Meta – lling Through South Mountain

Franklin and Adams Counties, Pennsylvania

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2021

INTRODUCTION

Welcome to the "Meta-lling through South Mountain" field trip for the Institute. Brittany and I hope you enjoy the scenery of this unique landform and absorb the information that you will hear today. We are excited to be your hosts today and look forward to showing you just a quick glimpse of the complexity of the geology of South Mountain. The stops chosen today represent what we think are some of the best in this part of South Mountain and surroundings to accomplish our goal. We have set an agenda today so we can hopefully complete our tour on schedule. Please ask questions, take pictures and collect samples to add to your memories.

10:10 am	Depart from Red Run Park
10:20 – 10:35	Stop 1. Tomstown Spring
10:45 – 11:10	Stop 2. Waynesboro Fish and Game Club – Antietam Cove Fault
11:30 – 12:15	Stop 3. Waynesboro Reservoir - Metavolcanics
12:40 – 1:10	Lunch at Carroll Valley Borough Park and Rock Descriptions
1:25 – 3:00	Stop 4. Jacks Mountain Tunnel – Folding/Faulting/Quartzite/Metabaslt

STOP 1: Tomstown Spring/Watering Hole (Brittany)

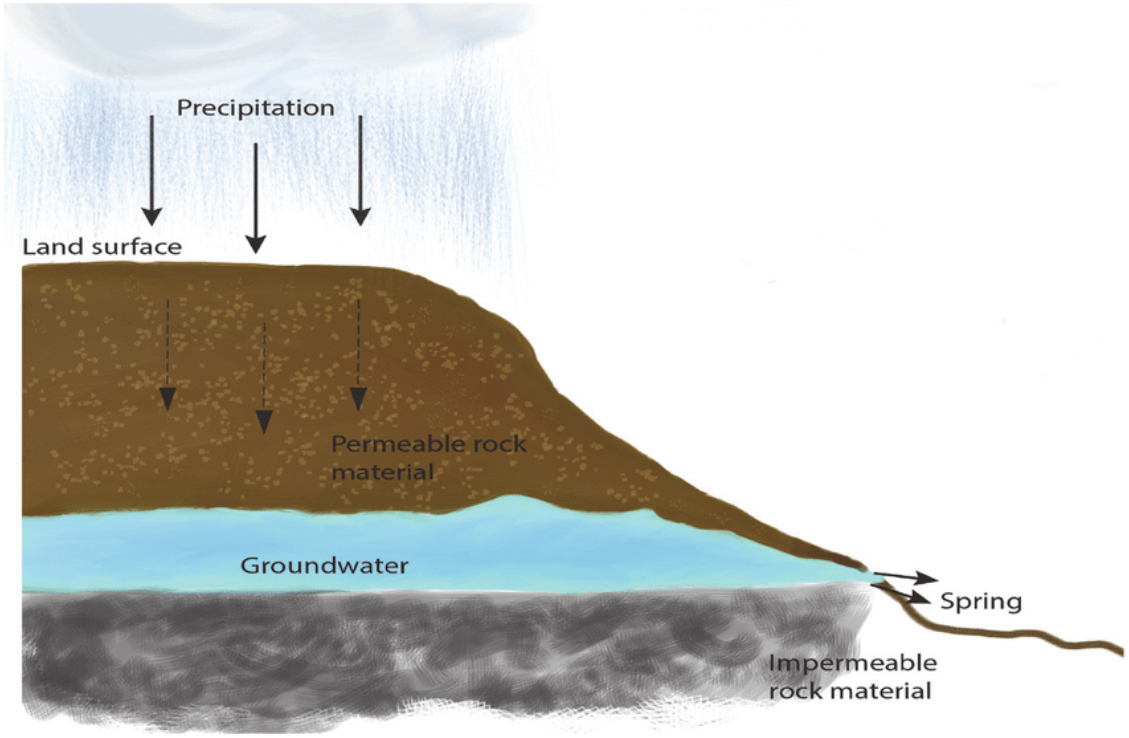
Groundwater: Most groundwater comes from precipitation. Precipitation infiltrates below the ground surface into the soil zone. When the soil zone becomes saturated, water percolates downward. A zone of saturation occurs where all the interstices are filled with water. There is also a zone of aeration where the interstices are occupied partially by water and partially by air. Groundwater continues to descend until, at some depth, it merges into a zone of dense rock. Water is contained in the pores of such rocks, but the pores are not connected and water will not migrate. The process of precipitation replenishing the groundwater supply is known as recharge. In general, recharge occurs only during the rainy season in tropical climates or during winter in temperate climates. Typically, 10 to 20 percent of the precipitation that falls to the Earth enters water-bearing strata, which are known as aquifers.

Groundwater is constantly in motion. Compared to surface water, it moves very slowly, the actual rate dependent on the transmissivity and storage capacity of the aquifer. Natural outflows of groundwater take place through springs and riverbeds when the groundwater

pressure is higher than atmospheric pressure in the vicinity of the ground surface. Internal circulation is not easily determined, but near the water table, the average cycling time of water may be a year or less, while in deep aquifers it may be as long as thousands of years.

Spring - A spring is a point at which water flows from an aquifer to the Earth's surface. A spring is a water resource formed when the side of a hill, a valley bottom or other excavation intersects a flowing body of groundwater at or below the local water table, below which the subsurface material is saturated with water. A spring is the result of an aquifer being filled to the point that the water overflows onto the land surface. They range in size from intermittent seeps, which flow only after much rain, to huge pools flowing hundreds of millions of gallons daily.

The **water table** is the top level of groundwater. Surface water is an exposed part of the water table.



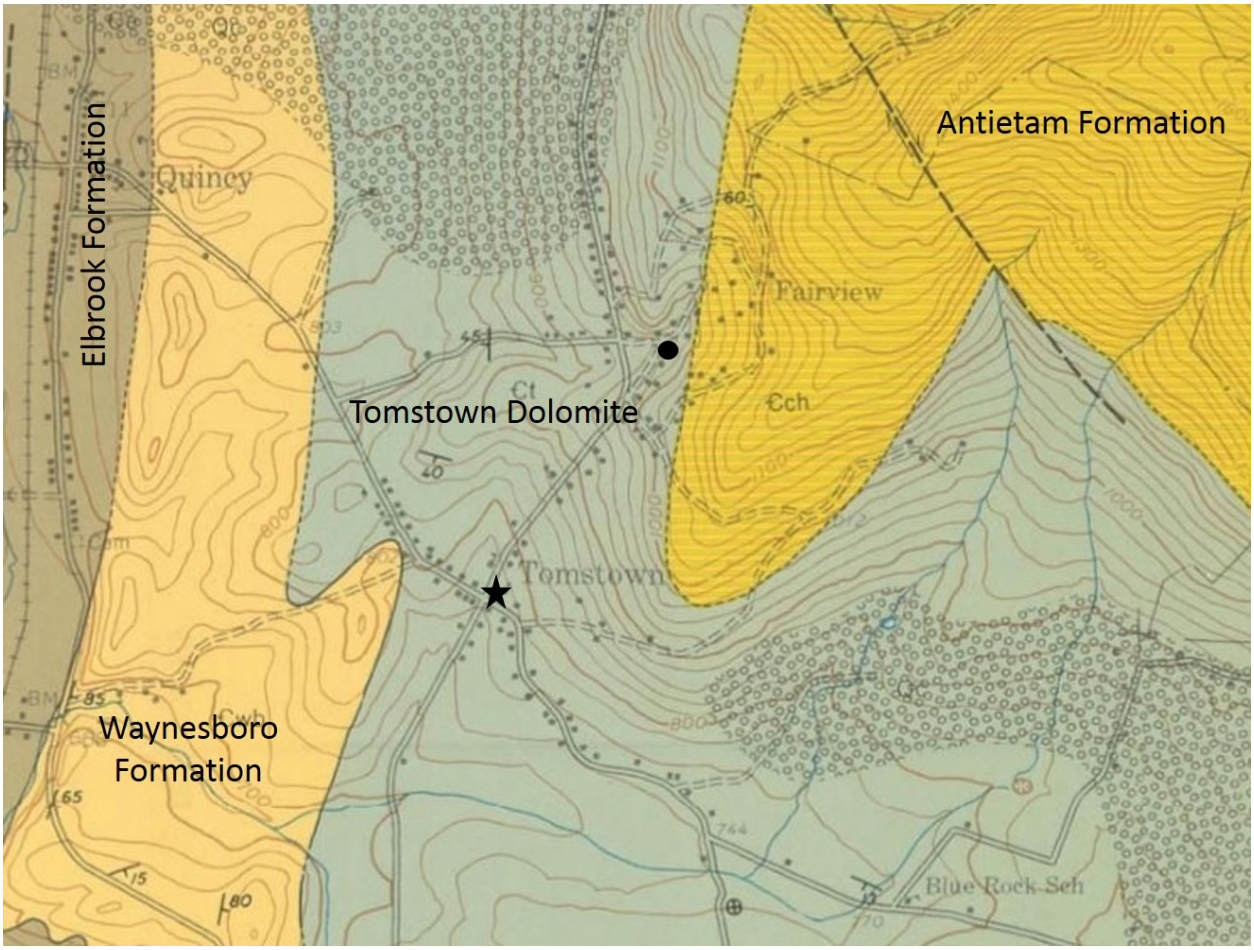
Tomstown Watering Hole Location: Corner of Tomstown Road and Mentzer Gap Road in Tomstown, PA. Coordinates: 39°47'34.3"N 77°33'41.8"W.

Rock Type(s):

1. Tomstown Formation/Dolomite - The Tomstown Dolomite or Tomstown Formation is a geologic formation in Maryland, Pennsylvania, Virginia and West Virginia. It

preserves fossils dating to the Lower Cambrian Period (Cambrian - 541 – 485.4 mya). Massive dolomite containing thin shaly interbeds.

2. Antietam Formation – Lower Cambrian to Precambrian (4,600 – 541 mya) Gray, buff weathering quartzite, sandstone and quartz-schist; thick-bedded, and resistant.
3. Waynesboro Formation – Lower- Cambrian - Thin basal and upper ridge-forming sandy units, middle portion is blue limestone.
4. Elbrook Formation – Middle- Cambrian - Light-colored calcareous shale and limestone.



What To See Here: To the West is Cumberland Valley. The valley is bound to the west and north by the Ridge-and-Valley Appalachians (Bear Pond Mountains/Blue Mountain), to the east and south by South Mountain, to the northeast by the Susquehanna River at Harrisburg, and to the south by the Potomac River. Most of the valleys are 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 location and is found in rare outcrops within South Mountain in the deepest valleys. The Tomstown spring has a yield of 12 gallons per minute.

Geology:

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.

One thing to note, looking at the geologic map you can see the more resistant quartzite of the Antietam Formation in contact with the soft Tomstown dolomite allowing water to feed more readily into the topographic low area of the Tomstown spring.

Carbonate rock, like limestone and dolomites is prime for ''Karst terrain'' which is a landscape formed primarily by the dissolution of soluble rock and is characterized by sinkholes, sinking streams, closed depressions, subterranean drainage, and caves and the Tomstown dolomite is a soft karst-forming carbonate rock.

Is the Water safe to drink: In 2011, a Waynesboro developer proposed residential development in the township. As part of this development, environmental assessment and sampling needed to be completed, including the Tomstown watering hole. This sampling led to the discovery of a trichloroethylene or TCE contamination, a hazardous chemical known to cause cancer, and can damage the liver, kidneys and the immune system. If you want to give it a try and taste it today, it would be fine. Long term consumption is not recommended.

STOP 2: Waynesboro Fish and Game Club – Antietam Cover Fault (Jeri)

Location: 10205 Fish & Game Road, Waynesboro, PA. Washington Township.

Coordinates: 39° 46’ 40” N 77° 30’ 23”

What is a fault? A fault is a fracture in the crust of the Earth where measurable displacement is recognized. There are several different types of faults based on the orientation of how they have moved. Some faults are formed by compressional stress; some are formed with tensional stress (pulling apart) and some are caused by strain where pieces of crusts slide past each other. There are some faults in the Great Valley. Most are confined to this section of the Ridge and Valley Province. What makes the Antietam Cove Fault unique is that it passes into South Mountain and just not for a brief distance.

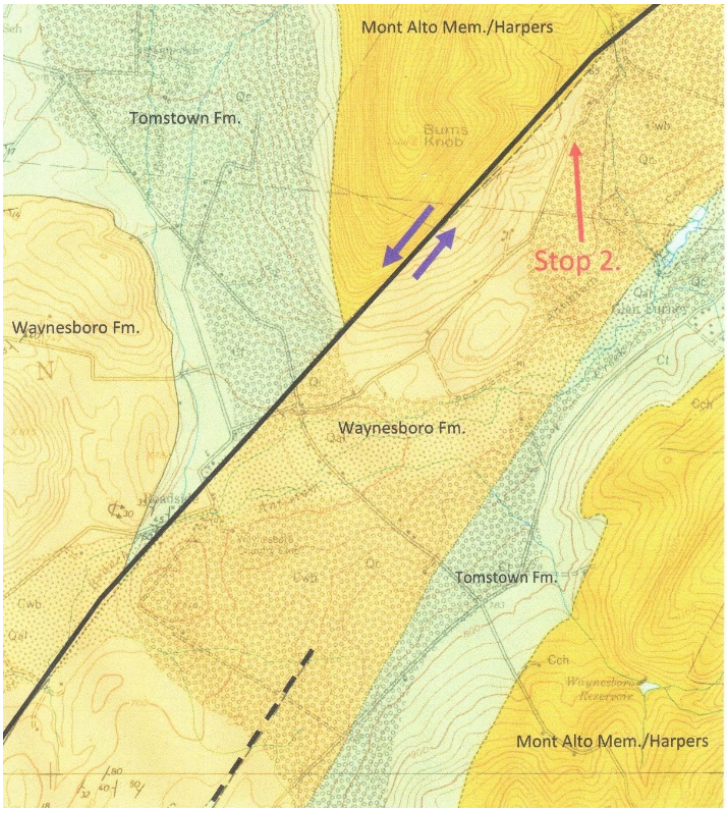
Geology:

Although we cannot recognize physically there is a fault passing under your feet, measurements on rock exposures both out in the Great Valley and extending into South Mountain indicate that these rocks have been placed under some sort of strain. The Antietam Cove fault is so named

of the cove that extends into the mountain as seen from the parking lot. The Antietam Cove fault begins in the area of the Mason-Dixon Line and travels in a north-northeast direction almost to U.S. Route 30 west of Cashtown. Research shows that there is a possibility that this fault may intersect another major fault system that parallels the highway known as the Carbaugh-Marsh Creek fault.

We are standing on the Waynesboro Formation, a limestone unit. The rock is soft and easily is weathered and eroded relatively speaking. On the north side of the fault, we have from left to right (west to east), the Waynesboro Formation, Tomstown Formation and the Mont Alto Member of the Harpers Formation. The Tomstown is composed of limestone and the Mount Alto Member is a much more resistant phyllite and quartzite. For example, Burns Knob to our north is composed of the Mont Alto Member. Why is the cove here? It is all due to the presence of the fault. Rocks caught within a fault zone are broken into smaller pieces due to the pressure and movement and then are weathered and eroded faster than the surrounding rock.

The Antietam Cover Fault is a strike-slip fault where displacement is lateral and not so much vertical. Notice the arrows on the geologic map below. This is the relative movement of the fault. Just how much displacement is involved is still not yet determined but appears to be sizeable, maybe several thousands of feet. Lastly, we consider this strike-slip fault has a left lateral fault, meaning that as we stand and look at the fault, the other side of the fault has moved to the left.



STOP 3: Waynesboro Reservoir/Watershed (Brittany)

Location: Antietam & Watershed Roads, Hamiltonban Township

Coordinates: 39° 49’ 08” N 77° 28’ 19”

Geology:

Metarhyolite – A low-grade, felsic metavolcanic rock with preserved evidence of its original rhyolitic character. At this location the metarhyolite is of Precambrian (4000 – 541 mya) age. It is pale-red-purple or grayish purple with moderate red to dusky red or grayish-red-purple flow banding contacts with bands approximately 0.5 to 2mm wide.

Flow Banding - visually distinguishable “bands” or layers in volcanic rock that differ based on composition, texture, or geochemical characteristics. Each stratum represents an individual flow so some flow lines indicate a very watery lava.

Metabasalt – A metamorphically-altered basalt. At this location the metabasalt is of Precambrian (4000 – 541 mya) age. It is green, greenish-gray and gray, massive to well-cleaved rock of uniformity, fine to medium-grained. Irregular to oval-shaped vesicles filled with minerals including quartz, epidote and feldspar.

Mont Alto Member of Harpers Formation – Cambrian (541 – 485.4 mya) – Gray quartzite

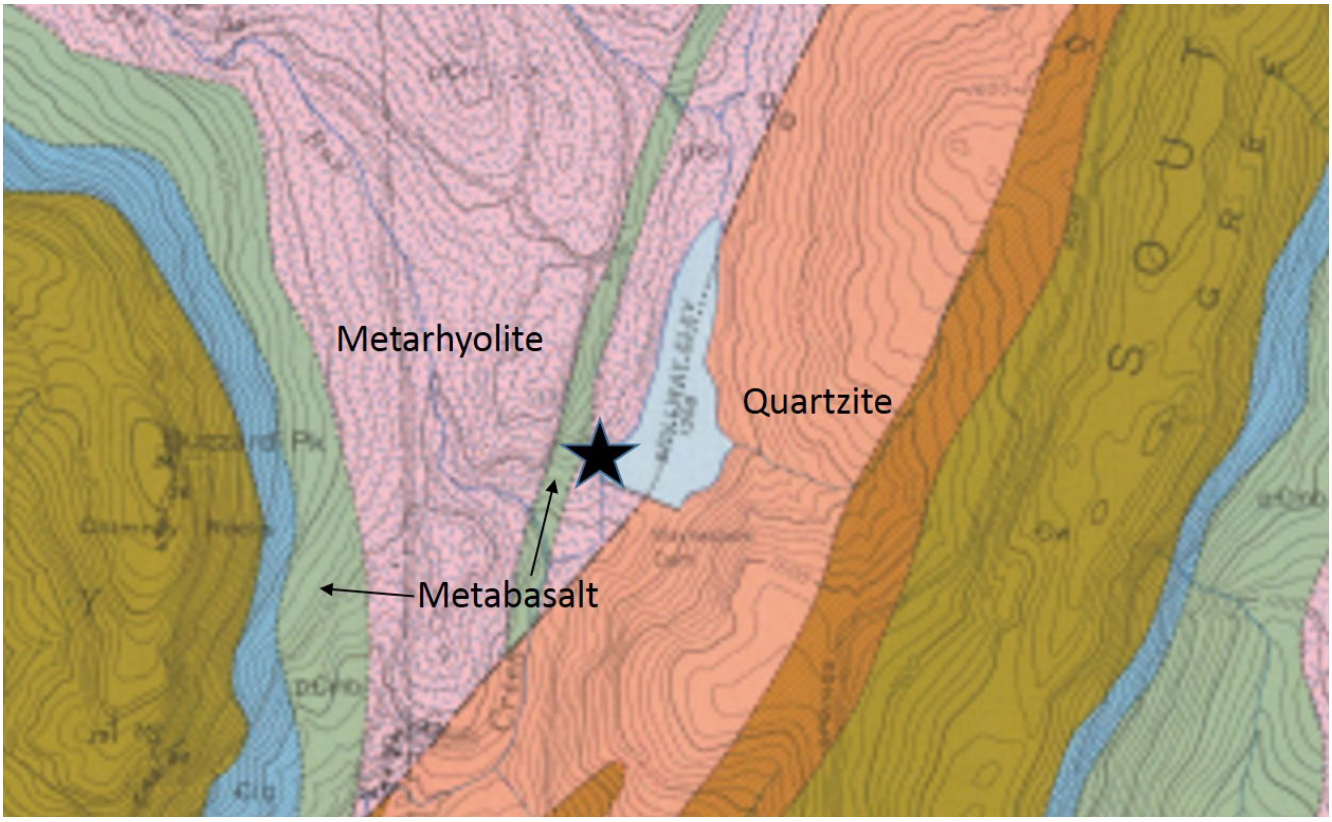
What To See Here: In this location we see fine-grained aphanitic metarhyolite to porphyritic metarhyolites. Many rocks with an overall fine-grained texture display scattered minerals that are more than 1 mm across. This is a porphyritic texture which indicates that the magma sat and cooled a bit below the Earth's surface, thus giving time for the large crystals to grow, before erupting onto the surface and cooling very quickly. The large crystals are termed phenocrysts while the aphanitic rest of the rock is called the groundmass. A metabasalt ridge can be seen in the distance. Metabasalt is more resistant to weathering than metarhyrolite therefore ridges of metabasalt stand tall, similar to the famous resistant rock of Devil’s Tower.

Note: Aphanitic rocks are certain igneous rocks that are so fine-grained that their component mineral crystals are not detectable by the unaided eye.

The fault located here is defined as: sense of displacement unknown or undefined.

Geological History: The rocks here consist of aphanitic, extrusive volcanics (dominantly basalts and rhyolites) that have been subsequently metamorphosed. They represent late Precambrian rift-related volcanism which occurred during the opening of the Proto Atlantic Ocean, reflecting the continental rifting of Rodinia during the Late Proterozoic from approximately 600-540 million years ago. Around 250 million years ago, the North American continent collided with

Africa (Alleghanian Orogeny), folding and uplifting the rock into a massive mountain range as great as the modern Himalayas. The intense heat and pressure metamorphosed the existing rock. Basalt, originally formed during oceanic rifting and rhyolite formed during continental rifting became metabasalt and metarhyolite, respectively. Since then, the rock has slowly eroded and represents the oldest rocks seen in South Mountain.



LUNCH STOP: Carroll Valley Borough Office and Park

Location: 5685 Fairfield Road, Fairfield, PA Hamiltonban Township

Coordinates: 39° 45’ 39” N 77° 22’ 52”

Instructions: Restrooms are available in the left rear of the Borough building. Depending on the weather, you are invited to eat in your car, on a bench or rock or in the park pavilion. Before departing there is some geology to be seen here.

The Rocks: Along the walkway between the building and the park complex are several large rocks. The rock on the left (road) side is a sedimentary rock known as breccia. The rock is found under the Borough park and is Triassic in age. Notice the angular rock fragments within the large rock. Any rock containing angular rock fragments is known as breccia. We can take this rock origin a bit further. A rift valley existed here some 200 million years ago as Pangaea was splitting apart. The valley walls were rather steep and the area was receiving an

abundance of rainfall. Water flowing toward and into the rift valley was strong and was able to carry large rock fragments. Once the water got to the flat rift valley floor, the speed of the water quickly decreased and all of the large material was dropped into the sediment near the valley walls. From the air, the deposit resembled an alluvial fan so today the breccia can be classified as a fanglomerate. O, by the way did we mention that this area during the Triassic Period was located at the latitude of Miami, FL and was an "Everglades" environment.

The rock on the opposite side of the path from the fanglomerate is an igneous rock known as diabase. Diabase formed from magma perhaps 3-4 miles beneath the surface during the Jurassic Period. If the magma reached the surface it would have turned into a rock known as basalt. The rock is composed of medium-sized crystals (mostly dark), The grain size can tell you the speed it cooled from the magma. If the rock exhibits a fine-grained appearance, the lava cooled rather quickly. If the magma cooled slowly, the crystals are larger, such as granite. Diabase is nicknamed "ironstone" because of its stupidness. When hit, for example, by a farming implement, the farmer knows it. Notice the outside of the diabase is weathering a light orange. This is typical of diabase and is formed from a small amount of iron-oxidizing from within. Also notice that this sample is beginning to take on a spheroidal weathering design, a characteristic appearance of igneous rocks. Diabase is resistant to erosion and weathering so it occupies the higher elevations of the Piedmont Gettysburg-Newark Section in which we are now located. Ski Liberty is a diabase mountain.

Diabase is the last episode of the rifting apart of Pangaea. Our crust was injured by the tensional stresses from the separation of the landmasses from the supercontinent. Magma intruded up through the crust to reheal "Mother Earth" which cooled to form a diabase.

STOP 4. Jacks Mountain CSX Railroad Tunnel (Jeri)

Location: CSX Railroad, east of Gladhill, Hamiltonban Township.

Active Railroad, permission needed to access the tunnel

Coordinates: 39° 44' 40" N 77° 26' 41"

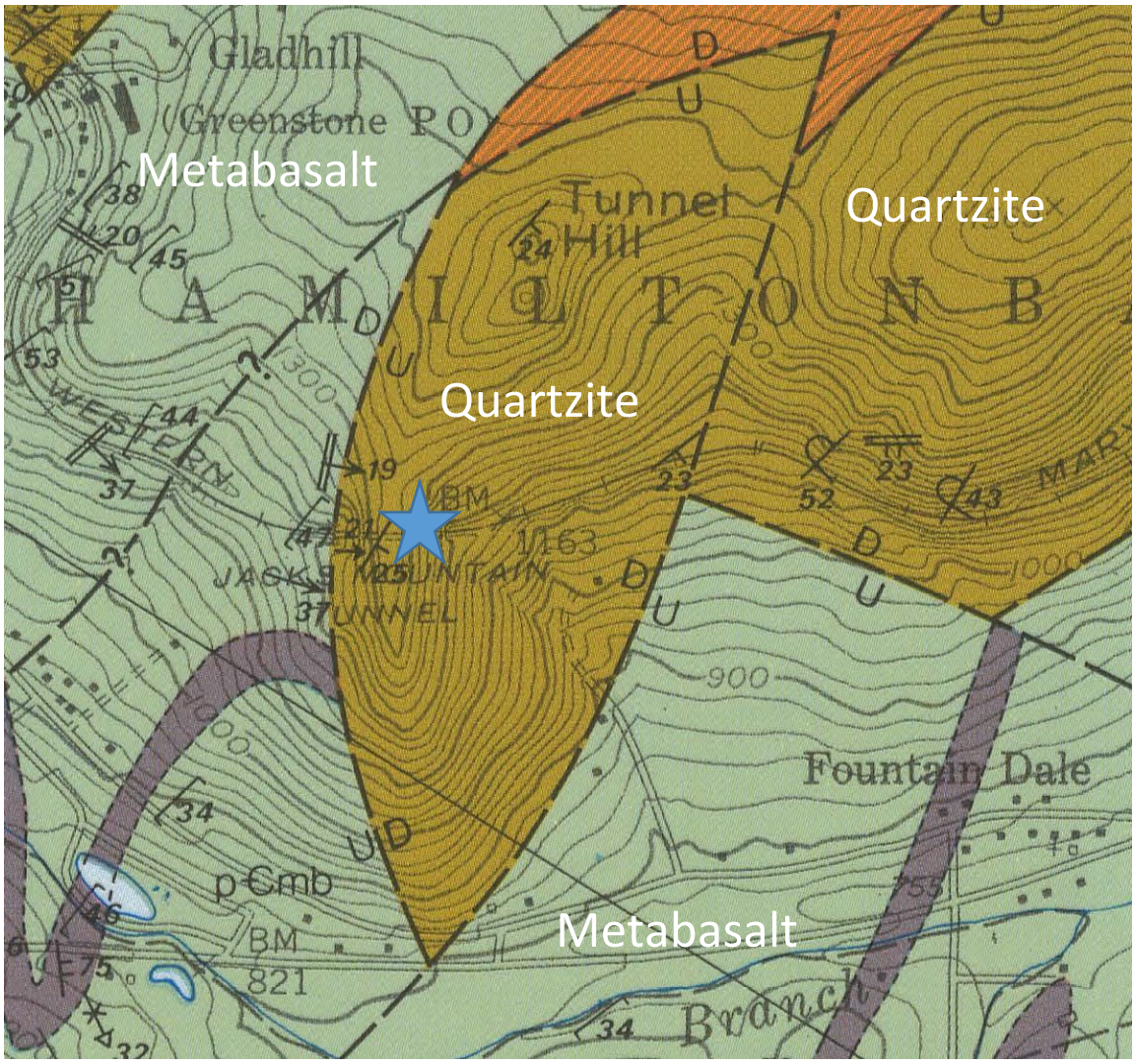
What: The round trip walk on the railroad bed to Jacks Mountain Tunnel is 1.5 miles. Please be cautious of objects laying on the bed, railroad ties and railroad bed being washed out. At places, the bed is wide enough that walking on the outside of the rails is possible. Other places have steep drop-offs not allowing walking on the outside of the tracks possible. Once we enter the tunnel, it is encouraged that everyone has a flashlight and use caution. There are places where there is no stone between the railroad ties. We will stop just inside the west portal of the tunnel to examine the geology and again about halfway through the 400-foot tunnel. The best rock exposure to be seen here is on the east side of the tunnel.

Geology: Exposures of the Catoctin metabasalt will be encounter early in the walk. Take notice of the blocky appearance and its characteristic brownish weathering hues. The fresh rock is a dark greenish color and contains calcic plagioclase feldspar, pyroxene and chlorite. No flow structures have been seen in the exposures. The fractures in the metabasalt are known as joints. Joints were created by stress but no displacement has been detected. Usually there are several different directions of the joints known as a joint set. By measuring and recording the azimuth and dip angle of the joints, geologists can determine the direction of the stress applied.

As you approach the west portal of the tunnel, watch for a change in rock type. We will be leaving the Catoctin metabasalt and passing into the Cambrian-aged Weverton Formation. The Weverton is composed of thick-bedded quartzite, which is a dirty-white in color. The quartzite is composed of a high percentage of quartz with other minor minerals such as iron oxide included. Can you find the contact between the metabasalt and the quartzite?

The contact between the two formations is known as a fault contact. Just inside of the tunnel and seen on both sides of the tunnel you will see a prominent crack traveling up the wall at about 30°. This is known as a thrust fault where the quartzite has been pushed up and over the metabasalt. A closer look at the fault area, you may see some of the rock has been bent (folded) due to the movement. The remaining part of the tunnel is composed of the Weverton quartzite.

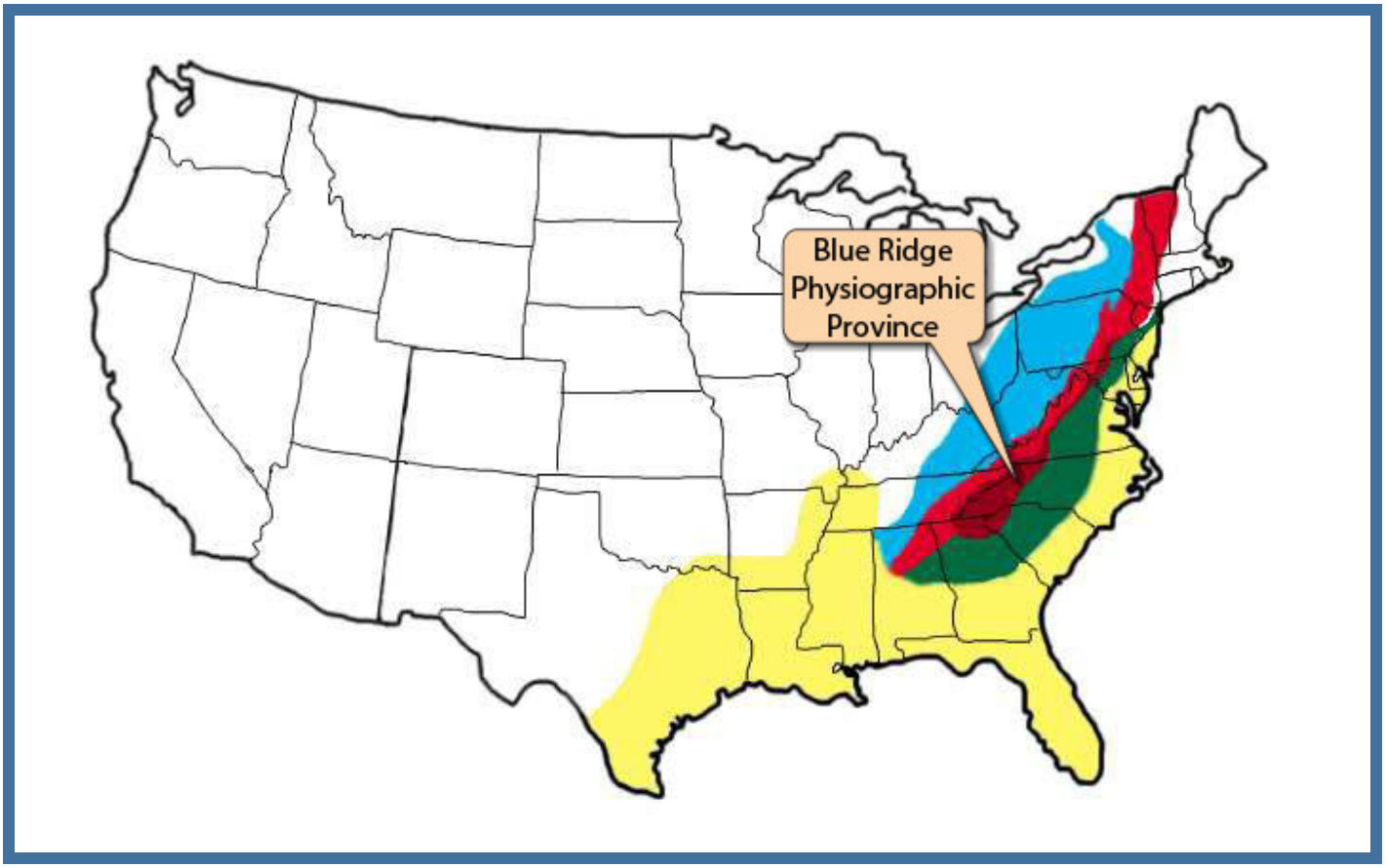
Exit the east portal and look at the quartzite, particularly on the northside of the railroad. Try to follow the thick beds of this metamorphic rock. It gets a little tricky to follow as the rock here has been folded. In some cases the beds have been stretched and made thinner. This is a great example of recumbent folding and shows you the amount of stress and strain that occurred within South Mountain during two tectonic episodes of crustal collisions.

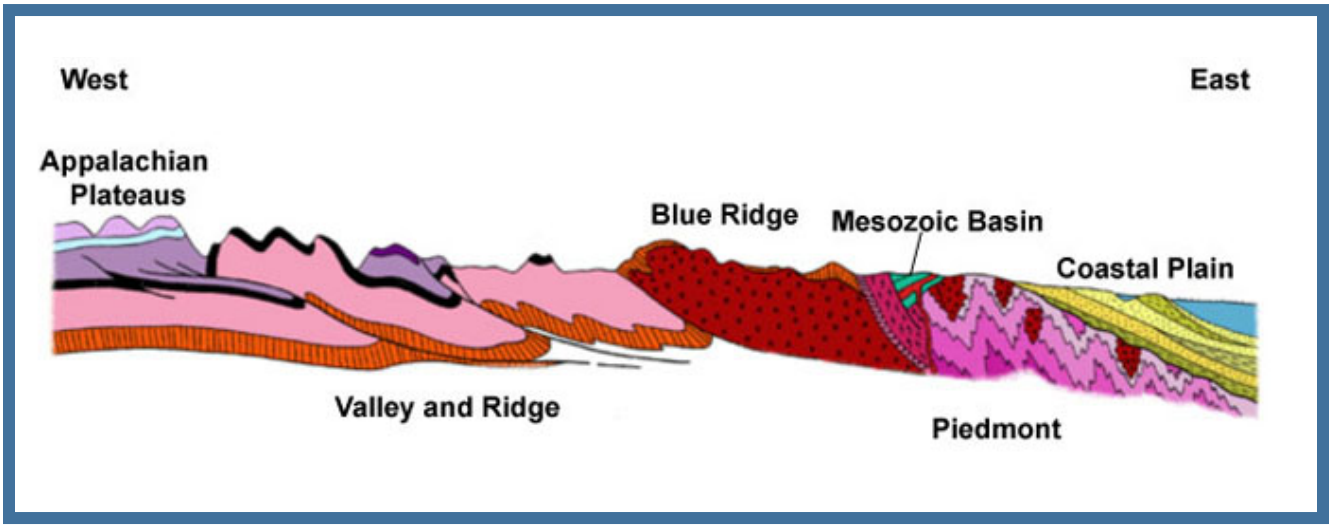


Thanks for attending the field trip and hope you had a good time. Please feel to contact us with any further questions at jonesgeo@comcast.net. We always love to hear from our participants.

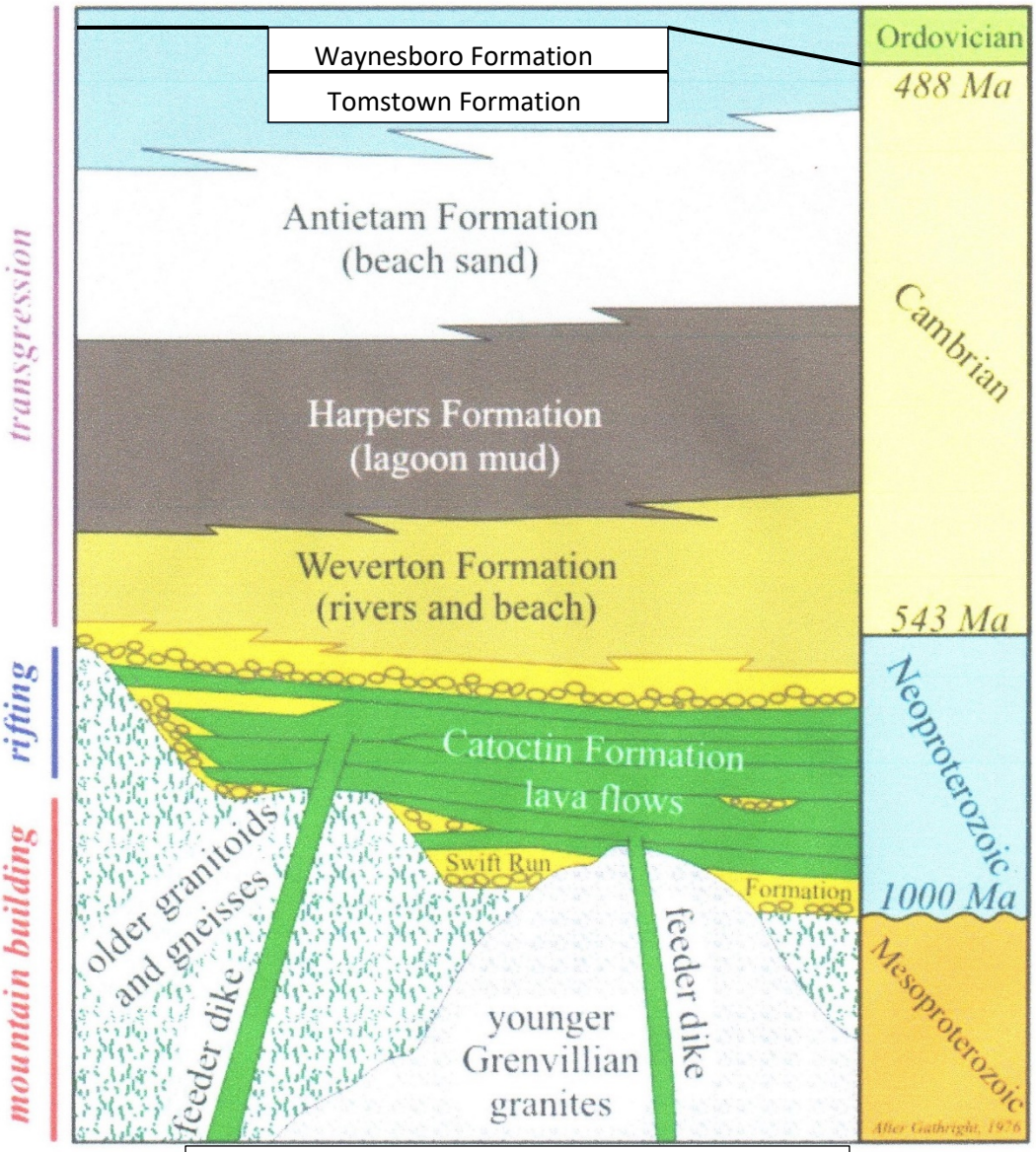
Our thanks to the staff at The Institute for sponsoring this and every geology program. We always find the audience belonging to The Institute engaged in the program.

Depending upon your direction to return home, you may access Pa. Route 16 by going down the hill and turn left at the Fountaindale Fire Company onto Old Waynesboro Road. To head toward Gettysburg, you can turn left out of the church parking area and follow Iron Springs Road to Pa. Route 116.





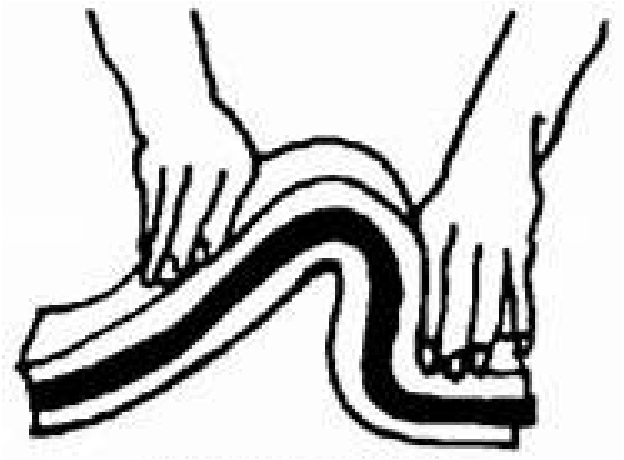
Courtesy of the VA Division of Geology and Mineral Resources



Stratigraphy of the South Mountain area

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



Overturned Anticline

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