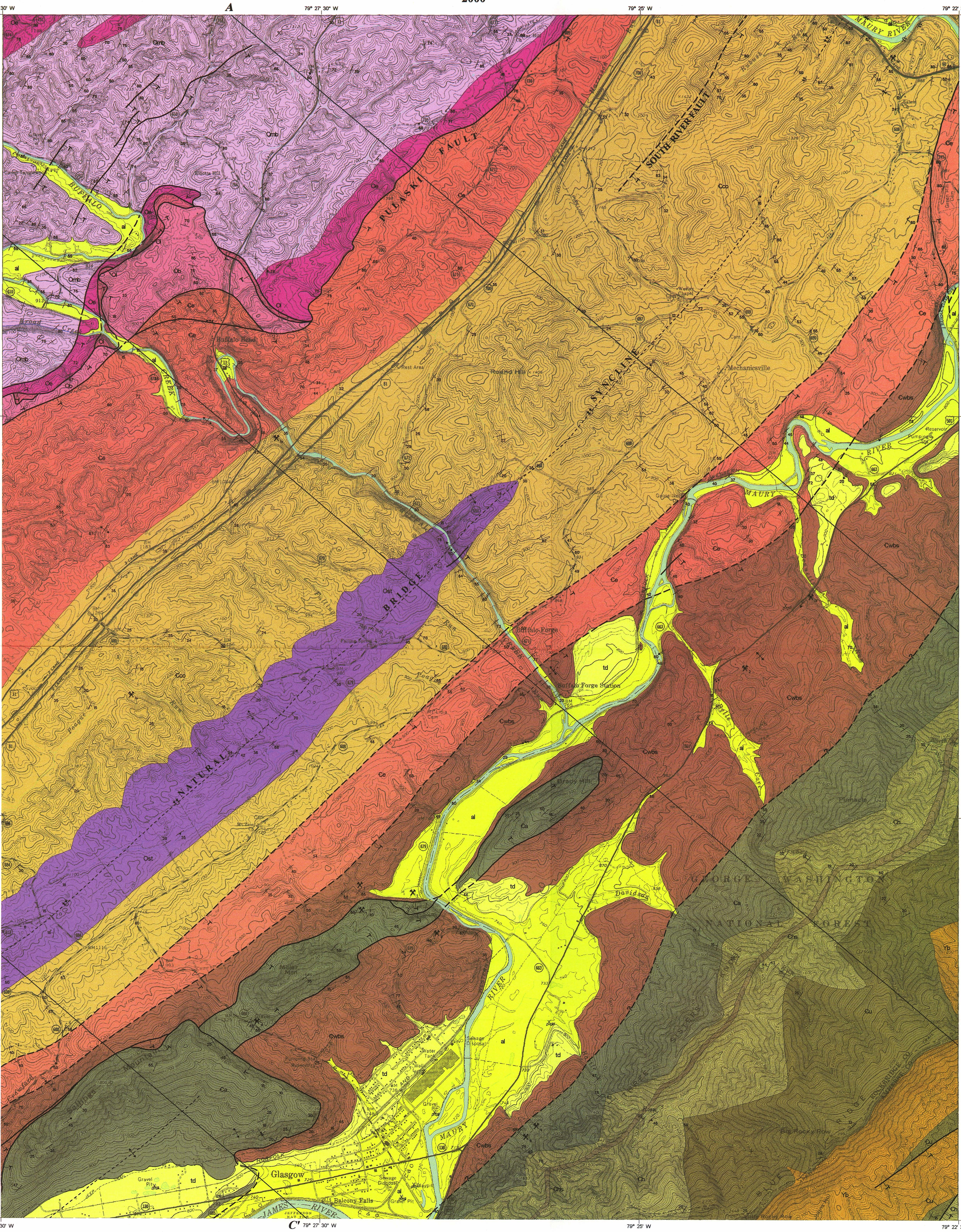
COMMONWEALTH OF VIRGINIA
DEPARTMENT OF MINES, MINERALS AND ENERGY
DIVISION OF MINERAL RESOURCES

GEOLOGY OF THE GLASGOW QUADRANGLE, VIRGINIA

Geology by Edgar W. Spencer
2000

PUBLICATION 154 PLATE A
GEOLOGY OF THE
GLASGOW QUADRANGLE, VIRGINIA



Base Map is U.S. Geological Survey DRG, 1965 Glasgow Quadrangle, Virginia 7.5 minute series
Projection: Polyconic
Map Scale = 1:24,000

Contour Interval 20 feet

This map was prepared in cooperation with the U.S. Geological Survey under the National Cooperative Geologic Mapping Program - STATEMAP component

Digital Conversion in cooperation with Department of Geography, Radford University, Radford, Virginia

EXPLANATION

QUATERNARY

al — **Alluvium:** Channel, flood-plain, and fan deposits of unconsolidated clay, silt, sand, and cobbles. Colluvium, a mixture of mountain soil and alluvium and talus deposits, mainly quartzite fragments of the Antietam Formation and Snowden Member of the Harpers Formation, occurs on the flanks of the Blue Ridge, not mapped. Fan deposits and colluvium cover most of the Shady Formation along the flank of the Blue Ridge and on Sallings Mountain. *Estimated thickness:* 0 to 30 feet (0 to 10m).

td — **Terrace deposits:** High level terrace deposits consisting of unconsolidated clay, silt, sand, and cobbles occur along the Maury River. These deposits interfinger upslope with colluvium on the flank of the Blue Ridge. Downslope these deposits grade into more recent alluvium. *Estimated thickness:* 0 to 100 feet (0 to 30 m).

ORDOVICIAN

Omb — **Martinsburg Formation:** Black to light-gray and light-olive-gray, thin-bedded, fine- to medium-grained limestone occurs in the lower part of the formation. Olive-green to greenish-gray shale and siltstone make up the bulk of the formation. Upper portions of the formation do not crop out in this quadrangle. *Thickness:* 1000 to 2000 feet (300 to 600 m).

Oe — **Edinburg Formation:** Black, aphanic limestone in thin beds, interbedded with black shale (Liberty Hall lithofacies); black limestone and nodular limestone (Lantz Mills lithofacies); and coarse-grained, blue-gray limestone with reddish cast on weathered surfaces (Botetourt Limestone Member of Cooper and Cooper, 1946). *Thickness:* 500 to 1000 feet (150 to 300 m).

Ol — **Lincolnshire Limestone:** Limestone, light- to dark-gray, fine- to coarse-grained, with black chert nodules. The thick-bedded, coarse-grained Murat lithofacies is a biostrome. Thickness: 200 to 400 feet (70 to 130 m). New Market Limestone: Limestone, medium- to dark-gray, aphanic to fine-grained. Blocks of the New Market Limestone that occur along the Pulaski fault are mapped with the Lincolnshire Limestone. *Thickness:* 0 to 160 feet (0 to 53 m).

Ob — **Beekmantown Formation:** Dolostone, light- to dark-gray, fine- to coarse-grained, mottled light- and dark-gray, fine- to coarse-grained, crystalline beds locally contain nodular, black and light-gray to white bedded chert. Thinly laminated dolostone weathers to form massive layers interbedded with medium-gray, aphanic limestone. *Thickness:* 1500 feet (450 m).

Ost — **Stonehenge Formation:** Limestone, dark-gray, fine-grained, laminated to thick-bedded, with black nodular chert. Dolostone, light-gray, fine- to coarse-grained, as thin- to medium-interbeds, massive, reefoid bodies. *Thickness:* 300 to 500 feet (100 to 165 m).

CAMBRIAN

Єco — **Conococheague Formation:** Dominantly limestone with dolostone and sandstone beds in lower part. Limestone, medium- to dark-gray, fine-grained, thin-bedded with wavy, siliceous partings that weather in relief. Dolostone, medium-gray, fine- to medium-grained, laminated to thick-bedded with primary features similar to those in the limestone. Sandstone, medium-gray, brown weathering, cross-laminated, medium- to thin-bedded, carbonate cement. *Thickness:* 2000 feet (650 m).

Єe — **Elbrook Formation:** Dolostone and limestone with lesser amounts of shale and siltstone. Dolostone, medium- to dark-gray, fine- to medium-grained, laminated to thick-bedded. Limestone, dark-gray and white, fine-grained to aphanic, thin- to medium-bedded, with algal structures. Shale, light- to dark-gray, dolomitic, platy weathering, with minor grayish-red or olive-green shale. *Thickness:* 1000 to 2000 feet (300 to 600 m).

Єwbs — **Waynesboro Formation and Shady Dolomite undivided:** Shale, siltstone, dolostone, and limestone. Shale, greenish-gray and grayish-red, laminated to thin-bedded. Dolostone, light- to dark-gray, aphanic to medium-grained, thin- to thick-bedded, with ripple marks and mudcracks. Limestone, medium- to dark-gray, thin- to medium-bedded; silty borings indicate bioturbation. Haynes (1991) provides a detailed description of the Waynesboro southwest of Glasgow. *Thickness:* 1000 to 1500 feet (300 to 450 m). **Shady Dolomite:** (Not exposed in this quadrangle; description based on exposures to the southwest in the Arnold Valley quadrangle.) Dolostone with minor limestone and shale. Limestone, medium- to dark-gray, fine-grained, thin- to medium-bedded with siliceous partings. Dolostone, light-gray, fine- to medium-grained, crystalline, thick-bedded. *Thickness:* 1000 to 1500 feet (300 to 450 m) in the Arnold Valley quadrangle (Spencer, 1968).

Єa — **Antietam Formation:** Quartzite, medium-gray to pale-yellowish-white, fine- to medium-grained, cross-laminated, medium- to very-thick-bedded, very resistant to weathering; calcareous quartz sandstone at top; many beds contain *Skolithos linearis*. *Thickness:* 600 to 700 feet (300 to 233 m).

Єh — **Harpers Formation:** Sandstone, orthoquartzite, siltstone, and shale. Sandstone, feldspathic, greenish-gray, medium- to coarse-grained, cross-laminated. Orthoquartzite, white to light-brown, fine-grained, medium- to thin-bedded. *Thickness:* 1000 to 1500 feet (300 to 450 m).

Єhs — **Snowden Member** (Єhs), *Skolithos* -bearing, white to grayish orthoquartzite and medium- to coarse-grained, thick-bedded sandstone with crossbeds. Shale, dark-gray or dark-greenish-gray, fissile, argillaceous, silty laminae common, with interbeds of siltstone and fine-grained sandstone. *Thickness:* 50 to 100 feet (18 to 30 m).

Єu — **Unicoi Formation:** Sandstone and quartzite with interbedded phyllite, tuffaceous phyllite, and conglomerate. Sandstone, lithic or feldspathic, pinkish-gray to dark-greenish-gray, fine- to coarse-grained, grains angular, poorly sorted, locally conglomeratic. Quartzite, largely in the upper part of the unit, white, pale-green, or gray, vitreous, medium- to coarse-grained, locally feldspathic, medium- to thick-bedded, resistant to weathering and erosion. Phyllite, reddish-, purplish-, or greenish-gray, with purplish tuffaceous phyllites in lower part. Conglomerate, fine to coarse, polymictic pebble conglomerate, medium- to thick-bedded, with lithic clasts and quartz pebbles. *Thickness:* 600 to 800 feet (185 to 245 m).

PROTEROZOIC Y

Yb — **Blue Ridge basement complex:** Pyroxene-bearing granitoid rocks and granulite gneiss, undivided.

KEY

CONTACTS
- Exposed or approximate
- Inferred or covered

FAULTS
- Solid - exposed or approximate; dashed - inferred or covered; T - on the upper plate; U - upthrown side, D - downthrown side of high angle fault; ? - probable fault.

FOLDS
- Anticline
- Overturned anticline
- Syncline
- Overturned syncline

ATTITUDE OF ROCKS
- Strike and dip of inclined bedding
- Strike and dip of overturned bedding
- Horizontal bedding
- Strike of vertical bedding
- Strike and dip of bedding where top of beds can be distinguished
- Strike and dip of overturned bedding where top of beds can be distinguished

ATTITUDE OF FOLIATION
- Strike and dip of schistosity
- Strike of vertical schistosity

LOCATION OF QUARRIES OR PROSPECTS
- Active Quarry
  1) Lone Jack Quarry Complex
- Inactive Quarry
  2) General Shale Products Company
  ls limestone
  d dolostone
- Inactive Pit
  g Gravel
  cl Clay
  ls Limestone or Dolostone
  q Quartzite

MINOR FOLDS
- Anticline, showing plunge
- Minor antiform
- Minor overturned anticline
- Overturned anticline, where top of beds can be distinguished
- Overturned anticline, showing plunge
- Syncline, showing plunge
- Minor overturned syncline
- Minor synform
- Minor fold
- Minor fold, showing plunge

OTHER SYMBOLS
- Shear zone
- Fault breccia
- Water well

The map was compiled digitally and the geospatially referenced digital files are available from the Division of Mineral Resources, P.O. Box 3667, Charlottesville, VA 22903.

PHYSIOGRAPHY

The Glasgow quadrangle is located along the boundary between the structural-physiographic provinces of the Blue Ridge and the Great Valley of Virginia. Maximum relief occurs along the Blue Ridge flank where topography is closely related to the structure of the underlying rocks. Distinct northeast-trending ridges are defined by the Unicoi and Antietam Formations. Variations in resistance to weathering and erosion of the northwest-dipping rock units in the lower Cambrian section combine with their structure to form a prominent series of triangular-shaped flat irons. Sallings and Miller Mountains, both underlain by Antietam quartzite, form an external structural element of the Blue Ridge. They stand completely separated from the Blue Ridge and other outcrops of the Antietam. The James and Maury Rivers flow between them and the Blue Ridge. This external ridge is interpreted as a remnant of a thrust sheet which is more extensively exposed in the Buchanan quadrangle (Bloomer, 1941; Bloomer and Werner, 1955; Spencer, 1968) to the southwest.

Northwest of the Blue Ridge, the Valley is characterized by rolling hills and rounded ridges of northeast trend typical of the Great Valley of Virginia. Maximum relief in the Valley is about 600 feet (180 m). Many of the streams in the Valley are closely adjusted to the structure and resistance of the bedrock. Between Buena Vista and Glasgow, the Maury River is largely confined to a zone underlain by the Waynesboro and Elbrook Formations, both of which are easily eroded. In contrast, Buffalo Creek flows at right angles across structural trends and across rocks of varying resistance. Although Buffalo Creek flows in an unusually straight channel across structure, no evidence of structural control for its course has been found. At the northwestern border of the Glasgow quadrangle, Buffalo Creek flows in a meandering course and appears superimposed on the underlying bedrock.

At Glasgow, immediately downstream from the confluence of the Maury and James Rivers, the James River abruptly turns and flows southeast across the Blue Ridge, cutting across the resistant rocks of the Chilhowee Group. The large structural features exposed in the James River Gap can be traced across the river. Some, like the outcrop belts of the Antietam, the Unicoi, and the crystalline basement, cause rapids in the river. The cascades in the river, especially those formed by the Antietam, are known as Balcony Falls. It is not obvious that the location of the gap is structurally controlled; however, careful study of fracture intensity has not been done.

KARST FEATURES

The best developed karst features in this area occur within the outcrop belts of the Stonehenge and Conococheague Formations along the axial portion of the Natural Bridge syncline. A large number of sinkholes occur south of Buffalo Creek in the center of the map area. Openings from these are located a short distance away in the cliffs above Buffalo Creek. A few sinkholes also occur in the Beekmantown outcrop belt in the footwall of the Pulaski fault. Although small sinkholes are common, no major perennial streams are presently diverted to underground courses. Buffalo Creek is entrenched along much of its course between Buffalo Bend and the Maury River. The steep cliffs and narrow valley along Buffalo Creek resemble the valley of Cedar Creek at Natural Bridge, but no evidence could be found to indicate that the stream formerly flowed through a natural tunnel as has been suggested for Cedar Creek.

STRUCTURE

Most of the Glasgow quadrangle is located in the Great Valley of Virginia. The northwestern flank of the Buena Vista anticline (Buena Vista Quadrangle)forms the southeastern boundary of the Great Valley except in the southern part of the Glasgow quadrangle where Sallings and Miller Mountains, part of the Blue Ridge thrust sheet, are located northwest of the Buena Vista anticline. The Natural Bridge syncline, which is developed in rock units ranging in age from lower Cambrian to upper Ordovician, is the largest structural feature in this portion of the Valley. The Pulaski fault is located along the northwestern limb of the Natural Bridge syncline.

NATURAL BRIDGE SYNCLINE

The broad belt of Conococheague and Stonehenge Formations which runs diagonally across the map crops out in the trough of the asymmetric Natural Bridge syncline. On the overturned southeastern limb of the syncline, rocks of the Elbrook and Conococheague Formations exhibit complex deformation. Local northwest-directed thrusting has taken place along the contacts between rock units on the southeastern limb. In contrast, the northwestern limb is only slightly deformed despite the presence of the Pulaski thrust along the edge of this limb of the syncline.

The hinge of the Natural Bridge syncline is best exposed along Buffalo Creek near the bridge on State Road 698 and along the Maury River north of U.S. Highway 60 between Lexington and Buena Vista. At Buffalo Creek, the structural attitude of the beds changes abruptly, and the beds on the southeastern limb are folded into asymmetric folds, some of which are overturned toward the northwest. Cleavage dips southeast at 60-80 degrees and is parallel to bedding in many places. Deformation is locally intense, especially near the axis of the Natural Bridge syncline, indicated by the small sheath folds and larger mesoscopic folds in the Conococheague Formation. Locally highly distorted and displaced beds occur along the hinge of the syncline.

Near the northern boundary of the Glasgow quadrangle, exposures along the Maury River are excellent and the complexity of the structure of the Natural Bridge syncline becomes more apparent. The South River fault, mapped by Bick (1960) in the Lexington quadrangle, probably extends into the Glasgow quadrangle. Where exposed along the Maury River, this fault causes duplication of part of the Conococheague Formation. Although the fault zone itself was not found in the Glasgow quadrangle, the width of outcrop of the Conococheague is too great to be a normal section, and a complex fold structure is present on trend with the hanging wall of the thrust as mapped in the Lexington quadrangle.

Farther east along the Maury River at least two other southeast-dipping thrusts are exposed along the Chessie Trail. The rocks on the hanging wall of these faults may be part of the Elbrook Formation, but in both cases Conococheague is also in these fault slices. Another fault is present near the western border of the city of Buena Vista, where overturned beds of the Elbrook Formation are faulted onto the Conococheague Formation. Along the Pulaski fault, overturned beds of the Elbrook Formation are faulted onto the Conococheague Formation.

PULASKI FAULT

The Pulaski fault (the Staunton-Pulaski fault of older literature) crosses the northwestern corner of the Glasgow quadrangle. The fault plane is located in the Elbrook Formation on the northwestern limb of the Natural Bridge syncline. The Elbrook is thrust over the Edinburg Formation with stratigraphic throw of approximately 6000 feet (2000m). The Elbrook on the hanging wall block is not strongly deformed, but the Edinburg and Martinsburg Formations on the footwall are complexly deformed beneath the fault. From the northern edge of the Glasgow quadrangle to Buffalo Bend, the trace of the Pulaski fault is relatively straight, and the bedding on both the hanging wall and footwall exhibits no large folds or unusually complex structure, but near Buffalo Bend, the trace of the fault turns toward the northwest and a highly complicated zone of folds and subsidiary faults is developed on the footwall side of the fault trace.

West of Buffalo Bend, a large, folded, wedge-shaped body consisting of the Beekmantown Formation, Lincolnshire Limestone, and the Edinburg Formation is situated on the footwall of the Pulaski fault. The Beekmantown is not well exposed in this block, but scattered outcrops including a few residual pieces of Beekmantown chert are present, and the Lincolnshire forms discontinuous outcrops belts around the Beekmantown.

This anomalous structure on the footwall of the Pulaski fault is interpreted as a wedge-shaped block removed from the top edge of a ramp where the Pulaski thrust rose from a plane of decollement in the Elbrook-Waynesboro to a higher level in the Edinburg-Martinsburg section (Spencer, 1991). The wedge is thought to have been transported in the Pulaski fault zone to a position northwest from its place of origin. Details of portions of this block have been described by Bloomer (1947) and Vosen (1991).

BLUE RIDGE

The southeastern corner of the Glasgow quadrangle is located in the Blue Ridge structural and physiographic province. The Blue Ridge basement complex is composed of Precambrian-age granulite-facies metamorphic and igneous rocks, all of which are part of the Grenville province.

SALLINGS MOUNTAIN KLIPPE

[illegible]

ECONOMIC GEOLOGY

[illegible] The Waynesboro shale which is suitable for manufacture of bricks occurs in a wide belt along the Maury River. The Elbrook, Conococheague, Stonehenge, Beekmantown, Lincolnshire, and parts of the Edinburg Formations are suitable for aggregate. Gravel is present in the flood plain of the Maury River, and in the past clay pits were operated by Locher Brick Company at Glasgow. Evaluation of clay and shale samples collected in this area is reported by Calver and others (1964).

The Lone Jack quarry (active quarry No.1, with three pits) is located off State Road 679 along the Northwestern edge of Sallings Mountain klippe. The Antietam quartzite and Waynesboro shale, limestone and dolostone are quarried. The stone is mainly used for aggregate.

An inactive quarry (No. 2) located east of U. S. Highway 501 between Buena Vista and Glasgow was operated by the Locher Division of General Shale Products Company. Shale from the Waynesboro Formation was quarried for use in the manufacture of bricks at the Locher plant in Glasgow.

ACKNOWLEDGEMENTS

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I would also like to thank James Whisenhunt, a student in the Geography Department at Radford University, for digitizing the initial mylar under the direction of Dr. Lori LeMay. Elizabeth V. M. Campbell and Rebecca S. Hope deserve credit for digital editing and digitally incorporating the many changes to the map and for the final cartographic layout.

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Geology by Edgar W. Spencer
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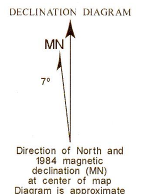
Base Map is U.S. Geological Survey DRG, 1963 Buena Vista Quadrangle, Virginia, 7.5 minute series Photorevised 1982

Projection: Polyconic
lon 0 = -79.3125000
lat 0 = 37.5000000
Map Scale = 1:24,000



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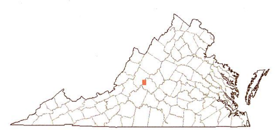
0 — 500 — 1000 — 1500 — 2000 — 2500 — 3000 — 3500 meters

Contour Interval 40 feet



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EXPLANATION

QUATERNARY

al — **Alluvium:** Channel, flood-plain, and fan deposits of unconsolidated clay, silt, sand, and cobbles. Colluvium, a mixture of mountain soil and alluvium and talus deposits, mainly quartzite fragments of the Antietam Formation and Snowden Member of the Harpers Formation, occurs on the flanks of the Blue Ridge, not mapped. Fan deposits and colluvium cover most of the Shady Dolomite along the flank of the Blue Ridge and on Sallings Mountain. *Estimated thickness:* 0 to 30 feet (0 to 10 m).

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CAMBRIAN

Cco — **Conococheague Formation:** Dominantly limestone with dolostone and sandstone beds in lower part. Limestone, medium- to dark-gray, fine-grained, thin-bedded with wavy, siliceous partings that weather in relief. Dolostone, medium-gray, fine- to medium-grained, laminated to thick-bedded with primary features similar to those in the limestone. Sandstone, medium-gray, brown weathering, cross-laminated, medium- to thin-bedded, carbonate cement. *Thickness:* 2000 feet (650 m).

Ce — **Elbrook Formation:** Dolostone and limestone with lesser amounts of shale and siltstone. Dolostone, medium- to dark-gray, fine- to medium-grained, laminated to thick-bedded. Limestone, dark-gray and white, fine-grained to aphanic, thin- to medium-bedded, with algal structures. Shale, light- to dark-gray, dolomitic, platy weathering, with minor grayish-red or olive-green shale. *Thickness:* 1000 to 2000 feet (300 to 600 m).

Cwbs — **Waynesboro Formation and Shady Dolomite (undivided):** Shale, siltstone, dolostone, and limestone. Shale, greenish-gray and grayish-red, laminated to thin-bedded. Dolostone, light- to dark-gray, aphanic to medium-grained, thin- to thick-bedded with ripple marks and mudcracks. Limestone, medium- to dark-gray, fine-grained, thin-bedded; silty borings indicate bioturbation. Haynes (1991) provides a detailed description of the Waynesboro southwest of Glasgow. *Thickness:* 1000 to 1500 feet (300 to 450 m). **Shady Dolomite:** (Not exposed in this quadrangle; description based on exposures to the southwest in the Arnold Valley quadrangle) Dolostone with minor limestone and shale. Limestone, medium- to dark-gray, fine-grained, thin- to medium-bedded with siliceous partings. Dolostone, light-gray, fine- to medium-grained, crystalline, thick-bedded. *Thickness:* 1000 to 1500 feet (300 to 450 m) in the Arnold Valley quadrangle.

b — **Basalt dikes and sills:** Basalt, dark-greenish-gray, locally amygdaloidal in lower part.

Ca — **Antietam Formation:** Quartzite, medium-gray to pale-yellowish-white, fine- to medium-grained, cross-laminated, medium- to very-thick-bedded, very resistant to weathering; calcareous quartz sandstone at top; many beds contain *Skolithos linearis*. *Thickness:* 600 to 700 feet (200 to 233 m).

Ch — **Harpers Formation:** Sandstone, orthoquartzite, siltstone, and shale in the western part of the quadrangle. Metaquartzite, metasiltstone, and phyllite in the eastern outcrop belts. Sandstone, feldspathic, greenish-gray, medium- to coarse-grained, cross-laminated. Orthoquartzite, white to light-brown, fine-grained, medium- to thin-bedded. Metamorphosed equivalents in eastern belts are sericitic and greenish in color. *Thickness:* 1000 to 1500 feet (300 to 450 m).

Chs — **Snowden Member:** *Skolithos*-bearing, white to grayish orthoquartzite and medium- to coarse-grained, thick-bedded sandstone with crossbeds. Shale, dark-gray or dark-greenish-gray, fissile, argillaceous, silty laminae common, with interbeds of siltstone and fine-grained sandstone. *Thickness:* 50 to 100 feet (18 to 30 m).

Cu — **Unicoi Formation:** Sandstone and quartzite with interbedded phyllite, tuffaceous phyllites, and conglomerate. Sandstone, lithic or feldspathic, pinkish-gray to dark-greenish-gray, fine- to coarse-grained, grains angular, poorly sorted, locally conglomeratic. Quartzite, largely in the upper part of the unit, white, pale-green, or gray, vitreous, medium- to coarse-grained, locally feldspathic, medium- to thick-bedded, resistant to weathering and erosion. Phyllite, reddish, purplish, or greenish-gray, with purplish tuffaceous phyllites in lower part. Conglomerate, fine to coarse, polymictic pebble conglomerate, medium- to thick-bedded, with lithic clasts and quartz pebbles. *Thickness:* 600 to 800 feet (185 to 245 m).

Cc — **Chilhowee Group undivided:** Chilhowee Group includes the Antietam, Harpers, and Unicoi Formations.

PROTEROZOIC Y

CZc, g — **Catoctin Formation:** Metabasalt, purplish tuffaceous phyllite, and metasedimentary rocks. Metabasalt, grayish-green to dark-green, fine-grained, slightly schistose chlorite-bearing. Pillow lavas are locally present (Spencer and others, 1989). Purple and green, chlorite-sericite phyllite and slate; contains relict pumice, lithic fragments, and devitrified glass shards. **Pillow lavas and metabasalt dikes and sills (g)** are interlayered with arkosic granule conglomerate, siltstone, quartz-pebble conglomerate, purple tuffaceous phyllite, feldspathic sandstone, and tuff. Repetition of layers by faulting and folding makes thickness estimates uncertain. Minimum thickness is several hundred meters.

Yb — **Blue Ridge basement complex:** Charnockite and quartzofeldspathic granulite gneiss, undivided. Three detailed petrographic descriptions by J. D. Bell are presented below.

Yl — **Leucocharnockite (Yl):** Light colored, coarse grained charnockite. This body which is exposed at Indian Rocks intrudes quartzofeldspathic granulite gneiss (see R2 below).

ddz — **Cataclastic rocks (ddz):** Basement rocks east of and close to the Blue Ridge fault exhibit strong ductile and cataclastic deformation as described by Spencer (1995). The basement rocks on the hanging wall of the Blue Ridge fault are much more diverse than those in the footwall block. Granite, diorite, and massive quartz veins not found west of the Blue Ridge fault occur in this area.

KEY

CONTACTS
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- Inferred or covered

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- Strike and dip of inclined bedding
- Strike and dip of overturned bedding
- Horizontal bedding
- Strike of vertical bedding
- Strike and dip of bedding where top of beds can be distinguished
- Strike and dip of overturned bedding where top of beds can be distinguished

ATTITUDE OF FOLIATION
- Strike and dip of foliation
- Strike of vertical foliation

LOCATION OF MINES, QUARRIES OR PROSPECTS
- Active Quarry
- Inactive Quarry
- Active Pit

SAMPLE LOCATIONS
- R-9149 Sample location

FOLDS
- Anticline

MINOR FOLDS
- Anticline, showing plunge
- Minor antiform
- Minor overturned anticline
- Overturned anticline, where top of beds can be distinguished
- Overturned anticline, showing plunge
- Syncline, showing plunge
- Minor overturned syncline
- Minor synform
- Minor fold
- Minor fold, showing plunge

OTHER SYMBOLS
- Shear zone
- Fault breccia
- Basal conglomerate
- flp Flood-prone area

PETROGRAPHIC DESCRIPTIONS

Petrographic descriptions of representative samples of three of the most distinctive basement lithologies follow (J. D. Bell, personal communication). Additional petrographic descriptions by Bell, indicated by repository numbers on the map, are available at the Division of Mineral Resources.

R1. Mangerite grading towards diorite located along U.S. Highway 60 near Humphreys Gap.
A medium- to coarse-grained, bluish-green rock with banded texture. Microcline perthite crystals up to 2 mm long contain sparse coarse stringlet exsolution lamellae of turbid (epidote? replacement) plagioclase, together with much finer-scale string lamellae. Plagioclase forms subhedral crystals up to 2 mm long, showing lamellar twinning, and turbid alteration which in some instances pseudomorphs the whole crystal; composition is medium andesine. Myrmekite-like structures are fairly common. Quartz is less abundant than feldspars and forms anhedral crystals up to 1 mm in length. Orthopyroxene is faintly pleochroic from very pale pink to very pale green and is variably replaced by fibrous amphibole and grains of opaque mineral, with some chlorite and epidote, some crystals being virtually intact, whereas others are wholly pseudomorphed; the replacement resembles the "chicken-wire" texture, more familiar in hydrated olivine. The amphibole cuts across cleavage planes in the feldspars in places. Accessory minerals include apatite, opaque mineral, and zircon. The overall texture is granoblastic with numerous 120° contacts between equant feldspar crystals. Classification is based on low quartz content, high ferromagnesian content, and plagioclase content and composition (andesine).

R2. Mangerite, tending toward diorite located near Indian Gap overlook on the Blue Ridge Parkway.
A coarse grained rock with porphyroblastic texture, grayish-green in color with bluish-purple weathering. Quartz is pale blue and ferromagnesian minerals have been altered to hematite. Both perthite and plagioclase occur as porphyroblasts up to 1 cm long, and as smaller crystals; the former includes stringlet exsolution lamellae of plagioclase which shows turbid alteration to epidote. Plagioclase is about An^{25} in composition. Quartz occurs as clusters of strained crystals up to 5 mm in length, smaller rounded grains, and stringlets in myrmekite-like structures. Original ferromagnesian minerals (two pyroxenes ?) have been completely replaced by hematite pseudomorphs or chlorite + brownish fibrous amphibole; some pseudomorphs have incomplete rims of a brown-bluish pleochroic amphibole. In some places, linear symplectites of brown amphibole and quartz cut across the other minerals. Accessory minerals include apatite, opaque mineral, and zircon.

R3. Mangerite granulite gneiss collected along U.S. Highway 60 near Oronoco Church (Stop 2-2 *in* Bartholomew and others, 1991).
A medium to coarse grained mesocratic rock with distinct banded structure and prominent red garnets up to 3 mm in diameter. Apart from one turbid plagioclase porphyoblast containing many quartz blebs, the grain size is relatively even. Pink garnet is partially replaced by brown mica and is in some instances rimmed by quartz and/or traversed by quartz veinlets. Perthite (some of which shows microcline-style polysynthetic twinning) contains stringlet exsolution lamellae which are partially altered to epidote. Plagioclase shows variable, in some cases complete, turbid alteration and usually sutured contacts with adjacent perthite crystals; blebs of quartz and myrmekite-like structures also occur in the plagioclase. The composition is about An^{30}. Orthopyroxene is variably replaced by fibrous amphibole, and is yellowish-green in appearance, with very faint pleochroism. Quartz occurs as equant grains with rounded outlines. Accessory minerals include an opaque mineral, apatite, and zircon. The general texture is granoblastic polygonal, with occasional recrystallization rims along crystal boundaries. Graphite has been tentatively identified in hand specimen.

PHYSIOGRAPHY

The town of Buena Vista is located in the Great Valley of Virginia, but most of the Buena Vista quadrangle lies within the Blue Ridge physiographic province. Maximum relief occurs along the Blue Ridge flank, where topography is closely related to the structure of the underlying rocks. The highest peak in the area, Bluff Mountain, elevation 3372 feet (1028 m), stands approximately 2300 feet (700 m) above the valley of the Maury River to the west and over a thousand feet above the crest of the mountain to the east in the Blue Ridge portions of this quadrangle. The Unicoi and Antietam Formations define a prominent northeast trending ridge along the northwestern flank of the Blue Ridge anticlinorium. The northwest-dipping Antietam quartzites exposed along the flank of the Blue Ridge at Buena Vista are cut by northwest-flowing streams to produce flat irons. These streams are tributaries of the Maury River which flows through Buena Vista, and was partially responsible for major flooding in the town in 1969 and 1971 (Runner, 1969), and 1995. The flood-prone portions of the town are indicated on the map. A flood wall was completed in 1997.

STRUCTURE

The internal part of the Blue Ridge is composed of Grenville-age metamorphic and igneous rocks. Along its western flank, the Chilhowee Group clastic sedimentary rocks form the cover on the Blue Ridge basement complex. South of Oronoco, sedimentary, metasedimentary, and volcanic rocks–part of the Catoctin Formation and the Chilhowee Group–are nonconformably on the basement. Although a few thin greenstone layers are present at the base of the Unicoi farther south and west, the thick pile of greenstone called the Catoctin Formation is confined to the northern part of the belt referred to as the Oronoco belt (Spencer, in Glover and others, 1994; Spencer, 1995). Strongly deformed crystalline basement is thrust upon this belt from the southeast along the Blue Ridge fault. In the Buena Vista quadrangle, a basement-cored anticline, the Big Piney Mountain anticline, lies along the northwestern border of the Oronoco belt. A slice of faulted and steeply-dipping cover rocks forms the western flank of the Big Piney Mountain anticline. The fault on the western edge of this slice is interpreted as one of two major splays off of the Snowden fault which was first recognized by Bloomer and Werner (1955) and previously described (Spencer, Bell, and Kozak, 1989; Spencer, 1994). Uncertainty about the continuity of this fault arises because it has not been positively identified where it crosses a broad outcrop belt of Harpers Formation. This eastern splay separates the crystalline rocks of the Big Piney anticline from a larger basement-cored anticline, named the Buena Vista anticline (Bloomer and Werner, 1955) which continues southwest across the James River into Arnold Valley where it plunges beneath the Blue Ridge thrust. A western splay of the Snowden fault passes just west of Bluff Mountain and may be continuous with a thrust fault exposed on Route 60 about two kilometers southwest of Humphreys Gap.

Southwest of the James River gap, the Blue Ridge thrust is located on the northwestern flank of the Blue Ridge between the Blue Ridge and the Great Valley of Virginia. In most places, rocks of the Chilhowee Group and in some places crystalline basement occur on the hanging wall, structurally above lower Paleozoic carbonate rocks. The Blue Ridge thrust is exposed in the southwestern corner of the Buena Vista quadrangle. Its northward continuation lies in the Forks of Buffalo and Cornwall quadrangles. To the south, it passes through the Big Island, Snowden, and Arnold Valley quadrangles where it lies beneath the partial klippe at Sallings and Miller Mountains in the Arnold Valley and Glasgow quadrangles (Spencer, 1968; Plate A, this publication).

BUENA VISTA ANTICLINE

Bloomer and Werner (1955) gave the name Buena Vista anticline to the northeast-trending southwest-plunging anticline developed in the Blue Ridge basement complex and its cover in the area southeast of the town of Buena Vista. This structure has been traced southwest into Arnold Valley where it plunges beneath the Blue Ridge thrust. To the northeast, in the Cornwall and Montebello quadrangles, the rocks that comprise the southeastern limb of the Buena Vista anticline are faulted out by the Blue Ridge fault.

The structure of the northwestern flank of the Blue Ridge as suggested by the flat irons formed by the Antietam, and exposed from Buena Vista to Glasgow, is deceptively simple. The Antietam dips northwest at angles ranging from 80 degrees near Glasgow to 30 degrees near Buena Vista. Large flexures are present in the Antietam along the mountain front near Buena Vista. The underlying shales, sandstones, and siltstones of the Harpers Formation are complexly folded and faulted. The folds are disharmonic with respect to the overlying Antietam and the underlying Unicoi. They are interpreted as intraformational deformation due to differential movement between the thick and less ductile quartzites above and below the Harpers Formation. These structures are thought to have formed during an early phase of deformation during which a decollement developed within the Harpers. Generally, the Snowden member of the Harpers Formation forms a continuous and prominent ridge between the Antietam outcrop belt and the Blue Ridge basement complex. The Snowden member and other sandstone and quartzites in the Harpers are folded in some places and at least one southeast dipping thrust fault is present along its northwestern edge in Washer Hollow. The Snowden is distinguished from other less continuous sandstones in the Harpers by the presence of *Skolithos*.

Breccias in the Antietam are present in Washer Hollow, Poplar Cove, and Pedlar Run. At each of these localities, the breccias appear to trend northeast-southwest, and occur within the Antietam rather than along the northwestern edge of the Antietam. The breccias appear to indicate a steeply dipping fault, and in Poplar Cove, slickensides suggest that the northwestern side is up, as might be expected if the breccias are associated with a backthrust.

SNOWDEN FAULT

The Snowden fault is named for exposures just west of the former Snowden post office in the Snowden quadrangle. The fault splits where it enters the southwestern corner of the Buena Vista quadrangle. One branch continues northeast over Peavine Mountain toward Bluff Mountain tunnel. It continues to the northeast, and may continue within the basement complex to the northern border of the quadrangle. Mesoscopic structures along the fault indicate that it is a southeast-dipping thrust fault exhibiting northwest vergence, but along parts of its trace, younger rocks of the Harpers and Unicoi Formations and some Catoctin rocks are located on the southeast side of the fault contact with older gneisses of the Blue Ridge basement.

In the southwestern corner of the Buena Vista quadrangle, the branch of the Snowden fault that trends up the slope of Silas Knob converges with a thrust fault that emerges from the basement complex in the Glasgow quadrangle. If the Snowden fault is a thrust as interpreted by the author, the thrust that carries basement rocks onto Chilhowee lies in the footwall of the Silas Knob branch of the Snowden fault. Thus, in the southwestern corner of the Buena Vista quadrangle, the basement is bounded by faults on both sides. Basement gneisses are structurally above the Unicoi and below the Harpers. The author interprets this as a slice of basement that was thrust onto the Unicoi on the southeastern limb of the Buena Vista anticline.

The Silas Knob branch of the Snowden fault passes into the basement northwest of Bluff Mountain and continues to the northeast. Bloomer and Werner (1955) tentatively connected this fault with a thrust fault that lies on trend and is exposed on U.S. Highway 60 southwest of Humphreys Gap. Where Route 60 crosses this fault, it is a thrust on which Precambrian basement rocks are thrust northwest over the Unicoi. The Unicoi and Harpers in the footwall of this fault dip southeastward, apparently overturned during the compression associated with the thrust.

A second branch of the Snowden fault crosses Peavine Mountain and continues toward Bluff Mountain tunnel where the lower part of the Harpers and Unicoi Formations are cut out. The fault is poorly exposed where its trace lies within the shales and phyllites of the Harpers Formation on the southeastern flank of Bluff Mountain. However, good exposures occur where the Snowden fault merges with another fault in the northern tributary of Otter Creek and in the upper tributaries of Browns Creek. At these localities, the Snowden member of the Harpers on the hanging wall of a southeast dipping fault is folded and overturned toward the northwest. Stratigraphic throw along this fault increases northeast of Bluff Mountain tunnel where the Harpers Formation is in fault contact, first with Harpers Formation, then with the Unicoi Formation, and finally with basement gneisses. Southeast of Bluff Mountain, the Harpers Formation is faulted against basement of the Buena Vista anticline. The straight trace of the fault north of Bluff Mountain tunnel suggest that this portion of the fault is steeply dipping, but the fault dips southeast on the flank of Bluff Mountain.

The name Big Piney anticline is assigned to the northeast-trending, basement-cored anticline that extends from Big Piney Mountain into the southeastern corner of the Cornwall quadrangle. A narrow, steeply dipping and faulted strip of Chilhowee Group (Unicoi and Harpers) lies between the Big Piney Mountain and Buena Vista anticlines. Along this northwestern margin of the Big Piney Mountain anticline, the contact between Unicoi and basement is a nonconformable contact characterized by basal conglomerate containing clasts of the basement. In this belt, the Unicoi is vertical or slightly overturned to the northwest.

Near Oronoco, along Route 60 and in Davis Mill Creek, a narrow slice of the basement and its cover are exposed. Along one of the contacts, a conglomerate containing clasts of basement rocks occurs in the base of the cover. This contact is interpreted as a nonconformity. Because the sedimentary and volcanic rocks near other contacts exhibit evidence of shearing and well developed southeast dipping cleavage, and an absence of unfolding (reversed duplication of section) was found, the remaining contacts are interpreted as fault contacts. The trace of these faults converges toward the north in the Cornwall quadrangle.

ORONOCO BELT

The name Oronoco belt refers to the long relatively narrow outcrop belt of the greenstone and sedimentary cover of the Blue Ridge basement complex located on the east limb of the Big Piney Mountain anticline and mainly southwest of Oronoco, Virginia (Spencer in Glover and others, 1994). The Oronoco belt is bounded on the east by the Blue Ridge fault, a thrust that carries crystalline basement rocks onto the sedimentary cover. Along most of the eastern side of the Oronoco belt the Blue Ridge fault coincides with zones of ductile and cataclastic deformation in the basement. The character of the western border of the Oronoco belt varies along the length of the belt as does the stratigraphy within the belt. Near the north end of the belt, Catoctin greenstones and associated sedimentary and metasedimentary rocks lie with nonconformity on the Precambrian crystalline basement. South of the Lynchburg Reservoir, distinctive maroon shales, phyllites, siltstones, and subgraywackes thought to be eastern equivalents of the Chilhowee Group lie with nonconformity on the basement. At Big Piney Mountain, where the cover rocks lie over and wrap around the southern end of the Big Piney anticline, a high angle normal fault with at least 30 feet (10 m) of throw is present near the basement-cover contact.

The Oronoco belt is pinched out to the north where crystalline basement in the hanging wall of the Blue Ridge fault completely covers the Catoctin Formation; the northernmost exposures of the Catoctin Formation in this belt are located along Davis Mill Creek in the Montebello quadrangle. The Catoctin Formation is exposed farther north along the northwestern flank of the Blue Ridge, but its character to the north differs in that most of the flows to the north exhibit features such as columnar jointing, and flow top structures associated with subaerial extrusion of lava. In contrast, the greenstones in the Oronoco belt contain pillow-like forms. These pillow-shaped bodies (Bowring, 1987; Spencer, Bowring, and Bell, 1989) are flattened. In most outcrops close to the Blue Ridge fault, southeast-dipping penetrative cleavage in the greenstones obscures all primary structural features.

Structure within the Oronoco belt is more complex than is implied by the map pattern. Individual lava flows separated by sedimentary beds taper toward the southwest, and the number of flows decreases toward the southwest. Flows that exhibit strongly developed cleavage also commonly contain vesicles, which are flattened in the plane of the cleavage and elongated in the direction of dip of the cleavage. Many of the pillows exhibit the same flattening. At some localities, the sedimentary rock interlayered with the greenstones is highly sheared and exhibits isoclinal folds suggesting that movement has taken place between flows. The fact that the structure in the sedimentary rock and the width of the belt indicate that the package of volcanic and sedimentary rocks has been stacked by thrust faulting beneath the Blue Ridge fault. Breccias containing fragments of greenstone are present in float along U.S. Highway 60. The presence of thrust faults and folds in this poorly exposed section makes estimates of its thickness impossible.

ECONOMIC GEOLOGY

Iron was mined in Buena Vista during the late 1800's. William H. Ruffner, Superintendent of Public Instruction for Virginia, made studies and mapped the ore bodies. At the time of his mapping, the mines were in operation and many prospect pits were available. Few traces of the open pits remain. Campbell (1880) described the deposits as follows: "The great bodies of ore in this belt are Limonites, though some promising beds of Hematite (Red) have been found... Beginning then with the portion N.E. of the Bolivar Falls, on James River gap, we find, within the first two miles, extensive openings along the western slope of the mountain, from which thousands of tons of these ores have been mined and shipped...."

The iron ores along the base of the Blue Ridge including those at Buena Vista were later described by Fontaine (1883). He reported that these ores had been worked since the Revolutionary war. As described by Fontaine, the ore occurs in the weathered shales of the Waynesboro Formation. The iron has concretionary structure, commonly nodular in character and imbedded in clay. "The form in which the ore occurs is usually as irregular beds, or rather masses, composed of sheets or nodules of ore, mingled with more or less clay. These masses assume roughly the character of bands of clay containing here and there deposits of ore...It (the ore in a freshly opened pit) is a highly manganiferous ore heavily laden in color, and showing on analysis metallic iron 27 percent, metallic manganese 20 percent, phosphorus .84 percent. Lumps of nearly pure manganese might be selected. According to the statement of Capt. Jordan the ore was followed first by an open cut, and then by a shaft to the depth of 170'..." Bloomer (1941) and Bloomer and DeWitt (1941) described titaniferous sandstone located near the base of the Unicoi Formation on the Forest Service road northeast of Buena Vista. These deposits have not been mined.

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This map was compiled digitally. The geospatially referenced digital files are available from the Division of Mineral Resources, P.O. Box 3667, Charlottesville, VA 22903.

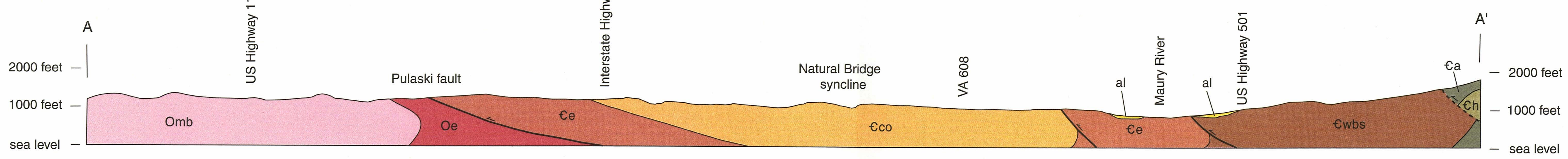
COMMONWEALTH OF VIRGINIA
DEPARTMENT OF MINES, MINERALS AND ENERGY
DIVISION OF MINERAL RESOURCES

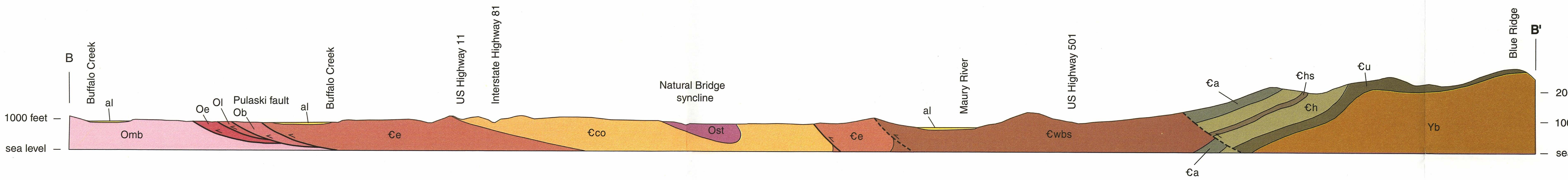
GEOLOGIC CROSS SECTIONS AND STRUCTURAL MAPS FOR THE GLASGOW AND BUENA VISTA QUADRANGLES, VIRGINIA

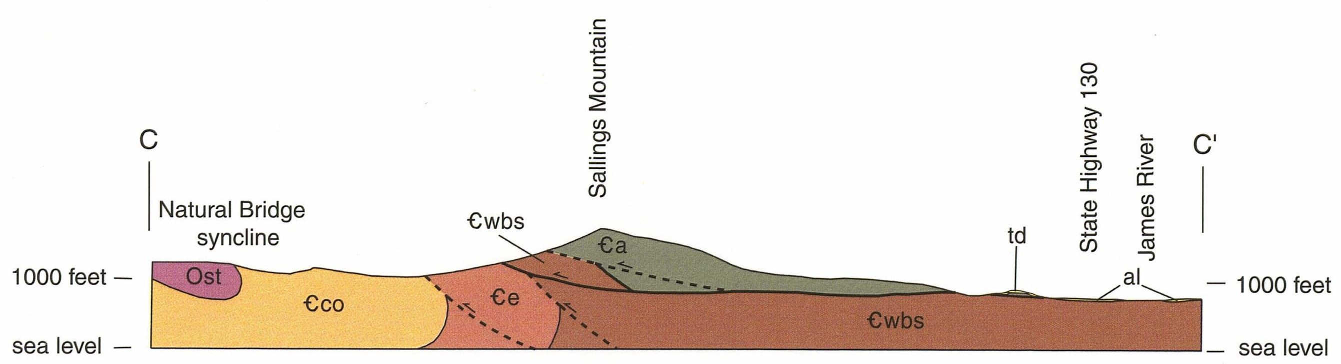
Edgar W. Spencer

2000

PUBLICATION 154 PLATE C
GEOLOGIC CROSS SECTIONS AND STRUCTURAL MAPS FOR THE GLASGOW AND BUENA VISTA QUADRANGLES, VIRGINIA







Cross sections A--A', B--B', and C--C', Glasgow quadrangle.
Intraformational structural features including strongly asymmetric folds with northwest vergence and minor southeast dipping thrust faults (not shown in the sections) have caused apparent thickening of all of the Cambrian rock units with the exception of the Antietam and Unicoi Formations. These small scale features are particularly evident in the Waynesboro, Elbrook, and Conococheague Formations on the overturned southeast limb of the Natural Bridge syncline. Similar features are present in the Martinsburg Formation on the footwall of the Pulaski fault.

A southeast dipping thrust is shown between the Antietam and Waynesboro-Shady Formations, undivided. This fault is not exposed in the Buena Vista or Glasgow quadrangles, but a thrust is present in this position farther north.

Larger scale structural features involving the Shady Formation may lie beneath the Waynesboro Formation, but the Shady Formation is not exposed in the Glasgow or Buena Vista quadrangles. The Shady is exposed to the southwest in the Arnold Valley reentrant as indicated on the regional sketch map, Figure 1.

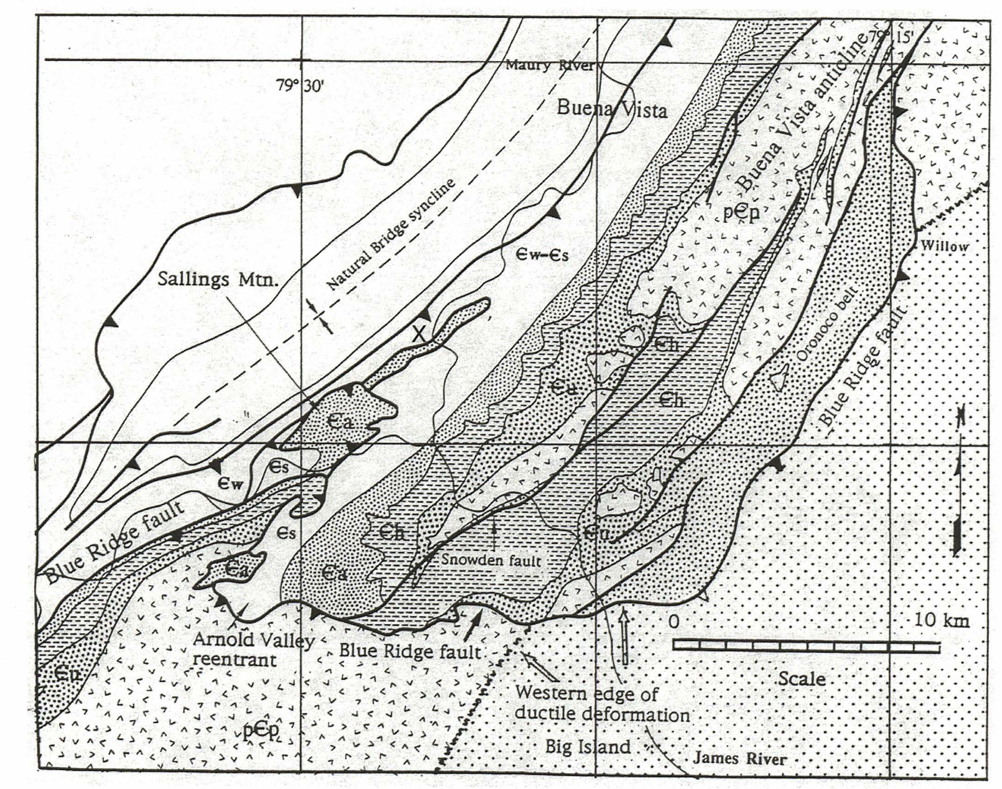
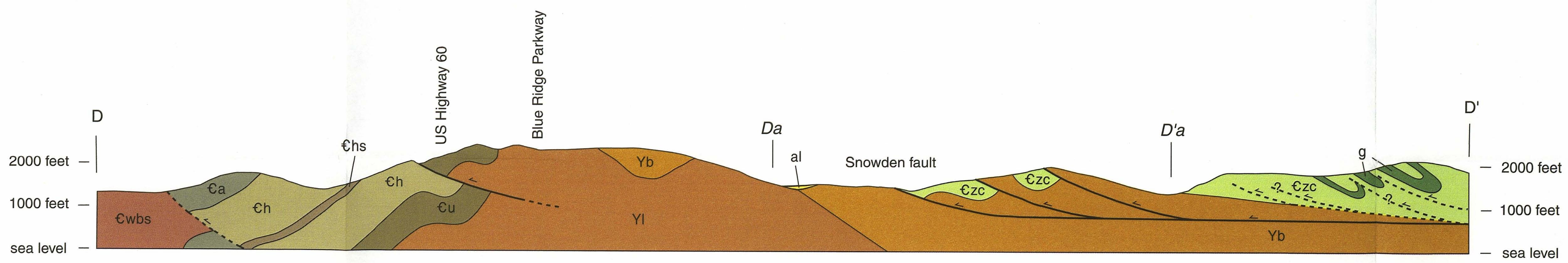
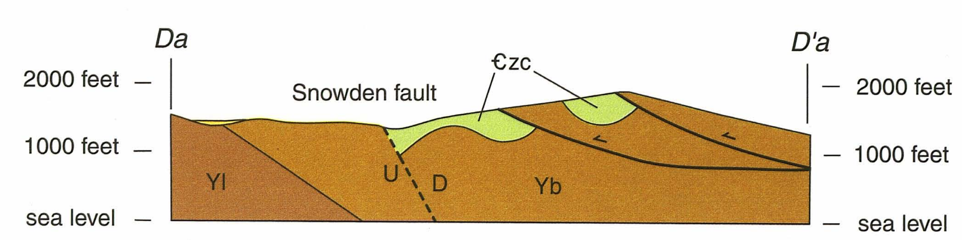


Figure 1. Regional sketch map showing the southwestern extension of the major structural features in the Glasgow and Buena Vista quadrangles. An unexposed thrust fault (not shown on this map or in Figure 3) may be located along the contact between the Antietam and Shady-Waynesboro Formations, undivided, in the Glasgow and Buena Vista quadrangles.

Cross sections D--D', E--E', and F--F', Buena Vista quadrangle.
Intraformational structural features including strongly asymmetric folds with northwest vergence and minor southeast dipping thrust faults (not shown in the sections) have caused apparent thickening of the Harpers, Catoctin, and Chilhowee units.

A southeast dipping thrust is shown between the Antietam and Waynesboro-Shady Formations, undivided. This fault is not exposed in the Buena Vista or Glasgow quadrangles, but a thrust is present in this position farther north.





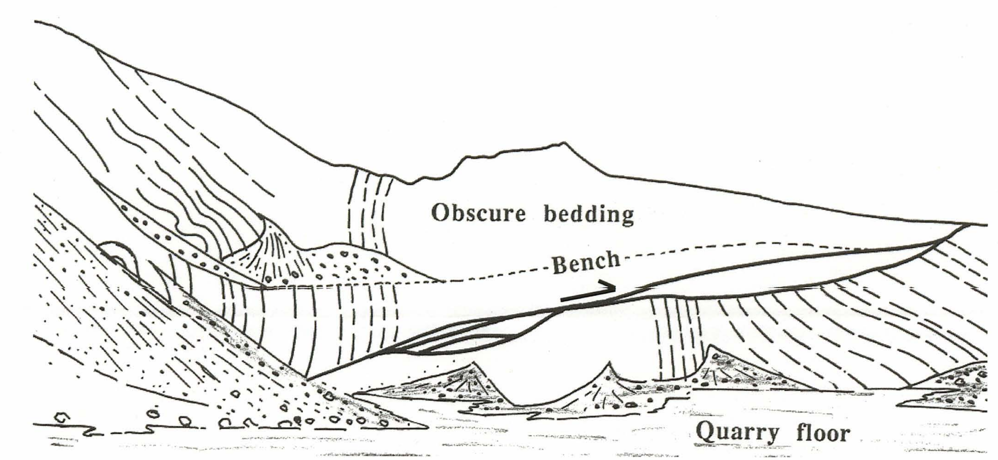
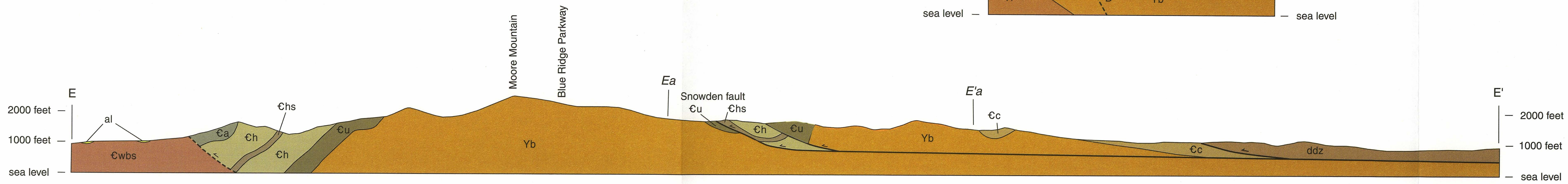
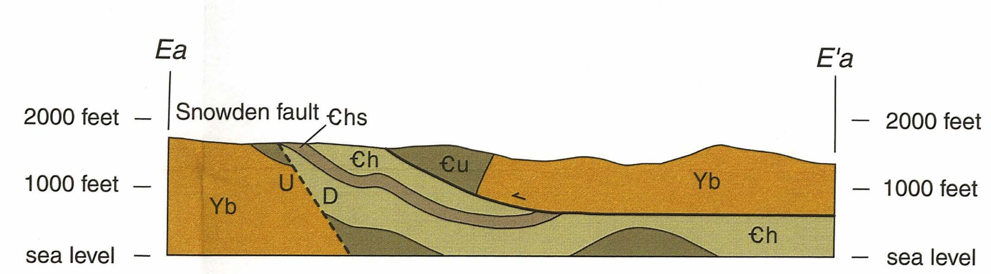


Figure 2. Sketch of a quarry wall at the Rockbridge Stone Products Quarry (formerly known as the Lone Jack Quarry) located near Glasgow, Virginia ("X", Figures 1 and 3). A branch of the southeast-dipping thrust fault that lies beneath Sallings and Miller Mountains is exposed in this quarry wall.





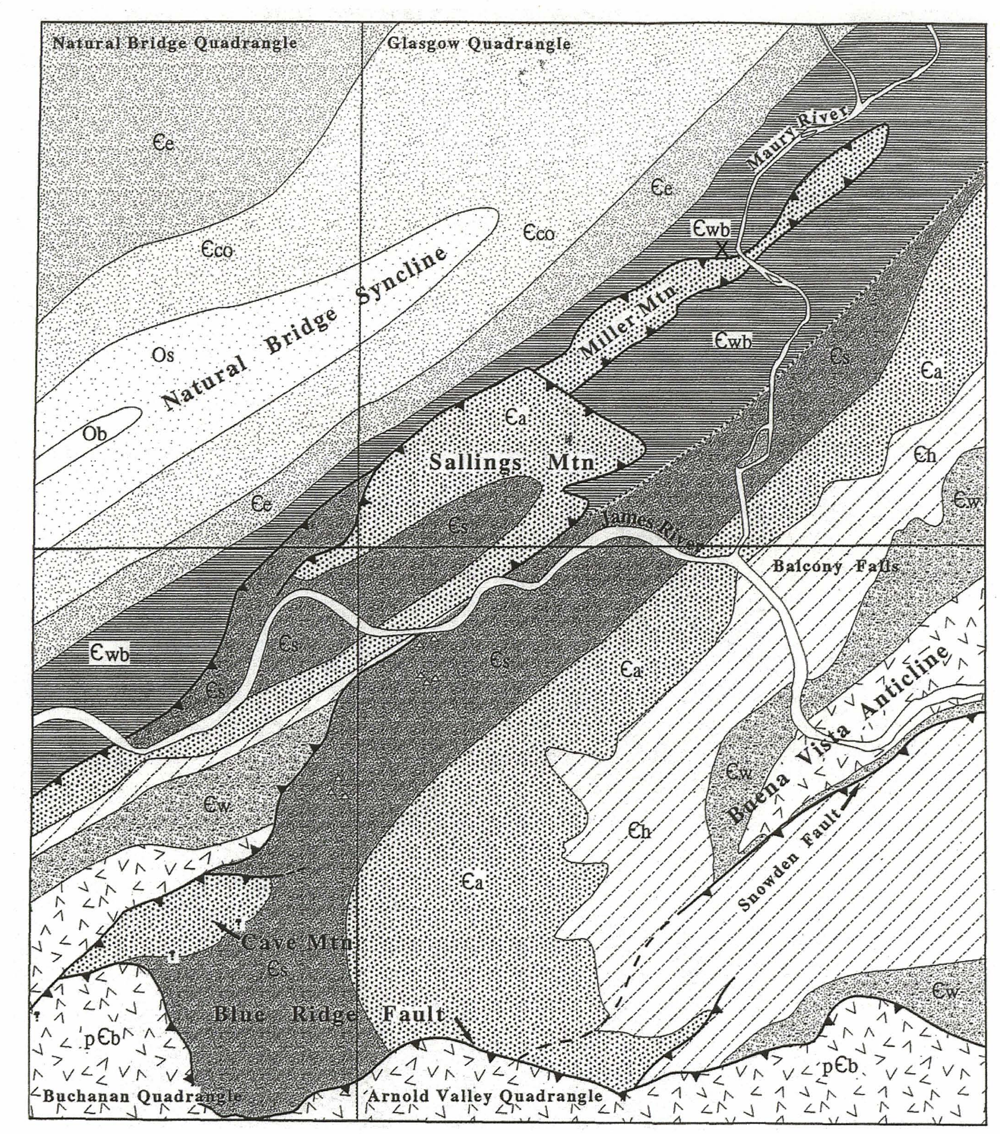
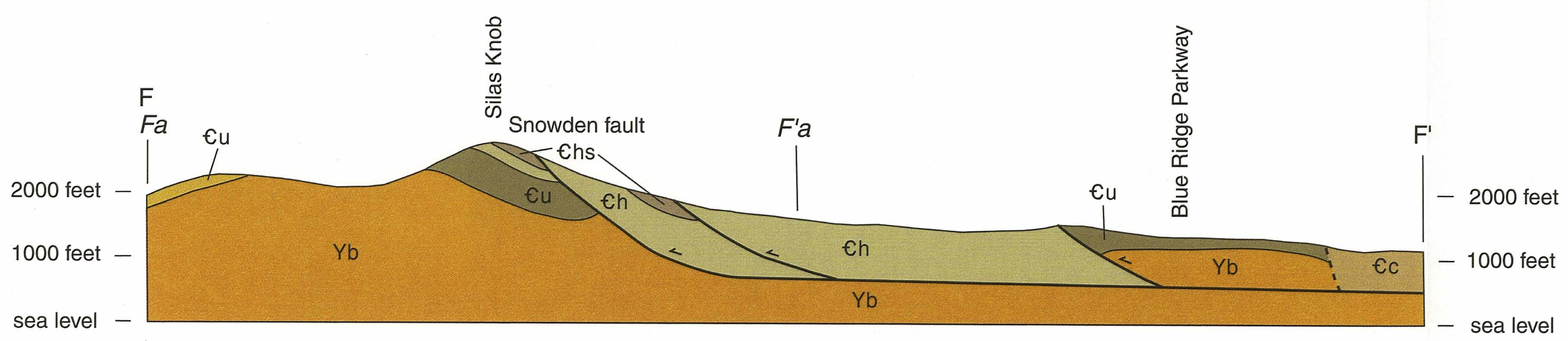
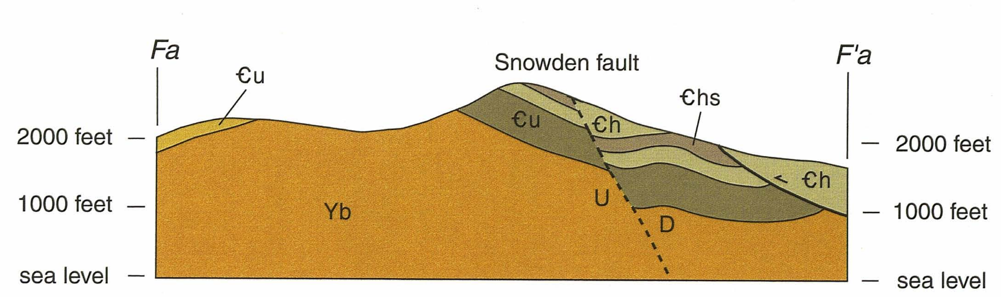


Figure 3. Map of Sallings and Miller Mountains and the relationship of structures of these mountains to the Arnold Valley reentrant.





Cross sections Da--D'a, Ea--E'a, and Fa--F'a, Buena Vista quadrangle.
These sections show alternative interpretations of the subsurface structure across the Snowden fault. Along much of the trace of this fault, Precambrian rocks crop out on the northwest side of the fault, suggesting that it is a normal fault and younger than the folding and thrust faults in this region. However, farther southwest in the Arnold Valley reentrant, the Snowden fault does not appear to cut or displace the late Paleozoic Blue Ridge fault. Small- and mesoscopic-scale folds on the hanging wall side of this fault indicate northwest vergence, and small thrusts and cleavage dip to the southeast. For these reasons, the Snowden is interpreted as a thrust fault that formed after an earlier normal fault. These sections across the Snowden fault show an alternative interpretation of the Snowden interpreted as a normal fault.

digital cartography by Nick Evans