HARRISBURG AREA GEOLOGICAL SOCIETY
21ST SPRING FIELD TRIP

MAY 12, 2012

Shermans Creek from Dellville to Duncannon
Perry County, Pennsylvania

Guidebooks for HAGS Field Trips

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2nd Annual Field Trip- Geology along the Susquehanna River, south-central Pennsylvania, J. Ronald Mowery, editor, April 16, 1983, 55 p. $5.00 plus $2.00 S8H.

3rd Annual Field Trip- Stratigraphy, structural style, and economic geology of the York-Hanover Valley, G. Robert Ganis and David Hopkins, April 28,1984, 51 p. $5.00 plus $2.00 S&H.

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17th Annual Field Trip- Geomorphology in the Northern Cumberland Valley, PA, including the Carlisle Deluge of 1779, Noel Potter, Jr., Donald Hartman, and Helen Delano, April 18, 1998, 49 p, $7.00 plus $2.00 S&H.

18th Annual Field Trip- The Cove Syncline by canoe, William M. Roman and Michael A. Knight, May 15, 1999, 16 p. plus maps, Out of Print

19th Annual Field Trip- Geology of the Kishacoquillas Valley and vicinity, Mifflin County, Pennsylvania, Michael A. Knight and William M. Roman, May 20, 2000, 18 p. plus maps and sections, $7.00 plus $2.00 S&H.

20th Field Trip- Geology and Geomorphology of the South Mountain Area, Cumberland and Franklin Counties, Pennsylvania, Noel Potter, Jr., and William D. Sevon, May 14, 2011, 64 p., $10.00 plus $2.00 S&H.

No formal guidebooks were prepared for the 9th (1990) and 14th (1995) Field Trips. The 2001 trip was a repeat of the 2000 trip.

Available from: *Harrisburg Area Geological Society; Joan Anderson, Treasurer; PA Dept of Military and Veteran Affairs; Bureau of Environmental Management; Environmental Compliance Division; Bldg. 0-11, Ft. Indiantown Gap; Annville, PA 17003; (717) 861-9414; joaanderso@state.pa.us*

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21ST SPRING FIELD TRIP

Shermans Creek from Dellville to Duncannon
Perry County, Pennsylvania

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MAY 12, 2012

Cover Image: Folded layers of the Irish Valley Member of the Catskill Formation at north end of stream meander between Dellville and Duncannon

CONTENTS

ATTACHMENTS

INTRODUCTION

The 2012 field trip of the Harrisburg Area Geological Society explores the lower reach of Shermans Creek from Dellville to Duncannon in Perry County, Pennsylvania. This reach of Shermans Creek was part of a longer trip planned for the 18th field trip (Roman and Knight, 1999), which continued down the Susquehanna River to Marysville. Unfortunately, low water conditions forced the trip to start at Amity Hall on the Juniata River instead, and the Shermans Creek portion of the trip was abandoned.

We plan to follow Shermans Creek by canoe or kayak for approximately 7.5 miles as it flows primarily northeastward along the strike of the north limb of the Cove syncline. Upper Devonian bedrock of the Catskill Formation underlies this reach of Shermans Creek. We will see outcrops of the type section of the Sherman Creek member along the transverse legs of a tight meander away from Cove Mountain, outcrops of the Irish Valley member at the northern end of this meander, and ledges formed by the Clark's Ferry member in the last transverse stretch of the stream before its confluence with the Susquehanna River.

Unfortunately, the stream banks are fairly steep, and sometimes muddy, so no stops are planned along the trip. As we follow the water's course through the deformed and eroded strata of the Cove syncline, participants are encouraged to observe and appreciate the myriad of sedimentary, tectonic, fluvial, and mass-wasting processes that have shaped the stream basin.

Should the water level of Shermans Creek be too low, an alternate trip is available on the Susquehanna River from Duncannon to Marysville, a distance of approximately 8.0 miles. The alternate trip will put in on the Susquehanna River in Duncannon and follow the river as it traverses the water gap through Peters (North Cove) Mountain, crosses the core of the Cove syncline, and flows through the water gap in Second (South Cove) Mountain. The trip will terminate in Marysville just upstream of the Rockville Bridge and the water gap through Blue Mountain. The alternate trip extends the stratigraphic section encompassed by the trip upward into the Mauch Chunk Formation, which underlies the core of the Cove syncline.

PADDLING TIPS

Certain hazards create a risk of capsizing, becoming swamped, or getting stranded when canoeing or kayaking on Shermans Creek or the Susquehanna River. Recognizing these hazards and knowing how to avoid or handle them will reduce the risk of an unpleasant experience. Below are a few useful tips:

1. Always wear a Personal Flotation Device (PFD).

2. Try to stay in the main stream channel where the water is deepest. On meanders, the main channel is usually on the side of the stream having a steeper (cut) bank. Avoid the more gently sloped (point bar side) of the meander where the water is shallow and you may ground your canoe or kayak.

3. Avoid sweepers (i.e., leaning or fallen trees or projecting branches). Becoming entangled in a sweeper may result in swamping or capsizing the canoe as the natural tendency is to lean in the upstream direction away from the branches.

4. Avoid rocks, logs or branches protruding from the water—they may be indicators of larger, submerged obstacles (e.g., strainers).

5. When approaching rock ledges, look for and steer toward the smoother water veeing downstream, which indicates the location of a gap in the ledge where deeper water is usually present.

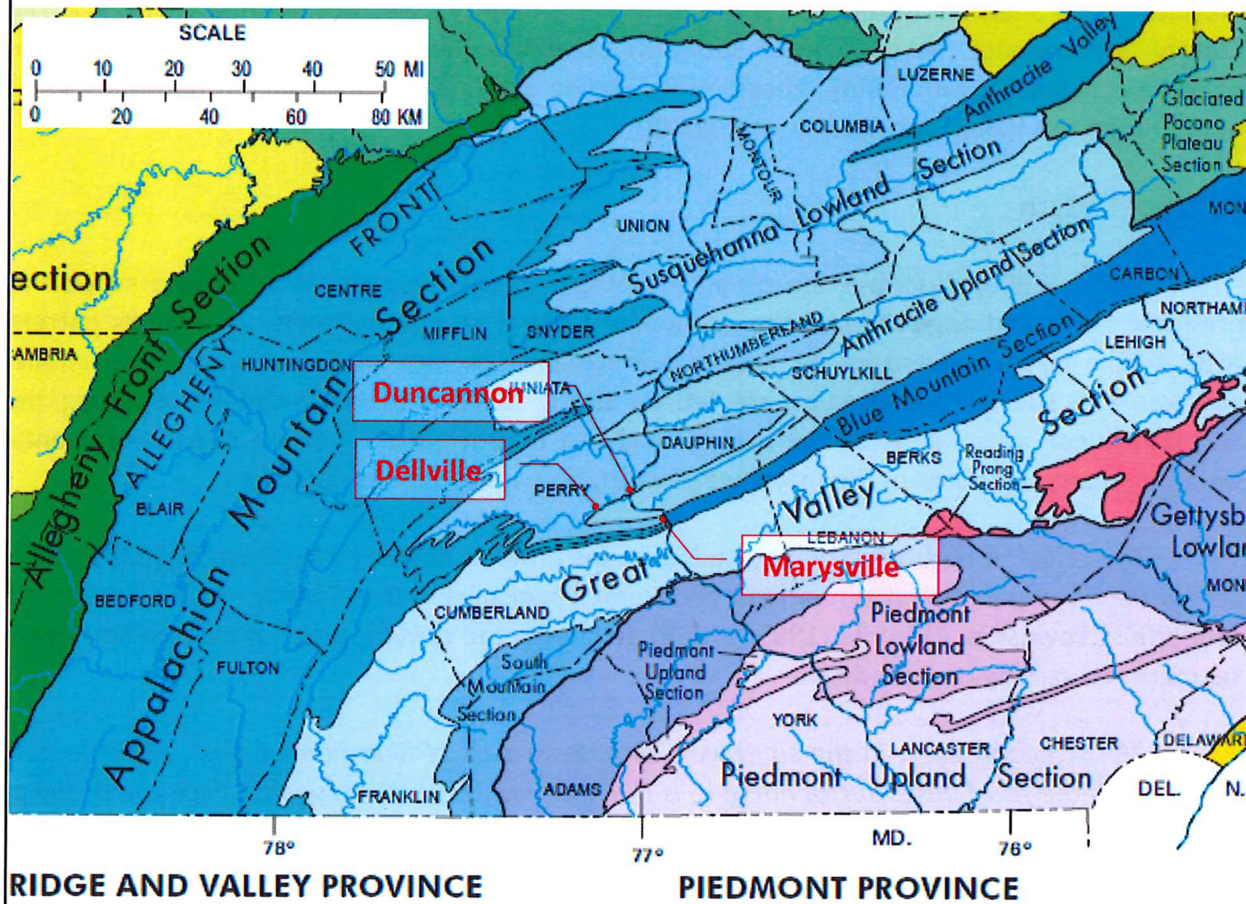
6. If you do capsize, stay calm. Over-turned canoes float and can be tipped back over. First, assure that everyone is safe before attempting to retrieve equipment. Stay with your canoe unless you judge that doing so will be dangerous. If you can stay with the canoe, you can guide it into quiet water. Stay at the upstream end of the canoe so that if the canoe becomes pinned, you don't. If possible, hold on to your paddle since you will need it later. Don't try to swim in rapids. Float in your life jacket on your back, with your feet downstream. If the water is cold, get ashore quickly.

7. If someone else's canoe is capsized or swamped, offer your assistance. Retrieve people before equipment. If it's cold, get them ashore, dry them, and warm them immediately to minimize the risk of hypothermia.

PHYSIOGRAPHY

By virtue of lying beyond the limit of the Pleistocene ice advances and within a folded mountain belt having a long erosional history, Perry County's landscape displays a remarkable, textbook-quality example of concordance between topography and bedrock lithology. In the area of the field trip, Shermans Creek flows generally east-northeast along the base of Cove Mountain, which locally delineates the boundary between Susquehanna Lowland section and the Anthracite Upland section of the Ridge and Valley physiographic province (Figure 1) (Sevon, 2000). As a result, the northern part of the Shermans Creek valley generally lies within the Susquehanna Lowland section, and the southern part of the valley generally lies within the Anthracite Upland section. Beginning about 1.2 mile above its confluence with the Susquehanna River, Shermans Creek is incised into the lower slope of Cove Mountain, which locally forms the northern escarpment of the Anthracite Upland section.

Figure 1: Field trip localities on a portion of the physiographic map of Pennsylvania (Sevon, 2000).



The back-up trip on the Susquehanna River from Duncannon to Marysville traverses the core of the Cove syncline, which forms the southern portion of the "fishtail" of the Anthracite Upland section. Marysville is situated within the narrow Fishing Creek valley, which runs between Cove Mountain to the north and Blue Mountain to the south and forms the southernmost portion of the Susquehanna Lowland section (Figure 1). Fishing Creek is one of five streams named Fishing Creek in Pennsylvania[1], one of which flows through Fort Hunter.

The Susquehanna Lowland section is situated within the Susquehanna River valley and is characterized by low to moderately high linear ridges and linear valleys resulting from fluvial erosion. Cove Mountain outlines a major syncline plunging to the east. In Dauphin County, on the east side of the Susquehanna River, the south limb of Cove Mountain is known as Second Mountain and the north limb as Peters Mountain. Between Peters Mountain and Second Mountain, the Susquehanna River traverses the core of the Cove syncline, skirting the tightly folded nose of Third Mountain, which opens into Sharp and Stony Ridges to the east.

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[1] http://en.wikipedia.org/wiki/List_of_rivers_of_Pennsylvania#Alphabetically

The headwaters of Shermans Creek drain eastward from the complex mass of folded mountains (Conococheague Mountain, Rising Mountain, Perry Amberson Ridge, Bowers Mountain, and Sherman Mountain) which form Perry County's western boundary with Franklin County and connect Perry County's southern boundary (Blue Mountain) with its northern boundary (Tuscarora Mountain). These mountains lie within the Appalachian Mountain section of the Ridge and Valley province (Sevon, 2000).

Drainage Pattern

Sevon (2000) describes the drainage pattern of the Susquehanna Lowland section as primarily trellis and angulate and the Anthracite Upland section as trellis. The trellis pattern results from headward erosion of subsequent streams through weak layers in strike parallel valleys. The subsequent streams are fed by short, straight stream segments draining the adjacent linear ridges generally at a right angle to bedrock strike. Some stream segments, including many segments of the major waterways, flow transverse to structure.

The effect of bedrock lithology on Shermans Creek is described by Claypole (1885) in his accounts of the geology of Wheatfield and Penn Townships, Perry County. In his section on Wheatfield Township, Claypole (1885, p. 388) attributes the development of transverse stream segments to varying rock hardness:

> *"A projecting point in the southwest includes a part of Sherman's Creek. Dellville mill, with the few houses surrounding it, is the only hamlet in the township since the decay of Montebello*[2]*. At this part of its course Sherman's Creek is deflected to the northward by striking the hard beds near the top of the Catskill group. After flowing north for a mile it meets the almost equally hard beds near the base of the group, and is again deflected southward. Exactly similar changes are produced in the Buffalo [Creek], in Juniata Township, by striking on the same beds of rock."*

In his section on Penn Township, Claypole (1885, p. 283) describes how Cove Mountain prevents surface waters from entering the Township:

> *"The outer slopes of the Cove Mountain throw all the waters coming from the west outside the township. Sherman's Creek is thus compelled to skirt the northern face of the mountain until it reaches the Susquehanna below Duncannon."*

More resistant sandstone beds form nick points at several locations on Shermans Creek and the Susquehanna River. Depending on discharge, these rock ledges may impede or restrict navigation by canoe and kayak. For this reason, it is imperative to look for and steer toward the smoother water veeing downstream, which indicates the location of a gap in the ledge where deeper water is usually present.

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[2] The "decay of Montebello" refers to the ruins of the settlement surrounding the Montebello Furnace, which was abandoned circa 1848 according to Hain (1920, p. 274).

Water Gaps

About a mile upstream of Duncannon, the Shermans Creek trip passes through a minor water gap developed in Pine Ridge, where paddlers should exercise caution to avoid rock ledges that may impede navigation. The backup trip on the Susquehanna River passes through scenic water gaps in Peters Mountain and Second Mountain (Cove Mountain in Perry County) and terminates at Marysville just above the water gap through the double crested ridge of Kittatinny and Blue Mountains. Rock ledges in the Peters Mountain gap may be avoided by staying stream right, while it is necessary to stay stream left (toward Dauphin Borough) to avoid the numerous rock ledges associated with the gap through Second Mountain.

The Susquehanna River water gaps have been a classic area of geologic study and recognized as one of Pennsylvania's outstanding scenic geological features (Geyer and Bolles, 1979). The National Park Service officially designated the area of the first five water gaps north of Harrisburg as a National Natural Landmark in 1968, and state geologist Dr. Arthur Socolow was the featured speaker at the dedication ceremony held September 4, 1968 (Pennsylvania Geology, 1969)[3]. Unfortunately, the dedication plaque installed south of Berry Mountain along US Routes 11/15 was stolen. The Susquehanna Water Gaps Coalition, which was formed in 2007, prompted the National Park Service to furnish a replacement plaque, and a rededication ceremony was held in Marysville on September 9, 2011[4].

Numerous hypotheses have been advanced to explain the occurrence and location of water gaps in the folded Appalachian Mountains. Way (1999, p. 360) and Epstein (1966, p. B80) summarize the salient points of three of these hypotheses as follows:

- Chance location due to superposition from earlier drainages Johnson (1931):
    - Original drainage lines were obliterated during a Cretaceous marine transgression.
    - Present drainage pattern is mainly the result of superposition from a coastal-plain cover.
    - The location of a gap was purely by chance and is not systematically related to any weakness in the ridge, although there may have been local adjustment to structure.

- Position control by structure and topography inherited from Permian-initiated drainage (Meyerhoff and Olmsted, 1936):
    - Present drainage descended from the pattern that had been established in Permian time.

[3] The designation includes the Susquehanna River gaps in Blue Mountain, Second Mountain (Cove Mountain in Perry County), Peters Mountain, Berry Mountain, and Mahantango Mountain (Buffalo Mountain in Perry County).

[4] http://www.dcnr.state.pa.us/news/resource/res2009/09-0923-susquehannawatergaps.aspx

- Pattern controlled by structure and topography produced during the Appalachian orogeny.
- Gaps are found along transverse structures or in the northwest limbs of overturned folds.

- Headward piracy accompanying northwestward-moving drainage divides (Thompson, 1949):
  - Original divide between streams flowing into the Atlantic Ocean and those flowing into the continental interior was located on crystalline rocks along the Blue Ridge-Reading Prong axis.
  - Original divide was unstable because the southeastward-flowing streams had shorter courses (steeper gradients) than those that flowed northwestward.
  - As a result, the divide shifted northwestward by normal stream erosion (headward piracy), and the gaps in Kittatinny and Blue Mountains are located at points of rock weakness.

From his study of water and wind gaps in resistant ridges in the Stroudsburg area, Epstein (1966) reported the following observations:

- Gaps are found in three locations:
  - where resistant rocks dip steeply and have a narrow width of outcrop,
  - where folds die out over short distances, or
  - where folding was more intense locally than in nearby areas.
- All gaps trend roughly perpendicular to the strike of the ridges and parallel to major cross-joint sets.

These observations led Epstein (1966) to favor the hypothesis of structural features controlling the location of water gaps rather than regional superposition of streams upon resistant rocks. His study of Wind Gap suggested to him that when streams encounter resistant beds, they may lose tributaries as a result of capture by other streams, which may not yet have encountered the same obstacle.

STRATIGRAPHY

The stratigraphy of the Shermans Creek basin was described in detail by E. W. Claypole (1885) in his report on the geology of Perry County. The 1885 report includes a geologic map by John H. Dewees dated 1881 and a revised map by Claypole dated 1882, 1883. The geology of the portions of the basin within the Duncannon and Wertzville 7.5-minute quadrangles is described more recently by Dyson (1963 and 1967) in his reports on the northern and southern halves of the New Bloomfield 15-minute quadrangle. The geology of the portions of the Susquehanna River in the Halifax and Harrisburg West 7.5-minute quadrangles is mapped by Hoskins (1976) and Root and Hoskins (1975-1976). Table 1 provides a summary and approximate correlation of the mapping units used in the cited published maps.

Table 1. Summary and Correlation of Published Geologic Map Units and Symbols

<table>
<tr><th>Perry County (Dewees, 1881)</th><th>Perry County (Claypole, 1882, 1883)</th><th colspan="3">N ½ New Bloomfield 15' Quad [Newport & Duncannon 7.5' Quads] (Dyson, 1963)</th><th colspan="2">S ½ New Bloomfield 15' Quad [Shermansdale & Wertzville 7.5' Quads] (Dyson, 1967)</th><th colspan="2">Harrisburg West 7.5' Quad (Root and Hoskins, 1975-1976); Halifax 7.5' Quad (Hoskins, 1976)</th></tr>
<tr><td>Mauch Chunk Shale (XI)</td><td>Mauch Chunk red shale (XI)</td><td colspan="3">Mauch Chunk Formation (Mmc)</td><td colspan="2">Mauch Chunk Formation (Mmc)</td><td colspan="2" rowspan="2">Mauch Chunk Formation (Mmc)</td></tr>
<tr><td rowspan="4">Pocono Sandstone (X)</td><td rowspan="4">Pocono gray sandstone (X)</td><td colspan="3" rowspan="3">Pocono Formation (Mpo)</td><td colspan="2">Lower Member (Mmcl)</td></tr>
<tr><td rowspan="2">Pocono Formation (Mpo)</td><td>Unnamed members</td><td colspan="2">Pocono Formation (Mp)</td></tr>
<tr><td>Spechty Kopf Member (DMps)</td><td colspan="2">Spechty Kopf Formation (MDsk)</td></tr>
<tr><td rowspan="6">Catskill Formation</td><td rowspan="4">Buddys Run Member (Dcbr)</td><td>Upper Sandstone Member (Dcs)</td><td rowspan="6">Catskill Formation</td><td rowspan="2">Duncannon Member (Dcd)</td><td rowspan="6">Catskill Formation</td><td rowspan="2">Duncannon Member (Dcd)</td></tr>
<tr><td rowspan="4">Catskill Sandstone (IX)</td><td rowspan="5">Catskill red sandstone and shale (IX)</td><td>Upper Redbed Member (Dcur)</td></tr>
<tr><td>Clark's Ferry Member (Dccf)</td><td>Clark's Ferry Member (Dccf)</td><td>Clark's Ferry Member (Dccf)</td></tr>
<tr><td>Lower Redbed Member (Dclr)</td><td>Sherman Creek Member (Dcsc)</td><td>Sherman Creek Member (Dcsc)</td></tr>
<tr><td colspan="2" rowspan="2">Irish Valley Member (Dciv)</td><td rowspan="2">Irish Valley Member (Dciv)</td><td rowspan="2">Irish Valley Member (Dciv)</td></tr>
<tr><td>Catskill Sandstone (IX) lower part</td></tr>
</table>

Copies of portions of the cited mapping (Dewees, 1881; Claypole, 1882-1883; Dyson, 1963, and 1967; Hoskins, 1976; and Root and Hoskins, 1975-1976) are included as fold-out attachments (four sheets) to this guidebook. From Dellville to its mouth at Duncannon, Shermans Creek is entirely underlain by the Catskill Formation. The Susquehanna River between Duncannon and Marysville passes upsection from the Catskill Formation through the Spechty Kopf and Pocono formations into the Mauch Chuck Formation in the core of the Cove syncline, and then passes back downsection into the Catskill Formation at Marysville.

Catskill Formation

According to Faill and Wells (1974, p. 107), "the name Catskill originated in the Catskill Mountains of east-central New York (Mather, 1840) and has been applied since the 1880's to the sequence of predominantly red, nonmarine rocks (and the underlying transitional marine-nonmarine rocks) of Upper Devonian age in Pennsylvania (White, 1881, 1882; Claypole, 1885; d'Invilliers, 1891; among others; see also Chadwick, 1933 for the early history of the name Catskill)."

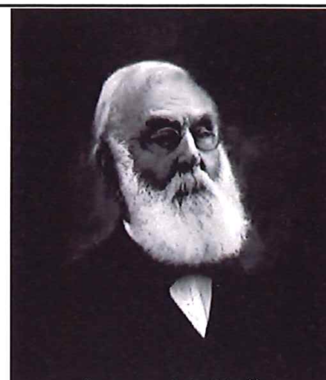
In his report on the geology of Perry County, Claypole (1885, p. 72) states that the Catskill is an "easily distinguished group of rocks, so conspicuous by its massive red beds." In describing the contact between the Catskill Formation and the underlying Chemung Formation, Claypole wrote (1885, p. 72), "Occasional red beds occur near the top of the Chemung, but the division, for the purposes of this report, has been drawn where the great mass of red sandstone and shale begins to appear."

Despite the apparent simplicity of the contact based on the appearance of extensive red beds, Claypole found this contact to be problematic in practice due to the presence of Chemung species (*Spirifer mesostrialis* and *Spirifer disjuncta*) within the lower portion of the Catskill Formation. He reported the former species in a 4-inch-thick green shale about 200 feet above the lowest fish bed of the Catskill Formation and the latter species in the Kings Mill sandstone, a bed of white sandstone, about 500 feet above the base of the Catskill. These particular fossils were the cynosure of a widely reported debate involving Claypole, New York State Geologist James Hall, and Cornell Professor Henry S. Williams at the 1884 meeting of the American Association for the Advancement of Science in Philadelphia (see Box 1).

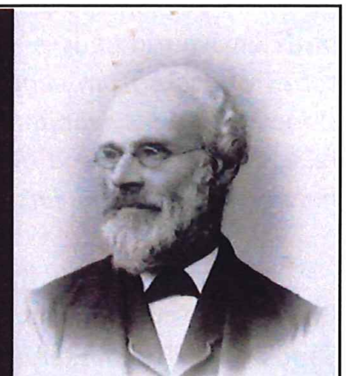
Claypole (1885, p. 76) eloquently described the dilemma posed by the presence of the Chemung forms within the Catskill strata:

"The stratigraphical geologist may be disposed to draw a hard line at the base of the red rocks and to say that all above the line shall be Catskill, fossils included. The palaeontologist may feel inclined to draw the line at the highest shell-bearing bed and to say that all below the line shall be Chemung, red sandstone and shale included. But neither is a logical sequence from the facts. Passage beds must be expected between all the great formations. The day is near when all the hard lines hitherto drawn across the geological column will be blurred, and system will shade into system as gently as the colors of the rainbow fade into one another."

Box 1. Media-attracting wager made at the 1884 American Association for the Advancement of Science Meeting in Philadelphia, Pennsylvania



James M. Hall



E. W. Claypole

The following account is from a biography of New York State Geologist James M. Hall (Clarke, 1921, p. 512-514):

"And just in these years occurred an incident of a serio-comic scientific sort, forgotten now no doubt but still with a lesson upon reserve in statement of scientific conclusions. The American Association for the Advancement of Science met in Philadelphia in 1884 where Professor Henry S. Williams of Cornell University gave an account of his work in running cross-sections of the Upper Devonian strata of southwestern New York from which he deduced a 'mongrel fauna' between the Chemung and the overlying red beds of the Catskill formation. In the discussion which followed Mr. Hall applauded the paper, though questioning the wisdom of the expression 'mongrel fauna.'

Then E. W. Claypole, of the Pennsylvania geologists, took up the thread of the discussion declaring that he too had found a fauna between the Catskill and Chemung which carried the two Spirifers, S. disjunctus and S. mesastrialis, indices of very distinct geological horizons. This statement brought the septuagenarian to his feet with positive declaration that it was not only contrary to his long experience but to the facts.

The warmth of the contention excited the attention of the reporter for the Philadelphia Press which came out the next morning with the story that Hall had said: 'If any one will show me these two Spirifers side by side in the same rock, I will sacrifice my life's work. I will give up my reputation, eat my hat and make the person who shows me the rock a present of my coat and boots!' The story was good and was sent broadcast to the newspapers with amplifications, the New York Tribune adding that Professor Williams took the next train for Ithaca, sent on a piece of rock containing the offending Spirifers with the message: 'You have it now. Please eat your hat and send me your coat and boots by express.'

Hall waited patiently a week or so and then wrote out the story for the Albany Argus. He had directed his strictures to the statement of Mr. Claypole which he declared was as wrong now as then. Mr. Williams had been summoned to Ithaca by illness at home and had sent on no specimens with the two fossils together; and he would still eat his hat, etc., if any one, no matter who, could prove his statement wrong. There the story ended except for the unenviable notoriety a man is bound to get when he sends out the truth to catch a lie. But the fact remains today that Hall's claim was absolutely correct."

The challenge of delineating the base of the Catskill Formation based on the appearance of extensive red beds is also described by Prosser (1884): *"Any geologist who has followed this series of rocks from central New York eastward to the Catskills, and then along their eastern slope into Pennsylvania, knows very well that red beds appear at different horizons in various parts of the area, and also realizes the utter impossibility of indicating the same approximate horizon by drawing a line through the lowest red beds."*

In the geologic map by Dewees (1881) accompanying Claypole's 1885 report on Perry County, the dilemma is resolved by using darker and lighter colors to represent Unit IX—Catskill Sandstone. The darker color represents the lower part of the Catskill Formation containing the Chemung forms.

Based solely on lithology, in the southern half of the New Bloomfield 15-minute quadrangle, Dyson (1967) provides the following descriptions for the various members of the Catskill Formation, in ascending order:

- *Irish Valley Member (Dciv): Medium-gray and reddish-gray siltstones, shales, and fine-grained sandstones. Includes some medium-gray sandstones up to 80 feet thick which may be persistent. Brachiopods and crinoids at numerous horizons in both gray and red beds.*

- *Sherman Creek Member (Dcsc): Grayish-red to brownish-red shales, siltstones, and fine-grained sandstones with some gray, fine-grained sandstone interbeds. The upper part is dominantly sandstone.*

- *Clark's Ferry Member (Dccf): Gray- to grayish-red, cross-bedded quartzite and sandstone (in part conglomeratic) containing red shale pebbles.*

- *Duncannon Member (Dcd): Upper sandy part contains medium gray- to medium-dark-gray, thick conglomeratic sandstones, separated by thinner units of grayish-red shale and siltstone overlain by 100 feet of grayish-red shale containing pebbles (to 2 inches in diameter) of various lithologies. Characterized by pronounced cyclic sedimentation. Lower part contains grayish-red to brownish-red shales, siltstones, and fine-grained sandstones with some gray, fine-grained sandstone interbeds. Characterized by pronounced cyclic sedimentation.*

According to Dyson (1967, p. 34), the Irish Valley Member is a marine-nonmarine transitional zone having 30 percent redbeds and measuring 2,251 feet thick on the east side of the Juniata River at Newport. Dyson (1967, p. 35) describes a varied flora and fauna within the upper part of the Irish Valley member:

> *"In the interfingering zone between the Irish Valley and the overlying redbed member are several horizons with abundant large carbonized plant stem fossils. Some of these in cross section appear to be anthracite stringers up to ¼ inch thick. There are several of*

these occurrences along State Highway 850 in the west subquad of the Wertzville quadrangle. Interbedded with some of the gray sandstones are thin olive-gray clay shales which appear to be lacustrine. Several small pelecypods with Spirobis-type worm tubes attached were found in these strata."

The upper three members consist of sandstone bodies and sandstone-mudstone interbeds. Based on study of their outcrops along U.S. 322 at Second Mountain, Peters Mountain, and Buffalo Mountain, Diemer (1992) reports the Sherman Creek and Duncannon Members are composed of about equal amounts of sandstone and mudstone, and the Clark's Ferry Member is dominated by sandstone and not as widespread. The upper three members are thought to represent an alluvial plain depositional environment (Diemer, 1992).

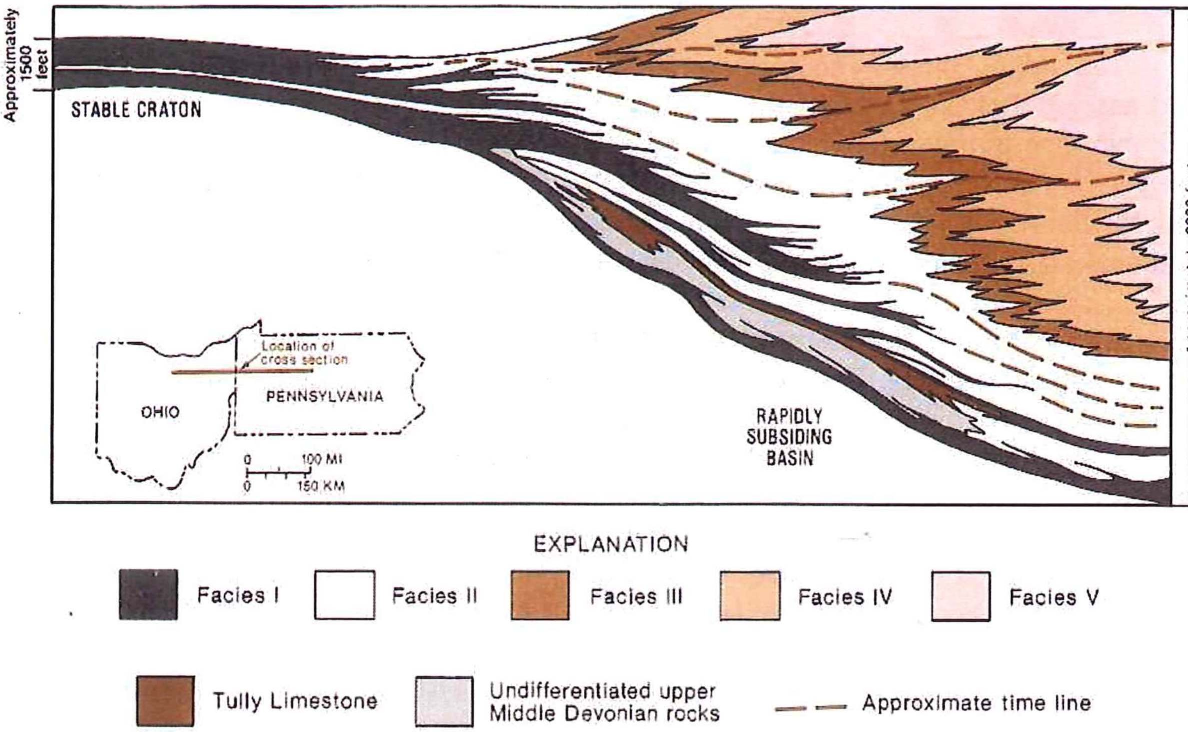
Because of the complexity of the Upper Devonian rocks, some researchers have found it more useful to categorize these rocks as facies (within chronostratigraphic units) rather than as lithostratigraphic formations. Table 2 provides a comparison of the Upper Devonian facies described in Pennsylvania by Harper (1999) and in New York by Rickard (2000). Dyson's Irish Valley Member appears to include Facies IV (Cattaraugus facies) rocks, while the upper three members of the Catskill Formation (Sherman Creek, Clark's Ferry, and Duncannon Members) appear to consist mostly of Facies V rocks (Catskill facies). The chronostratigraphic units comprise generally coeval groups of laterally varying facies of varying thicknesses.

Harper's (1999) schematic representation of the Upper Devonian facies across the western Appalachian basin (Figure 2) indicates a general thickening of the basin-filling sediments in an eastward direction. The overall vertical pattern indicates a shallowing upward sequence with the shoreline prograding in a westward direction; however numerous subordinate marine transgressions (relative rises in sea level) are inferred from the repeated eastward on-lapping of the dark gray to black, somewhat calcareous and sparsely fossiliferous shales of Facies I onto the other facies. As the thinnest and most laterally persistent indicator of the basin's fluctuating relative sea level, Facies I is used to delineate approximate time lines, which are shown as dashed lines in Figure 2. The chronostratigraphic groups delineated by the time lines display considerable lateral variation in both lithology and thickness. A similar east-west diagrammatic cross section has been developed for the portion of the Catskill delta in New York (Rickard, 2000, p. 121, Figure 8.16).

Spechty Kopf and Pocono Formations

Above the upper sandstone of the Duncannon Member of the Catskill Formation lie the Upper Devonian and Mississippian age strata of the Spechty Kopf and Pocono Formations, which form the backbone of Cove Mountain. Epstein and others (1974) raised the Spechty Kopf to formation rank, and it is mapped accordingly in the maps of the Halifax and Harrisburg West 7.5-minute quadrangles (Hoskins, 1976; Root and Hoskins, 1975). In his geologic map of the southern half of the New Bloomfield 15-minute quadrangle, Dyson (1967) maps the Spechty Kopf as a 200-foot-thick lower member of the Pocono Formation. Dyson (1967) describes the Pocono Formation as follows:

Figure 2: Schematic section showing relationships of Upper Devonian facies and their relationship with formations of the upper Middle Devonian (Hamilton Group) across the western Appalachian basin (Harper, 1999). See Table 2 for facies descriptions.



"Pocono Formation (Mpo): Medium- to thick-bedded, medium- to coarse-grained, cross-bedded, micaceous, gray conglomeratic sandstone and sandstone with some shale and siltstone interbeds. Quartz pebble conglomerate up to 20 feet thick about 200 feet above base. Spechty Kopf Member (DMps) is lower 200 feet and is sandstone with some conglomerate and minor redbed and siltstone interbeds. Carbonized plant remains and marcasite nodules abundant. Some marcasite zones are interleaved with films and lenses (¼ inch thick) of anthracite. Most if not all the formation is characterized by cyclic (rhythmic) sedimentation."

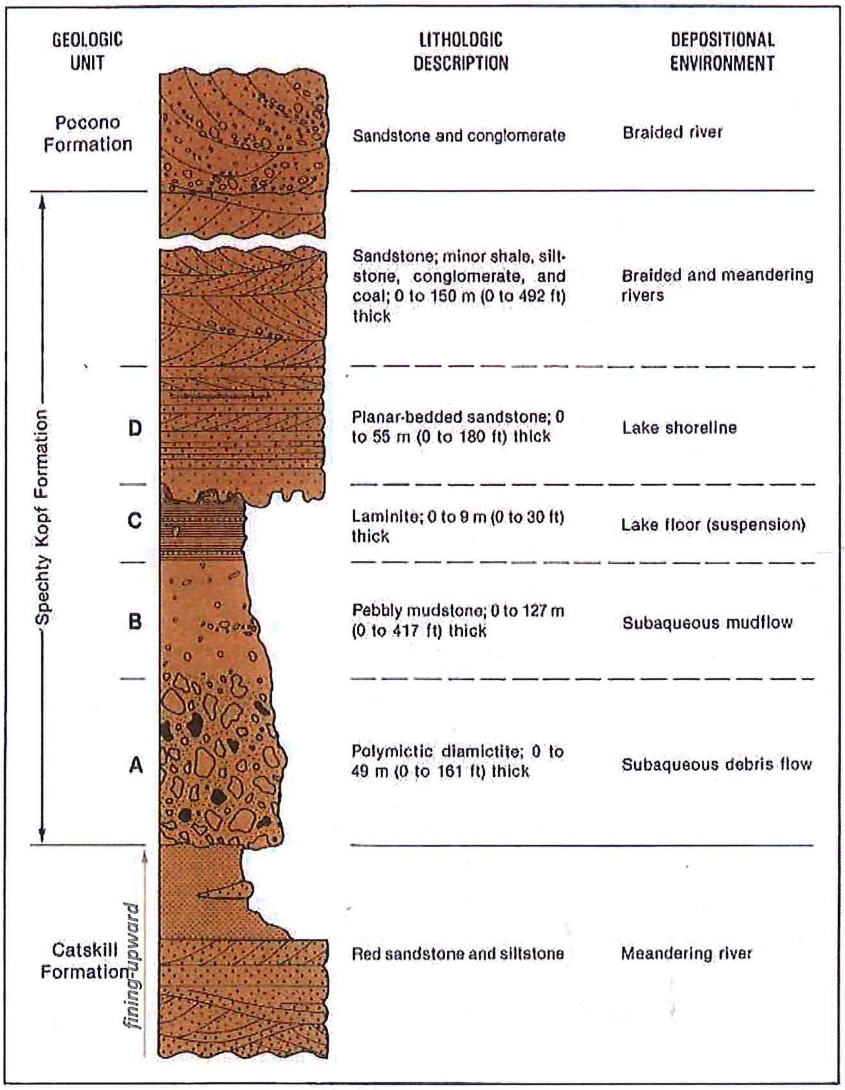
Dyson reports (1967) that the Spechty Kopf generally becomes coarser west of Peters Mountain and that the amount of conglomerate and conglomeratic sandstone becomes appreciable to the west and south around Cove Mountain. The Spechty Kopf outcrops within the steep outer scarp slope on both limbs of the mountain. Dyson (1967) thought that the Pocono was probably deposited on a coastal plain, mainly in stream channels and floodplains. The Spechty Kopf Formation has been mapped only within the Anthracite Upland and Anthracite Valley Sections of the Ridge and Valley province, so the outcrops on Cove Mountain occur at the southwestern extent of its range.

Berg's (1999) generalized stratigraphic column of the Spechty Kopf Formation (Figure 3) illustrates a succession of polymictic diamictite, pebbly mudstone, laminite, and planar bedded

Table 2. Upper Devonian Facies of Pennsylvania and New York

<table>
<tr><th colspan="3">PENNSYLVANIA (Harper, 1999)</th><th colspan="5">NEW YORK (Rickard, 2000)</th></tr>
<tr><th>Facies</th><th>Depositional Environment</th><th>Lithology</th><th>Facies</th><th>Depositional Environment</th><th>Lithology</th><th>Environments</th><th>Fossils</th></tr>
<tr><td rowspan="2">V</td><td rowspan="2">Mixed continental, fluvial-deltaic, and marginal-marine environments.</td><td rowspan="2">Gray to red, thin- to thick-bedded mudstones, claystones, siltstones, sandstones, and conglomerates; sparsely to moderately fossiliferous.</td><td>Pocono</td><td>Piedmont</td><td>Conglomerate with round white quartz pebbles
Pebbly sandstone & siltstone (purple or maroon)
Thick layers</td><td>Braided streams near foot of mountain range</td><td>Rare fossils</td></tr>
<tr><td>Catskill</td><td>River flood plain</td><td>Red, green & gray shale
Green mudstone & siltstone
Medium to coarse-grained quartz sandstone
Pebbly sandstone
Sandstone beds coarser at base & fining upward
Cross-bedding in sandstone; scouring, root traces, mud cracks</td><td>River floodplains with meandering streams; shale, mudstone & siltstone in the floodplains; sandstone--in channels</td><td>Few fossils overall; in places, plant and fish fossils are common</td></tr>
<tr><td>IV</td><td>Delta-derived detrital sediments of mixed fluvial-deltaic and linear-clastic shorelines; interspersed open-marine carbonates deposited during eustatic sea-level rises.</td><td>Interbedded silty, micaceous mudrocks and fine- to coarse-grained, thin- to thick-bedded siltstones, sandstones, and conglomerates; moderately to highly fossiliferous. Occasional beds of sparsely to highly fossiliferous limestone.</td><td>Cattaraugus</td><td>Near shore marine-nonmarine cycles</td><td>Gray & green shale, siltstone & sandstone
Alternating layers of red shale, siltstone, & sandstone
Gray & green rocks: winnowing, bioturbation, ripple marks
Red rocks: root traces, mud cracks</td><td>Close to shore, alternately above and below sea level
Green & gray rocks are marine
Red rocks are nonmarine</td><td>Low in number & variety
Red rocks contain plant fossils</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Detrital sediments of the shallow-marine open shelf.</td><td rowspan="2">Light- to dark-colored greenish, brownish, purplish, or reddish, highly fossiliferous shales, siltstones, and fine-grained sandstones.</td><td>Chemung</td><td>Nearshore marine, diverse subtidal shelf</td><td>Gray shale, mudstone, & siltstone
Fine- to medium-grained sandstone
Layers of fossil shells
Flat pebble conglomerate
Laminations, cross-bedding, ripple marks, flute & groove casts, convoluted sedimentary structures</td><td>Several shallow water environments near shore and in tidal zone: beach, channel, tidal flat, lagoon, swamp, offshore bar, delta, near shore, open shelf
Underwater: delta, near shore, open shelf</td><td>High number & variety (except in a few environments) of shelled sea animals, brachiopods, and bivalve mollusks</td></tr>
<tr><td>Portage B</td><td>Open shelf, slope</td><td>Thin layers of siltstone, cross-laminated, graded
Turbidites in gray shale</td><td>Outer part of shelf below motion of fair-weather waves
Slope</td><td>Low number & variety of swimmers & sea bottom dwellers</td></tr>
<tr><td>II</td><td>Turbidites of the delta-fed submarine ramp (slope).</td><td>Interbedded dark-gray shales and thin-bedded, light- to medium-gray siltstones; sparsely fossiliferous.</td><td>Portage A</td><td>Base of slope, basin edge</td><td>Black and medium to dark gray shale, mudstone, and siltstone
A few layers of fine grained sandstone in dark gray shale
In siltstone: cross-laminations; casts of grooves, tracks, trails, & flutes convoluted bedding; ripplemarks</td><td>Deeper waters at base of slope to basin margin</td><td>Low number & variety of swimmers & sea bottom dwellers</td></tr>
<tr><td>I</td><td>Anoxic bottom muds of the basin proper (shallow or deep water).</td><td>Dark-gray to black, somewhat calcareous, pyritic, sparsely fossiliferous shales.</td><td>Genesee</td><td>Central basin (like Marcellus)</td><td>Black shale
A few thin layers of dark limestone rich in clay
Septarian nodules and concretions
Pyrite
Shale splits easily into thin sheets</td><td>Deep water part of basin far from land
Very little oxygen near the bottom</td><td>Low number & variety of swimmers & sea bottom dwellers: ammonoids, conodonts, brachiopods, and mollusks</td></tr>
</table>

Figure 3: Generalized stratigraphic column showing the character of the Spechty Kopf Formation and inferred depositional environments (Berg, 1999).



sandstone overlain by sandstone with minor shale, siltstone, conglomerate, and coal. Berg (1999, p. 133) notes that the "polymictic diamictite and pebbly mudstone are unique in the upper Paleozoic of Pennsylvania" and that they "probably represent a major event near the end of the Devonian." The mostly nonsorted polymictic diamictites contain igneous, meta-igneous, and metasedimentary clasts (Berg, 1999, p. 133). The earliest metamorphic clasts from the Piedmont are found within the lower part of the Spechty Kopf and do not appear in younger beds (Faill, 1999, p. 428-429)[5].

[5] Participants in the HAGS 1992 spring field trip (*Paleozoic geology of the Paw Paw-Hancock area of Maryland and West Virginia*), which was led by Marcus Key and Noel Potter, Jr., may recall observing the polymictic diamictite in the base of the Rockwell Formation in the I-68 road cut through Sideling Hill in Maryland (Key and Potter, 1992, Stop 3).

Berg (1999) also reported the presence of "occasional *dropped in* pebbles, granules, and sand grains" in the laminite, which suggests the possibility of sediments deposited from debris-laden floating ice in a lacustrine setting, but he discounted this hypothesis given the prevailing presumption of an equatorial climate during the Devonian-Mississippian transition. The stratigraphic correlation chart of Pennsylvania indicates that unconformities exist above the Spechty Kopf Formation and below it throughout most of its range (Berg and others, 1993).

Brezinski, Cecil, and Skema (2010) studied the polymictic diamictite in the lower part of the Spechty Kopf Formation and the coeval portion of the Rockwell Formation in Pennsylvania, Maryland, and West Virginia. Their study comprised 50 sections, 40 of which included the diamictite succession. The study sections included diamictite exposed in outcrops of the Spechty Kopf in Peters Mountain and in Second Mountain on the east side of the Susquehanna River. Their study led them to propose glaciation as the major event responsible for the occurrence of the polymictic diamictite. They outlined a glacigenic succession of facies as follows:

- Diamictite substrate: a 3- to 5-m-thick interval of deformed strata immediately below the unconformity with the Catskill Formation at the base of the diamictite strata featuring highly contorted bedding, low angle shear planes, imbricate thrusts, and rotated blocks of Catskill material thrust up in to the diamictite.
- Diamictite lithofacies: consists of several subfacies that are interpreted to be subglacial, englacial, supraglacial meltout, and resedimented deposits.
- Mudstone lithofacies: localized intervals of chaotically bedded, clast-poor mudstone (subaqueous proximal debris flows) and laminated mudstone (varvites).
- Pebbly sandstone lithofacies: proglacial braided outwash deposits underlying the diamictite and coarsening upward (preceding glacial advance) and overlying the diamictite and fining-upward (following glacial retreat).

From the tectonic and depositional frameworks, Brezinski, Cecil, and Skema (2010) infer that the facies were deposited in a terrestrial setting within the Appalachian foreland basin during a single glacial advance and retreat. They cite regional patterns consistent with glaciation, including wet climate paleosols in areas not covered by ice but subject to increased rainfall, river systems eroding deeper channels in response to marine regression during glacial advance, and marine facies to the west containing ice-borne dropstone boulders preserved within coeval units of the Cleveland Shale Member of the Ohio Shale. They correlate this stratigraphic interval with a global episode of sea-level decline responsible for deposition of the Hangenberg Shale/Sandstone in Europe, which records the Hangenberg biotic crisis near the Devonian-Carboniferous boundary.

Mauch Chunk Formation

Mississippian rocks of the Mauch Chunk Formation underlie the valley formed by Cove Mountain. In his report on the southern half of the New Bloomfield 15-minute quadrangle, Dyson (1967, p. 39) describes the Mauch Chunk as follows:

"The formation is composed of cyclical-bedded, grayish-red shales, siltstones, and sandstones. No fossils, except a few plants In the Mauch Chunk-Pocono transition zone, have been found in the map area, but farther east, a few tracks, presumably of amphibians, have been reported. In the lower part of the formation scattered pebbles of relatively large size (3- to 4-inch diameter) are common in several stratigraphic units. A number of limestone-pebble zones, in which the fragments vary from sand size to pebbles 1 inch in diameter, occur in fine-grained, grayish-red sandstones throughout the formation."

Dyson describes the lower 194 feet of the Mauch Chunk as transitional with the underlying Pocono Formation and maps it as an unnamed lower member (map unit Mmcl). Dyson estimates a thickness of 5,000 feet for the Mauch Chunk along the axis of the Cove syncline, which is much thicker than usual, and attributes the greater thickness along the axis to flowage from the flanks or faulting.

Diabase Dike

A diabase dike of Triassic age cuts diagonally across the Susquehanna River just downstream of the mouth of Shermans Creek. On the east side of the water gap, the dike manifests itself in the end of Peters Mountain as a highly weathered vertical reentrant in the Duncannon Member of the Catskill Formation. Dyson (1967, p. 41) reports the dike is nearly 45 feet thick and dips about 80 degrees to the south at its exposure in Peters Mountain on the east side of the Susquehanna River water gap. The intruded shales are metamorphosed to hard, dark-gray hornfels. The dike weathers more deeply than the rock it intrudes, and it can be traced, both on the ground and in aerial photographs, by the streak of yellow-brown clay to which it weathers.

SURFICIAL MATERIALS

In addition to thin residual soils, surficial materials in the area of the field trip include terrace deposits, colluvium, recent alluvium, and artificial fill. Quaternary terrace deposits are mainly sand and gravel. Dyson (1967) maps an extensive deposit along the east side of the Susquehanna River south of the axis of the Cove syncline. Sheets of colluvium are found on the flanks of most of the major ridges north of the Great Valley. Recent alluvium consists of silt, sand, and gravel deposits found at the mouth of Shermans Creek and along the Susquehanna River. Dyson (1967) maps a deposit of artificial fill, consisting mostly of ash and cinders along the railroad tracks on the west side of the Susquehanna River in the northern part of the Cove.

PALEOGEOGRAPHY

The rocks of the Catskill clastic wedge are part of the Kaskaskia sequence and were derived from the Appalachian orogen to the east (Dott and Prothero, 1994; Hibbard and others, 2006). According to Sevon and Woodrow's (1981) Late Devonian paleogeography and lithofacies map (Figure 4), as presented by Harper (1999, Figure 7-20), the future Commonwealth of Pennsylvania was situated south of the Equator during the Acadian orogeny. Clastic sediments (redbeds) derived from the eastern highlands were being deposited in a foreland basin in eastern Pennsylvania, while farther west, green to black shales were being

Figure 4: Late Devonian physiographic and lithofacies map (Harper, 1999, Figure 7-20).

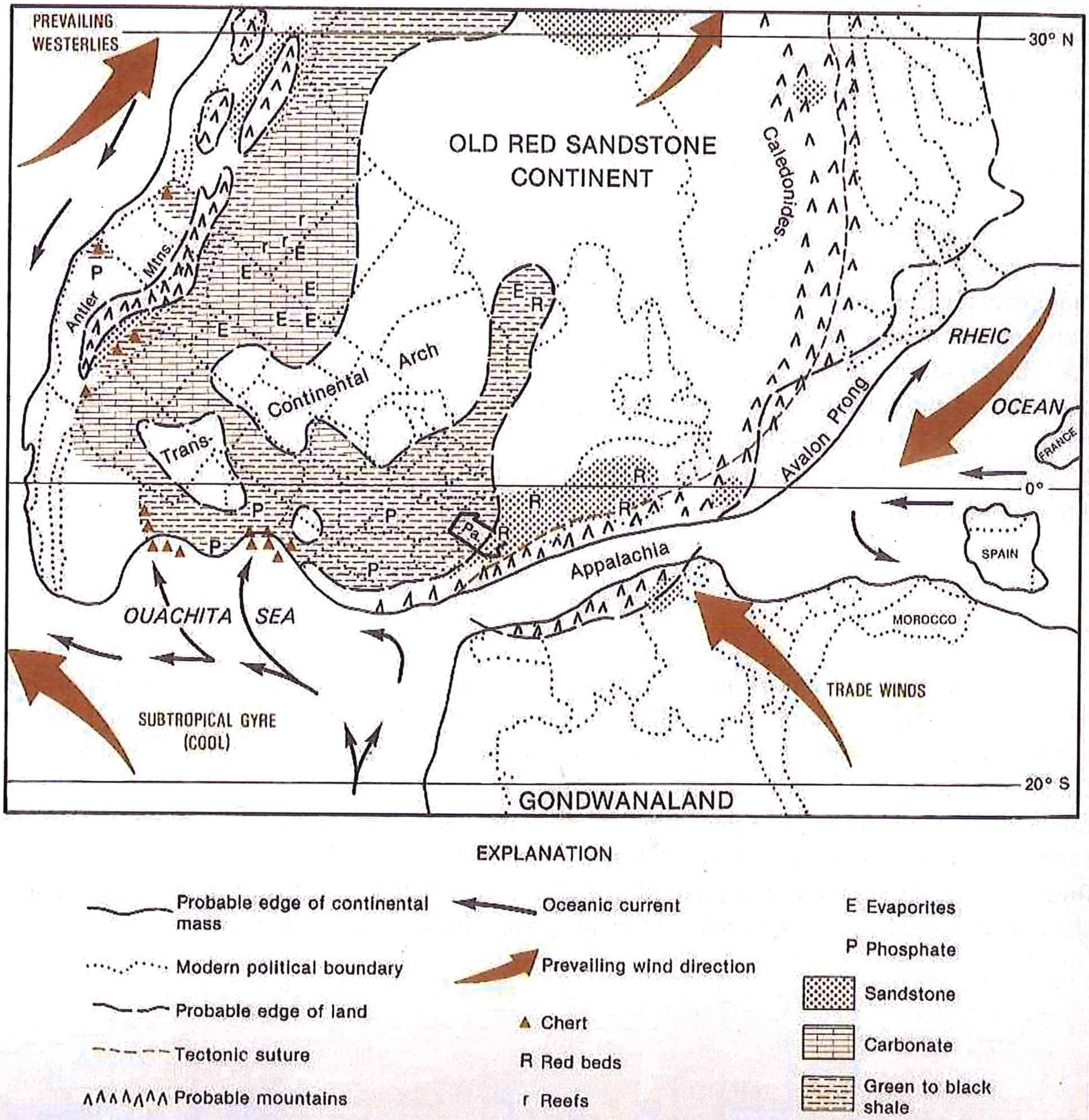
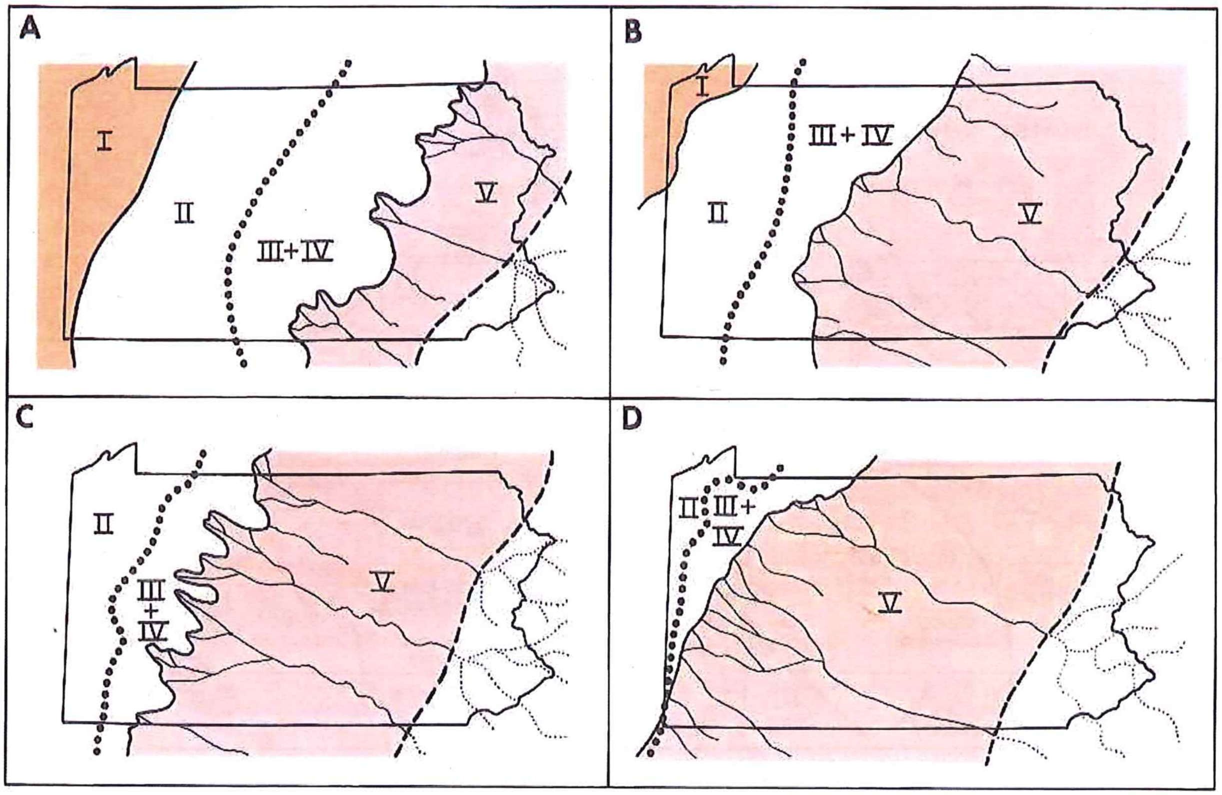


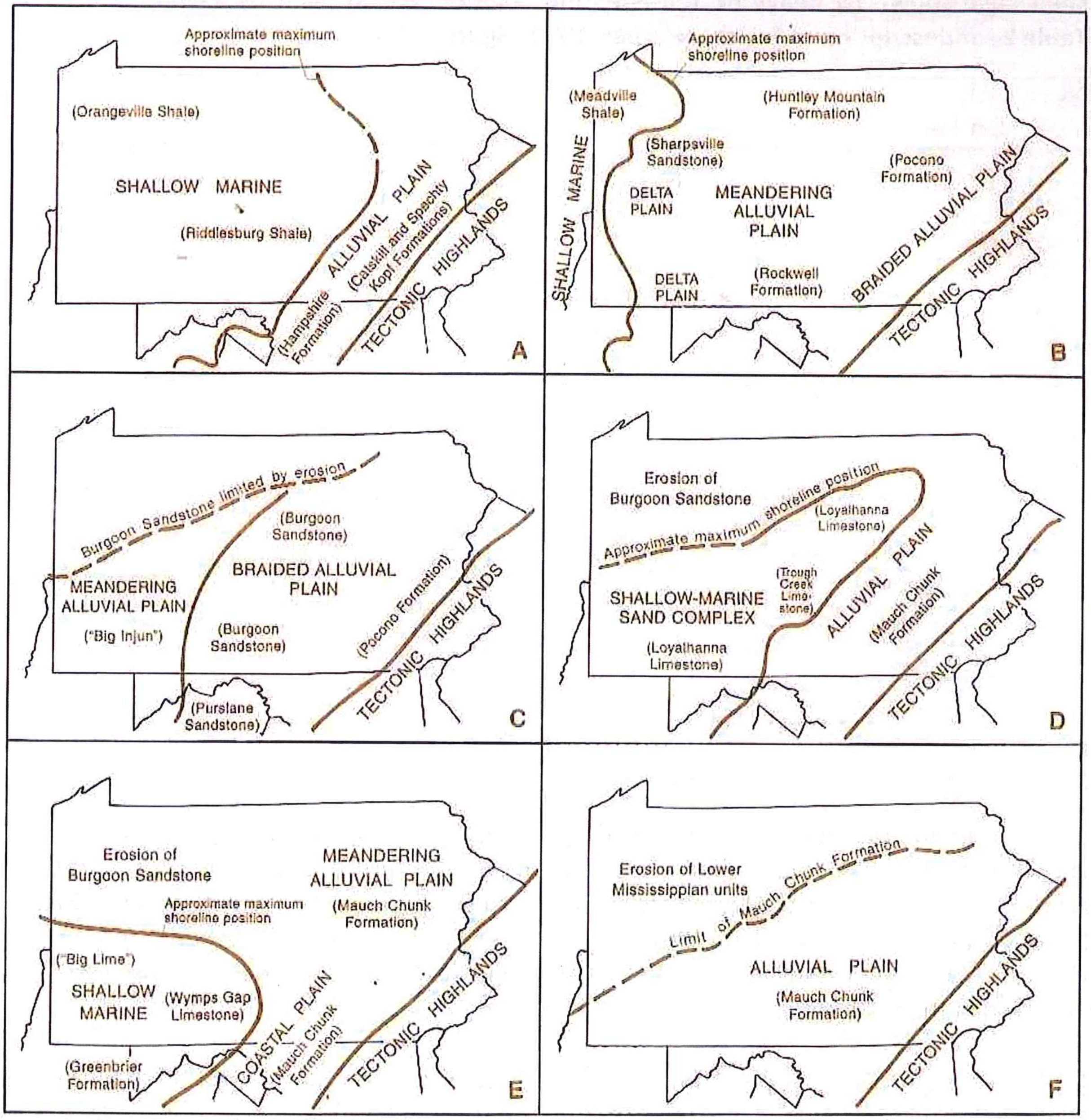
Figure 5: Late Devonian paleogeographic maps showing progradation of Catskill Facies I through V during deposition of the Senecan and Chautauquan Series. A: Middle Senecan; B: Early Chautauquan; C: Middle Chautauquan; D: Late Chautauquan. Approximate shelf edge shown by heavy dotted line, and edge of coastal plain by dashed line. See Table 2 for description of facies. (Harper, 1999, Figure 7-21).



deposited in an epicontinental sea extending into western Pennsylvania. Progradation of the Catskill delta extended the redbeds westward across the future Commonwealth as shown in Figure 5. The first panel of Figure 5 corresponds to the period when the Irish Valley Member (Facies IV and V) was being deposited, and the other panels roughly correspond to the periods when the Sherman Creek Member, Clark's Ferry Member, and Duncannon Member were being deposited in the field trip area.

Brezinski, Cecil, and Skema (2010, p. 280) report that current Late Devonian paleographic reconstructions place the central Appalachian basin about 30 to 45 degrees south of the Equator, which is much closer to the Equator than the inferred 60 degree South latitude of other reported Late Devonian glacigenic successions in South America and Africa. Brezinski, Cecil, and Skema (2010, p. 280) suggest that the midlatitude and low altitude Appalachian glacigenic succession in the Spechty Kopf and Rockwell Formations may be a vestige of a more widespread Late Devonian glaciation and may help explain the role global cooling played in the Late Devonian biotic crisis know as the Hangenberg extinction, which decimated more than 45 percent of marine genera.

Figure 6: Generalized Mississippian paleogeography. A: Early Kinderhookian, B: Late Kinderhookian; C: Osagean; D: Late Meramecian; E: Early Chesterian; and F: Late Chesterian. (Brezinski, 1999, Figure 9-12).



During the Mississippian, eastern highlands continued to shed sediments westward into Pennsylvania (Figure 6). Sediments forming the Pocono Formation were deposited on a braided alluvial plain close to the eastern highland during a lowstand period when nonmarine deposition predominated throughout Pennsylvania. Sediments forming the Mauch Chunk Formation were deposited on an alluvial plain during a period of marine transgression indicated by the calcareous rocks of the Loyalhanna Formation in western Pennsylvania followed by another regression.

STRUCTURE

The Cove Mountain syncline is the major structural feature of the field trip area. The axial trace of the syncline strikes approximately N63°E where it crosses the Susquehanna River. The plunge of the syncline in the map area is approximately 10 degrees to the east (Dyson, 1967, p. 44). On the east side of the Susquehanna River, the limbs of the Cove syncline embrace the south-westernmost extension of the southern anthracite basin, which is generally delineated by the Pottsville Formation forming the ridges of Third Mountain.

The effect of structure on drainage development is evident in the tendency of many stream segments to run parallel to bedding or transverse to bedding and parallel to the trend of cross-cutting joints. This pattern is evident in Shermans Creek's meander away from Cove Mountain, and in Conodoguinet Creek's numerous meanders in northern Cumberland County as it approaches its confluence with the Susquehanna River at West Fairview. Epstein (1966) identified structural controls on the development of water gaps and wind gaps in resistant ridges in the Stroudsburg area.

The Shermans Creek basin is situated within the Pennsylvania salient, a pronounced zone of curvature in the trend of major fold axes. This curvature is evident in the change in strike of Blue Mountain, which varies from about N33°E in northern Franklin County, to N52°E in western Perry County, to N80°E in eastern Perry County. A flexure coinciding with the location of the Susquehanna River water gap brings the strike of Blue Mountain to about N62°E in Dauphin and Lebanon Counties. Wise (2004) discusses several models explaining development of the Pennsylvania salient and proposes a two-azimuth transport model based on a compilation of Piedmont tectonic transport data.

HYDROLOGY

According to the U.S. Geological Survey (USGS), Shermans Creek drains an area of 244 square miles.[6] The USGS maintains gauging station no. 0156800 on the left bank of Shermans Creek just downstream of PA Highway 34. The drainage area above the gauging station is 207 square miles, and the gauge datum is 422.63 feet (USGS).

Figure 7 provides a daily hydrograph of minimum, median, mean, and maximum daily-mean discharge, based on 82 years of records from 1930 to 2011. The minimum daily-mean discharge ranges from 9.9 cubic feet per second (cfs) on August 15, 2002 to 145 cfs on April 15, 1966. Baseflow, as reflected by the minimum daily-mean discharge curve, generally increases from mid-January to mid-April during the winter/spring thaw, and generally decreases from mid-April to mid-August as evapotranspiration increases over the summer, and then generally

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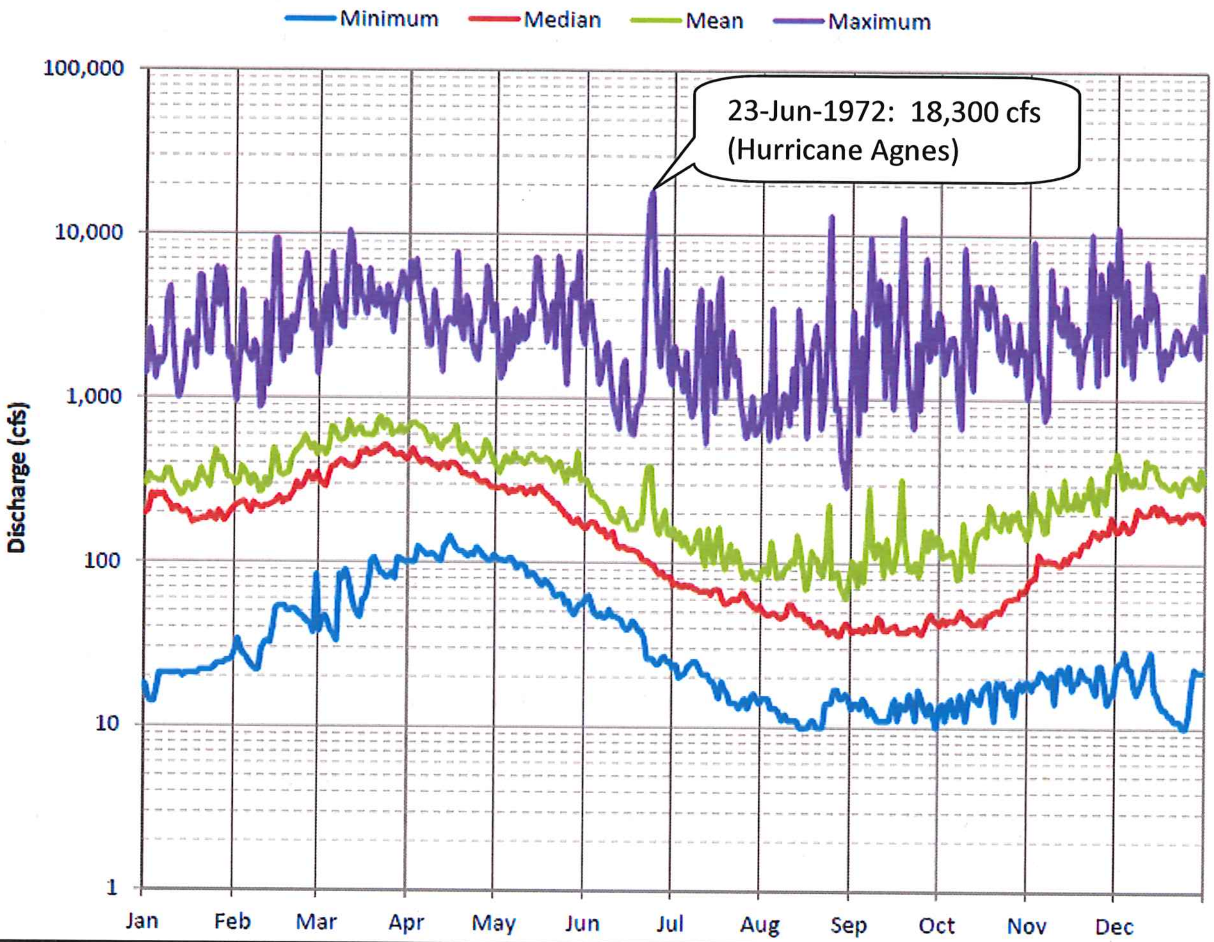
[6] http://water.usgs.gov/nawqa/ne/lsus/lsus_factsheet.html

Figure 7: Hydrograph of minimum, median, mean, and maximum daily-mean discharge of Shermans Creek at Shermansdale (USGS data).



increases slowly over the fall as evapotranspiration decreases. Median and mean daily-mean discharge peak in late April, slightly earlier than the peak in minimum daily-mean discharge.

The historic peak streamflow of 44,000 cfs on July 22, 1927 falls outside the period of record. The three highest peak streamflows within the period of record are associated with hurricanes, their remnant tropical storm, or strong Category 1 storms: 27,500 cfs on June 23, 1972 (Hurricane Agnes), 22,300 cfs on August 24, 1933 (a strong Category 1 storm—"the Chesapeake-Potomac Hurricane"), and 21,700 cfs on September 18, 2004 (Hurricane Ivan). Shermans Creek below PA 34 in Shermansdale is generally canoeable when the stage is at least 1.5 feet at Shermansdale, which is usually the case within ten days of rain until late May (Gertler, 1993).

On the Susquehanna River, the USGS maintains gauging station no. 01570500 on the east bank of City Island, 60 feet downstream of the Market Street Bridge in Harrisburg. The drainage area upstream of the gauging station is about 24,100 square miles, and the gauge datum is 290.01 feet (USGS).

Figure 8: Hydrograph of minimum, median, mean, and maximum daily-mean discharge of the Susquehanna River at Harrisburg (USGS data).

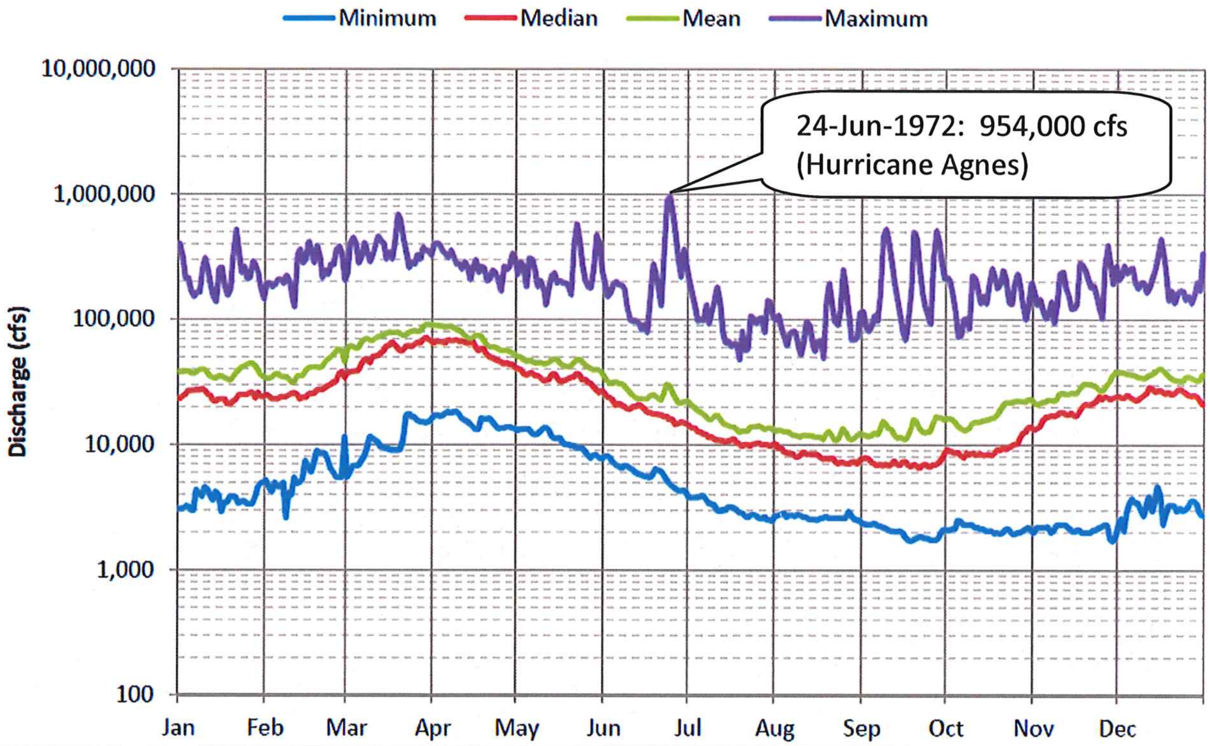


Figure 8 provides a daily hydrograph of minimum, median, mean, and maximum daily-mean discharge, based on 121 years of records from 1891 to 2011. The minimum daily-mean discharge ranges from 1,700 cfs on November 29, 1931 and September 18, 1964, to 18,400 cfs on April 9, 1891. The Susquehanna River hydrograph shows that baseflow fluctuates seasonally in a pattern similar to the one described for Shermans Creek even though the base flow of the Susquehanna River is about 2,000 times greater than the Sherman Creek's baseflow.

The historic peak streamflow of 1,020,000 cfs occurred on June 24, 1972 (Hurricane Agnes), which is the day after the peak observed on the Shermans Creek at Shermansdale. According to the Susquehanna River Basin Commission (2007), Tropical Storm Agnes took 72 lives and did more than $2.8 billion dollars ($15.4 billion in 2012 dollars) worth of damage in the Susquehanna River Basin. The second highest peak is 740,000 cfs on March 19, 1936, an event known as the St. Patrick's Day flood. From scour channels and large diabase blocks found along the Susquehanna River at Conewago Falls south of Harrisburg, Sevon (1993) has inferred that extraordinary floods may have surged down the river during the Pleistocene. Such extreme floods may have occurred during multiple Pleistocene deglaciations or during multiple catastrophic drainages of glacial Lake Lesley, which was formed by glacial ice blocking the West Branch of the Susquehanna River near Williamsport, Pennsylvania (Sevon, 2011, 1993).

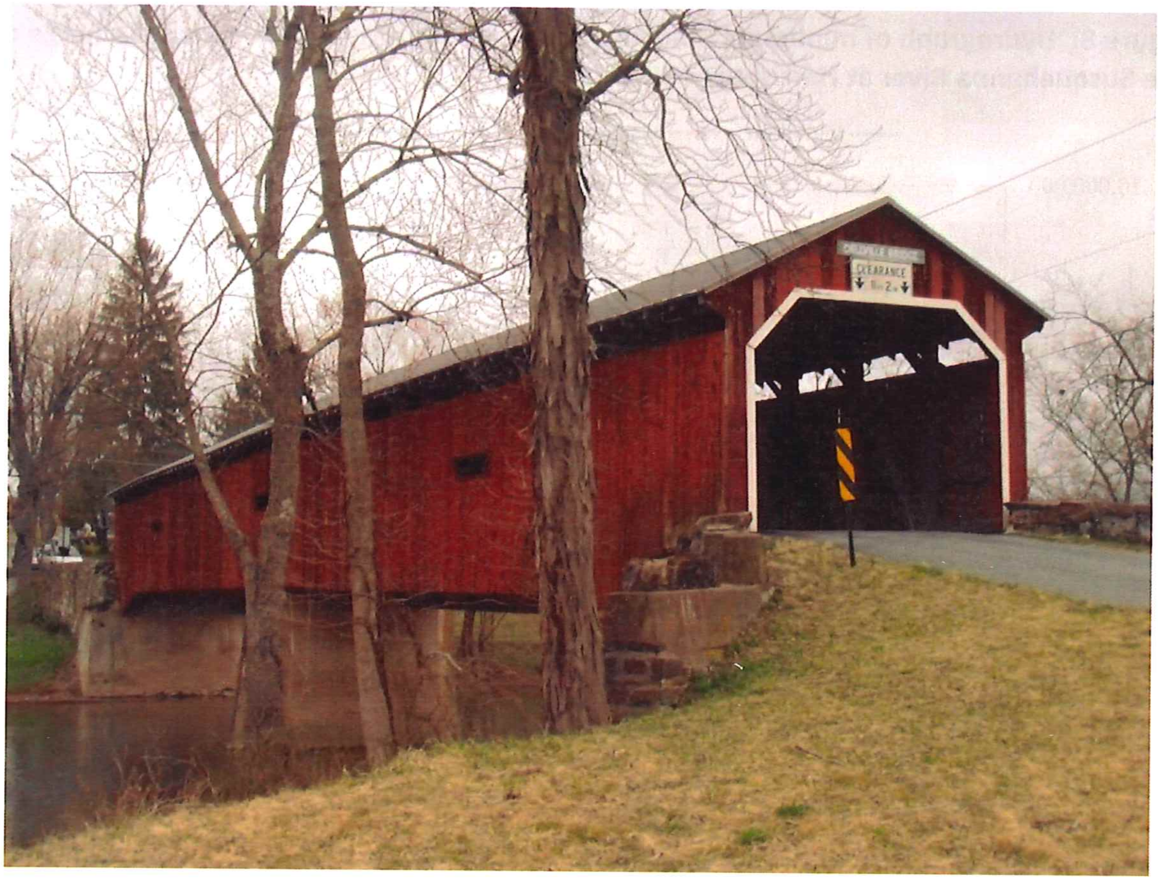


Figure 9: Dellville Bridge over Shermans Creek.

SHERMANS CREEK (DELLVILLE TO DUNCANNON) STREAM LOG

The trip begins at Blue Mountain Outfitters, which is located along the east side of U.S. Routes 11 and 15 in Marysville. Marysville is the largest borough in Perry County and was developed largely as a "railroad town" (Hain, 1922, p. 1000). Blue Mountain will provide canoe rental and shuttle service. From Marysville, we will travel north on U.S. Routes 11 and 15 to the south end of Duncannon, where we will take PA 274 West to S.R. 2002, which we will follow to Dellville and the point of departure for the canoe trip. The stream log begins at the covered bridge over Sherman Creek in Dellville.

Mile   Description   (See Attached Map 3 for geologic map showing approximate route.)

0.0   Put in on the right bank of Sherman Creek just upstream of the Dellville Bridge. Stream elevation is approximately 478 feet above sea level.

Dellville Bridge (Figure 9) is the largest of fourteen covered bridges in Perry County. The bridge is 174 feet long, 20 feet wide, and features a wood planking roadway. Originally known as Billows Bridge, the bridge was built in 1889, following the flood of that year. The original construction was Burr arch single span. In 1932, the bridge was reinforced with a concrete center pier, and in 1957, it was further reinforced with two 36-inch steel I-beams (Perry County Tourist Bureau, 1983). A plaque on the downstream wingwall of the left abutment indicates the bridge was rebuilt in October 1973 after the visit of Tropical Storm Agnes in June 1972. The bridge was replaced by a new concrete bridge located upstream of the bridge in 2007 and is now closed to through traffic.

Dellville Mill (Figure 10) is situated approximately 1,000 feet upstream of Dellville Bridge on the left bank of Shermans Creek. According to the Perry County Tourist Bureau (1989), the mill was turbine-operated and equipped with mill stones and flour rollers. A 3-foot high dam upstream of the mill provided head to run the mill.

Hain (1922, p. 1081) provides the following account of the mill's history through the early 20th century:

"Christian Smith and Isaac Kirkpatrick purchased a small tract, and in 1841 erected a gristmill, which they operated until 1853, when Smith sold his interest to Daniel Ristline. The other interest passed to John Souder. In 1856, Mr. Ristine sold his interest to Eli Young, and it came to be known as Young's mill to that generation. The other interest also came into the possession of Mr. Young in 1878, and after his death, it was conveyed to Amos N. Hunsecker, in 1894. In 1911 he sold to Roy Rice, the present owner."

Figure 10: Dellville Mill, located just upstream of bridge over Shermans Creek.

The next century of the mill's history is described by the Sherman Creek Conservation Association (2008, p. 5-12):

"The mill was a prominent focal point of the local community under Rice's ownership. The mill passed from Rice to C.E. Reidinger in 1931. Reidinger never really operated the mill full time; this coupled with the specific time period of the 20th century soon saw the mill closing down operations as did so many of its counterparts throughout the country. The current owner is refurbishing the mill, perhaps to eventually have it operational."

From the Dellville Bridge to about Mile 0.7, the stream flows across the lower part of the Sherman Creek Member of the Catskill Formation. Layers of shale, siltstone and sandstone can be seen in the bluff on the right side of the stream (Figure 11) and in the stream bed when the water is clear. The stream flows in a generally southeasterly direction, oblique to bedrock strike. Travel is in an up-section direction (towards the core of the Cove syncline).

0.4 Small tributary enters on left.

0.7 Rock walls ruins (Figure 12) on the left bank just upstream of a small island are thought to be the ruins of Dugan's Mill. The downstream end of the small island coincides with

Figure 11: Lower part of the Sherman Creek Member of Catskill Formation.

Figure 12: Possible ruins of Dugan's Mill.

the contact with the upper part (predominantly sandstone) of the Sherman Creek Member of the Catskill Formation. A concordant, intermittent tributary enters Shermans Creek from the right just past the end of the island.

According to Hain (1922, p. 1080), Jacob Seidel of Fishing Creek, erected the original mill at this site shortly after 1820 using lumber from a mill he dismantled In Rye Township. A man named Shapely purchased the mill about 1850 and five years later, sold the mill to Dugan and Zorger, who dismantled it and built a new mill in 1856. Following the demise of Mr. Zorger in 1895 and Mr. Dugan in 1896, James Shearer acquired the mill.

0.8 Stream bends left (to the northeast) and runs roughly parallel to bedrock strike and the crest of Pine Ridge to the south. More resistant, cross-bedded quartzites and conglomeratic sandstones of the Clark's Ferry Member underlie the crest of Pine Ridge.

1.3 Re-cross the contact between upper and lower parts of the Sherman Creek Member. Shermans Creek roughly follows this contact between Mile 1.3 and 2.0. The upper part underlies the scarp slope of Pine Ridge on the right (Figure 13).

Figure 13: North flank of Pine Ridge.

2.0 Just downstream of house on right, a tributary enters Shermans Creek from the south. This transverse tributary drains a linear strike valley between Pine Ridge and Cove Mountain through a gap in the Clark's Ferry Member and together with its sub-tributaries, displays a very angular, trellis drainage pattern. At its mouth, the tributary is flowing over sandstone beds of the upper part of the Sherman Creek Member, which are dipping 40 degrees to the south-southeast per Dyson's (1963) geologic map. At this point, Shermans Creek is starting to bend to the north (down-section) to follow a transverse meander away from Pine Ridge.

2.7 Just upstream of the metal bridge carrying Dellville Road (S.R. 2002) over Shermans Creek, sandstone beds on the right are dipping 35 degrees upstream according to Dyson (1963). This section of Dellville Road is subject to flooding by Shermans Creek (Figure 14).

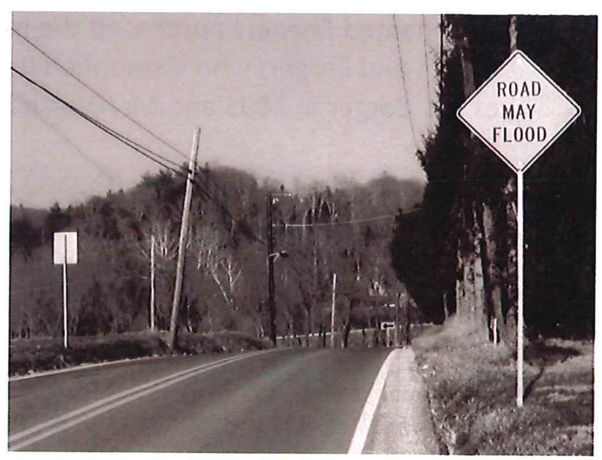


Figure 14: Flood-prone Dellville Road.

Fio Forge School is indicated on Dellville Road approximately one mile west of the bridge, suggesting that Fio Forge was located along this stretch of Shermans Creek. According to Swank (1878, p. 45), "a forge called Fio was built on Sherman's creek, about four miles from Duncannon, in Perry county, in 1829, by Lindley & Speek." Hain (1922, p. 273) provides the following history of Fio Forge:

"Fio forge, in Wheatfield Township, was built on a plot of ground which was warranted in 1766 by Benjamin Abram and which contained 207 acres. In 1827 Israel Downing and James B. Davis purchased twenty-three acres and began the erection of the forge, which they had almost completed in July, 1828, when they sold to Jacob Lindley and Frederick Speck. They owned and operated it until 1841, when it passed to Elias Jackson, Samuel Yocum, and Daniel Kough, who at the same time operated Mary Ann furnace in Cumberland County. It later passed to a man named Walker, who retained Kough as manager. On March 14, 1846, a great flood on Sherman's Creek carried away the dam and the plant was abandoned."

3.0 Cross contact between the Irish Valley and Sherman Creek Members of the Catskill Formation. In the next 0.75, Shermans Creek makes a 180 degree turn and heads back to the south-southeast toward Pine Ridge.

3.2 Irish Valley Member of Catskill Formation exposed in bluff on left as stream approaches the apex of the meander (Figure 15). Note differential weathering of shale and sandstone layers and indications of stream scour. Dyson shows beds dipping 18 to 35 degrees to the south-southeast between about mile 3.2 and 3.4.

3.3 Dark Run flows into Shermans Creek near apex of meander.

Figure 15: Irish Valley Member of Catskill Formation.

3.4 Approximate apex of the meander. Shermans Creek begins going back up section, and strata begin dipping downstream (Guidebook Cover Photo).

3.8 Shermans Creek is now flowing over the Sherman Creek Member again.

4.0 Small incising, concordant tributary enters along strike from the left.

Figure 16: Colluvium mantling north flank of Pine Ridge.

4.1 Pass beneath metal bridge carrying Dellville Road (S.R. 2002) over Shermans Creek.

4.7 Shermans Creek is now flowing over the upper part of the Sherman Creek Member and beginning to turn back east-northeast. After turning, the creek will generally follow bedrock strike for about 1.5 miles as it flows along the base of the northern, colluviated flank of Pine Ridge (Figure 16). Avoid the large boulders that occasionally occur along the creek.

6.1 Perry County Recreation Association swimming pool and picnic pavilion is on the left.

6.3 Tributary enters from left just as Shermans Creek begins a sharp turn to the right toward a water gap through Pine Ridge.

6.4 Shermans Creek flows generally transverse to strike from mile 6.4 to 6.6 as it traverses a gap through Pine Ridge. In the narrower part of the gap, between about mile 6.4 and 6.5, the stream crosses the Clark's Ferry Member, which is a thinner and less persistent member of the Catskill Formation. Exercise care to avoid resistant rock ledges extending across the creek through the gap.

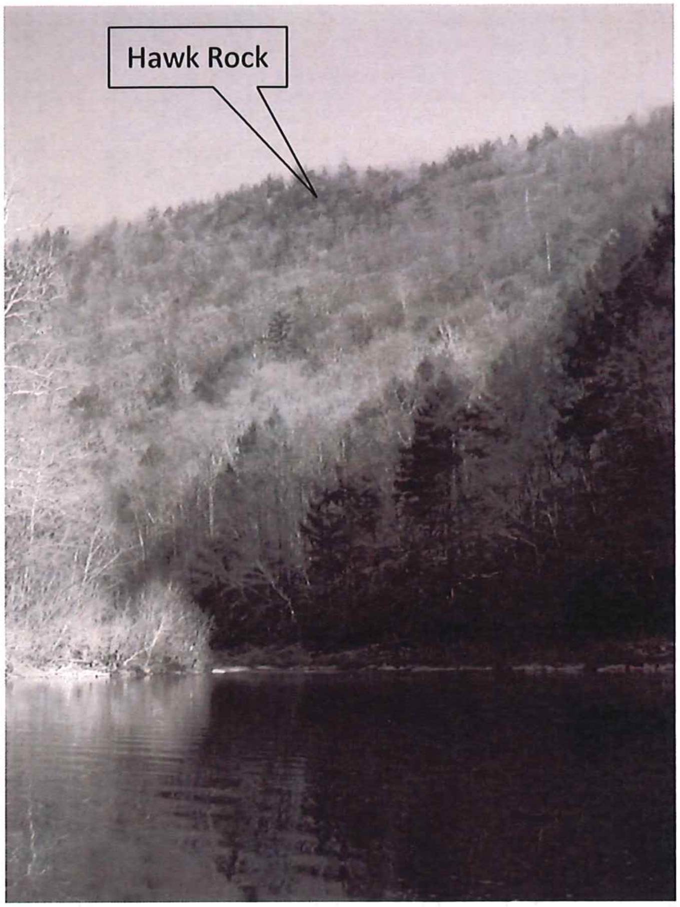


Figure 17: Hawk Rock on Cove Mountain.

6.5 The Duncannon Water Company's water supply reservoir is located up a hollow on the right. This hollow is underlain by the lower part of the Duncannon Member, which is less resistant than the Clark's Ferry Member forming the crest of Pine Ridge to the north, and the upper part of the Duncannon Member forming the flank of Cove Mountain to the south. On a clear day, a prominent sandstone outcrop forming a ledge known as Hawk Rock is visible below the crest of Cove Mountain to the southeast (Figure 17). Hawk Rock is a popular destination for day-hikers and rest point for thru-hikers on the Appalachian Trail, a footpath running from Maine to Georgia (Wilshusen, 1983). Hawk Rock provides a spectacular vista on the confluence of the Juniata and Susquehanna Rivers, the Borough of Duncannon, the western end of Peters Mountain, and most of eastern Perry County.

6.6 Shermans Creek begins to bend to the left (northeast) for the final leg of its journey to the Susquehanna River. This last leg is underlain by the lower part of the Duncannon Member and roughly parallels bedrock strike, with some sinuosity, through the narrow valley between Pine Ridge to the north and Cove Mountain to the South.

7.1 Shermans Creek generally follows the contact between the Clark's Ferry Member, which forms the flank of Pine Mountain to the north, and the Duncannon Member, which forms the flank of Cove Mountain to the south.

7.5 Pullout point upstream of the bridge carrying Inn Road and the Appalachian Trail over Shermans Creek (Figure 18). From this bridge, the trail continues 1,021 miles to its northern terminus on Mount Katahdin in Maine and 1,113 miles to its southern terminus on Springer Mountain in Georgia (Chazin, 1988). Blue Mountain Outfitters has access through private residence. An alternative pullout point is located on the south bank immediately downstream of the first bridge. The climb is steep, but short. Another alternative is to continue out on to the Susquehanna River and paddle upstream to the subway beneath the railroad tracks (Ann Street in Duncannon).

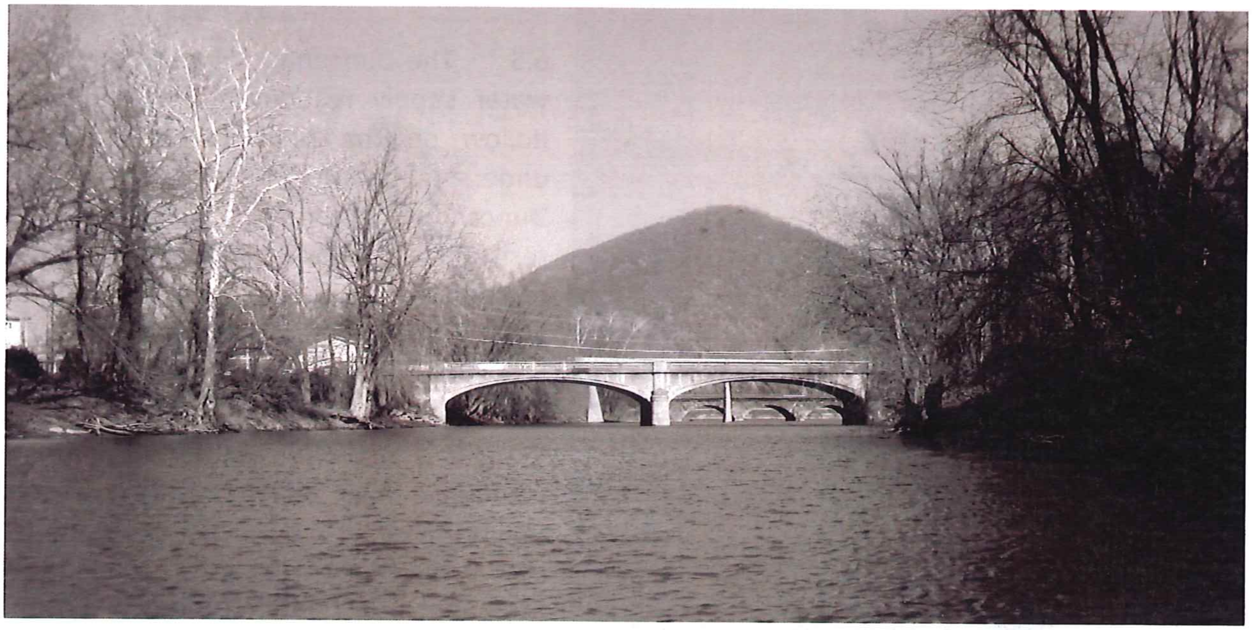


Figure 18: Three bridges over Shermans Creek just upstream of its confluence with the Susquehanna River at Duncannon. Peters Mountain is in background.

The Duncannon Iron Works were formerly located on the banks of Shermans Creek at its confluence with the Susquehanna River. Hain (1922, p. 276-279) provides a detailed history of the iron works, which began with the erection of a forge on the north bank of Shermans Creek in 1827. Over the course of the 19th century, the plant grew to straddle both banks, and its facilities included a stave mill, a nail factory, a furnace, an iron storage house, and a large stone office building. On March 14, 1846, a flood on Shermans Creek took out the dam and part of the rolling mill. The same flood washed away the Juniata River bridge and the eastern span of the Susquehanna River bridge. The dam and rolling mill were rebuilt. Another flood in May 1860 took out the dam and rolling mill. The rolling mill was rebuilt, but the dam was never rebuilt since the mill was then steam-powered. The furnace ceased operations in 1900 and was dismantled in 1901-1902. The nail factory ceased operations in 1908. The plant was taken over by the Lebanon Iron & Steel Company in 1910.

SUSQUEHANNA RIVER (DUNCANNON TO MARYSVILLE) RIVER LOG

Should the water level of Shermans Creek be too low, then the backup plan is to paddle the Susquehanna River from Duncannon to Marysville. Blue Mountain Outfitter uses subways beneath the Pennsylvania Railroad to access the Susquehanna River in Duncannon. The subway to be used depends on subway conditions. The river log below begins at the Ann Street access on the south end of town.

Mile Description (See attached Maps 3 and 4 for geologic map showing approximate route.)

0.0 Put in on the right bank of the Susquehanna River at the Ann Street access, which is underlain by the Sherman Creek Member of the Catskill Formation.

0.3 Stay right to avoid ledges formed by the Clark's Ferry Member. Little Juniata Creek enters on the right.

0.5 Dyson (1967) maps alluvial deposits on both sides of the mouth of Shermans Creek, which enters on the right. The Duncannon Iron Works was located at the mouth of Shermans Creek (see description at the end of the Shermans Creek stream log).

Tilted strata of the Catskill, Spechty Kopf, and Pocono Formations are visible across the river in the west end of Peters Mountain (Figure 19). The upper part of the Sherman Creek Member and the Clark's Ferry Member of the Catskill Formation form the north scarp of the lower bench. The bench is underlain by the lower part of the Duncannon Member. The steeper slope above the bench is underlain by the upper part of the Duncannon Member and the Spechty Kopf Formation higher up the slope. The Pocono Formation forms the crest of Peters Mountain. Recess in the Duncannon Member indicates the location of a 45-foot-thick Triassic diabase dike (Figure 19).

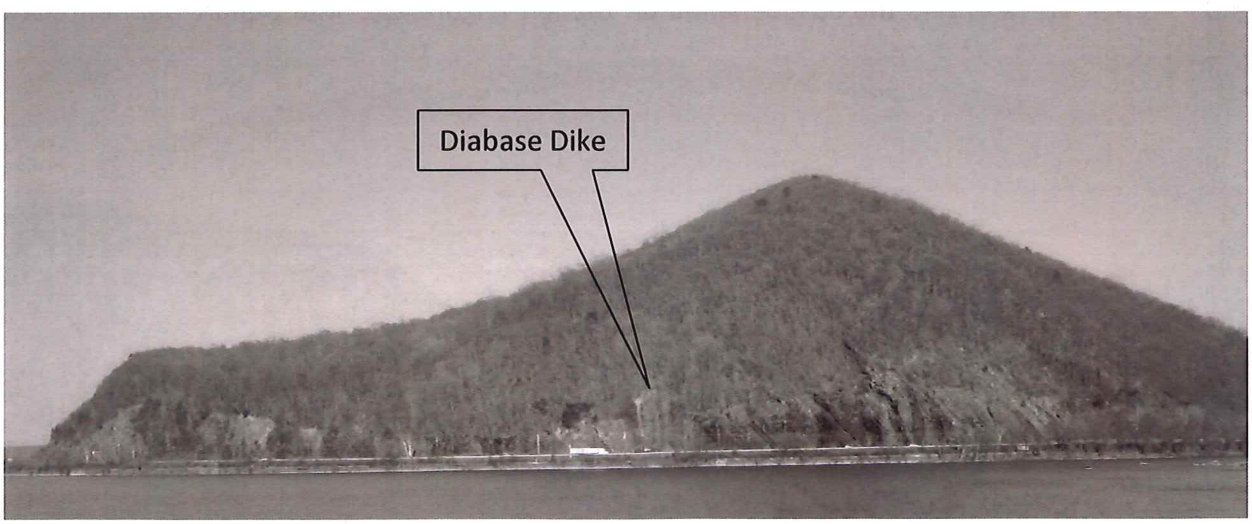


Figure 19: Peters Mountain on east side of the Susquehanna River.

0.6 Stay right from mile 0.6 to 1.6 to avoid ledges in the upper part of the Duncannon Member, the Pocono Formation, and the lower part of the Mauch Chunk Formation.

0.8 Cross the Triassic diabase dike, which Dyson (1967) maps within the Spechty Kopf Formation beneath the western portion of the river. The dike cuts through the Pocono Formation on the eastern end of North Cove Mountain.

1.2 Cross contact between the Pocono Formation and the Mauch Chunk Formation. The latter underlies the core of the cove.

1.5 Cove Creek enters from the right. Dyson (1967) maps artificial fill (mostly ash and cinders) along the railroad in this area.

1.7 Stay left of large island on the right and stay right of smaller islands on the left.

2.3 Cross the axis of Cove syncline. Dyson (1967) maps islands on right as Quaternary alluvium and river bank on the right as Quaternary terrace deposits.

3.5 From mile 3.5 to 5.5, the river flows generally east, roughly parallel to bedrock strike.

4.0 Large island on the right is called Berrier Island. The central portion of the island contains State Game Lands 319. Begin paddling toward left bank to avoid ledges ahead at water gap through Second (South Cove) Mountain.

4.5 Stonework along the left bank is ruins of the Pennsylvania Canal.

4.7 Blue Mountain is visible through the water gap in Second Mountain (South Cove) Mountain (Figure 20).

4.8 Clark Creek enters the Susquehanna on the left (Figure 21). The Dehart Dam on Clark

Figure 20: Water gap in Second (South Cove) Mountain.

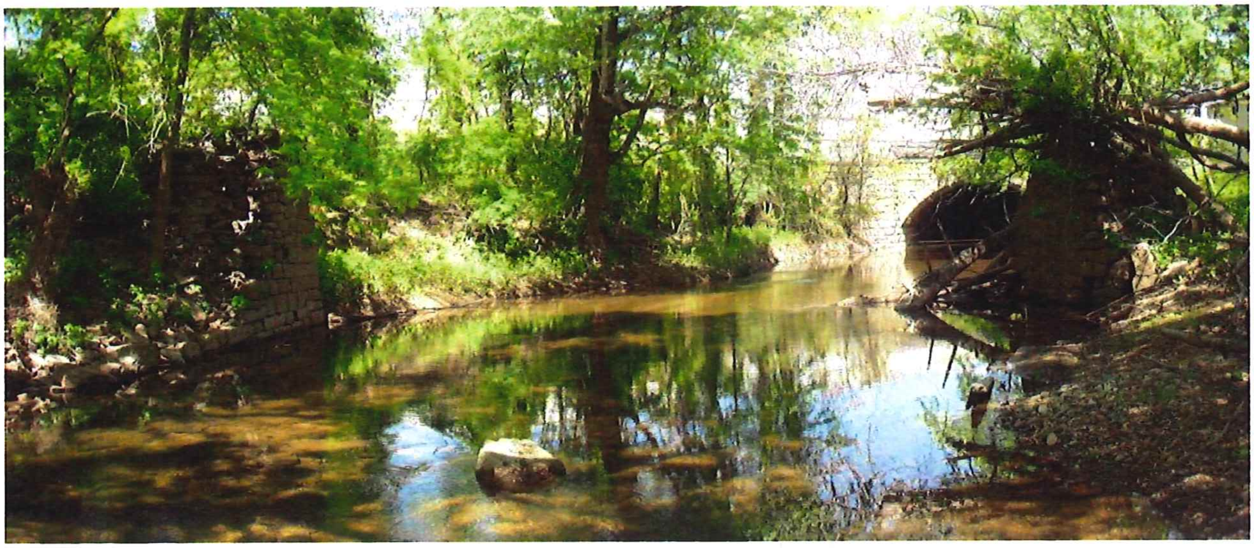


Figure 21: Mouth of Clarks Creek.

Creek impounds a water reservoir that serves the City of Harrisburg.

6.3 Borough of Dauphin is on the left.

6.5 Stoney Creek enters Susquehanna at the south end of Dauphin. Look for the 25-foot-tall replica of Statue of Liberty erected on one of the old piers of the Northern Central Railroad, which crossed the Susquehanna between Marysville and Dauphin (Figure 22).

6.7 Cross contact between the Mauch Chunk and Pocono Formations and enter water gap through Second Mountain (South Cove Mountain).

7.0 Cross contact between the Pocono and Spechty Kopf Formations. This contact follows

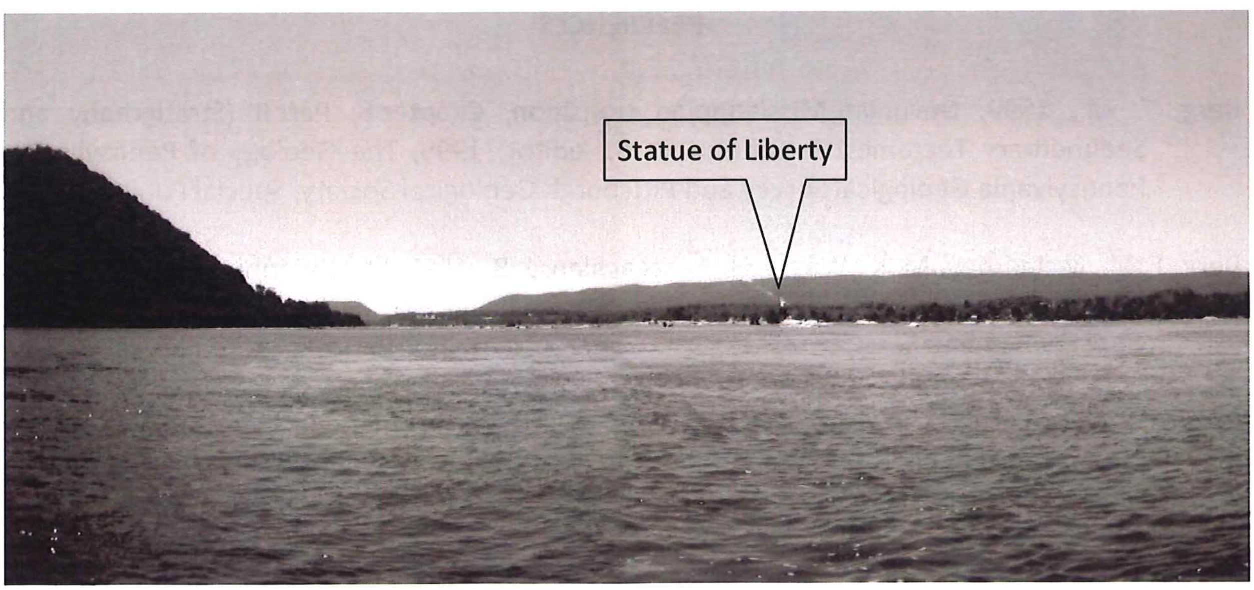


Figure 22: Statue of Liberty replica on former railroad pier.

the crest of Second Mountain on both sides of the river. Note that the older Spechty Kopf Formation overlies the younger Pocono Formation because the strata are overturned and dipping to the south. Stay close to the left side of the river to avoid ledges in the Pocono and Spechty Kopf Formations.

7.1 Cross contact between Spechty Kopf Formation and Duncannon Member of the Catskill Formation. Begin heading back toward the west side of the river.

7.4 Cross contact between the Duncannon and Clark's Ferry Members of the Catskill Formation.

7.5 Cross contact between the Clark's Ferry and Sherman Creek Members of the Catskill Formation. Continue heading toward west side of river while avoiding rock ledges. Aim toward brown patch on right bank.

8.0 Pull out at Heritage Park river access on right bank.

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REFERENCES

Berg, T. M., 1999, Devonian-Mississippian transition, Chapter 8, Part II (Stratigraphy and Sedimentary Tectonics) *in* Schultz, C. H., editor, 1999, The Geology of Pennsylvania: Pennsylvania Geological Survey and Pittsburgh Geological Society, Special Publication 1.

Berg, T. M., McInerney, M. K., Way, J. H., MacLachlan, J. B., 1993, Stratigraphic correlation chart of Pennsylvania, 3rd ed., slightly revised: Pennsylvania Geologic Survey, 4th ser., General Geology Report 75.

Brezinski, D. K., Cecil, C. B., and Skema, V. W., 2010, Late Devonian glacigenic and associated facies from the central Appalachian Basin, eastern United States: Geological Society of America Bulletin 2010, v. 22, no. 1-2 p. 265-281.

Brezinski, D. K., 1999, Mississippian, Chapter 9, Part II (Stratigraphy and Sedimentary Tectonics) *in* Schultz, C. H., editor, 1999, The Geology of Pennsylvania: Pennsylvania Geological Survey and Pittsburgh Geological Society, Special Publication 1.

Chadwick, G. H., 1933, Great Catskill delta, and revision of Late Devonic succession: Pan American Geologist, v. 60, p. 91-107, 189-204, 275-286, 348-360.

Clarke, J. M., 1921, James Hall of Albany, geologist and palaeontologist, 1811-1898: Albany, http://www.ebooksread.com/authors-eng/john-mason-clarke/james-hall-of-albany-geologist-and-palaeontologist-1811-1898-ala.shtml.

Chazin, D. D., 1988, Appalachian Trail data book (10th ed.): The Appalachian Trail Conference, Harpers Ferry, West Virginia.

Claypole, E. W., 1885, A preliminary report on the palaeontology of Perry County, describing the order and thickness of its formations and its folded and faulted structure: Pennsylvania Geological Survey, 2nd ser., Report of Progress F2.

Dewees, J. H., 1881, Geologic map of Perry County (to illustrate his field notes of 1878) in Claypole, E. W., 1885, A preliminary report on the palaeontology of Perry County, describing the order and thickness of its formations and its folded and faulted structure: Pennsylvania Geological Survey, 2nd ser., Report of Progress F2.

Diemer, J. A., 1992, Sedimentology and alluvial stratigraphy of the upper Catskill Formation, south-central Pennsylvania: Northeastern Geology, v. 14, nos. 2-3, p. 121-136.

d'Invilliers, E. V., 1891, Report on the geology of the four counties, Union, Snyder, Mifflin, and Juniata: Pennsylvania Geological Survey, 2nd ser., Report of Progress F3.

Dott, R.H., Jr. and Prothero, D.R., 1994, Evolution of the Earth, 5th ed.: McGraw-Hill, Inc.

Dyson, J. L., 1967, Geology and mineral resources of the southern half of the New Bloomfield quadrangle, Pennsylvania: Pennsylvania Geologic Survey, 4th ser., Atlas 137cd, 86 p., scale 1:24,000.

Dyson, J. L., 1963, Geology and mineral resources of the northern half of the New Bloomfield quadrangle, Pennsylvania: Pennsylvania Geologic Survey, 4th ser., Atlas 137ab, 63 p., scale 1:24,000.

Epstein, J. B., 1966, Structural control of wind gaps and water gaps and of stream capture in the Stroudsburg area, Pennsylvania and New Jersey *in* Geological Survey research 1966, Chapter B, U. S. Geological Survey Professional Paper 550-B, p. B80-B86.

Epstein, J. B., Sevon, W. D., and Glaeser, J. D., 1974, Geology and mineral resources of the Lehighton and Palmerton quadrangles, Carbon and Northampton Counties, Pennsylvania: Pennsylvania Geological Survey, 4th ser., Atlas 195cd, 460 p.

Faill, R. T., 1999, Paleozoic history, Chapter 33, Part VI (Geologic History) *in* Schultz, C. H., editor, 1999, The Geology of Pennsylvania: Pennsylvania Geological Survey and Pittsburgh Geological Society, Special Publication 1.

Faill, R. T., and Wells, R. B., 1974, Geology and mineral resources of the Millerstown quadrangle, Perry, Juniata, and Snyder Counties, Pennsylvania: Pennsylvania Geologic Survey, 4th ser., Atlas 136, 276 p., scale 1:24,000.

Gertler, Edward, 1993, Keystone canoeing—a guide to canoeable waters of eastern Pennsylvania (3rd ed): Seneca Press, Silver Spring, Maryland, 423 p.

Geyer, A. R., and Bolles, W. H., 1979, Outstanding scenic geological features of Pennsylvania: Pennsylvania Geologic Survey, 4th ser., Environmental Geology Report 7.

Hain, H. H., 1922, History of Perry County, Pennsylvania: Hain-Moore Company, Harrisburg, Pennsylvania, 1,088 p.

Harper, J. A., 1999, Devonian, Chapter 7, Part II (Stratigraphy and Sedimentary Tectonics) *in* Schultz, C. H., editor, 1999, The Geology of Pennsylvania: Pennsylvania Geological Survey and Pittsburgh Geological Society, Special Publication 1.

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: Geological Survey of Canada Map 2096A, scale 1:1,500,000.

Hoskins, D. M., 1976, Halifax preliminary geologic quadrangle map *in* Dodge, C. M., and Bert, T. M., compilers, Atlas of preliminary geologic quadrangle maps of Pennsylvania: Pennsylvania Geologic Survey, 4th ser., Map 61, scale 1:62,500.

Johnson, D. W., 1931, Stream capture on the Atlantic slope, a study in the evolution of the Appalachian rivers: Columbia University Press, New York, 142 p.

Key, M. M., Jr., and Potter, Noel, Jr., 1992, Paleozoic geology of the Paw Paw-Hancock area of Maryland and West Virginia: Guidebook for the 11th Annual Field Trip of the Harrisburg Area Geological Society, May 9, 1992.

Mather, W. W., 1840, Fourth annual report of the geological district of New York: New York Geological Survey, Annual Report 4, p. 209-258.

Meyerhoff, H. A., and Olmstead, E. W., 1936, The origins of Appalachian drainage: American Journal of Science, 5th ser., v. 32, p. 21-42.

Pennsylvania Geology, 1969, *Susquehanna Water Gaps dedicated*, v. 1, no. 2, p. 4-5.

Perry County Tourist Bureau, 1983, Covered bridges of Perry County: Perry County Tourist Bureau, New Bloomfield, Pennsylvania.

Perry County Tourist Bureau, 1989, Old mills of Perry County: Perry County Tourist Bureau, New Bloomfield, Pennsylvania.

Prosser, C. S., 1894, The Devonian System of eastern Pennsylvania and New York: U. S. Geological Survey Bulletin 120.

Rickard, L. V., 2000, Oldest forests and deep seas, Erie Lowlands and Allegheny Plateau, Chapter 8, Part II (Bedrock Geology) *in* Isachsen, Y. W., Landing, E., Lauber, J. M., Rickard, L. ., and Rogers, W. B., editors, 2000, Geology of New York—a simplified account: New York State Museum Educational Leaflet 28.

Roman, W. M., and Knight, M. A., 1999, The Cove Syncline by canoe, 18th Annual Trip of the Harrisburg Area Geological Society, May 15, 1999.

Root, S. I., and Hoskins, D. M., 1975-1976, Harrisburg West preliminary geologic quadrangle map *in* Dodge, C. M., and Bert, T. M., compilers, Atlas of preliminary geologic quadrangle maps of Pennsylvania: Pennsylvania Geologic Survey, 4th ser., Map 61, scale 1:62,500.

Sevon, W. D., 2011, Transport of diabase blocks and boulders by the Susquehanna River at Conewago Falls, Northwesternmost Lancaster County, PA: Geological Society of America, Abstracts with Programs, vol. 43, no. 1, p. 129.

Sevon, W. D., 2000, Physiographic provinces of Pennsylvania, 4th ed.: Pennsylvania Geological Survey, 4th ser., Map 13, scale 1:2,000,000 http://www.dcnr.state.pa.us/topogeo/maps/map13.pdf.

Sevon, W. D., 1993, *River on a rampage*, Pennsylvania Geology, v. 24, no. 2, p. 2-7.

Sevon, W. D., and Woodrow, D. L., 1981, Upper Devonian Sedimentology and stratigraphy, in Berg, T. M., and others, Geology of Tioga and Bradford Counties, Pennsylvania: 46th Annual Field Conference of Pennsylvania Geologists, Guidebook, Wellsboro, PA.

Shermans Creek Conservation Association, 2008, Draft Southern Perry County watershed conservation plan, Chapter 5 (Cultural and Historical Resources) http://www.shermanscreek.org/Chapter%205%20MASTER.pdf

Susquehanna River Basin Commission, 2007, Tropical Storm Agnes in the Susquehanna River Basin: SRBC Information Sheet, http://www.srbc.net/pubinfo/docs/Agnes.pdf.

Swank, J. M., 1878, Introduction to a History of Iron Making and Coal Mining in Pennsylvania: Published by the author (Secretary of the American Iron and Steel Association), Philadelphia, PA.

Thompson, H. D., 1949, Drainage evolution in the Appalachians of Pennsylvania: New York Academy of Science Annals, v. 52, art. 2, p. 31-62.

U.S. Geological Survey, USGS 01568000 Sherman Creek at Shermans Dale, PA: http://waterdata.usgs.gov/usa/nwis/nwisman?site_no=01568000.

U.S. Geological Survey, USGS 01570500 Susquehanna River at Harrisburg, PA: http://waterdata.usgs.gov/nwis/nwisman/?site_no=01570500&agency_cd=USGS.

Way, J. H., 1999, Appalachian Mountain Section of the Ridge and Valley Province, Chapter 29, Part V (Physiography) *in* Schultz, C. H., editor, 1999, The Geology of Pennsylvania: Pennsylvania Geological Survey and Pittsburgh Geological Society, Special Publication 1.

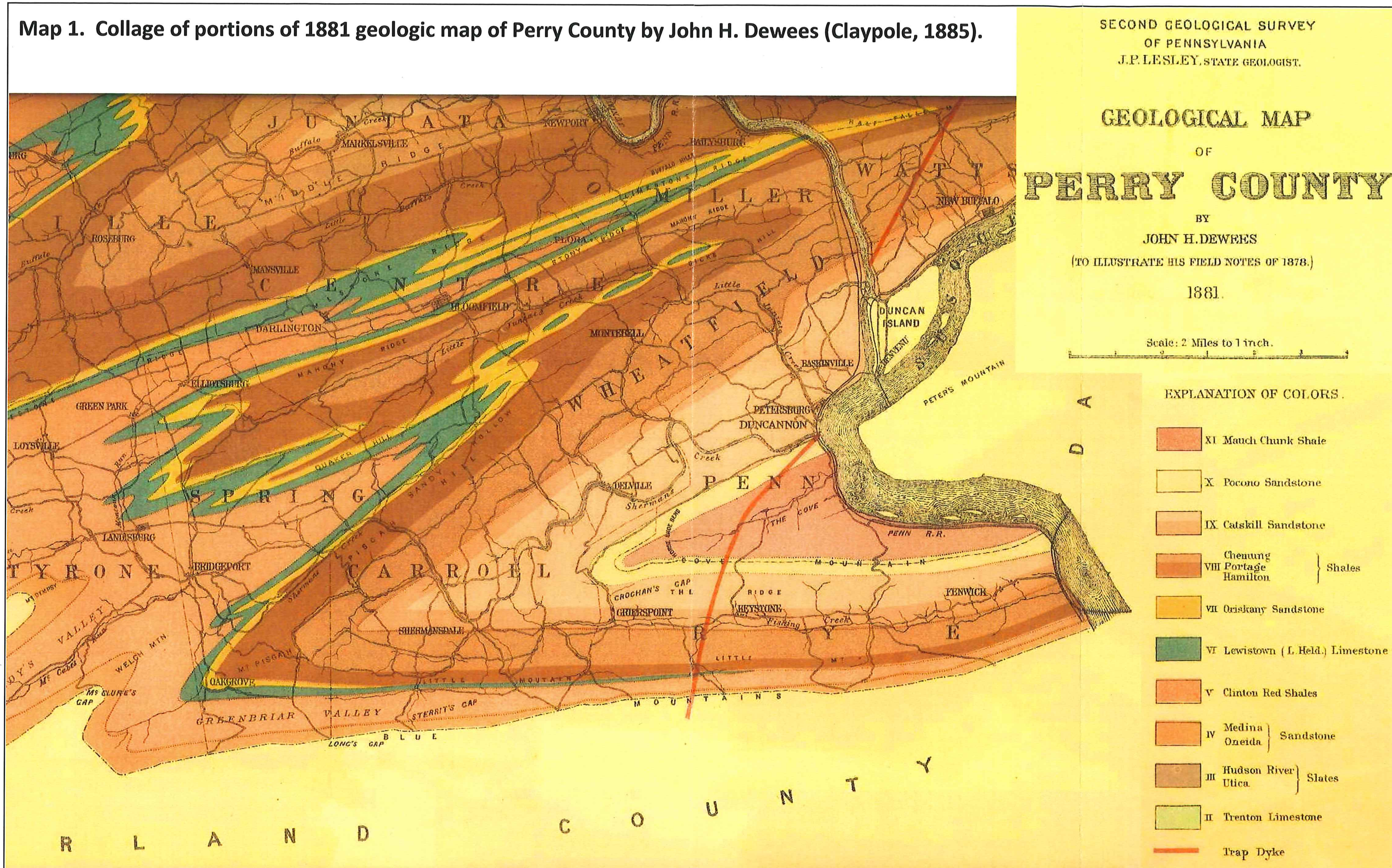
White, I. C., 1881, The geology of Susquehanna County and Wayne County, Pennsylvania: Pennsylvania Geological Survey, 2nd ser., Report of Progress G5.

White, I. C., 1882, The geology of Pike and Monroe Counties, Pennsylvania: Pennsylvania Geological Survey, 2nd ser., Report of Progress G6.

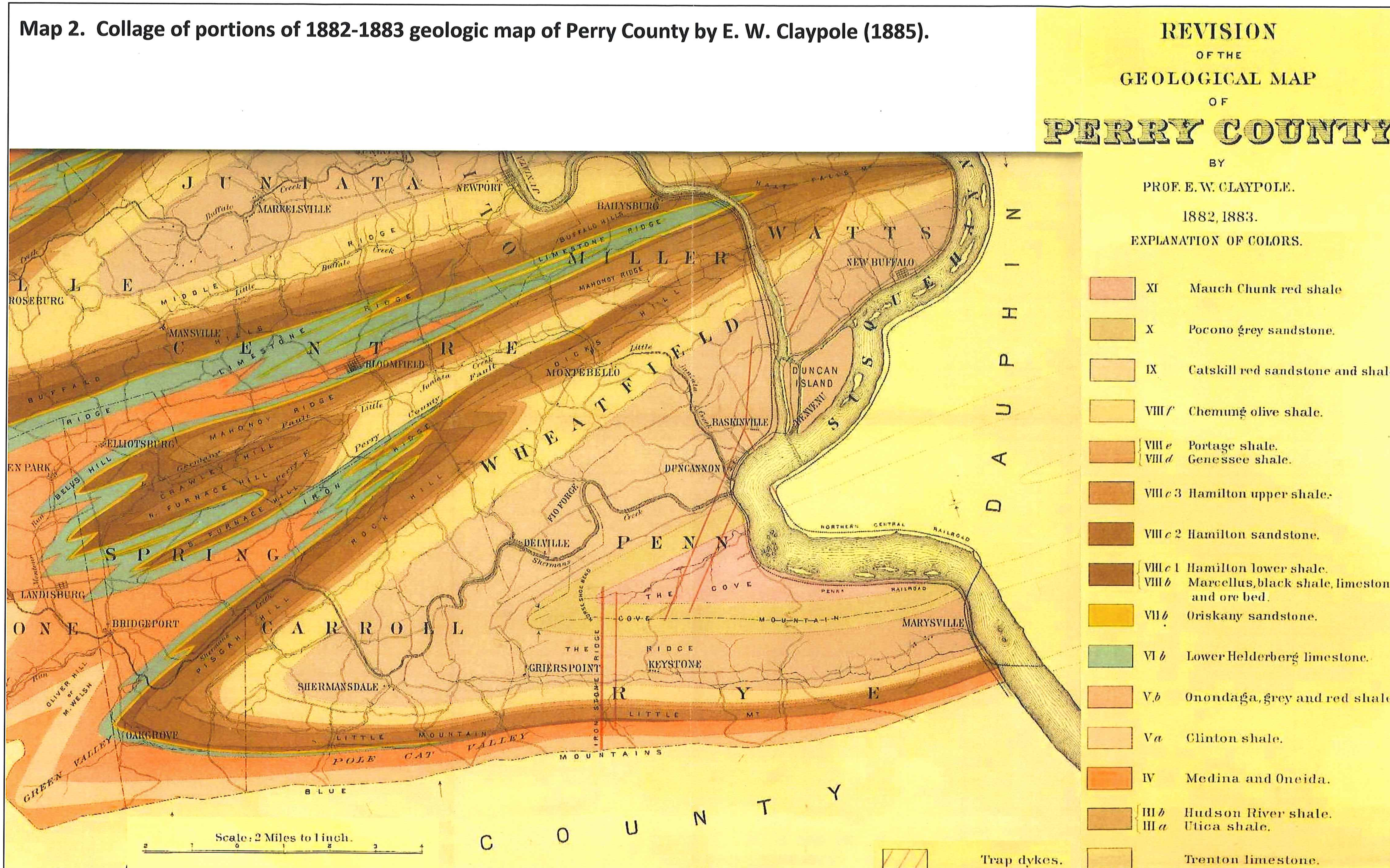
Wise, D. U., 2004, Pennsylvania salient of the Appalachians: A two-azimuth transport model based on new compilations of Piedmont data: *Geology*, v. 32, no. 9, p. 777-780.

Wilshusen, J. P., 1983, Geology of the Appalachian Trail in Pennsylvania: Pennsylvania Geologic Survey, 4th ser., General Geology Report 74, 121 p.

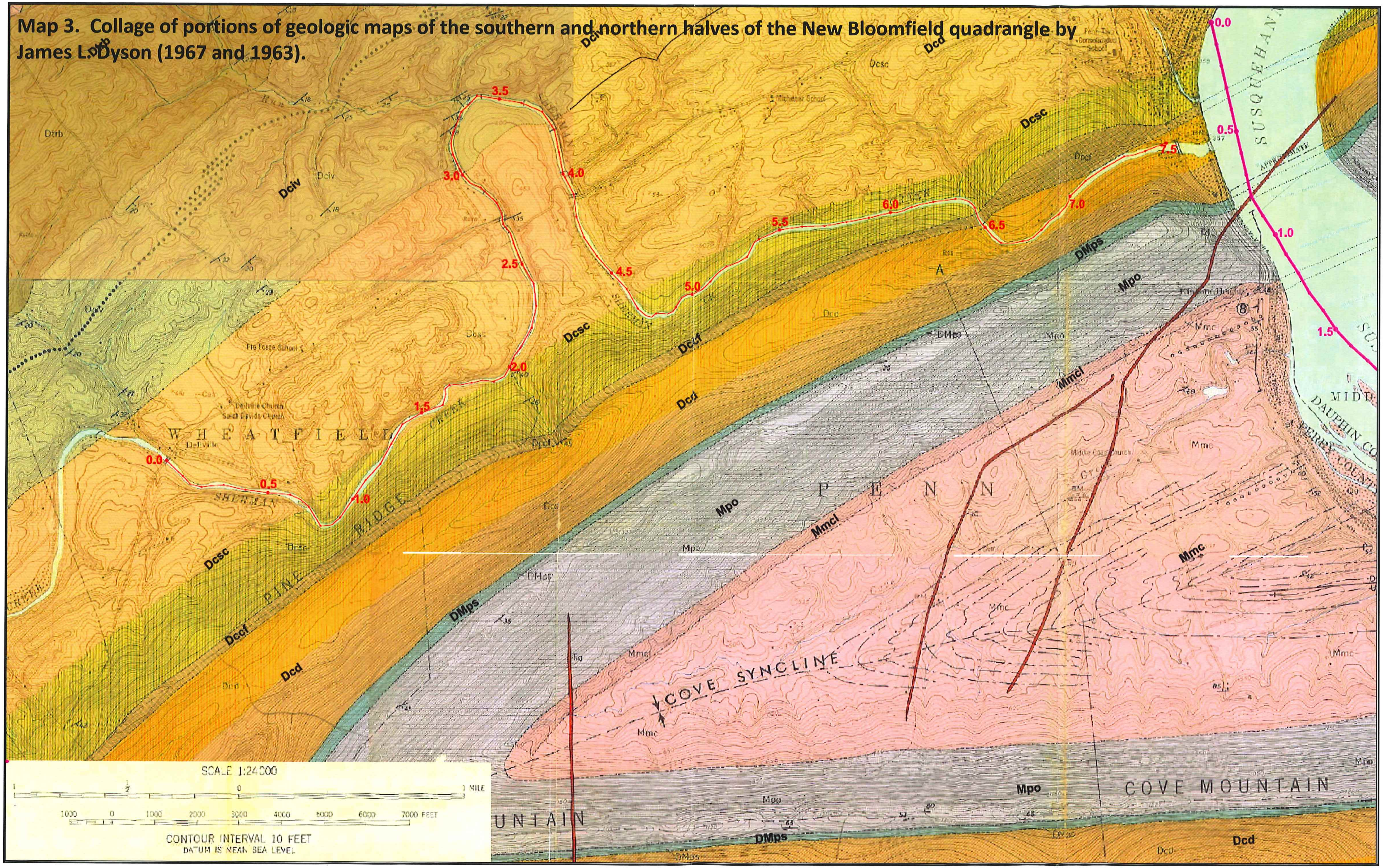
Map 1. Collage of portions of 1881 geologic map of Perry County by John H. Dewees (Claypole, 1885).

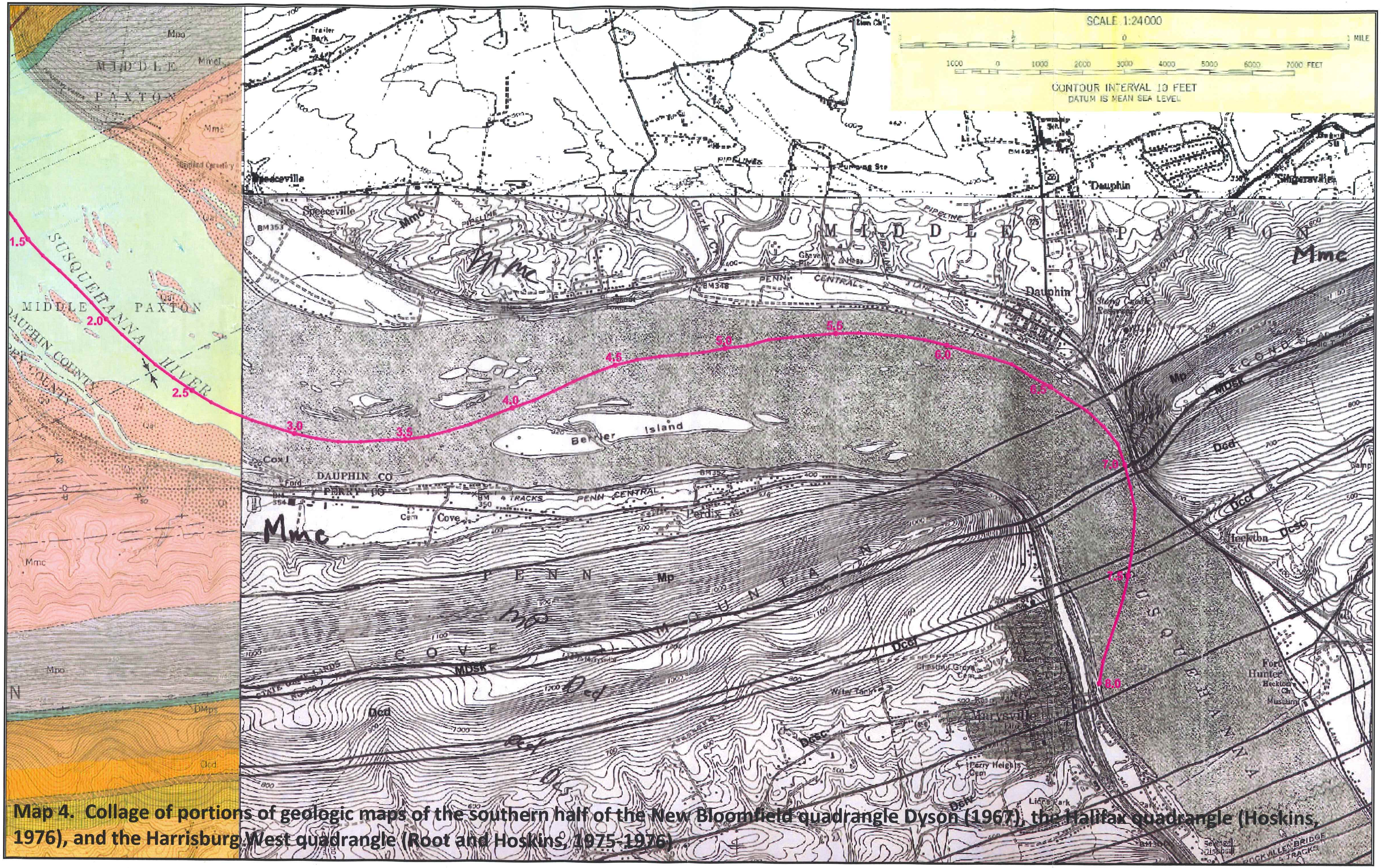


Map 2. Collage of portions of 1882-1883 geologic map of Perry County by E. W. Claypole (1885).



Map 3. Collage of portions of geologic maps of the southern and northern halves of the New Bloomfield quadrangle by James L. Dyson (1967 and 1963).





Map 4. Collage of portions of geologic maps of the southern half of the New Bloomfield quadrangle Dyson (1967), the Halifax quadrangle (Hoskins, 1976), and the Harrisburg West quadrangle (Root and Hoskins, 1975-1976).

EXPLANATION (Modified from Dyson, 1967)

af

ARTIFICIAL FILL

Mostly ash and cinders. Along Pa. RR in northeast corner of map area.

Qal

RECENT ALLUVIUM

Stream channel deposits composed of silt, sand, and fine to coarse gravel. On Susquehanna River contains a large percentage of anthracite coal, mainly silt to sand size.

Qc
Qcr

COLLUVIUM

Sheets of debris (Qc)—present on slopes of all principal ridges north of the Great Valley, but mapped only on Blue Mountain. On north slope of the mountain consists mainly of flaggy and platy slabs of Rose Hill sandstone. Forms a veneer with a minimum thickness of 6 feet. On south slope forms a blockfield of Tuscarora sandstone and minor amounts of Juniata sandstone. Rock streams (Qcr)—stone stream of blocks and smaller fragments of sandstone, clay, and chert from the Old Port Formation.

Qt

TERRACE DEPOSITS

Mainly sand and gravel along Susquehanna River and Sherman Creek (near Sherman's Dale). At places on Sherman Creek consists of a thin veneer covering rock terraces.

₮d

DIABASE

Dikes of dark-gray, fine- to medium-grained diabase, consisting mainly of labradorite and augite.

Mmc
Mmcl

MAUCH CHUNK FORMATION

Grayish-red-to moderate-red shales, mudstones, siltstones, and cross-bedded sandstones. Some sandstone units are channel fillings. Mud cracks and ripple marks common. In lower part of formation are several limestone-pebble conglomerates (pebbles to 4 inches indicated by dotted line) a number of mud-plate conglomerates, and several sandstones containing lithic pebbles up to 4 inches long. Cyclic stratification pronounced. Lower 194 feet transistional with underlying Pocono and mapped as Lower Member (Mmcl).

Mpo
DMps

POCONO FORMATION

Medium- to thick-bedded, medium- to coarse-grained, cross-bedded, micaceous, gray conglomeratic sandstone and sandstone with some shale and siltstone interbeds. Quartz pebble conglomerate up to 20 feet thick about 200 feet above base. Spechty Kopf Member (DMps) is lower 200 feet and is sandstone with some conglomerate and minor redbed and siltstone interbeds. Carbonized plant remains and marcasite nodules abundant. Some marcasite zones are interleaved with films and lenses (1/4 inch thick) of anthracite. Most if not all of the formation is characterized by cyclic (rythmic) sedimentation.

Dcd
Dccf
Dcsc
Dciv

CATSKILL FORMATION

Duncannon Member (Dcd)—upper sandy part shown by blue pattern. Medium gray-to medium-dark-gray, thick conglomeratic sandstones, separated by thinner units of grayish-red shale and siltstone and overlain by 100 ft of grayish-red shale containing pebbles (to 2 inches in diameter) of various lithologies. Characterized by pronounced cyclic sedimentation. Lower part contains grayish-red-to brownish-red shales, siltstones, and fine-grained sandstones with some gray, fine-grained sandstone interbeds. Characterized by pronounced cyclic sedimentation.

Clark's Ferry Member (Dccf)—gray-to grayish-red, cross-bedded quartzite and sandstone (in part conglomeratic) containing red shale pebbles.

Sherman Creek Member (Dcsc)—grayish-red-to brownish-red shales, siltstones, and fine-grained sandstones with some gray, fine-grained sandstone interbeds. The upper part of the formation shown by blue pattern is dominantly sandstone.

Irish Valley Member (Dciv)—medium-gray and reddish-gray siltstones, shales, and fine-grained sandstones. Includes some medium-gray sandstones up to 80 feet thick which may be persistent.

The lowest sandstone, the "King's Mill" (dotted line) is about 250 feet above the base. Brachiopods and crinoids at numerous horizons in both gray and red beds.

Dtrb

TRIMMERS ROCK AND BRALLIER FORMATIONS undivided

Fossiliferous medium-dark-gray, very fine-grained sandstone, siltstone, and shale. Weathers olive and yellow brown. Shale and siltstone dominant in lower part.