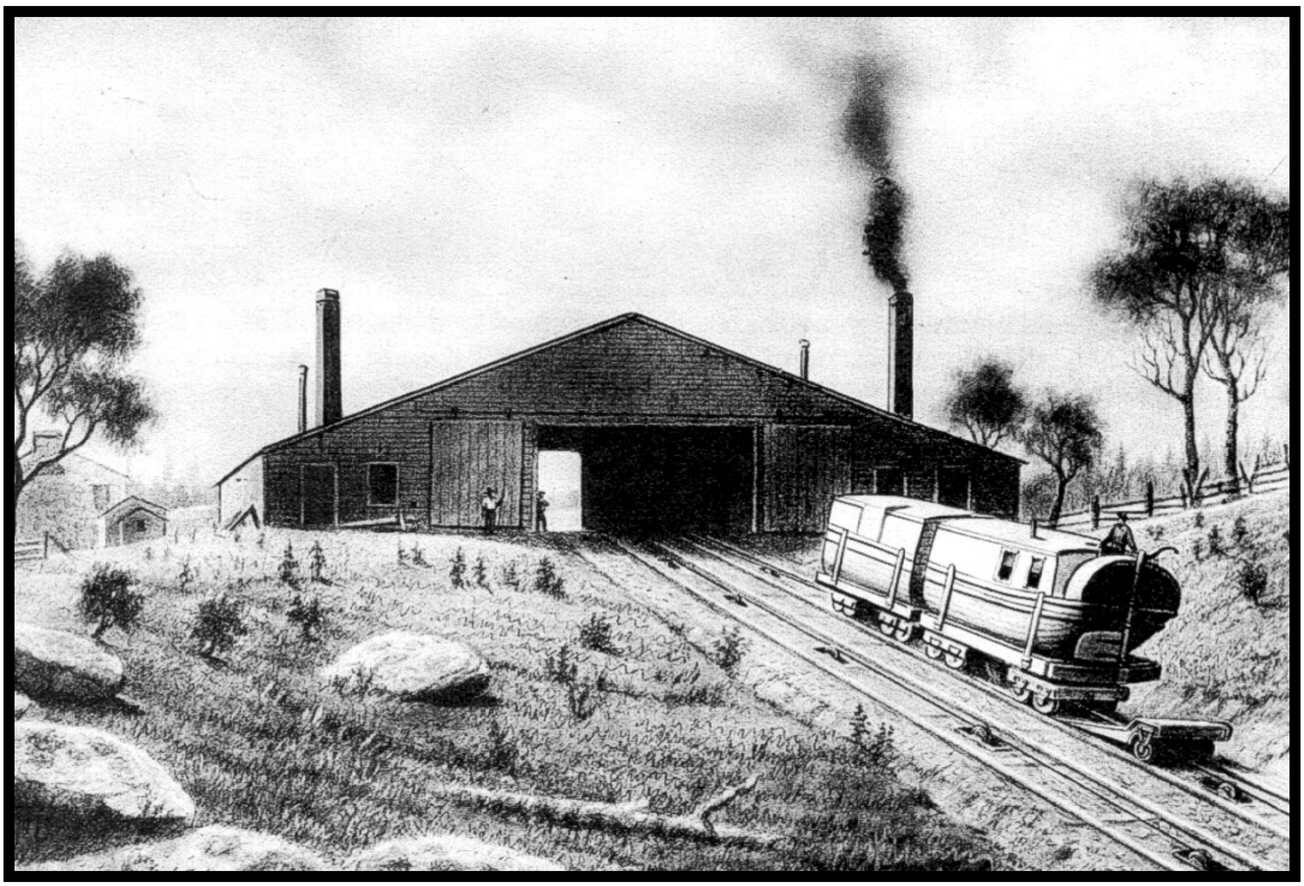
THE HISTORY AND GEOLOGY OF THE

ALLEGHENY PORTAGE RAILROAD

BLAIR AND CAMBRIA COUNTIES, PENNSYLVANIA



Guidebook for the

Pittsburgh Geological Society
Field Trip

May 11, 2002

Guidebook for the

PITTSBURGH GEOLOGICAL SOCIETY

Field Trip

Saturday, May 11, 2002

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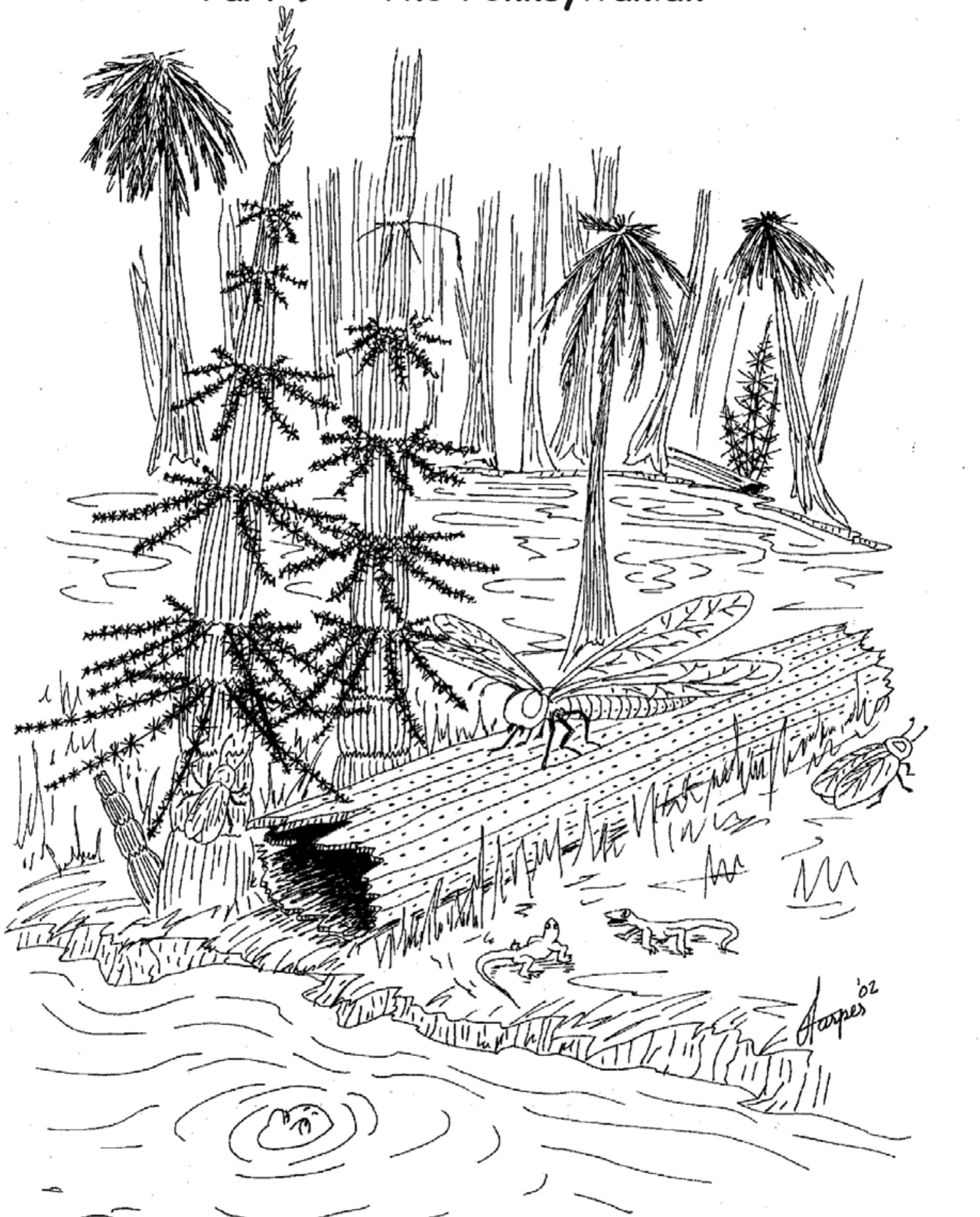


Those damned bugs think they own the world. Boy, just give me a few hundred million years of evolution and I'll show them a thing or two!!!

THE HISTORY AND GEOLOGY OF THE PORTAGE RAILROAD, BLAIR AND CAMBRIA COUNTIES, PENNSYLVANIA

John A. Harper
Pennsylvania Geological Survey

INTRODUCTION

The Allegheny Portage Railroad was the first railroad over the Allegheny Mountains. Considered a technological wonder in its day (1834-1854), the railroad played a critical role in opening the interior of the United States to further settlement and additional trade. It allowed settlers and traders to travel from the east coast to the center of the North American continent without major interruption by forming a link between the Juniata River canal of the Pennsylvania Mainline Canal System in central Pennsylvania and the Ohio River drainage (via the Conemaugh and Allegheny rivers). David Stevenson, a distinguished English civil engineer, spoke of the Allegheny Portage Railroad as a mountain railway that had no equal. “America now numbers among its many wonderful artificial lines of communication, a mountain railway, which, in boldness of design, and difficulty of execution, I can compare to no modern work I have ever seen, excepting perhaps the passes of the Simplon, and Mont Cenis, in Sardinia; but even these remarkable passes, viewed as engineering works, did not strike me as being more wonderful than the Allegheny Railway in the United States."(Stevenson, 1838).

During its lifetime, thousands of people made the journey on the Portage Railroad, including the English novelist Charles Dickens. Dickens, who traveled to America in 1841-1842, chronicled his trip in his *American Notes for General Circulation*. He described his journey from Harrisburg to Pittsburgh this way:

> We had left Harrisburg on Friday. On Sunday morning we arrived at the foot of the mountain, which is crossed by railroad. There are ten inclined planes; five *as*cending, and five *de*scending; the carriages are dragged up the former, and let slowly down the latter, by means of stationary engines; the comparatively level spaces between, being traversed, sometimes by horse, and sometimes by engine power as the case demands. Occasionally the rails are laid upon the extreme verge of a giddy precipice; and looking from the carriage window, the traveller gazes sheer down, without a stone or scrap of fence between, into the mountain depths below. The journey is very carefully made, however; only two carriages travelling together; and while proper precautions are taken, is not to be dreaded for its dangers.
>
> “It was very pretty travelling thus, at a rapid pace along the heights of the mountain in a keen wind, to look down into a valley full of light and softness; catching glimpses, through the tree-tops, of scattered cabins; children running to the doors; dogs bursting out to bark, whom we could see without hearing; terrified pigs scampering homewards; families sitting out in their rude gardens; cows gazing upward with a stupid indifference; men in their shirt-sleeves looking on at their unfinished houses, planning out to-morrow's work; and we riding onward, high above them, like a whirlwind. It was amusing, too, when we had dined, and rattled down a steep pass, having no other moving power than the

> weight of the carriages themselves, to see the engine released, long after us, come buzzing down alone, like a great insect, its back of green and gold so shining in the sun, that if it had spread a pair of wings and soared away, no one would have had occasion, as I fancied, for the least surprise. But it stopped short of us in a very businesslike manner when we reached the canal: and, before we left the wharf, went panting up this hill again, with the passengers who had waited our arrival for the means of traversing the road by which we had come.
>
> On the Monday evening, furnace fires and clanking hammers on the banks of the canal, warned us that we approached the termination of this part of our journey. After going through another dreamy place - a long aqueduct across the Alleghany River, which was stranger than the bridge at Harrisburg, being a vast low wooden chamber full of water - we emerged upon that ugly confusion of backs of buildings and crazy galleries and stairs, which always abuts on water, whether it be river, sea, canal, or ditch: and were at Pittsburg. (Dickens, 1842, 160-161)

The Allegheny Portage Railroad went through two iterations (Old and New Allegheny Portage Railroads), then was bought and dismantled by the Pennsylvania Railroad in 1854. Today, only parts of the railroad remain. The Allegheny Portage Railroad National Historic Site, a unit of the National Park Service, covers 1,500 acres of the site where the Allegheny Portage Railroad arrived at the top of Allegheny Mountain. It includes a Visitors Center, the historic Lemon House, a reconstruction of Engine House #6, the Skew Arch Bridge, picnic area, and hiking trails. The park also oversees the Staple Bend Tunnel, which is located approximately 4 miles east of Johnstown in Cambria County. The inclined planes and some of the railroad right-of-way west of Allegheny Mountain remain, much of it being used as PA Route 53 between Summit and Johnstown. The Allegheny Ridge Heritage Corridor, a private not-for-profit organization operating with state support, has marked the route, and we will follow some of that route from the Hollidaysburg to Johnstown. Along the way, we will examine outcrops, historic sites and rock outcrops, have opportunities to take lots of photographs, and, in general, spend a day absorbing the history of this unique mode of transportation.

HISTORICAL PERSPECTIVE

The Pennsylvania Mainline Canal System

By the beginning of the 1800s, the main population centers of the United States were found only along the Atlantic seaboard – Boston, New York, Philadelphia, Baltimore, Washington, D.C., etc. Traveling from Europe to the US had been relatively easy – you got on a boat, sailed across the Atlantic, and, God willing, arrived safely at your destination. Traveling westward from the coast, however, presented a host of difficulties for the average person. First of all, as General Forbes and his army found out in the previous century (Briggs, 1997), the Allegheny Mountains presented a formidable barrier to westward travel. In fact, they proved to be THE boundary between civilization and the great western frontier. There were brave souls who made the trek – originally pioneers, then soldiers, then those who saw a better life away from the main population centers. But these brave hearts and fools generally struggled with great hardships, and many did not survive. Slowly, people began following the pioneers westward as tales of vast stretches of fertile farmland, great rivers, abundant forests and game, and troves of mineral resources found their way back east. However, although there were lots of tracks and trails, there were very few established roads at the time.

> A critical fact in the world of 1801 was that nothing moved faster than the speed of a horse . . .
>
> And except on a racetrack, no horse moved very fast. Road conditions in the United States ranged from bad to abominable, and there weren't very many of them. The best highway in the country ran from Boston to New York; it took a light stagecoach, carrying only passengers, their baggage, and the mail, changing horses at every way station, three full days to make the 175-mile journey. The hundred miles from New York to Philadelphia took tow days. South of the new capital city of Washington, D. C., there were no roads suitable for stagecoach; everything moved on horseback. "Of eight rivers between [Monticello] and Washington," [President Thomas] Jefferson wrote in 1801, "five have neither bridges nor boats." It took Jefferson ten days to go the 225 miles from Monticello to Philadelphia.
>
> . . . The Americans of 1801 had more gadgets, better weapons, a superior knowledge of geography, and other advantages over the ancients, but they could not move goods or themselves or information by land or water any faster than had the Greeks and Romans. (Ambrose, 1996, p. 52, 53)

Figure 1. Photograph of Allegheny Mountain from Catfish Ridge above Hollidaysburg showing the imposing nature of the Allegheny structural and topographic front. Blair Run Gap is on the far left, and Sugar Run Gap is on the right.

Therefore, turnpikes began to be built early in the 1800s. The National Road (now US 40) was probably the most famous of these. Another was the Huntingdon, Cambria, and Indiana Turnpike (now old US 22), which was completed in 1819. This road (actually a dirt track) crossed the Allegheny Mountains within the deeply etched valley called Blair Run Gap between Hollidaysburg and Cresson (Figure 1) (Jacobs, 1945). Roads such as these often had little to recommend them, other than that there were no better alternatives. Road surfaces could be anything from incredibly bad to downright impassible. Rivers offered a better, faster, and safer means of transportation, but they were controlled by both the landscape and the vagaries of nature. Drought meant no river transportation, whereas too much rain created potentially disastrous floods within the river valleys. In order to make sure there was sufficient (enough, but not TOO much) water to operate boats and barges, or to provided water transportation in areas where rivers did not flow, people solved their transportation problems by constructing canals.

> Because the movement of commerce was by water, Americans of 1801 were constantly thinking about water. Their heads were full of schemes to build canals, using locks to advance upriver or to go around rapids. Jefferson wrote of "a people occupied as we are in opening rivers, digging navigable canals, making roads." (Ambrose, 1996, p. 53)

Pennsylvania actually considered creating a canal system late in the 1700s, but it wasn't until the 1820s that any progress on the concept began to occur. On March 31, 1824 the Pennsylvania Legislative Assembly appointed a Board of Canal Commissioners to investigate possible canal routes between Harrisburg (civilization – sort of) and Pittsburgh (the boondocks) (Wilson, 1897). The Board considered two possibilities: 1) the Juniata and Conemaugh rivers, the latter of which flowed into the Allegheny and, eventually, into the Ohio; and 2) the West Branch of the Susquehanna River and Sinnemahoning Creek with a cross-country link to the Allegheny River in McKean County. A year later a second commission began making surveys and estimates for a system of canals that would link: 1) Philadelphia to Pittsburgh; 2) Allegheny (now Pittsburgh's North Side) to Erie; and 3) a section that would ultimately connect with the existing canals in New York. A Canal Convention that convened in Harrisburg in August 1825 generated a canal concept that won much public support. This resulted in petitions, circulated throughout the state, being presented to the legislature.

Construction of the Pennsylvania canal system began in 1826 and continued until about 1840 without interruption. The system eventually became a hybrid of public and private canals and railroads (Figure 2), but for travelers trying to get to Pittsburgh from Philadelphia the entire journey was made in canal boats. The boats were loaded onto cars in Philadelphia on the Columbia-Philadelphia Railroad, the forerunner of the Pennsylvania Railroad. Then at Columbia, on the Susquehanna River in Lancaster County they were unloaded. The journey continued northward in a canal constructed along the Susquehanna River to the mouth of the Juniata River north of Harrisburg. The canal boats then traveled westward along the Juniata River canal as far as Hollidaysburg at the foot of the Allegheny Mountains. At this point, the boats were loaded onto the Allegheny Portage Railroad, which took them over the mountains and deposited them into the Conemaugh River canal at Johnstown. The Conemaugh linked Johnstown with the Allegheny River, Pittsburgh, the Ohio River, and the great western frontier.

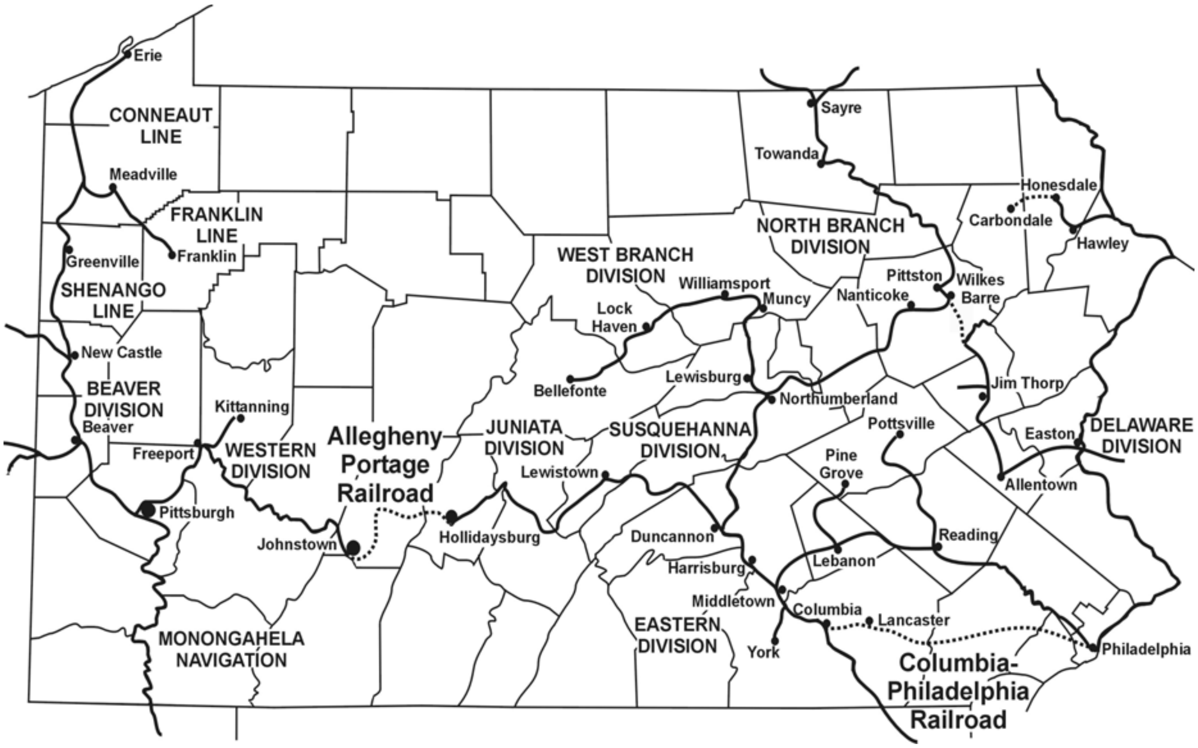


Figure 2. Map of the Pennsyl-vania canal system and associated railroads (dotted) (modified from Shank, 2001). The Juniata Canal, a division of the Pennsylvania Mainline Canal, ran 127 miles between Duncan's Island in the Susquehanna River and Hollidaysburg, and had 86 locks. It remained in operation from 1832 until 1888.

The Pennsylvania Main Line Canal, as it was called, opened in 1834 and operated for 20 years.

This brief history seems straightforward enough from the perspective of 171 years of hindsight. However, the story of how the Allegheny Portage Railroad eventually came to be is one of false starts, varied perspectives and opinions, numerous trials and tribulations, and the inability of the legislature, the Canal Board commissioners, and several governors to make decisions.

A Canal Tunnel Through the Mountains

The original concept of the Pennsylvania canal system included a continuous waterway from Philadelphia to Pittsburgh (Wilson, 1897; Jacobs, 1945). This meant constructing a canal tunnel through Allegheny Mountain. It would have been 4.5 miles long and filled with water to provide continual passage of canal boats. Two of the Canal Commissioners, Colonel Holgate and Mr. Clark, sent a report to the governor in February 1825:

> The project of tunneling some three or four miles through a mountain is, to the uninformed, a fertile source of amusement, from which they can extract the value of their taxes in good-humored laughter; and to the envious, and secret or avowed enemy of public improvements, it cannot fail to be a subject of malignant and bitter sarcasm. Even good men, who love to see the improvement of their country, have been startled at the idea of burrowing in the ground for a few miles, to let large boats pass through the bowels of the Allegheny. To such

> it will be a consolation to know that tunnels are now become and becoming, very common. An engineer of the first standing in this country has said that "tunnels are now so common that the necessity of them is no greater obstacle than the increase of expense." (Wilson, 1897, p. 37)

The two commissioners estimated the cost of such a tunnel would be $480,000. The third Commissioner, Charles Treziyulney, reported to the Governor a few weeks later with a very different conclusion. He felt that, considering the physical difficulties of actually executing the project, and the huge expense involved, the tunnel was completely impractical.

> In short, the whole country, from the upper forks of the Juniata to the forks of the South branch of the Conemaugh is mountainous; mountain rising after mountain in quick succession. The main one where the proposed tunnel is to pass, is hemmed in and surrounded by other high mountains, with steep slopes separated from one another by narrow ravines and presenting no favorable situation for canaling, either by lockage or tunneling. Here nature has refused to make her usual kind advances to aid the exertions of man; mountains are thrown together, as if to defy human ingenuity, and baffle the skill of the engineer. (as quoted in Wilson, 1897, p. 37)

The governor, faced with such contrary information, decided not to decide on the matter.

The next year, the Commissioners sent another report to Governor Shulze describing the results of the on-going engineering surveys. They recommended the Juniata-Conemaugh route was preferable to the Susquehanna-Allegheny route, but they also recognized at that time that the canal tunnel concept was impractical. They couldn't figure out how to keep it filled with water without tunneling at a much lower elevation than originally proposed, which also would have increased its length. This was considered an "insuperable objection," and by the time of the 1826-27 legislative session the tunnel idea was all but dead. The alternative, the Board decided, was a portage across the Allegheny Mountains to Johnstown.

Canvass White, the engineer in charge of the 1826 survey, suggested that canal boats could be constructed in three or four pieces, divided transversely, so they could be transported over the portage without changing the cargo. This was the first official suggestion that sectional boats should be built. These boats played a very important role in the history of the Pennsylvania canal system, specifically the Pennsylvania Mainline Canal and the Allegheny Portage Railroad.

The Advantage of Railroads

> With regard to travel by land, [President Thomas Jefferson] imagined the possibility of locomotion by something other than horse power. He was attracted by the idea of using steam power to move carriages. In 1802 he predicted, "The introduction of so powerful an agent as steam [to a carriage on wheels] will make a great change in the situation of man." Jefferson was a hundred years ahead of the automobile, however powered. He never saw a train. (Ambrose, 1996, p. 53)

At the same time the first Board of Canal Commissioners was convening, a series of reports on the new-fangled railroad began to attract a lot of attention, particularly as to the possibility of using railroads rather than canals to cross the state (Wilson, 1897). As the number of railroad supporters increased, the demands on the Legislative Assembly also increased for a study of the efficacy of railroads to serve the transportation needs of the Commonwealth. On February 5, 1825 the Pennsylvania Senate appointed a committee to study the practicality of constructing a railroad from Philadelphia to Pittsburgh. Unfortunately this proposition was way ahead of its time – Pennsylvania just wasn't ready for cross-state railroads in 1825. But it focused attention on the fact that the best way across the state was along the route eventually chosen for the Pennsylvania Mainline Canal. Thus, the "unrealistic" railroad concept actually was partially responsible for the legislature authorizing the canal surveys. It also provided information on the eventual use of railroads for the Allegheny Mountain portage.

There were also those who thought the best portage over the mountains was by highway. It would have been relatively easy to turn the mud trail of the Huntingdon, Cambria and Indiana Turnpike westward from Hollidaysburg into a well-maintained highway, and by the end of 1826 opinion for the portage was fairly balanced between the concepts of turnpike and railroad. Eventually, the railroad proposal began to gain ground. George T. Olmstead, assistant engineer on the canal survey, reported in January 1827:

> Not having sufficient time, no regard was paid to a particular location of the railway, the general route only could be attended to, and reserve sufficient time to locate the canal down the Conemaugh and Kiskiminitas. Agreeably to the directions of William Strickland, Esq., I continued the exploration for the railway to the confluence of Stony Creek, at Johnstown, where the basin for the termination of the western division of the canal, was located. The distance, elevation, and depression over the mountains, are as follows:

From the Juniata basin to the mouth of Popular Run, 3 miles; elevation	33.69 ft.
To Dobbin's farm, 11 miles 31 chains; elevation	1,311.88 ft.
To the summit of the Allegheny mountain at Bobb's Creek Gap, 13 miles 72 chains; elevation	1,591.39 ft.
From Bobb's Creek Gap to the confluence of the south branch of the Conemaugh, l4.2 miles; depression	1,050.33 ft.
From south branch to Johnstown, 13 miles; depression	297.67 ft.
	1,348.00 ft.

> Making the whole distance 41 miles 32 chains, and the total ascent and descent to be overcome by railway, 2,939.39 feet. The banks of the Conemaugh river, from the junction of the south branch to Johnstown are high and very precipitous, and bluffs of rocks alternate on either side. It has also a very rapid descent of more than 23 feet to the mile. By the plan now proposed, the portage will be 13 miles longer than was originally contemplated and with the accession of Stony Creek, there can be no doubt of a permanent supply of water. Perhaps, on further investigation, the portage may be made shorter. Considerable time

> must be spent on the ground to investigate the subject properly. (as quoted in Wilson, 1897, p. 38, 40)

Unfortunately, because development and construction of the canals remained the Canal Commissioners primary concern during 1827, they were unable to decide on the best method of portage. It took another year before they could accomplish anything substantive.

The engineer in charge of the 1828 surveys favored a double portage – a railroad side by side with a paved (macadam) turnpike road sharing the same grade of one degree or less. But he couldn't convince the Canal Board to make a clear decision either, so he resigned later that year and was replaced by Moncure Robinson. Robinson had thought long and hard about the topic of portage before actually ascending to his important role. Early in 1829 Robinson visited the Allegheny Mountains already convinced that a railroad would be a far superior method of portage than either a canal tunnel or turnpike roads. He also believed that stationary steam engines and locomotives would be far more effective and economical sources of power than horses. He saw two determining factors for siting the portage; 1) a deep gap in the mountain, and 2) the shortest distance between Hollidaysburg and Johnstown. He reported to the Canal Commissioners in November 1829, proposing the best way to cross the mountain was by means of a system of straight, inclined planes operated by stationary engines. The proposed railroad wouldn't exceed 38 miles in length, in contrast with any possible macadam turnpike road that would have to be at least 50 miles long to be as effective. In addition, he recommended shortening the distance over the mountain summit by constructing a one-mile long tunnel about one mile north of the existing turnpike (now old US 22). The tunnel could be constructed at an elevation of 1,264 feet above the canal at Hollidaysburg, fully 177 feet lower than the summit. He estimated the cost of this railroad would be $936,004.87. (Wilson, 1897).

You would think that such straightforward information would have settled the question of a railroad versus a turnpike portage. It did not. Robinson's recommendations were far too bold and straightforward for the governor, the legislature, or the canal board to make any decisions until they could receive confirmation by other civil engineers. So in 1830 the canal board appointed a Board of Engineers, consisting of Moncure Robinson, Lieutenant Colonel S. H. Long, and Major John Wilson, to re-survey (once again!) the Allegheny Mountains.

The engineers reported to the board that fall. They concluded that Robinson's original proposal for a railroad was best and that it should cross the mountain at Blair Gap. They also suggested reducing the length of the railroad by building a viaduct across the Little Conemaugh River at one meander bend and digging a 1,000-foot long tunnel through another. Long and White disagreed with Robinson on the proposed summit tunnel, however. They favored a route that included eleven inclined planes, six on the east side of the mountain and five on the west, connected by a cut through the summit that would be 1,500 feet long and no more than 18 feet deep. Robinson vigorously defended his tunnel proposal and predicted that within five years it would become obvious that he was correct. This, generally, was the only part of Robinson's original proposal that was not accepted. On March 21, 1831 the governor finally signed a legislative act authorizing the building, without delay, of the Allegheny Portage Railroad (Wilson, 1897).

Construction (Finally!!!)

On the 30th of March, this railroad portage was placed under Sylvester Welch as principal, and Moncure Robinson as consulting engineer, and Samuel Jones as superintendent. Mr. Jones having been appointed June 7, 1830, Superintendent of the Western Division of the Pennsylvania canal, his jurisdiction was thus extended to Hollidaysburg. The surveys from Johnstown to the summit, commenced early in April, 1831, were completed and line located by May 20, and the work let to the lowest bidders at Ebensburg on May 25, 1831. From the summit to Hollidaysburg the surveys were completed in the month of July, the line located and contracts let at Hollidaysburg on the 29th of that month. (Wilson, 1897, p. 43)

The contractors set to work, building ten inclined planes (instead of Long and Wilson's proposed eleven), the Conemaugh Viaduct, the tunnel near Johnstown (the Staple Bend Tunnel), and the railroad right-of-way. The right-of-way was 120 feet wide to accommodate any additional track that might be necessary in the future, and to ensure that any fallen trees would not block the tracks. Construction encountered many problems. Most of the chosen route was heavily forested. The contractors had to cut a lot of timber before they could begin grading the railroad, but the fresh timber did not burn readily and the logs typically were too big to drag out without being cut up into smaller segments. The work went slowly. In addition, the contractor originally hired to build the Conemaugh Viaduct near South Fork backed out of the contract without having gotten much work completed, and that portion of the construction had to be re-contracted the next year.

Railroad Bed

The railroad bed was 25 feet wide, wide enough for two sets of tracks. One set of tracks was laid between the inclined planes and two sets were laid on the inclines so cars could be raised and lowered simultaneously, thus counterbalancing each other (more on this later). The bed was constructed so that the steepest grade was no more than 10.25 percent.

Railroad Tracks

The tracks consisted of rolled iron rails, each 18 feet long and 237 pounds, set in cast iron "chairs" secured by iron wedges. The whole assembly was then attached to a set of cut stone blocks called "sleepers" (Figures 3 and 4). The "sleepers" were cut from local sandstone

Figure 3. Photograph of stone "sleepers" along the Allegheny Portage Railroad right-of-way at the Allegheny Portage Railroad National Historical Site.

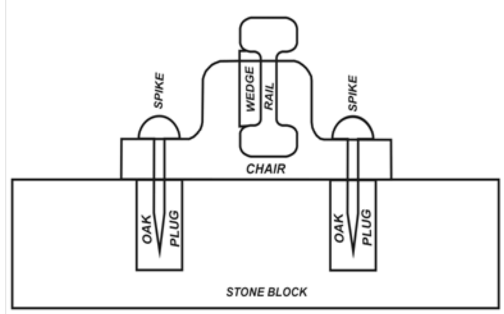


Figure 4. Details of the edge rails and stone "sleepers" on the Allegheny Portage Railroad (redrawn from Shank, 1975).

bedrock or float by stonemasons (depending on when you visit the Allegheny Portage Railroad National Historic Site you can watch a docent demonstrate the old techniques). Where such rock wasn't available, or would have cost too much, wooden timbers (ties) replaced the "sleepers." The "sleepers" were spaced approximately every three feet along the road. The blocks tended to shift with weather and moisture variations, so the rails often separated, making it impossible for trains to move safely along the tracks. Eventually wooden cross ties, such as those seen on railroads today, were replaced most of the "sleepers." The ties bound the two rails together so they would not separate; they were not as prone to movement and were much easier to prepare or replace. Although Harfords, Davis & Co. of Wales made the rails, pins, wedges, and many of the cast iron chairs, at least 61,000 chairs were cast locally in Frankstown, Blair County and Blairsville, Westmoreland County. They kept the spacing of the rails constant by placing wooden cross ties between each pair of "sleepers."

Ropes

The ropes used to raise and lower canal cars on the inclined planes consisted of a combination of Italian and Russian hemp laid in shrouds of from 360 to 450 yarns. These varied in length from 3,616 to 6,632 feet, with a composite length of 11 miles and 708 yards, and had a total cost of $20,531.05 (Welch, as quoted in Shank, 1975). Seven of the ropes were seven inches in circumference (about 2.24 inches in diameter). Four of them were each made in one piece, whereas the others were each made of several pieces spliced together. Unfortunately, these ropes, as strong as they were, broke frequently. John Roebling (Figure 5), the architect and engineer who built the Brooklyn Bridge, suggested using "wire rope" such as he was developing, and by 1849 all of the Portage Railroad's rope had been replaced by metal cables.

Figure 5. John Roebling, inventor of wire cable that make traveling the inclined planes on the Portage Railroad safer. Roebling, a German native, settled in Saxonburg, Butler County, Pennsylvania and set up shop. He made his first wire rope in 1841 to replace the hemp ropes on the railroad. His wire cables later were used in his famous suspension bridges, such as the Brooklyn Bridge.

Engines

The track segments between Hollidaysburg and the foot of Allegheny Mountain, and those between the inclined planes, had low grades that allowed horses to haul the railroad cars. Eventually, locomotive engines replaced the horses, but this transition was not completed until the New Allegheny Portage Railroad was constructed. The inclined planes, however, always used high-pressure stationary steam engines to raise and lower railroad cars. In 1831 a young engineer named Edward Miller traveled to England to get the latest information on railroads. In 1832, because of the knowledge he had gained, he was named Principal Assistant Engineer on the Portage Railroad and was placed in charge of the inclined plane machinery.

Miller designed most of the machinery (Roberts, 1878). There were two engines at each incline, were each fed by three boilers. Most were 35-horsepower engines with 14-inch cylinders and a 5-foot piston stroke that allowed ascending cars to move at about 4 miles per hour. These had boilers 30 inches in diameter and 20 feet long. Engines at inclined planes 2, 5, 9, and 10 were somewhat smaller 30-horsepower engines having 13-inch cylinders and a 5-foot stroke, and had boilers 30 inches in diameter and 18 feet long. By increasing the amount of steam, the engines could produce up to 60 horsepower, thus enabling the systems to haul heavier loads, or to move the cars up the inclines at a faster pace. The machinery for raising and lowering canal cars (see below) originally was to be operated by single-cylinder engines with flywheels. However, because of safety factors, the Canal Commissioners decided instead on two-cylinder engines with no fly-wheels, and the accompanying machinery had to be adapted to that power source. Principal Engineer Sylvester Welch felt that flywheels were the major cause of accidents on other inclined planes where stationary engines were used.

> With a fly-wheel, if a car is thrown off the railway, or if any derangement takes place with the rope that will cause it to stop, the machinery or the rope must break, before the fly-wheel can be stopped; and when this takes place, all the cars upon the plane will run down, and be injured or entirely destroyed. Without the fly-wheel, the rope is strong enough to stop the engine without danger of being broken. (Welch, as quoted in Shank, 1975)

Hoisting Mechanism

The engines, boilers, and machinery for operating the ropes resided below track level in an engine house at the top of each incline. Two cast iron wheels, eight feet in diameter and with 6-inch grooves for the ropes, were placed vertically in the center of each set of tracks 100 feet from the head of the incline (Figures 6 and 7). Four-foot cogwheels on the assembly made them revolve in opposite directions, and a set of clutches allowed the wheels to be disengaged while the engines were operating. A third cast iron wheel, nine feet seven inches in diameter (the exact distance between the centers of the two sets of tracks on the incline), revolved horizontally on a movable carriage between the vertical wheels and the head of the inclined plane. This latter wheel generally was anchored in one spot by a weight suspended in a well, but it could be moved about 15 feet when necessary. At the bottom of the incline, a similar horizontal wheel on a carriage was anchored in a similar fashion 40 feet from the foot of the incline. A double pulley block, rope, and windlass allowed it to be moved about 50 feet. The rope that hauled the canal cars ran a complicated pattern. First it passed over one of the two vertical wheels, then through a hole in the pit wall, around the horizontal wheel, back through another hole in the pit wall, under and over the second vertical wheel, down the incline, around the horizontal wheel at the bottom, and finally back up the incline. Eighteen-inch wheels spaced 24 feet apart between the tracks supported the rope on the incline. Since the rope was moving down one track and up the other simultaneously, one car could be hauled up the incline while another was going down. If the weight of cars descending the incline exceeded that of cars ascending, or if there where no ascending cars at all, the engines were disengaged from the hoisting mechanism and gravity took over. A water brake (see Figure 7) regulated the velocity of the descending cars, keeping them from running out of control. This brake consisted of a water-filled cylinder, 14 inches in diameter and six feet long, bolted to the pit wall separating

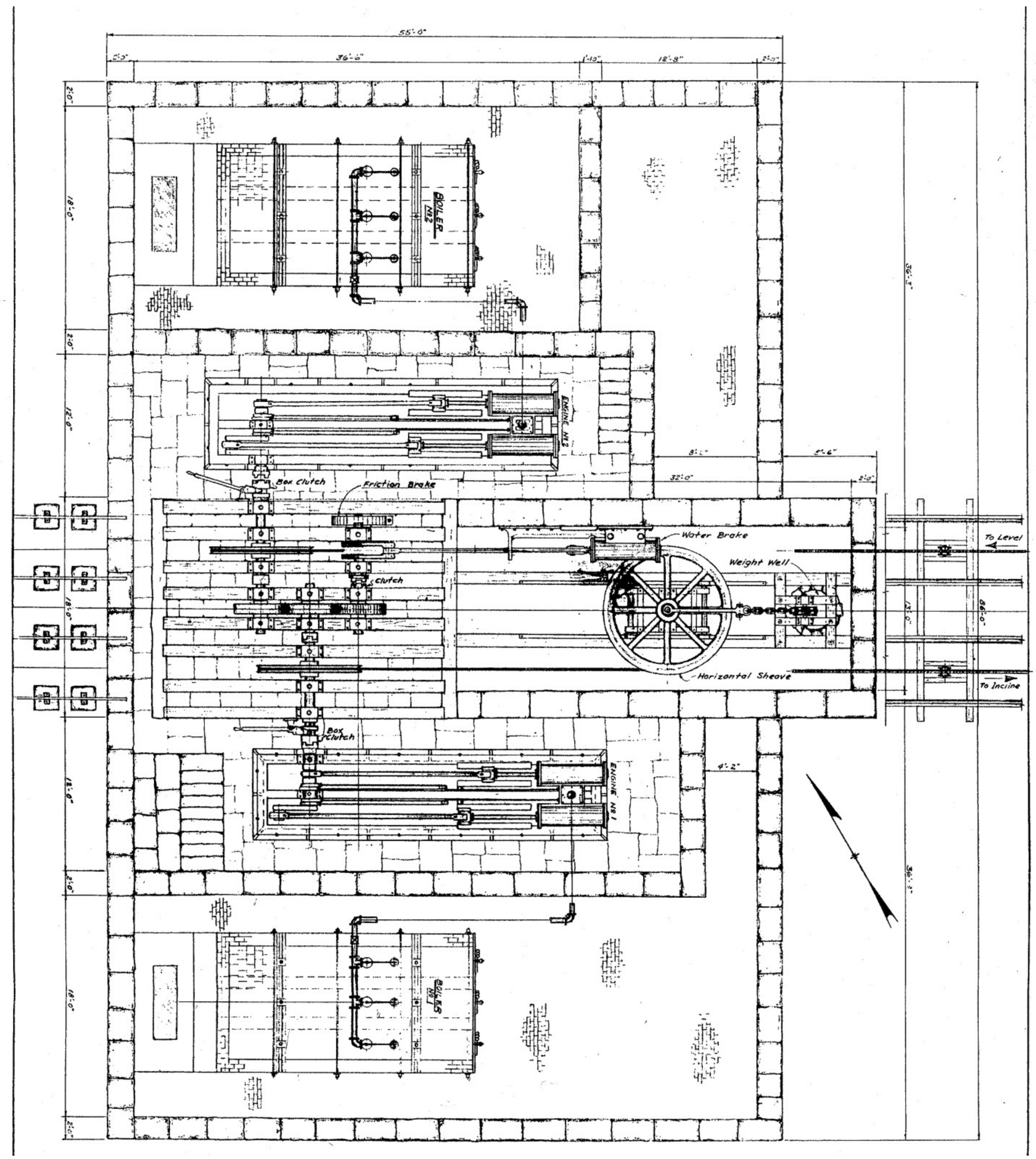


Figure 6. Schematic plan view diagram of a typical engine house used for the stationary engines on the inclined planes by Fred R. Connacher (reproduced from Shank 1975). See Figure 7 for a cross sectional schematic diagram.

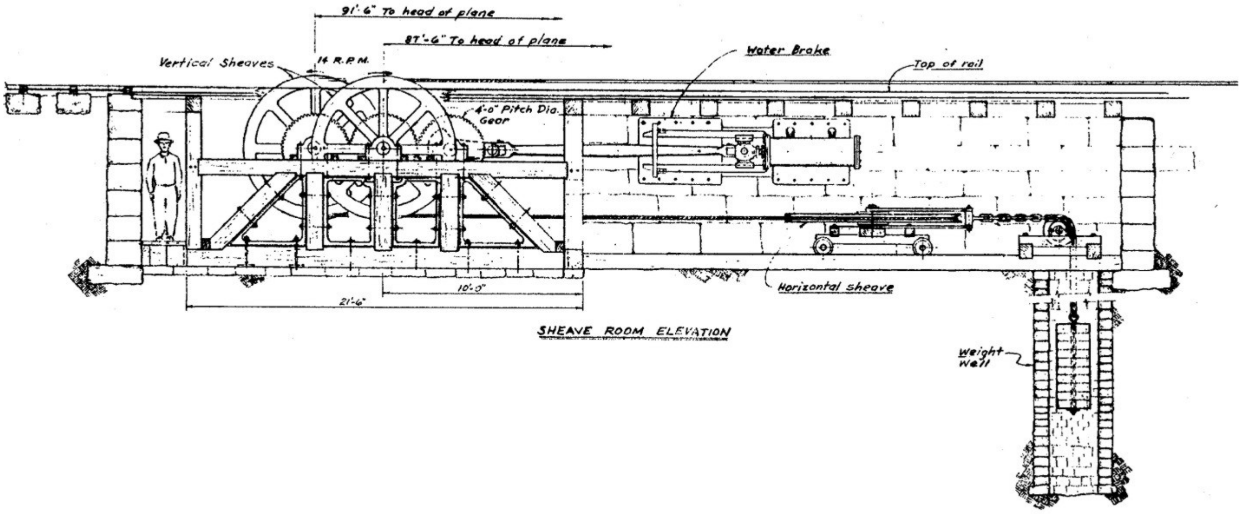


Figure 7. Cross sectional schematic diagram of a typical engine house used for the stationary engines on the inclined planes by Fred R. Connacher (reproduced from Shank 1975). See Figure 6 for a schematic plan view.

one of the engines from the horizontal wheel. The cylinder had air chambers at either end and a side pipe with a sliding valve that allowed the water to pass into and out of the cylinder at the stroke of the piston, which was attached by gears to the drive shaft. The sliding valve was used to regulate the water flow, which in turn regulated the velocity of the descending cars. A clutch allowed the brake to be disengaged when the engines worked the hoisting mechanism. "Safety cars" (Figure 8), special trucks attached to the rope on the downhill side of the cars, provided additional braking ability.

Locomotives

The first commercial steam locomotive in America operated near Honesdale, Pike County, Pennsylvania in 1829. The Portage Railroad, which began operations five years later, did not use locomotives - horses pulled the cars on the level surfaces and slight inclines. The engine "Boston" (Figure 9) became the first locomotive to run on the Portage Railroad, in 1835. It did the work of 18 horses and proved so successful that over the next few years the railroad

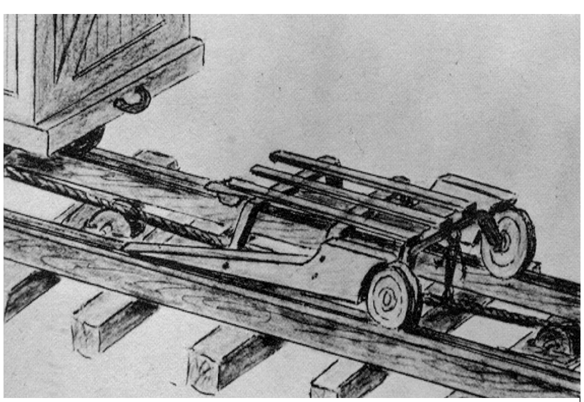


Figure 8. "Safety car" used on inclined planes to prevent rail cars from crashing out of control down the inclines if the cable broke (from Shank, 1975).

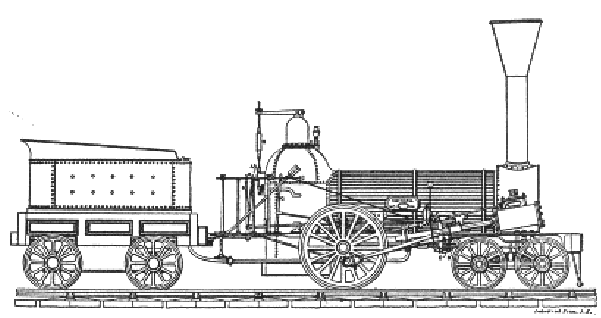


Figure 9. Locomotives, like the Norris shown here, or horses pulled cars on the levels between inclines. The long level between incline 10 and Hollidaysburg was steep enough to allow cars to descent by gravity, with a locomotive used only to control speed.

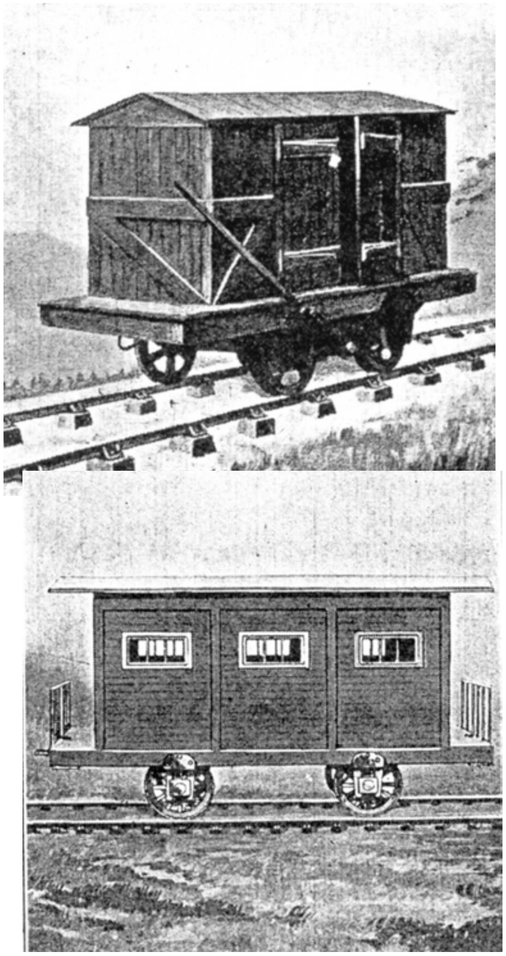


Figure 10. Early railroad cars on the Portage Railroad. Top—a typical box car. Bottom—a typical passenger car.

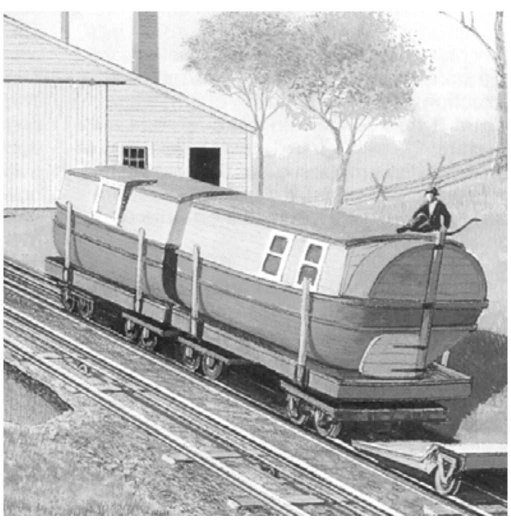


Figure 11. Canal boats were built in sections to allow them to be moved relatively easily from canal to railroad and back.

acquired 16 more locomotives. Eventually the use of horses was phased out completely.

Canal boats and Cars

At the opening of the Allegheny Portage Railroad on March 18, 1834, there were 25 cars ready for use. Another 25 became available by April 1, and 30 more by April 18. These could be hauled by either horse or locomotive. Although designed specifically to haul canal boats, the Portage Railroad also hauled other types of cars, such as the one in Figure 10. The canal boats were built in sections (Figure 11) to make their movement overland practicable. Passengers and goods boarded half a canal boat that was mounted on wheeled trolleys in Philadelphia. Horses or mules hauled the sections through the streets to the railway terminus where the boat halves were transferred to special railroad trucks. Originally drawn by horses, the canal cars eventually were taken overland by locomotives (the Columbia-Philadelphia Railroad shown in Figure 12 was the original Pennsylvania Railroad). At the Susquehanna River, the boat sections were reassembled and drawn by horses to the Juniata River canal, then along the Juniata to Hollidaysburg. There they were transferred once again to railroad trucks and hauled over the mountain by locomotives and stationary engines. Finally, at Johnstown at the western end of the Allegheny Mountain Portage, the boats were reassembled to complete the journey to Pittsburgh on the Conemaugh River canal. Canal boats apparently were not meant as luxury accommodations. Charles Dickens described them quite vividly as "a barge with a little house in it, viewed from the outside; and a caravan at a fair, viewed from within." The sleeping arrangements consisted of "three long tiers of hanging book-shelves, designed apparently for volumes of the small octavo size. Looking with greater attention at these contrivances (wondering to find such literary preparations in such a place), I descried on each shelf a sort of microscopic sheet and blanket; then I began dimly to comprehend that the passengers were the library, and that they were to be arranged, edge-wise, on these shelves, till morning." (Dickens, 1842, p. 154)

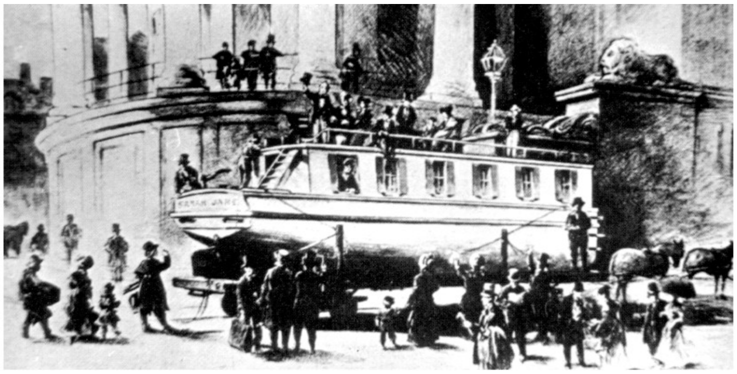


Figure 12. Illustration of a sectional canal boat being hauled on railroad tracks, by horse, from Philadelphia to the Susquehanna River (from Shank, 2001). This was the origin of the Pennsylvania Railroad.

Completion of the Railroad

The first single track was completed and open for traffic March 18, 1834, less than three years after the final surveys had been done. The second track was finished in late spring of 1835. The Portage Railroad was 36½ miles long, and had a total rise and fall of 2,570 feet between Hollidaysburg and Johnstown. The inclination of the planes varied from about 0.07 percent to a little over 10%. The viaduct over the Little Conemaugh River (Figure 13) eight miles east of Johnstown comprised a single semi-circular, 80-foot arch 28 feet wide and standing 70 feet above the surface of the water. The tunnel at Staple Bend on the Little Conemaugh (Figure 14), four miles east of Johnstown, was the first tunnel built in America. It was 901 feet long, 20 feet wide, and 19 feet high at the top of the arched ceiling.

The Allegheny Portage Railroad was completed in less than four years, no mean feat for the early 19th century, especially considering the length of time required for much smaller projects today. And for the next 20 years the railroad would serve well those willing to travel west to make their fortunes. The whole journey from Philadelphia to Pittsburgh, a distance of about four hundred miles that used to require months of hardship, could be covered in relative comfort in less than a week.

The New Allegheny Portage Railroad

It didn't take long after the Portage Railroad opened before people were complaining about the lack of convenience and the safety of the inclined planes. Generally regarded as "nuisances," the inclines just about doubled the cost of operation as compared with the level or

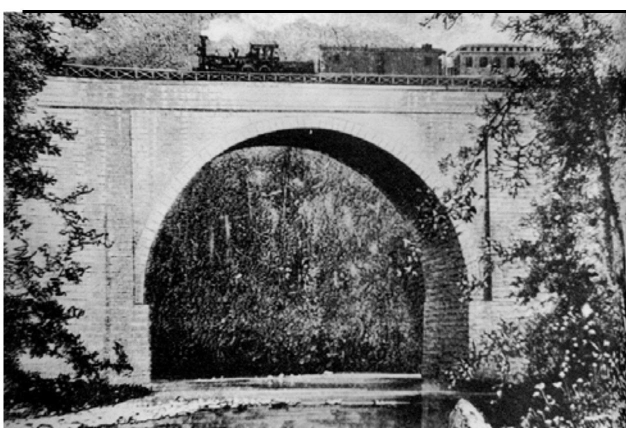


Figure 13. Illustration of the Conemaugh Viaduct (from Shank, 1975). Built to carry the Portage Railroad over the Little Conemaugh River, this historic structure was one of the victims of the great Johnstown Flood of 1889.

Figure 14. Photograph of the northeastern portal of the Staple Bend Tunnel. Photo by Kennedy (2001).

very low-grade parts of the railroad. Word of this unsatisfactory nature reached the state legislature and on the last day of the legislative session, June 16, 1836, they charged the Canal Commissioners with finding a better way of taking travelers over Allegheny Mountain.

By October 15, 1836 two corps of engineers had run yet another survey, this time a crest line along the mountains, looking for a better water gap than Blairs Gap. Sugar Run Gap, about four miles to the north (Figure 1), was much lower topographically, but the surrounding hills seemed to be formidable obstacles to constructing a new railroad, so that potential route was abandoned. A more thorough exploration of the area around Blairs Gap indicated that it was still the best route. The engineer in charge, Charles DeHaas, wanted to keep as much of the old road as possible, including the Staple Bend Tunnel and the Conemaugh Viaduct. He recommended increasing the overall distance, thereby allowing for a lower grade of not more than 48 feet per mile. This would allow the railroad to enter the Staple Bend Tunnel without use of an inclined plane or deepening the floor of the tunnel. He would have run the new road along the Little Conemaugh River almost to Cresson, through a tunnel at Blairs Gap, down the eastern side of Allegheny Mountain by a long and winding route that eventually had it coming back into the valley of Blairs Gap Run opposite Plane No. 10, and then on to Hollidaysburg. The total distance would have increased to 58 miles and it would have bypassed every inclined plane but the first. Although nothing came of this idea immediately, DeHaas' plan had the effect of convincing the Canal Commissioners that Allegheny Mountain could be crossed without resorting to inclined planes.

In 1840, S. M. Fox, principal assistant engineer, determined that a railroad line could cross the mountain, avoiding the inclined planes entirely, and increasing the overall distance only slightly. From Summit to Johnstown no grade would exceed 45 feet per mile, and the route would make use of eight miles of the old grade with an increased distance of only one mile. Fox determined that the best place to put a tunnel was at the summit of the Sugar Run gap. From Hollidaysburg to the Sugar Run summit was only four miles longer than the existing line to Blair Gap summit, and it would avoid Inclined Planes 6 through 10 while keeping the grade to less than 45 feet per mile. Neither DeHaas' nor Fox's reports seemed to make much of an impression with the Board of Commissioners, however, because it took until construction of the Pennsylvania Railroad began in 1847 before they turned their attention to a "New Portage Road."

The old railroad was constantly being repaired. For example, every spring the tracks had to be repaired and readjusted because of frost heave. Landslides, foundation problems in the engine houses, and embankment failures caused almost daily problems along the road (does this sound familiar, or what???). Probably the biggest problem, however, was the ever-present problem of rotting wood in road and bridge superstructures. But the bureaucracy did a bad job of planning for repair appropriations and, although the inclined planes needed repairs almost immediately, there wasn't any money for the job. Therefore, repairs were done piecemeal on a daily basis and the railroad was never actually in good working order. The railroad authorities wanted to replace the old rails with T-rails, but the legislature wouldn't hear of it. About the only important improvement made before 1850 was the replacement of hemp ropes, which had a bad habit of snapping, with John Roebling's metal cables. With the beginning of construction of the Pennsylvania Railroad across the state in 1847, the legislature began to understand that the "old" Portage Railroad had outlived its usefulness. This became especially apparent when the Pennsylvania Railroad hoped to use the Portage as part of its line until it could complete its own line over the mountains. Such economic interests had their impact.

In his “state of the state” address in January 1850, Governor William F. Johnston stated that it cost no less than $10,000 per year to keep each inclined plane in repair. He called the railroad “evil”, and suggested spending $500,000 to bypass four of the five inclined planes between Summit and Johnstown. For the sake of economy, however, he did not suggest replacing the planes on the east side of the mountains – only repairing them. He felt the Pennsylvania Railroad would be able to make good use of the Portage for many years if these changes were made.

Later that year the Legislature decided to bypass the inclined planes altogether. After the appropriate surveys and report were completed, the Legislature authorized reconstruction that would avoid the planes on the western slope, and in June 1851 work began. The new road bypassed Inclined Planes 1 through 3 by the beginning of 1853. From there the road continued along the western slope of the mountains, paralleling the Pennsylvania Railroad line to a small branch of Clearfield Creek where the two lines diverged (Plate 1). The Pennsylvania line went through a 3,570-feet long tunnel through the summit, down the northern face of Sugar Run Gap and around the eastern face of Allegheny Mountain to Altoona via Horseshoe Curve. The New Portage Railroad went through the summit via a tunnel only 1,800 feet in length and ran down the southern face of Sugar Run Gap. It curved around the eastern slope of Allegheny Mountain to Blair Run Gap where it crossed the Old Portage Railroad at the foot of Inclined Plane 8 on the Muleshoe Curve viaduct. From there it paralleled, and occasionally crossed, the Old Portage Railroad line to the top of Inclined Plane 10, then down the slope of the foothills to Newry and north to Duncansville where it used the old picked up the old railroad line (Plate 1). A six-mile-long branch railroad from Duncansville to Altoona provided access between the Pennsylvania and Portage lines. By February 1854 the Pennsylvania Railroad was ready to go over the mountain on its own road, and by July 1855 the New Portage Railroad, although incomplete, began operations.

The New Portage Railroad was 45 miles long – 18 miles from Hollidaysburg to the summit, and 27 miles from the summit to Johnstown. The summit was 150 feet lower than on the old road, reducing the total ascent and descent by 300 feet. The maximum grade for the new Portage road was 66 feet per mile on the western slope and 75 feet per mile on the eastern slope of the mountain. The minimum curvature radius was 700 feet. The summit tunnel was dug at the narrowest and lowest point at Sugar Run Gap, 135 feet below the summit. The Pennsylvania Railroad tunnel, by comparison, was as much as 200 feet below the summit, even though it was only a few hundred yards further north. The Board of Commissioners pronounced the New Portage Railroad “superior to the New York and Erie, the Pennsylvania, or the Baltimore and Ohio Railroad” (Wilson, 1897, p. 79). Thus, the Old Allegheny Portage Railroad, once considered one of the “wonders of the age”, had done its work, lived its history, and was decommissioned.

The Demise of the Portage Railroad

Wouldn’t you know it? No sooner had the New Portage Railroad gone into operation than the state government decided to sell it, and the entire canal system along with it. The New Portage had cost over $2 million dollars to build, and there was no way that revenues from its use were ever going to equal, let alone exceed, its operating costs. The rest of the canal system was also in bad shape financially (as well as physically), and the advent of the cross-state Pennsylvania Railroad had put a serious crimp in any revenues the system could have generated.

The cost of the state canal system from Philadelphia to Pittsburgh had been $16,504,655.84 (Jacobs, 1945). When the system went on the blocks, the Pennsylvania Railroad was the only bidder, making payment with bonds valued at $7,500,000, less than half of the total cost. On August 1, 1857 the Pennsylvania Railroad took possession of the Eastern, Juniata, and Western divisions of the Pennsylvania Mainline Canal, including the Portage Railroad, and began dismantling them. The Portage Railroad went first, then the canals. By 1858 the Portage was gone. By 1864 the Pennsylvania Railroad had abandoned the entire Western Division of the Pennsylvania Mainline Canal. In 1866 they sold the remaining 178 miles of canal to the Pennsylvania Canal Company, a private enterprise, for $2,750,000.

The Pennsylvania Railroad used most of the rails from the Portage Railroad to extend the Pittsburgh, Fort Wayne and Chicago Railroad the 82 miles between Plymouth and Chicago, Illinois. Many of the stone “sleepers” were sent to Altoona for use in masonry for the railroad shops. A small side track allowed use of the New Portage tunnel as a subsidiary route, and portions of the tracks at Hollidaysburg and Lilly were used as sidings. Other than that, the day of the Portage Railroads was at an end. Long neglected by all but local historians, many of the inclined planes disappeared beneath a cover of forests and the railroad right of way in places was used, and eventually paved with asphalt, for road traffic.

REGIONAL GEOLOGY

Physiography

This field trip crosses three physiographic sections representing two of the major provinces of the Appalachians. These include, from east to west (the direction of travel): 1) the Appalachian Mountain Section of the Ridge and Valley Province; 2) the Allegheny Front Section of the Appalachian Plateaus Province; and 3) the Allegheny Mountain Section of the Appalachian Plateaus Province (Figure 15). Each of these can be recognized by specific physiographic and geological characteristics, and each presented different sets of problems during construction of the Allegheny Portage Railroad.

The Appalachian Mountain Section of the Ridge and Valley Province consists of long, narrow ridges and broad to narrow valleys exhibiting moderate to very high relief (Sevon, 2000). Within the field trip area the most prominent ridge trends generally northeast-southwest. Twists and turns in the vicinity of Hollidaysburg make this a complex topographic feature (Figure 16). North of the city it is called Brush Mountain; to the east, where it forms a great angular loop, it is known as Lock Mountain; Loop Mountain is the segment to the southeast of

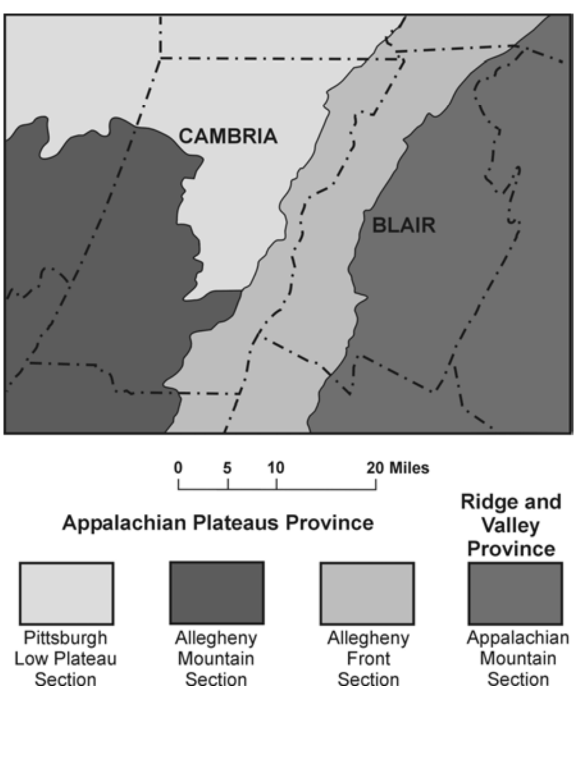


Figure 15. Generalized physiographic map of Blair and Cambria Counties (modified from Sevon, 2000).

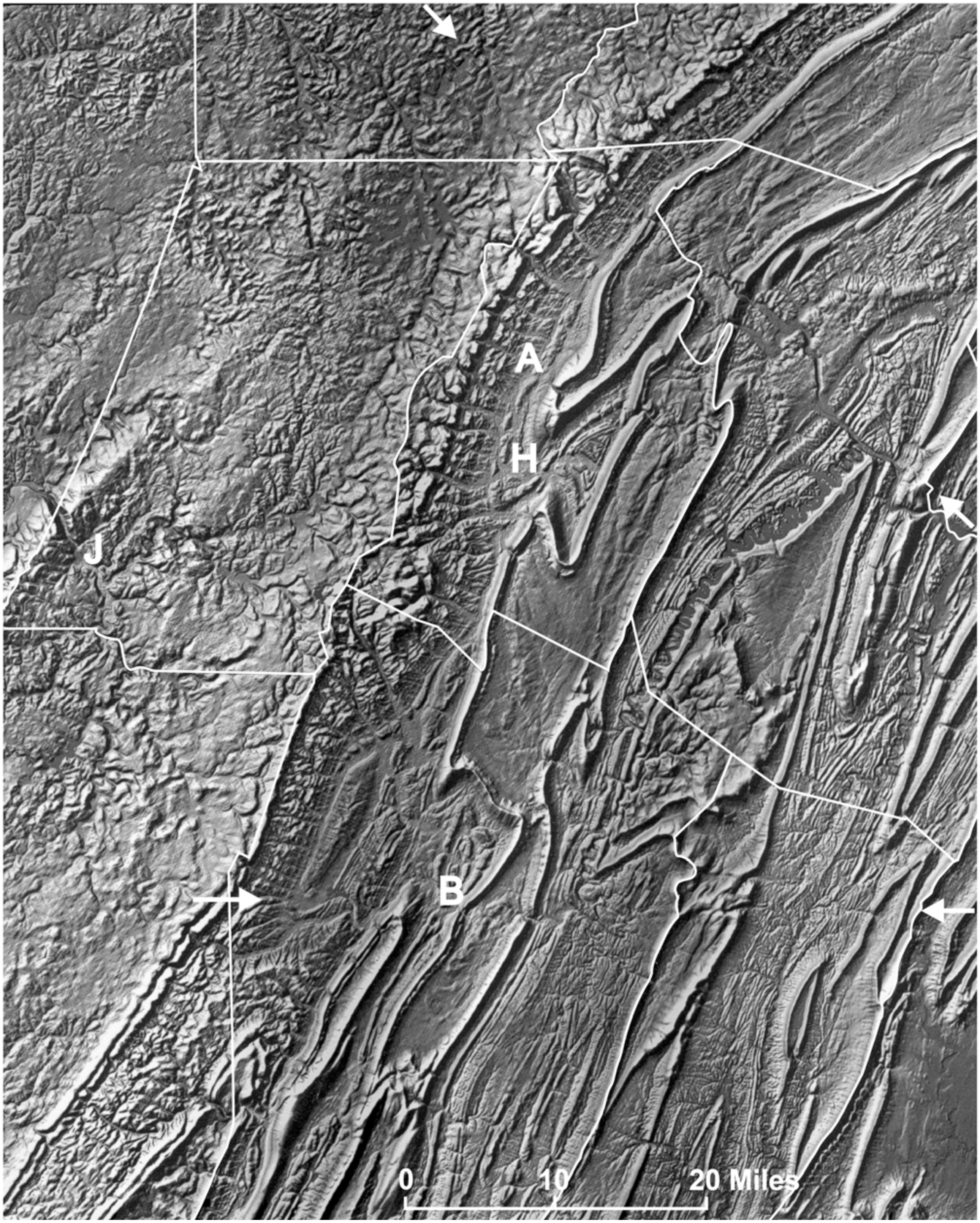


Figure 16. A portion of the Digital Shaded-Relief Map of Pennsylvania (Commonwealth of Pennsylvania, 1999) showing the contrast between the Ridge and Valley and the Appalachian Plateau. County boundaries are in white. Locations of towns include A – Altoona, B – Bedford, H – Hollidaysburg, and J – Johnstown. Arrows indicate transverse fracture features (see Structural Geology).

town; and Short Mountain and Dunning Mountain can be found south of Hollidaysburg. Subsidiary ridges, such as Catfish Ridge to the south of town (Figure 16), are also common. These ridges typically are the remnant flanks of breached anticlines and synclines. Catfish Ridge results from resistant cherty limestones and sandstones of the Upper Silurian and Lower Devonian Keyser and Old Port formations. Although these rocks generally contain more sandstones than the underlying formations, sandstone is not very important in the formation of the mountain itself. Ridge and Valley Province ridges have fairly steeply dipping slopes, as much as 20^o in places. The valleys within the province generally have floors of shales and/or carbonate rocks, both of which are easily eroded in Pennsylvania's climate. Some fairly resistant rock layers produce much reduced ridges and knobs within the valleys. The long continuous valley west of Hollidaysburg generally lies at an elevation between 1,200 and 1,400 feet but rises to about 1,600 to 1,750 feet in the foothills of Allegheny Mountain. This valley goes by many names, depending on where you are. North of Altoona it is called Bald Eagle Valley; between Altoona and Hollidaysburg it is called Logan Valley; and west and south of Hollidaysburg it goes by the name of Frankstown Valley.

The Allegheny Front Section of the Appalachian Plateaus Province consists of a series of rounded to linear hills, cut by deep, narrow valleys, rising by steps to the escarpment of the Allegheny Front (Figure 1), then tapering away to the west in a series of undulating hills. Local relief is moderate to high (Sevon, 2000). Allegheny Mountain (or, alternately, the Allegheny Mountains) is synonymous with this section. Allegheny Mountain, the most prominent feature in the area, is the eastern scarp of the Appalachian Plateau, an enormous wall of rock with ridge tops between 2,000 and 2,400 feet above sea level. It spans about 700 miles along the boundary of the Ridge and Valley and Appalachian Plateaus provinces (Hunt, 1974).

Wide ridges decreasing in elevation toward the north, separated by broad valleys, characterized the Allegheny Mountain Section of the Appalachian Plateaus Province. Like the Allegheny Front Section, local relief is moderate to high (Sevon, 2000). Although the elevations and relief generally are greater than in the adjacent Pittsburgh Low Plateau Section to the west, the two sections are fairly similar. Both consist of broad, open folds, parallel to the tighter ridges of the Ridge and Valley Province, but which become more subdued toward the west. The underlying rocks typically lie in horizontal strata except where the folds occur. Within the area of this field trip there is one major fold – Laurel Hill, which lies west and north of Johnstown. This is the highest and most structurally complex of the Appalachian Plateau folds in Pennsylvania.

All of the ridges, escarpments, and folds have been dissected at intervals by deep valleys or gaps. Known sometimes as water gaps, or wind gaps where no water currently flows, these valleys often indicate the positions of ancient streams that carved down through the Appalachians over millions of years. The most obvious in the vicinity of Hollidaysburg are: 1) the 800-feet deep McKee Gap where Hatter Creek separates Short Mountain from Dunning Mountain about six miles to the south; and 3) the 900-feet deep Point View Gap where the Frankstown Branch of the Juniata River flows through Lock Mountain about 9 miles to the northeast. Along Allegheny Mountain the most prominent in the vicinity of the field trip are Burgoon Run, Sugar Run, and Blair Run gaps. Many of the present day streams of Pennsylvania are remnants of those ancient streams. For example, the Conemaugh River, which flows through the Conemaugh Gorge water gap in Laurel Hill at Johnstown, probably originated in the Early Triassic as a river flowing off the western slopes of the newly formed Alleghanian Mountains, carrying tons of detritus in suspension across a great alluvial plain that stretched all the way across the Midwest and Canada. Although they flow eastward now, streams such as the Frankstown Branch of the Juniata River used to flow westward before deep erosion of the mountains and stream piracy by the Susquehanna River changed their direction of flow during the Mesozoic (Sevon, 1993).

Drainage

Allegheny Mountain forms the major drainage divide in this area. Streams on the eastern side of the mountain flow via the Juniata River to the Susquehanna River into Chesapeake Bay and the Atlantic Ocean. Streams on the western side flow via the Conemaugh and Youghiogheny Rivers to the Allegheny, Monongahela, Ohio, and Mississippi and, finally, to the Gulf of Mexico.

The Juniata River is the major waterway of the Appalachian Mountain Section, draining approximately 3,400 square miles of central Pennsylvania. The main channel of the Juniata River forms to the east, near the village of Petersburg in Huntingdon County, at the confluence of the southern Frankstown Branch (whose tributary, the Beaverdam Branch, flows through Hollidaysburg), and the northern Little Juniata (which flows through Tyrone). The Little Juniata drains 342 square miles whereas the Frankstown Branch drains 396 square miles (Juniata Clean Water Partnership, 2000). Both of these rivers originate as numerous tributary creeks on the east slope of Allegheny Mountain. Other tributaries originate on the west slopes of the first set of ridges and within the shale-floored valley between Allegheny Mountain and the ridges. The gradients of the larger streams, such as the Frankstown Branch, are moderate, but smaller streams have much steeper gradients (Butts, 1945). For example, the Frankstown Branch has a gradient of 10.8 feet per mile, whereas one of its tributaries, Poplar Run, has a gradient of 62 feet per mile. It is interesting to note that these gradients are not constant. Frankstown Branch has an average gradient of 23 feet per mile in its first seven miles. This changes to an average 11 feet per mile over the next nine miles, and then to 6 feet per mile over the last 14 miles (Butts, 1945).

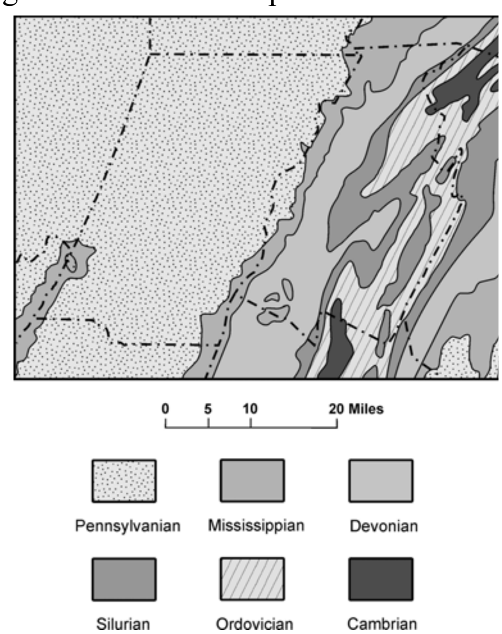


Figure 17. Generalized geologic map of Blair and Cambria Counties (modified from Commonwealth of Pennsylvania, 1990a).

The major rivers of the Allegheny Mountain Section include the Conemaugh River, which drains the northern half of the section, and the Youghiogheny River, which drains the southern half. The Conemaugh forms at the confluence of the Little Conemaugh River and Stoneycreek River in Johnstown. Near Saltsburg, in Indiana County to the west, Loyalhanna Creek joins the Conemaugh and, at this point, the name changes to Kiskiminetas River despite the Conemaugh being a major river in the area. The combined Kiskiminetas-Conemaugh watershed drains about 1,887 square miles. This is the largest single sub-basin of the Allegheny River, draining 16 percent of the Allegheny's total drainage (Kiski-Conemaugh River Basin Alliance, 1999). The combined Stoneycreek-Conemaugh-Kiskiminetas

River flows 122 river miles through western Pennsylvania from northern Somerset County to the Allegheny River. Because of its steep topography, the river valley is one of the most flood prone areas of the state.

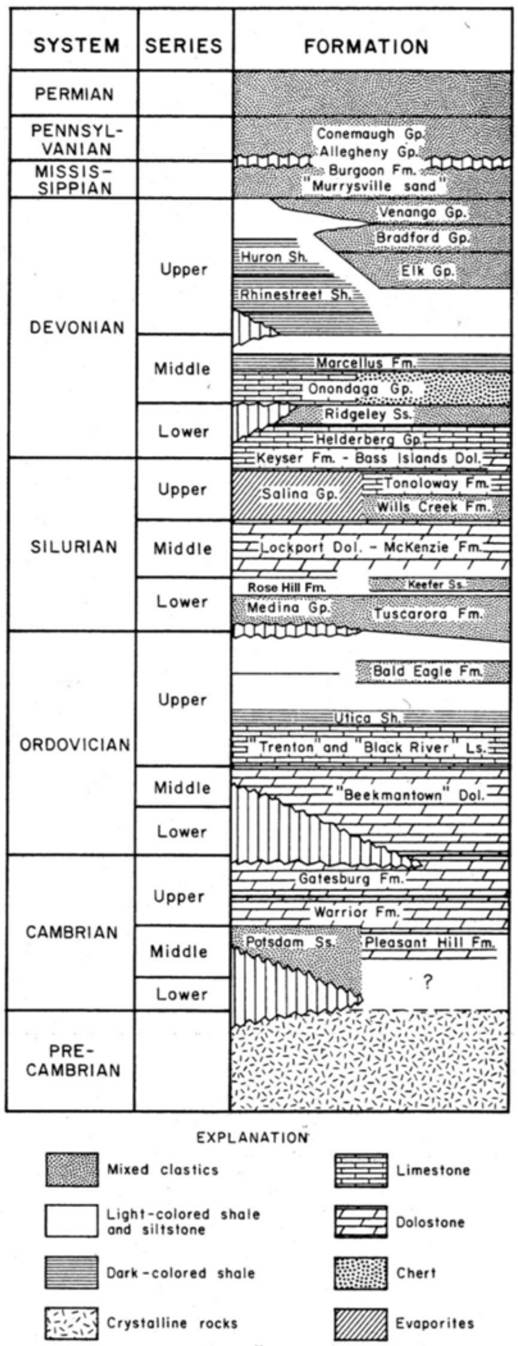


Figure 18. Generalized stratigraphic column of the rocks of western Pennsylvania (modified from Harper and Laughrey, 1987).

Stratigraphy

The rock strata within the general vicinity of the field trip span approximately 205 million years of geologic time, from the Middle Cambrian to the Late Pennsylvanian (Figure 17). Butts (1945) estimated the thickness of these strata to be in the neighborhood of 23,000 to 25,000 feet. The field trip route, however, will cross rocks ranging in age only from Early Silurian (Clinton Group) to Middle Pennsylvanian (Conemaugh Group) (Figure 18). Middle Cambrian through Middle Ordovician bedrock in the Hollidaysburg area occurs only east of the crest of the Brush-Dunning Mountain ridge complex, and will not be discussed further. The western flanks of the ridge complex expose Upper Ordovician through Lower Devonian, whereas easily eroded shales of the Middle and Upper Devonian form the floor of the Logan-Frankstown Valley west of Hollidaysburg. Upper Devonian and Lower Mississippian shales and sandstones underlie the eastern escarpment of Allegheny Mountain, and Mississippian sandstones form the summit. From there westward the bedrock consists of Middle Mississippian through Middle Pennsylvania terrigenous rocks.

Lower Silurian Tuscarora sandstones derived from erosion of the Taconic highlands to the east gave way to mudrocks and carbonates later in the Silurian. During this transition, the amount of clastic material decreased upward until, by the end of the Silurian, the rocks comprise fossiliferous marine limestones (see, for example, Stop 1). The Tuscarora Sandstone acts as the major ridge former in the Ridge and Valley Province. Although we will not be able to examine it close up, it is very noticeable as the nearly ubiquitous boulder fields and talus deposits of white sandstone crowning the upper slopes of the higher ridges. Lower Devonian rocks in central Pennsylvania range from bioclastic shelf carbonates to very coarse-grained sandstones, the result of fluctuating shallow marine depths and increasing clastic input from the east. Sea level continued to fluctuate through the Middle Devonian with carbonates replacing clastics replacing carbonates. By this time, the Acadian orogeny was taking place on the eastern margin of Laurentia. Faill (1985, 1999) found no evidence of Acadian deformational structures in Pennsylvania west of the Piedmont, but noted that sedimentological changes provide a good record of the event. Numerous K-bentonites within the upper Onondaga and lower Marcellus formations (Tioga ash falls) demonstrate that the Acadian orogeny was under way by that time.

The encroachment of the Catskill deltaic complex, which began in eastern Pennsylvania in the Middle Devonian, dominated the Late Devonian and Early Mississippian in central and western Pennsylvania. As a result of the Catskill progradation, Upper Devonian rocks consist almost entirely of sandstones, siltstones, and shales, with a few minor limestone beds punctuating the section. The lower part of the section is dominated by marine shelf mudrocks with a general increase in grain size upward through the section. The rocks also reflect a generally upward shallowing sequence, from prodeltaic through distributary to continental alluvial deposition. Pennsylvanian rocks in the report area consist of a highly variable sequence of fluvial and deltaic sandstones, shales, siltstones, and claystones, coals, and both marine and nonmarine limestones. With the exception of a few marine limestones, the individual beds generally have limited areal extent, occurring most commonly as lenses and pods. Thickness for individual units range from a few inches to several tens of feet. Because of this extreme variability only a few of the more extensive and economically important units have been formally named.

Surficial deposits of Quaternary age generally consist of unconsolidated material lying on bedrock. These deposits can be separated into distinct types of material based on how and where they were formed. Faill and others (1989) recognized the following types in the Cambria/Blair County area: regolith, colluvium, alluvium, and artificial fill or “works of man”. The composition and arrangement of materials varies greatly depending on the location of the material.

Structural Geology

The Ridge and Valley structural province is the classic example of a folded and faulted foreland mountain system; the structures formed during the Alleghany orogeny (Faill and Nickelsen, 1999). The majority of the fold belt extends 700 miles along the eastern interior of North America, from Pennsylvania to Alabama. Only a narrow band about 10 miles wide extends from eastern Pennsylvania through New Jersey and New York into the Hudson and St. Lawrence Valleys (Rodgers, 1970).

In contrast, the Appalachian Plateau is characterized by relatively flat-lying rocks, interrupted at intervals by low, broad anticlines lying parallel to the Ridge and Valley. The folds are gentle features with wavelengths between 5 and 20 miles. Wavelengths decrease to the west. These folds also are low, ranging from only a few hundred feet to about 2,500 feet (Wiltschko and Chapple, 1977). They are asymmetric, having dips generally of three or four degrees on the northwestern limbs and five or six degrees on the southeastern limbs. Surface faults generally are of small extent and offset (although, the faults associated with the Tipton Block near Tyrone are quite extensive – see Faill and others, 1989). Numerous faults have been mapped in the subsurface during oil and gas exploration.

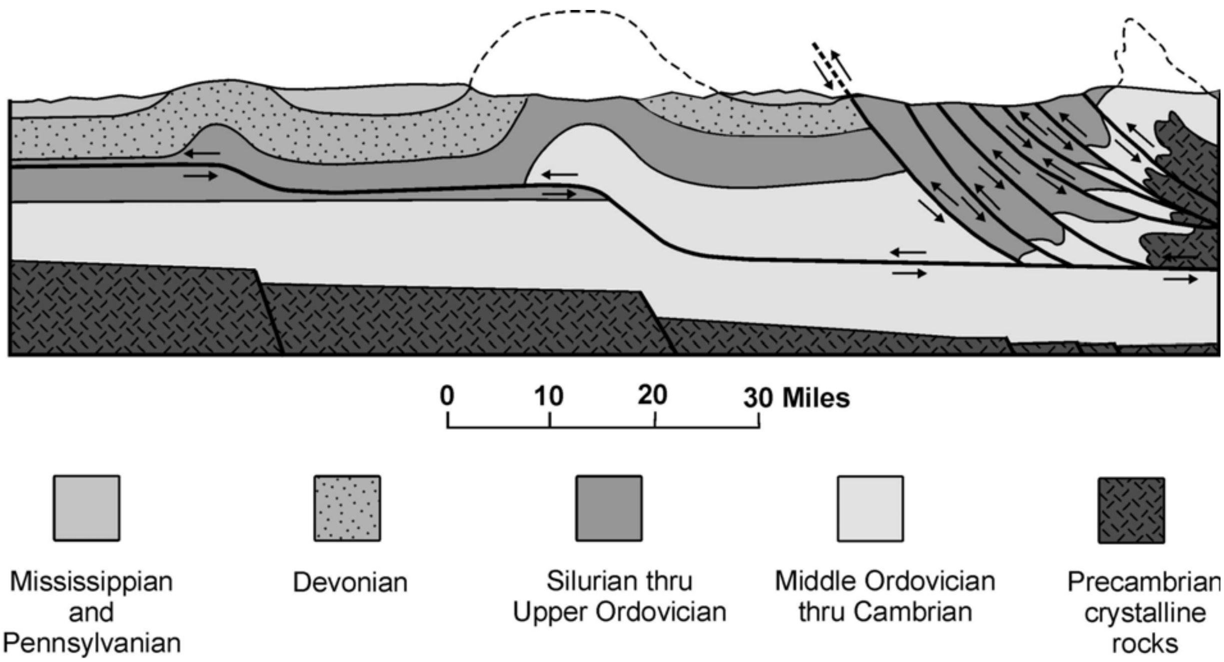


Figure 19. Generalized cross section of the western part of the Ridge and Valley and the eastern part of the Appalachian Plateau, showing the structure.

Although folds as seen at the surface in the Ridge and Valley and Appalachian Plateau are the most obvious structures, the most important tectonic element actually is a system of southeast-dipping thrust faults that rise through the Paleozoic rock section (Faill and Nickelsen, 1999). These faults generally run parallel to bedding for many miles, acting as *décollement* surfaces within certain ductile rock units, before ramping upward through more brittle ones. Many of these faults are blind – that is, they do not intersect the surface of the earth (Figure 19). Seismic survey data suggest ramping typically occurs above basement normal faults associated with the breakup of the supercontinent Rodinia in the Late Precambrian and Early Cambrian. During the Alleghanian orogeny, the Upper Ordovician through Permian sedimentary rock section was transported northwestward along a basal Cambrian *décollement* and deformed in a series of imbricate thrust sheets. These strata are generally deformed in approximate imitation of the basal deformation, but contain folds and faults of their own as well.

Ridge and Valley folds were once thought to be long, continuous folds broken here and there by subsidiary structures resulting from Alleghanian compression alone. However:

> It is now recognized that the folds are but one of a number of stages of a deformation that extended over a period of time, during which the principal stress directions changed orientation. The deformation stages included pretectonic hydraulic jointing followed by tectonic cross-fold extension jointing and layer-parallel shortening, which is expressed as both rock cleavage and conjugate wedge and wrench faulting. Major flexural-slip folding overprinted all previous structures and led to layer-parallel extension on the steep limbs of folds. The last structures of the Alleghany orogeny were late strike-slip faults, which are sometimes associated with major reverse lineaments, and out-of-

sequence high-angle reverse faults. (Faill and Nickelsen, 1999, p. 270)

Although Plateau folds generally are limited in size and scope, folds in the Ridge and Valley come in all sizes, from anticlinoria (wavelength >10 miles) to specimens you can hold in your hand (Nickelsen, 1963). (Synclinoria and smaller-order synclines in both the Ridge and Valley and Appalachian Plateau are basically passive structures lying between the anticlinoria and anticlines.) In the Ridge and Valley, the anticlinoria extend from the Transylvania fault zone of Root and Hoskins (1977), which strikes almost due east-west through Bedford and Breezewood (Figure 16) to the Blue Ridge, to the Susquehanna River or beyond. The folds within the anticlinoria generally have lengths less than 60 miles (Faill and Nickelsen, 1999). Many of the anticlinoria contain subsidiary *en echelon* folds that are controlled by local thrust faults occurring within different stratigraphic intervals along the length of the major folds. Smaller (second- and third-order) folds generally stand upright, many with vertical or overturned limbs. Some are recumbent (Epstein and others, 1974). The fold axes do not exhibit smooth curving along their lengths; rather they consist of small, straight segments that change orientation in increments, from one or two to as many as 20 degrees. Some of these folds are elongate domes, whereas others are long and linear.

Most of the faults present at the surface in the Ridge and Valley are thrust faults. However, wrench faults do occur in major zones that cross regional strike. Normal faults typically are rare and small, restricted to vertical and overturned beds in the northwest limbs of the anticlines. In contrast, surface faults in the Plateau generally are normal faults associated with ancient landslides (slumps) adjacent to Paleozoic river banks. The few thrust faults occur mostly within the major folds in the eastern part of the Plateau.

The Cambrian *décollement* extends beneath the Ridge and Valley probably as far southeast as the Great Valley, Blue Ridge, and much, if not all, of the Piedmont (the basis of the Eastern Overthrust Belt that had oil and gas explorers interested in the early 1980s). It ramps upward at the Allegheny structural front to the level of the Silurian Salina Group, which forms the principal basal detachment horizon beneath the Appalachian Plateau from West Virginia to New York (Gwinn, 1964; Frey, 1973). Thrust faults that splay off the basal *décollement* to form the cores of anticlines tend to be moderately steep and parallel to bedding in the southeastern anticlinal limbs. In contrast, the faults in northwestern anticlinal limbs have low dips and crosscut bedding (e.g. the Nittany anticline – see Gwinn, 1970).

The Ridge and Valley, and the Appalachian Plateau, also contain many transverse fracture zones, some with documented strike-slip components. The Transylvania fault zone of Root and Hoskins (1977) mentioned above is the longest in central Pennsylvania. Most large transverse zones have been described as lineaments or cross-strike structural discontinuities (CSDs) (Kowalik and Gold, 1976; Rodgers and Anderson, 1984; Harper, 1989; Gold, 1999). The most prominent of these is the Tyrone-Mt. Union lineament, which appears to be the longest in the state (running from at least the northern terminus of the Blue Ridge to Lake Erie). It stands out in the Ridge and Valley as the parallel courses of the Little Juniata and Juniata Rivers (Figure 16). In addition, Faill (1987) has described numerous small structures exposed along its trace in the Little Juniata River valley near Birmingham, including slickensided transverse faults, mesoscopic disharmonic folds, and high fracture density. It also terminates many second- and third-order folds, both in the Ridge and Valley and the Appalachian Plateau. It apparently has a right-lateral strike-slip component of about 37.5 miles in the basement (Lavin and others, 1982, based on evidence from gravity data), but a down-to-the-southwest normal fault component in the Paleozoic cover (Rodgers and Anderson, 1984). According to Canich and Gold (1985), this zone is still seismically active.

Faill and Nickelsen (1999) divided the Alleghanian deformation in the Ridge and Valley into a several stages in which one or another process was predominant: 1) pre-Alleghanian deformation, which left a regional record of extensional joint sets in coals in the Appalachian Plateau. The presence of several overprinted extensional joint sets implies different stress orientations resulting from epeirogenic movements and/or early Alleghanian layer-parallel shortening (Nickelsen and Hough, 1967); 2) overprinted episodes of layer-parallel shortening, which produced extension joints, spaced cleavage, small-scale folding, and conjugate wrench faulting and thrusting; 3) major folding; 4) late stages of folding in which layer-parallel extension on the steep fold limbs produced joints and both strike and transverse extensional wedges; and 5) strike-slip faulting that cuts all previous structures and appear to be restricted to major gaps located on lineaments.

Economic Geology

Geological resources in the Blair/Cambria County area include both fossil fuels and non-fuel mineral resources. Non-fuel mineral resources can be divided further into metallic and nonmetallic commodities. Fossil fuels that occur in the area include coal, oil, and natural gas.

Non-Fuel Mineral Resources – Metallic

Iron Ore – Iron ore mines were quite common in Blair County in the 1800s; even Cambria County had some iron ore mines until the collapse of the local iron industry after the Civil War. Local ores were limited in both quantity and quality, and in the 1870s, with the discovery of high quality iron ore in the Great Lakes region, the iron industry declined in all but a few places like Pittsburgh and Sharon. Iron ores are actually quite common in rocks in the area of the field trip (Platt, 1881; Platt and Platt, 1877). “Ferruginous” limestones and hematites occur in the Catskill Formation, at the base of the Marcellus Formation, and in several zones within the Rose Hill and Keefer Formations (Figure 18) in central Pennsylvania. Most of the mining activity in the Hollidaysburg area was centered on two ores in the Rose Hill, the “Double Fossil Ore” near the top of the formation and the “Frankstown ore bed” near the middle. The Double Fossil Ore consists of two fossiliferous, calcareous, iron-rich zones separated by sandstone and shale. Of the two, the lower one was the richer, but at 35% metallic iron (Faill and others, 1989), it had to be mixed with other local ores. The “Frankstown ore bed” (or Frankstown Fossil Ore, as Faill and others, 1989 called it) is an iron-rich (roughly 40% metallic iron) limestone layer approximately two feet thick, making it one of the richest ores in the area. As the name suggests, it is especially well developed in the vicinity of Frankstown, northeast of Hollidaysburg. Unfortunately, it thins rapidly outside of this area. Near the base of the Rose Hill is the “block ore bed” or Hard Fossil Ore. This bed was mined only locally because of its hardness and low iron content. However, it could be used when mixed with higher quality ores. In other areas of Blair County, iron deposits occur as hematite nodules disseminated in cave and sinkhole fills in the Tonoloway and Keyser carbonates (Figure 18). These ores can be quite rich. Faill and others (1989) cited ores containing 50 to 60% metallic iron. The Johnstown ore bed (lower Glenshaw Formation) (Figure 18) in the area around Johnstown once furnished enough material to supply several furnaces, including the old Cambria furnace near the base of

Laurel Hill (Phalen, 1910).

Lead and Zinc – Although lead and zinc have not been found in economic quantities within the area of this field trip, it should be noted that lead and zinc deposits in the Lower Ordovician Beekmantown rocks of Sinking Valley northeast of Altoona were mined during the Revolutionary War. Under the direction of General Daniel Roberdeau, for whom historic Fort Roberdeau is named, the deposits were worked in the southern end of Sinking Valley during 1778 and 1779 as a source of lead for bullets. Miller (1924) states that the operations were short-lived due to the cost of transporting mining equipment to the frontier, smelting the ore, keeping the laborers at work, and keeping the hostile Indians at bay. The deposits, which consist primarily of galena, sphalerite, and smithsonite (Faill and others, 1989), were reworked during several periods in the late 1800s. Analyses of the zinc ore from the Birmingham area in northern Blair County indicate contents as much as 47.5% zinc oxide and 5.5% lead (Miller, 1924).

Non-Fuel Mineral Resources – Non-Metallic

Sandstone, limestone, and dolostone are economic resources that can be cut for dimension stone or flagstone, or coarsely crushed for use as aggregate. In addition, sandstone can be finely crushed as ganister and glass sand, and unconsolidated deposits of sand and gravel can be used as glass sand and aggregate; limestone can be finely crushed for chemical lime uses. Claystone and shale comprise the raw materials for many products such as bricks, ceramics, refractory bricks, lightweight aggregates, pottery and stoneware, and fillers, depending on their qualities.

Cut Stone – Although many of the local Devonian, Mississippian, and Pennsylvanian sandstones (e.g. Foreknobs, Catskill, Burgoon, and Pottsville among others) (Figure 18) were used for foundations and basement fills, it appears as though only the Tuscarora and Juniata (Upper Ordovician) sandstones were used as dimension stone in the vicinity of Blair County. Glenshaw sandstone was quarried along the Allegheny Portage Railroad near the Lemon House (at the top of Inclined Plane No. 6) and for use as "sleepers" on the railroad (see Stop 5). The sandstones in the upper part of the Catskill Formation (Duncannon Member of Faill and others, 1989) probably are the best local rock for flagstone use. It is possible that other sandstones in the Mississippian and Pennsylvania might be suitable, but the generally thicker bedding, and cross bedding characteristic of these rocks probably excludes them from more than local, noncommercial use. Local limestones and dolostones were used early in the history of Blair and Cambria Counties as evidenced by the number of houses, churches, and other buildings that have been constructed with them. Numerous old farmhouses are made of blocks of limestone and dolostone. Dimension stone is rarely quarried anymore in the area. Any rock usable as dimension stone is by nature difficult to work with, which raises the expense in producing it. Other building materials such as concrete and brick are easier and less expensive to manufacture.

Aggregate – Coarse aggregate (crushed sandstone, limestone, or dolostone, and gravel) that meets Pennsylvania Department of Transportation (PennDOT) requirements for low skid-resistance level (SRL) can be used in a limited way for highway surface concrete. Some of the sandstone units having a potential use for SRL in this area aggregate include the Tuscarora Formation, the Ridgeley portion of the Old Port Formation, sandstones in the Scherr, Foreknobs, and Catskill Formations, and the Burgoon and Loyalhanna Formations (Figure 18).

Ordovician (Trenton, Black River, Beekmantown, etc.) and Silurian (Tonoloway) carbonates have been found to be excellent for cement aggregate, bituminous aggregate, road base, and agricultural aggregate. Although these carbonates are excellent for concrete, they generally have low SRLs, and may have limited use in highway surface concrete in the future. PennDOT Type A fine aggregates must be clean and free of clay, vegetable substances, and other extraneous materials. The principal source of fine aggregate in Pennsylvania are the glacially derived sands found in the river channels and moraines of western and northeastern Pennsylvania. No glacial deposits exist within the field trip area, but the river valleys, and especially the floodplain deposits, contain an abundance of sand-size material that can be dredged or quarried and sifted where necessary. The main source of sand in central Pennsylvania over the years has been the Ridgeley portion of the Old Port Formation. The sandstone is relatively thick and friable, and can be crushed fairly easily to produce quartz sand. The earliest quarries were opened in the 1920s, chiefly producing a mortar sand (Faill and others, 1989). Stone and American Foundrymen's Association (1928) reported that the company at Mines, in Blair County, produced sand from a pit about 35 feet deep from what appeared to be disaggregated Tuscarora Sandstone.

Ganister – Ganister is good quality siliceous sandstone used for manufacturing refractory brick for furnace linings. The almost pure quartz sandstones of the Tuscarora Formation, which crops out outside the field trip area, are the best source of ganister in the area (Table 1). In fact, the Tuscarora outcrops in Blair County gave rise to a large, economically important industry in the Hollidaysburg area in the 1800s. However, if the sandstone has an iron content above 1.25, it is virtually useless. Although Tuscarora sandstone is relatively pure, it does have some iron content which restricts the allowable temperature in the furnace. Furnaces run much more efficiently at higher temperatures. Therefore, replacement sources of silica brick were sought containing lower iron contents than those found in the Tuscarora. As a result, the ganister industry in Blair County collapsed early in the 1900s.

Glass and Molding Sand – Glacially derived sands found in the river valleys of western Pennsylvania gave rise to the glass industry in the Pittsburgh area, but the Ridgeley portion of the Old Port Formation generally is regarded as the only real source of glass sand in central Pennsylvania. This rock provides sand suitable for glass manufacturing along its outcrop belt to the east of Hollidaysburg. Phalen (1910) believed the sandstone of the Pottsville Group (Figure 18) would have been suitable for crushing and using as glass sand. Analysis of the sandstone from the west flank of Laurel Hill indicated 97.5% silica with very few impurities (Table 2). Stone and American Foundrymen's Association (1928) reported that a heavy loam suitable for

Table 1. Chemical composition (in percent) of the ganister-quality sandstones in the Tuscarora Formation from Lock Mountain just east of Hollidaysburg (data from Butts, 1945).

	Sample Number						
Constituent	1	2	3	4	5	6	7
SiO_2	97.9	97.98	97.3	98.65	99.1	98.15	98.2
$Fe_2O_3 + Al_2O_3$	0.9	0.95	1.2	0.3	0.6	1.2	1.35
CaO	0.4	0.25	0.3	0.25	--	--	--
MgO	0.36	0.29	0.3	0.3	Tr.	Tr.	Tr.

Table 2. Analysis of sand from a Pottsville Group sandstone on the western flank of Laurel Hill, in Westmoreland County (from Phalen, 1910).

Constituent	Percent
SiO_2	97.54
Al_2O_3	0.81
Fe_2O_3	0.09
CaO	1.04
MgO	0.06
Na_2O	0.02
K_2O	0.16
H_2O at 100°C	0.03
Ignition loss	0.49

molding occurred along the Stoneycreek River in Ferndale, a southern suburb of Johnstown, where it was being used by a local steel company for a variety of iron castings.

Chemical lime – The Middle Ordovician carbonates of the Trenton and Black River groups in central Pennsylvania contain 90 to 95% $CaCO_3$. Even the less pure dolomitic layers within these carbonates can contain anywhere from 50 to 85% $CaCO_3$ (Butts and others, 1939; Butts, 1945). High-calcium Trenton and Black River limestone was quarried to the north, east, and south of Hollidaysburg in the late 1800s and early 1900s for blast furnace flux in the Pittsburgh area. Many of the Middle Ordovician limestones are of high enough quality to be suitable for other chemical lime uses as well, including agricultural lime. In addition, the Tonoloway and Keyser formations (Figure 18) also contain high-quality limestones that have been used for agricultural lime. The lower part of the Keyser (called "calico rock") is exceptionally pure and can be used for a variety of purposes (Table 3). The Keyser, in fact, was quarried near Hollidaysburg along its outcrop near the base of Brush Mountain for use as flux in Pittsburgh furnaces (Platt, 1881). The "calico rock" is also suitable for paper and glass manufacturing. Unfortunately, the high-calcium portions of the limestone formations typically are thin and interbedded with less pure rock. As a result, these rocks are generally not very economical in quality for chemical grade lime. Within the Allegheny Group (Figure 18), the Johnstown limestone, which is often called the "Johnstown cement bed", is the most valuable limestone. As the name implies, it was once an important source of lime for cement manufacture around Johnstown. An analysis (Table 4) shows, however, that it is not always a high-quality limestone.

Clay and shale products – Claystone and shale from the Rose Hill and Bloomsburg formations (Figure 18) do not have especially good qualities and appear to be useful only as building bricks. Devonian claystone and shale also appear to be mostly useful as structural products. Faill and others (1989) reported that clays leached out of Old Port carbonates are plastic, have good strength, good color, and a good firing range, and are free of any deleterious

Table 3. Chemical analyses of six samples of "calico rock" (lower Keyser Formation limestone) in the vicinity of Hollidaysburg (data from Butts, 1945).

Constituent	Sample Number					
	1	2	3	4	5	6
$CaCO_3$	86.78	96.72	95.09	95.01	2.84	95.22
SiO_2	8.44	1.9	1.55	1.18	1.26	1.86
$MgCO_3$	0.31	1.96	1.1	1.96	1.79	1.4
Al_2O_3	0.81	0.8	1.4	0.53	2.91	0.72
Fe_2O_3	0.09	0.12	0.18	1.1	0.15	0.11

Table 4. Analysis of the Johnstown limestone (Allegheny Group) from near Mineral Point, Cambria County (data from Miller, 1934).

Constituent	Percent
SiO_2	4.97
Al_2O_3	2.57
Fe_2O_3	0.56
MnO	0.48
CaO	48.36
MgO	1.21
SO_3	0.13
Na_2O	0.08
K_2O	0.53
H_2O at 100°C	0.09
Ignition loss	41.17

carbonate. Their potential uses include structural clay products, such as face brick, structural tile, sewer pipe, and stoneware. They are limited only by the size of the residual deposit. Middle and Upper Devonian shales, especially the Marcellus, Mahantango, and Harrell (Figure 18), probably have only building brick potential because of their short workability and low strength; there is also a potential for use as lightweight aggregate. Pennsylvanian underclays commonly have a variety of qualities, making them desirable for a variety of uses. The Mercer flint clay in the Pottsville Group is arguably the most valuable, and it has been mined extensively in the hills along the Little Conemaugh River from South Fork to Mineral Point (Phalen, 1910; Shaw, 1928; Leighton, 1941). It's high silica and aluminum content (Table 5) makes it especially suitable as a high-duty to super-duty refractory clay. Flint clay also occurs associated with the Mahoning coal of the Glenshaw Formation in the hills around Johnstown. The plastic underclay beneath the Lower Kittanning coal in the areas around South Fork and Johnstown has value in the production of building brick and facing brick and, possibly, stoneware. When mixed with the Mercer flint clay, the Lower Kittanning plastic clay produces a high-grade refractory brick (Phalen, 1910). Some of the Allegheny Group shales have potential for lightweight aggregate. Conemaugh Group (lower Glenshaw) shales and claystone within 300 feet of the Upper Freeport coal generally have much use as building brick.

Table 5. Analyses of Mercer flint clay from the vicinity of South Fork (from Phalen, 1910).

Ultimate analysis	**Percent**
SiO_2	44.3
Al_2O_3	38.31
Fe_2O_3	1.4
MnO	0.1
CaO	0.82
MgO	0.59
SO_2	Trace
FeO	0.71
Na_2O	0.22
K_2O	0.17
Water at 100°C	0.75
Ignition loss	12.77
Total	100.14

Fossil Fuels – Coal

Coal has always been King in Pennsylvania, and particularly in Cambria County where coal and steel went hand-in-hand for generations. Sisler (1926) indicated that Cambria County was the fourth largest producing county in Pennsylvania, and was also the largest exporting county for coal.

The coal seams that occur in western Pennsylvania are shown in Figure 20. The principal seams mined in Cambria and Blair Counties include the Brookville, Lower Kittanning, Middle Kittanning, Upper Kittanning, Lower Freeport, and Upper Freeport, all of which are part of the Allegheny Group. The Mercer coal (Pottsville Group) and the Mahoning, Brush Creek (Gallitzin), and Bakerstown seams (Conemaugh Group, Glenshaw Formation) also occur in Cambria County, but have not been significant producers. Table 6 shows reserves as of 1970.

Pottsville Group Coals – Faill and others (1989) indicated

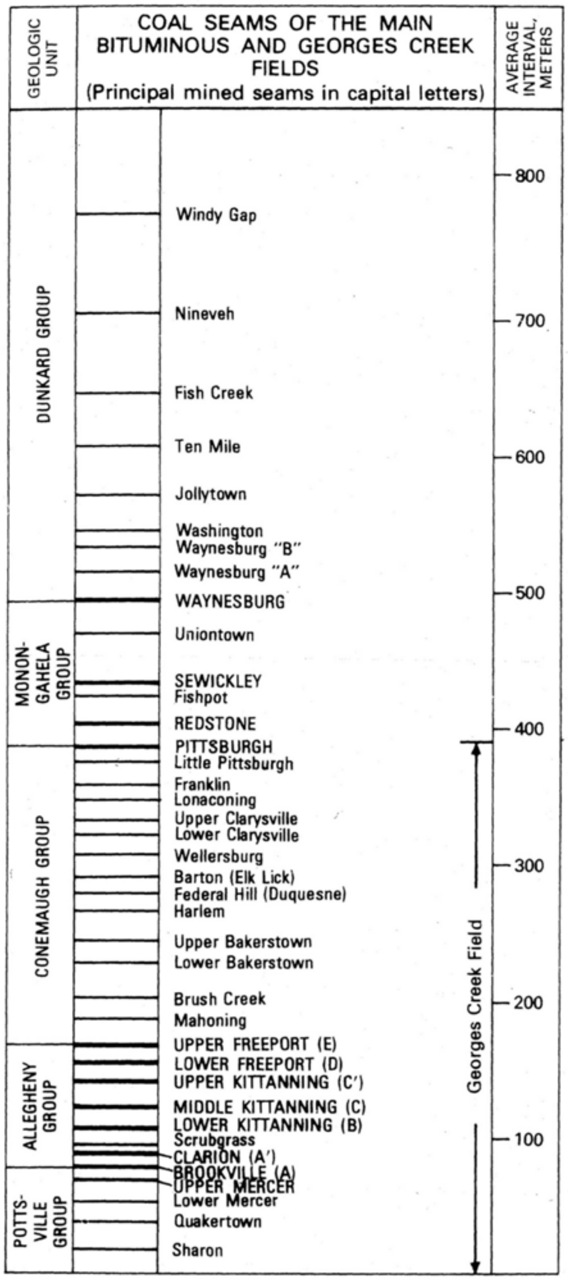


Figure 20. Generalized stratigraphic column of the Pennsylvanian rocks of western Pennsylvania, showing the named coals (from Edmunds and others, 1979).

that a few drill holes in the Altoona area penetrated a coal complex in the Pottsville Group that included several splits or individual coal beds of limited lateral extent. These are called Mercer coal. Sisler 1926) described the Mercer coal as thin and mixed with many partings of bone and shale. It crops out in the deeper parts of the Little Conemaugh River valley between South Fork and Mineral Point, near the axis of the Ebensburg anticline. It has been strip mined, but not extensively (Glover, 1990). Sisler (1926) claims it is of commercial importance here because of its association with the Mercer flint clay underneath. It is unlikely that it is sufficiently thick in the general area to be mined more extensively or more economically.

Allegheny Group Coals – The Brookville coal, although generally thin, occurs over much of the area of the field trip in Cambria County. It has been mined here and there along the eastern edge of Allegheny Mountain and in the gorge of the Little Conemaugh River near South Fork and Mineral Point (Glover, 1990) where it has been found to be almost four feet thick (Sisler, 1926). Glover (1990) showed that it crops out along the Little Conemaugh near the Staple Bend Tunnel as well, but apparently has never been mined there. Sisler (1926) indicated that it gets up to four feet thick just south of Johnstown, but that it contains many shale splits and beds of bone coal and pyrite nodules as to make it mostly uneconomical. The Clarion coal apparently is either absent over much of the area or is too thin to mine. Sisler (1926) described it as being generally less than 12 inches thick. In the vicinity of the field trip it has only been mined, if at all, along the eastern edge of Allegheny Mountain, in association with the Brookville coal (Glover, 1990).

The Lower Kittanning coal is the most persistent and most extensively mined of the coals in the area between Summit and Johnstown. Even as far back as the days of the Portage Railroad the Lower Kittanning was being worked in the vicinity of Inclined Plane No. 6 (Platt, 1881). Faill and others (1989) reported four separate seams within the interval of the Lower

Table 6. Data on coal reserves in Blair and Cambria Counties (data from Edmunds, 1972).

	Blair County	Cambria County
Original in-place reserves[1]	78,515,000	5,383,000,000
Minimum thickness	18 inches	18 inches
Mined and lost tonnage[1]	30,000,000	865,000,000
Strip mine production[2]	2,877,061	27,610,963
Deep mine production[2]	2,415,388	582,158,967
Total mined and lost[2]	35,292,449	1,474,769,930
Total remaining reserves[2]	43,223,551	3,908,230,070

[1]Estimate based on data published in 1943.
[2]As of 1/1/1970.

Kittanning in the Altoona area to the north, with the third from the top being the most extensive and most valuable. Sisler (1926) reported that the Bens Creek coal, a local seam mined on Bens Creek, occurs about 14 feet above the Lower Kittanning. It might be one of the four seams mentioned above. The Middle Kittanning coal is rarely mined in the area of the field trip. This is probably due, as Faill and others (1989) recognized in the Altoona area, to the seam being generally less than 28 inches thick where it is present. They stated that it contained a "bony" layer at the top. Sisler (1926) brushed the Middle Kittanning off as being "unimportant and of poor quality." What little mining has been done has been by stripping (Glover, 1990). The Upper Kittanning coal is persistent in the area, but has been mined extensively only in the southern part of Cambria County (Sisler, 1926; Glover, 1990). Faill and others (1989) stated that it is generally less than 24 inches thick in the Altoona area.

Although the Lower Freeport coal is a good quality coal that was extensively mined in the northern half of the county (Sisler, 1926), is not a persistent seam in the area of the field trip. It has been deep mined only in a 10 or 15 square mile area north of Ehrenfeld and in the hillsides above South Fork (Glover, 1990) where it is about four feet thick (Sisler, 1926). It has been strip mined in limited areas along the eastern edge of Allegheny Mountain, around Cassandra and Bens Creek where it is about two feet thick, and near Johnstown where it is about three feet thick (Sisler, 1926; Glover, 1990). The Upper Freeport, by comparison, is deep and strip mined extensively in the southern part of the county where it is of higher quality and thicker (Sisler, 1926). It generally ranges from 32 to 56 inches thick in Cambria County (Faill and others, 1989).

Conemaugh Group Coals – The Mahoning, Brush Creek (also called Gallitzin in this area), and Lower Bakerstown coals have not been mined within the area of the field trip. Thickness and lateral extent of all are limited. They rarely exceed a few inches in thickness, although the Brush Creek coal at Stop #3 is about 15 inches thick. The Mahoning coal has no value itself, although it is associated with iron ore and underclays that have been mined in the area (Sisler, 1926). In general, these coals are generally considered to have no economic importance.

Oil and Natural Gas

There hasn't been a lot of drilling for oil and natural gas in the area of this field trip. No oil has been found near the report area, unless it is minor amounts of light oil (condensate) associated with natural gas production. The nearest oil fields are about 50 miles to the northwest in Clarion and Jefferson Counties. Rather, all of the nearby exploration has been for gas. Some exploration and development has involved the deeper formations – those below the Tully Limestone (Figure 18), 6,000 to 12,000 feet in depth. Most of the hydrocarbons found in the surrounding counties have come from sandstones of the Upper Devonian Venango, Bradford, and Elk groups approximately 1,000 to 5,000 feet in depth. A number of deep wells have been drilled within the field trip area, particularly on Blue Knob in the southwest corner of Blair County, about 10 miles south of US 22, on Rager Mountain, the local name for Laurel Hill north of the Conemaugh River, and in the vicinity of South Fork.

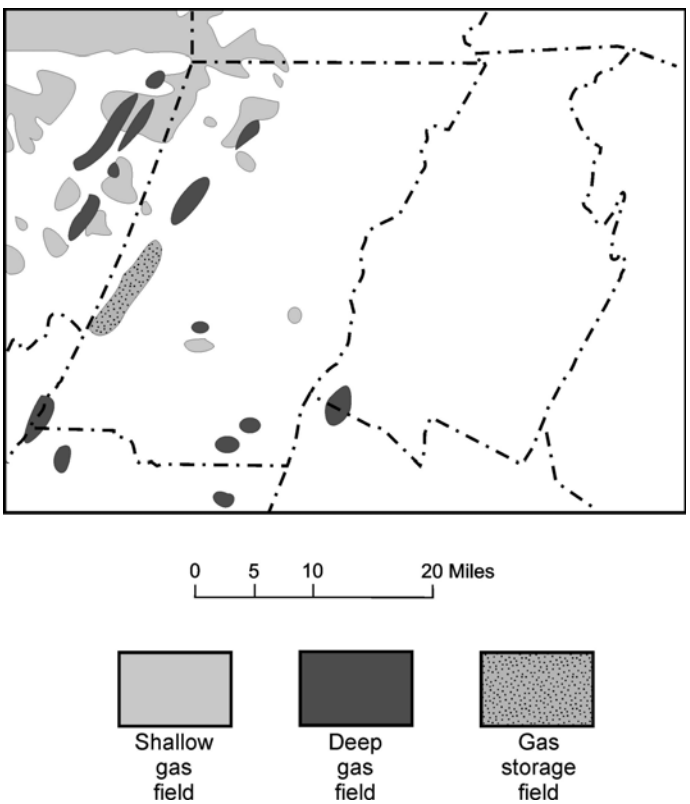


Figure 21. Generalized map of the oil and gas fields and pools in Blair and Cambria Counties (modified from Commonwealth of Pennsylvania, 1993).

Exploration for gas from the Huntersville Chert and Oriskany Sandstone (the Ridgeley Member of the Old Port Formation in central Pennsylvania) has occurred over a wider area than has shallow exploration. Within Blair and Cambria counties virtually all shallow exploration has been confined to the northwestern townships of Cambria County (Figure 21), with only the Salt Fork field (near Johnstown) and one well in Pavia field as exceptions. In contrast, deep exploration has been almost equally divided between the Plateau and the Ridge and Valley. But exploration and discovery do not necessarily equate with one another. Only a few places within the two counties have ever produced much deep gas (Figure 21), and one of those – Rager Mountain – has been in gas storage since 1971, only five years after its discovery.

The prospects for finding additional gas resources in Blair and Cambria counties vary. Cambria stands a better chance than Blair because the highly distorted rocks of the Ridge and Valley were subjected to higher geothermal gradients during the Appalachian orogeny than were those of the Plateau. In fact, in Pennsylvania, the only area of the Ridge and Valley that has been productive is the Broad Top synclinorium in Bedford County.

Briggs and Tatlock (1999) determined that 351 billion cubic feet (bcf) of gas might still be found in the Mississippian and Upper Devonian rocks of Cambria County (calculated from probable, possible, and speculative resource estimates). They estimated that an additional 103 bcf could potentially be found in the Huntersville and Oriskany as well. Blair County had no shallow potential according to their evaluation, but might provide up to 13 bcf from the Oriskany. Other potential targets included the Tuscarora Sandstone and deeper (Cambrian and Ordovician) thrust sheets of the Eastern Overthrust Belt. Briggs and Tatlock also calculated potential coalbed methane resources in Cambria County at 100 bcf.

EDWARD MILLER AND THE GEOLOGY OF THE ALLEGHENY PORTAGE RAILROAD

Introduction

The geology of the Portage Railroad route, and of the area around the railroad, was first explored during the initial surveys for the right-of-way. Early (i.e. pre-Revolutionary War) explorations for mineral resources were limited and very much confined to lead, zinc, iron ore, and coal deposits. Some early settlers made use of coal and iron ore throughout the Johnstown and Hollidaysburg area, but we don't actually know when that first occurred. We do know that coal had been found at least as early as 1769, and probably used at that time. And from the journal of Joshua Gilpin, a businessman from Philadelphia who owned property in western Pennsylvania, we learned that iron mills existed in Johnstown by 1809, and that limestone and aluminum-rich claystones cropped out in the hillsides around the town (Brice, 1989).

The numerous surveys for the Pennsylvania Mainline Canal made prior to 1831 were more concerned with topography than with geology. However, geology undoubtedly became important when the canal tunnel was first proposed, and later when local natural resources became necessary for actually building the railroad.

Edward Miller was the Portage Railroad's Principal Assistant Engineer, and he made quite a name for himself. J. Peter Lesley, Director of the Second Geological Survey of Pennsylvania, called Miller "a Civil Engineer of great ability" (Lesley, 1876, p. 48). Miller later served as Chief Engineer of the Pennsylvania Mainline Canal in 1838-39, became an Associate Engineer of the Pennsylvania Railroad under J. Edgar Thompson in 1847, and eventually established his own company in 1862. Wilson (1899) described Edward Miller & Co. as a "firm whose name was a synonym for ability, energy, integrity and boundless resources."

Edward Miller made the first geological report of the Blair and Cambria County area at the 1835 meeting of the Geological Society of Pennsylvania in Philadelphia (Miller, 1835). Miller was quite busy with his duties, serving in the main office with Principal Engineer Sylvester Welch. In his "leisure" time he examined rock outcrops, gathered specimens, took instrument readings, and speculated on what he found:

> The deep excavations made for the Portage, and the bold ravines and gorges with which the mountain is serrated, afford every opportunity which can be desired for an examination, and I have endeavored to procure results which may be depended upon as accurate, so far as they extend. The dip and bearings of the various strata were ascertained by proper instruments; and the topographical details from correct manuscript maps, and other data belonging to the state, and now in the engineer's office at Johnstown. (Miller, 1835, p. 251)

Miller's Geological Observations

Miller's (1835) contributions included: 1) an outline map of about 200 square miles of what are now Cambria, Blair, Bedford, and Huntingdon counties at a scale of 1:63,360; 2) a cross section along the railroad from the west side of Hollidaysburg (near the present-day Fort Fetter/Gaysport boundary) to the area around Cassandra at Inclined Plane No. 3; and 3) specimens presented to the society that were studied by prominent geologists and paleontologists of the day.

The map showed, among other things, the crest line of Allegheny Mountain, the courses of all the streams, the Portage Railroad right-of-way, and the dip and strike of the strata.

The cross section is by far the most interesting and informative contribution (Plate 2). Miller's original was 10 by 5.5 inches and had a horizontal scale of 1 inch = 3,000 feet and a vertical scale of 1 inch = 300 feet (Plate 2 is a redrafted version, so the scales aren't exact). Miller apologized for the distortion – "Allowance must of course be made for the distortion caused by so great a difference between the scales." (Miller, 1835, p. 252) He divided the cross section into areas numbered 1 to 4 and included detailed information on the types of strata, dip of beds, bed thicknesses, and total thicknesses of each. But Lesley, ever the unsatisfied critic, had only slight praise for the man who later became one of the most distinguished civil engineers in the country:

> Had he not, in obedience to the taste of the eastern geologists, and from habit as a constructing engineer, *exaggerated the vertical scale to eight times that of the horizontal scale,* so as to distort all the dips, this section would be not only of the highest interest as a classic in the science, but would stand us in capital stead in our annual report this year (1874-'5); comparing it, as we then could, with the elaborate section which Mr. Platt has had made for his report on the Clearfield and Jefferson district, along the Snow Shoe and Bellefonte railroad. Mr. Platt will give Mr. Miller's text in his report on Cambria and Somerset counties, (Report of Progress in 1875,); but the section as Mr. Miller published it is worthless . . . (Lesley, 1876, p. 49)

Miller took dips and strikes along the whole railroad and found that the dip direction did not vary greatly from "W.N.W". He also found that the dips between Inclined Plane No. 3 and Inclined Plane No. 6 did not vary much from 3.5^{o}, but that eastward from Inclined Plane No. 6 the dip gradually increased to 23^{o} at Hollidaysburg.

Miller's section No. 1 (on the left side of Plate 2) included what we now map as Rose Hill (Lower Silurian) to the top of the Onondaga Limestone (Figure 18). He described it as being alternating shale and limestone with the shale predominant. He noted that one limestone bed (at *b* in Plate 2 – the Onondaga) was about 50 feet thick but wasn't very fossiliferous except where it had been weathered. The other limestones (probably Wills Creek and Tonoloway) contained beds as thin as one inch and were fossiliferous.

Section No. 2 included the Hamilton Group through the lower half of the Catskill Formation (Figure 18), measured at 5,710 feet thick. Although predominantly shale, the number and thickness of sandstones increased westward (Brallier to Scherr to Foreknobs), and many of the beds contained marine fossils. The western edge of section No. 2 contained the red shales of the lower Catskill.

Section No. 3 included the upper Catskill Formation and at least a portion of the Rockwell Formation, with alternating shale and micaceous sandstone (predominant) measured at 3,370 feet. The color of the rocks changed gradually from red to green traveling westward. Miller noted that the sandstones could be easily quarried in thin slabs of large size.

Miller called section No. 4 "The coal measures." He determined that the starting point for this sequence of rocks was at point *e* (on Plate 2) ". . . because there is at this place a decided change in the character of the rocks, and we find, for the first time, sandstone containing vegetable remains of a kind which, I believe, is never found except in the immediate vicinity of coal." (Miller, 1835, p. 253-254) In fact, he started the "coal measures" too low in the section. The plant fossils he found probably occurred in the upper Rockwell or, perhaps, the Burgoon. Swartz (1965), Inners (1987) and Faill and others (1989) all described plant remains in this portion of the section. Lesley (1876, p. 49) in his typical style of criticizing virtually everyone and everything he didn't agree with, stated, ". . . his fourth, or Coal Measure division . . . commences as low as No. X ["Pocono" = upper Rockwell and Burgoon], no doubt to the satisfaction of our western geologists . . ." This was a rather acerbic critique of the fellow professionals, to say the least.

Section No. 4 also contained a quartzose limestone bed about 30 feet thick (*f* in Plate 2). This is the Loyalhanna Formation, which we will examine at Stop 4 on the field trip. The first true coal appeared at the top of Inclined Plane No. 7 (*g* on Plate 2), probably the Mercer coal (Pottsville Group), or, less likely, a well-developed seam in the Mississippian Mauch Chunk Formation. It was only a few inches thick, and since Incline Plane No. 7 passes through the Burgoon, Loyalhanna, and Mauch Chunk (Berg and Dodge, 1981), it probably was found upslope from the plane, rather on it. Miller also found iron ore a little above the coal.

> From this place, we find the usual strata which form the coal measures of England. Bituminous coal, shale, sandstone, clay and iron stone, in many varieties and numerous alternations. The coal strata are numerous, from one inch to six feet in thickness, and very various in quality; differing materially sometimes in the same stratum. I have designated [on Plate 2] all that I am acquainted with, which occur within the limits of the section, by black lines. Some of those shown are too small to be worked advantageously, and there are probably several which have escaped observation. (Miller, 1835, p. 254)

He also found that iron stone (probably siderite nodules) was abundant and reminded him of that found in the coal measures of England.

He found only three limestone beds cropping out in section No. 4: 1) the Loyalhanna, mentioned above; 2) a light blue limestone in a bed three feet thick along Bens Creek near Cassandra (Inclined Plane 3), which is probably the Upper Freeport limestone; and 3) a limestone in the bed of Limestone Run, a small creek between Lilly and Cassandra. He assumed it was the same limestone as the one in Bens Creek.

Sandstone varied both in appearance and quality, with outcrops showing a lot of jointing, probably due to valley stress relief (Ferguson, 1967). Miller found the best quarries typically occurred within stream valleys where large blocks lay strewn upon the ground. Considering the amount of sandstone needed for "sleepers" and construction of foundations, bridges, and culverts, it was extremely important to make note of this.

Miller's cross section contained letter designations used to reference the various strata and the specimens collected in them. He stated that rare minerals would not be found along the railroad, and that his specimens were valuable only to illustrate the geology of the Allegheny Mountains, but "... alas! the suite of specimens which he sent ... to the museum of the society in 1833, cannot now, perhaps, be recovered." (Lesley, 1876, p. 49) Some of these specimens, if not all, probably reside in a variety of collections around the state, but no one knows where. This valuable historical collection appears to have been lost for all time. But at least we have published reports with illustrations that can help us deduce what Miller provided to science.

Miller's Collected Specimens

The first paper concerning specimens collected by Miller was a report on some plant fossils by Richard Harlan, a well-known physician and paleobotanist of the early 1800s. These came from the surface of a coal bed at the top of Allegheny Mountain (Harlan, 1835). He claimed Miller told him that marine fossils occurred both above and below the plant fossils, but how this is possible I don't know. Miller might have meant that marine fossils occur both above and below the coal bed, referring to separate marine zones in the Allegheny Group. Lesley (1876) interpreted Harlan's statement to mean "layers of rock holding marine shells lay over and under the shales with plants". Harlan described only three plants from the Portage Railroad, *Pecopteris obsoleta*, *Pecopteris milleri* (named in honor of Edward Miller), and an unnamed species of *Neuropteris* (also, he included an illustration and discussion of *Lycopodiolites dichotomus* Sternberg from the anthracite fields of Schuylkill County, Pennsylvania). None of these names is recognized by modern paleobotanists (e. g. Darrah, 1969).

Timothy A. Conrad published the second paper devoted to Miller's specimens. These were all marine shells collected at the top of Inclined Plane No. 3 (see Stop 7 for a complete discussion). New species included *Stylifer primogenia*, *Turbo tabulatus*, *Turbo insectus*, *Productus confragosus*, and *Pecten armigerus*. Only two of these, *Strobeus primogenius* and *Worthenia tabulata*, are recognized today as valid species. Conrad (1835) also discussed the occurrence of other shells that he considered conspecific with European forms, and what they mean.

Thomas G. Clemson, who had been with the Royal School of Mines in Paris, France, and later became superintendent of the Flemington Mines in New Jersey (Lesley, 1876), performed chemical analyses of mineral specimens supplied by Miller. These specimens included coal and siderite. Clemson (1835) expounded profusely on the importance of these specimens to the iron industry in the United States. Unfortunately, his analyses are greatly lacking by today's standards. Lesley (1876, p. 50), ever quick to criticize, stated that the analyses "... show how crude were the ideas of chemists then, respecting the demands which a future coal trade would make on their art; not a word about sulphur, phosphorus, potash, soda, magnesia, - merely volatile matter, 15; ashes. 8; carbon, 77 = 100." But Lesley says nothing of Clemson's physical descriptions of his specimens, which, in fact, are quite good:

> This coal [from the Portage Railroad] is of a brilliant black. Its structure is foliated in two senses, and conchoidal or uneven in another. Very fragile. The pieces assume a pseudo regular or trapezoidal appearance. The whole mass is zoned, and sometimes divided by thin layers of a fibrous black coal resembling charcoal. Its luster is resplendent, with an occasional tinge of iridescence; in a

cross sense it is black, velvety and dead. Its powder is black, inclined to brown. It ignites with facility, and burns with a bright, long, fuliginous flame, giving much smoke. Is very fat, and by distillation furnishes a light voluminous coke, much bitumen, water and gas, the latter product free from ammonia . . . Ashes free from carbonate of lime, very little iron, colour grey. (Clemson, 1835, p. 272)

An additional description of iron ore:

> Specimens of siderose or, lithoid spathic iron accompanied the other substances. These ores are found nodules of different sizes, varying in form; they are known frequently as kidney ores; when broken, have a blue brown colour, conchoidal fracture. Sometimes lamellar crystals of the sulphuret of zinc are found on breaking a mass. When reduced to powder, its colour is grey; submitted to heat, develops the odour of bitumen.
>
> The ore is composed as follows:

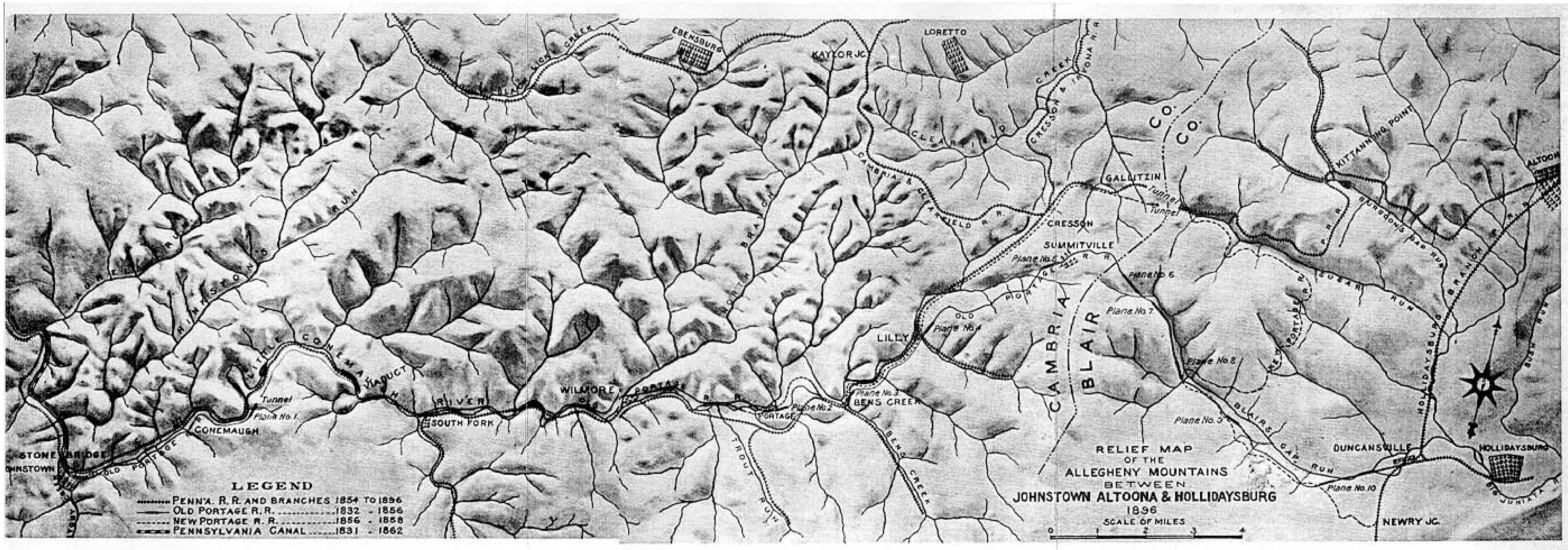
Carbonate of protoxide of iron (protoxide of iron 49.42, carbonic acid 30.94)	80.36
Sand and argile,	12.60
Carbonate of lime,	1.00
Carbonate of manganese, carbonate of magnesia, bitumen and water,	6.04
	100.00

> One hundred parts of this ore, then, yield 38.2 of metallic iron. (Clemson, 1835, p. 274)

He also described a specimen of mineral charcoal, which Miller frequently found disseminated in some of the coal beds. This particular specimen consisted of 66% carbon, 27% "cinders", and 7% volatile matter.

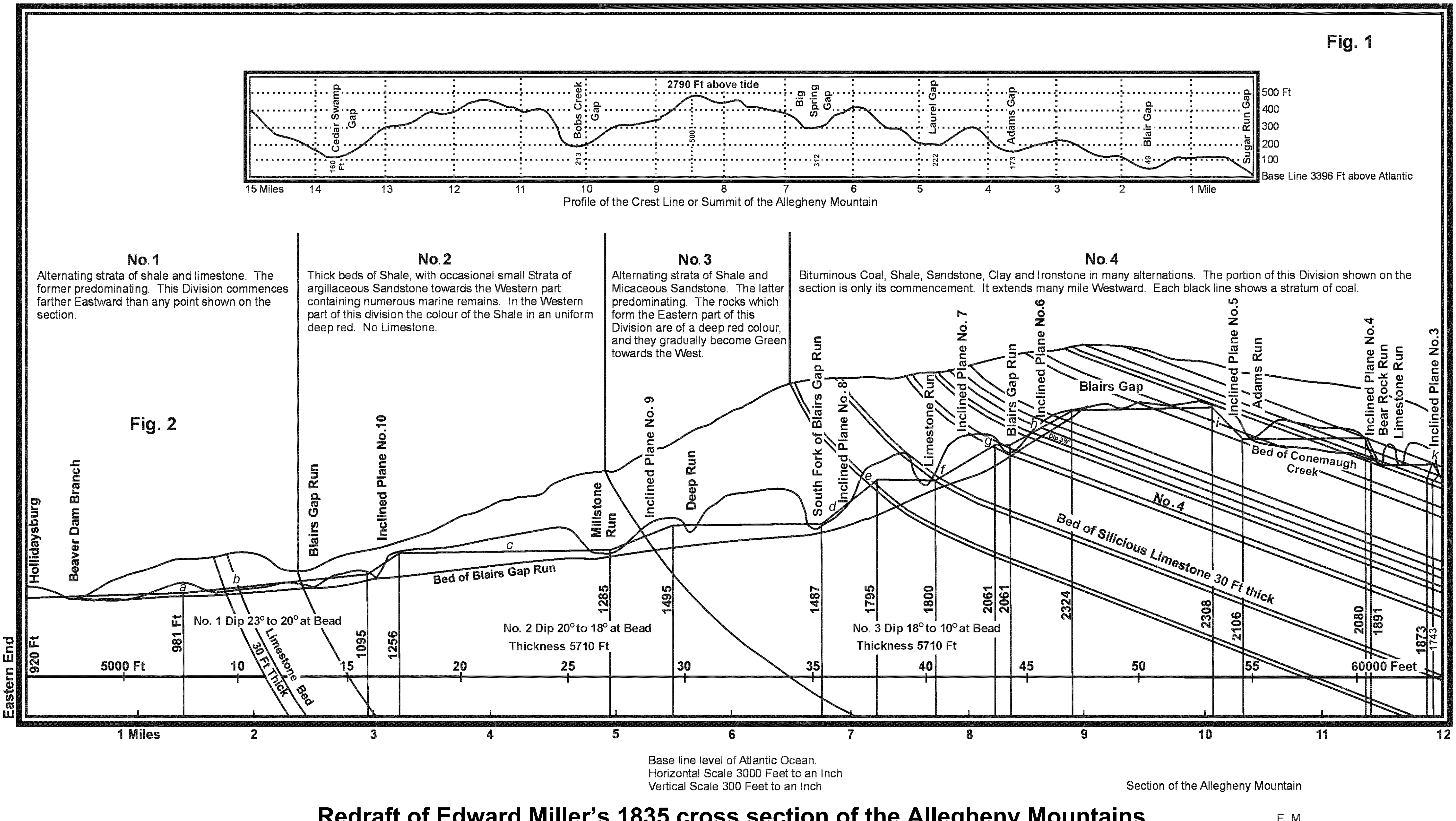
As Brice (1989, p. 125) stated, "These few short descriptions serve to illustrate that there was geologic exploration taking place before the official geological survey . . ." which began in 1836.

Plate 1



Relief map of the Allegheny Mountains showing the routes of the Old Allegheny Portage Railroad, the New Allegheny Portage Railroad, and the Pennsylvania Railroad (from Shank, 1975).

Plate 2



Redraft of Edward Miller's 1835 cross section of the Allegheny Mountains

ROAD LOG AND STOP DESCRIPTIONS

Mileage Int.	Mileage Cum.	Description
0.00	0.00	Leave Monroeville Park and Ride bus shelter behind Monroeville Mall. Turn left and head toward the Monroeville Expo Mart.
0.40	0.40	Bear right onto Mall Boulevard and get into the right hand lane.
0.20	0.60	Bear right on the entrance ramp to Business US 22 East.
0.05	0.65	Stop sign. Enter traffic on Business US 22 East.
1.80	2.45	Intersection with PA 48. Continue straight ahead on Business 22 East.
0.05	2.50	Entrance to the Pennsylvania Turnpike, I-76 on right. Continue straight ahead on Business 22 East.
0.10	2.60	US 22 East merges with Business US 22 East on the right.
1.20	3.80	Outcrop of the Ames Limestone (Conemaugh Group, Glenshaw Formation) in the hillside to the left. This is a very fossiliferous locality.
0.65	4.45	Exit to PA 286 on right. Continue straight ahead on US 22 East.
0.90	5.35	Landslides are very common along this stretch of US 22 because bedrock is the unstable claystone of the Pittsburgh red beds (Conemaugh Group, Glenshaw Formation).
0.50	5.85	Intersection with Old William Penn Highway (old US 22) at the traffic light. The Brush Creek marine zone, both limestone and shale (Conemaugh Group, Glenshaw Formation), are exposed in the highwall of an excavation for a storage area just beyond the building on the left.
0.05	5.90	Enter Westmoreland County and the Borough of Murrysville.
0.30	6.20	The historical marker on the right pays tribute to the great Murrysville Gas Well, drilled in 1878. Michael and Obediah Haymaker drilled the great Haymaker well on the Remaley farm near the axis of the Murrysville anticline. The well "blew in" at 34 million cubic feet of gas per day, the largest gas well ever drilled up to that time. There was a great explosion and fire extended 100 feet into the air. The gas burned for 1½ years before being brought under control. Upon viewing the well, George Westinghouse suggested that the gas could be piped to Pittsburgh to be used in place of coal in the mills. This was the start of the gas industry in the United States.
1.45	7.65	The shopping center on the left is significant because, at the time the land was being excavated in the early 1970s, the Brush Creek limestone and shale were exposed for a limited time. Enough time for a local man to find some remarkably preserved specimens of an ophiuroid (brittle-star) new to science. In fact, it was the first Pennsylvanian ophiuroid described from Pennsylvania.
1.55	9.20	Outcrop of remarkably thick section of the Clarksburg limestone (Conemaugh Group, Casselman Formation) on the right.
0.40	9.60	Outcrop of the Pittsburgh coal (Monongahela Group, Pittsburgh Formation) on the left. The coal was deep mined here at one time, as evidenced by several pieces of mine timber that can be seen sticking out

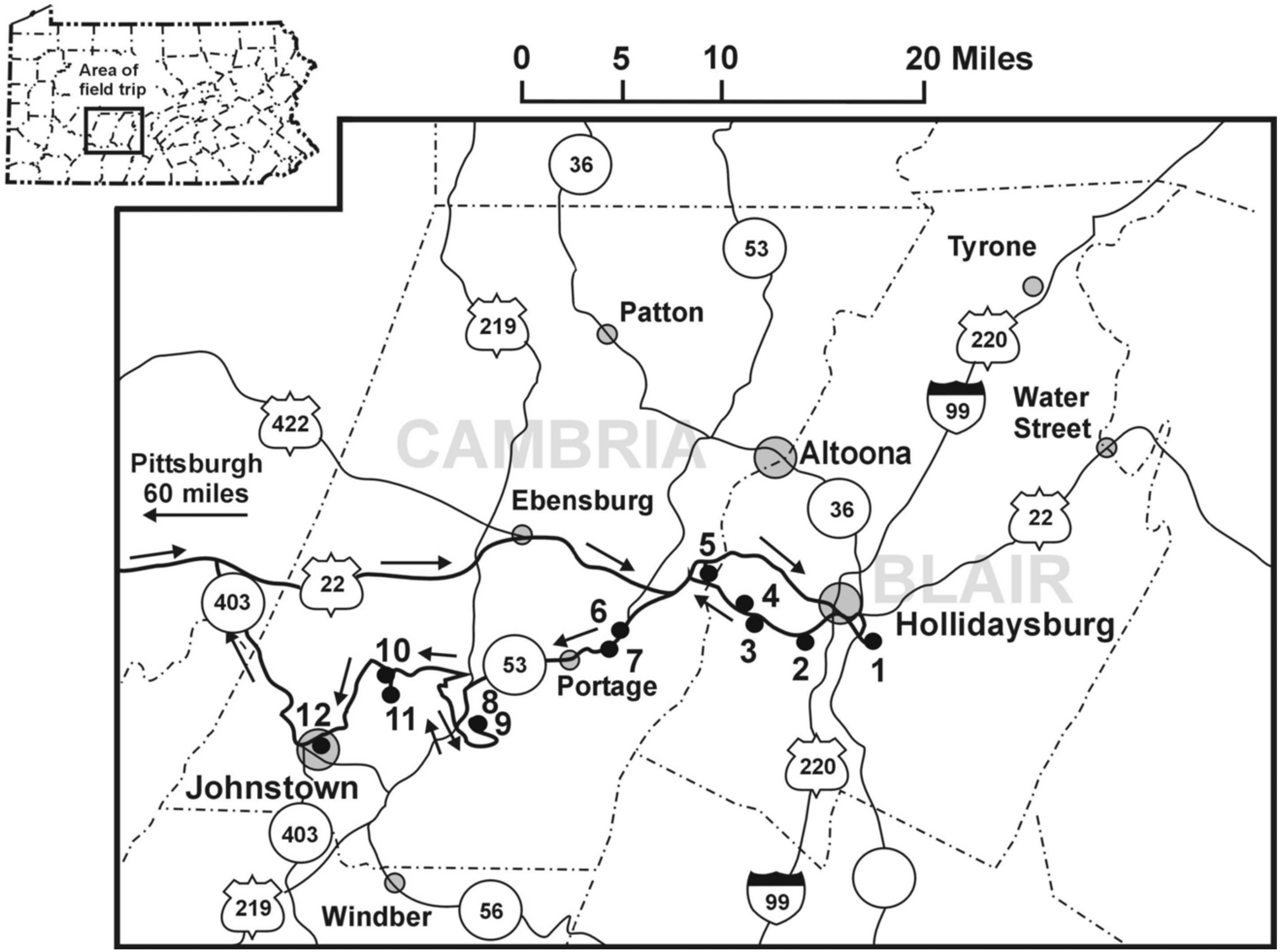


Figure 22. Map showing the route of the field trip and the locations of the stops.

		of the hillside.
3.55	13.15	Entrance to PA 66, Pennsylvania Turnpike extension on the right. Continue straight ahead on US 22 East.
0.15	13.30	Cross over PA 66.
0.70	14.00	Dominion Transmission Company's Oakford Storage Facility on the left. This is one of the largest gas storage operations in Pennsylvania, e ncompassing more than 13,000 acres in Westmoreland County (Follador, 1995).
2.00	16.00	Intersection with PA 819 in Five Points. Continue straight ahead on US 22 East.
4.35	20.35	Intersection with US 119. Continue straight ahead on US 22 East and US 119 North.
1.15	21.50	Intersection with PA 981 in New Alexandria. Continue straight ahead on US 22 East and US 119 North.
4.50	26.00	Intersection with PA 982. Continue straight ahead on US 22 East and US 119 North.
3.00	29.00	Enter the Borough of Blairsville.
0.20	29.20	Exit to Truck Route PA 217 on the right. Continue straight ahead on US 22 East and US 119 North.
0.90	30.10	Cross the Conemaugh River and enter Indiana County.
0.30	30.40	Exit to PA 217 on right. Continue straight ahead on US 22 East and US 119 North.
0.95	31.35	Coal mine works on the left is the I-22 Processing, Inc. Rt. 22 tipple. I-22 Processing is based in Latrobe, PA.
1.50	32.85	Exit to US 119 North toward Indiana and Punxsutawney on the right. Continue straight ahead on US 22 East.
0.45	33.30	We are climbing the northwestern flank of Chestnut Ridge anticline. Roadcuts on left and right expose channel sandstones and floodplain deposits of the Birmingham member (Conemaugh Group, Casselman Formation).
0.15	33.45	Good view of the Homer City Power Plant in the distance on the left. The tallest stack, at 371 feet tall, is considered the third tallest smoke stack in the world.
3.10	36.55	Crest of Chestnut Ridge, elevation 2,030 feet.
0.15	36.70	Good view of Laurel Hill anticline in the distance on the right.
0.50	37.20	Smoke stacks and steam from the cooling towers at the Seward Power Plant in the distance on the right.
2.20	39.40	Exit to PA 259 on the right. Continue straight ahead on US 22 East.
1.60	41.00	Enter the Village of Clyde.
2.45	43.45	Exit to PA 56 on the right. Continue straight ahead on US 22 East.
0.95	44.40	Exit to PA 403 on right. Continue straight on US 22 East.
0.50	44.90	Good view of the Conemaugh River gorge through Laurel Hill on the right.
1.20	46.10	Enter the Village of Gas Center.
1.40	47.50	The ridge straight ahead is Laurel Hill.
0.90	48.40	Enter Cambria County.

1.40	49.80	The roadcut on the right exposes sandstones and red beds of the Mississippian Mauch Chunk Formation.
0.70	50.50	Crest of Laurel Hill, elevation 2,440 feet.
1.10	51.60	Enter the Village of Chickaree.
1.20	52.80	East-dipping beds of Mahoning sandstone (Conemaugh Group, Glenshaw Formation) on the left.
1.45	54.25	Exit to PA 271 on the right. Continue straight ahead on US 22 East.
4.25	58.50	Exit to US 219 South toward Johnstown and Somerset on the right. Continue straight ahead on US 22 East and US 219 North.
0.30	58.80	Exit to US 219 North to DuBois and Bradford on the right. Continue straight ahead on US 22 East.
0.40	59.20	Intersection with PA 160. Continue straight ahead on US 22 East.
0.65	59.85	Exit to Ebensburg on the right. Continue straight ahead on US 22 East.
0.85	60.70	Good view of Ebensburg on the left.
1.30	62.00	Exit to Old US 22 to Ebensburg and Loretto on the right. Continue straight ahead on US 22 East.
0.90	62.90	Good view of Old US 22 on the right.
1.70	64.60	Cross over Old US 22.
0.20	64.80	Exit to PA 164 on the right. Continue straight ahead on US 22 East.
3.30	68.10	Cross the Conrail Railroad tracks. These tracks follow the path of the Pennsylvania Railroad, which was built in the 1850s.
0.10	68.20	Exit to PA 53 on the right. Continue straight ahead on US 22 East.
1.90	70.10	Exit to Old US 22 and the Village of Summit on the right. Continue straight ahead on US 22 East.
0.30	70.40	Cross under Old US 22.
1.30	71.70	Exit to Gallitzin and Allegheny Portage Railroad National Historical Site on the right. We will visit the Historical Site later on this field trip (see Stop 5). Continue straight ahead on US 22 East.
0.50	72.20	Enter Blair County.
0.10	72.30	Roadcuts on the left expose dark gray shale and sandstone in the lower Glenshaw Formation (Conemaugh Group), probably a shaly section of the Mahoning sandstone.
0.50	72.80	Coal refuse on the right from strip mines in the Lower Kittanning, Lower Freeport, and Upper Freeport coal seams located along the eastern slope of Allegheny Mountain (Glover, 1990). We are descending the front of Allegheny Mountain toward the Ridge and Valley. The valley occupied by US 22 and the CSX (Conrail) Railroad tracks (to the left) is Sugar Run Gap. US 22 crosses the New Allegheny Portage Railroad right-of-way near here.
1.90	74.70	Roadcuts on the right expose massive sandstones of the Lower Mississippian and Upper Devonian Rockwell Formation.
1.80	76.50	Roadcuts on the left expose small patches of red beds of the Upper Devonian Catskill Formation.
0.70	77.20	Roadcuts on the left expose shales and sandstones of the Upper Devonian Foreknobs Formation.
1.45	78.65	Bear right onto exit ramp to US 22 East and PA 764 South.

0.40	79.05	Pass under the expressway to US 220 and I-99.
0.35	79.40	Get into the right lane and follow US 22 East and PA 764 South toward Duncansville and Hollidaysburg.
0.40	79.80	Merge with traffic.
1.50	81.30	Turn left onto US 22 East toward Duncansville and Hollidaysburg.
0.10	81.40	Enter the Borough of Duncansville.
1.15	82.55	Exit to US 220 North on the left. Continue straight ahead on US 22 East.
0.85	83.40	Enter the Borough of Hollidaysburg.
0.30	83.70	Cross the Beaverdam Branch of the Juniata River. Continue straight ahead on US 22 East.
0.10	83.80	Across the railroad yards on the right is a NeoVictorian building with a grassy playground. This is the Hollidaysburg Canal Basin Park and Museum located in the Gaysport section of the Borough.
0.30	84.10	Turn right at the traffic light onto PA 36 South.
0.10	84.20	Cross the Conrail Railroad tracks.
0.40	84.60	Cross the Juniata River.
0.20	84.80	Turn left onto Chimney Rocks Road.
0.35	85.15	Turn left onto Clapper Lane at the sign for Chimney Rocks Park.
0.10	85.25	Notice the abandoned lime kiln on the left.
0.05	85.30	Turn right into the lower parking area and park the vehicles.

STOP 1. CHIMNEY ROCKS PARK: KEYSER FORMATION AND FIELD TRIP OVERVIEW

This stop (Figure 22) affords a spectacular view of Hollidaysburg, the Juniata River, and Allegheny Mountain. It is also a historical site with a geological twist (or, perhaps, a geological site with a historical twist).

Introduction

Chimney Rocks perch on the northwest edge of Catfish Ridge, a low ridge supported by durable carbonates in the Upper Silurian and Lower Devonian. The old Chimney Rocks quarry (Figure 23), and Chimney Rocks themselves (Figure 24), provide dramatic panoramic views of Hollidaysburg and the surrounding area, including the Juniata River and Allegheny Mountain. Chimney Rocks (Butts, 1945 called them "Tower Rocks") include a series of tall, rugged pillars or "chimneys" of eroded Keyser Formation limestone (Upper Silurian and Lower Devonian) standing in relief. Chimney Rocks can be seen

Figure 23. Photograph of Chimney Rocks Park, showing the old quarry walls of Keyser limestone.

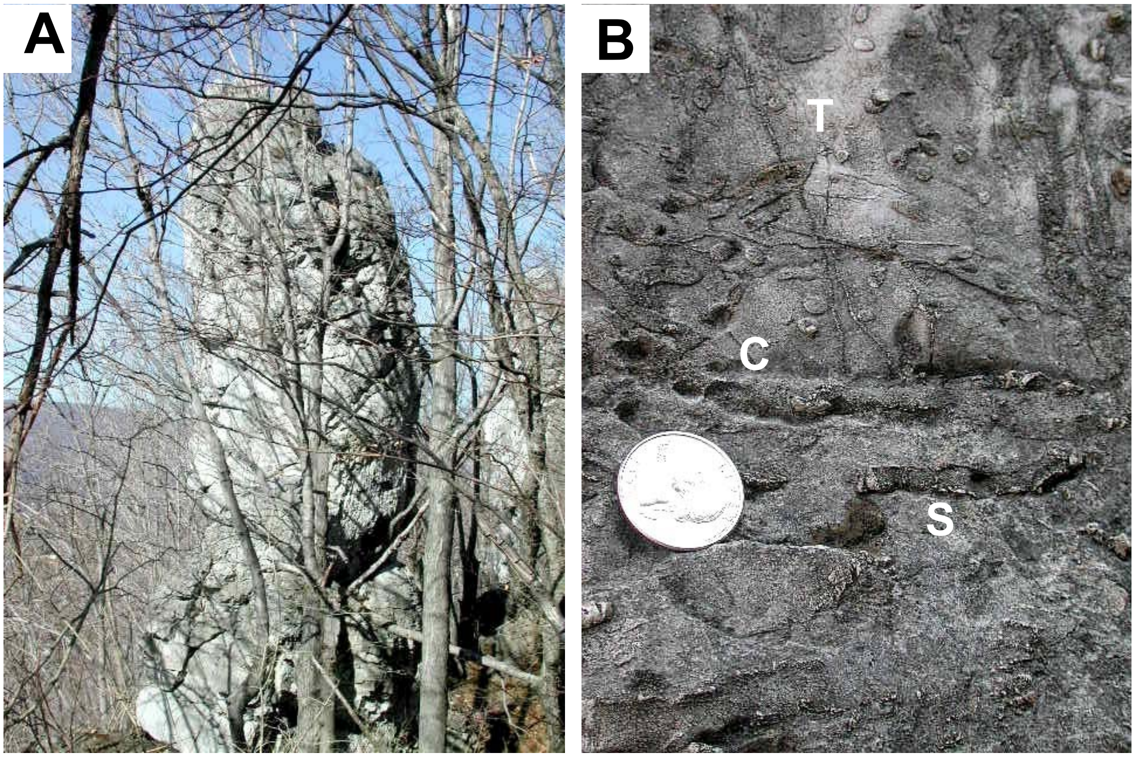


Figure 24. Photographs of the Keyser limestone at Chimney Rocks. A - One of the limestone pillars partially obscured by trees. B - The limestone is very fossiliferous. S—stromatoporoid, C—crinoid columnal, T—trace fossil (horizontal burrow).

from as far away as US 22 on Allegheny Mountain. According to legend, the Oneida Indians, who lived in this area, used Chimney Rocks as a vantage for signal fires, alerting villages in the Juniata River valley of impending events. The Chief's Seat in particular, a rock pad atop the pillars, is supposed to be the site where the Chief of the tribe would sit in this area and view his world below.

The Chimney Rock Limestone Company operated the quarry, mining the high grade "calico" rock at the base of the Keyser Formation (see below), which ranges in thickness from 20 to 25 feet (Miller, 1934). The limestone was burned for lime in the kiln seen just below the parking lots. Other limestone layers provided crushed stone used for aggregate and road metal. O'Neill (1964) indicated the quarry, which was still active in 1962, had the potential to provide riprap and railroad ballast as well.

The Blair County Historical Society obtained this land and deeded about 100 acres to the municipality of Hollidaysburg late in 1994. With the assistance of state funding, the borough created this park, which includes the old quarry and Chimney Rocks, as part of the Allegheny Ridge State Heritage Park. Development of the public access area began in 1998 and is still being funded by the state and local governments. The old quarry area has been cleaned up and turned into a grassy park. Be aware of the signs restricting access to the quarry walls. If you would like to view the rock close up, try the unrestricted outcrop near the upper parking lot. Although much can be seen from the Lower viewing area at the quarry, the best viewing is from a platform built on the Chief's Seat at the top of the ridge. A relatively short, though somewhat strenuous (for those not in good physical shape) hike up the hillside is necessary to get to Chimney Rocks.

Geology

As mentioned above, Chimney Rocks is a series of prominent pillars (Figure 24A) of eroded Keyser Formation. Ulrich (1911) named the formation for a series of gray, fossiliferous, crystalline to nodular limestone beds exposed in quarries on the eastern outskirts of the town of Keyser, Mineral County, West Virginia. Lithologically, the Keyser consists of a basal fossiliferous limestone, overlain by nodular limestone, coarse-grained limestone, and shaly and laminated limestone. O'Neill (1964) stated that the Keyser ranges from 88 to 202 feet in thickness. Faill and others (1989) determined the thickness of the Keyser in Blair County to be about 100 feet.

Woodward (1943) indicated that, throughout central Pennsylvania, the Keyser can be separated into two major units – a lower nodular limestone and an upper series of relatively shaly beds. He noted that chert is present, as are zones (he called them "reefs") of stromatoporoids, which mainly occur above the nodular zone. A very pure, massive, crinoidal limestone commonly occurs at the base of the formation.

Actually, the lower half of the formation contains several different types of limestone. The basal layer, which Butts (1945) called the "calico rock", comprises about 30 feet of fine-grained, medium-gray, fossiliferous limestone containing irregular patches ("eyes") of white, pink, or yellow calcite. These beds often contain crinoids, corals, brachiopods, and columnar and mound-like algal stromatolites, and stromatoporoids (Figure 24B). The fossils can be seen in weathered and etched exposures where they stand out against the matrix. Above the basal limestone is a sequence, approximately seven feet thick, of coarse-grained, nodular limestone and shaly laminated limestone. The nodular limestone is fossiliferous, medium-gray calcisiltite that contains isolated dense nodules up to baseball size surrounded by very thin shaly limestone layers. Fossils include corals, brachiopods, bryozoans, and crinoid debris.

Overlying the lower half of the formation are about 20 feet of fragmental, medium-gray, thin- to medium-bedded, fine- to very coarse-grained, fossiliferous calcarenite. Fossils consist mostly of abundant crinoid columnals. The limestone contains interbeds of calcisiltite. Above this are 20 feet of fine-grained, fossiliferous calcisiltites exhibiting undulatory bedding. Woodward's (1943) shaly beds occur near the top of the sequence. Fossils in this sequence include horn corals, halysitid corals, brachiopods, bryozoans, and stromatolites.

The upper 50 feet of the formation alternates between stromatolitic, dark-gray calcisiltite and medium-gray, argillaceous, fossiliferous calcilutite and calcisiltite. Near the top of this sequence are six or seven feet of fine-grained dolostone. The uppermost beds are gray calcisiltites containing mud cracks, crossbedding, and fossils.

Head (1969) divided the Keyser into ten lithofacies: 1) laminated; 2) banded; 3) stromatoporoid biostrome; 4) coral-stromatoporoid bioherm; 5) coral-stromatoporoid calcarenite; 6) calcilutite-calcisiltite; 7) calcarenite; 8) nodular; 9) terrigenous shale; and 10) terrigenous sandstone. He also erected three members. The lower Byers Island Limestone Member consists of 93 feet (at the type locality) of generally thin bedded and nodular limestone (lithofacies 8) with a few beds of massive nodular limestone, and six feet of stromatoporoid biostrome (lithofacies 3) near the middle. The middle Jersey Shore Limestone Member consists of 35 feet (at the type locality) of highly fossiliferous, thin bedded to massive limestone, ranging from calcilutites to calcarenites (lithofacies 5 through 7), with abundant biostromes (lithofacies 3 and 4), and some interbedded dolostones. The upper LaVale Limestone Member consists of 34.8 feet (at the type locality) of, primarily, sparsely fossiliferous calcilutites, calcisiltites, dololutites, and dolosiltites (lithofacies 6) with a very thin (1 to 2 inches) calcarenite (lithofacies 7) and an 8 inch thick stromotoporoid biostrome (lithofacies 3).

If you have a chance to examine the Keyser Formation, either in the old quarry or at Chimney Rocks, see if you can determine which of Head's (1969) lithofacies and member descriptions best represents the strata you are seeing.

ROCKHOUNDS TAKE NOTE: this is a municipal park. Although I'm sure the city fathers of Hollidaysburg would just as soon not have their park carted away by overly enthusiastic geologists, it probably won't hurt to take a small specimen with you when you leave. PLEASE – DO NOT HAMMER ON THE CHIMNEY ROCKS THEMSELVES. Try to confine your collecting to the area around the quarry, and if at all possible, pick up a piece lying on the ground. The fewer signs of hammering, the better.

History of The Juniata River Canal and Hollidaysburg Canal Basin

Frankstown, which lies northeast of Hollidaysburg along the Juniata River*, about two miles east of Hollidaysburg, was a far more important town in 1830 than was Hollidaysburg. Hollidaysburg, established in 1796, was essentially a tavern stop on the Huntingdon, Cambria and Indiana Turnpike, too far out in the frontier area of Pennsylvania to be considered of any significance. That all changed as the result of one reluctant farmer.

Frankstown was the original selection for the western terminus of the Juniata River Canal. It lies at the confluence of the Little Juniata and Frankstown branches of the Juniata River and was a natural location for a canal basin. The canal engineers decided the best place for the basin was on the farm of Jacob Wertz, but, for whatever reason, he refused their offer of $10,000 for the land. Perhaps he was greatly attached to the land, or didn't like progress, or was holding out for a larger sum. Whatever the reason, Wertz refused to sell. Then John Blair, who lived at Blair's Gap (present day Foot of Ten – see mile 92.80) at the foot of Allegheny Mountain, used his influence as a member of the Pennsylvania Legislature to have the basin relocated to Hollidaysburg. Many people argued that there wasn't enough water in the Beaverdam Branch at Hollidaysburg to operate the canal. Supposedly, another legislator, John Williamson, remarked, ". . . the eyes of the boatmen would be blinded with the dust which would rise from the bottom of the basin." (Jacobs, 1945, p. 160)

Despite the criticism, in 1831 the Canal Commission awarded Nicholas Hewit of Hollidaysburg the contract for the work between Hollidaysburg and Huntingdon. Within the space of five years Hollidaysburg grew from a tiny frontier village with a population of about 76 to an inland seaport with a population of 3,000. Hundreds of laborers and builders, stone masons and engineers were recruited from the surrounding countryside and from distant towns to dig the canal, build the railroad, and cut the stone for the numerous related structures. And all because a farmer wouldn't sell his land!

With the opening of the Pennsylvania Mainline Canal, Hollidaysburg developed into an important inland shipping terminal and transfer point. The town became a major commercial gateway between the Atlantic seaboard and the western frontier (Figure 25). It became the county seat of Blair County in 1846. Altoona soon became more important commercially, thanks to the Pennsylvania Railroad, which established a major base of operations there in the 1850s. However, Hollidaysburg continued to play an important role through most of the 20th

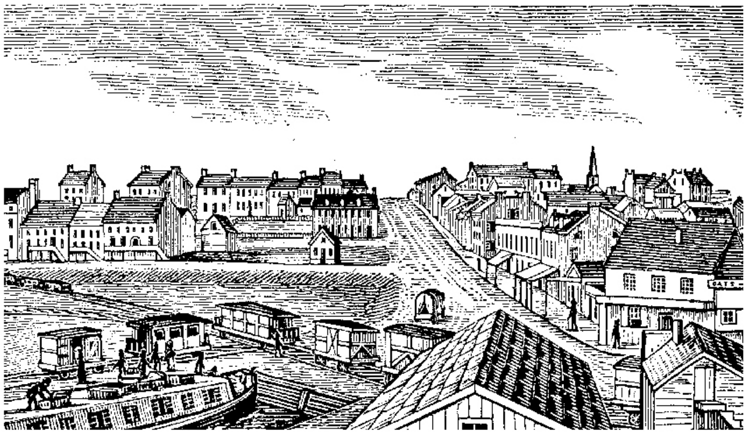


Figure 25. Old lithograph of Hollidaysburg, circa 1840, showing the canal basin and Portage Railroad in the lower left quarter (from Baumgardner and Hoenstine, 1952).

century as a commercial, industrial, and governmental center for the region (Borough of Hollidaysburg, 2001). Many of the canal-era buildings still survive in Hollidaysburg, providing interesting studies for historical architecture buffs.

The Hollidaysburg Canal Basin consisted of three interconnected basins (Jacobs, 1945). The upper basin, which was situated along Bedford Street, essentially where the Canal Basin Park is now located (Figure 26), was about 1,100 feet long and 120 feet wide. The main basin, which was 1,695 feet long, 120 feet wide, and six feet deep, extended along South Juniata Street from Montgomery Street to Jones Street, approximately where PA 36 crosses the Conrail yards (Figure 26). A 600-foot canal segment connected these two basins with a lock to a smaller basin located just below what is now Juniata Street. The third pool, located near the intersection of US 22 and Allegheny Street, acted as a feeder reservoir for the other two. Canal boats proceeded into the upper basin along the Juniata River. At the lower basin, the boats were unloaded either onto the Portage Railroad or the various wharves that were located along the basin margin (Figure 26). A railroad track actually ran down into the canal basin in order to facilitate the easy transferal of boats to the railroad (Jacobs, 1945). The south side of the canal basin, about where the cloverleaf on PA 36 is now, was occupied by three boatyards where boats were built and repaired. The canal weigh lock was situated at the foot of Jones Street, and the weighmaster lived in the brick house on the northwest corner of Juniata and Jones Streets (Jacobs, 1945) (Figure 26). A boat was

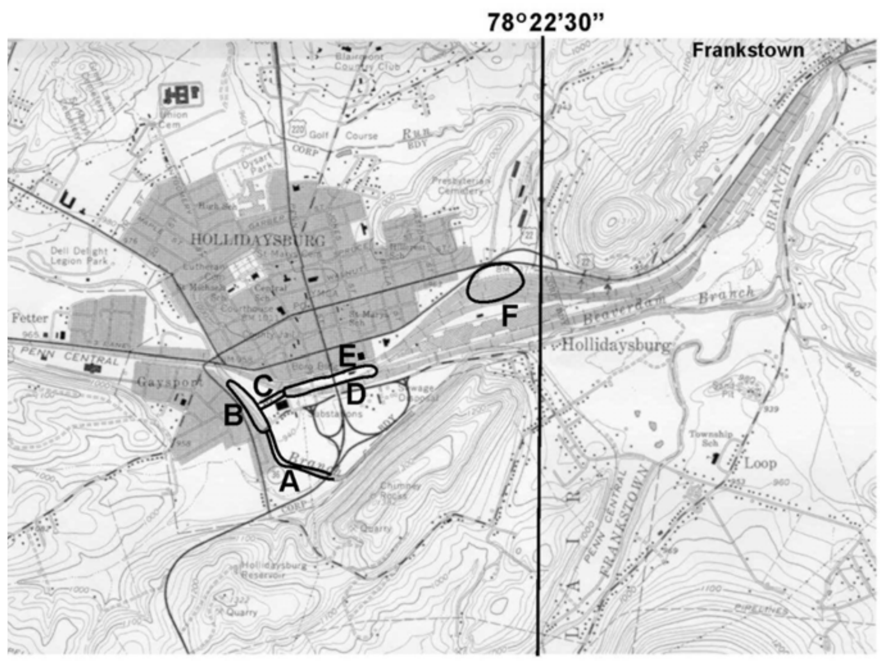


Figure 26. Topographic map of a portion of the Hollidaysburg and Frankstown 7½ -minute quadrangles, showing the approximate locations of the Hollidaysburg canal features. A – Juniata canal. B – Main canal basin. C – Connecting segment. D – Upper basin. E – Weigh lock and weighmaster's house. F – Feeder basin.

weighed by running it into a lock at either end and fastening the lock gates to make them as water-tight as possible. Then the water was drawn off through a channel leading to a waste weir. At that point, the boat would be resting on large scales where it could be weighed as accurately as it could be on land. The section adjacent to the canal was a typical seaport, with businesses servicing the canal workers and travelers.

Juniata canal boats could carry 60 to 80 tons of freight and/or people. The typical boat was about 80 feet long, 14 feet wide and 7½ feet deep. The horses and mules that pulled the boats along the canal were stabled in the bow of the boats, the cabin and bunks were in the stern, and the cargo was stored in the hold in the center. A new Juniata boat cost about $1,000 (Jacobs, 1945).

The port of Hollidaysburg was a very busy place, with one boat arriving every 20 minutes on average. The number of passengers and the amount of freight coming into Hollidaysburg required the building of boat slips and docks, large warehouses and freight forwarding houses, and hotels and taverns that catered to boatmen and travelers alike. At the height of the canal's popularity there were five large forwarding warehouses on the north bank of the basin. In the early days of the canal, the boats were unloaded at the docks and the freight and passengers transferred to railroad cars for the trip across the mountains. The invention of sectional canal boats (Figure 12) improved this process immeasurably by allowing the boat sections to be hauled out of the water, disassembled, and placed on trucks (railroad undercarriages).

After the trip to Johnstown the boat sections were reassembled and continued down the canal to Pittsburgh.

Freight shipped separately typically was loaded onto boxcars (similar to the passenger car shown in Figure 10) by brute strength. Railroad workers often worked all night loading cars. And then, in the morning, they traveled by rail the 36 miles over the Allegheny Mountains to Johnstown where they then had to unload the cars. At times they must have worked 72 hours with their only rest, if you can call it that, being the ride to Johnstown. One canal boat loaded with freight could fill as many as 12 boxcars, making two trains of five or six cars each. (Jacobs, 1945).

Passengers and freight weren't the only things the canal brought to Hollidaysburg. Many cases of ague, euphoniously called the "Juniata Jigs" by some newspaper wags, arrived during warm weather; and when it took a strong grip on a man "he shook 'til his teeth rattled." Hollidaysburg's apothecaries kept busy selling quinine and bitters as cures for the disease (Jacobs, 1945).

During the apex of its operation, the canal basin and railroad handled between 215 million and 255 million tons of freight annually, bringing about $115,000 per year to the state coffers (Jacobs, 1945). Tens of thousands of people passed through Hollidaysburg during the canal era. By the late 1850s, however, the canal system was obsolete.

Although the Pennsylvania Railroad bought the Pennsylvania Mainline Canal system in 1857 and dismantled the Portage Railroad, the Hollidaysburg canal basin continued in limited operation, serving the needs of area farmers and manufacturers. Eventually, the last canal boat, the "William A. Fluke," left Hollidaysburg on April 22,1872 (Jacobs, 1945). The canal between Hollidaysburg and Williamsburg was abandoned that year. Necessary repairs had been largely ignored, and frequent flooding caused extensive damage to the infrastructure. The feeder reservoir for the canal basin, for example, had been a beautiful, 500-acre body of water that became a favorite resort for fishermen. The farmers in the river valley below Hollidaysburg feared that the dam would eventually break and drown them (Johnson, 1889).

When the canal was abandoned in 1872, the Pennsylvania Railroad cut the breast of the dam to prevent the water from overflowing and flooding the adjoining land. On February 10, 1882 the dam finally gave way and the water flowed into the Juniata River. Wagonloads of stranded fish were gathered and sold in Hollidaysburg (Jacobs, 1945). The dam was never repaired. Since that time the land been used for other purposes.

The canal bed over much of its distance became the right-of-way for a branch of the Pennsylvania Railroad between Hollidaysburg and Huntingdon. In Hollidaysburg the canal basin was filed with cinders; it is now part of the rail yard south and east of the borough. East of Huntingdon the canal was so greatly damaged by a flood in 1889 that it also was abandoned. Traces of the once busy waterway can be seen still at several places in the Juniata River valley, east of Hollidaysburg.

In the late 1980's plans for restoration of the canal and canal basin in Hollidaysburg soon began to take shape. After several years of research and fund-raising, the Borough began to study creating a linear park, connecting the Legion Park on North Juniata Street to the original site of the Canal Basin. Eventually, the plan encompassed Chimney Rocks. The newly built Canal Basin Park lies along the Beaverdam Branch of the Juniata River in the Gaysport section of Hollidaysburg. For anyone interested in studying the canal basin in further detail, Canal Basin Park has a museum (fee charged), which, when completed, will illustrate the transfer of canal boats from the canal to the Allegheny Portage Railroad.

Return to PA 36.

0.50	85.80	Continue straight through the intersection onto Bedford Street in the Gaysport section of Hollidaysburg.
0.35	86.15	Between the buildings on the right you can see Canal Basin Park. This was supposed to be finished in the summer of 2001, but it seems they are done with it yet.
0.20	86.35	Bear right at the stop sign at the intersection with Newry Street without stopping.
0.05	86.40	At the traffic light, turn left onto US 22. Be careful of traffic exiting Hollidaysburg ahead and to the right.
0.55	86.95	This area of Hollidaysburg is called Fort Fetter on the Hollidaysburg topographic map. The actual Fort Fetter, built near here in 1777, was crucial to the survival of the residents of the area around Hollidaysburg. It was not an official military fort, but a blockhouse built by nearby settlers as a gathering place for protection of families during times of trouble (Pennsylvania Archaeological Council, 2000). It lay farther west in this section of Pennsylvania than any other fort. During the Revolutionary War, local militia and rangers manned the garrison and attempted to keep the hostile Seneca Indians, who used the nearby Kittanning War Path, at bay. The only incident considered of historical importance occurred on June 3, 1781, when a troop of British soldiers and about 100 Seneca Indians from the Genesee River valley in New York entered the area and ambushed a detachment of Bedford County and Cumberland County militia from the fort near Frankstown, east of Hollidaysburg. Eleven members of the militia were killed, five were

wounded, and ten, including Captain John Boyd, were taken prisoner. Despite the decisive British/Indian victory, they never again attempted an incursion into the area (Smith, 1999).

The Blair County Historical Society placed a bronze marker along Sixth Avenue Road between Eldorado and Duncansville in 1922.

0.20	87.15	Traffic light at intersection with Patchway Road. Between here and Duncansville the road crosses the Wills Creek and Tonoloway formations (Silurian). Notice the open flats bordering the highway through this area. This is the result of the slow rate the Juniata River has taken in cutting down though Lock Mountain (Willard, 1939). There are quarries in the Helderberg carbonates at various places around the valley, but for the most part the Devonian bedrock barely shows until we begin to approach the Allegheny Front.
0.10	87.25	Outcrop on the left of Wills Creek Formation.
0.55	87.80	Entering the Borough of Duncansville. Duncansville was settled in the 1830s as a result of the Allegheny Portage Railroad. The level expanse of the Blair Gap Run floodplain was ideal for farmland and for a variety of industrial pursuits that were within easy reach of the Huntingdon, Cambria and Indiana Turnpike, the Allegheny Portage Railroad, and the Pennsylvania Mainline Canal. Plots were laid out in 1830 by Samuel Duncan and Jacob Walters, with the Duncan property, named Duncansville, on the west side of the north-flowing Blair Gap Run and the Walters property, named Walterstown, on the east side (Robertson, 1945). Rivalry and confusion between the two villages, separated only by a small bridge over the small stream, finally caused Duncan and Walters to decide on a single name for the area. A flip of a coin decided it, and Walterstown was annexed to Duncansville.

Duncansville received the nicknamed "Irontown" in the 1800s because of its important forges, mills, and foundries. The most important mill began as a gristmill, but became a forge before plans were completed. Eventually it became a rolling mill. The plant was enlarged and made more productive in the 1880s, but by the early 1900s it had been dismantled. Duncansville also had a thriving brick plant constructed in the 1850s that lasted until 1907. The plant probably used local mudrocks for raw materials.

With the closing of the iron and brick plants in the early 1900s, Duncansville's claims to notoriety would have to wait for Tom Lindsey to come along with his semi. Duncansville is his home. In 2000, Lindsey became the Big Rigs World Champion (the "sport" of modified semi truck pulling) for the fourth year. The last I heard, he was striving to make it five.

0.90	88.70	Intersection with PA 764 (formerly US 220). We are on the Huntingdon, Cambria and Indiana Turnpike (now Old Rt. 22). For many years, the route from Huntingdon and Hollidaysburg west over the Allegheny Mountains was little more than a footpath. Because of new settlements established in the late 1700s (Loretto and Ebensburg in particular) just

west of the mountains, however, it became important to improve the trail for settlers who were beginning to head in that direction. Through the efforts of the settlers residing along this route, especially John Blair, who had his homestead in what is now Foot of Ten on Blair Gap Run (see mile 92.80), the Pennsylvania Legislature authorized, and partially funded, the improvements of the trail that would allow wagons to cross the mountain. Blair and his sons were very influential in developing many transportation facilities in the area, including the Huntindon, Cambria and Indiana Turnpike, the Pennsylvania Mainline Canal, and the Allegheny Portage Railroad (Hoenstine, 1952). Blair's most illustrious son was John Blair (1766-1832). Blair County is named for him, as is Blairsville in Indiana County (built on the canal). When the turnpike became chartered in 1815, John Blair was elected president. Through his efforts, the development and extension of the turnpike over the mountain was vigorously persued.

Continue straight on Old US 22.

0.20	88.90	Bear left across the highway onto Foot of Ten Road.
0.50	89.40	Turn left onto Mill Street.
0.60	90.00	Cross Blair Run.
0.65	90.65	Outcrop of Brallier Formation shales and siltstones on the left.
0.70	91.35	Turn into dirt access road on the right.

STOP 2. INCLINED PLANE NO. 10.

The area we've been travelling through is called the village of Foot of Ten. Inclined Plane No. 10 is back in the woods to the south of the village. After we park the vehicles at the entrance to the access road, we will walk the 100 or so feet back through the woods to view the plane.

Inclined Plane No. 10 (Figure 27) stretched 2,295.61 feet up the mountain to overcome 180.52 feet of elevation (Wilson, 1897). The portion of the inclined plane we will view is fill material rather than excavated hillside. As you will notice, the lower end of the inclined plane is missing. It apparently fell victim to the need for building space along the floodplain of Blair Run in Foot of Ten (or, perhaps, to the ravages of Blair Run flash floods – the storm of May 31, 1889 caused considerable damage throughout central Pennsylvania). Our vantage allows us the opportunity to view a stone culvert built over a small tributary of Blair Run (Figure 28). This sandstone block construction gives us our first clue to the quality workmanship of early 19th century stonemasons. The

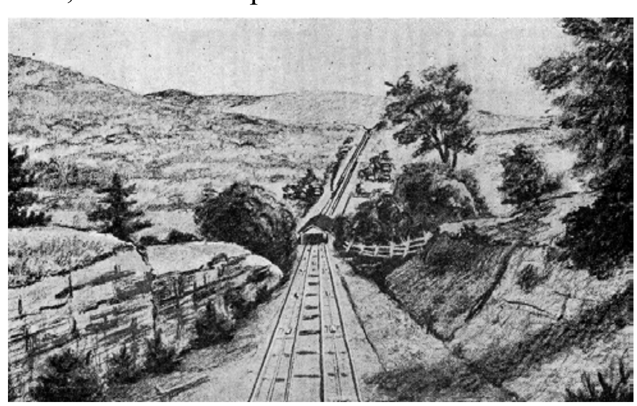


Figure 27. Illustration of Inclined Plane 10 looking east with Foot of Ten to the left and Duncansville in the distance (from Baumgardner and Hoenstine, 1952). John Blair's homestead is located near this vantage point. The building at the bottom of the plane is the hitching shed.

Figure 28. Photograph of the culvert beneath Inclined Plane No. 10 near Foot of Ten.

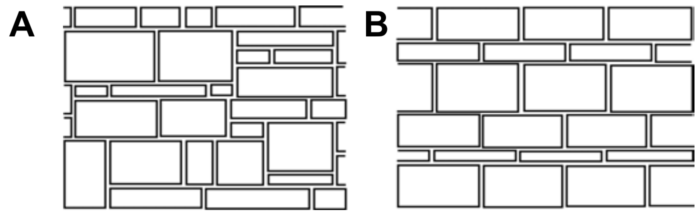


Figure 29. The differences in ashlar (cut, rectangular) stone. A - Random ashlar, made from cut stones that fit together but are not in rows. B - Coursed ashlar, made from cut stones that fit together and are placed in rows (course refers to a row of stones).

National Park Service has stabilized and added erosion control systems to the structure, which is constructed of cut coursed ashlar stone (Figure 29) in a radiating arch. Reconstruction required retention of all the original stone work, installation of new culvert liner pipes and flared end sections, a mat slope protection system, and the reestatablishment of the top stones to their original orientation (National Park Service, 1997). Since railroad construction crews used local material for the railroad, it is safe to say that the fill material is probably Brallier Formation shales and siltstone (the bedrock in this area). The stone for the culvert might be from the Foreknobs or Scherr Formation, which form bedrock a mile or two to the west. It is also possible they quarried the Mahoning sandstone (Conemaugh Group, Glenshaw Formation) at the top of Allegheny Mountain and hauled it the down the Huntingdon, Cambria and Indiana Turnpike.

Bedrock Geology

As mentioned above, the bedrock at Inclined Plane No. 10 is Late Devonian Brallier Formation. This formation consists of interbedded shale, silty shale, and siltstone of variable thickness, which are relatively easy to dig and make a good source of road material and random fill (Geyer and Wilshusen, 1982). Faill and others (1989), using measured outcrops, calculated a thickness for the Brallier between 2,400 to 2,800 feet in the Altoona area. Gas wells just west of Hollidaysburg, however, indicate the thickness is actually between 1,200 and 1,800 ft. The Brallier consists mostly of medium- to dark-gray, generally homogeneous, variably silty and only sparsely fossiliferous shales (constituting 50 to 80% of the formation according to Faill and others, 1989), and light- to medium-gray siltstones. Lundegard and others, 1980 characterized the Brallier as a series of turbidites having sharp planar bases and undulatory upper contacts deposited in submarine fans. The rock sequences are better explained as submarine ramp turbidites, however (Harper, 1999). The Brallier grades upward into the Scherr Formation which is distinguished by the presence of scattered beds of sandstone. An outcrop of the Brallier can be seen on the east side of Mill Road just before the entrance to the Incline Plane No. 10 access.

Return to Foot of Ten Road.

0.85 92.20 Turn left onto Foot of Ten Road.

0.60 92.80 The house on the right at the historical marker is the Blair Homestead (Figure 30), home of John Blair. He was a member of the Pennsylvania Legislature and was extremely influential in getting the Allegheny Portage Railroad built. Blair County is named for him.

Figure 30. Photograph of the Blair Homestead. Thomas Blair built the front part of the house in 1785, and his famous son John built the stone part in 1827.

0.85 93.65 Intersection with Valley Forge Road. If you turn left and follow the road up the hill to the south, you will cross the right-of-way of both the Old and New Portage Railroads.

Continue straight ahead on Foot of Ten Road.

0.15 93.80 Intersection with Old US 22. Bear left and head west.

0.95 94.75 To the left (southwest), just above the valley of Deep Run, Inclined Plane No. 9 (Figure 31) rose through 189.5 feet of elevation over a plane 2,720.8 feet long (Wilson, 1897). Bedrock is Late Devonian Catskill Formation, a series of interbedded red and green sandstones, siltstones, and shales typically considered to be continental in origin.

0.10 94.85 Access road to Plane Nine reservoir and dam on the left.

0.20 95.05 Catskill red beds are exposed in the cut made for the water tank on the right.

0.15 95.20 Plane Nine reservoir and dam on the left. The engine house of Inclined Plane No. 9 was approximately directly across Blair Run Gap from the foot of the dam. Plane Nine Dam is an earthen dam that was built in 1907. Geotechnical investigations by Hamel and others (1993) provided a framework for improvements that included construction of a floodwall and spillway capable of accommodating a

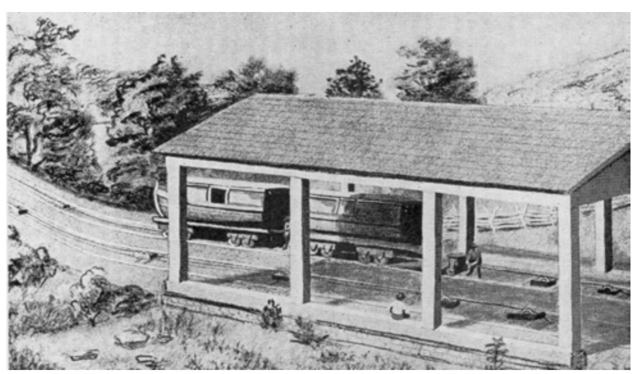


Figure 31. Illustration of Inclined Plane 9 showing the hitching shed where the cables were attached to the cars (from Baumgardner and Hoenstine, 1952).

		"Probable Maximum Flood". It is expected that the improvements will last well into the 21st Century (Hamel and others, 1993).
0.90	96.10	To the right is a state game commission parking lot which allows access to the New Portage Railroad right-of-way. There are outcrops of Upper Devonian and Lower Mississippian Rockwell Formation sandstones in the parking lot.
0.10	96.20	Passing under the Muleshoe Curve Bridge (Figure 32). The Muleshoe Curve is part of the old right-of-way for the New Portage Railroad, which was built to replace the inclined planes of the Old Portage Railroad. The New Portage Railroad only operated a few years before being bought by the Pennsylvania Railroad in 1857 and dismantled. The present Muleshoe Curve Bridge was built by the Pennsylvania Railroad in 1904 when it reopened the New Portage Railroad route from Hollidaysburg to Gallitzin. The track was finally removed in 1984 and plans are under way to use the right-of-way as a rail-trail.
0.05	96.25	Pull over to the left side of the road, just past the Muleshoe Curve Bridge, and park.

Figure 32. Photograph of the Muleshoe Curve Bridge, formerly used by the New Portage Railroad and the Pennsylvania Railroad.

STOP 3. INCLINED PLANE NO. 8.

Although there is plenty of room to park and walk around, EXTREME CAUTION should be taken to avoid walking too close to Old US 22. This is a two-lane road treated by the motorists as a four-lane expressway. **WATCH OUT FOR SPEEDING VEHICLES**.

We will cross the barrier and walk into the woods to have a brief look at Inclined Plane No. 8 (Figures 33 and 34), which is still very much in evidence. The inclined plane is accessible by foot trail and affords the opportunity for anyone with a transit and stadia to determine just how much of an incline the plane presented. It was paved at one time as can be seen by the asphalt that still covers much of the plane. This was the longest of the inclined planes, climbing 3,116.92 feet up the mountain in order to overcome 307.6 feet of elevation (Wilson, 1897). The National Park Service found the remains of the foundation for the engine house at the upper end of the plane and has plans to at least partially restore it.

Geology

The bedrock of Inclined Plane No. 8 consists of the variegated sandstones and shales of

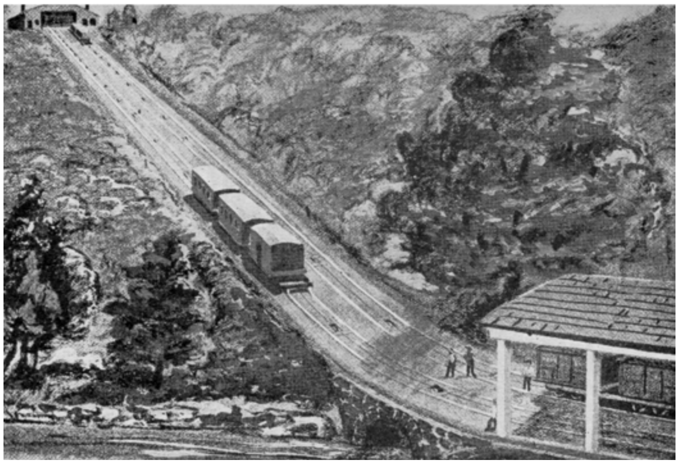


Figure 33. Illustration of Inclined Plane 8 adjacent to what is now the Old US Route 22 at the Muleshoe Curve (from Baumgardner and Hoenstine, 1952). This was the longest inclined plane on the railroad.

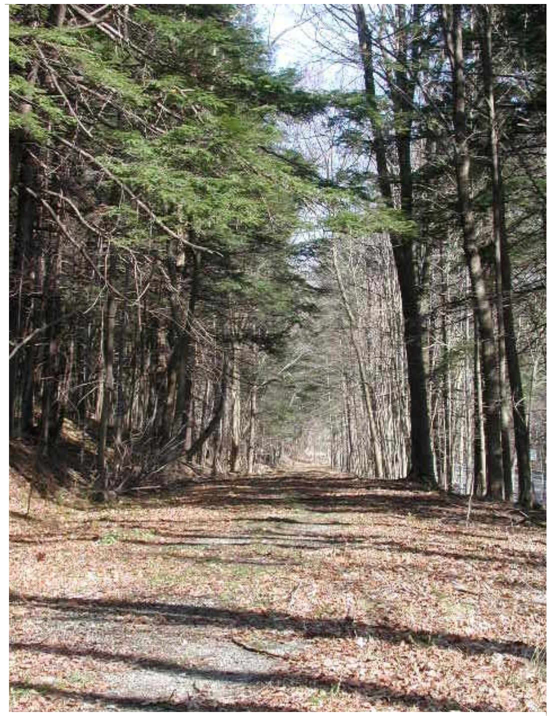


Figure 34. Photograph of Incline Plane No. 8 as it appears today.

the Late Devonian-Early Mississippian Rockwell Formation. This is the sequence of rocks between the Burgoon Sandstone and the Catskill Formation red beds that, for many years, was called Pocono Formation in western Pennsylvania (e.g. Butts, 1945). One formally named member, the Riddlesburg Shale, occurs near the middle of the Rockwell along the Allegheny front and in the Broad Top basin in Bedford County. In many places the top of the Rockwell contains a sequence of red shales called the Patton red beds. The Devonian-Mississippian systemic boundary is conformable within the Rockwell Formation. Based on palynology, the boundary lies approximately in the middle of the formation (Streel and Traverse, 1978), just below the Riddlesburg Shale.

The Rockwell Formation consists primarily of light olive-gray or olive-gray, fine- to very fine-grained, very thin- to (rarely) very thick-bedded, micaceous, subgraywacke sandstone, with subordinate olive-gray to light olive-gray, very thin- to medium-bedded siltstone and shale (Faill and others, 1989). Both trough and planar cross bedding are common, as are carbonized fossil plant fragments, shale clasts, and brown limonitic spots (Inners, 1987; Faill and others, 1989). The formation is about 300 ft thick. Probably the best and most complete exposure in the area is along the Conrail Railroad line from Horseshoe Curve in Burgoon Run Gap to US 22 in Sugar Run Gap (Inners, 1987).

Sevon (1985) speculated that deposition of the Upper Devonian portion of the Rockwell occurred after the Catskill Delta had stopped prograding westward. The predominantly gray, fine- to medium-grained sandstones in this portion of the section formed in nearshore and coastal plain environments at the same time as the transgressive, often pebbly barrier bar and shelf sandstones of western Pennsylvania (Hundred-Foot, Gantz, Murrysville, and other drillers' sands). Sevon (1985) also speculated that Rockwell sediments derived by stream cannibalization of the Catskill alluvial plain, rather than from erosion of the Appalachian highlands to the east. Inners (1987) considered the upper part of the Rockwell to have formed in shallow marine and coastal alluvial-plain environments. Thick, predominantly fluvial sandstones formed in meandering streams, and the purplish red and green mudstones formed in

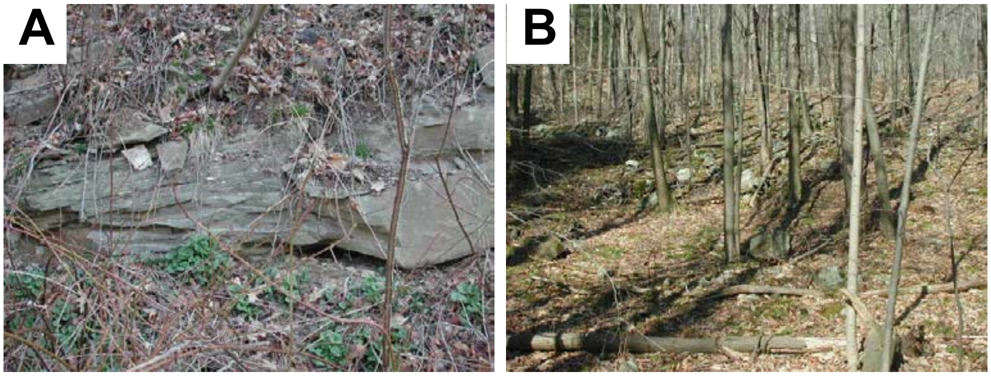


Figure 35. Photographs of Rockwell Formation. A. Trough cross bedding in sandstone at the Pennsylvania Game Commission parking lot just east of Muleshoe Curve Bridge. B. Boulder colluvium at Inclined Plane No. 8.

tidal-flat and/or alluvial overbank deposits (Inners, 1987).

Most of the exposures of Rockwell at Inclined Plane No. 8 consist of sandstone boulder colluvium (Figure 35A), with a few true outcrops on the steep hillside. The few outcrops looked at briefly, both here and at the Game Commission parking lot on the east side of Muleshoe Curve Bridge, exhibit well developed trough cross bedding (Figure 35B). According to Geyer and Wilshusen (1982) the Rockwell is difficult to excavate, but that cut-slope stability is good except where bedding and joints intersect and the rock is steeply dipping toward the cut. More than likely the Rockwell sandstones were used for the foundation of the engine house, "sleepers" on the railroad, and stonework in the culverts constructed along the railroad. It is a good source of fill and embankment facing.

Return to the vehicles and CAREFULLY continue uphill on Old US 22.

0.15	96.40	You can see the Incline Plane No. 8 right of way on the left.
0.50	96.90	Old US 22 splits into two two-lane highways on either side of Blair Run.
0.60	97.50	Entrance to Gallitzin Spring on the left. The source of water here is Mississippian Burgoon Sandstone. The spring, like the town and state park to the north, is named for Rev. Dr. Demetrius Augustine Gallitzin, a Catholic priest. Father Gallitzin rode his horse up through the wilderness from Conewago (near Harrisburg), the first Catholic settlement in Pennsylvania, to the McGuire Settlement near present day Loretto, a journey of about 130 miles. His trek had one purpose: to minister to a Protestant woman named Mrs. Burgoon. Father Gallitzin had been a young Russian prince, born in 1770, who was sent to the United States in 1792 to go to school. He left the Greek Church and became a zealous Roman Catholic Missionary (Roberts, 1878), renounced his wealth, was ordained in 1795, and never returned to Russia. He started his career at Conewago, but soon decided to establish a frontier mission in the wild, inhospitable region of the Alleghenies. To build a spiritual empire here was the vision, which dazzled before his mind. It was while coming to these mountains with his followers that the "Gallitzin Spring" had its beginning. His church in Loretto was, for a while, the only Catholic

church between Lancaster, Pennsylvania and St. Louis, Missouri. He died in Loretto, a town he helped found, in 1840.

0.20 97.70 Upper Dam and Reservoir on the left. The eastbound lanes of Old US 22 on the far side of the valley occupy Inclined Plane No. 7 (Figure 36). The inclined plane was 2,655.01 feet long and rose 260.50 feet up Allegheny Mountain (Wilson, 1897).

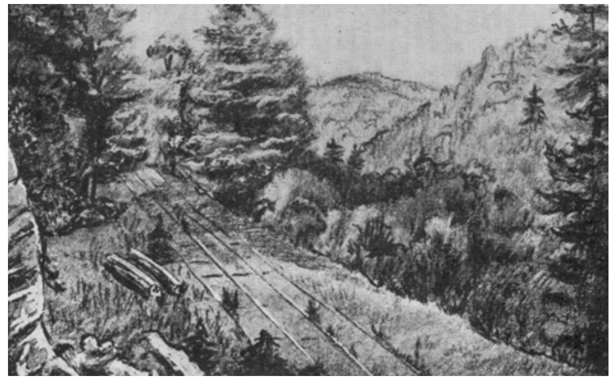


Figure 36. Illustration of Inclined Plane 7 (from Baumgardner and Hoenstine, 1952). Nothing is left of this incline as a result of construction of the eastbound lane of Old US Route 22

0.20 97.90 Pull over to the left side of the highway and park.

STOP 4. EDWARD MILLER'S SILICEOUS LIMESTONE (THE LOYALHANNA FORMATION)

CAUTION: be very careful exiting the vehicles and crossing the road here. This is four-lane divided highway, and traffic has a habit of sneaking up VERY quickly on the unsuspecting rockhound.

Introduction

The bedrock cropping out across the highway (on the northeast side) (Figures 37A and B)

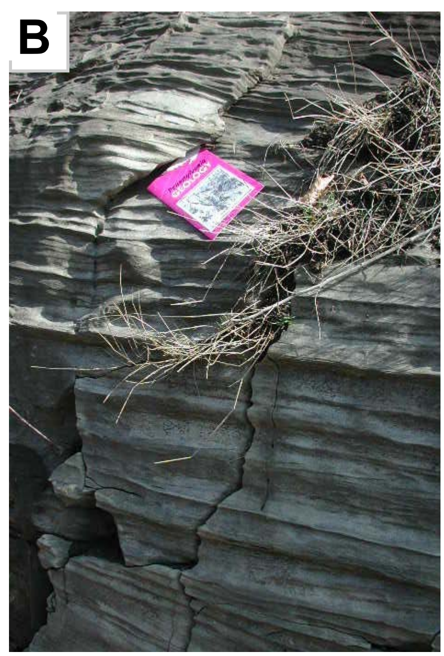


Figure 37. Photographs of the Loyalhanna Formation on the Old Allegheny Portage Railroad. A - Spectacular large-scale cross bedding. B - Small-scale cross bedding and differential weathering of alternating layers of quartz sand and carbonate sand results in the zebra-striped pattern that is probably the most tell-tale feature of the Loyalhanna. Copy of Pennsylvania Geology (6 X 9 inches) for scale.

should be highly recognizable to anyone who has studied the geology of western Pennsylvania. It is none other than the Loyalhanna Formation, commonly called Loyalhanna Limestone, even when, as here, it is a calcareous sandstone. Miller (1935) first documented this formation in his description of the geology of the railroad. As he remarked:

> At *f*, is a bed about 30 feet thick of limestone, containing so large a proportion of silex, that it forms good mortar without any admixture of sand. It is exceedingly hard, and full of irregular seams and fissures. (Miller, 1935, p. 254) (see Plate 2)

As Miller observed, the Loyalhanna is very hard. It is difficult to excavate, especially with primitive means (picks and shovels, and black powder), but it has good cut-slope stability so the railroad should have had little trouble with rockfalls (Geyer and Wilshusen, 1982). It is also a good source of construction aggregate and road material. I've often wondered if some of the "sleepers", particularly between Inclined Plane No. 7 and No. 6, might have been worked out of Loyalhanna boulders.

Geology – The Controversy of Fact and Speculation

Butts (1904) named the Loyalhanna Limestone for exposures along Loyalhanna Creek where it flows through Chestnut Ridge anticline in Westmoreland County. Edmunds and others (1979) described the Loyalhanna Formation as a thin tongue of the middle Mississippian Greenbrier Group limestone that extends across southwestern Pennsylvania into the central part of the state (where it is called Trough Creek Limestone). Wells (1974) traced it along the Allegheny Front as far as Sullivan County, 37 miles east of Williamsport. It also occurs in western Maryland and northern West Virginia (Ahlbrandt, 1995). The formation grades from a quartzose limestone in the south to a calcareous quartz arenite in the north. A quick examination of the outcrop along Old US 22 will convince you that the Loyalhanna at this locality falls into the calcareous quartz arenite category.

Much of the Loyalhanna consists of fine-grained quartz sand and silt, and carbonate grains of various kinds (including ooliths, indeterminate peloids, grapestone aggregates, and abraded remains of echinoderms, bryozoans, brachiopods, and endothyrid foraminiferans). Its most characteristic feature is the medium- to large-scale festoon cross bedding that can be seen at this exposure (Figure 37A). The spectacular cross bedding suggests that the Loyalhanna originated as eolian deposits, and, in fact, some early investigators (e.g. Hickok and Moyer, 1940) considered the Loyalhanna to be eolian in origin. Other early investigators (e.g. Campbell, 1902; Flint, 1965) considered it to be a nearshore marine complex of beach, dune, bar, and sheet sands. Adams (1970), Brezinski (1984), and others have studied the formation in great detail and determined that it actually resulted from deposition in marine and transitional subaqueous environments.

Brezinski (1984; 1989) recognized two lithofacies in the Loyalhanna Formation: a festoon cross bedded arenaceous grainstone to calcareous orthoquartzite facies, and an interbedded grainstone and red shale facies. Except near the upper contact, large-scale cross bed foresets occur throughout the first lithofacies. Adams (1970) concluded that the depositional environment for this lithofacies was most likely shallow high-energy marine. Brezinski (1984) postulated that it probably represents a shallow-water complex of sand waves analogous to submarine sand wave fields described from the North Sea and Long Island Sound.

> Many modern sand wave fields are located in estuarine regions on shallow marine shelves (Walker, 1979). These estuaries or reentrants along the coast lines serve as sand sinks. Any sand which is introduced is constantly reworked but has no means for escape. Moreover, estuarine settings are often sites of unusually strong tidal exchanges, as a result of tidal resonance within a constricted embayment. A good example of this is the Bay of Fundy. The strong tidal exchange is more than sufficient to keep the sand waves contained within the embayment in near constant motion. Commonly, one of the tides (flood or ebb) dominates the sediment movement, giving a strongly directional paleocurrent azimuth. (Brezinski, 1984, p. 19)

Ahlbrandt (1995), however, believed that the Loyalhanna formed as an eolian deposit. He recognized what he felt were stratigraphic and sedimentologic features characteristic of eolianites from Paleozoic sand seas (ergs) in Wyoming and Colorado. Ergs are huge areas of at least 3,000 square miles, and typically more than 4,600 square miles, covered by wind blown sand. The Loyalhanna covers 17,000 square miles in West Virginia, Maryland, Pennsylvania, and Ohio and averages 60 feet thick (maximum 103 feet). Ahlbrandt (1995) argued that the Loyalhanna has features similar which are entirely consistent with Paleozoic eolian deposits, including:

1) festoon cross bedding (mean dip = 20°, mode = 20 to 25°, and range = 5 to 40°, as measured by Adams, 1970). Mean dips of barchan, transverse ridge, and blowout dunes have mean dips, respectively, of 22°, 24°, and 16°.
2) scale and dip of Loyalhanna cross bed sets (maximum thickness = ~100 feet, average thickness = ~60 feet, maximum cross bed set thickness = 16 feet) are consistent with the eolian deposits. At an average thickness of 60 feet, a 60-foot dune is relatively small when compared to modern dunes in Nebraska, which are commonly 200 to 300 feet high.
3) a variety of colors – red and white, or gray – resulting from syndepositional or diagenetic affects, specifically, the red shale lenses sometimes found intercalated within the cross-bedded sequence which Ahlbrandt (1995) interpreted as interdune deposits. The red color indicates an oxidizing environment where groundwater dampened the sediments.
4) very fine-grained sand in cross-bedded units, and bimodal and more poorly sorted sand in horizontally laminated units, characterize interdune or sand sheet deposits, while uniformly fine-grained sand characterizes sand dunes.
5) tourmaline to zircon ratios and sandstone compositional analyses documented by Adams (1970) (Table 7) are consistent with the light/heavy separation ratios documented for the eolian Pennsylvanian-Permian Casper Formation of Wyoming.
6) abrasions on and reworking of conodonts consistent with observations of conodont reworking by eolian action.

Ahlbrandt (1995) presented good arguments for the eolian origin of the Loyalhanna Formation. However, I feel the evidence is just as good that the Loyalhanna is subaqueous in

Table 7. Comparative non-opaque heavy minerals for two size classes in the Loyalhanna Formation (data from Adams, 1970).

Sample number	Size range	Tourmaline	Zircon	Staurolite	Garnet	Rutile	Other	Tourmaline to Zircon ratio
1	0.063 to 0.125	35.5	45.5	12	6	1	0	0.78
	0.125 to 0.250	55	8.5	32	4.5	0	0	6.47
2	0.063 to 0.125	28.5	54.5	10	2.5	2.5	2.5	0.53
	0.125 to 0.250	79	2.5	14	3.5	0.5	0.5	31.6

origin. For example, The strontium and sodium trace element signatures suggest a marine origin for the Loyalhanna (Christopher Laughrey, personal communication, 2002). Adams (1970) found just as much evidence as for the formation being of marine origin as Ahlbrandt (1995) found against it:

1) a high proportion of carbonate clasts (mostly skeletal debris, including marine megafossils, and ooliths). Although microfossils and ooliths are small enough to be easily windblown and deposited in dunes, megafossils are unlikely to be transported far even by hurricane winds.
2) the regional occurrence of a normal marine limestone above the Loyalhanna, and the local occurrence of a normal marine limestone under it.
3) reducing conditions, indicated by a pyritic greenish gray facies, characterize much of the formation. Reducing conditions are more typical of subaqueous than subaerial environments.
4) the range of grain sizes is more typical of nearshore marine sediments than either eolian or beach deposits.
5) only 12.5% of the cross beds exceed 5 feet in thickness. Although eolian dunes on barrier islands are similar in scale, other attributes (texture, geometry, etc.) disagree with such a depositional interpretation.
6) convex cross bed foresets, and brecciation of bedding, are common in modern eolian sand deposits, but are absent in the Loyalhanna.

As the Loyalhanna seaway became increasingly constricted to the northeast, all quartz and carbonate sand introduced into the mix was circulated within the basin, but was not removed Brezinski (1984). Paleocurrents, studied by Adams (1970) and Hoque (1975), indicate a northeastward direction (essentially into the embayment). This suggests a dominance of flood over ebb tides (Brezinski, 1984), while the wide variance in azimuths suggests sand wave migration parallel to shoreline rather than parallel to the basin axis (Hoque, 1975). Interpreted tidal bar and tidal channel deposits in central and northeastern Pennsylvania reinforce the concept of strong tidal forces. In these areas there are also interbedded marine and nonmarine lithologies within the Loyalhanna, indicating repeated marine transgressions and shoreline progradations.

If it appears that the interpretation of depositional environments of the Loyalhanna is controversial, the age of the formation will also cause some confusion. The age of the formation has not been adequately defined owing to a general lack of identifiable mega- and microfossils. Therefore, the age of the formation is, contrary to modern stratigraphic concepts, based mostly on its lithostratigraphic correlation with the Greenbrier Series of southern West Virginia and Virginia (Ahlbrandt, 1995). We know the Loyalhanna is Mississippian in age because it lies within and between known Mississippian formations. The formation also contains Mississippian endothyrid foraminifera that probably represent original, as opposed to reworked, fossils. However, there is disagreement as to which Mississippian stage the formation represents. Berg and others (1986) showed the Loyalhanna as being Middle to Late Meramecian in age. Conodonts from supposed Loyalhanna-equivalent strata in West Virginia correlate with the Ste. Genevieve Formation of the upper Mississippi Valley, which is known to be Meramecian and Chesterian in age. Ahlbrandt (1995), on the other hand, based on unpublished USGS conodont information, placed the Loyalhanna in the early (but not earliest) Chesterian.

Return to the vehicles and continue uphill on Old US 22.

0.90	98.80	Notice the orange water on the right. Acid mine drainage coming from mines at the top of the hill is Enter Blair Run at this point.
0.05	98.85	Skew Arch Bridge and Allegheny Portage Railroad Memorial on the left, and Inclined Plane No. 6 on the right. You can see the reconstructed engine house for the inclined plane at the top of the hill.
0.45	99.30	Enter Cambria County. Engine House No. 6 and Lemon House on the right.
0.20	99.50	Entrance to the Allegheny Portage Railroad National Historic Site Picnic Area on the right.
0.30	99.80	Cresson Ridge summit, elevation 2,430 feet.
0.30	100.10	Turn right onto entrance ramp to US 22 East.
0.65	100.75	Merge with traffic.
0.90	101.65	Bear right onto the exit ramp to Gallitzin and the Allegheny Portage Railroad National Historic Site.
0.50	102.15	Turn right and enter the Allegheny Portage Railroad National Historic Site.
0.55	102.70	Pass the Visitors Center and park in the parking lot

STOP 5. ALLEGHENY PORTAGE RAILROAD NATIONAL HISTORIC SITE

This will also be our Lunch stop. After lunch, feel free to roam through the Visitors Center, visit the "sleeper" quarries, Inclined Plane No. 6 (which overcame 266.5 feet of elevation over its 2,713.85-feet length – Wilson, 1897), Engine House No. 6, the Lemon House, the Skew Arch Bridge, and the Allegheny Portage Railroad Memorial (Figure 38 to 41). Hiking trails and the grass-covered inclined plane allow easy access to all of these features. **PLEASE BE EXTRA CAREFUL** crossing Old US 22 when visiting the Skew Arch Bridge and railroad memorial. Traffic will be coming uphill (from the left), so be sure to look that way before crossing.

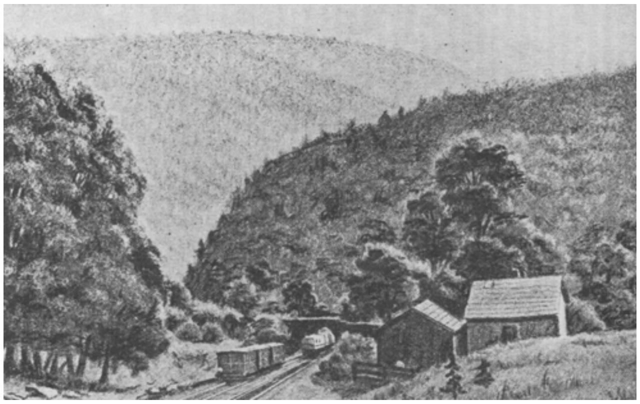


Figure 38. Illustration of Inclined Plane 6 and the Skew Arch Bridge (from Baumgardner and Hoenstine, 1952).

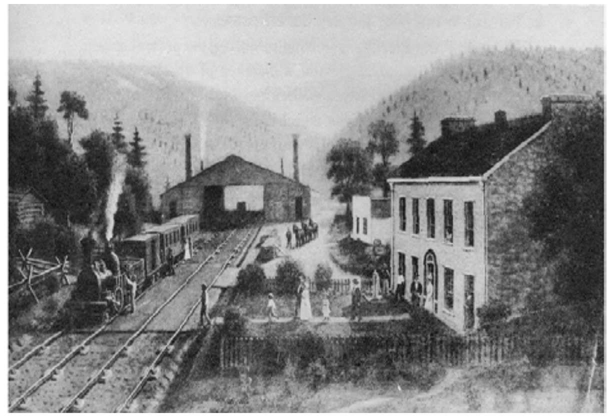


Figure 39. "Lemon Inn on the Portage Railroad" by George Storm. This is an illustration of the Allegheny Portage Railroad at the top of Inclined Plane 6 (now part of the Allegheny Portage Railroad National Historic Site). The original painting is in the State

The National Park Service established the Allegheny Portage Railroad National Historical Site in 1964 to commemorate the first railroad crossing of the Allegheny Mountains. The park protects many of the remnants of the railroad, including Inclined Plane No. 10, Inclined Plane No. 8, the features associated with Inclined Plane No. 6, and the Staple Bend Tunnel about four miles east of Johnstown (see Stop 10).

Visitors Center and Adjacent Exhibits

The Visitors Center has informative and educational exhibits, including artifacts and models, that help tell the story of the railroad. A full-scale model of the Lafayette, one of the locomotive used on the railroad, stands in one corner. The Visitors Center also has a 60-seat auditorium where they show a 20-minute orientation film about the Portage Railroad. Other amenities include a bookstore where many of the texts used in constructing this guidebook were purchased, restrooms, pay phones, and a water fountain. Access to the outside historic exhibits is easily obtained on a wheelchair-accessible boardwalk.

And the staff is very friendly and helpful. In fact, on Sunday afternoons during the summer and fall months the park offers a series of ranger-led hikes to some of the hidden treasures of the Allegheny Portage Railroad outside the main park area. The hikes vary from 1½ to seven miles in length. Reservations are required. If you are interested in coming back, you can obtain a schedule of all offered ranger programs at the Visitors Center.

Figure 40. Photograph of the restored Lemon House at the Allegheny Portage Railroad National Historic Site.

Engine House Six Interpretive shelter includes the excavated original

Figure 41. Photographs of the Skew Arch Bridge (left) and Portage Railroad Memorial (right) at the Allegheny Portage Railroad National Historic Site.

engine house foundation, as well as full-scale models of stationary steam engines and boilers used in raising and lowering cars on the inclined plane. Informative and interactive exhibits help explain the workings. If park staff is present, they might give you a demonstration.

The Lemon House (Figure 40) is an historic hotel and tavern on the railroad. It was a common rest and dining stop for railroad passengers. The National Park Service has restored this historic tavern's first floor to how it would have looked in 1840, using both reproduction and period furnishings. Docents can explain about the social and economic aspects of the railroad in the furnished tavern's bar room, dining room, parlor, and exhibit area.

Bedrock and Surficial Geology

The stonemasons hired to cut stones and construct "sleepers", culverts, engine house foundations, and the Skew Arch Bridge did much of their work within an easy walk of the Visitors Center. In fact, a leisurely stroll down the boardwalk will provide a good view of the many small pits where the stone was extracted and cut.

The bedrock at the park consists of the upper part of the Allegheny Group and the lower part of the Conemaugh Group (Glenshaw Formation) (Figure 42). The Allegheny and Conemaugh groups both consist predominantly of variable sequences of rock types consisting predominantly of medium-gray silt shale and dark-gray clay shale with some light-gray sandstone, and red and gray claystone. The Allegheny contains numerous, thick, mineable coal seams such as the Upper Freeport and Lower Kittanning, whereas only thin, generally unmineable coals occur sparsely throughout the Conemaugh. Nonmarine limestones are common in the Allegheny but rare in the Glenshaw Formation. The Glenshaw has four or five marine zones (Figure 42), typically consisting of a central argillaceous limestone surrounded by fossiliferous shales, whereas Allegheny marine zones typically are more brackish and sparely fossiliferous (the major exception being the Vanport Limestone).

Inclined Plane No. 6 crosses the Upper Freeport coal (the group boundary) approximately 100 feet below the engine house. Glover (1990) showed the Upper Freeport has been mined extensively throughout the area, including beneath the park (mine subsidence anyone?). A hike of only ½ mile northeast or southwest from Old US 22 will bring you to Upper Freeport strip

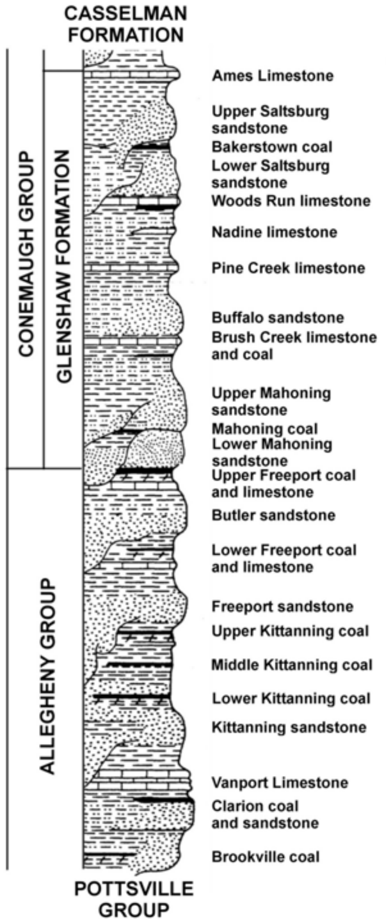


Figure 42. Generalized stratigraphic section of the Allegheny Group and the Glenshaw Formation (lower half of the Conemaugh Group). Modified from Harper and Laughrey (1987).

mines. During an early visit to the park, I was told that an old coal mine shaft supposedly existed across the railroad from the Lemon House. Although I searched, I couldn't find any openings. However, there are shallow depressions in the low bank on the northeast side of the railroad, nestled among the evergreen trees, that might represent remnant shafts or mine collapse features.

Most of the area downhill from the Visitors Center is covered with a surficial deposit of regolith and colluvium consisting of sandstone boulders in an unsorted mixture of unconsolidated material. The boulders are Mahoning sandstone (lowermost Conemaugh) (Figure 42), which is well developed in this area (Geyer and Wilshusen, 1982 indicated that it is well developed in the subsurface at Cresson, just west of the park). It is also conspicuous in the Patton area of north-central Cambria County where it forms a flat surface of considerable extent (Stone, 1932). It is typically a heavy, coarse, and, in places, conglomeratic sandstone that typically occurs in two sequences about 35 to 40 feet thick each, separated by shales, a minor coal, and/or sometimes a thin nonmarine limestone. In the subsurface of western Pennsylvania it often has no recognizable parting at all, forming one mass of sandstone up to 100 feet thick. Where exposed at the surface, it tends to break down into abundant boulders that seem to be strewn across the landscape in helter-skelter fashion. In Cambria County, such accumulations occur in the Patton area, near Cassandra (see Stop 7), and here at the park. Stone (1932) indicated that some blocks are 10 feet across and provided an excellent source of local building stone. It would have been relatively easy, even in the 1830s, to sift through the boulder field here at the edge of Allegheny Mountain to find suitable stone to cut.

Feel free to examine the boulder quarries, both along the boardwalk and down the slope from the engine house. One of the exhibits along the boardwalk illustrates how the stonemasons shaped the boulders into cut stone. This exhibit stands beside a boulder that still shows the marks of the early 19th Century stonecutter's trade (Figure 43).

Figure 43. Photograph of a block of Mahoning sandstone at the Allegheny Portage Railroad National Historic Site, showing a stonemason's drill holes. Part of this boulder must have been used on the Portage Railroad as a "sleeper" or an ashlar block.

Skew Arch Bridge and Portage Railroad Memorial

Down the inclined plane, and across the westbound lanes of Old US 22 are the Skew Arch Bridge and the lower half of the inclined plane (Figure 41). When the Allegheny Portage Railroad was being built, it became obvious that the Huntingdon, Cambria and Indiana Turnpike would cross the railroad about midway along Inclined Plane No. 6. The Skew Arch Bridge was built in 1832-33 to carry the turnpike traffic over the railroad (Hoenstine, 1952). They built the bridge of coursed ashlar (Figure 29) laid diagonally across the inclined plane without mortar. The stonework, which is undoubtedly Mahoning sandstone from the quarries upslope, is held firmly in place by keystones. The bridge was in continual for over 100 years until a new concrete road, now the eastbound lanes of Old US 22, was built. Amazingly, the bridge is still in a near perfect state of preservation. In 1928, the Blair County Historical Society erected a tablet on the bridge bearing an inscription by the Honorable Plymouth W. Snyder:

> This tablet erected in 1928 by the Blair County Historical Society of Pennsylvania to perpetuate this Skew Arch built in 1832-33 to carry the Huntingdon-Blairsville section of the modern turnpike over Inclined Plane No. 6 of the Allegheny Portage Railroad.

The site also contains a monument erected in 1934 to commemorate the centennial of the completion of the Allegheny Portage Railroad (Figure 41). The monument originally was 10 feet high, erected from "sleepers" from the Portage Railroad. It was unveiled on October 1, 1929 in the presence of a large assemblage of Pennsylvania Railroad and Pennsylvania State officials, historians, and other interested persons. The site for the monument occupies about one-half acre, purchased by the Blair County Historical Society from James Glass and wife in 1928. The society presented the monument to the Commonwealth of Pennsylvania at the unveiling, but maintained the custodianship.

Return to the parking lot and drive back to US 22.

0.90	103.60	Cross US 22 and turn left onto the entrance ramp to US 22 West.
0.60	104.20	Merge with traffic.
1.20	105.40	Bear right onto the exit ramp to Cresson and Summit.
0.20	105.60	Turn right onto Old US 22 West. We are passing through the community of Summit, formerly known as the Borough of Summitville (Baumgardner, 1952). Down the hill on Old US 22 West is the Borough of Cresson, originally a summer resort owned by the Pennsylvania Railroad (Johnson, 1889). The area was first settled by farmers, followed by workers for the Allegheny Portage Railroad, the Pennsylvania Railroad, and coal miners. The first coal mines in the area opened in 1816, and coal mining and railroading became the economic base of the area for many years. The pure mountain air and the old Cresson Hot Springs spurred many wealthy industrialists from Johnstown and Pittsburgh, including Benjamin Jones (of Jones and Laughlin Steel fame), Andrew Carnegie, and William Thaw, to build or lease summer homes in the area. The quality of the climate was so good that in the early 1900s a Tuberculosis Sanitarium was established on the hill east of town. It is now the site of the state Correctional Institution at Cresson. Cresson was incorporated in 1906. Today the Cresson area is a

residential community served by small businesses, light industry and farming. The area is also home to many historical features, including: Mount Aloysius Academy, founded in 1853 by the Sisters of Mercy; Braemer Cottage; the former Cresson Hot Springs; Mountain House Inn; Cresson Sanitarium (the state correctional facility); and the Admiral Robert E. Peary Monument honoring the Cresson native first to reach the North Pole.

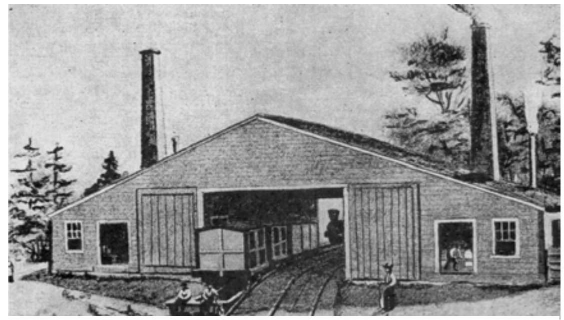


Figure 44. Illustration of the engine house at Inclined Plane 5 (from Baumgardner and Hoenstine, 1952).

0.20 105.80 Intersection with Level Road (SR 2019). The Summit Mansion Hotel, a well-known hotel built at the intersection of the railroad and the turnpike in 1832, formerly sat on the northwest corner of this intersection. Unfortunately, the building burned to the ground in 1980. Both Baumgardner (1952) and Lewie (2001) write lovingly of this grand old hotel, now just a memory.

Turn left. We are now riding on the Allegheny Portage Railroad right-of-way.

0.20 106.00 We are now descending Inclined Plane No. 5 (Figure 44). Bedrock is Mahoning sandstone. According to Wilson (1897) this plane is 2,628.6 feet long and descends 201.64 feet of elevation.

0.85 106.85 Level Road and the Portage Railroad diverge here as Level Road rises to cross US 22.

0.25 107.10 Cross US 22.

1.50 108.60 Enter the village of Wheelers Hill.

0.40 109.00 We are now descending Inclined Plane No. 4 into the Borough of Lilly. Bedrock here is Glenshaw Formation, possibly Mahoning or Buffalo sandstone. We will ride down only about half of the inclined plane. The lower half is now wooded hillside with houses at the bottom. The entire I nclined Plane No. 4 (Figure 45) was 2,194.93 long and overcame 187.86 feet in elevation (Wilson, 1897).

0.10 109.10 Enter the borough of Lilly. Notice that the road turns right while the inclined plane continues straight down the hill into Lilly. Joseph Moyer and his wife acquired 332 acres of land in this area in 1806, and

Figure 45. Illustration of Inclined Plane 4 just east of Lilly (from Baumgardner and Hoenstine, 1952).

it became known as the "Dundee" tract. For seven years the Moyers operated a gristmill on the property. They sold the land in 1813 to Simon Litzinger who, in turn, sold it to Joseph Lilly in 1825. Lilly, who had wanted to establish a town on the land, died before he could fulfill his dream. His son, Richard Lilly, divided the land prior to the building of the Portage Railroad and sold off the parcels. The newly founded town was at first called "Dundee" after the Moyer tract. The town became increasingly important to the local industry – James Conrad’s sawmill cut a large amount of timber, much of it hemlock and oak, for the Portage Railroad. Because of the odor emanating from the mill, it was suggested the town be called “Hemlock,” and for a time the post office used that name. Eventually they named the town for Richard Lilly. Originally called Lilly's Station, this whistle stop on the Pennsylvania Railroad became known simply as Lilly's. Finally, in 1883, it was incorporated as the Borough of Lilly.

Lilly’s most famous native probably was Bill Tremel, who pitched for the Chicago Cubs for three years in the mid-1950s.

0.15	109.25	Turn left onto Willow Street.
0.20	109.45	Intersection with Cleveland Street (PA 53). Turn left.
0.05	109.50	If you look to the left you will see the lower half of Inclined Plane No. 4 descending into Lilly. Turn right and stay on PA 53 South. We are back on the Allegheny Portage Railroad right-of-way.
0.05	109.55	Turn right onto Washington Street, pull over to the left, next to the creek, and park.

STOP 6. LILLY CULVERT

This stop is intended only as a brief, but close-up, look at one of the stone culverts constructed for the Portage Railroad.

The Portage Railroad engineers determined that it would take 72 culverts to cross all the small streams along the railroad right-of-way. Principal Engineer Sylvester Welch, in a report to the Board of Canal Commissioners in 1831, estimated the total cost for all the bridges, culverts, and aqueducts would be $110, 473.68, or just over 9% of the total cost to build the railroad (Rotenstein, 1997). Welch divided the 72 culverts into two types, those spanning ten or more feet and those spanning less than ten feet. Fifty-two of the culverts spanned three feet or less. The two largest culverts had spans of 25 feet. All 72 were constructed of solid sandstone cemented with lime mortar. “The walls at the ends of each culvert are built of hammered stone, laid in courses. The copin and steps and the voussoirs that form the heads of the arch, are smoothly cut.” (Welch, in Rotenstein, 1997, p. 4).

Lilly Culvert (Figure 46), as it is known, spans Burgoon Run about 500 feet west of the base of Inclined Plane No. 4. Its official title was “Culvert A on Section 30” (Section 30 of the railroad was 3,600 feet long and included Inclined Plane No. 4) (Welch, in Rotenstein, 1997). The culvert is an elliptical stone arch with curving wing walls. It spans 18 feet and rises of 6 feet 6 inches. The head wall, as measured between the wing walls, is 27 feet wide and 19 feet high. The overall length of the bridge is 42 feet, including the wing walls, and its width is 22

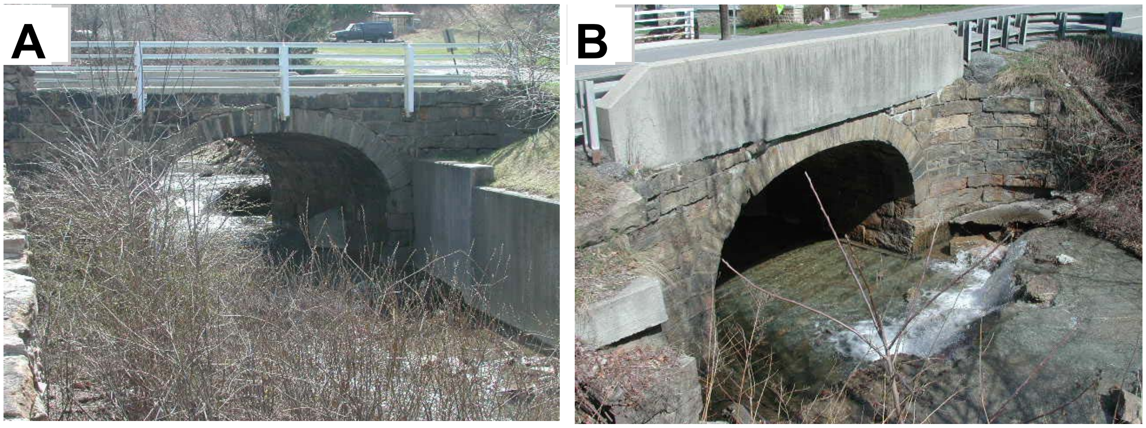


Figure 46. Photographs of the Lilly Culvert, a bridge built for the Allegheny Portage Railroad in 1832. A – North side. B – South side.

feet total (the road is 18 feet wide). It contains 6,590.18 cubic feet of masonry. The bridge was built of local rock, probably Mahoning sandstone, which would be abundant in the surrounding hills. The stone was laid as coursed ashlar blocks (Figure 29) with lime mortar.

Some of the notable features of this culvert are some original timber cribbing exposed at a few places in the creek, wing walls that are curved on both the upstream and downstream sides of the bridge, and the lack of a parapet (Rotenstein, 1997).

Lilly Culvert was completed in October or November 1832 at a total construction cost of $852.26. When the Pennsylvania Railroad bought and dismantled the Portage Railroad in 1857, the right-of-way was converted to a street called Portage Street and the culvert was retained. It is interesting to note that the state never relinquished its title to the right-of-way, and in 1911, after the state legislature formed PennDOT, the road was designated as Legislative Route 276 (later designated State Route 53). In 1988 the Lilly Culvert was listed on the National Register of Historic Places (Rotenstein, 1997)

Return to the vehicles, turn around, and return to PA 53.

0.05	109.60	Turn around, return to PA 53 and turn right.
0.40	110.00	Good view of the Conrail Railroad tracks to the right.
0.60	110.60	PA 53 and the Allegheny Portage Railroad diverge. The railroad continued on a fairly level course to the right while PA 53 climbs in elevation.
0.20	110.80	Plane Bank Road (the Portage Railroad right-of-way) enters PA 53 on the right.
0.50	111.30	We are now descending

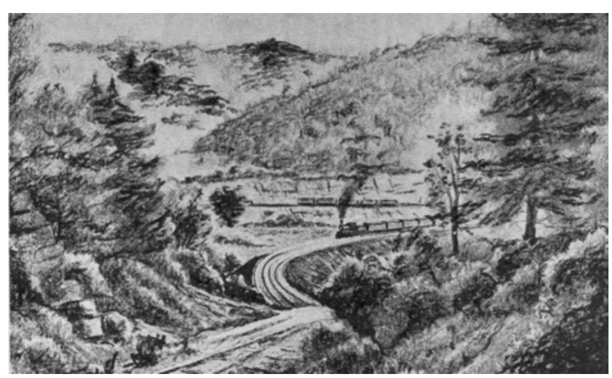


Figure 47. Illustration of Inclined Plane 3 above Bens Creek, near Cassandra (from Baumgardner and Hoenstine, 1952). Just west of the incline the Conrail Railroad (originally the Pennsylvania Railroad) crosses the Portage Railroad grade (now PA Route 53).

Inclined Plane No. 3 (Figure 47). This inclined plane was 1,480.25 feet long and 130.5 feet high (Wilson, 1897).

0.20 111.50 Pull to the right side of the road and park.

STOP 7. INCLINED PLANE NO. 3 AND BRUSH CREEK MARINE ZONE

Because of the danger of parking along this road on a curve, we will descend a little way on the remnant of Inclined Plane No. 3 toward Cassandra. We will then pull over to the right side of the road, disembark, and walk back up the hill to the head of the plane. **PLEASE USE EXTREME CAUTION**: PA 53 is used by heavy trucks and speeders, and the curve at the top of the hill provides a blind that drivers cannot see around. Stay as close to the sides of the road as possible.

This spot is of historic importance in geology because it is the location from which the first marine fossils described from the Coal Measures of North America were obtained.

Geology

When the Portage Railroad was being built, Assistant Principal Engineer Edward Miller studied the excavations and surrounding countryside for a variety of geological and engineering purposes. He described the strata that made the most impression on him (Miller, 1835), collected samples, and had some of the more prominent scientists of his day describe and report on them at the first (and only) Geological Society of Pennsylvania meeting (Clemson, 1835; Conrad, 1835; and Harlan, 1835). These included a report on invertebrate marine fossils that have become very recognizable as characteristic of Middle Pennsylvanian strata in North America.

> The most interesting specimens found in this quarter, are in the deep cuttings at the head of inclined plane No. 3, locality *k* [on the right side of Plate 2]. A stratum of good coal 2 feet thick is found at this place, having a roof of black shale 4 feet thick, upon which is an unstratified bed of argillaceous rock, containing a great variety of shells and other marine remains, with sulphuret of iron and balls of iron stone. The upper part of the stratified shale also contains marine impressions, and some of the more delicate remains have been replaced by sulphuret of iron. In breaking these rocks to pieces to facilitate their removal, great numbers of shells were loosened and fell out. Specimens 16 to 24, locality *k.* (Miller, 1835, p. 254-255)

The section, minimally described by Miller, occurs within the Brush Creek cyclothem of the Glenshaw Formation, Conemaugh Group (Figure 42). The coal is called the Gallitzin coal in Cambria County, but it has also been called the Mason coal and the Brush Creek coal. It lies 107 feet above the Upper Freeport coal in Cresson where it is 15 inches thick (Butts, 1905), and crops out in the railroad cut west of the eastbound tunnel at Gallitzin, where it is 6 inches thick. Butts (1905) indicated that it is exposed in the railroad cuts near Cassandra (adjacent to Inclined Plane No. 3). In this vicinity, it is 100 feet above the Upper Freeport coal and about 15 inches thick. The Gallitzin is not an economical coal by modern measures, but it has been worked

Figure 48. Photograph of a piece of Miller's (1835) "unstratified bed of argillaceous rock" (Brush Creek limestone" from the roadcut at the top of Inclined Plane No. 3. Lens cap (about 3 inches) for scale.

between Lilly and Cassandra (Butts, 1905). If the coal is still exposed at the time of the field trip (the hillside tends to grow thick vegetation), you will see it is about 15 inches thick, not the 2 feet Miller (1835) described. The shale above the coal should be the lower marine shale of the Brush Creek, but I haven't been able to find any fossils in it. It is best seen on the northwest side of the road. I have found the "unstratified bed of argillaceous rock" on the southeast side of the road, but only as float (Figure 48). Raymond (1910) said this layer is no longer exposed because the soft shales above it have crumbled down and covered it. That may well be, but not even digging in the colluvium has turned up the Brush Creek in place. I've also examined the railroad cuts at Cassandra and found nothing even remotely fossiliferous above the Gallitzin coal. It is possible that this far east the marine zone is found only as remnant pods of black, argillaceous limestone.

Paleontology

Timothy Abbott Conrad was a well-known naturalist affiliated with the Academy of Natural Sciences of Philadelphia and, according to Lesley (1876), one of the most active members of the Geological Society of Pennsylvania. He is now recognized as one of the pioneers of paleontology (Wheeler, 1935). His expertise on Cenozoic shells from the southeastern states, particularly Eocene fossils from Alabama, made him the most suitable candidate available to describe the new Carboniferous fossils. In the first (and only) volume of Transactions of the Geological Society of Pennsylvania, Conrad (1835) described and illustrated the fossils provided by Miller from Inclined Plane No. 3. According to Weller (1898), Conrad's was only the fourth published paper containing descriptions of Carboniferous invertebrate fossils from North America. Raymond (1910) claims Conrad's is the first published report describing fossils from the Coal Measures, but this isn't true because many plant fossils had already been described by 1835. However, it ***is*** the first published report of invertebrate fossils from the Coal Measures (Pennsylvanian) of North America. As a result, this is truly a sight worth preserving for historical purposes.

Conrad's (1835) paper included three new species of snails, a brachiopod, and a bivalve (Figure 49). Unfortunately, Conrad's type specimens have been lost, but many of them are so recognizable from the illustrations that there is no question of their identification:

Stylifer primogenia (Figure 49A) is now known as *Strobeus primogenius* (Figure 49B). This species is quite common throughout the marine zones of the Allegheny and Conemaugh groups of western Pennsylvania, as well as other Pennsylvanian strata across the country.

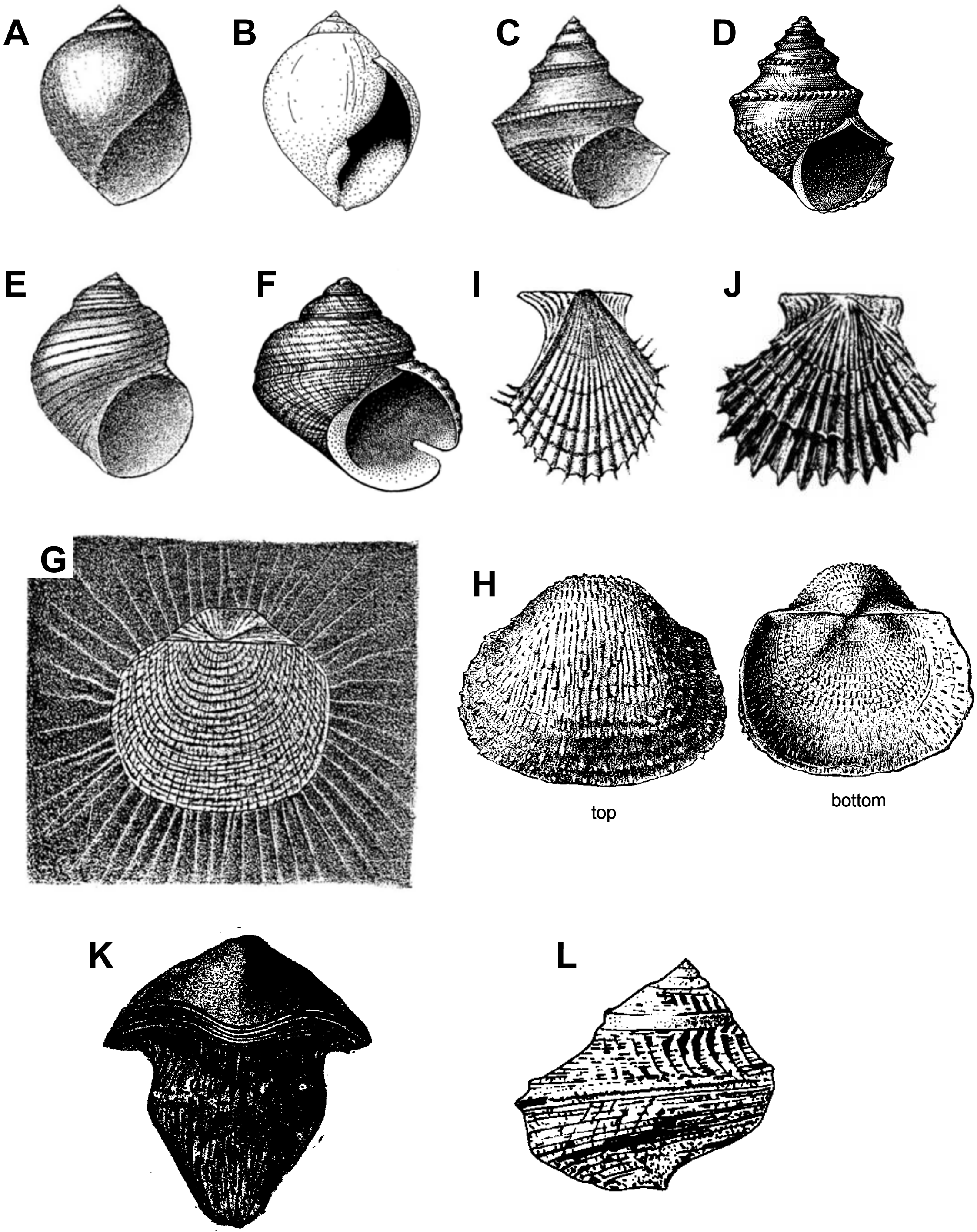


Figure 49. Fossils from the Brush Creek marine unit (Glenshaw Formation) at the head of Inclined Plane No. 3. Compare Conrad's (1835) original illustrations (A, C, E, G, and I) with the more modern ones (B, D, F, H, and J). A – *Stylifer primogenia*. B – *Strobeus primogenius* (Conrad). C – *Turbo tabulatus*. D – *Worthenia tabulata* (Conrad). E – *Turbo insectus*. F. *Shansiella carbonaria* (Norwood and Pratten). G – *Pecten armigerus*. H – *Acanthopecten carboniferus* (Stevens). I – *Productus confragosus*. J – *Juresania nebrascensis* (Owen). K – *Petalodus alleghenienssis* Leidy. L – *Raphistomella* (*Raphistomella*) *grayvillense* (Norwood and Pratten.

Turbo tabulatus (Fiugure 49C) is now known as *Worthenia tabulata* (Figure 49D), and is one of the more recognizable Pennsylvanian fossils from North America. It occurs commonly in the Brush Creek marine zone throughout southwestern Pennsylvania.

Turbo insectus has not been redescribed or reillustrated since Conrad's original report. However, the illustration (Figure 49E) probably refers to *Shansiella carbonaria* (Nortwood and Pratten), described originally from Illinois. *Shansiella*, like *Worthenia*, is one of the more recognizable fossils commonly found in the Brush Creek marine zone throughout southwestern Pennsylvania (Figure 49F). Conrad's illustration shows a snail somewhat more high-spired than *S. carbonaria*, but 19th century fossil illustrators commonly exaggerated specimens, or added details that did not exist. Also, there has never been a report of any other species of snail from the Brush Creek having similar features.

Productus confragosus (Figure 49G) is probably *Juresania nebrascensis* (Owen) (Figure 49H), the most common productid brachiopod found in the Brush Creek marine zone in southwestern Pennsylvania. In fact, *J. nebrascensis* is the only productid listed by Raymond (1910) from collections he made in Brush Creek near this locality (see below). Miller had provided Conrad with numerous distorted and pyritized specimens, but Conrad's description is inadequate for a scientific description. Conrad seems to have been struck more by the preservation of the spines illustrated in Figure 49G than in how the species differed from known European forms.

Pecten armigerus (Figure 49I) is probably *Acanthopecten carboniferus* (Stevens) (Figure 49J). The only specimen Conrad had to work with was "the interior of the left valve" (probably an external mold). *Acanthopecten carboniferous* occurs throughout the Pennsylvanian marine rocks of the Appalachian basin.

Conrad (1835) also listed nine other fossils from the Brush Creek at Inclined Plane No. 3, but failed to describe or illustrate them. Being familiar with the scientific literature of Europe, Conrad considered most of them to be at least similar, if not conspecific, with well known European forms. Some of them can be identified at least to genus (by modern standards) with a certain amount of confidence because the fauna of the Brush Creek has been well studied. It also helps that Raymond (1910) provided a list of fossils collected from the Brush Creek near this locality (see below) that assists in identifying Conrad's specimens.

Brachiopods:	*Productus scoticus* Sowerby
	Productus sulcatus Sowerby
	Spirifer undulatus Sowerby
Bivalves:	*Unio* allied to *U. subconstrictus* Sowerby =?*Palaeoneilo oweni* (McChesney)
Coelenterates:	*Cyathophyllum ceratites* Goldfuss = Stereostylus sp.
	Calamopora polymorpha Goldfuss = possibly a fenestrate bryozoan
Crinoids:	*Cyathocrinites pinnatus* Goldfuss = probably one of the erisocrinids

Cephalopods: *Orthoceras*, undetermined, = probably *Pseudorthoceras knoxense* (McChesney)
Nautilus, undetermined =? *Metacoceras* sp.

Raymond (1910) identified the fossiliferous rock as the Brush Creek limestone, and listed numerous other fossils collected from the first cut west of Bens Creek Station on the Pennsylvania Railroad (Inclined Plane No. 3 was east of Bens Creek Station). These included (using updated nomenclature):

Brachiopods: *Chonetinella plebeia* (Dunbar and Condra)
Derbyia crassa (Meek and Hayden)
Juresania nebrascensis (Owens)
Bivalves: *Nuculopsis girtyi* Schenck
Palaeoneilo oweni (McChesney)
Astartella concentrica (Conrad)
Gastropods: *Strobeus primogenius* (Conrad)
Glabrocingulum (*Glabrocingulum*) *grayvillense* (Norwood and Pratten)
Worthenia tabulata (Conrad)
Knightites (*Cymatospira*) *montfortianus* (Norwood and Pratten)
Pharkidonotus percarinatus (Conrad)
Soleniscus typicus (Meek and Worthen)
Cephalopods: *Pennoceras seamani* Miller and Unklesbay

This is also the type locality of the shark tooth *Petalodus allegheniensis*, described by Joseph Leidy (1856) (Figure 49K).

The specimens of rock I've been able to find and take home to examine for fossils has yielded only a very sparse fauna. The snail, *Glabrocingulum* (*Glabrocingulum*) *grayvillense* (Norwood and Pratten) (Figure 49L) is the most common fossil. See if you can find anything interesting.

Return to the vehicles and continue south on PA 53.

0.15	111.65	Coal waste (bony) pile with red dog on left. The village of Bens Creek, a small mining community, is down the valley to the left. At the bottom of the inclined plane and to the right is the village of Cassandra.
0.10	111.75	This area was called Oil City by early railroad settlers because an oil pump station was built here. Cassandra Road to the right leads into the Borough of Cassandra, which began life as Leap's Crossing, a shanty town for the Portage Railroad workers in this area. The town's name was changed to Derby when a hotel and store were built. Later, in 1908, the borough was incorporated and the name changed to Cassandra after the daughter of the principal landowner in the area. The Allegheny Portage Railroad diverged from PA 53 near here and ran along the side of the hill in front of us. You can still see the right-of-way as the level incision in the hillside directly ahead. PA 53 follows the

right-of-way of the New Portage Railroad.

The railroad cuts on the Conrail Railroad tracks at Cassandra are the deepest on the mainline. These were dug in 1898 by the Pennsylvania Railroad as part of the realignment of the railroad between Portage and Lilly. The straightaway between the cuts in the mountain is almost three miles long. They can be viewed from a old iron bridge, a single lane iron bridge originally used to take PA 53 over the tracks. The Cassandra bypass, built to alleviate the bottleneck of traffic created by the bridge, was completed in 1935 and the bridge ceased being used for road traffic a year later. Since being rediscovered in 1998, the bridge, now called the Cassandra Overlook, has become a popular train viewing area. The bridge is located in such a way as to allow train viewers to obtain spectacular pictures and videos of east and westbound trains. A "Welcome Rail Fans" sign greets visitors at the entrance to the railroad overlook. A scenic picnic area insures that visitors to the site will have an enjoyable day train watching. Railroad aficionados from all over the world have come here to watch trains.

0.10 111.85 The Old Portage Railroad right-of-way is above us on the left. It is currently used as an access road to the Conrail Railroad tracks.

0.45 112.30 Pass beneath the Jamestown Bridge on the Conrail Railroad (formerly the Pennsylvania Railroad).

0.10 112.40 Turn left onto Plane Road. Plane Road becomes the Portage Railroad right-of-way at the top of the hill. PA 53, which passes around the base of the hill, follows the right-of-way of the New Portage Railroad.

0.05 112.45 The Old Portage Railroad right of way enters Plane Road from the left. Plane Road occupies the right of way from this point.

0.15 112.60 Stop sign at intersection with Jamestown Road. Continue straight and pass through Jamestown. Jamestown was the town where the Portage Railroad officials lived and had their offices.

0.65 113.25 We are now descending Inclined Plane No. 2 (Figure 50). This inclined plane was 1,760.43 feet long and overcame 132.4 feet of elevation (Wilson, 1897).

0.20 113.45 Bear left onto PA 53 at the stop sign.

0.20 113.65 Intersection with PA 164 West. Continue straight.

0.05 113.70 Enter the Borough of Portage. Established in the 1830s, Portage began as a hotel and resting place on the Portage Railroad. It became incorporated in 1890. In the early 1930s a rock known as

Figure 50. Illustration of Inclined Plane 2 just west of Jamestown (from Baumgardner and Hoenstine, 1952). The superintendent and other officers of the railroad had their offices here.

the Achannessink rock, which bears ancient carvings, was found here. The rock provided a link with the region's Indian past. The Achannessink rock appears to indicate that Portage was once the headquarters of the Turtle Clan, a division of the Delaware Indians. Portage exists today mostly because of coal, which was first mined at Bens Creek (near Stop 7) in 1872. On April 29, 1874, the Sonman Mine, Portage Colliery Company, and Portage Coal Company became incorporated. Since that time, almost 60 different shaft, longwall, slope, drift, and room-and-pillar mining operations have operated in the Portage Area. Despite its sometimes ugly heritage, coal forms the basis of much of Portage's economy, even today. Visitors to the town can tour the Portage Station Museum, the Sonman Coal Preparation Area, and the site of a mine explosion in 1940 that killed 63 miners, among many other sites. Portage's past remains prominent in the form of abandoned mine drainage, company houses, refuse piles, and many other remnants of a dying industry.

Figure 51. The tipple at the Maryland Shaft #2 of the Wilmore Coal Company at Wilmore. The shaft was about 850 feet deep.

0.10	113.80	Intersection with PA 164 East. Continue straight ahead on PA 53 South.
0.80	114.60	Outcrop of sandstone on the right, probably Saltsburg (Conemaugh Group, Glenshaw Formation). You can also see a very thin bed of coal, which could be one of the Bakerstown seams.
0.40	115.00	Outcrop of Saltsburg? sandstone on the right.
1.10	116.10	Enter the village of Wilmore. Axis of the Wilmore Syncline is at about this point.
0.40	116.50	Intersection with PA 160. About one mile south of here is the abandoned Maryland Shaft No. 2 of the Wilmore Coal Company. Opened in 1945, it was the deepest bituminous coal shaft in Pennsylvania (about 850 feet deep). It was leased by Bethlehem Mining Company in 1961 and abandoned and sealed in the 1970s and most of the colliery equipment has been dismantled (Lindbloom and others, 2001) (Figure 51). Continue straight on PA 53 South.
0.20	116.70	Cross the North Branch of the Little Conemaugh River. About 1.5 miles upstream (to the right) is Wilmore Dam and reservoir. You'd think the

		people in this river valley would have had enough of dams by this time!
0.45	117.15	Pass beneath the Conrail Railroad.
0.55	117.70	Turn right onto Tunnel Street. This is a rough road, so be careful.
0.30	118.00	Pass beneath the Conrail Railroad.
0.35	118.35	Outcrop of Morgantown sandstone on the right. Butts (1905) called this Summerhill sandstone.
0.20	118.55	Pass beneath the Conrail Railroad.
0.50	119.05	Pass beneath the Conrail Railroad.
0.35	119.40	Notice the yellow color of the Little Conemaugh River to the left. Abandoned mine drainage (AMD) has eliminated fish from a major portion of the Conemaugh River watershed. People who enter the polluted waters can suffer from skin irritations. Streambeds within the watershed have crusts of orange or white. Floodwalls in downtown Johnstown are stained red, and culverts and bridge abutments on the Little Conemaugh, Stoneycreek, and Conemaugh rivers have been damaged by the corrosive activity of the acidic water. The AMD problem of this area is severe, to say the least. In the early 1990s, an alliance of concerned citizens and local, state, and federal agencies, led by the Somerset and Cambria County conservation districts, developed a program to help clean up AMD-impacted waterways. They began by sampling the streams throughout the river valley. Once the group determined which waters were the most severely impacted, they began to construct systems to filter the pollutants from the water. Many of the treatment systems use limestone to reduce the acidity of the water and retention ponds to settle the metals from the water. The efforts are still under way throughout both Cambria and Somerset Counties.
0.15	119.55	Pass beneath the Conrail Railroad. Enter Summerhill.
0.10	119.65	Turn right onto PA 53.
0.85	120.50	Pass beneath US 219.
0.20	120.70	Turn left onto the entrance ramp to US 219 South.
0.30	121.00	Merge with traffic.
1.45	122.45	Cross the South Fork.
0.15	122.60	Bear right onto the exit ramp to PA 869.
0.30	122.90	Turn left onto PA 869 East.
0.05	122.95	Pass under US 219.
0.45	123.40	Enter the village of Saint Michael. Saint Michael is essentially what is left of the South Fork Fishing and Hunting Club and Lake Conemaugh (see explanation under Stop 8). Many of the old Victorian "cottages" of the club members remain, as well as the impressive Clubhouse, along what was once the shoreline of Lake Conemaugh one block above PA 869. Local coal companies established Saint Michael after the great Johnstown flood of 1889. The Clubhouse now serves as a restaurant.
		An abandoned mine shaft in Saint Michael is considered to be the single worst source of pollution in the Little Conemaugh River Basin, responsible for almost 30% of the pollutant load in the watershed. The main discharge contributes more than 2500 gallons per minute of acidic

		water with high concentrations of dissolved aluminum and iron. The discharge overwhelms and renders the South Fork of the Little Conemaugh River toxic to all forms of aquatic life. Paul C. Rizzo Associates of Monroeville, a developer of hydroelectric projects, became interested in the Saint Michael area because the discharge would allow the utilization of a pump storage system to generate electricity during peak demand times. Diversion of water from the mine shaft to the hydroelectric project can improve water quality in the South Fork. Cambria County and Rizzo entered into a Memorandum of Understanding that will require Rizzo to treat all water from the shaft. They will discharge the treated water that isn't needed within the system, thereby saving disposal costs and creating a useful product (Cambria County Conservation and Recreation Authority and Paul C. Rizzo Associates, Inc., 2001).
0.25	123.65	Notice the large building on the next street up the hill to the right. This is the lodge built for the South Fork Fishing and Hunting Club.
0.30	123.95	The buildings along PA 869 weren't here in 1889. This was the bottom of Lake Conemaugh. But if you look up the hill to the right you can see some rather large houses with elaborate decorative trim. These are the "cottages" that belonged to members of the South Fork Fishing and Hunting Club.
0.45	124.40	Turn right at the sign to the Johnstown Flood National Memorial onto Lake Road and cross South Fork Creek and railroad tracks.
0.20	124.60	Picnic pavillion on the right
0.15	124.75	Picnic pavillion on the right
0.40	125.15	Coal Miners Memorial on the left.
0.90	126.05	The parking area to the left will give us a good photo opportunity of the remains of the dam on our return from the Johnstown Flood National Memorial.
0.30	126.35	Turn right at the sign to the Johnstown Flood National Memorial visitor's center.
0.10	126.45	Pass the Visitors Center and park in the parking lot.

STOP 8. JOHNSTOWN FLOOD NATIONAL MEMORIAL

The Johnstown Flood National Memorial is part of the National Park System. It is open year around except for New Years Day, Martin Luther King Day, Washington's Birthday, Veterans Day, Thanksgiving, and Christmas. It has a Visitors Center with restrooms, programs, and a book sales area. An award-winning 35-minute film, shown daily at the Visitors Center, helps recreates the Johnstown Flood of 1889. The Park Service offers a variety of talks, tours, and other programs during the summer months (you can obtain a complete schedule of daily activities at the Visitors Center). The Visitors Center also features multimedia exhibits, including a fiber-optic map, which describes the path of the Flood. Other exhibits tell the story of the fabled South Fork Fishing and Hunting Club.

The park has walking trails to the north and south abutments of the South Fork Dam. There is a picnic area located near the south abutment available for public use (we will pass the

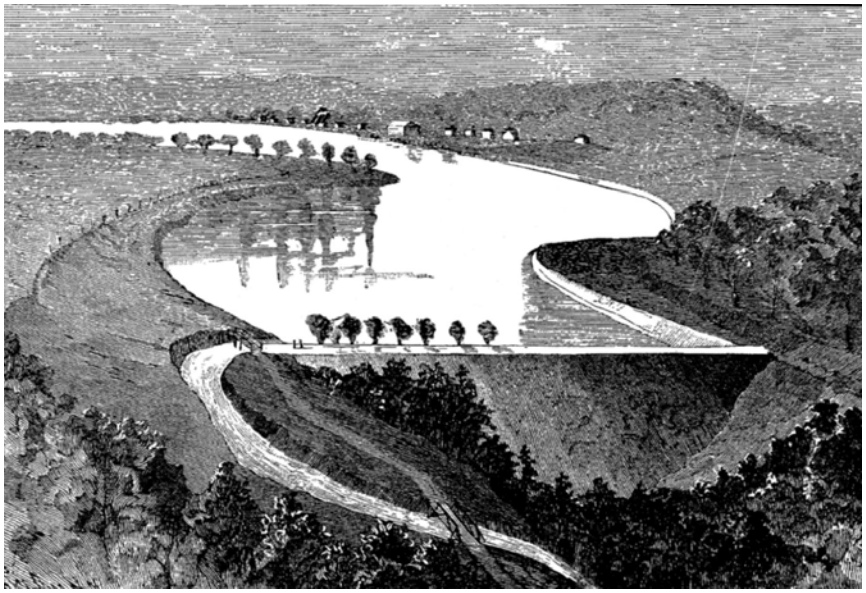


Figure 52. Illustration of South Fork Dam and Lake Conemaugh (from Law, 1997).

access road to the picnic area on the way to South Fork).

The Great Johnstown Flood

The Commonwealth of Pennsylvania began building the South Fork dam (Figure 52) in 1839 to supplement the Pennsylvania Mainline Canal during periods of drought in the Conemaugh River and its tributaries. It was 70 feet high and more than 900 feet long – at the time, it was the world's largest earthfill dam holding back the world's largest manmade lake, 2.7 million cubic feet of water (Kaktins, 1989). It had a spillway that was 70 feet wide, and three culverts with cast iron pipes at the bottom so arranged that they could be raised when there was too much water in the lake, and permit the escape of the surplus. These gates were in big stone arches, through which the water passed to the canal when the lake was used as a feeder (Johnson, 1889). It cost $166,647 and was finished in 1852, just in time for the demise of the Pennsylvania Mainline Canal system. When the Pennsylvania Railroad took over the western division of the canal system, they had no use for the dam and lake. The cast iron pipes were removed and sold as scrap, while the dam was allowed to deteriorate without any thought as to possible future problems.

Benjamin Ruff bought the property from the Pennsylvania Railroad in 1879, hoping to interest the wealthy families of western Pennsylvania into investing in a private summer resort where they could escape the hectic city life and relax in the mountains (Wichterman, 1998). South Fork Creek was considered one of the best trout streams in the state, and the lake would have provided a wealth of recreational opportunities for those with the cash to afford it. Ruff sold shares in the resort to people like Andrew Carnegie, Henry Clay Frick, Andrew Mellon and many other Pittsburgh entrepreneurs. The group built a 47-room clubhouse and elaborate Victorian palaces, which they referred to as "cottages". They called themselves the South Fork Fishing and Hunting Club, and the lake they dubbed Lake Conemaugh.

> For twenty-five years the lake was used only as a fish-pond and the dam and gates were forgotten. Five years ago the lake was leased to a number of Pittsburgh men, who stocked it with bass, trout, and other game fish. I have heard it said that the waste-gates had not been opened for a great number of years. If this is so, no wonder the dam broke. Naturally the fisherman did not want to open the gates after the lake was stocked, for the fish would have run out. A sluiceway should have been built on the side of the dam, so that when the

> water reached a certain height the surplus could escape. The dam was not built with the intention that the water should flow over the top of it under any circumstances, and if allowed to escape in that was the water was bound to undermine it in a short time. With a dam the height of this the pressure of a quantity of water great enough it overflow it must be something tremendous. (Johnson, 1889)

When the club bought the old reservoir, the dam was in need of major repairs - a section about 160 feet long had been washed out of the middle, creating a sag in the top of the dam, and this was rebuilt for $17,000. Engineers from the Cambria Iron Works in Johnstown and from the Pennsylvania Railroad, and one hired by the club, made a thorough examination.

> They pronounced the structure perfectly safe, but suggested some precautionary measures to stop the constant leaks. The members of the club themselves discovered that the sewer that carried away the surplus or over flow from the lake was not large enough in times of storm. So five feet of solid rock were cut away in order to increase the mouth of the lake. Usually the surface of the water was 15 feet below the top of the dam, and never in recent years did it rise to more that eight feet. In 1881, when work was going on, a sudden rise occurred, and then the water threatened to do what it did on this occasion. The workmen hastened to the scene and piled debris of all sorts on the top and thus prevented a washout . . . There is not a shadow of doubt but that the citizens of Cambria county frequently complained, and that at the time the dam was constructed a vigorous effort was made to put a stop to the work. It is true that the leader in this movement was a citizen of Johnstown, but he was and is a large mine owner in Cambria County. His mine adjoins the reservoir property. He was frequently on the spot, and his own engineer inspected the work. He says the embankment was principally of shale and clay, and that straw was used to stop the leaking of water while the work was going on. (Johnson, 1889)

But the club refused to pay to have the dam and lake professionally repaired. The man in charge of the repairs had no engineering background, and no one in a position of authority seriously considered warnings that the dam was not strong enough for the water it retained. It was, after all, 380 feet thick at the base, and the top, 70 feet above, was about 35 feet thick (Johnson, 1889). Thus, only minor repairs were made, and other changes to improve the attractiveness of the vacation spot actually worsened the situation: 1) the culverts used to control the lake level were blocked to allow the water to rise; 2) a road was constructed across the dam wide enough for carriages to pass over two abreast, but in order to facilitate the road, the dam actually had to be lowered; 3) the spillway then stood only five feet or less below the top of the dam; and 4) the center of the dam began to sag, allowing water to spill over at that point. The South Fork Dam and Lake Conemaugh became a major disaster just waiting to happen.

And happen it did. A moderate rain that hit the Ohio Valley dropped only 2 to 4 inches of rain (Kaktins and Fry, 1989). But orographic effects due to the mountains in the Allegheny Mountain Section intensified the storm. It was raining heavily from Johnstown to Harrisburg on May 30 and 31, 1889 – according to the Johnstown Observer, Johnstown had already gotten

2.3 inches of rain by 11 AM of May 31 (Blodget, as reported by Kaktins and Fry, 1989). There was already some minor flooding in Johnstown, but as this was not unusual, no one thought much of it.

> It is not clear what was the total precipitation amount because the Johnstown station observer (a Miss Ogle) became one of the casualties in the subsequent flood. Blodget (1890) estimated that the Johnstown valley received 3 to 3.5 in of rainfall, and that the highlands areas perhaps twice that amount. The Franklin Institute isohyetal (equal rain-fall) map for the storm shows Johnstown experienced 5 to 6 in for the 26 hour duration of the storm. What is clear is that the area east of the Allegheny Front was actually hit harder by the storm than Johnstown. For example, the storm dumped 8.2 in on Harrisburg, 8.99 in on McConnellsburg, and caused record flooding in the Juniata River valley (Blodget, 1890). Floods also devastated the James and Potomac River basins in Maryland and Virginia, and the upper Allegheny River and Genessee River in New York. Of all the destruction caused by this storm system, across an area in excess of 12,000 sq mi (31,000 sq. km), however, it is the flooding in Johnstown that is remembered to this day. (Kaktins and Fry, 1989, p. 139-140)

Regardless of the amount of rain that actually fell on the Johnstown area, it raised the lake level and caused debris to clog the spillway, thus reducing its effectiveness even more. Johnson's (1889) purple prose pretty much says it all:

> Friday, May 31st, 1889. Record that awful date in characters of funeral hue. It was a dark and stormy day, and amid the darkness and the storm the angel of death spread his wings over the fated valley, unseen, unknown. Midday comes. Disquieting rumors rush down the valley. There is a roar of an approaching storm – approaching doom! The water swiftly rises. A horseman thunders down the valley: "To the hills, for God's sake! To the hills, for your lives!" They stare at him as at a madman, and their hesitating feet linger in the valley of the shadow of death, and the shadow swiftly darkens, and the everlasting hills veil their faces with rain and mist before the scene that greets them . . . The heavy rainfall raised the lake until its water began to pour over the top of the dam. The dam itself – wretchedly built of mud and boulders – saturated through and through, began to leak copiously here and there. Each watery sapper and miner burrowed on, followers swiftly enlarging the murderous tunnels. The whole mass became honeycombed. And still the rain poured down, and still the South Fork and a hundred minor streams sent in their swelling floods, until, with a road like that of the opening gates of the Inferno belching forth the legions of the damned, the wall gave way, and with the rush of a famished tiger into a sheepfold, the whirlwind of water swept down the valley on its errand of destruction –
>
> "And like a horse unbroken,
> When first he feels the reign,
> The furious river struggled hard,
> And tossed his tawny mane,
> And burst the curb, and bounded,

Rejoicing to be free,
And, whirling down in mad career,
Battlement and plank and pier,
Rushed headlong to the sea!"

In more matter-of-fact terms, at just after 3:00 PM the water spilling over the center sag of the dam caused the dam to fail, sending 20 million tons of water sluicing down the narrow Little Conemaugh River valley. The valley walls are steep, so the floodwaters had nowhere to go but downstream. The leading edge of the flood, swelled with enormous chucks of debris, was as much as 75 feet high and churned toward Johnstown at 40 miles per hour. To get an idea of the force of the flood, imagine if Niagara Falls were suddenly turned into the Little Conemaugh River valley for 35 or 45 minutes (the time it must have taken for the lake to empty).

The resulting flood is considered the third worst disaster in American History after the San Francisco earthquake of 1906 and the Galveston hurricane of 1900.

Thousands of people were swept up in a slurry of dirty water, mud, and tons of grinding, crushing debris that has been described as a mountain of rubbish moving at the speed of a locomotive. Nothing stood in its way; even the Conemaugh Viaduct, constructed to carry the Allegheny Portage Railroad over the Little Conemaugh River at the entrenched meander loop west of South Fork, was swept away. When the floodwall hit Johnstown, everything in its path was destroyed. The wall only stopped moving forward when it hit the side of Laurel Hill, causing a wave of water to back up into the Stoneycreek River, destroying many of the buildings in the floodplain south of Johnstown as well. Amazingly, the flood lasted only about 10 minutes in Johnstown; but the flood was just the beginning of the disaster. The Old Stone Bridge of the Pennsylvania Railroad just downstream of the convergence of the Little Conemaugh and Stoneycreek rivers stood its ground. But much of the debris, which included dead horses, trees, railroad cars and locomotives, houses, and other things the flood had destroyed, got caught up against the arches of the bridge and created a huge dam about 40 feet high. The floodwaters spread out over 30 acres trapping numerous victims of the flood.

But before anyone could be rescued, the debris caught fire and those who had escaped the ravages of the flood, only to be caught in the debris, were soon burned alive. Many of the bodies recovered from the devastation were never identified, and many hundreds of people went missing and were never found. In all, more than 2,200 people died, thousands were left homeless, and the once prospering city of Johnstown became a debris-clogged wasteland (Figure 53). The cleanup took years, with virtually no assistance from the wealthy people who were directly responsible for the disaster. Johnstown eventually rebuilt, but it took five years for the city to recover from the devastation.

For the complete story of the Johnstown flood, see McCullough (1968) and Law (1997). I also recommend Johnson (1889), who provided an early, florid, account of the flood. Just be prepared for some good old-fashioned, late Victorian, passionate and very opinionated writing.

Return to the cars and leave the parking area.

0.10	126.45	Turn left toward Saint Michael.
0.50	126.95	Turn right into the parking area.

A

B

C

Figure 53. Historical photographs of the destruction resulting from the Johnstown flood of 1889. A – ruins along the path of destruction. B – view from the corner of Main and Clinton streets, near the canal basin. C – ruins of the Cambria Iron Works (from Ehrenreich, 2000).

STOP 9. SOUTH FORK DAM

This will be a brief stop to let people take pictures of the breached dam (Figure 54). Return to the vehicles and continue on to PA 869 in Saint Michael.

Figure 54. Photograph of the breached South Fork Dam as it appears today.

Leave Stop 9 and return to PA 869 in St. Michael.

1.30	128.25	Turn right onto PA 869 West and proceed back toward Summerhill.
1.20	129.45	South abutment picnic a rea to the right.
0.25	129.70	Pass beneath US 219.
		Continue straight on PA 869 West.
0.25	129.95	PA 869 ends. Bear right onto PA 53 toward South Fork.
0.15	130.10	Cross South Fork.
0.10	130.20	Saltsburg sandstone outcrop on the right.
0.55	130.75	Enter the Village of Rockville. Bedrock is middle Glenshaw Formation.
0.25	131.00	Enter the Borough of South Fork. The Glenshaw-Allegheny boundary is just about at the Borough line. Mine waste on the surrounding hills is from both deep and strip mining of most of the Allegheny Group coals.
1.15	132.15	Turn left and cross the Little Conemaugh River.
0.10	132.25	Enter the Village of Ehrenfeld. A guy named Charles Dennis Buchinsky was born here on November 3, 1921, one of fifteen children born to Lithuanian immigrant parents. He was the only member of the Buchinsky family to complete high school, but that didn’t stop him from helping to support his family by working in the coal mines. He eventually left Ehrenfeld and went to Hollywood, California where he changed his name to Charles Bronson (yes – THE Charles Bronson). He once said, "I guess I look like a rock quarry that someone has dynamited." Despite his craggy, unconventional features and taciturn manner, he became an international star relatively late in his career, depicting men of action who were not afraid to use violence to get a job done.
		Turn right onto Portage Street. The actual Portage Railroad right-of-way is below us.
0.10	132.35	Mountains of coal mine waste on the left from both strip and deep mines in the Allegheny Group coal seams. You can see the Portage right-of-way, now a street in Ehrenfeld, on the right.
1.30	133.65	Stop sign. US 219 crosses the road to the right. Turn left and head uphill.
0.75	134.40	Turn left onto SR 3030.
1.75	136.15	Cross the axis of the Ebensburg anticline around this point.

1.70	137.85	Enter the Village of Mineral Point. The first warnings to the city of Johnstown of the impending flood came from this town.
0.30	138.15	Turn left on Beech Hill Road and cross the bridge over the Little Conemaugh River.
0.15	138.30	Pass beneath the railroad tracks.
0.15	138.45	Turn right into the parking area on the right.

STOP 10. THE STAPLE BEND TUNNEL AND INCLINED PLANE NO. 1

This will be another very brief stop because, in their infinite wisdom, the National Park Service has made Staple Bend Tunnel and Inclined Plane No. 1 accessible only to physically active people. Below the parking lot is the right-of-way of the Portage Railroad. It is now a biking and hiking trail. Staple Bend Tunnel is two miles west of this point along the trail, too far away to walk to and from during this field trip, and inaccessible to vehicular traffic. Therefore, this stop will provide only a brief description of what we WOULD see if we had the time or the means to get to the tunnel.

Tunnels were still very new in the United States in the 1830s, existing on only a few canals. In fact, in 1825 when the early canal engineers first considered the idea of digging a tunnel through the Allegheny Mountains to carry the Pennsylvania Mainline Canal from the Juniata to the Conemaugh, they had to define the term "tunnel" in their reports to the Canal Commissioners (". . . to be like a large well dug horizontally through a hill or mountain.").

The Staple Bend Tunnel, which was constructed between 1831 and 1833, was the first railroad tunnel, and the third tunnel of any kind, built in the United States (Graciano Corporation, 2001). Much of it was hand-dug by Irish immigrants and Welsh miners (who had a lot of experience with black powder). The tunnel cut through a ridge at the top of Inclined Plane No. 1 (Figure 55) where the Little Conemaugh River flowed in a broad entrenched meander. By constructing the tunnel, rather than following the river, the railroad saved two-and-a-half miles of track. The tunnel is 19 feet high and 20 feet wide within the arch, and penetrated 901 feet of lower Allegheny Group and Upper Pottsville strata (Glover, 1990, shows the Brookville coal at the surface near both portals, and Phalen, 1910 observed the Mercer clay in the tunnel), and the portals are decorated with limestone (Figure 14). For 150 feet at each end, its arches were made of cut stone. It cost $37,498.84 to build. Inclined Plane No. 1, on the south side of the tunnel, is 1,607.74 feet long and rises 150 feet (Wilson, 1897) (Figure 56).

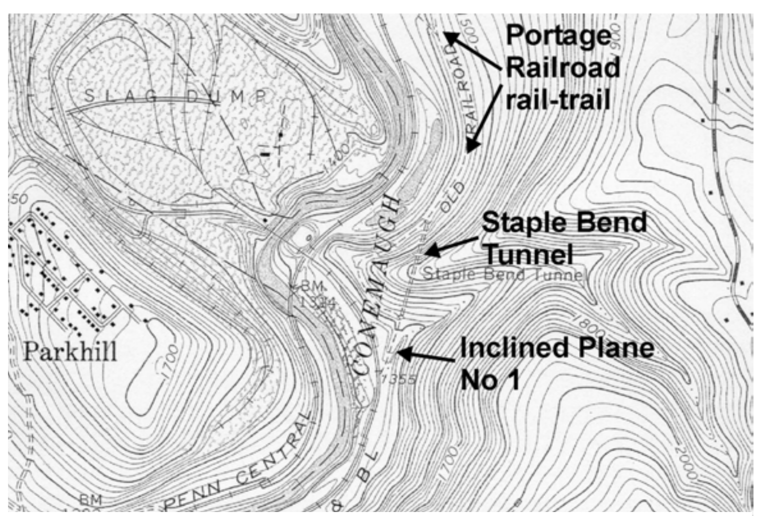


Figure 55. Topographic map of a portion of the Geistown 7½ -minute quadrangle, showing the location of the Staple Bend Tunnel and Inclined Plane No. 1.

After many years of neglect, Staple Bend Tunnel was given a facelift by the National Park Service with a $2.4 million federal appropriation. The tunnel officially

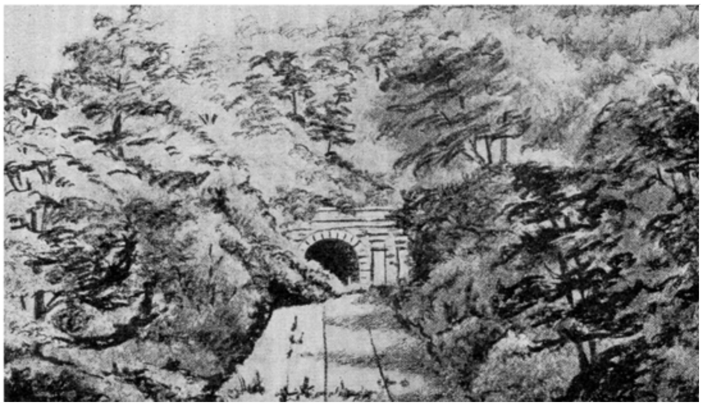


Figure 56. Illustration of Inclined Plane 1 and the Stapple Bend Tunnel (from Baumgardner and Hoenstine, 1952). This was the first railroad tunnel built in America.

reopened in July, 2001 as part of the Allegheny Portage Railroad National Historical Site. Preservation work on the tunnel entrances involved repointing the masonry, stonework repairs, and cleaning of the carved stone. Tunnel work included placement of rock bolts, shoring posts, and repointing the masonry. The appropriation also helped the Park Service build the two miles of hiking/ biking trail on the old railroad bed from the tunnel to Mineral Point. Cambria County Conservation & Recreation Authority also has plans to extend the trail two miles south to Franklin and about four miles north to Ehrenfeld. This will create an eight-mile, nearly level trail. Unfortunately, the trail is the only access to the tunnel.

Return to the vehicles and return to Beech Hill Road.

0.10	138.55	Return to Beech Hill Road and turn right.
0.20	138.75	Notice the Pottsville Group sandstone float on the hillsides.
0.40	139.15	Pull to the right side of the road and park.

STOP 11. THE CONEMAUGH VIADUCT

This will be another brief stop. We will walk through the field on the left across the road to the edge of the hill. From this vantage point we can look west to the great entrenched meander of the Little Conemaugh River and the place where the Conemaugh Viaduct used to be.

The Conemaugh Viaduct, built for the Allegheny Portage Railroad in 1832-33, was one of the earliest railway bridges in the country.

When the railroad reached Horseshoe Bend on the Little Conemaugh River, an entrenched meander loop (Figure 57), the railroad crossed the stream and cut across the narrow neck of the loop, thereby saving about two miles of distance (the length of the loop). This required a rather high bridge, which turned out to be an imposing structure (Figure 13). Solomon W. Roberts designed and supervised its erection by a stonemason named John Durno (Roberts, 1878). Originally, the bridge was to have two arches spanning 50 feet each, but the plans were altered and the final structure was 78½ feet high with a single semi-circular arch 40 feet high and spanning 80 feet. The arch was 3½ feet thick at the springing line, and three feet at the crown. The embankment at the end of the viaduct was 64 feet high. The foundation was built on timber on one end and on rock on the other (Wilson, 1897). From the foundation to the springing line of the arch the abutment walls were 29 feet high. The viaduct was 28 feet wide at the top of the parapets and 40 feet wide at the foundation.

The arch stones were cut from large erratic blocks of light-colored sandstone that were

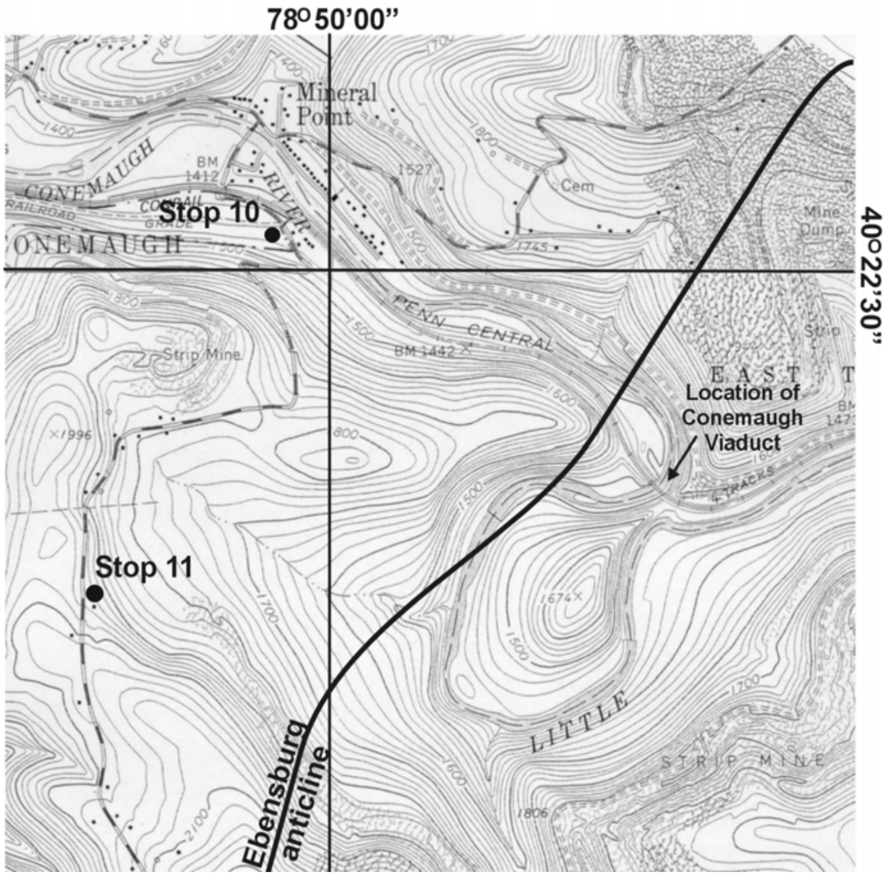


Figure 57. Topographic map of a portion of the Geistown and Nanty Glo 7½ - minute quadrangles, showing the locations of the entrenched meander loop of the Little Conemaugh River and the former location of the Conemaugh Viaduct.

found lying in the woods nearby. These were probably Pottsville Group sandstone blocks – the Pottsville crops out on the hillside where the river cuts through the Ebensburg anticline (Figure 57). The backing stone for the bridge was cut from Loyalhanna Formation sandstone, which is also found nearby within the Little Conemaugh River gorge. The face stones were cemented using mortar made from the Loyalhanna without the need for adding sand to the mix (Roberts, 1878). The viaduct was completed in the early spring of 1833 at a total cost of $54,562.54 (Wilson, 1897). It stood solid, in constant use for 55 years by the Portage Railroad and the Pennsylvania Railroad until it was destroyed on May 31, 1889 by the Johnstown flood.

A previous flood, in October, 1847, caused the bed of the Little Conemaugh River to wash out beneath the foundations of the viaduct. The railroad attempted to repair the damage by building a dam downstream and filling the washed out areas with brush and stone. Wilson in Baumgardner and Hoenstine (1952) speculated that these actions may have ultimately assisted in destroying the viaduct.

When the huge wave of debris-clogged mud later called the Johnstown flood came roaring down the Little Conemaugh River valley, the first obstacle it struck was the Conemaugh Viaduct. It has been estimated that the weight of the water was 18,000,000 tons, moving at a velocity of 15 miles per hour, in a narrow gorge with a fall of 53 feet per mile (a 1% grade). When it hit the viaduct, the water dammed up against it to the depth of 90 feet (Wilson, 1897). The viaduct stood solid temporarily, blocking the flood, which backed up in the river valley farther than South Fork. When the viaduct collapsed and was swept away, the backed-up flood surged forward, washing out the Pennsylvania Railroad for miles. It also swept South Fork away. It is hard to believe the flood didn't cut the neck of the meander loop and create a new channel.

The Pennsylvania Railroad eventually rebuilt the bridge over the Little Conemaugh River at the location of the Conemaugh Viaduct, but this one was made of steel and has stood for over 110 years.

Turn the vehicles around and return to Mineral Point.

1.85	141.00	The earth embankment directly ahead as we cross the Little Conemaugh River is the dam for Saltlick Reservoir – another earthen dam in the Little Conemaugh River valley!!! Turn left onto SR 3030.
0.15	141.15	Allegheny Group sandstones on the right.
0.10	141.25	Good view of the Portage Railroad right of way across the valley to the left.
1.40	142.65	Intersection with PA 271 in the Village of Wesley Chapel. Turn left.
1.20	143.85	Bear left onto Truck Route PA 271.
0.55	144.40	Enter the Village of Parkhill.
0.40	144.80	The road to the left is an access road to a large slag dump on the north side of the river. The Staple Bend Tunnel is directly across the Little Conemaugh River from Parkhill. Unfortunately, there are no good vantage points to view it here without trespassing on private property.
0.35	145.15	Outcrop of Mahoning sandstone (Conemaugh Group, Glenshaw Formation) on the right.
0.25	145.40	Good view of the Portage Railroad right of way across the valley to the left where the electric power cables cross the valley.
0.10	145.50	Thick, massive Mahoning sandstone on the right.
0.25	145.75	Outcrop of Upper Freeport coal on right beneath the sandstone.
0.10	145.85	Enter the Borough of East Conemaugh.
0.45	146.30	Turn left, stay on Truck Route PA 271.
0.20	146.50	Cross the Conrail Railroad tracks.
0.05	146.55	Cross the Little Conemaugh River and enter the Borough of Franklin.
0.05	146.60	Cross the Portage Railroad right-of-way.
0.05	146.65	Turn right onto Main Street.
0.05	146.70	Turn right, following Truck Route PA 271.
0.05	146.75	Cross the Portage Railroad right-of-way. Good view of East Conemaugh across the river and depressing view of a manufacturing town in decline on the left. These run-down mills included Bethlehem Steel's plate mill and car shops (where they made railroad cars).
0.45	147.20	The outcrop in the hillside across the river spans part of the Allegheny Group.
0.05	147.25	Enter the City of Johnstown.
0.05	147.30	Cross the Little Conemaugh River.
0.40	147.70	The Portage Railroad right-of-way is to the left across the parking lot and the river.
0.55	148.25	Cross the Frank Pasquerelli Bridge over the Little Conemaugh River.
0.05	148.30	Turn right onto Railroad Street at the end of the bridge. We are back on the Portage Railroad right-of-way.
0.20	148.50	Church Street and Railroad Street intersect with PA 271 at Five Points (see below). Bear right and stay on PA 271 South. The buildings on the

right are the Gautier Mills, built by the Cambria Iron Company in the late 1800s. They have been used almost continuously since their construction, first by Cambria Iron Works, then from 1923 through the early 1990's by the Bethlehem Steel Company. Johnstown America Corporation, manufacturer of railroad cars, currently uses the mills as one of its steel making facilities (Barbin, 1998).

0.05 148.55 Pull over to the curb and park at the meters.

STOP 12. THE JOHNSTOWN CANAL BASIN

We will park next to the Gautier Mill and take a walking tour of the Johnstown Canal Basin, starting at Five Points.

The City of Johnstown

Conemaugh, the original name for Johnstown, is a corruption of the Delaware Indian word (s) *Connu-macht*, meaning “Otter Creek”. The Delaware Indians occupied a town situated at the forks of the Conemaugh River long before European settlers entered this area in the late 1700s. As the Indian name suggests, the river once had a pristine quality that was lost at the end of the 1800s when large-scale coal mining began, allowing the degradation of water by AMD.

Settlers of European descent first came to this area immediately before the French and Indian War in the mid-1700s. The Allegheny Front had long been the treaty boundary between the Native American tribes and the settlers, but, as was typical of the early settlers, the natives were driven out and the area west of Allegheny Mountain was opened for settlement.

Joseph Johns laid out the town he called Conemaugh, located at the confluence of the Little Conemaugh and Stoneycreek rivers where they form the Conemaugh River, in 1800. The town was incorporated in 1831, and in 1834 it was renamed Johnstown in honor of its founder. The city had a major growth spurt during the mid-1880s as a result of iron and steel manufacturing. This was the home of Andrew Carnegie’s Cambria Iron Works, which later became Bethlehem Steel. The surrounding hills had a seemingly endless supply of coal, and iron ore and limestone could also be found. But its greatest resource was the water of its rivers – water for manufacturing, water for drinking, water for transportation.

Despite its manufacturing history, Johnstown is probably most famous today for its lack of foresight and the disastrous consequences that resulted. Johnstown is defined by its topography – it is a two-mile wide floodplain, formed by three rivers draining 34 square miles of upland with the deepest river gap in the eastern United States (Barbin, 1998) as their only egress from the region. In the early settlement years, the floodplains (bottomlands) were used for agriculture. The settlers drained the wetlands to make use of the organic-rich soils and establish numerous fertile fields, which, of course, removed the natural sumps for storing storm water runoff. In addition, dams built in the area to hold large volumes of water for commercial uses increased evaporation and reduced the flow of clean water into the system. The subsequent discovery of coal, iron ore, and limestone in the surrounding hills, along with the construction of the Allegheny Portage and Pennsylvania Railroads, helped establish Johnstown as a thriving manufacturing and transportation center. People flocked to Johnstown for jobs. They built houses, stores, churches, and other buildings on the former wetlands-turned-

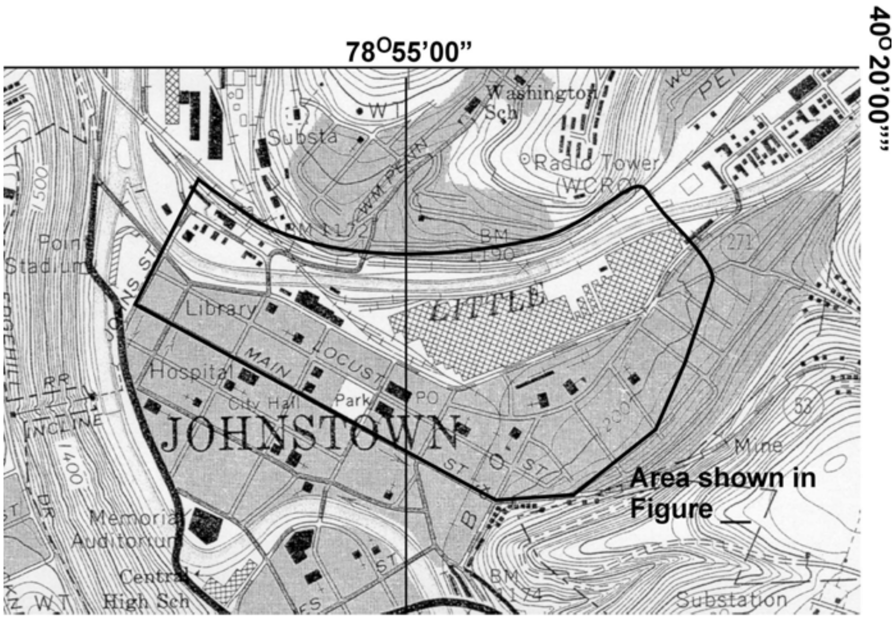


Figure 58. Topographic map of Johnstown, showing the location of the Johnstown canal basin.

farmland. The already overused soil became compacted and covered with structures, macadam, concrete, paving stone, and a variety of other impervious materials that increased runoff even more. Flooding was an annual event before the land was modified, but at least the Native Americans learned to live with it and use it. The paving of Johnstown resulted in increased flooding in the valley, much of it flash flooding during storms. People came to expect getting their feet wet. But even the devastation caused by the anomalous floods of 1889 and 1977, caused by burst dams (Kaktins and Fry, 1989), couldn't convince people not to continue building in the floodplains.

It is likely that Johnstown will continue to have floods, perhaps even large devastating ones. There are, after all, several large dammed reservoirs in the hills around Johnstown. A modern engineer would tell you that these dams are safe, and that failures such as occurred at South Fork and Laurel Run in 1889 and 1977, respectively, are highly unlikely to occur. But in these turbulent times, anything is possible. And even the Corps of Engineers' deteriorating concrete flood walls on the Conemaugh River can provide only a small measure of protection. The only solution to avoiding the devastation of future large-magnitude floods is to retreat to the hillsides, something the city is unwilling to do.

The Johnstown Canal Basin

The Allegheny Portage Railroad reached its final destination (on westward runs) at the canal basin in Johnstown. This basin was situated along the Little Conemaugh River between the intersection of Clinton and Railroad streets on the west and Church and Railroad streets on the east (Figures 58 and 59).

The canal basin (Figure 59) was essentially enclosed by the city to the south and to the north by an island, officially known as Long Island, but commonly called simply "The Island" (Storey, 1907). The Island was about 300 feet wide at the widest point. A smaller island called Goose Island, about 100 feet wide, lay to the west of The Island. Goose Island acted as the north wall of the Johnstown canal (Figure 59, A). The two islands were separated by a waste weir (B), which acted as a sluice for the basin. A feeder channel from the upstream side of the Little Conemaugh River entered the basin through a sluice at the northeast end of The Island (C). A second feeder stream, from Suppes' Dam on the Stoneycreek River south of the city, came into the basin at the present day location of Feeder Street (D). It separated the

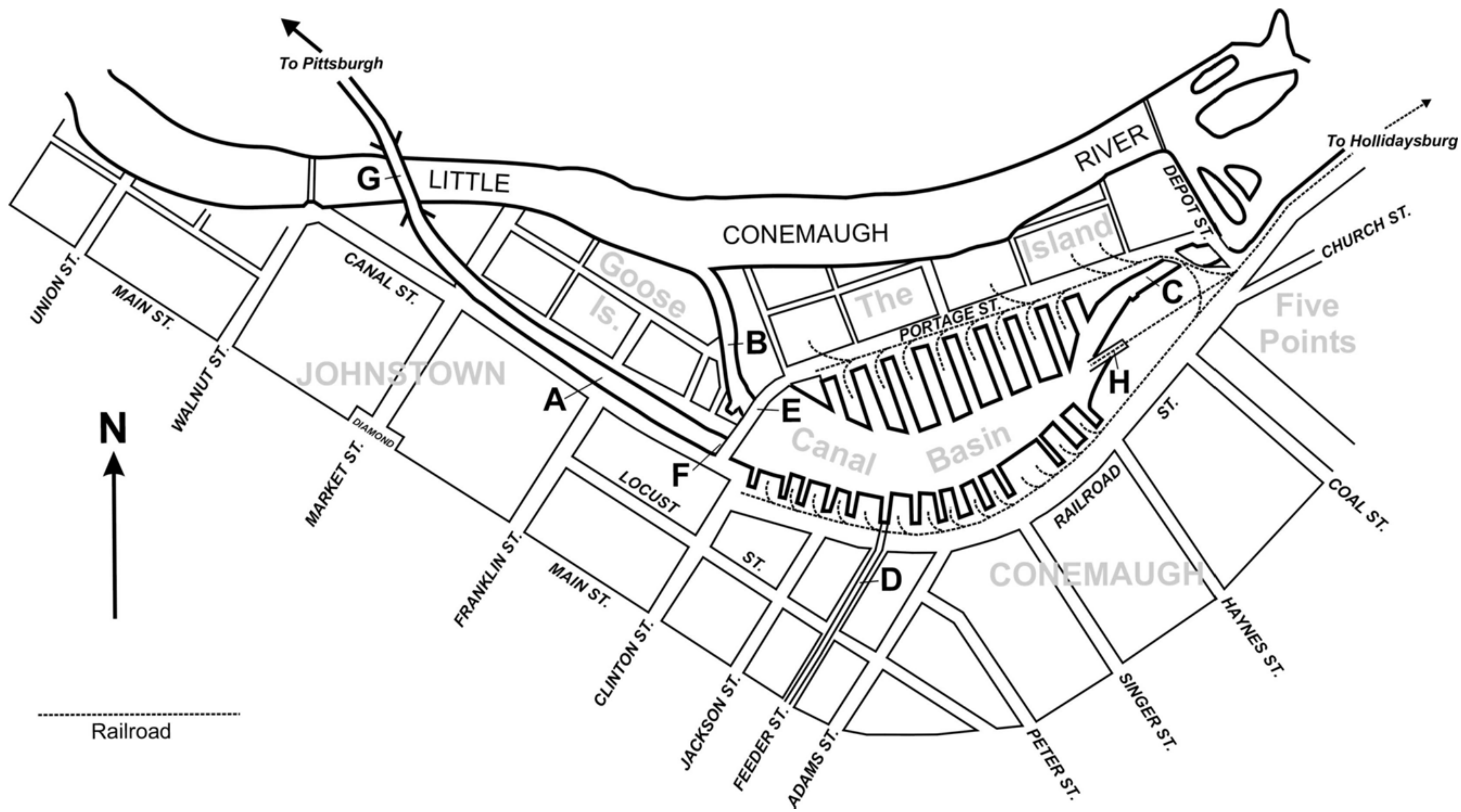


Figure 59. Map of the Johnstown Canal Basin, showing the locations of streets, railroads, and other features. See text for explanation of features.

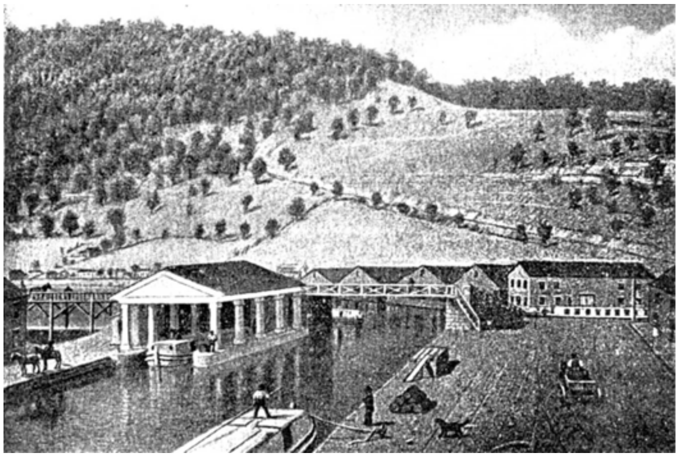


Figure 60. Illustration of the weigh lock at the Johnstown Canal Basin (from Storey, 1907).

city into Johnstown proper on the west and Conemaugh on the east. The Portage Railroad ran between Railroad Street and the basin on the mainland side and between Portage Street and the basin on The Island. The area of Conemaugh at the northeast end of The Island was known as Five Points because Portage, Railroad, Church, and Depot Streets, and the Portage Railroad, converged at that location. This was where railroad, road, and canal met to continue the Pennsylvania Mainline Canal (Storey, 1907).

The canal basin was shaped like a semi-circle. On the south, it started at the packet slip where Canal Street (now called Washington Street) and Clinton Street intersected and followed the curve of Railroad Street to Depot Street at the northeast end of The Island. On the north, it paralleled Portage Street in a straight line to the waste weir. It was 1,800 feet long and 600 feet wide at the widest point (at Singer Street) (Figure 59). Both sides of the basin were lined with warehouses and docks, or slips. Each warehouse had a slip, generally 15 feet wide by 80 feet long, long enough for two boats. One could be loaded while the other was being unloaded. Warehouses extended into the basin from either Railroad Street on the south or Portage Streets on the north. Each occupied a strip of land about 100 feet long and 75 feet wide. One or two sidings extended from the railroad to the rear end of each dock.

At the southwest end of The Island the Overhead Bridge (E) extended from Canal Street, across the canal and the south end of the waste weir, to The Island. It provided access to the freight houses and piers on The Island. It was 300 feet long and wide enough for wagons to pass. It sat on a pier on the Canal Street side, and gradually descended to the level of The Island at Portage Street (Storey, 1907). Prior to construction of the bridge in 1835, the only ways to reach The Island and Goose Island from the mainland were by driving a team across the bed of the Little Conemaugh River or by driving all the way up to Five Points. Unfortunately, the former was difficult at best and at worst, during high water, impossible.

The Johnstown canal (A) was about 60 feet wide and contained at least four feet of water. At the basin end of the canal on the north side, beneath the Overhead Bridge, there was a weigh lock (F) with weighscales (Figure 60). The purpose of the waste weir (B) was to control the necessary amount of water in the basin to float the canal boats, and to make it easier to repair them. If repairs were necessary, water could be let out of the basin. At the northwest end of the canal an aqueduct carried the canal boats across the Little Conemaugh River to a canal that crossed the floodplain between the Little Conemaugh and Conemaugh rivers.

Up until 1835, all canal boats were weighed in Pittsburgh. In 1835, Johnstown got its own weigh lock (F). This allowed the Commonwealth to determine if there were any sneaky business going on between Hollidaysburg and Johnstown, and between Johnstown and Pittsburgh. After a boat had been weighed and its freight accounted for, the captain paid the toll at the Collector's office and received his “clearance papers,” which allowed the boat to continue its trip on the canal. At various places between Johnstown and Pittsburgh the captain had to show his "clearance papers" to state officials. This helped prevent the smuggling of freight onto the boats between weigh locks. The procedure for weighing a boat was the same here as it was at Hollidaysburg (see Stop 1).

Storey (1907, p. 335) called the position of Collector "one of great prominence and importance, and paid a salary of $1,000 per year, with house rent. The office of Collector, as well as that of Weighmaster, was sought after by politicians from every part of the State." The Collector's office sat opposite the weigh lock.

The era of the Johnstown canal basin came to a close around 1851 when the Pennsylvania Railroad started hauling freight between Johnstown and Pittsburgh. The railroad was faster and less expensive than the canal, and would run even during times of low water. When the Pennsylvania Mainline Canal was finally abandoned, Principal Engineer Sylvester Welch and Samuel Jones, who owned The Island, donated Portage Street to the city. There's not much left of the canal basin in Johnstown today. The basin was filled in and Bethlehem Steel built a foundry at the site that encompasses The Island and Goose Island. Much of what was once Portage Street is now occupied by PA 271. Canal Street is now called Washington Street, and several other streets shown in Figure 59 have been given different names as well. The aquaduct over the Little Conemaugh River was replaced by a steel railroad trestle and the canal by railroad tracks.

Truth or Consequences

Shortly after the canal was built, the canal engineers realized that there would be times during the dry summers when there would be too little water in the Little Conemaugh River to keep the basin in operation. The Commonwealth began building a dam on the South Fork in 1835. However, the finances ran out and the project was abandoned for a few years. It was finally completed in 1845, and dammed up South Fork as far as three miles. The South Fork Dam broke in 1847, causing considerable damage to the canal and basin in Johnstown. Two smaller breaks occurred in 1862, but they didn't cause any serious damage. By this time, the Pennsylvania Railroad had dismantled the canal system and abandoned the dam and reservoir. They were purchased and the South Fork Fishing Club rebuilt the dam (more or less). Then came May 31, 1998! (Refer to Stop 8 for more details.)

The Johnstown Flood Museum sits at the corner of Washington (formerly Canal) Street and Walnut Street. It is an impressive building, built in 1891 as a library. Andrew Carnegie gave Johnstown the money to build the library, supposedly to assuage his guilty conscience for having been a member of the South Fork Fishing and Hunting Club, whose failure to maintain the South Fork Dam essentially wiped Johnstown off the face of the earth. The museum has exhibits, displays, photographs, and extensive archives (which can be researched by appointment only). The museum also tells the stories of the 1936 and 1977 floods.

Continue south on PA 271 (Railroad Street).

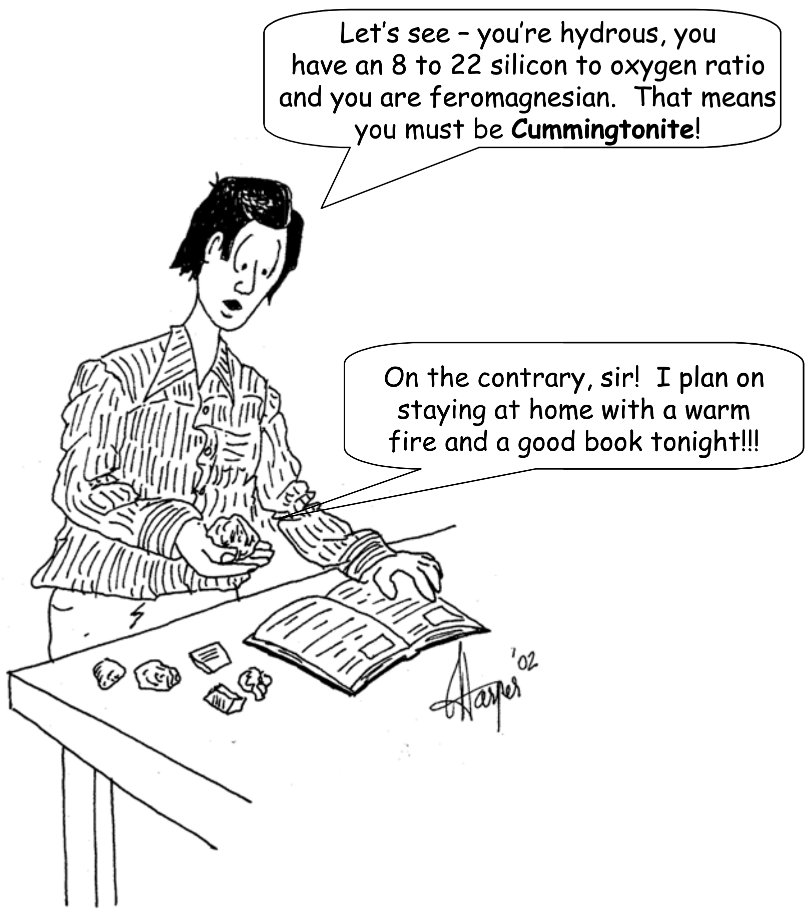
0.30	148.85	Turn right onto Washington Street (formerly Canal Street) at the light. The Penn Hotel at the intersection has a date of 1890. It was built the year after the great flood. The railroad tracks to the right sit on what used to be the Johnstown Canal.
0.25	149.10	If you look between the buildings on the right, you will see a green steel

		railroad bridge. This was built on the location of the Johnstown canal aquaduct across the Little Conemaugh River.
0.05	149.15	The building on the left at the intersection with Walnut Street is the Johnstown Flood Museum. The building on the right was built by Cambria Iron Company as their dispensary. The Pennsylvania Department of Corrections bought and renovated the building in 1995 for use as a halfway house for assisting criminals prior to parole (Barbin, 1998). Continue straight ahead toward PA 56 and PA 403.
0.20	149.35	Intersection with Johns Street. The Johnstown Incline can be seen on the left. Across the intersection to the left is Point Stadium, which offers both professional and amateur hockey and baseball.
0.15	149.50	Cross Stoneycreek River. The confluence of the Stoneycreek and Little Conemaugh rivers to form the Conemaugh River is just to the right of the bridge. Turn right at the traffic light onto PA 56 North and PA 403 North.
0.05	149.55	Turn right onto PA 56 North and PA 403 North at the traffic light.
0.10	149.65	Pass under the Old Stone Bridge, a type of rib-arched bridge, which was built by the Pennsylvania Railroad during 1887 and 1888 (Ehrenreich, 2000). During the Johnstown flood of 1889, it remained firm, and debris that swept down the Little Conemaugh River valley piled up against this bridge and caught fire. Untold numbers of people who survived the flood lost their lives when they were trapped in the conflagration. It was built of local sandstone, laid in cement mortar. Its survival was due more to the materials and workmanship than to any peculiarity of design. It is 50 feet wide with spans of only 58 feet, which makes it an unusually "stiff" structure (Ehrenreich, 2000). The bridge now appears to be mainly concrete because it has been repaired many times since its construction (Barbin, 1998).
0.35	150.00	Enter the Borough of Cambria City. Founded in 1853, Cambria City was the first home to the myriad of immigrants who came to Johnstown to work in the mines and the mills. It is reputed to have a bar and church on every block. Nationality churches and ethnic clubs indicate the area's diverse cultures. The art in the churches represent a celebration of the new citizens of Johnstown of their heritage and their faith (Barbin, 1998).
0.85	150.85	PA 56 and PA 403 diverge. Continue straight ahead on PA 403 North.
0.35	151.20	Turn right at the traffic light and cross the Conemaugh River.
0.10	151.30	Turn left at the end of the bridge.
1.20	152.50	Cross over Laurel Run. This is the creek that carried the 1977 Johnstown flood.
0.40	152.90	Enter Conemaugh River gorge through Laurel Hill.
0.20	153.10	Johnstown Area Wastewater Treatment Plant on the left.
0.10	153.20	Tipple for an old quarry in the Loyalhanna Formation on the right.
0.10	153.30	Outcrops of Upper Devonian and Lower Mississippian Rockwell Formation sandstones on the right.
1.20	154.50	Outcrop of Upper Devonian Catskill Formation on the right. These strata are dipping southeast.

1.00	155.50	Outcrop of the Upper Sandy zone of the Venango Group (Upper Devonian) on the right. The beds here are dipping to the northwest.
0.15	155.65	Enter Indiana County.
0.20	155.85	The massive black sandstone on the right is the Upper Devonian Murrysville sandstone, the same rock that produced gas in the Haymaker well in Murrysville (see mile 6.20).
0.15	156.00	Outcrops of Mississippian shale and sandstone on the right. The sandstone is a conglomerate containing marine trace fossils (e.g. *Bifungites* and *Arenicolites*) and the dark-gray shale is Riddlesburg, a marine to brackish member of the Rockwell Formation east of Laurel Hill and of the Cuyahoga Group west of the anticline. University of Pittsburgh at Johnstown professor Uldis Kaktins and his students have collected a few hard-to-come-by marine fossils (bivalves, cephalopods, and brachiopods) at this locality (U. Kaktins, oral communication, 1989).
0.10	156.10	Outcrops of Lower Mississippian “Rockwell tongue” (Shenango Formation) on the right.
0.30	156.40	Outcrop of Mississippian Burgoon Sandstone on the right.
0.30	156.70	Outcrop of the Mississippian Loyalhanna Formation on the right. The Loyalhanna is still a sandstone here, but the carbonate content has increased from the outcrop seen at Stop 4.
0.15	156.85	Charles F. Lewis Natural Area on Clark Run on right. This is a good place to stop and hike into the hills and down to the railroad tracks.
0.10	156.95	Outcrops of Pennsylvanian Pottsville Group and Mississippian Mauch Chunk Formation sandstones and shales on the right and left.
0.70	157.65	Intersection with PA 711 South. Enter the Village of Cramer.
0.05	157.70	Joyland Restaurant and Bar on the left. Notice the “Ladies Entrance”.
2.80	160.50	Cross US 22 and bear left onto entrance ramp.
0.30	160.80	Merge with traffic on US 22 West.
0.80	161.60	Exit to PA 56 on the right. Continue straight ahead on US 22 West.
4.15	165.75	Exit to PA 259 on the left. Continue straight ahead on US 22 West.
2.85	168.60	Chestnut Ridge summit.
1.10	169.70	Good view of the Homer City power plant on the right.
2.50	172.20	Exit to US 119 North. Continue straight ahead on US 22 West.
1.90	174.10	Enter the Borough of Blairsville.
0.70	174.80	Exit to PA 217 South on the right. Continue straight ahead on US 22 West.
0.20	175.00	Cross the Conemaugh River and enter Westmoreland County.
0.95	175.95	Exit to Truck Route PA 217 on the left. Continue straight ahead on US 22 West.
3.25	179.20	Exit to PA 982 South on the left. Continue straight ahead on US 22 West.
4.50	183.70	Intersection with PA 981 in New Alexandria. Continue straight ahead on US 22 West.
0.60	184.30	Cross Loyalhanna Creek.
0.50	184.80	Exit to US 119 South on the left. Continue straight ahead on US 22 West.

4.35	189.15	Intersection with PA 819.
2.45	191.60	Exit to PA 66 on the right.
7.70	199.30	Intersection with Old William Penn Highway. Continue straight ahead on US 22 West.
1.00	200.30	Exit to PA 286 on the right. Continue straight ahead on US 22 West.
2.00	202.30	Exit to US 22 West on the right. Continue straight ahead on Business US 22.
0.20	202.50	Turnpike entrance ramp to the right. Continue straight ahead on Business US 22 West.
0.20	202.70	Intersection with PA 48. Continue straight ahead on Business US 22 West.
1.70	204.40	Bear right onto entrance ramp to Monroeville Mall.
0.30	204.70	Pass beneath the Expo Mart.
0.15	204.85	Turn left onto Mall Boulevard.
0.40	205.25	Turn right into the Monroeville Mall Park and Ride.

End of the field trip. Drive safely on your return home.



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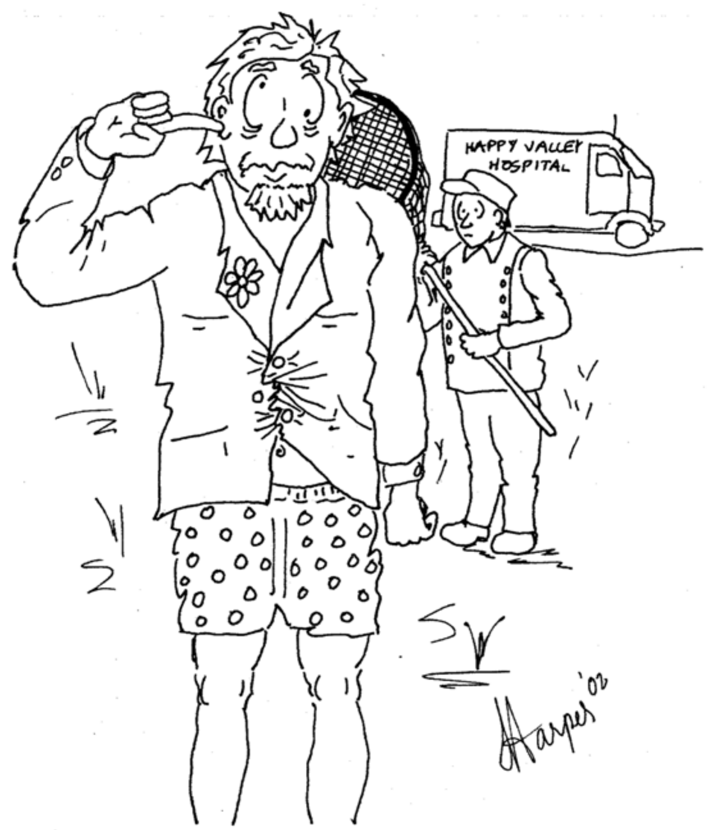

GRAYWACKE -An advanced form of senility, especially prevalent among sedimentary petrologists.