Map Unit Descriptions

Source: Rader, E.K., and Evans, N. H., editors, 1993, Geologic Map of Virginia – Expanded Explanation: Virginia Division of Mineral Resources, 80 p.

Mpo *Pocono Formation* Sandstone, light-gray or tan, medium- to coarse-grained, locally conglomeratic, thick-bedded, resistant, interbedded with thin, gray, organic shale and a few very-thin coal beds. Conformable with underlying Hampshire Formation; formation present north east of Alleghany and Roanoke Counties. Thickness may exceed 750 feet. It is laterally equivalent to the Price Formation to the southwest.

Dhs *Hampshire Formation* (Darton, 1892) Quartzitic mudstone, grayish-red or greenish- or brownish-gray; fine-grained, locally conglomeratic sandstone, planar cross-bedded to massive sand stone beds with coaly plant material; intertongues with underlying Chemung Formation. It thickens northeastward from 200 feet in Botetourt County to 2000 feet in Frederick County and is time equivalent to part of the upper Chattanooga Shale in southwestern Virginia. It is not present southwest of Botetourt and Alleghany counties.

Dch *Chemung Formation* (Hall, 1839). *Redefined as the Foreknobs Formation* (Dennison, 1970). Sandstone and shale, dark-gray and greenish-gray, fine-grained, thin- to thick-bedded, lithic sandstone and interbedded greenish-gray, fissile, clay shale. Minor quartz-pebble conglomerate, thin red sandstone, and locally, fossil shell beds. Very thin or absent in southwestern Virginia; thickens to about 2500 feet northeastward in Frederick County. Gradational contact with underlying Brallier Formation and equivalent to part of the Chattanooga Shale to the southwest. Redefined and described as part of the Greenland Gap Group by Dennison (1970).

Db *Brallier Formation* (Butts, 1918). Shale, sandstone, and siltstone. Shale, partly silty, micaceous, greenish-gray, grayish-brown and medium- to dark-gray, black, weathers light-olive-gray with light-yellow, brown and purple tints; black shale in thin beds and laminae, sparsely fossiliferous. Sandstone, micaceous, medium-light-gray, very fine- to fine-grained, thin- to thick-bedded, and light-brown siltstone interbedded with shale. Locally siltstone is in very-thin, nodular, ferruginous lenses (Bartlett, 1974). Lower contact transitional; base at lowest siltstone bed above relatively nonsilty dark-gray shale. Equivalent to part of the Chattanooga Shale. Formation thins southwestward; it ranges from 940 feet in thickness in southwestern Washington County (Bartlett and Webb, 1971) to more than 2200 feet in Augusta County (Rader, 1967).

Dmn *Millboro Shale and Needmore Formation*. *Millboro Shale* (Cooper, 1939; Butts, 1940). Shale, black, fissile, pyritic, with septarian concretions locally, gradational with underlying Needmore Shale; present south west of Shenandoah County except in southwesternmost Virginia; thickness is as much as 1000 feet in north-central western Viginia. Laterally equivalent to the Marcellus Shale and Mahantango Formation to the northeast and the lower part of the Chattanooga Shale to the southwest. It is gradational with the underlying Needmore Formation.

Dmrn *Marcellus Shale and Needmore Formation.*
Marcellus Shale (Hall, 1839; Butts and Edmundson, 1966). Shale, dark-gray to black, more or less fissile, pyritic. Thickness estimated to be 500 feet in Frederick County and

350 to 400 feet in the Massanutten synclinorium (Rader and Biggs, 1976). *Needmore Formation* (Willard, 1939). Shale, dark or greenish gray, with thin beds or nodules of black, argillaceous limestone and the Tioga metabentonite beds (Dennison and Textoris, 1970), generally present with the Millboro or Marcellus Shale and is disconformable with the underlying Ridgeley Sandstone. Thickness ranges from 0 to 160 feet and is replaced to the southwest by the Huntersville Chert.

DSz *LowerDevonian and Silurian formations undivided*

Landslides with intact stratigraphic units.

DSu *Ridgeley Sandstone and Helderberg and Cayuga Groups.*

Ridgeley Sandstone (Swartz, 1913). Sandstone, gray, fine-to coarse-grained, locally conglomerratic, weathers yellowish- to dark-yellowish-brown, friable, calcareous, and fossiliferous. Thickness ranges up to 150 feet but is highly variable locally; occurs in western Virginia north of Craig County. Same as the Oriskany Sandstone of Butts (1933), and is continuous with the Rocky Gap Sandstone to the southwest. It grades downward into the Licking Creek Limestone and has been extensively mined for iron ore (Lesure, 1957).

Helderberg Group.

Licking Creek Limestone (Swartz, 1929). Upper member is light-gray, coarse-grained, arenaceous limestone; lower member is medium-to dark-gray, fine-grained, chert bearing limestone. Thickness ranges from 0 to150 feet and is present northeastward from Craig County; same as the Becraft (upper member) and New Scotland (lower member) of Butts (1940). It conformably overlies the Healing Springs Sandstone where the sandstone is present. It was extensively mined for iron with the Ridgeley Sandstone.

Healing Springs Sandstone (Swartz, 1929). Sandstone, light-gray, medium- to coarse-grained, cross-laminated, and calcareous with local lenses of chert. Present in Alleghany, Bath, and Augusta Counties where it is generally less than 20 feet thick and conformably overlies the New Creek Limestone. It appears to be a northeast extending tongue of Rocky Gap Sand stone.

New Creek Limestone (Bowen, 1967; Coeymans Limestone of earlier reports). Limestone, light- to-medium gray with pink calcite crystals, very-coarse-grained, crinoidal, with lenses of quartz sandstone locally in the lower part. Occurs as local reefoidal buildups northeast of Alleghany County. *Keyser Formation* (Swartz, 1913). Limestone, sandstone, and shale. Limestone (upper), medium- to dark-gray, fine- to medium-grained, nodular, scattered, small chert nodules, biohermal, fossiliferous. Limestone (lower), medium- to dark-gray, fine- to coarse-grained, medium- to thick-bedded, very nodular, shaly, with thin (1- to 3-inch thick) crinoidal layers. Sandstone, medium-light-gray, medium-grained, calcareous, cross-bedded. Shale, medium-gray, calcareous. Upper and lower boundaries are conformable north of Clifton Forge. Thickness ranges from 250 feet in Highland County to 50 feet in Augusta County.

In Highland and Bath counties the upper and lower limestones are separated by a calcareous shale unit (Big Mountain Shale Member). To the south and southeast the shale is replaced by sandstone (Clifton Forge Sandstone Member). From Craig County

southwestward, the Keyser becomes all sandstone and is equivalent to the lower portion of the Rocky Gap Sandstone. Southwest of Newcastle the lower contact is disconformable.

For mapping purposes the Keyser is considered to be part of the Helderberg Group.

Cayuga Group.

Tonoloway Limestone (Ulrich, 1911). Limestone, very-dark-gray, fine-grained, thin-bedded to laminated, with some arenaceous beds; celestite locally occurs in vugs and as veins. Thickness ranges from a few feet in southwestern Virginia to more than 500 feet in Highland County. It is conformable with the underlying Wills Creek Formation and equivalent to the Hancock Formation of Southwest Virginia. *Wills Creek Formation* (Uhler, 1905). Limestone, medium-to dark-gray, fine-grained, arenaceous, thin-bedded, with calcareous shale and mudstone, and thin, quartzose sandstone beds. Occurs only in western Virginia where the thickness ranges from 0 to more than 400 feet. It conformably over lies the Bloomsburg Formation and is laterally equivalent to the upper part of the Keefer Sandstone to the east and southwest of Craig County where the typical Wills Creek lithology is absent.

Bloomsburg Formation (White, 1893). Sandstone, reddish-gray, fine-grained, thick-bedded with red mud stone interbeds. Thick ness ranges from 35 to 400 feet between Frederick County and the northern Massanutten Mountains respectively. It grades into the Wills Creek Formation to the southwest, and is probably equivalent, in part, to the Keefer Sandstone southwest of Craig and Botetourt counties. *McKenzie Formation* (Stose and Swartz, 1912). Shale, medium-gray, yellowish weathering and interbedded sandstone, medium-gray, medium-grained, friable, thin-bedded and calcareous. Thickens northeastward from a few feet in Bath County to about 200 feet in Frederick County. It is probably equivalent in part to the Keefer Sandstone to the southwest and southeast and appears to be conformable with the Keefer Sandstone in northwestern Virginia.

Skrt *Keefer Sandstone, and Rose Hill and Tuscarora Formations.*

Keefer Sandstone (Ulrich, 1911). Sandstone, light-gray, fine-grained, cross-laminated, medium-bedded, very resistant. Thins northward and southwestward from a maximum of over 300 feet in Craig and western Botetourt counties. To the north it appears to interfinger with the Wills Creek and McKenzie Formations. The Keefer is equivalent to the upper portion of the Massanutten Sandstone. (The Keefer Sandstone, as used in this report, includes all of the quartzarenites with minor *Skolithus*-bearing red sandstone and minor calcite cemented quartzarenite in the interval above the Rose Hill Formation and below the Tonoloway Limestone in Botetourt, Rockbridge, and Augusta counties between Eagle Rock and Augusta Springs (Lampiris, 1976).

Rose Hill Formation (Swartz, 1923). Sandstone, dark grayish-red, fine- to coarse-grained, poorly-sorted, argillaceous; hematite cement ed, quartz sandstone interbedded with red or yellowish-green clay shale and greenish-gray, fine-grained sand stone. It is largely siltstone and shale with minor sandstone and thin limonitic iron ore beds in Southwest Virginia. Conformable with the underlying Tuscarora Formation, the Rose Hill Formation ranges up to 500 feet in thickness in northern and western Virginia but pinches-out in southwestern Botetourt and Roanoke counties where the Keefer and

Tuscarora Formations merge. It is present with other Silurian rocks everywhere except in the Massanutten Mountains or where an unconformity exists in exposures east of Walker Mountain.

Tuscarora Formation (Darton and Taff, 1896). Quartzite, quartzarenite, and minor shale. Quartzite, light-gray with few nearly white, porcelaneous beds, fine- to medium-grained, with quartz-pebble conglomerate locally near base, quartz cemented, thick-bedded, and cross-bedded, resistant, cliff- and ledge-former, generally not more than 75 feet thick, comprises entire unit in many areas or is upper member where unconformably overlying a lower quartzarenite and shale member. Quartzarenite, light-yellowish-brown or medium-gray, fine-grained, thin-bedded, ranges in thickness from 0 to 175 feet. Shale, light- to medium-brownish-gray, arenaceous, thin interbeds in quartzarenite. Conformably overlies the Juniata Formation in central western Virginia. Where lower member is absent the upper member unconformably overlies the Juniata, Oswego, Martinsburg, or Reedsville Formations or may be conformable with the Juniata Formation in northern Virginia. In southwestern Virginia grayish-red, fine-grained, ferruginous sandstone with lenses of coarse-grained, quartz sandstone and quartz-pebble conglomerate are included in the upper part of the formation. The Tuscarora is equivalent to the Clinch Formation and to the lower part of the Massanutten Sandstone.

Ou *Sequatchie Formation, Reedsville Shale, Trenton Limestone,*
and Eggleston Formation.
Sequatchie Formation (Ulrich, 1913). Siltstone, limestone, and shale. Siltstone, calcareous, medium-gray to grayish-red, maroon, and green, even and wavy thin-beds. Limestone, argillaceous, gray, greenish-gray, and grayish-red to dusky-red, nodular, in 1-inch to 3-feet thick planar beds. Shale, grayish-red. Percentage of each lithotype varies through out the lateral and vertical extent of the formation. The Sequatchie Formation ranges from 250 to 440 feet in thick ness. Laterally equivalent to the Juniata Formation.
Reedsville Shale (Ulrich, 1911). Shale, siltstone, and minor limestone. Shale, locally silty, calcareous, yellowish-gray, grayish-olive, greenish-gray, and medium-gray. Siltstone, calcareous, greenish-gray to olive-gray, in 1- to 2-inch thick planar beds. Limestone, medium- to dark-gray, fine- to coarse-grained, fossiliferous, in 6-inch thick beds; and silty to argillaceous, medium-light-gray to medium-dark-gray and olive-gray, micrograined to medium-grained limestone, generally in 1- to 2-inch thick planar beds. A few very-fine grained sandstone beds are present within the unit. The shales are predominant throughout most of southwestern Virginia (Miller and Brosgé, 1954; Miller and Fuller, 1954). Siltstones and limestones are subordinate to and interbedded with the shales. The Reedsville Shale ranges from 275 feet in Lee County to approximately 1000 feet in Frederick County. It is equivalent to the upper Martinsburg of previous reports in western Virginia and is conformable with the underlying Trenton Limestone and Dolly Ridge Formation. *Trenton Limestone* (Vanuxem, 1838). Limestone, medium-light-gray to dark-gray and brownish-gray, micrograined to medium-grained, fossiliferous, thin- to medium-bedded, wavy- to platy-bedded with grayish-yellow and dark-gray shale partings, minor olive-black chert nodules; and one bentonite bed noted in western Scott County (Harris and Miller, 1958). (See Eggleston Formation description for additional discussion of the bentonite beds). Locally some of the dark-colored beds emit a petroliferous odor when broken. The Trenton Limestone ranges from 300 to 600 feet in thickness. *Eggleston Formation* (Matthews, 1934). Mudstone, siltstone, limestone, and

bentonite. Mud stone and siltstone, light-gray, greenish-gray and yellowish-gray, locally contains gray and white mottled calcite patches and stringers. Limestone, light-olive-gray to olive-gray and light-brown, aphanic to medium-grained, thin-bedded; with argillaceous, yellowish-gray, micrograined to medium-grained limestone. Two thick (1-3 feet), greenish-gray, bentonite beds in upper part of unit. Olive-black chert nodules are locally present**.** Mudstone is dominant in lower and locally in upper part; light-olive-gray to olive-gray limestone is dominant in middle part of unit. The Eggleston Formation ranges from 125 to 180 feet in thickness.

Oeln *Edinburg Formation, and Lincolnshire and New*

Market Limestones (northeast of Roanoke County). *Edinburg Formation* (Cooper and Cooper, 1946). Limestone and shale. Limestone, dark-gray to black, aphanic, thin-bedded with thin, black shale partings, locally contorted lime stone beds, intraformational limestone breccias, and olistoliths interstratified with typical planar bedded lime stone (Liberty Hall lithofacies). Limestone, medium- to light-gray, fine- to coarse-grained, nodular with very thin, black shale partings (Lantz Mills lithofacies). Limestone, light-gray, medium- to coarse-grained, thick-bedded (St Luke Limestone Member). Shale, black, graptolites common, basal unit in Augusta, eastern Rockingham, and southern Page counties. Thickness ranges from 400 feet at Strasburg to approximately 100 feet west of Lexington with a maximum of nearly 1500 feet near Harrisonburg.

Lincolnshire Limestone (Cooper and Prouty, 1943). Limestone, light- to dark-gray, fine- to coarse-grained, with black chert nodules. Light-gray, coarse-grained limestone probably represents carbonate mounds *(Murat limestone)*. Upper contact is gradational; the lower contact is disconformable. Thickness ranges from 25 feet west of Front Royal to 280 feet northwest of Lexington (Cooper and Cooper, 1946).

New Market Limestone (Cooper and Cooper, 1946).

Limestone, medium- to dark-gray, aphanic to fine-grained. The upper portion of the New Market, the major quarry rock of northern Virginia, is massive micrite that weathers to fluted ledges. The lower portion is dolomitic with scattered lenticular, black, pyritic limestone, locally conglomeratic at the base. Upper contact is disconformable and the lower contact is a locally angular unconformity. The thickness ranges from 0 near Staunton to 250 feet west of Edinburg.

Ob *Beekmantown Group*. Includes the Pinesburg Station Dolomite, the Rockdale Run Formation, and the Stonehenge Limestone (northern Virginia only) or the Beekmantown Formation and Stonehenge Lime stone (central and south western Virginia).

Pinesburg Station Dolomite (Sando, 1956). Dolostone, dark- to light-gray, fine- to medium-grained, medium- to thickbedded with minor nodular white chert. It ranges from 0 to 400 feet in thickness and is equivalent to beds in the upper Beekmantown Formation. Present only in Clarke and Frederick counties and is conformable with the underlying Rockdale Run Formation and unconformable with the over lying New Market or Lincolnshire Limestones.

Rockdale Run Formation (Sando, 1958). Dominantly lime stone and dolomitic limestone, lesser dolostone with minor chert throughout. Limestone, light- to medium-gray, fine-grained generally, but coarse, bioclastic limestone lo cal ly, medium- to thick-bedded.

Dolostone, light-gray, fine- to medium-grained, thick-bedded with “butcher block” weathering and minor nodular or bedded chert in both limestone and dolostone. Unconformably overlain by the New Market Lime stone where the Pinesburg Station Dolomite is absent. It is laterally equivalent to the Beekmantown Formation and conformably overlies the Stonehenge Limestone. The formation is about 2700 feet thick.

Beekmantown Formation (Clarke and Schuchert, 1899). Dominantly dolostone and chert-bearing dolostone with lesser limestone. Dolostone, light- to very-dark-gray, fine- to coarse-grained, mottled light- and dark-gray, with crystal line beds locally contains nodular, dark-brown or black chert and thick, hill forming, lenticular chert beds in lower part. Limestone, very-light- to medium-gray, fine-grained, medium- to thickbedded, locally dolomitic and locally fossiliferous. The formation is present from Page and Shenandoah counties southwestward in the easternmost exposures of the Lower Ordovician rocks. It and the underlying Stonehenge Limestone, are equivalent to the Mascot and Kingsport Dolomites of the upper part of the Knox Group. It is unconformably overlain by Middle Ordovician limestones and conformably overlies the Stonehenge Limestone.

Erosion, related to the unconformity at the top of the Beekmantown Group and Knox Group, has produced erosional breccias, local topographic relief, and paleokarst topography as well as significant regional thinning of the rock units. The Beekmantown Group thins from about 3000 feet in Page County to less than 700 feet in Washington County, largely because of post-Beekmantown erosion.

Stonehenge Limestone (Sando, 1956). Limestone with interbedded dolostone in northwestern Virginia. Limestone, dark-gray, fine-grained, laminated to massive, with black nodular chert. Dolostone, light-gray, fine-to very-coarse-grained, as thin- to medium-interbeds or as coarse- grained, massive, reefoidal bodies. Reefoidal bodies are restricted to the middle portion of the formation. The formation con form ably overlies the Conococheague Formation and thins north west ward from 400 or 500 feet in the southeasternmost exposures (Page County) to a few tens of feet in the north western exposures (western Rockingham County) and is not recognizable or included in the lower Beekmantown or upper Conococheague in much of southwestern or western Virginia. It is equivalent to the lower part of the Kingsport Dolomite.

OCco/Cco *Conococheague Formation* (Stose, 1908). Dominantly limestone with significant dolostone and sandstone beds in lower part and locally in upper part. Limestone, medium- to very-dark-gray, fine-grained, thin-bedded with wavy siliceous partings that weather out in relief. Vertically repetitious primary sedimentary features such as sharpstone conglomerate, laminated bedding, and algal structures indicate cyclic sedimentation. Dolostone, medium-gray, fine- to medium-grained, laminated to massive-bedded with primary features similar to those in the limestones. Sandstone, medium-gray, brown weathering, cross-laminated, medium to thin-bedded, forms linear ridges, large ly associated with dolostone beds but quartz sand common in most lithologies. Formation is present throughout the Valley of Virginia southeast of the Pulaski and North Mountain faults. It ranges in thickness from about 2200 feet in northern Virginia to 1,700 feet near Abingdon. The Conococheague is approximately equiv a lent to the Cop per Ridge and Chepultepec Formations and conformably overlies the Elbrook Formation.

Om Martinsburg and Oranda Formations.

Martinsburg Formation (Geiger and Keith, 1891). Three lithologic packages are recognized in the Martinsburg (in ascending order): black shale and limestone; sandstone and shale; and sandstone (Rader and Biggs, 1976). The lower unit consists of 200 to 250 feet of black calcareous shale, black aphanic, argillaceous limestone; and thin, light-brown K-bentonites. The bulk of the formation, more than 2800 feet, is composed of olive-green to gray, fine- to medium-grained, lithic sandstone and greenish-gray shale and siltstone. These lithologies occur in base-truncated Bouma cycles. Graded bedding, flute casts, and load casts are common. The upper unit, about 170 feet thick, is brownish-gray, medium- to coarse-grained, quartz sandstone. The lower two-thirds of this sandstone contains near-shore, marine fossils.

Oranda Formation (Cooper and Cooper, 1946). Limestone and siltstone. Limestone, medium- to dark-gray, fine-grained, very argillaceous. Siltstone, black to dark-gray; both lithologies silicified where in contact with a K-bentonite. Five K-bentonites identified in the type section (Rader and Read, 1989).

Ous *Juniata Formation, Reedsville Shale, Trenton Lime stone, and Eggleston Formation.*

Juniata For ma tion (Darton and Taff, 1896). Siltstone, shale, sand stone, and limestone. Siltstone, shale, and sandstone, locally calcareous, grayish-red, locally fossiliferous; with some interbeds of greenish-gray shale, quartzarenite, and argillaceous limestone. Cycles consisting of a basal, crossbedded quartzarenite with a channeled lower contact; a middle unit of interbedded mudstone and burrowed sandstone; and an upper bioturbated mudstone are commonly present north of New River (Diecchio, 1985). The Juniata Formation ranges from less than 200 to more than 800 feet in thickness. In southwestern Virginia the red, unfossiliferous, and argillaceous Juniata Formation is present in the southeastern belts. It is equivalent to the gray, fossiliferous, and limy Sequatchie Formation of western belts (Thompson, 1970;

Dennison and Boucot, 1974). Even though the beds along Clinch Mountain, in Scott County, contain minor amounts of carbonate rock (Harris and Miller, 1958) the majority is grayish-red siltstone, which is typical of the Juniata Formation. Figure 3. Correlation of Upper and Middle Ordovician units.

Reedsville Shale. Refer to description under **Ou**.
Trenton Limestone. Refer to description under **Ou**.
Eggleston Formation. Refer to description under **Ou**.

Ce *Elbrook Formation* (Stose, 1906). Dolostone and limestone with lesser shale and siltstone. Dolostone, medium-to dark-gray, fine- to medium-grained, laminated to thick-bedded. Limestone, dark-gray, fine-grained, thin- to medium-bedded, with algal structures and sharpstone conglomerate. Shale and siltstone, light- to dark-gray, dolomitic, platy weathering, with minor grayish-red or olive-green shales. Interbedded limestone and do lo stone dominate the upper part of the formation; dolomitic siltstone and shale and thin- bedded argillaceous limestone dominate the lower part. The formation ranges between 1500 and 2900 feet in thick ness in the southeasternmost exposures but is incomplete elsewhere due to faulting. The Elbrook of northern Virginia is transitional with the Nolichucky and Honaker Formations (locally the limestone facies of the

Nolichucky has been differentiated from the Elbrook by Bartlett and Biggs (1980). It is also approximately equivalent to the rock sequence comprised of the Nolichucky and Maryville Formations, the Rogersville Shale, and the Rutledge Formation. Farther southwest the Conasauga Shale is the Elbrook equivalent. The Elbrook appears to be conformable and gradational with the underlying Waynesboro or Rome Formations.

From Washington County to Augusta County much of the Elbrook Formation adjacent to the Pulaski and Staunton faults is a breccia of the "Max Meadows tecontic breccia type" (Cooper and Haff, 1940). These breccias are composed of crushed rock clasts that range from sand size to blocks many feet long, derived almost entirely from the lower part of the Elbrook Formation. The breccia commonly forms low lands characterized by karst features.

Cwb *Waynesboro Formation* (Stose, 1906). Largely do lo stone and lime stone with distinctive up per and lower sequences of interbedded red mudrock, red sand stone, and do lo stone. Dolostone, light- and dark-gray, mottled, fine- to coarse-grained, thick-bedded, calcareous. Limestone, medium-gray, fine-grained, thick-bedded, locally with black chert nodules. Mudrock, grayish-red, locally fi ssile, interbedded with do lo stone and sandstone. Sandstone, dark- grayish red, fine- to medium-grained, medium- to thin-bedded, forms low ridges and hills. The Waynesboro Formation is laterally equivalent to the Rome Formation and is only present north east of Roanoke. It is well exposed in Botetourt County (Haynes, 1991) and in Clarke County (Gathright and Nystrom, 1974) where lower shale beds of the Elbrook Formation were incorrectly included in the Waynesboro as an upper member. It is conformable with the underlying Tomstown Dolomite and is between 1100 and 1200 feet thick.

Cch *Chilhowee Group* (Keith, 1903). The Chilhowee Group includes the Antietam, Harpers, and Weverton Formations in the northeastern portion of the Blue Ridge Province and the Erwin, Hampton, and Unicoi Formations in the southwestern portion of the Blue Ridge Province.

Antietam Formation (Williams and Clark, 1893). Quartzite, medium-gray to pale-yellowish-white, fine- to mediumgrained, locally with very minor quartz-pebble con glom er ate, cross-laminated, medium- to very-thick-bedded, very resistant, forms prominent cliffs and ledges, contains a few thin interbeds of light-gray phyllite, has calcareous quartz sand stone at the top that is transitional with the overlying Tomstown Dolomite, and many beds contain *Skolithos linearras*. It is laterally equivalent to the Erwin Formation to the southwest. The formation interfingers with the underlying Harpers Formation and ranges in thickness from less than 500 feet in Clarke County to nearly 1000 feet in Rockingham County (Gathright and Nystrom, 1974; Gathright, 1976).
Harpers Formation (Keith, 1894). Metasandstone, metasiltstone, and phyllite. Metasandstone, dark-greenish gray to brownish-gray, fine-grained, sericitic, thin- to medium-planar bedded, locally bioturbated, *Skolithos*-bearing litharenite; dark-gray, fine-grained, cross-laminated, thickbedded, laterally extensive bodies of quartzite; and very-darkgray, medium- to coarse-grained, thick-bedded, ferruginous, very resistant, quartzitic sandstone. These beds were extensively mined for iron ore north of Roanoke (Henika, 1981). Metasiltstone, dark-greenish-gray, thin, even bedded, sericitic, and locally bioturbated. Phyllite, medium- to light-greenish-gray, bronze weathering, laminated, sericitic. The Harpers is laterally equivalent to the Hampton Formation to the southwest

and they are so similar that the names have been used interchaneably in the northern Blue Ridge (Gathright, 1976;

Brown and Spencer, 1981). The Harpers conformably over lies the Weverton or Unicoi Formations, thickens northeastward from about 1500 feet north of Roanoke to about 2500 feet in Clarke County. The thicker sections are dominated by phyllite and metasiltstone and the thinner sections by metasandstone and quartzite.

Weverton Formation (Williams and Clark, 1893). Quartzite, metasandstone, and phyllite. Quartzite, medium to very dark-gray, weathers light-gray, fine- to coarse-grained, well rounded quartz-pebble conglomerate beds locally, medium- to thick-bedded, cross-bedded, very resistant, with interbedded metasandstone, dark-greenish- gray, feldspathic, thick-bedded, with ferruginous cement in some beds. **Phyllite**, light- to dark-greenish-gray or dark-reddish-gray, laminated, sericitic, with coarse sand grains and quartz-pebble conglomerate in a few thin beds, generally in lower part. Formation ranges in thickness from more than 600 feet in Clarke County to less than 200 feet in Augusta County (Gathright and Nystrom, 1974; Gathright and others, 1977). The Weverton is lithologically very similar to strata in the upper portion of the Unicoi Formation to the south to which it may be equivalent. The Weverton appears to unconformably overlie the Catoctin and Swift Run Formations and the Blue Ridge basement complex and is present northeast of Augusta County.

Cr *Pumpkin Valley Shale and Rome Formation*. *Pumpkin Valley Shale* (Bridge, 1945). Shale, light-greenish-gray to dark-greenish-gray, grayish-brown, and maroon; a few beds of similar colored siltstone; sparse beds of limestone and dolostone. The Pumpkin Valley Shale conformably overlies the Rome Formation. The formation is approximately 350 feet thick.

Harris (1964) identified the Pumpkin Valley Shale of Southwest Virginia as a formation within the Conasauga Group; however, because of similar lithologies it is often in distinguishable from the Rome Formation and the two formations commonly are mapped together. *Rome Formation* (Hayes, 1891). Siltstone, shale, sand stone, dolostone, and limestone. Siltstone and shale, greenish-gray and grayish-red, laminated to thin-bedded. Sandstone, micaceous, locally glauconitic, greenish-gray and reddish-gray, very-fi ne- to medium-grained, thin-bedded. Dolostone, light- to dark-gray, aphanic to medium-grained, thin-to massive-bedded, with ripple marks and mudcracks. Limestone, argillaceous, very light-gray to dark-gray, thin- to medium- bedded. Carbonate rocks range from sparse 1- to 2-feet-thick beds in western Scott County to discontinuous units as much as 50 feet thick which comprise 30 to 40 percent of the formation in western Russell and Washington counties (Evans and Troensegaard, 1991; Bartlett and Webb, 1971). Maximum recorded thickness is 1500 feet in the Clinchport area (Brent, 1963); although this may have included the Pump kin Valley Shale. A complete thickness has not been determined be cause the lowermost part of the Rome Formation is normally absent due to faulting.

Cs *Shady Dolomite* (Keith, 1903). Dolostone with minor limestone and shale divided into three members: Ivanhoe (upper) Member; Austinville (middle) Member, and Patterson (low er) Member. *Ivanhoe Member*, dark-gray, fine-grained limestone and minor interbedded black shale; 100 to 500 feet thick. *Austinville Member*, very-light-gray to

cream colored, fine- to medium-grained, crystalline or saccharoidal, massive-bedded dolostone with several sequences of interbedded limestone, very-dark-gray dolostone or mottled dolostone and shale; 1000 feet thick. *Patterson Member*, medium- to dark-gray, fine-grained, thin-bedded do lo stone or limestone with silicious partings and intraformational breccia beds; 800 feet thick. The Shady Dolomite is gradational with the underlying Erwin Formation and the upper two members grade southeast ward into shaly dolostone with biohermal mounds, intraformational limestone or dolostone breccias, oolitic limestone, and arenaceous limestone and dolostone. This upper, southeastern facies, is in part equiv a lent to beds in the lower Rome Formation (Pfiel and Read, 1980). The Shady is very poorly exposed except near New River in Wythe and Smyth counties where it is at least 2100 feet thick and where major lead and zinc deposits were mined from the upper members (Cur ri er, 1935).

CZc Catoctin Formation (CZc, CZcb, CZct, CZcs, CZcr, CZhb, CZlb)

CZc *metabasalt*. Grayish-green to dark-yellowish-green, fi ne-grained, schistose chlorite- and actinolite-bearing metabasalt, commonly associated with epidosite segregations. Mineralogy: chlorite + actinolite + albite + epidote + titanite ± quartz + magnetite. Relict clinopyroxene is common; biotite porphyroblasts occur locally in south eastern outcrop belts.

Geophysical signature: The Catoctin as a whole has a strong positive magnetic signature. However, between Warrenton and Culpeper the lowest part of the Catoctin, which consists of low-titanium metabasalt and low-titanium metabasalt breccia, is non-magnetic, and displays a strong negative anomaly. Metabasalt **(CZc)** is by far the most widespread unit comprising 3000 feet or more of section (Gathright and others, 1977). Primary volcanic features are well preserved in many places. In the northwestern outcrop belt, these include vesicles and amygdules, sedimentary dikes, flow-top breccia, and columnar joints (Reed, 1955; Gathright, 1976; Bartholomew, 1977); relict pillow structures have been reported in Catoctin greenstones east of Buena Vista (Spencer and others, 1989). In the southeastern outcrop belt, amygdaloidal metabasalts are common, as are volcanoclastic rocks interbedded with basaltic flows (Rossman, 1991). Fragmental zones occur locally between individual lava flows; map-scale hyaloclastite pillow breccias occur at three stratigraphic levels within the south eastern outcrop belt **(CZcb, CZhb, CZlb**; Espenshade, 1986; Kline and others, 1990).

Yc *charnockite.* Includes dusky-green, mesocratic, coarse- to very-coarse-grained, equigranular to porphyritic, massive to vaguely foliated pyroxene-bearing granite to granodiorite; contains clinopyroxene and orthopyroxene, intermediate-composition plagioclase, potassium feldspar, and blue quartz. Reddish-brown biotite, hornblende, and poikilitic garnet are present locally; accessory minerals in clude apatite, magnetite-ilmenite, rutile, and zircon.

Geophysical signature: charnockite pods in the southeastern Blue Ridge produce a moderate positive magnetic anomaly relative to adjacent biotite gneisses, resulting in spotty magnetic highs.

This unit includes a host of plutons that are grouped on the basis of lithology, but are not necessarily consanguineous. These include Pedlar charnockite, dated at 1075 Ma (U-Pb

zircon, Sinha and Bartholomew, 1984) and Roses Mill charnockite (Herz and Force, 1987), dated at 1027±101 Ma (Sm-Nd, Pettingill and others, 1984).

Yl *leucocharnockite*. Leucocratic, coarse-grained to megacrystic pyroxene-bearing granite, porphyritic in part with euhedral potassium feldspar phenocrysts, interstitial plagioclase and quartz; ferromagnesian minerals include orthopyroxene, clinopyroxene, magnetite-ilmenite; hornblende, red-brown biotite, and garnet may be present. Accessory minerals include zircon, monozite, and apatite. Pyroxene is thoroughly uralitized.