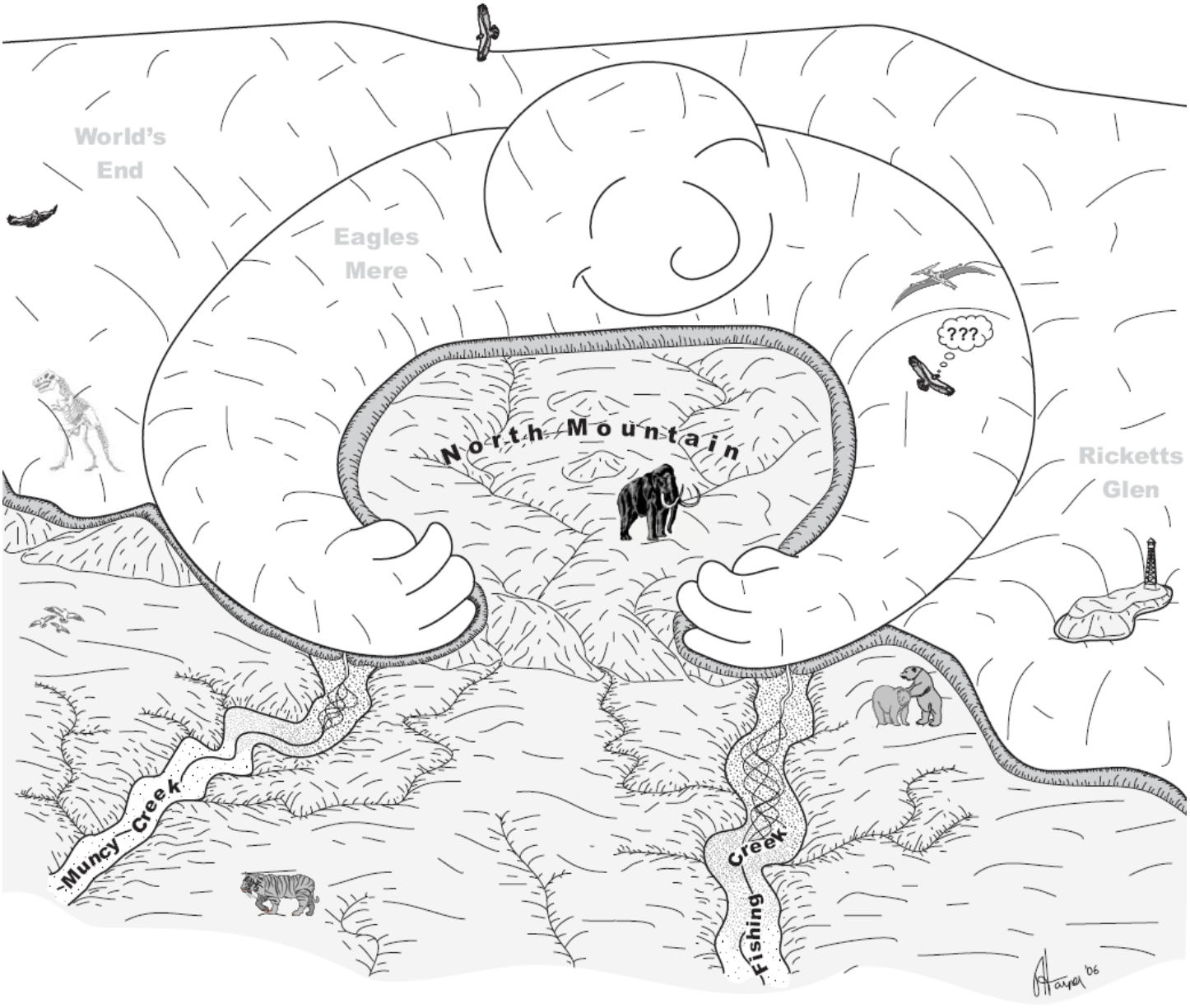
THE HAYSTACKS, "RICKETTS FOLLY," AND THE END OF THE WORLD:

GEOLOGY OF THE GLACIATED ALLEGHENY HIGH PLATEAU, SULLIVAN, LUZERNE AND COLUMBIA COUNTIES, PENNSYLVANIA



71ST ANNUAL FIELD CONFERENCE OF PENNSYLVANIA GEOLOGISTS

Hosts: Bloomsburg University
Pennsylvania Geological Survey
Ricketts Glen State Park
Susquehanna University

October 5 – 7, 2006
Ricketts Glen State Park

Guidebook for the

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GEOLOGY OF THE GLACIATED ALLEGHENY HIGH PLATEAU, SULLIVAN, LUZERNE AND COLUMBIA COUNTIES, PENNSYLVANIA

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Hosts: Bloomsburg University, Pennsylvania Geological Survey, Ricketts Glen State Park, Susquehanna University

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Cover: An amorous happy-go-lucky Late Wisconsinan glacier embraces North Mountain as it spills over a re-entrant in the Allegheny Plateau, while some interesting wildlife cavorts through the idyllic scenery (concept by Duane D. Braun, artwork by John A. Harper)

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Frontispiece. Group photograph of the 2005 Field Conference of Pennsylvania Geologists at Pymatuning State Park (Stop 3).

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PREFACE

The 71st Annual Field Conference of Pennsylvania Geologists welcomes you to Ricketts Glen State Park and our grand experiment in "roughing it"! Although we have visited many state facilities (mainly for lunch stops!) over the years, this is the first Field Conference to be officially headquartered in a state park. We thank you in advance for your forbearance concerning any logistical problems that may arise because of necessary adjustments in our usual Conference procedures.

Our field trips on the Glaciated Allegheny High Plateau will take place amid some of the grandest scenery in the northeastern United States, counting among the attractions two of Pennsylvania's most picturesque and geologically interesting state parks—Ricketts Glen and Worlds End, as well as Eagles Mere and its beautiful glacially dammed lake. Ricketts Glen boasts 22 named waterfalls, a fascinating late glacial-postglacial history, innumerable bedrock outcrops, and a "Grand View." Worlds End has two spectacular scenic overlooks and a classic Pottsville "rock city," either within its boundaries or nearby.

Much of the Conference is based on the surficial geologic mapping of Duane D. Braun of Bloomsburg University, who since 1990 has mapped more than one hundred 7.5-minute quadrangles in northeastern Pennsylvania, including nearly all of three 1:100,000-scale quadrangles—Allentown, Scranton, and Honesdale—and a good bit of a fourth, Williamsport East.

Our understanding of the bedrock geology of the Conference area is still largely based on the reconnaissance mapping of Thomas M. Berg and William D. Sevon for the 1980 *Geologic Map of Pennsylvania*, but new work by Joseph Hill of Bloomsburg University and Jennifer Elick of Susquehanna University is adding further insights on the Devonian-Pennsylvanian non-marine succession and the marine Upper Devonian, respectively. Of particular bedrock interest is the enigmatic "Haystacks sandstone bed" in the upper part of the Huntley Mountain, which will be seen on a Pre-Conference field trip, as well as at two STOPS during the regular Conference field trip. Although early on it looked as though Norman Gillmeister (Bloomsburg University, retired), Joseph Hill, and Donald Woodrow (Hobart and William Smith Colleges) would present differing views on the nature of the Haystacks, it appears from the articles included here that they are pretty much in agreement.

Through Robert Bruce Ricketts, namesake of Ricketts Glen State Park, the "71st" has ties to the "1st" and "73rd"—to Battery F, 1st Pennsylvania Light Artillery, and the 73rd Field Conference to be held in Gettysburg two years from now. At the banquet on Friday night, Peter Tomasak of Sweet Valley (co-author of *Ricketts Battery: a history of Battery F, 1st Pennsylvania Light Artillery*) will speak on the life of Colonel Ricketts, whose biography he is currently writing. The Conference Guidebook also includes an article by George Turner (Bloomsburg University) on the opposition to the Civil War in Columbia County in 1863, the unfolding of which took place in northern Columbia County between Bloomsburg and North Mountain immediately after the battle of Gettysburg.

So "Enjoy, enjoy!" And, please, no matter what your religious persuasion, pray for good weather!

ACKNOWLEDGMENTS

In addition to the contributors to the Guidebook, the FCOPG owes a great debt of gratitude to numerous individuals who helped with the planning and logistics of this year's Conference. Terry Daltroff, Park Manager of Ricketts Glen State Park, cooperated fully in allowing use of his park's facilities for lodging and camping, welcoming reception, and the various field trips. Bill Kocher-, Park Manager of Worlds End State Park, gave us free use of the picnic pavilions along Loyalsock Creek for Saturday lunch. For permission to enter private property, we thank Mr. William Leberfinger (Leberfinger's quarry) and Mr. Howard "Buddie" Nye (Sullivan Falls Camp). Martha Inners was of great assistance in preparing the Day-1 road log and the trail log and photographs for the Thursday "Walking Tour" over the Falls and Highland Trails in Ricketts Glen State Park. The Lackawanna Forest District, DCNR Bureau of Forestry granted us access to the "Grand View" fire tower in Ricketts Glen State Park.

QUATERNARY HISTORY OF THE RICKETTS GLEN, EAGLES MERE, AND WORLDS END REGION OR WHY THIS AREA IS A LAND OF WATERFALLS AND LAKE BASINS

by
Duane D. Braun

OVERVIEW

During the Quaternary, northeastern Pennsylvania experienced a climate that alternated between cold, glacial-periglacial conditions and warm, humid-temperate interglacial conditions. About ten such alternations have affected the region during the last one million years (Braun, 1989, 1994, 1997, 2002, 2004b). There is evidence for four different glacial advances across the region in that there are three different aged glacial limits mapped southwest of the area (Figure 1) (Braun, 1994; Sevon and Braun, 1997) with a fourth limit now being separated out (Braun, 1999 and ongoing work). The farthest to the southwest and oldest glacial limit is considered to be pre-Illinoian-G age (850 Ka) (Braun, 1994) or even 2 Ma age (Stanford, 1997). The next distinct glacial limit is considered to be either late Illinoian (150 Ka) or pre-Illinoian-B (450 Ka) in age and is only about 15 km (10 miles) beyond the most recent, late Wisconsinan-age (26 Ka) glacial limit. Other glacial advances have approached the area and caused severe periglacial activity (Braun, 1989, 1994, 1999, 2002, 2004b).

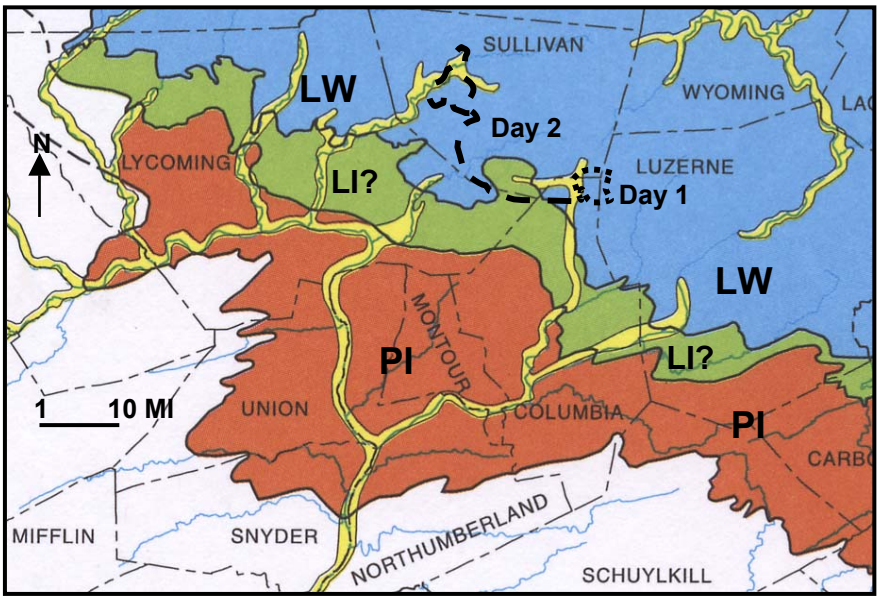

Figure 1. Map showing the different age glacial limits and each day's route of the field trip (adapted from Sevon and Braun, 1997).

LW Late Wisconsinan
LI? Late Illinoian or older
PI Pre-Illinoian G or older

Day 1 Dotted line
Day 2 Dashed line

Each glacial advance across the Ricketts Glen/Worlds End area would have accomplished some erosion. The older glacial termini are parallel to the Late Wisconsinan terminus (Figure 1) and glacial striations in the area covered by the older glaciations are in the same direction as striations within the late Wisconsinan limit (Braun, 1994). This indicates that the older glaciers moved across the region in about the same direction as the late Wisconsinan ice and that they should have eroded and deposited in a pattern generally like that of the late Wisconsinan. Preglacial valleys oriented near parallel to the ice flow could be significantly scoured and partly back filled in each glaciation. Valleys oriented transverse to ice flow would be the least scoured and the most back-filled, sometimes becoming completely buried.

Any glacial ice or meltwater erosion feature on the present landscape in this area was probably initiated by the earliest glaciation and enlarged by each succeeding glaciation.

Only late Wisconsinan-age deposits and constructional landforms have been observed in the Ricketts Glen/Worlds End area and elsewhere within the late Wisconsinan limit in northeastern Pennsylvania (Braun, 1994, 2004a, ongoing mapping). The last glacial advance was quite effective in removing older glacial deposits, presumably of similar thicknesses to those of late Wisconsinan age, from the landscape. The till deposits are dominated by fresh clasts of the local bedrock; indicating considerable Wisconsinan erosion of the bedrock. Older deposits may still exist under the late Wisconsinan deposits where glacial scour was minimal, such as in valleys transverse to ice flow, but such deposits have not yet been separated out from the late Wisconsinan materials.

On the Conference field trips, we will be traveling just outside to at most 15 mi (25 km) inside the terminal position of the late Wisconsinan glacier (Figure 1). This is where glacial ice scour would be expected to be minimal due the thinness of the glacier and the short duration of ice cover. This is also where glacial sediment deposition would be expected to be maximal. The primary landscape changes due to glaciation in this area are drainage derangements caused by the thick glacial deposits partly to completely burying preglacial valleys. Such drainage diversions are expressed on the landscape today as abrupt changes in a stream's gradient, waterfall knick points, and basins containing lakes or wetlands. On the various field trips we will be examining some of the best examples of the region's drainage derangements at Ricketts Glen State Park and Eagles Mere.

The total duration of Late Wisconsinan ice cover is on the order of 2,000 to 3,000 calendar years at the terminus in the Ricketts Glen area and 8,000 to 10,000 calendar years at the northern boundary of Pennsylvania (Ridge, 2003; Braun, 2004a). (All ages will be given in calibrated calendar years rather than Carbon-14 years that get progressively more "too young", the older the C-14 dates are.) The late Wisconsinan ice entered Pennsylvania about 27,000 years ago and reached its terminal position about 25,000 years ago (Ridge, 2003; Braun, 2004a). Glacial retreat from the terminus started around 22,500 years ago and reached the Pennsylvania - New York State line about 18,000 years ago (Braun, 2004a). This means that it took around 4000 years, for the ice to retreat the 60 miles (96 km) along a S 20^0 W flow-line from the terminal moraine south of Ricketts Glen to the New York line. If the ice retreated at a steady rate (assuming no significant re-advances) it would have taken about 65 calendar years to recede one mile. At that rate, the ice would have retreated across a single 7.5' quadrangle in about 500 years or so.

Mapping of the glacial deposits in northeastern Pennsylvania suggests that several (5 to 15) short - lived (several decades) still-stands of the glacial ice front occurred as it receded across an individual 7.5' quadrangle (so called stagnation-zone retreat) (Braun, 2002, 2004a, 2006). During each still-stand the ice deposited a belt of thicker material, often expressed in individual valleys as a 100-150 ft (30-50 m) thick till knob that partly dams the valley. In valleys parallel to ice flow, a south to north series of till knobs form "beaded valleys" that have a series of fairly evenly spaced narrower and wider segments (Braun, 2002, 2004a, 2006). In valleys oriented transverse to ice flow, till knobs also block the drainage but their spacing is more irregular and they often high on the side of the valley.

Most valleys transverse to ice flow are usually asymmetric with a steep south side and gentler north side underlain by a mass of thick till or a "till shadow" (Coates 1966; Braun, 2002, 2004a, 2006). The till shadow partly to completely buries the center of the preglacial valley cut in bedrock. The post glacial stream often incises into the south bedrock side of the valley and starts cutting a bedrock gorge that contains a series of waterfalls. Often the gorge is "one sided" with bedrock ledges on its south side and till on its north side (Figure 2). Such a one sided gorge will be visited on Day 1 at STOP 5 and several examples of such gorges are noted on the road logs of the field trips. Sometimes the burial of the transverse valley is so deep that the postglacial stream is diverted to an adjacent valley (Braun, 2002).

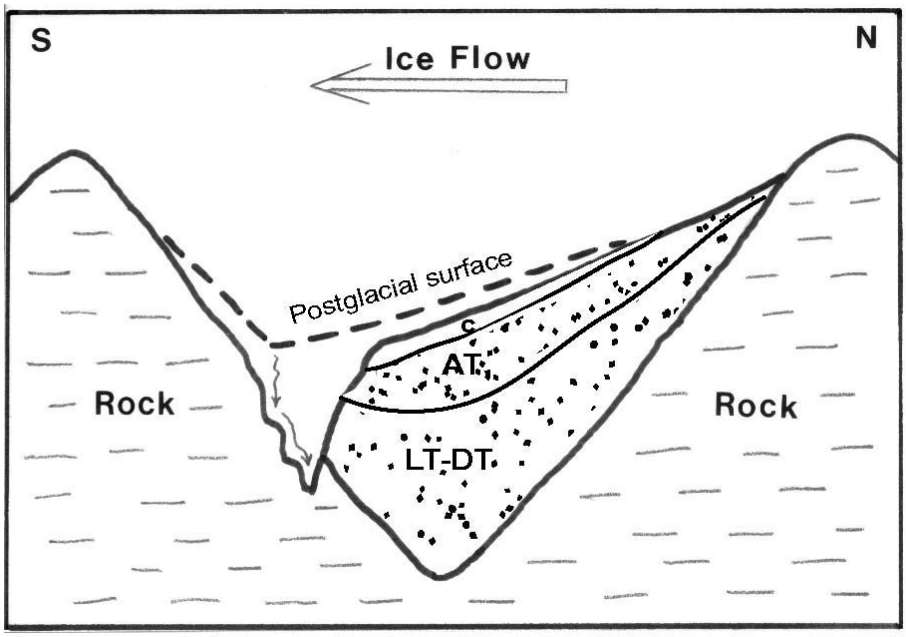

Figure 2. Cross-section sketch of a now asymmetric valley transverse to ice flow showing a "till shadow" on the north side of the valley and post glacial stream incision along the south side of the valley.

C Colluvium

AT Ablation till

LT-DT Lodgement & Deformation till

After the late Wisconsinan glacier receded from the terminus, cold periglacial climatic conditions prevailed in the Ricketts Glen/Worlds End area for about 8,000 years, until almost the beginning of the Holocene. During that time, the exposed sandstone ledges were frost-riven and shattered (Peltier, 1949; Harrison, 1966, Braun, 1994,1997, 2004a) and the blocks transported downslope by various processes collectively known as gelifluction (Coates and King, 1973; Coates, 1981; Braun, 1994, 1997). These processes resulted in a boulder colluvium mantle often extending 500 ft (150 m), and in places, as much as 1000 ft (300 m), down-slope of individual sandstone ledges. A number of exposures show late Wisconsinan till or ice-contact gravel under the boulder colluvium. The glacial till deposits themselves have been "mobilized" on the slopes by gelifluction (Braun, 1994, 1997, 2006c). On the upper to middle parts of the slopes, the upper 2 to 3 ft (0.5-1.0 m) of material is colluvium derived from till. The material often shows a well-developed down-slope fabric (tabular clasts near parallel to the ground surface). On the lower parts of the hill-slopes the "colluviated till" is often 6 to 15 ft (2-5 m) thick.

In northeastern Pennsylvania, postglacial fluvial erosion of the till-mantled slopes was also significant as shown by numerous alluvial/debris flow fans in the region. The most rapid erosion occurred immediately upon ice recession and lasted until tundra vegetation became established (so called paraglacial erosion). The fans are best developed where small, steep gradient streams enter the broad floors of the ice scoured, near parallel to ice flow trunk valleys. Hundreds of such fans have been mapped in the region and a few of them will be driven across on the Day-2 field trip.

In the latest Pleistocene, less than 15,000 years ago (Dalton and others, 1997), forest vegetation became well established in the area. This acted to reduce erosion and sediment load of tributary streams while trunk streams continued to incise into the glacial deposits. Throughout the time from ice recession to present, the streams have been progressively incising into and removing much of the glacial sediments. The larger the stream and the narrower the valley, the more complete is the removal of the glacial deposits. Loyalsock Creek is one such stream that has removed so much of the glacial material that it has broad, relatively low alluvial terraces on its floor rather than glacial outwash terraces or kame terraces. In the Holocene the only areas of significant sediment deposition have been on the floodplains of the larger streams in the region, such as Loyalsock Creek. Those deposits are primarily overbank sand deposits that overlie gravelly outwash deposits. Small-scale climatic changes during the Holocene are reflected in changes in the rate of alluvial terrace formation and overbank sedimentation.

THE WATERFALLS AT RICKETTS GLEN - AN EXAMPLE OF STREAM DERANGEMENT FROM GLACIATION

When the ice front retreated to the northeast, a layer of bouldery glacial till was left behind, partly filling in old valleys and creating lakes and swamps on the flat Appalachian or Allegheny Plateau upland around the Ricketts Glen area. The most significant drainage change caused by the glacier was the diversion of the headwaters of South Branch Bowman Creek and Big Run to Kitchen Creek. In preglacial times, the areas of what are now Lake Leigh and the eastern part of Leak Jean drained eastward down South Branch Bowman Creek (curved arrows on Figure 3, Figure 4A). Ganoga Lake and the area that would become the western part of Lake Jean drained westward down Big Run. The preglacial drainage divide between these areas and Kitchen Creek ran in an arc around the head of what is today the Glens (dashed line on Figure 3; Figure 4B).

Glaciation altered the drainage pattern so that the stream in Glen Leigh captured the former headwaters of South Branch Bowman Creek and the stream in Ganoga Glen captured the headwaters of Big Run. Glacial meltwater assisted the Glen Leigh branch of Kitchen Creek in capturing the "Lake Leigh" drainage. In each glaciation, the ice retreated northeastwardly and temporarily impounded a lake in the eastwardly draining South Branch Bowman Creek valley. The drainage from that proglacial lake cut a channel or sluiceway, across the divide into the Glen Leigh valley (double line arrow, center of Figure 3). It probably took all four glaciations to finally cut the sluiceway deep enough through the preglacial divide so that the Lake Leigh area could continue to drain down through Glen Leigh after glaciation. Today, the divide between South Branch Bowman Creek and the stream in Glen Leigh is a broad valley occupied by a swamp, the abandoned sluiceway for the former glacial lake in South Branch Bowman Creek valley (under the double line arrow, Figure 3).

Glacial deposition was instrumental in the capture of the Ganoga Lake-western Lake Jean drainage by the Ganoga Glen branch of Kitchen Creek. The last glacier deposited 20 to 30 ft of till in the area of what is today the intersection of PA 487 with Ganoga Lake and Big Run Roads (B on the center left of Figure 3). The buried valley floor elevation and the till thickness was confirmed by seismic refraction profiling (Carey, 1991; Carey and Braun, 1992). This material blocked the Big Run valley and forced the drainage to follow its present path through Ganoga Glen (Figures 3 and 4B). Today, seepage from Lake Jean flows through the glacial till blockage and appears at the head of Big Run (just west of PA 487) as a spring, which has a steady discharge of 25 gallons per minute (Carey, 1991) even in the driest of summers.

These drainage diversions added about 7 mi^2 to the Kitchen Creek drainage basin. The increased water flow from this added drainage area is what has been cutting the falls in the Glens since the last glacier retreated. The gradient of the Glens is too steep for the present amount of water flow. As shown in the profile diagram (Figure 5), the gradient of a stream with a drainage equal to that of Kitchen Creek, such as Sullivan Branch of Fishing Creek (C on the upper left corner of Figure 3), is less steep than the gradient of the Glens. The falls are rapidly (in geologic terms) eroding upstream and will continue to do so until the gradient is reduced to the appropriate angle for the size of the present drainage basin of the Glens. Before the falls retreat all the way headward another glaciation will occur and the drainage pattern may be changed yet again.

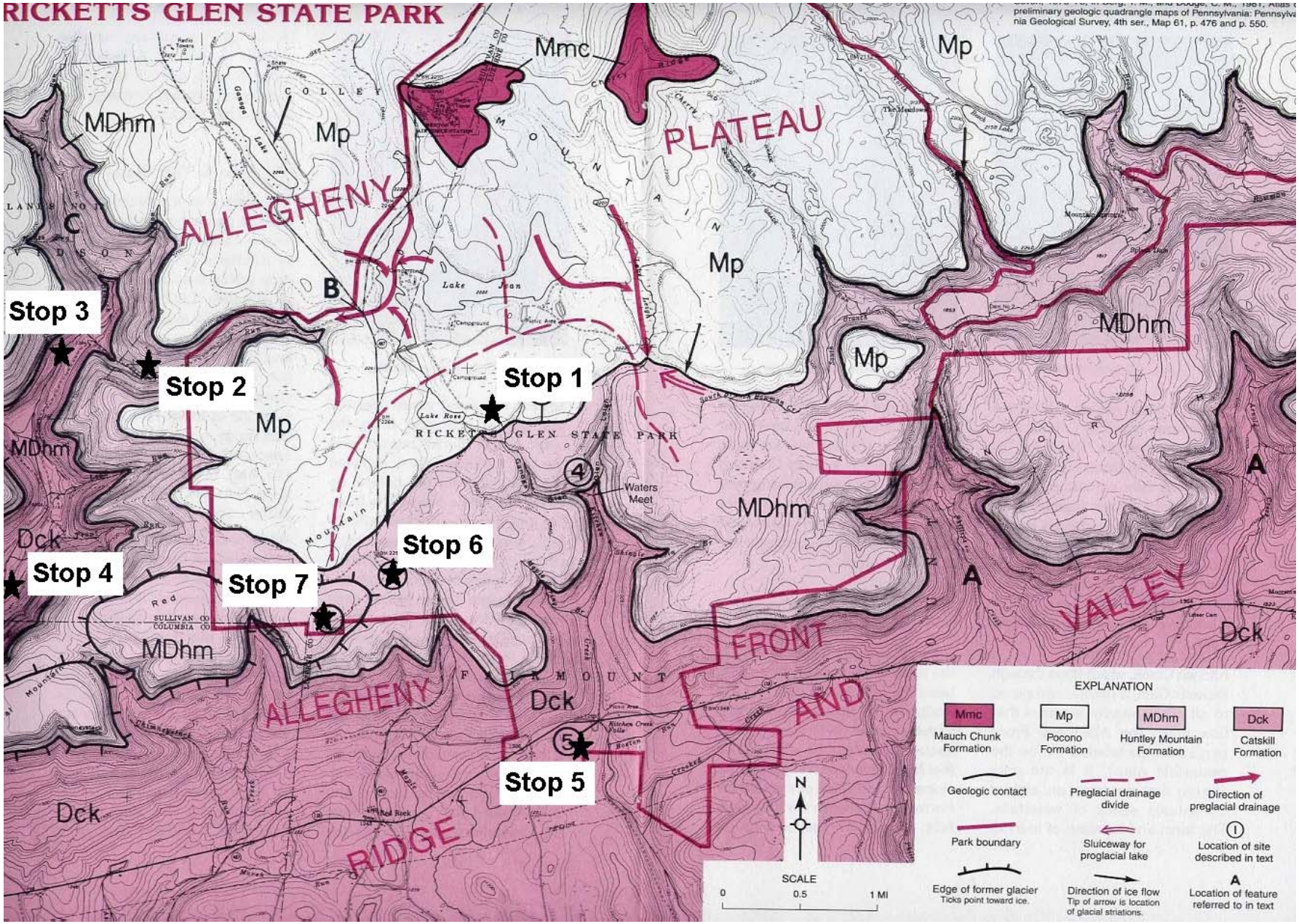

Figure 3. Map showing field trip stops 1 - 7, topography, drainage (both preglacial and present), and bedrock geology (adapted from Braun and Inners, 1998).

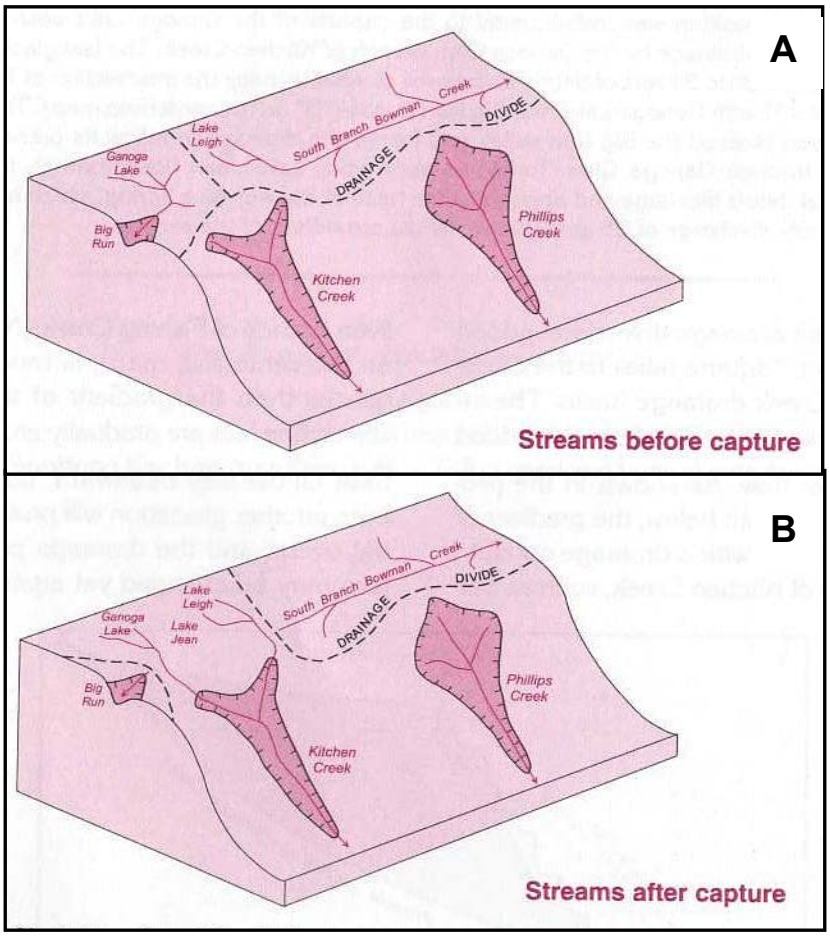

Figure 4A. Block diagram illustrating the preglacial drainage pattern in the Ricketts Glen area (Braun and Inners, 1998).

Figure 4B. Block diagram illustrating the postglacial drainage pattern in the Ricketts Glen area. (Braun and Inners, 1998)

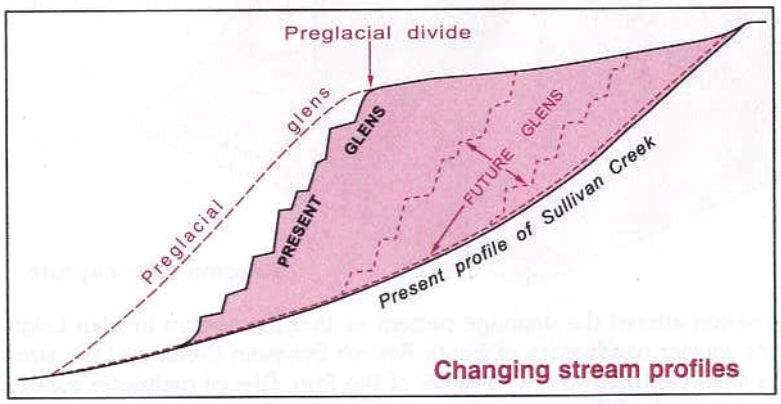

Figure 5. Comparative longitudinal profiles of Sullivan Creek and the Glens streams. Sullivan Creek has been carving its valley out of the Allegheny Plateau since preglacial times and has a "mature" relatively smooth concave upward profile. The Glens streams have major knickpoints that are eroding rapidly headward to they can eventually reduce their gradients close to that of Sullivan Creek (Braun and Inners, 1998).

KITCHEN CREEK FALLS - AN EXAMPLE OF A "TILL SHADOW" BURIED VALLEY WITH A "ONE-SIDED" BEDROCK GORGE.

When the late Wisconsinan glacier was retreating to the east across this site, the ice flow was southwest obliquely across the face of the Allegheny Front. South flowing Kitchen Creek was transverse to this ice flow and was almost entirely buried by a "till shadow" projecting eastward from the face of the mountain. Downstream of PA 118 at the top of Kitchen Creek Falls, the creek turns 90^0

to the east and cascades down the side of the buried preglacial valley's west side. Immediately downstream of the falls, the bedrock ledges rise up on the west side of the valley and are almost non-existent on the east side of the valley, a "one-sided" bedrock gorge. Farther downstream, the buried valley of Kitchen Creek is bracketed by bedrock on its west side and bedrock in a tributary on its east side (Figure 6). Upstream of PA 118, sandstone ledges continue exclusively along the west side of the valley with till and overlying ice-contact stratified drift often exposed on the east (buried) side of the valley.

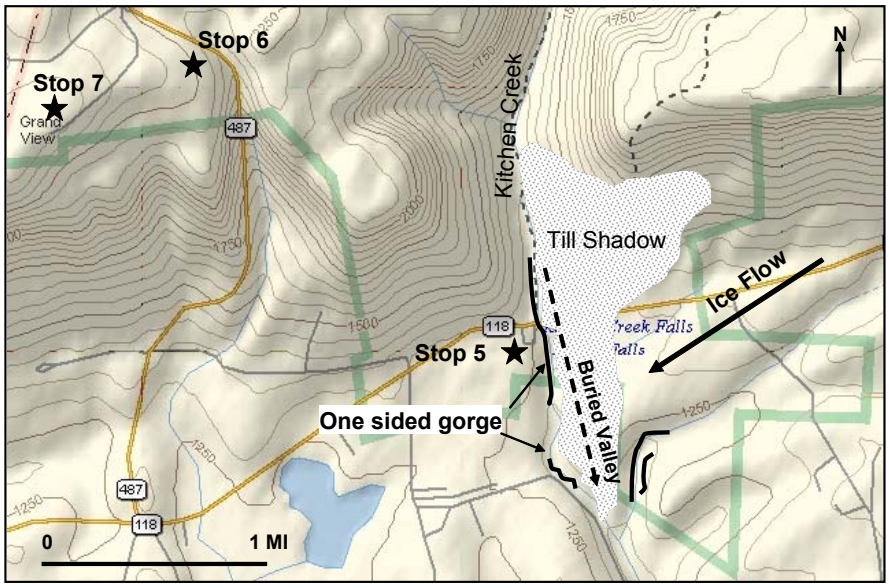

Figure 6. Map showing the area around Kitchen Creek Falls and the location of the "till shadow" buried valley beside the falls.

EAGLES MERE LAKE, AN EXAMPLE OF A TILL KNOB DAMMED LAKE

Eagles Mere Lake (an entirely private, members-only lake) is essentially on top of the Appalachian (Allegheny) Plateau with a water surface elevation of 1994 ft. The hilltops around it rise to 2100 ft. The cool summers at this altitude are what attracted wealthy Philadelphia residents to the area in the late 19th century. Many large summer "cottages" remain from that era and new such "cottages" are being built today. Residents have long wondered why their lake is on top of the Plateau and why its outlet is at the top of a waterfall. (At the outlet today, a weir at PA 42 now controls lake level and the fill for PA 42 now buries the head of the falls).

Since the late 19th century, once it was understood that the region had been glaciated, it has often assumed that either the glacier scoured out the Eagles Mere Lake basin or it was dammed by a moraine at its south end. Ashley (1943) suggested that the lake was dammed by a "mass of morainic material" on its north end and that the lake was once the head of north draining Rusty Run (yellow dashed arrow on Figure 7).

Recent surficial geology mapping (Braun, 2005b) shows that the lake is surrounded on three sides (south, east, and north) by sandstone ledge-rimmed knobs while the knob on the west side is covered by glacial till (Figure 7). The lake basin is asymmetric with the deepest part of the lake, at 43 ft, close to the western shore beside the till covered knob. There is a red mudstone unit that outcrops in a pit in the knob northwest of the lake (the same red-rock as at STOP 6) so the knob west of the lake could still be that mudstone, just covered with a thin veneer of till. So well data was gathered and seismic profiling was done to determine the material inside the knob on the west side of the lake (Becker, 2005). As shown on Figure 7, well casing length strongly suggested that there was more than 100 ft of unconsolidated material under the knob. Seismic profiling on the west side of the knob confirmed that there is more than 100 ft of glacial deposits under the knob (Becker, 2005) (Figure 7). The elevation of

the buried bedrock valley floor there is about 20 to 30 ft lower than the deepest part of Eagles Mere Lake. So the lake is dammed by a till mass on its west side and the drainage was diverted to the south, over a regional divide, into the Muncy Creek basin. In preglacial times the Eagles Mere Lake area was the head of Kettle Creek. That creek drains westward to join the southwest draining Loyalsock Creek. The glaciation induced drainage change turning stream flow to the south is a common occurrence throughout northeastern Pennsylvania. The largest such southerly diversion is the Pine Creek gorge, the Grand Canyon of Pennsylvania.

LOYALSOCK VALLEY NEAR WORLDS END, AN EXAMPLE OF A VALLEY WHERE THE "TILL SHADOW" HAS BEEN MOSTLY REMOVED

The 1000-ft deep Loyalsock valley in the vicinity of Worlds End State Park trends slightly north of west, almost perfectly perpendicular to regional ice flow (Figure 8). So, one would expect that a thick "till shadow" would have been deposited in the valley. Mapping of the surficial deposits (Braun, 2005b) has shown that to be true but the valley is so narrow and the creek so large, that most of the "till shadow" has been removed by the creek in postglacial times.

That a thick mass of till once buried much of the deep valley is shown by a buried incised meander a couple of miles upstream of Worlds End State Park (southeast corner of Figure 8). There more than 250 ft of till buries a pre-glacial incised meander that used to loop around to the north (blue arrow loop on Figure 8). The present stream has a smaller incised meander loop there that exposes more than 100 ft of till with slump headwall scarps another 100 ft above that. On the downstream side of the present incised loop is a short bedrock gorge through the preglacial incised meander spur. The till rises almost 500 ft up the north side of the valley at this site, with another 50 ft or so of till below present stream level.

At Worlds End State Park there are other meanders incised into the bedrock. There the stream has pretty much re-established its preglacial course, leaving only a relatively thin remnant of the "till shadow" on the north side of the valley (Figure 8, north of STOP 10A). Immediately up and down stream of the park the creek has also almost completely removed the till fill. This would be expected in such a narrow, deep valley. The valley's form can be vividly seen from Canyon Vista (STOP 10A).

To either side of the Loyalsock valley the broad, almost flat hilltops of the Appalachian (Allegheny) Plateau surface are almost bare of glacial deposits (Figure 8). Only in the hollows (first-order valleys) carved into the Plateau top are till deposits present. Those deposits tend to have boulder-mantled surfaces from the abundance of sandstone boulders available for the glacier to pluck out of the plateau surface. These boulder surfaces actually cover till that is usually much less bouldery. The boulder-rich surface of these tills is caused by a combination of periglacial frost heaving of boulders to the surface and immediately post-glacial (paraglacial) surface washing/ winnowing of matrix material from the till surface.

In this region the soil mapping has been only of occasional use in determining what areas are underlain by till. When the surface is covered by boulders the soil mapper often assumes that bedrock is close to the surface and maps the area with a shallow to bedrock soil. In these bouldery areas one needs to carefully examine the surface mantle to differentiate between a bedrock area and a till area. In a frost-shattered bedrock area the clasts are dominantly angular and essentially a single lithology (normal bedrock "float"). In an area of bouldery till, the clasts have a mixture of shapes from angular to well rounded and a mixture of lithologies (though often of only slightly different sandstones). As I like to say, a lot of what I do is simple but subtle in mapping these deposits. You also have to walk the surface, even airborne LIDAR (Light Detection and Ranging) will not differentiate the clast shape and lithology between a bedrock area and a thick till area.

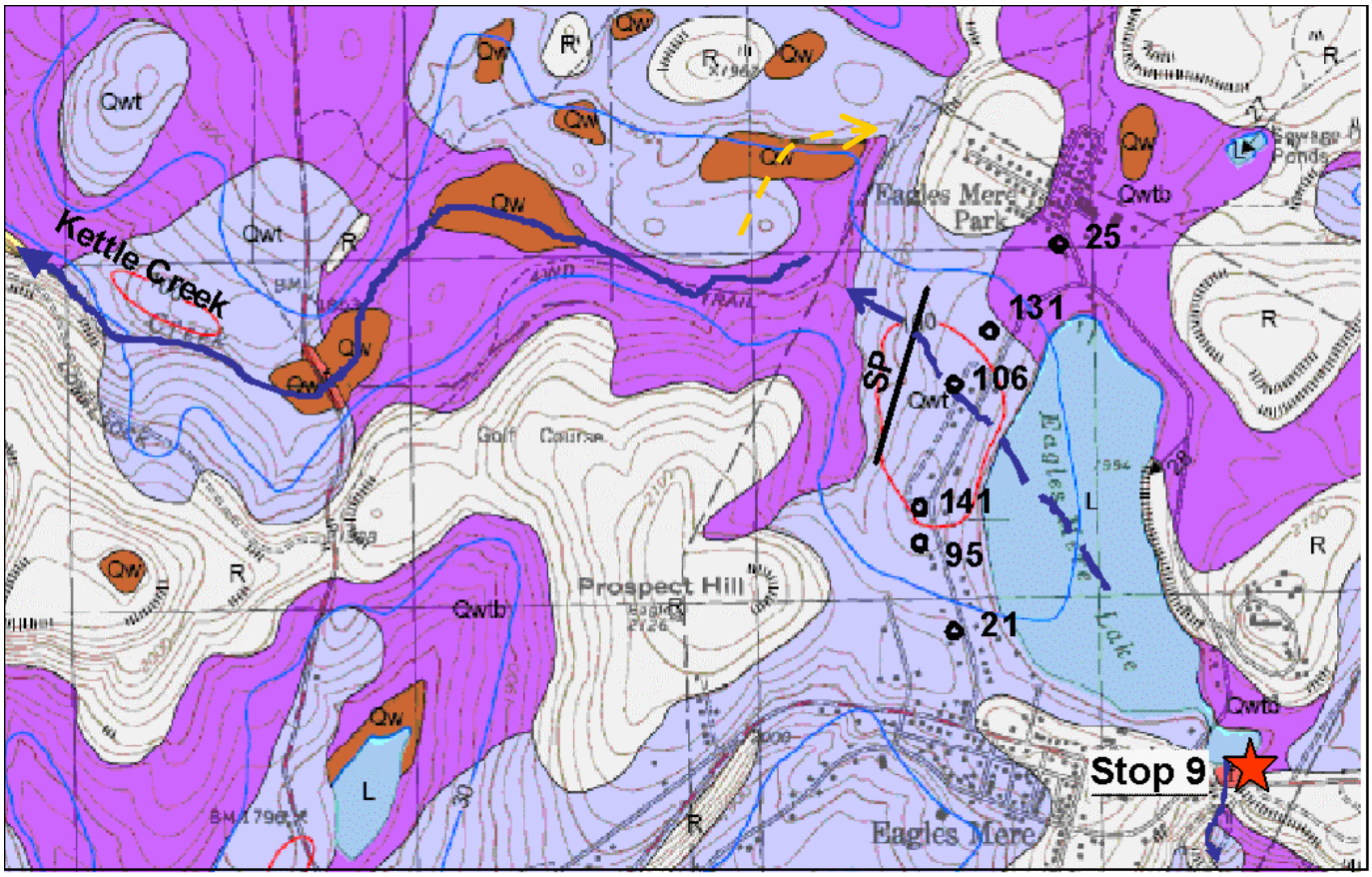

Figure 7. Surficial deposit map around Eagles Mere Lake (Braun, 2005b).

Qw - - Wetland
Qwt - - Stony till
Qwtb - Boulder till

R -- - Bedrock < 6 ft. from surface
Ledges – Lines of tick marks

Thickness contours: Blue = 30 ft.
Red = 100 ft.
Numbers – Well casing length, ft.
SP line – Seismic refraction profile
Blue dashed line – buried course of
Kettle Creek.
Yellow dashed arrow –Ashley's proposed buried outlet.

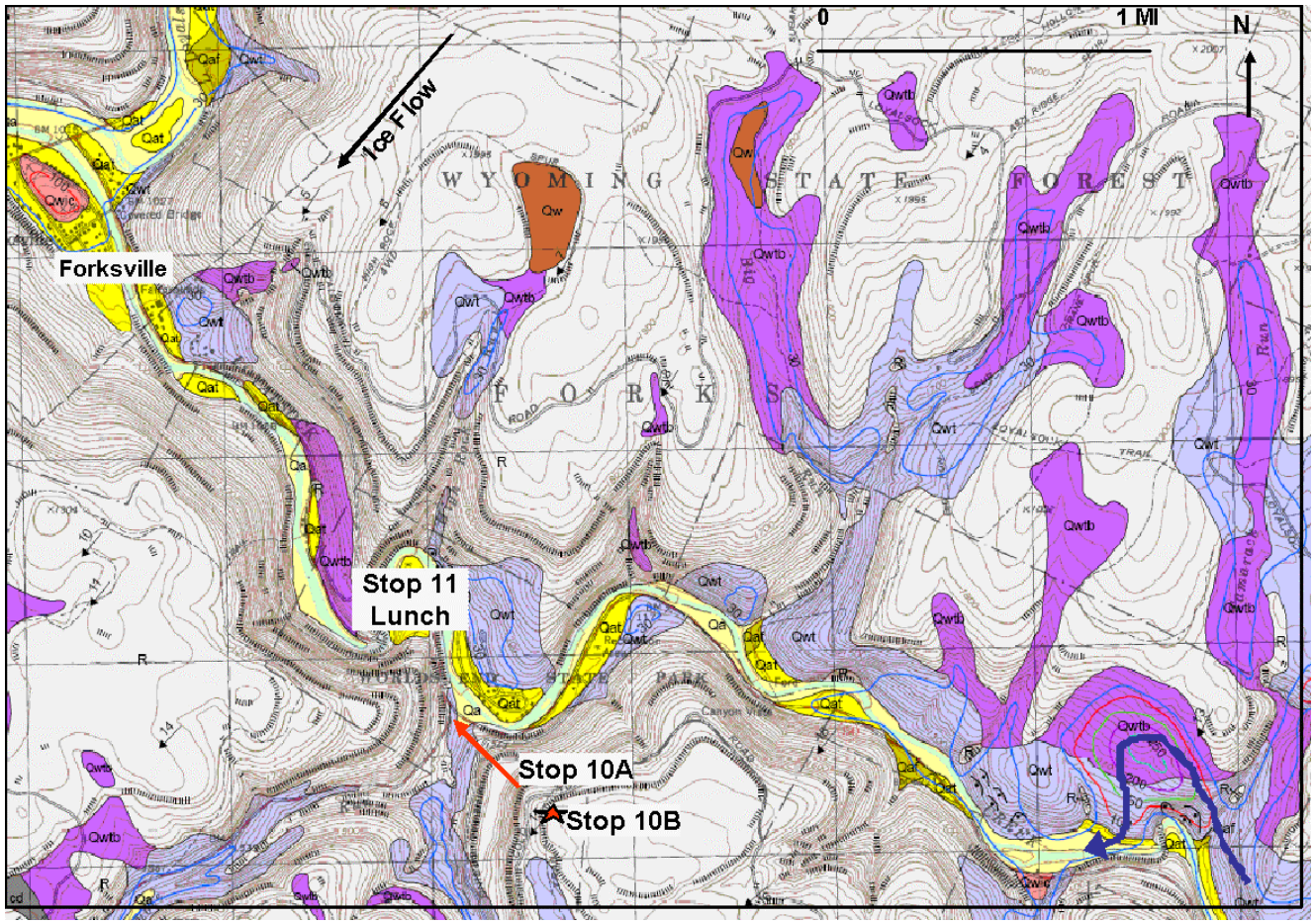

Figure 8. Surficial deposit map of the Loyalsock valley in the Worlds End area (Braun, 2005b). Qa = Alluvium; Qat = Alluvial terrace; Qw – Wetland; Qwt - Stony till; Qwtb - Boulder till; R - Bedrock < 6 ft. from surface; Ledges – Lines of tick marks; Thickness contours, in ft.: Blue = 30; Red = 100; Green = 150; Purple = 200; Light blue = 250; Small numbered arrows = striation site with site number; Arc with dot = slump headwall.

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SOME COMMENTS ON THE BEDROCK STRATIGRAPHY OF NORTH MOUNTAIN AND THE LOYALSOCK UPLANDS, NORTH-CENTRAL/NORTHEASTERN PENNSYLVANIA

by
Jon D. Inners

Bedrock formations exposed on North Mountain and the Loyalsock uplands of the Glaciated Allegheny Plateau range from the Upper Devonian Lock Haven Formation—which crops out in the southwest-plunging Wilmot anticline north of Forksville, Sullivan County—to the Middle Pennsylvanian Pottsville Conglomerate—which caps hilltops in the field trip area to the south of the Loyalsock along the axial trace of the Bernice syncline (see Faill, unpublished manuscript). Much more widely exposed are intervening rock units, particularly the Catskill and Huntley Mountain Formations and the Burgoon Sandstone/Pocono Formations.

Lock Haven Formation. The Lock Haven Formation is the oldest and only fossiliferous, marine rock unit that we will see on the Conference field trip. At the Leberfinger quarry near the southwest-plunging nose of the Wilmot anticline north of Forksville (STOP 12), the uppermost part of the Lock Haven consists predominantly of interbedded olive-gray silty clay shale and fine-grained sandstone containing a profusion of *Cruziana* trails and numerous bedding planes on which an abundance of brachiopod valves, crinoid columnals, and orthoconic cephalopod shells are scattered. Many of the beds are rippled. For a much more complete description, see STOP 12 in this Guidebook.

Probably only a few hundred feet (at most) of the formation are exposed in the field trip area. Total thickness of the formation in the subsurface may exceed 2000 feet.

The fossiliferous rocks of the Lock Haven Formation represent the marine correlatives of the subaerial Catskill Delta along the north edge of the strongly down-warped Appalachian basin. To the south, the Lock Haven grades almost imperceptibly into the proximal turbidites and fossiliferous, shallow-marine sands of the Trimmers Rock Formation (see Inners, 1978, 1981). A good example of the occurrence Lock Haven-type sediments in the northernmost belt mapped as Trimmers Rock (Berg et al., 1980) is the roadcut on the east side of PA 487 at Benton, Columbia County.

The Lock Haven Formation in the field trip area is early/middle Late Devonian (Chemungian) age (Berg et al., 1993).

Catskill Formation. Occupying the lower mountain slopes and valley bottoms of the Glaciated Allegheny High Plateau is the Catskill Formation, the thickest and most widely exposed stratigraphic unit in the field trip area. Though it is likely that the three members of the formation mapped in the Williamsport area and in the North Branch Susquehanna River valley—the Irish Valley, the Sherman Creek, and the Duncannon (from oldest to youngest)—can be recognized on the High Plateau (e.g., Faill et al., 1977, and Inners, 1981), only the Duncannon Member on North Mountain will be discussed in any detail here. This upper member of the Catskill Formation is particularly well exposed in the Glens of Ricketts Glens State Park (Pre-Conference Field Trip 1) and along the route and at several STOPS on the Day-1 field trip around North Mountain. The Duncannon is made up of interbedded gray and red sandstones and red siltstones and red silty claystones arranged in repetitive, asymmetrical, fining-upward cycles generally 25 to 50 ft thick. The gray and red sandstone unit commonly constitutes about half of the cycle thickness. The cycles typically have sharp erosional bases, but lithologic boundaries within cycles are gradational. The gray sandstones are strongly crossbedded in the lower part, exhibiting both wedge- and trough-shaped sets up to about 3 ft thick, and planar bedded in the upper part (Sevon, 1985). Lenticular beds of intraformational conglomerates ("calcareous breccias," or "agglomerates") commonly occur at or just above the erosional base of the thick gray sandstone beds.

The overlying fine-clastic deposits are typically mudcracked and rootworked and may contain dipnoan lungfish aestivation burrows (see STOP 5).

The Duncannon Member is 500 to 600 ft thick along the Allegheny Front on Red Rock and Central Mountains and on the mountainsides bordering the deeply incised valley of Fishing Creek at Central and Jamison City. Its thickness along the Loyalsock at Forksville is probably similar. Sherman Creek and Irish Valley rocks are exposed along PA 87 and Millview Mountain Road north of Forksville (Day-2 road log, miles 38.6 to 40.0), but were not subject to measurement or detailed examination. Total thickness of the Catskill Formation in the field trip area is probably about 5000 feet.

The three members of the Catskill Formation were deposited on the westward and northwestward aggrading Catskill Delta, the sediments probably mainly derived from rivers associated with the Monroe sediment-dispersal system of Sevon (1985). The Irish Valley represents deposition in the coastal marine/non-marine transition zone, and the Sherman Creek deposition by meandering rivers on the distal delta plain. The well developed fining-upward cycles of the Duncannon Member were deposited by meandering rivers on the proximal alluvial plain of the Catskill Delta (Sevon, 1985). The basal gray sandstones are channel and point-bar deposits; the medial fine sandstones and siltstones represent levee deposits; and the rootworked claystones at the top are overbank, flood-basin deposits (Inners, 1981).

The Catskill Formation in the field trip area is middle to late Late Devonian (Chemungian, Cassadagan, and Conewangoan) in age (Berg et al., 1993).

The Catskill Formation is the only formation in the field trip area that has been the target of historic economic interest. At the turn of the 20th century, copper mineralization was discovered in the lower Duncannon (or possibly upper Sherman Creek) Member in the vicinity of Central, Columbia County (see Day-1 road log). A short "boom" followed in which at least ten prospects were explored, but by 1909 the company founded to exploit the "ore" had folded (McCauley, 1961; Newton and Sperry, 2002). In the 1950's and early '60's, interest in the old prospects again revived—not for copper, but for the associated uranium (McCauley, 1961). Excellent descriptions of the geology and mineralogy of several of these sites can be found in Sevon et al., 1978. A definitive compendium of information on the history, geology, and mineralogy of similar Late Devonian "redbed copper-uranium" localities in the Picture Rocks and Sonestown quadrangles to the west can be found in Smith and Hoff (1985).

Huntley Mountain Formation. Conformably overlying the Catskill Formation and "transitional" with both the underlying Duncannon Member and the overlying Pocono Formation/Burgoon Sandstone is the Huntley Mountain Formation (Berg and Edmunds, 1979). In the field trip area, the Huntley Mountain consists predominantly of medium-to-thick-bedded, greenish-gray to light-olive gray, fine-grained sandstone. Trough crossbedding is common, but somewhat more typical is flaggy, planar bedding exhibiting parting-step lineation. Red beds—consisting of siltstone, silt shale, claystone, and clay shale—compose a variable percentage of the formation, less in the North Mountain area than in the Loyalsock uplands to the northwest (Braun, pers. comm., 2006). The thickest and most persistent of these is at or near the top of the formation and is probably equivalent to the "Patton" shale of western Pennsylvania (Berg and Edmunds, 1979: see STOP 7). Lungfish aestivation burrows are of fairly common occurrence in the "red beds" of the Huntley Mountain (see STOPS 6 and 13; Royer, [1980]; mile 37.3, Day-2 road log). The most interesting minor lithology of the Huntley Mountain Formation in the field trip area is the Haystacks sandstone bed (Gillmeister and Springer, 1993). For extensive discussions of this unit, see Pre-Conference Field Trip 2 (Appendix) and STOP 9B.

Measured thicknesses of the Huntley Mountain in north-central Pennsylvania are generally between 500 and 600 feet. Geomorphic expression of the formation on the steep mountainsides of the Allegheny Plateau is typically an "intricate staircase or wedding cake" below the sharp Burgoon/Pocono escarpment (Berg and Edmunds, 1979).

The Huntley Mountain sandstones and red beds represent mainly meandering river deposits on a proximal alluvial plain that succeeded the "classically-defined" Catskill Delta (Berg and Edmunds, 1979; Berg, 1999; Sevon, 1985). The lithologies of the formation are typically arranged in fining-upward cycles, with thick sandstones and thin fine clastic sequences. Such cycles suggest that river systems of the Huntley Mountain carried a greater sand content that the Catskill rivers and that channel stability was less in the Huntley Mountain river systems, giving the overbank deposits less time to stabilize (Berg and Edmunds, 1979; Berg, 1999). While Berg (1999, p. 131) indicates derivation of the Huntley Mountain mainly from northern cratonic and northeastern orogenic sources, Sevon (1985, p. 88) postulates that the quartz-rich sediments that compose the bulk of the Huntley Mountain and its correlatives were eroded from "the proximal part of the former alluvial plain."

The Huntley Mountain Formation spans the Devonian-Mississippian boundary (Conewangoan to Kinderhookian; Berg et al., 1993), though the exact stratigraphic location of the break is unclear. Berg and Edmunds (1979, p. 79) report the Mississippian plant fossil *?Adiantites* from just below the Patton red shale in the type-section area of Lycoming County (p. 79), and the Devonian plant *?Archeopteris* from the same area about 290± feet below the Burgoon (p. 49-51, 68-69). This strongly suggests that the Haystacks sandstone (which occurs above "The Red Rock" on North Mountain) is, therefore, Early Mississippian in age (see Pre-Conference Field Trip 1 and STOP 1).

Up until the time of the preparation of the most recent geologic map of Pennsylvania (Berg et al., 1980), the Huntley Mountain (along with the correlative Spechty Kopf and Rockwell Formations), were mapped and stratigraphically described as the "lower Pocono" (see Berg and Edmunds, 1985; Berg, 1999). Locally, for example, in the section exposed along the old Berwick-Elmira Turnpike on Red Rock Mountain, Sherwood and Platt (1880) included the thick, well exposed sequence of gray sandstones and red shales extending from the top of the mountain to near the bottom (see Day 1, miles 18.5-19.1) in Formation No. X, the Pocono (p. 203).

Pocono Formation/Burgoon Sandstone. The medium- to thick-bedded, trough-crossbedded, light-gray, medium- to coarse-grained sandstones occurring conformably above the Huntley Mountain are mapped as Pocono Formation on Red Rock and Central Mountains (Day-1 field trip) and areas to the east and as Burgoon Sandstone to the west and northwest (Day-2 field trip). Though the mapped boundary is more or less an arbitrary cut-off, the Pocono does tend to contain appreciably more granule and small-pebble conglomerate than the Burgoon, particularly in the lower part (see Pre-Conference Field Trip 1; Sherwood and Platt, 1880, p. 203).

The Pocono-Burgoon is typically 150 to 250 feet thick in the field trip area. On North Mountain in Ricketts Glen State Park and vicinity, the lower conglomeratic beds of the Pocono Formation commonly form a distinct escarpment (25± ft high) that can be readily traced on air photos—and even on the topographic map (Sevon, 1981). On the plateau farther to the west and northwest, the Burgoon also forms an escarpment (above the characteristically tiered topography of the Huntley Mountain) that is readily traced on air photos (Berg and Edmunds, 1979, Fig. 23).

The quartz sandstones of the Pocono/Burgoon are typical braided-river deposits, formed on a vast sand plain that spread out at the foot of the Acadian Mountains—by this time somewhat reduced in elevation following the intense period of erosion that resulted in formation of the Catskill Delta (see Sevon, 1985). Planed-off crossbed troughs on Pocono ledges along the Highland Trail in Rickets Glen Park show the dominant direction of river flow to be toward the northwest (N45^{o}-65^{o}W) (see Pre-Conference Field Trip 1).

The Pocono Formation/Burgoon Sandstone is late Early Mississippian (Osagean) in age (Berg et al., 1993).

Mauch Chunk Formation. On North Mountain in Ricketts Glen State Park, the Mauch Chunk Formation occurs as several isolated hills in the northern part of the Park (Cherry Ridge, the Job Corps hill east to PA 487, and probably also the 2380+ ft-high hill east of Ganoga Lake (Red Rock

quadrangle). A maximum of about 100 feet of interbedded red and gray sandstone and shale in the lower part of the formation are present here. In Worlds End State Park in the Loyalsock uplands to the northwest, the Mauch Chunk is mapped as about 200 feet thick (Berg, 1981). It consists of a lower red shale and sandstone unit, a middle strongly crossbedded unit (Loyalhanna equivalent), and an upper massive sandstone unit (see Day-2 field trip). The lower unit forms a bench that stands out on air photos to provide an excellent mapping horizon is easily recognized (Braun, pers. comm., 2006).

The lower red shale and sandstone and upper predominantly sandstone units were deposited by meandering rivers on a low-lying alluvial plain, while the middle crossbedded sandstones mark the northeast end of the shallow marine embayment in which the Loyalhanna was deposited (Brezinski, 1999, p. 147 and Fig. 9-12).

The Mauch Chunk on the Glaciated High Plateau of the field-trip area is Late Mississippian (Meramecian and Chesterian) in age (Berg et al., 1993).

Pottsville Conglomerate. The youngest—and most photogenic—rock formation to be seen on the Conference field trip is the Pottsville Conglomerate. It occurs only in the Loyalsock uplands, mainly in Worlds End State Park and the vicinity of Forksville. About 150± feet of thick bedded to massive, crossbedded, white, pebbly quartz conglomerate cap the mountains on the south side of the canyon there (Berg, 1981). In this area the formations forms several spectacular "rock cities," the most accessible of which, the "Rock Garden," we will visit at STOP 10B—where much more descriptive information will be forthcoming!

The Pottsville Conglomerate is a braided-river deposit, *par excellence*. The beds exposed in the Loyalsock uplands probably correlate with the uppermost member of the Pottsville in the Anthracite region, the Sharp Mountain Member. The Sharp Mountain conglomerates formed on a vast alluvial plain that spread out from the foot of orogenic mountains to the southeast—but also possibly from bordering cratonic sources to the northeast (modern directions)—in Middle Pennsylvanian (Atokan-Desmoinesian) time (Edmunds et al., 1999, Fig. 10-18).

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HAYSTACKS WITHOUT HAY

by
Donald L. Woodrow

After nearly two centuries of study, we do not expect to find Late Devonian fossils or strata that truly surprise us. But, every once in a while, the post-Tully, pre-Burgoon interval discloses rocks and fossils so unusual as to force changes in our thinking. Two examples come to mind.

Wonderfully preserved vertebrate and other fossils have been found by Doug Rowe, Ted Daeschler and Neal Shubin among the red, Late Devonian strata exposed at Red Hill near Renovo, PA. Look for the story of these fossils at www.devoniantimes.org. If you want to see them, Doug Rowe, one of the original finders of the fossil locality, will show them to you at his museum in Renovo.

A second example of provocative finds in Late Devonian strata are the Haystacks and associated rocks (HAR) well exposed along Loyalsock Creek south of Dushore (Figure 9) and seen to lesser degrees in roadside, side-yard, and trail-side exposures in Eagles Mere and at Ricketts Glen State Park (Figure 10). We will visit some of these outcrops on the Conference field trips..

Figure 9. Panoramic view of the Haystacks sandstone, looking northward, at its type locality in Loyalsock Creek, Sullivan County, PA.

What is so unusual about these rocks? First, the Haystacks mounds are, to the best of our knowledge, unique in the entire Paleozoic column of the Appalachians. Inquiries among sedimentologists across the country and in Great Britain have not revealed other examples elsewhere. Second, HAR quartz-rich petrology sets them apart from strata immediately above and below. These two points suggest that we are dealing with strata formed in response to a singular event or events.

Figure 10. A single "Haystack" exposed along the south side of Loyalsock Creek. Individual bars on Jacob's staff are 10 cm each. Bottom of staff rests on the Huntley Mountain Formation sandstones.

Important observations about the Haystacks and associated rocks

1. Field mapping by Braun (pers. comm., unpub. data) of the HAR and its location in Ricketts Glen demonstrate their physical stratigraphic position in the upper part of the Huntley Mountain Formation. Attempts to place the HAR in a time framework based on palynology are ongoing. Duane Braun, Norman Gillmeister and others have located other HAR exposures and much HAR float across Sullivan, Lycoming, and Wyoming Counties (Gillmeister and Hill, this Guidebook).

2. HAR thickness varies from one to three meters with the thickest part extending as a ten-km wide band across Sullivan County in a NW/SE direction (Braun, pers. comm.). At Loyalsock Creek the sequence is about 3 meters thick but it thins to a meter or less over the rest of the mapped region.

Figure 11. An individual "Haystack" exposed at the type locality. Note the sharp, mostly planar lower contact with the underlying Huntley Mountain Formation. "Haystack" is approximately 1.25 m thick.

3. The Haystacks themselves are distinctive, mound-like sedimentary structures as much as 2 meters high (Figures 10, 11, 12). Some mounds are conical; others are bread loaf-like, but most are of lesser height and are variously shaped. Small, crater-like structures have been reported from the crests of some mounds as have small, lobate flow-masses on the sides of mounds. Neither of these observations has been confirmed.

4. Mounds (Haystacks) are not seen at all localities. In fact, no mounds are seen in the HAR outcrop only 2 km to the east of the Loyalsock Creek outcrop, in the falls of the creek draining north into Loyalsock Creek near the US 220 bridge. That exposure, like those at Eagles Mere and Ricketts Glen State Park, is made up of the basal (water-release structures) and upper (plane-bed) parts of the HAR. A fossil sand-volcano has been reported from the sandstones in the falls of the stream tributary to Loyalsock Creek but that observation has not been confirmed.

5. Mounds may be the defining feature of the HAR but it is important to note that the HAR is, in its entirety, made up of quartz-rich sandstones strikingly unlike the lithic arenites of the Huntley Mountain strata above and below. Gillmeister and Hill (this Guidebook) provide a full discussion of the HAR sandstone petrology.

Figure 12. Another view of the Haystacks at the type locality looking upstream. Note the hummocky upper surface of the Haystacks with as much as 2 m of relief.

6. The mounds rest with sharp contact on basal HAR strata which are disrupted by vertical, water-release structures (see Figure 20). Those strata rest with sharp contact on sandstones of the Huntley Mountain or they grade over a few centimeters. A few clasts of the Huntley Mountain sandstones have been seen in this basal sequence.

7. Capping the HAR are planar-bedded quartz-rich sandstones which surround the Mounds, but which do not drape over them.

8. The entire sequence at Loyalsock Creek is approximately 3 meters thick, and it appears to fine up-section.

Interpreting the Haystacks and associated strata

Fluvial processes, soil-forming processes, and the tectonics and rocks of the land to the southeast account for the sedimentary sequences and petrology of the Huntley Mountain and older Late Devonian rocks in Pennsylvania. However, the sudden appearance in the Huntley Mountain Formation of quartz-rich sandstones with unique sedimentary structures are not accounted for by those same sedimentary or tectonic processes.

The unique character of the HAR requires a unique sequence of events to emplace and preserve it. Its petrology requires a source distinctly different from that of the Huntley Mountain, and its sedimentary structures are most readily explained as the result of rapid deposition.

The quartz sand in the HAR must have a different source, perhaps a sandy, southern shore of what is now the Canadian Shield. That sand must have been delivered to this region energetically and rapidly, perhaps in a single event. Strata making up the basal part of the HAR must have arrived as a sandy slurry with water released from them to form the Haystacks. Later arriving quartz sand capped the HAR.

How long did all of this take? Minutes? Hours? Centuries?

We tend toward the shorter times because 1) water-release, sand-venting structures, and plane-beds all require or are most readily explained via rapid deposition, 2) there are no pronounced breaks in the sequence implying that it formed in a single event, 3) the basal and upper contacts are sharp, and 4) grain-size fines up section. All of this is suggestive of rapid deposition as one might expect in a sediment deposited in a single storm or by a tsunami.

What sedimentary process might we call into play to introduce to this alluvial plain a water-charged slurry of quartz sand from the north? Nothing works better to account for what we see than a tsunami sweeping into a Late Devonian alluvial valley from the NW, N or NE.

We want to discuss this and other scenarios on the Pre-Conference trip.

PETROLOGY OF THE "HAYSTACKS" SANDSTONE

by
Norman M. Gillmeister and Joseph Hill

Introduction

The "Haystacks" sandstone is a unique and poorly understood depositional sequence in the Devonian-Mississippian transition of Upper Huntley Mountain Formation as defined by Berg and Edmunds (1979). Formal investigations of the Haystacks have been extremely limited in both scope and number. To the authors' knowledge, a single abstract (Gillmeister and Springer, 1993) constitutes the entire body of literature dealing with the subject. The Haystacks roughly occupy a portion of the same stratigraphic interval as other enigmatic sequences, such as the diamictites of the Spechty Kopf Formation (Woodrow, pers. comm.; Epstein et al., 1974) and the Cedar Run conglomerate of Colton (1963). They are distinct lithologically and petrographically from the under and over-lying cross-bedded, planar to subhorizontal, fluvial sandstones of the upper Huntley Mountain Formation. Moreover, while the bounding sandstone units of the upper Huntley Mountain Formation (HMF) are clearly fluvial in origin, the genesis of the Haystacks remains unclear.

The type locality for the Haystacks sandstone occurs in and along a portion of Loyalsock Creek in the northwestern-half of the Laporte 7.5-minute quadrangle, Sullivan County, PA (Figures 13 and 14). Braun (pers. comm.) has recognized Haystacks-type rocks in the same stratigraphic interval as far west as the Picture Rocks 7.5-minute quadrangle, PA, and as far east as the Noxen 7.5-minute quadrangle, PA. Haystacks-type rocks have also been recognized as far south as Ricketts Glen State Park. The northern extent of the Haystacks has yet to be determined, but they have been recognized several kilometers north of the type locality by Braun and Gillmeister (pers. comm.). Braun (pers. comm.) interprets the Haystacks as a large, ovoid, lens running approximately 30 km NW-SE and 56 km NE-SW. Given an average thickness of one meter, the present volume of Haystacks-type rocks would be at least one cubic kilometer.

Geologic Setting

The Haystacks crop out in the easternmost expression of the Bernice-Mehoopany and Noxen synclines, just north of the Allegheny Structural Front. Structurally, the main outcrop of the Haystacks occurs just south of the axis of the Bernice syncline, which is cored by rocks of Pennsylvanian age, and generally parallels the trace of Loyalsock Creek (Figure 14). The encompassing HMF is characterized by a series of upward-fining fluvial cycles with predominant trough crossbedding, and relatively common plant and freshwater invertebrate fossils (Berg and Edmunds, 1979; Berg, 1981). The HMF likely represents deposition by a meandering-river system on the upper surface of the deltaic complex of the Catskill Formation (Berg and Edmunds, 1979). The upper HMF transitions into the Burgoon Sandstone, which is interpreted to represent deposition in a braided-river system (Berg and Edmunds, 1979).

No provenance studies have been conducted to the authors' knowledge either on the Haystacks or the HMF. Berg (1999) suggested cratonic and northeast sources for the HMF. Woodrow (pers. comm.) also shares this view. This agrees with a provenance study of the overlying Pennsylvanian Pottsville Formation by Meckel (1967), who determined that during Pottsville time, at least, the basin was being filled in asymmetrically by both cratonic and tectonic sources from the north and southeast, respectively. Robinson and Prave (1995) demonstrated that dramatic changes in paleocurrent trends within the Pottsville Formation indicated abrupt changes from dominantly northwest sediment-transport to southwest-directed transport, hence a change in source area during deposition. Paleocurrent indicators in the HMF have not been studied and are totally absent in the Haystacks-type rocks, making any interpretation of source area(s) equivocal.

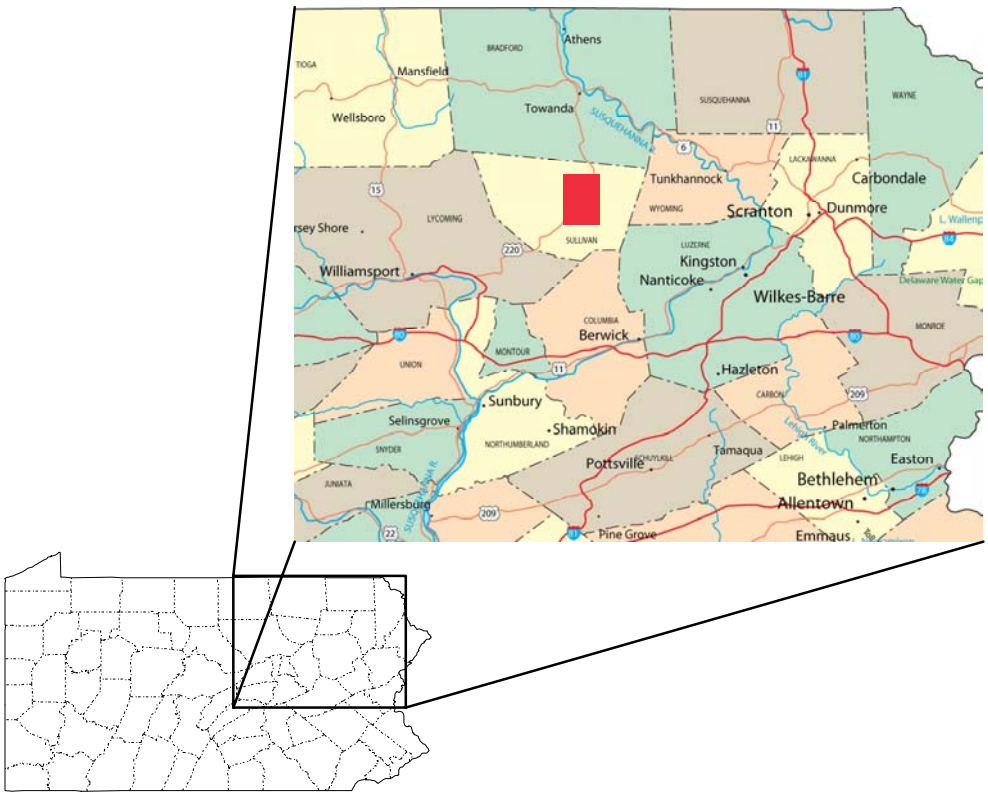


Figure 13. Location map showing approximate area of the Laporte 7.5-minute quadrangle (rectangle), NE Pennsylvania.

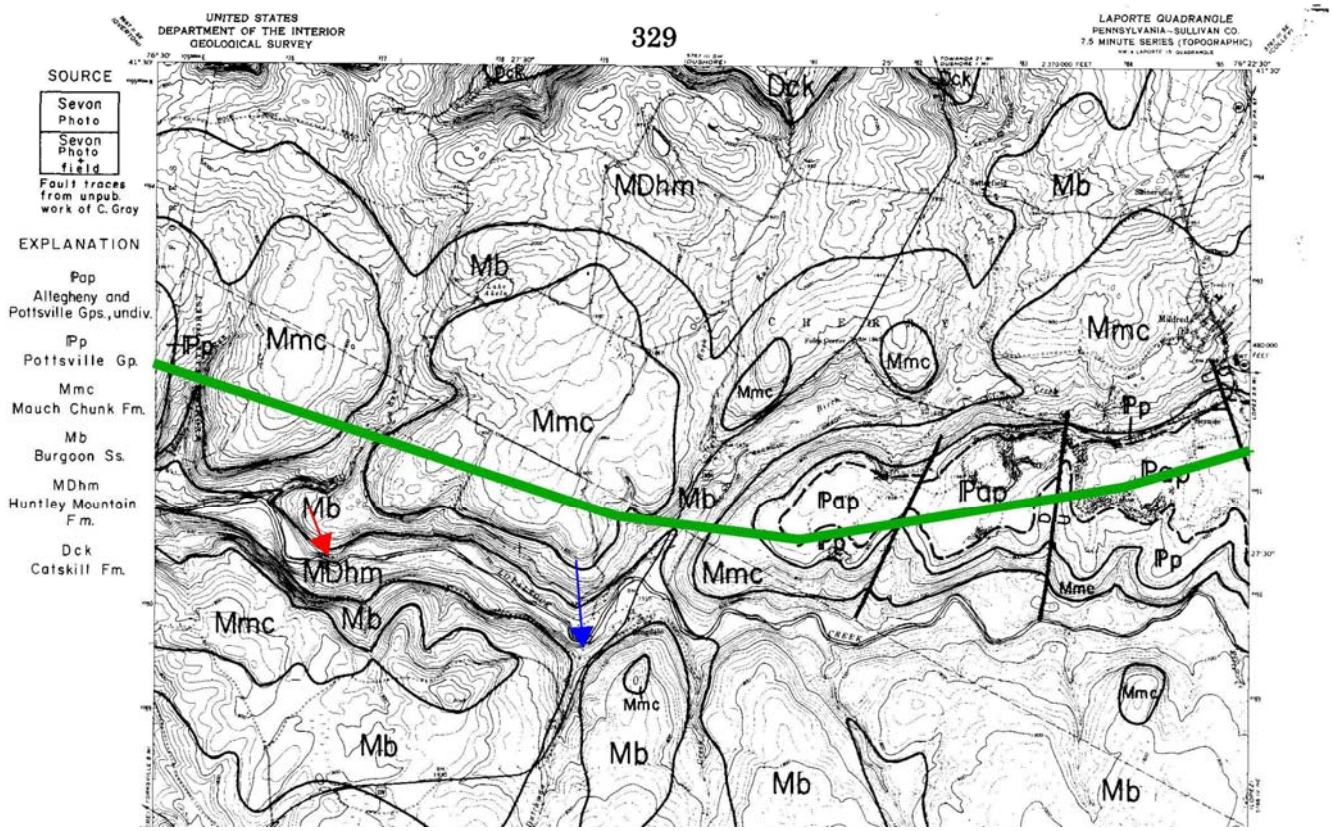


Figure 14. Geology of the northern half of the Laporte 7.5-minute quadrangle modified from Map 61, PA Geologic Survey as compiled by Sevon, 1977-78. Light arrow (near western edge) shows location of the Haystacks-sandstone type locality. Dark arrow shows location of Dutchman Falls. Wide line is approximate trace of the Bernice syncline.

Haystacks Description

The "Haystacks" sandstone is best exposed in Loyalsock Creek. At the type locality, the Haystacks are characterized by a sharp, planar bottom-contact and a hummocky upper surface (Gillmeister and Springer, 1993). Relief on the upper surface of the Haystacks at the type locality is as much as two meters. Elsewhere, Haystacks related rocks may show much lower relief on the upper surface, but generally show a sharp basal contact with the underlying HMF (Figure 15). The upper surface of the Haystacks is typically poorly exposed. It is best exposed along the southern bank of Loyalsock Creek at the type locality, where the Haystacks are separated from the sandstones of the HMF by a 0.5 – 1.50 m thick green, silty-shale cap rock. Due to the lack of exposure, it is not entirely clear that this shale cap is typical or atypical of the upper contact between the HMF and the Haystacks.

The Haystacks superficially appear to be a quartzite, a perception enforced by the highly indurated nature of the unit. They are massively bedded and show no primary relict internal sedimentary structures. The lower portion of the unit has spaced, vertical features that have been interpreted to be pressure solution surfaces (Gillmeister and Springer, 1993). The basal surface of the Haystacks sandstone is characterized by a highly corrugated (2-5 cm in amplitude) texture, which does not appear to be a soft-sediment feature (Figure 16). The upper surfaces of the Haystacks have been weathered smooth by Loyalsock Creek, but also show fine, anastamosing, vein-like structures that are likely dewatering in nature. These structures are composed of more highly indurated material that differentially weathers resulting in higher relief (Figure 17). A variably spaced cleavage, oriented ~N80E, is also developed and distinct on the lower surfaces. This cleavage is interpreted to be a result of pressure solution related to Alleghanian deformation and is roughly orthogonal to the local maximum principal stress direction. Visitors to the type locality will also find that the up-current side of some of the larger Haystacks have shatter cones from failed historic attempts to remove (by blasting) the Haystacks by the lumber industry.

Thicknesses for Haystacks-type rocks vary from as much as 2 meters at the type locality, to as little as 10 cm in the Picture Rocks quadrangle. Haystacks-type rocks away from the type locality commonly display conjugate sets of slickenlines, which generally trend northward and have moderate plunges north or south. No systematic study of these features has been conducted, but it is likely that they are related to layer parallel shortening during the Alleghanian orogeny inasmuch as they are parallel to the local maximum principal stress direction (Figure 18).

Haystacks-type rocks away from the type locality show features not identified at the type locality. The outcrop of Haystacks-type rocks in Ricketts Glen State Park along the Falls Trail reveals yet another enigma: small subvertical sand-dikes (Figure 19). These features have downward(?) tapering apophyses with thin lobate tops, or in some sections ringed tops (Figure 20). These features may be interpreted as clastic dikes, but that interpretation remains equivocal. Another possibility is that these are fractures that were infilled from an overlying bed of fine grain, fluidized(?) sand. This would require the slurry to have been injected downward, which has been reported (c.f. Boggs, 2001, pg. 126). The amplitude of the upper-surface of the Haystacks diminishes away from the type locality, approaching a planar surface.

A.

B.

Figure 15. (A) View of the Haystacks type locality looking upstream. (B) Detail of the lower contact between the Haystacks sandstone and the underlying HMF. Note the sharp contact with underlying crossbedded sandstones of the HMF and lack of primary sedimentary features preserved in the Haystacks. Also, note lower third of Haystacks show a vertical spaced cleavage interpreted to be a post-diagenetic feature.

Figure 16. Bottom of overturned Haystacks boulder showing the corrugated lower surface. The lower contact is sharp and nearly planar but does exhibit this texture, which is likely related to rapid "dewatering" during diagenesis.

Figure 17. View of more indurated anastomosing veins (arrow) that are common in the upper part of the Haystacks sandstone. Hand lens is approximately 2 cm in diameter.

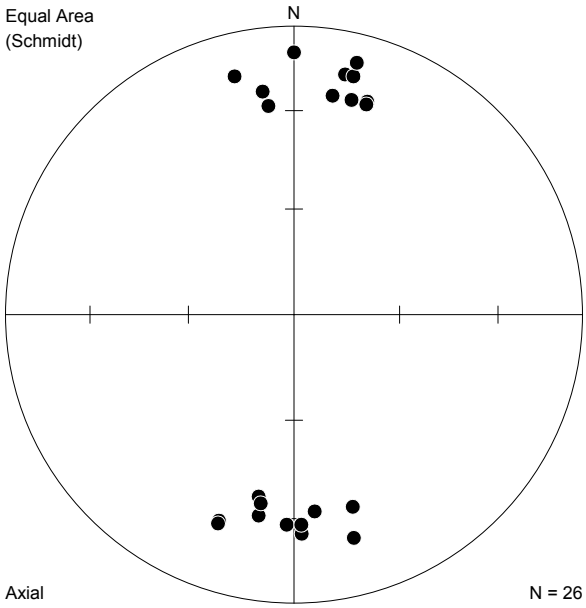


Figure18. Lower hemisphere, equal area projection of slickenlines from the Haystacks sandstone. Pattern is consistent with conjugate fracture surfaces due to north-directed, subhorizontal maximum principal compressive stress.

Petrology

Gillmeister and Springer (1993) described the Haystacks as clean, homogeneous, quartzitic sandstone with sparse "floating" quartz and chert pebbles up to 2.5 cm across (Figure 21). The Haystacks-type rocks are a true sedimentary quartzite and would plot in the quartz arenite field, although Haystacks-type rocks are not typical quartz arenites. Historically, they would have been classified as an "orthoquartzite," a term that has fallen into disfavor, but may be applicable in this case if one disregards the implication of igneous derivation. They are compositionally mature but poorly to moderately sorted, making traditional sandstone classification schemes difficult to apply.

In thin section, Haystacks-type rocks show no preferred grain orientation; instead most grains appear to be randomly oriented. Grains are typically angular to subangular. Most grains (>75%) are monocrystalline quartz, although polycrystalline quartz is not uncommon. Most quartz shows undulatory extinction and subgrain boundaries are evident in at least ten percent of the grains. Grain size is approximately 0.25 mm on average, but may vary from 0.5 mm to less than 0.1 mm. Larger grains, up to 1.1 mm or larger may occur but are not ubiquitous. The grains are quartz cemented with virtually no clay matrix. Extremely small (<0.05 mm) micas constitute up to 1% of the matrix. Tourmaline is present as an accessory mineral, as are unidentified opaque minerals, which together make up less than 0.5% of the rocks. Well rounded zircons are also present. Thin-sections of type-locality Haystacks sandstone are chert poor, whereas Haystacks-type rocks from other localities may have a significant amount of chert.

In contrast to the Haystacks, sandstones of the HMF are trough crossbedded moderately- to well-sorted quartz wackes. The bounding sandstones have abundant clay matrix (~15%) with subangular to subrounded grains up to 1.5 mm in size (Figure 22). Detrital chert fragments are present in the sandstones of the HMF and are more abundant than in the Haystacks. Polycrystalline quartz grains are common in the HMF as are lithics. The sandstones of the HMF also show good preferred grain orientation consistent with their deposition in a fluvial environment.

Figure 19. Subvertical sand-dikes (arrows) in Haystacks-type rocks exposed along the Falls Trail, Ricketts Glen State Park. Pen is 14 cm long.

Figure 20. Horizontal view of the upper surface of Haystacks-type rocks along the Falls Trail, Ricketts Glen State Park showing ring structures formed by clastic diking as shown in Figure 19. Pen is 14 cm long.

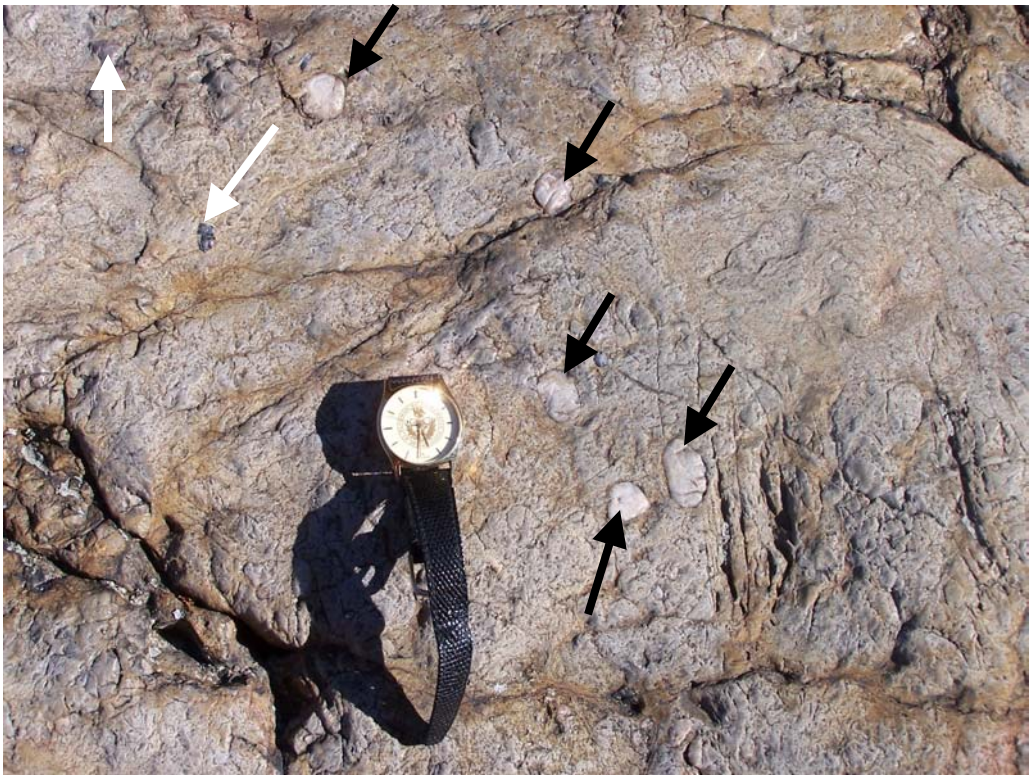


Figure 21. "Floating" quartz (black arrows) and chert (white arrows) pebbles in the upper part of the Haystacks sandstone at its type locality. Watch face is 3 cm in diameter.

Two distinctive features characterize Haystacks-type rocks. First, through-going thin fractures concentrate clays and have been interpreted to be related to pressure-solution-related features (Figure 23). Gillmeister and Springer (1993) suggest that pressure solution processes, along with large-scale fluid flow, eliminated the original clay matrix from Haystacks-type rocks. However, although the fractures do concentrate clays they do not exhibit the typical styolitic pattern associated with pressure solution. Recall that pressure solution works to increase the surface area of grain-to-grain contact and thereby reduce the effective stress. The basic idea of pressure solution is that high effective pressures develop at grain contacts, which then preferentially dissolve. The dissolved quartz would then ideally be reprecipitated as quartz cement. The quartz overgrowths on grains and the overall paucity of these through-going fractures point to any pressure solution processes being secondary. Fluidization, as suggested by Gillmeister and Springer (1993), is more likely to have removed any interstitial clays prior to any pressure solution related process (Figure 24).

The second distinctive feature of Haystacks-type rocks are Boehm lamellae in a large percentage of the quartz grains (Figure 25). Boehm lamellae are deformation lamellae in quartz grains that are typically associated with high strain. They typically occur in high pressure metamorphic rocks and have been suggested as indicators of bolide impacts. At the very least, the presence of Boehm lamellae in the substantial number of the quartz grains in the Haystacks-type rocks indicate a distinct source for the Haystacks as few grains having Boehm lamellae have been recognized in the bounding sandstones of the HMF.

Discussion

Our current understanding of the origin of the Haystacks sandstone and related rocks is limited. Very few investigations of the Haystacks have been undertaken to the authors' knowledge. As such, the Haystacks remain a locus of our investigations. The nature of the unit implies that it had unique history, either in terms of the source of the sediment, diagenetic history, or both.

It is difficult to quantify the similarity or dissimilarity of the HMF and the Haystacks sandstone, as the Haystacks have undergone a distinctive disturbance not recorded in the bounding HMF rocks. How similar would the fluvial sandstones of the HMF be to the Haystacks if one could remove the substantial clay matrix of the HMF? The HMF has a substantial lithic component (composite grains of metamorphic quartz, schists, siltstones, sandstone fragments, and chert), while the Haystacks are lithic poor (chert only). This suggests a different source area source area for the Haystacks.

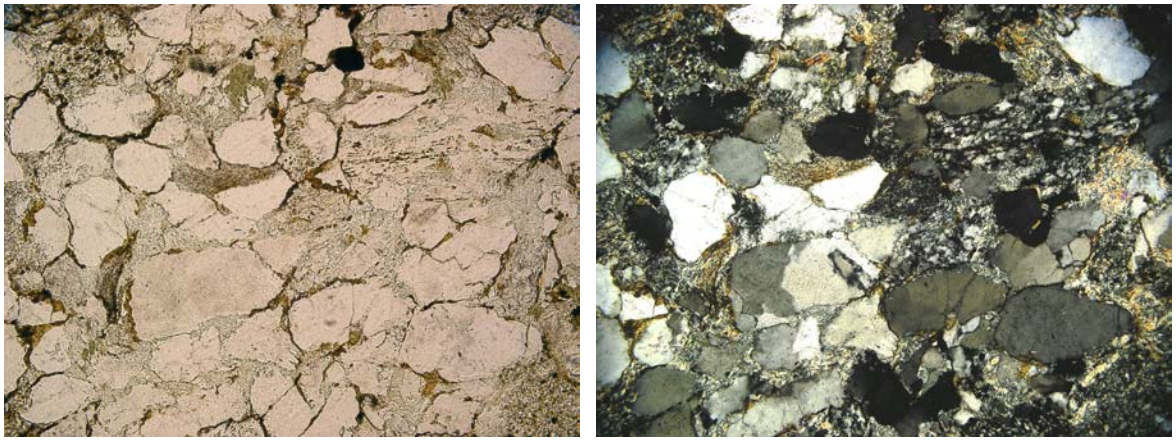


Figure 22. Photomicrograph of typical HMF sandstone in plane light (left) and cross-polarized light (right). Note the abundance of interstitial clay matrix and the overall lithic nature of the HMF. Field of view is approximately 4 mm.

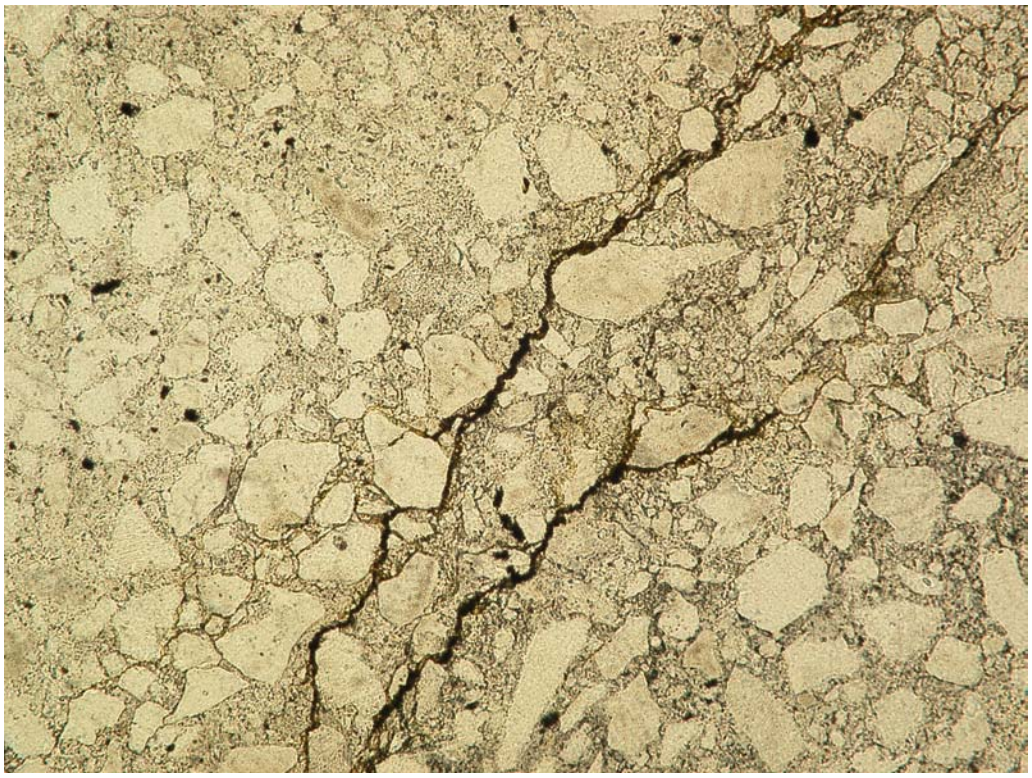


Figure 23. Photomicrograph (plane polarized light) of pressure solution features in the Haystacks sandstone. Note the angularity of the grains and the insoluble residue along the trace of the pressure solution. Field of view is approximately 6 mm.

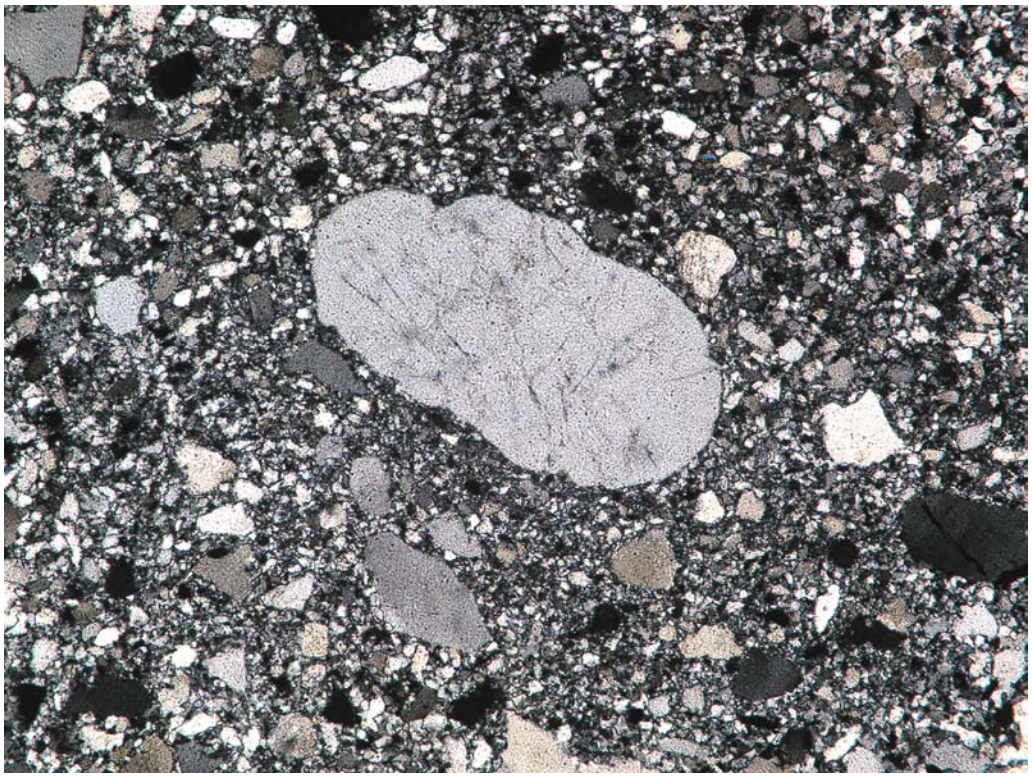


Figure 24. Photomicrograph of clean-quartz Haystacks sandstone (cross-polarized light). Note the angularity of most grains, the large rounded "floating" quartz grain in the center of the photomicrograph, and the abundant microcrystalline quartz matrix typical of Haystacks sandstone. Field of view is approximately 6 mm.

Inasmuch as, the Haystacks sandstone is composed only of stable minerals (quartz, chert, tourmaline, iron-oxides, zircon, and minor muscovite) a cratonic source or a $2^{nd}/3^{rd}$ generation sandstone source would be most reasonable, but this is directly contradicted by the fact that the Haystacks minerals are angular. The angularity implies a limited transport history, yet the stable mineral assemblage would be most easily explained by lengthy transport and/or weathering.

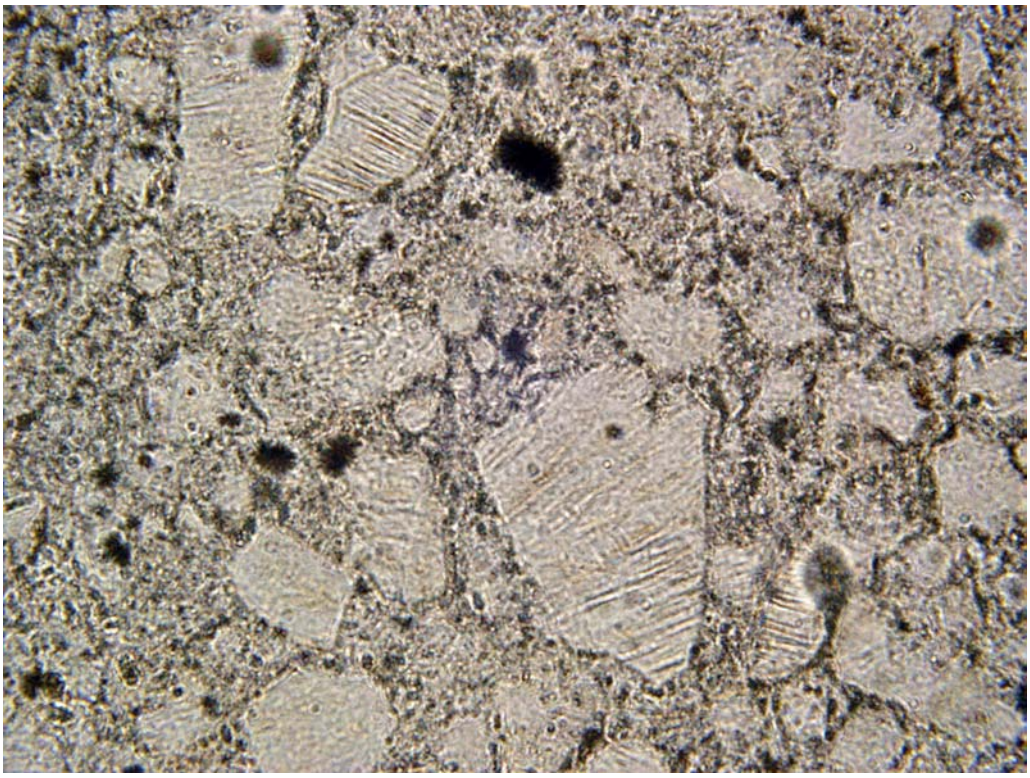
The Haystacks are a thin, but laterally persistent sheet of sediment enveloped by fluvial sandstones of the HMF. The lateral continuity of the Haystacks sandstone is inconsistent with a fluvial environment where more channelized flow would have been expected during deposition. Moreover, there is no evidence that during the deposition of the overlying HMF that upper surface of the Haystacks was channelized. This suggests rapid deposition and burial of the Haystacks.

The Haystacks also show multiple lines of evidence for fluidized flow within the unit: (1) "floating" pebbles of quartz and chert that are found in the Haystacks; (2) the lack of any relict primary sedimentary structures; (3) apparent dewatering features and super-cemented veins; (4) extreme silica-cementation of the unit; and (5) recrystallization. Each of these features is unique to the Haystacks. Together, they strongly suggested large-scale flow of a silica-rich fluid through the unit during diagenesis.

Conclusion

What combination of source area and depositional regimes could account for this highly indurated, clean sedimentary quartzite within a fluvial sequence? Frankly, we don't know. What is evident is that this unique unit represents a local time-stratigraphic marker. Its enigmatic depositional history is still open to debate. The combination of rapid deposition, fluidization, unique source area, and thin, but laterally persistent outcrop in the middle of a fluvial sequence is mystifying. Bolide impact? Tsunami? Subaerial debris flow? We're open to suggestions and "outrageous hypotheses."

A.



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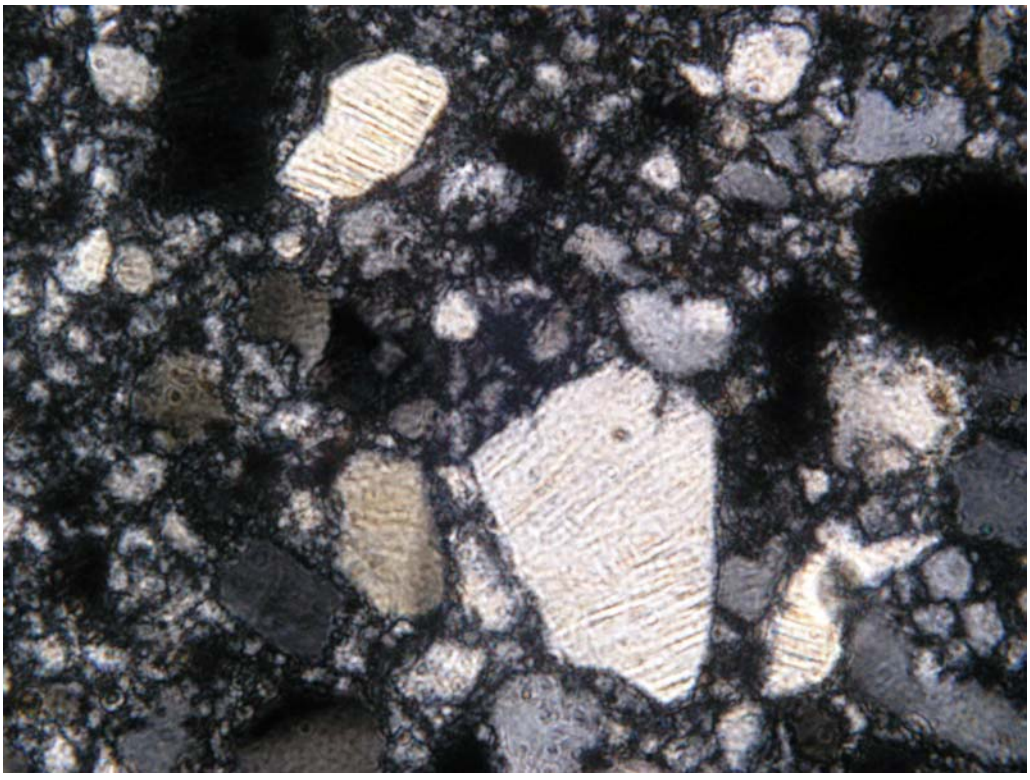

Figure 25. Photomicrograph of Boehm lamellae in quartz grains of the Haystacks sandstone. (A) plane polarized light. (B) Cross-polarized light. Field of view is approximately 2 mm.

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A HISTORY OF RICKETTS GLEN STATE PARK

by
Jay Krothe and Chester Siegel
(with additions by Jon D. Inners and Peter Tomasak and photos by Inners)

Ricketts Family Sketch

The Ricketts family, brothers Clemuel and Elijah, and several others moved from Lancaster County, Pennsylvania, to Columbia County about 1800. They founded a settlement, which they eventually called Orangeville after the original settlers of the area who had come from Orange County, New York.

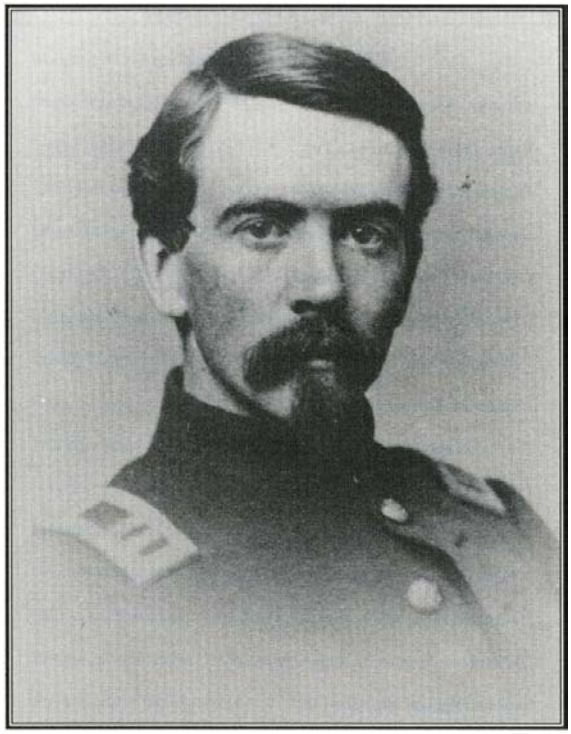

Figure 26. Captain Robert Bruce Ricketts, Battery F, 1st Pennsylvania Light Artillery (Sauers and Tomasak, 2001, p. vii).

Elijah Ricketts had two sons, William Wallace (1836-1862) and Robert Bruce (1839-1918), both of whom entered the army in 1861 to serve the North in the Civil War. W. W. Ricketts of West Point was elected Colonel and Regimental Commander of the 35th Regiment in July 1861. He was given a medical discharge in February 1862 and died of "consumption" in August 1862 at the age of 26. Robert Bruce Ricketts (Figure 26) enlisted as a private and eventually captained Battery F. Battery F gained fame at the Battle of Gettysburg when it helped to repulse a vicious Confederate attack on Cemetery Hill late in the evening of July 2, 1863. A few weeks before the end of the war, the younger Ricketts was brevetted Colonel while in action in front of Petersburg, Virginia (Sauers and Tomasak, 2001, p. 229).

Figure 27. Grave marker for Elizabeth R. (1842-1918) and Robert Bruce Ricketts (1839-1918) on the west side of Ganoga Lake, Colley Twp., Sullivan Co. (41°21'27"N/76°19'29"W).

Colonel Ricketts had studied law before the war and after his discharge from the army moved to Wilkes-Barre, where he made some plans to set up practice—but these never really materialized. He married Elizabeth Reynolds of Kingston, who bore him a son, William, and two daughters, Jean and Leigh. Colonel Ricketts was the Democratic nominee for lieutenant-governor of Pennsylvania in 1886, but refused the nomination for governor in 1888. He died of "Spanish influenza" at the height of the World War I pandemic, November 13, 1918. His wife followed him in

death six days later (Figure 27; Sauers and Tomasak, 2001, p. 218). Robert Bruce Ricketts' photo-portrait hangs on the Park Office Wall.

STAGE LINE

Construction of the Berwick-Towanda-Elmira Turnpike was started in 1822. Its route on Red Rock Mountain roughly parallels present PA 487. The Turnpike Company began running stages in 1827. The tollgate for this part of the route was at the top of Red Rock Mountain and was known as the Watson Place. Remnants are still visible west of PA 487 and north of the shale pit. Stages ran twice daily with the overnight stop at Schrifogel's Hotel on Loyalsock Creek two miles west of Lopez. The noon stop was at a log house, Long Pond Tavern, near Long Pond (Ganoga Lake). The eight-mile run from the tavern to the hotel was known for years as the "Road to Hell" because of its poor construction and bad country.

The stage line ceased operation in 1851 at which time it became a county road. The present state highway, PA 487, was built in 1907 when the turnpike road was abandoned.

Figure 28. The Ricketts Mansion (The Stone House, or "Ricketts Folly"), west side of Ganoga Lake, Colley Twp., Sullivan Co. (41°21'07"N/76°19'13"W).

STONE HOUSE

The Ricketts brothers, Elijah and Clemuel, were great sportsmen and patrons of Schrifogel's Hotel in the spring and fall. In the fall of 1850 they found the hotel full and spent an uncomfortable night on the parlor floor. On the way home from this trip they decided that they should have a sporting lodge of their own. Attracted to the area around Long Pond (Ganoga Lake), they purchased 5000 acres including Long Pond and began construction using field sandstone cut into 17" squares and cemented together with powdered limestone. The main building was 60 ft x 38 ft, with a 40-ft x 26-ft "L." It was three stories and had a full basement. The second and third floors were cut up into bedrooms. This huge stone house, of Colonial Architecture and set in the midst of a wilderness (Figure 28), was known for years as "Ricketts Folly." It was opened as a tavern and maintained as such the year through.

In 1872 Colonel Ricketts and Mr. Trenton started a sawmill business, which lasted three years. At this time a large 100-ft three story, wooden addition to the original stone house, containing primary bedroom with a lobby, poolroom, parlor, and storage room, also on the first floor, was added. The enlarged structure, named the North Mountain House, catering to summer and winter guests, primarily relations and friends. The hotel received train service for its last ten years with daily passenger runs from Towanda and Wilkes-Barre. Patrons came from as far away as New York, Harrisburg, Scranton, and Williamsport. The wooden structure was torn down in 1897 and replaced by a large formal garden (Figure 29). After the hotel closed in 1903, the remaining stone house became the

Figure 29. Well and site of wooden addition to the Ricketts Mansion (the "Mountain House"). After the addition was torn down, the area was turned into formal gardens.

summer residence of the Ricketts family. In 1913 a 40-ft sandstone addition was built and the limestone joints "pointed-up" with cement.

The North Mountain Fishing Club, forerunner of the present North Mountain Club, started in 1879 with memberships open to guests of the hotel for a $1.00 fee. This allowed them to fish Kitchen Creek. This was a difficult stream to fish, as there was only a long, steep path down the Glens to the head of the main stream. (Most fishing took place in the two-mile stretch between Waters Meet and Adams [Kitchen Creek] Falls.) After the hotel closed, the North Mountain Club leased the fishing rights to Kitchen Creek and purchased additional acreage below the Ricketts property, which is still held today.

COLONEL RICKETTS' ACQUISITION

Upon returning from the Civil War, Colonel Ricketts purchased the stone house and land from his father and uncle, and began an ambitious buying program. By 1873, he owned outright or controlled some 66,000 acres (over 100 square miles). In 1874, he sold 20,000 acres on Bowmans Creek to Lehigh Valley Railroad officials in hopes that the railroad would build a branch up Bowmans Creek.

Figure 30. Ganoga Lake, looking northwest from the outlet, Colley Twp., Sullivan Co.

The name of Long Pond (one mile long and 700 feet wide) was changed by Colonel Ricketts to Ganoga Lake, meaning "Water on the Mountain" in the Seneca Indian Language. This lake, on the Allegheny Plateau, elevation 2266 ft) is reputed to be the highest natural lake east of the Rockies (Figure 30). It is fed by underground springs and feeds Lake Jean and Kitchen Creek to the east and East Branch Fishing Creek to the west (through seepage down Big Run).

Fisherman staying at the Stone House Tavern discovered the falls in the Glens and on the lower reaches of Kitchen Creek in 1865. Colonel Ricketts named several of these falls for friends and relatives before he died. The highest, Ganoga at 94 ft, was named after Ganoga Lake. Because it was so difficult to fish the Glens area, Colonel Ricketts hired Matt Hirlinger and six other men in 1889 to build the present trail and stops around the falls. This monumental task wasn't completed until 1893, after four years of hard work.

Grand View was the name given by Colonel Ricketts to the top of the mountain. Here he had a 40-ft steel observation tower built from which one could see into eleven counties on a clear day. It is the present location of a tanker heliport used on fire fighting by the Bureau of Forestry.

FORESTRY SUMMER SCHOOL

The first known forestry summer school was started at the North Mountain House in 1873. Dr. Joseph Rothrock, Dr. Howard Kelly, Dr. Lewis Taylor, and Eugene Frank, an artist, conducted the school. Twenty-six students participated in the classes and outdoor activities. The school consisted of two small frame buildings surrounded by a tent colony

Dr. Rothrock was later to be known as the "Father of Pennsylvania Forestry" for his lectures promoting forestry management. These lectures resulted from a $12,000 legacy given by a French botanist, Francois Andre Michaux, to finance a 15-year (1877-1992) lecture series on forest management. Dr. Rothrock became the conservation spokesman of his time. This was the voice

decrying the very devastation, which was later to be wrecked on the timber plateau around this first summer school.

OIL

In 1865, six years after the oil strike in Titusville, Pennsylvania, an enterprising gentleman named Hadley salted some springs with oil balls and convinced the owners of the Wheeler & Wilson sewing machine company that for $40,000 he would make them "Oil Barons." The "Barons" financed the drilling of two wells, one 1900 ft in farm fields north of Lake Jean and another 2100 ft at Lake Rose, while Mr. Hadley left for Canada and didn't bother to check the results.

THE RAILROAD

Prior to the coming of the railroad, this country was a wilderness covered by virgin timber. The only access to the outside was the very inadequate road system keyed to the old Berwick-Elmira Turnpike. To open up this vast supply of timber the Lehigh Valley Railroad decided to build a loop off their main line. They started the loop at Kingston and Towanda. The Bowmans Creek Branch from Bernice south to Harvey's Lake was originally built by the Loyalsock Railroad between 1887 and 1892, but then immediately leased to Lehigh Valley upon completion (Hudson and Hudson, 1996, p. 59). By 1890 the railroad had extended its line from Lopez to Ricketts (see below) and on to Bowmans Creek. A spur ran from Ricketts to Ganoga Lake. With the country opened up to logging, lumber companies were formed all along the branch lines. The Fish Commission road to Mountain Springs Lake has followed the old railroad grade from Ricketts to Mountain Springs since the 1930's and from Mountain Springs to Noxen since 1948. The railroad branch from Towanda comes only as far as Dushore today.

THE LOGGING INDUSTRY (1890-1913)

The town of Ricketts was created in 1890 when Colonel Ricketts, General Henry Trexler, and Harry Turrell formed the Trexler & Turrell Lumber Company and built a sawmill and "company town" about 3 miles north of Lake Jean. Several of the building foundations are still evident at the "Ghost Town of Ricketts" where the Mountain Springs Road leaves PA 487 (Figures 31). The mill and log pond were southwest of the Sullivan-Wyoming County line, which bisected the town of 1,000. There were two schools, one for each county (Sullivan and Wyoming), a company store, hotel, church (Lutheran), grist mill, a lodge hall, and fifty homes (Hudson and Hudson, 1996, p. 59).

Figure 31. Site of the "Ghost Town of Ricketts" along Mehoopany Creek on the east side of PA 487, Forkston Twp., Wyoming Co.-Colley Twp., Sullivan Co. (~41°23'26"N/76°16'37"W), about 8 mi north of Red Rock.

The mill at Ricketts had a capacity of 75,000 board feet per day and contained a circular gang saw and band saw. It was the largest mill in this part of the country. In 1913, when all the timber had been cut, the mill operations ceased and the town of Ricketts disappeared. The timber cut was primarily virgin hemlock

and the northern hardwood group, beech, birch, maple, and cherry. There was also some white pine and spruce timber cut. American chestnut, the predominant tree of the northeast prior to the onset of the chestnut blight (a fungus disease introduced to this country about 1904) grew primarily at lower elevations and was found on the slopes up to the top but not on the plateau.

Figure 32. Cleared fields north of Lake Jean and south of the Job Corps Center on North Mountain at the north end of Ricketts Glen State Park, Colley Twp., Sullivan Co. (41°21'24"N/ 76°17'36"W). The structure with the immense "golf ball" on top is an old Cold War radar installation.

The cleared fields north of Lake Jean and south of the present Job Corps Center (formerly a radar base) site was the old from which was cleared and worked to provide food for the logging stock. This farm operation encompassed about 500 acres. Original settlers had cleared about 200 acres and Colonel Ricketts had 300 more cleared for pasture and hay fields. The fields are still open and are a good place to spot deer, turkey, and bluebirds (Figure 32).

ICE INDUSTRY (1900-1948)

In 1891 the Albert Lewis Lumber Company built a splash dam on Bowmans Creek to float logs down the creek to their mill at Stull. It did not work very effectively and was used for making ice shortly afterwards when the Mountain Springs Ice Company was formed. Ice-making being a profitable business, in 1907 they built a second dam, Ice Dam # 2, now owned by the Fish commission and forming Mountain Springs Lake. The two lakes each covered an area of about 40 acres. Above Dam #1, the town of Mountain Springs sprang up, housing people working for the ice company. The workers not living in company houses stayed either at the boarding house, in abandoned railroad cars, or old logging buildings—or they hiked in over the mountain from the valley, a distance of some two miles. Most of the workers were loggers or farmers that worked the ice during the off-season.

During the winter, up to 150 men worked the ice on these two dammed lakes and the smaller Bowman or Beech Lake. Crews on the ice plowed snow, marked the ice field to be cut, and cut the lakes into ice floats 55 ft x 80 ft which were floated down the channel to the two gang-saws which cut them into thirty 22 ft-x-2 ft cakes that varied with the thickness of the ice. The cakes were then planed smooth and conveyed up to be loaded, either directly into railroad cars or into one of the icehouses which were at both ice dams #1 and #2. The icehouse at Dam #2 was 1200 ft x 50 ft, and the house at Dam #1 was 1050 ft x 50 ft. Both consisted of rooms 150 ft x 50 ft x 32 ft high. The ice work was over when the houses were full. When full, the houses contained 65,000 tons of ice. This kept about 20 men busy in the summer loading railroad cars for shipment to New York and throughout western Pennsylvania. During the winter approximately 40,000 tons were shipped for consumer use and storage in other icehouses along the railroad. As many as 2,400 tons were shipped in one day.

The ice business at Mountain Springs lasted until 1948 when the railroad finally pulled out and closed down the business. The village of Mountain Springs disappeared in 1954, becoming another "ghost town" when the post office was closed and Art Kitchen, postmaster and company ice worker since 1913, moved out. At this time the Pennsylvania Fish Commission bought the dams, lakes, and creek bottom owned by the Ice Company. They condemned Ice Dam #1 and blew a hole in it in 1957. Ice Dam #2 was rebuilt as a concrete dam and enlarged in 1964. It was then renamed Mountain Springs Lake by the Fish Commission.

BUILDING OF THE LAKES

Lake Rose was originally built about 1842 as a log pond for a squatter named Dodson who was cutting and sawmilling cherry for bedsteads. Natives still refer to it as Dodson's Dam. This log dam was reinforced when the original log dam at Lake Jean was built in 1905. In 1907 the concrete dam at Lake Leigh was built (see Figures 1-39 and 1-40). These two dams were built for hydroelectric power that never materialized for various reasons. In 1956 the Department of Forests and Waters replaced the log dam at Lake Jean with a larger earth-fill dam and dikes at the east and west ends. This created the present Lake Jean, which joins the original Lake Jean with Mud Pond. The concrete dam at Lake Leigh was condemned for structural weaknesses and a hole blown in it in 1957 (see Figure 1-41).

GAME COMMISSION

The Pennsylvania Game Commission, established in 1905, bought 23,000 acres of Colonel Ricketts holdings in 1921. This was the first purchase of some 83,000 acres of State Game Lands adjoining the present State Park. About 1912, so the natives say, a man and his two sons killed the last deer on the mountain after trailing it for 3 days. About 1914 the Game Commission stocked deer in the Ricketts fields. Careful guardianship of these few deer by the Game Commission has resulted in today's large deer herd. Of the Park's 13,050 acres, 9,000 are open to public hunting. Combined with the surrounding State Game Lands, this gives the sportsman holding a Pennsylvania hunting license over 92,000 acres (more than 135 mi^2) of state land to pursue his favorite game, be it deer, bear, turkey, grouse, squirrel, or rabbit.

BIRTH OF THE PARK

Colonel Ricketts' heirs, through the Central Penn Lumber Company, sold 48,000 acres to the Game Commission from 1920 to 1924. This left them with over 12,000 acres surrounding the Stone House and the Lake Jean area. This large tract was approved by the Federal Government as a National Park Site in the 1930's. World War II brought an end to this plan for development, and in 1942 the heirs sold 1261 acres, the Falls and Glens area, to the Commonwealth of Pennsylvania for a state park. Additional purchases from William Ricketts in 1943 and 1949 resulted in a park nucleus of 10,318 acres of former Ricketts holdings. An additional 1,732 acres have been purchased from other individuals to bring the Park to its present boundaries. The remaining 2,000 acres of the Ricketts Estate, including the Stone House and Ganoga Lake, were sold in the 1950's by the William Ricketts heirs to the Ganoga Lake Association for private housing development. The Department of Forests and Waters (today known as the Bureau of Forestry) bid on the property but was out-bid by the Association.

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REPORT ON THE PROPOSED BLOOMSBURG AND SULLIVAN RAILROAD

Philadelphia, November 26, 1883

TO: Col. Jamison*, Bloomsburg, Pennsylvania
SUBJECT: Report on the projected route of the Bloomsburg and Sullivan Railroad

Dear Sir: —During the past season a survey has been made by Mr. James Brown of Bloomsburg, for a line of Railway from Rupert, Columbia Co., to Bernice in Sullivan County. By your direction, Mr. Brown brought the notes of his survey to my office, and I have furnished him with assistance to work them out, and to prepare a map, profile and estimate of quantities. I have consulted with Mr. Brown and advised him as to the details of Location and mode of Construction. During the present month I have made a personal examination of the country through which the proposed Railroad is located, having passed along the Valley of Fishing Creek from Rupert to the foot of the mountain, and having spent several days on the mountain between Ganoga Lake and Bernice.

I herewith present the results of my examinations, together with those of Mr. Brown's survey.

The line selected commences on the Cattawissa [*sic*] R. R. near Rupert Station and follows up the Valley of Fishing Creek to the foot of the mountain, a distance of about 27 miles. This portion of the route is along an open alluvial valley, and the selected location is for the most part at or near the foot of the hill on one side or the other of the valley, though sometimes extending across stretches of bottom land. On reaching the foot of the mountain the line deflects to the westward and follows the west branch of Fishing Creek for some distance. The North Mountain, which is a Spur from the Great Allegheny Plateau, faces boldly to the South with precipitous front, rising about 1200 feet in a little over half a mile. It is cut by numerous gorges which have step fall, rugged slopes and sharp jutting points….

From Rupert to the foot of the mountain, 27 miles, the ruling grades are: ascending Northward 52 8-10 feet per mile, descending Northward 42 feet per mile. A line could be located with continuing ascending grades Northward, but a few adverse grades have been introduced to lighten the gradation….

The Allegheny mountain passes through Central Penna., on the West side of Bald Eagle and Susquehanna Valleys, its escarpment following a line almost due North East until it reaches a point about North of Williamsport when it bears almost due East to the junction of Lycoming, Columbia and Sullivan Counties at which place it throws out to the southward the North mountains as a bold spur, then bears again to the North East and crosses the North Branch of the Susquehanna River to Tunkhannock. The Eastern and Southern face of the mountain is generally abrupt, while West of the summit it spreads out into a rolling plateau of great extent. Many streams head in the plateau. Some of them traverse considerable distances in the plateau, a few cut through the escarpment of the mountain, but all find their vent in either the North or West Branch of the Susquehanna, both of which streams cut the mountain to its base. In the region near the line of your proposed Railroad we find the waters of Fishing Creek flowing to the south and emptying into the Susquehanna near Bloomsburg. At the head of Fishing Creek proper we find the East and West branches, Coles Creek and Raven Run, while further Eastward

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*Incorrect spelling. The correct spelling is Jameson.

This report appeared in *The Columbian and Bloomsburg Democrat*, December 28, 1883. Nearly forty-five percent of the original report is deleted because it exclusively treated the area above North Mountain.

Reproduced from Newton, C. A., and Sperry, J. R., 2002, A quiet boomtown—Jamison City, Pa. 1889-1912 (Revised printing): Bloomsburg, PA., The Columbia County Historical and Genealogical Society, p. xiii-xviii, with the permission of the Society.

are the various branches of Huntington Creek, which unites with Fishing Creek South of the village of Stillwater. These various streams drain the South face of the North mountain.

…The great elevation from which these streams have to drop, and the peculiar geological character of the country, has caused them to flow to a greater or less extent in Canyons with rugged slopes, sharp turns and crooks, and numerous vertical falls, making it very difficult to utilize their gorges for the purposes of a railroad. The inaccessibility of this region has caused it to be very little explored, and we find on the North mountain, probably the largest stretch of virgin forest remaining in the State…an area of several hundred thousand acres, entirely uninhabited, except a few scattered clearings on its outskirts….

The object of my recent trip over the line of your proposed Railroad, was to obtain a general knowledge of the country and of its topography, character & resources. I was fortunate in being accompanied by Col. R. B. Ricketts of Wilkes-Barre, a gentleman who has made a thorough study of the North mountain district, who is perfectly familiar with its topography, Geology & resources, and who kindly placed at my disposal his private maps[,] gave every explanation asked for, and piloted me from point to point, so that I was enabled to see much more in the time at my disposal than I could possibly have done without his aid.

The Fishing Creek Valley from Rupert to the mountain is a good farming country interspersed with numerous small villages. On either side of the valley is a farming country, which at present has no Railroad facilities nearer than the valley of the North branch of the Susquehanna. Immediately in the vicinity of Bloomsburg are large quantities of the well known fossil iron ore of the Montour ridge. With this exception there are no minerals of any commercial value along the line of the road South of the mountain. After leaving the valley of Fishing Creek we strike the timber region. The mountain Plateau is covered with a heavy growth of Spruce, Hemlock and hard wood, with a few isolated patches of White Pine. Col. Ricketts who has explored the region extensively, in company with experienced lumbermen estimates that there are not less than 200,000 acres of Virgin timber land on the mountain Plateau in Sullivan[,] Luzerne & Wyoming Counties. Immediately on the Loyalsock there are several saw mills, the lumber from which I saw being hauled to Bernice. I am informed that at Thorndale and Laporte, both of which are West of the territory I examined, there are tanneries in operation, and I saw some Hemlock timber which had been cut down, and from which the bark had been removed. I visited a high point on a clearing near the Wyoming County line which overlooked the valleys of the Loyalsock, Mahoopany and Bowmans creeks, from which I could see vast acres of unbroken timber land extending to the limits of the horizon many miles from where I stood.

Ganoga Lake[,] otherwise known as Long Pond, is a sheet of water about 1 mile long, situated near the Turnpike road and about 3¼ mile North from the crest of the mountain; it outlet is by Kitchen Creek, a branch of Huntingdon Creek, which later, as before stated, is a tributary of Fishing Creek. At Genoga [*sic*] Lake is a clearing, on which there is a large and substantial two story stone house, a three story frame boarding house, barns and other buildings, the place having been improved and fitted up as a Summer Watering Place, capable of accommodating from 200 to 250 guests. After leaving the Loyalsock creek to come South—, 'Ganoga Lake' is the only habitation on the mountain, and East and West of it is an unbroken wilderness for many miles in either direction. A large tract of land around and including Ganoga Lake is owned by Col. Ricketts, who is the only person that has explored this section for minerals, and I am indebted to him for the information which I obtained in the matter. Col. Ricketts has made a number of drifts, test pits and shafts, some of which I visited and examined. A bed of valuable Yellow Ochre has been opened at a number of places. It varies from 3 to 6 feet thick. Col. Ricketts estimates it to average 4 feet in thickness, and states that he has traced it sufficiently to warrant him in claiming that it underlies 10,000 acres; what it may be beyond this area is not known….

I have been shown fine specimens of shot ore which I am informed exists as a bed 3 feet thick on Elk Run and on the West Branch of Fishing Creek. Col. Ricketts has not found the shot ore on his

property, but he states that it seems to occupy about the same geological horizon as the deposit on Ore Run…He also states that while exploring the various branches of the Mahoopany creek he found specimens of Brown Hematite iron ore, which as nearly as he could judge came from the same horizon, there being bog ore springs and exposures of bog manganese adjacent.

On the mountain Plateau we find a layer of impure Limestone well stratified and thin bedded. The presence of this limestone probably accounts for the good quality of the soil found in this section of the country.

The unsettled condition of the district and the absence of means of communication have prevented any extensive exploration of the ore deposits here described, and no actual workings have been made on a large scale, therefore I cannot express any opinion as to the commercial values of the ores….

The sources of Revenue for your Railroad are therefore:

1. The general business, (passengers and freight), incident to a prosperous farming country of considerable width, extending for some 27 miles along your road. Lime is needed for the farm lands, which will be hauled in from the North Branch Valley. Coal for fuel, store goods and miscellaneous freight will be considerable items. Farm produce, cross-ties and miscellaneous freight will be the business going out.

2. Lumber business from the mountain lands should be a large item. The present demand for sawed lumber, bill timber, mine ties, props and lagging through the anthracite coal district, affords a home market, now supplied from more distant points, and for which you would practically have the monopoly. Hemlock bark is at present in great demand for tanning purposes, and is growing scarcer and dearer every year. A branch line about 10 miles long from your main line on Loyalsock Creek to the waters of the Mahoopany should practically control the immense timber supply on the waters of the latter stream, and would also serve to develop the coal deposits which it is possible may be opened in that district. The local information which I have been furnished with is, that Hemlock bark is now selling at $7.50 per cord on board cars at Bernice, that with a railroad built in this region it can be readily sold at $3.00 per cord on the tree, and that the prices that can be realized for Stumpage of lumber are Hemlock $3.00, Spruce $5. to $6., White Pine $8. to $10. And that Hemlock lumber is now selling readily throughout the coal district at $15. To $16. The building of your railroad would at once bring this immense body of timber into market, and while making large profits to the land owners would furnish freight to The road. As the timber is at present practically excluded from market, and therefore utterly worthless, and an expense for taxes to its owners, it would seem that the true interest of the land owners would be to combine and build the Railroad themselves; or furnish the capital to do so, pro rata on their holdings of land.

3. The building of the Fishing Creek Railroad will afford a short line South & East, to the principal markets of the country for the coals of the Bernice and adjacent basins, the amount of which will be limited only by the extent of those basins, as I understand the coal is of superior quality and an especial favorite for household use.

I have not attempted to make any figures on the foregoing sources of revenue. That is a matter that is not in my province, but is a subject for the consideration of parties building on the road.

JOHN A. WILSON
Civil Engineer

Note: The Bloomsburg and Sullivan Railroad received its charter on December 21, 1883. Construction began in 1886, and track laying was completed as far as the future site of Jamison City in 1888 (Figure 33). Although plans to extend the line to Bernice were revived at various times over the next few years, such action was never undertaken. Col. John Jameson, to whom the above letter was addressed, was the chief contractor during

construction and served as president of the railroad until 1886. The fortunes of the Bloomsburg and Sullivan rose and fell with those of Jamison City. After the lumbering ceased on North Mountain and the sawmill closed in 1912, the railroad hung on until 1927 (even surviving two years beyond the closing of the tannery). In that year, the Bloomsburg and Sullivan "Limited" made its last run to Jamison City—and the tracks were torn up all the way back to Benton (Newton and Sperry, 2002, p. 8, 10-11,85, 120). In 1928 the Reading Railroad acquired the Bloomsburg-to-Benton remnant of the Bloomsburg and Sullivan (Graham, F. S., 1968, p. 46). Part of the old grade of the railroad between Bloomsburg and Benton is now a rail-trail.

The "Yellow Ochre" bed described by Mr. Wilson apparently occurs in the Pocono Formation in the vicinity of Ganoga Lake. Sherwood and Platt (1880, p. 206-207) provide interesting information on the stratigraphic position of the "Ocher" and on the chemical composition of an immediately underlying "bluish" carbonate iron ore (based on a boring made by Col. Ricketts). Two samples of this ore (one of them analyzed by Andrew McCreath of Harrisburg) showed 32.000 and 34.38 percent iron, "unusually low" sulphur, and "the phosphorus not high." Platt (p. 208) states that the analyses represent "a moderately valuable iron ore; one which could be used for mixing with richer ores in making pig iron for the use of Bessemer steel works."

The stratigraphic position of the "impure Limestone" on the "mountain Plateau" is uncertain. It does not seem to fit the description of a unit described by Platt (p. 204) as the "Limestone of X" (Huntley Mountain/ Pocono): a "massive limestone, fully 12 feet thick," with some layers of "rounded pebbles of carbonate iron ore, held together by a matrix of calcareous matter." (JDI)

Figure 33. The former Bloomsburg and Sullivan Railroad station (1889-1926) in Jamison City.

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OPPOSITION TO THE CIVIL WAR IN COLUMBIA COUNTY, PENNSYLVANIA

By

George A. Turner

When citizens of Columbia County in central Pennsylvania learned of South Carolina's attack on Fort Sumter in Charleston's harbor on April 12, 1861, they came together in a time of national crisis to rally support for the Union. An editorial in *The Star of the North*, a Bloomsburg newspaper, announced to its readers: "We are in the midst of a war!" It expressed a deep feeling of anger at the South for plunging the nation into a deadly conflict and shrouding its future in uncertainty. The North was a victim of a war forced upon it by Southerners who had long contemplated this treasonable act and actively prepared for it. Feeling assaulted, the newspaper called upon the citizens to ". . . recognize the deadly and terrible nature of the struggle in which we are involved, and summon up all our energies to prosecute it to a successful termination."[1] Its editor, Williamson H. Jacoby, urged the citizens to do their duty by entering the struggle with a resolute spirit to sustain the Union and defeat its enemies.

A few days after the fall of Fort Sumter, handbills appeared in Bloomsburg announcing a public meeting at the courthouse (Figure 34) on the evening of April 18 to review the threats to the Union and to determine the necessary steps to preserve it. It appealed to the public that political divisions must be set aside, and ". . . the time has come when every good citizen must declare himself on the side of the 'Union and Constitution.'"[2] In explicit language, it declared that patriots will take up arms to protect the country while those who hang back will be traitors. The response was enthusiastic; a huge crowd from Bloomsburg and the vicinity gathered at the courthouse for the meeting. A strong patriotic spirit dominated the proceedings with bands playing stirring music and numerous "cheers" for the Union, "Stars and Stripes," President Lincoln, and the armed forces. Political leaders from both the Democratic and Republican parties actively participated, and the following resolution exemplified this bipartisan spirit:

Figure 34. Columbia County Courthouse built in 1847 and the site of where the public meeting in support of the Union was held on April 18, 1861. From the 1860 Cummings Map of Columbia County

> That we always have been, and are now, in favor of the unbroken union of these States; and notwithstanding difference of opinion on political questions which heretofore existed among us, we are unanimously in favor of sustaining the Federal Government in any and all difficulties she now has or may hereafter have with either foreign or domestic foes.[3]

In a series of other resolutions, unanimously adopted, the people at the meeting deplored the national crisis, condemned efforts to disrupt the Union as traitorous acts, and denounced partisan activities as unconscionable behavior during a time of national peril. In a zealous spirit the meeting called upon all loyal citizens ". . .to emphatically condemn every traitorous demonstration against the government or its policy, either by speech or publication. . . ."[4] Young men willingly stepped forward to

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1 *Star of the North* (Bloomsburg, Pennsylvania), April 24, 1861.

2 *Columbia Democrat* (Bloomsburg, Pennsylvania), April 27, 1861.

3 *Columbia Democrat,* April 27, 1861.

4 *Columbia Democrat,* April 27, 1861.

volunteer for military service. Attorney Robert F. Clark, the presiding officer, announced that a subscription drive throughout the county was underway to raise the necessary funds to defray the costs of outfitting the volunteers. The *Columbia Democrat*, another Bloomsburg newspaper, considered the meeting a great success: "Never was such enthusiasm manifested in a public at this place."[5] Catawissa, a nearby community, on the same day also held a public meeting expressing its support for the federal government in dealing with this crisis. It passed a number of resolutions pledging support to preserve the Union and protect the "Stars and Stripes," the glorious ensign of liberty, and appealed to the public for funds to help defray the cost of recruiting volunteers.[6]

Within a week after the public rally, men from Columbia County imbued with a martial spirit volunteered without hesitation and quickly began forming three companies to go off to fight. To meet the expenses for equipping these units and to provide financial support for the families of those who enlisted, the citizens responded generously by raising nearly $1,500 in a few days. The newspaper, *Columbia County Republican*, in describing the public sentiment, equated it with a Fourth of July spirit. It was a time of excitement with parades, sounds of fife and drum, speeches, and men engaged in military drills. In a ceremony on Bloomsburg's public square, a group of ladies presented an expensive, beautiful, silk American flag to one of the volunteer companies.[7]

This enthusiasm and willingness to support the Lincoln administration in response to the attack on Fort Sumter would not last long in Columbia County. Within a short time it became apparent that this initial sense of unity in dealing with the war was far from being permanent and widespread. Democrats made it clear they were supporting the Union, which should not be interpreted as also endorsing Republican principles. Columbia County had a well established reputation as a Democratic stronghold that consistently supported Democratic candidates for local, state, national offices. In the 1860 presidential election Lincoln received 56% of the state's popular vote and carried 53 of the 65 counties; however, Columbia was one of the twelve counties that he lost. It was John C. Breckinridge, Vice President under President Buchanan and the southern states rights Democrat candidate, who won 55 percent of the Columbia County votes to Lincoln's 43 percent with the remaining two percent going to the northern Democrat Stephen A. Douglas and John Bell of the Constitutional Union Party. The county's northern townships, Benton, Fishing Creek, Jackson, Orange, and Sugarloaf, gave very strong support to Breckinridge who garnered 76% of the votes.[8] In Bloomsburg, the county seat, there were two anti-administration newspapers, the *Columbia Democrat* and *Star of the North.*

Criticism and doubts about the Lincoln administration's policies began surfacing in the summer of 1861 at Democratic rallies held in the county. It had become apparent after the first battle of Bull Run, July 21, in which the Union forces suffered a humiliating defeat, that the Confederates could not be beaten in a short war as many had believed. At a series of large public Democratic meetings attended by several thousand people in Benton, Rohrsburg, Berwick, and Slabtown, there were numerous speeches lamenting the serious problems facing the nation**.** Critics denounced what they called the mismanagement and corruption of the Republican administrations of the state and national governments, the extremism of the abolitionists causing sectional division, and the horrors of a civil war. There was growing fear the war would impose financial burdens on the people and, in turn, replace the nation's prosperity with poverty. Therefore, it was important to entertain and embrace negotiations for an honorable end to the war that would maintain the Union and the equality of all the states.[9]

These assemblies of Democrats, who became known as Peace Democrats, were politically conservative, inherently suspicious of government authority, and concerned over Lincoln's expansion of

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5 *Columbia Democrat,* April 27, 1861.

6 *Columbia Democrat,* April 27, 1861 and May 4, 1861, and *Star of the North,* April 24, 1861.

7 *Columbia County Republican* (Bloomsburg, Pennsylvania), May 2, 1861.

8 John F. Coleman, *The Disruption of the Pennsylvania Democracy, 1948-1860* (Harrisburg: The Pennsylvania Historical and Museum Commission, 1975), 177-178. *Columbia Democrat,* November 17, 1860.

9 *Columbia Democrat*, August 17 and September 7, 14, 21, 1861.

presidential powers. They called for a strict adherence to the Constitution, and claimed those who violated its provisions under the guise of saving it were acting hypocritically. Specially, in the opening weeks of the war when Congress was not in session, he expanded the size of the regular army beyond what was authorized by law. Lincoln also directed Salmon Chase, Secretary of the Treasury, to spend money for military measures which had not been appropriated by Congress. Clearly, these were congressional functions. What many felt was a dangerous usurpation of congressional power was Lincoln's unilateral decision to suspend the writ of *habeas corpus* in parts of Maryland. "Probably no President, not even Wilson nor Franklin Roosevelt, carried the presidential power, independently of Congress, as far as did Lincoln."[10]

In responding to the emerging Democratic charges, the *Columbia County Republican* began referring to the Democrats as "Jeff Davis Reserves" and "Breckinridge Secessionists." A meeting of the Greenwood Literary Society, in the Millville area, adopted a resolution strongly disapproving of those who supported peace talks and compromise with the secessionists as undercutting the efforts of the national government. It was their view that these Democrats were aiding and abetting treason.[11] John Staley, a Republican of Rohrsburg, in a letter to the *New York Tribune* claimed that for every Lincoln supporter in the northern part of Columbia County, there were two Jeff Davis or Breckinridge supporters.[12]

Levi Tate, editor of the *Columbia Democrat* and a Democrat member of the Pennsylvania House of Representatives, scoffed at the idea that Democrats were supporters of the Confederacy. "We deny that there are Jeff Davis men in this county, if there are they are not in the Democratic party."[13] An unnamed Democrat from Orangeville having knowledge of Staley's letter wrote to the *Columbia Democrat* denouncing his charge that Columbia County Democrats were secessionists. Instead, it was the Democrat party that was the true union party and had always opposed dissolution of the union. Rather, it was the Republican Party, dominated by abolitionism that nurtured sectional irritation and hatred which was responsible for causing the disunity now facing the nation.[14] Anonymous letter writer from the northern part of the county appeared in the *Columbia Democrat* claiming "the Republican Party was responsible in the main for the origin of this Fratricidal strife, for the very foundation principles of this party are antagonistic to the South."[15] The author believing in a states rights philosophy thought it was wrong for the Republicans to deny Southerners the right to take their slaves into the territories; it was the Democrats who were committed to do what was necessary to preserve the Union as long as it was constitutional. The Democrats were willing to support the war if it were for maintaining the Constitution and guaranteeing to each state its rights. However, it was feared that the abolitionist influence in the Lincoln administration would seek to make the end of slavery a war aim. "We do not wish to have Negroes of the South turned loose upon us. We don't want them here – free or slave."[16] In another letter that appeared in the *Columbia Democrat* by a Benton resident, the author felt the Union could not be saved by the use of force. Efforts should be made to end the conflict by achieving a political solution. It was essential to "come to an amicable arrangement of the difficulties existing between North and South, than to spend millions of wealth and lose thousands of men, and then be no nearer a settlement of our difficulties that we are now."[17]

After the initial enthusiasm for forming military companies to fight in the war, it gradually became more difficult to recruit volunteers. The patriotic spirit of defending the country was tempered as

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10 J. G. Randall and David Donald, *The Civil War and Reconstruction* (Boston: D. C. Heath and Company, 1961), 293.
11 *Columbia Democrat,* September 7 and 21, 1861.
12 *New York Tribune,* September 2, 1861.
13 *Columbia Democrat,* September 7, 1861.
14 *Columbia Democrat,* September 14, 1861.
15 *Columbia Democrat,* July 20, 1861.
16 *Columbia Democrat,* July 20, 1861.
17 *Columbia Democrat,* August 24, 1861.

accounts of hardships of army life, horrors of combat became known, and challenges for a family if the father/husband were in the military service. In a letter by George S. Lee, a soldier from Columbia County, he described the hardships facing a family of a fellow soldier.

> I saw a letter that was wrote to a married man in our company by his wife that says she is in need of subsistence; and wants him to come home and maintain the family. I think that the loyal people of Columbia must be very hard hearted to see the wife and children of a man that is serving his country suffer for the want of food; and if the man had not been promised that his family should not suffer for anything they needed, he would have stayed at home and maintained them himself; and they talk of binding out his children by the 1st of April if he does not provide for them, unless we are paid off before that time, which I am afraid will not happen. And farther, they talk of throwing his family out of the house in which they now live, and they have no place to go. This family lives about two miles and a half above the town of Bloomsburg.[18]

It was obvious by the summer of 1862, the war was not going to be short. With the need for more troops, the federal government in July 1862 requested the states to furnish 300,000 three-year enlistment soldiers and in August 300,000 nine-month militiamen. Each state received a quota from the War Department. To promote enlistments, and, hopefully, avoid the use of a state draft, counties began offering bounties, payment of money to volunteers for joining the army. The use of bounties became commonplace in the North.[19] A newspaper editorial urged men to sign up so the county could avoid a draft call.

> It is the intention that every district shall do her part in supplying men by volunteering and if not the mode of drafting, is sure to be put in operation. It may be very inconvenient for some of our young farmers to leave for the tented field some bright morning through the force of a draft, therefore they should encourage enlistments, and see that this company is filled up, which will in all probability save Columbia county from a draft. There are plenty of volunteers throughout the county, and all that is wanted is a little encouragement from our influential farmers and the ranks are soon filled up.[20]

However, only three townships out of twenty-three in Columbia County were able to meet their quotas for volunteers in the fall of 1862. Since men no longer were rushing to the colors, the county had to rely on the state militia draft to meet its quota. Imposing a draft was not popular since it caused ~~a~~ numerous hardships.[21] In the five northern townships, Benton, Fishingcreek, Jackson, Pine, and Sugarloaf, which were strongly Democratic and critical of the Lincoln administration, the percentage of men subject to military service who were in the army was 10.9% whereas in the rest of the county it was 16.3% – or nearly fifty percent higher.[22]

When President Lincoln issued his Emancipation Proclamation on September 22, 1862, this prompted further doubts about supporting the war. Northern response to the President's initiative was far from being universally praised. In general, there was an unfavorable reaction among Democrats who became more critical and disapproving of the Lincoln administration. They argued the President had betrayed the original war aim which was to preserve the Union. Lincoln had instead set forth a new war aim by embracing the abolitionist demand to free the slaves. His critics charged freeing the slaves in the

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18 *Columbia Democrat,* April 12, 1862.

19 *The Legislative Record: Containing The Debates and Proceedings of the Pennsylvania Legislature for the Session of 1863* (Harrisburg: Telegraph Steam Book and Job Office, 1863), 184. Randall and Donald, 328-29.

20 *The Star of the North,* August 20, 1862.

21 *Columbia Democrat,* September 20, October 25, and November 1, 1862.

22 *Columbia Democrat,* September 20, 1862.

rebellious states was a loathsome policy. In particular, those who called for a negotiated end to the war thought Lincoln's emancipation policy made it impossible to achieve any compromise with the South to end the conflict. It would most likely prolong the war.[23] In Lincoln's home state, the Illinois Legislature on January 7, 1863, adopted a resolution condemning the Emancipation Proclamation as a tragic mistake.[24]

The Emancipation Proclamation made it more difficult to get men to come forward to join the army. Alem B. Tate, solider from Columbia County, expressed his dismay over the abolition influence in the Lincoln administration.

> Whilst a civilian in your midst, I had formed many opinions in reference to this wicked Rebellion. I thought the soldiers in the army, were to a man, the warm and unflinching supporters of the Administrators at Washington, as to the manner of putting down this rebellion. But, that opinion, sir, is no longer entertained in my breast, or those, in this section of the army, to whom I have had the pleasure of conversing with. Abolitionism in the North, as well, I am sorry to say it, in the Cabinet of our rulers at the National Capitol, has caused many a true heart in many brave soldiers' breast, to pause and reflect in reference to his mission here. Questions arise, what am I here for? Is it to restore our country to her former greatness and prosperity for the hardships here endured, to be compensated by the elevation of the Negro to the equality of the White Man of the North?[25]

It was not uncommon to hear soldiers profess that they were willing to fight and die for the Union but were opposed to a war to liberate slaves. A soldier writing shortly after the Emancipation Proclamation went into effect declared: "When I enlisted in the Army it was to fight for the Union, and to restore the Government, but instead of that, it is for the Negro. I hope that our authorities will speedily throw Old Abe out of the chair and put some decent, honest President in his place."[26] G. W. Howell, a Columbia County soldier stationed in Virginia, writing to a friend back home angrily denounced Lincoln's policy of freeing the slaves. (This quote is a verbatim copy from the letter.)

> . . . uncle sam will have to quit haveing wite men shot for the sake of freeing a few infernal niggars. before he gets me to pick up the musket again. now I for my part dont believe in having A hundred white killed for to free one or two slaves nor I dont care about shooting A rebble for to take his Slaves from him. for I believe they have a rite to hold them and old abe I think was out of place when he issued his useless proclamation. now I wouldent mind playing solider if it was not for the purpose of freeing the negro. and then have him made our superiors. if old abe has command of the shanty a few years laonger. the negor will be respect more than a white man. . . .[27]

This disagreement with the Emancipation Proclamation found expression not just among soldiers but also in the Pennsylvania legislature. Representative John Magee, a Democrat from Perry County, introduced a lengthy resolution in the House of Representatives on March 26, 1863, that criticized the Lincoln administration on a number of points. Specifically, it opposed the Emancipation Proclamation

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23 John Hope Franklin, *The Emancipation Proclamation* (New York: Doubleday & Company, 1963), 62-63, 74-75, 78-81, 114-116, and 133-134.

24 Henry Steele Commager, ed., *Documents of American History*, Vol. I. (New York: Appleton-Century-Crofts, Inc., 1958), 422.

25 *Columbia Democrat,* December 20, 1862.

26 *Columbia Democrat,* January 24, 1863.

27 G. W. Howell to Perry DeLong, February 14, 1863. The letter is in the possession of Mrs. Carolyn Karas of Orangeville.

as being ". . . unwise, unconstitutional and void."[28] In addition, the legislators objected to the unwarranted suspension of the writ of *habeas corpus* and condemned the practice of subordinating civil laws and free government to military rule. They expressed support for a political resolution of the war by convening a convention ". . . for the purpose of proposing such amendments to the Federal constitution as experience has proved to be necessary to maintain that instrument in the spirit and meaning intended by its founders, and to provide against future convulsions and war."[29] After extensive debate for several days, the House approved the resolution on April 13 with Columbia County's two representatives, Democrats George D. Jackson and John C. Ellis, supporting it.

The Emancipation Proclamation focused attention on the race issue. Northerners feared that with the ending of slavery, they would be inundated by a mass exodus of blacks from the South. There was a concern that the former slaves would compete for jobs held by whites or as public charges, they would over burden the relief rolls. Others argued that the Lincoln administration was trying to impose racial equality between blacks and whites. These attitudes prompted numerous petitions from various parts of the state, including Columbia County, to be submitted to the Pennsylvania Legislature. The petitioners believed there was an impending wave of black immigration coming to Pennsylvania, and they wanted legislation to prevent persons of African descend from moving into the state. A typical petition was a printed form that allowed the insertion of the county's name.

> Whereas, Large numbers of Black and Mulatto persons have lately come, and are still coming into this county and State, from other States; And Whereas, The history of races clearly demonstrates that where the White and Black races mingle on equal terms, the White is degraded without elevating the Black race; And Whereas, The inevitable result of this influx of Blacks and Mulattoes will be that White labor will be depreciated and degraded, or that White men will be taxed to support them either in Alms-House or Jail, either of which cases will be highly detrimental to the County. We, therefore, respectfully pray your Honorable bodies to pass an Act prohibiting Blacks and Mulattoes from entering the state.[30]

Alexander Patton from Green County introduced into the Pennsylvania House of Representatives on February 5, 1863, a resolution describing the Emancipation Proclamation as " . . .unconstitutional, inflammatory and despotic. . . . " In addition, it stated that if the Lincoln administration did not retract it nor adhered to the constitution in conducting the war, then the federal had no right to make any requests to Pennsylvania ". . .for its men or other means for carrying on the war."[31] Although the legislature did not pass the resolution, it was a clear reflection of a hostile attitude toward emancipating slaves as a war objective.

Increased casualties, rising war costs, and the South's ability to resist successfully the Union armies caused Peace Democrats to advocate a negotiated settlement to end the Civil War and restore the Union. One approach envisioned a national constitutional convention to fashion a political compromise to bring the country back together. This idea prompted the Pennsylvania Legislature to support a call for a national convention that would try to find a political solution to end the conflict and bring peace between the North and South. Representative John C. Ellis on February 24, 1863, presented petitions

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28 *Legislative Record,* 886.

29 *Legislative Record,* 886.

30 Petitions requesting the Pennsylvania Legislature prohibit persons of African descent from moving into the state are in Record Group 7, Records of House of Representatives, House File, Boxes 18 and 19 and Records of Senate, Senate File, Box 66, Pennsylvania Historical Commission and Archives, Harrisburg. Representative. George D. Jackson of Columbia County submitted a petition to the legislature from his constituents on this issue. *Legislative Record,* 298.

31 Journal of the House of Representatives on the Commonwealth of Pennsylvania, of the Session Begun at Harrisburg, on the Sixth Day of January, 1863 (Harrisburg: Singerly & Myers, State Printers, 1863), 166-167.

from Columbia County that supported this approach to the House of Representatives.[32] Other petitions submitted throughout the state backed a political resolution of the war rather than depending on a military approach. The petitioners requested:

> ". . . that in the interest of peace and harmony, the Legislature of Pennsylvania do now enact a Constitutional call for the holding of a National Convention of the people of the United States, to consider and effect such measures of pacification and reunion as may arrest the discord and heal the political wounds which now divide and are rapidly ruining our Country.[33]

Democrats in northern Columbia County met at Stillwater early in April 1863 and passed several resolutions denouncing the Lincoln administration and comparing the President to a Russian czar. One read: "Resolve, That, the bloody struggle in which we are now engaged, is not in our opinion, carried on by the administration for the 'restoration of the Union as it was' nor for 'the Constitution as it is' but for the abolition of slavery, an object as morally and socially wrong, as it is unconstitutional."[34] In their view, he had mismanaged the war to such a point that he was no longer entitled to respect or worthy of confidence. These Democrats believed the war was a waste of money and lives. Strongly opposed to the draft, they claimed the people were under no legal, patriotic, or religious obligation to support the war. Levi Tate, editor of the *Columbia Democrat*, who held similar views, charged the administration with subverting the fundamental purpose of the war. "The war is for the abolition of slavery, not for the union as it was, not for the Constitution as it is, not for the purpose avowed;" then, using a racial slur, it had ". . . a different and unconstitutional purpose, a nigger war." To support this view, he cited the congressional resolution passed at the outset of the conflict that defined the purpose of the war. It read in part:

> This war is not waged on their part in any spirit of oppression or for any purpose of conquest or subjugation or purpose of overthrowing or interfering with the rights of established institutions of those States, but to defend and maintain the supremacy of the Constitution, and to preserve the Union, with the dignity, equality, and rights of the several States unimpaired; and that as soon as these objects are accomplished the war ought to cease.[35]

When President Lincoln ordered two draft calls for new troops to the states in the summer of 1862, Governors using bounties made every effort to induce volunteer enlistments, hoping to avoid a state draft. The likelihood that states might use a draft to meet their quotas prompted many to flee to Canada. When Pennsylvania decided it would have to use the draft, Governor Andrew Curtin informed Washington that there was strong resistance.[36] By the end of 1862 the number of volunteers had sharply declined. Military service entailed significant personal sacrifices if one had a family, ran a farm, or owned a business. Wartime industries attracted many workers with wages substantially higher than a soldier's paltry pay. At the same time there was a growing agitation against the war led by the Peace Democrats and other dissenting voices. This became a contributing factor in discouraging individuals to volunteer.[37]

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32 *Legislative Record,* 274.

33 Petitions for a Constitutional Convention, Record Group 7, Records of the Senate, Senate File, Box 66, Session 1, 1863, Pennsylvania Historical Commission and State Archives, Harrisburg, Pennsylvania.

34 *Columbia Democrat*, April 11, 1863

35 *Columbia Democrat,* May 9, 1863

36 Jack Franklin Leach, Conscription in the United States: Historical Background (Rutland, Vermont: Charles E. Tuttle Publishing Company, 1952), 138-148, 147.

37 Leach, 158-159.

With the decline in volunteering, governors were not very successful in meeting federal requisitions for using state militias, and a new method had to be employed to meet the manpower needs for the Union armies. Congress' answer to this problem was to pass a national conscription law on March 3, 1863, known as "An Act for Enrolling and Calling Out the National Forces, and for Other Purposes." Those liable for the draft were male citizens between the ages of twenty and forty-five, and were divided into two classes, all who were between the ages of twenty and thirty-five and those unmarried from thirty-five to forty-five. The second group could not be drafted until the others had been called. The law exempted the physically and mentally unfit, any son responsible for taking care of aged and infirm parents, a brother whose siblings were orphaned and under the age of twelve, and a father of motherless children who were less than twelve years old. It also stipulated that when two members of a family were serving in the military, there could be up to two exemptions for any family members liable for service. If a man were drafted, he could avoid service either by paying a commutation fee of $300 to the government or by hiring an acceptable substitute to take his place.[38] Therefore, men with money could buy their way out of the draft, which gave rise to the charge that "blood money" made the Civil War a "rich man's war, poor man's fight." This attitude prompted a parody of a popular recruiting song: "We're coming, Father Abraham, three hundred thousand more. / We leave our homes and firesides with bleeding hearts and sore. / We are the poor who have no wealth to purchase liberty."[39] Conscription became an important political and class issue that divided the two parties: 88% of the Democrats voted against the 1863 draft law while all of the Republicans supported it. Democrats opposing the Lincoln administration combined conscription and emancipation into a major partisan argument and condemned "the draft as an unconstitutional means to achieve the unconstitutional end of freeing the slaves."[40]

Columbia County Democrats who met at Stillwater a month after the passage of the draft act attacked the law as being unjust. Drawing attention to those with wealth who could buy their way out of the draft, they argued: ". . . it consigns the poor man to the hardships and dangers of the battlefield."[41] As conservative Democrats, they also saw the law as an invasion of states rights. In another meeting two weeks later at Jerseytown, they developed this idea further: "A war carried on contrary to the rules and provisions of that instrument [the Constitution], whether it be a crusade against slavery, or any other fanatical or delusory scheme, never can and never will receive our support."[42] They disputed the idea that the federal government had the authority to impose a draft and argued that national compulsory service was antithetical to the nation's history. The *Columbia Democrat* also subscribed to this idea by denouncing forced conscription as contrary to the customs and traditions of Americans: "It has been our pride and our boast that unlike the monarchies of the old world, our government has never been compelled to resort to a conscription of its citizens. . . ."[43]

Administering the draft became the responsibility of the Provost Marshal General's Office of the War Department. Each congressional district became a draft district for enrolling prospective draftees and conducting the draft.[44] This organizational approach alarmed the *Columbia Democrat*, for it saw

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38 George P. Sanger, ed., *Public Laws of the United States of America, Passed at the Third Session of the Thirty-Seventh Congress; 1862-1863* (Boston: Little, Brown, and Company, 1862), 731-733. Hereafter, cited as *Public Laws of the United States. Columbia Democrat* (Bloomsburg, Pennsylvania), August 20, 1864. Due to public hostility to the idea that one could buy one's way out of the draft, Congress repealed the commutation provision in July 1864. Eugene C. Murdock, *One Million Men: The Civil War Draft in the North* (Madison: The State Historical Society of Wisconsin, 1971), 6.

39 Philip Foner, *History of the Labor Movement in the United States: From Colonial Times to the Founding of the American Federation of Labor* (New York: International Publishers, 1947), 322.

40 McPherson, 608-609.

41 *Columbia Democrat,* April 11, 1863.

42 *Columbia Democrat,* April 25, 1863.

43 *Columbia Democrat,* April 4, 1863.

44 *Public Laws of the United States,* 732.

Washington superimposing its military authority over the states and threatening civilian government: "It is an exaggerated copy of the military organization under which despotism reigns in Russia and France."[45] The law stipulated that the Provost Marshal had the authority to arrest anyone who resisted the draft, counseled others to oppose the, draft, obstructed the operation of the draft, and engaged in treasonable practices.[46] The *Columbia Democrat* also objected to these provisions, believing that people's constitutional guarantees to discuss freely and express their opinions openly were now in jeopardy. It felt the Lincoln administration wanted to stifle or prevent any public debate of the draft law and would arrest those who opposed it: "All who question it, in either aspect, it denounces as traitors, deserving of summary punishment. It has encouraged political leagues and its blind partisans in heaping obloquy upon those who dare express their opinions upon the subject, and insulting them in every possible form."[47]

Another criticism leveled against the draft centered on its adverse impact on the state militia. The law gave the federal government the authority to mobilize the nation's military forces, a fundamental break from past practices of relying on the state militias called into service by the President. A conflict arose between those who thought that the central government had the power to enforce direct conscription and those who argued that it infringed upon state sovereignty, the right of a state to control its manpower resources.[48] Since all able-bodied men between the ages of twenty and forty-five were subject to conscription, states could be deprived of the means to maintain their militias. The *Columbia Democrat*, a staunch defender of the militia system, believed this was possible. Arguing that the Constitution distinctly recognized the states' militias, the paper said that enacting a national draft constituted a usurpation of the rights of states and a threat to liberty. It expressed concern that with the weakening of the militia system, the states would lose their ability of self-defense. States would become prostrate before the federal government. To rectify this perceived danger, the newspaper urged that the law be challenged in Pennsylvania's courts.

A legal test of the national draft law did occur when the Pennsylvania Supreme Court agreed to hear three similar cases involving three men drafted from Philadelphia, known as *Kneedler vs. Lane* on September 23, 1863. Only the plaintiffs presented their arguments in the case since federal government chose not to appear in court, taking the position that a state court lacked the authority to rule on the constitutionality of the draft. The court nevertheless rendered a decision: voting three to two, on November 9, 1863, the federal draft was unconstitutional and granting a preliminary injunction to prevent the plaintiffs from being inducted into the army.[49]

The majority held that Congress did not have constitutional authority to enact a federal draft law. The justices did not believe the constitutional provision, Article I. Section 8, that "congress shall have the power to raise and support armies," gave it the right to pass a conscription law. Chief Justice Walter

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45 *Columbia Democrat*, April 4, 1863.

46 *Public Laws of the United States*, 735.

47 *Columbia Democrat*, May 9, 1863.

48 Leach, 168.

49 *Pennsylvania State Reports, Comprising Cases Adjudged in the Supreme Court of Pennsylvania,* Vol. 9. (Philadelphia: Kay & Brother, 1864), 238-274. Hereafter, cited as *Kneedler vs. Lane.* Justice George W. Woodward of Wilkes-Barre, who was part of the court's majority which declared the federal draft law unconstitutional, had also been the Democratic candidate in the October 1863 gubernatorial election. Andrew Curtin, incumbent Republican governor, defeated him in a close election. Woodward, a Copperhead, did not think the Civil War could be won on the battlefield, and he saw the national crisis as a threat to states rights. "He shared the peace Democrats' antipathy toward greenback currency, arbitrary arrests, the denial of the writ of *habeas corpus*, the suppression of anti-administration newspapers and a federal conscription act." Arnold Shankman, "For the Union As It Was and the Constitution As It Is: A Copperhead Views the Civil War," *Rank and File: Civil War Essays in Honor of Bell Irvin Wiley,* eds. James I. Robertson, Jr. and Richard M. McMurry (Rafael, California: Presidio Press, 1976), 101. For a review of various court cases concerning the constitutionality of the draft law, see Leach, chapter 14: "Constitutionality of the National Conscription; Some Opinions and Decisions."

Lowrie argued that if the government is free to use conscription to recruit an army, the Constitution provides ". . . no regulation or limitation of the exercise of the power, so as to prevent it from being arbitrary and partial, and hence we infer that such a mode of raising armies was not thought of, and was not granted."[50] Specifically, there was no enumerated power to sustain a conscription law. With Americans fearing standing armies, Justice Woodward asserted that the nation's history and tradition interpreted the power to raise armies as being solely based on voluntary enlistments.[51]

Since the Lincoln administration had chosen not to participate in the case, it also refused to acknowledge the Pennsylvania Supreme Court's ruling; therefore, the draft continued without interruption. Further, Republicans were unconcerned about the decision due to the outcome of the recent judicial elections: David Agnew, a Republican and strong supporter of the war, defeated Democrat Chief Justice Lowrie.[52] With a new justice, the defendants sought an order to dissolve the preliminary injunctions of a month earlier. The new majority, three to two, on January 16 upheld the constitutionality of the draft and rejected the plaintiffs' arguments that their rights had been unlawfully invaded. Peace Democrats were disappointed and saw the court's reversal as an act of submission to federal despotism.[53]

The national draft law required persons subject to military duty to be enrolled, noting their place of residence, occupation, and age on July 1, 1863. It was a formidable task to secure this information; enrolling officers had to canvass the district, in essence, to conduct a door-to-door census. It was the hope that people would cooperate; however, Pennsylvania had serious problems with enrollment.[54] Samuel F. Pealer, an enrolling officer in Columbia County, encountered hostile threats at the Stillwater mill when he attempted to register four men. They refused to answer his questions, and ordered him to leave the mill, one threatening to knock his brains out. After this intimidation he left but was later warned that he was in danger of being attacked.[55] The Provost Marshal for the 13th District, which included Columbia County, reported that the draft headquarters at Troy was broken into on July 18,1863, and all of his papers stolen; consequently, much of the enrollment had to be done again.[56]

In Columbia County, Dyer C. Moss, a resident of Sugarloaf Township, described a political meeting at Moore's Schoolhouse where Levi Tate, the speaker, told his audience that ". . . not a man or a dollar until the administration was changed. He also said ". . . that they should obey all constitutional laws but that the conscription act was unconstitutional law."[57] Moss indicated that a neighbor, John Moore, told him ". . . that he would die at his own door before he would go to war if he was drafted."[58] The quota for Columbia County on June 3, 1864, was for 618 men. When the draft board met in Bloomsburg from late June to early July 1864, it became apparent that opposition to the draft was real. The *Columbia Democrat* estimated that about three-fourths of those called did not appear for induction; another local newspaper, *Star of the North*, indicated that large numbers of men from the townships were not reporting.[59] In an editorial it denounced the draft.

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50 *Kneedler vs. Lane*, 243.

51 *Kneedler vs. Lane*, 255.

52 Nicholas B. Wainwright, "The Loyal Opposition in Civil War Philadelphia," *Pennsylvania Magazine of History and Biography* 88 (1964): 308-309.

53 *Kneedler vs. Lane,* 295-296; Shankman, 106.

54 *Public Laws of the United States,* 733. Murdock, 43.

55 Statement by Samuel Pealer, U.S. Army Continental Commands, 1821-1920, Department of the Susquehanna and Pennsylvania, Judge Advocate General, Letters and Reports Received, January 1863 to October 1864, National Archives, Washington, D.C.

56 Itter, 152.

57 Statement by Dyer Moss, U.S. Army Continental Commands, 1821-1920, Department of the Susquehanna and Pennsylvania, Judge Advocate General, Letters and Reports Received, January 1863 to October 1864, National Archives, Washington, D.C.

58 Statement by Dyer Moss.

59 *Columbia Democrat,* June 11 and July 2, 1864; *Star of the North* (Bloomsburg, Pennsylvania), June 29, 1864.

> This thing of drafting for soldiers is about played out. In some districts nearly all report themselves, and get “exempted" or pay “commutation,” while in other districts very few are paying any attention to the "draft." We say the thing is about run into the ground! What will be tried next? Undertake to hunt up and arrest these men who have not reported? That would not pay. They could not be found; or at least enough of them to make it profitable to the "Government.” Ever since Abe Lincoln has waged war for the freedom of the negro, and subjugation of the South, he has had difficulty in getting soldiers to fight his battles.[60]

A resident in Orangeville writing to a friend in the army remarked that with the draft taking place, people were leaving the area, perhaps going to Canada: "I am thinking that if we were to go there we would feel quite at home, among so many of our Pennsylvanians."[61]

Lincoln on July 18, 1864, issued a draft call for 500,000 men. This became the third draft call in the same year when he had earlier order drafts in March for 200,000 and in April for 85,000.[62] This prompted the *Columbia Democrat* to complain that "Five hundred thousand poor men are to be torn and dragged from their families in the beginning of winter, leaving them to freeze and starve. . . .”[63] In the Provost Marshal's report for the 13th District, March 11, 1865, Captain Thomas E. Douglas wrote that there were 1,800 deserters in the district. He felt that if the Provost Marshal had had a military force of at least twenty soldiers, the number of deserters could have been reduced by one-third. The exact count of draft evaders in Columbia County is unknown, but clearly many men resisted the draft in Fishing Creek, Benton, Sugarloaf, Jackson, and Pine townships.[64] John G. Freeze, a Bloomsburg attorney and prominent Democrat, maintained that Columbia County, as well as the congressional district, had been subjected to unfair drafts due to excessively high quotas. There was a strong feeling that the War Department attempted ". . . to draw from the district nearly three times as many men as we were honestly obliged to furnish."[65] The complaint, which Freeze described as an "egregious outrage," stemmed from the failure of the Provost Marshal's office to credit the district for numerous volunteers who entered the army outside the district. Men from Columbia County often volunteered for military service from other counties due to higher bounties paid to increase enlistments.

Disenchantment with the war grew in the spring of 1864 with the news of the North's costly military campaign in Virginia. General Ulysses G. Grant had instituted a major offensive against the Army of Northern Virginia, commanded by General Robert E. Lee, located south of Washington and west of Fredericksburg, along the Rapidan and Rappahannock Rivers. Hopes grew that Grant, who had a successful military record in the West and an army of 115,000, compared with Lee's 64,000, would achieve a major military victory, defeat Lee, capture Richmond, and end the war. But after four major battles, Wilderness, Spotsylvania, Cold Harbor, and Petersburg, from early May and until mid-June Lee's army remained undefeated, and the Confederates still held Richmond. From these engagements the combined Union casualties, dead and wounded, came to 54,929, or forty-five percent of Grant's

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60 *Star of the North*, July 6, 1864

61 Aggie Montgomery to Perry DeLong, November 12, 1864. This letter is in the possession of Mrs. Carolyn Karas of Orangeville, Pennsylvania.

62 Mark M. Boatner, *The Civil War Dictionary* (New York: David McKay Company, 1959), 858.

63 *Columbia Democrat,* July 23, 1864.

64 Captain Thomas E. Douglas, Acting Provost Marshal for the 13th District of the State of Pennsylvania, Historical Report of the 13th District State of Pennsylvania, to Brig. General James F. Fry, Provost Marshal General, March 11,1865. Historical Reports of the State Acting Assistant Provost Marshals General and Districts Provost Marshals, 1865, National Archives, Washington, D.C. J. H. Battle, ed., *History of Columbia and Montour Counties, Pennsylvania* (Chicago: A. Warner & Co., 1887), part 2, 129.

65 John G. Freeze, *A History of Columbia County, Pennsylvania* (Bloomsburg, Pennsylvania: Ewell and Bittenbender Publishers, 1883), 238.

forces, a heavy toll. The Confederate losses were 27,000, numerically far less than the Union's, but high in that they accounted for forty percent of Lee's army.[66]

Columbia County opponents of the war sought to capitalize on the terrible losses. In a letter written by R. Broadt to a friend, he observed that around Jerseytown the peace Democrats, called Copperheads, were exaggerating the Union casualty figures: "The Copperheads tell war lies as bad as ever. They estimate Grant's loss at from 60 to 80,000 and Lee's lads slight. Judge Evans reports Grant's loss at 100,000 and the army all cut to pieces. . . ."[67] Expectations that Grant would win the war by early summer quickly faded. Instead, he was severely criticized for ordering frontal assaults on strongly held defensive positions and tolerating such horrendous casualties. His critics called him the "butcher."[68] In another major Union attack that also began in May, General William T. Sherman began to move south from Chattanooga toward Atlanta. However, by the end of June his campaign had met strong resistance from the Confederates, who inflicted more casualties on the North with another 20,000 dead and wounded.[69]

May and June saw Northern hopes for an early end to the war drowned in the sorrows of some 75,000 casualties. Editor Tate of the *Columbia Democrat* expressed a sense of despair.

> For more than three years this nation has been torn and desolated by a civil war, as fierce as any which history records. Its soil has been watered by the blood of contending armies. Hundreds of thousands of men have died on the field of battle or wasted away in camps and hospitals. The wail of mourning goes up from almost every household. The property created by the sweat of years of labor has been wasted, and that to be acquired by the toils of unborn millions is mortgaged to defray the cost of this terrible and unnatural struggle.[70]

By the summer of 1864 the Columbia County Peace Democrats were well known for their criticism of President Lincoln's policies and conduct of the war. The political debate between the Republican and Democrats had become polarized, and the bipartisanship exhibited at the outbreak of the war had long disappeared. The Republicans questioned the loyalty and patriotism of the Democrats. In turn, the Democrats called the Republicans "abolitionists" who were responsible for causing a sectional division in the country that prompted the Civil War and their determination to alter the nature of the war from one to save the Union to a crusade to end slavery. Racial views of the Peace Democrats prevented them from embracing a human rights program that would purge slavery from the American society. It was now the fourth summer of a never ending war. War weariness was felt by many as the cost of the conflict continued to increase, casualty figures mounted to where there were thousands who had died, and those who survived their wounds would forever bear the physical and psychological marks of combat. For the first time in the nation's history, the national government had the authority to impose a draft that could force individuals to fight in a war they opposed. Peace Democrats were not pacifists nor were they Confederate sympathizers when they denounced the draft. It came from their belief that it

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66 Shelby Foote, *The Civil War: A Narrative,* Vol. 3 (New York: Random House, 1974), 310.

67 R. Broadt to J. Thomas, July 6, 1864. This letter belongs to Jeffrey Girton who lives in Mifflinville, Pennsylvania. "Copperheads" became a common term during the Civil War to describe Peace Democrats who opposed Lincoln's war policies. The term first appeared in the *New York Tribune* editorial on July 20, 1861: "A rattlesnake rattles, a viper hisses, an adder spits . . . but a copperhead just sneaks." Their views on the war were often depicted as being treasonable, such as advocating a negotiated resolution of the conflict.

68 James M. McPherson, *Ordeal by Fire: The Civil War and Reconstruction* (New York: Alfred A. Knopf, Inc., 1982), 423.

69 J. G. Randall and David Donald, 425.

70 *Columbia Democrat,* July 30, 1864. There were at least forty-five anti-administration newspapers in Pennsylvania. William Itter, "Conscription in Pennsylvania During the Civil War," (Ph.d dissertation, University of Southern California, 1941), 162.

was unconstitutional. They were political conservatives who saw national conscription as an example of a growing enhancement of federal power which they feared.

It is in this contentious political environment, the Peace Democrats or Copperheads, were holding political meetings in the northern regions of the county where there was an overwhelming majority of Democrats. The speeches denounced the Republican war policy, and in particular, expressed a defiant attitude toward the draft. At these meetings, some secret, people took an oath to "support the Constitution as it is and the Union as it was." The oath encompassed a political statement. The Constitution should be understood from a strict constructionist viewpoint, a literal reading that embraced the exact meaning of the words rather than a liberal or implied interpretation. "The Union as it was;" it was a vision that looked to the past rather than the future. The Union was static, incased in a status quo environment that was unchanging. This was an entirely different outlook from the Republicans who embraced change.

Daniel McHenry, Columbia County Treasurer and a speaker at one of the meetings, implied that if a person were drafted, he should not report; he told his audience that the quickest way for the people to end war was to refuse to enter the army and not to pay taxes. He chided the men by praising the women for their bravery in driving off the enrolling officers when they came to their homes. Levi Priest of Benton said that Rohr McHenry, a Columbia County Commissioner, believed that the drafted men were determined not to go into the army, a decision he personally supported, feeling it was wrong to drag men away from their families. According to participants, the meetings took on the character of a secret organization with the intention to protect and give assistance if someone got into trouble with the draft. If difficulties occurred, members would use various signs to communicate with each other. When coming to a member's house at night, one knocked three times on the door. To recognize a member in the dark, one would say "bear" and the other person would respond by saying "bear" and then both would say "wolf." A signal used in daytime to indicate that one was a member was to run a hand along the coat collar.[71]

Another critic in the area was Rev. Alvah R. Rutan, who was emphatic in his denunciation of Lincoln and his war policy. William Forbes reported that Rutan told him "he would like to see a ball put through old Abe Lincoln's heart, and if he had an opportunity he would do it himself.[72] Seth Dodson affirmed Forbes' statement and added that the outspoken minister did not blame those who resisted the draft and refused to fight to free the slaves. Rutan argued that Lincoln was entirely at fault for the war and if the Democrats controlled the government, the war would soon come to an end.[73]

An incident at a church service at the North Mountain Schoolhouse, north of Benton, on July 30, 1864, illustrated the polarized attitudes over the war. The minister, Rev. P. F. Eyer, had his sermon disrupted when a group of six to eight men, described as being drunk, ". . . came to the door and began cursing and swearing . . . uttering the fiercest oaths . . ." and one called out, 'I learn that you are an abolition preacher, and if you are we will take you out and hang you on this hickory tree, but if you are a democrat preacher you can preach on.'"[74] Due to their abusive and disruptive behavior, he could not

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71 Information concerning the draft resistance in the northern part of Columbia County comes from sworn and subscribed statements made by thirty residents from the area who were knowledgeable about the opposition to the Civil War. Captain Bruce Lambert, 100-Days Mounted Pennsylvania Volunteers, and Colonel Charles Albright, 202nd Regiment of Pennsylvania Volunteers, solicited these statements. Lambert and Albright collected them after the federal troops arrived in Columbia County in August 1864 to suppress resistance to the draft. U.S. Army Continental Commands, 1821-1920, Department of the Susquehanna and Pennsylvania, Judge Advocate General, Letters and Reports Received, January 1863-February 1865, National Archives, Washington, D.C.

72 U.S. Army Continental Commands, 1821-1920, Department of the Susquehanna and Pennsylvania, Judge Advocate General, Letters and Reports Received, January 1863-February 1865, National Archives, Washington, D.C.

73 U.S. Army Continental Commands, 1821-1920, Department of the Susquehanna and Pennsylvania, Judge Advocate General, Letters and Reports Received, January 1863-February 1865, National Archives, Washington, D.C.

74 Rev. P. F. Eyer to Captain Francis Wessels, Acting Judge Advocate for the Department of Susquehanna and Pennsylvania, September 8, 1864. Rev. P. F. Eyer to Col. Charles Albright, 202nd Regiment of Pennsylvania

finish his sermon. The intruders attempted to drag Eyer from the pulpit and take him outside to the rest of the group, who were armed and whom he felt would do him great harm. However, two members of the congregation came to his assistance and enabled him to escape through a back window to safety.[75] Eyer saw this intrusion as a threat to anyone who supported the Lincoln administration and its war policy. To him, being a Democrat in Columbia County meant opposition to the draft, hostility to the government, and placing one's party above the country. Reuben Larish, a church member who witnessed the affair, said that Montgomery Cole, a prominent Democrat and justice of the peace in the township, was responsible for bringing the men to the schoolhouse to disturb the church service, and that Rev. Eyer was threatened because he supported the Union cause.[76]

In this politically tense milieu, the *Star of the North* announced in late June 1864 that the draft board was in session at Bloomsburg, and a large number of men living in the townships had not reported. The *Columbia Democrat* on July 2 noted about one-fourth of those drafted had failed to appear before the board.[77] Williamson H. Jacoby, editor of the *Star of the North*, made the following assessment of the draft: "The thing of drafting for soldiers is about played out. In some districts nearly all report themselves, and get 'exempt' or pay 'commutation' while in other districts very few are paying any attention to the 'draft.' We say the thing is about run into the ground!"[78] The government announced another new draft call on July 18, 1864, for 500,000 men. At the same time rumors circulated that there were several hundred draft deserters in Columbia County.[79]

Solomon Taylor, a Luzerne County Deputy Provost Marshal who lived in Fairmont Township, which bordered Benton Township in Columbia County, asked James Stewart Robinson (Figure 35) to help him apprehend army deserters and those who had failed to report to the draft. Robinson, a Civil War veteran, had recently returned home after serving for three years as member of Company F, 37th Regiment, Pennsylvania Infantry. He had advanced in rank from private to first lieutenant. Taylor also enlisted five others to join them. One account described them as Republicans from the Harveyville area in Luzerne County.[80]

Figure 35. James Stewart Robinson a member of a Provost Marshal party that searched for draft evaders in Raven Creek Valley, Benton Township, Columbia County. From H. C. Bradsby, ed., *History of Luzerne County, Pennsylvania with Biographical Selections* (Chicago: S. B. Nelson & Company,1893), 415.

Volunteers, September 26, 1864. U.S. Army Continental Commands, 1821-1920, Department of the Susquehanna and Pennsylvania, Judge Advocate General, Letters and Reports Received, January 1863-October 1864, National Archives, Washington, D.C.

75 U.S. Army Continental Commands, 1821-1920, Department of the Susquehanna and Pennsylvania, Judge Advocate General, Letters and Reports Received, January 1863-February 1865, National Archives, Washington, D.C.

76 Reuben Larish Sworn and Subscribed Statement, September 27, 1864, made to Col. Charles Albright, 202nd Regiment of Pennsylvania Volunteers. U.S. Army Continental Commands, 1821-1920, Department of the Susquehanna and Pennsylvania, Judge Advocate General, Letters and Reports Received, January 1863-October 1864, National Archives, Washington, D.C.

77 *Star of the North*, June 29, 1864 and *Columbia Democrat*, July 2, 1864.

78 *Star of the North*, July 6, 1864

79 *War of the Rebellion: A Compilation of the Official Records of the Union and Confederate Armies* (Washington, 1880-1901) Series III, Vol. IV, 607.

80 Russell Buckalew, Sworn and Subscribed Statement, September 29, 1864, made to Col. Charles Albright, 202nd Regiment of Pennsylvania Volunteers. U.S. Army Continental Commands, 1821-1920, Department of the Susquehanna and Pennsylvania, Judge Advocate General, Letters and Reports Received, November 1864-February 1865, National Archives, Washington, D.C. Hereafter, cited as Buckalew Sworn and Subscribed Statement.

The group started from the village of Fairmont Springs on July 30, 1864, to conduct a search in Columbia County. Unable to find Gomer Smith, a deserter from Sugarloaf Township, Taylor and his men sought another deserter, Thomas Smith, in the Raven Creek area of Benton Township. It was dark when they arrived at his house, between ten and eleven o'clock, and before they could surround it, Smith, hearing them, escaped into a cornfield. Then his wife set the dogs loose and went to the second floor window and blew a horn to alert the neighborhood. Foiled in their attempt to arrest Smith, the group returned to the main road when they heard people approaching them from a distance. Robinson told his party to stay on both sides of the road while he ordered the people to stop. When the party neared, he called on them to halt, and Taylor yelled "no firing"; but three shots were fired, and one hit Robinson. His comrades surprised by the attack, thrown into confusion, and coming to the aid of their friend, were unable to apprehend the attackers as they fled the scene.[81] Robinson was taken to a nearby home where a physician discovered a buckshot wound in the abdomen. The wound did not heal properly and as a result peritonitis developed which took his life. Robinson died at the age of twenty-nine.[82] His grave (Figure 36) is at Bethel Hill Cemetery in Fairmont Township, the inscription carved on the tombstone told of this death: "Was shot by a Rebel sympathizer in Benton Tp. Columbia Co., Pa., while assisting a U.S. officer in attempting to arrest deserters, July 31, and died of the wound, November 3, 1864." At the time when he was shot and when he died, no one had been arrested and prosecuted for the murder.[83]

Figure 36. Robinson's grave is in the Bethel Hill Cemetery, Fairmont Township, Luzerne County. It can be front in the front section of the cemetery near road.

The *Columbia Democrat* reported the incident and hoped that Robinson would recover. Its account, relying on statements by Robinson's friends, indicated that three men attacked the Provost Marshal's party, which returned the fire to no avail. The paper made a critical observation that there probably would have been little trouble if the deputies had not ". . . required might, secrecy, and arms.[84] The newspaper called the group "Lincoln Midnight Raiders.[85]

Despite a great deal of excitement over the shooting, the person or persons responsible for the shooting remained unidentified. Three weeks after the incident the paper published an anonymous letter, signed "A Democrat," from a person who lived in the area where the incident occurred.

> All we ask is to be let along that we may peaceably pursue our various vocations. We would have it understood, also, that the people do not intend to suffer themselves to

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81 Buckalew Sworn and Subscribed Statement. H. C. Bradsby, ed., 1296. *Columbia County Republican* (Bloomsburg, Pennsylvania), September 17, 1891.

82 *Columbia County Republican* September 17, 1891. *The Daily News-Dealer* (Wilkes-Barre, Pennsylvania), March 18, 1891.

83 Twenty-seven years later, the Sheriff of Luzerne County arrested Ellis Young who lived in Jackson Township, Columbia County, for the murder of Robinson on March 16, 1891. After a three day trial in Wilkes-Barre, the jury found Young not guilty of the charge on September 18, 1891. *Columbia County Republican*, March 19, 1891 and *The Daily News Dealer* (Wilkes-Barre, Pennsylvania), September 19, 1891.

84 *Columbia Democrat,* August 6, 1864.

85 *Columbia Democrat,* August 6, 1864.

> be draged [sic] from their homes by force to fight for the "Abolition Slavery." Let those who inaugerated [sic] the war, for this purpose, go and fight, and not hang back like cowards. They have made war on the principles upon which our Government was founded, and now ask us to aid in destroying these very principles. This should not be done.[86]

Prior to the Robinson shooting, draft officials at the state and national levels had growing concerns about problems in administering the new draft call issued on July 18 to add 500,000 more men to the army. Eli Slifer, Secretary of the Commonwealth, wrote to James B. Fry, Provost Marshal General, on July 20, 1864, informing him about increased opposition to the draft. "There are localities in which men drafted under former calls of the President refuse to respond and openly defy the Government. It is boldly threatened in a number of counties that the coming draft shall not be enforced."[87] The Board of Enrollment for the 13th Pennsylvania Congressional District (which included Columbia County) sent a request to Captain Richard I. Dodge, Acting Assistant Provost Marshall-General for the Western Pennsylvania, four days after the Robinson affair for the deployment of troops in Columbia County to help enforce the draft and suppress riotous events.[88] Dodge on August 10 wrote to Fry informing him about opposition to the draft in Columbia County. He described a rather bleak situation in the county. As many as 500 men were involved in an organized resistance to the draft and they are armed. "These men are encouraged in their course and assisted by every means by the political opponents of the Administration. The provost and assistant provost marshal are powerless to effect anything, having no force."[89]

Dodge referred to friends of the government who provided information from different parts of the state about individuals who have encouraged and supported those with a defiant attitude in ignoring the right of the government to implement a draft. Failure to act immediately and with appropriate force would create difficult problems for the forthcoming draft. He felt it was important to suppress draft resistance so that the proposed September draft might be carried out without any serious opposition. He proposed the following plan:

> Enter one county with a force sufficiently strong not only to put down but to overawe resistance; to remain in that county until every deserter, delinquent drafted men, and abettor of rebellion be arrested or run out of the county. When that is done, proceed to another. By this means bloodshed, in which there is the greatest danger, will be avoided, and the moral effect of the complete and bloodless subjection of the county will render success in every other county more certain and easy.[90]

Officials feeling a sense of urgency to address the draft problems in Columbia County adopted his plan. It was a surprise to Bloomsburg citizens to see troops getting off the train on August 13 and again three days later. The fairgrounds became the home for a force of about 300 soldiers which eventually became larger. The *Star of the North* commented about the new arrivals in town: "What is proposed for them to do in this county, we, of course, are not informed. Their object may be to intimidate Democrats, arrest drafted men, or to make the Abolitionists of the county feel more secure in their lives and property." A week after the first soldiers arrived, the entire assemblage with around 500

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86 *Columbia Democrat,* August 20, 1864.

87 Eli Slifer to James B. Fry, Provost Marshal General, July 20, 1864. Record Group 26, Records of the Department of State, Box 24, Records of the Secretary of Commonwealth, Folder, July 1864, Pennsylvania Historical Commission and Archives, Harrisburg, Pennsylvania.

88 Office Provost Marshal for 13th District of Pennsylvania to Captain Richard I Dodge, Acting Assistant Provost Marshall-General for the Western Pennsylvania, August 4, 1864. Record Group 110, Proceedings of the Board of Enrollment, 13 District Pennsylvania, Volume 12, National Archives, Washington, D.C.

89 *Official Records*, Series III, Vol. IV, 607.

90 Official Records, Series III, Vol. IV, 607.

men marching out of the town on Sunday morning, August 21, heading to the northern townships to suppress the opposition to the draft. There were countless rumors that once the troops arrived in the northern townships they would be met with armed resistance. This threat never materialized. Colonel Stewart in charge of the troops wrote to his superior officer, General Couch, Commander of the Susquehanna Department, indicating they encountered no resistance upon arriving in the Benton area and had been well received.[91] Troops patrolled the area in search of groups of deserters and an alleged fort in the mountains. After more than week of reconnaissance, nothing was found. At the same time military officials were collecting names of individuals from the local inhabitants who had information about the Peace Democrats and who opposed the draft.

Early in the morning of August 31, squads of soldiers arrived at several homes throughout the area and seized one hundred citizens. They were taken to a church in Benton for interrogation regarding their political views and attitudes about the draft. By early afternoon forty-four individuals were under military arrest but were not informed of the charges against them.[92] Escorted by soldiers, they were forced to march eighteen miles to Bloomsburg. Here they were put on a train that took them to Harrisburg and from there to Philadelphia. From the time of their detention and during their long ordeal going to Philadelphia, their captors had not provided them with any food. Their final destination was the prison at Fort Mifflin (Figure 37), south of Philadelphia along the Delaware River.[93] James McHenry, a merchant and one of the prisoners, wrote a letter to his family expressing his dismay of having been put in prison.

Figure 37. The Columbia County prisoners arrested by military authorities were imprisoned in Fort Mifflin. The picture was taken atop of the fort's western wall, and in the background is the Philadelphia skyline. Near the white flag pole are two entrances to the prison cells.

> "I confess I felt gloomy, for my life, I could not imagine what I was brought here for. Having all my life been taught and endeavored to obey all legally enacted laws of my country, reserving the right to freely criticize the acts of the Administration and as well as those that preceded it, without the least thought of violating the laws of the land."[94]

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91 Lieutenant Charles Stewart to General Darius Couch, August 23, 1864. Record Group 393, Department of Susquehanna and Pennsylvania Letters Received: 1863 to 1864, National Archives, Washington, D.C.

92 John G. Freeze, 398-400. This a list of the 44 individuals arrested: Mathias Appleman, Reuben Appleman, Samuel Appleman, Thomas Appleman, William Appleman, John Baker, Silas Benjamin, Dyer L. Chapin, Montgomery Cole, Charles Coleman, Joseph Coleman, Josiah Coleman, Samuel Coleman, Benjamin Colley, Scott E. Colley, Arwillis Davis, John R. Davis, James Evans, Hiram E. Everett, Valentine Fell, Abram Hartman, George Hurliman, H. H. Hurliman, Henry Hurliman, William Hurliman, John Karns, John C. Karns, Abraham Kline, Mathias Kline, Samuel Kline, John Lemon, Daniel McHenry, Elias McHenry, Elias J. McHenry, James McHenry, Rohr McHenry, Russell McHenry, Samue McHenry, John Rantz, William E. Roberts, Jonathan Steele, John J. Stiles, Joseph Van Sickle, and John Yorks. In a letter written by James McHenry he states there were actually 45 arrested rather than 44. "After arriving within the Fort it was found that there was one man more than there were names on the roll, consequently Silas McHenry was released and sent home. Letter appeared in the *Star of the North*, October 7, 1864.

93 John G. Freeze, 398-399.

94 Letter appeared in the *Star of the North*, October 7, 1864.

Who were these forty-four men taken from their homes by the military? Were they riff-raff" of the countryside? Definitely not, many were prominent people in their community and with good reputations. One newspaper account characterized the men as: "No more civil, law-abiding, honest and upright set of people can be found in the county, than just these people the Abolitionists have seen fit to wreck their vengeance upon."[95] Their average age was forty; the oldest person was Joseph Coleman, sixty-eight and a veteran of the War of 1812; the youngest was Arwillis Davis, age nineteen. Only fourteen were eligible for the draft, twenty to thirty-five years old. Thirty were farmers, six tradesmen, four merchants, two laborers, and one each an innkeeper and one distiller. Daniel McHenry was the Country Treasurer, Rohr McHenry was a County Commissioner, and Dyer L. Chapman was Justice of the Peace and had been a member of the Pennsylvania General Assembly. Others had or held local township offices.[96]

After a month and half in prison the government began releasing twenty some prisoners on parole after they took an oath of allegiance to the country. Military commissions would prosecute twelve men involved in obstructing and encouraging resistance to the draft. They would be tried for violating the federal Enrollment (Draft) Act, sections twenty-four and twenty-five. These provisions made it illegal for any individual to attempt or entice a person to avoid the draft or desert from his military unit. It was also against the law for an individual eligible for enrollment to resist or refuse to serve.[97] The commissions found seven defendants guilty with the remaining five not guilty. The punishment included imprisonment from six months to two years. There was one case in which the sentence was a $1,000 fine or up to two years in prison and second case with a fine of $500 dollars or up to one year in prison. The average amount of prison time served by all of the prisoners was 101 days. There were four who received longer prison terms, four months and eleven days. One of the prisoners, William E. Roberts, died while at Fort Mifflin.[98]

History reveals when in times of national crisis, particularly when there is a war, civil liberties are often under considerable pressure. The Peace Democrats strongly disagreed with the Lincoln administration and its supporters. These supporters, in turn, castigated their opponents to exercise the right of free expression and dissent. Those who were arrested were denied the writ of *habeas corpus* and to have access to the civil courts. A famous Supreme Court case, *Ex Parte* Milligan, decided one year after the Civil War, dealt with the issue of presidential power. Did President Lincoln have the authority to suspend the writ of *habeas corpus* and substitute military commissions to try civilians when civil courts were open and not in an area where war was being waged? The justices in a unanimous decision held that a President can not create military commissions to try civilians without the approval of the Congress. Five members of the court wrote in their opinions that neither the Congress nor the President could establish military commissions in areas free from combat and with civil courts open and functioning.[99] If this decision had been handed down before the Civil War, it would have made a major difference in respecting civil liberties.

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95 *Star of the North*, September 7, 1864.

96 Information about the forty-four prisoners comes from U.S. census records, tax records, Columbia County histories, and obituaries.

97 *Public Laws of the United States, 735.*

98 Freeze, 399-400 and 442-472.

99 Robert E. Cushman and Robert F. Cushman, *Cases in Constitutional Law* (New York: Appleton-Century-Crofts, Inc., 1958), 493.

ROAD LOGS AND STOP DESCRIPTIONS

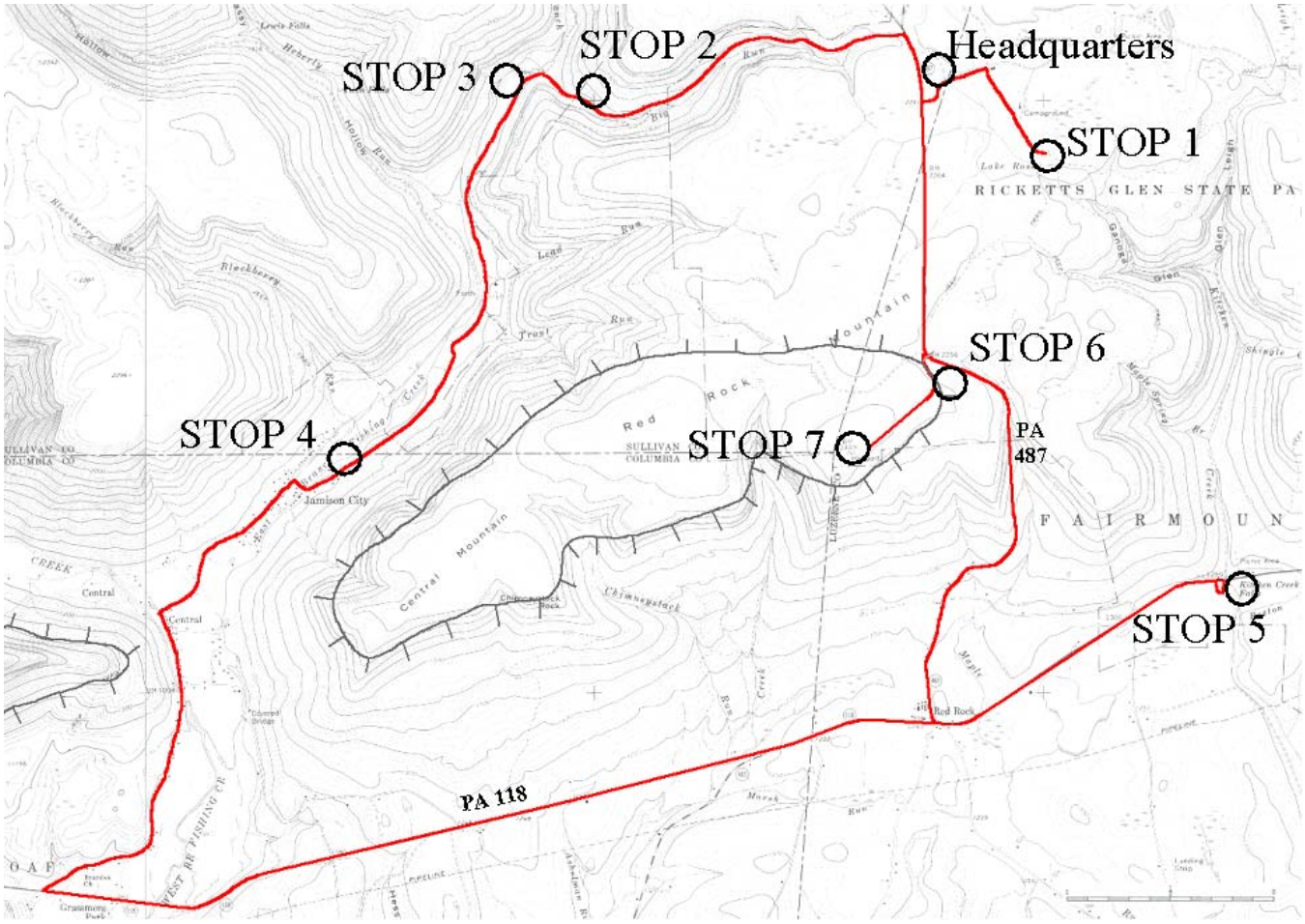


Figure 38. Map of Day-1 route and STOPS.
Approximate Late Wisconsinan glacial border is shown with hachures on the glacier side of the border.

DAY 1

(See Figure 38 for route and locations of STOPS.)

Miles Int.	Miles Cum.	Description
0.0	0.0	Leave parking lot at Park Office, Ricketts Glen State Park, turning left on park road at exit.
0.1	0.1	Cross Lake Jean Dam, emergency spillway on near (west) side. At the right [west] abutment of the dam, you pass from Sullivan County into Luzerne County. Sullivan County was formed from Lycoming County in 1847 and named for State Senator Charles C. Sullivan, who was instrumental in securing its creation. Luzerne County, formed from Northumberland County in 1786, was named for the Chevalier de la Luzerne, a French champion of American independence (see Beyer, 2000).
0.15	0.25	Turn right, following road to Falls Trail parking lot. The park maintenance sheds are to the left, and the former site of the park office is to the right after making this turn.
0.55	0.8	Parking lot at head of Falls Trail. Disembark.

STOP 1. THE FALLS TRAIL IN GANOGA GLEN DOWN TO GANOGA FALLS (41°10'46"N/ 76°17'30"W).

Leaders: Jon Inners, Duane Braun, and Joseph Hill. (See Appendix A for more details.)

The location of STOP 1 and the various sites to be observed on the walk along the Falls Trail down to Ganoga Falls is shown in Figure 39. A brief description of the geology and photographs of various features along the Falls Trail down to Ganoga Falls can be found in the Pre-Conference Walking Tour (Sites 1-9, Appendix 1).

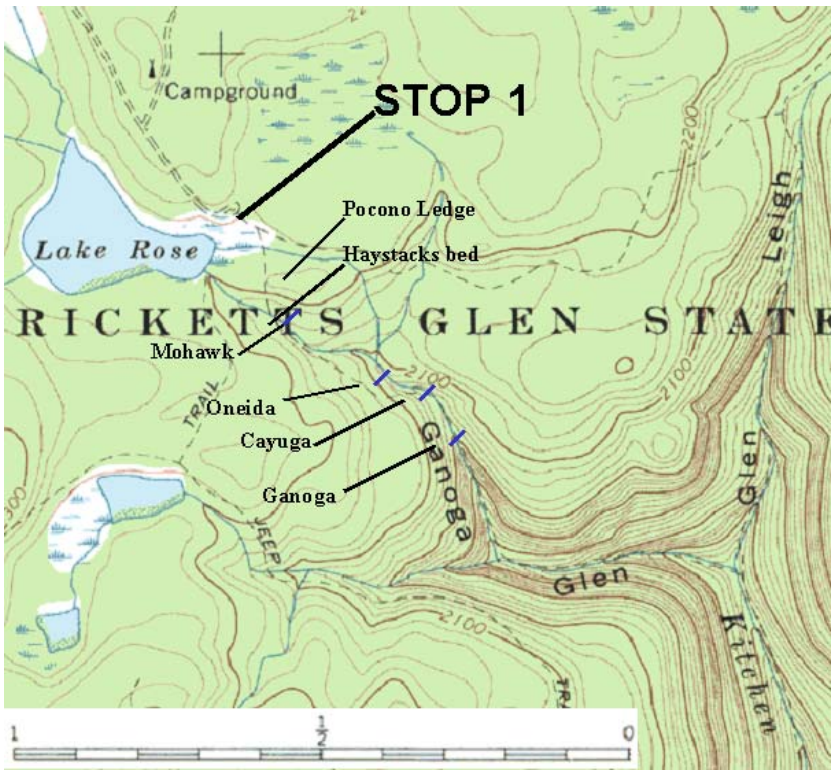


Figure 39. Location map for STOP 1.

Why the gorge and falls are here—stream diversion due to glaciation. We are now entering Ganoga Glen, the western branch of Kitchen Creek. In preglacial times the head of Ganoga Glen (drainage divide) was halfway between the present dam for Lake Jean and where we stand now (see dashed line on Figure 3). The preglacial drainage area above where the gorge begins was only 0.5 mi^2 (see Figure 3; Figure 4). When the receding late Wisconsinan glacier deposited the till dam across west-draining Big Run, 4 mi^2 of drainage area was diverted down Ganoga Glen, increasing the discharge eight-fold over what it had been. It is this increase in drainage area and discharge that has provided the erosive power to cut the present gorge and waterfalls. In essence, the present Ganoga Glen stream is out of equilibrium (overfit) and is rapidly cutting a knick point headward (the waterfalls) to reduce the gradient (see Figure 5). Headward knickpoint migration will eventually reach Lake Jean—but before that happens we will probably have another glaciation.

		Leave STOP 1, returning on Falls Trail Road.
0.5	1.3	Stop sign at maintenance shed. Turn left, recrossing Lake Jean Dam into Sullivan County and proceeding past park office to intersection of main park road with PA 487.
0.5	1.8	Stop sign at park entrance. Turn right on PA 487.
0.05	1.85	Just beneath the road here is the old late Wisconsinan till dam that blocked the former drainage path down Big Run of streams in the Ganoga Lake and western Lake Jean area (see Quaternary history, this guidebook; Braun and Inners, 1998). The road angling off to the northwest a hundred yards ahead exactly follows the old Berwick-Elmira Turnpike for many miles through Davidson and Laporte Townships. (About 5 mi to the north it crosses the evocatively named "Painter Den Creek.") About a mile

		to the northwest it passes Ganoga Lake and the former estate of Col. Robert Bruce Ricketts (1839-1918) (Krothe and Siegel, this guidebook). Just to the east of the middle of Ganoga Lake is a broad pavement outcrop in the upper Pocono that exhibits beautiful glacial striations.
0.5	1.9	Just before the above mentioned road angles off, turn sharply left onto dirt road (Jamison City Road) that leads steeply downhill on the north side of the Big Run valley. In pre-late Wisconsinan time, this sharply incised valley carried the runoff from Lake Ganoga and the area now inundated by the western part of Lake Jean.
0.55	2.45	Ledges of Pocono/Huntley Mountain sandstone on steep hillside to right.
0.75	3.2	Entering area of numerous cabins and hunting camps.
0.4	3.6	Cross Big Run. Note flood erosion (late June 2006) that has undercut the right bank just downstream of the culvert, creating a good exposure of stony till
0.05	3.65	At cabin of Sullivan Falls Camp, pull as far off to right of road as possible. Disembark.

STOP 2. LATE WISCONSINAN TILL AT SULLIVAN FALLS CAMP IN BIG RUN VALLEY AND POSTGLACIAL "ONE-SIDED" BEDROCK GORGE (GPS 41°20'15.6"/ N76°10'-53.3"W).

Leader: Duane Braun.

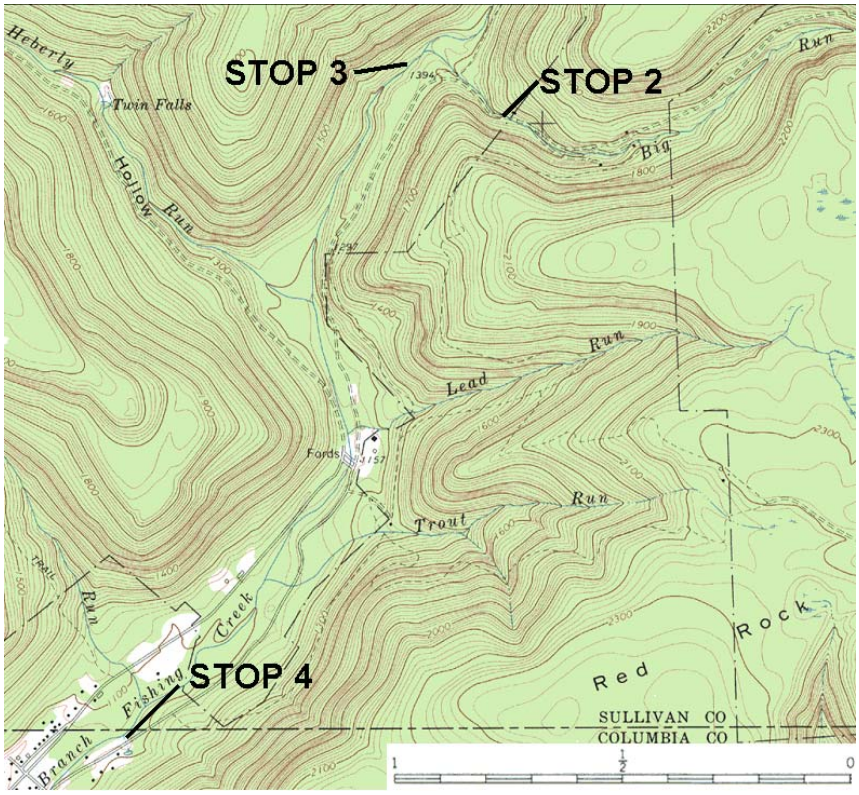


Figure 40. Location map for STOPS 2, 3, and 4.

We are standing in a deep, narrow valley (Big Run) transverse to ice flow (Figures 40 and 41). There is a thick late Wisconsinan "till shadow" on the north side of the valley. Behind the cabin is an exposure of the type of till that makes up much of the "till shadow." Up valley from here large slumps occurred in the 1970's that exposed more than 100 ft of this till, but those sites are now densely vegetated and not readily accessible for a group of this size. The till matrix here has a reddish-brown color from the mixing of a small amount of redbed material with the gray sandstone that dominates the stratigraphy to the north of here. The matrix texture tends to be a silt loam to fine sandy loam in soil terminology or a sandy silt matrix to a geologist. The till tends to be quite stony (Figure 42) with most clasts being the local sandstone. The sandstone clasts do not striate as readily as softer lithologies so you often have to look diligently to find striated clasts. The till when freshly exposed, is very compact (hardpan to local contractors or over-consolidated to civil engineers) and is under ice or basal till (lodgment and/or deformation till).

Just 200 ft downvalley from here, Big Run drops over an unnamed sandstone-ledge waterfall on the south side of the valley. This is one of those "one-sided" gorges discussed in the Quaternary History article (see Figure 2). (Bedrock is also exposed along the road directly across from the cabin.)

Figure 41. View looking to the west down Big Run, illustrating the narrow, deep nature of the valley, a perfect trap for glacial till.

Figure 42. Stony Late Wisconsinan till exposed behind Sullivan Falls Camp.

Leave STOP 2, continuing down Jamison City Road.

0.05	3.7	To right is an unnamed 20 ft-high cascade over ledges of Huntley Mountain sandstone—a crag of which is exposed to the left. The caprock of the falls is a well jointed, medium-light-gray, fine-grained sandstone, smoothed and scalloped by stream erosion. On the left side of the falls is a sharp, V-shaped reentrant.
0.2	3.9	Turn right into parking area. Disembark. Walk back into woods about a hundred yards to the incised stream valley and falls.

Figure 43. Sullivan Falls over sandstone and redbeds of the Duncannon Member.

STOP 3 AND LUNCH. SULLIVAN FALLS ON EAST BRANCH FISHING CREEK (GPS 41°20'09.0"N/76°20'25.1"W).

Leaders: Duane Braun and Jon Inners.

This 25-ft-high cascade, just downstream of the junction of Big Run with East Branch Fishing Creek (see Figure 18) is a "normal" falls in that there is no glacial derangement here. With bedrock on both sides, the East Branch here is simply cutting headward rapidly through the Duncannon Member of the Catskill Formation. The glacier did flow directly down the valley below the falls, and such "funneled" ice flow scoured the valley floor downstream of here. With the glacial deepening of the valley downstream, the East Branch has had a knickpoint migrating up valley, reaching this point today.

Sullivan Falls is developed on the upper part (mostly red claystone and siltstone) of one fining-upward alluvial cycle and the lower part (gray sandstone) of the succeeding cycle. The

falls is somewhat atypical of those generally developed in the Duncannon, in that it is clearly a cascade—not a cataract (Figure 43; see Appendix A). The face of the falls (21 ft.) consists of red clastics that project out as far—or farther—than the caprock (the basal 4 ft. of a 15-ft ± channel sandstone), causing the water to "cascade" down over the exposed rock.

		Leave STOP 3, continuing down Jamison City Road.
0.8	4.7	Concentration of sandstone boulders to left.
0.3	5.0	Sylvan white house and estate on left side of road, with East Branch Fishing Creek encroaching on the right.
1.1	6.1	Enter Columbia County, formed in 1813 out of Northumberland County (Beyer, 2000). Pull off as far as possible to right. Disembark.

STOP 4. GLACIAL STRIATIONS ON A SANDSTONE LEDGE IN EAST BRANCH FISHING CREEK (GPS 41°18'29.2"N/ 76°21'22.3"W) .

Leader: Duane Braun.

At this site an exposed sandstone ledge in East Branch Fishing Creek (see Figure 40) still retains the glacial striations scratched into the rock by the passage of the late Wisconsinan glacier. On ledges exposed since glaciation on adjacent mountains, the striations have generally been weathered away. Here the East Branch in recent decades to centuries has eroded away the glacial deposits and exposed "fresh" striations. The striations show that the ice streamed directly down the valley (S65°W ± 5°) (Figure 44). Ice flow was converging on this valley from the top of the Allegheny Plateau—and converging flow leads to significant glacial scour, such as occurred on a much larger scale in the Wyoming Valley of Pennsylvania (e.g., the "buried valley of the Susquehanna"; Ash, 1950). Ice flow was so strong in this area that at the present site of the Central Park Hotel (breakfast; mile 7.4) the ice turned 90° and flowed northwest up the West Branch Fishing Creek valley.

Figure 44. A. View of glacially smoothed top of sandstone ledge.
B. Glacial striations on the smoothed top of the sandstone ledge.

		Leave STOP 4, continuing down Jamison City Road.
0.2	6.3	Beautifully crossbedded ledge of Duncannon sandstone to left.
0.05	6.35	Bear right across bridge over East Branch Fishing Creek, entering Jamison City. Named for Col. Benton K. Jamison, financier of the Bloomsburg & Sullivan Railroad, which as terminated here in 1888, Jamison City soon boasted a sawmill (1889) and a large tannery. For two decades the "city" thrived on these two industries, but as the trees were used up, its fortune—and population—faded away. The sawmill closed in

1912, but the tannery hung on until 1925—at greatly reduced output (Newton and Sperry, 2002; Brasch, 1982, p. 116). Fortunately, it never faded to a "ghost town" like Ricketts. With the passage of Pennsylvania's progressive game legislation early in the 20th century, Jamison City's natural scenic beauty made it a "Mecca" for hunters—and it has maintained a solid existence as a community for over a hundred years.

0.05 6.4 Stop sign. Turn left on Broad Street. Directly ahead on the left (before the turn) is the former station of the Bloomsburg and Sullivan Railroad (1889-1926) (see Figure 33) and on the right the General Merchandise store of B. Frank Mather (1903-1926). Up Broad Street to the north about 0.3 mi are the ruins of the Jamison City tannery (Figure 45). (See Newton and Sperry, 2002).

Figure 45. Tall brick chimney marking the site of the Jamison City tannery.

0.1 6.5 Jamison City Hotel to left. The next building to the south on the same side of the street is the former Methodist Episcopal Church, dedicated on November 19, 1893 (Newton and Sperry, 2002, p. 49).

0.4 6.9 Hillside to right is formed of a "shoulder" of very stony Late Wisconsinan glacial till. The numerous erosional scars date from the late June 2006 flood.

0.45 7.35 Stop sign. Turn left on Central Road in Central. Central long predates Jamison City, having been established as Campbell P.O., named for Dr. W. M. Campbell, in 1840. The post office was discontinued in 1848, when Dr. Campbell moved away. It was reestablished in 1851 as the Central P.O. The village that grew up around the post office took the name Central (Brasch, 1982, p. 53-54). Like Jamison City its existence is largely predicated on the surrounding mountain scenery and the abundance of game.

Central is situated on the east bank of West Branch Fishing Creek, the largest of the headwater branches of Fishing Creek. The creek commonly appears on 18th-century maps as *Namescesepong*, probably an Anglicized corruption of a Delaware Indian word meaning "it tastes fishy," or "stream with fish" (Brasch, 1982, p. 86-87.)

The East Branch undoubtedly once joined the West Branch at the present-day location of Central, but it was pushed to the east side of the broad valley here by glaciofluvial and alluvial deposition on the West Branch. The East Branch now flows against the foot of Central Mountain on the east side of the valley and joins the West Branch about 1.5 mi south of here. Streams that flow subparallel to each other within the same valley, like the Yazoo and Mississippi Rivers at Vicksburg, Mississippi, are called "Yazoo streams" (Lobeck, 1939).

0.05 7.4 Central Park Hotel (established 1864) to left.

0.25 7.65 Good view of Central Mountain on the Allegheny Front to left across the broad combined floodplains of East Branch and West Branch Fishing Creek (Figure 46).

Until the middle of the 19th century, Central Mountain was known as North Mountain for its location in the northernmost part of Columbia County. After 1860, however, it

Figure 46. View of Central Mountain across the combined floodplains of East and West Branches of Fishing Creek. (Photo taken near Day-1 mile 9.0).

Figure 47. Catskill ledges at mile 9.0, near McCauley Cu-U Prospect 16.

gradually took the name of the nearby village—a name that became particularly dominant during the lumbering era of the 1890's and early 1900's (Brasch, 1982, p. 53). The designation North Mountain is now applied on modern maps to the Front east of Red Rock Mountain and Kitchen Creek in Luzerne County (Sweet Valley quad.)—and more generally to the entire Front and Plateau areas in the Elk Grove (west), Red Rock, and Sweet Valley (east) quadrangles.

0.1	7.75	Cross West Branch Fishing Creek. This main branch of Fishing Creek rises some 8 mi west of Central, flows eastward through a deeply incised valley parallel to the escarpment of the Allegheny Front just a mile or two to the south. It then turns south and flows past Central.
0.25	8.0	First of numerous ledges of Duncannon red and gray sandstone and red mudstone that occur at the base of the hillside to right for the next mile.
0.25	8.25	In the woods just to the right of the road here is McCauley Prospect 15, an abandoned prospect dating from a turn-of-the-20th century copper "boom" in the area south of Central (McCauley, 1961; Newton and Sperry, 2002). McCauley (p. 59-60) describes the prospect as a "pit about 5 feet deep and 10 by 15 feet in surface dimension." Such copper rich zones are typically radioactive, the mineralization typically being associated with carbonaceous and calcareous breccia zones (McCauley 1961; Sevon et al., 1978; Smith and Hoff, 1984).
0.75	9.0	Just above the Catskill ledges to right (Figure 47) is an old, shallow, 100-ft-long trench running along the base of the next higher ledge that is probably close to McCauley Prospect 16. McCauley (p. 60) describes the actual prospect as " a small recently excavated pit" in which "[m]ineralization is confined to isolated plant fragments within a gray to tan siltstone unit." He notes that "blocks of gray calcarenite [calcareous breccia?] were found on the floor of the pit."
0.1	9.1	Stop sign. Turn left on PA 118.
0.55	9.65	Cross West Branch Fishing Creek.
0.15	9.8	In the hills 0.3 to 0.6 mi to the right (south) of PA 118 here are McCauley (1961) Prospects 9 to 13 and Sevon et al. (1978) sites Red Rock A and B. The McCauley

		Prospects are old copper adits, pits, and trenches (p. 57-59); the Sevon et al. sites are located on Map 5 (p.99) with mining symbols.
0.25	9.9	Cross East Branch Fishing Creek. The two branches combine about 0.3 mi west of here to form the trunk Fishing Creek.
0.1	10.0	First of several small outcrops of Duncannon sandstone and mudstone on both sides of road.
0.5	10.5	Prominent ledges of north-dipping Duncannon sandstone to right. To left for the next 2 mi, but not visible because of the dense vegetation, there is well developed knob-and-kettle morainic topography on the lower 200 to 500 ft of the side of Central Mountain.
2.0	12.5	Cross Coles Creek.
0.2	12.7	Intersection with PA 487 South (coming in from right).
0.2	12.9	Enter Luzerne County.
0.55	13.45	Intersection with PA 487 North (to left) and SR's 4011 and 4013 (to right) in Red Rock. This hill is the north to south trending drainage divide between the Fishing Creek basin and the Kitchen Creek basin. To the south along SR 4013 are several meltwater sluiceway channels that have been cut through the divide; one of them is almost 100 ft deep.
0.45	13.9	Ricketts Glen Hotel and large pond to right. The pond and adjacent wetlands occupy headwater tributary hollows that are almost completely buried by glacial deposits (see Figure 6).
0.4	14.3	Enter Ricketts Glen State Park. To right for the few tenths of a mile, a meltwater sluiceway channel cut in bedrock runs parallel to the road.
1.1	15.0	Turn right into parking area just before bridge over Kitchen Creek. Disembark.

STOP 5. ADAMS (OR KITCHEN CREEK) FALLS: A POSTGLACIAL GORGE BESIDE A BURIED PREGLACIAL VALLEY (GPS 41°17'58'2"N/76°16'28.2"W).

Leaders: Duane Braun, Jon Inners, Gary Fleeger, and Angela Dippold.

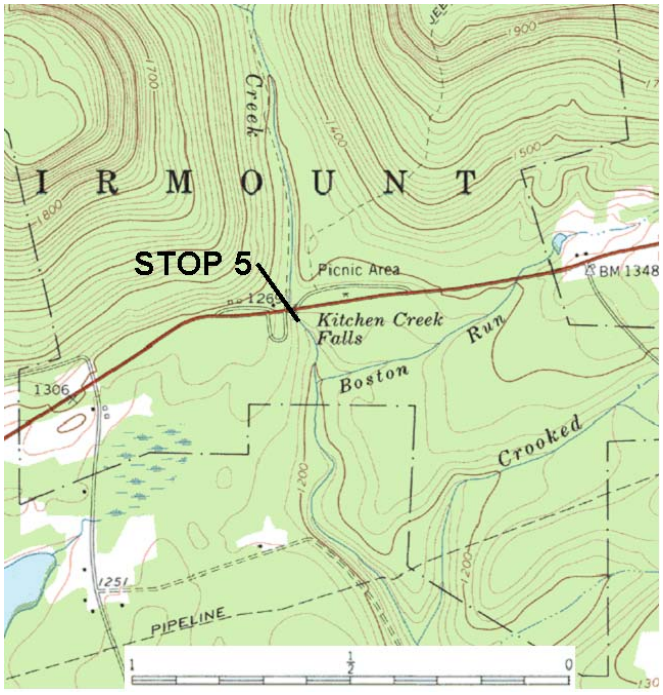


Figure 48. Location map of STOP 5.

Adams (or Kitchen Creek Falls) is the most accessible (Figure 48) and the most beautiful falls in Ricketts Glen State Park. Beneath the bridge on PA 118 is the upper falls (a 10-ft cascade), which has eroded a spectacular narrow rock gorge about 50 ft long, 20 ft deep, and only 3 to 5 ft wide into the Duncannon Member of the Catskill Formation (Figure 49). About 75 ft downstream from the bridge, the creek plunges over two picturesque falls, a splendid upper 25-ft cascade (middle falls, Figure 50) and a lower 10-ft cataract (Figure 51), developed in sandstone, siltstone, shale, and claystone of the Duncannon. Between the individual falls, the stream rushes through deep, narrow gorges that are fluted with numerous potholes (Figure 52). Below the middle (Figure 53) and lower falls are large plunge pools eroded by the turbulent water that descends the falls. The lower plunge pool (Leavenworth Pool) is about 30

ft in diameter and 8 to 10 ft deep (see Figure 51). Total retreat of the upper falls is about 200 ft, about 75 ft to Leavenworth Pool and 125 ft to the lip of the upper falls.

Figure 49. Gorge of the upper falls of Adams (or Kitchen Creek) Falls beneath PA 118 bridge.

Figure 50. Middle falls (cascade) of Adams Falls.

Figure 51. Lower falls (cataract) of Adams Falls and Leavenworth Pool.

Figure 52. Fluted and potholed gorges at middle and lower falls of Adams Falls.

Figure 53. Large pothole below middle falls.

Figure 54. Lungfish aestivation burrows on the trail below Adams Falls. Photo by Helen L. Delano.

Bedrock geology. The gorges, waterfalls, potholes, and plunge pools at Adams Falls are carved into mostly red sandstones, siltstones, and claystones forming parts of at least two fining-upward alluvial cycles in the Duncannon Member of the Catskill Formation. The sandstones are crossbedded and rippled, the siltstones rippled, and the claystones irregularly mudcracked. In the gorge below the upper falls, the red siltstone and claystone beds are streaked with numerous thin discontinuous, white-speckled, calcareous bands that contain abundant small, sometimes rounded—rarely rod-shaped—"caliche" fragments, as well as some possible fish bones. At the base of the cliff along the trail on the east side of the creek, at least four lungfish aestivation tubes (3 to 4 inches in diameter) occur in a bed of grayish-red silty claystone (Figure 54).

Bedding in the Duncannon here strikes about N80^{o}E and dips about 4^{o}NW. In the sandstone caprock and the immediately underlying shale and claystone of the upper falls is a distinct fracture zone about a foot wide that contains about a half-dozen closely spaced (2 inches $\pm$) joints, striking N2^{o}W and dipping 86^{o}E. This fracture zone lines up with the narrow gorge beneath the PA 118 bridge.

The buried valley and present "one-sided gorge. At this site one can observe the burial by glacial deposits of a valley transverse to ice flow—a process common in northeastern Pennsylvania. Here Kitchen Creek flows southward where the receding ice was flowing westward obliquely across the Allegheny Front (see Figure 6). A thick "till shadow" projects westward from the mountain front where Kitchen Creek cuts through the Front. In preglacial times the Kitchen Creek channel was a few hundred feet east of the present channel where PA 118 crosses it today (see Figure 6).

Evidence for the burial of the preglacial course of the creek is seen in the "one-sided" bedrock gorge nature of the present valley both upstream and downstream of the PA 118 bridge. Below the bridge are the falls and potholes of Kitchen Creek. Stand at the base of the falls and look to the north and east (towards PA 118 and to the right) to observe that the bedrock ledges get lower to the right, the east sloping surface of the preglacial valley.

Walk downstream to the footbridge across the creek and note again that the sandstone ledges are much higher on the west side (right side facing downstream) and much lower on the east (left facing downstream). If you walk a bit farther downstream, bedrock entirely disappears from the east (left) side of the valley and is replaced by the glacial till fill of the buried preglacial valley

Upstream of PA 118 and the falls, the valley is less incised and the "one-sided gorge" nature of the valley is more subtle. Walking upstream one will observe low sandstone ledges on the hillside and stream bank to the west (left) while there are no such equivalent ledges on the east (right) (Figure 6, p. 7). Instead, on the east side both till and ice-contact stratified drift are sometimes exposed by creek erosion, the upper part of the fill of the buried preglacial Kitchen Creek valley.

		Leave STOP 5, continuing around to right on park road.
0.1	15.1	Stop sign. Turn left on PA 118.
1.5	16.6	Turn right on PA 487 North (Red Rock Mountain Road) in Red Rock.
0.4	17.0	Directly ahead is the imposing wall of the Allegheny Front forming Red Rock (North) Mountain.
0.7	17.7	Rock cuts on the left for the next 0.5 mi are Duncannon sandstone, siltstone, and mudstone arranged in alluvial fining-upward cycles—gray sandstone at the base and red mudstone at the top.
0.8	18.5	Ledges of gray Huntley Mountain sandstone to left.
0.2	18.7	Turn left into unpaved parking area of quarry near top of Red Rock Mountain. Disembark.

STOP 6. "RED ROCK" QUARRY (GPS 41°18'50.1"N/76°17'59.8"W) .

Leaders: Jon Inners and Duane Braun.

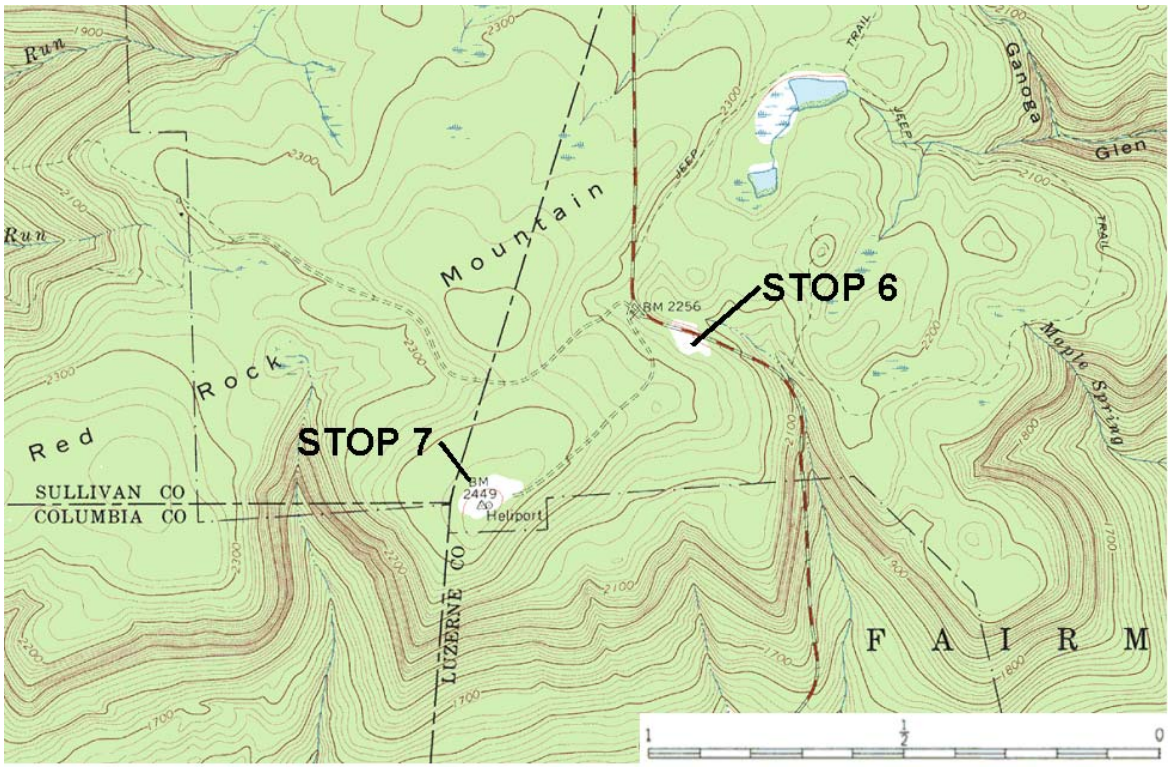


Figure 55. Location map for STOPS 6 and 7.

The gently north-dipping red shale and sandstone exposed here occur in the upper part of the Huntley Mountain Formation (Figures 55 and 56). It was from this distinctive horizon that Red Rock Mountain got its name. Because these beds made a conspicuous band across the old Berwick-Elmira Turnpike, which approximately follows PA 487 here, Nineteenth-century travelers called the locality "The Red Rock." Today, stone from this pit is used for road surfacing and camp-site construction in the park.

Figure 56. The "Red Rock" quarry in the upper Huntley Mountain Formation.

"The Red Rock" formed from channel and overbank floodplain deposits in the earliest Mississippian, about 360 million yrs. B.P. It is equivalent in origin, if not in exact stratigraphic correlation, to the Patton red shale of western Pennsylvania. A generalized stratigraphic section of the rocks exposed in the pit is as follows:

Unit	Thickness (ft)	Description
	4.0-5.0	Stony till.
9	4.0	Hackly, mottled, gy-rd & lt ol gy , silty v-f-g ss
8	4.0	Hackly, mottled, gy-rd & yel clst
7	5.0	Lt-ol-gy, gy-rd weathered, f-g ss.
	Erosional channel	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
6	0.8	Gy-rd, silty clst, w/ yel streaks & vertisol-like slickensides
5	3.0	Hackly, mottled, gy-rd & yel, silty clst, w/ yel streaks
4	1.0	Mottled gy rd & yel sandy slst
3	1.0	Hackly gy-rd clst
2	5.0	Covered
1	—	Mottled gy rd & ol gy, shaly clst, w/ abundant root traces (Floor of pit)

Prominent in the pit is a broad and shallow channel (275 ft wide and more than 5 ft deep). At the north end of the pit, the two sandstones and the intervening claystone above the channel disconformity merge into a 15 ft-thick sandstone with the 4 ft-thick claystone bed being represented by a 0.5 $\pm$ ft-thick caliche-bearing bed.

As noted above, the hackly, mottled claystone of unit 6 contains slickensided surfaces and is evidently a vertisol formed under alternately wet and dry conditions. In the late 1970's, lungfish aestivation burrows, 4 inches in diameter and more than a foot long, were exposed in the pit wall (Inners, [1980]; See STOP 13, Day 2).

Capping the pit is 4 to 5 ft of stony, reddish-brown late-Wisconsinan till.

		Leave STOP 6, turning left (north) on PA 487 and continuing north.
0.1	18.8	(Optional.) Pull off to left where two gated park roads lead off into woods. Disembark and walk back the road that leads southwest (left), following it for about 0.6 mi to the fire tower at the "Heliport."

STOP 7. GRAND VIEW ON RED ROCK MOUNTAIN (41°18'32"N/76°18'33"W) (OPTIONAL).

Leaders: Jon Inners and Duane Braun.

Grand View (elevation 2,449 ft), the highest point on Red Rock Mountain (see Figure 55), is a spectacular scenic overlook, though the growth of trees over the past several decades has restricted somewhat ground views to the south. (The outlook from the Department of Forestry fire tower is still unobstructed, but not available to the public.) To the east and west stretches the imposing wall of the Allegheny Front, rising as much as 1,200 ft above the rolling hills below (Figure 57). North of Grand View, the wooded undulating surface of the Allegheny Plateau extends uninterruptedly to the northern horizon. In the distance to the southeast appear the narrow, even-crested ridges of the Ridge and Valley fold belt. Particularly evident, even from the ground, are the mountains rimming the southwestern end of the Northern Anthracite field and the steep escarpment along the north edge of the Eastern Middle Anthracite field. Probably the most distant feature is the high "culm bank" at Jeansville south of Hazleton in the Eastern Middle field, 38 mi to the southeast (see below).

As shown in Figure 3, the rim of the Allegheny Front at Grand View is capped by erosionally resistant sandstones of the Huntley Mountain Formation. Just behind the Front (and visible from the fire tower) are an east-west trending series of knobs underlain by hard, quartzitic sandstones of the Pocono Formation. Sandstones and mudstones of the Mauch Chunk Formation cap higher knobs farther north

(such as the one on which the Job Corps Center is now situated). To the south of the Front, extending to the edge of the Northern field are low rolling hills developed on the less resistant interbedded mudstones, siltstones, and shales of the Catskill Formation.

Figure 57. View east along the Allegheny Front from Grand View (STOP 7).

East and west along the Front are numerous valleys and deep ravines ("glens") cut back into the escarpment. The second notch to the east is the valley of Kitchen Creek, splitting to the north into Ganoga Glen and Glen Leigh.

At the climax of the late Wisconsinan glaciation, about 20,000 years ago, the continental glacier covered the entire landscape surrounding Grand View. The margin of the glacier crossed the Allegheny Front about 3 mi west of Ricketts Glen Park and extended southeastward across the low terrain in front of the escarpment. Because of the thinning of the ice near its margin and the southwestward slope of the ice surface, Grand View and the high knob on Red Rock Mountain to the west were ice free and together projected above the glacier as a nunatak, or "lonely peak" (see cover and Figure 38).

Thanks to the Lackawanna State Forest District in Scranton, we will be able to ascend the tower, possibly even to the top (weather permitting). Some of the landscape features visible from the tower at Grand View (and even from the ground at most times) are:

S20°W	West end of Knob Mountain at Orangeville.
S15°W	West end of Catawissa Mountain at Catawissa.
S25°E	White vapor from the cooling towers of the Susquehanna Steam-Electric Station (nuclear) of PPL Electric Utilities near Berwick.
S30°E	Jeansville "culm bank" south of Hazleton.
S35°E	North Branch Susquehanna River water gaps at Shickshinny.
S90°E	Allegheny Front-North Mountain escarpment (see Figure 57).

The ridge on the horizon to the south-southeast is Butler-Buck Mountain at the north edge of the main Eastern Middle Anthracite Field.

		Leave STOP 7 (optional), continuing north on PA 487.
0.1	18.9	Sandstone ledges near the top of Huntley Mountain Formation on both sides of road. There is a 1 to 2 ft-thick Haystacks sandstone among these ledges.
0.2	19.1	Ledges of Pocono (Burgoon) Sandstone to right and left at crest of Red Rock (North) Mountain (elev. ~2340 ft). On top of the ledge to right are glacial striations trending due south. From here to the entrance to the Park, numerous trees have been blown down, most in a storm in 1999. Also many diseased beech trees are dead or dying.
1.1	20.2	Turn right at entrance to Ricketts Glen State Park, bearing right around curve on main park road.
0.1	20.3	Turn left into parking lot at Park Office. End of Day-1 field trip.

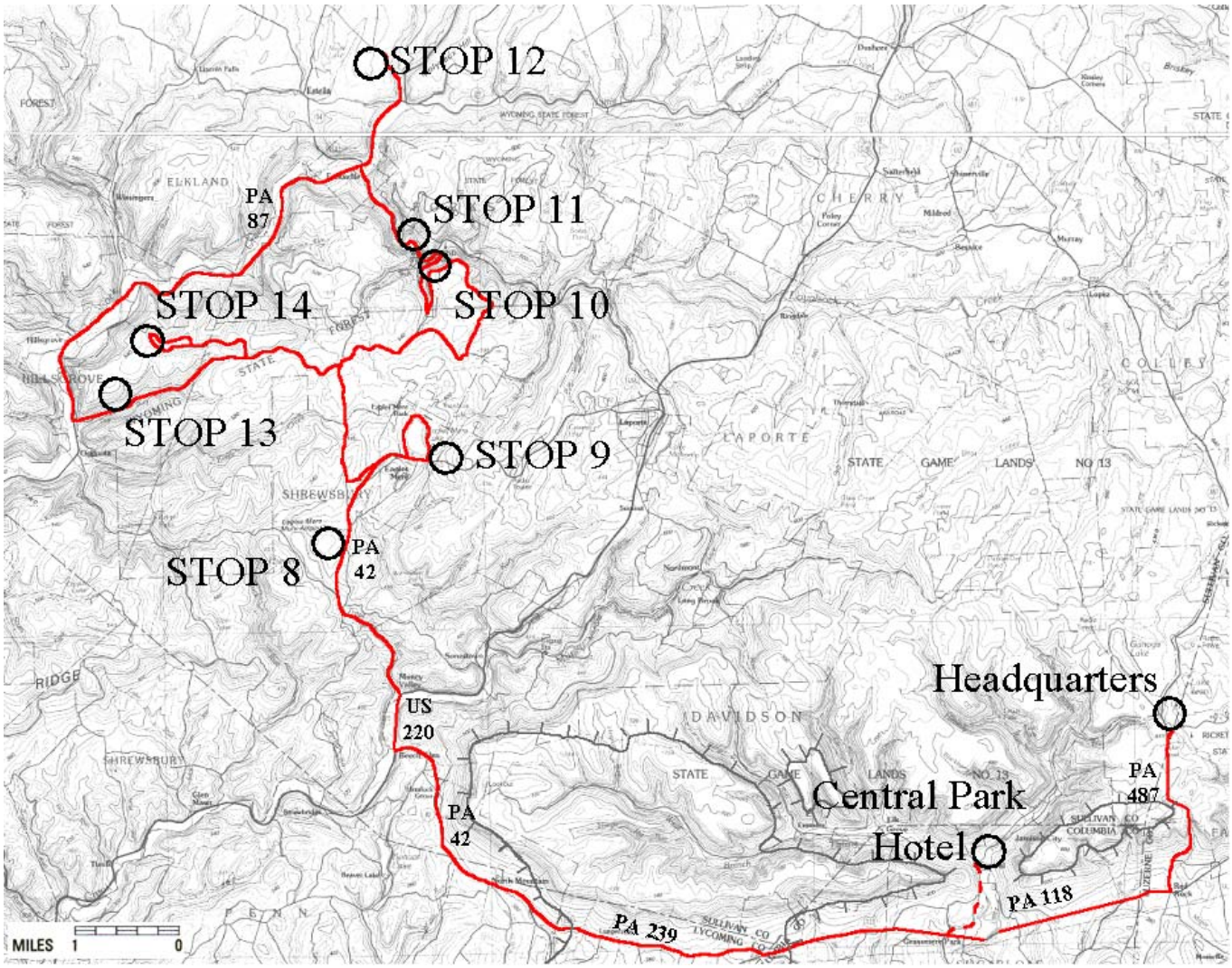


Figure 58. Map of Day-2 route and STOPS.
Approximate Late Wisconsinan glacial border is shown with hachures on the glacier side of the border.

DAY 2

(See Figure 58 for route and locations of STOPS.)

Miles Int.	Miles Cum.	Description
0.0	0.0	Leave Central Park Hotel, turning left (south) on Central Road.
0.4	0.4	Cross West Branch Fishing Creek.
0.2	0.6	To right is the first of several roadside ledges of Catskill red sandstone and mudstone (Duncannon Member). To the left are Wisconsinan outwash terraces of West Branch Fishing Creek.
0.6	1.2	Moss-covered ledges of red Catskill (Duncannon) rocks to right. These ledges were cut back about 15 years ago when the road was widened.
0.2	1.4	Houses perched directly on Catskill sandstone and mudstone ledges to right.
0.3	1.7	Stop sign. Turn right on PA 118.
0.7	2.4	Meltwater sluiceway in woods to right but nothing much to see from the road. PA 118 crosses it directly ahead.

0.3	2.7	On the Allegheny Front to the right of here the late Wisconsinan glacial terminus gradually sloped up the mountain side to the east and buried its eastern end back towards Central. Farther ahead to the right, the Allegheny Front projected out of the ice with glacial terminus on the north side of the mountain. On the side of the road are cuts in Catskill red sandstone and mudstone.
1.1	3.8	Till to right in the roadcut.
0.6	4.4	For the next 0.5 mi beyond Acorn Acres, you are crossing the late Wisconsinan terminal moraine. The moraine landform is prominent in to the woods to right, but it is not especially evident along the road due to the dense vegetation.
0.5	4.9	Weathered reddish-yellow pre-Wisconsinan till in cuts on both sides of road.
0.15	5.05	Enter Lycoming County, formed in 1795 out of Northumberland County.
0.05	5.1	Bear right on PA 239 North.
1.0	6.1	Colluvium from mountains buries pre-Wisconsinan till along the road for the next mile or two.
3.8	9.9	Intersection with PA 42, coming in from the left. PA 239 ends here, so you are now on PA 42 North. Reenter the late Wisconsinan terminal moraine belt; good knob-and-kettle topography for the next 0.5 mi.
0.2	10.1	Franklin Bethel United Methodist Church to right.
0.3	10.4	Kettle hole on left. On right the moraine trends northward, obliquely up the mountainside.
1.1	11.5	Enter Sullivan County.
0.2	11.7	Glacial striations trending southeast on Catskill sandstone ledge to right. We are on the east side of an arcuate lobe of ice that projected down the Muncy Creek valley reentrant in the Allegheny Front. While the center of the lobe was flowing southwest, its eastern flank flowed southeast around the western end of synclinal North Mountain.
0.6	12.3	Ledge of crossbedded, gray Catskill sandstone to right.
1.3	13.6	Catskill sandstone ledges to left; begin descent into the Muncy Creek valley proper.
0.6	14.2	Stop sign at bottom of hill. Turn right on US 220-PA 42 North in village of Beech Glen.
0.2	14.4	To left are alluvial broad terraces of Muncy Creek. Elsewhere along the creek are narrow remnants of higher-level late Wisconsinan outwash terraces.
0.1	14.5	Historical Marker to right reads. WYALUSING PATH. An Indian path from Wyalusing on the North Branch of the Susquehanna ran down Muncy Creek to the West Branch. Christian Indians, led by the Moravian Bishop Ettwein, came west over this path in 1772 to found a "City of Peace" on the Beaver River. (See Inners et al., 2002, p. 5, and Fleeger and Harper, 2005, p. 166.)
0.5	15.0	Enter village of Muncy Valley.
0.2	15.2	Cross Muncy Creek, then immediately turn left—staying on PA 42 North. (PA 220 and PA 42 Truck continue straight ahead.)
0.4	15.6	To right are more cuts through Catskill red sandstone and mudstone.
0.3	15.9	Begin ascent of Allegheny Front. To left are numerous cuts through gently north-dipping Catskill strata.
1.1	17.0	On left side of road is a "one-sided" gorge with the bedrock side next to the road (and difficult to see) and till side, overgrown by vegetation, facing the road.
1.6	17.5	Road levels off at top of Plateau escarpment. You are now crossing Huntley Mountain Formation, but this area is buried by till.
0.1	17.6	Road to Hunter Lake to left.

0.5	18.1	To left is a 40-ft-deep gully cut in late Wisconsinan till, but only its top is barely visible from the road.
0.8	18.9	The red mudstones to left occur near the top of the Huntley Mountain Formation and are probably correlative to the "Red Rock" in the shale pit at Ricketts Glen State Park and possibly the Patton shale of western Pennsylvania.
0.2	19.1	Huntley Mountain sandstone to left.
0.1	19.2	Turn sharply left onto Airport Road (dirt). Continue straight up hill for 0.2 mi, then turn left onto a gravel road that leads back about 0.2 mi to large pavement outcrop of Huntley Mountain sandstone. Disembark.

STOP 8. GLACIAL STRIATIONS AT FORMER EAGLES MERE LANDING STRIP (GPS 41°23'- 19.4"N/ 76°36'31.2"W) (Optional).

Leader: Duane Braun.

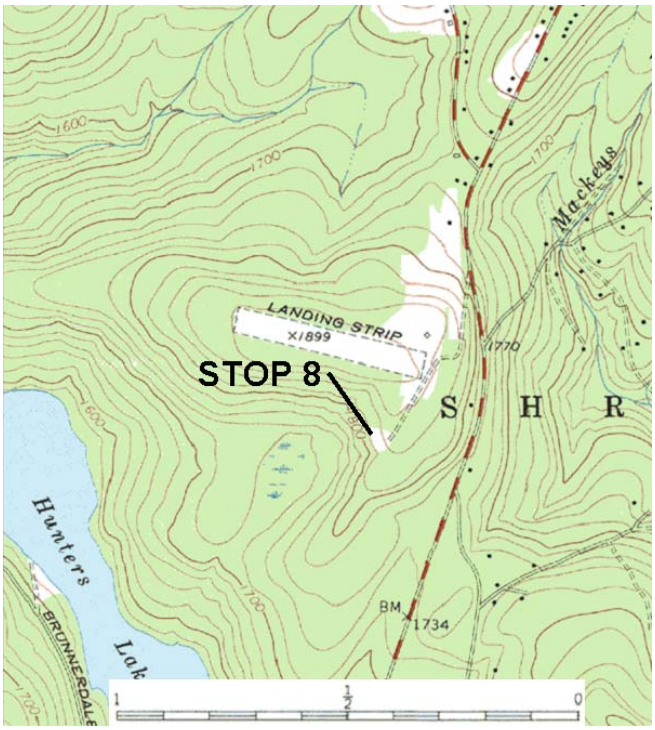


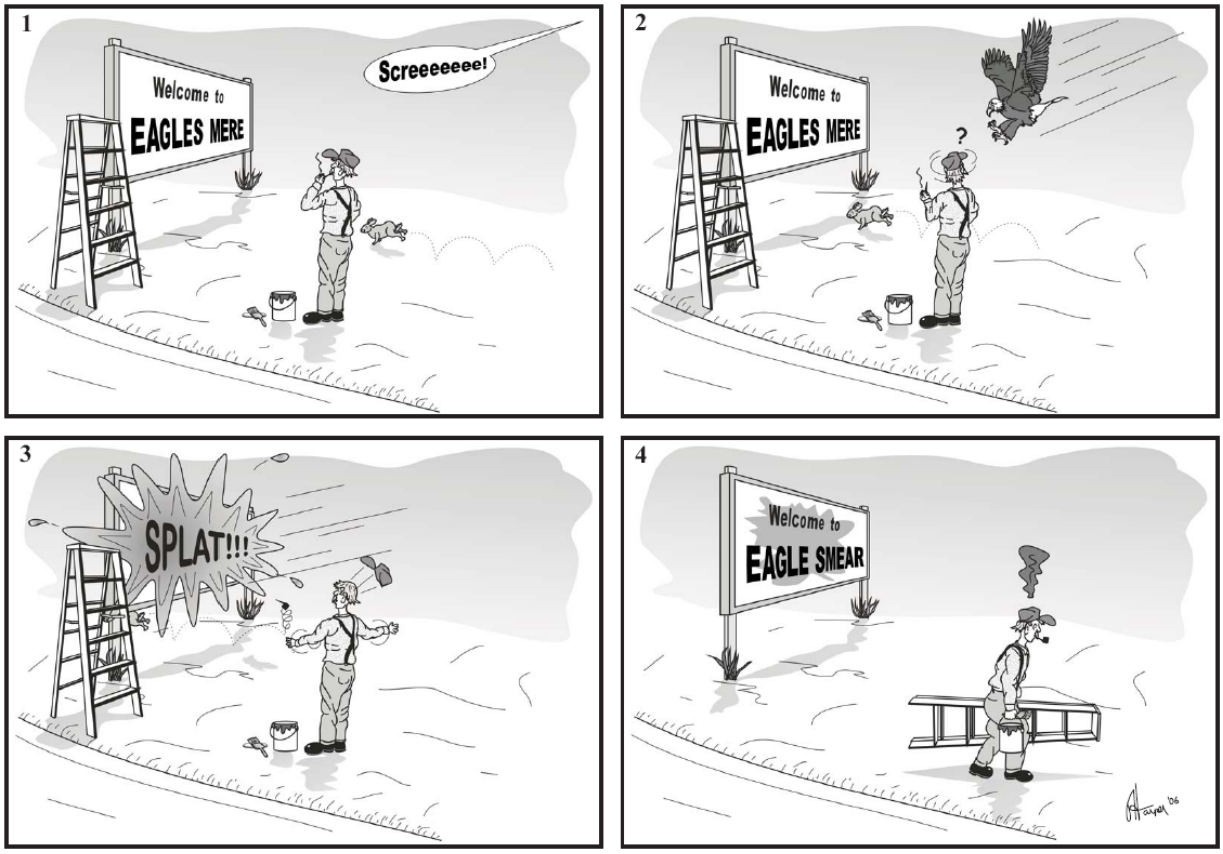
Figure 59. Location map for STOP 8.

This site (Figure 59) is one of the best glaciated bedrock surface "pavements" in the area. The till from an area a hundred feet across was removed without too heavily damaging the glacial striations on the bedrock (Figures 60). The striations very consistently trend S34°W ± a couple of degrees, across the entire site. The town recently sold the site and it is no longer readily accessible to the public.

Leave STOP 8, returning to intersection of Airport Road with PA 42. At stop sign, turn left on PA 42.

Figure 60. A. Striated bedrock pavement at STOP 8; B. Close up of striated pavement.

1.1 20.3 Enter borough of Eagles Mere, started as a summer colony for wealthy residents of Philadelphia in the late 19th century.



1.1 21.4 Turn left into parking area at Lily Pond. Disembark.

STOP 9A. THE ORIGIN OF EAGLES MERE LAKE, YET ANOTHER STREAM DERANGEMENT DUE TO GLACIATION (41°24'36"N/76°34'30"W).

Leader: Duane Braun.

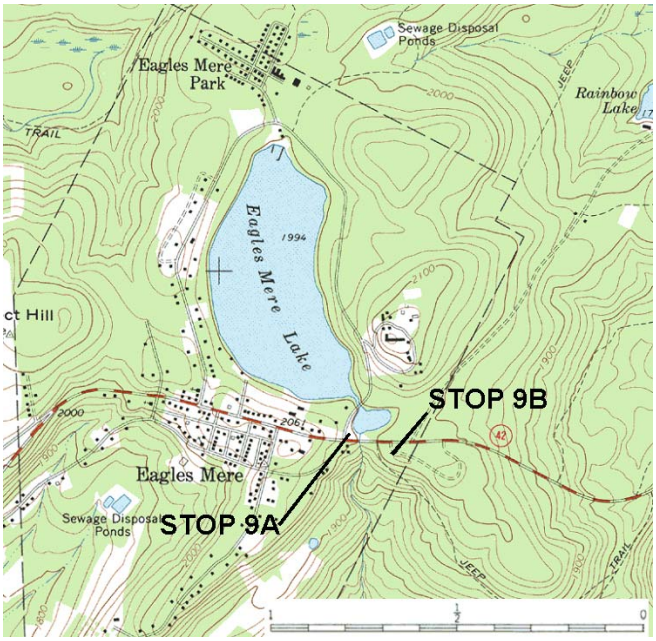


Figure 61. Location map for STOPS 9A and 9B.

As noted in the introduction to Quaternary History, the glaciated area of northeastern Pennsylvania is a land of lakes and waterfalls. You have both here with water from the outlet of Eagles Mere Lake tumbling southward down a series of falls as it leaves the Lake (on the other or south side of PA. 42) (Figure 61). The only question at this site is where did the preglacial drainage go? Again as noted in the Quaternary History article, a combination of surficial deposit mapping, well data, and seismic refraction profiling has shown that there is a more than 100 ft-thick till dam on the west side of the lake (see Figure 7). So in preglacial times the Eagles Mere Lake area was the head of westward draining Kettle Creek. The diversion of the drainage to the south is a common result of glaciation throughout northeastern Pennsylvania.

Leave STOP 9A, crossing PA 42 to low, rocky hill with pagoda on far (south) slope.

STOP 9B. HAYSTACKS SANDSTONE BED THE IN HUNTLEY MOUNTAIN FORMATION AT EAGLES MEER (41°24'33"N/76°34'24"W).

Leaders: Duane Braun, Norman Gillmeister, Joseph Hill, and Jon D. Inners.

Figure 62. Contact between the Haystacks sandstone and the underlying typical Huntley Mountain Formation.

See Gillmeister and Hill (this Guidebook) for a discussion of the stratigraphy and petrology of the Haystacks sandstone in the Conference area. Figure 62 shows the contact between the Haystacks sandstone with the underlying typical Huntley Mountain Formation below the pagoda. Notable here are small thrust faults in the "Haystacks" (Figure 63), the slickenlines of which trend as follows:

Ledge below Pagoda	N5°E
Ledge near road	N50°E^10°NW

Variable glacial striation directions on an irregular bedrock surface. This site well shows how ice flow wraps around irregularities in a bedrock surface and gives dramatically different striation directions. There is a 65° variation in striation direction at the site, ranging from S5°E to S60°W. The regional flow direction is around S35°W and that is what can be measured of the tops and upper stoss side of individual sandstone "Haystacks". On the east side of a sandstone "Haystack," striations will trend more to the southwest such as two measurements taken at the site of S50°W and S60°W. On the west side of a "haystack" or on a west-facing ledge, the striations will trend more to the southeast such as a measurement at the site of S5°E. Also ice flow direction changes as the ice retreats and thins over the site. This can produce crosscutting striations and on one "Haystack" the regional S35°W striation direction is crosscut by S 46° W direction. The occurrence of abundant striations in this area indicates that the ice here was "wet based." "Cold-based" ice protects the landscape, with shearing occurring within the ice rather than along the ice-rock contact.

Figure 63. Irregular surface of the Haystacks sandstone at STOP 9B. At the bottom of the photo are slickensides on the bottom plate of a small thrust fault that cuts the very brittle sandstone.

Leave STOP 9, continuing along PA 42 to right (east), then turning almost immediately on Lakewood Avenue.

0.2	21.6	To left is the present outlet of Eagles Mere Lake (a wooden walkway crosses it.)
0.8	22.4	To left is the south end of Eagles Mere Lake.
0.3	22.7	The original outlet of the lake is to the right (west) of this point.
0.7	23.4	Stop sign. Turn right on PA 42.
0.1	23.5	Bouldery till on right.

0.3	23.8	Bear right on Country Club Road.
0.2	24.0	To right is the clubhouse of the Eagles Mere Country Club.
0.2	24.2	Cemetery to right.
0.3	24.5	Stop sign. Turn right.
0.2	24.7	Stop sign. Turn right (north) onto SR 3009.
0.2	24.9	To right is a beaver-dammed wetland. The till knob beneath us partially dams the valley.
0.6	25.5	Cross drainage divide between south-flowing Muncy Creek and west-flowing Loyalsock Creek. The divide is a bedrock saddle underlain by the Huntley Mountain Formation between two Burgoon knobs.
0.2	25.7	Cross beaver-pond wetland. To left is a large beaver dam—and beyond that a till dam. This is the head of Kettle Creek. Eagles Mere Lake once drained through here.
0.2	25.9	Enter Loyalsock State Forest.
1.1	27.0	Turn right onto Shanerburg Road toward Canyon Vista. (On left, just before the turn is the trailhead sign to High Knob Vista.) For the next mile, Shanerburg Road passes over knob-and-kettle topography of bouldery till (late Wisconsinan recessional moraine), but the dense vegetation makes it difficult to see. Note the profusion of Pocono and Pottsville sandstone and conglomerate boulders in the woods on both sides of the road.
1.6	28.6	Big till knob on right.
0.1	28.7	Bear right, continuing on Shanerburg Road. (Note that Mineral Springs Road on left goes more directly to Canyon Vista.)
1.4	30.1	Turn left on Cold Run Road. You are here on a Burgoon Sandstone hilltop.
0.1	30.2	Begin descent of gentle dip slope on Burgoon.
0.3	30.5	Passing through boulder colluvium derived from the Burgoon.
0.2	30.7	The ledge to left marks the top of the Burgoon.
0.1	30.8	The bench here is on lower Mauch Chunk red mudstone. This is a very distinct photo-mapping horizon over a wide area.
0.1	30.9	To left is a beautifully crossbedded sandstone ledge in the middle Mauch Chunk. This may very well represent the Loyalhanna of western Pennsylvania. (Loyalhanna-equivalent crossbedded strata have been recognized as far east and southeast as the Scranton area and Lehigh Gorge State Park.)
0.3	31.2	The road is here passing along the top of the Mauch Chunk Formation. Dead trees on both sides of the road mark devastation from the elm-span worm (which preferentially eats maple trees!) in the middle 1990's. To left is a large fenced in area to permit regeneration of cherry trees—which are heavily browsed by deer. This forest is the center of cherry lumber production in the nation—perhaps the world. Fenced in areas typically cover 10 to 20 acres. Most of the trees outside the fence are black birch.
0.6	31.8	To left is a ledge of upper Mauch Chunk sandstone with glacial striations indicating S53^{o}W ice flow.
0.1	31.9	To left in the woods is a ledge of basal Pottsville conglomerate that comes down to the road just ahead where Cold Run Road enters Worlds End State Park.
0.3	32.2	The road has curved around and is now trending west parallel to Loyalsock Creek in the deep valley to right. The Pottsville ledge continues around the hill to left.
0.8	33.0	Turn into parking area for Canyon Vista Overlook and the "Rock Garden." Disembark.

STOP 10A. CANYON VISTA OVERLOOK, WORLDS END STATE PARK (GPS 41°27'46.2"N/ 76°34'31.0"W).

Leader: Duane Braun.

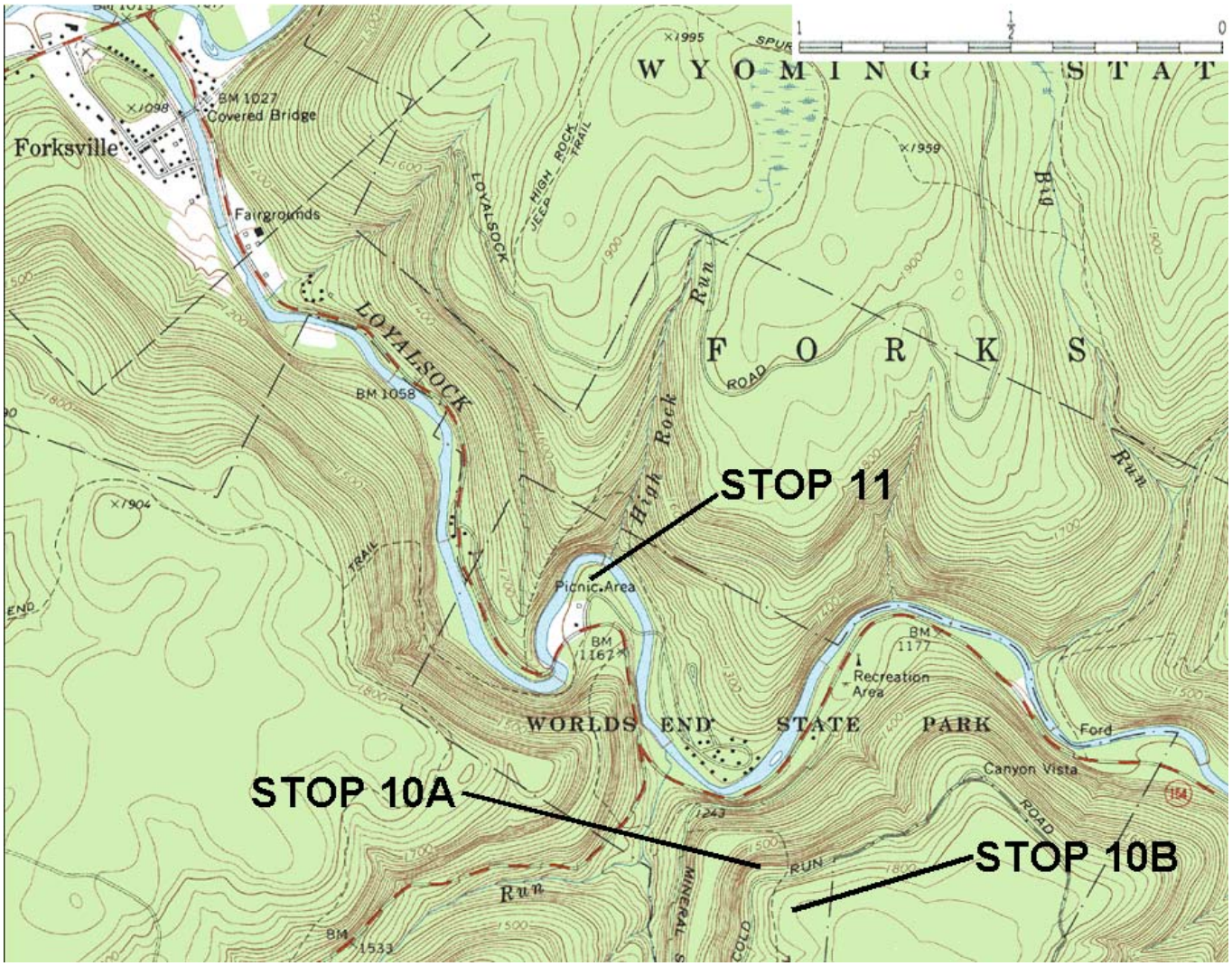


Figure 64. Location maps for STOPS 10A, 10B and 11.

At this site (Figure 64) we are looking northwest, down the Loyalsock Valley where directly below us are three incised meanders at Worlds End State Park (Figure 65). Farther down valley is the village of Forksville, where the Loyalsock valley turns to the southwest (to the left) and is joined by the Little Loyalsock coming in from the northeast (the right). From this vantage point it almost looks as if the Loyalsock valley just ends at the ridge on the near skyline, rather than turning abruptly to the southwest. The broad, nearly flat ridge tops of the Appalachian Plateau to either side of the Loyalsock valley are capped by the Pottsville Conglomerate. A distinct bench a couple of hundred feet below the ridge tops marks the contact between the Mauch Chunk Formation and the underlying Burgoon Sandstone. Below that, the Huntley Mountain Sandstone makes up the rest of the slope to near the valley floor. Redbeds at present stream level were included in the lower Huntley Mountain (Berg, 1981a), but may represent the upper most Catskill Formation.

Figure 65. Panoramic view northwest from Canyon Vista.

The flat-topped Appalachian Plateau surface and the subtle cliff and bench topography on the valley sides appears as if it had never been glaciated. But as noted in the introductory article on the Quaternary History, this area has been glaciated at least four times. Those glaciations though have only covered this area cumulatively on the order of 50,000 years over the last one million years. Also we are near the terminus of each of those glaciations where glacial scour is minimal and glacial deposition is maximal. This area remains a landscape primarily shaped by fluvial erosion and looks much like it did in preglacial times.

As has been emphasized on the first day of this field trip, it is the deposition of glacial sediments that has caused the most landscape change in this region through stream derangement. Loyalsock Creek flows west here, transverse to ice flow, and a sizeable "till shadow" partly filled the valley as the ice withdrew from the valley. But the valley is so narrow and steep sided that the creek has incised rapidly down the bedrock-till contact and has ended up pretty much where it was in preglacial times. On the other side of the valley from here (the north side of the valley) there is a remnant of the "till shadow", a till mass that rises almost 500 ft above the floor of the valley (see Figure 8). It forms the center of the incised meander spur across the valley from us. The next incised meander downstream is actively migrating north and has completely removed the "till shadow" and has deeply cut into the bedrock wall on the north side of the valley, an excellent outcrop you will see at STOP 11. Evidence that the Loyalsock valley once had a thick "till shadow" is seen a couple of miles upstream of here where one of the incised meanders of the creek remains buried by about 250 ft of till (lower left corner of Figure 8).

The hilltops all around us are essentially bare bedrock with a thin veneer of till in places. Once the glacier retreated from the area, the sandstone ledges were immediately exposed to intense periglacial frost activity for thousands of years. This frost riving is what has produced the "Rock Garden" of detached joint blocks in the Pottsville Conglomerate that you will see once you walk up the hill to part B of this STOP.

Leave STOP 10A, walking back across Cold Run Road and following trail to the "Rock Garden."

STOP 10B. THE "ROCK GARDEN," WORLDS END STATE PARK (GPS 41°27'43.5"N/ 76°34'26.9"W).

Leaders: Duane Braun, Jon Inners, and Gary Fleeger.

Figure 66. A. The "Rock Garden"; B. Pavement of the "Rock Garden" disrupted along joints.

The "Rock Garden" in the woods just east of Canyon Vista (see Figure 64) is a classic "rock city"(Figure 66), one of several in or near Worlds End State Park. Like many such features in northeastern and western Pennsylvania, it is formed from the Pottsville Conglomerate (or its western equivalent, the Olean) (see Royer, [1980]). Though their origin is generally (as here) ascribed to intense periglacial activity following retreat of the late Wisconsinan continental glacier, the "streets" between large "city blocks" have in at least one case been hypothesized to have originated from "slow chemical erosion of the sandstone along joints"(Weibel, 1999). That this is clearly not the case here will be shown in the following discussion.

Figure 67. A. Open joint ("street") in frost-riven Pottsville Conglomerate; B. Widely detached blocks of Pottsville Conglomerate, forming "thoroughfare."

Origin by periglacial activity. Immediately after the glacier retreated from the area about 22,000 years ago, the Pottsville Conglomerate ledge would have been a single smoothed mass with a polished and striated surface. Only tight joints would cut the surface; any even slightly open joints would have permitted the glacier to pluck out those joint blocks. Then for about 7000 years, there were periglacial cold climate conditions with intense frost activity on top of this mountain. During that time the conglomerate ledge was intensely frost riven with the blocks progressively separating and creeping down slope by gelifluction (solifluction) from seasonal surface melting of permafrost (Figure 67). That produced the jumble of large blocks, commonly called "rock cities" or "rock gardens" that one sees at

this site. The blocks are not moving under today's climate; this is essentially a "fossil" periglacial landscape.

One can readily visualize how one could reassemble the ledge by moving the various blocks in certain directions, by certain amounts, and doing some rotations of the blocks (a new computer game?). Such "rock cities" are ubiquitous around all ledges in this region. The best "rock cities" form from the largest blocks and those blocks come from the toughest rock. So in this region it is the Pottsville Conglomerate that produces the most spectacular "rock cities." This is the best "rock city" in Worlds End State Park but there is a much larger one a couple of miles east of here on the north side of the Loyalsock valley. There the crevasses are 40 ft deep and the blocks 10's of feet across. It is also a favorite roosting site for the local turkey buzzard flock, which makes the boulders even whiter.

Weathering. During the latest Pleistocene and Holocene, weathering of the exposed ledges and blocks has etched into the sandstone and conglomerate and has removed the glacial polish and striations that were here when the glacier retreated. Only on the beveled tops of the largest, most resistant quartz pebbles are very fine striations trending S42^{o}W to be seen using a hand lens. In places shallow solution depressions or pans (incipient *Opferkessel*) have developed in this almost pure quartz rock (Figure 68). (It is likely that freeze-thaw plucking of sand grains and small pebbles may contribute to deepening of some pans.) The facts that the striated quartz pebbles project only a small fraction of an inch above the weathered pavement surface and that the largest incipient *Opferkessel* are only about 2 inches deep strongly suggest that that weathering along the joints must have been on a similar scale—not nearly so great as to cause separation of the conglomerate blocks by several feet (see Figure 67A). Given time, however, natural acidic rain can eat away the Pottsville Conglomerate—and we humans are speeding up the process through fossil-fuel burning.

Figure 68. Shallow solution pan, or *Opferkessel*, on the conglomerate pavement of the "Rock Garden."

Figure 69. Crescentic fractures on the south edge of the Pottsville Conglomerate ledge.

Crescentic fractures. In places along the southern edge of the Pottsville ledge are "trains" of crescentic fractures left by the glacier. Ice flow would put more then usual pressure on the bedrock when it descended over the edge of the ledge. Boulders imbedded in the ice would be both pressed down against and pushed across the top edge of the ledge. That would put the bedrock surface under the boulder in tension and a crescentic fracture, concave down-ice flow, would form. Such crescentic fractures tend to be 10's of centimeters long and a several centimeters deep (Figure 69). The boulder embedded in the ice forms a series of such crescentic fractures, one after the other (a "train" of fractures) as it alternately sticks and then slips to another position on the bedrock surface.

		Leave STOP 10B, returning to buses at parking area and proceeding down Cold Spring Road.
0.2	33.2	To left is a massive sandstone ledge of the upper Mauch Chunk Formation. The upper part of the formation is massive and planar bedded, the lower part crossbedded (in part, Loyalhanna equivalent).
0.3	33.5	Cross small tributary and enter till shadow in lee of "Rock Garden" hill.
0.2	33.7	At head of switchback where Cold Spring Road intersects Mineral Springs Road, continue around to right down Mineral Springs Road.
0.1	33.8	Pit in bouldery till to right.
0.5	34.3	Leave till shadow and enter exposed bedrock area with ledges of Burgoon Sandstone to right.
0.3	34.6	Spectacular boulder talus and frost-riven sandstone ledges to right.
0.2	34.8	Steep drop on left is the undercut slope on the outside of the incised meander bend that is immediately below Canyon Vista.
0.3	35.1	Stop sign. Turn left onto PA 154, with Loyalsock Creek to right.
0.1	35.2	Note large cobble-boulder bar along creek to right. These bars were formed during the Hurricane Ivan flood of 2004.
0.2	35.4	On left is a high cut in the lower Huntley Mountain as mapped by Berg (1981a)—mostly sandstone, but containing interbeds of red mudstone. To right is a large cobble-boulder bar greatly enlarged by the Ivan flood. The overall "white" color of the deposit is due to the abundance of gray, white-weathered sandstone and conglomerate from the Pottsville, Burgoon, and Huntley Mountain.
0.1	35.5	Worlds End State Park Chapel to right.
0.3	35.8	More red beds to left.
0.1	35.9	Park Headquarters on late Wisconsinan outwash terrace to right.
0.1	36.0	Turn right into main parking lot of Worlds End State Park.
0.2	36.2	Disembark at far end of parking lot.

STOP 11 AND LUNCH. WORLDS END STATE PARK AND LOYALSOCK CREEK (GPS 41°28'23.2"N/76°34'57.6"W).

Leader: Duane Braun.

HISTORY OF WORLDS END STATE PARK

The name "Worlds End" reflects the fears of pioneers who traveled the first road through the valley, located on the bank of Loyalsock Creek.

One section of the road had no turnouts to allow travelers from different directions to pass. On one side was a 300-foot drop into the Loyalsock; on the other, steep banks of rock and earth. It is presumed that many persons almost met their "worlds end" on this narrow road between Forksville and Eagles Mere.

By 1895 the dangerous roadway had been replaced and almost forgotten. In 1932 the commonwealth acquired the property. Several years later, the name of the park created there was changed from Worlds End to Whirls End, to highlight the whirlpool located at the sharp bend of the creek [see mile 36.3]. *Based on evidence for the earlier name from local maps, however, the park was renamed Worlds End in 1943.*

When the state acquired the property, it was a stump and slash-filled area, a wasteland created by recent clearcuts and sawmill operations. Park development began with a $50 allocation and a small staff. Most of the present park facilities were built between 1933 and 1942 by the Civilian Conservation Service. The Loyalsock Trail reached the park in 1950. An

enlarged campground was built in 1960. The present park headquarters was constructed in 2002. Text of plaque in the Park Office.

The high cliff is where one of Loyalsock Creek's incised meanders is actively undercutting the mountainside at the outside of its bend (see Figure 64). The creek has re-established itself in its preglacial course without getting entrenched in the meander spur on the south side of the valley (where the Park headquarters is). There are a series of alluvial terraces stepping down the lower 100 ft of the meander spur (see Figure 8) that show that the creek migrated rapidly enough to the north that it didn't get incised in the bedrock on the meander spur. In the 22,000 years since the glacier receded from the area, Loyalsock Creek has removed most of the glacial fill in its valley. It should be able to remove the rest of the glacial deposits before the next glacier arrives 10's of thousands of years from now.

The question here is a stratigraphic one: Are we looking at redbeds in the lower Huntley Mountain Formation or the upper Catskill Formation? This site has been mapped as being in the middle of the Huntley Mountain Formation (Berg, 1981a). The Huntley Mountain at Forksville is mapped as being 600 ft thick and here we are 300 ft below the Burgoon contact on the cliff above us. At the Huntley Mountain type section there are a few red mudstone units noted and a lot of covered interval that may well be redbeds. So the red mudstone at stream level here may well just be one of those occasional red units within the Huntley Mountain (Figure 70). But when one walks this creek and its tributaries, as was done for the surficial deposit mapping, redbeds (including some red sandstone) are almost continuous underneath this mudstone (down section). So if those strata are more lithologically like the Catskill than the Huntley Mountain, why not call it Catskill?

Figure 70. Gray sandstone overlying red mudstone in cliff along Loyalsock Creek across from STOP 11 at Worlds End State Park—Huntley Mountain or Catskill?

Of course that would leave the Huntley Mountain only 300 ft thick here. Throughout this area the gray sandstones in the middle of the Huntley Mountain appear thinner and the redbeds thicker in both the upper (like at Eagles Mere) and lower parts of the formation. What is needed here is a bunch of measured sections to better work out the stratigraphy. The many "one-sided" bedrock gorges around here provide plenty of outcrop (check the surficial maps). Eventually paleontology studies in these rocks may give us some time markers to see where the Devonian-Mississippian boundary actually lies in these strata.

		Leave STOP 4, proceeding out of parking lot back to PA 154.
0.1	36.3	Stop sign. Turn right on PA 154, and immediately cross Loyalsock Creek. To right of the bridge is the site of the "whirlpool" at times of high water. To left is the Swimming Beach of Worlds End State Park.
0.3	36.6	Leave Park. Note continuation of Ivan cobble-boulder bars along Loyalsock Creek to left.

0.3	36.9	Boulder till to right.
0.4	37.3	To right is a deep cut through sandstone and mudstone mapped as lower Huntley Mountain (Berg, 1981a). Lungfish aestivation burrows occur in one of the red mudstone beds near road level (Royer, [1980]).
0.2	37.5	Enter village of Forksville, named after the "Forks," i.e., the confluence of Little Loyalsock Creek with Loyalsock Creek. To right are the Sullivan County Fairgrounds.
0.4	37.9	Covered bridge over Loyalsock Creek to left.
0.2	38.1	Historical Marker to right reads: HAROLD "RED" GRANGE (1903-1991). Legendary football player, nicknamed "The Galloping Ghost," born in Forksville. Member, College Football Hall of Fame & Pro Football Hall of Fame. Career began at Wheaton (Ill.) High School; scored 75 touchdowns. Played 1923-1925 for University of Illinois: an All-American each year. Professional player, 1925-34, mainly with Chicago Bears. Lived in Forksville to age five; his family had farmed and worked lumber camps nearby.
0.1	38.2	Stop sign. Turn right on PA 154-PA87. Historical Marker to right reads: OLD WOOLEN FACTORY. A short distance SE, along the Loyalsock is the site of old factory established in 1810 by Samuel Rogers, Jr. During the War of 1812, it made kersey cloth for the army. Flood in 1816 stopped operation of the factory.
0.1	38.3	Cross Little Loyalsock Creek, with prominent outwash terraces to right. After crossing the creek, continue straight on PA 87 North. (PA 154 turns left).
0.3	38.6	Crossbedded gray and red sandstone and red mudstone of the uppermost Catskill Formation (Berg, 1981a) to left. We are now driving north, up-dip (down-section) into the Wilmot anticline.
0.5	39.1	Floodplain (alluvial terrace) of Loyalsock Creek to right.
0.2	39.3	The farm buildings and Wesleyan Methodist Church here occupy a large alluvial fan from a tributary to left.
0.4	39.7	Turn left onto Millview Mountain Road. Just after the turn a side road goes off to the left—and just beyond this is a ledge of Catskill sandstone dipping 45^{o} to the south. As we ascend the hill for the next mile, we will be driving in the up-dip direction towards the axis of the Wilmot anticline. The dip angle declines to a few degrees in a relatively short distance, indicating that this anticline has the form of a large kink-fold.
0.1	39.8	Large outcrop of south-dipping (30^{o}) Catskill sandstone to left.
0.2	40.0	Catskill strata dipping very gently south to left—approaching axis of Wilmot anticline.
0.7	40.7	Turn left into quarry. Disembark.

STOP 12. PALEOENVIRONMENTAL INTERPRETATION OF THE LOCK HAVEN FORMATION (UPPER DEVONIAN) AT THE LEBERFINGER QUARRY (GPS 41^{o}31'19.0"N/ 76^{o}35'31.1"W).

Leader: Jennifer M. Elick.

INTRODUCTION

Trace fossils provide valuable information that may aid in the interpretation of facies models and paleoenvironments, substrate conditions, and organism movements and behaviors (Pemberton et al., 1992). In particular, ichnology and sedimentology may be useful in identifying very specific shallow to marginal siliciclastic marine systems (Pemberton et al., 2001).

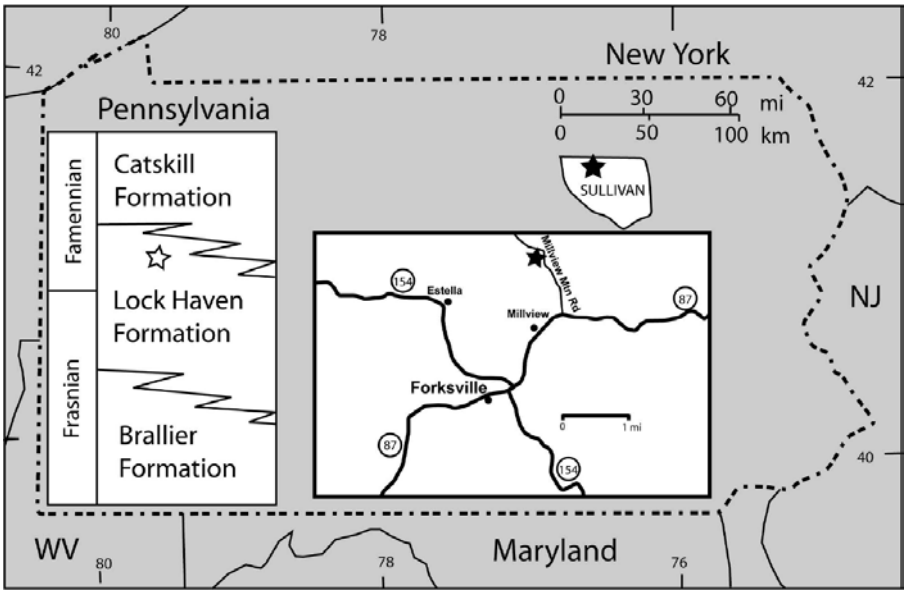


Figure 71. Map showing location of measured section in aggregate quarry (solid star) located on Millview Mountain Road, just off of State Route 87, near Forksville in Sullivan County, Pennsylvania. A geologic column is provided on the left side of the map showing the general stratigraphic position of the Lock Haven Formation (Upper Devonian) from this location.

At an aggregate quarry in Forksville, PA (Figure 71), the sedimentary structures and trace fossils found in the uppermost Lock Haven Formation (Upper Devonian) reveal the existence of a shallow marine shelf that may have been influenced by changing environmental conditions including tidal, storm, and tectonic activity. These rocks may provide us with a better understanding of the sedimentologic and tectonic influences of the Acadian orogeny leading up to the deposition of the Catskill Formation and subsequent infilling of the foreland basin. Though the stratigraphic section exposed in the quarry is relatively small (Figure 72), it reveals a great deal about the changing environmental conditions. This paper will attempt to (1) describe the stratigraphy of the aggregate quarry in Forksville, PA, (2) interpret the depositional setting for these sediments, and (3) to identify the processes influencing this depositional setting.

GEOLOGY

The strata described in this paper occur in the Leberfinger quarry located 1.25 miles to the north, on Millview Mountain Road, approximately 1.5 miles northeast of Forksville, PA on State Route 87 (Figure 1). The rock unit is the Lock Haven Formation (Berg et al., 1980; Berg and Dodge, 1981; Harper, 1999) (Figure 1), which is Late Devonian (Frasnian-Famennian) in age. It forms the southwest dipping limb of the Wilmot anticline (Berg, 1981c).

During the Late Devonian, Pennsylvania was located between 0 and 20° south latitude with the Acadian highlands to the southeast and the Catskill Sea to the west (Harper, 1999). Woodrow (1985) determined that this location would have resulted in a tropical wet and dry or desert-like climate with seasonally restricted rainfall due to a rain shadow effect produced by the Acadian Highlands. Erosion of these highlands provided large quantities of sediment which inundated a coastal setting and which spawned change in both marine and terrestrial environments. In central and northeastern Pennsylvania, the transition from Lock Haven to Catskill Formations represents a shallowing upward succession of storm-dominated shelf and tidal mudflat deposits to more terrestrial continental deposits, respectively (Harper, 1999; Castle, 2000; Elick, 2002). This has been interpreted to represent the progressive progradation of land during the Acadian Orogeny. Deposition of the Lock Haven and Catskill Formations represent high rates of sedimentation in response to Acadian orogenesis, and produce the Catskill regressive sequence (Slingerland and Hanshaw, 1989).

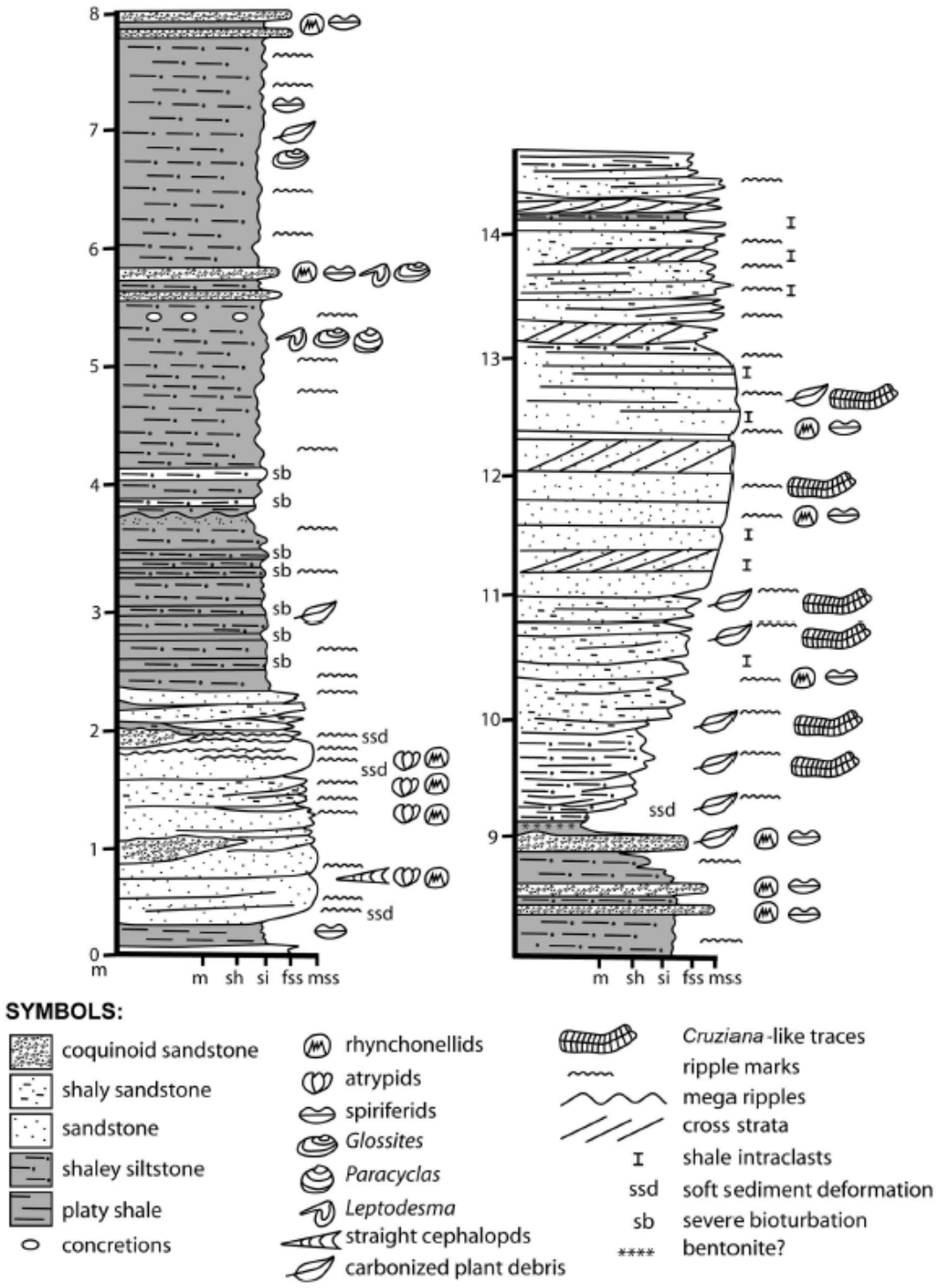


Figure 72. Stratigraphic column of the Lock Haven Formation (Upper Devonian) at Leberfinger quarry on Millview Mountain Road.

DESCRIPTION OF THE STRATA

Just over fourteen meters are exposed at the quarry (Figure 72), representing the uppermost part of the Lock Haven Formation. The upper part of the Lock Haven Formation near Forksville can be characterized as having two dominant lithofacies: a bluish gray shaly siltstone with thin stringers of

rippled sandstone and light olive gray medium-grained massive to slabby sandstone with thin partings of platy dark greenish gray shale (Figure 72).

The shaly siltstone is platy to slabby and may contain both discrete and amalgamated beds. These deposits exhibit intervals of planar lamination and severe bioturbation (10 to 20 cm thick). Thin, beds of fine- to medium-grained sandstone contain symmetrical or asymmetrical ripples with a N-S current direction, and they may be laterally discontinuous. Some intervals of this lithofacies appear to have lenticular bedding. Commonly the ripples display soft sediment deformation. This lithofacies also contains rare concretion layers, up to 10 cm thick and thin, iron-rich coquinoid sandstone beds or shell lag deposits (1 to 15 cm thick) (Figure 73A and B).

The light-olive-gray sandstone facies occurs at both the base and top of the measured section. It exhibits wavy and flaser bedding and contains both symmetrical and asymmetrical ripples, double-crested ripples (Figure 73C), and larger megaripples. Planar lamination and megaripples are found in the lower part of the measured section while tabular and hummocky cross stratification are more abundant in the upper part of the exposure. This lithofacies also contains hematite-rich coquinoid sandstone beds, small, rounded mudstone intraclasts, and common carbonized plant fragments and other fossils. There are thin, interbedded dark-olive-gray shale partings within this lithofacies and sharp surfaces separate bedding planes (Figure 73A). Some of the beds appear laterally discontinuous and may be truncated by other sandstone beds, yielding the appearance of multistoried channel sandstone beds.

Between the two lithofacies, occurring stratigraphically above a thick, erosionally truncated coquinoid sandstone bed (Figure 73A), is a light-bluish-gray clay interval (4 cm thick) that is bound by an accumulation of organic carbon, approximately 1 cm thick (Figure 73D). Preliminary work on this bed suggests it may be either a bentonite or may be a highly weathered layer of shale.

PALEONTOLOGY AND ICHNOLOGY

The two lithofacies contain organisms and trace fossils which may allow correlation to other nearby exposures. The fine, bluish-gray shaly siltstone contains both infaunal and epifaunal organisms including the bivalves *Leptodesma*, *Paracyclas*, and *Glossites*, and spiriferid, atrypid, and rhychonellid brachiopods. The sandstone lithofacies contains brachiopods (abundant), terrestrial plant fragments (common), and bivalves (rare); it also contains straight cephalopods (rare).

In addition to these organisms, abundant burrows such as *Cruziana*-like traces (Figures 73E and F), *Arenicolites*, *Rhizocorallium*, and less distinct horizontal burrows (up to 5 mm in diameter) were found mostly in the sandstone facies. The abundant *Cruziana* traces were typically found with carbonized plant fragments (up to 15 cm long), and some appear to have a subparallel alignment/orientation (Figure 73F). There is significant bioturbation in some of the beds in the muddy offshore facies. Though most of the trace fossils at the quarry were produced through the process of locomotion like *Cruziana* or feeding types like *Rhizocorallium*, which are preserved as hypichnia, a few, such as *Arenicolites*, can be characterized as dwellings and are considered exchnia (Pemberton et al., 2001).

A coquinoid sandstone is common in the finer lithofacies, but it also occurs in the sandstone lithofacies (Figure 73A). This coquinoid sandstone is a graded grainstone with drusy, sparry cement (Figure 73B). Some of the bioclasts that occur in the sandstone are articulate brachiopods (common), brachiopod spines (Figure 73B), and echinoderm plates (rare). Some of the other grains consist of well rounded mudstone and silty mudstone intraclasts, small concretions (up to 1.5 cm in diameter), and very fine, angular quartz grains (rare).

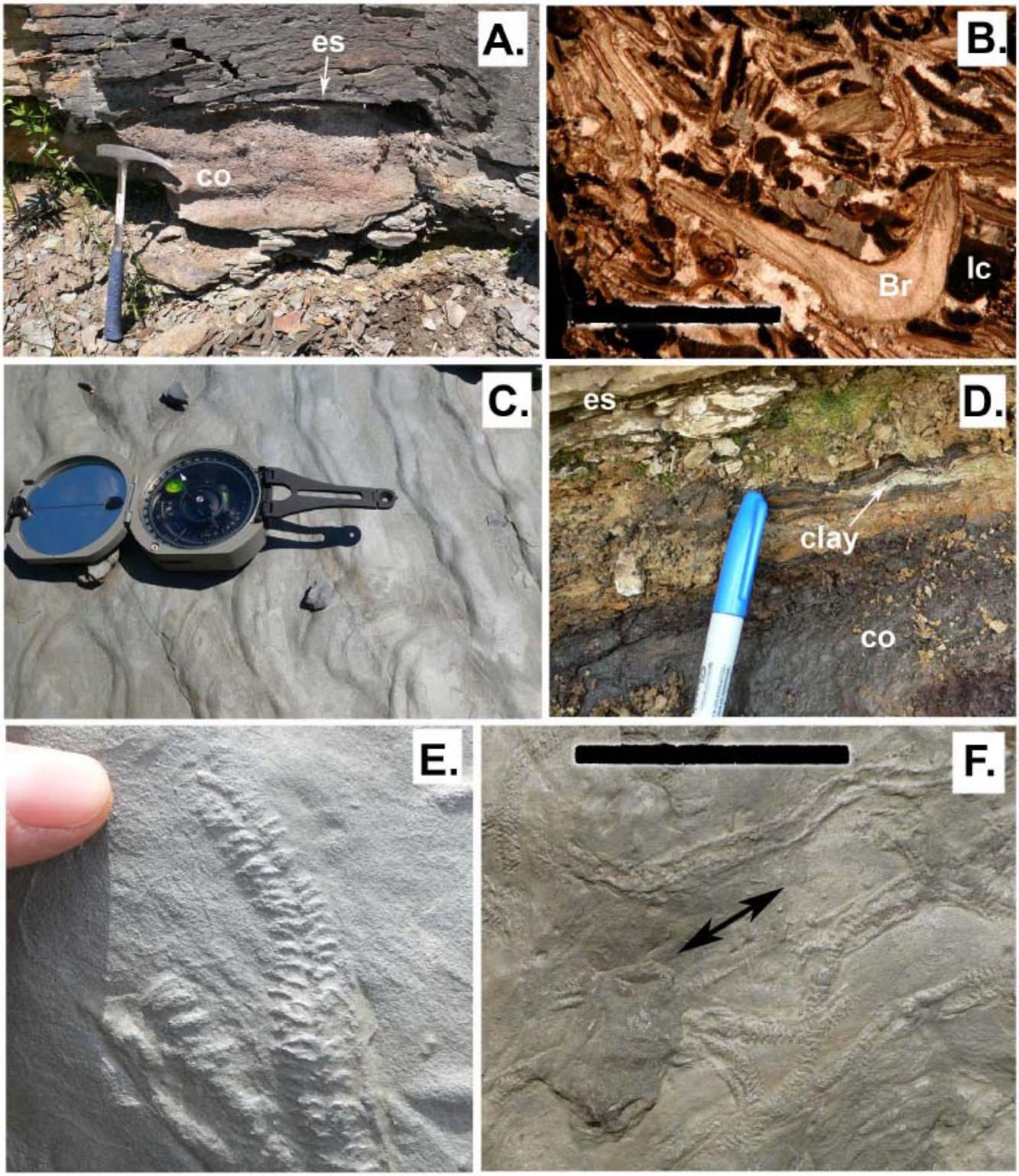


Figure 73. Some of the sedimentary features that help reveal depositional environment. A. A laterally discontinuous coquinoid sandstone (co) separated from overlying sandstone by erosional surface (es). B. Photomicrograph of graded coquinoid sandstone consisting of articulate brachiopods (Br) and intraclasts (Ic) cemented with drusy calcite spar (bar= 1mm). C. Double crested ripples. D. A layer of clay (possible bentonite) located between two 1 cm thick layers of organic plant material. This layer is located just above a coquinoid sandstone (co) and below a prominent erosional surface (es). E. A *Cruziana*-like trace fossil. F. Several *Cruziana*-like trace fossils which appear to have a subparallel orientation. Note the double-ended arrow indicating orientation (scale bar=10 cm).

PALEOENVIRONMENTAL INTERPRETATION AND DISCUSSION

In central and northeastern Pennsylvania, the Lock Haven Formation has been described as representing a shallow shelf environment, possibly an open marine shelf adjacent to sand ridges, situated on a foreland ramp that was periodically influenced by tidal and storm activity (Figures 74 A and B)(Wells and Inners, 1977; Slingerland and Hanshaw, 1989; Castle, 2000). Harper (1999) categorized the Lock Haven Formation as part of Facies IV, consisting of detrital sediments from mixed fluvial and clastic shorelines, and invoked a fluctuating sea level to account for the thin limestone beds found in this facies. Sea level fluctuations, sediment influx, and tectonic activity (subsidence) have all been invoked to describe some of the repeated depositional trends recognized in the Lock Haven Formation (Slingerland and Hanshaw, 1989; Castle, 2000).

Indeed, the texture and color of the sediments, paleontology and ichnology, and sedimentary structures in this section (Figure 72) all indicate a shallow shelf depositional setting that is near the shoreline. Based on descriptions of Walker and Plint (1992), the finer-grained shaly siltstone facies probably formed offshore, in a deeper, lower energy setting than the coarser sandstone facies. The sandstone lithofacies probably represents part of the shoreface environment. The diversity of bivalves and brachiopods suggests normal marine conditions, a conclusion also made by Wells and Inners (1977). Large terrestrial plant fragments suggest the depositional setting may have been near land, possibly adjacent to a fresh water source such a channel system.

Processes Influencing Shelf

The marine shelf was probably a low energy setting based on the prevalence of fine, planar-laminated deposits and small-scale ripples. Other features like double crested ripples have been described as forming in low energy settings, commonly coastal to nearshore environments (Lucchi, 1995). Some of the ripples exhibit a paleocurrent direction that is predominantly oriented north-south. This current direction is perpendicular to the predominant paleocurrent of terrestrial streams in the overlying Catskill Formation (Elick, 2002). A north-south oriented current direction may be indicative of the longshore current, which should flow parallel to the coast (Walker and Plint, 1992).

This shelf environment may have been influenced by periodic storms due to the presence of graded and laterally discontinuous coquinoid sandstones or shell lags (Figures 73A and B), hummocky cross-stratification and megaripples, mudstone intraclasts, and sharp erosional surfaces located between some beds. Such features reveal intermittent and higher energy conditions. Similar types of features in time equivalent deposits from northern and central Pennsylvania by Castle (2000) and Slingerland and Hanshaw (1989) and were interpreted as evidence for storm activity. Though some of the erosional surfaces may be attributed to storm processes, Castle (2000) recognized some sharp-based erosional surfaces to represent rapid changes in sea level associated with regressional sequences. Changes in sea level, he suggested, were related to tectonic processes, namely differential subsidence, due to an active foreland ramp. The erosional surface between the two lithofacies at 9 m (Figure 72 and 73A) may be one of these surfaces.

A thin clay interval found between the two lithofacies (Figures 72 and 73D) may potentially be a bentonite or a highly weathered layer of shale. The abundance of detrital material and lack of abundant biotite and zircon crystals suggests that it is a highly weathered shale interval. More work on this layer is necessary to determine the origin of the clay. This layer is bound between two 1 cm-thick layers of organic plant material (Figure 73D) which indicates that the basin may have experienced adjustments in sea level due to tectonic thrust loading (Figure 74B), sedimentation, or organic productivity at this interval.

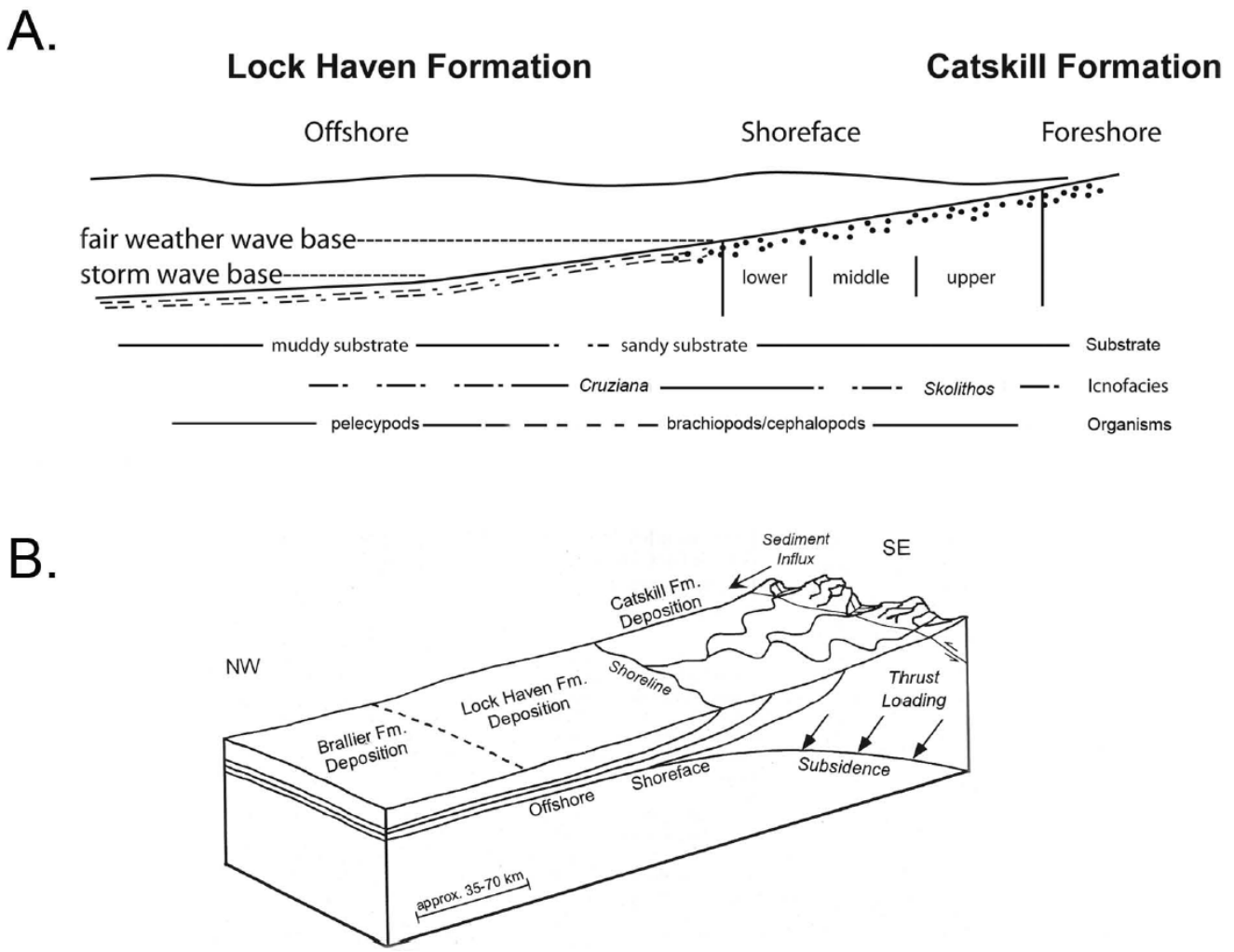


Figure 74. Paleoenvironmental interpretation of the Lock Haven Formation. A. Textures of sediment and ichnofacies located in the environments of the Lock Haven Formation (modified from Walker and Plint, 1992 and Castle, 2000). B. Location of the active foreland ramp environments and representative formations in relationship to Acadian front (modified from Castle, 2000).

In addition to storm and tectonic processes dominating this shelf, tidal activity may have influenced deposition, especially in the shallow shoreface environment. Flaser and wavy bedding found in this facies indicates that minor changes in paleoenvironmental energy may also have existed. Castle (2000) suggests the coarser sediment in the Lock Haven Formation may have been deposited at approximately 10 m depth, which would have been within the range of water depths influenced by active tidal forces.

Life On An Active Shelf

Organisms living on this active foreland shelf were adapted to the environmental conditions. Most of these organisms were bivalves and brachiopods that sat on or near the sediment surface. In the deeper, muddier offshore environment (Figure 74A), relatively flat clams would have floated on the muddy surface; they generally did not burrow deeply into the sediment but would have been able to be mobile on unstable substrates, especially following storm activity (Linsley, 1994). The more robust brachiopods on the other hand, were generally found more in the sandier, shallower more energetic environment (Figure 74A). Under these conditions, they could recline in the sand, without sinking into the sediment. The mud would have been soupy, based on the presence of soft sediment deformation. Soft sediment deformation

(Figure 72) in the form of ball and pillow structures and load casts formed because of rapid deposition of fine sediment, especially sand accumulating on top of a muddy silt deposit. This rapid deposition of sediment preserved the abundant trace fossils.

The *Cruziana* traces reveal that organisms were actively moving laterally in the mud (Figures 73E and F), probably in search of nutrients in the mud. This type of trace fossil is commonly found preserved in sandstone containing transported terrestrial plant fragments. In the shoreface environment, periodic events deposited sand on top of the burrows, increasing their preservation potential. Slingerland and Hanshaw (1989) recognized traces of the *Cruziana* and *Skolithos* Ichnofacies in the sandstone beds of the Lock Haven Formation in central Pennsylvania while Castle (2000) described many small horizontal burrows. Though *Cruziana* traces are named after and are typically associated with trilobites (Häntzschel, 1966), trilobites were not found in the Forksville quarry nor in the localities described by Slingerland and Hanshaw (1989) and Castle (2000). Because of this, these *Cruziana*-like traces may have been made by soft-bodied invertebrates whose body fossils were not preserved. The *Cruziana* ichnofacies is characteristic of a low-energy environment located below a normal fair-weather wave base (but not below the storm wave base) in well-sorted sands and silts (Figure 74A). These burrows were most likely produced by mobile suspension and detritus feeders on a shelf where low ichnodiversity was present (Brenchley and Harper 1998, Frey et al.,1990).

Trace fossils like *Arenicolites* and *Rhizocorallium* are collectively placed in the *Skolithos* and *Cruziana* Ichnofacies, respectively. Both of these ichnofacies occur on shallow shelves and may be indicative of intertidal conditions. The severe bioturbation in some of the beds in the muddy siltstone facies (Figure 72) may represent an influx of nutrients to surface deposits that encouraged organisms to ravage sediments for food, thereby disrupting bedding. This may be due to proximity to a terrestrial stream source or normal storm processes transporting nutrients on the shelf.

CONCLUSION

The transition between the Lock Haven and overlying Catskill Formations is one marked by rapid sedimentation and progradation. The rock exposed at the Leberfinger quarry in Forksville, PA, contains two dominant lithofacies which represent different parts of a shallow marine shelf: an offshore environment and a shoreface environment. Both of these environments record evidence of tidal, storm and possible tectonic activity that influenced the shelf. High-energy storm events washed nutrients into the basin from the adjacent shoreline, providing nutrients for bivalves and brachiopods, as well as soft bodied organisms. This resulted in an increased amount of bioactivity in the form of bioturbation. Abundant sedimentation ensured preservation of many organisms with hard parts, however, soft bodied organisms responsible for producing the *Cruziana*, *Arenicolites*, and *Rhizocorallium* trace fossils were not preserved.

		Leave STOP 5, turning right on Millview Mountain Road and descend hill back to PA 87.
1.0	41.7	Stop sign. Turn right onto PA 87 South.
1.4	43.1	Cross Little Loyalsock Creek.
0.1	43.2	Cross Loyalsock Creek.
0.1	43.3	Cemetery on left is on an isolated mass of glaciofluvial gravel, forming a "surficial *Umlaufberg*."
0.5	43.8	Historical Marker to right reads: RURAL ELECTRIFICATION. In 1936 seventy-five percent of Pennsylvania farms had no electric service. During the next five years, with Federal support, 14 consumer-owned cooperatives were formed in this State. Sullivan County Rural Electric Cooperative, serving users in Sullivan, Lycoming and Bradford counties, was incorporated Dec. 3, 1936.

		To left in the woods are late Wisconsinan outwash terraces.
0.4	44.2	Deep cut in lowermost Huntley Mountain Formation (Berg, 1981a).
0.5	44.7	South-dipping Huntley Mountain (Berg, 1981b) to left.
1.0	45.7	Cross the alluvial fan deposited by Scar Run, a steep-gradient tributary coming in from the east.
0.2	45.9	Cut in flat-lying Huntley Mountain Formation (Berg, 1981b).
0.3	46.2	Outwash terraces to left, alluvial terraces to right.
0.2	46.4	Cross Ketcham Creek alluvial fan.
0.3	46.7	To right Loyalsock Creek is on a bedrock ledge. At this point the road starts climbing over a large ice-contact stratified drift deposit (kame terrace) that rises over 100 ft up the side of the Loyalsock valley and extends for nearly a mile along the valley. This deposit has not been removed by Loyalsock Creek because it is "defended" by a sandstone ledge at present stream level.
0.8	47.5	Road cut through Huntley Mountain sandstone exposed where the road has been cut through the bedrock core of an incised meander spur of Loyalsock Creek.
0.3	47.8	Alluvial terrace to right, ice-contact stratified drift to left in woods.
0.4	48.2	Cross apex of another alluvial fan.
0.3	48.5	Deep cut in uppermost Huntley Mountain red sandstone and mudstone (Berg, 1981b) to left.
0.3	48.8	Cross series of alluvial terraces. Ivan floodwaters inundated the road in the swale just ahead. To left at the base of the mountain where there are farm buildings is a remnant of an outwash terrace 20 to 30 ft above the alluvial terraces.
0.1	48.9	Cross Loyalsock Creek and enter cut in lowermost Catskill red beds (Berg, 1981b).
0.5	49.4	Cross an outwash terrace remnant "hiding" in the lee of the bedrock ridge that the road just cut through.
0.2	49.6	Cross apex of large alluvial fan coming in from the right.
0.6	50.2	Enter Hillsgrove. Much of the village is on a large alluvial fan deposited by Mill Creek, a tributary that enters the Loyalsock valley from the north. The Mill Creek valley is essentially perpendicular to ice flow and has a thick "till shadow" whose erosion by the creek has provided the sediment for the fan here in the Loyalsock valley. North of here, freshly eroded till scarps 10's of feet high still provide abundant sediment to Mill Creek. The Mill Creek fan has "pushed" the Loyalsock Creek to the east side of its valley where it is actively undercutting the mountainside and exposing bedrock ledges.
0.4	50.6	Cross Loyalsock Creek. On the bank of the creek to left is a 40-ft-high cliff of Catskill sandstone (Berg, 1981b).
0.6	51.2	The alluvial terraces to right were covered by Ivan floodwaters in 2004. On the left is boulder colluvium at the toe of the almost 1000-ft-high, angle-of-repose mountain side.
0.7	51.9	Turn left onto Dry Run Road.
0.2	52.1	Dry Run Ranger Station of Loyalsock State Forest to right. For the next mile there will be sandstone ledges almost continually exposed on the steep slope to left. The west-trending Dry Run valley here is exceptionally narrow and steep. Postglacial fluvial erosion has removed almost all the thick glacial deposits that once partly filled this valley transverse to glacial-ice flow.
0.3	52.4	Pull off onto right side of road. Disembark.

STOP 13. BURROWS IN HUNTLEY MOUNTAIN FORMATION, DRY RUN: WERE THEY PRODUCED BY LUNGFISH? (41°25'19.43"N/76°41'57.8"W).

Leader: Jennifer Elick.

INTRODUCTION

Very large burrows occur in the Huntley Mountain Formation (Devonian-Mississippian) along Dry Run Road in the Wyoming State Forest, about 1.5 mi southeast of Hillsgrove, PA. This STOP description will (1) describe the stratigraphy, (2) interpret the depositional environment, and (3) determine the origin of large cylindrical burrows, first described in the Huntley Mountain by Berg and Edmunds (1979).

GEOLOGIC SETTING

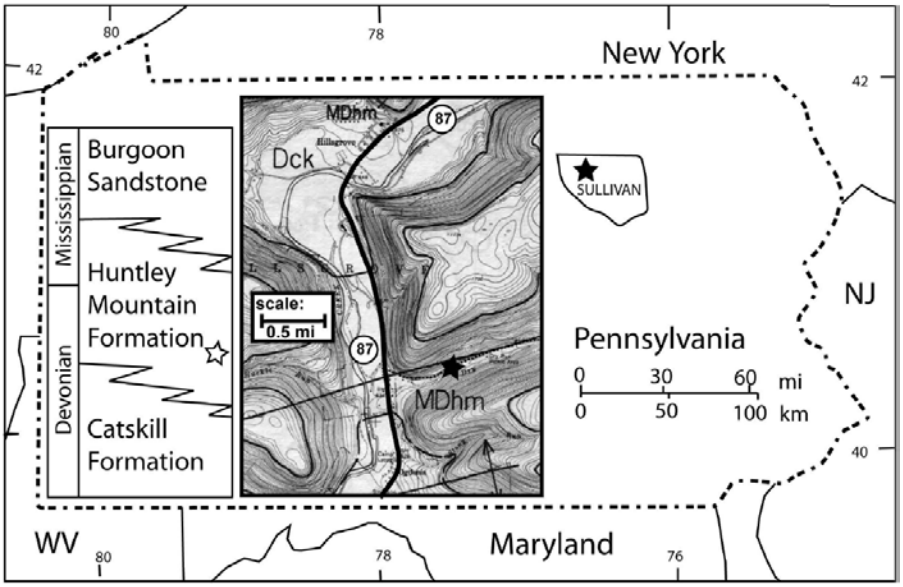


Figure 75. Map showing the location of the exposure described from Wyoming State Forest, near Hillsgrove, PA. The exposure, identified with a black star, is located approximately 1 mi northeast on Dry Run Road, just past the main entrance of the Forest.

The rocks in the Wyoming State Forest, located 1 mile east on Dry Run Road, just off of PA 87, are from the Huntley Mountain Formation, which occurs along the Devonian-Mississippian boundary (Figure 75) (Berg and Dodge, 1981). This transition between the Catskill and Burgoon Formations was named by Berg and Edmunds (1979). Other relatively time-equivalent, nonmarine rock units are the Spechty Kopf and Rockwell Formations (Berg, 1999). At the exposure in the Wyoming State Forest (Figure 75), the nearly horizontal beds of the Huntley Mountain Formation are located along the axis of the Barbours syncline (Berg and Dodge, 1981).

The lower part of the Huntley Mountain Formation contains fining-upward fluvial cycles that resemble those found in the underlying Catskill Formation (Berg, 1999). Although these cycles are thicker than in the Catskill Formation, the finer-grained members tend to be thinner (Berg and Edwards, 1979). Other features like plant fossils, freshwater invertebrates, and trough crossbedding indicate that the Huntley Mountain was deposited in a fluvial environment, possibly along a meandering river system (Berg, 1999).

DESCRIPTION OF STRATA

Several different facies are represented by the red beds exposed along Dry Run Road (Figure 76). These include: (1) a multistoried sandstone facies, (2) a silty mudstone facies, and (3) an interbedded sandstone and shale facies.

The multistoried sandstone facies is relatively thin (less than 1 m thick) and is composed light reddish gray beds of medium-grained sandstone (Figure 77A). These beds contain cross stratification, ripples, and planar laminations. Some of the beds contain dark reddish gray shale intraclasts. Individual beds incise the beds they overlay with sharp erosional contacts (Figure 77A).

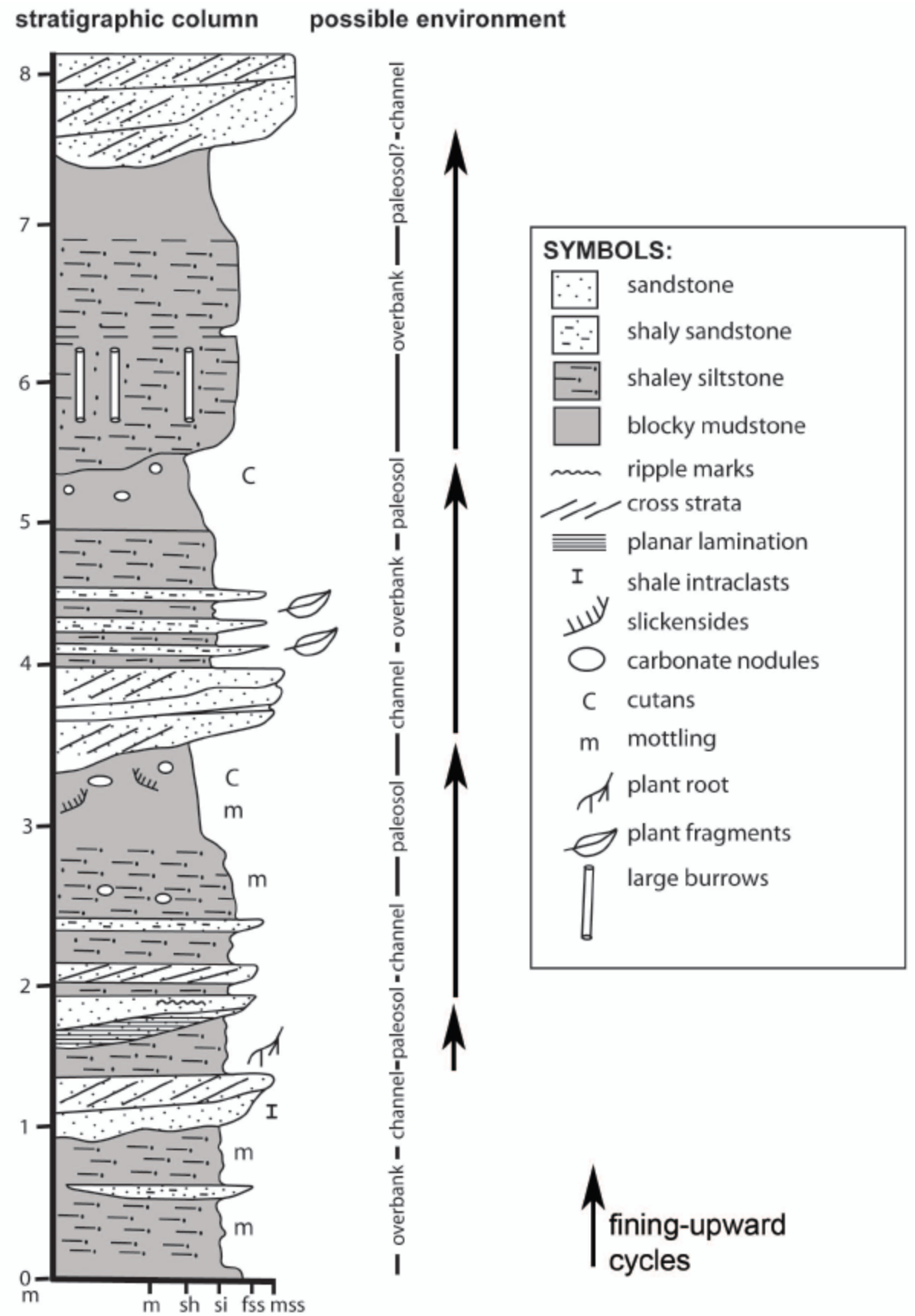


Figure 76. Stratigraphic column of exposure in Wyoming State Forest near Hillsgrove.

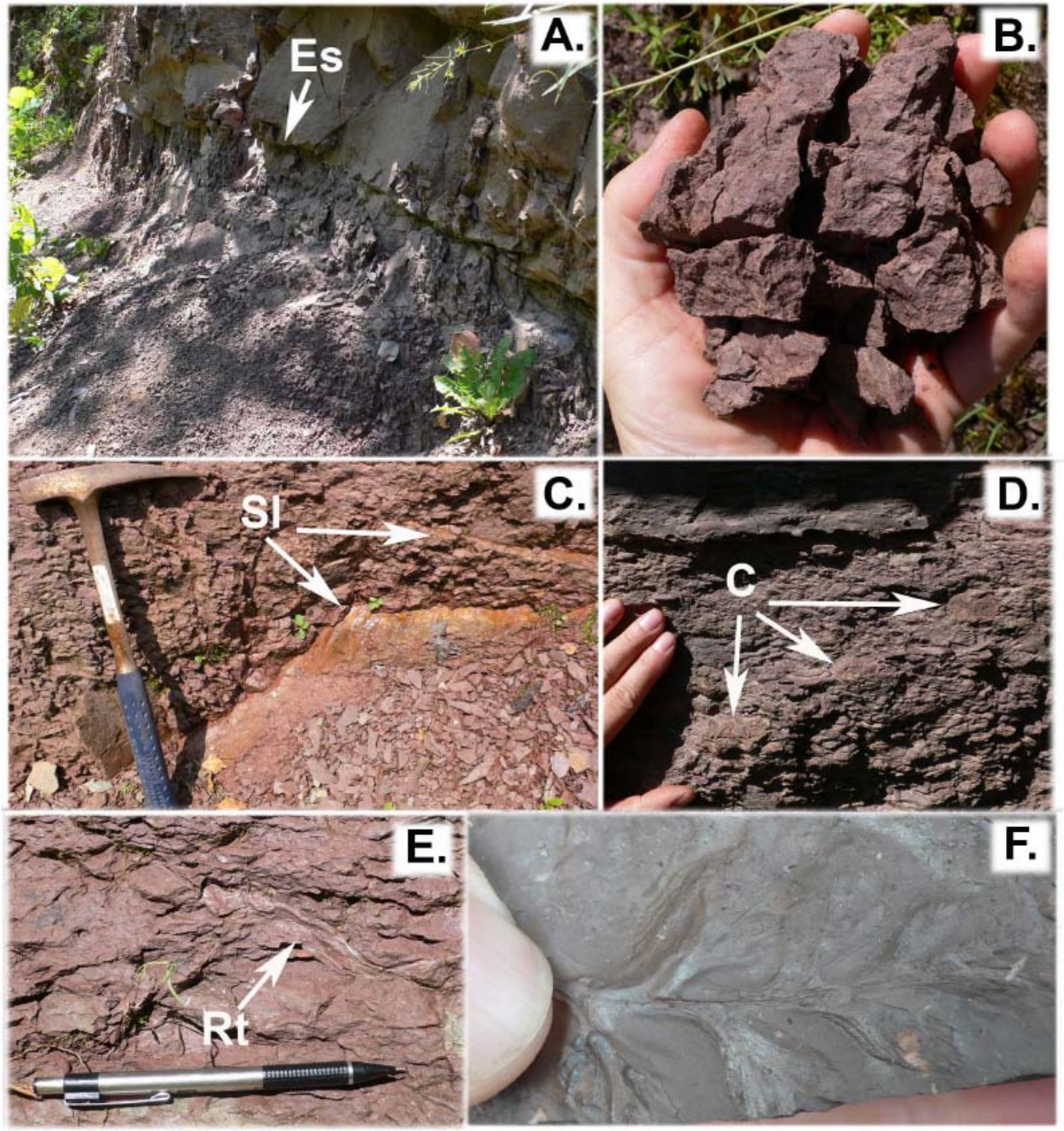


Figure 77. Features from the three interpreted facies. A. Erosional surface (Es) between the multistoried sandstone facies and underlying silty mudstone facies. B. Blocky texture exhibited by silty mudstone facies. C. Iron-stained slickensides from the silty mudstone facies. D. Carbonate nodules in silty mudstone. E. Root trace in lower part of silty mudstone facies. F. *Archaeopteris* collected from float along exposure.

The blocky silty mudstone facies (Figures 77A, B, C, D and E) is composed of two units that are dark reddish gray but may contain bluish-gray to light-greenish-gray mottling. The lower part of this facies is a shaly siltstone that may contain clay-lined plant fragments and root traces (Figure 77E). This member grades into the overlying blocky silty mudstone (Figure 77A, B, C and D). The silty mudstone

may contain orangish-brown, iron-stained slickensides (Figure 77C) and small carbonate nodules (Figure 77D). The lower part of this facies may have a gradual boundary with the underlying facies, while the upper part may be separated from the overlying beds by a sharp and irregular erosional surface (Figure 77A).

The interbedded sandstone and shale facies consists of light-reddish-gray shaly sandstone that grades into intervals of silty, platy shale. The shale is micaceous and may contain clay-lined plant fragments and small burrows. A clay-lined fragment of *Archaeopteris* leaves (Figure 77F) was found in the float adjacent to the exposure; based on the lithology of the surrounding matrix, it may be from this facies.

BURROWS

The burrows are located in the interbedded sandstone and shale facies and are composed of silty mudstone (Figure 76). They are cylindrical in shape, with a longitudinal axis that is normal to bedding (Figure 78A). The burrows are reddish gray in color, but have a bright red mottled zone around their perimeter (Figure 78B). They are up to 65 cm long and 15 cm wide (long axis in cross section) and appear to be similar to the surrounding matrix, but are distinctive in the manner in which they weather from the exposure. The burrows are not regularly spaced and may be found a few decimeters to a few meters apart. They appear to have micro-slickensided clay-lined layers (Figure 78C) that cause the burrow to break apart into distinct layers. In thin section, the burrows contain a silty mudstone matrix with small rounded shale intraclasts (up to 2 mm long) and root traces (Figure 78D).

DISCUSSION

Paleoenvironmental Interpretation

Previous interpretations have described the lower part of the Devonian-Mississippian age Huntley Mountain Formation as a series of fining-upward cycles representing a fluvial, meandering stream, depositional environment (Berg and Edmunds, 1979, Berg, 1999). At this locality, thin, fining-upward packages can be identified (Figure 76). Several different features in the interval of study indicate that these rocks were deposited by a freshwater stream system on the floodplain (Figures 76, 77, and 78).

The multistoried sandstone facies contains features like cross-stratification and ripples that suggest the transport of sediment by small streams (Figure 76). These channels scoured previously deposited sediments resulting in sharp erosional surfaces (Figures 76 and 77A). The blocky, silty mudstone (Figures 76 and 77A, B, C, and D) containing slickensides, calcareous nodules, and exhibiting a blocky morphology resembles a vertic paleosol or vertisol (Retallack, 1980). These types of soils experience shrink and swell conditions due to strong seasonality and expanding clays, resulting in the formation of slickensides (Figure 77C). Because of the strong seasonality (wet and dry seasons), pedogenic carbonate nodules like the ones in Figure 77D may form. The interbedded siltstone and shale facies may have formed as overbank deposits (Figure 76). These sediments were not exposed long enough to form distinctive soil units or become modified greatly. They contain common plant fragments, potentially *Archaeopteris* (Figure 77F), and may have been deposited adjacent to a channel system. *Archaeopteris* can be found in upland environments, typically along a source of fresh water (Driese et al., 1997). It is in this type of facies that the large burrows (Figures 78A-D) are found.

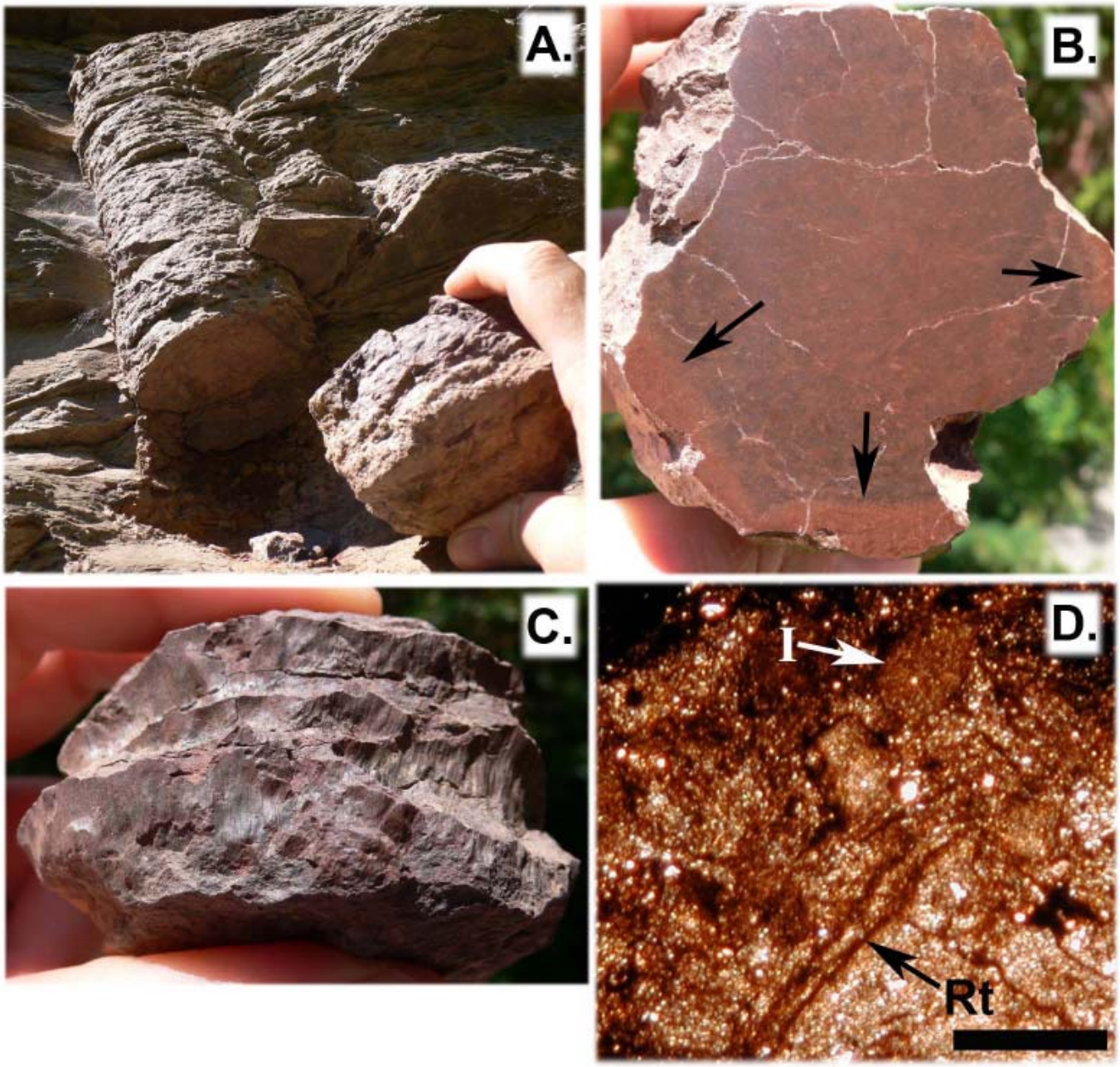


Figure 78. Photographs of large burrows from exposure in Wyoming State Forest. A. Large cylindrical burrow in surrounding matrix. Sample in hand was collected for petrographic analysis. B. Slabbed sample exhibiting bright red mottling around burrow perimeter. C. Micro-slickensides on burrow exterior. Burrows break along these weak planes. D. Photomicrograph of burrow fill. The matrix consists of blocky to slabby silty shale with small mudstone intraclasts (white arrow and I) (common) and some appears to be rooted (black arrow and Rt). The black scale bar is 1 cm.

Interpretation of Large Burrows

Although lungfish burrows have been described in Paleozoic rock (Olson, 1951; Romer and Olson, 1954; Olson and Bolles, 1975), only a few have been identified and described from the Devonian (Woodrow and Fletcher, 1969; Bridge and Gordon, 1985; Hasiotis, 2002) in the Appalachian Basin. Vertebrate burrows are known to extend back to the Devonian (Vorhees, 1975; Hasiotis, 2002), a time period known for the evolution and diversification of both fish and amphibians in freshwater environments.

Lungfish aestivation burrows may be produced due to ephemeral aquatic conditions and may be found proximal to distal alluvial, marginal-eolian and marginal-lacustrine environments (Hasiotis, 2002). Lungfish may produce these burrows when streams disappear during the dry season. Pedogenic carbonate nodules and slickensides in the vertic paleosols (Figures 76, and 77C and D) indicate that wet and dry seasonality was a factor when the sediment in this rock unit was deposited. Modern lungfish in Africa and South America are able to survive when their pools dry up by burrowing into the mud and sealing themselves within a mucous-lined burrow. Evidence of the burrow lining may be represented by the bright red mottling along the perimeter of the burrow (Figure 78B). Though they are known for being long, vertical and cylindrical, Hasiotis (2002) also describes them as commonly having a bulbous base.

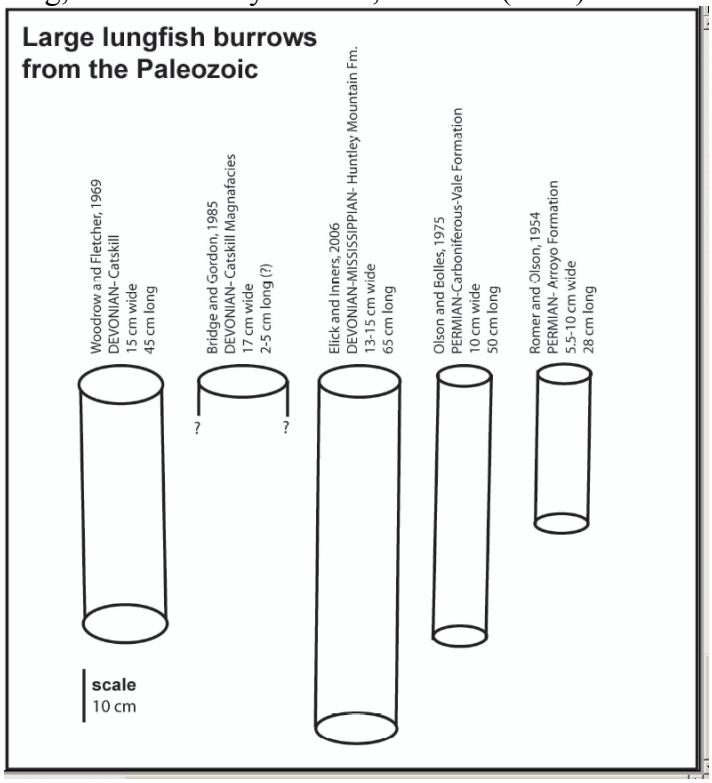


Figure 79. A comparison of large lungfish burrows from the Paleozoic. These burrows range in time from the Devonian to the Carboniferous. The large burrows described in this paper are included in this figure for direct comparison.

In the Huntley Mountain Formation (Devonian- Mississippian), large burrows (Figure 78A-D) can be found in a shaly siltstone that was probably deposited adjacent to a meandering channel system (Figure 76), possibly as overbank sediment. The dimensions of the large burrows in this study are similar to other burrows described as lungfish burrows from other sites throughout the Paleozoic (Figure 79). Though no fish remains were found in the burrows or in the rocks at this exposure (Figures 76 and 78), the presence of fish remains in burrows is not necessary to identify the burrows as having been produced by lungfish. Woodrow and Fletcher (1969) and Bridge and Gordon (1985) did not find lungfish remains in the burrows they identified. Indeed, if the wet season returns enough water to the stream system, one expects the lungfish to leave their burrows unharmed. Besides fish and amphibians, there are no other large vertebrates or invertebrates, which would have existed in this time range, that are likely to have produced the large structures.

When the fish became free of their burrows, they left behind large holes, which were gradually filled with alluvial sediments consisting of fine silts and mud, soil rip-up clasts, and plant material. Later exposure may have allowed plants or invertebrates to utilize formerly burrowed surfaces (Figure 78D). Because the vertic paleosols probably contained expandable clays, it seems reasonable to expect that the burrows might be infilled with the same type of clay, resulting in micro-slickensides (Figure 78C).

Because of where they occur within the depositional environment (Figure 76), their perimeter mottling (Figure 78B), and size/dimensions (Figure 79), the large burrows in the Huntley Mountain Formation were more than likely produced by lungfish. A greater number of burrows should be examined in order to better understand the burrow-producer.

CONCLUSION

The depositional environment for the Huntley Mountain Formation (Devonian-Mississippian) exposed in Wyoming State Forest, PA is one of a fluvial, meandering stream system. In this system, vertic soils (vertisols) formed along the floodplain, adjacent to small channels that periodically flooded,

adding new material to the soils, and in some extreme cases, eroding the upper parts of these soils. Intermittent wet and dry seasonality promoted this sedimentation and erosion and may have influenced some of the organisms in the environment like lungfish, which may have produced large aestivation burrows while enduring these paleoenvironmental stresses.

		Leave STOP 6, continuing along Dry Run Road.
0.2	52.6	On right is the Dry Run Picnic area, constructed by the Civilian Conservation Corps in the 1930's.
0.1	52.7	Ledge to left is the sandstone above burrows at Stop 13.
0.8	53.5	Till shadow to left (north) for next mile or two. The creek on right is flowing on bedrock and has been incising down the bedrock-till contact on the south side of the valley.
0.4	53.9	Bedrock and waterfall on right, till to left. This is yet another buried valley segment that has a "one-sided" bedrock gorge on its south side and a "till shadow" buried course on its north side.
		Directly ahead, cross Dry Run and continue up its south side.
0.2	54.1	Cross alluvial fan from tributary coming in from right.
0.8	54.9	Sharp curve to right. To left is a waterfall in the Burgoon Sandstone. Yet another "one-sided" gorge with the till filled valley farther to the left (north).
0.7	55.6	Turn left on Overlook Road toward High Knob Overlook.
1.4	57.0	Start driving westward along the crest of the ridge. To either side of the road is a forest "dead zone" with a number of dead tree-trunks projecting out of the tangle of young growth. This region is experiencing a lot of forest die-off on these ridge tops from invasive species of insects and fungi. Most of the maples here were killed in the middle 1990's by the elm spanworm infestation. Most of the beech trees are dying from the combination of the insect *Cryptococcus fagisuga* and the fungus *Nectria coccinea*. The hemlocks are dying from the woolly adelgid infestation. The gypsy moths are building up their numbers again and stripping forests east of here. The emerald ash borer that kills ash trees is moving east from Michigan. Also the Wyoming State Forest must put in deer exclusion fences now so the black cherry trees can regenerate in areas logged. Overall, the future of this forest is a troubled one.
0.9	57.9	Turn left into parking area at Overlook. Disembark.

STOP 14. HIGH KNOB OVERLOOK, WYOMING STATE FOREST (41°26'36"N/76°40'45"W).
Leaders: Duane Braun..

The Monument at the parking area reads:
Site in memory of Sumner Francis McCarty. First Forest Ranger 1930-1950, Wyoming State Forest. Monument erected 1983.

Quaternary changes to the landscape. Again, as at Canyon Vista, you are looking at a fluvial landscape with no large-scale changes from glaciation (Figures 80 and 81). There are many local stream derangements out there in individual valleys but the overall Plateau landscape looks much as it did in preglacial times albeit a bit lower (on the order of 10's of feet). The last glacier (late Wisconsinan) stopped on the skyline to the south and west of here. Earlier glaciations continued a few 10's of miles farther south and west with ice thicknesses here on the order of 1000 to 2000 ft. So in this area glacial scour has been minimal while glacial deposition has been maximal. But in the deep, narrow valleys around us, much of that material has been removed since glaciation.

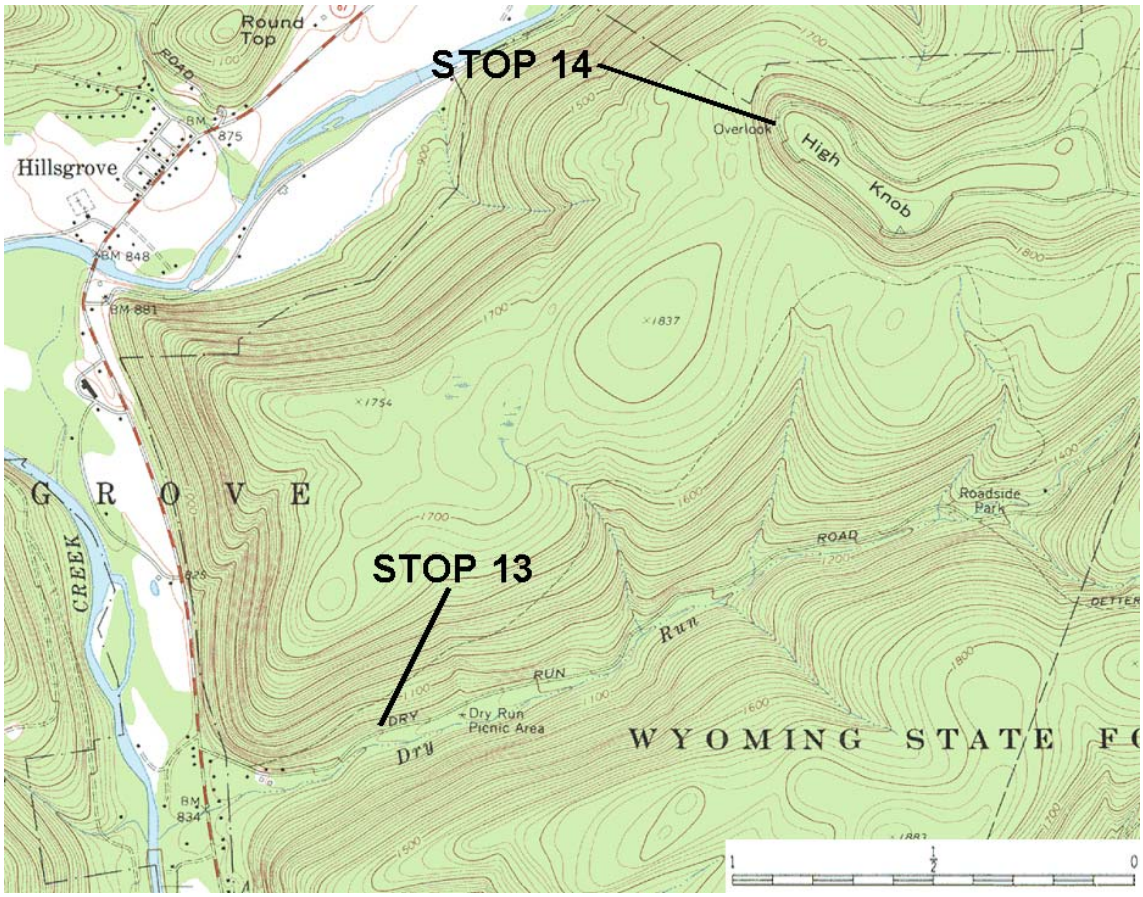


Figure 80. Location map for STOPS 13 and 14.

The area to the skyline covers two and one-half 7.5' quadrangles that were mapped by Braun in 2005 and 2006 during fifty or so days of fieldwork. Figure 82 is a reduced scale composite of those quadrangles that, at first glance, shows that the glacial deposits (purple and red) are generally limited to the valleys and the broad mountain tops are almost devoid of glacial deposits. The main exception to this is the large purple stripe that is readily apparent at the base of the escarpment on the north side of the breached Barbours anticline. That west trending escarpment was an ideal place for a more regional scale "till shadow" to be deposited at its base. So in the area of rolling hills in the breached anticline, the northern one-half is buried in till while the southern one-half has bare bedrock hills with remnant till masses in the narrow, deep valleys. In the trunk valleys like the Loyalsock, the removal of much of the glacial deposits since glaciation is shown on the map (Figure 82) by the dominance of yellow (alluvium, alluvial terraces, and alluvial fans) in those valleys.


Figure 81. Panoramic view from High Knob Vista. Immediately below is the Loyalsock valley. Directly to the west is the breached Barbours anticline with rolling hills carved out of the Catskill Formation. To the right of the breached anticline is a homoclinal ridge capped by the Burgoon Sandstone. To the left of the breached anticline is a synclinal mountain also capped by the Burgoon Sandstone.

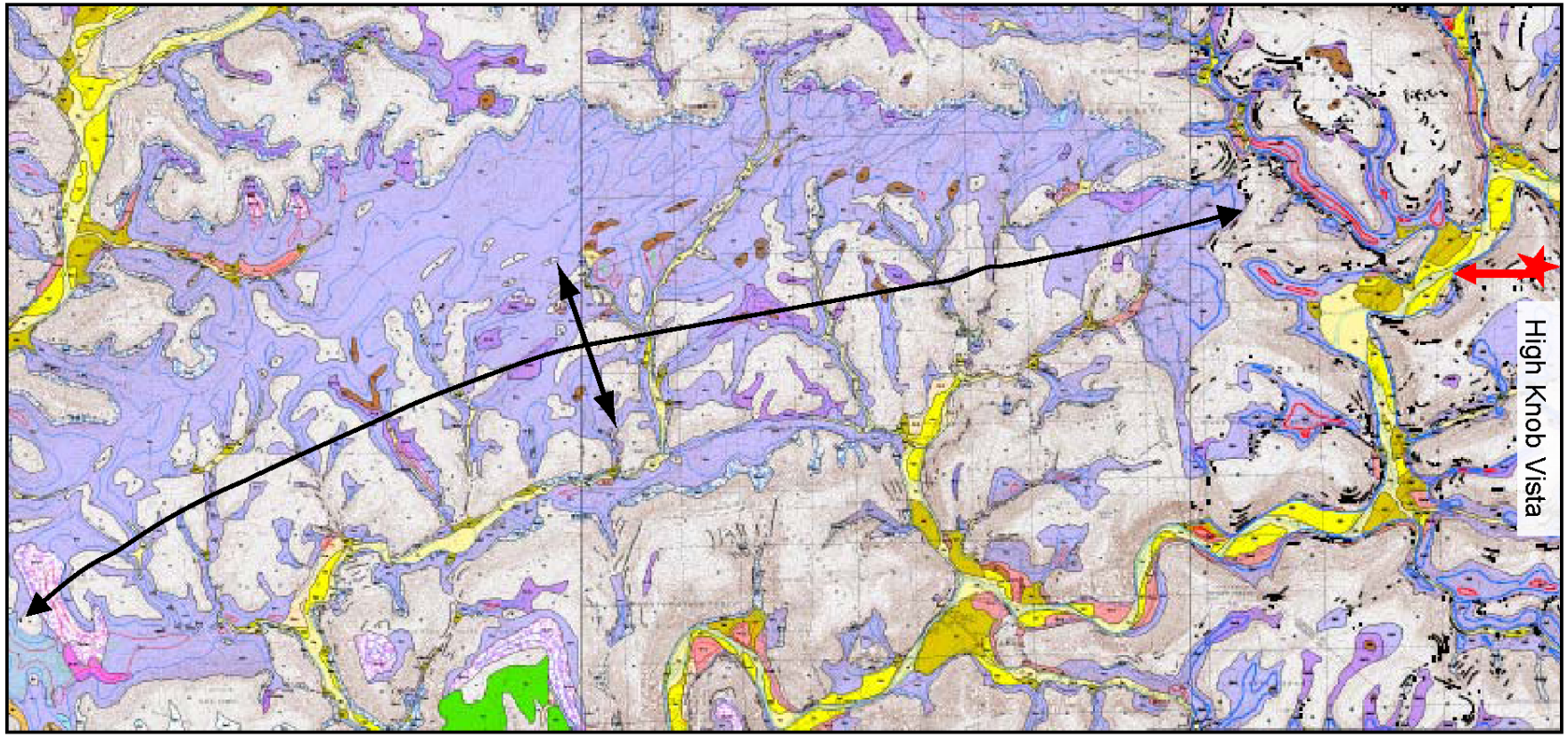


Figure 82. Surficial deposit map of the area visible from High Knob Vista.(Bodines, Barbours, and western one-half of Hillsgrove 7.5' quadrangles; Braun, 2005a, 2006a, 2006b).

ı - Alluvium; - Alluvial terrace; - Alluvial Fan; – Wetland; – Outwash;

– stratified drift; - Stony till; - Boulder till; – Illinoian till;

R - Bedrock < 6 ft. from surface;

Ledges – Lines of tick marks. Thickness contours, in ft.: Blue = 30; Red = 100; Green = 150.

Leave STOP 7, continue on down road and complete loop at top of ridge.

0.7	58.6	Good view of ridge top dead zones to left.
0.4	59.0	Turn left and return on Overlook Road to Dry Run Road.
1.3	60.3	Stop sign. Turn left on Dry Run Road.
0.1	60.4	On right is a the dry channel of a meltwater sluiceway.
1.9	62.3	To left is a wetland dammed by a moraine on its north side (farther left).
1.2	63.5	Turn right on SR 3009. You are now retracing the route back to Central and Ricketts Glen State Park that you traveled this morning.
1.8	65.3	Stop sign. Turn right onto PA 42 South.
4.2	69.5	Stop sign. Turn right onto US 220-PA 42 South at village of Muncy Valley.
1.0	70.5	Turn left, following PA 42 South at village of Beech Glen.
4.0	74.5	Continue straight on PA 239 South at Y-intersection of PA 239 and PA 42. (PA 42 veers off to right.)
5.1	79.6	Stop sign. Turn left onto PA 118.
3.2	82.8	Turn left onto Central Road.
2.0	84.8	Turn right into parking lot of Central Park Hotel. End of Day-2 field trip. Have a safe trip home!

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APPENDIX
PRE-CONFERENCE FIELD TRIPS

1. A WALKING TOUR OF THE GLENS, RICKETTS GLEN STATE PARK.

Leaders: Jon Inners, Gary Fleeger, and Duane Braun.

Walking Tour leaves from Lake Rose parking lot, 0.5 mi south of the Park maintenance buildings. Figure 1-1 shows the route to be followed by the tour and the location of selected described sites. Note: Right and left orientations in the Glens and below Waters Meet are all looking downstream!

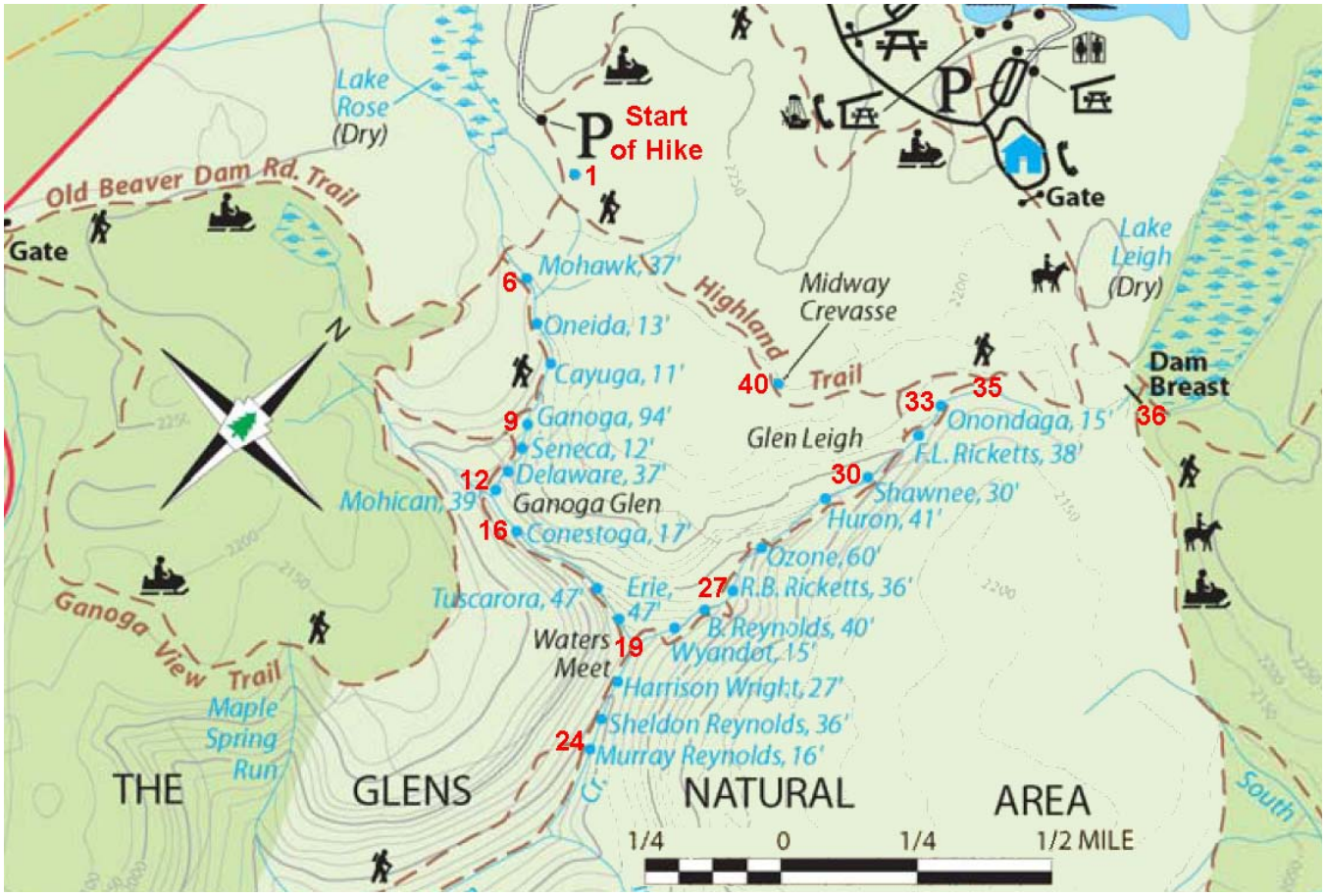

Figure 1-1. Route of Hike of the Glens, showing selected Sites of interest.

Figure 1-2. Pocono sandstone ledge at Site 1.

Falls Trail, Ganoga Glen

1. Pocono ledges along trail to left (Figure 1-2). Many boulders and frost rived ledges, some of the latter showing a steep north dip.

2. First steep drop off marked in woods by lowermost ledges of Pocono forming escarpment. About 10 feet down trail from top of escarpment, several small outcrops of greenish-gray silty clay shale occur in the trail. These mark the top of the Huntley Mountain Formation, the contact between the two formations being at the point where the trail steepens abruptly.

3. Wooden bridge across Lake Jean-Lake Rose outlet stream (Ganoga Glen Branch of Kitchen Creek). The distinctive "Haystacks Bed" (HSB) of the Huntley Mountain Formation crops out directly below the bridge and downstream in the streambed. From this point to about Site 5 the stream flows on top of this extremely resistant bed. Boulders of the HSB occur all along the stream and trail down to the first falls (Mohawk) and intermittently some distance below that.

4. Boulders of Haystacks bed on the left side of the trail here exhibit mudcrack-like sandstone dikes (Figure 1-3).

5. Haystacks Bed exposed again just above "3 steps down." Note the many boulders of the bed in the stream here.

6. MOHAWK FALLS (GPS 41°19'35.1"N/76°17'15.5"W), the uppermost falls in Ganoga Glen, a 37-ft cascade over thin-bedded, crudely flaggy gray sandstone in the upper Huntley Mountain Formation (Figure 1-4). Many boulders of the HSB occur downstream of Mohawk Falls. Also note the large glacially striated block to the left of the trail as you proceed south.

7. ONEIDA FALLS (GPS 41°19'32.6"N/76°17'08.7"W), a 13-ft cataract, capped by Huntley Mountain sandstone with the "Red Rock shale" beneath (Figure 1-5). The latter is apparently the only prominent red shale unit in the Huntley Mountain on Red Rock (North) Mountain, but Braun has found several relatively thick red units in the formation farther to the north in the Eagles Mere area. Just south of Oneida Falls a high cliff of upper Huntley Mountain sandstone can be seen far up on the hillside to the left. A small outcrop of hard, greenish-gray silty clay shale is exposed on the right side of the trail between Oneida and the next falls down.

8. CAYUGA FALLS (GPS 41°19'27.4"N/76°17'04.9"W), an 11-ft cascade over thin-bedded Huntley Mountain sandstone (Figure 1-6).

9. GANOGA FALLS (GPS 41°19'24.8N"/76°17'02.8"W), a magnificent 94 ft-high cascade and by far the highest falls in the Park (Figure 1-7). At the top of the steep trail leading down to the base of the falls, just outside a low wall of HSB boulders to the left is a large flat block of gray Huntley Mountain flaggy sandstone exhibiting parting-step lineation, a *sine qua non* of good flagstone. This sedimentary structure is a characteristic feature of planar sandstone beds formed by upper-flow regime water currents. Just before the trail drops down steeply to the base of the falls, a trail leads off to the right to the Old Beaver Dam Road and Ganoga View Trail. Along this steep trail to a "platform" leading back to the middle of the falls are continuous exposures of thin-bedded to flaggy, fine-grained sandstone of the Huntley Mountain. At the switchback of the trail (at the "platform") a 3 $\pm$ ft-thick bed of red shale is exposed. The gentle (2-3°) north dip typical of bedding in the Glens is evident all along the trail here.

10. SENECA FALLS (GPS 41°19'22.1"N/76°17'00.9"W), a 12-ft cascade over Huntley Mountain sandstone (Figure 1-8).

11. DELAWARE FALLS (~41°19'21"N/76°17'00"W), 37 ft high in total, is a double falls consisting of a upper cascade and a lower cataract, both over thin-bedded sandstone in the Huntley Mountain (Figure 1-9). Numerous potholes occur at the base of the falls.

12. MOHICAN FALLS (GPS 41°19'19.3'N/76°16'59.8"W), another double falls—totaling 39 feet high, this one consisting of two cascades over Huntley Mountain sandstone (Figure 1-10). The resistant ledge at the top of the upper cascade exhibits the planar, vertical N68°E joints characteristic of the sandstones on Red Rock Mountain and controlling the configuration of all of the waterfalls in the Glens (Figure 1-11).

13. To the right of a wooden bridge below Mohican Falls is a high, waterfall over Huntley Mountain sandstone on a tributary stream coming in from the west (Figure 1-12). This is one of the best spots in the Glens to view damage caused by the late June 2006 flood (Figure 1-13).

14. About 100 feet down along the trail from the wooden bridge at Site 13, a pavement outcrop of flaggy sandstone exhibits several open, "north-south" joints with water flowing through them—perhaps a good, albeit extreme, illustration of how groundwater moves through fractured rock.

Figure 1-3, Haystacks-type rocks along the Falls Trail, Ricketts Glen State Park showing mudcrack-like structures formed by clastic diking.

Figure 1-4. Mohawk Falls.

Figure 1-5. Oneida Falls, with "Red Rock shale" forming lower part.

Figure 1-6. Cayuga Falls.

Figure 1-7. Ganoga Falls, highest falls in the Park.

Figure 1-8. Seneca Falls.

15. Massive, water-polished ledge of Huntley Mountain sandstone, with eroded "chutes" and incipient potholes (Figure 1-14).
16. CONESTOGA FALLS (GPS 41°19'17.3'N/76°16'48.5"N), a triple falls totaling 17 feet high and consisting of two low cataracts and a higher cascade (Figure 1-15). At the top of the cascade are several incipient potholes. Midway down the cascade is a scoured "chute" in thick bedded sandstone.
17. TUSCARORA FALLS (GPS 41°19'17.7"N/76°16'46.9"W) is an impressive triple cascade over Huntley Mountain sandstone, totally 47 feet high (Figure 1-16).
18. ERIE FALLS (GPS 41°19'17.6'N/76°16'39.4"W), the last falls in Ganoga Glen, is a magnificent cascade 47 feet high (Figure 1-17). The sandstone beds here are at the base, or very near the base of the Huntley Mountain Formation.

Waters Meet

19. At Waters Meet (GPS 41°19'16.5"N/76°16'31.6"W), the two branches of Kitchen Creek—in Ganoga Glen and Glen Leigh—unite to form trunk Kitchen Creek (Figure 1-18).

Falls Trail below Waters Meet

20. Down the trail several hundred feet below Waters Meet is a scoured and fluted channel in Duncannon sandstone beneath a huge, rectangular boulder overhanging the left bank of Kitchen Creek (Figure 1-19). Note that such large, massive boulders are fairly common (see below) along this reach of the creek, a reflection of the difference in sandstone-bedding style between the thinner bedded Huntley Mountain and the thicker bedded Duncannon.
21. Another huge rectangular boulder ("Atlas Rock") sliding into the right side of the stream just to the left of the trail (Figure 1-20).
22. HARRISON WRIGHT FALLS (GPS 41°19'07.6"N/76°16'28.6"W), a 27-ft cataract typical of the Duncannon (Figure 1-21). The caprock is crossbedded, fine- to medium-grained sandstone at the base of an alluvial, fining-upward cycle. This overlies grayish-red mudstone and siltstone at the top of the underlying cycle. This is the classic "bridal-veil" falls of Inners [1980].
23. SHELDON REYNOLDS (GPS 41°19'04.5"N/76°16'26.2"W), another Duncannon cataract, this one 36 feet high, half gray sandstone at the top and half red mudstone at the bottom (Figure 1-22).
24. MURRAY REYNOLDS FALLS (GPS 41°18'59.0"N/76°16'25.0"W), a 16-ft cataract (Figure 1-23) and the last waterfall north of PA 118. (Kitchen Creek [Adams] Falls is 1.1 mi farther south.) The caprock is beautifully scoured and sculpted at the top (Figure 1-24).
Retrace route back to Waters Meet (Site 19).

Falls Trail in Glen Leigh

25. WYANDOTTE FALLS (GPS 41°19'17.2"N/76°16'30.7"W), a 16-ft cataract/cascade in the upper Duncannon Member (Figure 1-25). To the right of the falls is a large block of sandstone bearing two large lateral potholes.
26. BENJAMIN REYNOLDS FALLS (GPS 41°19'20.0"N/76°16'30.4"W), a 40-ft cataract over Duncannon sandstone (caprock) and red mudstone (Figure 1-26). Along the trail at the top of the falls are two conspicuous potholes—one 17 inches in maximum diameter, the other 4 inches in diameter. The latter is 10 inches deep and almost perfectly circular (Figure 1-27). A few feet downstream directly in line with the larger pothole is a conspicuous scoured "chute," perhaps formed about the same time as the pothole.
27. R. B. RICKETTS FALLS (GPS 41°19'25.9"N/76°16'28.1"W), a 36-ft cascade mainly over Huntley Mountain sandstone, the red mudstone at the base occurring at the top of the Duncannon (Figure 1-28).

Figure 1-9. Delaware Falls

Figure 1-10. Mohican Falls.

Figure 1-11. Northwest-striking joints at top of Mohican Falls.

Figure 1-12. Tributary falls below Mohican Falls at Site 13.

Figure 1-13. Debris and erosion from late June 2006 flood.

Figure 1-14. Polished ledges of Huntley Mountain sandstone at Site 15.

Figure 1-15. Conestoga Falls.

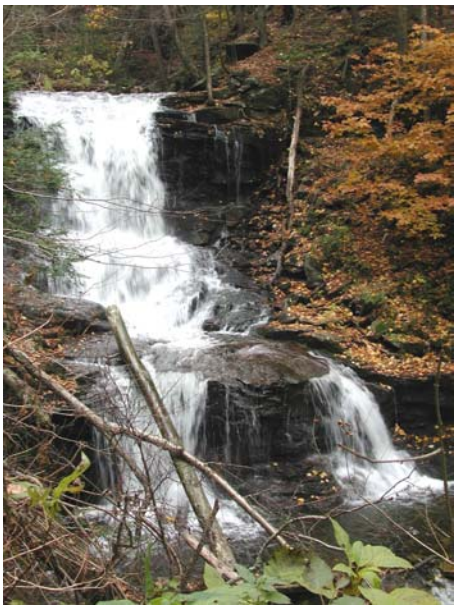

Figure 1-16. Tuscarora Falls.

Figure 1-17. Erie Falls.

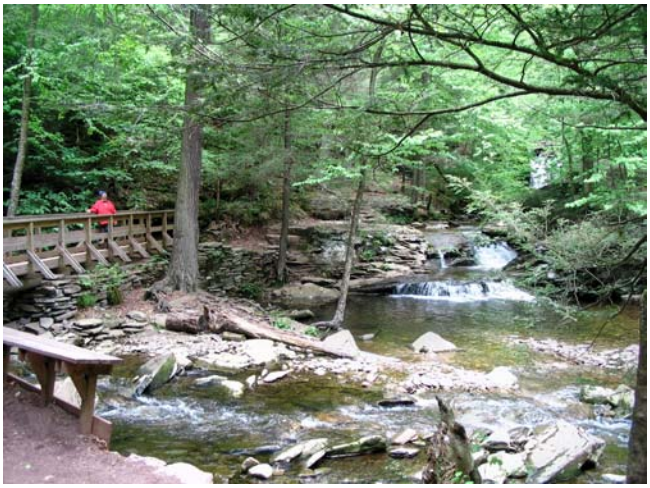

Figure 1-18. Waters Meet.

Figure 1-19. Scoured channel and boulder of Duncannon sandstone at Site 20.

Figure 1-20. "Atlas Rock" at Site 21.

Figure 1-21. Harrison Wright Falls, classic "bridal-veil" falls, in the Duncannon Member.

Figure 1-22. Sheldon Reynolds Falls.

Figure 1-23. Murray Reynolds Falls.

Figure 1-24. Scoured and fluted sandstone caprock of Murray Reynolds Falls.

Figure 1-25. Wyandotte Falls.

Figure 1-26. Benjamin Reynolds Falls.

Vertical joints in the sandstone at the top of the falls strike N87E. On the left side of the gorge just downstream of the crest of the falls, a small tributary stream forms an unnamed cascade.

28. OZONE FALLS (GPS 41°19'31.5"N/76°16'29.0"W), the second highest falls in the Park (Figure 1-29) is a 60-ft cascade over Huntley Mountain sandstone. (Some waterfall "maps" of the Park show this falls as being only 20 ft high.)

29. HURON FALLS (GPS 41°19'40.0"N/76°16'29.6"W), a 41 ft-high cascade over Huntley Mountain sandstone (Figure 1-30). Note the ripple marks on the loose sandstone block on the left wall of the gorge at the top of the falls. The "E-W" joint set is well developed in the flaggy sandstones below the falls.

30. SHAWNEE FALLS, (GPS 41°19'41.1'N/76°16'27.3"W) is a 30-ft cascade over Huntley Mountain sandstone following closely upon Huron Falls (Figure 1-31)—forming with that falls one of the deepest and most prominent rock-bound gorges in the Park (Figure 1-32). Just back from the top of Shawnee Falls is a flat boulder of sandstone exhibiting linear glacial grooves. This boulder is resting on a large, flaggy crossbed set (Figure 1-33).

31. On the trail beyond Shawnee Falls is another large pothole scoured out of a loose block of sandstone well above the level of the stream. On the bottom of another sandstone boulder along this same stretch of trail are numerous muddy lumps several inches in diameter that represent parts of lungfish aestivation burrows (Figure 1-34). Between this boulder and the next falls upstream (F. L. Ricketts) numerous potholes occur in sandstone ledges on the left edge of the stream, the largest being about 10 inches in diameter.

32. F. L. RICKETTS FALLS (GPS 41°19'49.4"N/76°16'25.8"W) is the picturesque 38-ft cascade that prompted Inners [1980] to describe the waterfalls in the Huntley Mountain Formation as "wedding-cake" falls (Figure 1-35). A bed of hard grayish-red shale (3-4 ft thick) exposed just the top of this falls may represent "The Red Rock" exposed in the pit on PA 118 (see STOP 6).

About three-quarters of the way along the steeply ascending trail to the right of F. L. Ricketts Falls, a shortcut trail leads off to the Highland Trail. Continue along the main trail to Onondaga Falls.

33. ONONDAGA FALLS (GPS 41°19'52.2"N/76°16'25.3"W), the northernmost falls in Glen Leigh, is a 15-ft cascade over thin-bedded sandstone in the Huntley Mountain Formation (Figure 1-36).

34. About 300 feet beyond Onondaga Falls on the right side of the trail is a large, broken outcrop of the hard and massive "Haystacks Bed" in the upper Huntley Mountain Formation (Figure 1-37).

35. At the junction of the Falls Trail in Glen Leigh with the Highland Trail (GPS 41°19'58.7"N/ 76°16'23.5"W), the HSB forms a low falls in the stream (Figure 1-38). Vertical joints parallel to the falls crest here strike N82°E.

For an optional hike along extended Highland Trail to Glen Leigh Dam, follow signs to Cherry Run/ Mountain Springs Trails. The dam is about 0.3 mi northeast of Site 35. Just beyond Site 35 is a large stand of hemlocks. Several of the big trunks are stripped of bark, probably in much the same manner as bark for tanning was stripped in the 1800's. A steep ascent on the trail to the dam marks the escarpment formed by the resistant quartzitic sandstones and conglomerates of the Pocono Formation.

GLEN LEIGH DAM

36. The old dam at the foot of the former Lake Leigh (GPS 41°20'09.7"N/ 76°16'09.0"W) is a 50 ± ft-high reinforced-concrete curtain dam structure built in 1907 for an intended hydroelectric project that never materialized (Figures 1-39 and 1-40; see Krothe and Siegel, this Guidebook). About fifty years later, the dam was declared unsafe. In 1957 three holes were blown into the right side of the dam near where the outlet pipes passed through the concrete curtain (Figure 1-41). These holes provide a picturesque view of the large swamp that is the remnants of Lake Leigh (Figure 1-42).

Return to Site 35 by the same route.

Figure 1-27. Deep pothole at top of Benjamin Reynolds Falls.

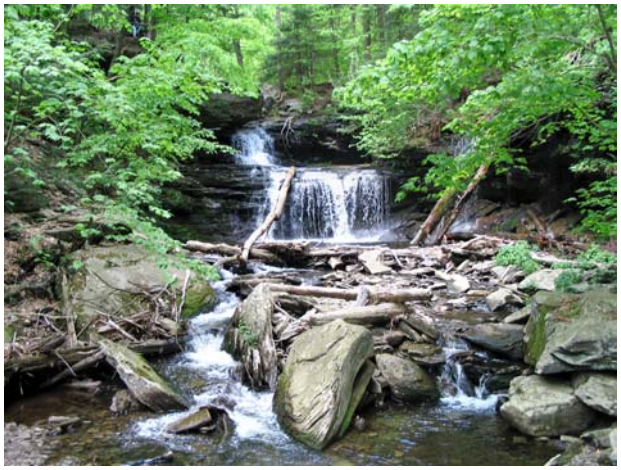

Figure 1-28. R. B. Ricketts Falls, exposing the contact of the Huntley Mountain and Duncannon.

Figure 1-29. Ozone Falls, the second highest falls in the Park.

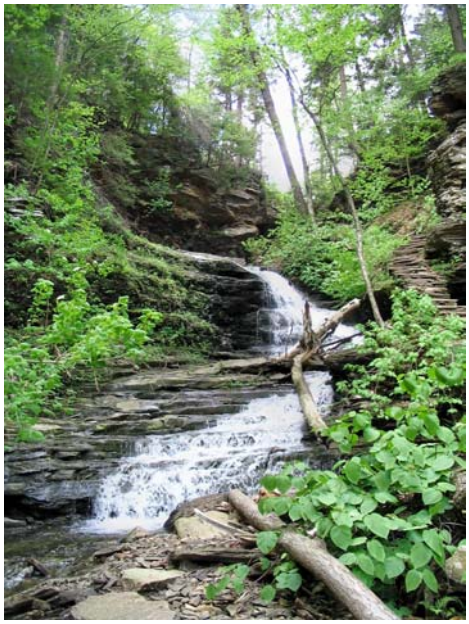

Figure 1-30. Huron Falls.

Figure 1-31. Shawnee Falls.

Figure 1-32. Gorge formed by retreat of Huron and Shawnee Falls.

Figure 1-33. Boulder with glacial grooves resting on crossbedded sandstone ledge at top of Shawnee Falls.

Figure 1-34. Plan view of lungfish aestivation burrows in sandstone boulder at Site 31.

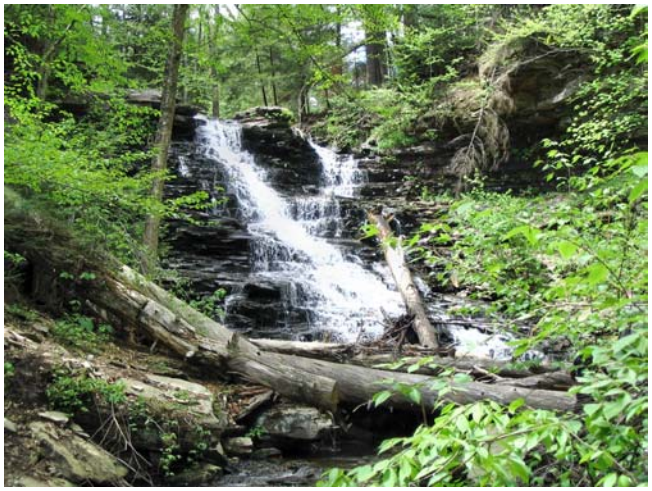

Figure 1-35. F. L. Ricketts Falls, a classic "wedding-cake" falls.

Figure 1-36. Onondaga Falls.

Figure 1-37. Outcrop of "Haystacks Bed" at Site 34.

Figure 1-38. Low falls over "Haystacks Bed" at Site 35.

Figure 1-39. Upstream face of Lake Leigh Dam.

Figure 1-40. Downstream face of Lake Leigh Dam, showing concrete-curtain construction.

Figure 1-41. Holes blown in Lake Leigh Dam in 1957.

Figure 1-42. View of Lake Leigh wetland through one of the demolition holes.

Figure 1-43. "Bear's Den Rocks" along Highland Trail at Site 39.

Figure 1-44. Plan view of trough cross beds at "Picnic Rock" (Site 39).

HIGHLAND TRAIL

The final leg of the Glens hike takes you back to the parking lot at Lake Rose along the Highland Trail (0.8 mi).

37. At this point (several 0.10's of a mile west of Site 35. the Highland Trail begins an ascent to the top of the Pocono escarpment. Numerous large displaced blocks of crossbedded Pocono sandstone litter the flat above this rise; the flat is probably formed on the uppermost ledge of the Huntley Mountain.

38. Just beyond the ascent noted above, the trail climbs steeply up to the top of the Pocono escarpment.

39. "BEAR'S DEN ROCKS" (GPS 41°19'45.6"N/76°16'50.3"W). To the left of the trail here at the crest of the escarpment is an incipient frost-riven and slumped "rock city" of Pocono sandstone, with open joint fractures commonly 1-2 ft wide (Figure 1-43). Particularly interesting is "Picnic Rock," whose flat, glacially planed-off top exhibits swirls that represent a plan view of intense trough crossbedding, current direction N45°W (Figure 1-44).

40. MIDWAY CREVASSE (GPS 41°19'44.8"E/76°16'54.6"W). The Highland Trail here passes through a narrow passageway between large blocks of Pocono sandstone and conglomerate that have been split apart mainly along joints by frost wedging and gravity creep (Figure 1-45). The entire mass of jumbled blocks is about 225 ft long 35 ft wide, and up to 15 ft high. Smaller blocks, partly covered by leaf litter, cover the ground surface from the Crevasse back to a bedrock ledge about 100 feet to the north. It is clearly apparent that the blocks have split off this ledge and have moved down the gentle slope to their present position, but the undisturbed trees and lichens growing on the blocks indicate that the blocks are not moving today.

Figure 1-45. Midway Crevasse.

The blocks are actually leftovers from the intensely cold, periglacial climatic conditions that existed here for several thousand years after the last glacier retreated from the area about 18,000 yrs B.P. As the glacier passed over the site, it plucked away exposed loose blocks and left behind an intact sandstone ledge. The freezing and thawing of water infiltrating along joints (and random fractures) and bedding partings resulted in the splitting off of a series of blocks from the parent ledge. (Slight outward shove from the parent ledge of some of the largest blocks may have been initiated by late stage glacial movement. [See Inners and Ver Straeten, 2001]). These blocks then slid down the slope to the present position of Midway Crevasse in the following way: During the brief summer of the early post-glacial period, the ground thawed out to a shallow depth under the blocks. This thawed material had a high water content, and it slowly flowed down the gentle slope, carrying the sandstone blocks with it. Continued frost wedging during the movement phase broke the blocks into numerous smaller blocks. The trail at Midway Crevasse follows one of the more prominent spaces between the transported blocks (Braun and Inners, 1998).

Figure 1-46. Broken and tilted blocks of Pocono sandstone at Site 41.

41. Just beyond Midway Crevasse a sandstone ledge at the top of the Pocono escarpment forms a 15 ft-high cliff with large blocks broken off and tilting down hill (GPS 41°19'43.9"N/76°16'59.6"W; Figure 1-46). Planed-off trough crossbeds on top of the ledge show current directions ranging from N60°E to N65°W.

42. A little farther west are more ledges at the top of the escarpment; then the trail drops down though a wooded, bouldery area with scattered low, broken sandstone cliffs to the south (left).

43. From the junction of Highland Trail with the Falls Trail to Ganoga Glen back to the Lake Rose parking lot, the trail follows along a flat developed mainly on top of the Huntley Mountain Formation, with a severely broken ledge of crossbedded Pocono sandstone just off to the east (right).

Walking Tour of the Glens Area ends at Lake Rose parking lot.

REFERENCES

Braun, D. D., and Inners, J. D., 1998, Ricketts Glen State Park, Luzerne, Sullivan, and Columbia Counties—the rocks, the glens, and the falls (2nd edition): Pennsylvania Geological Survey, 4th ser., Park Guide 13, 12 p.

Inners, J. D., [1980], Ricketts Glen State Park, Luzerne, Sullivan, and Columbia Counties—the rocks the glens, and the falls: Pennsylvania Geological Survey, 4th ser., Park Guide 13.

Inners, J. D., and Ver Straeten, C. A. 2001, Riccobono's "quarry in the Schoharie": stratigraphy, operations, and mass movement, *in* Inners, J. D., and Fleeger, G. M., eds., 2001—a Delaware River odyssey: Guidebook, 66th Annual Field Conference of Pennsylvania Geologists, Shawnee-on-Delaware, PA, p. 61-67.

2. THE "HAYSTACKS" ON LOYALSOCK CREEK, SULLIVAN COUNTY, PA.

Leaders: Norman Gillmeister, Joseph Hill, and Donald L. Woodrow.

ROADLOG AND STOP DESCRIPTIONS

Miles Int.	Miles Cum.	
0.0	0.0	Begin at the junction of PA 220 and PA 42 North in Muncy Valley and proceed north on PA 220.
0.1	0.1	Outcrops of red sandstones and mudstones in fining upward sequences of the Catskill Formation are nearly continuous on the left side of the road for the next 1.7 mi.
1.5	1.6	Champion Hill Road and covered bridge on the right.
0.15	1.75	Channel reconstruction and realignment work on Muncy Creek to protect the covered bridge after the June 2006 flood.
0.25	2.0	Pass the turn off to Sonestown on the right.
0.6	2.6	Begin the long climb up the Allegheny Front onto the Allegheny Plateau.
0.6	3.2	Outcrops of Catskill redbeds on the right for the next nine-tenths miles.
1.7	4.9	Pass turn to Scenic Overlook on left. A side trip to Wright's View will reward you with a view of the headwaters of Muncy Creek, North Mountain, and the area toward Ricketts Glen. Catskill Formation outcrops are visible on both sides of the road as you proceed north.
0.6	5.5	The contact between the Catskill Formation and the Huntley Mountain Formation is visible on the left. It is marked by the first appearance of gray, cross-bedded sandstone after ascending through a sequence of rocks that are all red.
1.2	6.7	Pass a rest area on the right.
1.8	8.5	Junction with Pa 42 South on the left. A freshly cut outcrop of Burgoon sandstone can be seen on the southwest corner of the road junction.
0.5	9.0	PA 154 branches off on the left.
2.4	11.4	Turn left onto Mead Road.
0.2	11.6	Parking areas on both sides of the road for the Haystacks and Loyalsock Trail. Park in the lot on the right.

Proceed on Loyalsock Trail from the lower end of the parking area down to an abandoned railway embankment and continue across it to Dutchman Falls. In wet weather it is better to turn right (toward PA 220) for less than 100 meters and then turn sharply left on a dirt road that leads to the Falls.

STOP 2-1. DUTCHMAN FALLS.

Quartzitic sandstone of the Haystacks-type is exposed at the lip of Dutchman Falls (Figure 2-1). The sandstone layer is about 1.5 m thick, highly resistant to erosion and characterized by nearly planar lower and upper contacts with gray crossbedded sandstones of the Huntley Mountain Formation. The base of the Haystacks-type sandstone is well exposed and the underlying rocks of the Huntley Mountain Formation can be traced through a series of cascades and the main drop of Dutchman Falls to the level of Loyalsock Creek. The rocks that overlie the Haystacks unit are usually not well exposed, but here there is only a stratigraphic gap of about 0.5 to 1 meter between the top of the Haystacks unit and Huntley Mountain Formation sandstone outcrop in the creek bed.

Figure 2-1. Dutchman Falls, Sullivan County, PA. The water cascades over the approximately 1.5 m-thick Haystacks sandstone, which is highly resistant to erosion. Note the sub-horizontal bounding surfaces of the Haystacks sandstone at this locality, in contrast to the hummocky upper surface at the type locality of the Haystacks sandstone.

The top of the Haystacks sandstone is well exposed in the streambed and is characterized by broad low-amplitude mounds that have a relief of less than 30 cm. The stream flows down the dip of the sandstone bed that is tilted gently to the north. The hummocky geometry of the top of the Haystacks sandstone that characterizes this unit at the Haystacks type locality is not evident here, but other features make it distinctly different than other rocks in the Huntley Mountain Formation. These include the highly indurated nature of the silica-cemented, medium-grained sandstone, the lack of primary sedimentary structures, and the white to pale pink color of the rock.

Sandstones of the Huntley Mountain Formation below the Haystacks unit are cut by two essentially vertical, systematic joint sets that trend about N5^{o}E and E-W and are spaced at 0.5 to 1 m. Shorter, non-systematic joints that are present may not be vertical. The systematic joint pattern does not propagate into the Haystacks sandstone, where joints are irregularly spaced and where most do not correlate with the orientation of those below.

Return to the railway embankment and turn west (i.e.,right). Crossbedded sandstones of the upper Huntley Mountain Formation are exposed intermittently along the path. After ~ 0.8 miles, conglomeratic sandstones of the lower Burgoon Formation are exposed in the railroad cuts. Outcrops of the Burgoon continue until the junction with the Haystacks trail spur. Turn right and proceed downhill to Loyalsock Creek and follow the trail downstream about 0.25 mi to the Haystacks type locality.

STOP 2-2. THE HAYSTACKS

The Haystacks are not only geologically interesting, but also are a wonderful swimming-hole during the summer months, with several deep plunge pools and smooth bottomed channels for easy sliding down the rapids. If the water level is low and the weather is dry, we should be able to examine some of the detailed features of the Haystacks.

The thin Haystacks sandstone unit is exposed transversely to the channel of Loyalsock Creek at this locality. The strike of the rocks is about N80^{o}E and they dip gently (6-7^{o}) north toward the axis of the Bernice syncline. The contact with the underlying crossbedded sandstones of the Huntley Mountain Formation is well exposed, but the overlying material has been stripped to expose the spectacular hummocky geometry of the Haystacks. That is not to say that there is no evidence for the nature of the overlying material. Gray, crossbedded, fluvial sandstones of the Huntley Mountain Formation are exposed in a low cliff on the south bank of the stream. These sandstones are typical of the unit inasmuch as they are coarse grained, lithic and micaceous, with abundant clay matrix and accessory brown tourmaline (Figure 2-2). They, in turn, overlie a green silty mudstone (Figure 2-3) that has a pronounced east-west-striking spaced cleavage. A covered interval of at most 1 m lies between this unit and the top of the Haystacks sandstone. Presumably this unit continues through the covered interval and is the cap-rock to the Haystacks sandstone. Petrographically, the clay minerals in the green mudstone are highly birefringent, which would indicate substantial recrystallization at elevated temperatures.

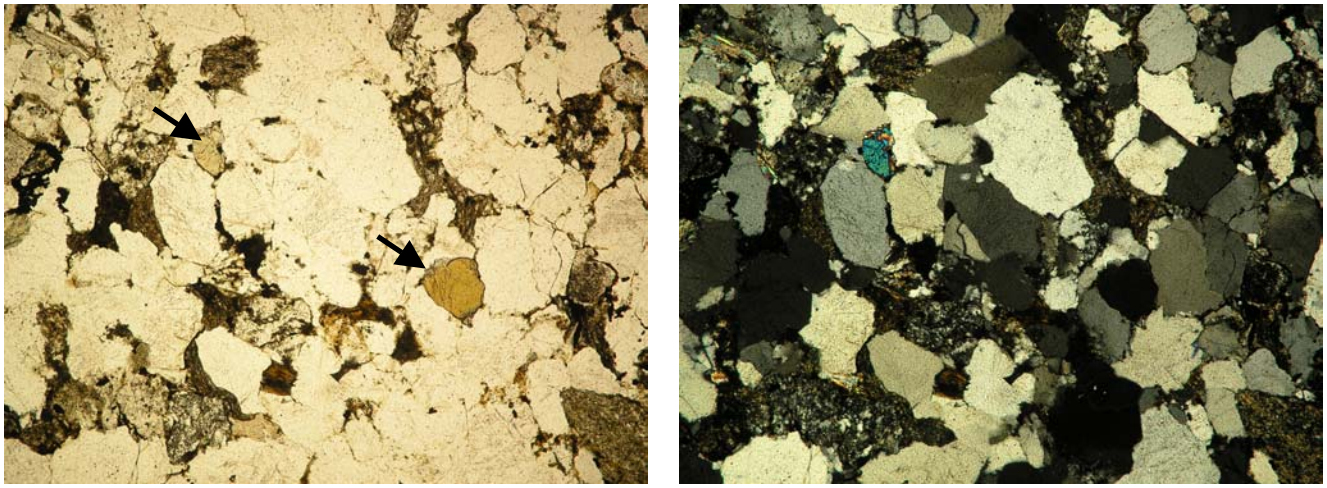

Figure 2-2. Photomicrograph of Huntley Mountain Formation sandstone in plane-polarized light (left) and cross-polarized light (right). Note the greenish-brown tourmalines (arrows) and abundant lithic fragments. Also note the extreme birefringence of the tourmaline in the upper left of the photographs. Field of view is approximately 2 mm.

The most easily accessible exposures of the Huntley Mountain Formation sandstones that lie below the Haystacks unit are upstream of the hummocks in the stream channel. Here bedding plane slabs show well developed linguoid ripples and absolutely no evidence of soft-sediment deformation. Sets of widely spaced joints, roughly E-W and N-S, agree with regional tectonic trends.

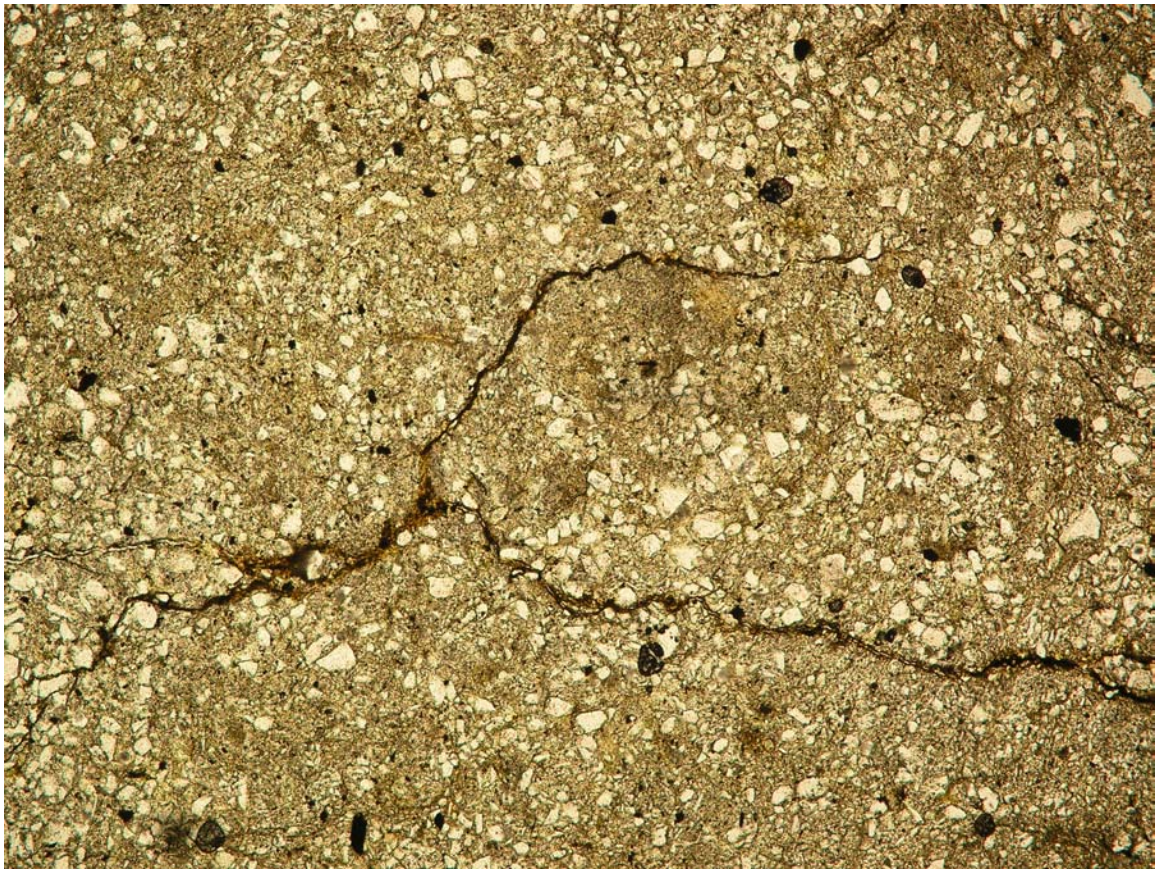

Figure 2-3. Photomicrograph of the green silty mudstone caprock that overlies the Haystacks sandstone at the type locality. Note the obvious differences between this unit and the typical Huntley Mountain sandstones and the underlying Haystacks sandstone. Field of view is approximately 1 mm.

The Haystacks themselves are characterized by domal structures up to 2 m in amplitude on a nearly planar base, such that the thickness of the quartzitic sandstone varies from as little as 20 cm to as much as 2.5 m (Figure 2-4). With respect to three-dimensional geometry, only two examples of similar structures have been described in the literature, namely stromatolitic mounds and large sand volcanoes (c.f., Collinson and Thompson, 1982, p. 133 and 138, respectively).

The rock that makes up the Haystacks sandstone is a medium-grained, silica-cemented quartz sandstone, that is, in effect, a sedimentary quartzite. Petrographic examination indicates the presence of abundant microcrystalline cement and extensive recrystallization of larger quartz grains, leading to grain-size reduction and sutured grain boundaries (Figure 2-5). This explains the commonly glassy appearance of the rock and its conchoidal fracture, if one can manage to break it. It should be noted that the degree of induration of the rock is not constant inasmuch as there are areas where it tends to weather around grain boundaries and pebbles. Overall, the rock is highly indurated. Mono- and polycrystalline quartz grains range from angular to rounded and there are "floating" pebbles of quartz up to 2.5 cm in long dimension and smaller pebbles of dark-gray chert (Figure 2-6). The size and shape of the included pebbles vary, with the chert pebbles being the least rounded. There is no clay matrix in these rocks, which distinguishes them from other rocks in the Huntley Mountain Formation, but small amounts of hematite, magnetite, muscovite, and tourmaline are present. These rocks, in short, appear to have been flushed clean of "dirt".

Figure 2-4. View, looking downstream, of the type-locality outcrop of the Haystacks sandstone. Note the exposure of the overlying Huntley Mountain Formation sandstones along the bank , upper right of photograph.

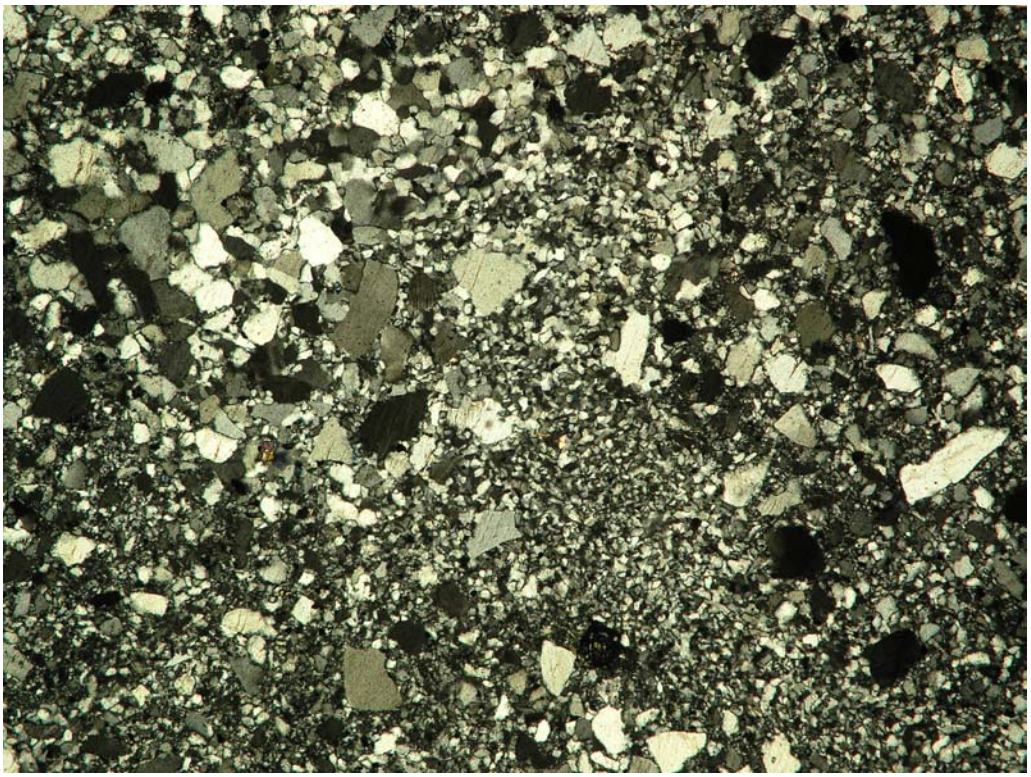

Figure 2-5. Photomicrograph of the Haystacks sandstone. Note recrystallization textures and microcrystalline quartz typical of Haystacks sandstone. Field of view is 1.5 mm.

Figure 2-6. "Floating" pebbles in the upper Haystacks sandstone. Hand lens is 2 cm in diameter.

No primary sedimentary structures are visible in the Haystacks, but there secondary features that appear to be networks of veins that are more resistant to erosion than the surrounding rock (Gillmeister and Hill, this Guidebook, Figure 17) and larger features that we interpret to be caused by fluid transport through the rock (Figure 2-7) and/or liquifaction. In thin-section, the Haystacks rocks show no preferred grain orientation or relict primary internal structure.

The base of the Haystacks sandstone can be seen in overturned loose blocks. It is irregularly corrugated in a manner that does not appear to be related to any type of soft-sediment loading feature. The bottom portion of the Haystacks is penetrated by E-W striking, nearly vertical pressure solution surfaces that in places continue short distances into the underlying sandstone. In places, these surfaces are closely spaced just above the base of the Haystacks sandstone and may dip to the north at angles of 50^{o} (Figure 2-8). Based on the orientation of these surfaces, we interpret them to be caused by Alleghanian deformation.

Figure 2-7. Probable dewatering structures in the upper part of the Haystacks sandstone. Note that the vein-like structures to the left of the watch are more indurated than the surrounding rock and, therefore, more resistant to erosion. The watch face is 2 cm in diameter.

A minimum of three sets of brittle fractures is locally developed in the upper part of the Haystacks: striking N-S, N80^{o}W, and N30^{o}W. Most of the fractures are vertical, but some dip to the north and northeast at about 60o (Figure 2-9).

While we are looking at the outcrop, we would like to discuss the possible origin of the Haystacks as liquifaction features and how such an origin might be possible without developing similar features in the rocks above and below. An additional topic of discussion is evidence for large-scale fluid flow through the rocks and the nature and possible timing of such flow. We are open to suggestions!

Figure 2-8. Contact between planar-bedded sandstones of the Huntley Mountain Formation (bottom of photograph) and the massive Haystacks sandstone (line). Note the closely spaced cleavage in the basal Haystacks sandstone (arrows) that becomes more widely spaced in the rock above. The hand lens is 2 cm in diameter.

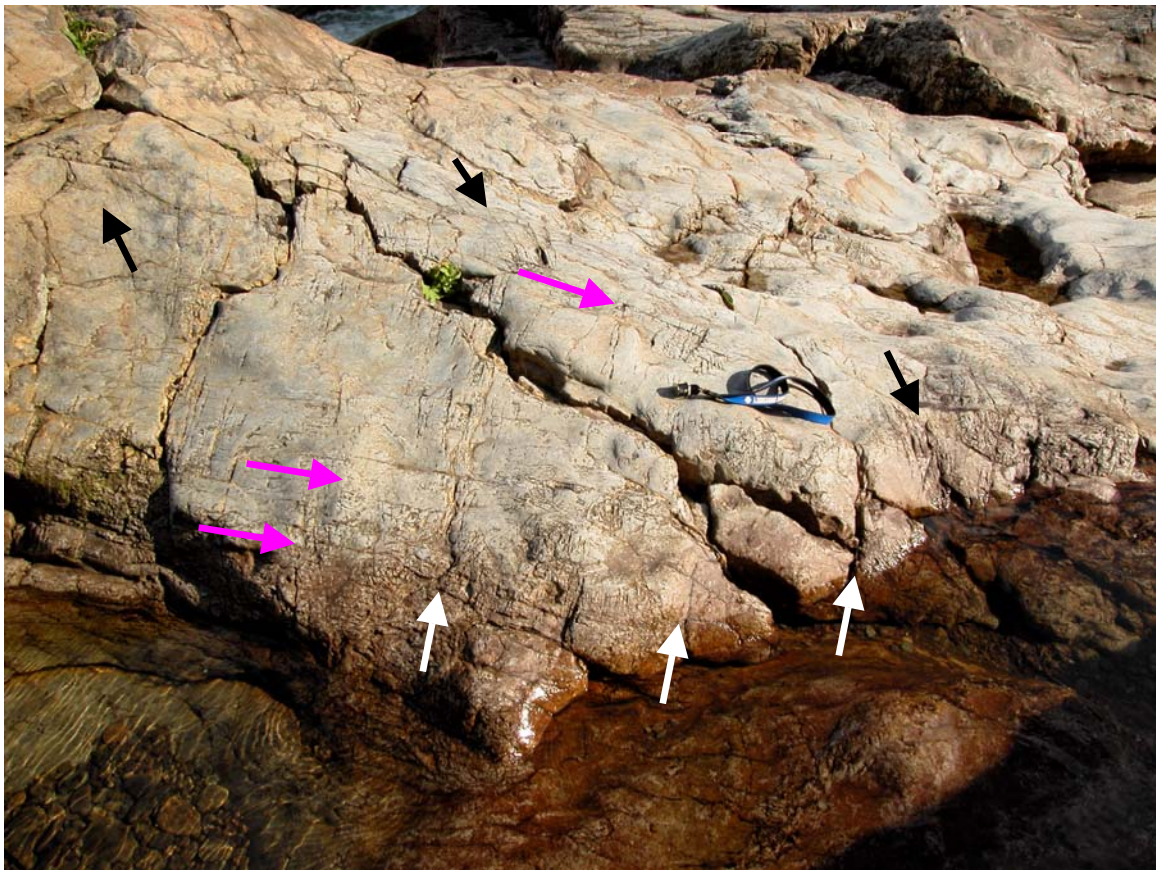

Figure 2-9. The smooth upper surface of the Haystacks sandstone that is cut by three fracture sets that trend as follows: N-S (white arrows), N80°W (gray arrows), N30°W (black arrows). Hand lens for scale.

Retrace your path to the parking area or follow an alternate return route that parallels Loyalsock Creek for some distance. Proceed straight ahead, rather than turning uphill when leaving the Haystacks area, and follow the red-on-yellow blazes and "LT" markers of this branch of the Loyalsock Trail. The route for eight-tenths miles is through forest, generally out of sight of the creek. The trail then descends to creek level at a sharp bend to the north (your left) that is marked by a sign. Look across the creek and you will see outcrop of Haystacks sandstone on the north bank in a layer that is 0.5 to 1.5 m thick (Figure 2-10). Note that the hummocky geometry of the Haystacks is not as pronounced as at STOP 2-2 and that it is essentially absent at STOP 2-1.

Figure 2-10. Haystacks sandstone overlying planar-bedded gray sandstones of the Huntley Mountain Formation. The view is of the north bank of Loyalsock Creek about 0.8 mi upstream from the Haystacks

You will have views of outcrops of crossbedded sandstone of the Huntley Mountain Formation that lie stratigraphically below the Haystacks bed as the trail continues on the south bank of Loyalsock Creek. It then rises steeply, bending to your right as it does so, to join the path along the railway embankment. Turn left toward the parking lot and PA 220.

REFERENCE

Collinson, J. D., and Thompson, D. B., 1982, Sedimentary structures: George Allen and Unwin, London, 194 p.