Guidebook for the 5th Annual Field Trip of the

HARRISBURG AREA GEOLOGICAL SOCIETY

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SELECTED GEOLOGY OF DAUPHIN AND NORTHUMBERLAND COUNTIES, PENNSYLVANIA

by

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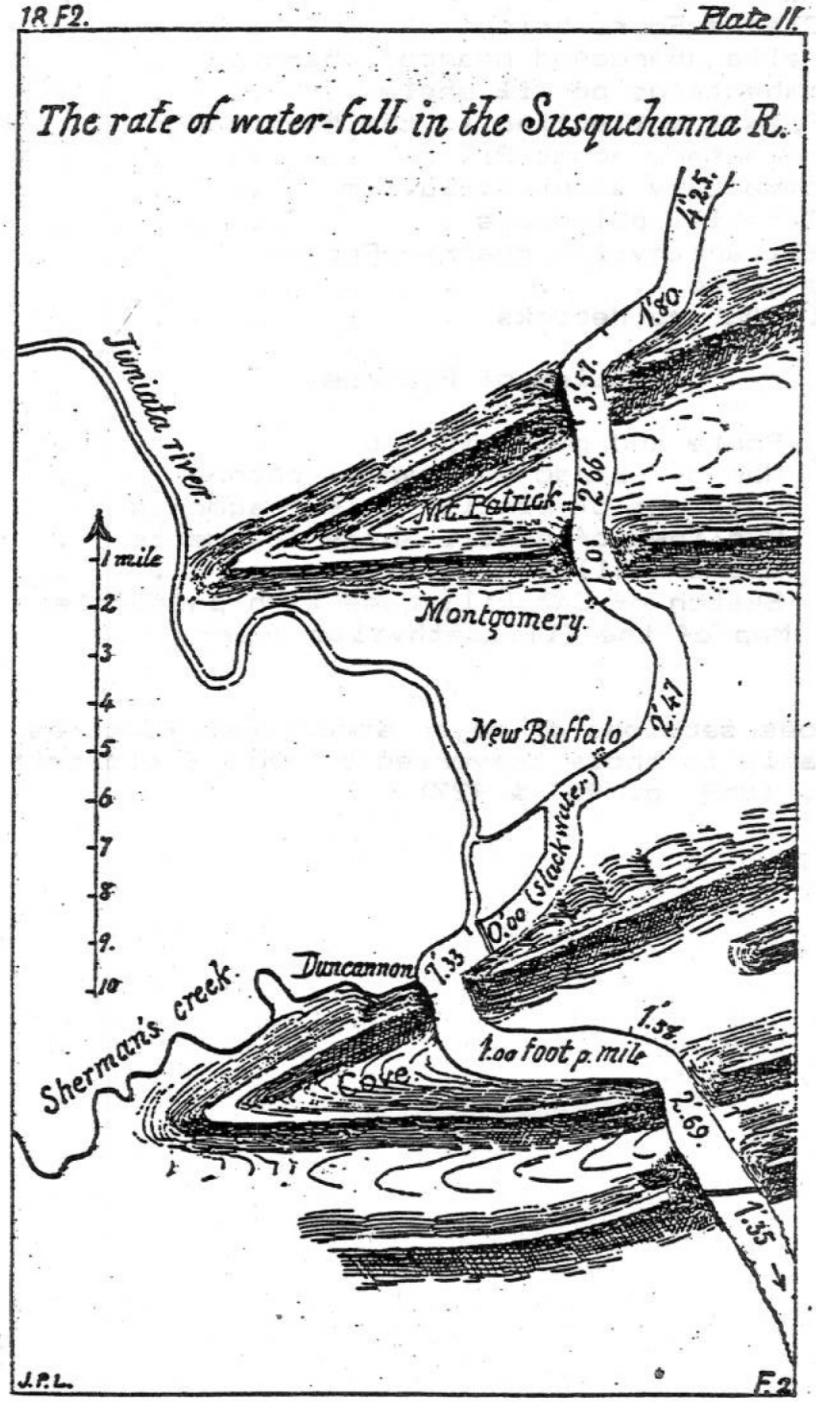
COVER: Cross sections of major structural features comparable to those traversed by this field trip (from Rogers, 1858, p. 923 & 927).



Frontispiece. The five anomalous water gaps north of Harrisburg (from Claypole, 1885, p. 18).

SELECTED GEOLOGY OF DAUPHIN AND NORTHUMBERLAND COUNTIES, PENNSYLVANIA

Introduction

This guidebook is the continuation of a tradition started in 1982 when the Harrisburg Area Geological Society conducted its first annual field trip. Subsequent field trips occurred in 1983, 1984, and 1985. Each trip has visited interesting geological sites in the general Harrisburg area and has held to the original intent of providing information about good geologic sites which might never be included in any other field trip. The first two trips were geologically diverse; the second two focused on specific themes.

This field trip presents an array of geologic items and is the first HAGS trip to examine geology exclusively north of Blue Mountain. the trip route follows the Susquehanna River north through the water gaps in Blue, Second, Peters, Berry, and Mahantango Mountains (Frontispiece). These water gaps are spectacular in appearance and have long been the subject of speculation about why the Susquehanna River cut through the resistant ridge-forming rocks where it did (Sevon, 1986).

The route (Figure 1) diverges from the Susquehanna River near Dalmatia and traverses across some of the valleys and ridges typical of the Appalachian Mountain Section of the Valley and Ridge Physiographic Province. Most aspects of the landscape typical of the Appalachian Section in Pennsylvania can be observed along this route. An excellent overview of the landscape features is available at Stop 6 on Berry Mountain.

Contributions to this guidebook and leadership on the field trip are as follows: Stop 1, Pete Wilshusen; Stops 2, 3, 4, 5, and part of 6, Bill Sevon; and Stop 6, Bill Edmunds and Bob Ganis. The guidebook was assembled by Sevon who assumes responsibility for any errors.

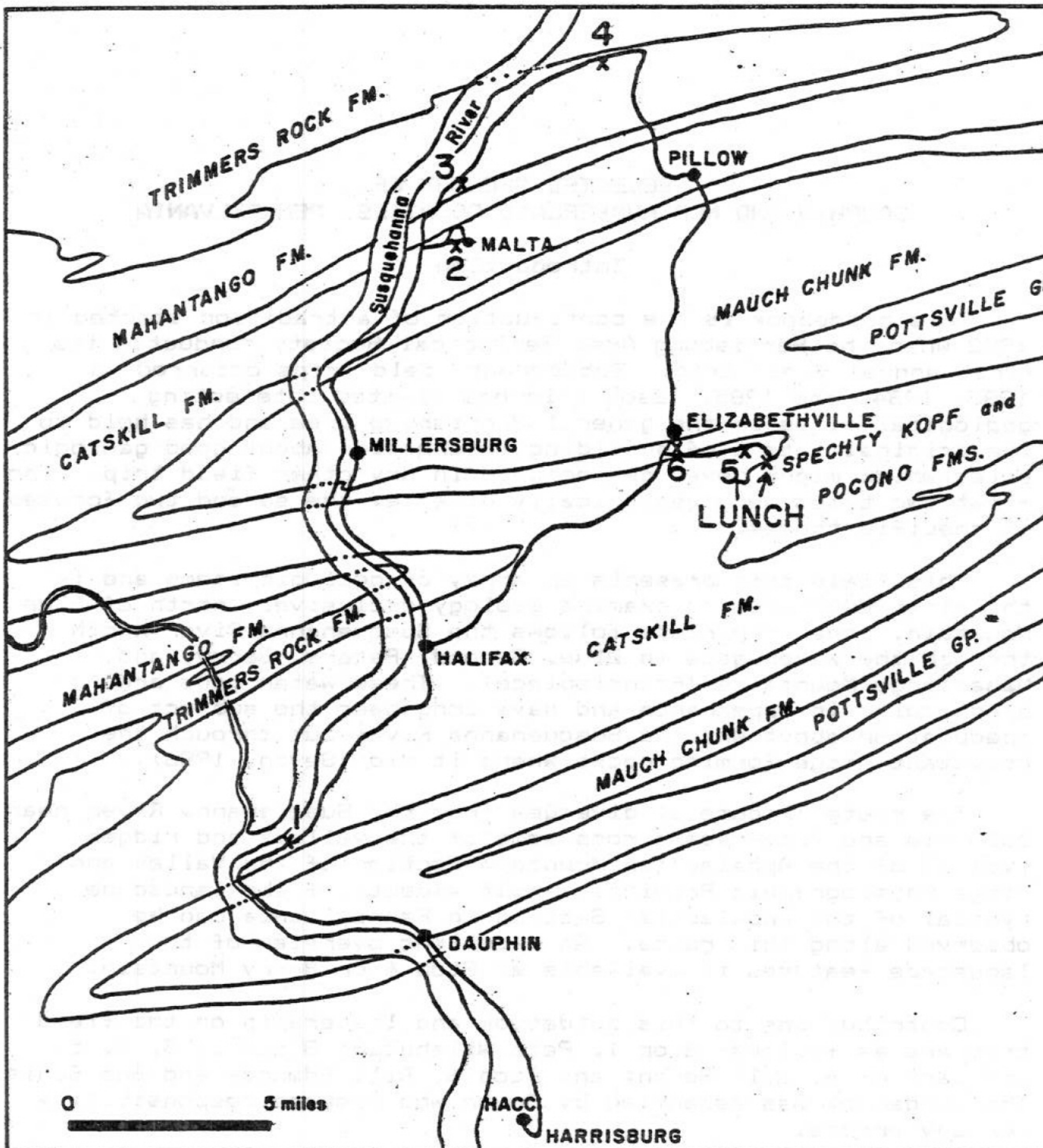


Figure 1. Map showing field trip route, location of stops, and geology as generalized from Berg and others, (1980).

ROAD LOG AND STOP DESCRIPTIONS

Mileage Inc	Cum	
0.0	0.0	**LEAVE** Harrisburg Area Community College east parking lot from telephone booth area.
0.2	0.2	**TURN LEFT** to Cameron Street.
0.3	0.5	**STOP SIGN. TURN LEFT** to Cameron Street.
0.2	0.7	**STOP LIGHT. TURN LEFT** onto Cameron Street. **GO STRAIGHT** ahead on US Routes 22 & 322.
3.3	4.0	Road cut on right is site of Stop 1, 1985 HAGS trip. Tuscarora Formation exposed in roadcut is different in facies from most Tuscarora. The rocks are very faulted and this structural complexity may contribute to the location of the water gap in Blue Mountain (Sevon, 1986).
0.4	4.4	Roadcut on right is in the Montebello Member of the Mahantango Formation.
1.4	5.8	Outcrops above road level along railroad track are in the Duncannon Member of the Catskill Formation.
0.4	6.2	Outcrops above road level along railroad track are in the Pocono Formation. **GET IN THE LEFT LANE FOR THROUGH TRAFFIC.** Town of Dauphin. The Pocono Formation forms Second Mountain through which the Susquehanna River has carved the second impressive water gap.
2.0	8.2	Numerous outcrops ahead on the right of the Mauch Chunk Formation.
3.7	11.9	Outcrops ahead on the right are the Peters Mountain section which starts in the Pocono Formation on the south end and proceeds stratigraphically downward through the Spechty Kopf Formation and the Duncannon, Clarks Ferry, and Shermans Creek Members of the Catskill Formation. The third water gap of the Susquehanna River is cut through these resistant rocks.
0.2	12.1	Deeply eroded zone on right is outcrop of Triassic diabase dike.
0.7	12.8	PA Route 147 N bears right. **CONTINUE STRAIGHT AHEAD** on US Routes 22 & 322.
0.8	13.6	West end of Clarks Ferry bridge. **TURN LEFT** onto paved road.
0.1	13.7	**TURN LEFT** into parking area. **STOP 1.**

CLARKS FERRY BRIDGE

The bridge under construction at Clarks Ferry replaces an old 2-lane structure built in 1925. This bridge is the newest of 7 bridges that have spanned the Susquehanna River at this well-traveled crossing. The first bridge was built in 1828 for the canal Commissioners and had to be rebuilt several times due to floods or fires (Shank, 1977). These early structures served the need for transportation by stage coach, canal boat, horse, foot, bicycle, and motor vehicle. The series of historic wooden covered bridges at Clarks Ferry had outboard towpaths on the downstream side to accomodate mules and teamsters pulling canal boats across the river serving both the Susquehanna and Juniata River canal systems. The walkway on the downstream side of the new bridge is part of the Appalachian Trail. Pier foundations of the old bridges can be seen at low water upstream from the newest bridge and the remains of a dam, constructed to pond water for canal boat crossings, are visible downstream.

The new bridge is founded on rocks of the Sherman Creek Member of the Devonian Catskill Formation which comprises alternating grayish-red siltstone in poorly defined, fining upward cycles, and minor intervals of gray sandstone (Berg and others, 1980). Strike is nearly perpendicular to the axis of the bridge (Figure 1) with bedding dips of 35°SE on the north limb of the Cove Syncline. This syncline encompasses the southeasternmost fin of the southern fish tail of the anthracite mining district. Old coal mines in the vicinity of Stony Creek about 20 miles east of this stop are on the fold axis.

A significant regional geologic feature closer to the bridge is a prominent bench alng the flank of Peters Mountain above the left bridge abutment. It is formed on a resistant unit of the Catskill Formation, the Clarks Ferry Member, which is gray to grayish-red, crossbedded sandstone and quartzite, in part conglomeratic, containing red shale pebbles (Dyson, 1963). Across the river, along strike to the southwest, the Clarks Ferry Member also forms Pine Ridge south of Duncannon.

Bridge piers in the river are on bedrock, but access structures involve construction on soils. The Pennsylvania Department of Transportation Final Report of the Soils and Geological Engineering Investigation dated April, 1984 contains the following (p. 11-12):

"The surficial materials along the flanks of the ridges consist of a thin veneer of colluvium derived from parent materials at higher elevations on the Ridge. Along the Juniata and Susquehanna Rivers, the surficial materials consist of Pleistocene terrace deposits underlain by glacial outwash of the Wisconsin glaciation. The Pleistocene terrace deposits are mined for sand and gravel. The soil overlying the Irish Valley Member is characterized by red and gray bands.

The soil types in the Project area. . .consist of urban land (alluvial deposits) and the Tioga series. Field observations indicate the urban land to consist of shale and sandstone boulders, cobbles and rock fragments in a silty sand or sandy silt soil matrix. The Tioga series consists of fine sandy silt soils which typically have an AASHTO classification of A-4. Typical engineering properites of the Tioga series include a maximum dry density of 115 to 120 pcf at an optimum moisture content of 9 to 11 percent. It has a low shrink-swell potential, a slight erosion hazard, a low steel corrosion potential and is moderately frost susceptible."

Also, a layer of soft, gray clay varying from 4 to 12 feet thick was encountered in some borings at depths of 16 to 23 feet.

The clay coincides with the location of the old Pennsylvania canal system.

Geologically this is not a difficult site for bridge design and construction. The main environmental concerns are with flooding and river ice. When river ice begins to break up and move because of increasing temperatures in late winter, imbricate flows can form and collide at the confluence of the Susquehanna and Juniata Rivers.

		LEAVE STOP 1. TURN RIGHT onto paved road.
0.1	13.8	**BEAR RIGHT** TO STOP SIGN. **TURN RIGHT** and recross the Clarks Ferry bridge.
1.1	14.9	**BEAR RIGHT** to PA Route 147. **NOTE:** this is a temporary routing because of construction of the bridge. When construction is completed, access to PA Route 147 N will be at the east end of the bridge.
0.1	15.9	**STOP LIGHT. TURN LEFT** onto US Routes 22 & 322.
0.5	16.4	**BEAR RIGHT** onto PA Route 147 N.
0.5	16.9	Alternate Stop 1 is here. Park on berm on right and cross road to view river and bridge.
5.7	22.6	**STOP SIGN. TURN LEFT** on PA Routes 147 N and 225 N.
1.5	24.1	**TURN LEFT** following PA Route 147 N in Halifax.
0.1	24.2	**TURN RIGHT** following PA Route 147 N.
4.6	28.8	Outcrops on right of Spechty Kopf and then Pocono Formations form Berry Mountain. This is the fourth water gap on the route.
1.3	30.1	Welcome to Millersburg.
0.3	30.4	Road on right leads to the Millersburg Ferry.
2.0	32.4	Mahantango Mountain. Outcrops descending from Pocono through Spechty Kopf into Catskill Formation. This is the fifth water gap.
4.1	36.5	Cross Mahantango Creek at Northumberland County line.
0.3	36.8	**TURN RIGHT** onto Mahantango Creek Road.
0.6	37.4	**TURN LEFT** on unmarked road at top of hill.
0.6	38.0	Descend from dissected uplands of the Harrisburg topographic surface into abandoned meander channel of Mahantango Creek. Note steep bank on left cut into rocks of the Trimmers Rock Formation and the flat surface traversed by the road. Hoskins (1976) mapped Wisconsinan alluvium in the area. No alluvium is readily visible from the road, but rounded pebbles and cobbles are present in the fields. The floor of this abandoned meander channel is approximately 130 feet above the present level of Mahantango Creek less than a mile to the south. Refer to Stop 2 for further discussion.
0.6	38.6	**TURN RIGHT** onto paved road.
0.1	38.7	View to right of abandoned meander channel.
0.3	39.0	**STOP SIGN. TURN RIGHT** onto Mahantango Creek Road in Malta.
0.4	39.4	**STOP 2.** Park bus on berm on right and walk back to outcrop at top of small hill. Road is narrow, but vehicle frequency is low. Be cautious!

MALTA ABANDONED MEANDER CHANNEL

The road cutbank on the north side of the road exposes alluvial sediment. The sediment is yellowish red (5YR5/6) in color and comprises a mixture of clay, silt, sand, pebbles, and cobbles. The pebbles and cobbles are rounded, subrounded, and angular and composed of a variety of lithologies presumably derived from bedrock sources within the valley. A washed sample of material collected from the cutbank contained mainly red and gray sandstone, siltstone, and claystone fragments.

Figure 2 shows the location of this abandoned meander core and its relationship to Mahantango Creek and the nearby Susquehanna River. The figure also shows the location of some

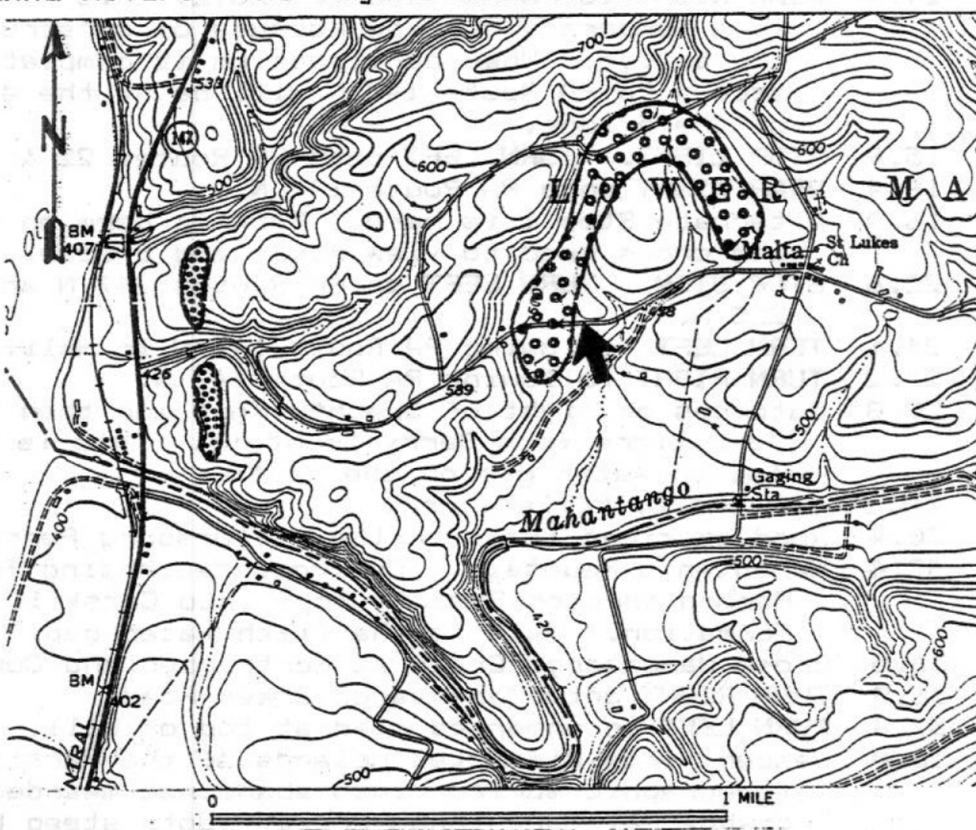


Figure 2. Abandoned meander channel of Mahantango Creek at Malta. Open circles indicate area of former meander; dots, areas of pre-Wisconsinan terrace gravels; and arrow, location of Stop 2.

of the alluvial and outwash materials mapped in the area by Hoskins (1976). These deposits and the topographic relationships in the area are critical to interpretation of this old meander channel. Hoskins (1976) mapped the sediment here as Wisconsinan alluvium, but did not discuss this site specifically. He attributed this and similar high level deposits along tributaries to the Susquehanna River to deposition contemporaneous with deposition of Wisconsinan outwash along the Susquehanna River. An evaluation of the origin and age of the deposit is in order. There seems little doubt that the deposit exposed here is related to the topographic expression of a former stream meander.

It also seems logical that the stream which cut the meander and deposited the alluvial sediment was Mahantango Creek. There is no obvious indication as to how Mahantango Creek progressed from here to its present position. It is possible that the creek meandered to the point that it cut off the meander and that the abandoned channel was once an oxbow. There is little evidence for that except that the topography (Figure 2) to the south of the road suggests that Mahantango Creek carved another cutbank about 60 feet above the present creek level and that the extended meander loop was gone by that time. Having accepted the mechanism for the topographic form and associated sediment, the question remains, when and why did Mahantango Creek meander?

Hoskins (1976) suggested that the deposition, and presumably the meander channel cutting, occurred during the Wisconsinan. Hoskins does not discuss the mechanics of this deposition with regard to stream downcutting and valley fill. Sevon (1985a, p. 18-19) suggested that the Susquehanna River was eroded to essentially its present level prior to the Pleistocene and that Pleistocene outwash deposits represent valley fill. Thus, as the Susquehanna River valley filled with gravel, the gradients of the tributaries would be altered, deposition would occur, and streams would be able to meander at higher levels. It is possible that as the Susquehanna River valley filled with glacial outwash and the Mahantango Creek valley responded in kind with alluvium, a position was reached where the creek meandered on an alluvial surface and cut the bank of the abandoned meander channel. Continued meandering resulted in meander cutoff and continued erosion of unconsolidated sediments has removed most of the fill which once was present in Mahantango Creek valley.

When did this happen? Hoskins (1976) says Wisconsinan. The color of the alluvial sediment, yellowish red, and the weathering of many of the clasts suggests that the weathering correlates with materials elsewhere in Pennsylvania which are thought to have been deposited during the Illinoian and subsequently weathered during the Sangamonian. This dating is supported by the relationship of similar elevation between the abandoned meander channel and pre-Wisconsinan terrace deposits near the mouth of Mahantango Creek. A much older age, Tertiary (?), can be rejected because of the lack of weathering of some of the sediment clasts and because of the meander channel position below the general level of the Harrisburg topographic surface of presumed Early Tertiary age.

LEAVE STOP 2. PROCEED STRAIGHT AHEAD.

1.1 40.5 **STOP SIGN. TURN RIGHT** onto PA Route 147 N.

1.7 42.2 **STOP 3.** Park in borrow pit area on right just beyond the crest of the hill.

PENCIL SHALE IN THE MAHANTANGO FORMATION

The large borrow pit opened here in the Fisher Ridge Member of the Mahantango Formation exposes two contrasting examples of pencil shale. Pencil shale, sometimes called pencil cleavage, is a general term applied to a type of rock fragmentation which produces thin, elongate pieces of rock often with a point at the end and sometimes with a shape resembling a pencil. The shape is presumably controlled by the intersection of planes of bedding and cleavage. Bedding here strikes N53E and dips 19°S. Cleavage strikes N74E and dips 71° N. The Fisher Ridge Member is composed of dark- to medium-gray siltstone and claystone with some medium-gray very fine grained sandstone. The siltstones and claystones are laminated and bed thickness ranges from 2.5 to 30 cm. Fractures are common and are spaced 0.3 to 1.8 m apart. Cleavage is well developed. Some beds show good exfoliation weathering with the resultant spheroidal shapes. A few elongate concretions, up to 55 x 22 x 15 cm, occur in the lower and middle parts of the borrow pit as do some siderite nodules up to 4 cm in diameter. Fossils are rare.

The rock above road level (parking area level) has small pencil shale fragments and the lower part of the exposed sequence has large pencil shale fragments. The pencil shale fragments of the upper part have a visual relationship with the bedding and cleavage planes. The relationship is not as evident in the lower part of the pit.

An intact handful of fractured shale from the upper part of the pit was gently broken allowing the mass to fragment naturally. The mass produced 39 thin, elongate fragments ranging in length from 15.8 to 2.5 cm. Arranged in order of decreasing length, each fragment had a mean difference of 0.35 cm in length from its ranked neighbors and a variance value of 0.37 cm. Two other axes of each fragment were measured at the center of the fragment length. The mean values were 0.7 and 0.5 cm with a variance value of 0.2 cm for each axis. The range of values for these other axes was considerably less than for the length: 1.3-0.3 cm and 0.9-0.2 cm. Most of the fragments had a suggestion of rectangular shape, but all had curved and irregularly shaped faces (Figure 3). Fragment faces were rough in texture and suggested that the rock was either a siltstone or had a high microcrystalline silica content. Many fragments had well-developed points at both ends and most had a point at one end. The size and shapes of this group of fragments seems representative of those observed in this part of the pit. The word splintery seems an appropriate descriptive adjective for these fragments.

The pencil shale in the lower part of the pit is considerably different. The fragments are much longer: up to 52 cm long observed and over 25 cm long common. The fragment dimensions normal to length are generally less than 2 cm and one dimension is frequently between 1/2 and 3/4 the value of the other. The fragments are very irregular in shape, frequently with more than 4 faces normal to length, and lateral changes in the number and orientation of the faces occur often. The faces are very smooth and always curved (Figure 4). Most fragments have well developed points at one end and many at both. The material appears to be claystone and is very dark gray in color in contrast to the black color of the other pencil shale.

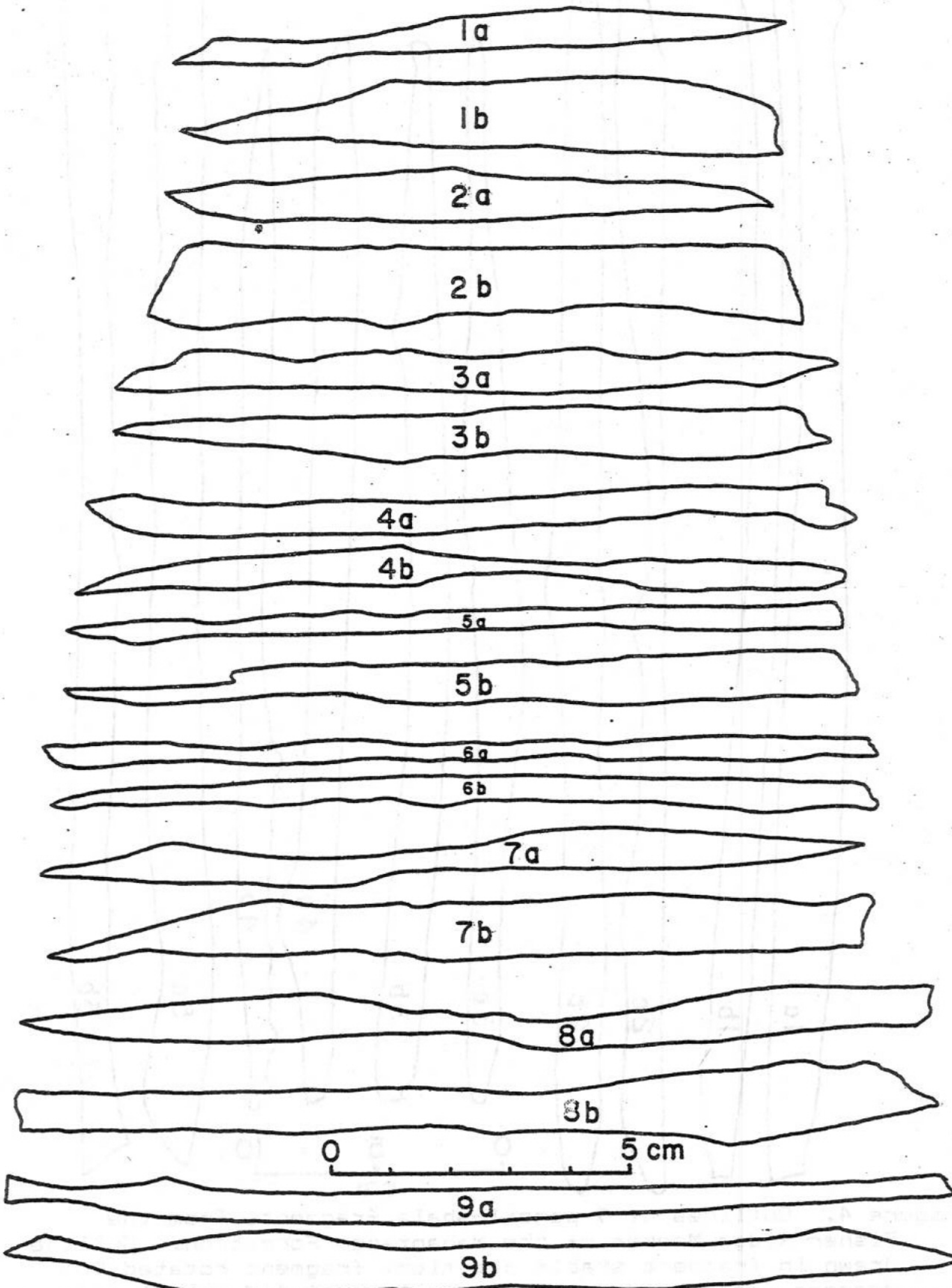


Figure 3. Outlines of 9 pencil-shale fragments from the Fisher Ridge Member of the Mahantango Formation. Outline drawn in fragment stable position; fragment rotated 90 degrees for second outline. Outlines are actual size.

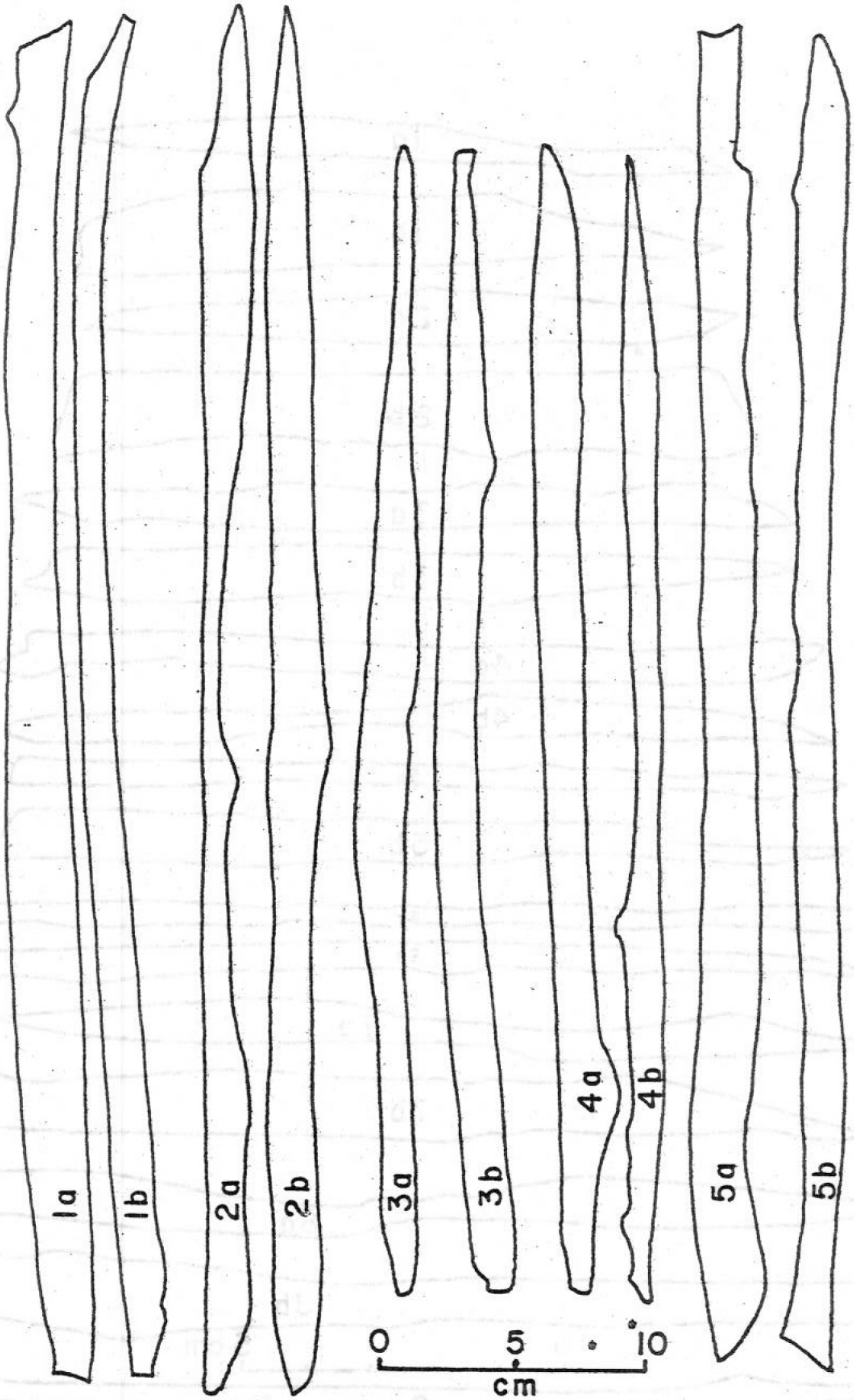


Figure 4. Outlines of 9 pencil-shale fragments from the Fisher Ridge Member of the Mahantango Formation. Outline drawn in fragment stable position; fragment rotated 90 degrees for second outline. Outlines 0.415 actual size.

Although most structure textbooks mention pencil shale, very little has been written about the phenomenon. At this site it is obvious that different forms of pencil shale can occur and here it appears that lithology may be the factor controlling the difference. However, no thin sections of materials from this site have been made and examined and the reality of real textural differences in the rock is a field evaluation only. The presence of well-defined bedding and cleavage planes seems a reasonable cause for the development of pencil shale fragments, but, because both generally occur as well-defined planes, their presence does not adequately explain the irregular and curved nature of the pencil shale faces. In addition, there is the question about why pencil shale develops at one location but not at another. Think about this when you examine very similar rocks at Stop 4. Much work needs to be done on this neglected topic. Any volunteers?

LEAVE STOP 3. PROCEED STRAIGHT AHEAD.

1.6   43.8   Enter Dalmatia.
3.0   46.8   **STOP 4.** Park in large pull-off area on right adjacent to outcrop.

MAHANTANGO FORMATION--FOSSIL COLLECTING SITE

This small outcrop is in the upper part of the Sherman Ridge Member of the Mahantango Formation on the north side of Hooflander Mountain. Bedding strikes N74E and dips 37°N. Spaced cleavage, differentiated from cleavage at Stop 3 because of its wider spacing, strikes N78E and dips 46°S. This part of the member is mainly light-olive to medium-gray claystone with well-defined beds containing abundant fossils. Hoskins (1976, p. 14) says that "pencil-like and shale-chip fragments" are characteristic of the claystones of this member. Note the absence of pencil shale in contrast to Stop 3.

The fossils at this locality are external and internal molds; the original calcareous shell material has been dissolved. Brachiopods (especially *Tropidoleptus* and *Devonochonetes*) and crinoid columnals are the most abundant fossils. Pelecypods and trilobites are fairly common. The spiral, rooster-tail-like markings (*Zoophycos*) on the bedding surfaces throughout the pit represent the feeding burrows of soft, worm-like organisms that left no skeletal remains. The following fossils have been found here (Hoskins and others, 1983, p. 142-143):

BRYOZOAN
- *Sulcoretepora*

BRACHIOPODS
- *Rhipidomella*
- *Tropidoleptus*
- *Protoleptostrophia*
- *Devonochonetes*
- *Mucrospirifer*
- *Mediospirifer*

GASTROPOD
- *Palaeozygopleura*

PELECYPODS
- *Palaeoneilo*
- *Leiopteria*
- *Paracyclas*
- *Cypricardella*
- *Orthonota*

CEPHALOPOD
- *Michelinoceras*

CRICOCONARID
- *Tentaculites*

TRILOBITES
- *Trimerus*
- *Greenops*

CRINOIDS
- Columnals

TRACE FOSSIL
- *Zoophycos*

The rocks here were deposited as sediments in shallow marine waters about 387 million years ago. The claystone is very uniform which may be the result of (1) very quiet deposition, (2) intensive burrowing and reworking of the sediments by organisms such as *Zoophycos*, or (3) both. The fossils occur mainly as bedding plane concentrations. The unbroken nature of the shells suggests little disturbance subsequent to death, that is, these do not seem to be storm deposits. We may ponder the tranquility of the original ocean floor and the nature of life and death at this location many millions of years ago.

Some observant people will note the presence of pieces of sandstone on the surface of the pit. These are pieces of the Montebello Member of the Mahantango Formation which occurs at the crest of the Hooflander Mountain to the south. These pieces of rock have moved down the slope by gravity and are part of the colluvium which occurs in abundance farther up slope.

LEAVE STOP 4. PROCEED STRAIGHT AHEAD.

1.7	48.5	**BEAR RIGHT** to PA Route 225.
0.1	48.6	**STOP SIGN. BEAR RIGHT** to PA Route 225 S.
0.2	48.8	**TURN RIGHT** on PA Route 225 S.
0.7	49.5	Meckley's Limestone Products, Inc. quarrying operation on right. They produce stone for a variety of products including clay pigeons.
2.9	52.4	Dauphin County line, entering Pillow. The town of Pillow occupies an interesting topographic position (Figure 5). The town appears to sit on an alluvial fan as evidenced by the fan-like topography. However, there does not appear to be much if any alluvial sediment on the surface. There is an exposure of alluvium on the west side of the road at the south side of town (Figure 5, arrow), but none is apparent elsewhere except in the bed of Deep Creek on the east side of town. The steep cutbank carved by Mahantango Creek north of the town indicates that the creek has been maintaining that position during at least 200 feet of downcutting. A possible explanation is that Deep Creek did have an alluvial fan character when its bed was 100-200 feet higher, but that for a long time it has incised its channel in its present position. During that time erosion has stripped the surface under Pillow of any former alluvial materials and created a fan-like shape cut on bedrock. The constant supply of resistant rock brought to Mahantango Creek has forced the stream to maintain a meander away from it's otherwise regular channel at the base of Mahantango Mountain. This may be a topographic form developed as a result of rejuvenated erosion of the Harrisburg topographic surface.
0.5	52.9	**STOP SIGN. TURN RIGHT** following PA Route 225 S.
0.2	53.1	Outcrop of alluvial fan clastics on right.
1.4	54.5	At this point (there is a road intersecting from the left) the route commences a traverse across the uplands of a broad valley which has been moderately dissected by erosion. The broad

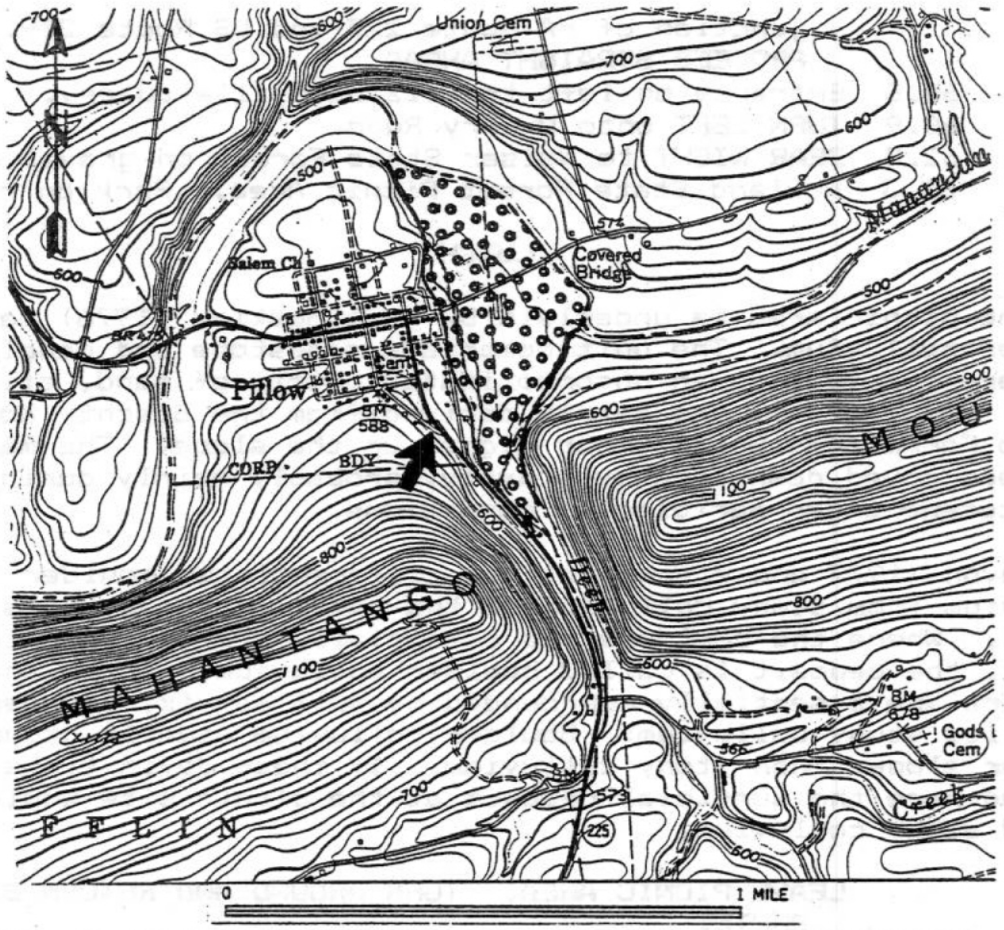


Figure 5. Topography and deflection of Mahantango Creek away from the base of Mahantango Mountain at the town of Pillow. Arrow indicates location of high-level alluvial-fan deposit. Open circles indicate present alluvial deposits of Deep Creek.

synclinal valley has only rocks of the Mauch Chunk Formation exposed at the surface. Rocks of the Pocono Formation which form the crests of the valley-bounding mountains, Mahantango Mountain on the north and Berry Mountain on the south, pass under the valley in the subsurface. The landscape of this broad valley presumably represents a moderately dissected remnant of the Harrisburg topographic surface (Sevon, 1985a) with upland surfaces suggesting the approximate level of the original surface. Traverses of many roads in the area in early April, 1986 when most fields were freshly plowed did not reveal any sites of suspected saprolite or old soil. However, the uniformity of the uplands in the valley is striking and the interpretation that the uplands were once related to the Harrisburg topographic surface seems reasonable. The view of this valley from Stop 6 is excellent.

1.6 56.1 **STOP SIGN. PROCEED STRAIGHT AHEAD** in middle of Berrysburg at junction with PA Route 25.

3.9 60.0 **STOP LIGHT** in center of Elizabethville at

junction of PA Route 225 and US Route 209.
PROCEED STRAIGHT AHEAD.

0.8	60.8	Entrance on left to Elizabethville quarry.
0.1	60.9	**TURN LEFT** onto Quarry Road.
1.9	62.8	**BEAR RIGHT** to Weiser State Forest on gravel road.
0.5	63.3	Rowland State Forest Picnic Area. Park on right.

LUNCH

The picnic area is underlain by what Hoskins (1976) mapped as boulder colluvium. The unit comprises sandstone and conglomerate boulders imbedded in an unconsolidated matrix of sand, silt, clay. The boulders are mainly derived from the Spechty Kopf and Pocono Formations which occur higher up the slope. The material has been moved downslope by gravity, probably mainly during the Pleistocene under periglacial conditions.

Sevon (1977 and elsewhere) has differentiated boulder colluvium from stony colluvium on the basis of slope and soil matrix. Where the boulders are essentially free of visible soil matrix, the deposit is called boulder colluvium. Where the boulders are essentially surrounded by soil matrix, the deposit is called stony colluvium. Boulder colluvium usually occurs on steeper slopes than stony colluvium. If these definitions were applied here the surficial deposit at the picnic site would be called stony colluvium.

LEAVE PICNIC AREA. TURN AROUND AND RETURN BY SAME ROUTE.

0.5	63.8	**BEAR LEFT** onto paved road.
0.1	63.9	**STOP 5.** Park in area adjacent to small borrow pit on right side of road.

SOIL DEVELOPMENT IN CATSKILL FORMATION FLOOD-BASIN DEPOSITS

This small borrow pit is opened in siltstones and claystones of the Duncannon Member of the Catskill Formation. A cleavage orientation of N80E with dip 80°S was measured here. Bedding appears to have a very low dip and a probable orientation is N85E for strike and 3°N for dip. Hoskins (1976, Plate 1) indicates that the axis of a minor anticline plunging to the southwest passes through this outcrop. The Duncannon Member comprises a series of cycles which fine upwards from a basal sandstone or conglomerate through finer-grained sandstones into siltstones and claystones. The color of the basal rocks in the cycle may be either gray or red, but the upper part of the cycle is always red. This member is probably the most distinctive and widespread of all of the members of the Catskill Formation. The cycles are interpreted to represent the deposits of meandering streams which traversed a gradually subsiding coastal alluvial plain about 360-367 million years ago (Sevon, 1985b). The coarse-grained materials in the lower part of the cycle represent channel deposits and the fine-grained materials in the upper part of the cycle represent flood basin deposits. Variation and subtle differences between cycles are characteristic of the member, but as a whole the member is remarkably consistent over a large area.

The rocks exposed in this borrow pit represent mainly the grayish red (5R4/2) flood-basin deposits of one cycle. Figure 6 presents a schematic diagram of the outcrop for purpose of reference. The lower part of the exposure (1) is

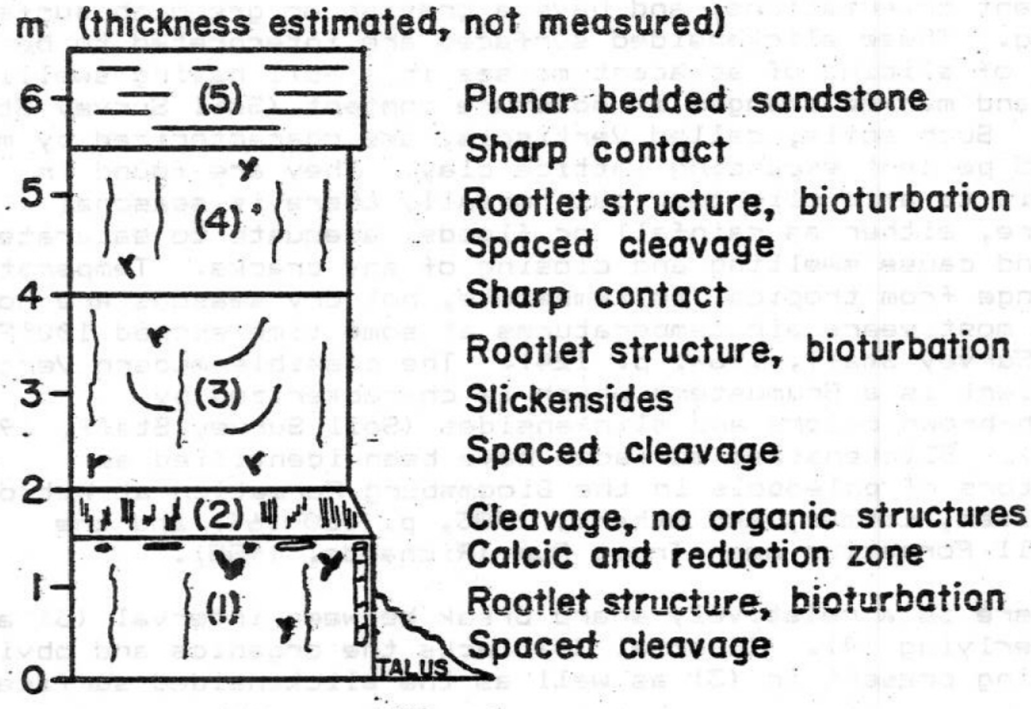


Figure 6. Diagrammatic sketch of sequence of flood-basin deposits in the Duncannon Member of the Catskill Formation.

siltstone-claystone with abundant evidence of plants and burrowing activity. The plants are indicated by the small (2-4 mm) wide slightly shiny, red, twig-like structures which are common on the surface of the rock. These features, commonly called rootlet structure, are clay replacements of original organic material. The rootlet structures range from a few millimeters to a centimeter or more in length and often bifurcate at one end. These structures presumably represent traces of original roots, but some may be traces of stems. Rarely, there are large traces which show an extensive branching pattern which has a real resemblance to roots. There are a few ellipsoidal structures about 2 x 4 cm in cross section and several centimeters long exposed in the central part of the outcrop face. These may be burrows or they may be traces of very large roots. The top of this zone has a discontinuous layer of reduction spots--places where the red color has been changed to pale olive (10Y6/2) by reduction of the iron. There are also a few small calcareous nodules in the vicinity of this reduction zone. Note also the excellent development of cleavage and the apparant alignment of the roots along the plane of cleavage. Why?

The top of (1) is transitional over a small interval into the siltstones of (2) (Figure 6). This interval appears to be coarser grained than (1) and has no rootlet structure. Cleavage is well developed, but with a closer spacing than either adjacent unit. The interval grades upward fairly abruptly into claystones of (3). This interval has cleavage spacing similar to (1) as well as rootlet structure and evidence of burrowing. Particularly noticeable in this interval are numerous slickensided surfaces. These surfaces are curved, have many different orientations, and have a grayish or greenish surface coating. These slickensided surfaces are interpreted to be the result of sliding of adjacent masses in a soil having swelling clays and marked changes in moisture content (Soil Survey Staff, 1960). Such soils, called Vertisols, are characterized by more than 35 percent expanding lattice clay. They are found in subhumid to arid climates, but normally there is seasonal moisture, either as rainfall or floods, adequate to saturate the soil and cause swelling and closing of any cracks. Temperatures may range from tropical to temperate, hot dry seasons are normal, and in most years air temperatures at some time exceed 100°F (Soil Survey Staff, 1960, p. 124). The possible modern Vertisol equivalent is a Grumustert which is characterized by reddish-brown colors and slickensides (Soil Survey Staff, 1960, p. 129). Slickensided surfaces have been identified as indicators of paleosols in the Bloomsburg Formation at Watsontown (Nickelsen, Cotter, and others, 1983, p. 160-164) and the Catskill Formation near Trout Run (Richards, 1985).

There is a relatively sharp break between interval (3) and the overlying (4). Interval (4) lacks the organics and obvious burrowing present in (3) as well as the slickensided surfaces.

At the top of the exposure is a fine- to medium-grained, planar bedded, gray sandstone (4). The sandstone has a sharp basal contact, but the contact does not appear to show any marked evidence of scour. The planar bedding appears to be the outstanding feature of the sandstone.

This sequence of rock contains a variety of features commonly associated with flood basin deposits of the Catskill Formation. The sequence represents a multiplicity of flood events which occurred some distance from the main channel of a stream flowing across the Upper Devonian Catskill coastal alluvial plain. The lower interval (1) represents accumulation of sediment deposited by many floods. The activities of burrowing organisms and plant growth were adequate to destroy the evidence of each individual flood. There was apparently a long interval of non-deposition at the top of (1) which allowed the development of a calcic zone now evidenced by the calcareous nodules. The reduction spots probably represent devlopment of reducing conditions around organic material and may be related to the next flood event. Interval (2) and possibly the lower part of (3) probably represent sediment deposited during a single flood. This flood was a catastrophic event of sufficient magnitude to bury the organic life existing at and near the surface of (1) and prevent it from routine vertical progression. Deposition was sufficiently rapid in the lower 1/2 m of interval (3) to prevent organics from becoming established and destroying the bedding through bioturbation.

The remainder of interval (3) contains the evidence of soil development discussed earlier and represents an interval of presumably often repeated small floods similar to interval (1). The sharp contact at the base of interval (4) may represent a major flood event which caused considerable scour. Activity by plants and animals are evident in interval (4), again indicating gradual accumulation of sediment, but the absence of slickensided surfaces suggests some change, either climatic or mineralogic. The planar bedded sandstone at the top of the sequence probably represents a crevasse-splay deposit formed when flooding broke through the levee adjacent to the main stream channel and carried sand into part of the flood basin which had been receiving only fine-grained flood deposits for a long period of time. This probably happened because the channel had migrated to a closer position.

LEAVE STOP 5. PROCEED STRAIGHT AHEAD.

0.7 64.6 **BEAR RIGHT** up hill at road fork.

1.1 65.7 **STOP SIGN. TURN RIGHT** onto PA Route 225 and into entrance of Elizabethville quarry. **STOP 6.**

ELIZABETHVILLE QUARRY

General Geology

The Elizabethville quarry (Figure 7) is operated in the sandstones of the Beckville and Mt. Carbon Members of the Mississippian Pocono Formation (Hoskins, 1976). Both members are composed dominantly of light- to medium dark-gray or olive-gray, fine- to very coarse-grained sandstone and conglomeratic sandstone with subordinate interbeds of medium- to dark-gray siltstone or shale with occasional thin coal beds. The two members are lithologically similar and are discriminated by the key-bed conglomerate at the base of the Mt. Carbon Member.

The Beckville Member is about 400 feet thick and should be almost entirely exposed in the quarry. The Mt. Carbon Member is about 750 feet thick with only the lower half exposed.

Bedding is from a few inches to several feet thick and is mostly more-or-less parallel although forset and tangential crossbedding and limited cut-and-fill structure occur. Zones of shale-pebble conglomerate, ripple marks, and parting lineations occur occasionally.

Berry Mountain, atop which the Elizabethville Quarry is located, is sustained by the resistant Pocono sandstones and lies on the south flank of the broad synclinorium which forms the northern "fishtail" of this area (Figure 1). Dips in the general vicinity of the quarry are between 35°N and 60°N. Subordinant adjustment faulting and folding occurs within the less competent shale and coal zones.

The Pocono Formation in this part of Pennsylvania is usually visualized as having been deposited in a braided fluvial environment. The source was a line of mountains well to the east which were drained by what may have been a number of more-or-less parallel, west-flowing rivers whose braided deposits coalesced laterally to form the widespread Pocono Formation (including the

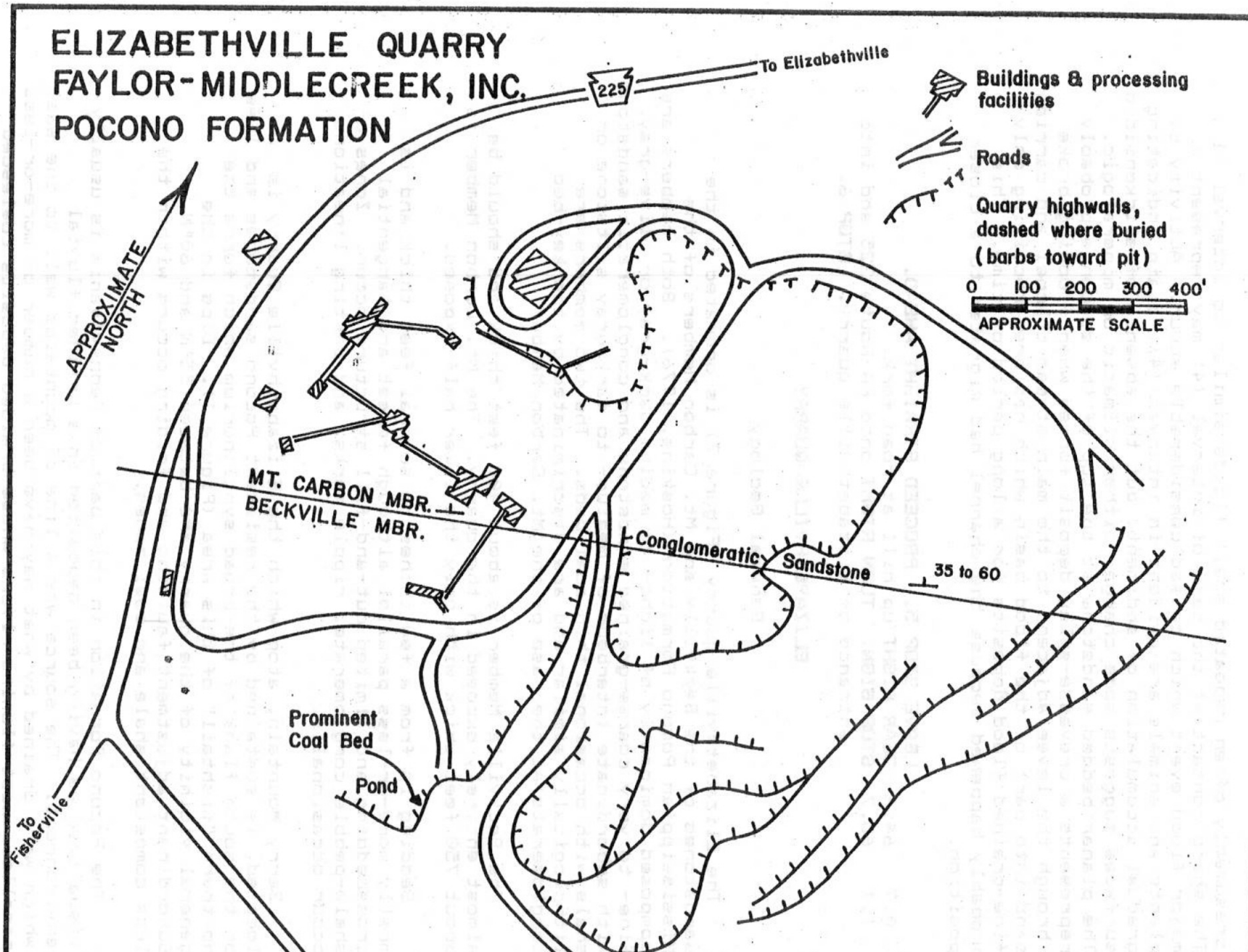


Figure 7. Map of the

underlying Spechty Kopf Formation).

The Pocono Formation contains no known faunal remains in this area, although plant material is fairly common. Most of the plant material has been macerated to unidentifiable fragments, but some branch or trunk casts, impressions, and carbonizations can usually be found. A number of leaf forms including Rhodea and other Early Mississippian flora were collected here by E. F. Koppe.

Economic Geology

The rock from this quarry is crushed for PennDot Type A SRL-E. coarse aggregate and Type B (for bituminous only) fine aggregate. Hard sandstones and conglomerates are abrasive and expensive to crush compared to softer carbonates that dominate the crushed stone business. So why bear the extra expense? Part of the answer is the skid resistant properties of the sandstones and conglomerates compared to the limestones and dolomites. PennDot has an aggregate skid rating system that requires more skid resistant rock on highways with higher traffic volume. A quarry with the highest rating, which is SRL-E, can market their stone to a broader area where high skid resistant aggregate is required, but may not be available locally. The aggregate from this operation has been used as far away as the border of Maryland and Pennsylvania.

A specialty use for the coarse aggregate from this quarry is drying beds in sewage treatment plants which require a maximum of 6 percent loss on a 120 cycle sodium sulfate soundness test, a comparatively rigorous test.

Geomorphology

The view north from the quarry on Berry Mountain is spectacular (assuming that visibilty is not hampered by rain, snow, sleet, hail, or fog). From this vantage point the broad synclinal valley lying between Berry and Mahantango Mountains appears almost flat with only slight dissection and it is not difficult to imagine the valley to be the remnant of a relatively flat topographic surface carved by erosion over a long period of time (Sevon, 1985a).

The linear ridge of Mahantango Mountain is visually striking as are the narrow water gaps. The next ridge north, visible through the water gaps, appears similar in form and elevation and one can easily conjecture that these uplands might be remnants of an even higher surface, the Schooley peneplain. A close look at the rocks in the quarry suggests an alternate hypothesis--the ridges owe their relief to their resistance to weathering and erosion which is greater than that of the rocks in the valleys.

One might also speculate while here about how much rock has been removed by erosion if this area was once covered by a thrust sheet (Sevon, 1986).

LEAVE STOP 6. TURN LEFT onto PA Route 225 S.

8.1 73.8 **TURN LEFT** following PA Route 225 S in Halifax.

0.2	74.0	**STOP SIGN. PROCEED STRAIGHT AHEAD** on PA Routes 225 and 147 S.
1.3	75.3	**BEAR RIGHT** following PA Route 147 S.
6.1	81.4	Clarks Ferry bridge on right. **PROCEED STRAIGHT AHEAD** on US Routes 22 & 322.
11.0	92.4	Junction with Interstate 81. **PROCEED STRAIGHT AHEAD** on US Route 22. **BE IN LEFT LANE.**
1.3	93.7	**STOP LIGHT. TURN RIGHT** to HACC.
0.2	93.9	**TURN RIGHT** to HACC.
0.2	94.1	**BEAR RIGHT** to HACC east parking lot.
0.2	94.3	**END OF FIELD TRIP! HAVE A SAFE TRIP HOME! SEE YOU NEXT FALL!**

REFERENCES CITED

Berg, T. M., Edmunds, W. E., and others, 1980, Geologic map of Pennsylvania: Pennsylvania Geological Survey, 4th ser., Map 1, scale 1:250,000.

Claypole, E. W., 1885, A preliminary report on the paleontology of Perry County: Pennsylvania Geological Survey, 2nd ser., Report of Progress F 2, p. 18.

Dyson, J. L., 1963, Geology and mineral resources of the northern half of the New Bloomfield quadrangle, Pennsylvania: Pennsylvania Geological Survey, 4th ser., Atlas 137ab, 63 p.

Hoskins, D. M., 1976, Geology and mineral resources of the Millersburg 15-minute quadrangle, Dauphin, Juniata, Northumberland, Perry, and Snyder counties, Pennsylvania: Pennsylvania Geological Survey, 4th ser., Atlas 146, 38 p., 2 plates.

Hoskins, D. M. and others, 1983, Fossil collecting in Pennsylvania (3rd ed.): Pennsylvania Geological Survey, 4th ser., General Geology Report 40, 215 p.

Nickelsen, R. P., Cotter, E., and others, 1983, Silurian depositional history and Alleghanian deformation in the Pennsylvania Valley and Ridge: Guidebook, 48th Annual Field Conference of Pennsylvania Geologists, Pennsylvania Geological Survey, 192 p.

Richards, P. L., 1985, Late Devonian paleosoils in north-central Pennsylvania (abs.): Geological Society of America, Abstracts with Programs, v. 17, no. 1, p. 60.

Rogers, H. D., 1858, The geology of Pennsylvania: Philadelphia, J. B. Lippincott and Company, v. 2, 1045 p.

Sevon, W. D., 1977, Surficial geology of the Linden and Williamsport quadrangles, Lycoming County, Pennsylvania, **in** Faill, R. T., Wells, R. B., and Sevon, W. D., Geology and mineral resources of the Linden and Williamsport quadrangles, Lycoming County, Pennsylvania: Pennsylvania Geological Survey, 4th ser., Atlas 134ab, Plate 2.

Sevon, W. D., 1985a, Pennsylvania's polygenetic landscape: Guidebook, 4th Annual Field Trip, Harrisburg Area Geological Society, Pennsylvania Geological Survey, 55 p.

Sevon, W. D., 1985b, Nonmarine facies of the Middle and Late Devonian Catskill coastal alluvial plain, **in** Woodrow, D. L. and Sevon, W. D., **eds.**, The Catskill Delta: Geological Society of America Special Paper 201, p. 79-90.

Sevon, W. D., 1986, Susquehanna River water gaps: many years of speculation: Pennsylvania Geology, v. 17, no. 3.

Shank, W. H., 1977, Historic bridges of Pennsylvania: York, PA, American Canal and Transportation Center, 68 p.

Soil Survey Staff, 1960, Soil classification, a comprehensive system, 7th approximation: Soil Conservation Service, U. S. Department of Agriculture, 265 p.

PREVIOUS HAGS GUIDEBOOKS STILL AVAILABLE

Potter, N., Jr. and others, 1982, Geology in the South Mountain area, Pennsylvania: Guidebook, First Annual Field Trip, Harrisburg Area Geological Society, 37 p.

Mowery, J. R. and others, 1983, Geology along the Susquehanna River, south central Pennsylvania: Guidebook, Second Annual Field Trip, Harrisburg Area Geological Society, 55 p.

Ganis, G. R. and Hopkins, D., 1984, Stratigraphy, structural style, and economic geology of the York-Hanover valley: Guidebook, Third Annual Field Trip, Harrisburg Area Geological Society, 51 p.

Sevon, W. D., 1985, Pennsylvania's polygenetic landscape: Guidebook, Fourth Annual Field Trip, Harrisburg Area Geological Society, 55 p.