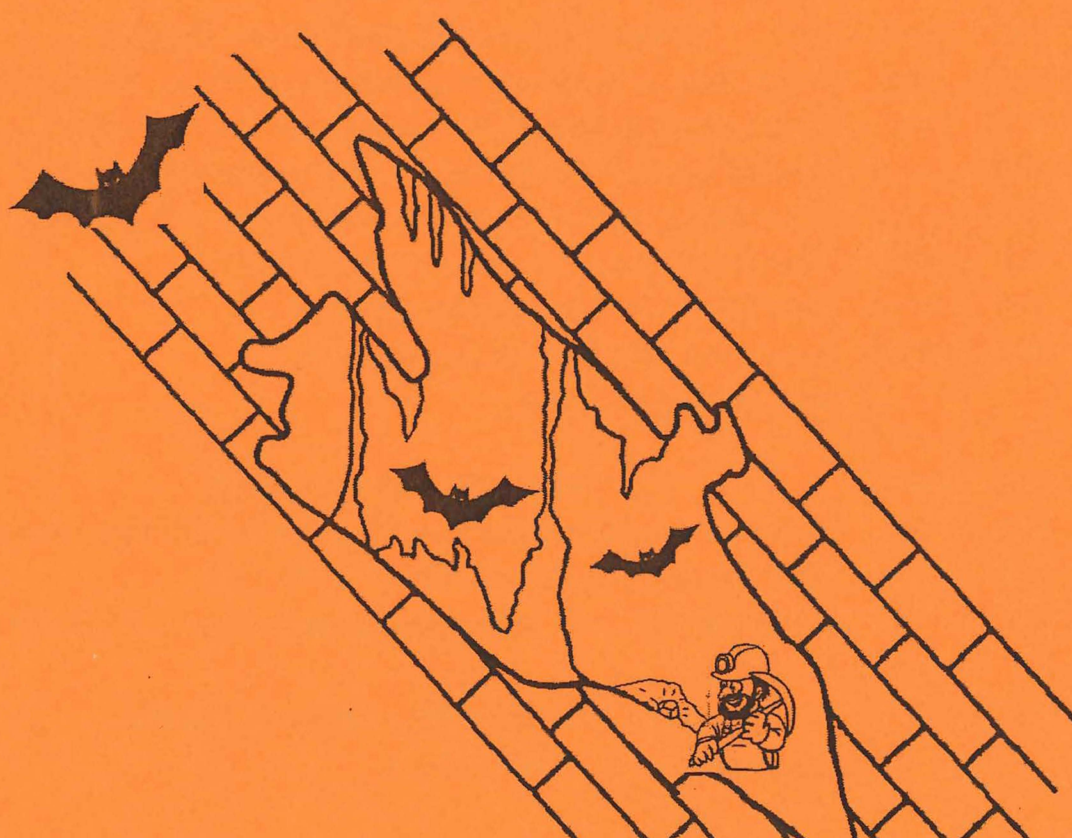
Halloween Limestone Adventure

Harrisburg Area Geological Society
&
Association of Environmental and Engineering Geologists

Saturday, October 22nd, 2011

Snyder and Centre Counties, Pennsylvania



ROAD LOG

Miles		
Int.	**Cum.**	**Harrisburg to Mount Pleasant Mills Quarry (Stop 1)**
-	-	Leave starting point? and head north on US 11/15
0.0	0.0	Turn left on to 104 north.
8.0	8.0	Turn left on to Flint Valley Road
0.8	8.8	Merge on to Freemont Road
0.2	9.0	Veer left on to Quarry Road
0.2	9.2	Turn left into Mount Pleasant Mills Quarry (Stop 1)
		Stop 1: Mount Pleasant Mills Quarry

Int.	Cum.	Quarry to Graybill's Grove (Stop 2)
0.0	0.0	Leave Stop 1, turning left (west) on to Quarry Road
1.5	1.5	Bear right to stay on Quarry Road.
0.2	1.7	Turn left on to Heister Valley Road.
3.9	5.6	Turn right into Graybill's Grove picnic grounds (Lunch/Stop 2).
		Stop 2: Heister Valley Gulf

Int.	Cum.	Graybill's Grove to Penn's Cave (Stop 3)
0.0	0.0	Leave Stop 2, turning left (east) on to Heister Valley Rd.
6.2	6.2	Turn left on to 104 north. Stay on 104 past Middleburg.
14.0	20.2	In Mifflinburg, turn left on to Chestnut Street (PA 45).
23.0	43.2	In Millheim, turn right on to North Street (PA 445).
3.1	46.3	Turn left on to Brush Valley Road (PA 192).
7.0	53.3	Turn left on to Penn's Cave Road.
0.5	53.8	Turn right into Penn's Cave (Stop 3).
		Stop 3: Penn's Cave

Int.	Cum.	Penn's Cave to Harrisburg
0.0	0.0	Leave Stop 3, turning left (east) on to Penn's Cave Road
0.5	0.5	Turn left on to Brush Valley Road (PA 192).
5.1	5.6	In Centre Hall, turn left on to Pennsylvania Avenue (PA 144).
5.1	10.7	Turn left on to General Potter Highway (US 322).
-	-	Follow 322 back to Harrisburg.

STOP 1: MOUNT PLEASANT MILLS QUARRY

Leaders: Bill Kochanov and Rose-Anna Behr

The Mount Pleasant Mills Quarry, owed and operated by National Limestone Quarry, has been in operation since 1986. Permission to enter the property has been graciously given by quarry owner, Eric E. Stahl. Thanks, Eric!

Coordinates: 40° 43' 38.16", -77° 01' 30"

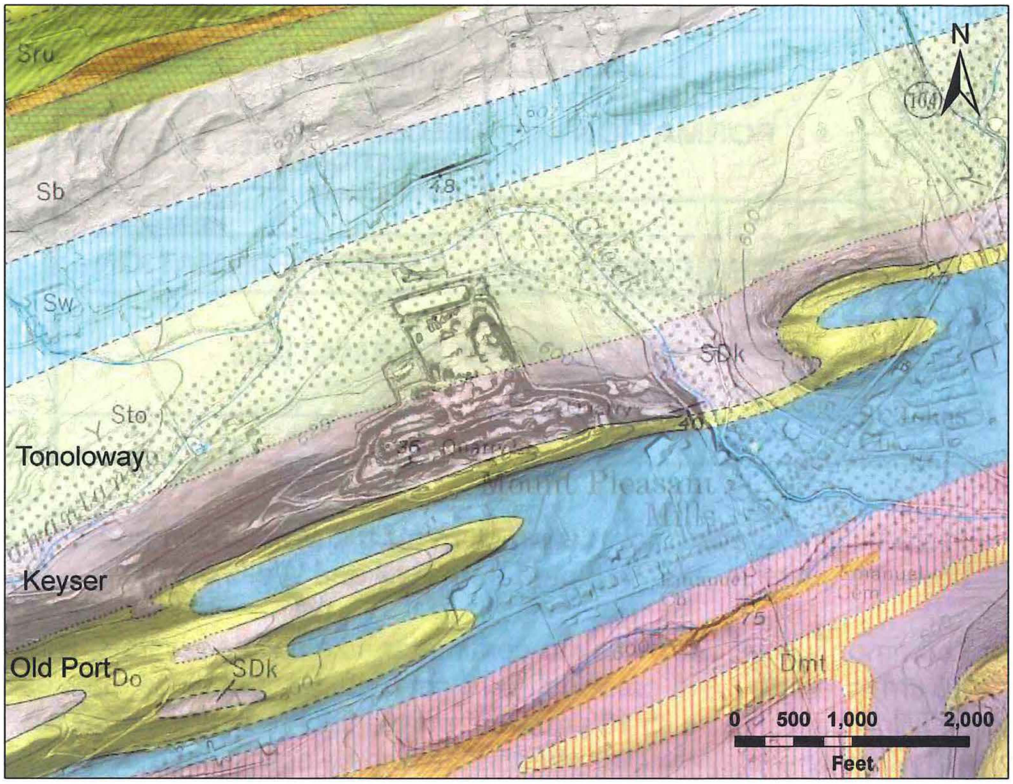


Figure 1. Geologic map of quarry area from Faill and Wells, 1974.

Stratigraphy

Lithologic descriptions and geologic map are adapted from MacLachlan and others (1995) and from Faill and Wells (1974). (Figure 1)

Tonoloway

The Tonoloway is laminated to thinly bedded, light to medium-gray limestone, argillaceous limestone, with some thin beds of medium-gray calcareous shale. Sedimentary structures include mudcracks, salt casts, algal laminations and small-scale stromatolites.

Fossils are scarce, limited to scattered ostracods and algal structures.

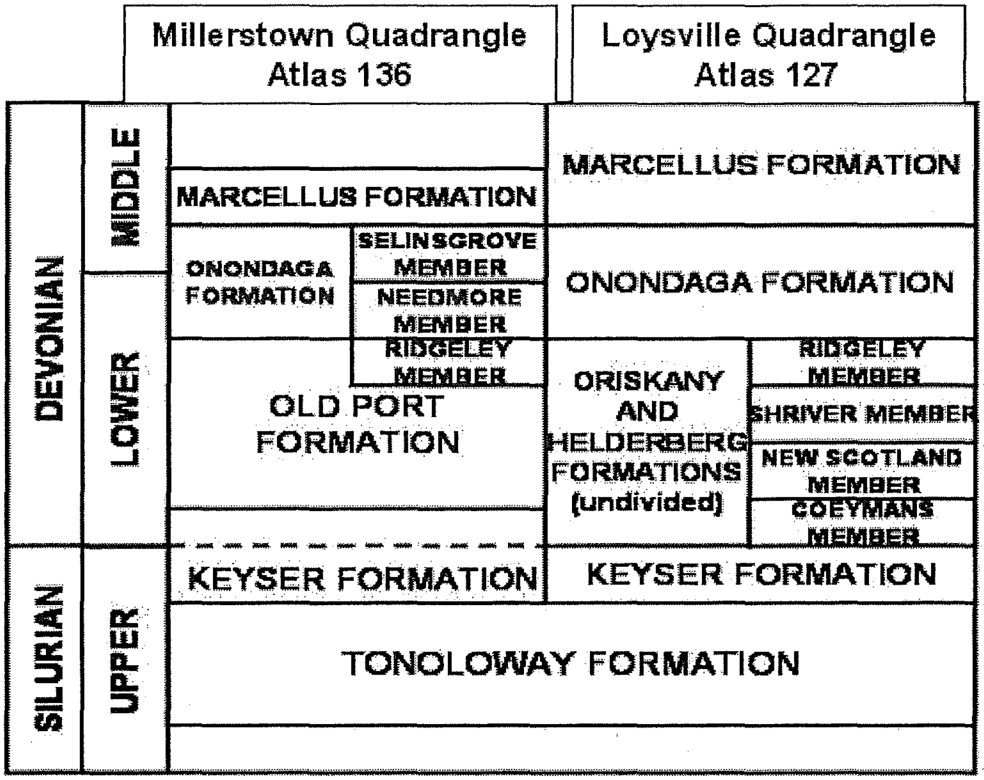


Figure 2. Stratigraphic correlation chart for the Millerstown and Loysville quadrangles. Adapted from Faill and Wells (1974).

Vugs are commonly lined with drusy to centimeter size calcite crystals; vugs ranging from 2-20 cm in length, 5-15 cm wide, 5-10 cm high. White calcite masses are also common filling fractures up to 15 cm wide; purple fluorite is present as an accessory mineral. Balls of white, acicular strontianite and celestine have been reported.

Keyser

Above the Tonoloway is the Keyser Formation (Figure 2). This is the rock the quarry is extracting. The Keyser is a medium to dark-gray, fossiliferous, lumpy to nodular limestone; laminated to thin-bedded towards the top, similar to the Tonoloway beds; dark-gray chert nodules are common in the upper few feet. Thin to thick bedded, often appearing massive; stylolites parallel to bedding; cleavage and bedding discontinuities contribute to its distinctive nodular or cobbly appearance.

Generally nonfossiliferous in the thin- to medium bedded units; otherwise, fossils are represented by typically disarticulated and broken fragments of brachiopods, crinoids, bryozoans, molluscs, coral, trilobites and ostracods; whole specimens are also common.

White calcite is present as vein filling.

Widened fractures as a result of carbonate dissolution were observed in an abandoned quarry just east of the active pit; particularly on the west highwall. The open fractures are cave-like in appearance but are too narrow for spelunking purposes. They coincide with bedding and structurally induced discontinuities.

Stone (1932) provides a location for Boyer Cave "...about a quarter of a mile northwest from Fremont (Mt. Pleasant Mills P.O.)" and notes that the cave is in the floor of a quarry – probably this quarry. Other caves have been recorded for this general area – Boyer Cave, Boyer West Cave, Boyer # 2 and Boyer #3 Cave (LaRock, 1976).

Old Port

Old Port is the local term covering lithologies within the Lower Devonian "Helderberg" sequence of limestone, shale, and chert. The majority of limestone units mapped from the same interval in West Virginia and Maryland such as the Coeymans and New Scotland Formations appear to be largely lacking and where present are a minor component being at best represented by a few thin beds.

Outcrops examined in the remnants of a hillside quarry, (approximately 0.3 miles ENE of the active pit, in the woods, uphill from the cemetery) show a gray-brown, poorly fissile, siliceous shale. The hillsides are draped with abundant chert. A similar outcrop occurs in the woods between the active quarry and Fremont Road displaying a nice transition from the shale into thin-bedded limestone and chert.

Although part of the section we will examine is mapped as the Old Port Formation, Woodward (1943, p. 85) refers to the New Scotland Limestone in western Maryland and most of northeastern West Virginia as being, "... separable into an upper shale (10 to 30 feet thick) and a lower calcareous member that exhibits conspicuous white chert." Perhaps this shale/chert interval is representative of the New Scotland in this general region.

The chert is dark gray to black when fresh, becoming light gray to white or yellow brown on weathering, and ranges in layering from nodular to thin-bedded to massive. It is highly fractured giving it a blocky character in weathered outcrops.

The chert is locally quite fossiliferous with large spiriferid brachiopods and gastropods. One may find the brachiopod *Eospirifer macropleura* which is a guide fossil for the lower part of the New Scotland. The gastropod *Platyceras sp.* is also common.

Regarding the source of phosphorus, MacLachlan and others (1995) describe the chert of the Old Port in the adjacent Freeburg quadrangle as being, "...underlain by a yellow-weathering shale (Mandata Shale Member) (apparently the source of phosphate nodules found along the road north of Kreamer)..." Phosphatic nodules occur in a number of organic–rich shales ranging from the Cambrian Burgess Shale, Alberta, to the Ordovician Martinsburg Formation (Blackmer, pers. comm.) to the Pennsylvanian (Kidder, 1985).

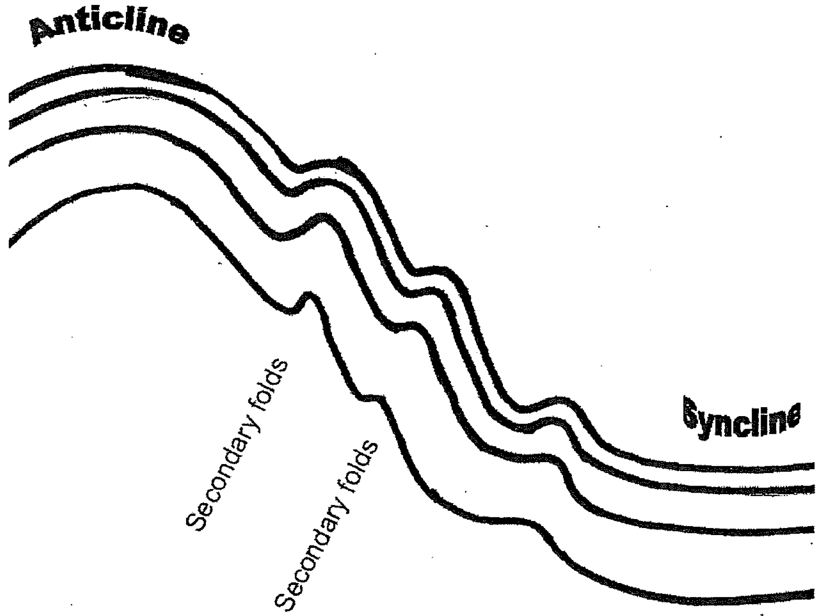


Figure 3. Generalize cross section of structures in the area.

Structure

The quarry is located in the Ridge and Valley physiographic province of Pennsylvania (Sevon, 2000). The region is marked by broad, large-scale anticlines and synclines. Anticlines are convex upward folds with the oldest rocks in the core. Synclines are concave upward folds, with the youngest rocks in the core. Shade Mountain and the Shade Mountain Anticline dominate the northern skyline. To the south, across the Quaker Valley Syncline which crosses Route 104 near Meiserville, you encounter the Tuscarora Mountain Anticline at the Perry County line. The wavelength of these folds is on the order of nine miles.

Secondary smaller anticlines and synclines decorate the flanks of the large folds (Figure 3). Near the quarry we see a series of these features. Just north of the quarry near Mahantango Creek is the axis of a small syncline. Within the quarry, near the south edge of active operations is the axis of a small anticline (Figure 4). You may notice the beds in the north part of the quarry dip steeply north, but those in the south dip the opposite way.

Anticlines do not always make mountains, nor synclines valleys. The shape of the land is more controlled by the strength of the rocks. For example, the older Tuscarora Sandstone that cores the anticlines of the largest mountains in this area resists erosion better than the younger shales and limestones that core the synclines.

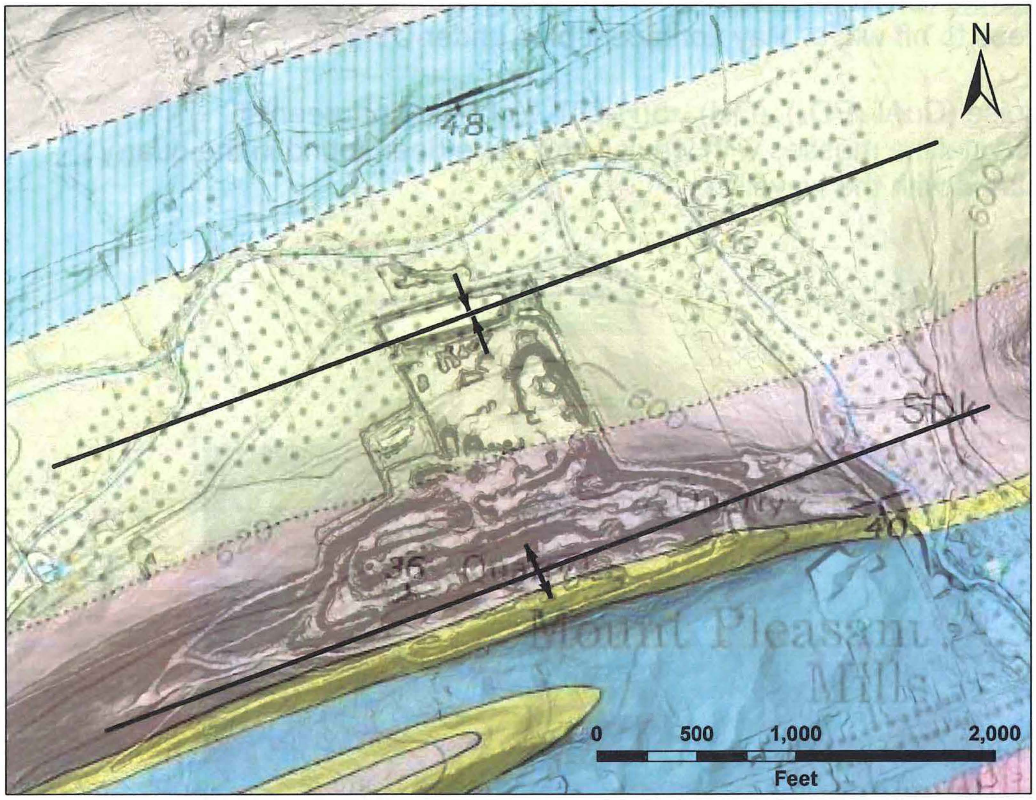


Figure 4. Map showing general location of small syncline and anticline through quarry.

Minerals of Note

- Calcite ($CaCO_3$)- Of course there is abundant calcite in a limestone quarry, but there are some exceptionally nice crystals to be found. Look for light yellow, doubly terminated calcite crystals up to 2 cm long.

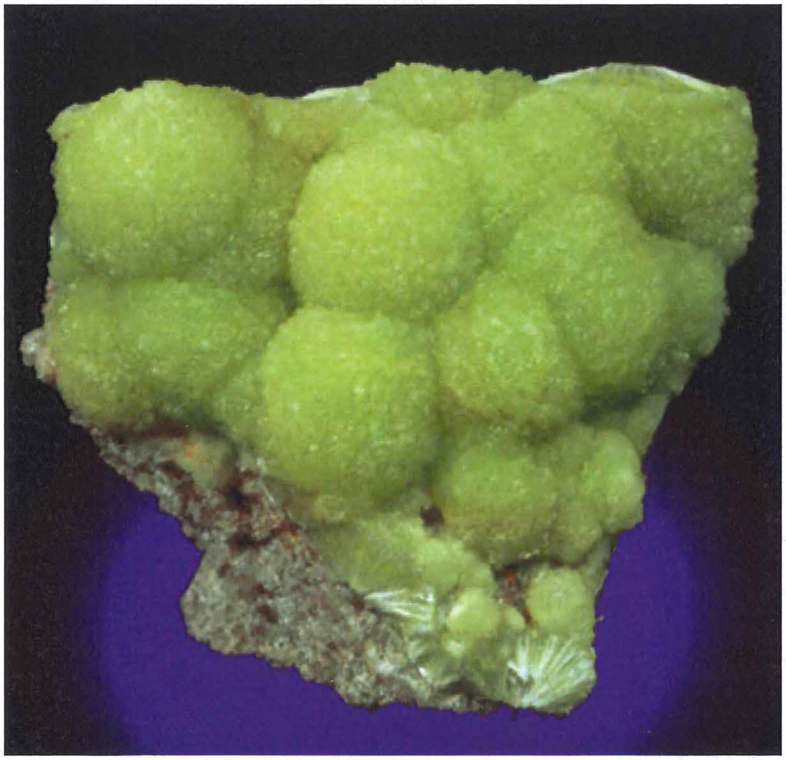
- Quartz (SiO_2)- Drusy to perfect one-cm quartz crystals are present within small vugs or on fracture surfaces of the chert.

- Fluorite (CaF_2)- Purple cubes or masses are found occasionally with calcite in veins.

- Wavellite ($Al_3(PO_4)_2(OH,F)_3 \cdot 5(H_2O)$)- Locally, mm to cm size balls or sprays of radiating wavellite crystals occur in small vugs within the chert and along open fractures in the chert and sandstone beds. This rare mineral is orthorhombic, colorless to white, yellow, and candy apple green, transparent to translucent. It occurs as minute prismatic crystals, usually in radiating hemispherical or globular aggregates (Gordon, 1922). X-ray diffraction confirms this is wavellite (Barnes, pers. comm., 2011)

- Strontianite ($SrCO_3$) - Needle-like crystals, generally in bundles or sheaves. Colorless to off white. May florescent blue under UV light.

- Turquoise ($CuAl_6(PO_4)_4(OH)_8{\bullet}5(H_2O))$- Light-blue or greenish microcrystalline masses with waxy luster have been found in the quarry associated with the wavellite.



Wavellite from Mount Pleasant Mills Quarry (photo from allminerals.com)

STOP 2: HEISTER VALLEY GULF

Leader: Bill Roman

To the west of Graybill's Grove picnic grounds lies an unusual geomorphic feature having the attributes of a small karst gulf.[1] The feature consists of a closed depression more than 300 feet long in the east-west direction and about 150 feet wide in the north-south direction (see Figures 6 and 7). A cluster of coalescing sinkholes may account for the irregular shape of the closed depression.

Drainage

The gulf functions as both a sink and a rise. Surface drainage from the south flank of Shade Mountain enters the gulf from the north. During dry periods, when the groundwater table is low, water entering the gulf is lost mainly to the subsurface by a series of swallets in the floor of the gulf, via seepage through the bed of the stream traversing the gulf, and finally to a large swallow hole at the southeast corner of the gulf adjacent to Heister Valley Road. During wet periods, the water level in the gulf rises and forms a ghost lake. A culvert beneath Mountain Road on the south side of the gulf provides an outlet for the lake water, which feeds a losing stream running along the west side of Heister Valley Road south of the gulf. During really sharp rises in the water level, water may overflow across Mountain Road (see photographs).

Soils

According to USDA soils mapping (Soil Survey Staff, 2010), the gulf lies at the juncture of soils derived from till to the south and colluvium to the north. As shown in Figure 6, the soils in the southern portion of the gulf are mapped as soil unit "ShB—Shelmadine silt loam, 3 to 8 percent slopes." These are poorly drained soils that develop in loamy till and typically occur along drainage ways. The northern portion of the gulf is mapped as soil unit "BxB—Buchanan very stony loam, 0 to 8 percent slopes." These are gravelly loams and gravelly silt loams developed in mountain slope colluvium derived from sedimentary rock. They occur along the base slope of mountain flanks along the sides of valleys.

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[1] The AGI glossary defines a karst gulf as "a steep-walled closed depression having a flat alluviated bottom; in some gulfs a stream flows across the bottom."

Glaciation

Published mapping indicates the Mahantango Creek valley may or may not be glaciated. The state geologic map (Berg and others, 1980) shows a lobe of Illinoian Muncy till within the valley. The northern edge of the lobe runs along the foot slope of Shade Mountain, and the southern edge of the lobe roughly follows Mahantango Creek and its West Branch from the Susquehanna River to Richfield and then PA Highway 35 west to the Mifflintown area of the Juniata valley. Re-evaluation of the tills in Pennsylvania indicates that these tills are actually pre-Illinoian in age, and based on magnetic data, more than 770,000 years old (Crowl and Sevon, 1999, p. 227). More recent mapping at a smaller scale restricts the unnamed pre-Illinoian tills to the north side of Middle Creek in eastern Snyder County (Sevon and Braun, 1997). This mapping is qualified to indicate only areas having till covering at least 10 percent of the ground are included. Earlier mapping by Leverett (1934) also restricts Pre-Illinoian till to the area above Middle Creek in eastern Snyder County.

Bedrock

Bedrock in the Mahantango Creek valley is part of a thin, shallow marine to terrestrial clastic sedimentary wedge with subordinate carbonate rocks and chert that formed during the Middle Ordovician to Lower Devonian period (Hibbard and others, 2006). According to published mapping (Faill and Wells, 1974), the gulf is underlain by the Tonoloway Formation, which consists primarily of laminated to thin-bedded limestone and some thin beds of medium gray calcareous shale (Figure 8). The Tonoloway Formation is estimated to be 500 to 600 feet thick in the Millerstown quadrangle, where it is underlain by the Wills Creek Formation and overlain by the Keyser Formation.

Faill and Wells (1974, p. 54) report that “a poorly developed karst topography occurs in terrain underlain by the Tonoloway and Keyser Formations” and that “local areas of interior drainage generally from one to three acres in size, occasionally contain swamps and small ponds.” Because of its relatively high purity, limestone from the basal portion of the Keyser Formation has been extensively quarried for agricultural lime in the Millerstown 15-minute quadrangle (Faill and Wells, 1974, p. 202). The Tonoloway Formation has also been quarried for limestone. Review of published reports on mineral resources provides no indication that the gulf is related to past quarrying activity (Faill and Wells, 1974, O’Neill, 1964, and Miller, 1934, D’Invilliers, 1891).

Structure

As shown in the geologic map (Figure 8), the long axis of the gulf roughly coincides with the axis of a syncline trending approximately N71°E (Faill and Wells, 1974, Plate 5). According to structural notations in the published mapping, at the west end of Limestone Ridge, approximately 2,000 feet east of the gulf, beds on the north limb of the syncline dip 37 degrees to the south, and beds on the south limb dip 65 degrees to the north.

Heister Valley Road Sinkhole

A sinkhole on the southeastern edge of the gulf has affected Heister Valley Road (S.R. 3006). According to PennDOT records, the sinkhole was first observed on January 23, 2009. At this time the sinkhole was directly adjacent to the roadway; however, it grew in size and affected most of the westbound roadway. In March 2009, the sinkhole was excavated and backfilled with R-3 rock and covered with subbase material. The roadway has been re-paved.

PennDOT drilled seven borings from August 25 to September 18, 2009. In addition to fill, the borings penetrated soils classified as silty sand (sm), silty-sand/clayey-sand (sm-sc), clayey sand (sc), and clay (cl). Top of rock was encountered at depths ranging from 32.9 feet to 42.8 feet. The rock was generally described as gray limestone with soil (clay and silt) seams. No voids were encountered in the borings.

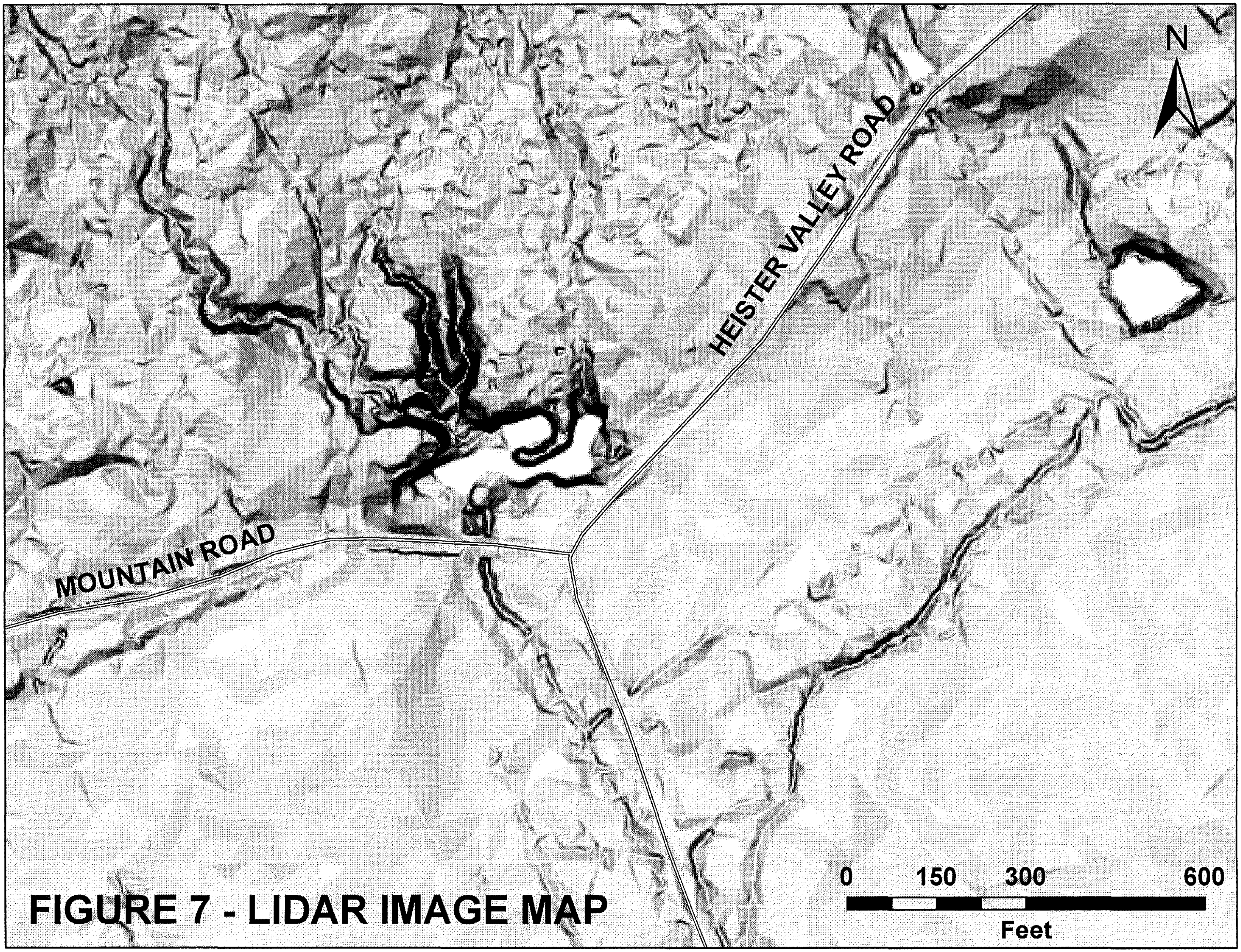


FIGURE 7 - LIDAR IMAGE MAP

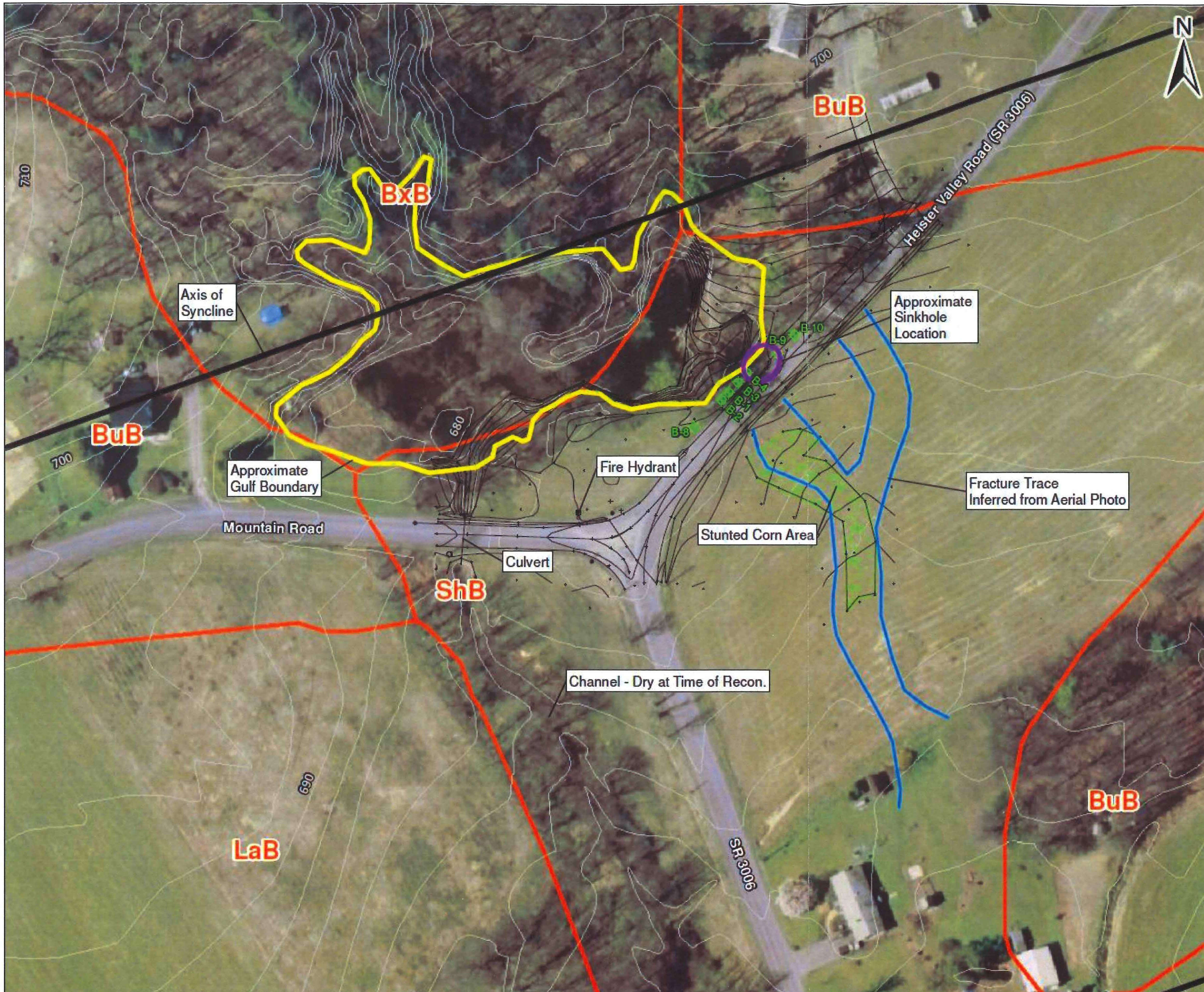


Figure 6

FEATURES MAP

Legend

- 2' LiDAR Contours
- Boring Locations
- PennDOT Provided Survey, 1' Contours
- USDA Soil Boundary

BuB Buchanan gravelly loam, 3-8% slope
BxB Buchanan very stony loam, 0-8% slope
LaB Laidig gravelly loam, 3-8% slope
ShB Shelmadine silt loam, 3-8% slope

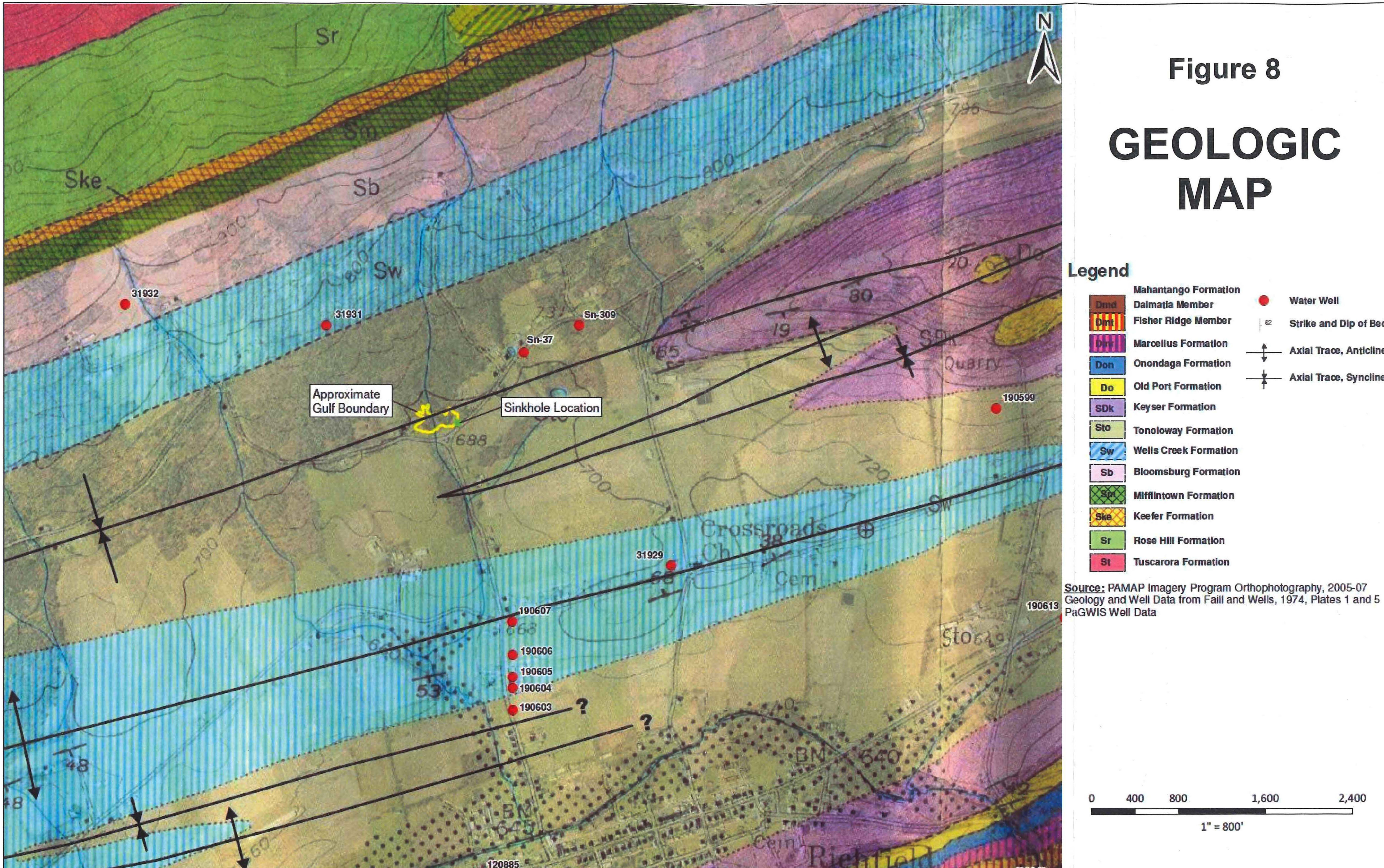
Source: USDA NRCS SSURGO Soil Database, 2008
PAMAP Imagery Program Orthophotography and LiDAR, 2007
PennDOT District 3-0 CAD Survey
Geology from Faill and Wells, 1974, Plate 5
Fracture Trace from USDA Aerial Photo AQK-58-33, Flown 9-8-1938

0 40 80 160 240

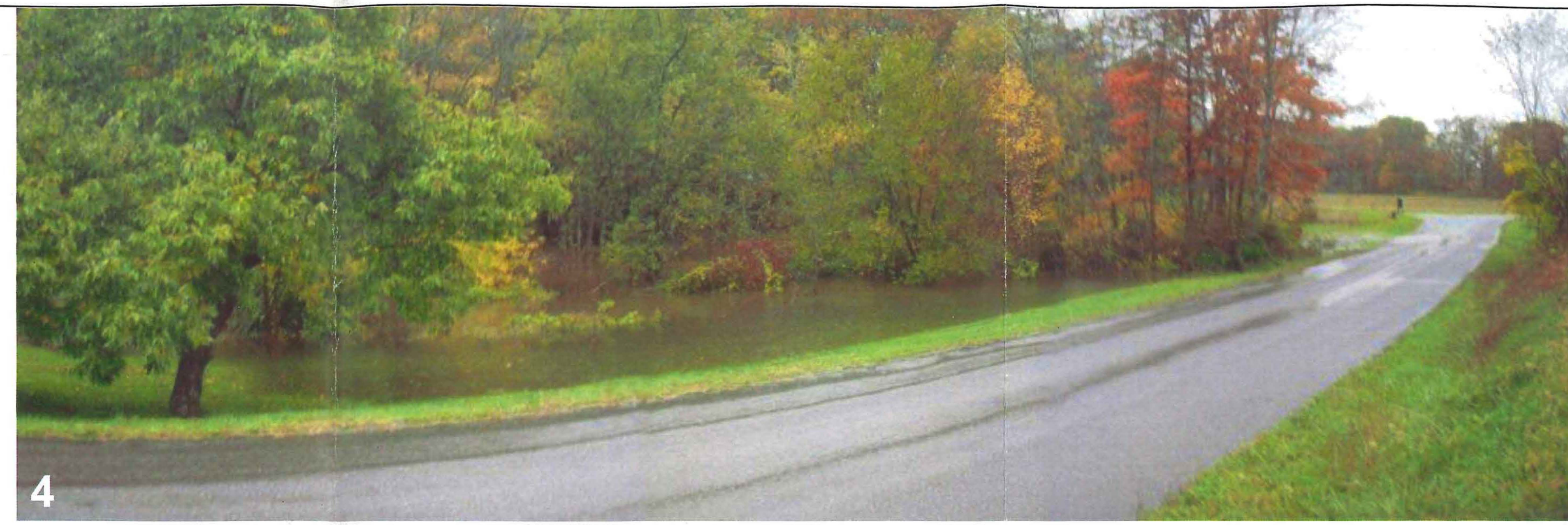
1" = 80'

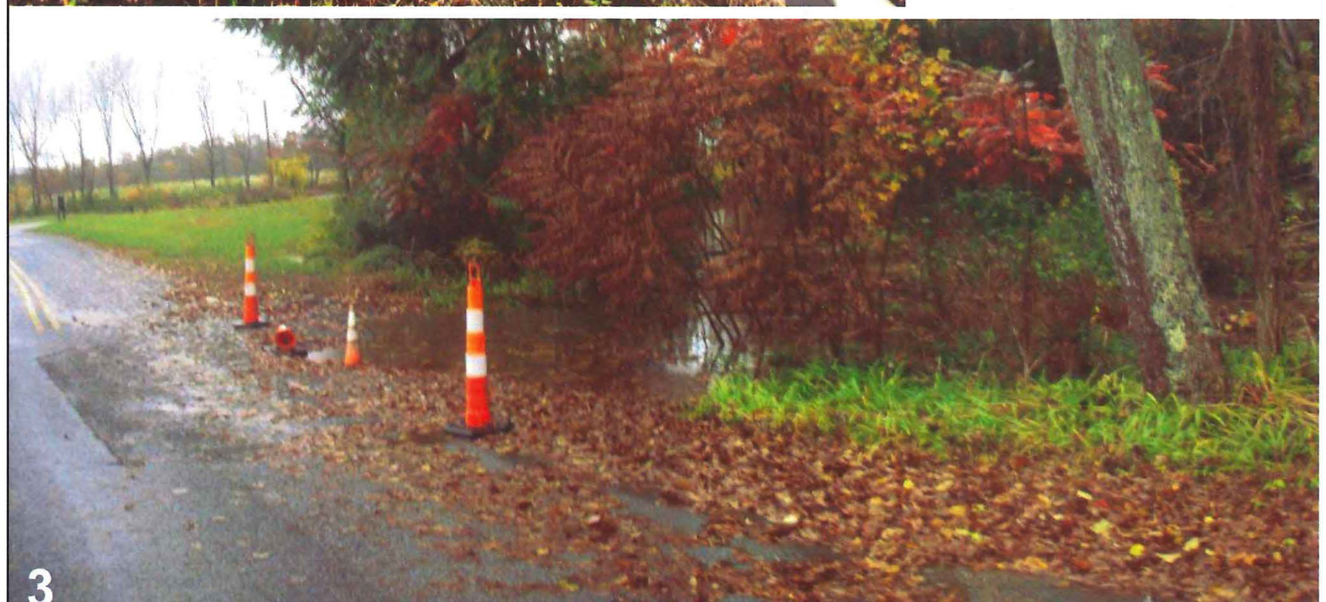
Figure 8

GEOLOGIC MAP



Source: PAMAP Imagery Program Orthophotography, 2005-07
Geology and Well Data from Faill and Wells, 1974, Plates 1 and 5
PaGWIS Well Data





1: View west along long axis of southern portion of gulf on March 2, 2009 (photo courtesy of PennDOT, District 3-0).

2: View west on October 21, 2010, showing lake at a lower level than in 2009.

3: View west on October 14, 2011, showing lake filling the gulf adjacent to repaired sinkhole in Heister Valley Road.

4: View northeast along Mountain road on October 14, 2011, showing lake filling the gulf.

5: View east of northern lobe of gulf on October 21, 2010, showing stream traversing the gulf.

6: View east on October 14, 2011 showing the lake overflowing Mountain Road.

7-10: Small swallets in floor of gulf observed on October 21, 2011

STOP 3: PENNS CAVE

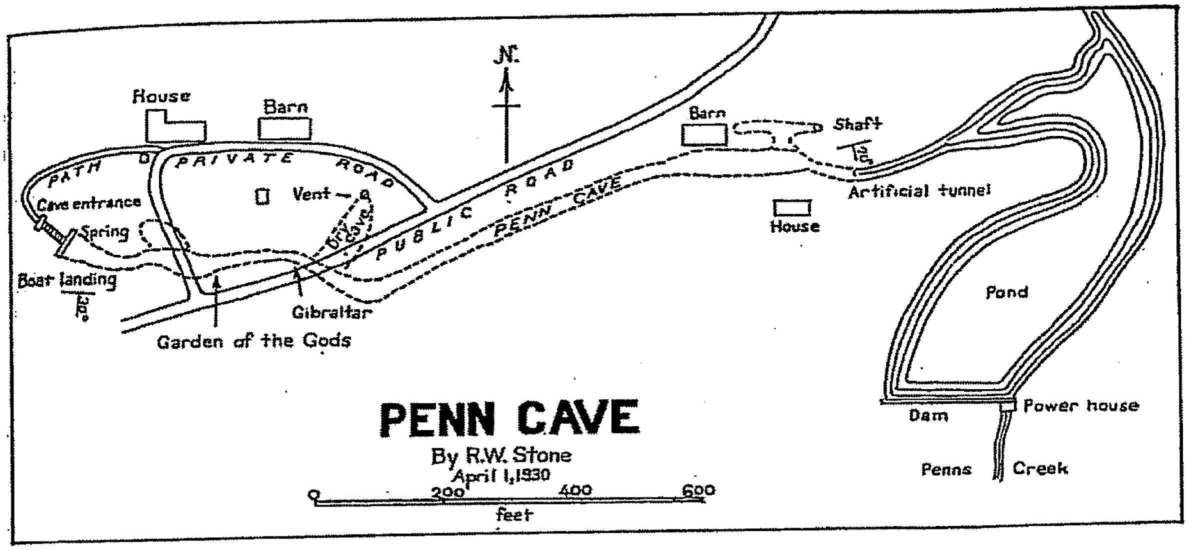


Figure 9. Map of Penn's Cave from Stone (1932).

You will no doubt hear the Indian legend and history of development of the cave from the tour guide. Maybe the guide will even be able to point out bats and wow us with the abundant speleological terminology of the underworld. We will not include any of that within our trip guide. We will however focus on the geology of the cave area (Figure 9), and formation of the cave.

Stratigraphy

Lithologic descriptions from Berg and others (1980). From oldest to youngest (Figure 10).

Benner-Loysburg Formations, Undivided

Loysburg Formation--light- to medium-gray, medium-bedded limestone (Clover Member) overlying laminated, alternating limestone, dolomitic limestone, and dolomite (Milroy ["tiger-striped"] Member).
Hatter Formation- medium-gray, fossiliferous, argillaceous limestone, laminated and dolomitic.
Snyder Formation-light- to medium-gray limestone, laminated to medium-bedded; has mud cracks, oolites, and dolomitic layers. Hatter Formation--medium-gray, fossiliferous, argillaceous limestone, laminated and dolomitic.
Benner Formation-light- to dark-gray, thick-bedded limestone (calcilutite); includes chemically pure Valentine Member at top, and, below, the less pure Valley View Member, which contains metabentonite beds--all laterally equivalent to impure limestones of Oak Hall Member; Stover Member at base is dark-gray limestone (calcilutite) having dolomite streaks; Benner is called "Linden Hall" by some workers. The cave is mainly in the Benner Formation.

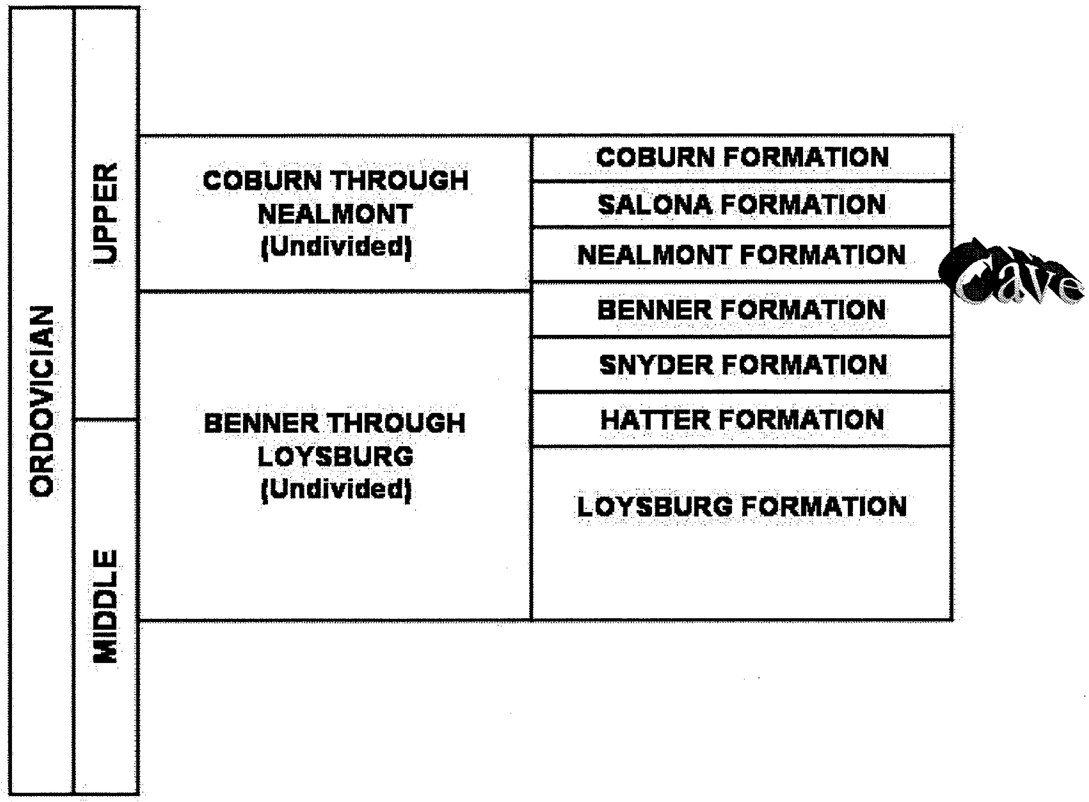


Figure 10. Stratigraphy of the Penn's Cave area. Note the cave itself is in the Benner (Linden Hall) and Nealmont Formations. Adapted from Thompson (1999).

Coburn-Nealmont Formations, Undivided

Nealmont Formation-medium-gray fossiliferous limestone (calcarenite--Rodman Member) overlying thin-bedded shaly limestone (calcilutite--Center Hall Member). Higher portions of the cave are in the Nealmont Formation.
Salona Formation-very dark gray to black, nonfossiliferous shaly limestone and calcareous shale containing metabentonite beds
Coburn Formation-medium-gray to very dark gray, very fossiliferous limestone and shaly limestone.

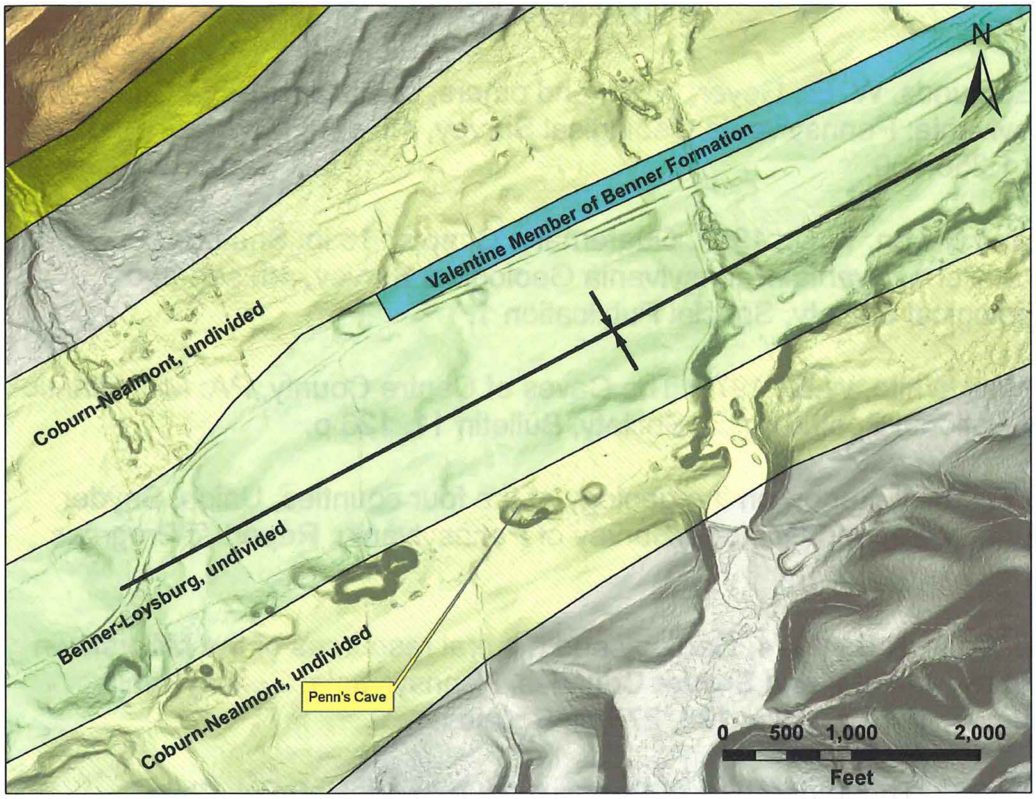


Figure 11. Geologic Map of the Penn's Cave region.

Structure

Penn's Cave occupies an anticlinal valley. In the middle of the anticline, the older Benner-Loysburg rocks are exposed. The flanks of the valley are made up of Coburn to Nealmont rocks. At the cave itself the rocks dip about thirty degrees southeast, as the cave has formed in the southern limb of the anticline.

Cave Formation

The Lidar image (Figure 11) reveals a string of depressions aligned with Penn's Cave from northeast to southwest, along the strike of the rocks. These depressions are sinks, sinkholes, and caves. Bedding of the rocks, and fractures and joints that formed during the folding of the rocks, provide conduits for water flow, which in turn dissolves the limestone. The removal of this material causes the formation of caves, and orientation of bedding and fractures controls the shape and orientation of the cave.

REFERENCES

Berg, T. M., Edmunds, W. E., Geyer, A. R., and others, compilers, 1980, Geologic map of Pennsylvania: Pennsylvania Geological Survey, 4th ser., Map 1, 2nd ed., 3 sheets, scale 1:250,000.

Crowl, G.H., and Sevon, W.D., 1999, Quaternary: Chapter 15 in: Shultz, C.H., 1999, The Geology of Pennsylvania: Pennsylvania Geological Survey, 4th ser. and Pittsburgh Geological Society, Special Publication 1.

Dayton, G.O. and White, W.B., 1979, The Caves of Centre County, PA: Mid-Atlantic Region of the National Speleological Society, Bulletin 11, 126 p.

D'Invilliers, E.V., 1891, Report on the geology of the four counties, Union, Snyder, Mifflin, and Juniata: Second Geologic Survey of Pennsylvania, Report of Progress F3.

Faill, R.T. and Wells, R.B., 1974, Geology and mineral resources of the Millerstown quadrangle, Perry, Juniata, and Snyder Counties, Pennsylvania: Pennsylvania Geological Survey, 4th Ser., Atlas 136, 276 p., 6 plates.

Gordon, S.G., 1922, The Mineralogy of Pennsylvania, Acad. Nat. Sci. Phila., Special Publication No. 1, p. 136-137.

Hibbard, J.P., van Staal, C.R., Rankin, D.W., and Williams, H., 2006, Lithotectonic map of the Appalachian Orogen, Canada—United States of America: Geologic Survey of Canada, Map 2096A, scale 1:1,500,000.

Kidder, D.L., 1985, Petrology and origin of phosphate nodules from the Midcontinent Pennsylvanian epicontinental sea: Journal of Sedimentary Research, v. 55, no. 6, p. 809-816.

Larock, E.J., ed.,1976, The Caves of Snyder County, Pennsylvania: Philadelphia Grotto, Mid-Atlantic Region of the National Speleological Society, Bulletin 10, 30 p.

Leverett, Frank, 1934, Glacial deposits outside the Wisconsin terminal moraine in Pennsylvania: Pennsylvania Geological Survey, 4th ser., General Geology Report 7 [http://www.dcnr.state.pa.us/topogeo/pub/GeneralGeology/G7/G7.aspx (accessed October 13, 2011)].

MacLachlan, D.B., Hoskins, D.M. and Payne, D.F., 1995, Bedrock geology of the Freeburg 7.5-minute quadrangle, Snyder County, Pennsylvania: Pennsylvania Geological Survey, 4th Ser., Open-File Report 95-04, 5 p., 1 map, scale 1:24,000.

Miller, B.L., 1934, Limestones of Pennsylvania: Pennsylvania Geological Survey, 4th ser., Mineral Resources Report M20.

Miller, J.T., 1961, Geology and mineral resources of the Loysville quadrangle, Pennsylvania: Pennsylvania Geological Survey, 4th ser., Atlas 127, 47 p.

O'Neill, Jr., B.J., 1964, Atlas of Pennsylvania's mineral resources, part 1. limestones and dolomites of Pennsylvania: Pennsylvania Geological Survey, 4th ser., Mineral Resources Report M50.

Sevon, W. D., 2000, Physiographic provinces of Pennsylvania, 4th edition, Pennsylvania Geological Survey, 4th ser., Map 13, scale 1:2,000,000.

Sevon, W.D., and Braun, D.D., 1997, Glacial deposits of Pennsylvania, 2nd ed.: Pennsylvania Geological Survey, 4th ser., Map 59, scale 1:2,000,000 http://www.dcnr.state.pa.us/topogeo/maps/map59.pdf (accessed October 13, 2011)].

Soil Survey Staff, 2010, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey [http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx (accessed October 13, 2011)].

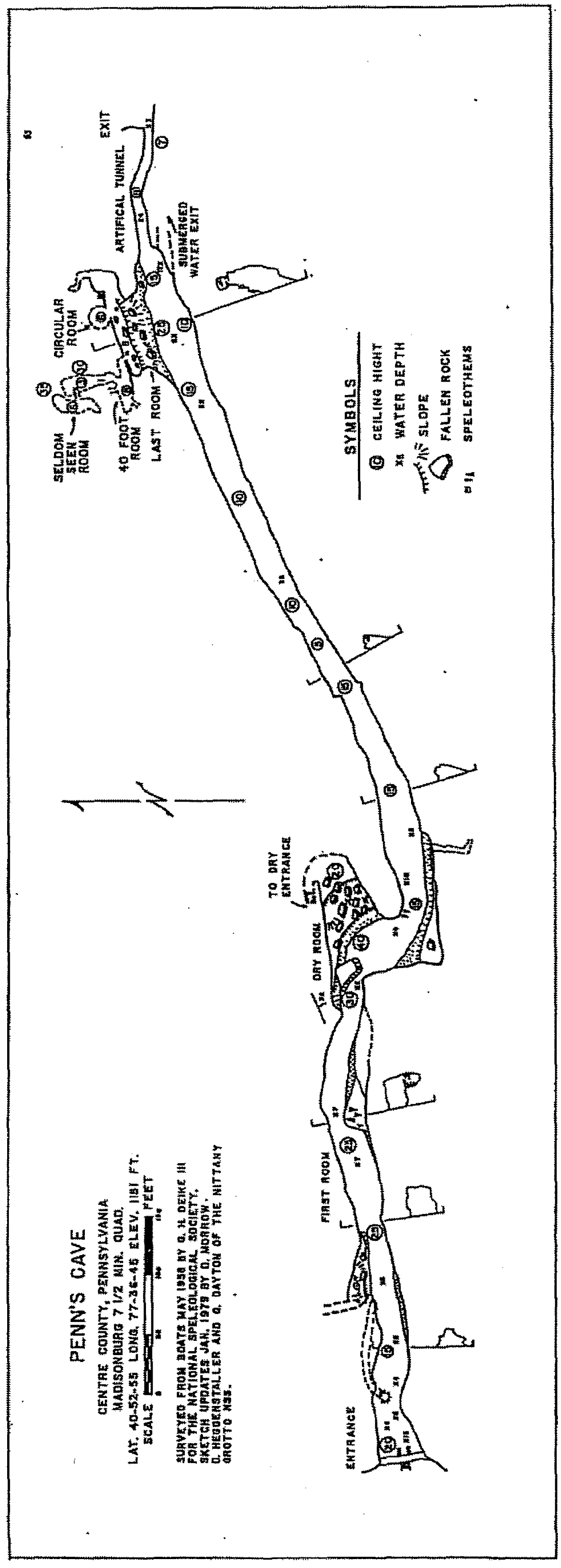
Stone, R.W., 1932, Pennsylvania Caves: Pennsylvania Geological Survey, 4th Ser., Bulletin G 3, 143 p.

Thompson, A.M., 1999, Ordovician: Chapter 5 in Shultz, C.H., 1999, The Geology of Pennsylvania: Pennsylvania Geological Survey and Pittsburgh Geological Society, 4th sers., Special Publication 1, p. 75-89.

Woodward, H.P., 1943, Devonian System of West Virginia: West Virginia Geological Survey, vol. 15, 655 p.

Appendix 1

This is a reprint of Dayton and Whites (1979) write up on Penn's Cave, found in <u>The Caves of Centre County, PA</u>: Mid-Atlantic Region of the National Speleological Society, Bulletin 11.



CE 37 PENN'S CAVE

Commercially-operated Penn's Cave is located at the western end of Brush Valley just off the nose of Brush Mountain, 5 miles east of Centre Hall. The large stream that rises in the cave forms the headwaters of Penns Creek.

The cave has two natural entrances. The water entrance opens from the bottom of a sinkhole several hundred feet in diameter and 75 feet deep. This entrance is at the water level defined by the underground stream and here there is a boat dock from which visitors are taken through the cave. The second, or dry entrance, is at the bottom of a small sink in the front yard of the Cave House. A third entrance was opened in 1929 by blasting a 75-foot tunnel through rock at the downstream end of the cave to permit boats to emerge onto a lake created by a small dam on Penns Creek, turn, and return through the cave.

The cave figures prominently in the tales and legends of the Valley of the Karoondinha, as the Indians called Penns Creek. Into these tales comes Nita-nee, legendary Indian princess, whose burial mound is said to be nothing less than Nittany Mountain itself raised over her grave in one night by The Great Spirit. (Shoemaker, 1950).

Penn's Cave and Penns Creek received their names from John Penn, grandson of William Penn. The large tract of land on which the cave is located was originally granted to James Poe in 1773, and the cave has been well known to local residents at least since that time. In 1860 the underground stream that flows through the cave was first traversed on raft by Issac Paxton and Albert Woods (Stone, 1932). In 1884 Jessie and Samuel Long came into possession of the property and realized the potential of a show cave. They built the Penn's Cave Hotel about 1885 and the cave began to attract visitors. Apparently business was not good enough, for after a period of years the enterprise was abandoned and the hotel and cave were deserted. In 1908 H.C. and R.P. Campbell purchased the property and put the cave on a solid commercial basis. Penn's Cave has been operated by the Campbell family ever since.

Penn's Cave is the downstream section of a master trunk drain for the groundwater in the western portion of Brush Valley. The cave consists of two superimposed passages. The lower component of the trunk is the stream passage. The upper component is discontinuous, in part overlapping and continous with the lower trunk, in other places forming the upper level rooms of the dry portion of the cave. The upstream termination of the cave is the entrance sink, but Penn's Cave Shelter is probably a fragment of the upstream portion. West of the entrance sink are several other steep deep sinkholes which likely mark the line of the partially collapsed trunk. No access to the upstream reaches of the trunk drain system beyond the sinkholes has been found. The downstream end of the Penn's Cave trunk is the spring from which Penns Creek emerges. The upper level terminates in breakdown at both ends.

The stream that flows through Penn's Cave rises from beneath the sinkhole breakdown just below the boat dock. The entire lower level is water-filled so that boats can traverse the cave. Water level is defined by the level of Lake Nitanee which is held by a small dam on Penns Creek about a quarter of a mile downstream from the downstream opening of the cave.

The entrance at the boat dock is a broad, smoothly-arched tunnel 20 feet wide and 10 feet high. Both walls come down to meet the water. The tunnel opens after 150 feet into a high-arched-ceiling room where the upper level comes in from the north and merges with the lower level to more than double its height. High ledges and balconys on both sides of the passage, remnants of the old floor of the upper level, are well-decorated with dripstone. From the First Room, the high ceilinged passage continues for 250 feet to the Dry Room. The Dry Room is a large chamber with the water-filled lower level along the south wall and a sandy shore and breakdown slope rising upward to the ceiling to the east. By climbing the breakdown slope one comes to a fragment of the upper level continuing along the same bearing as the main cave passage which soon ends in collapse. The Dry Entrance to the cave is located here.

Massive breakdown blocks, fallen into the stream, have created a narrow way: the "Straits of Gibraltar" just large enough to permit the boats to pass through. Beyond the straits, the lower level passage jogs to the south, crosses the bedding and then turns northeastward again following the strike but off-set from the line of the upper level passage. The inner section of the cave is a triangular-shaped passage formed by a bedding plane that makes up the ceiling and an irregular solution-sculptured wall along the north side. Sand bars and mud-flats occur so that here the stream has a sort of shore line. It is more than 500 feet from the jog to the point where the ceiling of the passage plunges below water level and the boat way enters artificial tunnel from which it emerges into a narrow defile which leads out to the lake.

Just upstream from the artificial tunnel, the Last Room opens on the north side of the passage. It appears to be another fragment of the upper level. The floor of the room rises steeply over a breakdown slope from the water's edge to a decorated chamber at the top of the slope. The south wall of both the upper and lower level are a single sloping limestone bed.

In the Last Room are a number of small decorated passages. In the northwest corner one can climb behind the columns to enter a parallel room (the Forty Foot Room) which is 20 by 40 feet and 8 feet high. Trending north from this room is a 45-foot passage and room which slopes south with a ceiling height of one foot at the southern end and 3 feet at the north end. At the northern end of the low passage a hole in the floor drops into the Seldom Seen Room, 25 x 30 feet and 6 feet high, sloping west. In the northeast corner of the Last Room is an opening to a small circular room that is roughly 6 feet high. In the eastern end of the Last Room, just to the east of the Circular Room, is an artificial electrical and air shaft to the surface. In the extreme eastern end of the Last Room is a small passage approximately 2.5 feet high and wide that snakes itself for some 40 feet to the north.

Recently explorations by the operating staff have revealed several side passages not seen on the regular tour. The first of these is just inside the main entrance where an opening in the ceiling extends above the lower level passage and re-enters it in the north wall just before the First Room. In the north wall of the First Room is a passage that reportedly is over 200 feet long and trends northwest. Just beyond the Dry Room in the south wall at the beginning of the straight Tunnel is a passage roughly 20 feet long that ends in a mud plug.

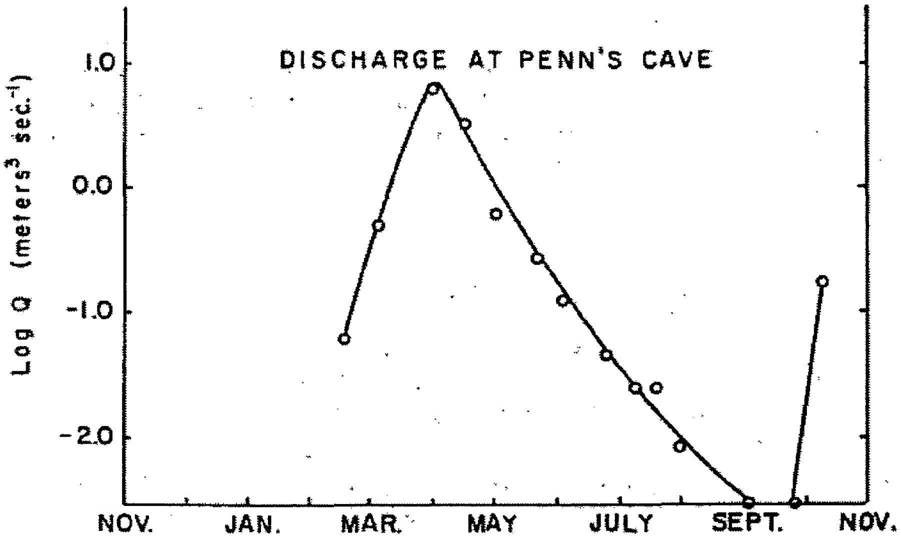
Penn's Cave is formed in the Nealmont and Linden Hall formations which here dip 33° SE and strike N 69° E. The stratigraphically-highest portions of the cave extend about 10 feet into the Rodman limestone member. The cave spans the 31 feet of Centre Hall member of the Nealmont limestone and the 74 feet of the Oak Hall member of The Linden Hall formation. The lowest portions of the cave extend about 10 feet down into the Stover member of the Linden Hall formation. According to Rauch's (1972) measurements, Penn's Cave contains 600,000 ft^3 of volume, 25% of which is in the Centre Hall and 60% of which is in the Oak Hall limestones.

The cave is a classic example of cavern development along strike joints. Both main segments of the lower level are developed along the strike of the limestone. The single short segment that crosses the bedding near the Straits of Gibraltar has a much smaller cross-section. Passage walls consist either of flat-bedding plane surfaces probably where breakdown has peeled away or smoothly sculptured surfaces. The north walls of the lower level are usually smoothly sculptured with bedding plane grooves as prominent features. The south wall in the high reach of passage between the First Room and the Dry Room is also sculptured. Most of the remainder of the south wall is a smooth bedding plane surface.

Penn's Cave is well decorated with speleothems. Soda straw and small pendant stalactites are common; draperies and related forms less so. Stalagmites are either of the narrow cylindrical "broomhandle" style or are terraced cylindrical styles. Location of joints bringing in surface waters are often mapped on the ceiling by lines of stalactites. Minerals or speleothems, other than the calcite dripstone and flowstone assembledges, have not been noted.

The Penn's Cave rising is a major regional resurgance. The flow varies (White and Stellmack, 1965) from 1-2 cfs at base flow to 230 cfs at peak flow. The annual hydrograph is a smooth seasonal curve peaking in the spring when there is high precipitation and snows are melting out of the mountains. Base flow conditions occur in September and October when ground water levels are low and there is little recharge . The catchment area for the cave is not known. Various attempts at dye tracing from the sinking streams along Nittany Mountain to the cave (e.g. McDuffee, 1956) have met with little success. However, the cave is the only resurgance in the area. It appears that the drainage basin extends westward beyond Centre Hall where there is a divide between the Penns Creek and Spring Creek basins, and eastward to the divide with the drainage as to Spring Bank. The topographic divide is about half way between the two springs, three miles east of Penn's Cave but there is no certainty that the underground divide is coincident with the topographic divide. Typical specific discharge for karst spring base flow is 0.1 to 0.2 cfs/mi^2 which would imply a catchment for Penn's Cave of about 10 square miles, smaller by a factor of 2 or so from the area encompassed by the surface divides. However, there seems little doubt that the group of sinking streams flowing from Nittany Mountain for the first five or so miles east of Centre Hall including the large stream at Ellenberger Gap (Deerbone Cave) must eventually reappear at the Penn's Cave rising. How these waters cross the anticlinal fold of Brush Valley transverse to the structure remains a mystery.

The chemistry of the waters emerging from Penn's Cave has been subject to several studies (e.g. Shuster and White, 1971). Water hardness and water temperature undergo considerable variation with season of the year and with local storms, indicating that Penn's Cave discharge is from a system of conduits rather than the outlet from a diffuse body of groundwater. It seems almost certain from chemical, hydrological, and geological evidence that there is much cave still undiscovered upstream from the group of sinkholes that terminate the upstream end of the Penn's Cave trunk.



Hydrograph at Penn's Cave Rising for 1962 water year

References

McDuffee, Ruth G. (1956) The development, occurrence, movement and quantity of ground water in the carbonate rocks of Brush Valley, Pennsylvania. B.S. Thesis, Dept. of Geology, The Pennsylvania State University, 44pp.

Rauch, Henry W. (1972) The effects of lithology and other hydrogeologic factors on the development of solution porosity in the Middle Ordovician carbonates of Central Pennsylvania. Ph.D. Thesis, Geochemistry, The Pennsylvania State University, 530pp.

Shoemaker, Henry W. (1950) Penn's Cave, The Telegraph Press, Harrisburg, 109pp

Shuster, Evan T. and William B. White (1971) Seasonal fluctuations in the chemistry of limestone springs: A possible means for characterizing carbonate aquifers. Jour. Hydrol. 14, 93-128.

Stone, Ralph W. (1932) Pennsylvania Caves. Pennsylvania Topographic and Geologic Survey Bull. G-3, 41-45.

White, William B. and John A. Stellmack (1965) Seasonal fluctuations in the chemistry of karst groundwater. Proc. 6th Internatl. Congress Speleol., Ljubljana, Yugoslavia, 3, 261-267.

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