PINE CREEK GORGE, THE GRAND CANYON OF PENNSYLVANIA: AN INTRODUCTORY CREATIONIST STUDY

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Abstract

The origin of Pine Creek Gorge in Pennsylvania is discussed from a young earth perspective as well as from a uniformitarian viewpoint. Field work in the region of the gorge is presented. Uniformitarian and creationist conjectures on the formation of the Appalachian Plateau, where the gorge is located, are reviewed.

Key Words: *Pine Creek Gorge, Appalachian Plateau, Catskill Formation, Lock Haven Formation, Delta Deposition.*

Introduction

When one accepts a recent Creation and Flood model of earth history, obviously many natural events such as canyon formation are assumed to have occurred quickly. Involved in rapid canyon formation is rapid erosion, a topic often discussed in the Quarterly. For instance, three articles (Williams et al., 1991; 1992a; 1992b) presented various views on the formation of the Grand Canyon of the Colorado River (references to other creationist works on the subject can be found in the series). This paper on Pine Creek Gorge is another introductory study reflecting the continuing field work of the Society on the topics of rapid erosion and canyon formation, important aspects of Flood geology.

Pine Creek Gorge is located approximately 50 miles south of the Finger Lake region of New York state. Known as the Grand Canyon of Pennsylvania, this unusual gorge (Figures 1 and 2), starts in Tioga County at Ansonia and extends nearly 50 miles southward to the edge of the Appalachian Plateau about five miles north of Jersey Shore in Lycoming County. Located in a sparsely populated region of north-central Pennsylvania, the gorge has attracted the attention of geologists for over 100 years. Since many interesting scenarios of drainage diversion have been developed for some of the rivers and creeks of Pennsylvania, it should be of no surprise that fascinating accounts of how this gorge originated have been postulated as well. These theories will be reviewed and we will offer other suggestions concerning the origin of Pine Creek Gorge. All of our conjectures will be cast within a creationist young-earth framework.

Appalachian Plateaus Province

Pine Creek Gorge is located on the Appalachian Plateau (Figures 3 and 4). Hunt's description (1974, p. 252) of this physiographic province is helpful:

> West of the fold mountains are the Appalachian Plateaus. The formations are nearly horizontal, a typical plateau structure, but they are so elevated and dissected that the landforms are in a large part mountainous. Thus the Appalachian Plateaus are mountainous with a plateau structure, . . .

A dissected plateau structure could have formed as illustrated in Figure 5.

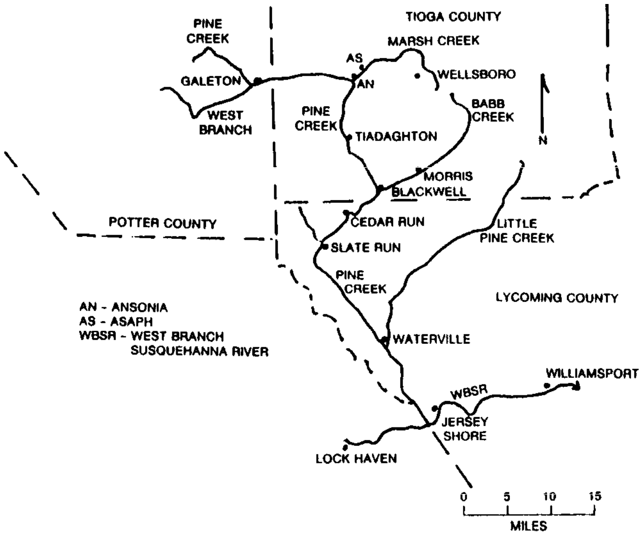

Figure 1. Pine Creek in north-central Pennsylvania; Pine Creek Gorge starts at the village of Ansonia and continues to the edge of the Appalachian Plateau approximately five miles north of the confluence of the Creek and the West Branch of the Susquehanna River near the town of Jersey Shore. Dashed lines represent county lines. Drawing by Emmett Williams.

The Appalachian Plateaus occupy an area equal to that of the Piedmont, Blue Ridge and Ridge and Valley Provinces combined (Hunt, 1974, p. 262). The Plateau region is:

> . . . an elevated tract of nearly horizontal or gently folded strata. . . . Altitudes range from about 1,000 feet along the western edges to somewhat more than 3,000 feet at the Allegheny Front (Hunt, 1974, p. 262).

The gently folded strata are sedimentary rock of Paleozoic age (Denny and Lyford, 1963, p. 2). The Province is divided into several sections based on differences in structure and prevailing erosion processes (Hunt, 1974, p. 262).

Stratigraphy

Pine Creek Gorge cuts through Upper Devonian rocks—mainly the Catskill formation (Figure 6). However from Ansonia to about one mile south of Tiadaghton, a distance of 10 miles, Pine Creek passes through rocks of the Upper Devonian Lock Haven formation (Berg et al. 1980). The Lock Haven formation (Figure 7), called the Chemung formation by previous workers,

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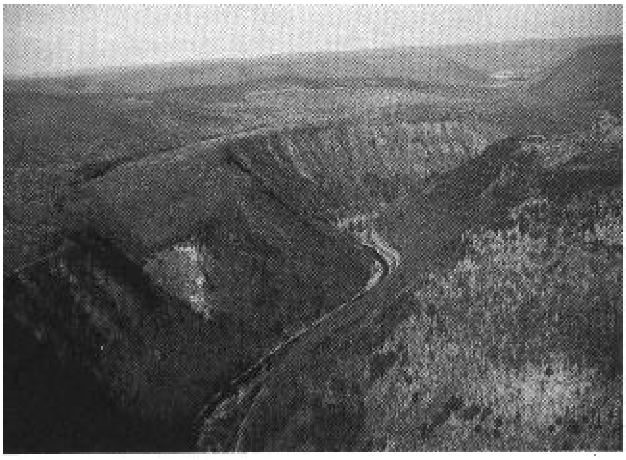


2a.

2b.

2c.

Figure 2. Views of Pine Creek Gorge
- a. Aerial view of gorge looking NNW toward west rim, entrance of gorge at Ansonia is in upper right portion of figure, November 1991. Photograph by Robert Goette.
- b. Aerial view of gorge looking west, Pinafore Run is seen at lower left and Owasse Slide Run to the right two miles southwest of Ansonia, November 1991. Photograph by Robert Goette.
- c. View of the gorge from a vista in Colton Point State Park (Figure 9) looking NNE, July 1992. Photograph by Robert Goette.

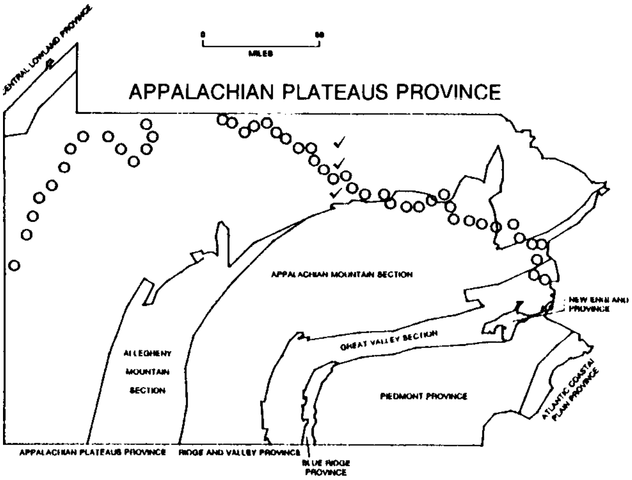


Figure 3. Simplified drawing of the physiographic provinces of Pennsylvania (after Berg et al., 1989). The Appalachian Plateaus Province extends from western Pennsylvania northeastward along the northern portion of the state. Only the Allegheny Mountain Section of the Appalachian Plateaus is shown on the figure.
oooo — late Wisconsinian glacial border
✓✓✓ — location of Pine Creek Gorge

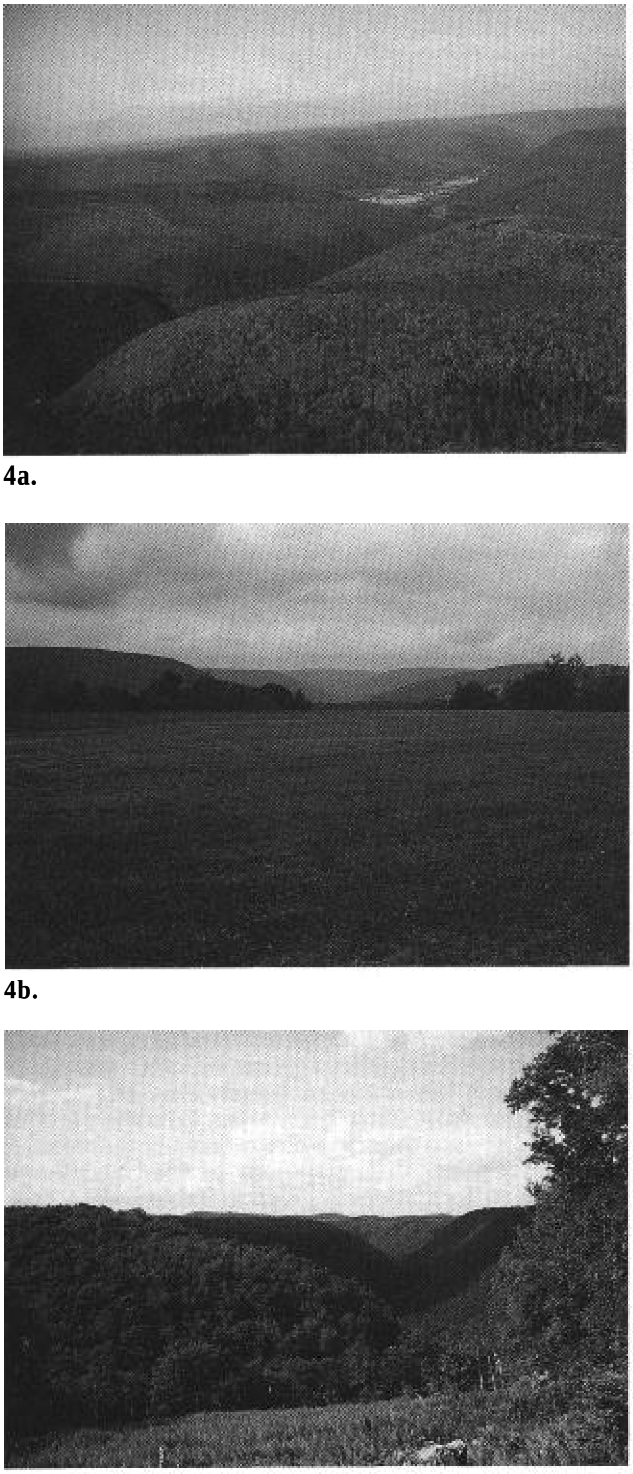
was ". . . named to apply to the interval of rock between the Brailler and Catskill formations . . ." (Faill and Wells, 1977a, p. 32). There are no exposures of the Brailler formation in Pine Creek Gorge, nor is the base of the Lock Haven formation visible. Thus care must be exercised in the use of the Lock Haven designation at that location.

There is no published geologic map of Pine Creek Gorge (Faill, 1992). However, the Cedar Run, Slate Run and Waterville quadrangles have been mapped in the lower (southern) gorge region (Colton, 1963; Colton and Luft, 1965; Colton, 1968). These investigators simply noted the Upper Devonian strata informally as red-bed sequence and lower sandstone sequence. Colton (1963) explained that formal stratigraphic names have been used in earlier reports by other geologists ". . . although few if any rock units have been previously traced from their type areas in other parts of Pennsylvania into the north-central part of the state." A brief description of the lithology of the Catskill and Lock Haven formations is given in Table I.

For possible correlation of these formations with other strata, see Sevon and Woodrow (1985, p. 4); Woodrow et al. (1988, p. 281). A description of the Catskill and Lock Haven formations in other parts of Lycoming County can be found in Faill and Wells

Table I. Description of Catskill and Lock Haven Formations (after Berg et al., 1980).

Formation	Thickness [feet] Tioga County, PA (after Seven and Woodrow, 1981)	Lithology
Catskill	500 - 1400(?)	Succession of grayish-red sandstone, siltstone and shale, generally in fining-upward cycles; some gray sandstone and conglomerate
Lock Haven	2250 - 2900(?)	Interbedded olive-gray sandstone, claystone and thin conglomerate; marine fossils throughout



4a.

4b.

4c.

Figure 4. Views of the dissected Appalachian Plateau, north-central Pennsylvania. Note the almost flat plateau surface.

a. Aerial view looking north along Pine Creek Gorge toward Ansonia in valley, November 1991. Photograph by Robert Goette.

b. View toward the north from Grand Canyon airport west of Wellsboro, August 1992. Photograph by Emmett Williams.

c. View looking north from Pine Creek vista on West Rim Road, 1.4 miles west of Tiadaghton, August 1992. See Anon. 1990. Photograph by Robert Goette.

(1977a; 1977b). Humphreys and Friedman (1975) provide another study of the Catskill formation in north-central Pennsylvania.

Uniformitarian Conjectures Concerning the Origin of the Appalachian Plateau

Pine Creek Gorge is incised in Upper Devonian rocks. Earlier in the century, uniformitarian geologists suggested that the Upper Devonian formations of the "Catskill Delta" were formed in a shallow sea located in a geosyncline. These sedimentary rocks in the delta were deposited at the edge of the Appalachian Basin by processes similar to those that form deltas today. Seven and Woodrow (1981, p. 11) stated:

> Throughout most of the Paleozoic, much of what presently constitutes the eastern half of North America was part of an inland sea which intermittently received elastic sediment from an eastern source area. The Appalachian basin was the central focus of this sedimentation.
>
> The largest integrated wedge of elastic sediment in the basin was deposited by the Catskill delta system during the Middle and Upper Devonian.

Barren (1913, p. 466) explained that:

> The uniformity in the character of the delta from northeast to southwest, its development marginal to the uplands, and the somewhat rapid gradation from gravel to sand and clay on leaving the mountains suggests the presence of a number of comparatively short streams which built flat coalescing fans rather than the debouchment of one or two great continental rivers.

Subsidence of the basin as the sediment collected is involved in the model. During the supposed formation of a delta complex from several sources, active orogeny was occurring to the east along with some local tectonic activity. Also erosion of the mountains to the east was thought to provide some of the sediment for delta formation. Later, uplift of the "delta" occurred. However as Sevon and Woodrow (1981, p. 19) explained:

> Although the term delta has been applied many times to the origin of the progradational deposits of the Catskill delta, a specific model has never been established.

If there was delta formation many different types of depositional environments would have existed, particularly as the delta increased in size. Sevon and Woodrow (1981, pp. 22-23) list 21 different depositional environments that had been postulated from prior studies of the Middle and Upper Devonian rocks of New York and Pennsylvania (also see Williams, 1985). Recently Woodrow (1985) and Woodrow et al. (1988) have synthesized models employing many of the depositional modes suggested in past field studies. It is interesting to note that the delta formation hypothesis has been opposed by some field workers. Allen and Friend (1968) postulated deposition in a vast coastal alluvial plain rather than a delta. Walker and Harms (1971) and Walker (1971) offered evidence for deposition along a quiet, prograding muddy shoreline. Gale and Siever (1986) contended that Middle to Upper Devonian Catskill sandstones in southeastern New York were ". . . part of a regressive alluvial plain sequence . . ." (p. 592).

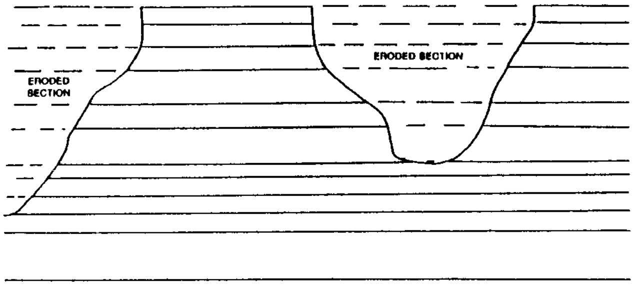


Figure 5. Representation of horizontal sedimentary rock layers forming a plateau. Solid lines represent strata still intact whereas dashed lines represent layers that have been eroded away. Plateau has been erosionally dissected, forming erosional mountains, after Mulfinger and Synder (1979, p. 334). Drawing by Emmett Williams.

Friedman and Sanders (1978, p. 186) argued for either or both a deep burial of horizontal Devonian strata in the northern Appalachian Basin or a past high geothermal gradient; the latter based on a discovery of anthracite in plant debris in the strata. Recently, Friedman (1987) offered more evidence for deep burial as did Gale and Siever (1986). If deep burial did occur, deposition in a shallow sea probably is not feasible unless one assumes rapid subsidence into an ever deepening basin.

The array of "depositional environments" to be incorporated into a uniformitarian model is formidable! A mention of some of the scenarios will illustrate this predicament concerning the formation of the "Catskill Delta." Dennison and Head (1975) emphasized transgressions and regressions that caused shoreline migration during deposition. Woodrow and Isley (1983) discussed the importance of deposition by turbidity currents. The model proposed by Woodrow (1985) combined alluvial processes, deltaic processes, wave-related processes, turbidity currents and slow deposition from suspension. Sevon (1985) examined deposition of nonmarine facies by meandering or braided streams. Lundegard et al. (1985) considered turbidite sequences in the Appalachian Basin. Bridge and Droser (1985) postulated estuarine-brackish water coastal bay origin for certain Upper Devonian sedimentary sequences in Pennsylvania. Slingerland and Loulé (1988) presented evidence for wind / wave and tidal processes involved in deposition along the Upper Devonian Catskill shoreline. The relationship of tectonic processes affecting deposition was discussed by Ettensohn (1985), Faill (1985), Ferrill and Thomas (1988), Jackson et al. (1988), Miller and Kent (1988) and Rast (1989).

This brief survey indicates the considerable amount of detail that must be included in a comprehensive depositional model for the "Catskill Delta" if it is assumed that all of the above sedimentary modes operated in the past. For further details on the formation of deltas see LeBlanc (1975), Colella (1988) and Smith *et al.* (1990).

Creationist Conjectures Regarding Formation of Alleged Ancient Deltas

Henry Morris has criticized the concept of deposition in geosynclines (near-shore troughs) and ancient shallow seas with attendant subsidence (Whitcomb and Morris, 1961, pp. 144-150). He also discussed the weaknesses in attempting to identify ancient environments of sedimentation on the basis of imagined similarity with present deposition processes (Morris, 1966, pp. 52-53). Burdick (1964, p. 42) claimed that interbedding was difficult to explain by uniformitarian processes and it could not be caused by deltaic, flood or wave action in a shallow sea. He suggested that a Flood tidal wave moving in one direction, then a later reversal with a tidal wave moving in the opposite direction depositing the interbedded layers, was a superior mechanism.

Since there are red beds in the Catskill formation, creationist comments on the development of these sediments would be appropriate. In a paper on the red beds of western United States, Clark (1966, pp. 12-16) postulated that they were Flood deposits. He stated (p. 12):

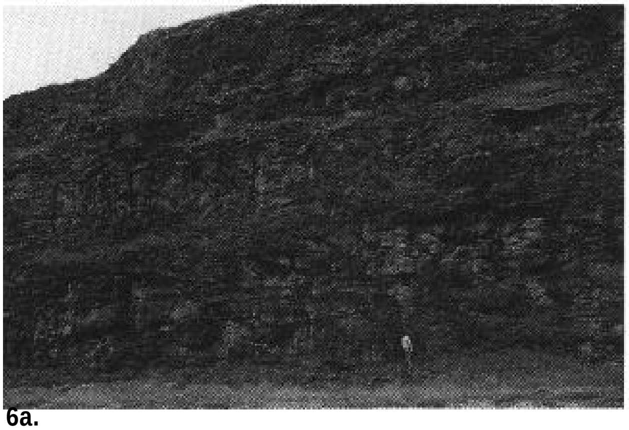
> A general lack of sources for these vast deposits of sandstone, shale and conglomerate is shown as critical to a satisfactory explanation of them from the viewpoint of uniformitarianism. Conclusions are (1) sediments were brought in from great distances, (2) great sweeps of water instead of local river or flood action were necessary to spread out these sediments over this vast area and (3) the various formations were laid down one after the other in rapid succession.

Clark (1971, p. 21) also briefly discussed the formation of a "vast series of deltas" in the Appalachian region as being a result of Flood action. In a paleoecological study of the black shales of the Pennsylvanian system of west-central Illinois, Peters (1971, p. 193) noted that, "All of the reported observations strongly support the Biblical tidal interpretation of fossil deposition and burial." This excellent field and laboratory work deserves serious study by creationists.

The Mississippi River delta has been studied and analyzed within a young earth framework (Allen, 1972; Mehlert, 1988). Allen (pp. 103-108) presented seven points of evidence that "apparently disprove the theory that delta sediments depress the crust of the earth" (p. 108). Also he considered that no river, estuary or normal ocean could have transported or deposited the underlying gravel stratum in the Mississippi River delta (p. 112).

In an extensive discussion of cyclic sedimentation (deposition of cyclothems), Woodmorappe (1978) examined the claim that most Paleozoic sedimentation occurred in shallow seas (p. 196). He noted that:

> . . . uniformitarianism breaks down in its attempts to find *bona fide* examples of such shallow seas today. . . . There simply is no existing models [sic] of epeiric sedimentation to guide our investigations . . . (p. 196).



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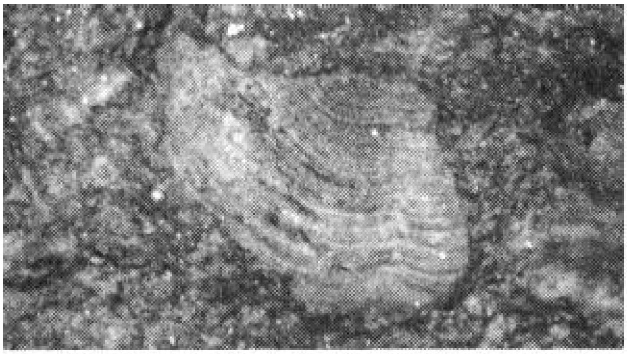

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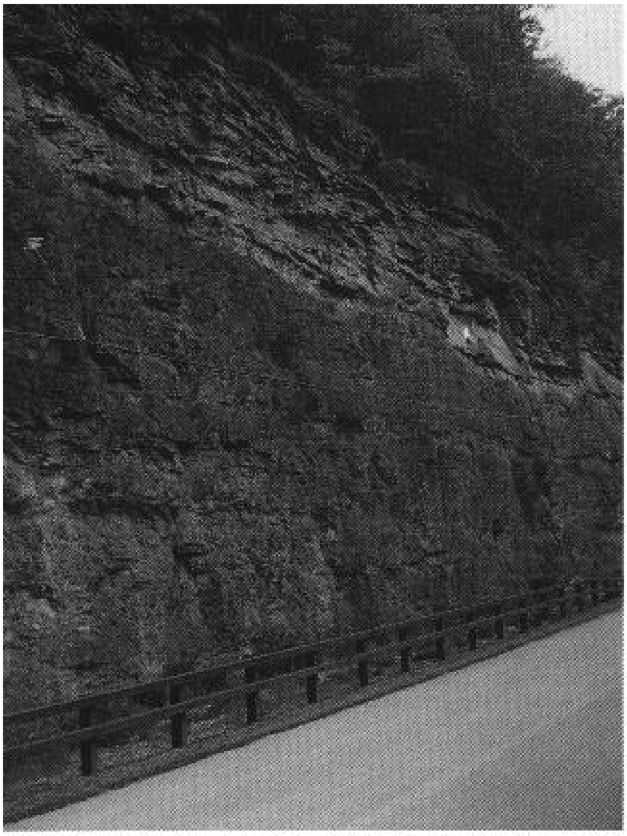

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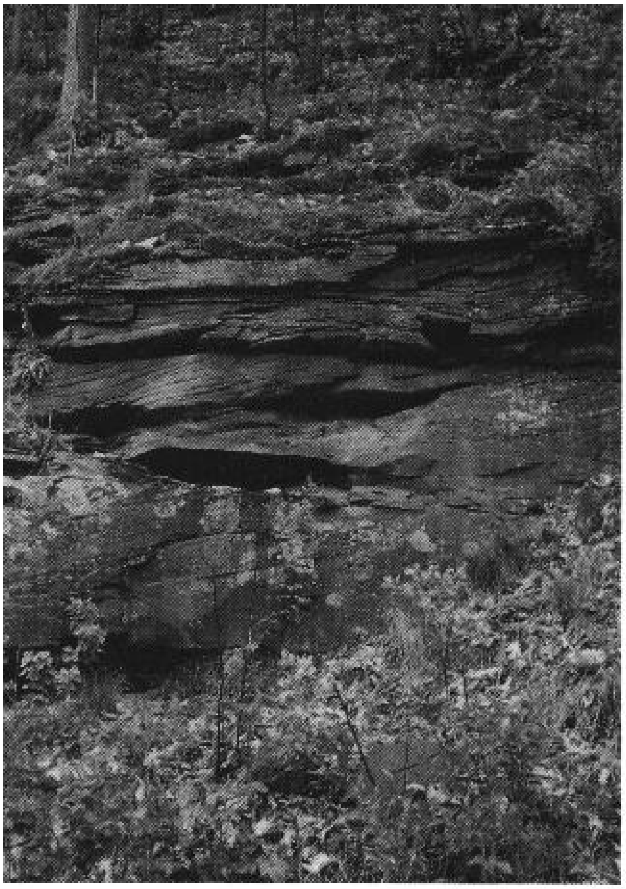
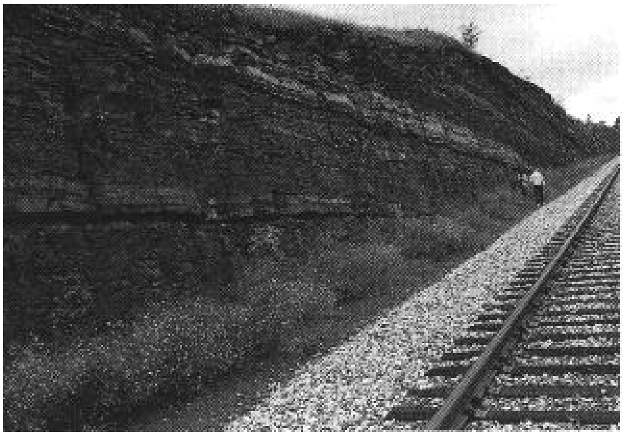


6d.

Figure 6. Sections of Catskill formation, north-central Pennsylvania
- **a. Road cut along US route 15, four miles northwest of Mansfield (Figure 9), above Tioga-Hammond Lake, August 1992. Photograph by Robert Goette.**
- **b. A fossil pelecypod shell found in the Catskill formation at location in Figure 6a, Photograph by Robert Goette.**
- **c. Road cut along PA route 414 at village of Cedar Run, lower sections of strata are "red beds" of Catskill formation, May 1992. Photograph by Emmett Williams.**
- **d. Typical cross-bedding, Catskill formation, Pine Creek Gorge near Blackwell, May 1992. Photograph by Emmett Williams.**

He suggested that the deposits are a result of the Flood and offered a Diluvial model to explain such sedimentation (pp. 197-199):

> Two Diluvian conceptual terms are now coined: Floodwater Mass Movement (FMM), and Floodwater Depositional Milieu (FDM). For illustrative purposes it may be stated that a long, thin, narrow sandstone (which uniformitarians claim was laid down by an ancient river; hence—by definition—in a fluvial sedimentary environment) was actually laid down by a swift, longitudinal FMM; the sandstone therein deposited in a torrential FDM. . . Also since it is claimed that "Ancient alluvial plains" may have ". . . wide lateral extent . . . " it can mean that, in reality it was a wide swiftly moving FMM which laid down the sedimentary rock.
>
> The . . . "shallow Paleozoic seas" were actually extremely-widespread but stagnant FMM's (p. 199).



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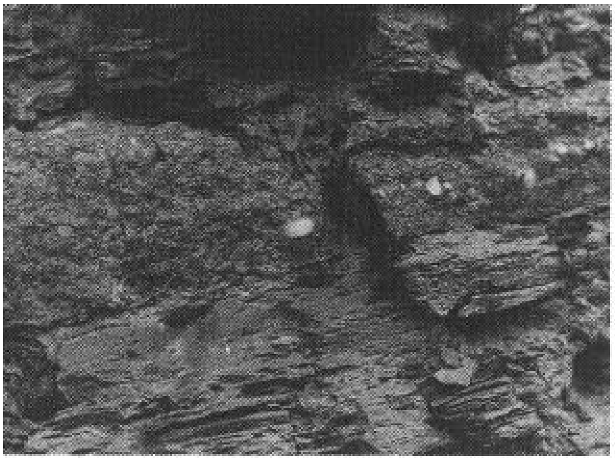

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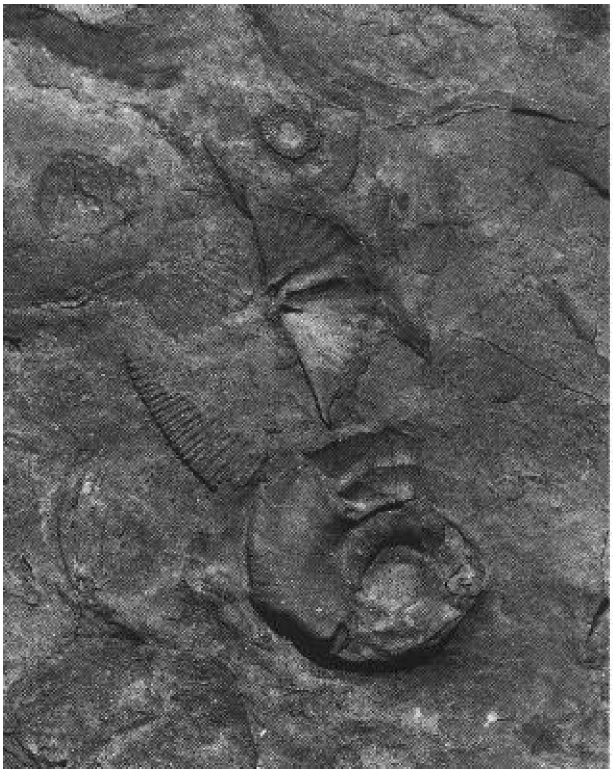

7d.

7e.

Figure 7. Sections of the Lock Haven formation, north-central Pennsylvania

- **a. Railroad cut along PA route 287, 1 mile south of Tioga (Figure 9), west of Tioga-Hammond Lake, August 1992. Photograph by Robert Goette.**
- **b. Lens of conglomerate in Lock Haven formation, same location as a., August 1992. Photograph by Robert Goette.**
- **c. Road cut along PA route 3006 between Stony Fork and Thumptown (4.75 miles northeast of Tiadaghton), August 1992. Note flaggy layers of sandstone. Photograph by Robert Goette.**
- **d. Fossils found at location in Figure 7c. From right to left in the center of the figure, an exposed cross-section of a crinoid stem, a spiriferid brachiopod and a gastropod. Photograph by Eugene Chaffin.**
- **e. Another impression of a brachiopods found at the same location. Photograph by Robert Goette.**

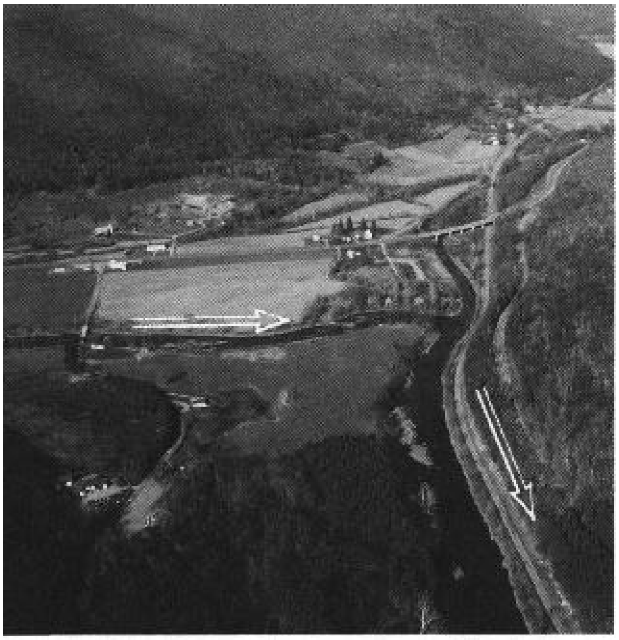

Figure 8. Pine Creek flows generally in an eastward direction (from left to right in figure), then turns south at Ansonia (right angle turn) and flows toward the Gorge (beyond bottom of figure). Marsh Creek flows generally from the north under the bridge joining Pine Creek. Arrows indicate direction of flow of Pine Creek, November 1991. Photograph by Robert Goette.

He concluded the discussion by stating that (pp. 199-200) :

> Since "sedimentary environments" in ancient rock are "Imaginative," the Diluvialist can justifiably reject the entire concept of "Sedimentary Environment" . . .

Sedimentation in basins along with tectonic activity in a Flood environment was discussed (p. 200). Then Woodmorappe considered the source areas for the sediment which formed the "Catskill Delta" and claimed that the Flood transported material from a series of sources (p. 202). He proposed a Diluvian interpretation of cyclothem facies in a prograding FMM front. In a brief discussion of sandstone and shale sedimentation, the author noted that "FMM dynamics easily explain the different sedimentary/stratigraphic properties of sandstone" (p. 205). He concluded as follows:

> The basic sedimentary, stratigraphic, and tectonic properties observed in cyclothemic rock provide a picture of the recessional aspects of the Flood (p. 205).

This original Diluvian thinking should be studied when viewing the Catskill Delta as a Flood deposit. Later Woodmorappe (1980) again reviewed "ancient sedimentary environments" and offered commentary from a Flood sedimentation viewpoint. Concerning the Bralier formation found on the Appalachian Plateau, he stated that: "The prominence of turbidites is especially suggestive of large-scale Flood deposition" (p. 215).

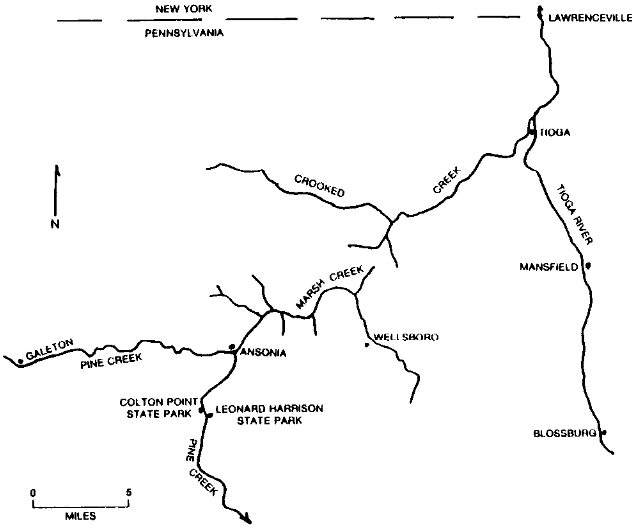

Figure 9. Map showing some drainage patterns in Tioga and Bradford Counties Pennsylvania (after Crowl, 1981, p. 40). Drawing by Emmett Williams.

Scheven (1990) briefly mentioned sedimentation in deep synclinal troughs and shallow basins (pp. 263-264). Tyler (1990) introduced a tectonically-controlled rock cycle model which included deposition within a fault-bounded sedimentary basin. He claimed that the model:

> . . . provides a framework for interpreting such distinctive features as good lateral persistence of beds, abrupt transitions between beds, regular and thick bed thicknesses, constant orientation of bedding planes, and planar unconformities (p. 297).

Austin et al. (1991) offered evidence against deltaic deposition of sandstones and shales in the Grand Canyon region (pp. 22-31). Sand wave deposition from ocean water and sources of the enormous quantity of sand needed to form the sandstone were presented within a Flood framework. Other creationists have written on certain aspects of Appalachian geology, e.g., McQueen (1986) and Chaffin (1990).

Speculations on the Origin of Pine Creek Gorge

Upper Pine Creek flows generally in a southeasterly direction in a low lying valley (Figure 8) until it meets Marsh Creek at Ansonia, where it makes a right angle turn and flows through the narrow Pine Creek Gorge (Figure 9) located in the highlands of the Appalachian Plateau. Such an unusual (unexpected?) change in direction has generated some conjecture as to "why."

Probably the first geologists to write about this change in direction of Pine Creek were Sherwood *et al.* (1878). We were unable to obtain their report, but in an early history (Anon., 1897) of Tioga County, this change in direction of flow of Pine Creek and its probable cause were briefly discussed.

> *Marsh creek* which unites with Pine creek at Ansonia, is a remarkable stream, with a motion so slow as to be hardly perceptible. . . . Its direction is exactly the reverse of that pursued by Upper Pine creek—as if the waters of Pine creek once flowed up Marsh creek, straight on toward the Tioga river. . . . It is a remarkable summit, if summit it can be called, which divides the waters

> flowing down Marsh creek to Pine creek, and those flowing down Crooked creek to the Tioga river. The idea is . . . quite popular, says Mr. Sherwood, among the inhabitants that Pine creek, instead of flowing south through the gorge . . . , flowed formerly through the valleys of Marsh creek and Crooked creek, into the Tioga river. . . . If Pine creek once flowed northward from Ansonia, what a mighty convulsion of nature must it have been that rent the mountain asunder and diverted its waters southward through one of the most weird chasms to be found in the chain of the Alleghenies?
>
> Another theory is that a small stream once had its source south of the supposed wall, and, on account of a "fault" in the rocks . . . , worked a small passage down the mountain. When the breast of the dam was broken, by the tremendous pressure behind it, there was such a mighty rush of water down the rivulet that in time the great chasm was cut and the course of Pine creek changed to the south (p. 26).

It was mentioned (pp. 26-27) that a lake may have existed in the valley north of the divide at Ansonia before the dam was breached. Sherwood is quoted (p. 27) as stating that a dam, "fifty rods in length from mountain to mountain" formed possibly during a glacial period, could have acted as an effective drainage divide where Pine and Marsh Creeks join.

Alden and Fuller (1903a, 1903b) suggested that the processes of stream development and the advance of ice sheets caused a drainage diversion of Pine Creek at Ansonia. They claimed that a drainage divide existed about two miles south of Ansonia (the lowest altitude drainage divide in the area, see Figure 10). Before the advance of any ice sheet, Pine Creek flowed northeast into Marsh Creek at Ansonia, then into Crooked Creek and into Tioga River and eventually into the St. Lawrence River. The advance of the first pre-Wisconsin ice sheet blocked the flow of the Tioga River near Corning, NY. The outflow was blocked and the water gathered into long, narrow lakes similar to the Finger Lakes of New York. The dammed water from the branching lakes overtopped the drainage divide two miles south of Ansonia. (The attitude of the drainage divide is impossible to determine at the present time because of subsequent erosion.) The south-flowing streams, south of the drainage divide, had been eroding headward toward the divide and once the dam was overtopped these streams joined the surging lake water flowing southward into the west branch of the Susquehanna River and eventually into the Chesapeake Bay.

A second advance of a continental ice sheet (Wisconsin stage) again dammed the northeast-flowing drainage with the formation of finger lakes and the exiting dammed water flowed into Pine Creek south through Pine Creek Gorge likely eroding it to greater depths.

In 1933 George Ashley briefly explained the drainage diversion as follows:

> Glacial deposits are likely to make many changes in the drainage of an affected region. Thus, in places, as the ice moved forward up a drainage basin, the streams flowing toward the ice were ponded against its front until the pond rose to such a height that it overflowed the edge of the basin into some other valley draining away from the front of the ice. This may have lasted long enough so that a new permanent outlet was established by cutting a deep gorge through the old rim of the basin. This happened, for example, with Pine Creek the headwaters of which were tributary of the Tioga River by way of Marsh Run. The gorge below Ansonia was cut through the rim of its old basin, making Pine Creek a tributary of the West Branch of the Susquehanna (pp. 41-42).

Figure 10. View looking WSW in Pine Creek Gorge near the confluence of Pinafore Run and Pine Creek approximately two miles south of Ansonia, where the postulated drainage divide existed. Notice how narrow the gorge is at this location, August 1992. Photograph by Emmett Williams.

Ashley expanded his explanation in 1945.

> For simplicity . . . suppose we divide Pine Creek into Upper Pine Creek west of Ansonia and Lower Pine Creek south of Ansonia.
>
> At one time Upper Pine Creek used to flow east and north past Ansonia by way of Marsh Creek, lower Crooked Creek and Tioga River, out of the State at Lawrenceville into New York State . . Lower Pine Creek had its real source in Babb Creek . . . (pp. 3-4).

The old drainage divide separating the northward flow toward the St. Lawrence River and the southward flow toward the Chesapeake Bay ". . . crossed Tioga County in a northeast-southwest direction about through Mansfield and Wellsboro" (p. 4). The divide was a broad arch of rock separating the north and south basins. Upper Pine Creek followed the basin to the north whereas Lower Pine Creek followed the basin to the south. The arch was "worn down" after several million years of erosion and headward erosion from a south-flowing stream could have cut a deep gap in the divide (p. 6). Once the glaciation blocked the northeast flow and the dammed water overflowed the gap or col and "rapidly lowered the new channel" (p. 7) so that after the retreat of the ice, Pine Creek continued to flow south in the lower elevation channel (Pine Creek Gorge).

11a.

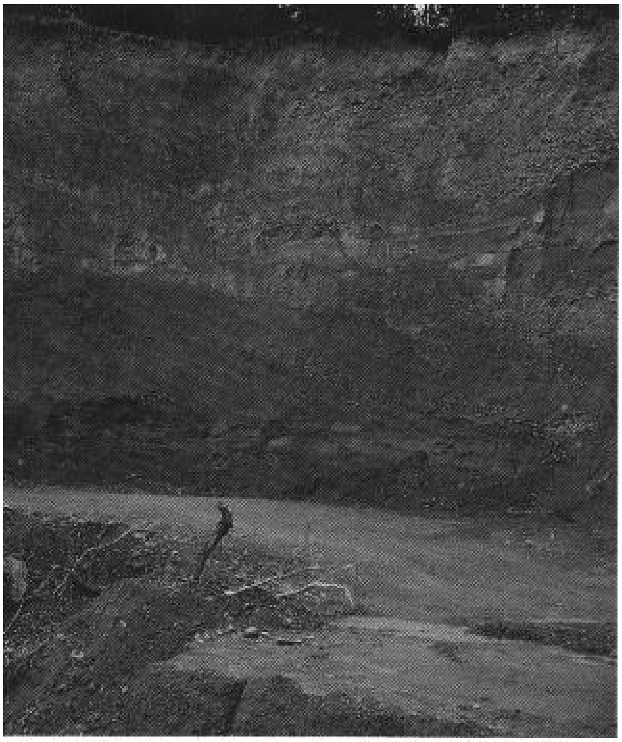

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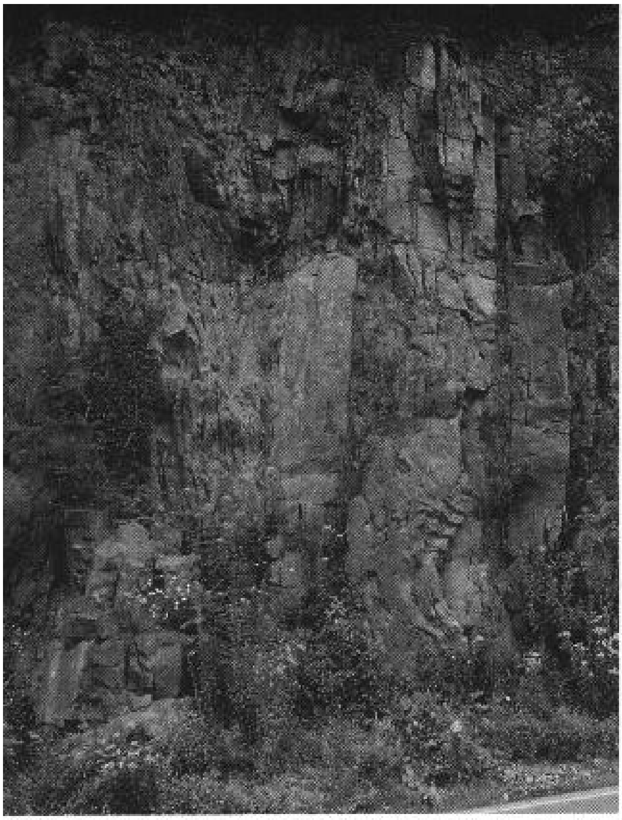
Figure 11 a. Soil profile above hammer in Pine Creek Gorge near Burdic Run, about four miles downstream from Ansonia, May 1992. Denny (1956) referred to the strongly weathered red drift as pre-Wisconsin paleosol. Photograph by Emmett Williams.

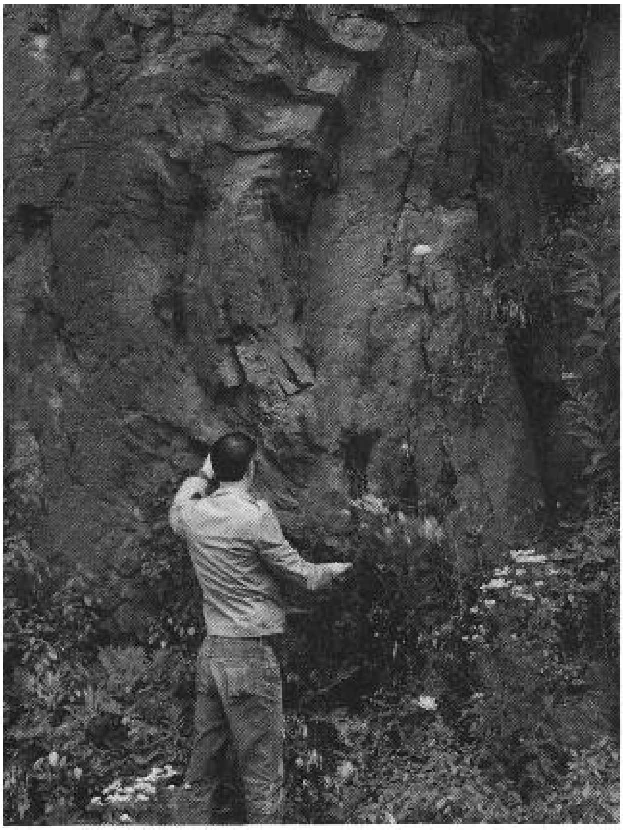
b. Kame northeast of Ansonia, May 1992. Photograph by Emmett Williams.

c. Cross-section of a kame, 0.5 mile east of Sabinsville, PA, May 1992. Photograph by Emmett Williams.

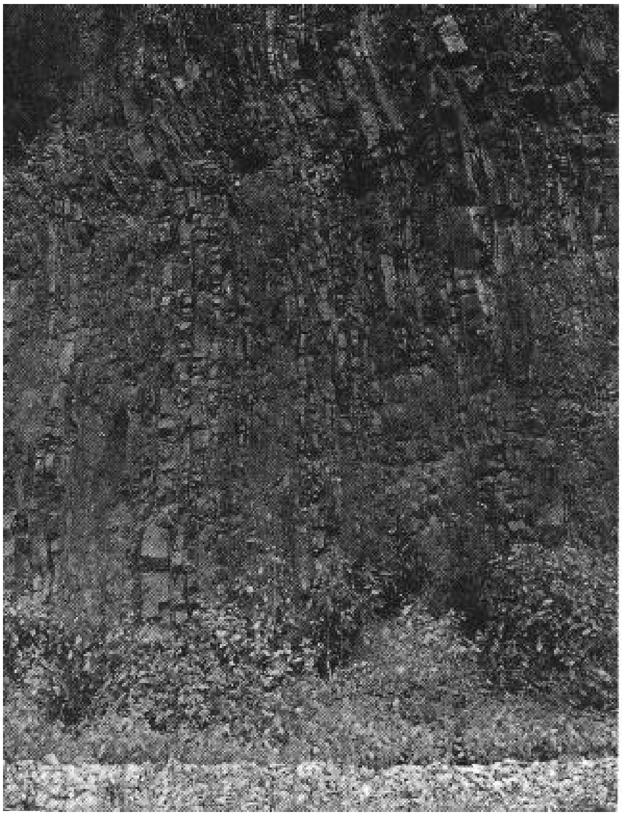
d. Likely a glaciofluvial deposit in the cut located at the west end of the bridge across Babb Creek in Blackwell, PA along PA 414, August 1992. Photograph by Robert Goette.



12a.



12b.



12c.

Figure 12 a. Steeply folded and vertical strata of Catskill redbeds, 2.8 miles north of intersection of US 220 and PA 44 along Highway 44, August 1992. Photograph by Robert Goette.

b. Closer view of folded strata shown in lower right of Figure 12a, August 1992. Photograph by Robert Goette.

c. Vertical flysch beds of Lock Haven formation approximately 1.4 miles north of intersection of US 220 and PA 44 on railroad cut (along old Penn Central Railroad bed). Note soil creep at top of flysch layers, September 1992. These strata are similar to the flysch beds of the Haymond formation in west Texas (Howe and Williams 1994). Photograph by Robert Goette.

d. Small brachiopods found cemented in one of the flysch layers along an old railroad cut, 2.1 miles north of intersection of PA 44 and US 220 at Torbert, PA, August 1992. Photograph by Robert Goette.

12d.

13a.

13b.

Figure 13 a. Portion of debris slide near Red Ledge, 0.75 mile south of Tiadaghton on the east slope of Pine Creek Gorge, May 1992. Photograph by Emmett Williams.
b. Small debris slide near Owassee (2.7 miles south of Ansonia) on the east slope of Pine Creek Gorge, August 1992. Photograph by Robert Goette.

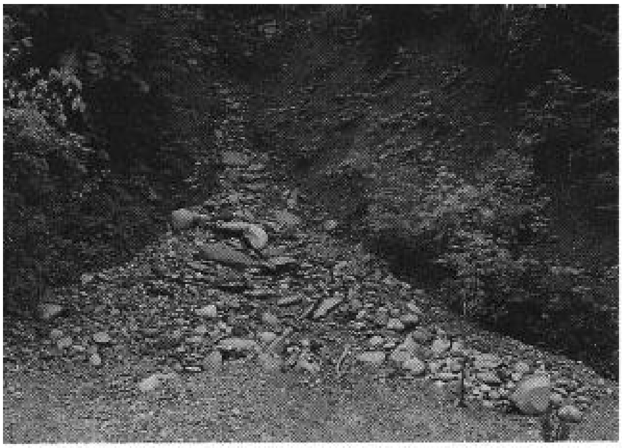


Figure 14. A washout from a deposit along the east side of PA 414, 0.7 mile north of Blackwell village limits sign, August 1992. Photograph by Robert Goette.

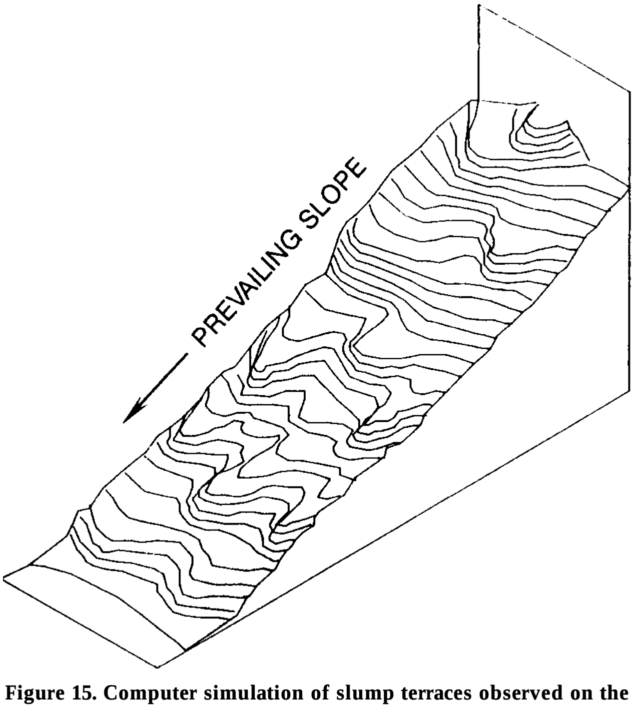


Figure 15. Computer simulation of slump terraces observed on the east slope of Pine Creek Gorge one mile north of Tiadaghton. Drawing by Eugene Chaffin.

Denny (1956, p. 53) and Denny and Lyford (1963, p. 18) studying the geomorphology, surficial geology and soils of the region, "dated" the time of the drainage diversion as follows:

> The overflow [of the dammed water] cut down the divide, and subsequent erosion of both glacial and nonglacial origin has produced the present canyon. Since gravel dating from pre-Wisconsin time occurs in the valley of Pine Creek south of the Wisconsin drift border, the cutting of the gorge probably antedates the Illinoian stage . . . (Denny and Lyford, 1963, p. 18).

In a more detailed model, Crowl (1981, p. 39) explained:

> The present drainage pattern of north-central Pennsylvania is the result of normal stream action modified by pre-glacial stream piracy and Pleistocene glacial ponding of streams with concomitant stream diversion across divides.

In discussing the pre-glacial drainage divide, he noted (p. 42):

> . . . the divide between upper Pine Creek-Marsh Creek-Crooked Creek drainage to the north and lower Pine Creek to the south lay along the present height of land about a mile north of Leonard Harrison / Colton State Parks. . . . Presumably a col lay in the divide between the two streams.

Then the northeast drainage was blocked by "an early ice sheet." Meltwater lakes formed in the valleys. The lake in the valley north of the Gorge drained through the col into lower Pine Creek.

> Abundant water flow, a steep gradient south of the col, and severe frost action associated with ice-marginal periglacial conditions would have severely broken these well-jointed rocks, and stream erosion would have been very effective at the site. Continued advance of the ice obliterated the lake, covered and scoured the divide (Crowl, 1981, pp. 42-43).

Then Crowl speculated that likely the drainage change occurred during the period of "Nebraskan" glaciation (p. 43). Later glaciations were postulated so that the erosion process outlined above continued until the establishment of "the present course of Pine Creek" (p. 43).

Since this view of drainage diversion was first suggested in the late 1800's and early 1900's when W. M. Davis' system of geomorphology exerted a strong influence on geological studies, a bibliography is given in Addendum I for anyone interested in examining the system to determine if it is compatible with a model of the Flood and its after-effects.

Coates (1974) and Coates and Kirkland (1974) proposed a different hypothesis for the formation of Pine Creek Gorge. Their view emphasized glacially-related erosion from meltwater to form the Gorge rather than any preglacial erosion. Referring to the region of the state where the Gorge is located as the open folds section, Coates (1974, p. 237) noted:

> Some of the most important glacial effects in this section occur in the northern part where large proglacial lakes were ponded against the divides of north-flowing rivers. Not only were thick glaciolacustrine deposits left throughout many valleys and on some hillslopes, but spectacular spillways formed by overflow of the lakes through narrow cols. . . . The most awe-inspiring of these features is the Pine Creek Gorge, . . . Here the nearly vertical 700 ft. high walls of the 20 mi chasm were formed by meltwaters impounded in the Tioga and Cowanesque Rivers.

Coates and Kirkland (1974) suggested a sequence of landscapes developed by glaciation on the Appalachian Plateau. They stated (p. 116):

> There is one series of events which has received inadequate coverage in the literature that is crucial to the evolution of the glaciated landscape and sets it entirely apart from the unglaciated part of the Plateau—the character of drainage divides. In the glaciated region there is an unparalleled development of an entire family of landforms that constitute a continuous series with many gradations of glacial cols, chute valleys, sluiceways, and through valleys. Erosion is the dominant characteristic of the first three, whereas the fourth is more dominated by transportation and deposition processes.

The first 16-20 miles of Pine Creek Gorge from Ansonia southward is classified as a single-cycle sluiceway formed by meltwater from a "single glacial episode" (p. 121). Sluiceways were defined as "elongated narrow valleys with steep walls that contain only minor tributaries due to the restricted width of the drainage divide that nearly parallels the valley" (p. 121).

The actual effect of glaciation, the southernmost extent of glaciation, various glacially-related features and the number of glacial stages on the Appalachian Plateau are definitely not closed subjects. For instance Braun (1989, p. 244) noted:

> The only part of the Appalachians where there is a consensus that glaciers have transformed the landscape is in the Finger Lakes region of the Appalachian Plateau . . .

Interested readers may wish to consult the following sources for further insight into the subject—Berg et al., 1981; Braun, 1989; Clark and Ciolkosz, 1988; Coates, 1974; Coates and Kirkland, 1974; Crowl, 1981; Crowl and Sevon, 1980; Denny, 1956; Denny and Lyford, 1963; Hunt, 1974; Leighton, 1941; Leverett, 1934; Shepps, 1962. See Figure 11 for some possible evidence of glaciation around Pine Creek Gorge. In considering such evidence, it would be well to heed Denny and Lyford (1963, p. 5) in their discussion of local glacial drift:

> Strongly weathered gravel, perhaps glacial outwash of pre-Wisconsin age, occurs along the West Branch Susquehanna River and its principal tributaries, Pine, Lycoming, Loyalsock, and Munsy Creeks. . . . Whether such gravels are indeed gla-

> cial outwash or whether they are alluvial deposits of nonglacial origin derived from adjacent highlands has never been determined.

Also Crowl and Sevon (1980, pp. 48-51) did not always agree with Denny and Lyford on their interpretation of evidence for glaciation in the Pine Creek Gorge region.

Most creationists who have written on the subject prefer a single episode of continental glaciation after the Flood with possible regional advances and retreats which sometimes are interpreted as multiple glaciations. (See Addendum II for a selected bibliography of creationist writings on glaciation.)

Some speculation is offered on the formation of Pine Creek Gorge based on a Flood-related model. It is assumed that the sediments that formed the Appalachian Plateau were deposited rapidly and also that when the Plateau was uplifted, these sedimentary layers were not fully lithified. Other assumptions are that the uplifted Plateau contained many post-Flood lakes and the climate was such that considerable precipitation likely fell on the region (Oard, 1990). The presence of many lakes, soft sediments and high rainfall likely resulted in the incising of the Plateau (Figure 5) as the runoff began to flow to lower altitudes toward the retreating ocean. Likewise many of the existing lakes could have been emptied due to this drainage from the Plateau.

If these assumptions are valid, a lengthy erosion process would not have been necessary to establish drainage patterns on the Plateau. Steep-sided gulleys would have developed quickly. Runoff water containing abrasive matter removed from the soft sediments would scour the landscape as the water flowed to lower elevations. Thus Pine Creek Gorge could have started forming very soon after uplift.

Prior to a period of glaciation any cols or gaps, if in existence, were likely not very high due to rapid erosion immediately after the Flood. If the cols were completely worn away or nonexistent, the present drainage pattern in Lower Pine Creek would have been established before glaciation and any subsequent glacially dammed water would have flowed southward through the already-existing steep-sided gulley south of Ansonia deepening it into the present gorge.

As one drives south on PA 44 toward Jersey Shore, the gently tilted Catskill rocks suddenly show steeper tilting and folding south of Waterville (Figure 12) as one approaches the Allegheny Front. The steep tilting is first noticeable on PA 44 at a location of 41°14’N, 77°20’W (Jersey Shore, Pennsylvania quadrangle, USGS topographic map). It is suggested that the uplifted strata could have formed a dam south of Waterville (the gorge is deepest at this village) blocking the south-flowing streams with the formation of small finger lakes in the lower Pine Creek drainage system. If glaciation blocked the northeast drainage out of Tioga County, this dammed water, plus the glacial meltwater, would have extended the postulated finger lake in Pine Creek Gorge to the north in the valley above Ansonia forming a large body of water in this region. The enormous pressure of water on the dam, the high amount of precipitation, the continued tectonic activity at the Allegheny Front along with the unlithified condition of the sediments in the dam would have contributed to the dam being breached. The subsequent erosion by the sediment-laden water draining toward the south would have scoured the already dissected Plateau even deeper along the path of Lower Pine Creek. This erosion would have eradicated the dam and destroyed any evidence of the postulated lakes. This tentative post-Flood scenario is offered as another possibility for the origin of the drainage system of Lower Pine Creek and Pine Creek Gorge.

Summary and Conclusions

Postulated mechanisms for the formation of Pine Creek Gorge have been reviewed. Also speculation for the development of the gorge within a young earth model has been offered. The latter model suggests the following possibilities:

1. Deposition of the sediments of the Appalachian Plateau in late stages of the Flood or immediately after the Flood.
2. Erosion of semi-consolidated sediments during or immediately after deposition.
3. Considerable precipitation and / or outflow water from the Plateau to cause (2).
4. Dam breaching or drainage divide overflow caused by (3).
5. Drainage patterns developed quickly with the subsequent lithification of sediments to stabilize these patterns.
6. Glaciofluvial water flow further deepened the drainage path in the gorge.

Appendix I
Debris Slides and Slumping in Pine Creek Gorge

Human activity in Pine Creek Gorge has been intense in the past. Many sawmills and logging railroads were active in and around the gorge. Hemlock (*Tsuga* sp.) was removed to be used in the tanning of leather and white pine (*Pinus strobus* Linnaeus) was cut for lumber (Taber, 1972). Until recently, the Penn Central ran trains through the gorge—the tracks having been removed a few years ago. Also a severe flood occurred in the area in 1832 (Clover, 1958, p. 10).

These activities probably disturbed much of the surficial geology in the gorge and any remaining evidence of a prior lake likely has been destroyed. During the logging era, much of the tree cover was removed. The roads, trails, logging slides, etc. probably encouraged debris slides and slumping during periods of heavy rainfall. While on the field trips to the gorge, we found evidence of recent debris slides (Figure 13), washout (Figure 14) and slumping (Figure 15). For other discussions of these geomorphic phenomena on the Appalachian Plateau, see Wilshusen, 1979; Jacobson et al., 1989.

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Glossary

Clastic—pertaining to a rock or sediment composed primarily of fragments derived from pre-existing rocks or minerals and transported some distance from their place of origin
Col—A saddle-like depression in the crest of a mountain ridge or the lowest point on a ridge
Cyclothems—sedimentary cycles that include coal beds
Epeiric—pertaining to an inland sea
Glaciofluvial—pertaining to meltwater streams flowing from glaciers and the deposits made by such streams
Glaciolacustrine—pertaining to deposits in glacial lakes
Prograde—to grow seaward by the accumulation of sediments; deltas often prograde
Turbidites—sediments deposited from turbidity currents

Addendum I
Geomorphic System of W. M. Davis

W. M. Davis developed his geomorphic system using the rivers and valleys of Pennsylvania as examples. This selected bibliography starts with his paper and the later references are in chronological order. These later papers have ample bibliographies for further study.

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For a brief creationist evaluation of the Davis geomorphic system see Austin, S. A. 1983. Did landscapes evolve? *Impact* No. 118. Institute for Creation Research.

Addendum II
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BOOK REVIEWS

Of Pandas and People: The Central Question of Biological Origins.” Second edition by Percival Davis and Dean H. Kenyon. 1993. Haughton Publishing Company. Dallas, TX. 170 pages. $18.00 hardback.

Reviewed by Wayne Frair**

Two types of pandas (giant and red) are native to the bamboo forests of southwest China. Both share many similar features including internal organs, behavior and sesamoid-bone “thumbs” for stripping the leaves off bamboo shoots. Even though the two pandas are alike in many ways, the giant panda is classified in the bear family and red panda in the raccoon family. Are the many similarities between the two types due to descent from common ancestry (homology), due to living in like habitats (convergence), or because they reflect design?

Using the panda as only one example the authors of this book authoritatively make an impressive case against evolution and the “intelligent design.” This design would be “analogous” to the comparison of the head of a U.S. president on Mt. Rushmore in South Dakota with the Old Man of the Mountain in New Hampshire. The former which was carved by man is evidence of intelligent design; whereas the latter is a natural rock formation which resembles a human head.

Various examples of design are explained in the six chapters which cover the origin of life, genetics, macroevolution, the fossil record, homology and biochemical similarities.

The book is well-illustrated with color drawings and photographs, has a helpful glossary and index, some word pronunciations in the text, a page with biographies of authors, and references at ends of chapters. Academic Editor for the book was Charles B. Thaxton. Two others, Mark D. Hartwig and Stephen C. Meyer wrote “A Note to Teachers,” which is an 11-page chapter at the end of the text. I found this particular chapter to be especially valuable in supporting and justifying the purpose of the book and in conveying a good understanding of the scientific method.

Pandas was written to be used as a supplement to “standard” biology texts assigned in high schools and colleges. The book may be somewhat advanced for an unmotivated high school student in an entry level course. But upper level high school and college students should find it very helpful. Biologists in various fields, and even more importantly, teachers at all levels, should read this book. The authors say:

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*Editor’s note: The first edition of this book was reviewed by Trevor Major. 1990. *CRSQ* 27:38.

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