INTRODUCTION

Welcome to the 2014 edition of Renfrew Rocks geology series. These trips over the years have been so energizing to your leader and associates. This year's trip carries slightly a different twist than the last several trips. After seeing the evaluations from the 2013 trip, it seems that participants wanted to do some mineral collecting. So, today we offer you the unique experience to visit three different quarries, each having its own personality and offering you the opportunity to find different mineral and fossil specimens. Of course, we need to also talk about the geology at each quarry, since that is important to what specimens you might find. One of these stops will include a newly described geologic site that you will not want to miss.

Interjected between quarry visits, we will make two stops in the Gettysburg National Military Park to give you a glimpse of how geology played a major role in the most important battle of the Civil War. While here, we will show you an attraction that is little known to park visitors, but you will find interesting. O yes, the most important stop of the day, lunch, will be on the battlefield.

Our final stop will take us to our most-western location near Kauffman, south of Chambersburg. Here, we will collect fossils representing sea creatures that lived here some 470 million years ago. What a way to end a day!!!

ACKNOWLEDGEMENTS

No fieldtrip is possible without sponsors. We want to thank Marge Kiersz, Lucinda D. Potter, CPA, and the Franklin County Rock and Mineral Club for their sponsorship of this program. A great way to become involved in "rockhounding" is by joining a club where you are surrounded by people with the same interests. Randy Van Scyoc, the cooperating quarry managers and Valley Quarries deserve a HUGE thank you for allowing us to visit their three quarries in the area. Valley Quarries has always been supportive of geologic education and we certainly appreciate their time and support to make this trip a reality. Last but not least is our mode of transportation, Baer's Bus Service of Waynesboro who has supported this geologic trip for many years and *never* got lost.

ABOUT THE LEADER

Jeri Jones, a native of York attended Catawba College in North Carolina and earned his degree in Geoarchaeology. Jeri owns Jones Geological Services where he studies the geology of southeastern Pennsylvania. In his 34 years of research Jeri leads groups on field trips and acts as a consultant to several area quarries. He conducts classes on a regular basis for the OLLI program at Penn State-York. He is also a member of the faculty at Messiah College in Grantham, PA. Jeri loves to educate others about the earth and space sciences. He received the Digman Award for Geologic Excellence from the Eastern

Chapter of the National Association of Geoscience Teachers. His interests include the mining history, local geologic history, groundwater resources and southeastern Pennsylvania earthquakes. He has authored four books, narrated a geologic education video series and written numerous articles. He also serves as clay consultant for Lincoln Speedway in Abbottstown, PA. He has been married to his loving wife for 25 years, Rev. Lou Ann and they reside near Spring Grove, PA.

SCHEDULE

8:30 am	Depart Renfrew Institute
9:00 am	Stop 1. Fairfield Quarry. Geologic Overview and Collecting
10:00 am	Depart
10:35 am	Stop 2. Gettysburg Plant. Geologic Overview and Collecting
11:35 am	Depart
11:55 am	Lunch Stop
12:30 pm	Depart
12:35 pm	Stop 3. Plum Road Bridge
12:50 pm	Depart
12:55 pm	Stop 4. Little Round Top
1:40 pm	Depart
2:10 pm	Stop 5. Cydonia Sand. Geologic Overview and Collecting
3:00 pm	Depart
3:30 pm	Stop 6. Kaufman Fossil Site. Geologic Overview and Collecting
4:30 pm	Depart

TOPOGRAPHY AND GENERAL GEOLOGY

One doesn't have to look very far around the landscape to see a change in elevation. Geographers and geologists have divided regions into what are called physiographic provinces. The characteristics that separate these provinces include type of terrain (valley, mountainous, hilly, etc.), rock types, vegetation and drainage. Our travels today will take us into Franklin and Adams counties and involves two physiographic provinces: the Piedmont and Ridge and Valley.

1. **Ridge and Valley Province:** Better known as the Appalachian Mountains, the terrain here is represented by alternating ridges and valleys. We will be visiting two sections:

   a. The South Mountain Section (SMS) lies along the northern and western edge of Adams County and Franklin County and is locally known as "South Mountain." Popular recreational areas within this section include Caledonia State Park and Michaux State Forest. Elevations range from 800-1,000 feet in the valleys and 1,400 - 2,100 feet on the ridges. Rocks within the SMS are Proterozoic to Lower Cambrian in age. The oldest rocks are volcanic in origin

and the younger rocks are composed of sandstone, quartzite, conglomerate and phyllite. Environments: Supercontinent rifting and early building of continental shelf.

b. Great Valley Section: (GVS) More commonly known as the Cumberland Valley and the Shenandoah Valley, Interstate 81 passes traverses this section. Elevations range from 400-700 feet above sea level with the higher elevations on the western side. Rocks include limestone, dolomite, sandstone and shale ranging from Cambrian to Ordovician age. Environment: marine

2. Piedmont Province: Occupies the remaining portion of Adams County and is composed of rolling terrain with scattered valleys. The Piedmont can be subdivided into three sections within Adams County:

a. Gettysburg-Newark Lowland Section (GNLS): Occupies the area between South Mountain and the southeastern corner of the county. Elevations average about 600 feet above sea level and in some areas, streams have cut downward into valleys 100-150 feet. Scattered hills ranging in elevation from 900 to 1,100 feet can be found, including foothills to South Mountain in the northwestern section of the county. Rocks include sandstone, shale, siltstone, conglomerate, limestone conglomerate and diabase. The sedimentary rocks are Late Triassic in age. Diabase is regarded as Jurassic in age. Environments: lakes, streams, swamps and playa and Pangean rifting.

b. Lowland Section (PLS): Elevations generally 400-600 feet above sea level characterized by a broad valley with isolated rolling and small rounded hills. Pigeon Hills marks the northern boundary of the PLS in this area with a maximum elevation of 1024 feet above sea level. Rocks include limestone, shale and sandstone ranging from Cambrian to Ordovician in age. Environment: early continental shelf

c. Upland Section (PUS): Characterized by terrain averaging in elevation of about 700-800 feet. The terrain is composed of rolling hills. Pigeon Hills , an isolated highland marks the northern boundary of the PLS in this area with a maximum elevation of 1024 feet above sea level. Rocks include volcanic rocks, quartzite, phyllite, sand schist. Age range is Proterozoic to Ordovician? Environment: marine and oceanic rifting.

With the exception of the GNLS area, the other rocks have been through one or two phases of continental rifting and several episodes of crustal collisions. The larger fold in the area is in the SMS. The SMS has been pushed up into an arch shaped fold (anticline) with numerous synclines and anticlines within the large fold. Folding and faulting is also located within the GV, PLS and PUS. The GNLS section rocks are relatively undeformed and consistently dip at a gentle angle to the north or northwest. The “Border Fault” is believed to occur between the GNLS and SMS. The Carbaugh-March Creek Fault runs through SMS at Caledonia State Park and is a major structure in the area. The fault has offset the SMS by about 3 miles to the west north of U.S. Rte. 30.

STOP 1. VALLEY QUARRIES – FAIRFIELD PLANT

The best current description of the quarry was just released at the March, 2014 Geological Society of America Northeastern Section Meeting held in Lancaster, PA. The below abstract and subsequent paper was presented at that meeting.

Northeastern Section - 49th Annual Meeting (23–25 March)

Paper No. 50-5

REPTILE TRACKWAYS PROVIDE A TRIASSIC DATE FOR ENIGMATIC ROCKS AT VALLEY QUARRIES FAIRFIELD OPERATION, PENNSYLVANIA

WEEMS, Robert E.[1], **VAN SCYOC, Randy**[2], GANIS, G. Robert[3], and BENDER, Brad[2], (1) U.S. Geological Survey, Mail Stop 926A, Reston, VA 20192, (2) Valley Quarries, 297 Quarry Road, Chambersburg, PA 17202, RVanScyoc@valleyquarries.com, (3) Consultant, Southern Pines, NC 28387

The age and origin of structurally isolated, metamorphosed carbonate rocks quarried by Valley Quarries near Fairfield, Pennsylvania has long been in doubt. The sequence consists of alternating stacks of massive, clast-supported carbonate conglomerate (lacking Blue Ridge volcanic or cover rocks) and thin, well-bedded, finer-grained carbonate laminites. Typical Triassic border fanglomerates in the Gettysburg Basin contain both Blue Ridge Proterozoic siliciclastic clasts and Paleozoic carbonate clasts derived from the west, so the rocks in the Fairfield quarry have an atypical depositional origin. A playa environment, *sensu lato*, is indicated by mudcracked bedding planes and footprints found on shaley bedding surfaces. The conglomerate units originated as episodic alluvial fan debris covering shallow lacustrine lakes and fringe areas. The lack of westerly derived Blue Ridge clasts and a similarity of the carbonate clasts to lower- middle Paleozoic units (Vintage, Kinzers, Ledger, and Conestoga Formations) in the York valley to the east suggest an easterly source. Frederick valley carbonates to the southeast (Frederick and Grove formations) also are a possible source area. The rocks quarried near Fairfield are intruded by basal Jurassic diabase dikes and also located near one or more large sills, both of which are part of the Central Atlantic Magmatic Province (CAMP). These intrusive rocks have thermally metamorphosed their surrounding rocks pervasively. This local thermal overprint on the conglomerate clasts masks regional metamorphic effects seen in their parent lithologies.

Until recently, no fossils were known from these rocks. Several of the carbonate laminite horizons are now known to have reptile footprints that include two kinds of small dinosaur (including *Grallator tuberosus*), two kinds of aetosaur (including *Brachychirotherium parvum*), the small lizard-like *Rhynchosauroides*, and parasuchian (phytosaur) swimming scrapes. This assemblage provides definitive evidence that this rock sequence is no older than late Ladinian (latest Middle Triassic) and no younger than Rhaetian (latest Late Triassic). Based on the presence of cyclic lake beds, the rocks quarried at Fairfield most likely are an isolated part of the Upper Triassic (uppermost Carnian to Norian) Gettysburg Formation.

Side Note: The original discovery of a foot track from Fairfield occurred in June, 2012 by a member of the Franklin County Rock and Mineral Club, who were on a collecting trip. In August, 2012, the club contacted Jones Geological Services to identify the specimen. I identified the track as a Grallator. The club returned for another field trip in October of the same year, which I was invited to attend. Within moments of arrival of the collectors, another specimen of a Grallator was found in the same area as the June find. Jones Geological Services preliminarily determined one layer of trackways. The in situ trackway was discovered in early 2013 by the quarry.

Much of the rock found here is termed a limestone conglomerate. A conglomerate is a clastic sedimentary rock, meaning that the rock is composed of sediment derived from pre-existing rocks. The matrix of the rock is a limestone, meaning it is composed of at least 50% calcium carbonate. The sub-angular to rounded fragments in the rock are mainly composed of limestone. The size of the clasts range from 0.5 inch to 11 inches. The rock is termed poorly sorted since a wide range of clast size can be found. Exactly where these limestone clasts came from is still a puzzle, although from the 2014 abstract above, they believe that the source area was wither to the east or southeast.

As indicated in the abstract, the finding of the trackway was a significant one. The age of these rocks have been debated for years. Stose and Bascom (1929) recognized the limestone conglomerate and placed it within the Triassic period since the surrounding rock was of that age. Kochanov and Faill (2008) proposed an Ordovician age for the limestone conglomerate based on their mapping and possible correlation with limestone found in the Great Valley to the west. The trackway find has now pegged a Triassic date on these rocks.

Minerals: With the several diabase intrusions observed in the quarry and a larger diabase intrusion to the north and east of here, the rocks within the quarry have been put under a low-grade thermal metamorphism. Around many of the limestone clasts within the conglomerate, a rim of chlorite (green) can be observed, a product of low heat. The interaction of the thermal metamorphism has created some interesting minerals within both this quarry and the older, water-filled excavation of the north side of Bull Frog Valley Road. Diopside, andradite garnet and pyrite are primary minerals formed by the heat.

Lapham and Geyer (1969) identified the following: apophyllite, calcite, chalcopyrite and garnet. Local micro-mineral collector Larry Eisenberger of Hanover, PA has identified the following mineral species: laumontite, heulandite, stilbite, chabazite, garnet, wollastonite, vesuvianite, pyrrhotite, wurtzite, chlorite, diopside, tremolite, quartz, opal, marcasite?, goethite, galena and gypsum var. selenite (personal communication).

STOP 2. VALLEY QUARRIES – GETTYSBURG PLANT

Although the Fairfield and Gettysburg plants are only separated by 10 miles, this quarry presents a much different picture of what the Mesozoic looked like. Here the bottom of a large diabase sheet (sill) can be observed in the upper north wall of the quarry. Diabase originated as magma during the early Jurassic. The rest of the quarry is composed of hornfels, originally sedimentary rock that was intensely heated by the magma. It is believed that the magma reached temperatures of ~1100° C (Faill, 2008). You can still observe original bedding in the walls. The lighter, tan-colored rocks were carbonate-rich layers within this sequence. Other than the diabase, the hornfels belong to the lower part of the Gettysburg Formation. Geologists can interpret the history of these rocks as each layer tells a story about the environments during the Late Triassic Period. Rhythmic periods of lake-stream-playa are seen in these rocks as well as other unaltered rock exposures in the area.

Actually the quarry was opened by John S. Teeter & Sons, Inc. in 1926. Several changes of ownership occurred until 1959 when Harry T. Campbell Sons Corp. purchased the property. Valley Quarries purchased the property in 1983. Among other uses, the hornfels is used in paving projects requiring a more resistant wearing aggregate, among other uses.

This quarry has been a hot-bed for mineral collectors since the 1950's. During my early years in the 1970's, museum-quality specimens of stilbite and natrolite were collected from the crevices in the hornfels. In 1977, a quarry blast exposed a large copper-sulfide deposit along the western wall. Attractive specimens of epidote and garnet and chysocolla were gathered by rockhounders and geologists. Hoff (1978) published a classic report on the mineralogy of this locality. A later report was published by Jones and Eisenberger (2006) who reported the following mineral species:

actinolite	andradite-grossular garnet	diopside	tourmaline
tremolite	apatite	bornite	chalcopyrite
chlorite	copper	djurleite	epidote
albite	orthoclase	hematite	magnetite
muscovite	pyrite	quartz	rutile
titanite	calcite	chabazite	heulandite
laumontite	natrolite	stilbite	stilpnomelane
chalcanthite	chrysocolla	cuprite	diotase
goethite	gypsum	malachite	montmorillonite
opal	pyrolusite		

STOP 3. PLUM RUN BRIDGE, GETTYSBURG NATIONAL MILITARY PARK

This small brownstone bridge constructed in the 1930's with thousands of visitors crossing it every year holds some geologic treasurers that most people do not realize. Located here within what is called "Devil's Kitchen." Plum Run flows between Little Round Top and Devil's Den, a mile upstream to the north. It is said that its waters ran red with the heavy casualties late on July 2nd and is nick-named "Bloody Run."

These sandstone and siltstone blocks making up the bridge were quarried from Trostle Quarry located along the Bermudian Creek south of York Springs, Adams County. The rock belongs to the Heidelsburg Member in the middle of the Gettysburg Formation and is about 210 Ma (mid-Late Triassic in age).

Dinosaur footprints are visible on selected top blocks of the bridge. Several of the footprints are obvious, but varying weather and lighting conditions can cause the appearance of some of the other tracks be difficult to see. Also, based on the variability of the feet interacting with differences in the sediment surface, firmness, and later processes can make identification of the tracks complicated.

Roger Cuffey (2008) constructed a detailed map of the bridge showing the location of the rock slabs containing foot tracks and species. The following species have been identified by Santucci and Hunt (1995) and Cuffey (2008):

Anchisauripus sillimani	Grallator tenuis
Atreipus milfordensis	Otozum minus

These dinosaurs are relatively small and some of the first species appeared in the Mesozoic Era (Age of the Dinosaurs). Because of the lack of skeletal material being found, an artist conception of what these animals looked like is solely based on the footprints. What species of dinosaur(s) are found between the Fairfield Quarry and Trostle Quarry?

Upon inspecting the other top-cap rocks you will see mud cracks, ripple marks and flute markings within the sediment. Mud cracks tell the part of the story when these sediments were exposed to the atmosphere and the drying of sediment took place. Ripple marks are formed in a channel of a stream or river and flute markings reflect the scouring of the bottom sand by rock fragments in a low-to-moderate energetic water current.

Trostle Quarry, long abandoned is cut into a hillside on the south side of the Bermudian Creek and just east of Latimore Valley Road. In 1996, Dr. Cuffey and your leader visited the quarry and found a foot track which was poorly preserved with no species assigned to it.

STOP 4. LITTLE ROUND TOP, GETTYSBURG

This site was chosen on the battlefield because the panoramic view from here allows us to present a brief summary of how the geology of the Gettysburg area played a role in the greatest battle fought on North American soil. What other battlefield contains so many famous locations. Names like Devil's Den, Little Round Top, High Water Mark and Pickett's Charge are commonly related to this battlefield.

As you have seen from our first 3 stops today, the rocks within the Gettysburg-Newark Lowlands Section contain igneous rock known as York Haven diabase and sedimentary rocks of the Gettysburg Formation such as limestone conglomerate, sandstone, siltstone and shale. Where the magma intruded up through the Gettysburg Formation, the heat and chemical reaction between these rocks created a metamorphic rock known as hornfels (Stop 2).

On the battlefield, because of its resistivity to weathering and erosion, higher elevations are underlain with diabase. These include Seminary-Warfield Ridge, Cemetery Ridge, Culp's Hill, Devil's Den, Little Round Top and Big Round Top. The lower elevations, for example in the middle of Pickett's Charge, are underlain by the softer sedimentary rocks. A transitional slope between these two rocks is composed of the hornfels. The Peach Orchard is one example of the hornfels. Where the Confederates made that famous "march" across Picketts Charge, hornfels underlies the area between Emmittsburg Pike and the High Water Mark. With Pickett's Charge, the Confederates started on a diabase ridge, walked down over hornfels and into the valley containing shale and sandstone and then back up in elevation across hornfels and onto diabase, where they were met by the Union line. The difference in elevation was 60 feet which doesn't sound like much change, but when you are marching and carrying artillery, it was a difficult task.

As you will read in the accompanying article written by Inners and Fleeger (2008) on the history and geology of Little Round Top, ridges of diabase were the preferred locations to "set up shop." Higher elevations allowed you a good vantage point and could control the strategies of both sides.

However, where there is diabase, there is very little soil. The slow weathering of diabase produces a yellowish clay soil, but soil production is slow. A common method of warfare protection is to trench into the soil. At Gettysburg that is nearly impossible. Only hiding behind the dense, rounded diabase boulders was the best way of protection. To add additional protection, such as here at Little Round Top, stone walls composed of diabase were quickly erected. Most of the rock walls on Little Round Top were constructed by the soldiers. Other stone walls on the battlefield were built by farmers as they removed these rocks off of their cultivated fields were used as property lines.

If you visit Devil's Den sometime, look for potholes in the diabase which mark percussion impacts from cannonballs. A number of diabase boulders took heavy hits during the battle.

STOP 5. VALLEY QUARRIES – CYDONIA SAND 1 PLANT

We have moved further west and in the ride from Gettysburg to Mount Cydonia, we have traveled about 340 million years back into time. You didn't know that Baer Transportation was actually a time machine!! To your leader this is one of the most scenic quarries he ever visited. On top of the mountain looking north you see the mountains of the Blue Ridge and lots of rock exposures. What more can anyone ask for?

The rocks exposed here are quartzites belonging to the Antietam Formation. Quartzite is a metamorphic rock that was originally sandstone. Subsequent heat and pressure from mountain building episodes kept the mineralogy of the sandstone the same but fused the quartz grains together, giving the rock a coarser-grained appearance. The quartzite here is a medium grained, white-to-light-gray color. The rock weathers to a yellowish, tan or light red color. Notice how friable the rock becomes upon weathering. The quartzites weather back into its original state, sand. Seams of clay are found within some of the quartzites. The beds are 6 to 12 inches in thickness. *Skolithos linearis*, a trace fossil, is found in some of the beds. It is believed *Skolithos* tubes were made from burrowing sea worms that resided in very shallow water, thus indicating that the Antietam Formation suggests a near-beach deposit. Notice that *Skolithos* run perpendicular to the layering of the rock, assisting geologists in determining the direction of bedding. Some tubes could cross nearly the entire thickness of a layer.

What makes *Skolithos linearis* important is, it is not only one of the oldest fossils found in the fossil rock, but geologists can place a relative date on the rock containing the fossils. *Skolithos* lived during the Lower Cambrian period, about 540 million years ago). *Skolithos* is considered an index fossil. Any rock anywhere in the world where you find a *Skolithos* places the age of the rock as Lower Cambrian. Thus, any rock strata found beneath the Antietam Formation is older and overlying rocks would be younger. This is the law of superposition using relative dating.

Ok, since you have kept up with the concept of relative dating, let's add another element into this discussion. As mentioned in the introduction on the topography and geology in this booklet, SMS is pushed up and now an eroded anticline containing numerous folds within the larger anticline (officially known as an anticlinorium). Now, if you picture this arch-shaped fold and continue to apply pressure from one side of the anticlinoriium, the sides of the fold will continue to push over vertical and actually become parallel with each other. The fold is now termed overturned. In the case of the SMS, the fold is pushed over vertical to the northwest (pressures came from the southeast to make this happen). Since we are on the western side of the gigantic overturned fold, the rocks here are actually flipped upside down. The youngest rocks are on the bottom and oldest on top.

The Antietam Formation is named from its good exposures along Antietam Creek in Washington County, Maryland, very close to where this trip stopped last year to do some panning for gold (Cloos, 1951).

The Antietam Formation in this area was first mapped by legendary Federal geologist George Stose. He determined the thickness of the Antietam Formation in Adams

County as being 800 feet (Stose, 1932). Fauth (1968) revised the thickness to 700-900 feet depending where in SMS you may be.

Berkheiser (1985) ranked the Antietam Formation quartzites at Mount Cydonia as the purest sedimentary unit investigated in that study of high-purity silica occurrences in the Keystone state.

STOP 6. KAUFFMAN RAILROAD CUT FOSSIL SITE

There always seems to be at least one challenge in organizing a field trip. After hearing the evaluations and suggestions from the 2013 trip into the Frederick Valley, we wanted to include a fossil stop on this trip. Afterall, fossils are a real treasure out of the Earth. Fossils help geologists draw a picture of what type of environment these organisms lived. More interesting is the fact that when you break a rock open and expose a prehistoric organism, you are the first person to see that fossil. So how cool is that?

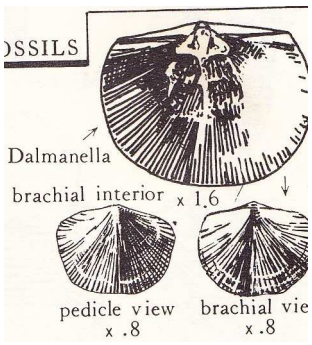
Fossil sites within the GVS are a rarity. Some of this is due to the lack of exposures in the GVS. Limestone and shale underlie most of the physiographic section and with these rocks being soft, they weather and erode easily. Many times, a geologist has to examine the float rock laying on the surface to determine what the bedrock is at that particular location. Jones Geological Services reviewed through many of the older geologic reports written in the Franklin County area hoping to uncover a fossil site that may be able to produce enough specimens easily for a typical Renfrew Institute sized group. Sometimes, historical research is important in learning geological facts about an area. Luckily, the Kauffman site was mentioned in an older edition of "Fossil Collecting in Pennsylvania" publication (Hoskins, 1969). Also, the best exposure of the Chambersburg Formation is found in this abandoned Pennsylvania Railroad cut (Root, 1968).

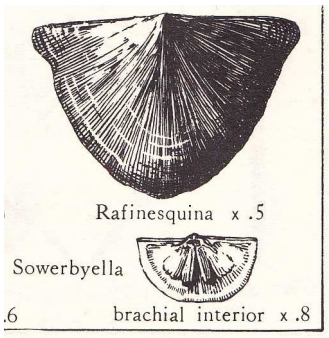
Dick Cooper and Jeri Jones traveled to Kauffman one winter day to recon the site. Fossils were found in the southern end of the long cut to the north of Kauffman Road West. We approached the landowner and permission was granted for us to include this as a stop. Be careful, as the early vegetation in the railroad cut may hinder easy access to some of the rock exposures. Please check for ticks.

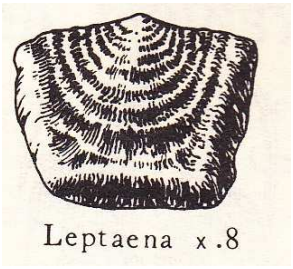
As mentioned above, the rocks exposed here belong to the Middle Ordovician Chambersburg Formation. Dark-gray cobbly limestone dominates this unit. Upon weathering, the cobbles litter the surface which is very distinctive to this formation. As many limestone units are, outcrops are sparse. The Chambersburg Formation seems to peek through the soil and doesn't have any rocky ledges exposed on the ground. Some argillaceous (clay) layers are also present. The thickness of the Chambersburg Formation is 750 feet (Root, 1968). Several metabentonite layers have also been mapped with this formation (Root, 1968). The significance of this material is that some bentonite clay is a result of the weathering of volcanic ash. The word "meta" in front of the word implies that it has been changed by heat and/or pressure over time. Thin bentonite beds have been reported in several other Middle Ordovician formation, one known to the leader occurring in the old Bethlehem Steel quarry near Middletown, Dauphin County, Pennsylvania. Its

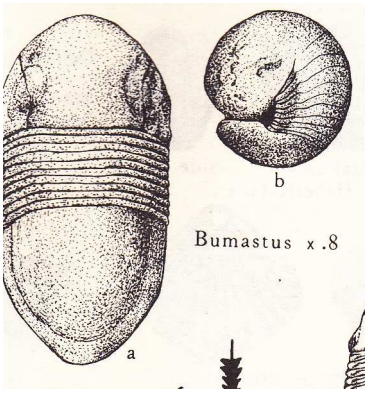
presence does imply that some sort of volcanic activity did occur during this time span someplace in the region.

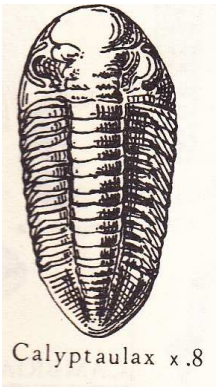
As for the fossils found here, the site is known for an unusual ball cystoid *Echinosphaerites.* Complete specimens of cystoids have been collected from this railroad cut, mostly to the south of Kauffman Road West. These fossils look like a small golf ball. The 800+ pentagonal and hexagonal plates that make up the body (theca) of the animal are covered by a very thin calcareous "skin". Some specimens have been found where the "skin" has been weathered off, exposing the plates. Rare separated calyx plates of the crinoid genus *Carabocrinus* are also found here. Four species of brachiopods (shells with two unequal halves), two species of trilobites (anthropods) and crinoid stems have also been idenitified from here (Hoskins, 1969).

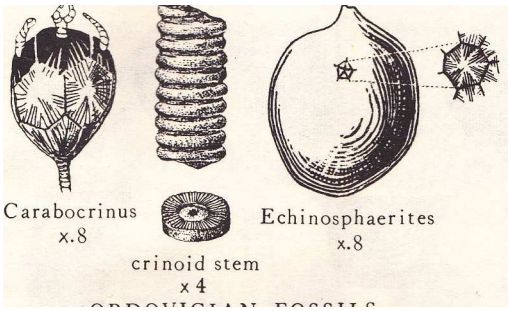












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