GEOLOGY AND MINERAL RESOURCES OF BUCKINGHAM COUNTY, VIRGINIA
Geologic Map Units Description
(from Geologic Map of Virginia, 1993 – Expanded Explanation; for more information and specific citations, please consult this publication)

MAPPED UNITS OF THE MESOZOIC BASINS

NEWARK SUPERGROUP (UPPER TRIASSIC)
c1 *conglomerate, carbonate clasts*. Rounded to subrounded pebbles, cobbles, and boulders of predominantly Cambrian and Ordovician limestone and dolostone in a matrix of fine- to coarse-grained, calcite-cemented, light gray, silty sand stone. Occurs only in the Culpeper basin.

br *breccia, mixed clasts*. Angular to subangular pebbles, cobbles, and boulders of mixed lithologies in a reddish-brown matrix of indurated medium- to coarse-grained sandstone.

NEWARK SUPERGROUP (LOWER JURASSIC)
ss *sandstone and siltstone*. Interbedded fine- to coarse grained, pebbly, reddish-brown, and arkosic sandstone and reddish-brown siltstone; rhythmically interbedded with siltstone and shale unit **(sh)**. Occurs only in the Culpeper basin.

ROCKS OF THE CENTRAL VIRGINIA VOLCANIC-PLUTONIC BELT

Arvonia Formation (Oa, Oas, Obq, Okq)
Oa *slate and porphyroblastic schist*. Dominantly dark gray to grayish-black, lustrous, very fine-grained, graphitic slate (northeastern sector); and, medium-grained, porphyroblastic garnetiferous biotite schist (southwestern sector). Discontinuous beds of quartzose muscovite schist, coarse grained to pebbly micaceous quartzite, and conglomeratic schist occur along the margins of the outcrop belt, stratigraphically at the base of the section. Interbeds of dacite metatuff occur in the western portion of the slate outcrop belt. Graded laminated metasiltstone and metasandstone are interbedded with slate in the central and eastern portions of the outcrop belt at the latitude of the James River (Evans and Marr, 1988); these rocks pass into porphyroblastic schists at higher metamorphic grades to the southwest. A distinctive garnet-amphibole-quartz interbed occurs within porphyroblastic schist south of the James River (volcanogenic marker?; Brown, 1969); north of the river, this passes down metamorphic grade into what is described as an oolitic chlorite schist (Smith and others, 1964).

Mineralogy: (slate) chlorite + muscovite + plagioclase + quartz + magnetite ± biotite ± calcite ± graphite ± pyrite; (porphyroblastic schist) biotite + muscovite + garnet + quartz + plagioclase + magnetite ± kyanite ± calcite; tourmaline and zircon are common accessories.

Geophysical signature: The Arvonia is marked by positive magnetic and radiometric anomalies. Originally referred to as the slate in the Arvonia belt by Rogers (1884), the unit was named Arvonia slate by Stose and Stose (1948), and raised to formation status by Brown (1969). An Upper Ordovician age for the Arvonia has been established from fossils collected by Watson and Powell (1911), Stose and Stose (1948), Tillman (1970), and Kolata and Pavlides (1986). The Arvonia has long been considered unconformable on top of adjacent units. Micaceous quartzite, pebbly muscovite schist, and conglomeratic schist are common at the base of the section where that boundary is not faulted (Stose and Stose, 1948; Smith and others, 1964; Brown, 1969; Evans and Marr, 1988). The base of the Arvonia is exposed in an old railroad cut near Carysbrook, Fluvanna County (Smith and others, 1964); there, a micaceous quartzite containing quartz pebbles rests on granite of the Carysbrook pluton. The Stoses (1948) considered the Arvonia a sequence deposited on a post-Taconic orogeny regional unconformity, and folded and metamorphosed during subsequent orogenies; that interpretation is consistent with geologic constraints as we know them today. The Arvonia is correlated with the Quantico Formation. History of the Arvonia district slate industry is discussed by Brown (1969) and Evans and Marr (1988).

Obq Bremo quartzite (Stose and Stose, 1948). Light-gray, fine- to medium-grained, thick-bedded and locally crossbedded quartzite; includes quartz-muscovite schist, and quartz-pebble conglomerate.

Mineralogy: quartz + muscovite + chlorite ± plagioclase ± potassium feldspar ± calcite ± magnetite- hematite ± zircon. The Bremo reportedly contains crinoid stems and brachiopods (Smith and others, 1964; Brown, 1969). Stose and Stose (1948) and Smith and others (1964) considered the quartzite stratigraphically above the slates and schists; Brown (1969) cited structural evidence that the Bremo does not occupy a position at the top of the Arvonia, but occurs locally in the middle or lower part. Smith and others (1964) and Brown (1969) considered the Bremo a member of the Arvonia Formation.

Okq *kyanite quartzite and schist*. White to light-gray, medium- to coarse-grained, well-foliated, locally crinkle-folded, quartzose kyanite schist and kyanite-bearing quartzite.

Mineralogy: kyanite + quartz + muscovite ± graphite ± pyrite ± garnet; kyanite constitutes as much as 30 percent of the rock. Kyanite-bearing quartzites and schists have been correlated with quartzose muscovite schists that occur locally at the base of the Arvonia Formation (Conley and Marr, 1980). Those workers report primary sedimentary structures in kyanite quartzite including wedge-shaped quartzite layers and quartzite-metapelite couplets; fining-upward sequences; channel fillings; and, large-and small- scale cross-beds.

Obf *Buffards Formation* (Brown, 1969). Includes greenish-gray conglomeratic quartzose muscovite schist containing ellipsoidal clasts of milky quartz, dusky-red quartzite, dark gray aphanitic rock, and greenish- gray phyllite; greenish-gray chlorite-muscovite schist with medium to fine, grayish-blue quartz grains; grayish-green chlorite-muscovite phyllite; biotite-muscovite-quartz schist. Mineral assemblages are those found in Arvonia slates and porphyroblastic schists. Conglomeratic schist occurs along the western margin of the principal Buffards outcrop belt, and as discontinuous lenses too small to show at 1:500,000 scale, at or near the western margin (stratigraphic base) of the Arvonia slate outcrop belt **(Oa)** (Evans and Marr, 1988).

Although Brown (1969) in defining the Buffards Formation considered these rocks to be a pyroclastic deposit stratigraphically above the Arvonia Formation, other workers have interpreted Buffards rocks to be at a lower stratigraphic position relative to the Arvonia. Conley and Marr (1980) considered the Buffards part of the Chopawamsic Formation, unconformably below the Arvonia. Stose and Stose (1948) and Evans and Marr (1988) considered the Buffards to be stratigraphically at or near the base of the Arvonia Formation.

Buffards conglomeratic schists contain tuffaceous and ferruginous-quartzite clasts similar to rocks that occur in the Chopawamsic Formation; this is consistent with the Buffards being derived in part from, and deposited unconformably on, the Chopawamsic. The chaotic, locally graded nature of the deposits is suggestive of a submarine fan channel deposit.

Ocg *Columbia pluton*. Light-gray, medium- to coarse grained, foliated. Includes biotite-muscovite granite, granodiorite, tonalite, and granitic pegmatite; contains xenoliths of biotite gneiss, amphibolite, and felsic metavolcanic rocks.

Mineralogy: plagioclase + quartz + microcline; common accessories include biotite, muscovite, epidote, zircon, apatite, garnet, magnetite, and pyrite (Bourland and Glover, 1979).

Geophysical signature: diffuse magnetic lows and radiometric highs.

The pluton was originally named Columbia Granite by Jonas (1928); this name was objected to by later workers because of the relatively small percentage of true granite present. The pluton includes the southeastern portion of the granodiorite unit of Smith and others (1964). Granitic rocks in the Carysbrook area of Fluvanna County are here considered part of a separate Carysbrook pluton, following the usage of Stose and Stose (1948). The Columbia includes, in part, the Hatcher complex of Brown (1969). Bourland and Glover (1979) refer to the pluton as the Columbia metagranite. Given the heterogeneous nature of the pluton, multiple intrusive phases are likely present.

Tonalite in the eastern part of the pluton has yielded ages of 590+/-80 Ma, (Rb-Sr whole-rock; Fullagar, 1971). Mose and Nagel (1982) report a Rb-Sr whole-rock age for the Columbia of 454±9 Ma. Because samples for this age are described as coming from the western portion of the Columbia, it is possible that the rocks dated were taken from what is herein mapped as the Carysbrook pluton **(grc)**.

Chopawamsic Formation (Ccv, Ccfv, Ccmv; Southwick, Reed, and Mixon, 1971)
Ccv *Chopawamsic Formation, undivided*, (Pavlides, 1981). Includes laterally discontinuous lenses and tongues of metamorphosed felsic, intermediate, and mafic volcanic flows and volcanoclastic rocks, with interlayered quartzite, quartzose greywacke, schist, and phyllite. Volcanic flows are locally highly vesicular; fragmental breccia and tuff are common. Felsic flows are typically light-gray aphanitic rocks with phenocrysts of quartz and feldspar; intermediate flows are dark-green amphibole-bearing rocks with fine-grained quartz-feldspar matrix; green stone metabasalts contain blue green amphibole, chlorite, albitic plagioclase, and quartz.

Geophysical signature: linear strike-elongate pattern of elevated magnetic anomalies.

The Chopawamsic is correlated with the James Run Formation in Maryland; the James Run has been dated at 570 to 530 Ma (U-Pb zircon; Tilton and others 1970). The Chopawamsic is unconformably overlain by the Late Ordovician Arvonia and Quantico Formations. Pavlides (1981 and subsequent works) has made the interpretation on the basis of geologic and geochemical data that the Chopawamsic and related plutons represent an ancient island-arc sequence.

Interlayered mafic and felsic metavolcanic rocks (Cfv, Cmv, Cbg, Cfq, Csg)
Heterogeneous layered assemblage correlates with the Chopawamsic Formation and Ta River Metamorphic Suite, on strike to the northeast, and in traceable into the Milton belt in North Carolina (Geologic Map of North Carolina, 1985).

Cfv *foliated felsite*. Grayish-orange-pink to white, fine- to medium-grained, foliated to granular metavolcanic rocks range in composition from rhyolite to dacite. Includes muscovite feldspar-quartz schist, gneiss and granofels; massive crystal metatuff; welded ash flow tuff; and, inequigranular metavolcanic breccia. Relict primary volcanic textures are recognizable where metamorphic grade is low (Henika, 1975; 1977).

This unit includes felsic gneiss with less common mafic and rare calcareous gneiss mapped by Tobisch (1972), in part the metamorphosed volcanic sequence of Gates (1981), and dominantly felsic-composition units mapped by Nelson (1992). The unit contains numerous granitic dikes, sills, and injections where it occurs in close proximity to Shelton Formation **(Ost)**.
Felsites occur interlayered with amphibolite, amphibole gneiss and schist **(Cmv)**, quartzofeldspathic biotite gneiss **(Cbg)**, sillimanite-quartz-muscovite schist and gneiss **(Csg)**, and ferruginous quartzite **(Cfq)**.

Cmv *amphibolite, hornblende-biotite gneiss and schist*. Black to moderate-olive-brown, medium- to coarse-grained, lineated and foliated; light-greenish-gray quartz-epidote stringers are common.

Mineralogy: hornblende + tremolite-actinolite + oligoclase + biotite + epidote + garnet.

Includes Blackwater Creek Gneiss and Catawba Creek amphibolite member of Hyco Formation of Baird (1989), hornblende gneiss of LeGrand (1960), gneiss unit of Kreisa (1980), and dominantly mafic composition units mapped by Nelson (1992). Amphibolite is interlayered with biotite gneiss, as discussed above.

Cbg *quartzofeldspathic biotite gneiss*. Heterogeneous layered sequence consists of salt-and-pepper and segregation layered biotite granite gneiss interlayered with biotite schist; dark-gray to black, fine- to coarse-grained, thin- to thickly-laminated hornblende gneiss and schist; lesser quartz-muscovite schist; and, locally, gray to green, medium-grained, calcareous gneiss and calc-silicate granofels (Tobish and Glover, 1969). This unit includes the upper and lower felsic gneiss units and intermediate volcanic rocks in the Hyco Formation as used by Baird (1989, 1991); and biotite gneiss and interlayered gneiss of Kreisa (1980), correlative with the biotite gneiss unit of Marr (1980a; 1980b).

Mineralogy: (quartzofeldspathic rocks), (1) quartz + albite + potassium feldspar + muscovite + chlorite + actinolite + epidote + calcite + magnetite + zircon; (2) quartz + oligoclase + muscovite + biotite + garnet + hornblende + magnetite + epidote + rutile + calcite + zircon; (mafic rocks), (1) quartz + albite + chlorite + epidote + actinolite + titanite + magnetite ilmenite. (2) quartz + oligoclase + andesine + hornblende + microcline + biotite + garnet + cordierite + magnetite + rutile + titanite + scapolite; (pelitic rocks), (1) quartz + albite + muscovite + chlorite + epidote + magnetite-ilmenite; (2) quartz + muscovite + biotite + kyanite + oligoclase + potassium feldspar + epidote + magnetite- ilmenite + garnet; (3) quartz + muscovite + sillimanite + magnetite-ilmenite; (calcareous rocks), (1) quartz + calcite + biotite + epidote + chlorite + tremolite + ilmenite; (2) calcite + quartz + epidote + hornblende + pyroxene + scapolite.

Geophysical signature: felsic rocks are delineated by strike-elongate positive radiometric anomalies (Henika and Johnson, 1980); mafic metavolcanic rocks and metasedimentary units are characterized by closed strike-elongate radiometric lows and closed strike-elongate aeromagnetic highs.

Cfq *ferruginous quartzite*. Dark-reddish-brown, fine- to medium-grained, thinly-banded, metamorphosed ironstone, contains discontinuous quartz-rich and magnetite- or specular hematite-rich lenses and layers. Quartzites are associated with gossan zones (Marr, 1980a; 1980b).

Geophysical signature: narrow strike-elongate positive magnetic anomalies. Ferruginous quartzites are distinctive marker units that locally outline map-scale structures in some places. This lithology is recognizable in rocks of variable metamorphic grade and degree of deformation and has been mapped within the Ta River **(Ctq)** and within correlative unnamed interlayered mafic and felsic metavolcanic rocks to the south west **(Cfq)**.

Csg *quartz muscovite schist and gneiss.* Very-light-gray to light-bluish-gray, fine- to medium-grained, layered kyanite mica schist, kyanite and sillimanite quartzite, and interlayered biotite-garnet schist.

Mineralogy: quartz + muscovite + plagioclase ± biotite ± garnet ± sillimanite ± kyanite ± magnetite. Includes the schist and gneiss unit of Tobisch (1972), and muscovite-quartz schist of Baird (1989, 1991).

grc *Carysbrook pluton*. Light-gray, medium- to coarse grained, massive to indistinctly foliated biotite granite.

Mineralogy: quartz + potassium feldspar + plagioclase + biotite + chlorite + muscovite + epidote.

Geophysical signature: diffuse pattern of elevated radiometric anomalies.

Although Smith and others (1964) included the Carysbrook pluton in a granodiorite unit with granitoid rocks in the vicinity of Columbia, Stose and Stose (1948) recognized that the granite at Carysbrook was different in texture and composition from the granodiorite at Columbia. Our mapping affirms that these are separate plutons. The Carysbrook is unconformably overlain by the Arvonia Formation; this relation is well-exposed in an abandoned railroad cut south of Carysbrook (Smith and others, 1964). The pluton intrudes the Chopawamsic Formation.

pg *plagiogranite*. White to light-gray, medium- to coarse grained, vaguely- to strongly-foliated plagioclase-rich granite and granite gneiss.

Mineralogy: quartz + plagioclase + biotite + muscovite ± potassium feldspar. Small plutons occur within layered metavolcanic rocks of probable Cambrian age.

um *ultramafic rocks*. Small pods and plutons of gray to greenish-gray, medium- to coarse-grained, locally porphyroblastic schist and granofels.

Mineralogy: tremolite-actinolite + chlorite ± talc ± plagioclase ± quartz; locally contains relict olivine.

my *mylonite*. Includes protomylonite, mylonite, ultramylonite, and cataclastic rocks. Lithology highly variable, depending on the nature of the parent rock, and on intensive parameters and history of deformation. In most mapped belts of mylonite and cataclastic rock (**my**), tectonized rocks anastomose around lenses of less-deformed or undeformed rock. In the Blue Ridge, some of these lenses are large enough to show at 1:500,000 scale. In many places mylonitic and cataclastic rocks are gradational into less deformed or undeformed adjacent rocks, and location of contacts between tectonized rocks (my) and adjacent units is approximate or arbitrary. These boundaries are indicated on the map by color-color joins with superimposed shear pattern.

Most mapped belts of mylonite represent fault zones with multiple movement histories. In the Blue Ridge, Paleozoic age contractional deformation fabrics are superimposed on Late Precambrian extensional fabrics (Simpson and Kalaghan, 1989; Bailey and Simpson, 1993). Many Piedmont mylonite zones contain dextral-transpressional kinematic indicators that formed during Late Paleozoic collisional tectonics (Bobyarchick and Glover, 1979; Gates and others, 1986). Paleozoic and older faults were reactivated in many places to form extensional faults during the Mesozoic (Bobyarchick and Glover, 1979).

STRATIFIED ROCKS OF THE BLUE RIDGE ANTICLINORIUM

Candler Formation (Cca, ls)
Cca *phyllite and schist*. Medium- to dark-gray and greenish-gray mica phyllite and sandy laminated schist. Lenses and pods of feldspathic quartzite, metamorphosed quartzarenite, dolomitic marble, and dark-gray to medium-bluish-gray, laminated marble are common in the upper part.

Mineralogy: quartz + albite + muscovite + chlorite + magnetite-ilmenite + epidote ± biotite ± chloritoid ± calcite. Chloritoid and magnetite porphyroblasts are common near the Bowens Creek fault.

Geophysical signature: Low amplitude, linear magnetic highs are superimposed on a pronounced southeast-sloping magnetic gradient between Alligator Back units northwest of the Candler and a persistent linear magnetic trough localized along the trend of the Bowens Creek fault zone.

Microstructural elements in the upper Candler indicate dextral transpression along a continuous shear zone (Bowens Creek fault zone) within the Candler outcrop belt from the Virginia-North Carolina boundary in Patrick County northeastward to at least the north end of Buffalo Ridge on the Amherst-Campbell County line. Conley and Henika (1970) and Gates (1986) hypothesized that the Bowens Creek fault is part of a major strike slip (wrench) system that is part or a continuation of the Brevard fault zone to the southwest . Northeast of the Scottsville Mesozoic basin, the Candler includes laminated metasiltstone (Ccas), ferruginous metatuff, dolomitic marble, and phyllite that are conformable above Catoctin metabasalt (Evans, 1984; Conley, 1989; Rossman, 1991); in Orange County, the Candler includes the True Blue formation of Pavlides (1989, 1990).

ls *limestone*. Medium-bluish-gray, thinly laminated limestone and laminated calcareous mudstone; resembles Everona Limestone.

Alligator Back Formation (CZas, CZac, CZmy; Rankin, and others,1973).
CZas *actinolite schist*. Dark-grayish-green chlorite-actinolite schist metabasalt.

Mineralogy: actinolite + epidote + chlorite ± biotite + albite + quartz + magnetite-ilmenite.

Geophysical signature: linear, positive magnetic anomaly. Schist commonly contains recognizable flow structures, deformed and mineralized pillow basalts, pyroclastic breccia, pink and white marble, and laminated metatuff. Massive to thin beds are interlayered with metamorphosed sedimentary and mafic to ultramafic rocks. This unit was previously mapped as the Catoctin Formation or the Slippery Creek Greenstone in the Lynchburg quadrangle (Brown 1958).

CZac *banded marble*. Light- and dark-gray, laminated fine to medium-grained marble, calcareous gneiss, and schist.

Mineralogy: calcite + quartz + biotite + muscovite + plagioclase + pyrite + magnetite-ilmenite. Thick to thin beds of marble are interlayered with graphitic phyllite and mica schist; the lithology grades from impure marble to calcareous metagraywacke depending on percent age of detrital calcite present. The unit includes the Arch Marble of Brown (1958) and the Archer Creek Formation of Espenshade (1954).

CZmy *feldspathic metagraywacke*. Heterogeneous assemblage of rock-types includes medium- to light-gray, laminated quartzofeldspathic to calcareous gneiss with thin mica schist partings; white and gray, fine- to coarse-grained, generally laminated marble; gray to greenish-gray fine-grained graphitic mica schist and quartzite; light-gray, medium- to fine-grained mica schist; massive quartzite and micaceous blue quartz granule metasandstone; and, dark-greenish-black actinolite schist.

Mineralogy: (1) quartz + potassium feldspar + plagioclase + biotite + muscovite + calcite + epidote + titanite + magnetite- ilmenite; (2) quartz + muscovite + chlorite + graphite + titanite + ilmenite; (3) quartz + albite + muscovite + biotite + titanite + ilmenite; (4) quartz + muscovite + garnet + kyanite; (5) chlorite + tremolite + magnetite-ilmenite; (6) chlorite + actinolite-tremolite + talc + dolomite + magnetite-ilmenite; (7) quartz + albite + actinolite + biotite + epidote + magnetite.

Units here mapped as Alligator Back Formation were previously mapped as the Evington Group (Espenshade, 1954; Brown, 1958; Redden, 1963; Gates, 1986; Patterson, 1987) and considered to be younger than the Lynchburg Group. Regional mapping by Henika (1991) and Scheible (1975) indicates that rocks assigned to Alligator Back Formation by Rankin and others (1973) are continuous with the upper part of the Lynchburg Group in the type section along the James River at Lynchburg (Jonas, 1927) and that the Alligator Back consistently dips southeast beneath the overlying Candler Formation from the Virginia-North Carolina border to the James River at Lynchburg.

Sedimentary and structural facing criteria indicate that rock units immediately southeast of the Candler Formation in an outcrop belt from Stapleton on the James River, southwest to Leesville Dam on the Roanoke River, are older than the Candler (Henika, 1992). Although previously mapped as upper Evington Group (Espenshade, 1954; Brown, 1958; Redden, 1963; Patterson, 1987), these rocks are herein correlated with the Alligator Back Formation (upper Lynchburg Group), having been uplifted against the Candler Formation to the northwest along the Bowens Creek fault (Henika, 1992). Rocks in the same outcrop belt along strike to the southwest of the Leesville Reservoir were previously correlated with the Alligator Back Formation by Conley (1985). The sequence of lithologic units within the Alligator Back Formation southeast of the Bowens Creek fault is the same as that proposed by Brown (1951; 1958), and Espenshade (1954) for the formations in the Evington Group, that are structurally above the Candler Formation. The sequence is based on the detailed structural and stratigraphic relationships first established by Brown (1958) in the Lynchburg 15-minute quadrangle.

<u>STRATIFIED ROCKS OF THE WESTERN PIEDMONT</u>

CZfm *Fork Mountain Formation* (Conley and Henika, 1973; Conley, 1985). Light- to medium-gray, fine- to medium grained, polydeformed and polymetamorphosed porphyroblastic aluminosilicate-mica schist, interlayered with medium-gray irregularly-layered garnetiferous biotite gneiss, migmatitic in part; calcsilicate granofels; amphibolite; rare white marble; and, coarse calc-quartzite lenses. Complex schistosity, multiple crenulation cleavages, and partly-retrograded, polymetamorphic aluminosilicate and garnet porphyroblasts are diagnostic of Fork Mountain schists. Primary sedimentary structures rarely are preserved. A spectacular polymictic breccia bed that can be traced along strike for several miles within the Fork Mountain near Stuart is a notable exception. Medium- to coarse-granular, blue quartz lenses, angular to rounded inclusions of boudinaged fine-grained, color-laminated, calc-silicate rock, and thick beds of coarse, clast-supported, epidotized lithic breccia are typical of the Fork Mountain biotite gneiss.

Prograde regional metamorphic mineral assemblages: (1) quartz + muscovite + biotite + garnet + staurolite + magnetite-ilmenite + rutile; (2) quartz + muscovite + paragonite + plagioclase + garnet + staurolite + sillimanite + magnetite-ilmenite + rutile; (3) quartz + biotite + sillimanite +

potassium feldspar + plagioclase + garnet + magnetite-ilmenite; (4) quartz + plagioclase + biotite + muscovite + sillimanite + garnet + tourmaline; (5) quartz + plagioclase + potassium feldspar + biotite + hornblende + epidote + ilmenite; (6) quartz + plagioclase + potassium feldspar + muscovite + biotite + sillimanite + magnetite-ilmenite + garnet + kyanite. Retrograde metamorphic mineral assemblages: (1) quartz + muscovite + chlorite; (2) quartz + muscovite + chloritoid + chlorite; (3) quartz + muscovite + staurolite + chloritoid; (4) quartz + muscovite + kyanite. Contact metamorphic mineral assemblages: (1) andalusite + sillimanite + kyanite + corundum; (2) corundum + spinel + magnetite + kyanite.

Geophysical signature: The Fork Mountain has a characteristic "curly maple" pattern on magnetic contour maps. This pattern is the result of isolated concentrations of highly magnetic minerals that produce rounded, high-intensity, positive and negative anomalies.

The aluminosilicate-mica schist is the upper part of the Fork Mountain Formation and forms a series of northeastward- trending ridges along the northwest side of the Smith River allochthon. The garnetiferous biotite gneiss is at a lower structural level of the Fork Mountain Formation near Martinsville where lower strata have been intruded by the Martinsville igneous complex, and the remaining metasedimentary rocks contain extensive thermal metamorphic zones localized along the intrusive contacts (Conley and Henika, 1973). Biotite gneiss in the Fork Mountain Formation has been interpreted to be a highly metamorphosed diamictite (Rankin, 1975; Conley, 1985; and Pavlides, 1989). At the northeastern limit of the Fork Mountain outcrop belt, in Appomattox and Buckingham counties, the dominant lithologies are polydeformed yellowish-gray chloritoid-chlorite-muscovite quartzose phyllite and quartz-rich mica schist. Tightly-folded, transposed pinstriped segregation layering at a high angle to the penetrative schistosity defined by phyllosilicate minerals is characteristic; polycrystalline quartz-rich boudins are abundant. These rocks are lithologically indistinguishable from those along the highly-tectonized western margin of the metagraywacke, quartzose schist, and mélange **(CZpm)** outcrop belt; current interpretation is that the Fork Mountain is correlative to some degree with **CZpm**.

Mine Run complex (OZI, OZII, OZIII; Pavlides, 1989; 1990)
OZIII *melange zone III* (Pavlides, 1989). Phyllite and schist matrix contains abundant euhedral magnetite; many matrix rocks are highly deformed on a mesoscopic and microscopic scale. Mafic exotic blocks **(mf)** include amphibolite, ultramafic rocks, serpentinite, and talc; many mafic and ultramafic blocks are composite. Biotite gneiss blocks **(gn)** are also present. Metavolcanic olistoliths **(vo)** are rare.

Geophysical signature: Strong positive magnetic anomaly. This unit is intruded by the Ellisville biotite granodiorite **(SOe)**.
CZpm *metagraywacke, quartzose schist, and melange*. Metagraywackes are quartzose chlorite or biotite schists containing very fine to coarse granules of blue quartz; primary graded laminations have been transposed by shearing into elongate lozenges that give the rock a distinctive pin-striped appearance in weathered surfaces perpendicular to schistosity. A mylonitic fabric is superimposed in varying degrees, as are late-stage chevron-style folds. In Buckingham, Appomattox, and Campbell Counties, rocks in this unit are progressively more tectonized from east to west across the outcrop belt; in the western portion, the dominant lithology is a

polydeformed, mylonitic mica schist with abundant quartz-rich boudins; transposed pinstriped lamination or segregation layering at a high angle to mylonitic schistosity is characteristic. Metagabbroic blocks ranging in size from 5 cm to 3 m across and larger have been identified at widely scattered locations throughout the outcrop belt.

Mineralogy: quartz + albite + epidote + chlorite + muscovite + magnetite ± chloritoid ± calcite; biotite- and staurolite-bearing assemblages occur in Appomattox and Campbell Counties. Detrital minerals identified in thin section include plagioclase, perthite, epidote, magnetite, tourmaline, and titanite. Lithic fragments include dacite tuff, gabbro, and monocrystalline quartz with zircon and biotite inclusions (Evans, 1984).

The northern portion of the outcrop belt includes mélange zone IV of the Mine Run complex of Pavlides (1989; 1990). In Albemarle and Fluvanna counties, **CZpm** includes the lower chlorite-muscovite unit of Smith and others (1964) and Hardware metagraywacke of Evans (1984). In Appomattox and Buckingham Counties, polydeformed quartzose mica schists in the western portion of the outcrop belt are lithologically indistinguishable from schists mapped as Fork Mountain Formation in structural blocks that occur to the west; these units are considered to be at least in part correlative. In Campbell County, polydeformed metagraywacke and mica schist is intruded by the Cambrian-age Melrose Granite **(Cm)**.

Interlayered felsic and mafic metavolcanic and metasedimentary rocks (Cfvs, Cmvs)
Cfvs *felsic metatuff, mica schist, and gneiss*. Includes light-gray to grayish-pink, very-fine-grained to aphanitic, thin-bedded dacitic metatuff, locally containing subhedral to euhedral plagioclase phenocrysts; very-light-gray pinstriped quartz-rich, muscovite and biotite-muscovite schist; and, medium-gray fine- grained salt-and-pepper biotite-muscovite gneiss.

Mineralogy: quartz + plagioclase + muscovite ± biotite + epidote + magnetite. These lithologies are interlayered with subordinate amounts of greenstone metabasalt and amphibole gneiss.

Cmvs *greenstone or amphibole gneiss*. Includes dark- to dusky-green, schistose actinolite-chlorite metabasalt with epidote- quartz segregations; and, layered hornblende-plagioclase gneiss. These lithologies are interlayered with subordinate amounts of dacitic metatuff, quartz-muscovite schist, and fine-grained salt-and-pepper biotite-muscovite gneiss.

<u>IGNEOUS ROCKS OF THE WESTERN PIEDMONT</u>

PzZdm *Diana Mills complex* (Brown, 1969). Principally hornblende metadiorite and hornblende-quartz metadiorite; includes hornblendite, amphibolite, metaperidotite, orbicular serpentinite, pegmatite, and aplite. Metamorphosed hornblende diorite and hornblende-quartz diorite are dark-grayish-green, medium-grained porphyritic, and massive to crudely-foliated. Phenocrysts are 1 to 10 mm anhedral to subhedral plagioclase of intermediate composition; matrix minerals include hornblende and plagioclase, with variable amounts of biotite and quartz. Accessory minerals include: apatite, zircon, muscovite, magnetite, ilmenite, and pyrrhotite. Epidote, chlorite, and titanite are common secondary minerals. Hornblendites are dark-green, medium- to coarse-grained rocks consisting dominantly of blocky euhedral to subhedral hornblende, with minor interstitial highly altered feldspar, and apatite. Amphibolite and metaperidotite are dark-green coarse grained rocks composed of anhedral pale-green uralitic hornblende which in places contains relict clinopyroxene and orthopyroxene, and rounded blebs of serpentine with cores of acicular tremolite, apparently after olivine. Orbicular serpentinite is dark-gray serpentinite composed of variable amounts of talc, amphibole, and chlorite, with fragmentary remnant pyroxene; the rock contains rounded orbicules from about 2 to 20 cm in diameter. These are composed predominantly of fibrous antigorite, oriented in concentric bands around the periphery, and contain cracks filled with magnetite, chlorite, and talc. Pegmatite and aplite are composed of plagioclase, epidote, clinozoisite, muscovite, and quartz; hornblende megacrysts are present in some pegmatite. The complex is generally concordant with the foliation in the enclosing metagraywacke **(Czpm)**, which shows enlarged micas and mica porphyroblasts adjacent to the contact. Structural setting and rock assemblage are suggestive of a layered intrusive sill (Brown, 1969). More recently the Diana Mills has been interpreted as an exotic block, emplaced within the enclosing unit by gravity sliding, or by other tectonic means (Brown and Pavlides, 1981; W. R. Brown, personal communication to Nick Evans, 1993).

Buckingham complex (PzZbq. PzZbk; Henika, 1969)
PzZbq *quartz diorite*. Light-gray, medium- to coarse-grained, biotite-quartz diorite; migmatitic zones, kyanite, and sillimanite occur adjacent to contacts in country rocks.

Mineralogy: quartz + plagioclase + potassium feldspar + biotite + epidote + allanite + muscovite + magnetite. This lithology cuts across older units in the Buckingham complex.

PzZbk *metamorphosed mafic and ultramafic rocks*. Dark greenish-gray, massive to layered, coarse-grained metagabbro, with metapyroxenite and metaperidotite layers. Early layered units are cut by late-stage aplitic granodiorite veins and dikes. Screens of metasedimentary country rocks separate differentiated metaperidotite - metagabbro sills. Younger quartz diorite pluton **(PzZbq)** partially brecciates older mafic rocks.

Mineralogy (secondary minerals in parentheses): metaperidotite, orthopyroxene + clinopyroxene + olivine + magnetite (+ tremolite-actinolite + chlorite + serpentine + talc + epidote + magnetite + calcite); metapyroxenite, orthopyroxene + clinopyroxene + hornblende + magnetite (+ chlorite + talc + plagioclase + epidote + quartz + magnetite); metagabbro, hornblende + clinopyroxene + orthopyroxene + biotite + plagioclase + magnetite (+ biotite + chlorite + epidote + muscovite + quartz + garnet).

Geophysical signature: Positive magnetic anomalies are associated with mafic and ultramafic sills.

gs *actinolite schist metabasalt*. Dark-green, variably schistose chlorite-actinolite-epidote greenstone metabasalt, amygdaloidal in part; massive yellowish-green epidosite segregations common.