A GEOLOGY FIELD TRIP

by

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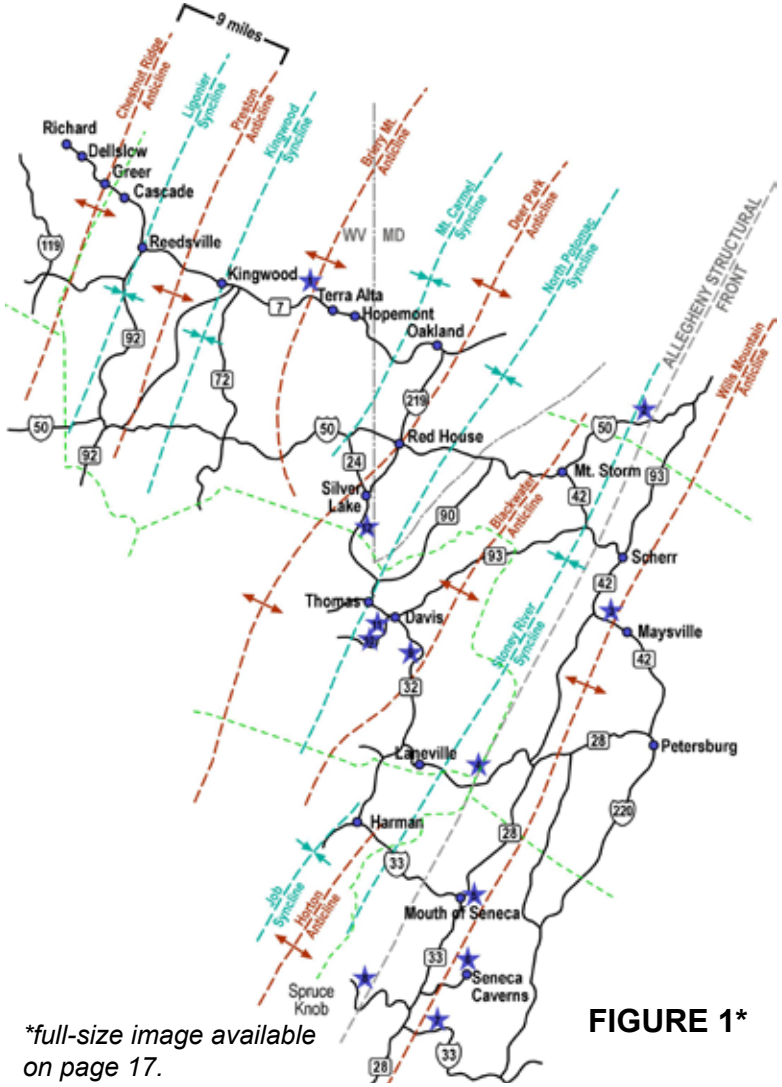


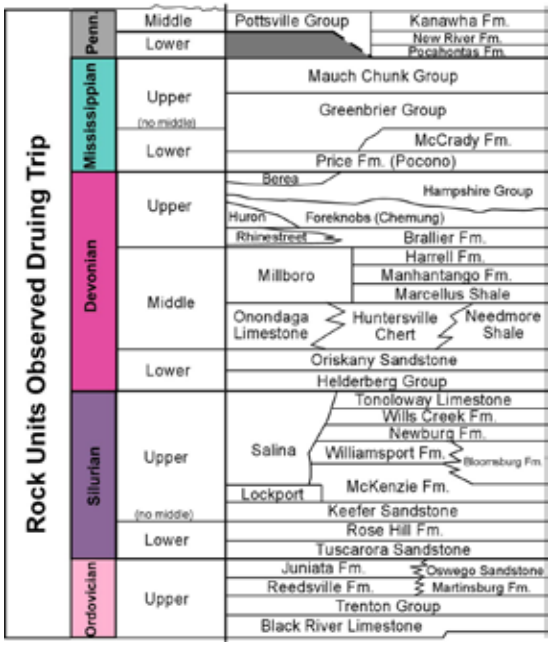
FIGURE 1*

**full-size image available on page 17.*

Introduction to Field Trip

I had several objectives in mind when I prepared this field trip. I want to develop in you an interest, an understanding, and an appreciation of geology of the region. I want to show you differences between three of the basic physiographic provinces within Appalachia, the Low Plateau, the High Plateau, and the Appalachian Mountain Section of the Valley and Ridge Province. I also want to show you the role that the kinds and structures of the underlying rocks plays in the formation of the topography of a region in order to have you better understand why the appearance of the land changes as you travel about the country. During the trip, you will also see excellent examples of the process of weathering as well as the erosive power of streams. The trip will visit several tourist areas and, in addition to their scenic beauty, you will learn that they represent excellent examples of important geologic features.

FIGURE 2



ROAD LOG

Introduction: As you begin the trip, there are two figures you will want to keep handy; Figure 1*, which is the road map showing the path of the trip and Figure 2 which is the stratigraphic column that lists all of the rock formations you will encounter on the trip and their

FIGURE 3

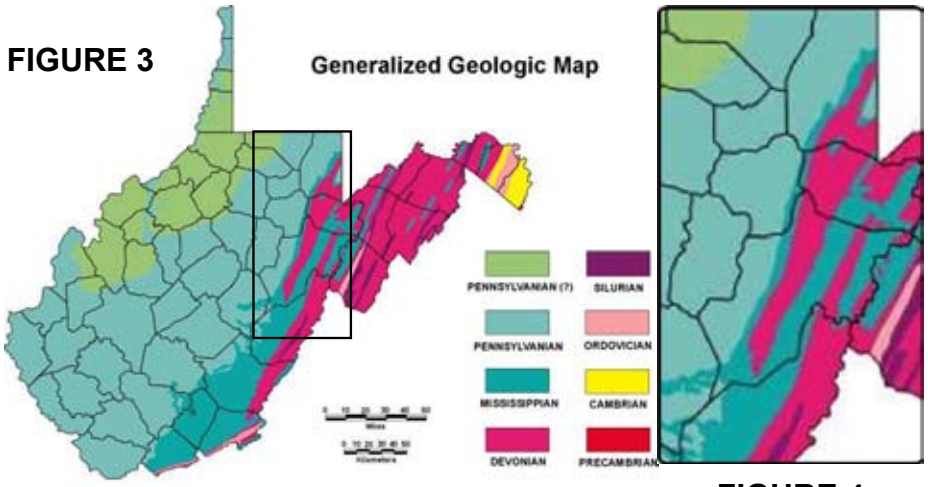


FIGURE 4

relative ages. I have also provided the Geologic Map of West Virginia (Figure 3) and an enlargement of the portiion of the geologic map that we will be traversing in our trip (Figure 4). Other figures are provided which are designed to provide you with more detailed information about the geology you will be seeing at individual stops.

Morgantown, WV

At Morgantown, you are near the eastern boundary of the Appalachian Low Plateau (Figure 5). All of the rocks you observe in road cuts west of Morgantown are Pennsylvanian in age and consist primarily of inter-layered sandstones, shales, and coals with a limited number of limestones. The Low Plateau is underlain by very low amplitude, symmetrical folds. In fact the amplitudes of the folds are so low that the beds of the exposed rocks appear horizontal. In contrast, while the structures within the High Plateau, while still symmetrical, have amplitudes that are high enough to appear as distinct northeast-southwest trending ridges such as Chestnut Ridge. With the summit approximately 1,000 feet (300 m) higher than Morgantown, Chestnut Ridge Anticline forms the eastern skyline as you approach Morgantown from the west.

Note: a majority of the illustrations are provided to illustrate a geologic concept. They have no implied scale unless otherwise noted.

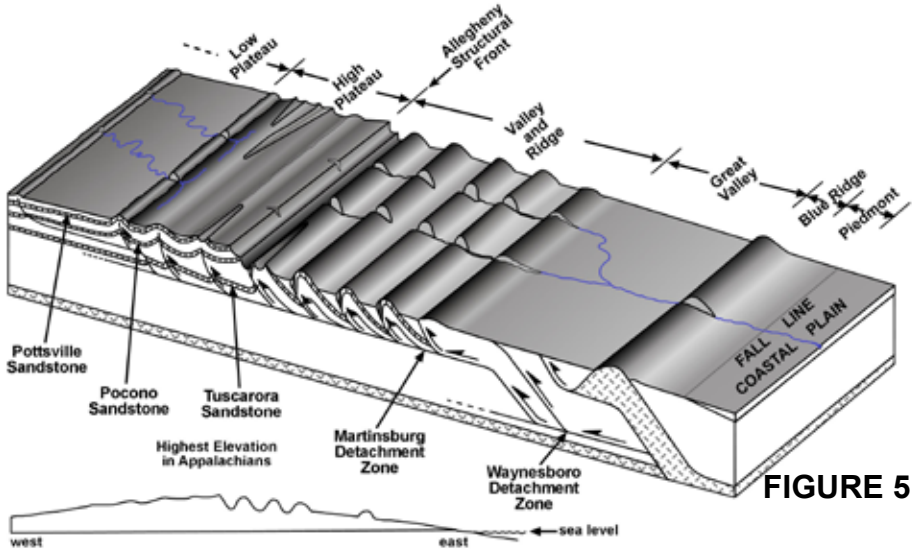


FIGURE 5

Morgantown, WV, to Dellslow, WV

Proceed to Sabraton and continue east on WV Rt 7. The portion of the trip from Morgantown to Kingwood can be followed on the cross section and map shown in Figure 6*. All of the rocks throughout the

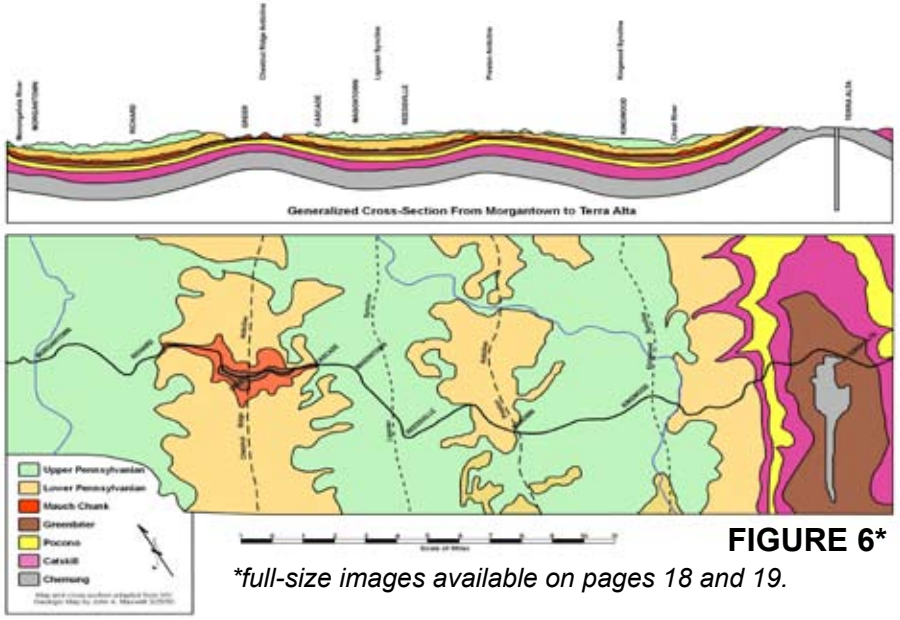


FIGURE 6*

**full-size images available on pages 18 and 19.*

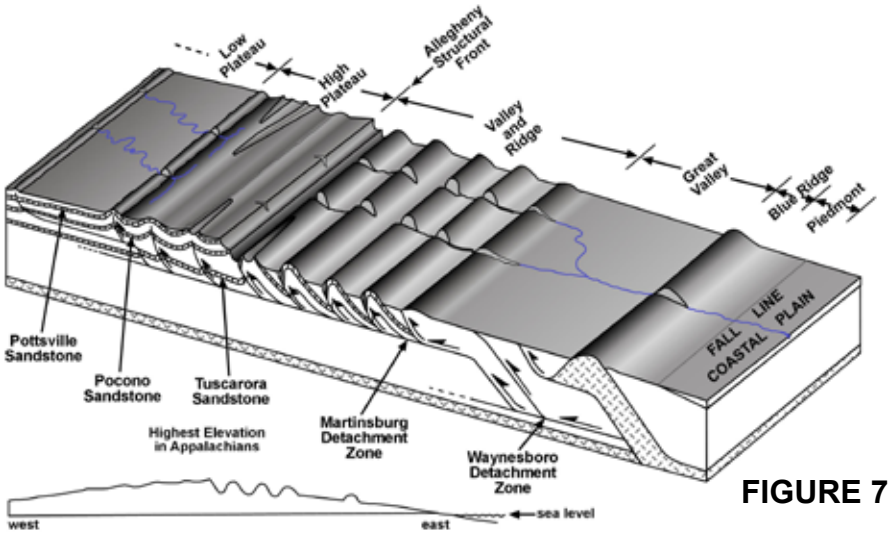


FIGURE 7

Low Plateau and most of the rocks you will see as you cross the High Plateau belong to the Pennsylvanian System which contains the coal beds for which Appalachia is famous. Many of the smaller towns within the region were coal towns. For example, the first small town through which the trip passes, Richard, had a small coking industry during the first half of the last century. Coals mined in the area were roasted in bee-hive ovens to drive off the volatiles and create coke. Coke is used in the steel industry to separate the iron from the iron ore in blast furnaces. The coke oxidizes in the furnace to produce carbon monoxide, CO, which then reacts with the iron ore, Fe_2O_3, to release the iron in a molten state:

$$3Fe_2O_3 + CO \rightarrow 2Fe_3O_4 + CO_2$$
$$Fe_3O_4 + CO \rightarrow 3FeO + CO_2$$
$$FeO + CO \rightarrow Fe + CO_2$$

The ovens were eventually shut down because they became uneconomical to operate and because the vapors generated during the coking process were an environmental hazard.

As the trip crosses Decker's Creek at Dellslow, West Virginia, you are leaving the Appalachian Low Plateau and entering the Appalachian High Plateau (Figure 7). At this point, you are at the western base of the first major structure of the High Plateau, the Chestnut Ridge Anticline. The Chestnut Ridge Anticline extends about 85 miles (137 km) from Uniontown, Pennsylvania, to Weston, West Virginia.

Dellslow, WV to Greer, WV

At Dellslow, the trip enters the water gap that Decker's Creek has cut through the Chestnut Ridge Anticline (refer to Figure 6). The large blocks of rock that appear along the roadway and in the creek were dislodged by physical weathering processes such as frost wedging from the Pottsville sandstone that arches over the Decker's Creek valley. The Pottsville sandstone is the first of several resistant sandstones you will see on the trip. The rock consists of quartz grains tightly cemented together by quartz. In places, conglomerates appear within the sandstone beds. If you've ever been to the overlook at Cooper's Rock, you were standing on the Pottsville sandstone very near the axis of the Chestnut Ridge Anticline, looking down into a classic V-shaped valley carved by the Cheat River. The Pottsville sandstone is the major ridge-former within the High Plateau. As the trip progresses across the High Plateau, you will see exposures of the Pottsville sandstone many times.

Note that as you enter the water gap, the bedding of the rocks dip toward you, meaning that you are approaching the axis of an anticline (Figure 8). As you drive toward an anticlinal axis, the individual rock units are getting progressively older. A geologist would say that you are "going down stratigraphically." As you drive through Decker's Creek water gap, note how narrow the stream appears to be relative to the dimensions of the valley. This points out that, given enough time, a small stream such as Decker's Creek is still a potent agent of erosion.

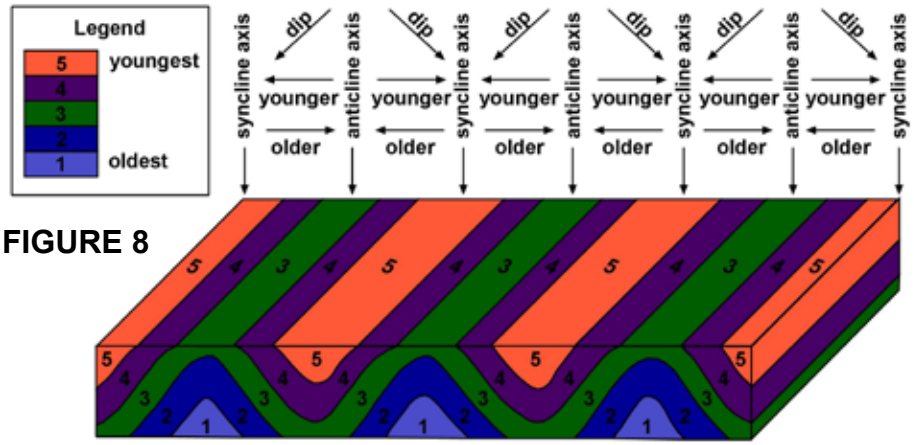


FIGURE 8

As you continue into the water gap, the next rock sequence to appear below the Pottsville sandstone, the Mississippian Mauch Chunk Formation, consists of interbedded sandstones and shales. Unfortunately, the Mauch Chunk is not well exposed along the roadway. The Mauch Chunk Formation is the first of three "red bed" formations you will see today. The red color of the sandstones and shales is due to coatings of hematite, Fe_2O_3. Geologists interpret the red beds you will see on this trip as indicating that the original sediments were deposited in shallow, highly oxygenate waters that promoted the precipitation of the iron oxides.

As you approach Greer, the road will make a right-angled turn to the left. The rock on your left, looking like a wall, is the Mississippian Greenbrier limestone. The surfaces of the blocks are excellent examples of joints. Joints are breaks in rocks perpendicular to bedding along which there has been no measurable movement. The blocks that you see in the outcrop were formed by the intersection of two sets of mutually perpendicular joints. While all rocks exhibit joints, few are as well exposed as these. The Greenbrier limestone is the oldest rock formation exposed in the Decker's Creek water gap. Shortly, you will pass the Marquette Cement mine and a mile or so later, the mine of the Greer Limestone Corporation. Both operations are mining the Greenbrier limestone. The rock produced at Greer is largely used for road construction and as the aggregate in concrete. The limestone mined at Greer is also mixed with high-purity limestone from Greer's Germany Valley quarry and ground into a fine powder to make agricultural lime. Agricultural lime is the white powder you see spread over yards and gardens during the spring to both neutralize the acid soils we have in this region and to provide the calcium nutrients that many of the plants you want to grow in your garden and lawn need; grass being one of them. The trip will visit Germany Valley later in the day.

As you passed through Greer, you crossed the axis of the Chestnut Ridge Anticline. As a result, as you continue through the water gap, you will notice that the bedding of exposed rocks dip away from you, meaning that you are now approaching the axis of the Ligonier Syncline (refer to Figure 8). Because the rock units get progressively younger as you approach a synclinal axis, you are said to be "going up stratigraphically".

Greer, WV to Reedsville, WV

Beyond Greer, the Pottsville sandstone appears once again along the road as it "comes down" on the east limb of the Chestnut Ridge Anticline. The road map in Figure 1 shows a town called Cascade which no longer exists. Originally, Cascade was the eastern equivalent of Richard in that both used local coals to generate coke in beehive ovens.

Note how the topography becomes more subdued as you drive toward Reedsville and how it resembles the topography around Morgantown. The similarity is an excellent example of how rock type and structure determine topography. The similarity is due to the fact that the same sequence of rocks are exposed in both areas plus the fact that the rock layers are essentially horizontal. In the case of the region near Morgantown the beds are horizontal because it is located in the Low Plateau where the amplitudes of the folds are so low that the bedding is essentially horizontal. In the case of the drive to Reedsville, the rock layers become more horizontal because you are crossing the axis of the Ligonier Syncline. In summary, similar rock types and bedding attitude create similar topography.

Reedsville, WV to Kingwood, WV

At the 4-way stop in Reedsville, turn left toward Kingwood. As the trip continues toward Kingwood, you will note several changes in the landscape. For one, the topography begins to rise and become more rugged. In addition, large sandstone boulders and outcrops of the Pottsville sandstone begin to appear along the roadway and in the fields. The reason for what you see is because you are approaching the axis of the broad Preston Anticline (see cross section in Figure 6). Because the amplitude of the Preston Anticline is nowhere near that of either the Chestnut Ridge Anticline to the west or to those you will see to the east later in the trip, the only affect of the structure is a broad arching of the landscape and an increase in the ruggedness of the topography as the Pottsville sandstone along the axis of the fold begins to be exposed at the surface. However, because the dip on the rocks associated with the broad Preston Anticline are low, the exposure of the Pottsville sandstone

does not form any dominant ridges. As you cross the High Plateau, time and time again you will see the influence of the Pottsville sandstone on the topography. In fact, anytime the topography becomes more rugged and sandstone outcrops appear as you cross the High Plateau, you can count on it being due to exposures of the Pottsville sandstone.

Kingwood, WV to Briery Mountain

As you approach Kingwood, Briery Mountain forms the skyline to the east. At Kingwood, you will cross the Kingwood Syncline and descend to the valley of the Cheat River. At this point, you are at the western base of Briery Mountain. Note from the cross section in Figure 6 that the Briery Mountain Anticline is a very large structure and that it has been "breached". Being breached means that the resistant rocks that formed the crest of an anticline have been removed by erosion, exposing the softer, more easily eroded rocks below. In the case of the Briery Mountain Anticline, the Pottsville sandstone was breached allowing the rocks as old as the Devonian Chemung Formation to be exposed along the axis of the fold (Figure 9).

The large size of the Briery Mountain Anticline, as compared to those that you have crossed up to this point, becomes evident as you climb the long, steep roadway to the top. Because of the breaching of the main structure, Briery Mountain is a monoclinal ridge, that is, it is underlain rock layers that dip in one direction, in this case, to the west. Because the slope of the roadway and the angle of dip of the western limb of the structure are about the same, outcrops of the Pottsville sandstone are more or less continuously exposed along the ascent.

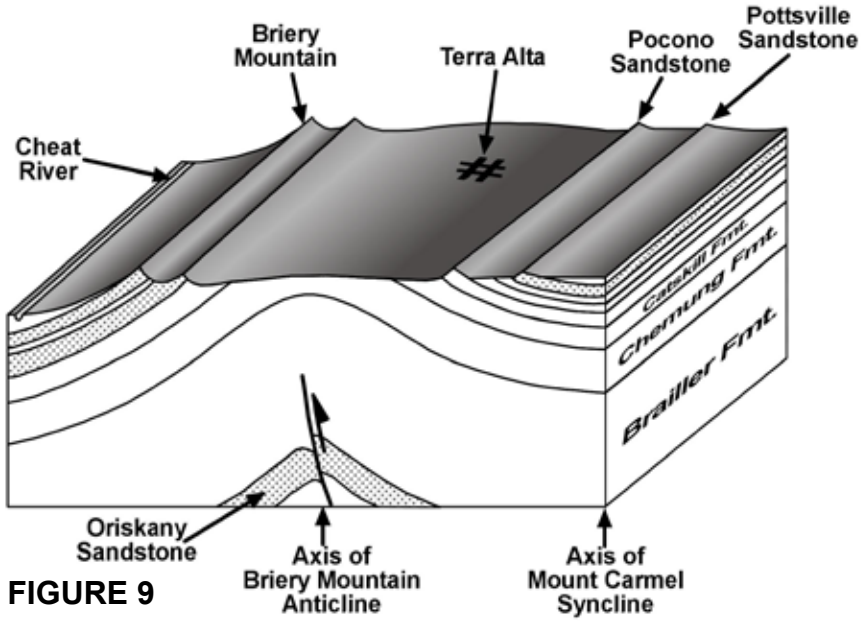


FIGURE 9

Briery Mountain to Stop #1.

After reaching the top of Briery Mountain at an elevation of 2,704 feet (834 m), the roadway drops into a small valley underlain by the Mississippian Greenbier limestone. The Greenbrier limestone is the same rock layer mined at the Marquette and Greer mines you passed earlier along Decker's Creek. The valley is an excellent example of how the low resistance of limestone to chemical weathering results in the formation of valleys. Later in the day, you will see two other examples of limestone valleys, Canaan Valley and Germany Valley. The ridge just beyond the small valley is due to the appearance of the next oldest major sandstone unit that you will see today, the lower Mississippian Pocono sandstone. The Pocono ridge, like Briery Mountain, is a monoclinal ridge on the west flank of the breached Briery Mountain Anticline.

After crossing the Pocono ridge, the rocks exposed along the roadway and the soil turn a noticeable red color due to the outcropping of the Devonian Hampshire Formation. The Hampshire Formation is the second of three dominant red bed units you will see today. Beyond the outcrops of the Hampshire Formation, the topography becomes increasingly subdued as you approach the axis of the anticline due to the combination of intermixed, flat-lying sandstones and shales of the Devonian Chemung Formation.

Stop #1

As you crest the hill, the roadway will turn down and to the right. In the bend, there is a pull-off to the left. At this point, stop and walk up through the field to the top of the hill; a distance of a few tens of yards. Assuming that it is a clear day, you will be looking back along the field trip route as it crossed the High Plateau. Not only will you be able to see Chestnut Ridge along the western skyline, but also the topographically lower Preston Anticline between your vantage point and the Chestnut

Ridge Anticline. There are few places where you can get this kind of geologic perspective.

I might also point out that you are standing over the Terra Alta gas field. In its day, the Terra Alta gas field was one of the most productive gas fields in the Appalachians. Today, it is used for gas storage. The local gas company buys gas during the summer when the demand and price is low, pumps it back underground into the original reservoirs for storage, and withdraws it during the winter when demand increases..

Stop#1 to Oakland, Md

From Stop #1, travel eastward through Terra Alta (pronounced by the natives as one word - Tearalta) to Hopemont. As you make the turn to the right at the Hopemont Hospital, the land drops slightly in elevation. At this point, you have dropped off the Pocono ridge on the eastern limb of the Briery Mountain Anticline back down into a Greenbrier limestone valley. The topography here is much more subdued than that which you observed on the western side of the structure because of the lower angle of dip of the eastern limb of the structure. From Hopemont, you will cross the Mt. Carmel Syncline and enter the breached Deer Park Anticline as you continue to Oakland, Maryland (Figure 10). Along the way, you will once again see evidence of the Pottsville sandstone cropping out to the surface and forming the major ridges.

Oakland, Md to Red House, Md

Drive through Oakland on WV Rt. 7 and turn south on US 219 toward Red House. The roadway parallels the axis of the breached Deer Park Anticline. The skyline to the east (your left) is Backbone Mountain, a monoclinal ridge underlain by the east-dipping Pottsville sandstone on the east limb of the structure (refer to Figure 10). The rocks throughout the valley are largely the flat-lying sandstones and shales of the Chemung Formation, once again giving rise to the gently rolling topography.

Red House, Md to the Allegheny Structural Front

At Red House, turn east on US 50. From Red House to Mt. Storm, you will cross the North Potomac Syncline and the Blackwater Anticline (refer to Figure 10). Note how the topography becomes increasingly rough as you drive eastward with the familiar blocks of the Pottsville sandstone beginning to appear along the roadway. What most individuals are not aware of as they drive eastward across Appalachia is the fact that the elevations have progressively increased. The elevation of Morgantown is about 900 feet (275 m) above sea level. By the time you get to Mt. Storm and the Allegheny Structural Front, elevations will have increased to about 5,000 feet (1,525 m) above sea level. The Allegheny Structural Front is the line of demarcation between the Appalachian Mountain Section of the Valley and Ridge Physiographic Province and the High Appalachian Plateau.

Perhaps this would be good time to summarize what you have seen so far. The trip started at the eastern margin of the Appalachian Low Plateau which extends westward to Ohio. Structurally, the Low Plateau is underlain by symmetrical folds with amplitudes so low that the rock beds appear to be horizontal. The rocks throughout the Low Plateau are a mixture of sandstones, shales, and coals. Beginning at Dellslow, you entered the Appalachian High Plateau. While the dominant structures are still symmetrical folds, the amplitudes of most of the folds of the High

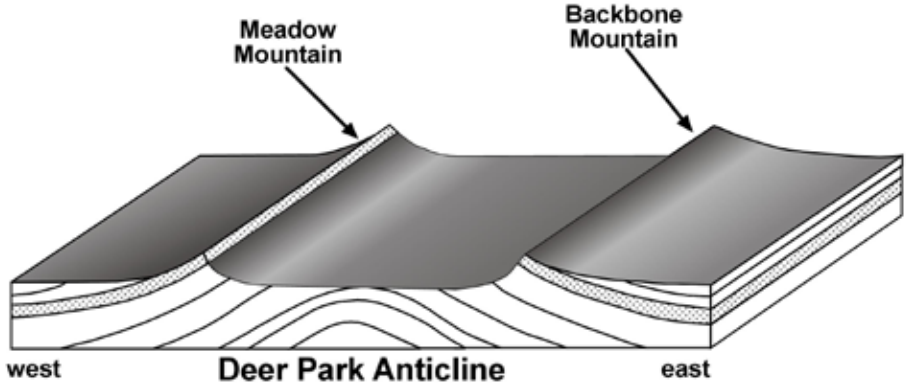


FIGURE 10

Plateau are high enough to produce anticlinal ridges, some of which are breached to form parallel monoclinal ridges. The erosion of the higher amplitude folds brought the resistant Pottsville sandstone to the surface where it was responsible for most of the ridges and much of the rugged topography that characterizes the High Plateau.

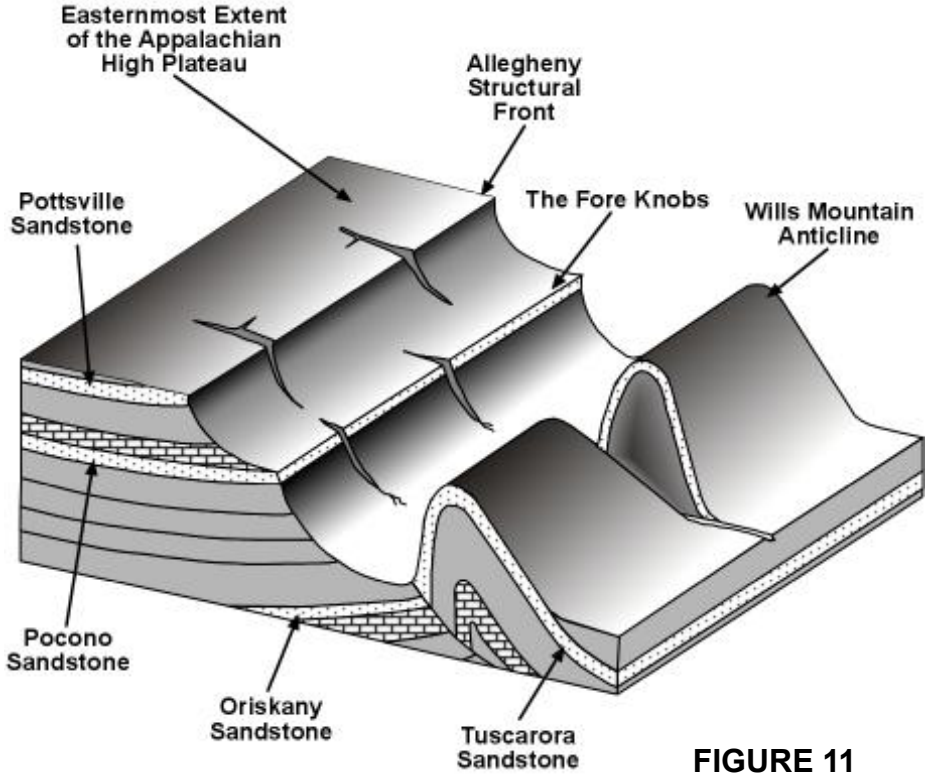


FIGURE 11

Stop #2

Just beyond Mt. Storm, you will arrive at the Allegheny Structural Front (Figure 11). At the very edge of the Front, there is a scenic overlook along US Rt. 50 to the right that will provide you with a spectacular overview of the Appalachian Mountains. The ridge before you is Wills Mountain Anticline, the westernmost structure of the Appalachian Mountain Section of the Valley and Ridge Physiographic Province. On a clear day, you should be able to see several ridges beyond Wills Mountain to the east. The notch that appears along the summit of Wills Mountain is called a wind gap. A wind gap began as a stream valley that was being carved across an anticline as the region was being uplifted. At some point, however, the rate of down-cutting by the stream was not able to keep up with the rate of uplift of the land. Eventually, the stream separated into two streams flowing down opposite sides of the ridge, leaving a wind gap behind. As a bit of historic trivia, Abraham Lincoln's mother was supposedly born beyond the wind gap on the eastern side of Wills Mountain.

Allegheny Structural Front to WV Rt. 93

You are now about to enter the Appalachian Mountain Section of the Valley and Ridge Physiographic Province. The dominant structures within the Appalachian Mountains are asymmetric to slightly overturned anticlinal folds, with the steep western limb commonly broken by high-angle thrust faults (Figure 12). Most of the mountains consist of long narrow anticlinal ridges capped by the Silurian Tuscarora sandstone with the adjoining synclinal valleys underlain by soft Devonian shales. As was the case with the High Plateau, many of the anticlinal structures are breached, forming monoclinal ridges on opposite sides of valleys underlain by Ordovician limestones.

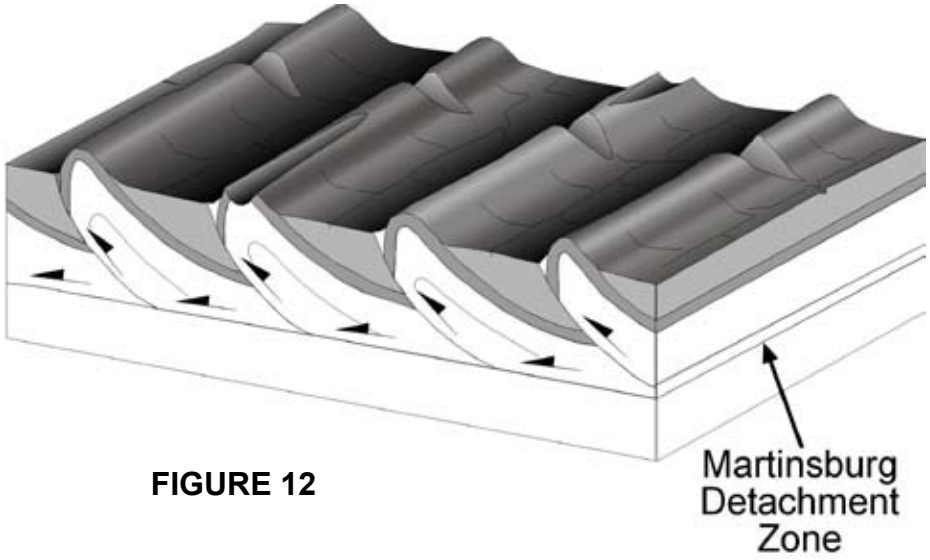


FIGURE 12

Continue on US Rt. 50 beyond the Front. As you descend the Front, you will drop below the Pottsville sandstone that caps the edge of the Front and pass through the red beds of the Mauch Chunk Formation. After passing through most of the Mauch Chunk red beds, the roadway encounters a relatively flat ledge known as the Fore Knobs (refer tp Figure 11) The Fore Knobs are held up by the second resistant sandstone you saw on Briery Mountain, the Pocono sandstone. Above the Pocono is the Greenbrier limestone which accounts for most of the Fore Knobs being a grassy pasture. The dissolution of the limestone provides the calcium ions that grass prefers as a nutrient. During the early settlement of the region, the pastures of the Fore Knobs were supposedly used to graze cattle.

At this point in your descent from the Front, you will see a sign warning truck drivers to “stay in low gear”. All too often, truckers unfamiliar with the road reached the flattened portion of the roadway on the Fore Knobs after dark and considered that they have completed the descent from the Front and shift to high gear. Unfortunately, the worst grade is yet to come. Once beyond the Fore Knobs, the roadway descends steeply through the red beds of the Hampshire Formation, the sandstone and shales of the Chemung Formation, the rust-colored shales and sandstones of the Brallier Formation and at the bottom of the grade, the black shales of the Hamilton-Marcellus Formation. Note that as you descend from the Fore Knobs, the beds begin to dip toward you at progressively increasing angles from nearly horizontal at the Pocono outcrop to very steep at the bottom of the grade. This increase in dip reflects your approach to near-vertical western limb of the Wills Mountain Anticline.

***** A word of caution: Because of the steep grades and hairpin turns, this stretch of road is extremely dangerous. Keep in mind that historically the main cause of accidents has been brake failure. I want you to enjoy the geology and the scenery, but not at the price of your life ***.**

WV Rt. 93 to Scherr, WV

At the intersection of US 50 and WV Rt 93, turn south on WV Rt. 93 to Scherr. You will be driving down a valley underlain by the black shales of the Devonian Hamilton-Marcellus Formation. The Hamilton-Marcellus Formation underlies most of the synclinal valleys in the Appalachian Mountains. Several places along the roadway, the Devonian Oriskany sandstone forms a small anticlinal structure called the Hopewell Anticline, on the western flank of the main Wills Mountain Anticline.

The Oriskany sandstone has played an important economic role in West Virginia. Within the Appalachian Plateau, the Oriskany sandstone reservoir produced more petroleum during the early years of the petroleum industry than any other single reservoir. For example, the Oriskany was the source of gas in the Terra Alta field. In most cases, the Oriskany sandstone is a calcareous sandstone which means that the quartz grains are cemented together by calcite, $CaCO_3$. At a quarry outside Berkeley Springs, West Virginia, however, the Oriskany is an ultra-pure quartzose sandstone with the quartz grains cemented by quartz. Sandstone from the quarry have long been used for the production of fine glass and crystal. In fact, it was Oriskany sandstone from the Berkeley Springs quarry that Corning Glass used to cast the glass disc that was used to make the reflecting mirror for the Mt. Palomar telescope.

Scherr, WV to Maysville Gap

At Scherr, continue southward on WV Rt 42 toward Maysville and Petersburg. Just south of Scherr, WV Rt. 42 will turn east into Maysville Gap, a water gap carved through Wills Mountain Anticline. As you enter the gap, you will have your first view of the Tuscarora sandstone exposed in the nearly vertical western limb of the structure. The Tuscarora sandstone is the major ridge-former throughout the Appalachian Mountains. As you pass through the gap, the Tuscarora can be seen to arch high above the valley floor. The sides of the gap are covered with scree consisting of blocks of rock broken from the

Tuscarora cliffs above. At places along the roadway, you will be able to see outcrops of the third major formation of redbeds, the Juniata Formation, that underlies the Tuscarora sandstone. As you near the eastern end of the watergap, the Tuscarora sandstone forms some spectacular waterfalls. If you have time, stop within the gap and enjoy the beauty of the geology and of the stream.

Maysville Gap to Petersburg, WV

As you emerge from the eastern end of Maysville Gap, you will notice the more gently-dipping eastern limb of the structure as the Tuscarora sandstone returns to road level. Comparing the attitudes of the vertical western limb and the more gentle eastern limb gives you a feeling for the asymmetry of the structure. Shortly beyond the Tuscarora outcrop, you will once again encounter the Oriskany sandstone, this time in the form of a monoclinal ridge called a hog back. Beyond the Oriskany ridge, you will enter a synclinal valley between the Wills Mountain Anticline to the west and the Patterson Creek Anticline to the east. The valley is underlain by shales of the Brallier and Hamilton-Marcellus formations.

Locally, this valley is known as “The Barrens” or “The Shale Barrens” because of its scarcity of trees. The reason for the lack of large plants is because, being located in the rainshadow of both the Front and Wills Mountain, the annual precipitation for the valley is less than 20 inches (50 cm). According to my botanist friends, 20 inches of annual precipitation is the absolute minimum for the survival of most trees. While the valley certainly doesn’t qualify as a desert, as you drive southward, keep an eye out for cacti that commonly grow along the fence lines.

Petersburg, WV to North Fork Gap

Driving south, the roadway parallels the monoclinal Oriskany ridge and Wills Mountain. Just outside Petersburg, turn west at the intersection with WV Rt. 28 toward North Fork Gap. As you drive toward the gap, you will be able to clearly see the monoclinal Oriskany ridge in the foreground and the Tuscarora sandstone arching high over the gap. The Allegheny Structural Front makes up the skyline to the west. The next stop, Dolly Sods, is located along the portion of the Front that you can see beyond the water gap.

North Fork Gap to Dolly Sods

As you exit North Fork Gap, you will once again see the vertical western limb of the Tuscarora sandstone. To your right, you will pass Smoke Hole Caverns which are commercial caves within the vertical outcrop of the Silurian Tonoloway limestone. The Oriskany sandstone will once again appear along the roadway. After a mile or so, Jordan Run Road will enter on your right. Turn right onto Jordan Run Road and bear left at the intersection. Over the next few miles, you will re-climb the Front. Try to identify the various rock units along the way. You should be getting pretty good at recognizing many of the rock units by now.

Once on top of the Fore Knobs, the road will run parallel to the Front for a few miles. There are several places along the roadway that you may want to stop and just enjoy the scenery and think about all of the geology that you have seen.

Stop #4: Dolly Sods

As you reach the summit of the Front, you will come to a T-intersection. Turn right and after a few yards, pull off the road and park at an information board that will give you the usual historical information about the area. Do not go to the “official” overlook which is further down the road; there is one that is infinitely better. Facing east, you will see a line of conifers that come out nearly to the road. To the left is an open area of low bushes and brambles. Keeping the conifers to your right, head out across the open area. As you cross the area, you will see a low-growing plant commonly called “ground pine”. This plant is the only descendent of a once majestic tree, *Lepidodendron*, that 300 million years ago was a major contributor to the peats that eventually became the coals of the eastern United States. You will see some fossil remains of *Lepidodendron* later at a stop on Canaan Mountain.

On you way to the edge of the Front, you will encounter large tilted blocks of the Pottsville sandstone. The most widely held explanation for their origin is that during the maximum advance of the Pleistocene ice sheet, which never got anywhere near where you are, the peri-glacial

climatic conditions that existed throughout most of Central and Northern Appalachia resulted in intense frost wedging the broke the layers of Pottsville sandstone that were exposed at the surface into blocks and left them in the jumbled array you now see. Within a hundred yards or so, you will come to the very edge of the Allegheny Structural Front where you can sit on the Pottsville outcrop that makes up the edge of

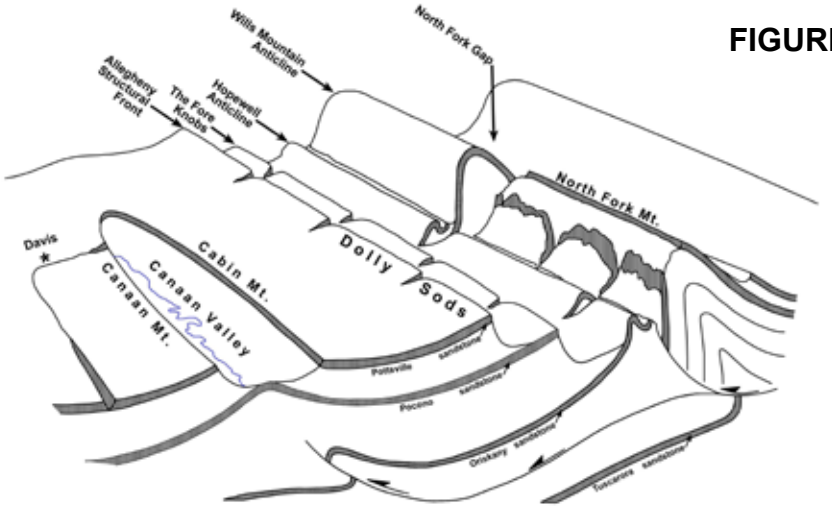


FIGURE 13

the Front and dangle your legs over the edge. I have provided a block diagram of the area for you to illustrate all that you will see from this vantage point (Figure 13).

Behind you, the Appalachian High Plateau stretches away to the west with Cabin Mountain making up the skyline. Beyond Cabin Mountain lies Canaan Valley and Canaan Mountain, both of which you will visit later in the trip. This place is called Dolly Sods after the Dolly family that settled here. Can you imagine what it must have been like living along the Front during those early days? The stunted growth of trees clearly indicates it experienced severe weather. Having made a winter backpacking trip onto the Sods, I can attest to how cold it can get. The trees with limbs only on the eastern side attests to the strong westerly winds that commonly whip the area. You should not be surprised to be told that another name for this place is “The Roaring Plains”.

The reason for coming to this spot is the view to the east. Before you is the most spectacular view of the Valley and Ridge Province I have ever seen. It almost speaks for itself. This place is what geology is all about. On a clear day you can see several ridges beyond Wills Mountain. Looking back through North Fork Gap toward Petersburg, note that the Tuscarora sandstone on the north side of the gap arches unbroken across the entire ridge. To the south of the gap, however, the structure has been breached with the Tuscarora sandstone having been eroded away along the summit. The outcrop of the Tuscarora along the eastern limb of the structure continues southward as North Fork Mountain while, along the western side of the structure, the Tuscarora sandstone forms a series of vertical outcrops separated by V-shaped notches carved out by streams flowing off the western side of the mountain. But why is the southern portion of the anticline breached while the northern portion is not? There is evidence that many, if not most, of the water gaps cutting across the ridges of the Appalachian Mountains are the sites of vertical faults that actually provided the zones of weakness sought out by the streams to carve their channels when the region was uplifted over the past 60 million years. In the case of North Fork Gap, the southern side of the fault was uplifted more than the northern side, resulting in the southern portion of the structure experiencing more intense weathering and erosion than the norther portion of the structure. Eventually, the combined efforts of physical weathering, mass wasting and erosion carved through the Tuscarora along the entire summit of the ridge.

Dolly Sods to Mouth of Seneca, WV

Before we leave Dolly Sods, I want to describe another way to exit or gain access to Dolly Sods. The trip will leave Dolly Sods by turning left at the T-intersection and returning to the Jordan Run Road intersection. Another way to leave is to go straight ahead at the T-intersection, drop down to Red Creek Valley, continue through Laneville, and intersect with WV Rt. 32. If you turn right onto Rt 32, you will enter the southern end of Canaan Valley in a mile or two. If you want to access Dolly Sods from Canaan Valley, head south from the valley and take the Laneville Road to the T-intersection at Dolly Sods. For those of you who are backpackers and want a beautiful two-day hike, the Red Creek backpacking trail starts at the Forest Service building near the bridge crossing Red creek, loops up and through Dolly Sods, and returns to the service building.

Leave Dolly Sods and retrace your path back to Jordan Run Road and WV Rt. 28. At WV Rt 28, turn right and head south to Mouth of Seneca. Along the way, you will see some spectacular outcrops of both the Oriskany and Tuscarora sandstones.

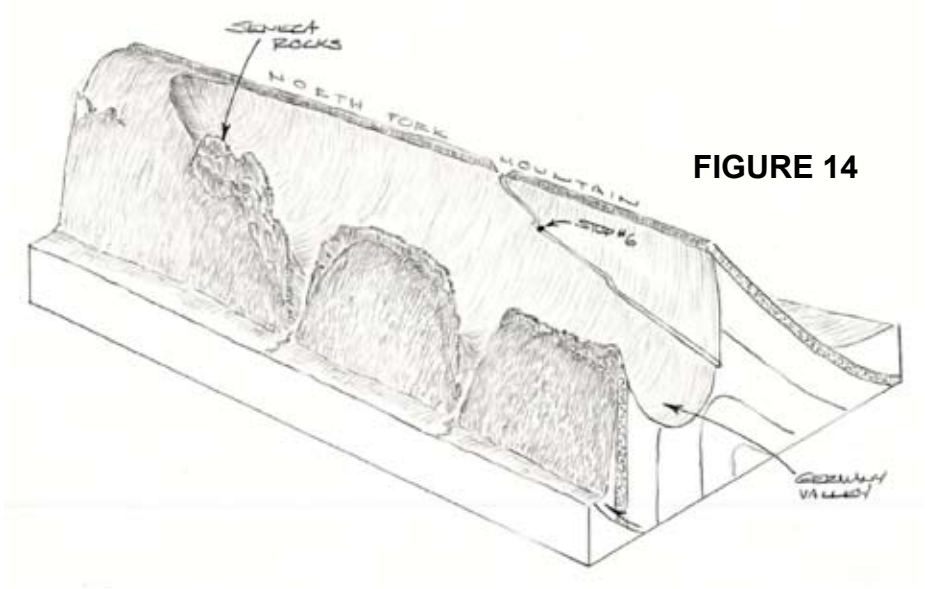


FIGURE 14

Stop #5: Mouth of Seneca, WV

Seneca Rocks, a well-known tourist spot, is the vertical outcrop of the Tuscarora sandstone exposed in the western limb of the Wills Mountain Anticline. Invariably, you will see rock climbers on the front face of the outcrop (Figure 14). During World War II, the Army used the rocks to train their commando troops in rock climbing.

Just beyond the intersection is a driveway leading to a Forest Service Information Center. If you feel ambitious, a climb to the top of Seneca Rocks is in order. A path to the top of the outcrop begins at the visitors center and ascends the front face of the outcrop. While the hike will take about an hour, it is worth the time. As you climb, take time to observe the Tuscarora sandstone. I think you can see why the Tuscarora is the major ridge-former in the Appalachian Mountains. There aren't many rocks more resistant to weathering and erosion than this one.

A second way to the top is by crossing North Fork and taking a road that leads through the water gap at the southern edge of Seneca Rocks (Stop #6). Once through the gap, a path takes off to the left and begins the climb to the top. The red rocks you will be climbing on belong to the Ordovician Juniata Formation which is the third and oldest of the three red beds that you will encounter during the trip. Once at the top, you'll be 900 feet (277 m) above the valley floor. Behind you will be the northernmost end of Germany Valley. You will get a better view of Germany Valley at a later stop on North Fork Mountain. In front of you will be the Allegheny Structural Front. Dolly Sods will be just barely within your line of sight along the Front to the north. The highest point in West Virginia, Spruce Knob at 4,863 feet (1,482 m) will be just out of sight along the Front to the south. As you look due west, you will see a small stream that has carved its channel back into the edge of the Front. On your return to Morgantown, you will follow this stream valley back up onto the Front. A note of caution. Be careful while you are on the summit of Seneca Rocks; too many lives have been lost by falling from the top.

Mouth of Seneca, WV to Seneca Caverns

Continue south on WV Rt. 33 toward Riverton. (If you are interested in going into a commercial limestone cavern, turn right at Riverton and follow the road to Seneca Caverns.) Along the way, you will pass sinkholes where the limestone has been dissolved along the intersections of two sets of joints (Figure 15). Caverns form as groundwater dissolves limestone along fractures and joints. The limestones in this case are

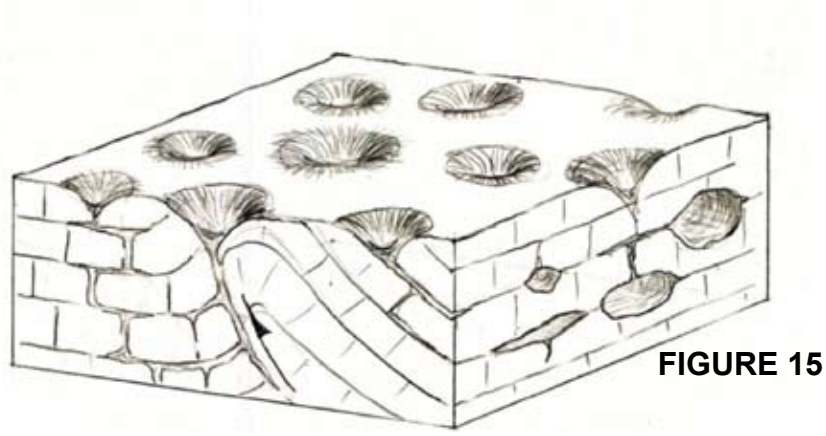


FIGURE 15

the Ordovician Black River and Stones River formations. Even if you don't choose to enter the caverns, along the way you will be able to see excellent examples of sinkholes that characterize karst topography that commonly forms in regions underlain by limestones.

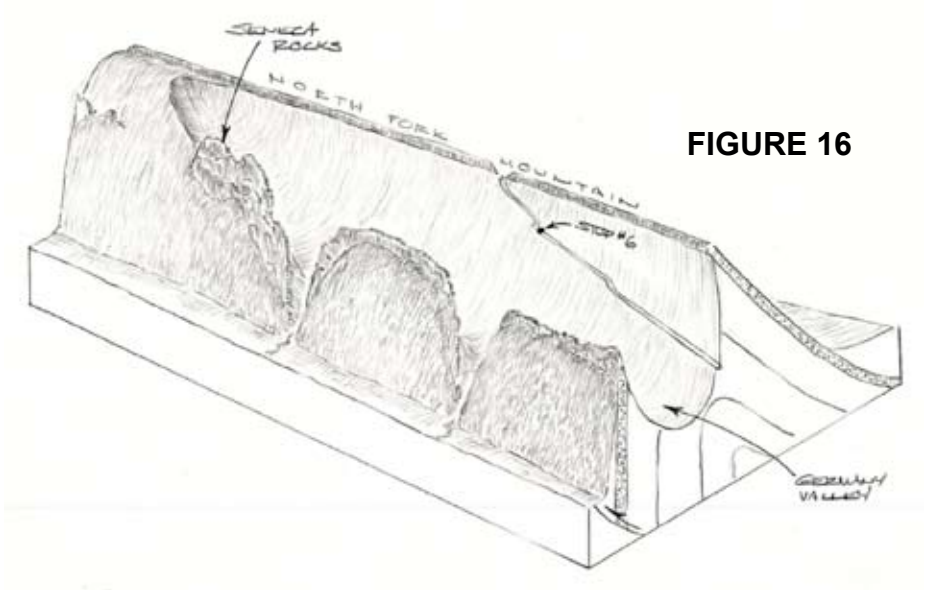


FIGURE 16

Seneca Caverns to North Fork Mountain: Stop #7

Return to Riverton and continue south on WV Rt. 33, passing through Judy Gap and into Germany Valley. As you climb the western flank of North Fork Mountain, you will have a truly spectacular view of Germany Valley. Near the top of North Fork Mountain, there will be a pull-off to the left which will be Stop #7 (Figure 16). From this vantage point, Seneca Rocks can be seen to your right at the very head of the valley. To the south of Seneca Rocks, you can see similar, but not so spectacular, outcrops of the Tuscarora sandstone along the vertical western limb of the structure and their associated V-shaped water gaps. Looking northward along the strike of North Fork Mountain, you can see the eastward dipping outcrop of the Tuscarora sandstone along the crest of the ridge. Imagine that at a point in time, the Tuscarora sandstone along North Fork Mountain arched up and over what is now Germany Valley and connected with the vertical outcrop of the Tuscarora sandstone along the western limb of the anticline. Once the combination of physical weathering, mass wasting and erosion breached the resistant Tuscarora sandstone south of North Fork Gap and exposed the soft sandstones and shales of the underlying Juniata Formation, Germany Valley began to form. Eventually erosion carved through the Juniata and Marinsburg formations, exposing the underlying Ordovician limestones that now form the valley floor. Greer Limestone's Germany Valley quarry can be seen toward the northern end of the valley. According to their estimates, at the present rate of production, Greer has enough high-quality limestone in the quarry to last for 500 years before they go underground. Obviously, Greer Limestone Corporation plans to be in business for a long time. Most of the limestone Greer produces from the Germany Valley quarry is used in blast furnaces to remove silica contaminants during the reduction of the iron ore:

$$CaCO_3 \rightarrow CaO + CO_2$$
$$CaO + SiO_2 \rightarrow CaSiO_3 \text{ (slag)}$$

It is also blended with the more magnesium-rich limestones from their operation at Greer to make agricultural lime.

If you're interested in fossils, you might investigate the outcrop of the Martinsburg Formation directly across the road from the overlook. The rocks are quite fossiliferous and you should have no trouble finding a variety of marine fossils. While most will be fossilized shells, if you're lucky, you may find a trilobite or two. A word of caution. Because the outcrop in located in a bend in the road, stay well away from the edge of the pavement and always have someone on the lookout to warn you of oncoming traffic.

While you are at this vantage point, I think it is interesting to point out that the sequence of rocks you see, from the Ordovician Black River and Stones River limestones that underlie the floor of Germany Valley to the Pennsylvanian Pottsville sandstone that outcrops along the Front, represents about 200 million years of Earth history. When the carbonate sediments that formed the Ordovician limestones rocks were being deposited, the first vertebrates were evolving in the form of jawless fish. By the time the Pottsville sediments were being deposited during Pennsylvanian time, animal evolution had advanced all the way through the amphibians to the first reptiles. While there was no life on land during Ordovician time, it began to appear during Devonian time and by the Pennsylvanian, the land was covered with forests. This was a time

when the vast swamps that accumulated the peat that would eventually be converted into our eastern coals covered the land. Amphibians dominated the swamps while early reptiles ventured onto the land. In addition, the Pennsylvanian Period has often been called the "Age of the Insect" when dragonflies with three-foot wingspans droned through the forests and swamps and foot-long cockroaches scurried about on the forest floor.

North Fork Mountain to Spruce Knob (Stop #8) to Mouth of Seneca, WV

Retrace the route back through Judy Gap and head north on WV Rt. 33. About a mile or so north of Judy Gap, the road to Spruce Knob turns off to the left. There isn't a lot to see at Spruce Knob. Although you will be on the edge of the Front, the view is not as spectacular as that from Dolly Sods. If you want to be able to say that you visited the highest point in West Virginia, by all means, go. It will take about an hour for the trip up and back. Otherwise, continue north on WV Rt. 33 to Mouth of Seneca.

Mouth of Seneca, WV to Harman, WV

At Mouth of Seneca, turn left and follow WV Rt. 33 toward Harman. For those who are backpackers, just west of Mouth of Seneca, a road to the left leads to the Seneca Creek Campground. A trail begins at the campground and ends up at Judy Springs Campground on Spruce Knob. The trail is a very easy hike and is quite scenic. While a round trip can be made in a long day, I would recommend making it a two-day trip with an overnight stay at Judy Springs Campground.

As you continue on WV Rt. 33 toward Harman, you will climb back up onto the High Plateau. However, because you followed a stream that had incised its channel back into the plateau, you will emerge onto the plateau several miles west of the Allegheny Structural Front. As you make the climb, see if you can identify the rock formations you pass. The red beds should give you an idea as to where you are stratigraphically as you make your way to the top. The western headwaters of these eastward-flowing streams represents the Eastern Continental Divide. Streams that headwater east of the Divide, such as the Potomac River, flow to the Atlantic while those the headwater west of the divide flow to the Gulf of Mexico via the Ohio and Mississippi rivers.

Harman, WV to Canaan Valley

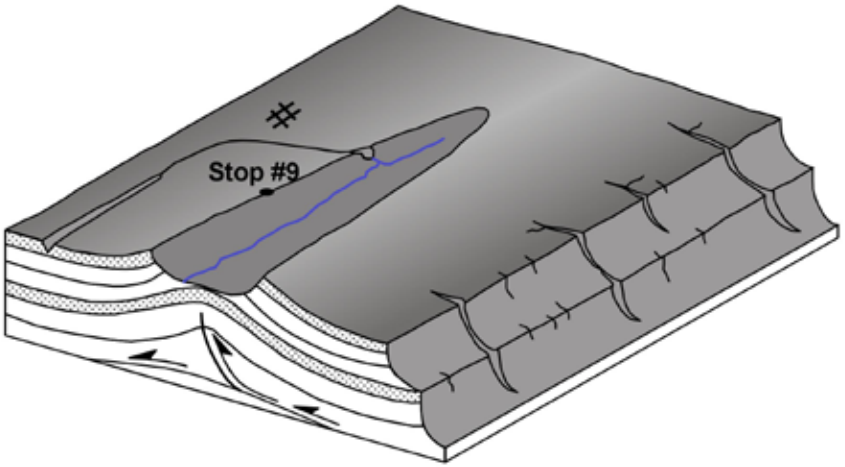
At Harman, turn right on WV Rt. 32. Just before you enter the southern end of Canaan Valley, you will pass the road leading to Laneville that I suggested was an alternative route to or from Dolly Sods. Immediately past the intersection, you will see the vertical outcrops of the Greenbrier limestone. Canaan Valley was formed by the breaching of the Blackwater Anticline. As you enter Canaan Valley, the entrance to Canaan Valley State Park is to the left and the entrance to Weiss Knob ski slopes is to the right. As you continue northward through the valley, you are driving parallel to the axis of the breached Blackwater Anticline. Canaan Mountain along the western side of the valley and Cabin Mountain along the eastern side are monoclinal ridges held up by outcrops of the Pottsville sandstone. Outcrops of the Greenbrier limestone that underlies the valley floor can be seen in the road cuts. The Pocono sandstone just barely comes to the surface along the axis of the structure. The Blackwater River headwaters in the southern portion of the valley and crosses the roadway at a small culvert. You will recognize it by the number of parked cars belonging to fishermen. I have NEVER come through the valley when there weren't fishermen in the stream. What has always amazed me is that the stream at that point is about four feet wide and two feet deep. Eventually, the river will leave the valley following a water gap through Canaan Mountain near the northern end of the valley.

Canaan Valley to Canaan Mountain: Stop #9

Toward the northern end of the valley, the roadway crosses the valley and begins to climb Canaan Mountain. The redbeds that appear along the roadway belong to the Mauch Chunk Formation. Just before you reach the top of the mountain, Stop #9 will be at a pull-off to the right.

You are again standing on the Pottsville sandstone looking across the valley to Cabin Mountain (Figure 17). Imagine the Pottsville sandstone arching over the valley and connecting with the Pottsville outcrop along Cabin Mountain. Your stop at Dolly sods is directly east of your present location beyond Cabin Mountain. The northern end of Canaan Valley

FIGURE 17



is an uninhabited swamp-marsh-bog complex. Botanist friends tell me that the plant community within the northern portion of the valley is very unique. Tundra and taiga plants growing there are leftovers from the periglacial climates that characterized the region during the maximum advance of the Pleistocene ice sheet which, for this region, was just south of the Pennsylvania-New York state lines. .

Directly across the road from the stop, the outcrop of the Pottsville sandstone may provide some excellent fossils of the types of plants that formed the coals for which West Virginia is famous. If you are interested in plant fossils, you might consider buying a publication available from the West Virginia Geologic and Economic Survey entitled "*Plant Fossils of West Virginia*" by Bill Gillespie, John Clendenning, and Herman Pfefferkorn. It's about as complete a treatment of Pennsylvanian fossil plants that you'll find anywhere. The fossils you will find at this site include a variety of leaves of the so-called "tree ferns" that were not true ferns but rather were seed bearers whose fronds resembled ferns. The

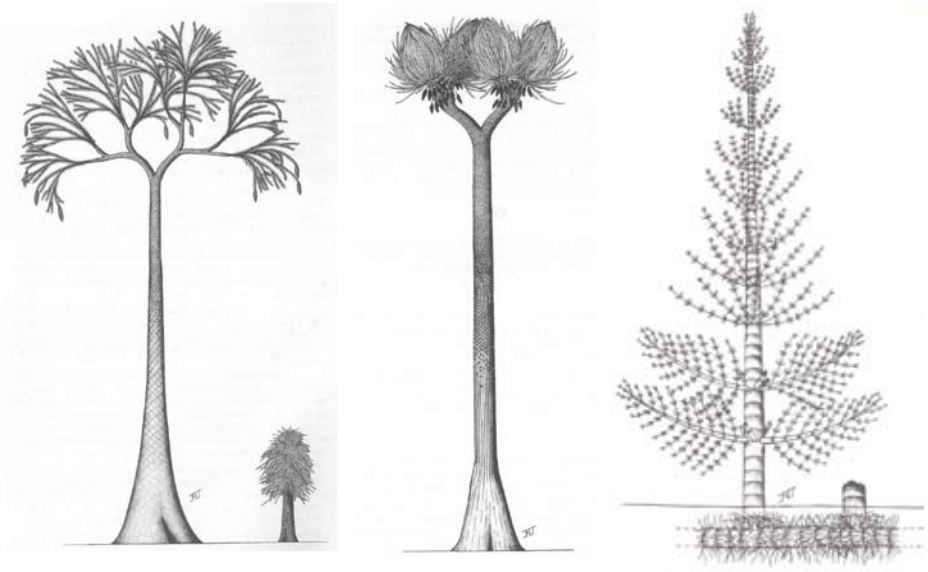


FIGURE 18

major plants growing during Pennsylvanian time include *Calamites* whose stem looks like bamboo, and L*epidodendron,* and S*igillarian* whose stem impressions look like the diamond pattern of a doormat (Figure 18, from "*Plant Fossils of West Virginia*"). The difference between the two fossils is that the diamond pattern spirals around the stem in lepidodendrons while it is aligned parallel to the stem in sigillaria. The stem of Calamites looks like the segmented stems of bamboo.

Canaan Mountain to Blackwater Falls State Park Stops #10 & #11.

Continue toward Davis, West Virginia. As the roadway descends from Canaan Mountain, the slope of the roadway follows the gentle slope of the west limb of the Blackwater Anticline. Note also the numerous blocks of Pottsville sandstone, the rugged topography, the sandy soil, and the dominance of conifers along the way. You will cross the Blackwater River just as you enter Davis. Just west of Davis, turn left onto the access road to Blackwater Falls State Park. Follow the road until it ends in the parking lot for the overlook located directly across the gorge from the lodge.

Stop #10

Stop #10 will be at the overlook (Figure 19). After leaving Canaan Valley, the Blackwater River flows westward to Davis where it turns southward, eventually flowing into the Cheat River. Along the way, the stream carved the gorge you see before you. At this point, you are standing on the Pottsville sandstone at the edge a youthful V-shaped stream valley that is 485 feet (148 m) deep. The gorge has often been referred to as the "Grand Canyon of the Blackwater".The dark color of the water is due to the tannic acid that is released by the decay of the leaves and bark of the hemlock trees that abound in the area. While the tannic acid does add an interesting flavor to the water, to my knowledge, the water isn't harmful to drink. During the early part of the last century, Davis and a nearby town, Thomas, were centers for the tanning of leather, primarily because of the local availability of tannic acid.

Stop #11

Backtrack along the access road to the parking lot serving the Falls. Blackwater Falls speaks for itself. Most individuals are unaware that waterfalls are very ephemeral features; geologically, they don't last very long. As you stand at the falls, note the shapes of the rocks at the base of the Falls. I think you can see where, based on their shapes, that the rocks came from the lip of the falls. Over time, as the softer underlying rocks are eroded, support for the outcrop of the sandstone that makes up the lip of the falls is removed. Lacking support, the sandstone along the lip of the falls breaks away, resulting in the slow retreat of the falls upstream upstream (Figure 20). As falls retreat and decrease in height, they eventually are turned into rapids which, in turn, are reduced to mere riffles in the stream. As you observe Blackwater Falls, keep in mind that they originated downstream where the Blackwater River flowed into Cheat River.

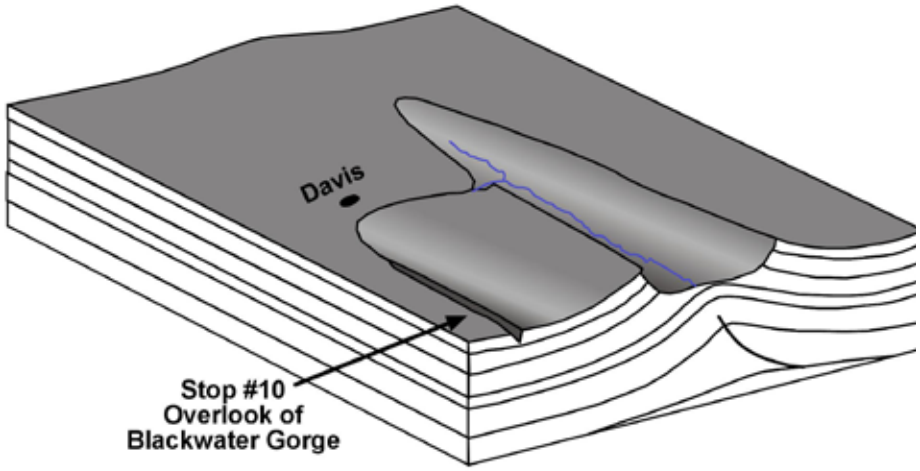


FIGURE 19

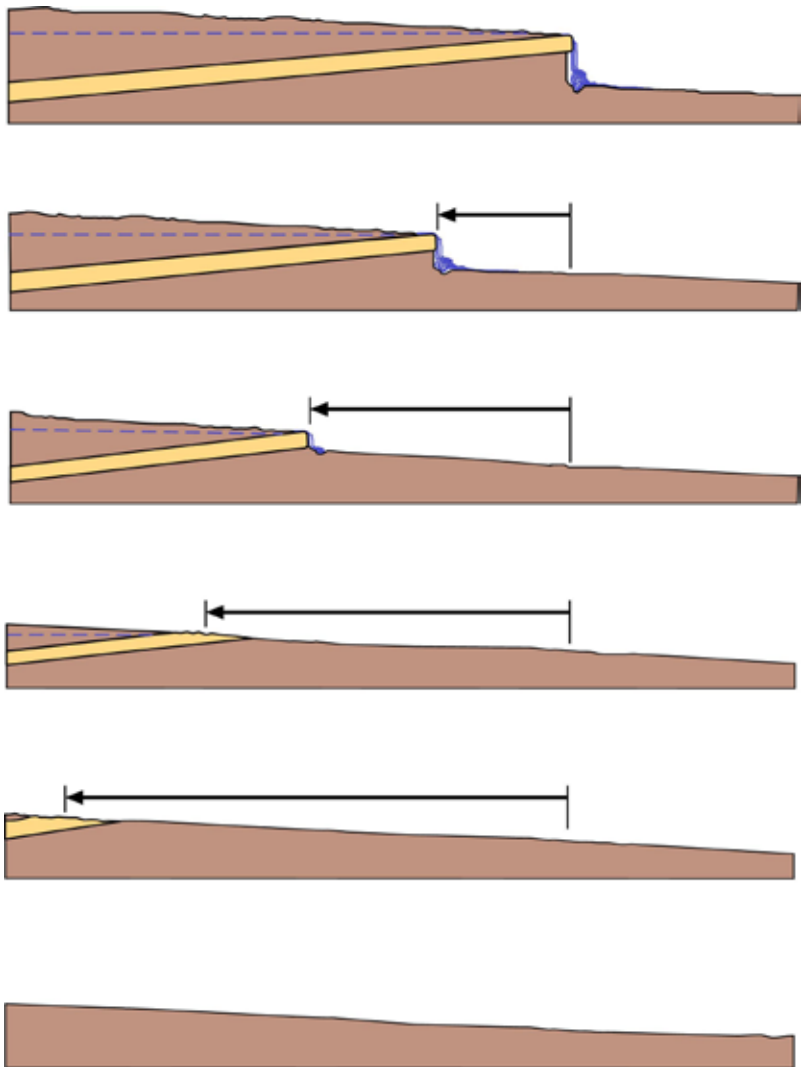


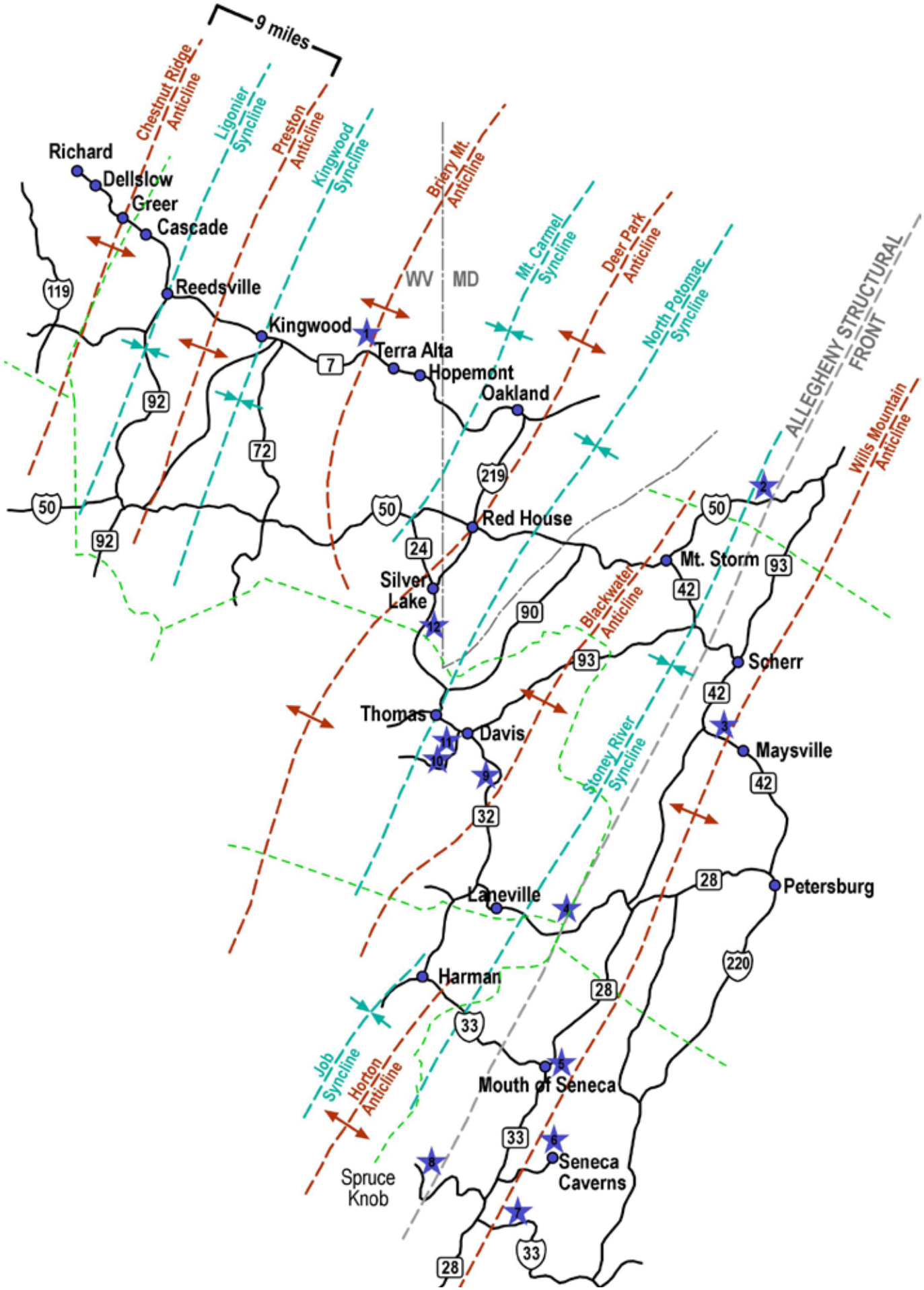
FIGURE 20

Blackwater Falls State Park to Backbone Mountain Stop #12

Leave Davis, West Virginia, and head west through Thomas, West Virginia. Take WV Rt. 219 out of Thomas through Fairfax Stone. Just west of Fairfax Stone, the roadway begins to descend Backbone Mountain. Part way down the mountain, turn off to the left at a scenic overlook. At this point, you are on the eastern limb of the breached Deer Park Anticline, the same structure you crossed at Oakland, Maryland (refer to Figure 10). From the overlook, your view is across rolling terrain underlain by the Chemung Formation. As you've seen before, this type of topography is expected where the underlying rocks are a mixture of sandstones and shales and where the bedding along the axis of the structure is relatively flat lying. The western limb of the breached structure can be seen along the western skyline.

Backbone Mountain to Morgantown, WV

Continue to Silver Lake. Turn left onto WV Rt. 24 which is a shortcut to U.S. Rt 50. Turn left on US Rt. 50. Follow US Rt. 50 through Fellowsville to WV Rt. 92 North. Follow WV Rt. 92 to Reedsville. At Reedsville, take WV Rt. 7 back to Morgantown. I sincerely hope that this trip has not only been enjoyable but has developed in you a better understanding and appreciation of the geologic processes that constantly shapes the land around us.


9 miles
Chestnut Ridge Anticline
Ligonier Syncline
Preston Anticline
Kingwood Syncline
Briery Mt. Anticline
Mt. Carmel Syncline
Deer Park Anticline
North Potomac Syncline
ALLEGHENY STRUCTURAL FRONT
Wills Mountain Anticline
Blackwater Anticline
Stoney River Syncline
Job Syncline
Horton Anticline
WV
MD
Richard
Dellslow
Greer
Cascade
Reedsville
Kingwood
Terra Alta
Hopemont
Oakland
Red House
Silver Lake
Mt. Storm
Scherr
Thomas
Davis
Maysville
Laneville
Petersburg
Harman
Mouth of Seneca
Seneca Caverns
Spruce Knob
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92
72
7
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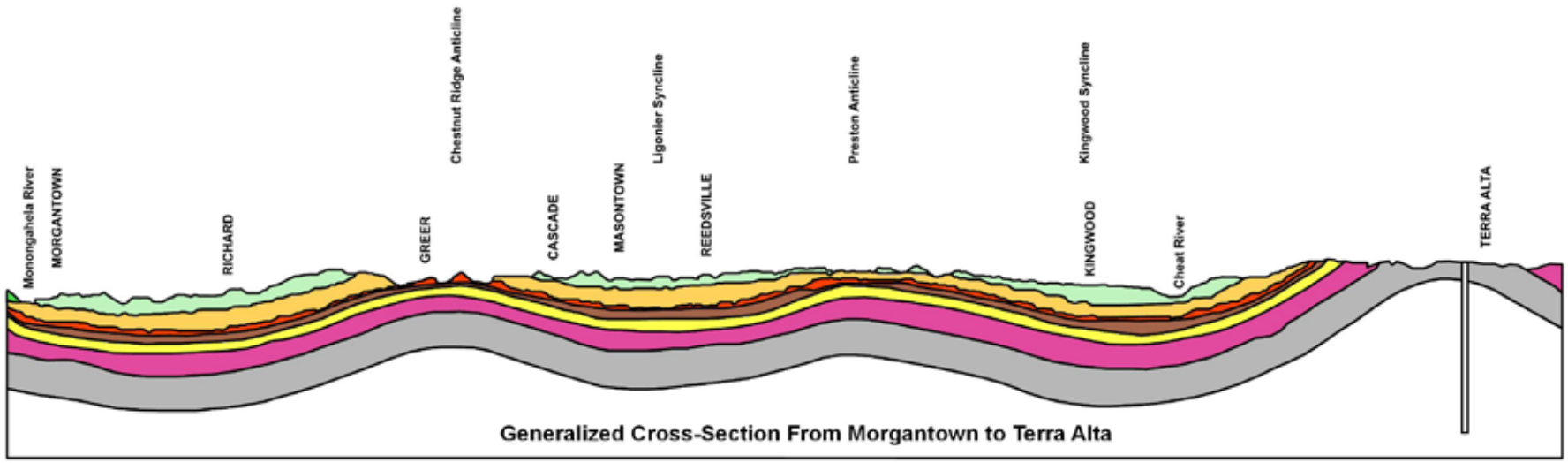
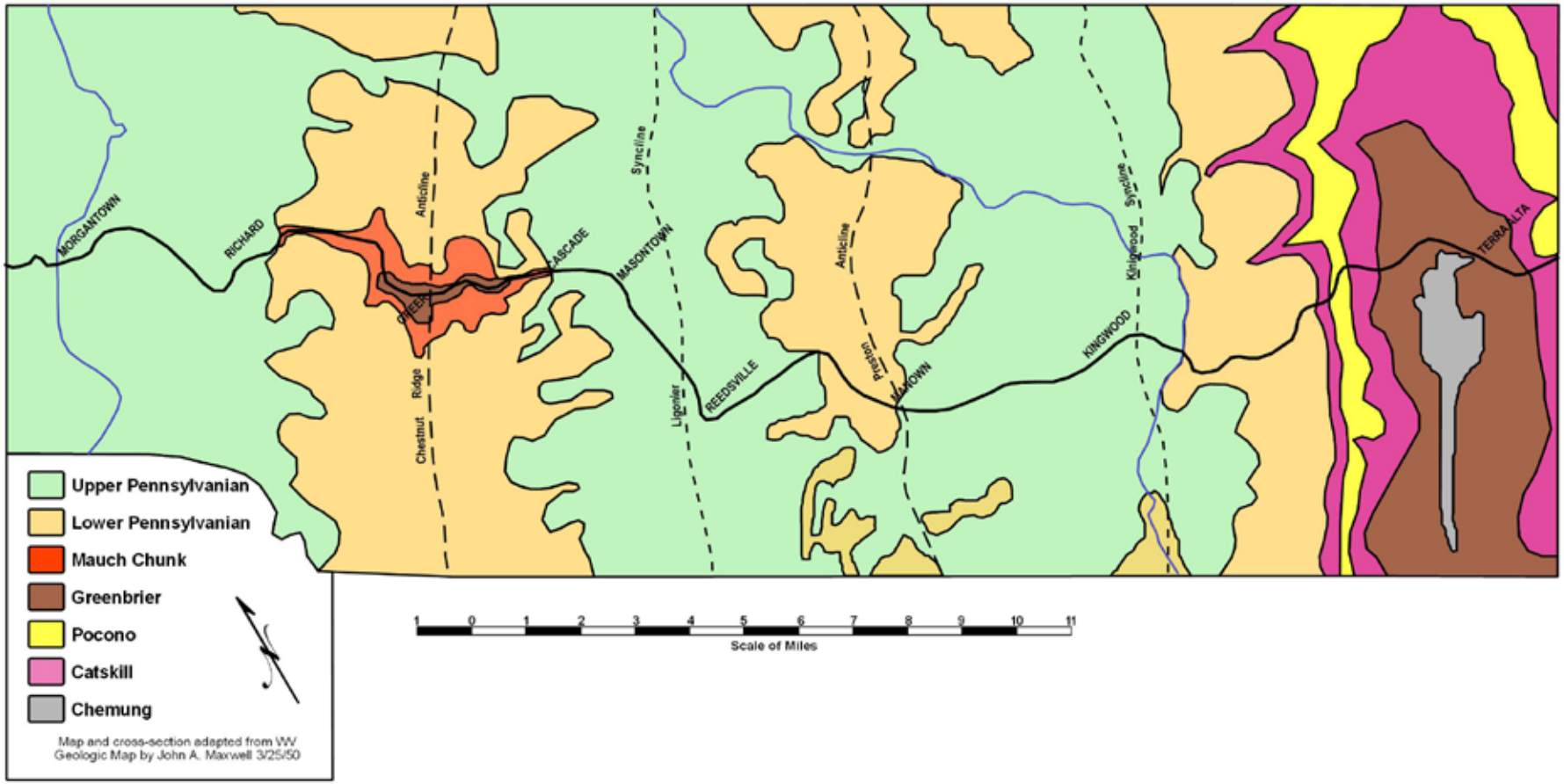
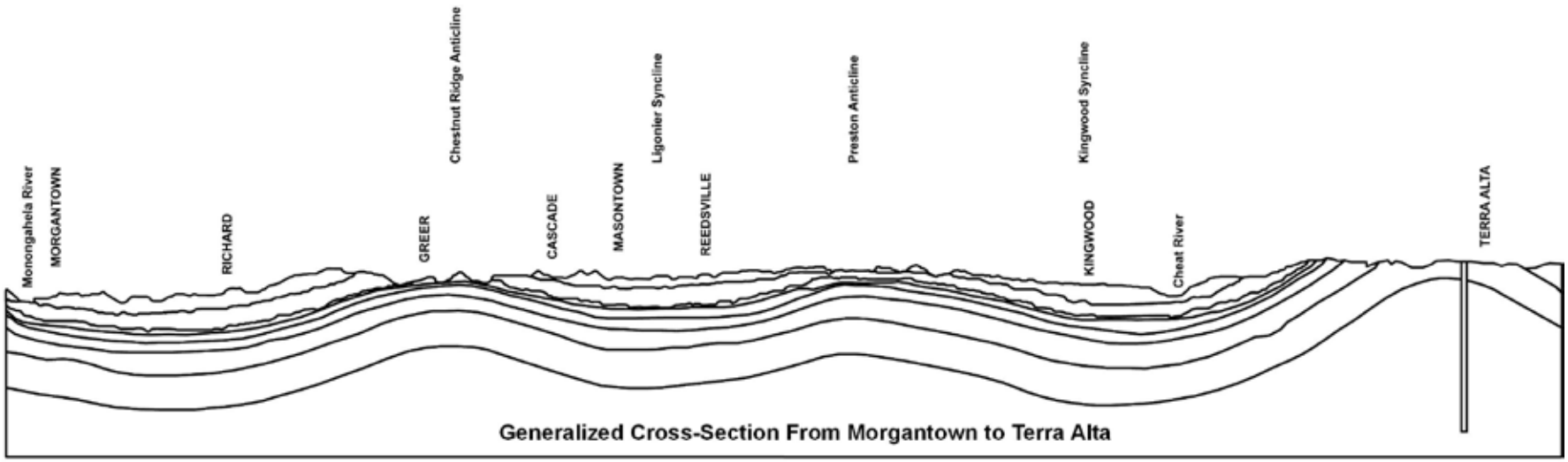


Generalized Cross-Section From Morgantown to Terra Alta





Generalized Cross-Section From Morgantown to Terra Alta