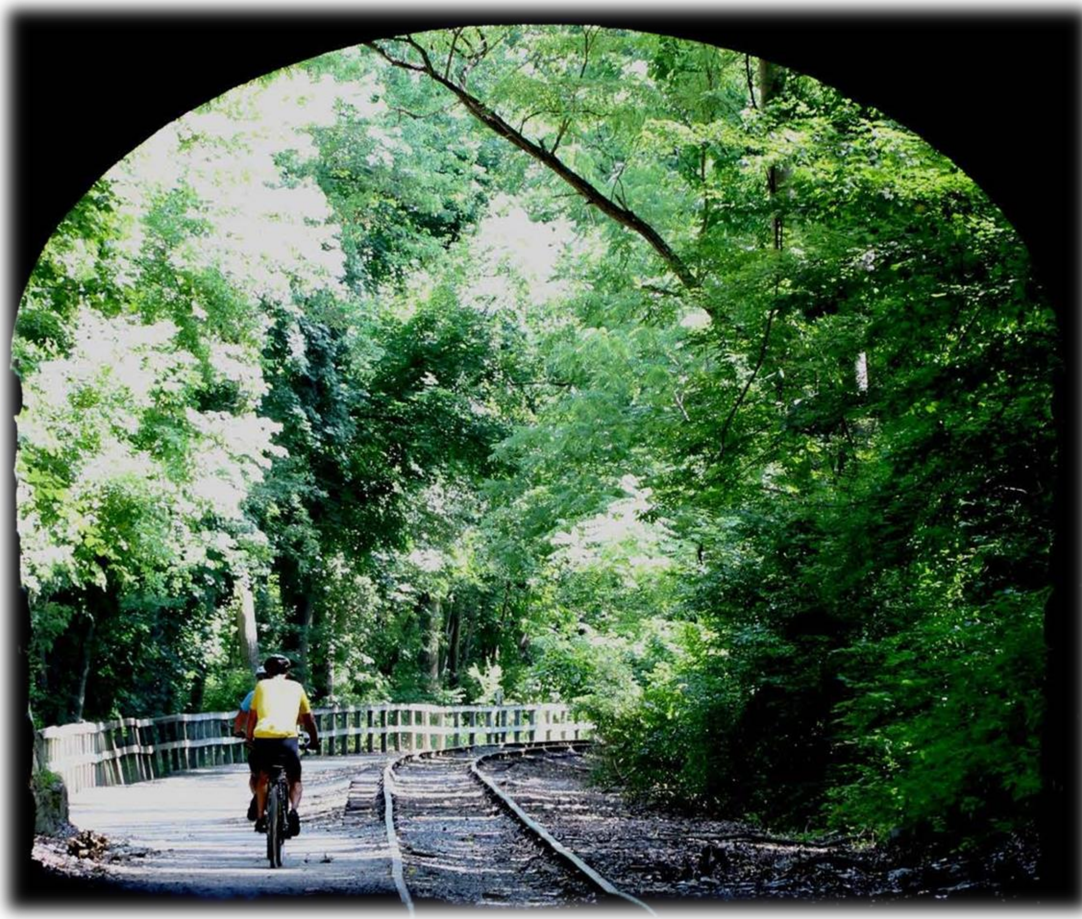
A guide for the geologic tourist to the

York County Heritage Rail Trail



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Trail of Geology
17–119.0

Cover Photo: Howard Tunnel. Photo by A. Muren.

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Introduction

Geology is everywhere beneath our feet. Our landscape has been formed by many slow processes that build up and erode the earth's surface. Our communities and transportation routes have developed upon the sculpted landscape. The Heritage Rail Trail County Park follows the former Penn Central Railroad, originally known as the Northern Central Railroad, which was built in 1838. The trail passes through the Lowland and Upland *sections* of the Piedmont physiographic *province* (Figure 1). A physiographic *province* is a region with a characteristic landscape. Within the *province* are *sections* whose landforms are distinct. Most of the trail is in the Piedmont Upland section that you see in the rugged landscape beside the trail. The hills of the Upland are underlain by harder, more resistant rocks including sandstone, quartzite, conglomerate, and phyllite. North of Indian Rock Dam Road lies the Piedmont Lowland section. The landform here is characterized by the broad, open Conestoga Valley. The valley is underlain by limestone, dolostone, and minor shale, which are all susceptible to erosion.

The corridor provides an excellent window for hikers and others to glimpse the underlying bedrock of central and southern York County. Since the rock strata cross the

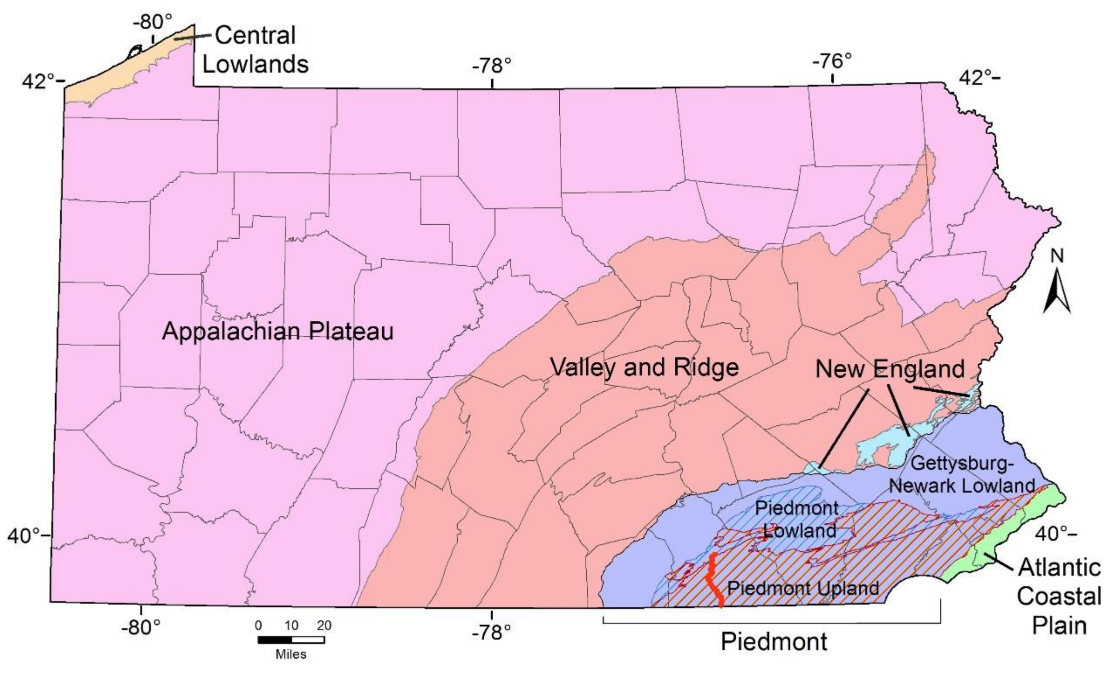


Figure 1. The physiographic provinces of Pennsylvania. In the Piedmont province, the three physiographic sections are shown. Trail shown in red.

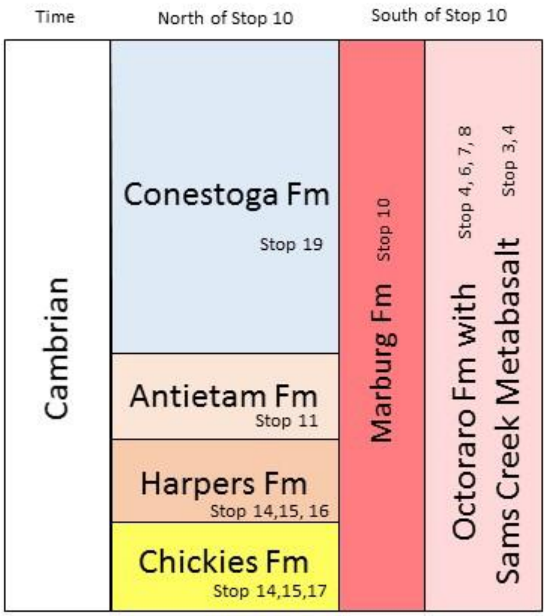


Figure 2. Formations along the trail.

county from southwest to northeast, and the corridor transverses the region from north to south, the trail exposes several formations (Figure 2), spanning nearly 200 million years of geologic history. The exposures along the 21-mile trail provide windows into the past. You will see how each of the rock exposures can be treated as a piece of a jigsaw puzzle. When all are put together, the big picture is revealed.

The Pieces of the Puzzle

If you could travel back in time to this spot 540 million years ago, you would find yourself in shallow water near a beach in a place geologists call the Octoraro Sea (Figure 3). The waves lap gently back and forth, and little worms burrow in the sand beneath your feet. A few streams feed pebbles out into the sea, and mud accumulates in the quiet coves. The sand, pebbles, and mud pile up over time, and will become the Chickies Formation. If you float out into deeper water, you can see a muddier bottom. Mud enters the sea by streams from the land, and the mud suspended in the water column settles out and accumulates on the sea floor. Lenses of sand record events where storm waves pulled material off the beach and dropped it into deeper water. The abundant mud and rare sand lenses became the Harpers Formation. As you move farther out to sea, you encounter a barrier island, similar to today's Outer Banks. This sandy bank of shallower water is home to trilobites, shelled animals, and worms burrowing in the sand. This will eventually become the Antietam Formation. As you swim out past the barrier island, you come upon a carbonate bank like the sea off the Florida Keys. This gently sloping continental shelf accumulates lime mud. The shelf is a quiet place where lime mud accumulates with occasional storms bringing in suspended mud from far away rivers. The materials will eventually form the Conestoga Formation. If you move farther away from the land, and descend the slope into deeper water, there is a place where only mud slowly accumulates on the Octoraro seafloor. This mud will become the Marburg and Octoraro Formations if you are willing to wait 500 million years to see them again at the earth's surface. Still

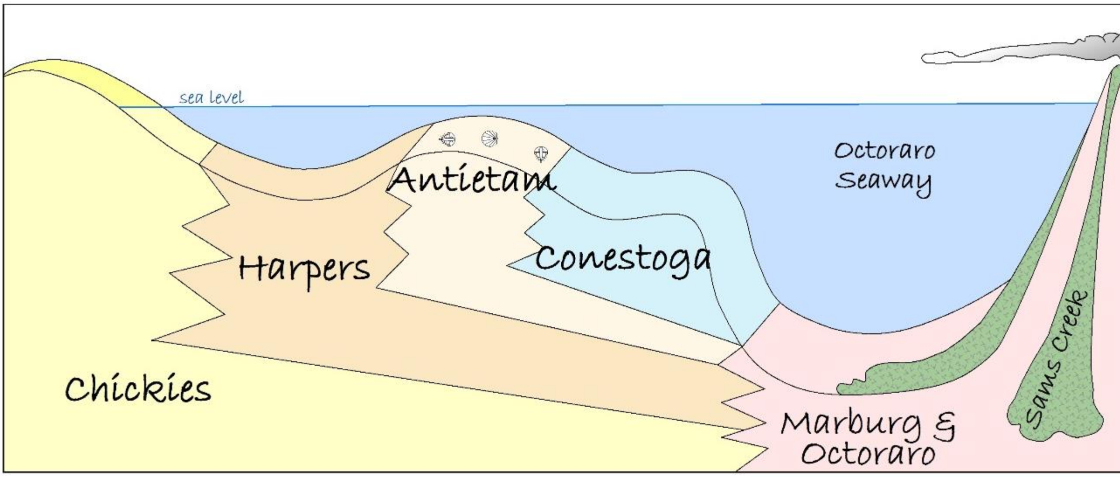


Figure 3. Cartoon cross-section view of the Octoraro Seaway.

further out to sea, there is a volcanic island or two, similar to Japan or the Philippines today. Occasional eruptions send lava flows of basalt out into the Octoraro Sea. The basalts cool and harden on top of the mud, and with time, heat, and pressure become the Sams Creek Metabasalts.

Over time the sands become sandstone, the muds become mudstone, the pebbles become conglomerates, lime mud became limestone and dolostone. As burial continues, heat and pressure transform the rocks. This is called metamorphism. The sandstone become quartzite, the basalt becomes metabasalt, and the mudstone becomes slate or phyllite, or if further cooked, schist (Table 1). These are the rocks you will encounter along the trail!

Original Rock Type *(Mineral components)*	**Metamorphic rock** → Increasing temperature/pressure
Clay, shale *(Mica, quartz)*	Phyllite, Slate, Schist, Gneiss
Sandstone *(Quart, feldspar)*	Quartzite
Basalt *(Albite, hornblende, epidote)*	Metabasalt
Limestone, Dolostone *(calcite, dolomite)*	Marble

Table 1. The types of rocks you will encounter along the trail.

The Pieces Get Jumbled

As if the story wasn't already complicated enough, the rocks that experienced different intensities of heat and pressure also got folded and faulted. This area has experienced two different episodes of continental collision and separation. These events built up mountains that erosion tore down. During collision, the earth's crust shortened by folding and faulting to accommodate the collision. There are two main types of folds (Figure 4). Anticlines are up-warps and synclines are down-warps. In an anticline, the younger rocks are on the outside. In a syncline, they are on the inside. These folds may be further complicated by secondary and tertiary folds on folds, or by the folds getting turned up onto their sides!

There are three main types of faults: normal, thrust, and strike-slip (Figure 5). Normal faults occur most often during rifting, or pulling-apart events. The block above the fault slides down. Thrust, or reverse, faults are the most common in crustal shortening settings. The block above the fault moves farther up! There are also strike-slip faults, where the two blocks move in opposite directions in the horizontal plane, like the San Andreas fault. You will see several faults along the trail: the Martic Line, Reynolds Mill Fault, and Stoner Overthrust. It is up to the geologists to sort out these pieces.

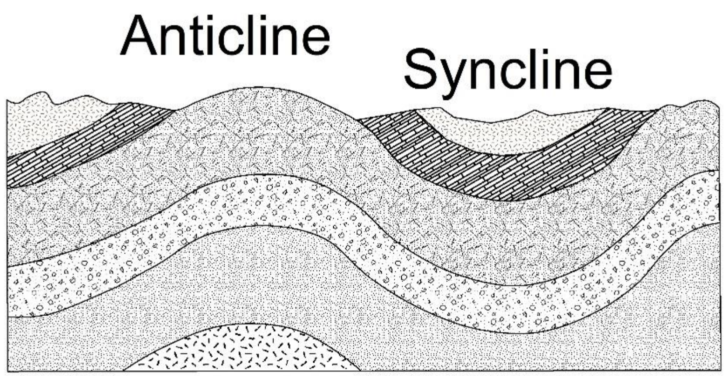


Figure 4. Sketch of folds including anticlines (up-warps) and synclines (down-warps).

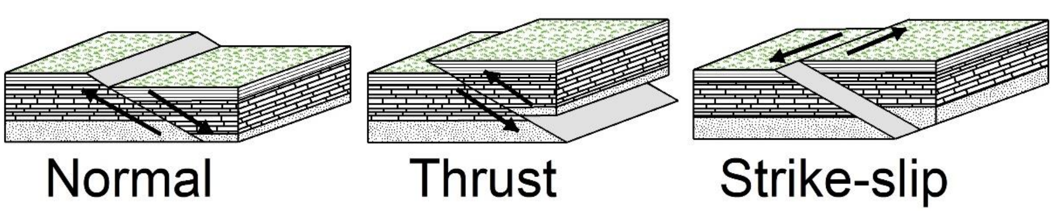


Figure 5. Sketch of three common types of faults.

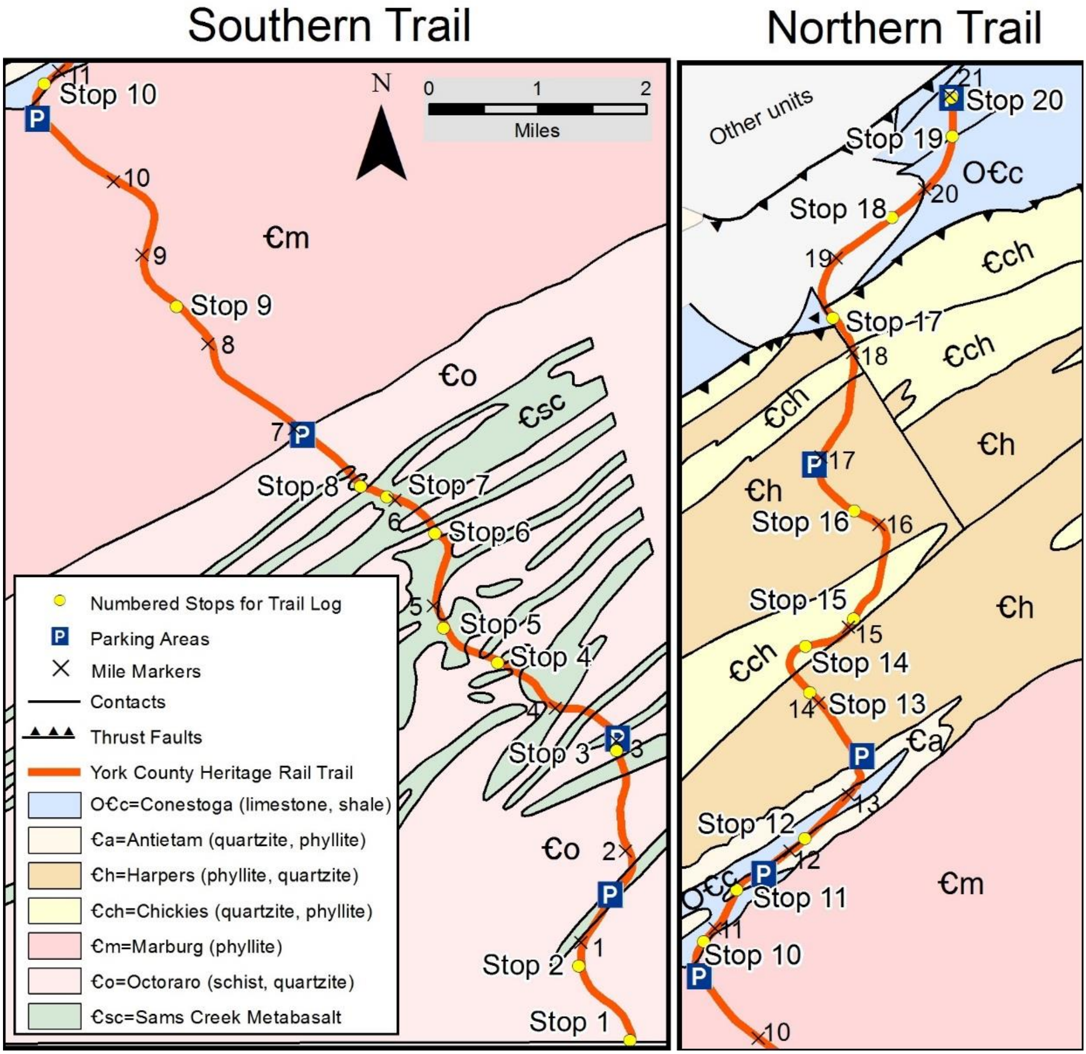


Figure 6. Geologic map of the rail trail. Map on the left is the southern half of the trail. Map on the right is the northern half. Scale is the same for both.

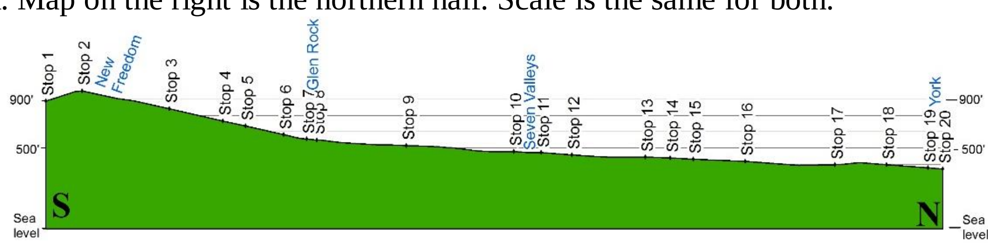
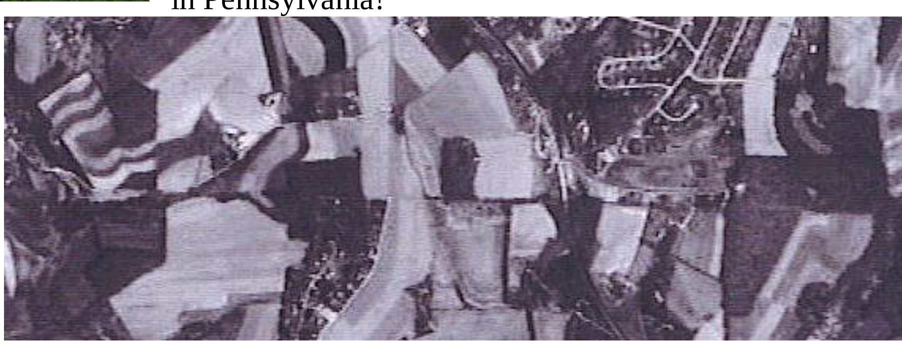


Figure 7. Profile of the trail with twenty times vertical exaggeration.

Trail Log

Enjoy the ride back in time. The stops below are favorite locations of the authors. Additional rock exposures are found between these points. The trail log begins at the southern end, but you may start at any point. Mileage is estimated based on air photos and mile markers posted along the trails. **Stop** refers to the numbered locations shown on Figure 6. **Inc** refers to the incremental mileage between points of interest, whereas **Cum** refers to the total mileage from the beginning of the trail. Please stay on the trail, as property adjacent to the trail is privately owned! Sorry, rock collecting is prohibited.

Inc	Cum	**Location**
0.0	0	**Stop 1. <u>Mason-Dixon Line</u>** 39.7210/-76.6979  The Mason-Dixon Line, the boundary between Maryland and Pennsylvania, is one of the most famous boundaries in the United States. It crosses the rail trail here. It was surveyed from 1763 to 1767 by two British astronomers, Charles Mason and Jeremiah Dixon, to settle a dispute between the Calvert and Penn families. Rectangular concrete markers, such as the one to the left, still appear at many places where major roads and railroads intersect the boundary. The Mason-Dixon Line acted as the line between the free and slave states in the middle of the 19th century. Did you ever want to be in two states at once? Place one foot in Maryland and the other in Pennsylvania!  Notice how the boundary shows up in an aerial photograph!
0.09	0.09	Cross Orwig Road.
0.43	0.52	Travel under Singer Road.

0.27	0.79	**Stop 2. <u>Summit Grove, Elevation 852 Feet</u>** 39.7310/-76.7047 Welcome to Summit Grove, the highest point on the rail trail with an elevation of 852 feet above sea level! This point is a great destination because it's all downhill from here. Traveling north to Glen Rock, you will encounter the greatest drop in elevation per mile at 62 feet per mile, or a 1.2% grade. South to Bentley Springs, Maryland, the slope is 80 feet per mile, or 1.5% grade. This may not sound steep, but it was a challenge for the trains' engines! Summit Grove is underlain by the Octoraro Formation, named for its fine exposures along Octoraro Creek in Lancaster County. The Octoraro Formation is composed of schist and quartzite–both metamorphic rocks. We will see a good outcrop at Stop 3. Metamorphic rocks are rocks that were subjected to heat and/or pressure, forming a new, distinct rock (see Table 1). What appears to be layering in these rocks is a result of metamorphism. Minerals within the rock are aligned parallel to each other. This is known as foliation.
0.25	1.04	Pass Mile Marker #1. Cross McCullough Avenue.
0.10	1.14	Cross East High Street.
0.19	1.33	Cross East Main Street in New Freedom.
0.08	1.41	Cross Franklin Street in New Freedom.
0.08	1.49	New Freedom Station Parking Area.
0.44	1.93	Cross Pleasant Avenue. Pass Mile Marker #2.
0.58	2.51	Cross Kirchner Road.
0.10	2.61	Cross South Branch Codorus Creek.
0.26	2.87	**Stop 3. <u>There's Gold in Them Thar Hills</u>** 39.7597/-76.6996 This is an outcrop of the Sams Creek metabasalt within the Octoraro Formation. The metabasalt started out as a lava flow onto the mud of the ocean floor. Since the metabasalts are found within the Octoraro Formation, we then can consider them to be of the same age. The metabasalts can be identified by the lack of schistose layering, a more-dense sound when struck with a hammer, and their darker green color. Albite, hornblende, epidote, and chlorite are the primary minerals. Associated with the metabasalts are quartz veins, which *may* host gold! Veins are hydrothermal deposits. Hot water carried elements upward within the Earth, following fractures. As the water

		cooled, the elements in the solution began to crystallize on the sides of the fractures. Veins include minerals such as quartz, hematite, mica, and gold. Amateur gold panners have found flakes in some of the streams in the area. The metabasalt often underlies the valleys in this area because it is less resistant to erosion.
0.06	2.93	Cross East Main Street in Boro of Railroad, Route 851 Railroad Parking Area. Pass Mile Marker #3.
0.4	3.33	Cross North Main Street, Route 616 and South Branch Codorus Creek on overpass built in 1871. Pass Mile Marker #4.
0.51	3.84	Cross Taylor Hill Road.
0.29	4.13	**Stop 4. <u>Gas Bubbles and the Help Mine</u>** 39.7715/-76.7155  The next stop is a rock exposure on both sides of the trail. This long outcrop is composed of alternating zones of metabasalt and Octoraro schist with thin quartzite beds. The individual layers of schist weather differently, some forming ledges and others weathering back and leaving a whitish clay. The different silica, or quartz, content in the schist causes this variation. The schist is well foliated, which means it has a sheet-like appearance, due to the mica content in the rocks. The mica grains are all aligned like pages in a book. Look for the metabasalt beds. The backpack in the photo marks the location of one if you need a hint. The beds are darker and, in some cases, holey! Do you notice small cavities or pits in the rock? These cavities are known as vesicles, and were created by gas bubbles that were trapped in the original lava. There are also pillow lavas here.

		 They are bumpy like a pillow on your bed, but not so soft. Pillow lava is the result of lava cooling under water. Also, there are occasional red bands of the iron-mineral hematite. It was extracted during the 19th century at the nearby Help Mine. You may notice some folds in the layers, and a well-developed joint set. Joints are just fracture planes without any movement. The dominate joints are northeast-southwest and east-west.
0.28	4.41	Cross Glen Brook Court and unnamed tributary on overpass.
0.25	4.66	**Stop 5. <u>Best Folds in Town</u>** 39.7761/-76.7228 On the west side of the trail is the best example of folding along the entire rail trail. Imagine the pressure involved in deforming the rock! We are still in the schists of the Octoraro Formation, but my, they have been wrinkled! 

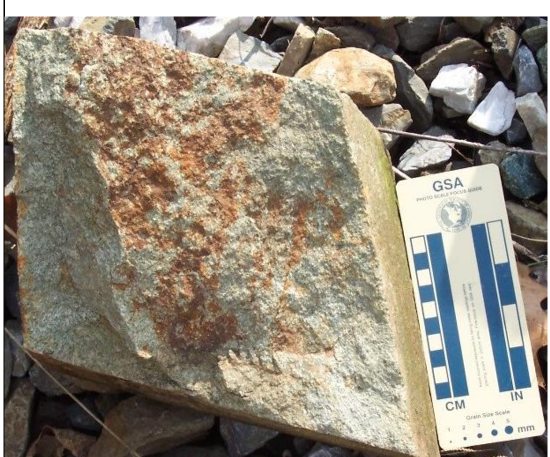
		The originally flat-lying beds have been folded into anticlines, or up-warps, and synclines, or down-warps. On these large folds, are smaller, similar folds. On these smaller folds, are even smaller folds still. Without continuous exposures and with the complication of folding, a geologist has a difficult time determining the true thickness of the formation. It would be much simpler if you could pull on one end of the exposure and straighten out the strata. Imagine the length of the county if we could pull out the folds! This outcrop is an example of crustal shortening. The rocks have been squished together! There is a major fracture in the rock that dips 47° northwest. In addition to the folding, there may be faulting, but geologists need to collect more information to verify it. While you are here, put your nose to the rock and see if you can find some magnetite cubes. These perfect little cubes stick out of the rock, and resist erosion until they are plucked free, leaving a square hole. If you had brought along a refrigerator magnet, you would see for yourself why this mineral is called magnetite.  Photo of tiny cubes of the mineral magnetite.
0.10	4.76	Cross South Branch Codorus Creek and Pleasant Valley Road, Route 616 on overpass. Pass Mile Marker #5.
0.41	5.17	Cross Walker Road and Trout Run on the overpass built in 1871.
0.15	5.32	Cross West Clearview Drive.
0.06	5.38	Cross Rail View Court.
0.18	5.56	**Stop 6. <u>Somewhere in the Hills South of Glen Rock</u>** 39.7887/-76.7239 From here to where the trail crosses the tracks is a long exposure of Octoraro schist. Notice the broken pieces below the outcrop are very smooth and silvery. This is the result of the mineral mica, which has a sheet-like structure. Look closely for quartz pods.

		 You will note some of these pods are folded! This is testament to multiple episodes of deformation. As we travel north through the Upland Section of the Piedmont physiographic province, the ridges decrease in elevation. The ridge that passes through here reaches elevations of over 900 feet above sea level. This ridge is one of the highest points in southwestern York County.
0.43	5.99	Cross Valley Street. Pass Mile Marker #6.
0.05	6.04	Cross an unnamed tributary that is following the metabasalt-schist contact.
0.02	6.06	**Stop 7. <u>South of Main Street, Glen Rock</u>** 39.7937/-76.7308  This is a fine exposure of tightly folded albite-chlorite schists of the Octoraro Formation with quartzite beds and quartz veins. The outcrop starts in the woods on the old lane, just after you cross the bridge. Schist is a metamorphic rock that started out as a mudstone. Original layering may be lost, and new layering, or schistosity, is formed by parallel sheets of the mineral mica. The rock varies in color from a grayish-blue to green. This variation is due to the difference in composition. Under a microscope, the minerals albite, chlorite, muscovite, and quartz are easily seen. Epidote, garnet, ilmenite, apatite, sphene, and iron oxide are usually present in small amounts.

		Notice the small pits seen on the exposed surfaces due to the weathering out of mineral grains. These may be magnetite or pyrite cubes, but they are gone, so we don’t know which! A three-foot-tall, six-foot-wide exposure of quartzite is located on the old road next to the trail. Look for the light-brown coloration of the rock, thicker beds, and lack of schistosity that set it apart from the schists.  Quartz veins and pods are associated with these metamorphic rocks. Occasionally mica and iron oxide are present in the veins. The veins are different than the quartzite layers, but made of the same mineral!
0.04	6.1	Cross Main Street, Route 216 and 616, in Glen Rock
0.09	6.19	Cross Water Street.
0.09	6.28	**Stop 8. <u>Octoraro Formation in Glen Rock</u>** 39.7949/-76.7337 Outcrop under Main Street, next to gravel parking area. This Octoraro Formation exposure underlies Main Street and marks the highest point in downtown Glen Rock. Here, we see the quartzite, the least common rock in this formation. The rock is pale white, and contains small grains of quartz and mica. Each layer started out as sand accumulated in horizontal layers on the bottom of an ancient ocean. They eventually turned to sandstone, then metamorphosed into quartzite, and finally were folded to almost

vertical. Although this rock has been metamorphosed, the original bedding is preserved. Quartzite is generally harder than schist, thus not eroding as fast, which is why we find it at the highest point in Glen Rock.

The bedding planes face the trail, so when you look at the outcrop you are looking at the original sea floor! To see the side of the beds, stand at the southern end and look north! Beds are about a foot and a half thick.



Notice the fractures running across the outcrop. These are joints, fractures caused by stress in the earth which show little or no displacement. Because the rocks fracture in a regular pattern, they were convenient to use for building stones.

Note the planar, nearly right-angle joints in outcrop or loose pieces of rock.

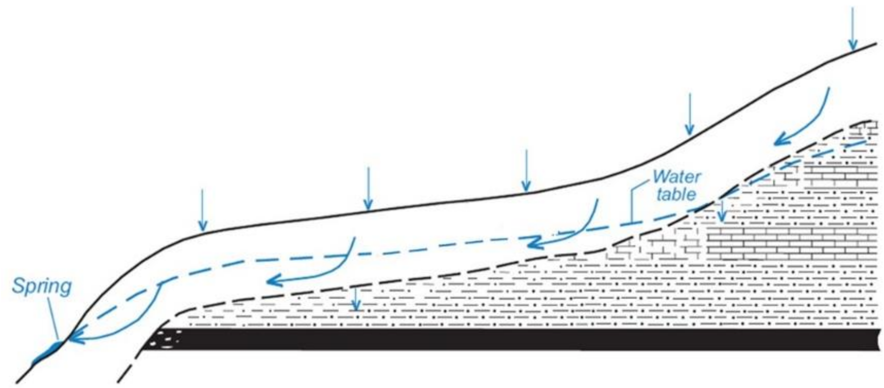
		Do you know how Glen Rock received its name? A glen is a narrow valley, usually with steep sides, such as Ricketts Glen or Watkins Glen. Indeed, Glen Rock does sit in such a valley.
0.07	6.35	Cross South Branch Codorus Creek
0.40	6.75	Cross Seven Valleys Road, Route 616
0.12	6.87	Cross Centerville Creek.
0.03	6.9	Future Route 616 Parking Area Pass Mile Marker #7.
0.46	7.36	Cross Owengarry Lane.
0.46	7.82	Cross unnamed tributary.
0.08	7.9	Cross Springfield Road. Pass Mile Marker #8.
0.48	8.38	Cross South Branch Codorus Creek.
0.04	8.42	**Stop 9. <u>The Highs, Lows, and Relief</u>** 39.8189/-76.7584 In this area, one can appreciate why this region is known as the Upland Section. Relatively narrow valleys are separated by elongated ridges, running in a northeast-southwest direction. Looking south, the ridge you just crossed reaches an elevation of 734 feet above sea level. You are 500 feet above sea level. The difference in elevation is 234 feet. This is the *relief*, the difference between the lowest point and the highest point in any given area. You are traveling on a floodplain underlain by the Marburg Formation. The lack of rock exposures tells us that the rock is rather soft and erodes easily. There were only a few small outcrops in the ridges you passed through.
0.11	8.53	Cross Larue Road.
0.03	8.56	Cross unnamed tributary to South Branch Codorus Creek and Boose Road.
0.43	8.99	Pass Mile Marker #9. Cross Granary Road.
0.24	9.23	Cross South Branch Codorus Creek.
0.05	9.28	Cross Seitzville Road. Pass Mile Marker #10 in about a half mile.
1.05	10.33	Cross Maple Street.
0.02	10.35	Cross unnamed tributary to South Branch Codorus Creek.
0.22	10.57	Hanover Junction Parking Area. Notice the side rail bed. Trains on this route used to bring ore from the Strickhouser Iron Mines at Raab Park to the main line.
0.05	10.62	Cross South Branch Codorus Creek.

0.30	10.92	**Stop 10. <u>The Martic Line</u>** 39.8486/-76.7761 Between the train station and here, there are several very small exposures of the Marburg Formation. The Marburg Formation is named for its exposures near the former town of Marburg, now under Lake Marburg in Codorus State Park near Hanover. The rock is a light-gray phyllite with excellent foliation. In places, the foliation is so well developed, the rock almost resembles slate. Phyllite started out as mudstone and was lightly metamorphosed. If it had experienced greater heat and pressure, it would have evolved into a schist. Notice how it is not as shiny as the schists we saw to the south. The foliation, or layering, is dipping 78° northwest. This may not be its original layering. Iron staining is present on weathered surfaces due to the oxidation of pyrite within the rock. At this stop there is a *very* interesting feature. Unfortunately, it is invisible!! It is the Martic Line, a structure that runs southwest-northeast from northern Maryland, across southeastern Pennsylvania to north of Philadelphia. It is named from the village of Marticville in Lancaster County. The true nature of the Martic Line is still being debated among geologists. Some say it is only a contact between the lightly metamorphosed rocks to the north and highly metamorphosed rocks to the south. Others suggest it is a major thrust fault. With the lack of outcrops showing the real relationship between these formations, much has been speculated from other data collected.
0.29	11.21	Pass Mile Marker #11. Cross unnamed tributary to South Branch Codorus Creek.
0.18	11.39	Cross over Main Street on the overpass in Seven Valleys.
0.1	11.49	**Stop 11. <u>Antietam: Outer Banks 540 Million Years Ago</u>** 39.8554/-76.7703 On the right side of the trail is a knee-high outcrop of the Antietam Formation. This formation was laid down in a barrier island setting similar to today's Outer Banks! Most of the formation is quartzite from the sands deposited on this off-shore bar. In this outcrop, we see the less-common phyllite. If you look closely, you can see the original compositional banding at about a 60° angle to the foliation. Look for a flat slab. Then, on the shiny face, look for color variations. Can you track those variations around to the back side of the slab?

		There are also tiny crystals of biotite that look like pepper grains on the rocks in places.
0.31	11.8	Seven Valleys Parking Area.
0.50	12.3	Pass Mile Marker #12. Cross Fishel Creek. **Stop 12. A River Flows Through It** 39.8622/-76.7583 This is a great place to view one of the valleys leading out of Seven Valleys. This valley is in a syncline, or “u-shaped” fold in the rocks (Figure 4). Imagine the vegetation missing and syncline stretching across the valley. The lower portion of the surrounding ridges are composed of the Antietam Formation, while the valley floor is underlain by the younger Conestoga Formation. There are no exposures of the Conestoga Formation in the valley, because it consists of limestone, and is easily weathered. You will see it at Stop 19. In a syncline, the younger rocks are in the center. Much of the Upland Section of the Piedmont is composed of synclines and anticlines. In this case, the geologic structure matches that of the topography, but synclines don’t always form valleys and anticlines don’t always form ridges. Notice the width of the valley that has been incised by the migration of the South Branch of the Codorus Creek, the major waterway in this section of the county. The stream flows north from its headwater near New Freedom. It joins the main branch of the Codorus Creek near Indian Rock Dam. Notice that the valley is wide and flat through this section of the trail. The flat area between the stream and surrounding ridges is known as the floodplain. The area may be underwater during flooding. If you dig into the floodplain, a layered profile of sand and clay represents flood events of the past. How does a floodplain become so wide? You will notice that the stream has bends and curves (referred to as *meanders*). As the stream flows northward, the water seeks the easiest journey. When the water encounters resistant bedrock, instead of trying to erode through the rock, the water will travel around the barrier, forming a meander. A lack of resistant rock may allow an even wider meandering pathway. Erosion takes place along the outside of the meander in *cutbanks*, while sediment is being deposited on the inside of the curve in *point bars*. During flooding, the stream is carrying a large amount of

		 sediment either by suspension or traction (particles rolling along the stream bottom). When the waters recede, the stream is no longer capable of carrying the sediment, thus depositing the particles along the bed creating sands bars. These additional deposits will force the stream to create a new channel. Through this continuing process of erosion and deposition, meanders migrate back and forth across the stream valley. Although a very slow process, a wide floodplain is one characteristic of an old stream valley, as seen here.
0.48	12.78	Cross South Branch Codorus Creek.
0.04	12.82	The house on the west side of the trail is the original Glatfelter homestead built in 1753. The rock is Antietam quartzite, which was quarried in the hill behind the house.  Pass Mile Marker #13.

0.31	13.13	Glatfelter Station Parking Area turn off to right.
0.25	13.38	Cross Glatfelters Station Road.
0.6	13.98	Pass Mile Marker #14. Cross small unnamed tributary to South Branch Codorus Creek **Stop 13. <u>Oxbows and Springs</u>** 39.8818/-76.7572  The South Branch of the Codorus Creek flows on the east side of the rail trail. You can see good examples of meanders in the river, oxbow lakes (shown above and accented with blue curve), and meander scars, particularly in the winter when the trees are bare. Please stay on the trail. As mentioned at Stop 12, a meander is a curve in the river. A meander scar is an abandoned meander bend. Oxbow lakes are lakes that form in these cut-off meanders. Along the west side of the trail there are several springs. A spring is the intersection of the water table at the earth surface. Often, springs are created when a layer of rock acts as a barrier to water flow (known as an aquiclude). A body of rock that allows water to be transmitted is an aquifer. If the aquiclude is in a ridge such as this one, the water will appear on the hillside in springs. Geologists use the location of springs to assist them in determining the geology of an area. Because faults are fractures in the bedrock, they provide a natural channel for water to flow. In some cases, a line of springs could

		represent a fault zone, a major joint system, or an outcrop belt of the aquiclude. Many people think spring water is the purest water. Sometimes, this is true. But ask yourself "Where is this water coming from before it gets to the spring?" There could be something higher on the ridge that may harm the water, such as an old landfill, industrial dump, junkyard, a farm that uses chemicals, or the rocks may be high in uranium or arsenic. Water tests show roadside springs are often contaminated. Would you drink this water? No, thanks. 
0.27	14.25	Cross unnamed tributary to South Branch Codorus Creek.
0.3	14.55	**Stop 14. <u>Reynolds Mill Fault and Chickies Formation</u>** Near bend in tracks- 39.8880/-76.7579 The northern half of the outcrop is phyllite and quartzite of the Chickies Formation. The name comes from Chickies Rock along the Susquehanna River in Lancaster County. That is the type locality for these rocks. The original rock was shale, a sedimentary rock composed of clay and minor sandstone. Heat and pressure during continental collision caused the clay to recrystallize into mica, giving the rock a new mineral composition and appearance, now known as phyllite. The original layering within the shale has been nearly destroyed and can only be seen with a microscope. The quartz in the sandstone layers recrystallized to quartzite. The Chickies Formation phyllite has a near-vertical foliation parallel to the trail (orange hatches on photo). The southern half of the exposure is Harpers Formation phyllite, which has a gentler southwest dip to the foliation (red lines). The Reynolds Mill Fault runs through

		 the middle of the outcrop. The conflicting orientations of foliations clues us in to the presence of the fault. Notice several drill holes spaced throughout this exposure. They were hand-drilled during construction of the Northern Central Railroad in 1838. Pass Mile Marker #15
0.54	15.09	**Stop 15. <u>Howard Tunnel</u>** 39.8916/-76.7495 The most famous historic structure along the rail trail is Howard Tunnel. The tunnel took two years to construct and opened in 1840. In 1866, renovations widened the tunnel for two train tracks as traffic increased. Can you find the date stones on either end of the tunnel? Harpers Formation phyllite is exposed here. The rock is made of quartz, chlorite, and mica with a small amount of pyrite. The chlorite gives this rock its greenish color.

		Look for quartz veins, some of which contain small perfect quartz crystals. There are small folds on either side of the tunnel.  If you closely examine the rocks on the southwest side of the tunnel, you will notice a small step-like feature going down the rock. This feature is known as slickensides. These are formed by the grinding of two rock surfaces as faulting occurs. The Reynolds Mill Fault continues from the last stop through here. The Chickies Formation (Stop 14) is faulted against the Harpers Formation. Streams will always find the easiest path through a valley. When the stream encounters resistant rock, the water will go around the rock instead of attempting to pass through it. The rocks within the Reynolds Mill Fault have been highly fractured, thus intensifying the weathering and erosion and forming an easier passage for the South Branch of the Codorus Creek. For this reason, and the fact that the creek is a mature-aged stream, the channel is well established with no rapids, waterfalls, or strong currents visible.
0.47	15.56	Cross South Branch Codorus Creek and Twin Arch Road. Pass Mile Marker #16.
0.77	16.33	**Stop 16. <u>Harpers Formation Phyllite</u>** 39.9059/-76.7492 This is the longest continuous rock exposure along the rail trail, in places creating rock bluffs almost thirty feet high. It is the Harpers Formation phyllite. The apparent layers, or foliation, is tilted 75-88° southeast. The regional trend, or strike, is generally northeast-

		 southwest. If you follow this rock to the southwest you will eventually arrive in Harpers Ferry, West Virginia, where the rock got its name. Notice the prominent joints cutting through the exposure, many of which are parallel to each other. Jointing is very common and can be seen in most of the exposures along the rail trail. By measuring the joints, geologists can decipher the direction and amount of the stress placed on the rocks during a mountain-building event. The scenic ravines and small tributaries found all along the trail often follow the joints. The joints broke the bedrock, creating planes of weakness, which allowed for accelerated weathering and erosion. Take a closer look at the rocks for small cubes of limonite pseudomorphs. These were originally cubes of pyrite, or “fool’s gold” made of iron and sulfur. When it weathers, the sulfur in pyrite is  replaced by oxygen, forming limonite, a dark-brown iron oxide. The cubic shape remains, but with a different mineral, thus being a pseudomorph, or “false form.” In some cases, the crystal has been weathered out, leaving a square cavity. Can you locate any?
0.60	16.93	Cross Days Mill Road. Brillhart Station Parking Area. Pass Mile Marker #17.
0.14	17.07	Cross South Branch Codorus Creek.
0.5	17.57	Cross South Branch Codorus Creek, again.

0.28	17.85	Cross unnamed tributary to Codorus Creek.
0.15	18	Cross Indian Rock Dam Road. Pass Mile Marker #18
0.41	18.41	**Stop 17. <u>Reservoir Hill Railroad Cut Chickies Formation</u>** 39.9318/ -76.7524 In this 2,000-foot-long railroad cut, we see the cross section of Reservoir Hill, which is the southern border of the Lowland Section. Most the rocks from Maryland to this stop are metamorphic. To the north, they are mostly sedimentary. The rocks exposed here are phyllite with rare layers of quartzite of the Chickies Formation. Can you find the beds of quartzite? The rock is composed mainly of quartz, with minor amounts of mica and iron. Remember, quartzite is the metamorphic equivalent of sandstone. Look on broken rock faces for the sandy texture. The original sand was probably deposited in a shallow ocean or perhaps on a beach. During metamorphism, the quartz grains grew into larger crystals, which may be seen with the naked eye. Have you ever wanted to walk in a fault? At this location, you are standing at the intersection of two faults!! A fault is a fracture or tear in the Earth where rocks have moved. Usually, the movement is measured in feet, or even in miles, along some of the more significant faults in the world. One un-named normal fault is aligned northwest-southeast, almost parallel to the trail. The rocks on the northeast side of the fault have slid down relative to the southwest side on a plane dipping east. The other fault is a thrust fault known as the Stoner Overthrust. It is parallel to the north edge of Reservoir Hill. The Stoner Overthrust is offset by the un-named fault, which tells us that the thrust fault occurred first and is older. Some of the rocks have been folded during fault movement. The small folds, the presence of quartz veins, and the erratic appearance of the foliation suggest faulting took place nearby. The faulting of the bedrock allowed the weathering and erosion processes to work faster, cutting off Reservoir Hill to the southwest and allowing Codorus Creek to flow through the gap.

		 West of here, on private property along the Codorus Creek, is Indian Rock. This was a recreational area in the 1920s, popular for picnicking and swimming. The rock resembles a whaleback, measuring about eighty feet long and twenty feet high. It is an erosional remnant of an anticline. The quartzite is more durable than the surrounding phyllite which has weathered away.
0.18	18.59	Cross Indian Rock Dam Road on the overpass. Hyde sign.
0.25	18.84	Cross Golf Club Drive. Pass Mile Marker #19.
0.20	19.04	Cross over driveway of country club.
0.62	19.66	**Stop 18. A View of the Lowland Section from 395 Feet** 39.9451/ -76.7420 Looking back to the southeast, you can see Reservoir Hill, also known as Violet Hill. This ridge reaches an elevation of 860 feet at Sam Lewis State Park. Looking north, you see the Conestoga, or York, Valley. Geologically, this valley is rather complex–the result of folding and faulting. This valley is a syncline, a u-shaped fold. The younger rocks of the Conestoga Formation that you will see at Stop 19 are exposed in the middle of the valley. The northern edge and southern edge are made of the older Chickies Formation. With limited rock exposures, a geologist must infer much of this knowledge. A few natural exposures, and quarries, reveal that the valley is highly faulted. In places, the bedrock has not only been moved several hundred feet, but also rotated ninety degrees from its original position. Just think about the pressure that was involved in such a crustal movement!!
0.02	19.68	Cross South Richland Avenue on the overpass.
0.40	20.08	Cross Grantley Road. Pass Mile Marker #20.
0.22	20.3	Cross unnamed tributary to Codorus Creek.
0.13	20.43	Cross Kings Mill Road.
0.20	20.63	**Stop 19. Conestoga Formation** 39.9559/ -76.7314 College Ave.

		Because limestone and dolostone are less resistant to erosion, outcrops are somewhat rare. Small outcrops of the Conestoga Formation limestone are found along the stream bank and in the Codorus Creek bed. The bedrock creates small riffles that you can see at low flow. The name Conestoga is derived from the village in Lancaster County, where the best exposures of this rock were studied by geologists in 1922. Boulders of quartzite were placed along the creekbank by the U.S. Army Corp of Engineers as part of the flood prevention plan for York. The rocks were quarried in the Codorus Creek Gorge north of U.S. Route 30.
0.04	20.67	Cross West College Street.
0.11	20.78	Cross West Princess Street.
0.11	20.89	Cross West King Street.
0.09	20.98	**Stop 20. <u>The York Valley</u>** 39.9609/-76.7314, The trailhead is 370 feet above sea level. The York Valley runs from Frederick, Maryland through Hanover, York, Wrightsville, Lancaster, and Morgantown, Pennsylvania. The valley is in the Piedmont Lowland Section, which is underlain predominantly by limestone and dolostone with minor shale, which are all susceptible to erosion. North and east of here, the valley is bordered by the Hellam Hills. Sandstone, quartzite, conglomerate, and volcanic rocks within the hills are resistant to erosion. To the south, the valley is bordered by a highland, which is underlain by metamorphic rocks such as quartzite and phyllite that you saw at Stop 17. Both highlands belong to the Upland Section of the Piedmont Province. Because rocks such as limestone, dolostone, and shale are less resistant to erosion and weathering, these rocks typically form valleys. The harder, more resistant rocks including sandstone, quartzite, conglomerate, and phyllite are ridge-formers. Mile Marker #21

If you enjoyed this tour, check out the Trail of Geology 16–116.0, “A guide for the geologic tourist to the Northern Extension of the York County Heritage Rail Trail” on the Pennsylvania Department of Conservation and Natural Resources website.

Park Regulations

- The park is open year-round, dawn until dusk, and is patrolled by York County Park Rangers.
- Users must stay on the trail, as property adjacent to the trail is privately owned.
- Motorized vehicles are prohibited on the trail except for emergency and maintenance vehicles.
- Pets are permitted on the trail, but must be kept on a leash. Owners must clean up after their pets.
- The railway is operational from New Freedom (Mile 1) to Hanover Junction (Mile 11). Stay clear of the tracks at all times.
- Do not walk on the railroad tracks!
- Horseback riders should clean up after your horses.
- All riders are encouraged to wear approved helmets.
- For trail conditions, contact park headquarters at 717-840-7440 or follow on Twitter “@yorkcountyparks”. Trails may be closed to certain users depending on trail conditions, please call ahead.