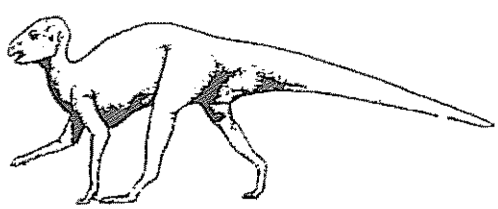
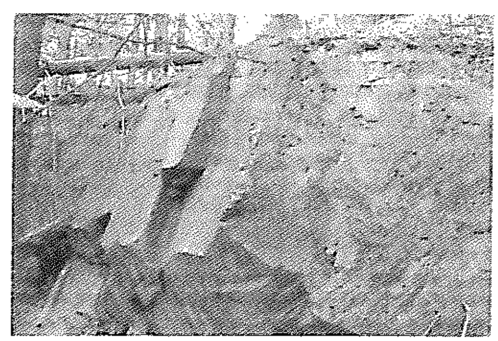
An Overview of Adams County, Pennsylvania Geology





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HACC-Gettysburg Campus Continuing Education
Field Trip
April 30, 2011

TOPOGRAPHY OF ADAMS COUNTY

Topography is the "lay of the land" or landforms. In this part of the United States, the landforms are greatly influenced by the underlying rock. Harder rocks underlie the higher elevations since they tolerate the everyday weathering and erosional processes. Examples of these rocks in Adams County include quartzite, diabase, and conglomerate. Softer rocks like, shale, sandstone, and carbonate rocks (limestone and dolomite) underlie the valleys or lower elevations.

One doesn't have to look very far around the landscape to see a change in elevation. Geographers and geologists have divided regions up 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. Adams County lies within two physiographic provinces as described below:

1. Ridge and Valley Province: Better known as the Appalachian Mountains, the terrain here is represented by alternating ridges and valleys. The South Mountain Section (SMS) lies along the northern and western edge of Adams 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. Elevations of several higher landmarks: Rocky Knob - 1872; Graetenburg Hills - 1522; The Knob - 1894; Culp Ridge - 1416; Jacks Mountain - 1572.

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. Elevation averages 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. Elevations of several higher landmarks: McKee Hill - 1186; Round Top - 785; Little Round Top - 650; Culps Hill - 600; and, Round Hill - 835.

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 Hill, the westward extension of the Pigeon Hills of York County is 1021 feet above sea level.

c. Upland Section (PUS): Characterized by terrain averaging in elevation of about 700-800 feet, although the Pigeon Hills, located at the eastern border of the county increase in elevation of over 1,000 feet. This section is higher in elevation due to slightly more resistant rock compared to the PLS.

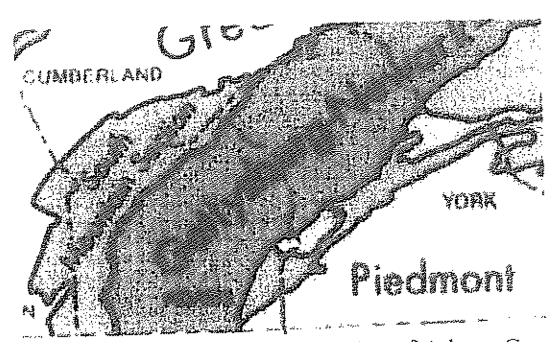


Fig. 2. Physiographic Province Map of Adams County
Adapted from Pa. Geologic Survey Map 13 (1999)

Adams County also spans two major drainage basins. The northern portion and most of the eastern part of the county ultimately drain to the Susquehanna River primarily by the Conewago Creek and its tributaries. The south-central and southwestern parts of the county, including the area around Gettysburg, are drained by tributaries (primarily Rock, Marsh, Middle and Toms Creeks) of the Monocacy River which empties into the Potomac River.

GENERAL GEOLOGY

Rocks found in Adams County range in age from at least 700 million years old to about 170 million years. Rock types include sedimentary, igneous and metamorphic. The oldest rocks (Precambrian) are located within the SMS. The last rock-forming episode in the area occurred within the GNLS, the area that most of this trip today will be concentrated in (Fig. 3).

Figure 4 is a stratigraphic column showing the formations found in Adams County. The youngest rocks are found at the top (diabase) while the oldest are at the bottom (Catoctin Formation).

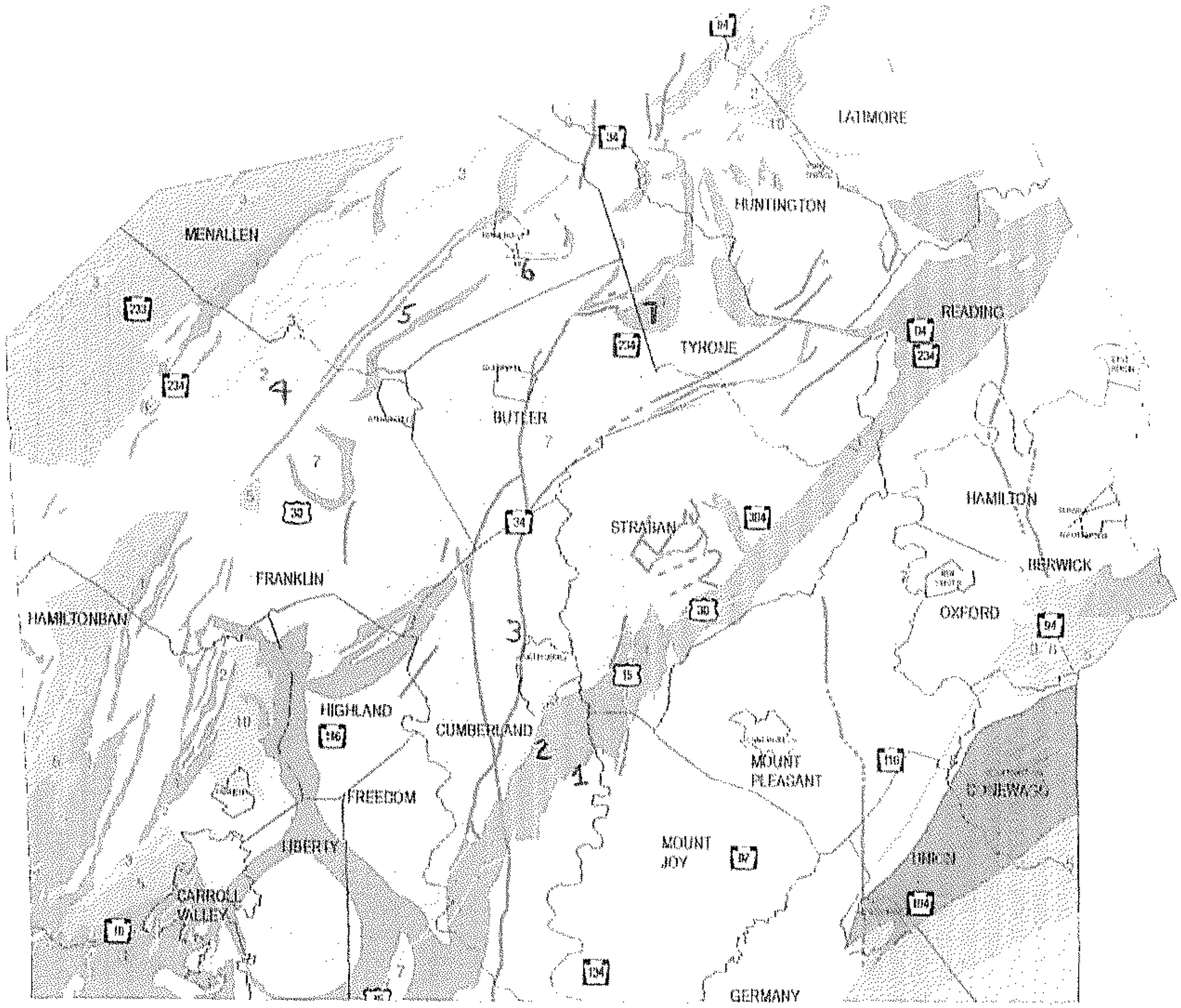
Containing most of the oldest rocks in the county, the SMS has undergone several "mountain building" episodes. As a result, the rocks have been intensely folded and faulted. Geologists feel that the SMS has been folded into a arch shape with the arch leaning toward the northwest. Although not able to be seen by a passer-by, a major fault, the Carbaugh-Marsh Creek Fault, is located where U.S. Route 30 passes through South Mountain. From a satellite photograph, it is obvious that South Mountain north of U.S. Route 30 has been pushed about 4 miles to the west relative to the highlands to the south of U.S. Route 30 (Fig. 5).

The PLS and PUS have again been pushed and shoved due to at least one continental collision. Although continuous rock exposures do not exist to see examples of the folding and faulting, geologists carefully studying the strata can measure these structures.

The GNLS contains the youngest rocks in Adams County. These rocks were deposited after several episodes of "mountain building, thus the rocks have not been deformed. The rocks uniformly dip toward the northwest 20-30 degrees. Minor faulting occurs within this area. A major fault borders the western edge of the GNLS where it intersects with the SMS.

Various mineral resources have been removed from Adams County during historic times. These resources range from iron ore (magnetite, limonite and hematite), copper, ornamental stone, clay, sand, aggregate and lime.

NOTES



DCNR

ADAMS COUNTY

April 2008

N W E S

0 1 2 3 4 5 Mi

Stream or river

1, Dikes (if present)

Municipal boundary

web site: www.dcnr.state.pa.us/topogeo/groundwater/rocktypes.aspx

ROCK TYPES *See complete description. Not all rock types in the legend may be present on the map.

- 1, Dark crystalline rocks
- 2, Light crystalline rocks
- 3, Schist*
- 5, Quartzite
- 7, Red sedimentary rocks*
- 8, Limestone
- 9, Dolomite
- 10, Limestone and dolomite
- 11, Limestone or dolomite*
- 15, Shale or siltstone*

Figure 4. Geologic Formations in Adams County

Formation Name	Rock Type(s)	Thickness-Feet
Diabase	Dar-gray igneous rock	1800
Gettysburg	Shale, sandstone, congl.	16000
New Oxford	Shale, sandstone, congl.	6900
Beekmantown Group	Limestone, marble	300+
Conestoga	Limestone	1000+
Ledger	Dolomite, marble	2000
Kinzers	Limestone, marble	50?
Tomstown	Dolomite, limestone	1000+
Vintage	Limestone	500
Antietam	Sandtone, quartzite	800
Harpers	Siltstone, graywacke	2,500-3,100
Weverton	Quartztie, phyllite, graywacke	800-1,000
Chickies	Quartzite, phyllite, congl.	800
Loudoun	Phyllite, graywacke	100-150
Catoctin metabasalt	Greenish volcanic rock	1000+
Catoctin metarhyolite	Reddish/purplish volcanic rock	2,200-2,900
Catoctin Schist	schist	100-150

Thickness from Stose (1932) and Taylor and Royer (1981)

Other features observed in the rock are all sedimentary in origin, in other words, formed when the sediment was being deposited. These markings, like ripple marks, scour marks, load casts, and raindrop imprints are very common. Several surface markings on some slabs were initially thought to represent impressions of dinosaur skin are now interpreted as one of the above sedimentary features. These markings greatly assist the geologist in interpreting the environment in this area during Triassic times (Fig. 12). The same processes that affect our Earth today have been at work for millions of years. This principle is known as uniformitarianism. For example, since we understand and observe how ripple marks are formed by the ocean water along the beach today, a rock that has ripple marks can be correlated with that environment.

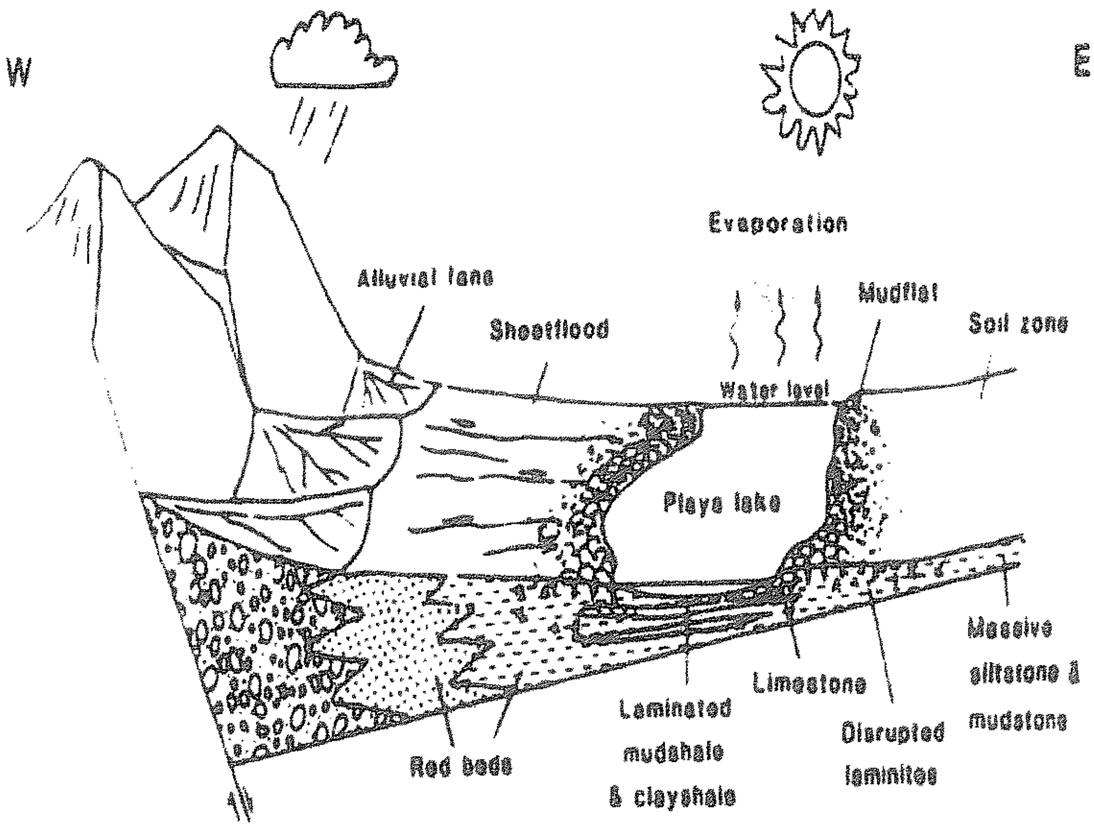


Fig. 12: Cross section and paleoenvironmental model of a Mesozoic rift basin.
(From Gore, 1988).

NOTES

Jeri Jones, a native of York attended Catawba College in North Carolina and earned his degree in Geoarchaeology. He returned back to York and became employed with York County Parks, now serving as the Program Coordinator. Jeri also owns Jones Geological Services where he studies the geology of southeastern Pennsylvania. In his 30 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 Harrisburg Area Community College and OLLI program at Penn State-York. His interests include the mining history, geologic history, groundwater resources and southeastern Pennsylvania earthquakes. He also authored four books, narrated a geologic education video series and written numerous articles. Jeri writes a blog for the York Dispatch titled "Rocks Under Your Feet." He is married to Lou Ann, a United Church of Christ minister and resides in the Spring Grove, PA area.

Itinerary:

9:00 am	Depart HACC-Gettysburg
9:15 am	STOP 1 – Valley Quarry – Gettysburg Plant
10:15 am	Depart
10:30 am	STOP 2. Plum Run Bridge – Confederate Ave.
10:50 am	Depart
11:05 am	STOP 3. CSX Railroad Cut – Lee's Headquarters
11:40 am	Depart
12:00 pm	Lunch at Lions Club Park – Cashtown
12:40 pm	Depart
1:00 pm	STOP 4. Buchanon Fire Company rhyolites
1:30 pm	Depart
1:50 pm	STOP 5. Potato Road – Border Fault
2:15 pm	Depart
2:30 pm	STOP 6. Main Street, Bendersville – Aspers Basalt
2:55 pm	Depart
3:10 pm	STOP 7. Chestnut Hill – Earthquakes
3:35 pm	Depart
4:00 pm	Arrival at HACC-Gettysburg

STOP 1. Valley Quarry – Gettysburg Plant

- The quarry was previously known John S. Teeter and Sons, Inc. and Harry T. Campbell Sons Corp.
- The rock here is being widely used for paving projects requiring a more resistant wearing aggregate, among other uses.

- Exposed in most of the quarry are the lower beds of the Gettysburg Formation known as hornfels, a metamorphic rock.
- These rocks were originally mudstones, siltstones and sandstones laid down in a tropical climate and some evidence of evaporates included
- In the western highwall, diabase (an igneous rock) is exposed. This is the lowest part of a diabase intrusion that is about 1800 feet thick and dipping toward the northwest.
- This rock is classified as belonging to the York Haven Diabase.
- Diabase is very dense and cooled from magma at least a mile or more beneath the surface (intrusive).
- The diabase cannot be used by the quarry due to its hardness.
- Magma intruded into the sedimentary rocks and baked the sandstone, siltstone and mudstone into hornfels (heat only – known as thermal metamorphism or contact metamorphism).
- This intrusion is known is known as the Gettysburg Sheet and is classified as a sill.
- Temperature of the magma was ~1100° C.
- The ight colored tan-weathering greenish rocks suggest a higher carbonate-rich rock.
- Cross-bedding, channels and remnants of evaporate minerals suggest a playa (beach-like or seasonal lake) environment.
- Minerals identified from here include:
  High temperature – actinolite, andradite, grossular, diopside, tourmaline and tremolite.
  Medium temperature – apatite, bornite, chalcopyrite, chlorite, copper, djurelite, epidote, feldspar, quartz, hematite, magnetite, mica, pyrite, rutile and titanite.
  Low temperature – calcite, chabazite, heulandite, natrolite, stilbite, stilnomelane.
  Weathering – chalcanthinite, chalcocite, chrysocolla, cuprite, dioptase, goethite, malachite, montmorillinite, opal, pyrolusite, selenite and sericite.

STOP 2. Plum Run Bridge – Confederate Ave., Gettysburg National Military Park

- Rocks used here were taken from Trostle Quarry located along the Bermudian Creek 3.3 miles due east of the U.S. Rte 15 – PA Rte. 94 intersection near York Springs, Adams County.
- A total of 57 foot prints were removed from Trostle Quarry in the 1930's.
- Rocks are sandstone and siltstone belonging to the Heidlersburg Member of the Gettysburg Formation, dated at ~ 210 mya.
- Foot prints of four species of dinosaurs can be seen in selected blocks on top of the bridge.

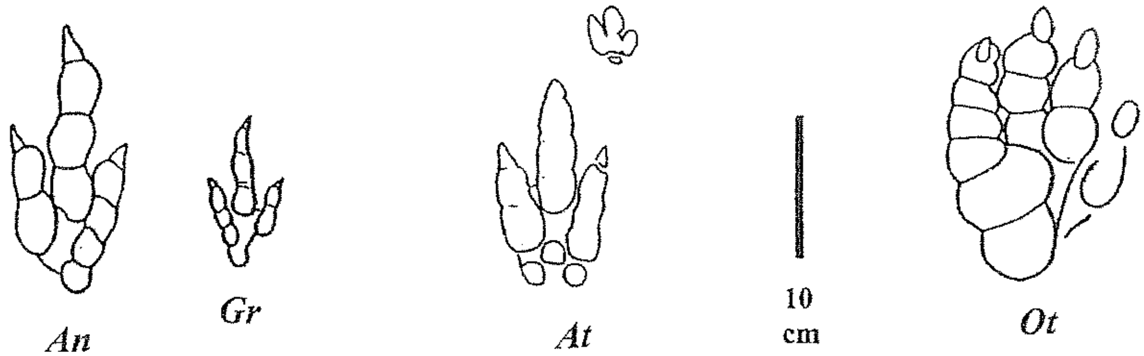


Figure 8-1. Plum Run bridge dinosaur footprints; all to same scale; abbreviations also used in Fig. 8-2.
Left, ***An***, *Anchisauripus sillimani* (and ***Gr***, smaller *Grallator tenuis),* 3-toed hind-prints 12-15 cm (and 7-8 cm) long;
center, ***At***, *Atreipus milfordensis,* fore- and 3-toed-hind-print (latter 10-12 cm long); scale bar 10 cm;
right, ***Ot***, *Otozoum minus,* 4-toed hind-print 15-25cm long;
(from Haubold 1971, p. 66, Lull 1953, p. 167, Haubold 1971, p. 66, Lull 1953, p. 154; Haubold 1984, p. 155, Olsen & Baird 1986, p. 65-69; Haubold 1971, p. 83,Lull 1953, p. 191; respectively).

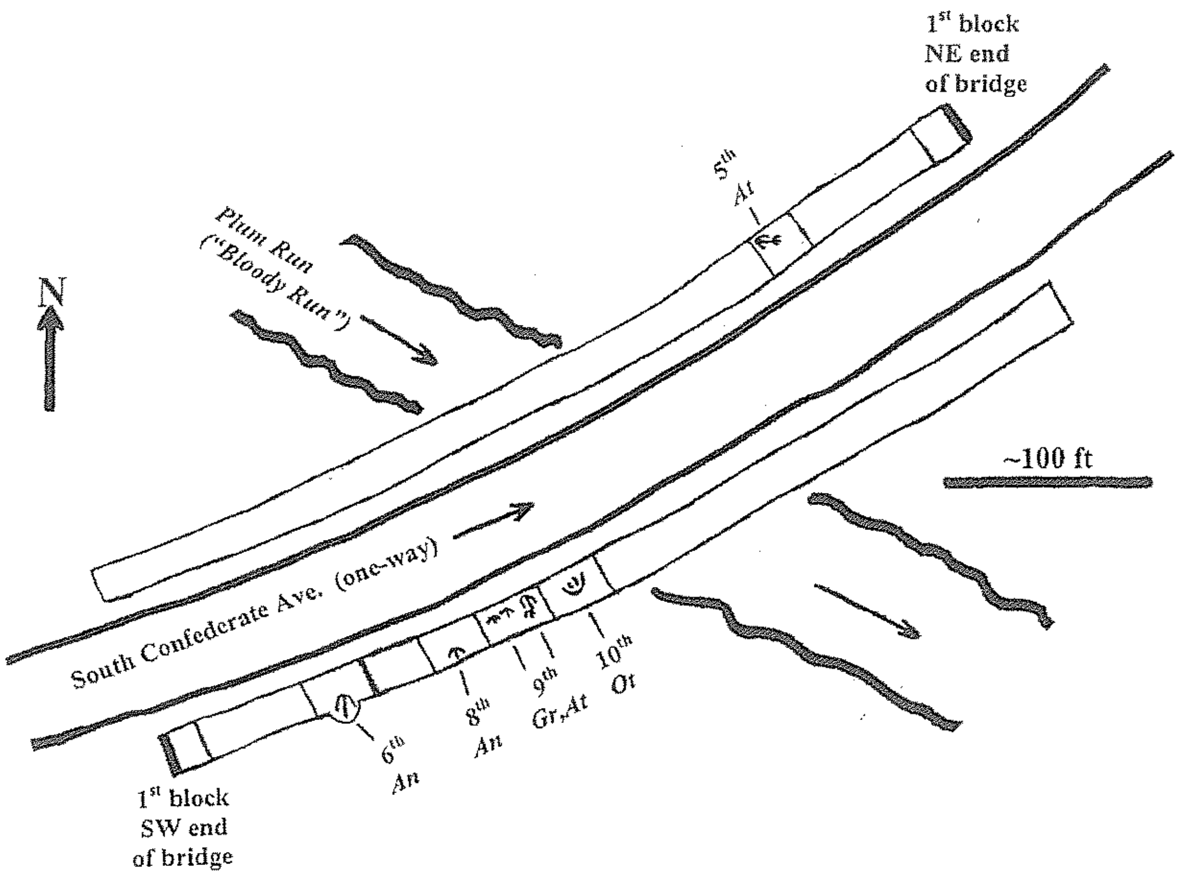


Figure 8-2. Sketch map of the Plum Run bridge, showing positions (by counting blocks) and identifications (using the abbreviations in Fig. 8-1) of dinosaur footprints visible in 2006.

From Fleeger, 2008

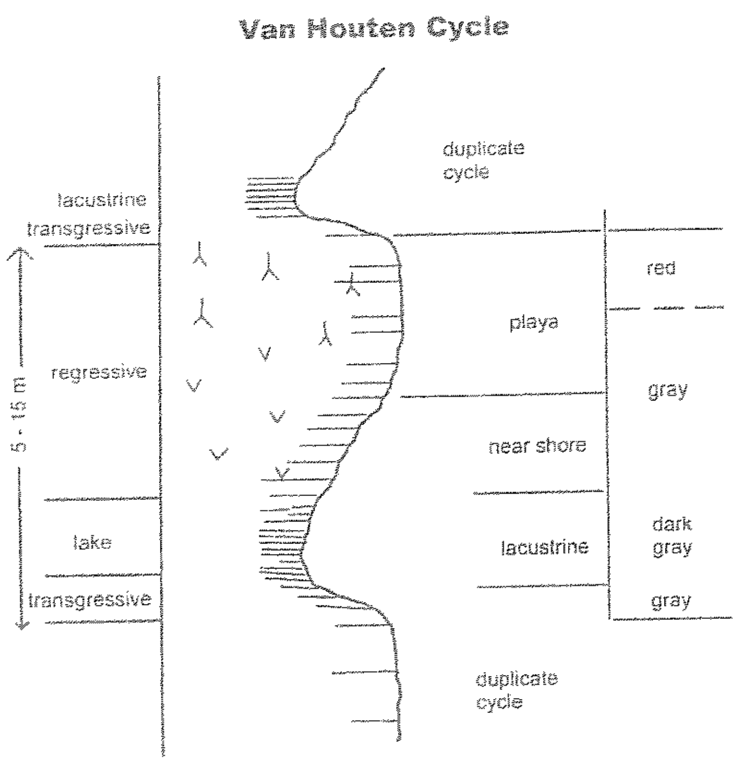
- The condition of preservation of these foot or hand prints lies heavily on the material in which they stepped. Prints are not as well preserved in a sandy texture compared to those in the siltstones.
- Other sedimentary features including ripple marks and dessication (mud) cracks can be seen in some of the blocks.

POINT OF INTEREST A – Devil's Den and Little Round Top, Gettysburg National Military Park

- This is the classical exposure of diabase. Walking through this rock outcrop, you will see many features, both occurring during the forming of the rock from magma and those that affected the rock later.
- Features include cooling cracks where the magma cooled at different rates, causing these cracks.
- The diabase through weathering has become rouded in shape known as spheroidal weathering. Although the magma never reached the surface here, the magma cooled into the diabase. This occurred perhaps 1-2 miles below the surface. Weathering and erosion evidentially brought the rock to the surface.
- Because diabase doesn't create a thick soil, soldiers could not trench for defense. They had to rely on these boulders or build diabase stone fences for protection.

STOP 3. CSX Railroad Cut – Lee's Headquarters

- Approximately 110 feet of reddish shale and sandstone as exposed here belonging to the Gettysburg Formation. Notice the thin bedding of the shale and thicker beds of the sandstone.
- Bedding is dipping 24° to the northwest. These rocks are basically lying in their original position since no major tectonic events have affected them.
- The reddish color of the rock is due to oxidation of iron as the sediment was occasionally exposed to the air following deposition.
- Walking east along the tracks, notice the change of color in the rock. This is another example of hornfels (similar to Stop 1). A diabase intrusion is located behind the gabion fence. Diabase can be seen at the junction of the sidling and main line as well in the south bank along the main line.
- This intrusion is known as a dike and measures 92 feet thick, dipping 50° southeast.
- Notice the size of the crystals in the diabase. Are they small (micro) or larger? The crystals in this diabase are micro indicating that the magma cooled relatively quick.
- Think about granite with its large crystals. This indicates a small cooling period.
- Before the railroad cut was modified with false wall, this was the best geologic exposure showing a diabase intrusion in southeastern Pennsylvania.



Van Houten Cycle
duplicate cycle
lacustrine transgressive
regressive
5 - 15 m
lake
transgressive
red
playa
gray
near shore
dark gray
lacustrine
gray
duplicate cycle

- A small amount of copper (malachite) was found at the diabase-hornfels contact.
- Several large cooper and iron mineral deposits were formed in this same manner, i.e. Cornwall Iron Mines (Lebanon County), Dillsburg Iron Mines (York County) and Stone Jug copper prospect (Adams County).

POINT OF INTEREST B – Carbaugh-Marsh Creek Fault

- As we enter South Mountain on U.S. Rte. 30, we are driving on the Carbaugh-Marsh Creek Fault. This fault formed as a result of the great African-North America collision ~325 mya during what we call the Alleghenian Orogeny.
- Viewed from a satellite photograph, one can see the fault. South Mountain north of U.S. Rte 30 has been shifted ~3 miles further west than the south side.
- Within a fault, the rock gets broken from the movement which accelerates the weathering and erosion process. The gap is a result of this faulting and erosion and allowed the Confederates to travel to Gettysburg.
- The Confederates used this gap to head to Gettysburg from near Chambersburg.

POINT ONF INTEREST C – Catoctin Metarhyolite

- From the Lion Club Park to the intersection with PA. Rte 234, metarhyolite is exposed along U.S. Route 30. A nice outcrop of this volcanic rock is seen just east of the intersection with Pa. Rte. 234.
- Metarhyolite has undergone some metamorphism thus the "meta" is front of the rock name.
- The word "Catoctin" is the proper name for this formation, named for its fine exposures in the Catoctin Mountains in Maryland.
- This rock and its associated volcanic rock metabasalt (oceanic rifting) are related to the breakup of a super continent known as Rodinia about 600 mya. The metarhyolite has been recently dated at ~570 mya.

STOP 4. Buchannon Valley Fire Department metarhyolite exposure

- Metarhyloite is composed mainly of orthoclase feldspar and quartz.
- This rock formed on the edge of Rodinia as the supercontinent rifted apart (continental rifting).
- Rhyolite has the same minerals as granite, the other difference on how the rocks were formed.
- This rocks belongs to the Catoctin formation of Proterozoic age
- As you walk this small exposure, look for rhyolite that might have flow lines or some indication of lava flows.

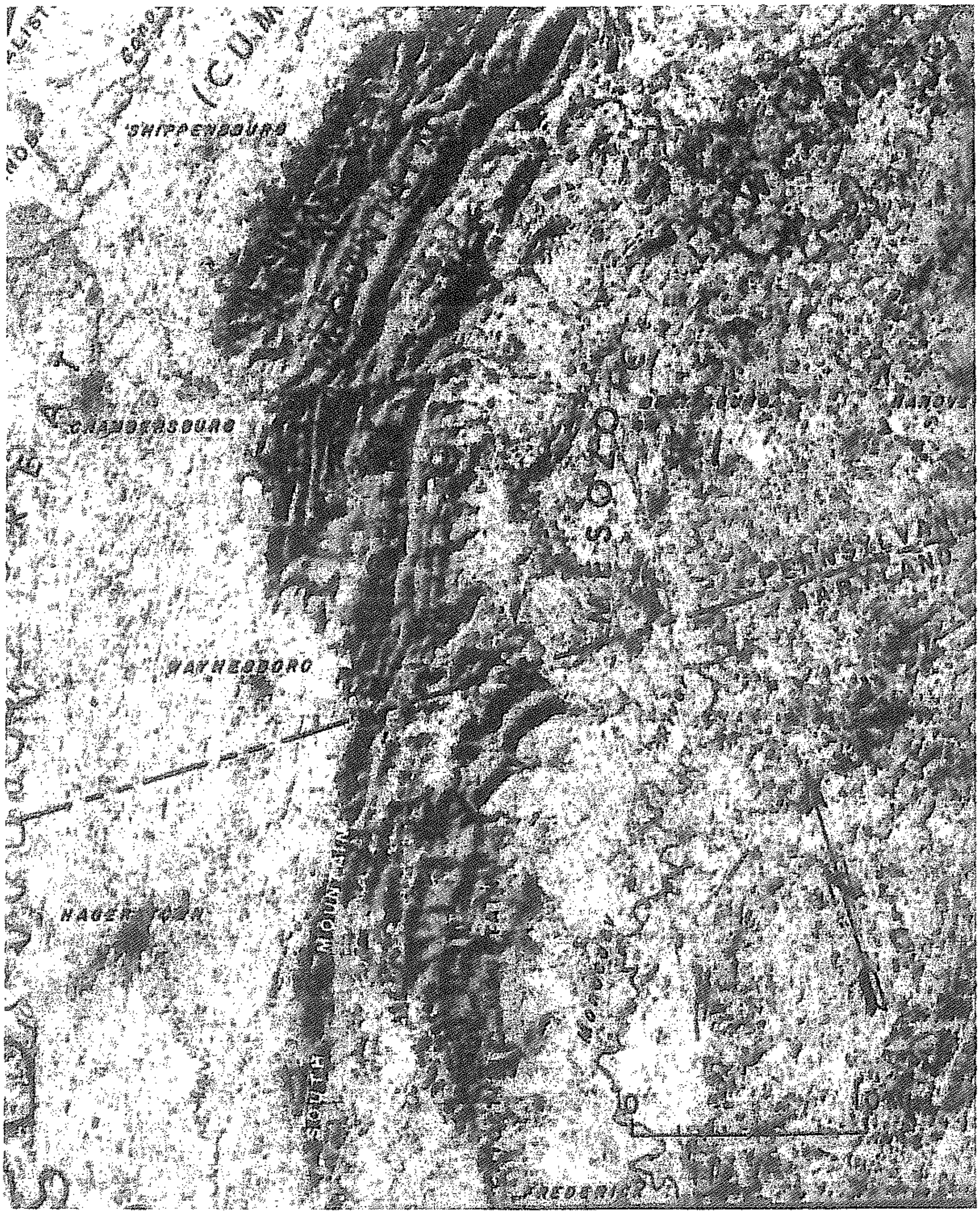


Figure 5. Satellite photograph of South Mountain, PA. Great Valley Section on left and the Gettysburg-Newark Lowland Section on right.
(taken from Way, 1986)

STOP 5. Potato Road - The Border Fault

- This valley represents the border between rocks of South Mountain (about 600 mya) to those of the Piedmont Gettysburg-Newark Section containing rocks about 200-170 mya. We are standing on the older side.
- This fault was active in at lease the Mesozoic Era as Pangaea was rifting apart.
- This is the western side of what is called the Gettysburg Basin, a downwarped piece of crust that had much erosion of sediment in and the intrusion of magma up through the rifting crust.
- Quaker Valley is a valley because rocks in a fault area have been previously fractured and crushed, allowing quicker weathering and erosion to take place.

STOP 6. Main Street, Bendersville Road Cut – Aspers Basalt

- Most magma that intruded into the Triassic rocks and older rocks cooled inside of the earth as the rock diabase.
- All of these intrusions are Jurassic in age.
- The Aspers Basalt is the only evidence in this region that was an actual lava flow – a very small flow but it did exist.
- There may had been additional flows, but these may have been eroded away.
- This exposure shows you just how difficult it is sometimes for a geologist to interpret the geology. This rock is concealed and only can be found when you dig into the hillside or walk into the orchard.
- Look for a light-brownish rock that is potted with cavities. These cavities were "gas pockets."

STOP 7. Chestnut Hill Diabase Intrusion – Earthquakes

- Chestnut Hill is underlain with Jurassic-age diabase, similar to that in the CSX Railroad cut.
- Diabase is a very dense rock, weathering in a rounded (spheroidal) shape.
- Here the diabase intruded through Gettysburg Formation sedimentary rocks.
- On May 26, 1994, an earthquake was recorded from this area. The tremor had a magnitude of 2.8 with a depth of 11 km.
- With no seismographs in the immediate area, its location is not exactly known, perhaps a +/- of ~5 km around Chestnut Hill.
- The closest seismographs are located at Soldier's Delight State Park near Owings Mill, MD and Millersville University in Millersville, PA.

GEOLOGIC TIME SCALE

EON	ERA	PERIOD		EPOCH	AGE IN MILLIONS OF YEARS BEFORE PRESENT
					Present
Phanerozoic	Cenozoic	Quaternary		Holocene	0.01
				Pleistocene	1.6
		Tertiary	Neogene	Pliocene	5.3
				Miocene	23.7
			Paleogene	Oligocene	36.6
				Eocene	57.8
				Paleocene	66.4
	Mesozoic	Cretaceous			144
		Jurassic			208
		Triassic			245
	Paleozoic	Permian			286
		Carboniferous	Pennsylvanian		320
			Mississippian		360
		Devonian			408
		Silurian			438
		Ordovician			505
		Cambrian			570
Precambrian	Proterozoic				2500
	Archean				3800
	Hadean				4550

(From Decade of North American Geology, 1983)