A Drive Around the Neighborhood with a Geologist

A Tour of the Surroundings of South Mountain, Pennsylvania and Maryland

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Jones Geological Services has conducted a number of field trips throughout South Mountain in Franklin and Adams counties in the past. For the 2022 edition of the annual The Institute Geology Trip we sought out several new stops and included several of the "most favorite" sites from previous trips. With the schedule change of this year's destination from the Gettysburg National Military Park with the closing of several of the key sites, this trip was organized in three weeks. This saying, the field guide is not as extensive as usual but contains a lot of information that will be explained along the way.

Our journey will begin at Red Run Park at Rouzerville on the west side of South Mountain (SMS) located within the Great Valley Section (GVS) of the Ridge and Valley Province (RVP). We will visit a typical Great Valley site at the end of our day.

Our route will take us across the SMS to the east side and exam the youngest rocks will we see on this trip. From there we will embank into the SMS to explore the geologic history and mysteries of the oldest rocks of this journey. Heading back to Red Run Park, we will examine one of the classic rock sites that once made up an ancient continental shelf.

Here is our tentative schedule:

Starting Point - Red Run Park
STOP 1. The Mesozoic Era Here – Grace Bible Church, Tract Road
STOP 2. Emmitsburg Reservoir Catoctin Meta basalt and Loudon Formation Graywacke
STOP 3. Full Gospel Pentecostal Church, Harbaugh Valley Road, Stream Erosion.

LUNCH STOP – Penn Mar Park, Penn Mar Road

STOP 5. High Rock, South end of Penn Mar Road
STOP 6. Raven Rock Boulder Field, 0.75 miles north of Raven Rock Road (MD Route 491)
STOP 7. Route 419, Weverton Formation Quartzite, 0.25 mile south of Ritchie Road
STOP 8. Route 419, Harpers Formation Phyllite, 0.25 north of Fruit Tree Road
STOP 9. Waynesboro Formation Limestone Exposure, Old Mill Road south of Amsterdam Road.

PLEASE NOTE THAT STOP 9 IS ON PRIVATE PROPERTY AND ACCESS HAS ONLY BEEN GRANTED FOR THIS TRIP!

On the next several pages are basic information that will be referred to during the trip.

Fig. 1. Simplified Rock Cycle:

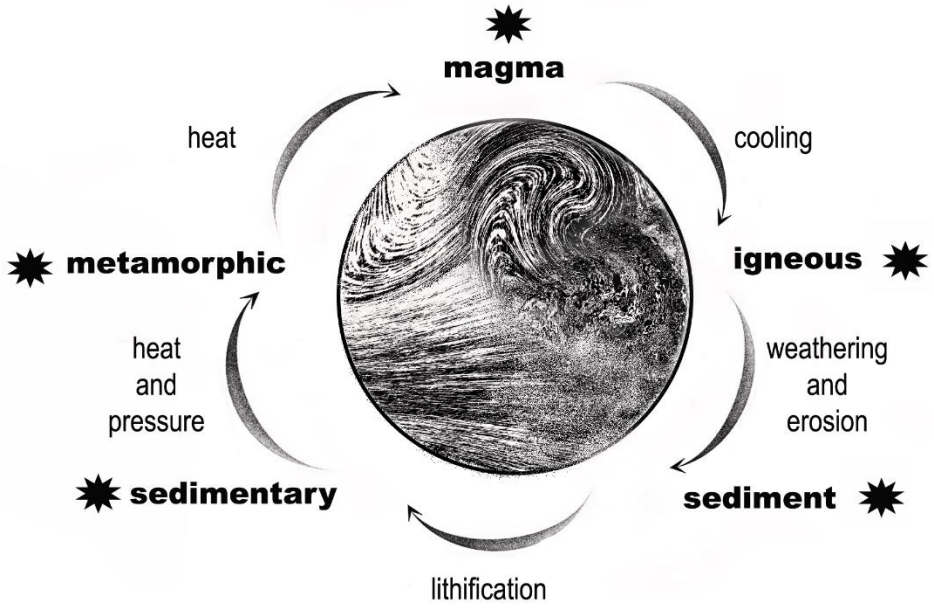


Fig. 2. Time Scale:

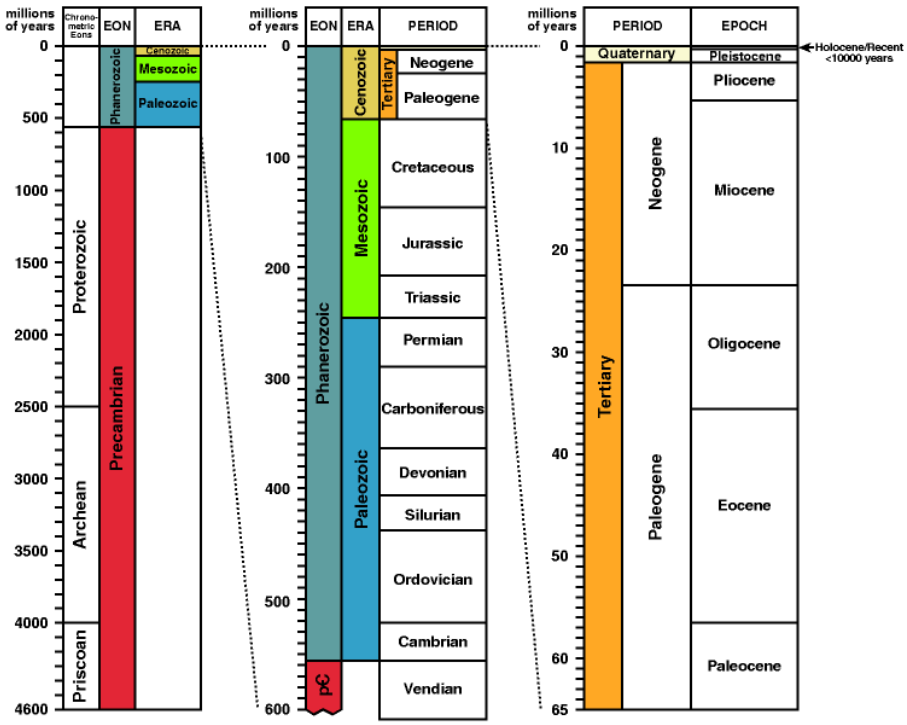


Fig. 3. Physiographic Provinces in central Pennsylvania:

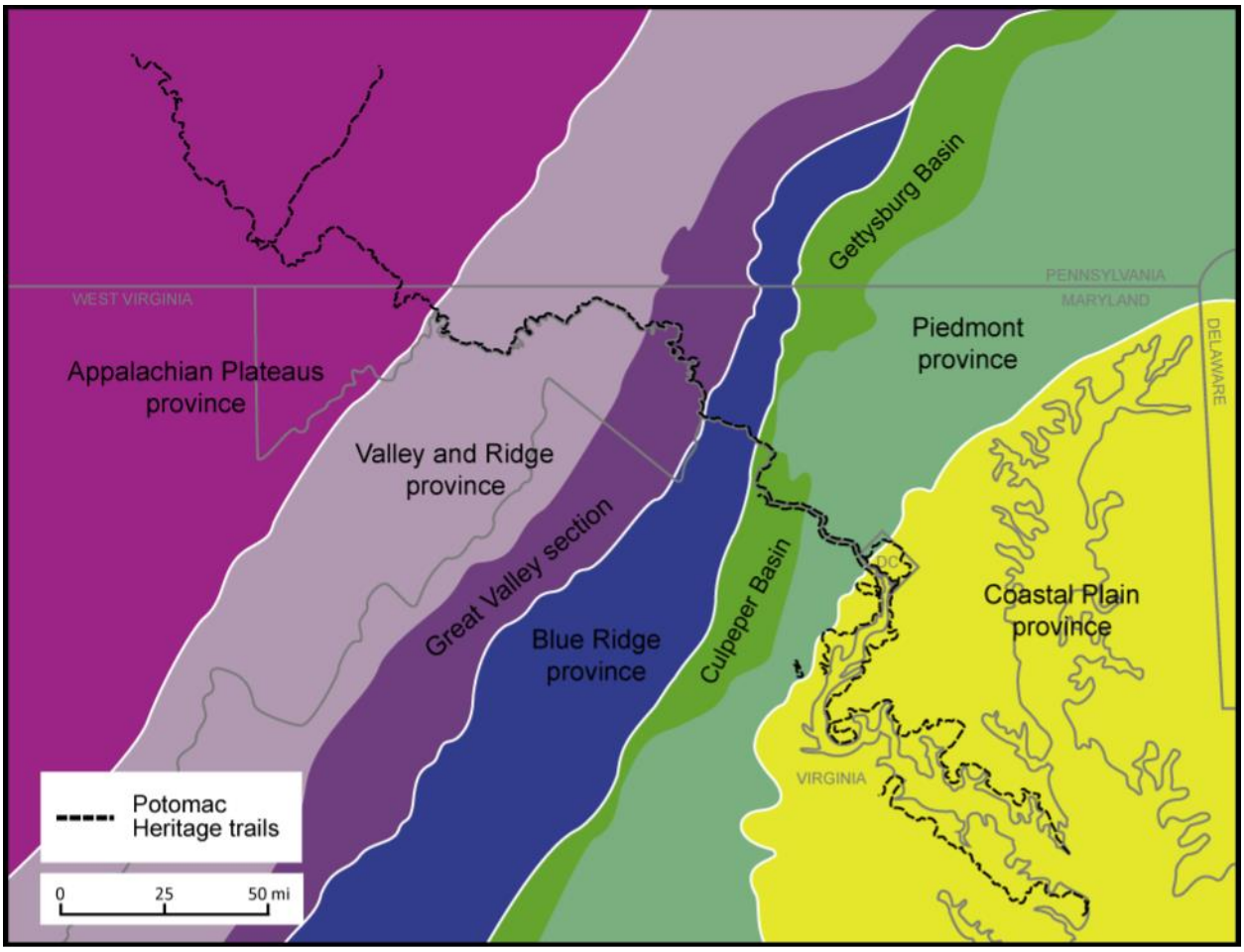


Fig. 4. Folding:

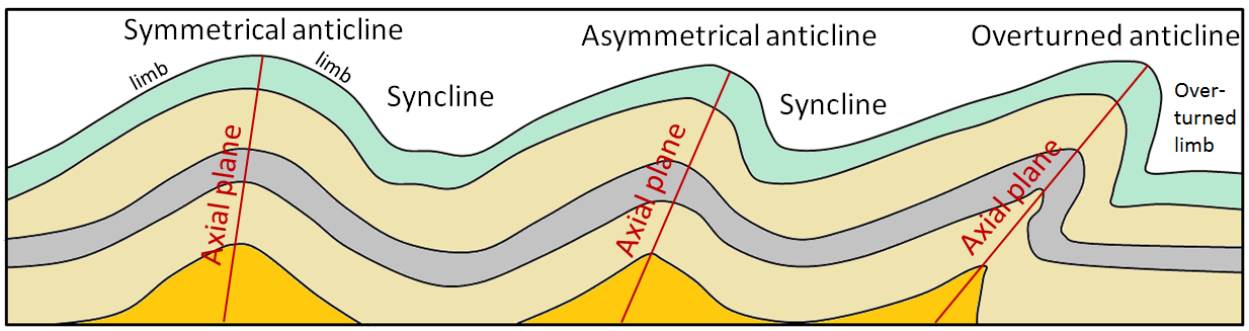


Fig. 5. Supercontinent Rodina:

Pannotia at 545 Ma *Source: Kroner and Stern (2004); Abdelsalam et al. (2002); Dalziel (1997)*

Fig. 6. Mesozoic Basins on the East Coast.

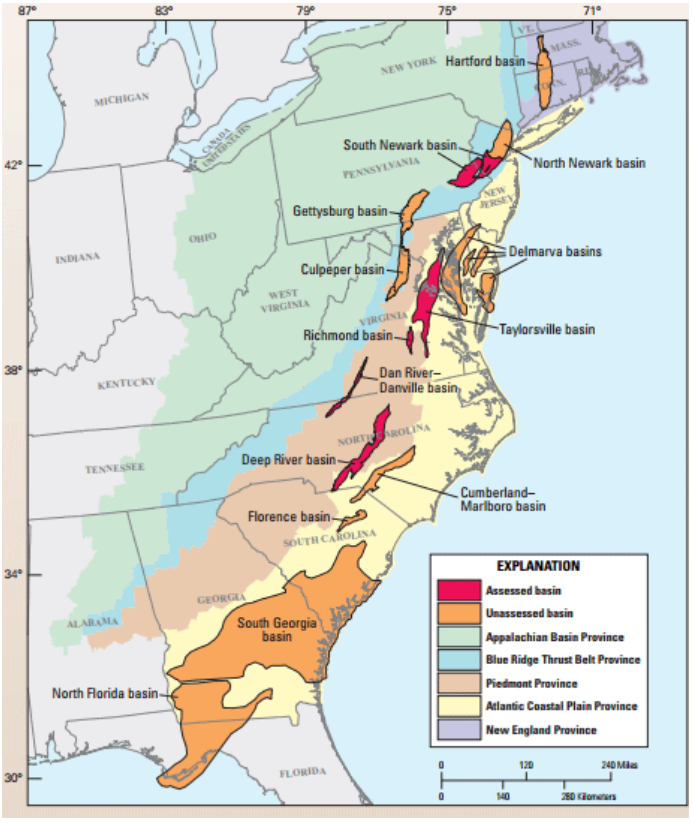
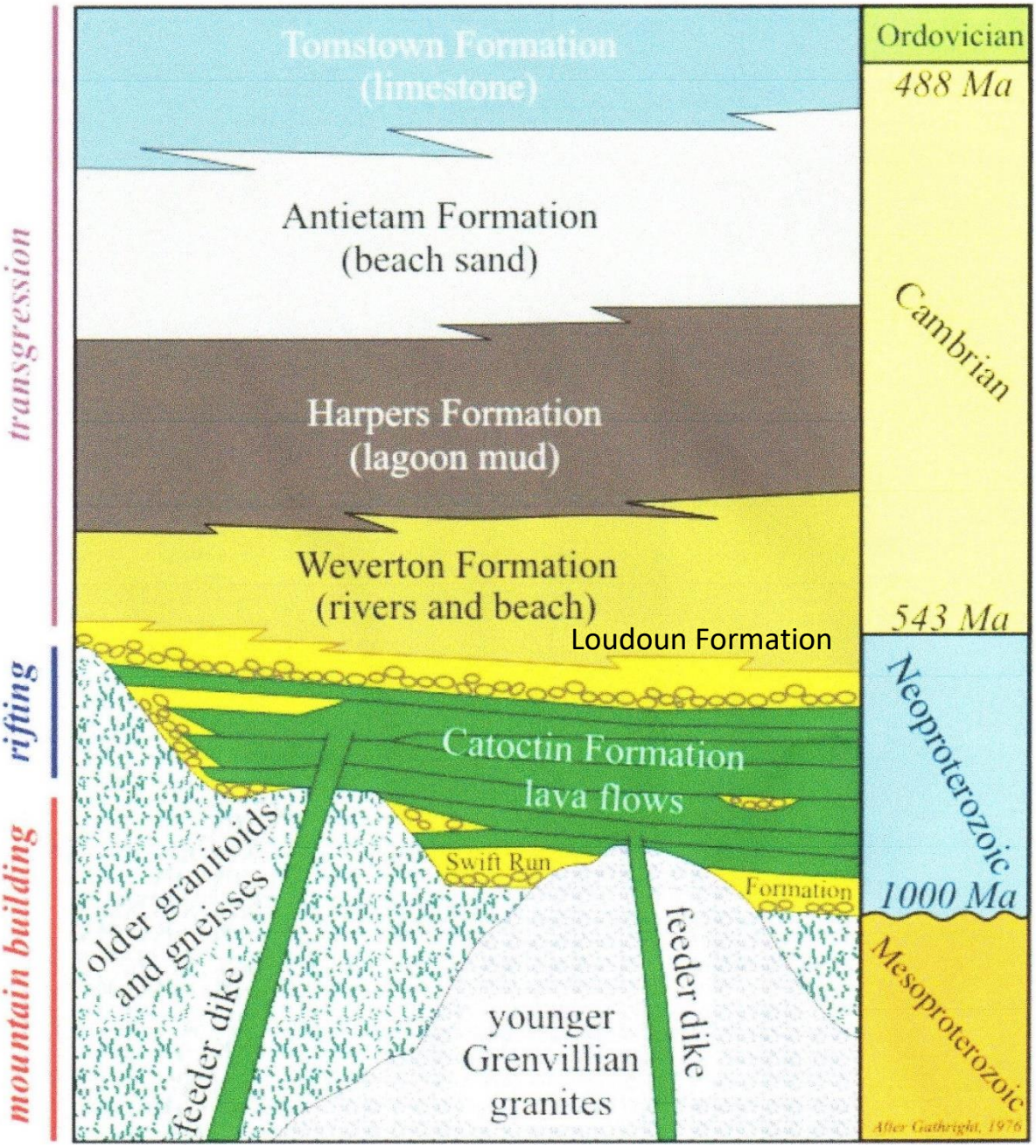


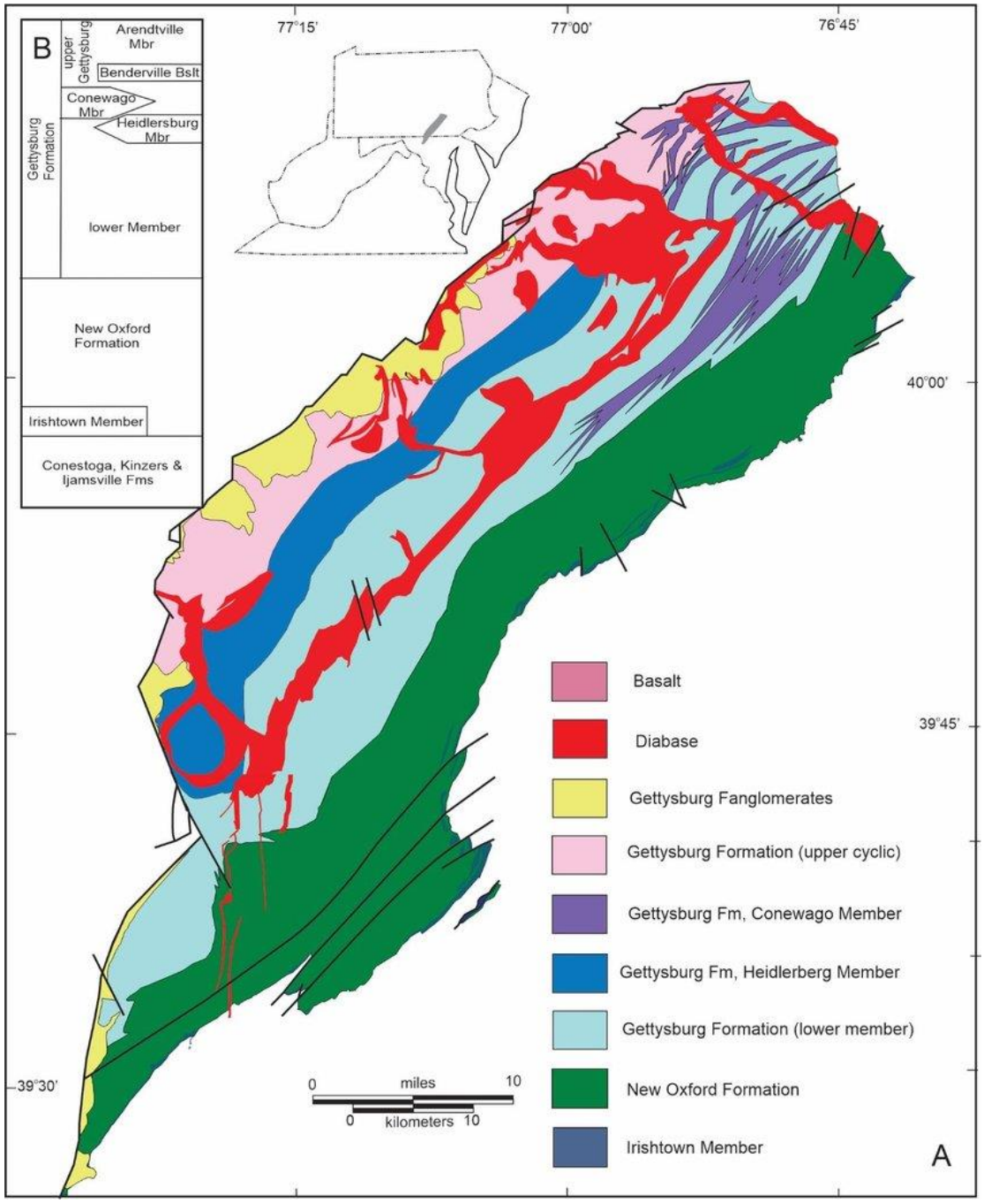
Fig. 6. Stratigraphic Column of SMS:



Formation Names and Thickness Encountered on This Trip in SMS

Harpers Formation	Phyllite	300-1,000 feet
Weverton Formation	Quartzite	500-1,400 feet
Loudoun Formation	Phyllite/Graywacke	200 feet
Catoctin Formation	Meta rhyolite/Metabasalt	3,000-3,200 feet

Fig. 7. Rocks of the Mesozoic Basin:



Formation Names and Thickness Encountered on This Trip in Mesozoic Basin

Diabase		1, 800 feet
Gettysburg Formation	Shale/Sandstone/ Conglomerate/ Breccia	16,000 feet
New Oxford Formation	Shale/Sandstone/Conglomerate	6,900 feet

Fig. 8. Stratigraphic Column of the Great Valley: (From Root, 1968)

System	Series	Group	FORMATION	DESCRIPTION	THICKNESS (in feet)
ORDOVICIAN	Middle Ordovician		Martinsburg Formation	Black, carbonaceous and fissile shale, weathers buff, with yellow-green to dark-gray fine-grained graywacke beds.	>1,000
			Chambersburg Formation	Dark-gray, cobbly limestone, argillaceous, with abundant irregular shaly partings Some metabentonite beds present.	750
		St. Paul	New Market Row Park	Vaughanitic limestone at top. Granular fossiliferous limestone, black chert, and sparse dolomite in middle. Vaughanitic limestone at base.	1,000
	?	Beekmantown	Pinesburg Station Dolomite	Light-colored, thick bedded, finely-laminated dolomite.	450
	Lower Ordovician		Rockdale Run Formation	Mostly mechanical and stromatolitic limestone. Laminated light gray or buff dolomite interbeds in upper half. Some chert in middle and at top. At base ±500 feet of pure marbleoid limestone, locally with abundant chert and pink stromatolitic limestone.	+2,500
			Stonehenge Formation	Stromatolitic and fine-grained mechanical limestones that become predominantly mechanical toward the north.	775
			Stoufferstown Formation	Coarse-grained mechanical limestone with dark-gray siliceous seams, prominent ridge former.	260
CAMBRIAN	Upper Cambrian	Conococheague	Shadygrove Formation	Pure light-colored limestones, stromatolitic in part. Abundant pinkish limestones and cream colored cherts.	650
			Zullinger Formation	Cyclically-bedded stromatolitic-mechanical limestone, interbanded limestone and dolomite, interlaminated limestone and dolomite, thin dolomite. Several thin local quartz sand beds.	2,500
	Middle Cambrian		Elbrook Formation	Light-colored, calcareous shale and argillaceous limestone, blue limestone and dolomite in middle ridge former. Pure dark limestone at base.	estimated ±3,000
	Lower Cambrian		Waynesboro Formation	Thin buff basal and upper red ridge-ofrming sandy units. Middle portion is blue limestone.	±1,000
			Tomstown Formation	Dolomitic limestone to limestone in upper part. Mottled silty dolomite in middle part. No exposures at base.	estimated 1,000 –
CAMBRIAN ?	Lower Cambrain ?	Chilhowee	Antietam Formation	White quartzite with bluish-cast in places, coarse grained, pure, with many skolithos tubes.	500-800
			Harpers Formation	Dark-banded, hackly schist to slate with prominent middle member of massive hard, white quartzite that thickens to the north.	2,750
			Weverton Formation	Gray fel spathic sandstone, coarse grained. Some white quartzites. Conglomerate at base.	1,250
PRECAMBRIAN			Catoctin Formation	Altered rhyolitic flows, finely-laminated, red to purple color. Altered basalt with chlorite and epidote.	

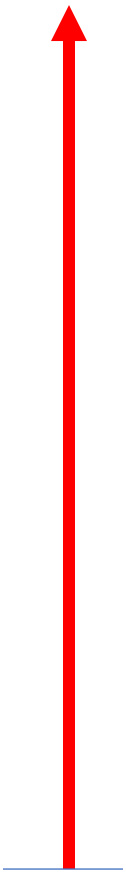


Fig. 9. Taconic Orogeny about 420 million years ago:

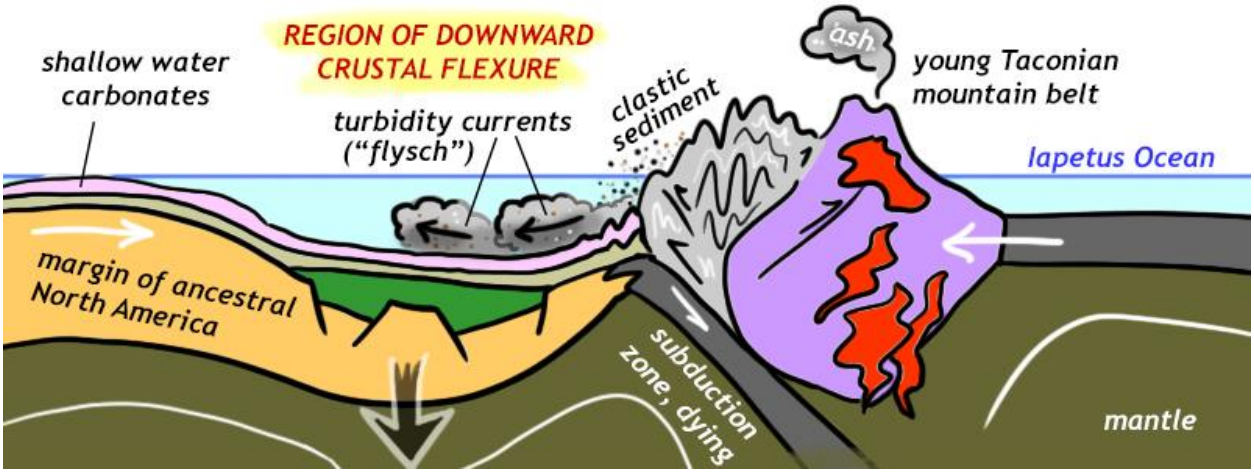
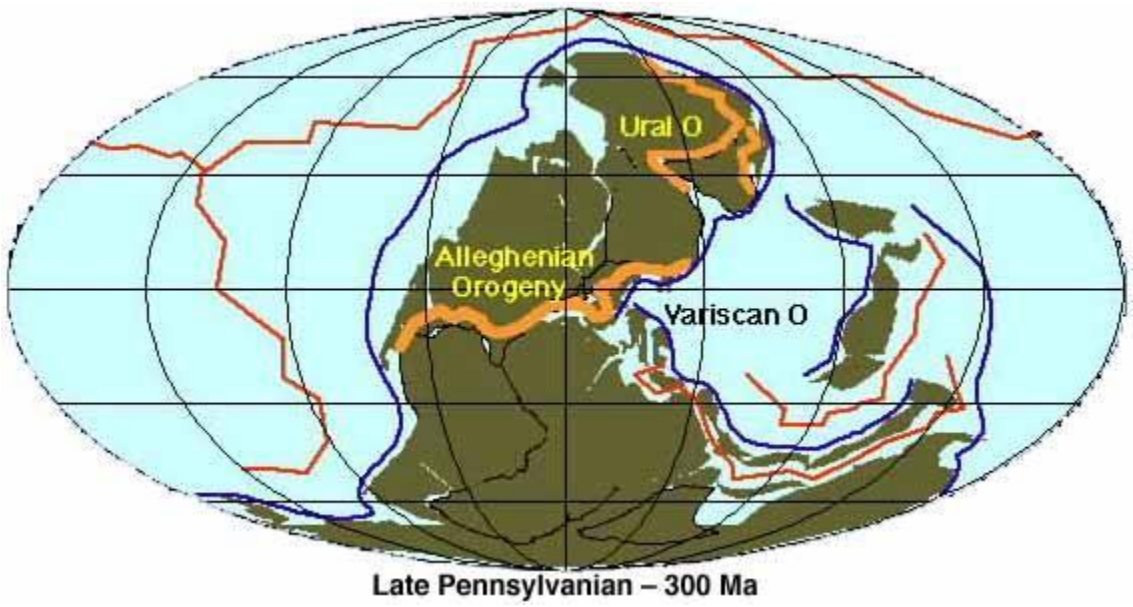


Fig. 10. Alleghenian Orogeny about 300 million years ago:



STOP 1. Mesozoic Basin from Grace Bible Church, Tract Road

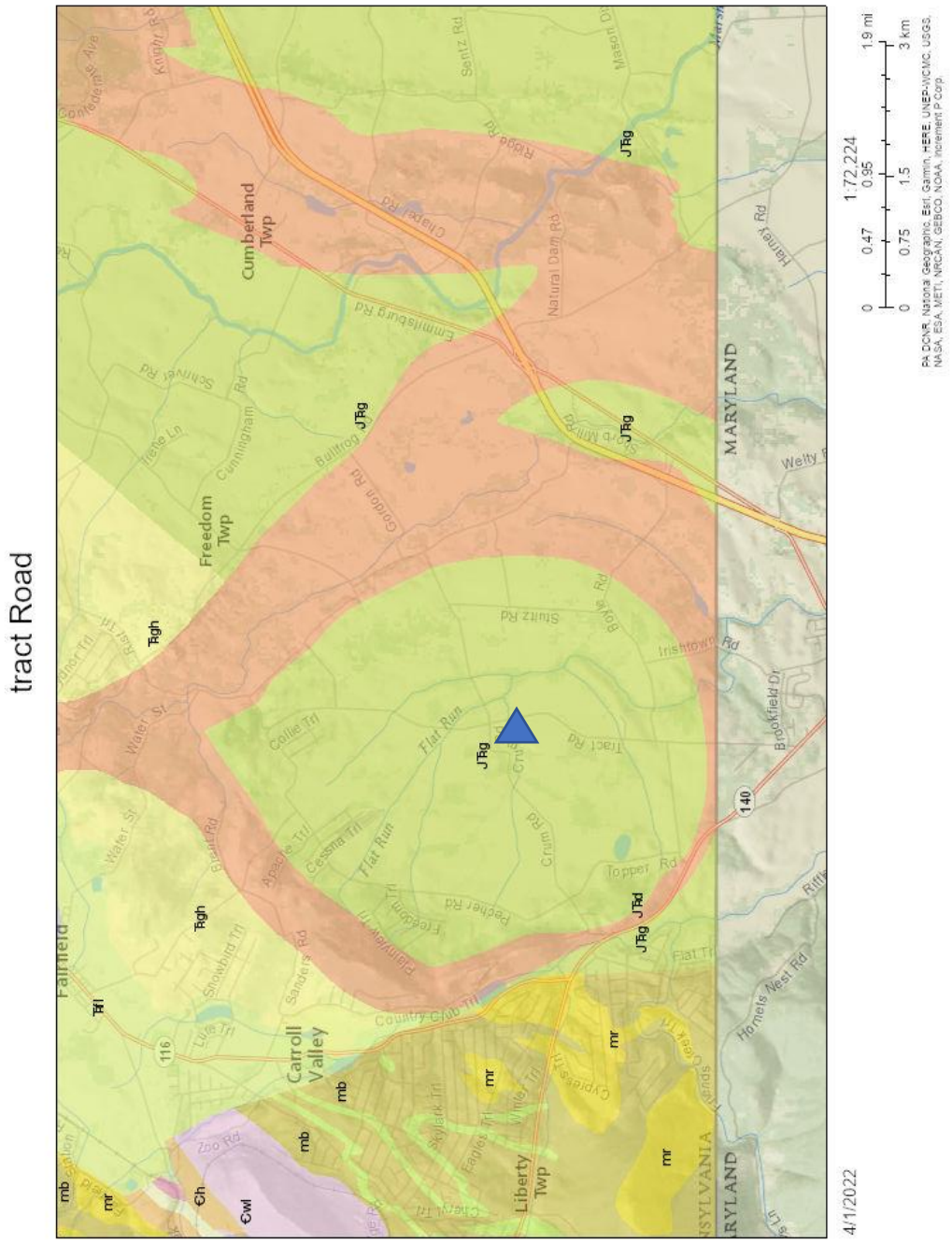
Physiographic Province and Section: Piedmont/Gettysburg-Newark Lowlands Section
Geological known as the Gettysburg Basin

Age of Rocks – Triassic (sedimentary) and Jurassic (igneous)

Environment: Tropical as in southern Florida and a part of rift valley involving the split-up of Pangaea. As this area was a rift valley with steep valley walls, much sediment was being transported into the rift by heavy rains forming the reddish-brown sedimentary rocks (brownstone). The valley turned out to be a failed rift, but the crust was injured. Magma intruded up into the sedimentary rocks that healed the crust together again (diabase). The sedimentary rocks are softer than the diabase and underlie the lower elevations. Diabase underlies the higher elevations and can be observed as large, rounded boulders (spheroidal weathering) and making up stone fences. The sedimentary rocks were deposited upon a valley floor that tilted gently to the northwest and today are dipping 15-35° in that direction. The rocks have not been deformed. With the diabase, one can determine if the magma cooled quickly or slowly. If the diabase has large crystals, it cooled slower. A fine-grained rock shows that the magma cooled rapidly. In larger intrusions, often time the magma cooled faster on the edges and slower in the middle. The diabase intrusion on the right side of the map on Figure 12 is the same intrusion where Devil's Den, Little Roundtop, Big Roundtop and Culps Hill are located. It was on this ridge where the Union setup their "fishhook" for defensive. This is also the same diabase intrusion that Cemetery Ridge is found which was the target for the Confederate soldiers during Pickett's Charge.

Unique: Exam the geologic map below and notice that the diabase intrusion forms a complete circle. Geologists called this a ringed dike and is unique to the Mesozoic Basin.

Fig. 12. Geologic Map of the Gettysburg Basin in This Area. (From PA Geologic Survey Interactive Map, 2022)



STOP 1.

Direction of Travel: Go south on Tract Road. Turn right onto Orchard Road and continue until Pa. Route 16. Turn left onto Pa. Route 16. Bear right onto Mountain View Road and continue to first stop sign. Turn right onto Annadale Road. Follow Annadale Road and turn right onto Crystal Fountain Road. Continue until you arrive at the Emmitsburg Water Pumping Station (two fenced in area on both sides of road).

STOP 2. Loudoun and Catoctin formations rocks

Physiographic Province and Section: Ridge and Valley/ South Mountain Section

Age of Rocks – Proterozoic and Lower Cambrian

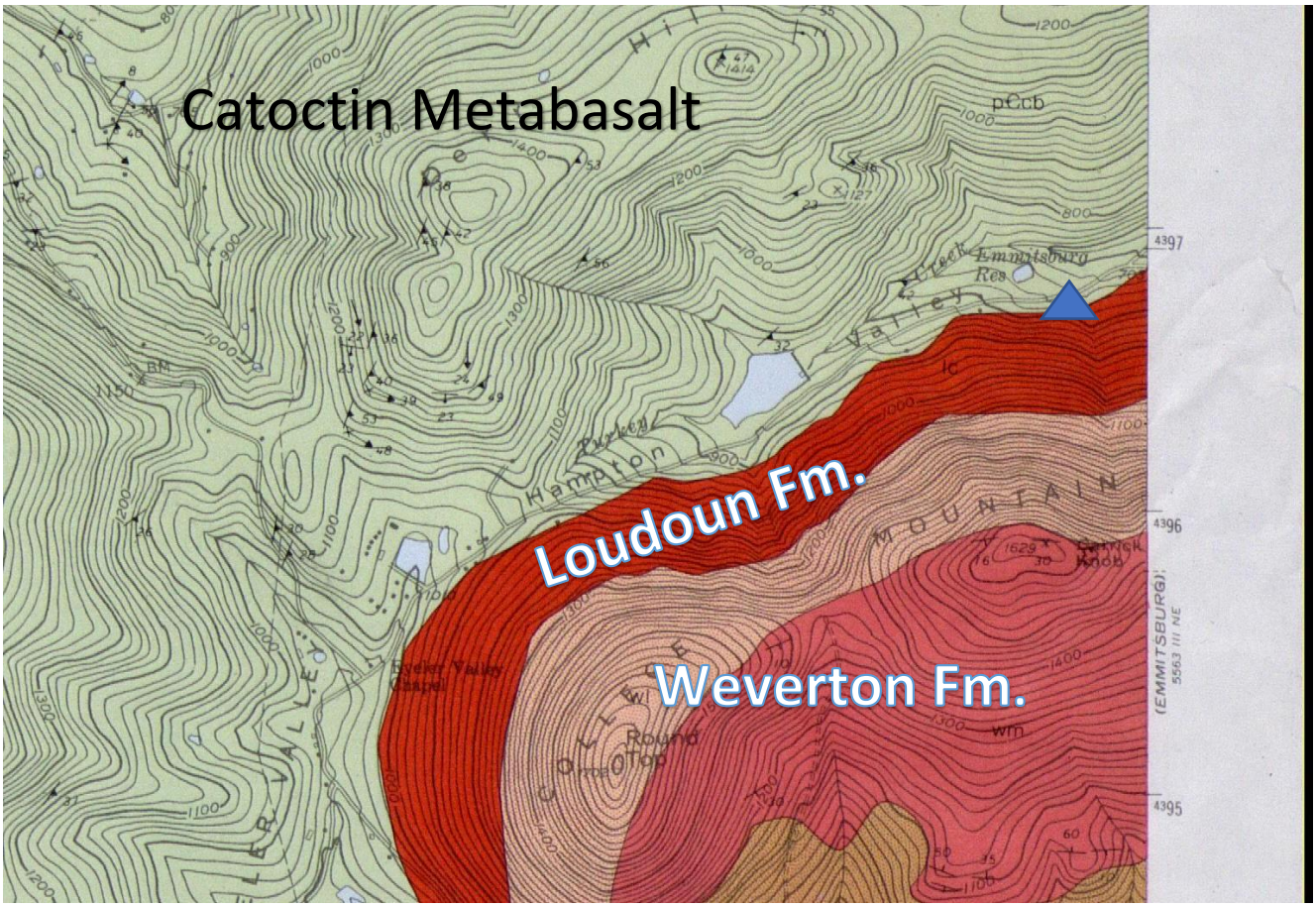
Environment: Welcome to South Mountain, which was at one time another rift valley just like Stop 1, but much older. This rift valley involved the breaking apart of an ancient supercontinent known as Rodina that formed and existed for about 400 million years in the southern hemisphere. As the continents were breaking apart, volcanism was occurring. Basalt was forming on the oceanic floor and another volcanic rock known as rhyolite was forming on the continental crust. All of the rocks within the SMS were later metamorphosed involving two mountain -building events known as an orogeny. Since the volcanic rocks were changed during these events, "meta" has been added to their names. Look for the greenish rocks. These are the metabasalts dated from 620-560 mya. The light gray rocks that are laying on the surface is a rock known as graywacke belonging to the Loudoun Formation which is slightly younger than the Catoctin metabasalt. Here we are close to the contact between the two formation which is why we find both rock types here.

Graywacke is sedimentary rock composed of sand-sized particles that show little evidence of transportation in water. The source of this sediment was close-by and was the earliest evidence of the starting to build a continental shelf off an ancient North America known as Laurentia. So here we are seeing phases of geologic activity: rifting of Rodinia and the early building of a continental shelf.

Unique: The Loudoun Formation is the only rock unit within the SMS containing graywacke. Our next driving segment rock appearances will be entirely metabasalt. Watch for the greenish color of the rocks including the numerous rock fences.

Direction of Travel: Go several blocks and turn left onto Hampton Valley Road. Pass the Emmitsburg Reservoir on the right. Pass the Summit Lake Camp Resort. Turn right onto Eylers Valley Road. Turn left into the parking lot of Full Gospel Pentecostal Church.

Fig. 13. Geologic Map of the Stop 2 Area. (From Fauth, 1977)



STOP 3. Friends Creek and Stream Erosion of the Landscape

Physiographic Province and Section: Ridge and Valley/ South Mountain Section

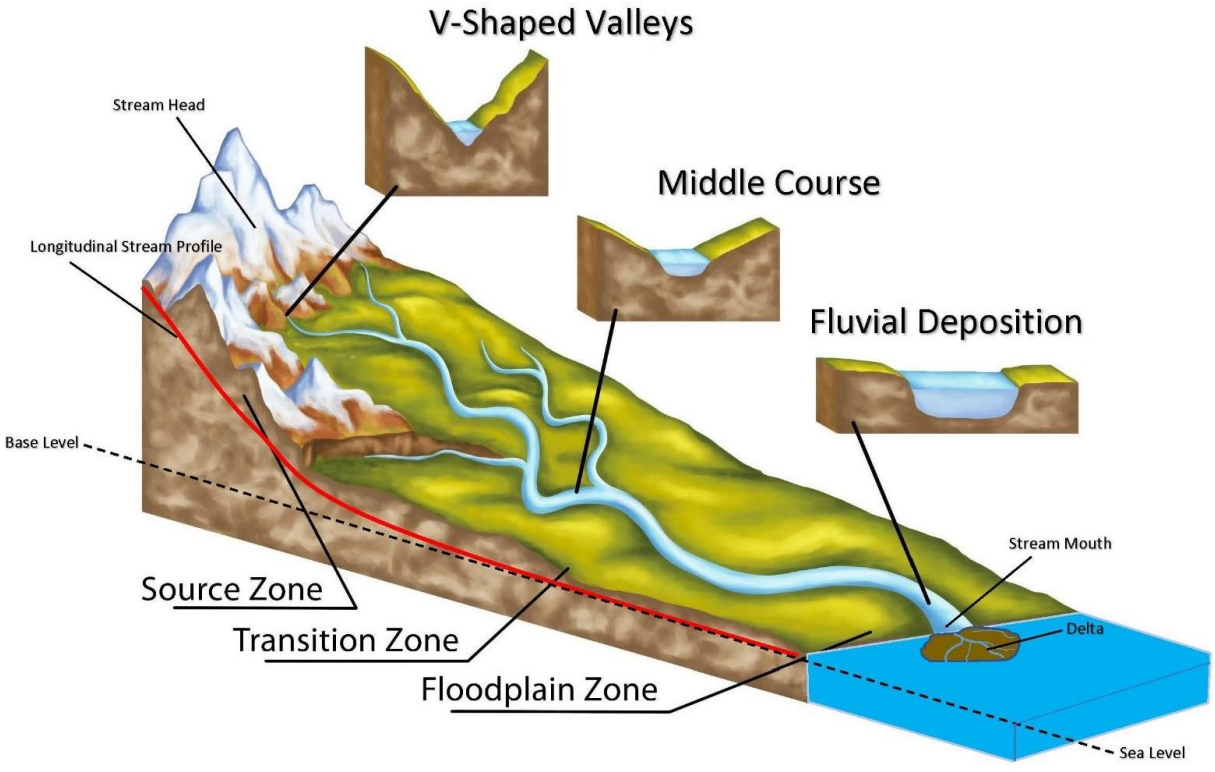
Age of Rocks – Proterozoic

Environment: We usually talk about the building of our continent through geologic events, but rarely discuss what is going on with our landscape today. WE live on a passive margin where little geologic activity is occurring. This is because we are riding in the middle of the North American not exposed to plate boundaries, volcanoes, or major earthquakes. Weathering and erosion are active today. Already if you were watching the hillside or even the roadsides, you

have seen evidence of these two agents. Loose rocks, maybe rock (talus) fields on the mountain sides and rock fences. Weathering is the breakdown of material where it turns into sediment, which is eventually carried into streams. Friends Creek winds itself down the valley through the "middle" of the SMS and the metabasalt. The stream is downcutting into the crust as seen by the cut banks. Several waterfalls are seen where the rock is slightly more stubborn. Under normal weather conditions this stream is carrying very small sized sediment known as clay. With higher precipitation, the stream is able to carry larger fragment like silt, sand, gravel and perhaps boulders. These narrow valleys were formed by erosion of thousands of years as the stream continues to downcut and occasionally meanders side to side to widen a valley. The stream's control is controlled by the underlying geology. Sometimes the channel of a stream is dictated by even faults (fractures in the Earth that make wonderful channels for a stream).

Unique: All of these streams, if traced upstream following smaller tributaries have their origin at a spring(s). Along the route you may see spring houses particularly at farms. The elevation of ponds tucked among the valleys represent the height of the water table. The quality of the springs in the SMS is rated as good unless a pollutant is introduced downstream.

Fig. 14. Typical Profile of a Mountain Stream



Directions of Travel: Turn left onto Eylers Valley Road. At stop sign continue straight onto Sunshine Trail. Cross the Mason-Dixon Line and bear left onto Harbaugh Valley Road. Turn left onto Gladhill Road and continue mid-way up the hill and park on your right.

STOP 4. Catoctin Metarhyolite Roadcut

Physiographic Province and Section: Ridge and Valley/ South Mountain Section

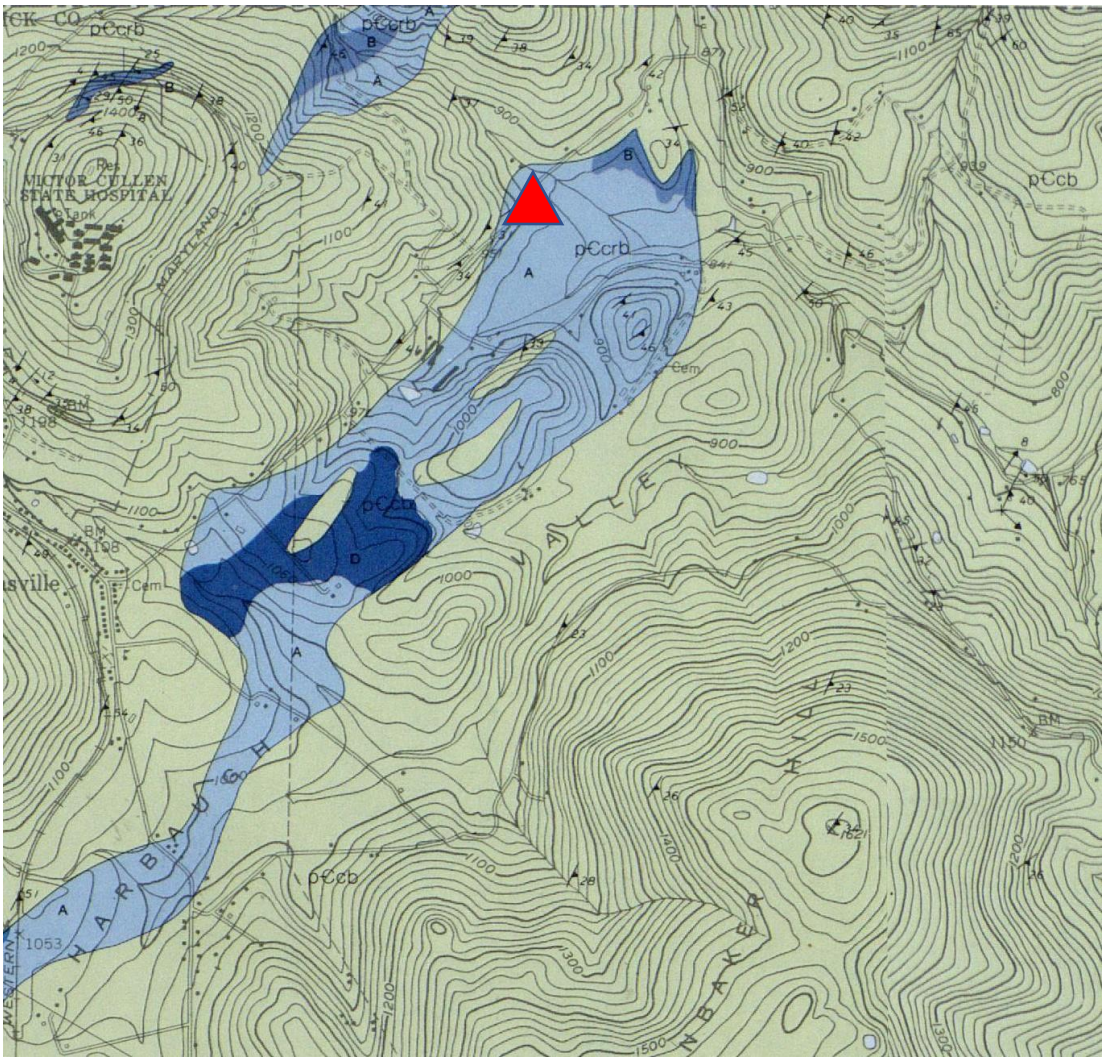
Age of Rocks – Proterozoic

Environment: Here is volcanic rock #2, metarhyolite. The rhyolite is easy to tell apart from its brother, metabasalt. Remember metabasalt is greenish in color. Rhyolite contains lighter colored minerals such as feldspar and quartz (same as granite) and has a light color weathering rind. Outcrops of the metarhyolite in this part of the SMS is rare, so we had to pick a site where talus of can be found. As mentioned earlier this volcanic rock is formed from volcanic activity on a continental plate. Its presence confirms that two different stages of rifting was occurring with Rodinia. North of U.S. Route 30, metarhyolite is more common than metabasalt. South of U.S. Route 30, the vice versa is true. There are seven varieties of metarhyolites within the SMS, either a difference in texture and/or color.

Unique: A fine-grained gray metarhyolite was sought by prehistoric people at least 8,000 years ago. One of the largest metarhyolite prehistoric quarries is found in the Carbaugh Run Preserve just south of Caledonia State Park off of District Road. The preserve is open to visitors but please did not remove any plants or rocks from the area.

Directions of Travel: Continue on Gladhill Road, which turns into Jacobs Church Road to Pa. Route 16. Turn left onto Pa. Route 16 at Blue Ridge Summit. Cross over the CSX Railroad tracks, pass the Sunoco gas station, and turn left onto Fort Ritchie Access Road. Turn right onto Pen-Mar Road and continue up the hill into Pen Mar. At stop sign continue straight to Pen-Mar Park on right. After lunch (30-35 minutes) we will meet at the pavilion at the overlook to discuss the geologic history of the area.

Fig. 15. Geologic Map of Stop 4 Area. (From Fauth, 1977)



STOP 5. High Rock

Physiographic Province and Section: Ridge and Valley/ South Mountain Section

Age of Rocks – Early Cambrian

Environment: Early continental shelf of Laurentia. Rock exposed here is the Buzzard Knob Member of the Weverton Formation. This is the lowest (and oldest) rock of this formation. The quartzite, a metamorphic rock, is light-to-medium gray, moderately bedded rock. Cross bedding is common in this unit. Crossbedding is an indication that this sand originally formed in a shallow marine environment. Metamorphism changed the quartz sand into a coarse texture and the rock became denser. Notice the direction of the dip of the layers. As discussed at Pen-Mar Park, we are now on the western side of the South Mountain Anticlinorium and expect the layers to be tilted to the east or southeast.

Unique: The Buzzard Knob Member is a ledge former. The elevation here is 1820 feet above sea level, allowing us to see a picturesque view of the Great Valley. The elevation in the valley directly below us is 800 feet. This is great example of the difference in the durability of the rocks. Rocks within the SMS are harder than the limestones, dolomites and shale of the Great Valley. How many landmarks can you identify in the valley or out on the first ridge of the famous Appalachian Mountains? Because of accessibility both driving to and leaping out onto the valley floors, High rock is a popular hang-gliding location.

Directions of Travel: Retrace steps on Pen-Mar Road to Highfield-Cascade. At intersection, turn right onto MacAfee Hill Road and go past entrance to Fort Ritchie. Turn right onto Ritchie Road and travel about 3.2 miles to pull off area on the right side. Watch for rocks sticking up. There is a small pull over are just south of the first pull-off.

Fig. 16. High Rock showing the bedding of the Weverton Formation Quartzite

STOP 6. Raven Rock Block Stream

Physiographic Province and Section: Ridge and Valley/ South Mountain Section

Age of Rocks – Early Cambrian

Environment: The rock is composed of the Weverton Formation (Buzzard Knob Member). The Weverton outcrops on the ridge to the west. The Catoctin Formation metabasalt outcrops on the ridge to our east. For the second time today, here is an example of weathering and erosion, but this time this feature occurred during the Pleistocene, better known as the "Ice Age."

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.

Many people, including the author, have known this site as "Devil's Racecourse." 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 Racecourse" is located on a hillside north of Charmain. This block field is about 0.80 miles 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 is 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 of quartzite and was originally sandstone. It appears the some of the quartzites

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 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 tabular blocks on edge. Several surfaces 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 high precipitation or a 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.

Directions of Travel: Continue south on Ritchie Road to MD Route 419 (Raven Rock Road). Turn right and go about 0.25 miles to the Appalachian Trail Crossing Road sign. Park on the right side.

STOP 7. Weverton Formation Overturned Quartzites
(Exposure of overturned Weverton quartzite on map)

Physiographic Province and Section: Ridge and Valley/ South Mountain Section

Age of Rocks – Early Cambrian

Environment: Early Continental Shelf Building on Laurentia. Similar to stops 4 and 5, we continue to be in the Weverton Formation Buzzard Knob Member. Afterall we are following the last ridge on the west side of SMS that is underlain by the Weverton. In this roadcut is a great example of seeing what we call overturned beds. These rocks have literally been pushed upside down as part of the SMS Anticlinorium. The layering in this moderately thickness quartzite is obvious and dipping toward the east as many of the rocks in the SMS do. Notice the large block of quartzite that has fallen from the ledge above. The fallen block is being held in place by several edges of the lower quartzite.

Unique: Just go back in time and imagine this rock was once beach sand, forming in the Southern Hemisphere and probably in at least a sub-tropical environment. During the Early Cambrian times, there was little life in the Iapetus Ocean other than maybe early echinoderms. Trilobites didn't appear in the ocean for about another 25 million years.

Directions of Travel: Travel south on Raven Rock Road for about 0.5 mile to the guardrail section on the right prior to Fruit Tree Lane.

Stop 8. Harpers Formation Overturned Phyllite
(Exposure of overturned Harpers Formation on map)

Physiographic Province and Section: Ridge and Valley/ South Mountain Section

Age of Rocks – Early Cambrian

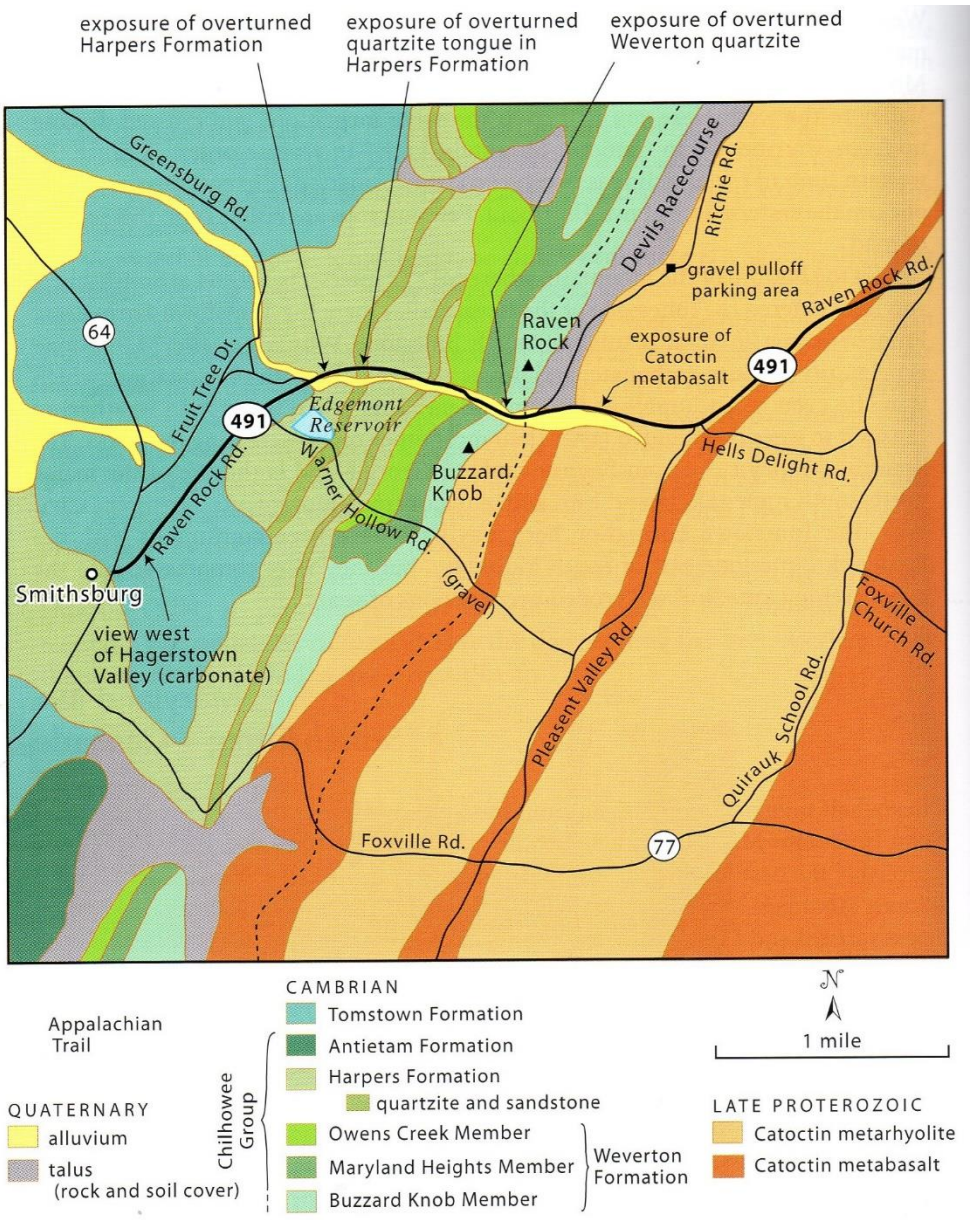
Environment: Continuing to build Laurentia Continental Shelf. The next youngest formation above the Weverton unit is the Harpers Formation. This rock was once mud (lagoonal (that lithified into the sedimentary rock known as shale. During the orogeneses, the shale (clay) was metamorphosed where the clay was changed into small mica flakes and forming the rock into a phyllite. Similar to Stop 7, this rock has also been overturned. The only different here is that what you believe is bedding is actually called cleavage. With thin-bedded rocks such as shale, when metamorphism occurs the mineral will be oriented perpendicular to direction of the pressure producing cleavage. Often cleavage will make the original bedding obscure. The original bedding is running near vertical.

Unique: The Harpers Formation also contains thin beds of quartzite, representing coarser sediment being washed in from a local source. Between Stop 7 and 8 is a small exposure of the Harpers Quartzite. A large exposure of the Harpers Formation is found on PA Route 16 has you climb the mountain traveling east from Rouzierville.

Directions of Travel: Continue on Raven Rock Road a short distance. Turn right onto Fit Tree Lane and follow to MD Route 64. Turn right and follow to intersection with MD Route 418. Turn right and cross the Mason-Dixon Line. Turn left onto Amsterdam Road and turn right onto

Buena Vista Drive. Turn left onto Old Mill Road and cross the small concrete bridge. ENTERING PRIVATE PROPERTY. PERMISSION IS ONLY GRANTED FOR THIS TRIP!!

Fig. 17. Geologic Map of Stops 7 and 8. (From Mears. 2010)



(Map from Mears, 2010)

STOP 9. Waynesboro Formation

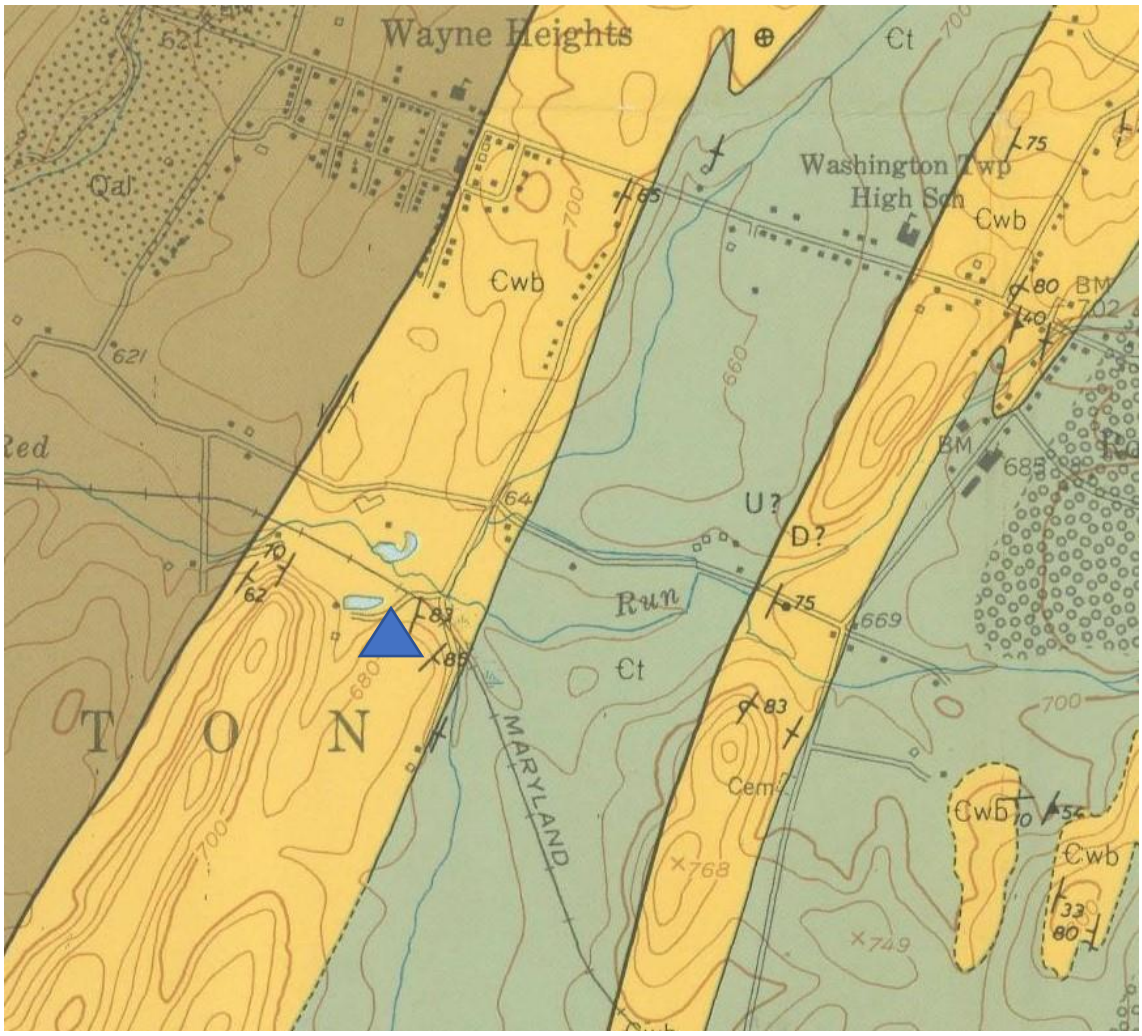
Physiographic Province and Section: Ridge and Valley/ Great Valley

Age of Rocks – Early Cambrian

Environment: The mature building of the Laurentia continental shelf. We have moved off of the SMS into the Great Valley. Although we saw dramatic scenery of the Great Valley from 1,000 higher, we are now down in the valley. The Great Valley Section has several regional distinctions such as the Shenandoah Valley, Cumberland Valley, Lebanon Valley and Lehigh Valley. All of the rocks are sedimentary in origin. Limestone, dolomite, sandstone and shale are dominant. The change from the early sediment is seen on earlier stops (mostly sand and some clay) to a dominant calcium carbonate deposition shows there was a switch in sediment origin to rocks that form today in a tropical environment such as the Caribbean setting. Calcium carbonate can also be formed from the secretion of marine animals and the building of reefs. Structurally the Great Valley is a series of folds (overturned anticline and synclines) interpreted by faults. Although most limestone units are soft rocks and underlie valleys, the Waynesboro Formation with its sandy content is a ridge former. As you drove up MD Route 65 and MD Route 418, there was a ridge of your right side of the road. This ridge is composed of the Waynesboro Formation, and we are now in that ridge. The limestone and dolomite here are thickly bedded. It is tough to recognize the layering. Each layer represents a certain period of deposition.

Unique: Because the Waynesboro Formation is a ridge-former, there are more abundant exposures that many of the limestones in the Great Valley. The type of site for this formation is along PA Route 16 at the cemetery in Waynesboro.

Fig. 18. Geologic Map of the Wayne Heights Area. (From Root, 1968)



Directions of Travel: That concludes our tour today. To return to Red Run Park, retrace your route out to Midvale Road. Turn left and continue to PA Route 16. Turn right and proceed to the park.

References

Fauth, J.L., 1978. Geology and mineral resources of the Iron Springs and Blue Ridge Summit Quadrangles, Adams and Franklin Counties, Pennsylvania. Pa. Geol. Survey, 4th ser., Atlas 129cd. Harrisburg.

Mears, J., 2010. Roadside Geology of Maryland, Delaware and Washington, D.C. Mountain Press Publishing Co., Missoula, MT.

Pennsylvania Geologic Survey, 2022. Interactive Geologic Map of Pennsylvania. Middletown, PA.

Root, S.L., 1968. Geology and mineral resources of southeastern Franklin County, Pennsylvania. Pa. Geol. Survey, 4th ser., Atlas 119cd. Harrisburg.