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Geologic Map of the Swift Run Gap Quadrangle, Virginia
Virginia Division of Geology and Mineral Resources

GEOLOGIC MAP OF THE SWIFT RUN GAP QUADRANGLE, VIRGINIA

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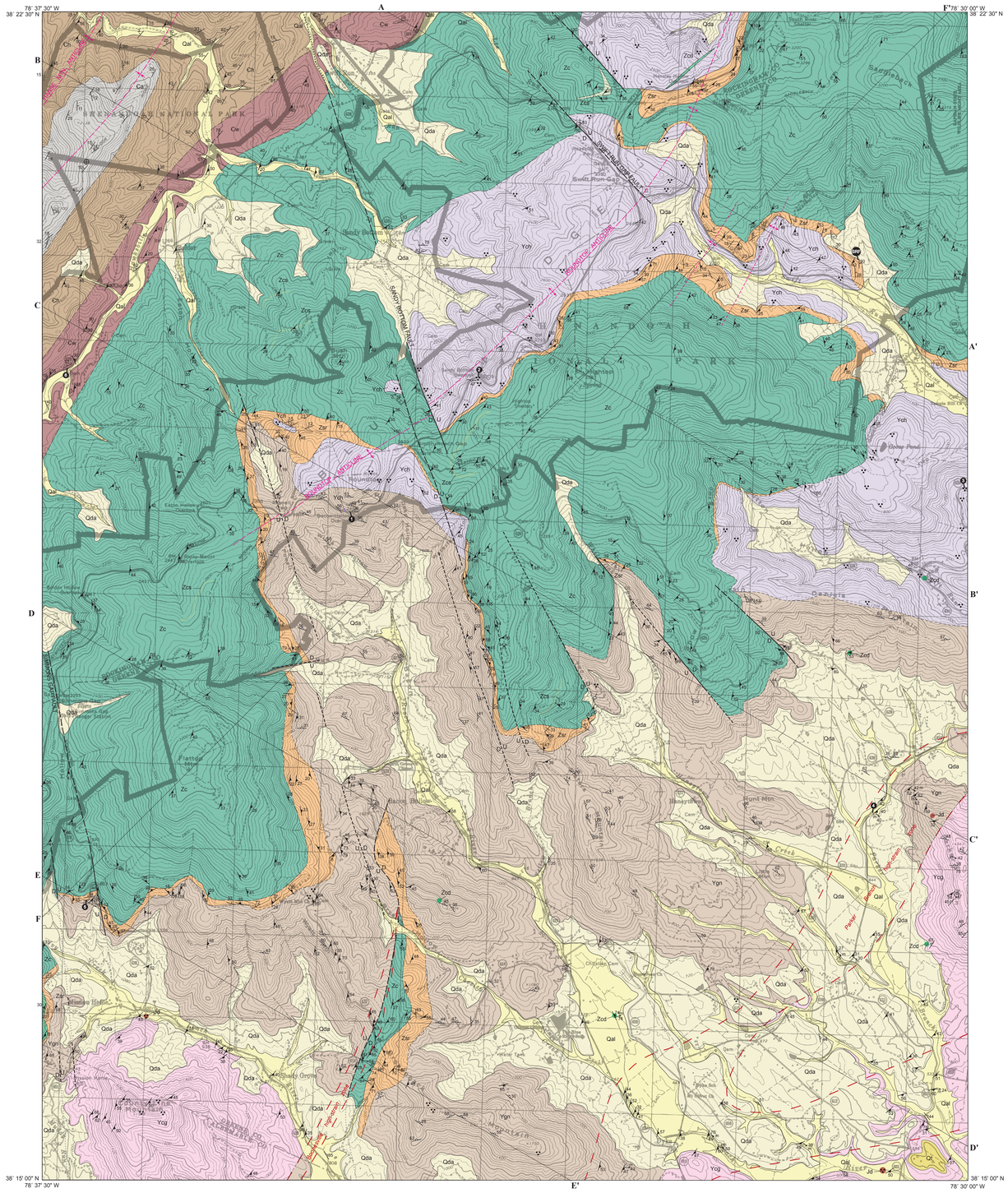

Basemap, modified U.S. Geological Survey DRG
1998, Swift Run Gap Quadrangle, Virginia
Projection: Polyconic UTM NAD 1927 Datum

MN 9°32' 169.5 MILS; GN 0°31' 27 MILS
UTM GRID AND 2009 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000
1 0.5 0 1 2 KILOMETERS
1000 0 1000 1000 METERS
0.5 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 FEET
CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
TO CONVERT FROM FEET TO METERS, MULTIPLY BY 0.3048
Geology mapped from March 2004 to July 2008

1	2	3
4		5
6	7	8

1 Elkton West
2 Elkton East
3 Fletcher
4 Mcgaheysville
5 Stanardsville
6 Browns Cove
7 Free Union
8 Earlysville
ADJOINING 7.5' QUADRANGLE NAMES

DESCRIPTION OF MAP UNITS

QUATERNARY

Qal Alluvium: clay, silt, sand, and rounded cobbles of vein quartz, greenstone, charnockite, gneissic granitoid, and quartz sandstone. Very coarse-grained along upland streams. 3 to 16 feet (1 to 5 m) thick.

Qt Terrace Deposits - weathered cobbles and pebbles of greenstone and vein quartz in a reddish orange, silty matrix. Strath elevation ~100 feet (30 m) above modern drainage. 3 to 16 feet (1 to 5 m) thick.

Qda Debris Fans/Alluvial Aprons - poorly sorted cobbles and boulders of greenstone and megacrystic granitoid (greenstone>granitoid) in a red silty and sandy matrix. Deposits grade from very coarse bouldery debris fans along the steep mountain slopes into surfaces of cobbles and boulders extending away from the mountain front. 5 to 25 feet (2 to 7 m) thick.

JURASSIC

Jd Diabase dikes - fine-grained, dark gray to black, weathers orange, massive and crops out as blocky outcrops. Plagioclase, clinopyroxene, orthopyroxene, and opaque minerals. 3 feet to 30 feet (1 cm to 9 m) wide. Dot- orientation of dike unknown.

CAMBRIAN

Ca Antietam Formation: quartz metasandstone – White to tan, thin to massively bedded, fine- to medium-grained, very well-cemented quartz arenite interbedded with green and pink, laminated phyllite and argillite. Skolithos are common. Antietam Formation is at least 600 ft (~180 m) thick in the quadrangle, but the top of the formation is not exposed in the quadrangle.

Ch Harpers Formation: interbedded phyllite and metasandstone – Green to bluish gray or brown, weathers to a brown, thin to thickly bedded, fine- to medium-grained, ferruginous metasandstone and interlayered sandy metasiltstone and phyllite. Finer-grained rocks are well foliated. 1500 - 1700 ft (450 -520 m) thick in the quadrangle.

Cw Weverton Formation: quartzose phyllite and metasandstone – Green-gray, weathers to a light brown, laminated quartzose metasiltstone and coarse-grained, reddish-purple, interbedded metasandstone and quartzose metasiltstone. Green to purplish gray metasiltstone is present locally at the base of the formation. The siltstone is deformed to a well foliated phyllite. Weverton Formation is up to 650 ft (200 m) thick in the quadrangle.

NEOPROTEROZOIC

Zcs **Zc** **Zcd** Catoctin Formation: metabasalt with interlayers of epidotized breccia, arkosic conglomerate and phyllite – Dark green to greenish gray, fine-grained, massive to well foliated metabasalt composed of plagioclase, actinolite, epidote, chlorite, and opaques, with accessory quartz, magnetite, and olivine. Metabasalt is commonly amygdaloidal with amygdules of epidote, white quartz, and red jasper. Where strongly deformed, metabasalt is sheared to mylonite, containing shear bands of chlorite and actinolite. Relict columnar joints are preserved in less deformed metabasalt. Metabasalt is interbedded with layers of arkosic conglomerate and phyllite (Zcs). Veins of white quartz locally cut the metabasalt and associated interbedded metasedimentary rocks. Catoctin Formation is up to 1800 ft (550 m) thick in the quadrangle. Dot- orientation of dike unknown (Zcd). Isotopic ages for rocks in the Catoctin Formation, from locations north and south of the Swift Run Gap quadrangle, range from 550 to 570 Ma (Badger and Sinha, 1988; Aleinikoff and others, 1995).

Zsr Swift Run Formation: arkosic phyllite, meta-arkose, phyllite, and arkosic metaconglomerate – Brown to greenish gray, fine- to coarse-grained, interbedded, moderately to well foliated. Conglomerates contain clasts of granitoid basement, quartz, mudstone (phyllite), and minor volcanic fragments. Granule conglomerate is common, but local outcrops of pebble to cobble conglomerate occur. Plane and cross bedding is common in sandy layers. Arkosic phyllite is matrix supported with angular to rounded clasts of quartz and feldspar in sericite and quartz matrix. Thickness of the Swift Run Formation is highly variable ranging from absent to up to 300 ft (0 to ~90 m) thick in the quadrangle. Deformed quartz veins are common in phyllite. The original type location of the Swift Run Formation was located in the quadrangle along U.S. Rt. 33, 1 mile east of Swift Run Gap (Jonas and Stose, 1939); it was destroyed during road widening of U.S. Rt. 33. An outcrop 1 mile to the east along a tributary to the north of U.S. Rt. 33 makes an admirable neostratotype for the Swift Run Formation.

MESOPROTEROZOIC

Ych Charnockite - dark green to blue-gray, weathers to distinctive black and white appearance, medium- to coarse-grained, massive to weakly foliated charnockite composed of perthite, plagioclase, quartz, and orthopyroxene with minor amphibole and accessory apatite, clinopyroxene, titanite, opaque minerals, zircon, and fluorite. Some areas mapped as charnockite include abundant inclusions (up to outcrop-scale) of gneissic granitoid at a scale not possible to map at 1:24,000. Dikes of charnockite cross cut the gneissic granitoid. U-Pb zircon age of 1,049 ± 12 Ma from locality 2 at Sandy Bottom Overlook on the Skyline Drive (Southworth and others, 2009).

Ygn Gneissic Granitoid - gray to bluish-gray to brown, weathers to orange-brown, medium- to coarse-grained, weakly to well foliated alkali feldspar granite to granite with perthite, quartz, plagioclase, microcline, and biotite, ± orthopyroxene and amphibole, with accessory white mica, chlorite, apatite, titanite, opaque minerals, zircon, and locally accessory garnet. Amphibole is uralitic, and plagioclase is myrmekitic. Biotite content varies across the unit, increasing from west to east. Immediately beneath the Catoctin/Swift Run/basement unconformity, gneissic granitoid is commonly altered with abundant epidote and pink K-feldspar. Gneissic granitoid is cut by dikes of charnockite. Gneissic granitoid commonly displays two foliations: an older fabric defined by aligned aggregates of feldspar and quartz and a younger fabric characterized by aligned white mica, recrystallized quartz, and biotite. Alteration minerals include uralite and chlorite. U-Pb zircon age of 1,163 ± 17 Ma from the Free Union 7.5' quadrangle 2 miles (~3 km) southwest of Dyke (Southworth and others, 2009).

Ycg Charnockitic Gneiss - gray to bluish-gray, weathers to orange-brown, fine- to medium-grained, quartz monzonitic to granitic gneiss with perthitic microcline, plagioclase, quartz, orthopyroxene, clinopyroxene, biotite, and amphibole, with minor white mica, opaque minerals, apatite, and zircon. Charnockitic gneiss commonly displays two foliations: an older fabric defined by aligned aggregates of feldspar and quartz and a younger fabric characterized by aligned white mica, recrystallized quartz, and biotite. Alteration minerals include uralite and chlorite. U-Pb zircon age of 1,163 ± 17 Ma from locality 1 on the Skyline Drive immediately southwest of Bacon Hollow Overlook (Southworth and others, 2009).

CORRELATION OF MAP UNITS

ISOTOPIC AGE DETERMINATIONS

Sample Location	Rocktype	Map Symbol	Technique	Age (Ma)
1	granitoid gneiss	Ygn	U/Pb- zircon	1,163 ± 17[1]
2	charnockite	Ych	U/Pb- zircon	1,049 ± 12[1]
3	charnockite	Ych	$^{40}Ar/^{39}Ar$- hbl	922 ± 4[2]
4	mylonite	Ygn	$^{40}Ar/^{39}Ar$- sericite	322 ± 3[2]
5	arkosic phyllite	Zsr	$^{40}Ar/^{39}Ar$- sericite	321 ± 4[2]
6	quartzose phyllite	Cw	$^{40}Ar/^{39}Ar$- sericite	341 ± 4[2]

[1]Southworth and others (2009); [2]Bailey and others (2007).

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MAP SYMBOLS

For all contact and fold symbols: lines are solid where the location is exact, long-dashed where the location is approximate; short-dashed where the location is inferred; dotted where the location is concealed. For clarity, Quaternary units are all delineated with solid lines. For geologic observation symbols, observation sites are centered on the strike bar for foliation and bedding or centered on arrow for lineations. Note- some structural symbols appear in areas mapped as surficial deposits these small outcrops are exposed in streams.

Contacts

Fault Contacts

Transverse fault (U- upthrown side, D- downthrown side)

Mylonitic high-strain zone

Folds - showing direction of plunge where appropriate

Anticline

Syncline

Location Symbols

Abandoned quarry

Location with associated isotopic age determination

New Swift Run Formation stratotype

Geologic Observations

Strike and dip of inclined beds

Horizontal bedding

Strike of vertical bedding

Strike and dip of overturned bedding

Strike and dip of compositional layering

Massive rock (no penetrative fabric)

Strike and dip of greenschist foliation

Strike and dip of high-temperature foliation

Strike of vertical foliation

Strike and dip of foliation and trend and plunge of associated lineation (mineral or elongation)

Trend and plunge of long axis of columnar joints

GENERALIZED GEOLOGIC & STRUCTURAL MAP

GEOLOGY OF THE SWIFT RUN GAP QUADRANGLE

The Swift Run Gap quadrangle includes ~60 square miles in Greene and Rockingham Counties, Virginia in the Blue Ridge geologic province. The area lies astride the crest of the Blue Ridge mountains which rise to elevations in excess of 3,500'. Nearly one-third of the quadrangle is in Shenandoah National Park. The region had been previously mapped at scale of 1:62,500 by Brent (1960), Allen (1963), and Gathright (1976).

The Swift Run Gap quadrangle is underlain by four major geologic units: 1) Mesoproterozoic basement rocks (Y), cover rocks including the 2) Neoproterozoic Swift Run and Catoctin formations (Zcs), and the 3) early Cambrian Chilhowee Group (Cc) all of which are unconformably overlain by a series of 4) unconsolidated surficial deposits. A few, thin dikes of Jurassic diabase also occur in the quadrangle. The quadrangle is located on the western limb of the Blue Ridge anticlinorium, a regional scale structure that extends from south-central Pennsylvania to central Virginia. The major rock units have been penetratively deformed, folded, faulted, and are cut by high-strain zones.

Mesoproterozoic basement units include granitoid gneiss, granite, and charnockite (orthopyroxene-bearing granite) that generally crop out to the southeast of the Blue Ridge crest. The contact between the Neoproterozoic cover units (Swift Run and Catoctin formations) is, at most locations, an unconformity. The Catoctin Formation underlies the highest peaks in the quadrangle. Siliciclastic rocks of the Chilhowee Group crop out along the western ridges of the Blue Ridge. Surficial deposits are common on sloping fan-like surfaces along the eastern edge of the mountains and adjacent to most streams. Eaton and others (2001) and Morgan and others (2004) provide a more detailed discussion of surficial deposits in the region.

A distinctive coarse foliation to compositional banding is developed in the older Mesoproterozoic basement units (Ycg and Ygn) and is defined by aligned aggregates of feldspar and quartz and mafic minerals that developed under high grade metamorphic conditions prior to the intrusion of the younger Mesoproterozoic charnockite (Ych). In the Swift Run Gap quadrangle the high grade foliation is folded, although it commonly has an east-west strike and characteristically dips to the north. A younger foliation is variably developed in both the basement and cover rocks, this foliation strikes northeast-southwest, dips to the southeast, and developed at the greenschist facies during regional metamorphism in the Mississippian, as revealed by $^{40}Ar/^{39}Ar$- sericite ages of 340 to 320 Ma obtained at sample locations 4-6 (Bailey and others, 2007).

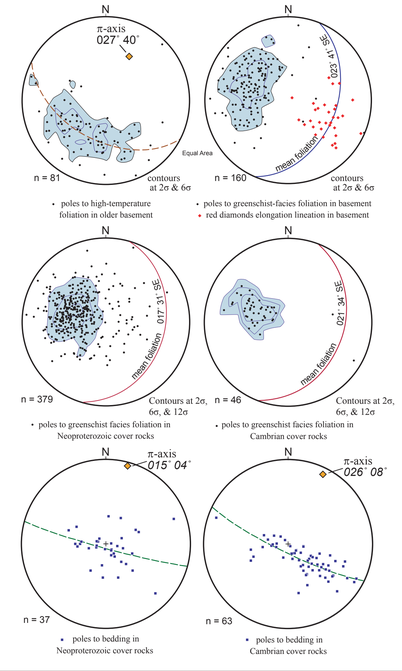
The Boonesville and Parker Branch high-strain zones form anastomosing belts of mylonitic rocks characterized by strongly deformed rocks with a northeast to southwest striking foliation, southeast to east dipping foliation, and southeast plunging mineral elongation lineations. Sense of shear indicators generally record top-to-the northwest to west asymmetries. These zones developed during regional greenschist facies metamorphism and contractional deformation in the middle to late Paleozoic, experiencing reverse slip (hanging wall up to the northwest movement) with displacement on the order of 2,000 to 6,000 feet (600 to 2,000 m). The kinematics and tectonic significance of these zones is discussed more fully in Bailey and Simpson (1993) and Bailey and others (2006a).

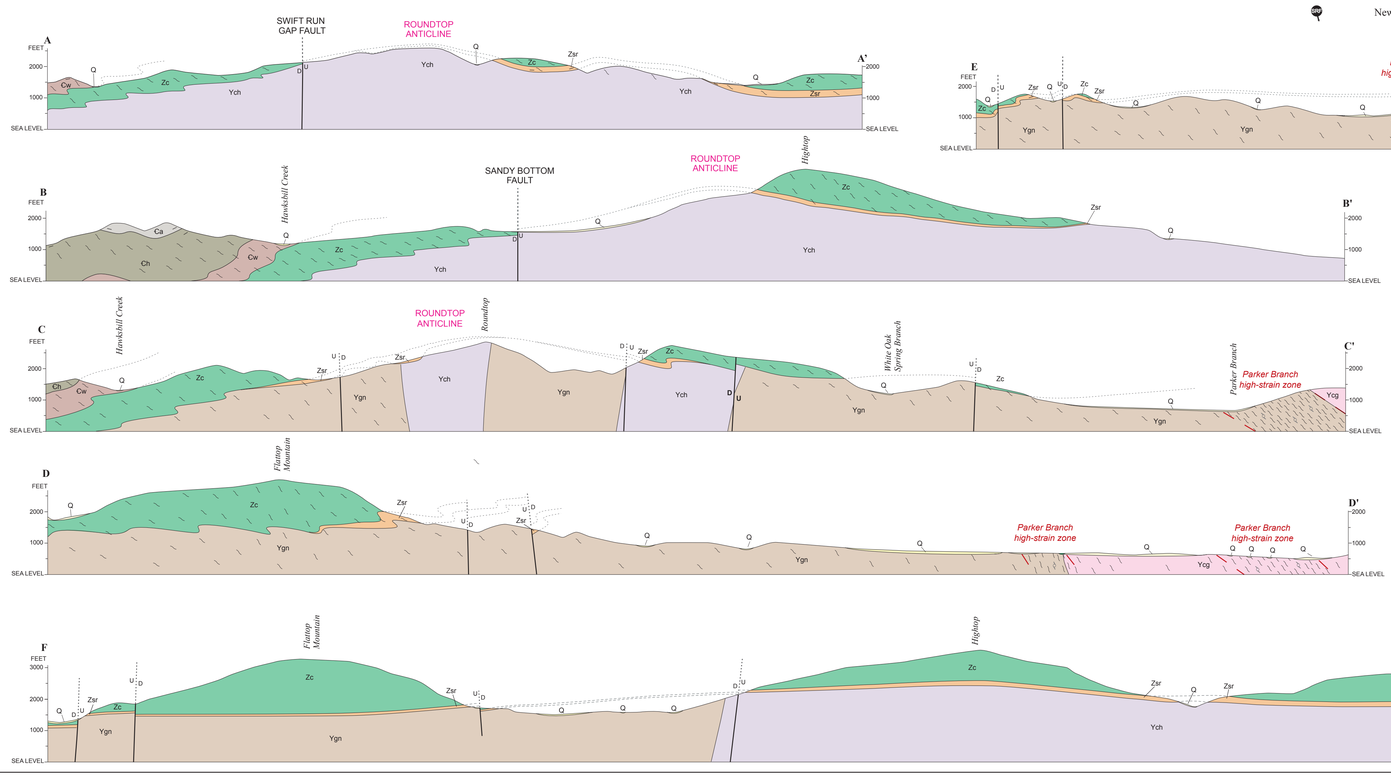
An outlier of the the Swift Run and Catoctin formations, the Brokenback Mountain half graben, is bound on the west by mylonitic rocks of the Boonesville high-strain zone. This structure may represent an original Neoproterozoic half graben complex into which the Swift Run and Catoctin formations were downdropped to the east. Paleozoic contractional deformation reactivated the bounding fault as a high-strain zone and produced asymmetric overturned folds within the cover sequence.

Cover rocks of the Swift Run, Catoctin, Weverton, Harpers, and Antietam formations are folded. Early folds are typically asymmetric northwest-verging structures. The regional penetrative foliation is axial planar to the early folds. Later deformation refolded the early folds into a series of gentle to open map-scale structures (including the Hanse Mountain and Roundtop anticlines) that plunge very gently to the northeast.

A suite of north-northwest to northwest striking transverse faults occurs in the Swift Run Gap quadrangle. Named faults include the Simmons Gap, Powell Gap, and Swift Run Gap faults. These steeply dipping faults cut all the major bedrock units. In map view, transverse faults displace geologic contacts by up to 1,000 feet (300 m), but the actual displacement along these structures is dip-slip with a maximum displacement of ~300 feet (100 m). Deformation associated with the transverse faults is brittle and the trace of these faults commonly forms lineaments and coincide with topographic gaps in the Blue Ridge mountains. These faults are parallel to a regional suite of Jurassic diabase dikes, and the transverse faults, which record minor east-northeast extension, may be of the similar age (Bailey and others, 2006b). Bacon Hollow, a deep trough-shaped valley, is bound by en-echelon transverse faults that displaced rocks in the center downward relative to the flanks. Although the modern topographic relief of Bacon Hollow far exceeds the structural relief across the transverse faults, the graben-like structure may have developed in the Mesozoic and facilitated the erosion that led to the valley's modern form. The old Hightop Copper Mine is localized along a tranverse fault.

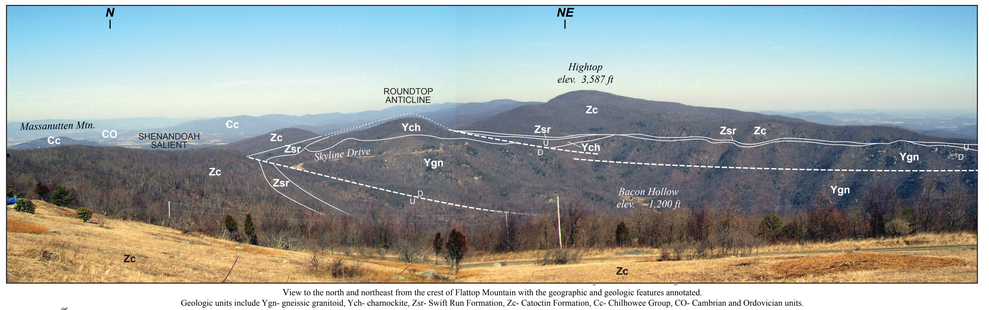
STEREOGRAMS OF STRUCRURAL ELEMENTS





Interpretive cross-sections
1. No vertical exaggeration
2. Subsurface structures interpreted from surface measurements
3. Thickness of surficial deposits may be exaggerated

foliation
bedding
sense-of-shear indicator



View to the north and northeast from the crest of Flattop Mountain with the geographic and geologic features annotated.
Geologic units include Ygn- gneissic granitoid, Ych- charnockite, Zsr- Swift Run Formation, Zc- Catoctin Formation, Cc- Chilhowee Group, CO- Cambrian and Ordovician units.

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