“Unearthing the Mysteries of the Crust”

Geology of the Front Royal and Strasburg Virginia area and Hedgesville, West Virginia

For Renfrew Institute
Family Geology Trip
May 9, 2015

Jeri L. Jones
Jones Geological Services
www.jonesgeo.com
Email: jonesgeo@comcast.net

INTRODUCTION

The day has finally arrived to make this particular geologic excursion into the different areas. A great deal of planning has occurred over the winter months searching out the best sites in Virginia and West Virginia to make this trip successful. It was through a Renfrew survey completed earlier in 2015 that told us exactly what you might be interested in seeing or doing. If you are along on the trip to see some interesting rocks, nice scenery, collect fossils or just plan right out have a fun time, you are at the right place. So, here we go!

We will be visiting three different geological areas or physiographic provinces. Each province or section tells a different story about the evolution of our Earth over time. The first area that we will visit is the Blue Ridge Province locally known as the Blue Ridge Mountains. These stops will include collecting a volcanic rock about 600 million years old (mya) and another rock known as unakite, which was a part of the crust of a an ancient continent known as Rodinia some 1.1 billion years ago (bya). We will venture onto the Skyline Drive for about a 20 mile roundtrip to view several classical sites and have lunch on top of the mountain. I hope for a clear day so the views can be enjoyed.

Our second area to visit near Strasburg, VA will concentrate on the limestone making up the Great Valley Section of the Ridge and Valley Province. The roadcut is a classical and has been visited by many geologists. Sharp eyes will detect thin volcanic ash layers, several different types of limestone and some trilobites.

Our day will end as we travel north along Interstate 81 to Hedgesville, WV to a working shale pit. Within the Manhantago Formation, you will be able to find marine fossils dating to about 380 mya. At the conclusion at this stop, we will be able to determine what animals lived and what the ocean environment was like.

Here is the itinerary for the day. We would like your cooperation in staying on schedule so that we can spend the planned time at each site.

8:30 – Depart Renfrew
10:00 – STOP 1. Arrive at Front Royal Rte. 522 metabasalt
10:30 – Depart
10:45 – STOP 2. Arrive at Brownstone Road Unakite
11:25 Depart
11:45 – STOP 3. Arrive Skyline Drive 5.3 metabasalt
12:15 – Depart
12:20 - Skyline Drive Visitors Center & Lunch
1:10 – Depart
1:25 – STOP 5. Arrive Skyline Drive 10.7 basement rock and metabasalt
1:55 – Depart
1:35 – STOP 6. Arrive at Strasburg Limestone/Trilobite site – Battlefield Road
2:35– Depart
3:25 – STOP 7. Arrive at Hedgesville Fossils, Hedgesville Road Rte. 9.
5:00 – Depart
6:00 – Arrive at Renfrew

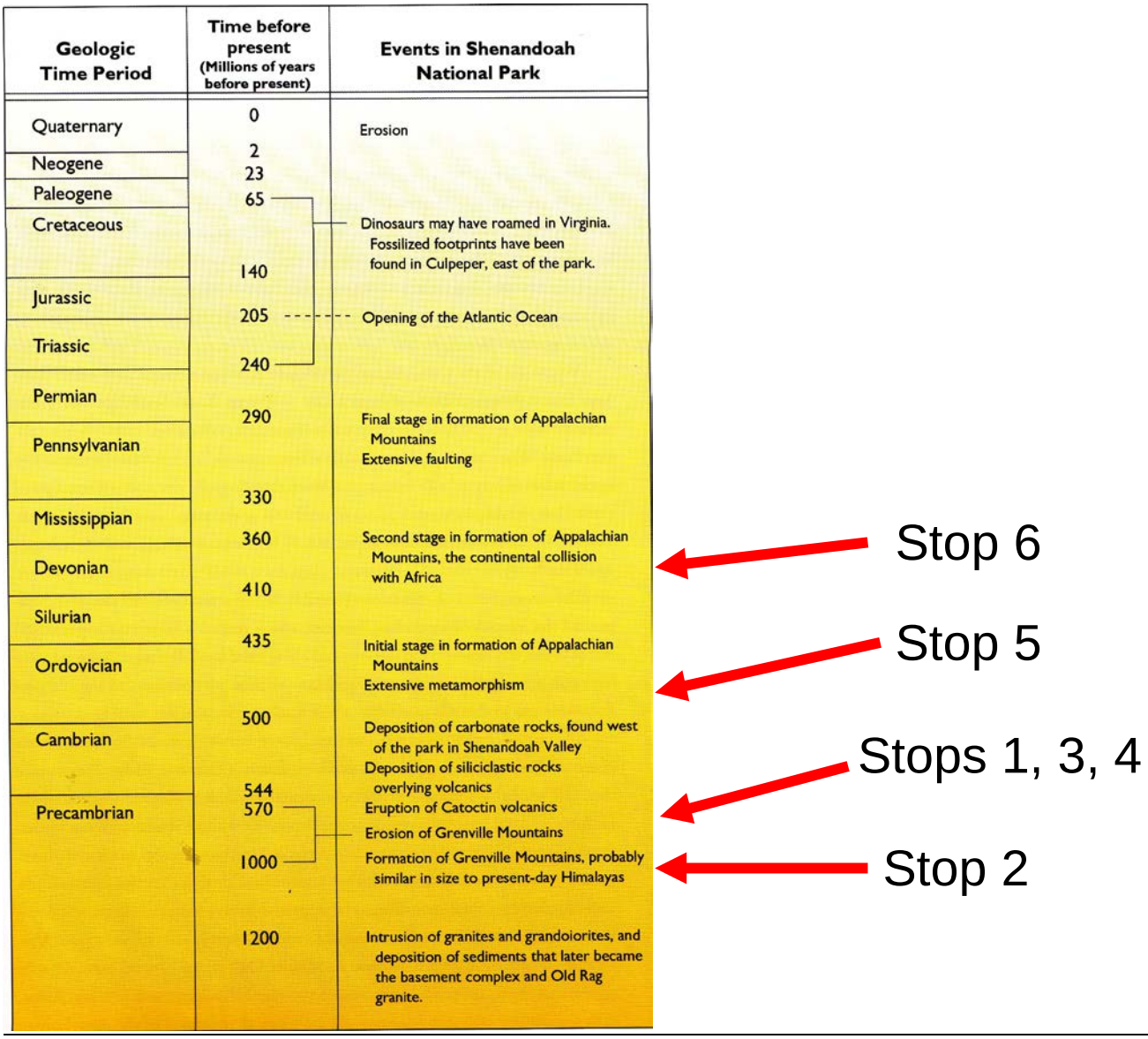


Fig. 1. Listing of Stops in Relation to the Geologic Time Scale (modified from Badger, 2012)

ACKNOWLEDEMENTS

Thanks goes to the Shenandoah National Park for granting us an educational wavier to access the Skyline Drive free of charge; Robert Badger of the University of New York at Potsdam for his correspondence on Skyline Drive sites; Otmar Dengel for allowing access to the unakite site; Daniel Gnatt, Vice President of Operations for Gnatt Excavating and Contracting Company for granting permission to collect at the Hedgesville site and Callan Bentley of Northern Virginia Community College for sharing his college class fieldtrip guides with me. Field assistants Dick Copper, Marcia Glatfelter and my wife, Lou Ann have assisted in locating potential sites for this trip. Many thanks goes to Renfrew Institute for allowing me to come back for another year of geologizing with always a great group.

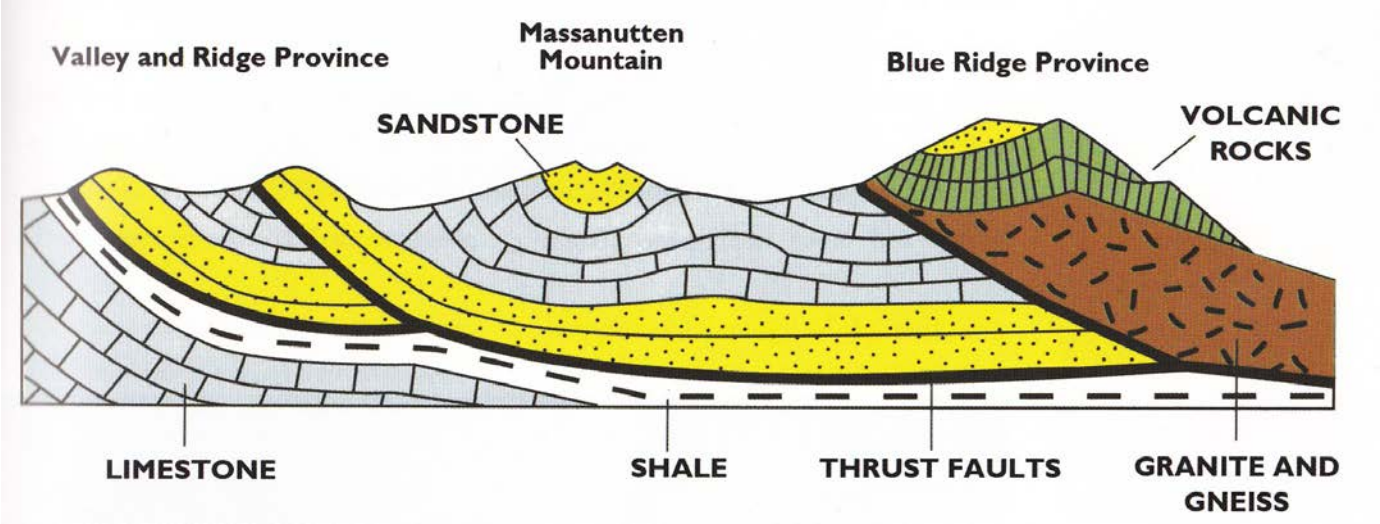


Fig. 2. Simple Geologic Cross Section Stops 1 through 4. From Badger, 2012)

STOP 1. VA ROUTE 522 CATOCTIN METABASALT

Keywords: metabaslt, metamorphism, chrysotile, epidote, joints, vesicles

Ready to go find some geology? Our first stop involves a rock that once was lava approximately 540-600 mya during the Proterozoic and Early Cambrian periods. Some of the earliest research on the dating of this rock had its age up to 820 mya but revisions of the dating techniques, overlying stratigraphy and fossils has refined the dates. The rock is now called a "meta" basalt since it was affected by heat and pressure (metamorphism) at least one time and probably twice in its history. The rock is dark-green in color due to its mineral content. Minerals such as chlorite, actinolite and epidote are present. Larger pods of epidote can occasionally be seen in this roadcut. Also veinlets and pockets of whitish chrysotile (fibrous serpentine) is frequently seen, The rock weathers to a greenish-brown color. The vertical cracks seen in the bedrock are known as joints, a structure formed as a result of movement after the lava became lava, during a mountain-building episode (known as an orogeny). You will notice how dense the rock is when struck with a hammer. Be careful of flying pieces or how close you are to someone when striking the rock. Often it is better to search out a piece of metabasalt that has already been displaced from the roadcut to crack. Make sure when collecting a sample, you get a piece exhibiting the dark green fresh color. You will also encounter in this roadcut some small quartz veins cutting through the metabasalt. Also look for small cavities in the rock. These are known as vesicles and were formed as gas escaped from the rock leaving a cavity and never filled in with mineralization. The thickness of the Catoctin Formation is 1,500-2,500 feet in this area (Rader and Biggs, 1976).

Fig. 3. Vesicles in the metabasalt on Rte. 522

If the Catoctin Formation metabasalts sound familiar, we have visited this rock closer to home on past fieldtrips. Since the metabasalts are found only in the Blue Ridge

Province, South Mountain in Pennsylvania contains a rock that looks fairly identical to the rocks here in Front Royal. Locations in Pennsylvania where we have visited this rock include Jacks Mountain tunnel, The PennDot shed on Pa. Rte. 16 near Carroll Valley and at the Specialty Granules quarry in Charmain.

Also, interestingly, its twin brother rock known as rhyolite which is found in the northern part of the Blue Ridge Province is absent in this area. Matter of fact, rhyolite is seen as far south as near Frederick, Maryland in the Blue Ridge but not any further south.

The metabasalt represents a period of rifting associated with the early opening of the Iapetus Ocean. Approximately 600 mya ago, a supercontinent known as Rodinia was breaking apart. The basalt formed as a result of oceanic rifting similar to what is occurring along the Mid-Atlantic Ridge in the Atlantic Ocean. The rhyolite reflects a period of rifting related to the continental crust being torn apart, but as indicated above, this rock is not seen in this part of the Blue Ridge province. You will see several classic outcrops of the metabasalt later at Stops 3 and 4.

Fig. 4. Asbestos pocket within the metabasalt on Rte. 522.

STOP 2. VIRGINIA RTE 649 BASEMENT ROCK EXPOSURE

Keywods: Unakite, orthoclase feldspar, , metasomatism, Rodinia, Middle Proterozoic

So you want more excitement? We move to this more remote area at the base of the Blue Ridge Mountains to allow you to collect a rather rare rock, or at least in the Pennsylvania-Maryland area it is rare. Known as basement rock, this is the oldest rock known within the Blue Ridge Mountains and one of the oldest rocks known on the East Coast. The rock varies in composition from location to location, but is generally classified as a granite, grandodiorite, granitic gneiss or in this case

for Stop 2 known as unakite. Along an abandoned road, examples of unakite can be found. Don't expect to find much outcrop of the rock as weathering has taken its toll on the unakite. The best collecting is near or in the small stream at the concrete bridge or in the bank to the east of the bridge. Also, if you are careful, walk further north on Browntown Road pass the dirt driveway on the right to a small embankment on the right. There are some pieces of the unakite exposed here.

Fig. 5. Unakite sample from near Vesuvius, Virginia (Pitts, 2010).

If you are going to collect along the abandoned roadbed in the woods, take notice to the terrain here. Look at the hillside as it drops in elevation from right to left. You can see two distinct drop-offs here. The higher portion to the right (or in the direction of where the bus is parked) is actually underlain by the Catoctin metabasalt (similar to what you saw at Stop 1). It is the lower portion of the elevation that contains the unakite (Raqder and Biggs, 1975). Weathering has taken a toll of the rock and you will have to break some pieces to find a fresh surface.

So what is unakite? First discovered in the United States in the Unakas mountains of North Carolina from which it gets its name, **unakite** is an altered granite composed of pink orthoclase feldspar, green epidote, and generally colorless quartz. It exists in various shades of green and pink and is usually mottled in appearance. A good quality unakite is considered a semiprecious stone; it will take a good polish and is often used in jewelry as beads or cabochons and other lapidary work such as eggs, spheres and animal carvings. It is also referred to as epidotized or epidote granite. In some of the Blue Ridge occurrences, an epidotized augen gneiss is present exhibiting foliation structures (http://en.wikipedia.org/wiki/Unakite).

Granite is an intrusive igneous rock. The rock formed from magma buried deep within the Earth. The magma never reached the surface, solidifying into a rock probably 4-5 miles deep. The fact that the crystals in the rock can be seen with your eye tells us that the rock cooled slowly, such as a granite. You might remember that the metabasalt contains small microscopic crystals indicating that the rock cooled faster compared to the unakite. Later chemical alteration of plagioclase feldspar by heated water or other solutions created the epidote (metasomatism).

Famous unakite sites exist further south in Augusta and Roanoke counties, Virginia have yielded fine lapidary specimens and can be seen for specimens for sale at area mineral shows or swaps. A site near Vesuvius can still be collected and yields some fine colorful specimens.

What also makes this rock important to collect is its age. The unakite is believed to be 1.1 bya and represents an ancient mountain range formed as a result of a continental collision (such as today's example of the Himalayan Mountain). This mountain range extended from Texas to Newfoundland. Some geologists believe the mountain range extended into Mexico (Badger, 2012). This rock was the crust on a part of Rodinia. Several larger exposures of the basement are visible along the Skyline Drive between miles 21-33 (Davis and others, 1958; Badger, 2012).

This basement rock is assigned to the Pedlar Formation which is assigned a Middle Proterozoic age on the geologic time scale. The Pedlar Formation appears to be diminishing out of the more recent works describing the older rocks and only being referred to as the "basement" rock.

STOP 3. SIGNAL KNOB OVERLOOK – SKYLINE DRIVE MILE 5.3

Keywords: Massanutten Mountain, Signal Knob, erosion, sandstone, conglomeratic sandstone

Welcome to the Skyline Drive, a 109-mile long stretch of roadway that runs on the top of the Blue Ridge Mountains from Front Royal to Waynesboro, Virginia. Along the way, many exposures of sedimentary, igneous and metamorphic rocks are found, which tell the story of the evolution of this famous mountain range, at least in Virginia. Should you want to learn more about the geology of the Skyline Drive, check out a publication "Geology along the Skyline Drive – A Self-Guided Tour for Motorists" written by Robert Badger (2012). The book is for sale in the gift shop at the Dickey Ridge Visitor Center (lunch stop). If you enjoy hiking and are in shape, there is an excellent 7.1-mile round trip hike on Old Rag Mountain north of Syria within the Shenandoah National Park. "A Hiker's Guide to the Geology of Old Rag Mountain" written by Paul Hackley (2006) is also available at the gift shop. Ok, now that the commercial break is over let's go and see some geology.

As a reminder, while on the Skyline Drive, we need to keep all hammers inside the bus. **Collecting of samples are not permitted within Shenandoah National Park.** In a way, that is good as the two exposures we picked out for this trip are good outcrops to look at and photograph but not for rock collecting. Anyway, you already have a sample of this rock in your possession.

Before crossing the road to examine the exposure, let us take a look at the overlook. It is hoped while writing this guidebook that Mother Nature is on our side and presents us with a great day to see the landscapes. Our elevation here is 2,085 feet above sea level (asl). From here, the next prominent ridge to the west about 8 miles away is Massanutten Mountain, located within the George Washington National Forest. The mountain bisects the Shenandoah Valley just east of Strasburg in Shenandoah County in the north, to its highest peak east of Harrisonburg in Rockingham County in the south. The geology of the Massanutten Mountains is dominated by Silurian Massanutten Sandstone, a lateral equivalent of the Tuscarora Formation in the Appalachian Mountains to the west, overlying the Ordovician Martinsburg shale. Erosion of the Martinsburg shale in some areas of the mountain caused the sandstone to break and slide to form talus slopes. The Massanutten Sandstone is folded in a synclinorium, and it outcrops at the ridge tops (http://en.wikipedia.org/wiki/Massanutten_Mountain).

At the north end of Massanutten Mountain is Signal Knob, a location of Confederate lookout and signaling post during the Civil War.

The valley between us and Massanutten Mountain and the large valley west of Massanutten Mountain belong to the Great Valley Section of the Ridge and Valley Province. This area is underlain with Early Paleozoic-aged limestone, sandstone and shale. These rocks are softer in composition, allowing weathering and erosion to be accelerated compared to the harder rocks on the ridges. To the west, further out, is the first ridge of the Appalachian Mountain Section, another member of the Ridge and Valley Province. From here the ridge is 22 miles in distance.

Fig. 6. Massahutten Mountain seen from the Signal Knob Overlook. Signal Knob is the second level of mountain from right.

Let's cross the road to observe the bedrock!. Be careful crossing the road and watch for traffic while visiting the site. This stop is dedicated to our tour participants. Up to this point you have learned about metabasalt and unakite and some other interesting tidbits of geology. Here is your time to shine. Take a look at the exposure and try to theorize what you are seeing. We love to hear theories, as that is what makes science so interesting. It is not unusual to have 10 geologists looking at the same outcrop and you get 10 different stories. We will allow you to investigate and then share your ideas. There may be prizes involved here.

PLEASE DO NOT READ ANY FURTHER UNTIL OUR DISCUSSION IS HELD.

So here is the dirt on this stop's rocks. Um, there is a hint, I used the word "rocks," meaning more than one rock type. When you walked over to the exposure and stepped onto rock, you are standing on the top of a metabasaltic flow (Catoctin). Notice at about knee level, there is a different rock appearing. This rock has a gritty feel to it and looks different when weathered. This is a shaly sandstone and notice as you look upwards through the rock, the rock contains increasingly larger rounded rock fragments. At the top of the layer, about 15-25 inches thick, there are fragments of quartzite (metamorphosed sandstone). This is called a conglomeratic sandstone. In which part of this layer of sedimentary rock was a stronger water current involved? This part of the exposure tells us that following a period of volcanism, a period where a stream flowed on top of the basaltic lava occurred, probably lasting for several hundred to perhaps several thousand years carrying the sediment.

Above the sedimentary layer, we have another metabasaltic flow (Catoctin). This layer is several tens of feet thick and would have covered several square miles of area. Within both volcanic flows look for the cavities in the rock known as vesicles (Badger, 2012). These were gas pockets that broke leaving a cavity and not yet filled in with any minerals. You saw a similar structure at Stop 1.

STOP 4. INDIAN RUN OVERLOOK – SKYLINE DRIVE MILE 10.7

Keywords: Piedmont, columnar jointing

Moving to our southern-most point on this trip along the Skyline Drive, we visit an overlook that allows you to see to the east. If weather permits, you can look southeast and east to see out past the Blue Ridge Province which is the Piedmont physiographic province. Looking east-southeast at a distance of about 23 miles is Warrenton, Virginia. The Warrenton area is underlain by sedimentary and igneous rocks belonging to the Mesozoic Era. The valley in front of you is the location of Va. Rte. 522. The white water tower in the valley to the southeast is at Flnit Hill, a distance of about 5.5 miles.

We are going to walk north from this overlook a short distance and examine the rock on the west side of the road. We brought you here because this is another (yes, another) exposure of the Catoctin Formation metabasalt. But there is a special reason to visit this site!! At this locality you can see the best example of columnar jointing found on the Skyline Drive. Yes, there are several other nicer examples of columnar jointing in Shenandoah National Park, but they are along hiking trails.

Fig. 7. Columnar jointing at the Indian Run Overlook

What is columnar jointing? It is caused by the contraction of cooling magma. Upon cooling, the surface of a lava flow gradually contracts due to a decrease in volume as the liquid changes to a solid. As the magma contracts, cracks propagate outward from regularly spaced points; the angles between cracks are also fairly regular. This process is similar to the formation of mudcracks on a baseball field as water evaporates and the mud dries. The basalt continue to crack, and grow below the surface as the magma cools and crystallizes at depth. The result is the formation of five-to-six vertical columns that extend from the top to the bottom of the flow. Most often columnar jointing occurs in thin basaltic flows. Here the columns are 6-8 inches across, but have been observed within the park as wide as 30 inches (Badger, 2012).

If the lava flow is horizontal, the cracks will be vertical in appearance. However, if the underlying surface is not flat, then the two cooling surfaces – one on top and the other on the bottom, will not be parallel and the columns may curve. Columns may also curve due to slight forward movement of the flow during cooling.

A rather famous site, Devil's Tower National Monument in Wyoming has fabulous columnar jointing. In Pennsylvania, the only example known by your leader is at the Carbaugh Run Reservoir in Michaux State Forest, southeast of Caledonia State Park.

STOP 5. VA RTE 601 ROADCUT NEAR STRASBURG

Keywords: Bedding, dip, limestone, micrite, metabentonite, fossils, contact, Taconic Orogeny

We return back to the valley for our next venture. After a short drive from Front Royal westward to Strasburg, we will spend the remainder of the day in the Great Valley Section of the Ridge and Valley Province. The valley is predominantly composed of limestone (a sedimentary rock containing mostly calcium carbonate), dolomite (a sedimentary rock containing mostly magnesium carbonate) with minor amounts of shale and sandstone. These rocks in this area are Cambrian and Ordovician in age and reflect the building of a continental shelf off of the east coast of an ancient North America known as Laurentia.

Fig. 8. A portion of the Rte. 601 limestone roadcut

This site is a classic site to study carbonate geology. Within this roadcut which measures about 900 feet long, are layer upon layer of limestone, a small amount of shale and several thin layers of metabentonite. You will be presented the chance to study the outcrop for a moment and answer these questions:

1. In which direction is the rock dipping into the surface? Rocks are generally formed on a horizontal or near-horizontal angle. If the dip is steeper than that, this tells a geologists that some form of tectonic event has occurred to cause this.
2. What is your estimate on the angle of dip? A vertical dip (90°) would be where the layers go up and down.
3. At what end of the roadcut would the oldest rocks be found? A law of superposition states that the rocks on the bottom are the oldest, ***UNLESS*** the beds have been turned upside down due to tectonic movement.

4. One last challenge. There are 3 different formations in this roadcut. These formations are all mostly limestone and can be generally divided by several small differences within the appearance of the rock. Below are several characteristics about each formation. Upon your inspection of the roadcut can you determine where one formation stops and another begins? From oldest to youngest, the formations are:

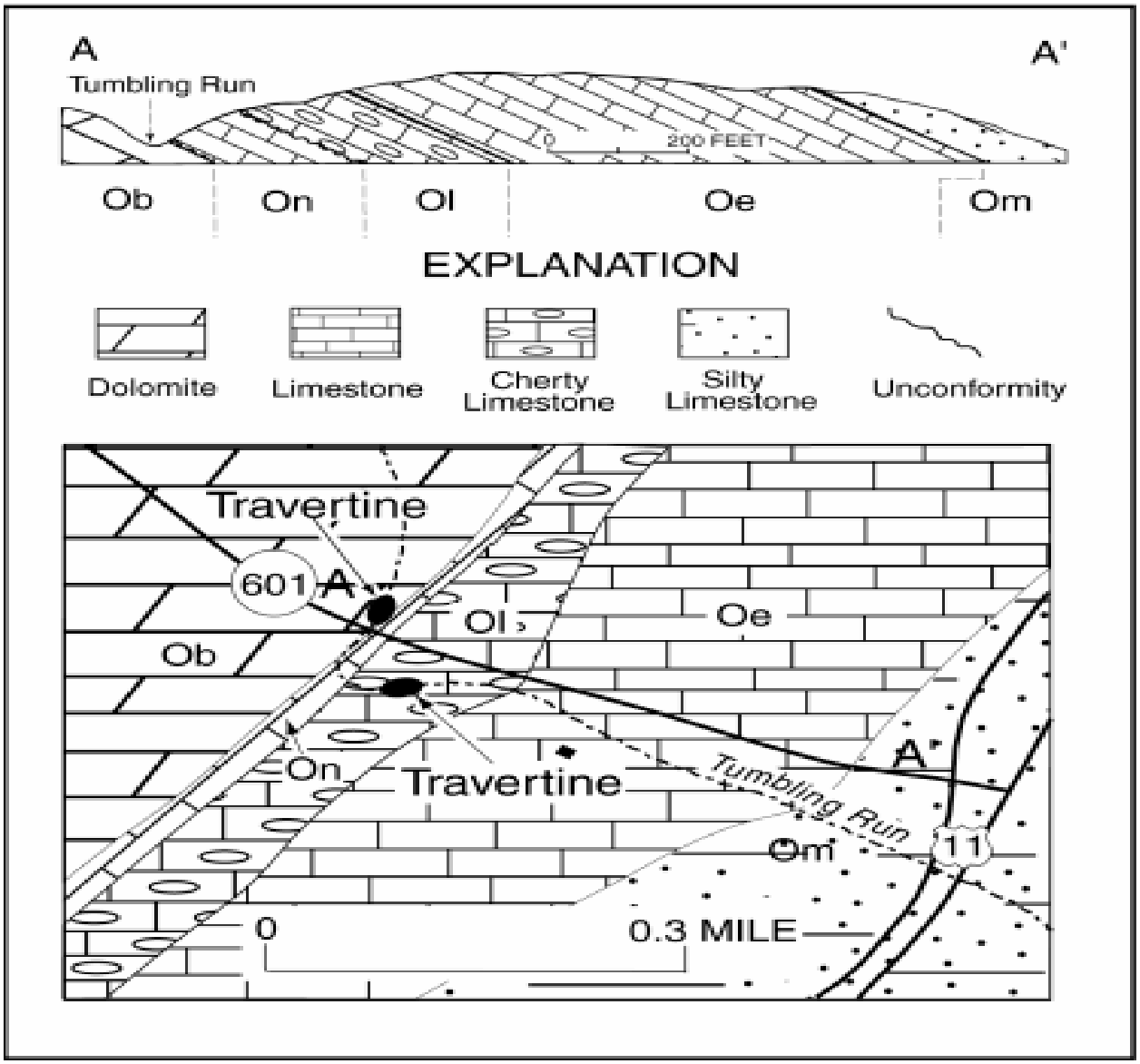


Fig. 9. Simplified Geologic Map of the Rte. 601 roadcut
Ob – Beekmantown Group – under bridge
On – New Market Formation
Ol – Lincolnshire Formation
Oe – Edinburg Formation
Om – Martinsburg Formation – not see on this tour
(from Orndorff and Harlow, Jr., 2002)

New Market Formation: Middle Ordovician in age

Composed of micrite. **Micrite** is a limestone constituent formed of calcareous particles ranging in diameter up to 4 μm formed by the recrystallization of lime mud (http://en.wikipedia.org/wiki/Micrite).
The rock is a medium gray, dense rock with medium bedding.
Thickness is about 55 feet with the base exposed in stream bed beneath the bridge.
Fossils present include bryzoan, ostracods, brachiopods and gastropods.

Lincolnshire Formation: Middle Ordovician in age

Thin-bedded dark gray limestone,
Limestone containing black chert,
Light gray cherty limestone and thin (up to 12 inches thick) layers of a buff-colored metabentonite (interpreted as volcanic ash).
Fossils include bryzoan, gastropods, ostracods, trilobite (Homotelus), brachiopods, and algae (Girvanella).
Thickness here is about 590 feet.

Edinburg Formation: Middle Ordovician in age

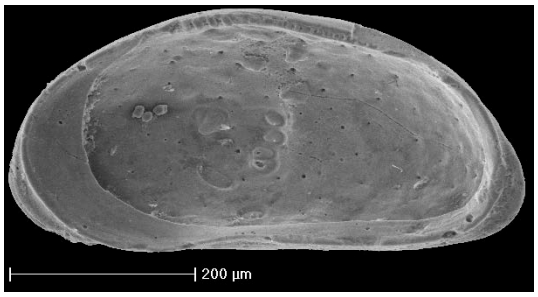
Cobbly, buff gray limestone,
Slabby to cobbly limestone,
Shaly,cobbly limestone,
Nodular to cobbly limestone,
Dense, black slabby limestone,
Chert,
Irregularly bedded medium-to coarse-grained limestone.
Fossils include cystoid (Echinosphaerites), algae and brachiopods.
Thickness is about 630 feet (Cooper and Cooper, 1946; Edmundson, 1945; Rader and Biggs, 1976).

Your guide will place yellow tape at the contact between the New Market/Lincolnshire formation contact and the Lincolnshire/Edinburg formation contact.

The best fossil collecting in your leader's opinion is south of a dry wash filled with limestone about two-thirds of the way south. Several loose rocks with chalky weathering exhibits some darker impressions of fossils.

Girvanella algae

Echinosphaerite



Ostracod


Homotelus trilobite

A little more detail can be told from these rocks. The New Market and Lincolnshire formations were deposited on a continental shelf during a rather quiet time off of the coast of Laurentia in the Iapetus Ocean. This continental shelf became well established by the Middle Ordovician Period. Shortly after the deposition of the Lincolnshire material, a mountain-building event known as the Taconic Orogeny was beginning to occur as a chain of volcanic islands were colliding along the East Coast. The orogeny is so named as the Taconic Mountains in New England were uplifted during this time. The Edinburg Formation exhibits some chemistry in the rock that tells us that the ocean was becoming muddy and more fine-to medium sized sediment was being introduced onto the continental shelf. The overlying Martinsburg Formation, which we don't see here, formed from sediment that was being deposited within a subduction zone related to the volcanic islands.

STOP 6. GANTT'S EXCAVATION AND CONTRACTING QUARRY HEDGESVILLE, WEST VIRGINIA

Keywords: Shale, Middle Devonian, brachiopods, pelecypods, bryozoan, crinoid, trilobite

Last stop of the day is your chance to find some fossils within the most fossiliferous rock unit in the Mid-Atlantic region. Known as the Mahantango Formation of Late Devonian age, this shale, limestone and sandstone unit contains marine fossils of animals that once lived in a shallow portion of the Iapetus Ocean. The waters were somewhat warm, tropical muddy waters. During this time, our continent was located in the area of today's Caribbean Ocean. Life was flourishing in the sea as nearly all forms of the animal kingdom were alive and well. Animals such as bryzoan, brachiopods, pelecypods, crinoids, coral and trilobites were present. Good sites in Pennsylvania from the Mahantango Formation can be found in Perry, Northumberland and Schulykill counties.


Fig 9. Pelecypods found at the Gnatt property.

The entire property is underlain by the Mahantango Formation, a rock unit consisting of brown-to-olive-to-gray laminated shale, siltstone and fine-grained sandstone. The Mahantango Formation is named from the North Branch of Mahantango Creek in Perry and Juniata Counties, Pennsylvania.

This formation is Middle Devonian in age (392-385 million years mya and is found throughout the Ridge and Valley Province, Appalachian Mountain Section from Virginia northward. The Mahantango Formation is a member of the Hamilton Group, composed a group of shale units, depending upon location ranges in thickness of 970 feet in Pennsylvania.

The Mahantango Formation conformable underlies the Marcellus Shale throughout the region.

The Mahantango represents a terrestrial to marine transition zone that went through many transgressive-regression sequences. The fine-grained rocks represent a shallow sea environment and accounts for many of the fossils. Coarser grained sediments represent near-shore environments, beaches, or possibly delta lobes. These environments were tide-dominated and often had violent storms. The Montebello Sandstone member is an example of a storm dominated rock unit. Brachiopod fossils are scattered in massive sandstone beds throughout the rock unit, while the Sherman Ridge member is more laminated with fossilized ripple marks often indicating tidal current directions (Prave and Duke, 1996).

Approximately 75 feet of the Mahantango Formation is exposed at the Gnatt Excavation, The majority of the rock exposed is the shale and siltstones. The ridge-former sandstone is mostly concealed by overburden. All of the rock dips uniformly 23- 27° to the southeast (Fig. 3). There is no rapid change of dip angle or direction to indicate any faulting or major folding within the excavation. However, Dean and others (1987) showed dips as high as vertical on the north side of State Rte. 9 near the U.S. Post Office. This may suggest the presence of a fault near the roadway.

Fig. 10. Brachiopod from the Gnatt operation.

All of the shale and siltstones weather to a reddish-brown color. The shale is friable, breaking about quickly upon weathering. The siltstone is slightly more resistant to the elements. Alternating layers of shale and siltstone are found on Tier 2. The presence of the siltstone creates small vertical ledges in this area (Fig. 4). Much of the rocks exposed in the vertical faces on Tier 4 are also siltstone (Fig. 5). Bedding thickness ranges from 0.25 – 1.5 inches thick with the average at 1 inch (Jones, 2015).

Fig 11. Mudcracks in shale from the Gantt operation.

Although we have included some pictures here of some of the most common fossils from this rock unit, go to http://viewsofthemahantango.blogspot.com/p/mahantango-formation-fossils.html for more pictures and identification of your specimens.

Athyris Brachiopod

LIngula Brachiopods

Large Spiriferids Brachiopods

Cyclonema Cephalopod

Nuculites Pelecypod

Pleurodictyum Coral

Fenestella Bryozoan

Phacops trilobite
(PA State Fossil)

Greenops trilobite

PUTTING IT ALL TOGETHER

So, you have survived a trip of geologizing, collecting and having fun (well, at least we hope you did). Now you can go home and unpack your finds and try to remember what specimen belongs to what stop. In a way it is easy. No collecting was done on the Skyline Drive so that eliminates Stops 3 and 4. So the only location with metabasalt (the green rock) was Stop 1. The colorful rock (if you found a fresh piece of unakite) goes with Stop 2. The

limestone maybe with fossils and/or chert goes with Stop 5 and the shale with fossils is Stop 6. Now that wasn't so hard, was it?

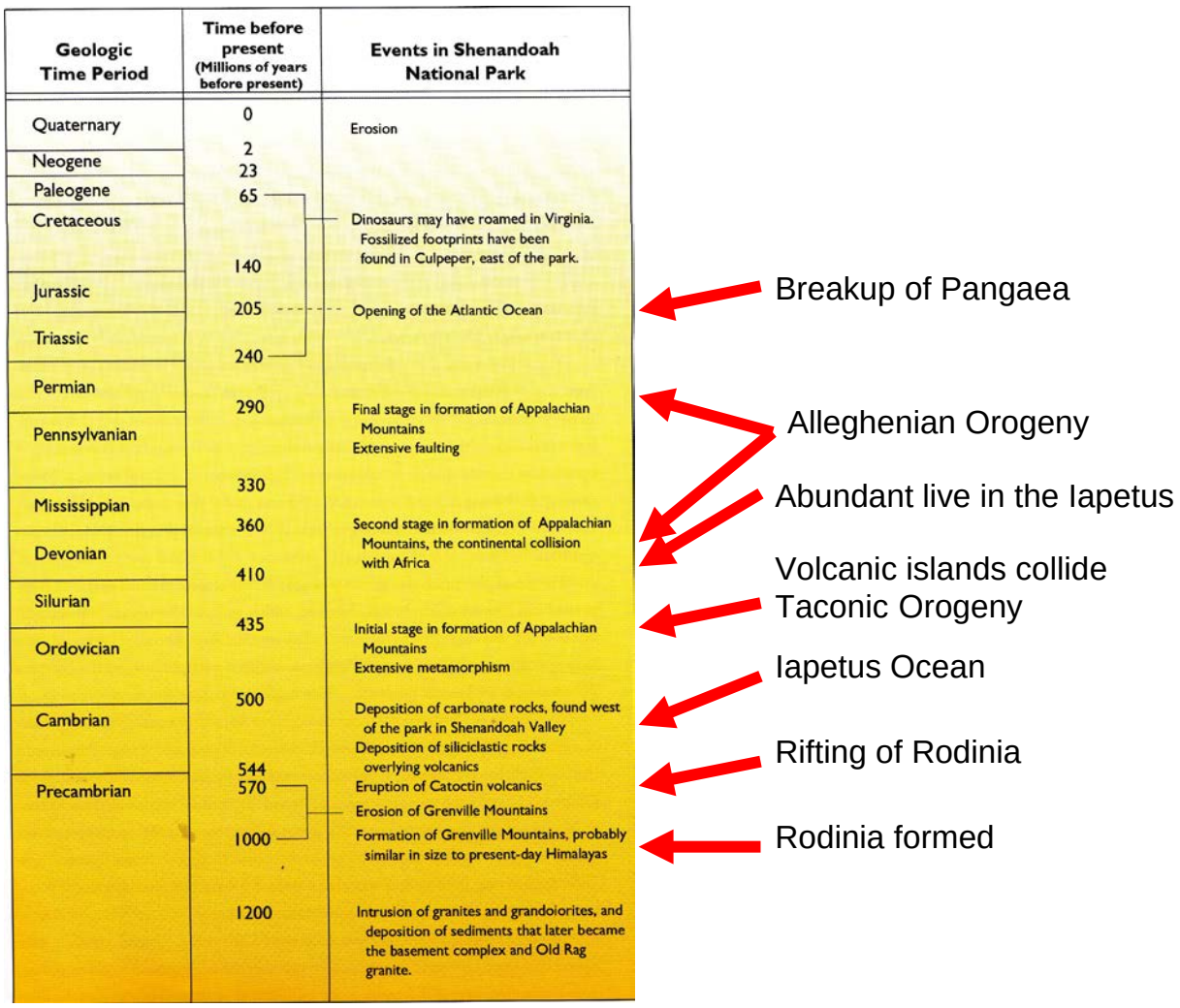


Fig. 12. Major Geologic Events in the Area (modified from Badger, 2012)

We ventured back into time to a period of time when a supercontinent known as Rodinia existed. Our unakite represented 1.1 bya rock that composed some of the crust of that ancient landmass. We also collected metabasalt that originally was formed during the rifting apart of Rodinia approximately 540-600 mya. That rock was later changed (metamorphosed) by hydrothermal action altering the mineral composition during the collision of volcanic islands with our East Coast (Taconic Orogeny) and later the coming together of Africa and ancient North America to form Pangaea (Alleghenian Orogeny). Our limestone stop was dedicated to the building of a continental shelf in the Iapetus Ocean off the east coast of Laurentia (ancient North America before Pangaea broke apart) . We also saw just briefly in the youngest limestone unit the start of unrest of the Taconic Orogeny. Finally, in Hedgesville, we collected evidence of animals that lived in the Iapetus Ocean when marine life was at its peak and before a future extinction period existed. That is a pretty nice story to tell about our past, but like a sequel to a movie, there is a lot more to tell on another trip!!

REFERENCES

Badger, R.L., 2012. Geology along the Skyline Drive, Shenandoah National Park, Virginia. Shenandoah National Park Association.

Cooper, B. N., and Cooper, G. A., 1946, Lower Middle Ordovician stratigraphy of the Shenandoah Valley, Virginia: Geol. Soc. America Bull., vol. 57, no. 1, p. 35-113.

Davis, G. L., and others, 1958, Ages of rocks and minerals: Carnegie Inst. Washington Year Book 57, p. 1?6-181.

Dean, S.L., Kulander, B.R., and Lessing, P., 1987. Geology of the Hedgesville, Keedysville, Martinsburg, Shepherdstown and Williamsport Quadrangles, Berkeley and Jefferson Counties, WV. WV Geological Survey, Map WV -31.

Edmundson, R. S., 1945. Industrial Limestone and Dolomite in Virginia: Northern and Central Parts of the Shenandoah Valley, Virginia. Va. Geol. Survey, Bull 65.

Hackley, P., 2006. A Hiker's Guide to the Geology of Old Rag Mountain in Shenandoah National Park, Virginia. Shenandoah National Park Association.

Jones, J.L., 2015 Geology of the Gnatt Exvacating and Contracting Company Quarry, Hedgesville, Berkeley County, West Virginia. In-house publication.

Orndorff, R.C., and Harlow, Jr., G.E., 2002. Hydrogeologic Framework of the Northern Shenandoah Valley Carbonate Aquifer System. U.S. Geologic Survey Karst Interest Group Proceediungs, Shepherdstowwn, WV.

Pitts, A., 2010. Not Necessarily Geology. https://notnecessarilygeology.wordpress.com/2010/05/23/unakite/

Prave, A.R., Duke, W.L., Slattery, W. (1996). A depositional model for storm- and tide-dominated prograding siliciclastic shorelines from the Middle Devonian of the central Appalachian foreland basin, USA. Sedimentology, 43, 611-629.

Rader, E.K., and Biggs, T. H., 1965. Geology of the Front Royal Quadrangle, Virginia. Va. Geol. Survey, Rept. Investigations 40.

_____, 1976. Geology of the Strasburg and Toms Brook Quadrangles, Virginia. Va. Geol. Survey Rept. Investigations 65.

Views of the Mahantango, 2014. http://viewsofthemahantango.blogspot.com/p/mahantango-formation-fossils.html

Wikipedia, 2013. Micrite. http://en.wikipedia.org/wiki/Micrite.