorite schist.

Along Moccasin Creek (plate 1), andesitic metatuff is overlain by siliceous phyllite (sp) which contains several concordant lenses of massive quartz. At locality 14 (plate 1), a quartz lens is approximately 50-feet thick and contains pseudomorphs of limonite-after-pyrite which exceed 5 cm in size. In the small stream located west of locality 14 (plate 1), chloritoid has been identified in sericite phyllite exposures, and panned concentrates of stream sediment consistently contain 8-11 flakes gold per pan. Throughout the area, massive quartz lenses in the siliceous phyllite (sp) contain inclusions of green muscovite phyllite.

At locality 15 (plate 1), an outcrop of a very fine-grained felsic tuff (ffv) occurs within the siliceous phyllite unit. In hand specimen the rock resembles chert, but microscopic examination reveals mainly quartz and feldspar, and minor magnetite. One phenocryst of beta quartz was identified in thin section. Similar rocks form a thick stratigraphic section along the Little River in the southwestern portion of the quadrangle (locality 19, plate 1). These rocks are interpreted to represent unaltered protoliths of the sericite phyllites.

In the Moccasin Creek area (plate 1), the top of the upper volcanic group consists of silver gray to greenish phyllite (locality 7, plate 1) and mafic volcanics (locality 8, plate 1) comprised of chlorite-mica schist, epidote-quartz granofels, and greenstone (actinolite-epidote-chlorite-plagioclase). Abundant disseminated magnetite is associated with epidote in some samples. This unit is interpreted as a basaltic flow or tuff, locally hydrothermally altered. The most pronounced positive aeromagnetic anomaly in the Eastern slate belt is associated with this unit (fig. 2).

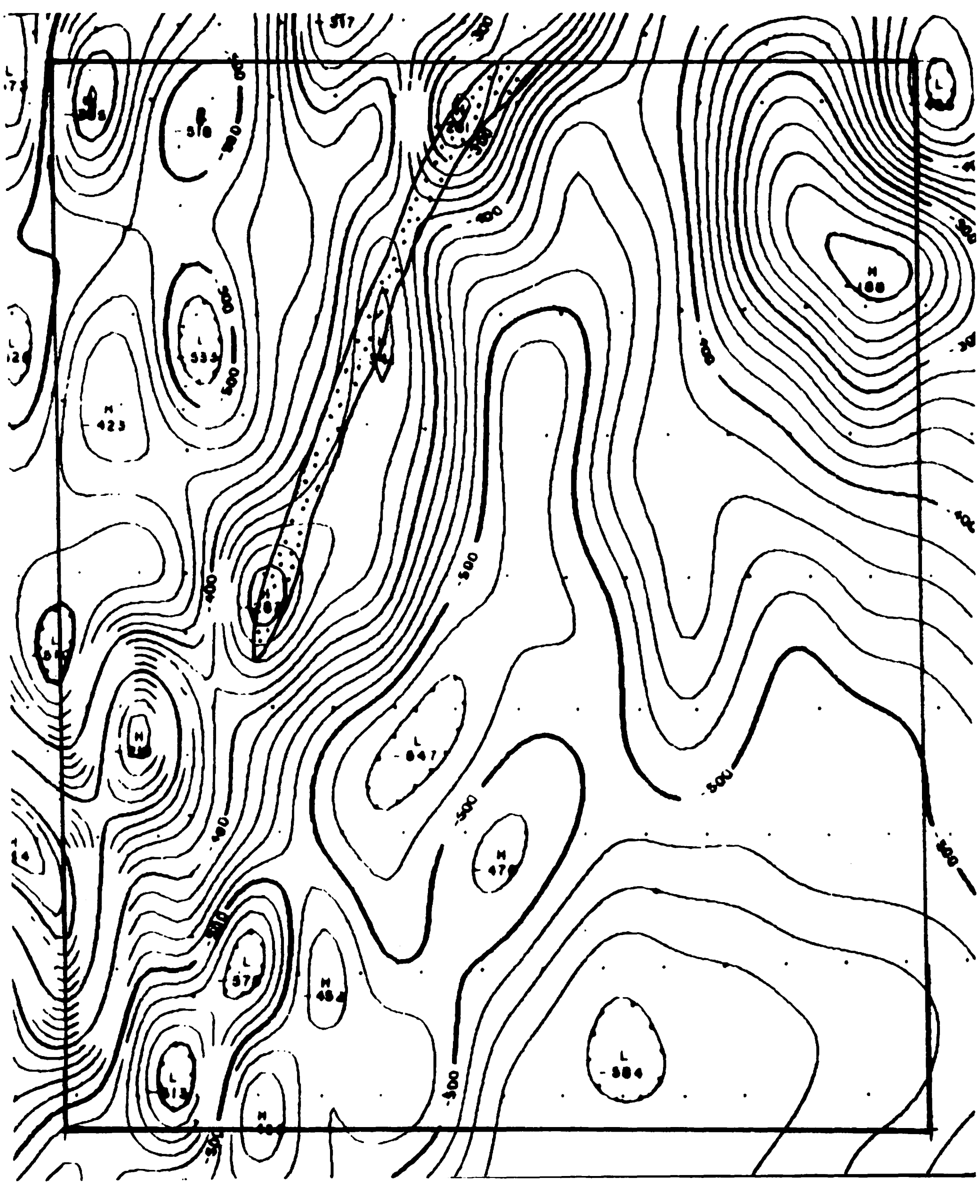

Figure 2. Aeromagnetic map of the Stancils Chapel 7.5-minute quadrangle. Scale 1:100,000. Dots represent flight lines. The mafic metavolcanic unit is shown by the pattern. (Aeromagnetic map is from the U.S. Geological Survey, 1976)

Metasedimentary Sequence

The metasedimentary sequence in the Stancils Chapel quadrangle consists of two units distinguished on the basis of bedding features, mineralogy, and grain size. These units are a laminated argillite (lower) and a massive metasiltstone (upper).

The laminated argillite consists of thin, crenulated, mica-rich phyllitic layers, that alternate with thicker, more massive, quartzose layers. The scale of layering is variable from micro- to megascopic. Commonly, phyllitic layers are 1 mm or less thick, and the quartzose layers are 3 to 4 mm thick. In fresh exposures (localities 9 and 16, plate 1), blackish coloration of the phyllitic layers suggests that the argillite is locally graphitic. Muscovite and chlorite form the phyllitic layers. These minerals, plus quartz, comprise the siliceous layers.

The upper unit of the metasedimentary sequence is massive metasiltstone. Chlorite and muscovite are dispersed throughout the rocks and the alignment of these minerals defines a weak foliation. Bedding is obscure, or absent. Silt-size quartz and plagioclase are the dominant minerals. Accessory minerals include titanite, epidote, apatite, and black opaques.

Igneous Rocks

This report briefly describes the Sims pluton. More detailed studies of the Sims pluton will be presented in a report by Speer (in preparation), *The Sims pluton, Nash and Wilson Counties, North Carolina.*

The Sims pluton occupies the northeast corner of the Stancils Chapel quadrangle (plate 1) and is oval in outcrop pattern. The pluton appears to control the courses of Turkey Creek and Moccasin Creek in the vicinity of Buckhorn Reservoir. The Sims pluton is a composite body with a megacrystic granitoid lithology (the Conner granitoid) and an equigranular biotite granitoid lithology (the Sims granitoid). Only the Conner granitoid crops out in the Stancils Chapel quadrangle. The Sims granitoid is not exposed in the Stancils Chapel quadrangle, but may underly the Coastal Plain sediments in a small area in the extreme northeast corner of the quadrangle (plate 1).

The Conner granitoid is a pale-orange to moderate-orange-pink coarse-grained biotite monzogranite. It contains abundant tabular, subhedral to euhedral alkali feldspar megacrysts up to 5 cm in a finer groundmass, which gives the rock a hiatal or inequigranular texture. Biotite is commonly altered to muscovite, chlorite, epidote, and rutile. Accessory minerals include apatite, carbonate, fluorite, thorite(?), and zircon. Opaque minerals are hematite-ilmenite, pyrite, chalcopyrite, and pyrrhotite.

On the western side of the pluton, near the contact with argillite, coarse-grained muscovite-quartz rocks crop out and occur as float. Farrar (1985b) described these rocks as quartz-muscovite hornfels. They are described as greisen by Cook (1972). These rocks are considered to be greisen in this report because they are coarsely crystalline, fluorine-rich rocks contained entirely within the granite. Muscovite grains up to 5 mm across occur in unoriented masses with or without quartz. Quartz is intermixed with muscovite or as separate veins. Cook (1972) reports pyrite + chalcopyrite + molybdenite in the greisen zone. Galena and sphalerite are also present.

Unconsolidated Sediments

Coastal Plain sediments in the northeastern portion of the Stancils Chapel quadrangle (plate 1) were described by Hoffman and Carpenter (1992). The stratigraphy was established from auger drill data and field mapping. This drill data is restricted to the northeast corner of the quadrangle, primarily on units over the Sims pluton (plate 1).

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 100K quadrangle as part of the 1994 STATEMAP program. That study will evaluate Coastal Plain units throughout the Stancils Chapel, and other, quadrangles. This mapping will be incorporated into revised releases of the Stancils Chapel, and other, quadrangles as mapping progresses.

Coastal Plain sediments in the northeastern corner of the quadrangle are possibly of Pliocene age and consist of an upper and a lower unit (Carpenter and

Carpenter, 1991; Hoffman and Carpenter, 1992). The lower unit consists of medium to coarse sands and gravels. These sediments are poorly sorted, and sand grains are generally angular to subangular in shape. Sands of the overlying upper unit are finer grained, better sorted, and show greater rounding of quartz grains. In the northeastern portion of the quadrangle (plate 1), sands of the upper unit at elevations above 240 feet contain a major reserve of heavy minerals that extends into adjacent quadrangles. The heavy mineral assemblage consists of ilmenite, staurolite, kyanite, sillimanite, zircon, rutile, and tourmaline.

STRUCTURE

The dominant structural fabric (S_2) in the Stancils Chapel quadrangle is a N10° - 20° E foliation that parallels the trend of the rock units. The foliation dips steeply to the northwest or southeast. The northeast trend also parallels the axes of two regional F_2 folds, the Smithfield synform and an unnamed antiform. The axis of the Smithfield synform passes through the southeast corner of the quadrangle (plate 1) and is occupied by massive metasiltstone. The axis of an unnamed antiform extends through the center of the felsic quartz crystal tuff in the northwest corner of the quadrangle. A secondary (S_3), or crenulation, cleavage, visible in outcrop and hand samples, trends N 0°-10° W. This secondary cleavage is commonly parallel to the axes of regional F_3 folds described by Farrar (1985b). An S_1 foliation was not recognized in this quadrangle.

At locality 17 (plate 1), a structural anomaly is defined by local east-west strike trends and by brittle deformation of the argillite. The change in strike from the regional trend may be the result of drag along a late north-northeast-trending fault. Because of poor exposure, this zone could not be traced from this locality.

MINERAL RESOURCE POTENTIAL

No mines or quarries are active in the Stancils Chapel quadrangle. Occurrences of molybdenum, copper, mica, heavy minerals, and gold, however, have been identified on the Stancils Chapel quadrangle.

During the period 1989 - 1991, a large titanium-zircon reserve was discovered and delineated in Coastal Plain sediments at elevations above 240 ft. This deposit, known as the Bailey deposit, shows a close areal association with the Sims pluton, and occupies portions of the adjacent Lucama, Bailey, and Middlesex quadrangles. Total reserves are estimated to be 30 million short tons of sand at an average heavy mineral content of 6.1 weight percent. Valuable heavy minerals are ilmenite, zircon, rutile, and leucoxene. These minerals compose 65 to 70 percent of the heavy mineral suite (Mallard, 1992).

In the late 1960's, molybdenite was discovered in the Sims pluton. Subsequent geochemical surveys identified several soil geochemical anomalies for molybdenum and copper in the western portion of the Sims pluton near the community of Conner. Fifteen holes, totaling 3,100 vertical feet, were drilled in the granite and adjacent slate belt. The cores contained up to 127 ppm molybdenum and 650 ppm copper over 10 ft intervals with narrow zones of higher grade material. At the slate belt-Sims granite boundary, quartz veins contained galena, sphalerite, chalcopyrite, and pyrite. Economically viable concentrations of metals were not identified (Cook, 1972). A more detailed summary of this work will be included in a report by Speer (in preparation).

Currently, the Sims granitoid is quarried for crushed stone near the community of Sims (Bailey quadrangle). Only the Connor granitoid crops out in the Stancils Chapel quadrangle. The coarse-megacrystic Conner granitoid probably has a low Los Angeles abrasion hardness. The xenomorphic Sims granitoid is a better stone for aggregate because of its more even texture and higher Los Angeles abrasion test hardness. Pavement exposures represent potential quarry sites that would require less removal of overburden (i.e., soil or Coastal Plain sediments).

Greisen, a quartz-muscovite rock containing pyrite, occurs in a zone approximately 2 miles long zone along the southwestern boundary of the Sims pluton (locality 12, plate 1). Mica occurs as small, unoriented masses up to 5 mm in size, and constitutes up to 75 percent of the greisen. The mica does not appear to be deformed, or to be intimately intergrown with quartz. This greisen is being evaluated as a possible source of high quality mica for use as a filler in paints, wallboard, plastics, cosmetics, and other specialty products. The results of this study will be released as a separate open-file report (Speer, in preparation).

Sand in the Coastal Plain sediment is a potential mineral resource. Upper unit sands tend to be fine-grained, with a size distribution similar to that required for glass sand. Processing of the sand to produce a commercial glass sand product would require removal of heavy minerals, clay, and iron stains. In less pure form, these sands are probably suitable for blending with asphalt used in paving roads. Sands in the lower unit are coarser and locally contain significant concentrations of gravel. Both the coarse sand and gravel are potential sources of construction aggregates and filter media for treatment of municipal waste water.

Gold has been panned from streams draining areas underlain by the siliceous phyllite (sp) with massive quartz lenses at locality 18 (plate 1). Rocks within this unit have been intensively silicified, and pyrite is locally abundant. This unit may contain buried or concealed deposits of base metals and/or gold beneath the extensive Coastal Plain cover.

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