U.S. DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

Preliminary Geologic Map of the South Boston 30 X 60 Minute Quadrangle, Virginia and North Carolina

by

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Open File Report 93-244

Prepared in cooperation with the Virginia Division of Mineral Resources

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1993

INTRODUCTION AND GENERAL GEOLOGY

The South Boston 30X60-minute quadrangle (Figure 1) is located in south-central Virginia and northernmost North Carolina. It covers an area of about 4,800 square kilometers in parts of Brunswick, Charlotte, Halifax, Lunenburg, and Mecklenburg Counties, Virginia, and parts of Granville, Person, Vance, and Warren Counties, North Carolina. The quadrangle contains most of John H. Kerr Reservoir (also known as Buggs Island Lake), much of Lake Gaston, segments of the Roanoke, Dan, and Meherrin Rivers, and two Virginia state parks (Occoneechee State Park and Staunton River State Park). Cities include Chase City, Clarksville, Kenbridge, South Boston, South Hill, and Victoria (all in Virginia).

This preliminary geologic map is a compilation of published and unpublished sources (Figure 2), including early results of a new geologic mapping project. It will be superseded by a published geologic map after the new work has been completed. One reason for releasing this preliminary version is to make current data available for use by the Virginia Division of Mineral Resources in compiling a new state geologic map of Virginia. It also should help to meet practical and scientific needs of other users until the final map has been completed. The preliminary map serves as a basis for assessing the present knowledge of geology in the region, for prioritizing limited resources for new mapping, and as a foundation for supporting studies such as those that involve sampling for geochemistry and geochronology.

The South Boston 30X60-minute sheet lies in the Piedmont Lowlands subprovince of the Piedmont physiographic province (Hack, 1982). It extends eastward from amphibolite-facies gneisses and schists in the Milton belt, across a problematic and debateable Paleozoic terrane boundary locally straddled and flanked by small Mesozoic rift basins, across greenschist-facies volcanogenic rocks of the Carolina slate belt, into amphibolite-facies gneisses and schists of the Raleigh metamorphic belt (Figure 3). Late Proterozoic to late Paleozoic intrusive rocks range in composition from granite to gabbro. The metamorphic rocks are cut by late Paleozoic strike-slip faults, including the Nutbush Creek and Lake Gordon mylonite zones of the Eastern Piedmont fault system, as well as older and younger faults.

In the Milton belt, this compilation incorporates mapping by Kreisa (1980) which differs significantly from that of Tobisch and Glover (1971). Nevertheless, the compilation is consistent with the overall nappe structure proposed by Tobisch and Glover (1971) and Tobisch (1972). This structural style contrasts sharply with the upright folds and steep dips along the western flank of the Carolina slate belt.

In addition to marking a contrast in structural styles, the boundary between the Milton belt and Carolina slate belt is a complex tectonic zone characterized by a steep metamorphic gradient (Tobisch and Glover, 1969), ductile shear zones including the Clover shear zone (Baird, 1988, 1989; Shell and Hibbard, 1993), and early Mesozoic normal faults (Kreisa, 1980; Johnson and others, 1985; Goodwin and others, 1986; Ramsey, 1982).

The western flank of the Carolina slate belt in the South Boston 30X60-minute quadrangle has been previously mapped (Laney, 1917; Kreisa, 1980) and contains the type areas of the Hyco, Aaron, and Virgilina Formations (listed in ascending stratigraphic order). In this report, stratigraphic nomenclature for these formations follows that of Harris and Glover (1988); Figure 3 of Harris and Glover compares this terminology with those of Laney (1917), Glover and Sinha (1973), and Kreisa (1980). The north-northeast-trending Virgilina synclinorium, originally recognized by Laney (1917) and named by Brown (1953), is a complex structure consisting of several synforms, antiforms, and internal faults (Glover and Sinha, 1973; Kreisa, 1980). This compilation indicates structural and stratigraphic complications in the northern part of the synclinorium that cannot be resolved without additional mapping. Farther east, the Carolina slate belt contains a variety of felsic to mafic metavolcanic rocks, volcanogenic metasedimentary rocks, and intrusive rocks ranging in composition from granodiorite to gabbro. In the Oxford, N.C., 15-minute quadrangle just south of this area, Hadley (1973, 1974) found a lack of evidence for stratigraphic continuity and sequence, but interpreted the metavolcanic rocks to be in the lower part of the Virgilina sequence with much interlensing of rock types and some repetition by folding. Geologic mapping in the eastern part of the Carolina slate belt is in progress and stratigraphic relationships remain undetermined.

The Carolina slate belt is bounded on the east by the Nutbush Creek mylonite zone (Casadevall, 1977), which lies along the western margin of the late Paleozoic Buggs Island granite pluton. This pluton is bounded on the east by another major ductile fault zone of the Eastern Piedmont fault system, the newly recognized Lake Gordon mylonite zone (Horton and others, 1993). The Lake Gordon and Nutbush Creek mylonite zones show good evidence of late Paleozoic dextral strike-slip movement (Druhan and others, 1988; Horton and others, 1993).

The Raleigh metamorphic belt east of the Lake Gordon mylonite zone consists of variably migmatitic amphibolite-facies gneisses and schists (Sacks and Horton, 1993). These rocks may be part of the Raleigh terrane of Stoddard and others (1991), a southern extension of the Goochland terrane of Farrar (1984, 1985a, 1985b), or part of an accretionary complex (Sacks and Horton, 1993). The metamorphic rocks are intruded by massive to foliated two-mica granites of probable Pennsylvanian and Permian age such as the Wise, South Hill, and Stones Mill plutons (see Explanation of Map Units).

Three early Mesozoic rift basins occur along and near the boundary zone between the Milton belt and Carolina slate belt. From south to north, these are the Scottsburg, Randolph, and Roanoke Creek basins. Further investigation is necessary to determine if they represent erosional remnants of a formerly continuous basin. Early Jurassic diabase dikes dip steeply and cut across older rocks throughout the Piedmont. This map extends the known distribution of Early Jurassic rhyolite porphyry dikes described by Stoddard and others (1986) and Stoddard (1992) just southeast of the map area.

Surficial units include fluvial terrace deposits (Tt) along the Roanoke River and Dan River, as well as alluvium that underlies present-day floodplains (Qal).

Geological problems highlighted by this preliminary map include the origin of the Milton belt and whether these gneisses are higher-grade equivalents of Carolina slate belt rocks (Baird, 1989, 1991), an unrelated terrane (Horton and others, 1989, 1991; Hibbard, 1991; Samson and others, 1992a, 1992b), or perhaps both; the significance of faulting along the Milton belt-Carolina slate belt boundary; the stratigraphy and structure of the Carolina slate belt east of the Virgilina synclinorium; the relationship of the newly discovered Lake Gordon mylonite zone to the Nutbush Creek and Hylas zones of the Eastern Piedmont fault system; the nature of the Raleigh metamorphic belt (whether or not it belongs to a "Grenville Goochland terrane"); and the significance of plutonic rocks including undated peralkaline granite (North View pluton) and Mesozoic rhyolite porphyry dikes.

Mineral resources include the Hamme tungsten district (Parker, 1963; Gair, 1977), copper and gold deposits of the Virgilina district (Laney, 1917; Carpenter, 1976; Johnson and others, 1989), and granite presently quarried for crushed stone. The relationship of groundwater resources to bedrock geology in the western part of the area is discussed by Legrand (1960). Useful field guides to geology in and near the quadrangle are provided by Kreisa, 1980; Harris and Glover, 1985; Goodwin and others, 1986; Stoddard and others, 1987; and Baird, 1989). Airborne magnetic and gamma-ray surveys are also available (Zietz and others, 1977a, 1977b; U.S. Geological Survey, 1978a, 1978b).

EXPLANATION OF MAP UNITS

[Succession of minerals in composite rock names are in order of increasing abundance. Example: muscovite-biotite granite contains more biotite than muscovite.]

CENOZOIC SURFICIAL DEPOSITS

Qal — Alluvium (Holocene) -- Unconsolidated deposits of gravel, sand, silt, and clay on floodplains of major streams

Tt — Fluvial terrace deposits (Tertiary?) -- Unconsolidated gravel and sand on hills and slopes mainly near Roanoke River and Dan River

EARLY MESOZOIC ROCKS

Intrusive rocks

Jp — Rhyolite porphyry (Early Jurassic) -- Aphanitic-porphyritic rock containing phenocrysts of alkali feldspar (sanidine) and quartz; locally amygdaloidal; occurs as steeply-dipping dikes. Part of suite described by Stoddard and others (1986) and Stoddard (1992)

Jd — Diabase (Early Jurassic) -- Dark gray to black, fine- to medium-grained, composed mainly of plagioclase and augite. Undivided unit includes olivine diabase (which contains minor olivine) and quartz diabase (which contains minor amounts of very fine-grained quartz and potassium feldspar). Occurs as steeply-dipping dikes

Stratified sedimentary rocks of rift basins (Scottsburg, Randolph, and Roanoke Creek basins)

Ŧs — Predominantly siltstone and shale with minor layers of sandstone and conglomerate; in Scottsburg basin

Ŧsc — Predominantly sandstone and conglomerate (undivided); in Randolph basin

Ŧc — Conglomerate of Roanoke Creek basin

LATE PALEOZOIC MYLONITIC ROCKS

mlg — Mylonitic rocks of Lake Gordon mylonite zone (undivided) -- Variably mylonitic rocks derived from biotite gneiss, muscovite-biotite schist and gneiss, granitic gneiss, and granite

mn — Mylonitic rocks of Nutbush Creek mylonite zone (undivided) -- Variably mylonitic and commonly lineated rocks derived from a variety of protoliths including phyllitic metasedimentary rocks, metavolcanic rocks, granitic gneiss, and plutonic rocks ranging from granite to tonalite

mnp — Phyllonite of Nutbush Creek mylonite zone

LATE PALEOZOIC GRANITES

PPg — Two-mica granite -- Biotite-muscovite granite, muscovite granite, and leucogranite; medium to coarse grained, massive to foliated, commonly garnet-bearing. Includes Stones Mill granite of Meador (1949), granite of South Hill pluton and unnamed bodies, mainly east of Nutbush Creek mylonite zone.

PPgw — Granite of Wise pluton -- Muscovite-biotite granite, biotite-muscovite granite, and leucogranite containing accessory garnet. Undated but interpreted as part of Pennsylvanian-Permian suite of granites (McSween and others, 1991).

Pbi — Granite of Buggs Island pluton (Pennsylvanian) -- Muscovite-biotite granite, medium- to coarse-grained, massive to well foliated (Pennsylvanian age 314 ± 16 Ma Rb-Sr whole-rock age by Kish, 1983)

RALEIGH METAMORPHIC BELT EAST OF LAKE GORDON MYLONITE ZONE

gg — Gneissic metagranite (granitoid gneiss) -- Metamorphosed granite, leucogranite, and granodiorite; well-foliated, commonly lineated, and in places compositionally banded; medium to coarse grained, locally containing feldspar megacrysts. Variably mylonitic and lineated along Lake Gordon mylonite zone near Kenbridge, Va.

rt — Talc schist, actinolite-talc schist, and soapstone -- Occurs as lenses in schist and gneiss (rsg)

rsg — Gneiss and schist of Raleigh metamorphic belt -- Interlayered biotite gneiss, muscovite-biotite gneiss, muscovite-biotite schist, and sillimanite-mica schist (undivided). Gneisses are compositionally banded and locally migmatitic. Includes minor interlayers and lenses of granitic gneiss, biotite-amphibole gneiss, amphibolite, garnet-mica schist, calc-silicate granofels, and rare ultramafic rocks.

ROCK UNITS BETWEEN NUTBUSH CREEK AND LAKE GORDON MYLONITE ZONES

ggn — Granitoid gneiss -- Light gray, commonly leucocratic, foliated, commonly lineated, and locally banded; age undetermined

vk — Layered mafic and felsic metavolcanic rocks of Kenbridge, Va. -- Possibly equivalent to similar unit (Zvl) west of Nutbush Creek mylonite zone

CAROLINA SLATE BELT

Intrusive Rocks

gnv — Peralkaline granite of North View pluton -- Medium to coarse grained, well foliated to almost massive, commonly lineated; age undetermined. Described by Farrar and Givan (1988)

Rocks of Vance pluton (also termed "Vance County pluton;" U-Pb zircon date is 571$\pm$17 Ma ; LeHuray, 1989)

€Zvg — Biotite granodiorite (Cambrian or Late Proterozoic) -- Foliated and metamorphosed

€Zvt — Hornblende-biotite tonalite and quartz diorite (Cambrian or Late Proterozoic) -- Foliated and metamorphosed

Zqd — Quartz diorite -- Intrusive into lower part of Hyco Formation (Zh)

[The following undated plutonic rock units are tentatively inferred to be Cambrian or Late Proterozoic on the basis of U-Pb zircon ages from similar rocks in the Flat River complex of McConnell and Glover (1982), Roxboro pluton (Glover and Sinha, 1973), and Vance pluton (LeHuray, 1989, see above). Age prefixes are omitted from map-unit symbols because of uncertainty.]

Rocks of Clarksville batholith

gcl — Leucocratic biotite granodiorite -- Very light gray, fine- to medium-grained, and foliated

gcm — Medium-grained biotite granodiorite -- Light gray and foliated

gcp — Porphyritic biotite granodiorite ("Buffalo granite" of Laney, 1917) -- Light gray, coarse grained, and foliated

gro — Granodiorite of Red Oak pluton -- Part of "Redoak granite" as used by Laney, 1917); poorly exposed, age undetermined

di — Medium-grained diorite -- Unit mapped by Laney (1917) within Red Oak pluton

gdb — Biotite granodiorite -- Pluton north of Fort Mitchell, Va.

gd — Biotite granite and granodiorite -- Very light gray and generally medium-grained; part of igneous complex near Meherrin River

to — Metatonalite -- Foliated, medium to coarse grained, and locally porphyritic; predominantly tonalitic in composition but ranges from biotite granodiorite to biotite tonalite and quartz diorite. Part of igneous complex near Meherrin River

gb — Metagabbro to metadiorite -- Dark greenish gray, medium- to coarse-grained, variably foliated to massive hornblende metagabbro and metadiorite; includes "Abbeyville gabbro" of Laney (1917)

Metavolcanic and Metasedimentary Rocks

[Stratigraphic nomenclature on this map in the area of the Virgilina synclinorium follows the usage of Harris and Glover (1988)]

Virgilina Formation as used by Harris and Glover (1988) (Late Proterozoic?) -- Equivalent to "unit IV" of Glover and Sinha (1973)

Zvp — Metasedimentary unit (upper part) -- Predominantly phyllite, volcanic sandstone and slate; minor layers include greenstone and felsic metatuff; mapped by Kreisa (1980) as upper member of Aaron Formation

Zvg — Greenstone unit (lower part) -- Predominantly light greenish-gray schistose, mafic metavolcanic rocks; generally equivalent to "Virgilina greenstone" as used by Laney (1917) and "middle member of the Aaron Formation" as used by Kreisa (1980)

Aaron Formation as used by Harris and Glover (1988) (Late Proterozoic?) -- Generally equivalent to "unit III" as used by Glover and Sinha (1973), the "lower member of the Aaron Formation" as used by Kreisa (1980), and part of the "Aaron slate" as used by Laney (1917). Late Proterozoic (or possibly early Cambrian) age is bracketed between underlying Hyco Formation (620$\pm$20 Ma; Glover and Sinha, 1973) and intrusive Roxboro metagranite (575$\pm$20 Ma; Glover and Sinha, 1973)

Za — Metasandstone, metamudstone, and minor volcanic metaconglomerate -- Light gray to greenish gray and phyllitic to slaty; contains minor interlayered felsic and mafic metavolcanic rocks

Zac — Pebble metaconglomerate and pebbly to granular metasandstone -- Interbedded with slate and metasandstone; clasts are mainly pebbles but locally include cobbles. Distinctive marker unit of Kreisa (1980)

Zh — Hyco Formation (Late Proterozoic) -- As used by Kreisa (1980) and Harris and Glover (1988); mainly phyllitic felsic metatuff containing quartz and feldspar phenocrysts. Equivalent to "Hyco quartz porphyry" of Laney (1917) and "Unit II" of Glover and Sinha (1973). U-Pb zircon age is 620$\pm$20 Ma (Glover and Sinha, 1973). Fossils in the Hyco are described by Cloud and others (1976)

[Ages of the following units are undetermined and no stratigraphic order is implied]

Zvl	Layered felsic and mafic metavolcanic rocks (undivided) -- Layered felsic and mafic metatuffs, minor greenstone (metabasalt), and phyllitic metasedimentary rocks; interlayered on scales as small as a meter or less
Zvm	Mafic metavolcanic rocks -- Relatively massive, epidote-rich greenstone (metabasalt flows, locally amygdaloidal), thin-layered greenstone metatuff, mafic crystal metatuff, and chlorite-sericite phyllite occurring at different stratigraphic positions
Zvf	Felsic crystal, lithic, and crystal-lithic metatuffs -- Thin to thick bedded, containing subordinate layers of laminated felsic metatuff, coarse agglomerate, felsic (rhyodacite?) flows, and greenstone dikes and flows. Resembles Hyco Formation (Zh)
Zph	Phyllitic metasiltstone -- Fine-grained sericite phyllite, sericite-quartz phyllite, and chlorite-sericite phyllite interlayered with fine-grained phyllitic felsic and mafic metatuffs
Zff	Fissile fine-grained metafelsite -- Strongly foliated, laminated felsic (dacitic?) metatuff, locally containing magnetite octahedra; minor interlayers include felsic crystal tuff and greenstone. Includes Goshen Schist of Laney (1917).
Zpv	Phyllitic volcaniclastic rock -- Grayish-green, fine-grained, chlorite-sericite phyllite containing flattened white pumice clasts; includes thin sandy to pebbly layers and meter-thick interlayers of greenstone and felsite. Locally a coarse-grained volcanic breccia.
Zcg	Quartz-pebble metaconglomerate -- Occurs within phyllitic metasiltstone (Zph)
Zvc	Felsic crystal metatuff -- Thin to thick bedded, containing medium- to coarse-grained phenocrysts of plagioclase and(or) quartz in a very light gray to medium gray, fine-grained matrix

ROCK UNITS ALONG MILTON BELT-CAROLINA SLATE BELT BOUNDARY

Pzgt	Granite gneiss ("Tanyard Branch Granitic Gneiss" of Baird, 1989) -- variably foliated metagranite, fine- to medium-grained (age undetermined). Highly elongate pluton; cataclastic texture is common near Mesozoic rift basins (Baird, 1989)
gra	"Granite dike" as mapped and interpreted by Laney (1917) -- Light gray, medium- to fine-grained, about 30-60 meters wide
Zlg	Mylonitic gneiss -- Includes fine-grained "layered gneiss" between two normal faults just south of the Triassic Scottsburg basin (Kreisa, 1980, p. 5). Also includes rocks mapped by Tobisch and Glover (1971) as "layered quartz-diorite gneiss" and later described by Tobisch (1972) as strongly layered biotite-hornblende gneiss, fine- to medium-grained and composed of plagioclase and quartz, varied smaller amounts of hornblende and(or) biotite, and minor epidote and chlorite. Kreisa (1980, p. 5) indicates that fine-grained "layered gneiss" south of the Scottsburg basin broadens near the Va.-N.C. State line into a mile-wide zone gradational into adjacent gneisses
Zhg	Hornblende-plagioclase gneiss -- As mapped by Tobisch and Glover (1971), may include amphibolite-facies equivalents of Hyco Formation (Zh) as well as rocks equivalent to amphibolite and hornblende gneiss (Zma) and(or) amphibolitic metabasalt (Zam)
Zam	Amphibolitic metabasalt -- Dark green to black amphibolite composed mainly of hornblende, plagioclase, quartz, epidote and locally biotite. Probably metabasalt; contains fine-grained felsic gneiss interlayers interpreted to be metadacite. Interpreted by Baird (1989) as "St. Matthews Church Amphibolite Member of Hyco Formation"

MILTON BELT

Intrusive and Altered Rocks

SOgs	Shelton Granite Gneiss of Jonas (1932) -- Medium- to coarse grained, foliated and commonly lineated; equivalent to Shelton Formation of Henika (1977). U-Pb zircon age is 463$\pm$14 Ma (Hund, 1987); Rb-Sr whole-rock age is 429$\pm$7 Ma (Kish, 1983)
PzZgb	Metagabbro and metadiorite (Kreisa, 1980)

PzZto Gneissic tonalite ("Ellis Creek Gneiss" of Baird, 1989) -- Medium-grained felsic gneiss composed of plagioclase and quartz with lesser amounts of biotite, hornblende, chlorite, and epidote; age undetermined

uh Hornblendite -- Dark-gray, coarse-grained, composed predominantly of hornblende; mapped by Baird (1989) as "gabbroic rocks" and here interpreted to be altered mafic (or ultramafic?) rocks

um Altered ultramafic rocks -- Greenish-gray, composed of actinolite, chlorite, epidote, and pyroxene (Kreisa, 1980)

Layered metamorphic rocks

[Late Proterozoic ages for the following units are tentatively assigned on the basis of a single 740 Ma U-Pb zircon date (Glover and others, 1971) of gneiss from the Milton belt. Otherwise, ages of the following units are undetermined and no stratigraphic order is implied]

Zms Muscovite-biotite schist (Baird, 1989, 1991)

Zmfg Biotite-quartz-feldspar gneiss -- Includes "upper felsic gneiss unit" and "lower felsic gneiss unit" of Baird (1991)

Zmqs Muscovite-quartz schist (Baird, 1989, 1991)

Zmhf Fine-grained hornblende-bearing felsic gneiss (Blackwater Creek Gneiss of Baird, 1989)

Zma Amphibolite and hornblende-plagioclase gneiss -- Includes rocks mapped and interpreted by Baird (1989) as "Catawba Creek Amphibolite Member of Hyco Formation" and by Legrand (1960) as "hornblende gneiss"

Zmgs Biotite gneiss and schist -- Interlayered fine- to medium-grained biotite-quartz-feldspar gneiss and mica schist; includes "biotite gneiss" of Kreisa (1980) and "pelitic schists" of Baird (1991)

Zmhb Predominantly medium-grained hornblende-biotite gneiss -- Interlayered with lesser amounts of biotite-quartz-feldspar gneiss, hornblende gneiss, amphibolite, and mica schist. Includes "hornblende-biotite gneiss" of Kreisa (1980) and "intermediate volcanic rocks" of Baird (1989, 1991). Generally more mafic than Zmgn

Zmgn Interlayered biotite gneiss, hornblende gneiss, amphibolite, and mica schist (undivided) -- As mapped by Kreisa (1980)

EXPLANATION OF MAP SYMBOLS

Contact--Dotted where concealed under water

Fault -- Dotted where concealed under water

Normal fault (Mesozoic)--Hachures on apparently downthrown side; dotted where concealed under water

Strike-slip fault (Late Paleozoic)--Showing relative horizontal movement; dotted where concealed under water

Thrust fault (Paleozoic?)--Sawteeth on upper plate; dotted where concealed under water

Antiform--Showing crest line and direction of plunge

Synform--Showing crest line and direction of plunge

Overturned antiform--Showing direction of dip of limbs

Overturned synform--Showing direction of dip of limbs

~ ~ ~ ~ Shear zone -- zone of variably sheared rocks, including mylonitic rocks as well as less deformed rocks

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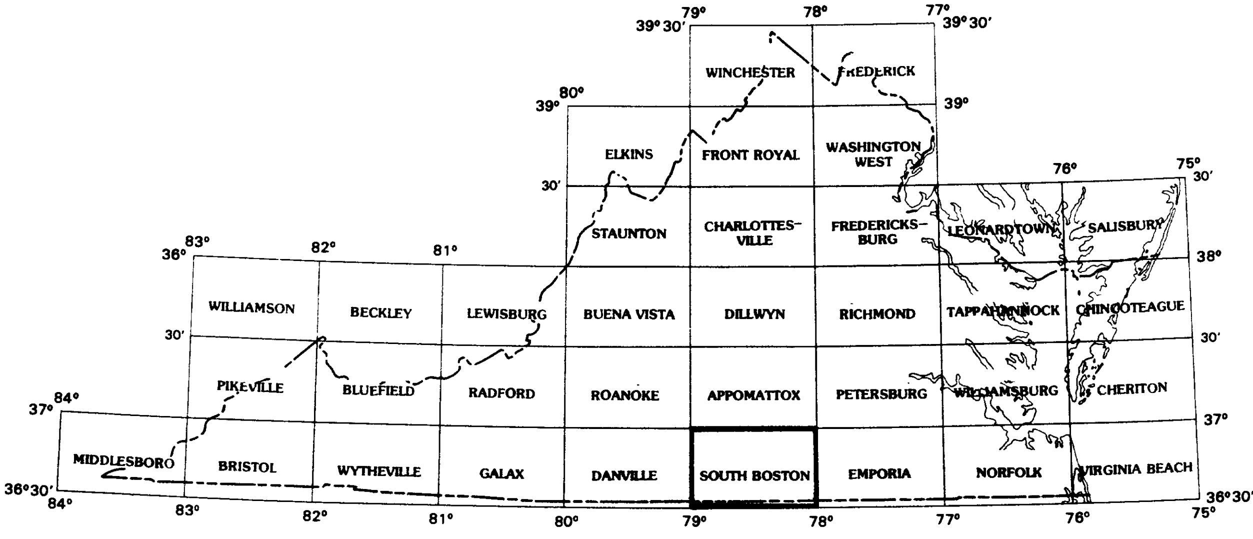

Figure 1. Index map showing location of the South Boston, Va.-N.C., quadrangle and other 1:100,000-scale 30 X 60 minute quadrangles in Virginia.

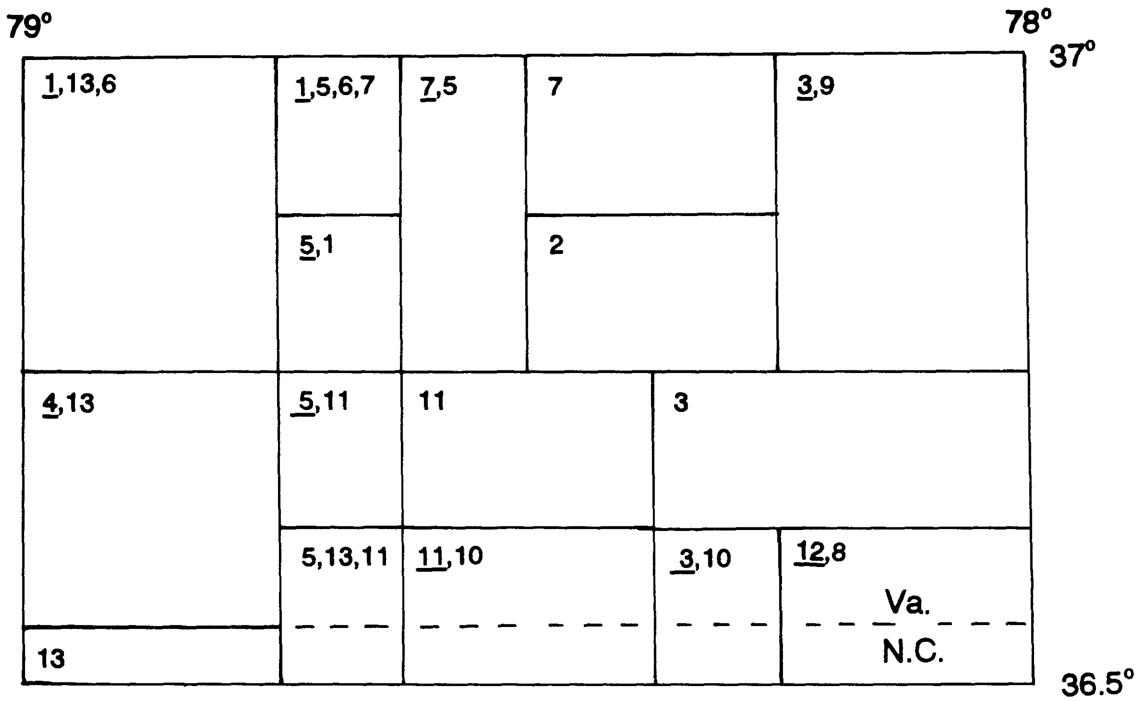

Figure 2. Sources of geologic-map data used in this compilation. Underlined numbers on map refer to most important contribution to an area.

1 -- Baird (1989, 1991)
2 -- Burton, William C., unpublished data
3 -- Horton, J. Wright, Jr., unpublished data
4 -- Kreisa, (1980)
5 -- Laney (1917)
6 -- LeGrand (1960)
7 -- Marr, John D., Jr., unpublished data
8 -- McDaniel (1980)
9 -- Meador (1949)
10 -- Parker (1963)
11 -- Peper, John D., unpublished data
12 -- Sacks, P.E., unpublished data
13 -- Tobisch and Glover (1971)

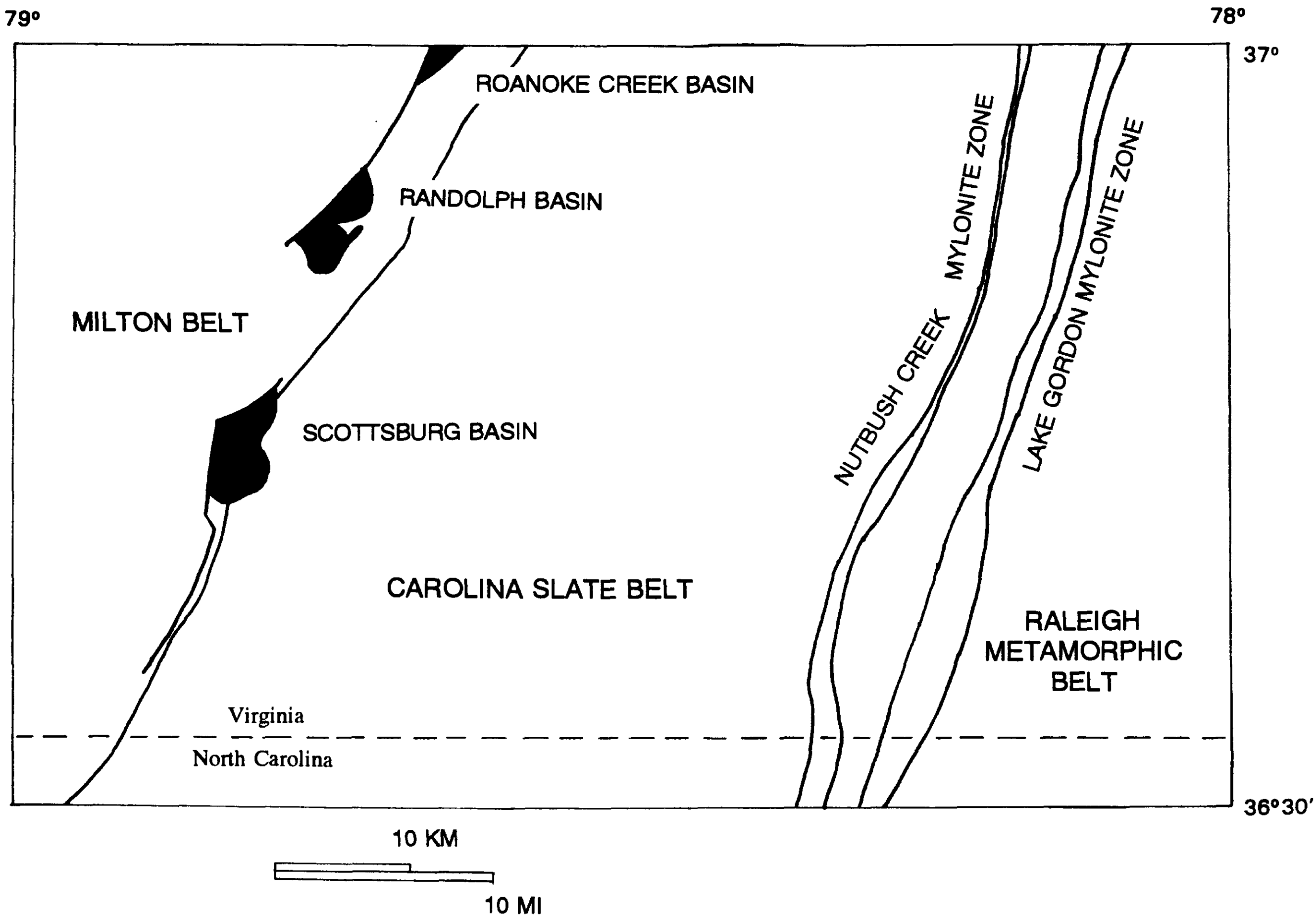

Figure 3. Index map showing geologic belts and selected features.