For the Renfrew Institute for Cultural and Environmental Studies

May, 2018

Stomping through time in South Mountain Field Trip

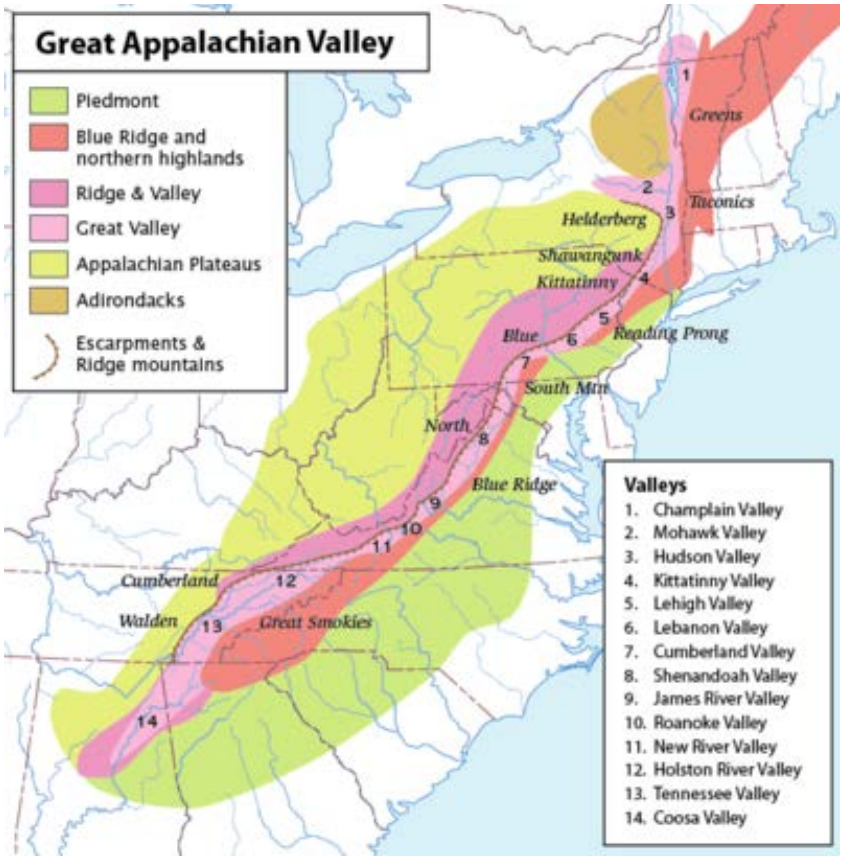
ITINERARY

8:30	Depart Renfrew
8:50	STOP 1. Raven Rock Hollow Block Stream
9:20	Depart
9:40	STOP 2. Specialty Granules Inc.
11:10	Depart
11:15	Arrive STOP 3 – Reed Hill Copper Mine
11:45	Depart
11:55	Arrive STOP 4 – Strawberry Hill Quarry and Lunch
12:55	Depart
1:25	Arrive STOP 5 – Caledonia Furnace
1:55	Depart
2:05	Arrive STOP 6 – Mt. Cydonia Sand Company
2:50	Depart
3:20	Arrive STOP 7 – Carbaugh Run Preserve
4:50	Depart
5:20	Arrive STOP 8 – Tomstown Watering Hole
5:45	Depart
6:00	Arrive back to Renfrew

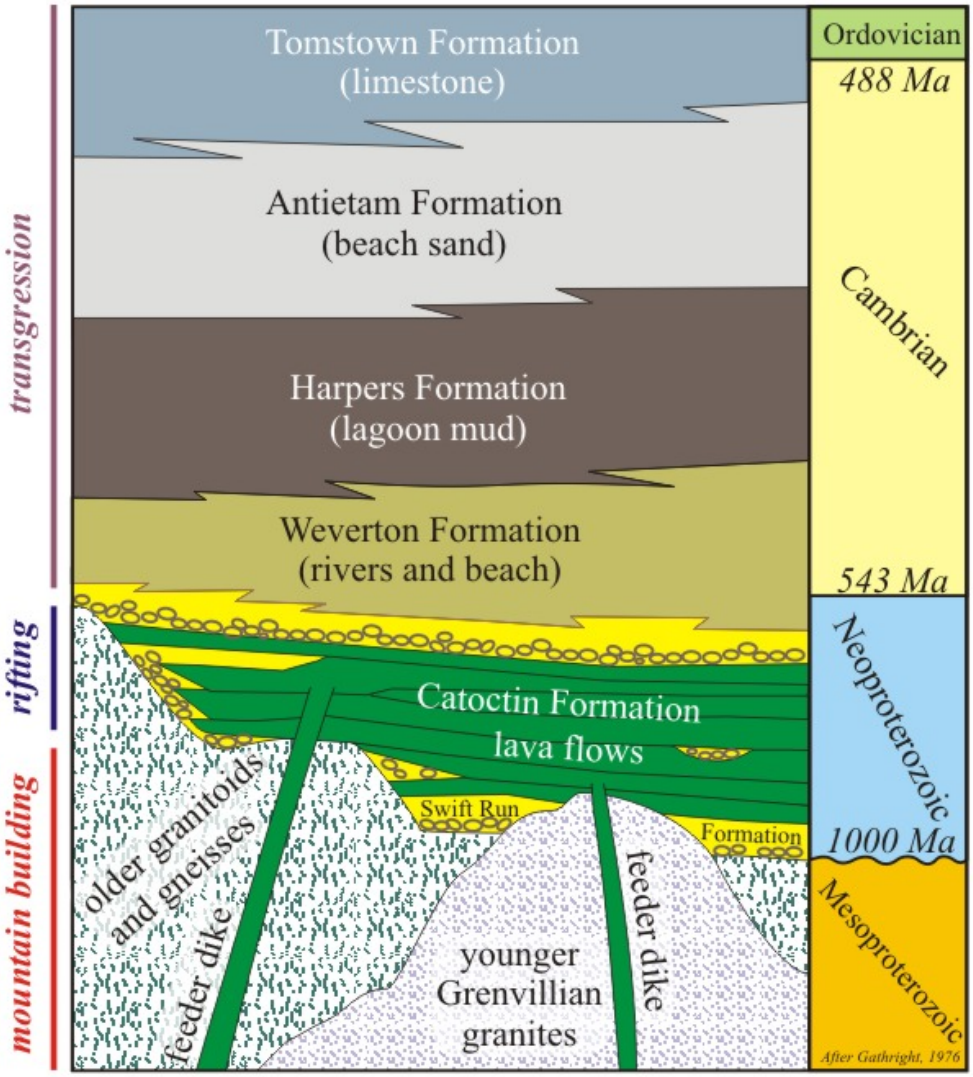
About the Leader

Jeri Jones, a native of York attended Catawba College in North Carolina and earned his degree in Geoarchaeology. Jeri owns Jones Geological Services in Spring Grove, PA where he studies the geology of southeastern Pennsylvania. In his 38 years of research Jeri leads groups on field trips and acts as a consultant to several area quarries. He has traveled throughout the country conducting field trips and programs for all ages. He conducts classes on a regular basis for the OLLI program at Penn State-York. He previously taught at HACC-Gettysburg, York College of Pennsylvania and Messiah College. He received the Digman Award for Geologic Excellence from the Eastern Chapter of the National Association of Geoscience Teachers. His interests include the mining history, geologic history, groundwater resources and southeastern Pennsylvania earthquakes. He has authored four books, narrated a geologic education video series and written numerous articles. He, along with fellow geologist Dennis Low, is writing a "Kids Guide to Pennsylvania Geology" book. Jeri is also a contributor for a publication "World Book of Slate." Jeri also is a guest columnist for the York Daily Record where he writes about local earth science.

Introduction Diagrams



Location of the Blue Ridge

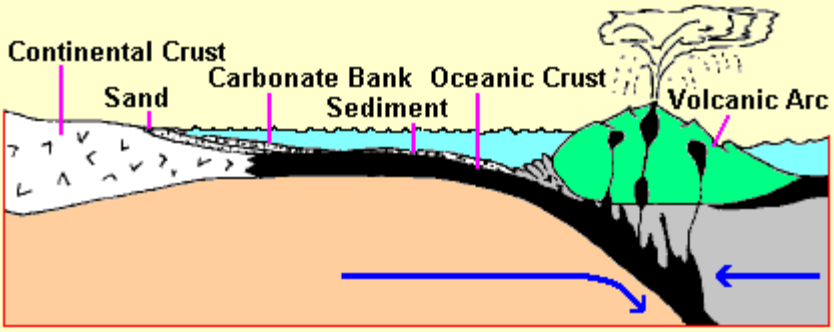


Stratigraphy of South mountain

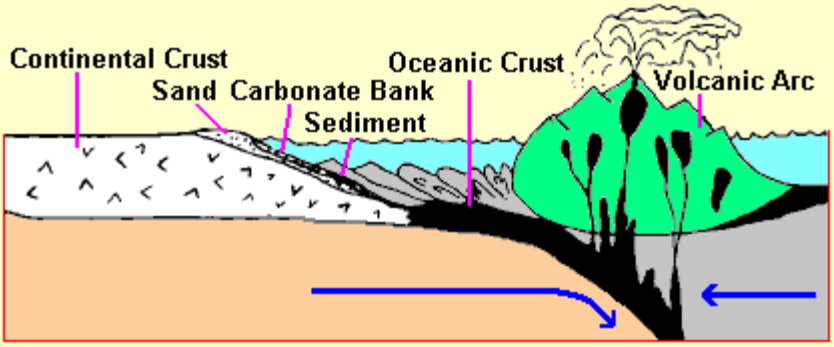
Formation Names and Thickness Encountered On This Trip

Waynesboro Formation	Limestone/sandy dolomite	±1,000 feet
Tomstown Formation	Limestone	1,350 feet
Antietam Formation	Sandstone/phyllite	500-900 feet
Harpers Formation	Phyllite	300-1,000 feet
Weverton Formation	Quartzite	500-1,400 feet
Catoctin Formation	Metarhyolite/metabasalt/schist	3,000-3,200 feet

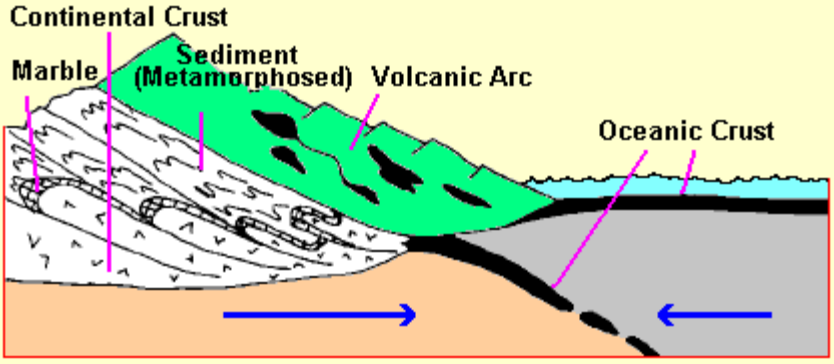
Cross Sections of Eastern North America
(as it may have looked)



543 million years ago, active volcano is offshore

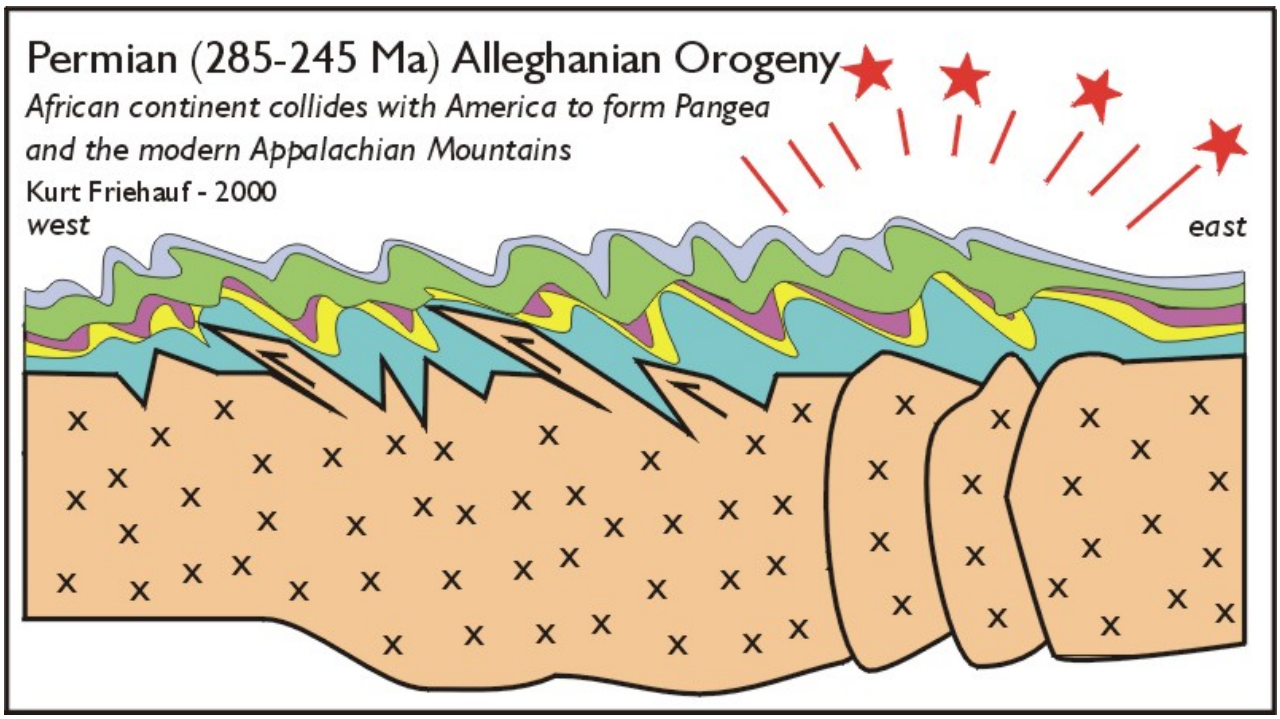


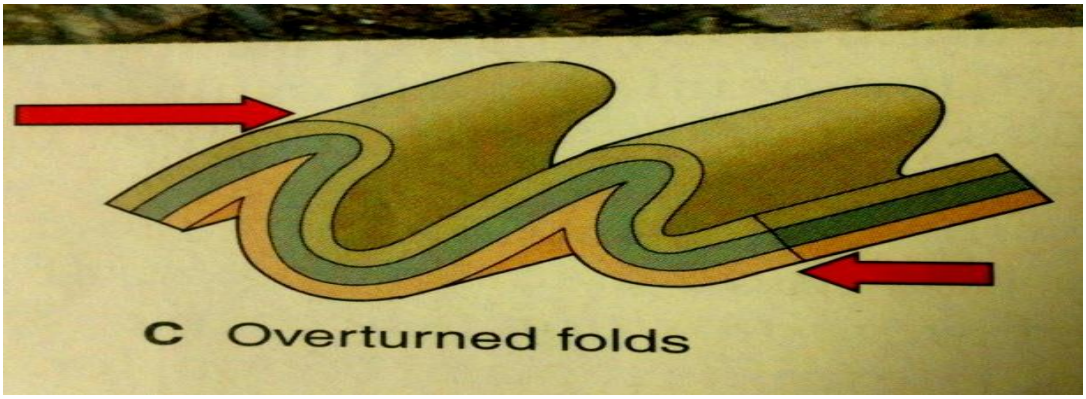
500 million years ago, volcano and pile of sediments scraped off the subducting slab are larger



440 million years ago, collision between the volcanic islands and the ancient continent (Taconic Orogeny) formed a tall mountain range. This range has since eroded leaving its roots exposed in the rolling hills of the Eastern Piedmont

USGS *Topinka, USGS/CVO, 2001; Modified from: Plank and Schenck, 1998, Delaware Piedmont Geology, Delaware Geological Survey*


Permian (285-245 Ma) Alleghanian Orogeny
African continent collides with America to form Pangea
and the modern Appalachian Mountains
Kurt Friehauf - 2000
west
east


C Overturned folds

STOP 1. Raven Rock Hollow Block Stream

Watch For: Orientation of tabular blocks suggesting movement
Sorting of large and small boulders to form circles
Features resembling the snowplow effect as blocks got pushed

This point of interest is located on Fort Ritchie Road, about 0.7 mile north of MD Rte. 491. The block field is visible from the road and there is a dirt pull-off area on the west side of the road with a path leading back to the locality. Many people, including the author, have known this site as “Devil’s Race Course”. Apparently, not to confuse residents, this site was named in a guidebook used by the Field Conference of Pennsylvania Geologists (Sevon and Potter, Jr., 1991). The more notable “Devil’s Race Course” is located on a hillside north of Charmain.

This block field is about 0.80 mile long in a north-northeast to south-southwest direction. The width of the field varies but does not exceed 170 feet wide. Of the black streams that occur in South Mountain, this particular feature has the uniqueness of not supporting vegetation, so observing the features of this field are easy.

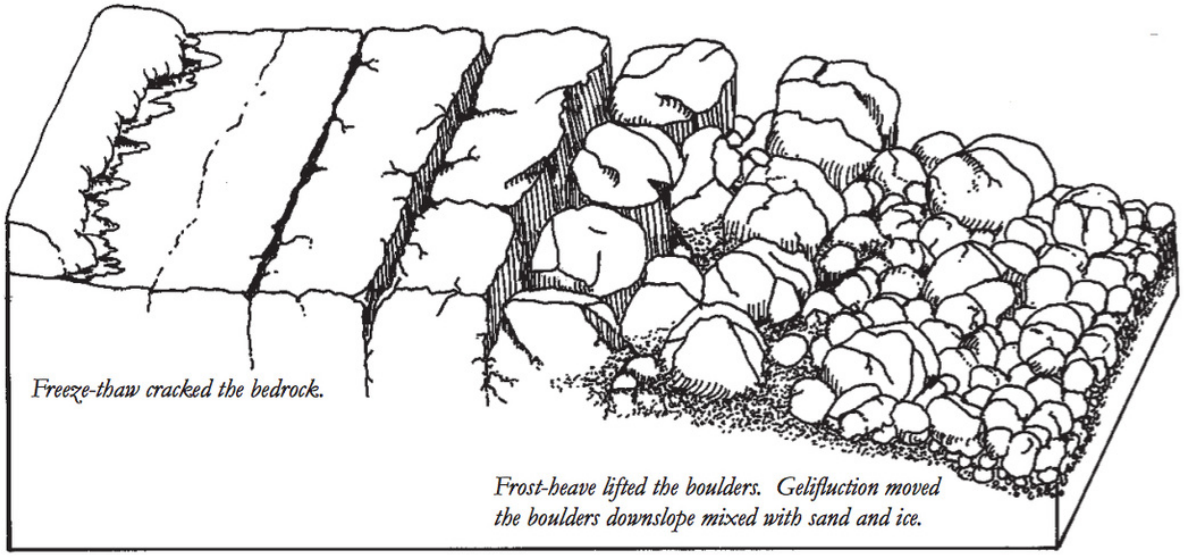
Although the Catoctin Formation underlies Fort Ritchie Road and the hollow, the rock making up the block field is the Weverton Formation quartzite. Quartzite is a metamorphic rock composed on quartzite and was originally sandstone. It appears the some of the quartzite traveled from in the forested area on the northwest side of the block stream (Clark, 1991). The contact between the Catoctin Formation and Weverton unit runs nearly parallel and near the axis of the hollow. The slope of the field is 3.5-4.0°

The blocks closer to the quartzite outcrop to the northwest are larger in size than those further down the hollow. There are blocks covered in vegetation along the western side of the block field. Look for solution pits in the boulders where water can collect today. There are indications that processes within the block stream oriented some of the blocks tabular blocks on edge. There are several surfaces that have been ground by movement again another block. Perhaps some of this grinding took place after the main movement took place. Also, there are sorted patterned ground and depressions that are circular or slightly elongated in the direction of flow that may have formed after the main event (Clark, 1991). After a high precipitation or quick snowmelt period, if you visit this site, subsurface running water can be heard. At the south end of the block field, the water emerges as a stream. This stream may have acted as the mechanism for the removal of ground matrix between or under the boulders. Also, the water may have formed interstitial ice that acted as a matrix and a mechanism for block transport.

The boulder stream was believed to have been formed during the Pleistocene Period (Ice Age) and considered a periglacial feature (occurred during a warm period

between ice advances). During the Pleistocene, our climate was similar to that of today's Hudson Bay area with alternating cold and warm periods.

The largest boulder field on the East Coast is located at Hickory Run State Park in Carbon County, Pennsylvania. Another smaller boulder field, but very unique is Ringing Rocks in Bucks County, Pennsylvania. Here you may take a hammer and hit the diabase boulders, each boulder having its own tone.



Possible origin of the boulder stream (from Clark 1991)

STOP 2. Specialty Granules Inc. Quarry

Watch For: Metarhyolite and metabasalt
Levels
Reclamation
Granules

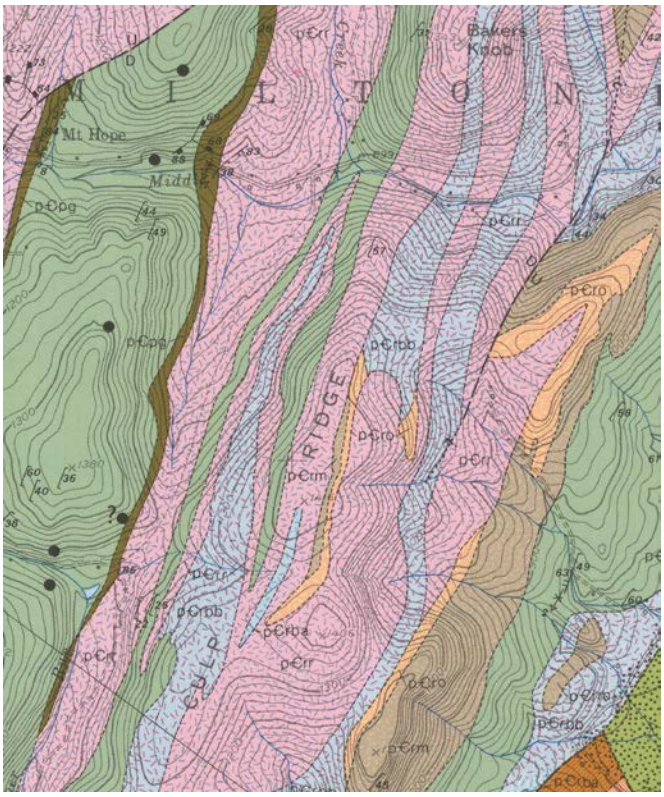
A very special stop for Renfrew is this large quarry now being operated by Specialty Granules of Hagerstown, Maryland. The operation began in 1923 and operated under different ownerships.. In 1989, ISP was the owner. In 1996, GAF operated the quarry. Special Granules, who has a history of producing high quality specialized products in North America for over 90 years, took over the operation in 2011.

The quarry is removing the metarhyolite and metabasalt of the Catoctin Formation. The metabasalt is being crushed and processed into roofing shingle granules. A total of 18 colors of granules can be manufactured from the 3 plants located here on site. Approximately 600,000 tons are being shipped annually by truck

and CSX Railroad. There are 0.75 miles of conveyor belts on the property transporting the rock from beginning to the end product.

The primary rock, metabasalt, is a greenish color. The metabasalt represents volcanic activity formed on a oceanic plate approximately 550 – 600 million years ago during the Proterozoic. The reddish rock in the quarry is the metarhyolite, a volcanic rock similar in composition to granite. Metarhyolite indicates volcanic activity on a continental plate. The rock is also Proterozoic in age. Both volcanic rocks formed during the rifting of the supercontinent Pannotia, located in the Southern Hemisphere. Native copper is occasionally found within the metabasalt here. The Specialty Granules Inc. operation does not have a use for the native copper and regards the element a nuisance. The quarry is permitted to remove rock a total of 10 levels. Each level has a depth of 50 feet. Currently, the quarry has five levels. Some 6 – 60 feet of soil must be removed to get to bedrock. About 12-14 feet of weathered rock has to also be removed to get to the “good” quality bedrock. About 600,000 tons of rock and dirt is used to reclaim the older portion of the quarrying operation.

Recently, Specialty Granules, Inc. has started to sell some of the lower-grade rock as aggregate. This part of the operation is in its infancy, but just another avenue of finding a use for the rock removed. When operating a quarry, the operators are looking to get any possible revenue for any material removed. As one geologist working for a company once told me, “You want to get the squeal out of a pig.”



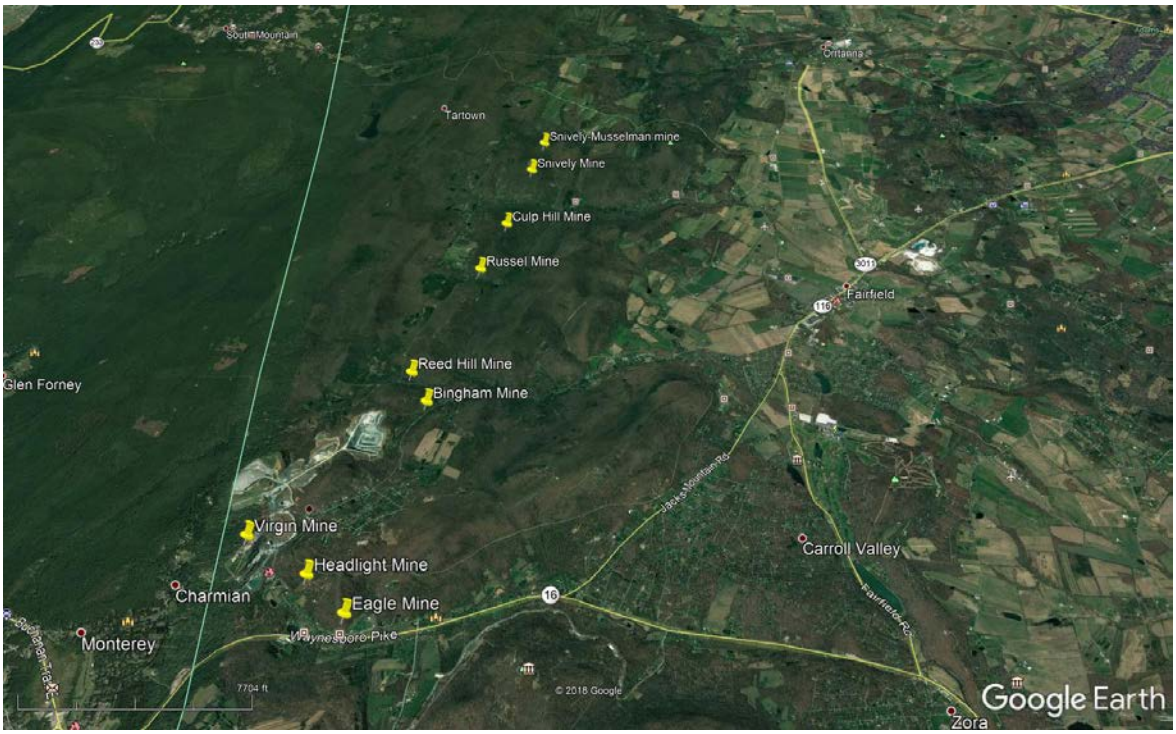
Geologic map of the Gladhill area (from Fauth, 1978)

STOP 3. Reed Hill Copper Mine

Watch For: Malachite (green mineral) and cuprite (dark red mineral)
Adit (horizontal mine shaft)
Dump (location where the “junk” rock was piled out of the way)

The Reed Hill Copper Mine is one of the few remaining copper prospects in South Mountain that has not been disturbed by machinery and is rather easy to walk to. It is the only public accessible mine containing underground workings in the area. The mine was developed by the Reed Hill Copper Company. The chief workings are an open cut about 145 feet long and 15 feet deep, trending north. Two adits follow mineralized zones (quartz veins) further north, each about 30 feet long. Reports of copper masses each weighing as much as a pound have been found here.

The copper originated from chloride-bearing aqueous solutions released during the metamorphism of the basaltic rocks at greater depth. Copper was leached from the deep, hot dry rocks and added into the cooler, near surface rocks in which were undergoing hydration. Weathering of the ore-bearing rocks altered the native copper into malachite (green) and more rarely azurite (blue). Most of the prospects occur near the contact with the metabasalt and other rocks or where the metabasalt has been sheared by crustal movement (Geyer and others, 1976).



Location of copper mines in the Mt. Hope – Charmain area

STOP 4. Strawberry Hill Quarry

Watch For: Schist (metamorphic rock), Foliation, Crenulations

On the western boundary of the Strawberry Hill Preserve is an abandoned quarry containing what is termed a sericitic schist. A schist is a high-grade metamorphic rock showing good cleavage. The major minerals in this rock is sericite, a fine-grained, light gray-to light green mica. The area is mapped as belonging to the Catoctin Formation metarhyolite, but apparently the rock has been severely sheared and metamorphosed. The schist is a very thin rock unit and not common in South Mountain. Stose, (1932) suggests that the schist was a volcanic ash that became metamorphosed. Fauth (1978) states that the Summit Mining Industries removed the rock here and trucked it to near Aspers, Adams County where it was crushed and ground. The material has been used as a paper and paint filler and as an insecticide carrier.

Taking a closer look at the rock, you will notice that the rock seems to be layered and tilted into the Earth at a gentle angle. Being a metamorphic rock, this “layering” appearance is known as foliation. During metamorphism, the minerals (mostly sericite in this case), became compressed perpendicular to the direction of the pressure and formed the foliation. If you examine the bedrock exposures on the floor of the quarry you will also notice “ribbon” lines in the rock. These are crenulations created by the tight folding within the rock and related to the shearing that the rock underwent.

Crenulations in the Catoctin schist at Strawberry Hill

STOP 5. Caledonia Furnace and the Carbaugh-Marsh Creek Fault

Watch For: Furnace, Iron Ore, Charcoal, Limestone
Strike-Slip Fault, Displacement

Caledonia State Park was once the site of an iron furnace owned by Thaddeus Stevens, a native of Caledonia County, Vermont. Stevens began operation on the furnace in 1837. He was a member of the U.S. House of Representatives, a noted abolitionist, and is known as the father of the public school system in the Commonwealth of Pennsylvania.

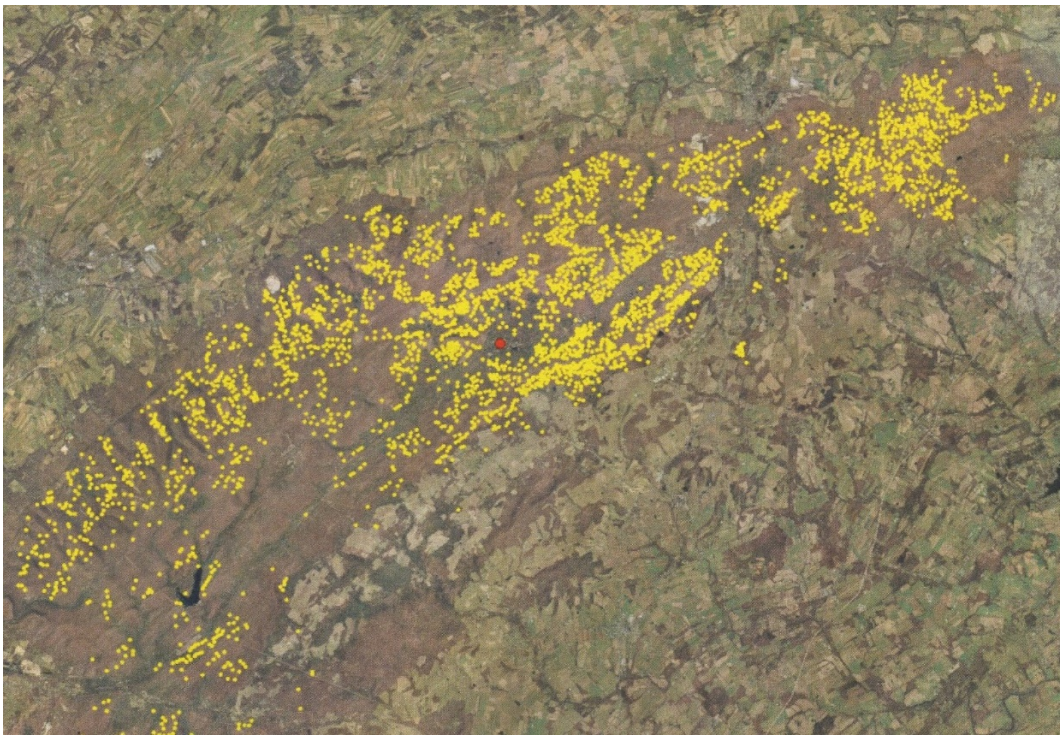
The iron furnace was destroyed during the American Civil War in June 1863 by the Confederate cavalry under the command of General Jubal Early. Some historians believe that the furnace was destroyed not just to slow the industrial power of the Union but also because of Stevens' views opposing slavery. The pastures surrounding the furnace were used as field hospitals during the Battle of Gettysburg later in July 1863 (Wikipedia, 2018).

To operate furnace three agents were needed. First, iron ore had to be accessible within the area. In the 19th century, transportation of any natural raw products did not travel far. Indeed, the western slopes of South Mountain contain a large number of iron ore deposits. The second agent is wood, preferably chestnut forests. The trees were cut down and piled into a teepee fashion and covered with dirt. The pile of wood was lit on fire and slowly smoked (not burned) to produce charcoal. It took about 10-12 days for a charcoal tender to produce one acre amount of charcoal. During a furnace's peak performance, a furnace used this amount of charcoal in 24 hours. Finally, limestone had be locally available. Limestone was used as a flux which would be used to remove the impurities out of the iron. The waste floated to the top of the furnace and removed to the furnace's dump pile. Today, this waste is known as slag.

Although we don't have time to walk it, the Furnace Trail here at Caledonia features interpretive signs and props to explain how a furnace operated.

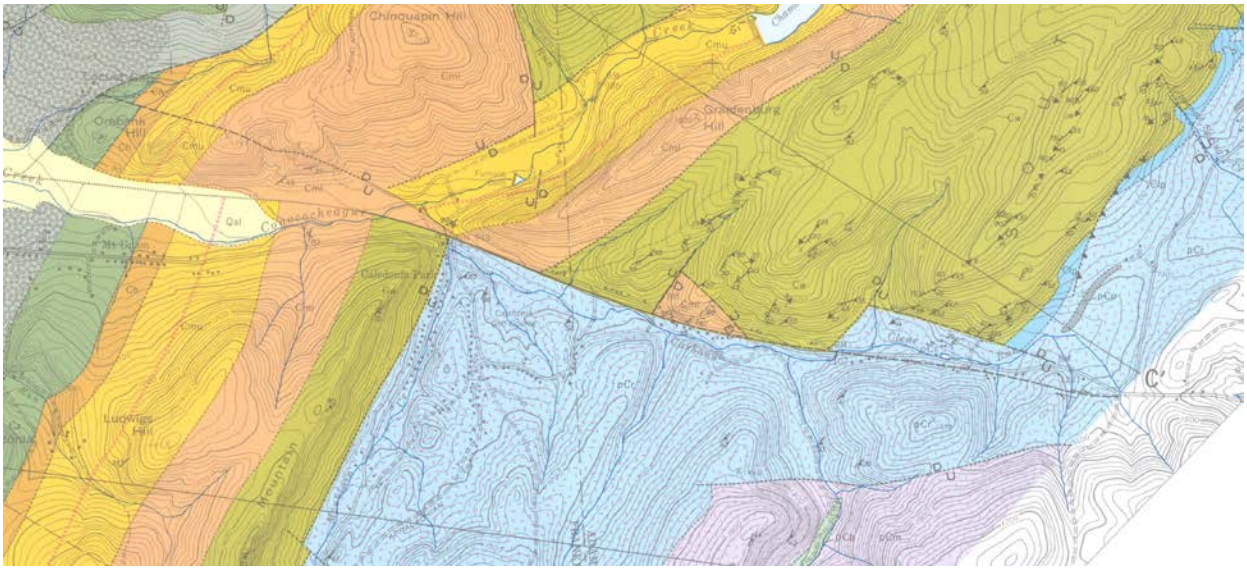
While here, this is a great opportunity to explain a major fault passing through South Mountain. Known as the Carbaugh-Marsh Creek Fault, this structure has allowed U.S. Route 30 to be constructed through the mountain. During the Alleghenian Orogeny as the rocks now making up South Mountain were being solved to the northwest, the section of South Mountain south of here stopped, but the rocks to our north continued to move approximately three miles further. This created a strike-slip fault.

West of South Mountain near Interstate 81, the Carbaugh-Marsh Creek Fault does a southward turn and continues in that direction to at least Greencastle or possibly further south. The rock being pushed and broken was more easily weathered and eroded to produce this gap. The presence of this fault here, allowed the Confederates to travel to Gettysburg with their artillery and gear.



Location of charcoal hearths between Dillsburg (upper right) and Caledonia (lower left). The red dot is location of Pine Grove Furnace (from Potter, Jr., 2014)

Satellite view of South Mountain (NASA)

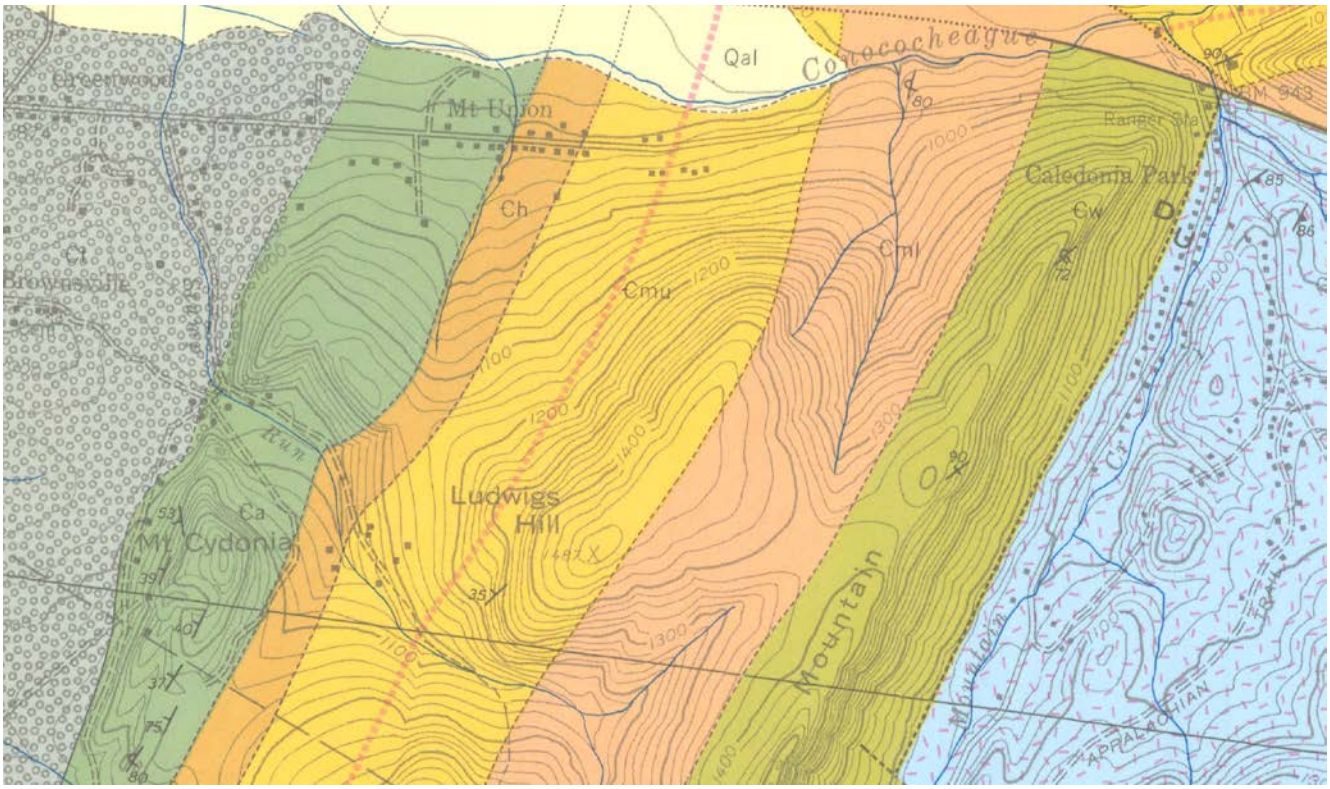


Geologic map of the Caledonia area showing the Carbaugh-Marsh Creek Fault (Fauth, 1968)

STOP 6. Mt. Cydonia Sand

Watch for: Antietam Formation, Sandstone, Dip, *Skolithos linerairs*

1. Sandstone exposed here is the Antietam formation of Lower Cambrian age or Late Proterozoic age
2. Thickness is ~800 feet.
3. These two pits combined are ~one mile long.
4. Notice the bedding. In what direction are the rocks tilting into the earth?
5. The strike of the rock is a line perpendicular to the direction of dip.
6. Giant ripple marks were discovered here in 1981. These ripple marks were about one-foot in height and three-feet between the ripple peaks (mega ripples).
7. A fossil found here are worm tubes known as *Skolithos linearis.* Although the actual worm has never been seen, their burrows are well preserved. This fossil is known as an index fossil since this species only lived for a short span (several millions of years).
8. This fossil was identified by Charles Darwin after receiving a *Skolithos* specimen from a naturalist in Lancaster County, Pa.
9. Combining #4 and #5 plus what you might know about marine worms today, what do you think this area looked like ~600 million years ago?
10. In which direction is the *Skolithos* running compared to the bedding in the rock?
11. Why would you not find *Skolithos* in the limestones of the Great Valley?
12. What two agents are working on the rock here to generate the sand?
13. What are some uses for sand?



Geologic map of the Mt. Cydonia area (Fauth, 1968)

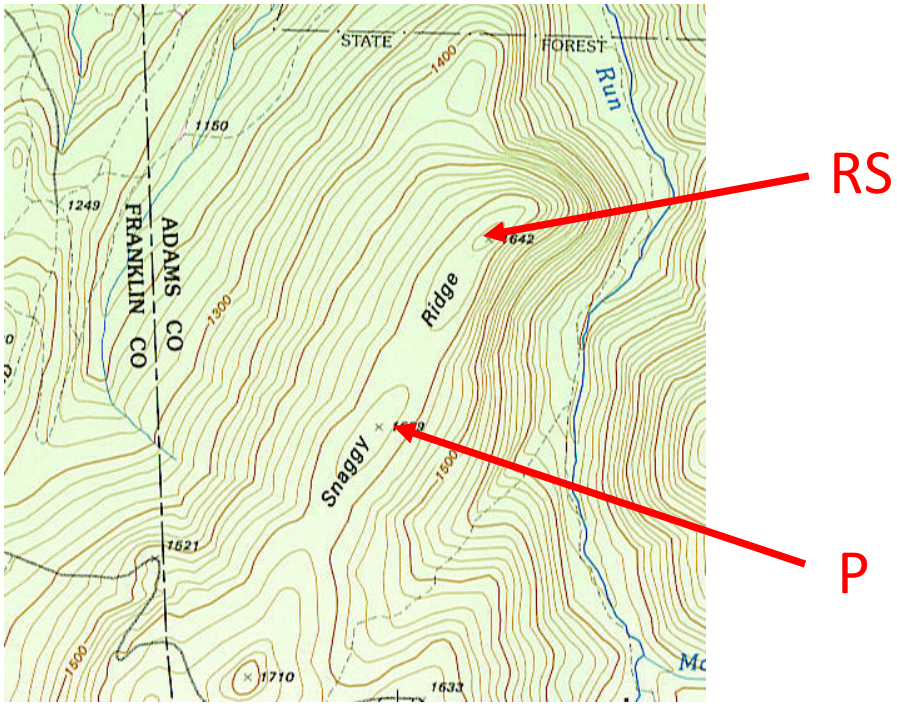
STOP 7. Carbaugh Run Prehistroic Quarries

Watch For: Metarhyolite, Prehistoric, Bulb of Percussion, Platform, Flake

1. The rock exposed here is the Catoctine Formation metarhyolite. Metarhyolite is a volcanic rock but because the rock was introduced to metamorphism, “meta” has been added to the rock’s name.
2. Compared to an igneous rock formed underground, what are the differences? **Remember no collecting of material here – you may have a Ranger waiting for you**

3. Rhyolite is a relative to an igneous rock that forms inside the earth containing primarily quartz and feldspar. What is that rock?
4. Thin wavy lines in the rock represent what?.
5. Rhyolite forms from lava because of continental rifting. In this case, this rock formed when the supercontinent Pannotia began to break apart ~ 600-700 million years ago/
6. Prehistoric people recognized that this rock was great for manufacturing stone tools (the first geologists)

7. Research conducted here by the Pennsylvania Historic and Museum Commission concluded that prehistoric people dating back at least 8,000 years quarried the rock here.
8. From here manageable pieces of metarhyolite were transported down the hill to Carbaugh Run where the flintknappers produced the tools.
9. Modern-day flintknappers have learned that a rock kept wet will flintknapp better.
10. Because of the fine-grained makeup of this rock, the metarhyolite works very well.
11. How can you tell a natural flake from a man-made flake? A manmade flake will have a bulb of percussion and usually a platform, whereas a natural flake does not.
12. A flake that has been worked on the edge will look like a serrated knife blade (bifacial) or only worked on one side (look for small flake scars).
13. Artifacts made of metarhyolite have been seen in archaeological sites all over Pennsylvania and parts of surrounding states. What are the possibilities how the material got to those sites?
14. Several other quarry sites are known in this part of South Mountain. The best material for producing tools is only found on top of Snaggy Ridge.



Topographic map of the Carbaugh Run Preserve
P – prehistoric pits; RS – rock shelters

STOP 8. Tomstowm Watering Hole

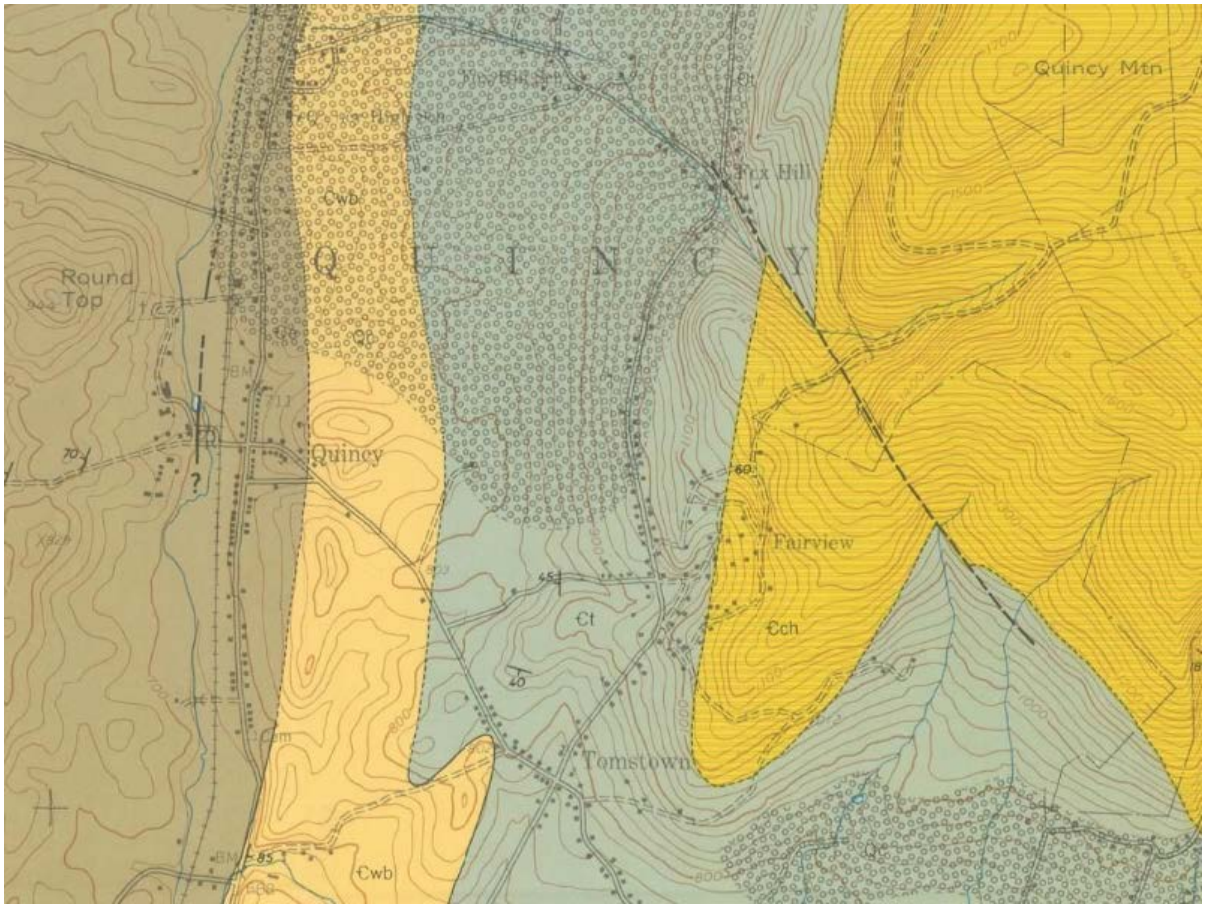
Watch For: Groundwater, Aquifer, Aquitard, GPM, Spring, Permeability, Porosity

For our vantage point here, we get one of our first views of the Cumberland Valley to the west. Most of the valleys is underlain with various types of limestone and dolomite. The hardness of these rocks dictates the rolling topography that exists between here and roughly Interstate 81. West of Interstate 81, close to the Appalachian Mountains, a ridge parallels the famous mountains and is composed of shale.

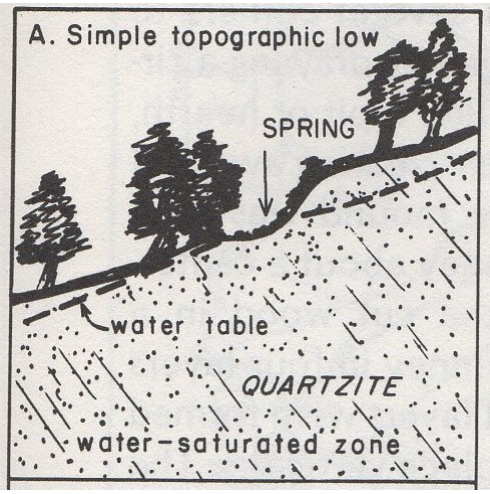
The Tomstown Formation underlies this quiet village and is found in rare outcrops within South Mountain in the deepest valleys. Compared to the harder rocks we saw today, the limestone is very soft and if you find an outcrop, treat it like gold.

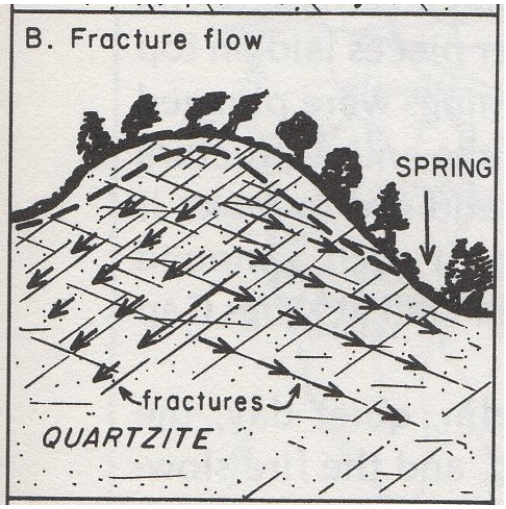
This is a great location to introduce some groundwater terms to you. Springs are common along the western slope of South Mountain because of the geology. Some of you may be familiar with the Huntsdale Fish Hatchery in Cumberland County. This hatchery is present because of the large number of springs flowing off South Mountain. Over 10,000 gallons of water per minute drains into the Huntsdale facility Way, 1986).

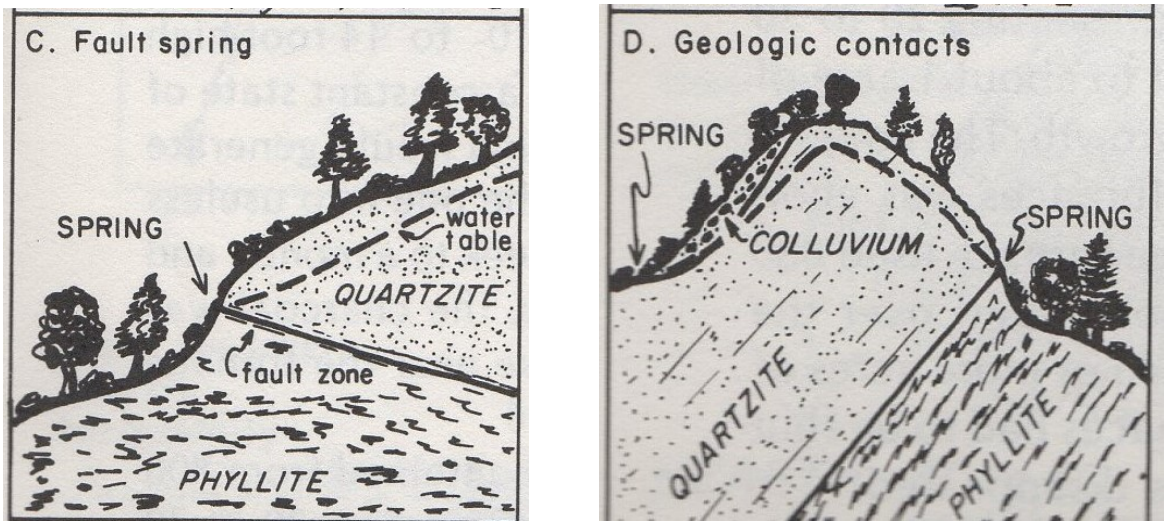
The Tomstown spring has a yield of 12 gallons per minute (Becher and Root, 1981). Several factors are involved here for groundwater to produce this spring. A simple topographic low can be a spring. Regular fracturing in the bedrock, allowing water to flow through the rock can also produce a spring. Perhaps groundwater will easily move along a fracture of weakness or a fault to the surface on a hillside. Finally, a spring can occur at the base of a thick zone of colluvium with bedrock. Since the bedrock is more resistance to allowing water to flow through it, a spring will form along the contact.



Geologic map of the Tomstown area. Yellow is Harpers Formation; dark green is Tomstown Formation; tan is Waynesboro Formation and brown is Elbrook Formation (Root, 1968)







Possible Explanations for Origin of the Springs on the west flank of South Mountain (from Way, 1986)

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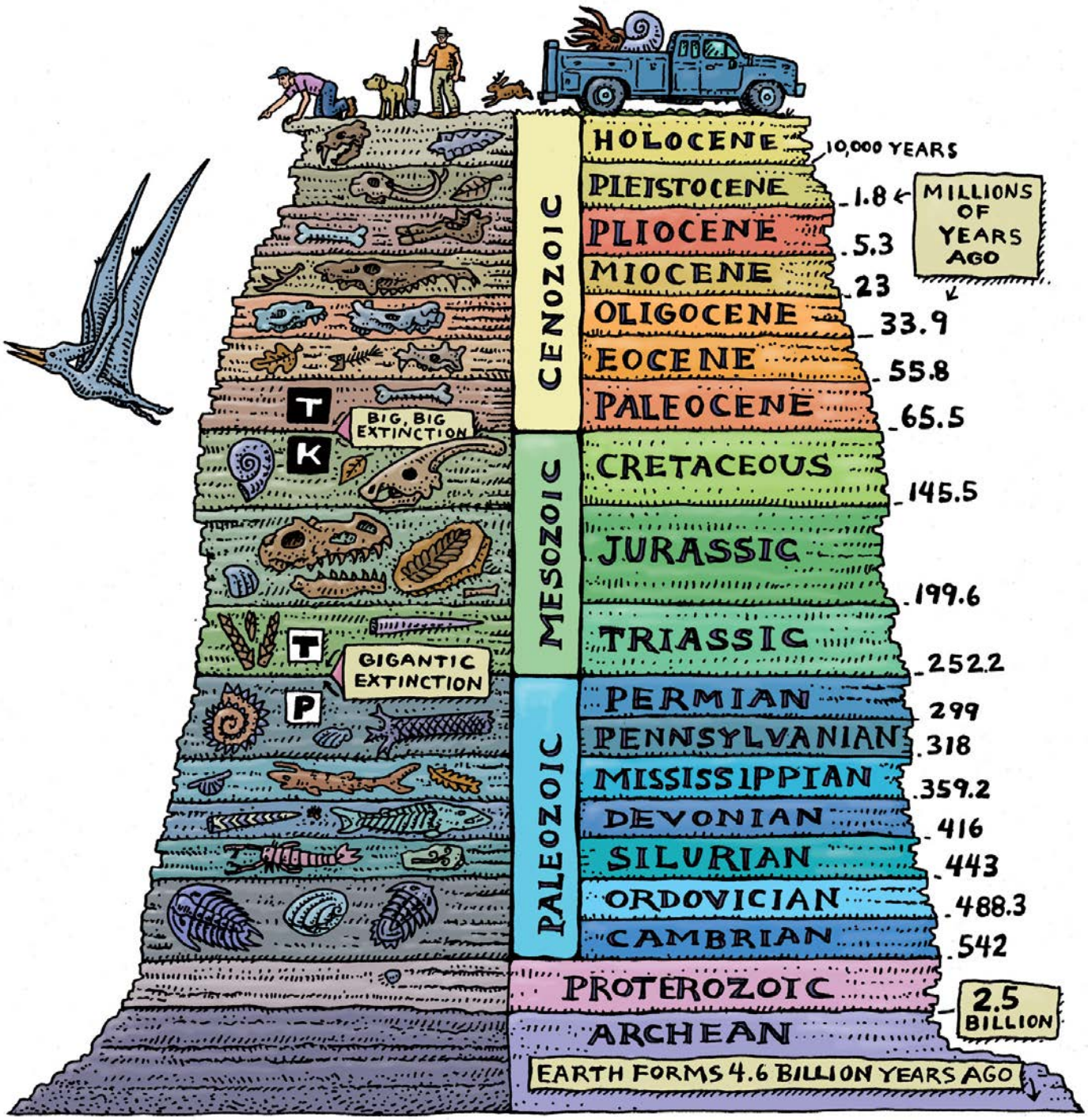
HOLOCENE
10,000 YEARS
PLEISTOCENE
1.8
PLIOCENE
5.3
MIOCENE
23
OLIGOCENE
33.9
EOCENE
55.8
PALEOCENE
65.5
CRETACEOUS
145.5
JURASSIC
199.6
TRIASSIC
252.2
PERMIAN
299
PENNSYLVANIAN
318
MISSISSIPPIAN
359.2
DEVONIAN
416
SILURIAN
443
ORDOVICIAN
488.3
CAMBRIAN
542
PROTEROZOIC
2.5 BILLION
ARCHEAN
EARTH FORMS 4.6 BILLION YEARS AGO
MILLIONS OF YEARS AGO
CENOZOIC
MESOZOIC
PALEOZOIC
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K
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