pennsylvania
DEPARTMENT OF CONSERVATION
AND NATURAL RESOURCES

Educational Series 7

COAL

IN PENNSYLVANIA

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF
CONSERVATION AND NATURAL RESOURCES

BUREAU OF GEOLOGICAL SURVEY

COMMONWEALTH OF PENNSYLVANIA
Josh Shapiro, Governor

DEPARTMENT OF
CONSERVATION AND NATURAL RESOURCES
Cindy Adams Dunn, Secretary

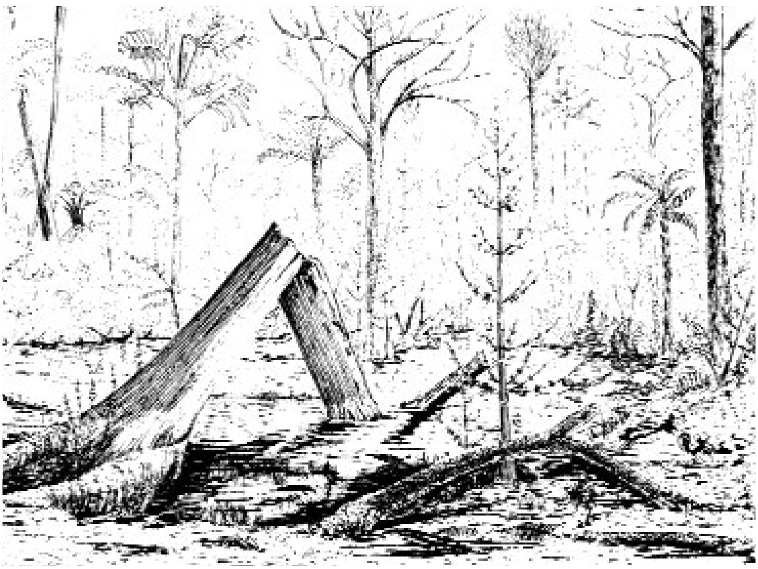
OFFICE OF CONSERVATION AND TECHNICAL SERVICES
Claire Jantz, Deputy Secretary

BUREAU OF GEOLOGICAL SURVEY
Gale C. Blackmer, Director

Educational Series 7

Coal in Pennsylvania

by William E. Edmunds



PENNSYLVANIA GEOLOGICAL SURVEY

FOURTH SERIES

HARRISBURG

2002

When reproducing material from this publication, please cite the source as follows:

Edmunds, W. E., 2002, Coal in Pennsylvania (2nd ed.): Pennsylvania Geological Survey, 4th ser., Educational Series 7, 28 p.

Pennsylvania
Department of Conservation and Natural Resources
dcnr.pa.gov/about/Pages/default.aspx

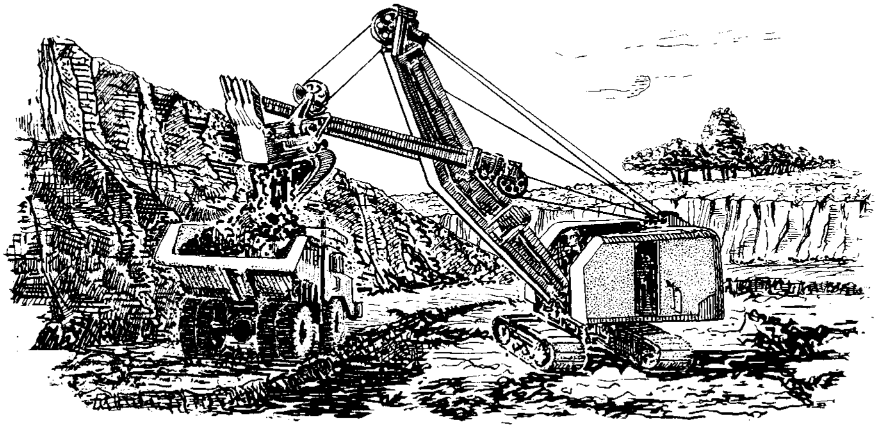
Bureau of Geological Survey
dcnr.pa.gov/about/Pages/Geological-Survey.aspx

Illustrations drafted by John G. Kuchinski and Albert E. Van Olden

Edwin F. Koppe (deceased) is gratefully acknowledged for his help in the preparation of the first edition of this report.

Thanks also to Clifford H. Dodge (Bureau of Topographic and Geologic Survey) for providing updated information in the "Introduction" and "Coal Resources of Pennsylvania" sections for the third printing.

First Edition, 1968
Second Edition, May 2002
Third Printing, Slightly Revised, June 2006
Fourth Printing, December 2023



COAL IN PENNSYLVANIA

by William E. Edmunds

INTRODUCTION

Noted geologist David White once said, “Coal is like character—the deeper you go into it, the more interesting it becomes.” Except in areas where it is mined or is being transported in long strings of railroad coal cars, coal is rarely seen in modern America. Nevertheless, it is a present and important factor in everyone’s daily life. It is burned to generate our electricity and to make our iron and steel. It is refined to make medicines, plastics, synthetic rubber, fertilizer, cosmetics, food products, paint, dyes, and even the fibers of our clothes.

The history of coal is a long one, stretching back 25 centuries or more. In the fourth century B.C., the Greek philosopher Aristotle mentioned coal in his book, *Meteorology.* Coal was commonly used in Europe as early as the thirteenth century; however, with the invention of the steam engine, which provided the powerful lifting, drawing, and pumping equipment necessary for large-scale mining, coal became a major industry.

The earliest known mention of coal in North America is of that on Cape Breton Island, Canada, in 1672. A map made by the explorer Joliet in 1673 shows a coal location in Illinois.

The earliest note of coal in Pennsylvania appears on a map made by John Pattin in about 1752, which indicates coal at a site along the Kiskiminetas River a few miles below the present community of Saltsburg on the Indiana-Westmoreland County line. The earliest record of actual coal mining in Pennsylvania is shown on a "Plan of Fort Pitt and Parts Adjacent" in 1761. Fort Pitt was located in what is now downtown Pittsburgh where the Allegheny and Monongahela Rivers join to form the Ohio River. The mine was located across the Monongahela River near the top of Coal Hill (now called Duquesne Heights). These early miners removed the first few tons of coal from the fabulous Pittsburgh seam, which has been called, with considerable justice, the world's most valuable single mineral deposit. The first mine superintendent was Major Edward Ward of the Fort Pitt garrison.

The Fort Pitt mine was also the site of another less enviable "first"—the first mine fire. In 1766, the Presbyterian minister Charles Beatty wrote: "A fire being made by workmen not far from where they dug the coal, and left burning when they went away, by the small dust communicated itself to the body of the coals and has set it on fire, and has been burning almost a twelve month entirely under ground . . ."

The first clear record of anthracite coal appears on a map prepared by John Jenkins, Sr., in 1762, which showed "stone coal" in two places. The first use of anthracite was by the Gore Brothers in their blacksmith shop at Wilkes-Barre in 1769.

The coal industry grew slowly but steadily from those early days, matching the growth of American industry. The great expansion in coal mining took place following the Civil War, when coal powered the vast industrial revolution of the late nineteenth and early twentieth centuries. Pennsylvania's great reserves of high-quality coal, including coking coal, were directly responsible for the presence of our iron and steel, chemical, glass, and metal-fabricating industries. Much of the railroad network in Pennsylvania was specifically constructed to transport coal.

The Pennsylvania coal industry saw its greatest year in 1918, when 330,000 miners produced a staggering 277 million tons of coal worth $705 million at that time. World War I was at its height, American industry was straining every muscle, and virtually everything that required power ran on coal—industry, railroads, steamships, electrical generation, and most home and commercial heating.

The years following World War I, which led into the Great Depression of the 1930s, saw American industry virtually grind to a stop and coal requirements decline accordingly. In 1944, during World War II, coal production again peaked at almost 209 million tons, but declined steadily thereafter until 1961 when 80 million tons was mined. Something else had happened. Coal was assailed on all sides by vigorous competitors. Most of the home and commercial heating market was lost to oil and natural gas. Railroads and steamships converted to oil. New processes displaced coal from part of the basic metal-smelting industry, and although coke is still required in iron making, improved technology decreased the amount of coke needed to produce a ton of iron.

Coal production stabilized at between 80 and 95 million tons per year from 1961 to 1981, then fell irregularly to 63 million tons in 1993, the lowest figure since 1885. This decline reflected the severe contraction of coal markets in coke production, retail and commercial sales, and industrial use, as well as the depletion of many of the most accessible coal deposits and more stringent environmental regulation. Although sales to electric utilities grew somewhat, much of the potential there was lost to nuclear energy.

With continued increasing demand for electricity and the end of new nuclear plant construction, coal production has increased rapidly in the past several years, reaching a high of 87 million tons in 1998. Output in 2004 totaled 75 million tons. Fifty percent of Pennsylvania production now comes from large underground mines in Greene County. Approximately 7,000 Pennsylvanians were directly employed in coal mining in 2004.

The economic benefits derived from the widespread use of coal have not come without serious cost to the environment. Acid drainage from coal-mining operations has caused extensive pollution of streams and loss of fish and other wildlife. Mining also results in disruption of groundwater resources, soil erosion, and scarring of the land. Abandoned piles of waste material left behind from coal mining and coal processing blight many areas and contribute to surface water and groundwater pollution. Increasingly strict regulation of coal mining and processing has reduced harmful side effects, and remedial work has corrected some of the past damage. Still, many mining-related environmental problems can be expected to persist into the future.

You have now learned something of coal's industrial importance and its impact on Pennsylvania, but what is this black rock that burns? Where is it found? Why is it found in one part of Pennsylvania and not another? What are the different types of coal? How is it used? The following sections contain answers to some of these questions.

WHAT IS COAL?

Miners tell us that coal is a black rock that occurs as layers in the earth that can be mined continuously for many miles. Most of these coal layers found in Pennsylvania range from a few inches up to 10 or 12 feet in thickness.

A geologist describes coal as a black rock composed of thermally altered and highly compressed plant material that grew millions of years ago in swamps and then was buried under great thicknesses of sand and mud. It now occurs as extensive layers within the rocks beneath the earth's surface.

Chemists say that coal is a rock composed mostly of the elements carbon, hydrogen, and oxygen, plus smaller amounts of many other elements such as nitrogen, sulfur, phosphorus, and calcium, all combined in highly complex chemical compounds. In addition, a chemist would note that these chemical compounds are of the type that take up energy when they are formed and give off energy when they break down and return to their original state. It is this bound-up energy that is released when coal is burned.

A biologist would further point out that carbon, hydrogen, and oxygen are the main constituents of the complex compounds making up living plants, and these same compounds hold energy derived from the sun. Also, the biologist knows that when a plant dies, it is usually exposed to bacterial action and decay in the atmosphere. The chemical processes by which the plant stored the various elements and the sun's energy are quickly reversed, and these elements and the energy are released. Only if the dead plant material is protected from decay, as by natural burial by sediments, can this reversal be stopped.

Thus, coal is a rock composed of the altered and compressed remains of plant material, which, by burial, escaped decomposition and which occurs as layers within the surface rocks of the earth. Figure 1 shows that coal contains, stored within itself, the elements and sun's energy that these plants collected into their own constituent compounds when they grew many millions of years ago. When coal is burned, these stored elements and energy are released just as when a piece of wood is burned.

HOW IS COAL FORMED?

Coal is principally derived from plant material, so in order to form coal, a plentiful source of plants is needed. Because dead plant material is very delicate and subject to decay when left exposed to the atmosphere, a method of protecting it is necessary. Finally, coal is very much unlike plant material in appearance, having been considerably altered and greatly compressed, and, therefore, a method to accomplish these changes is needed.

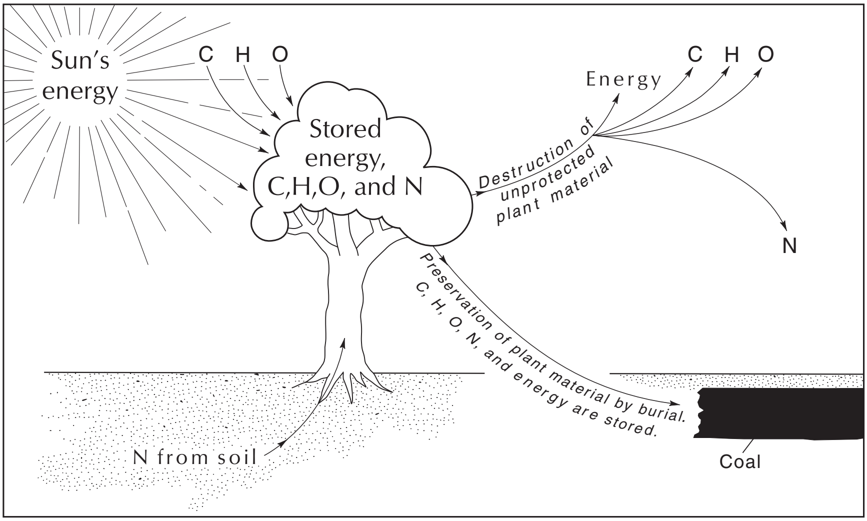


Figure 1. Source of the chemical elements and energy stored in coal. C, carbon; H, hydrogen; O, oxygen; N, nitrogen.

Anyone who has ever visited or seen pictures of the vast Everglades Swamp of Florida or the swamps of the floodplain and delta of the lower Mississippi River has obtained some idea of the kind of place that provided the great quantities of plant material that later became coal layers in Pennsylvania. The frontispiece of this booklet shows a typical swamp scene, and Figure 2 shows a view of one type of coastal swamp that existed in Pennsylvania during the time when the coal-forming plants first accumulated, approximately 320 million years ago.

The trees and other plants that grew abundantly in and around the shallow swamp produced a great accumulation of fallen leaves, twigs, branches, and trunks. These settled to the bottom of the shallow swamp water or formed thick floating mats upon which other plants lived and died, adding still more plant debris. The stagnant water of the swamp helped to preserve the dead plant material from decay. This accumulation of partially decomposed plant material is called peat—the first step to becoming coal.

The geography of Pennsylvania today bears little resemblance to that of coal-forming times. Our rugged mountains, high ridges, and long valleys did not yet exist at that time. Except in the southeastern quarter of the state, all land was low and flat and had rivers flowing westward to drain into

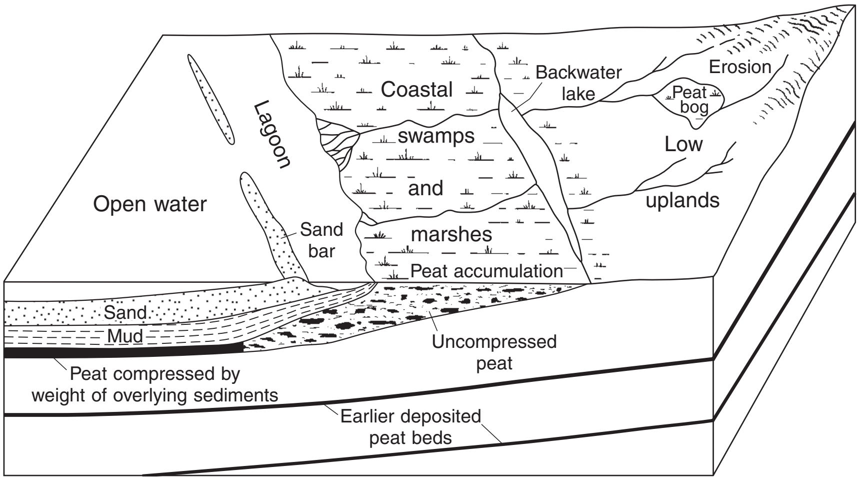


Figure 2. The accumulation of peat in coastal swamps.

and through densely vegetated floodplains and coastal swamps, where peat accumulated (Figure 2). Periodically, the rivers overflowed into the swamps, burying and compressing the peat under thick layers of sand and mud. In other cases, the sea encroached landward into the swamps, covering the peat with marine mud. After burial, the peat remained protected from decay.

We have learned how the first two requirements for the formation of coal—a source of plant material and preservation of that material from decay—are accomplished. Now we will see how this collection of bark, leaves, and wood becomes shining black coal.

The alteration from plant fragments to coal is a gradual change, consisting of many stages. The product of each of the intermediate stages is known by a different name and is basically a change in the proportions of the three principal elements—carbon, oxygen, and hydrogen. Table 1 shows the sequential stages (called ranks) in the development of coal. The amount of carbon, oxygen, and hydrogen and the heating value for each are also shown.

The change from plant material to peat, lignite, and higher ranks of coal is effected by two somewhat different processes. One process is biological and chemical, involving the action of bacteria and, for the most part, affecting only the peat and early lignite stages. The other process is physical and chemical and is brought about by the application of heat.

Table 1. *Carbon, Oxygen, and Hydrogen Content and Heating Value for Examples of the Various Stages (Ranks) of Coal Development*[1]

Coal rank	Carbon (percent)	Oxygen (percent)	Hydrogen (percent)	Heating value in Btu per pound of coal[2]
Wood	49.2	44.5	6.3	6,500
Peat	59.0	35.0	6.0	4,500
Lignite (North Dakota)	72.0	22.5	5.5	7,000
Subbituminous coal (Wyoming)	78.0	16.5	5.5	9,300
High-volatile bituminous coal (Illinois)	82.0	12.5	5.5	11,250
High-volatile bituminous coal (Ohio)	84.5	10.0	5.5	13,250
High-volatile bituminous coal (Pittsburgh, Pa.)	87.5	7.0	5.5	13,850
Medium-volatile bituminous coal (Connellsville, Pa.)	89.5	5.0	5.5	13,850
Medium-volatile bituminous coal (Clearfield, Pa.)	90.5	4.5	5.0	14,100
Low-volatile bituminous coal (Broad Top, Pa.)	91.5	4.0	4.5	14,350
Semianthracite coal (Bernice, Pa.)	92.5	3.5	4.0	13,750
Anthracite (Pennsylvania)	94.0	3.0	3.0	13,600
Graphite (Chester, Pa.)	100.0	0.0	0.0	—

[1]Adapted from Ashley (1928).

[2]One Btu (British thermal unit) is the amount of heat necessary to raise the temperature of 1 pound of water 1°F. The higher the Btu content of a coal, the more heat it will produce when burned.

After dead plant debris sinks into the waters of the swamp in which it grew, bacteria go to work, breaking down the cell structure and reducing the plant material to rotted wood and leaves, fine fragments, or a jellylike mass. Bacterial action probably continues for only a short time after the peat is buried under sand and mud deposits in the swamp. As the layer of sediment grows thicker, its weight compacts the peat to a small fraction of its original thickness, driving out moisture and closing pore space.

Beyond the peat stage, the process of coal formation is advanced largely by the action of heat, which raises the rank of coal by driving off moisture and gases. Temperature increases steadily as the peat is buried deeper and deeper below the surface of the earth. As thousands of feet of sediments are added, the increasing heat sequentially alters peat to lignite, subbituminous coal, bituminous coal, and, finally, anthracite. This process of coalification works slowly and brings about these changes over large areas.

GEOLOGIC HISTORY OF THE COAL-BEARING ROCKS OF PENNSYLVANIA

All of the important coals of Pennsylvania were deposited during a portion of the earth's history named in honor of our state—the Pennsylvanian Period. Where the Pennsylvanian Period fits into the geologic time scale is shown in Figure 3.

As noted in the section on "How is Coal Formed?," the Pennsylvania coals were formed in river floodplains and coastal swamps. Wherever a swamp existed, a layer of coal-forming peat accumulated. The layer was then buried by mud and sand. This happened again and again, and as time passed, each layer of peat became coal, and the covering sediments hardened into sandstone, shale, and limestone. The final result was a sequence of rocks more than 4,000 feet thick, consisting of widespread layers of coal separated by thick intervals of other rock types. Roughly, it resembles a thick book, in which every twentieth page is made of black paper to represent the coal seams.

Coals occur in some rocks of other ages in this state, but all are minor in comparison with the vast, economically valuable coal seams of the Pennsylvanian Period.

All of the coal layers were originally deposited as virtually flat-lying beds. Subsequent periods of mountain building in Pennsylvania, however, have folded and broken the rocks to varying degrees. Most of the bituminous coal fields of western and north-central Pennsylvania were only mildly affected by this mountain building. Here, the beds are only slightly folded, as shown in Figure 4. In the anthracite area, however, the layers have been bent into large folds and occasionally broken along great cracks or faults in the earth, as shown in Figure 5.

PLANTS AND ANIMALS OF THE COAL-FORMING PERIOD

We have already been told that coal seams originate as thick collections of plant material. Our plants of today bear little resemblance to plants of the Pennsylvanian Period, which grew in and around the coal swamps. There were no oaks or elms or pine trees, no fruit trees, no grass,

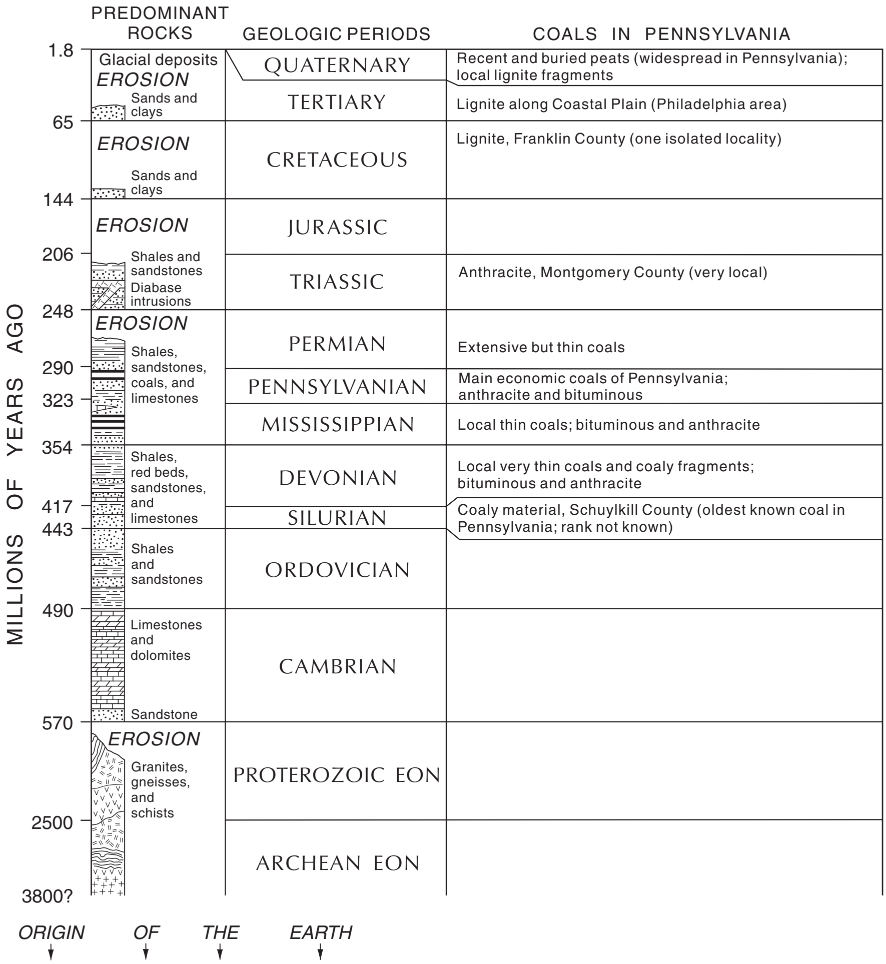


Figure 3. Geologic time scale and the age of Pennsylvania coals.

no flowering plants of any kind. Let us see what some of these ancient plants looked like when they were alive.

Because the fossil remains of these ancient plants represent the broken fragments of many species mixed together, it is difficult to determine which leaves, branches, bark, and roots went together in the original plant. It is very much like mixing together the pieces of several jigsaw puzzles and then trying to sort them out again in order to do each of the puzzles.

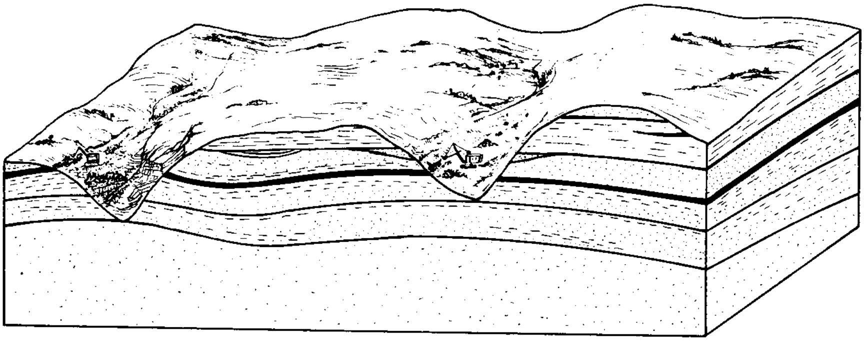


Figure 4. Schematic block diagram of western Pennsylvania showing nearly horizontal coal strata.

Some of the more outstanding plants of the Pennsylvanian Period are shown in Figures 6 through 12. *Lepidodendron* (Figure 6) and *Sigillaria* (Figure 7) were tall, slender trees up to 100 feet high that had narrow leaves up to 30 inches long. *Cordaites* (Figure 8), an ancestor of

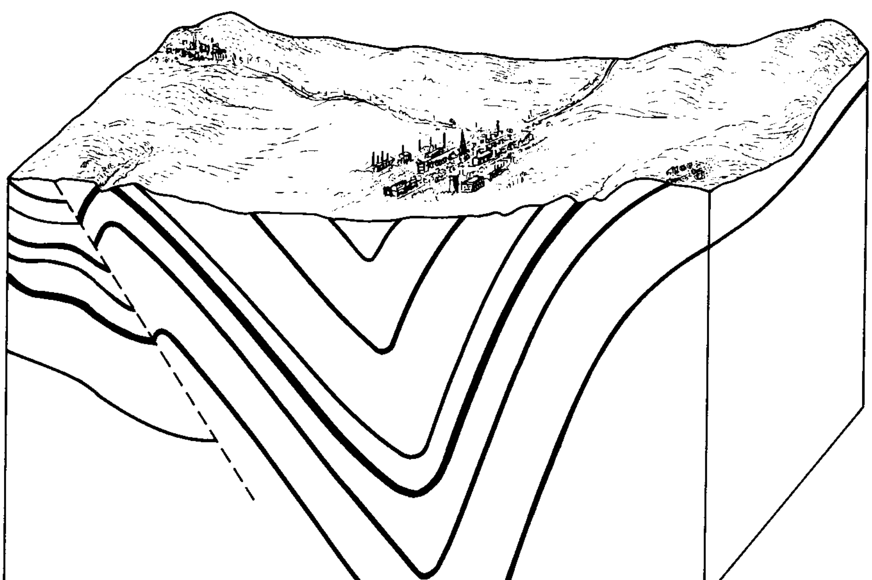


Figure 5. Schematic block diagram of the anthracite region showing folded and faulted coal strata.

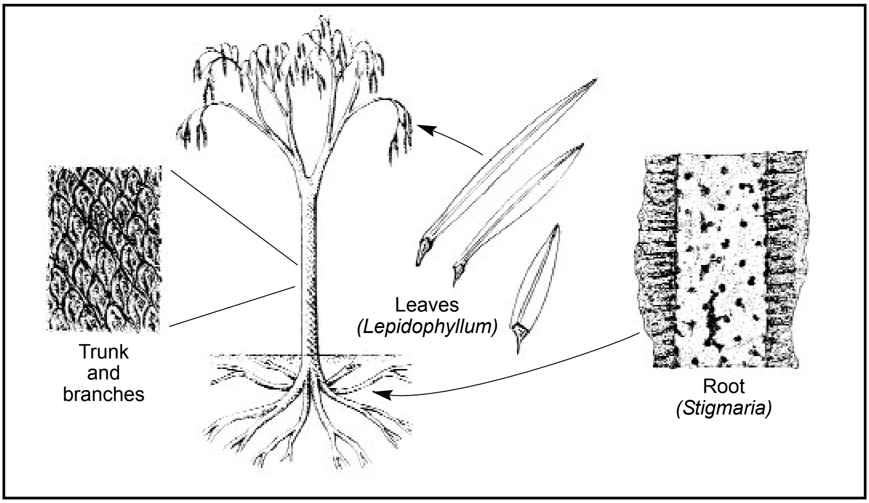


Figure 6. *Lepidodendron,* a coal-age tree.

the modern pines and spruces, was a giant tree, sometimes topping 100 feet tall, having large, straplike leaves up to 3 feet long. *Calamites* (Figure 9), a treelike relative of the inconspicuous modern horsetails, grew to a height of 20 to 40 feet. *Sphenophyllum* (Figure 10) was a low shrub

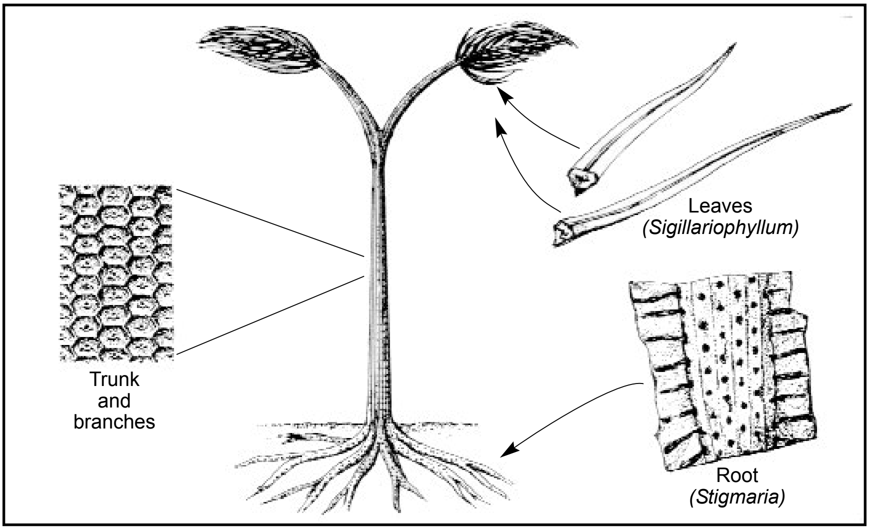


Figure 7. *Sigillaria,* a coal-age tree.

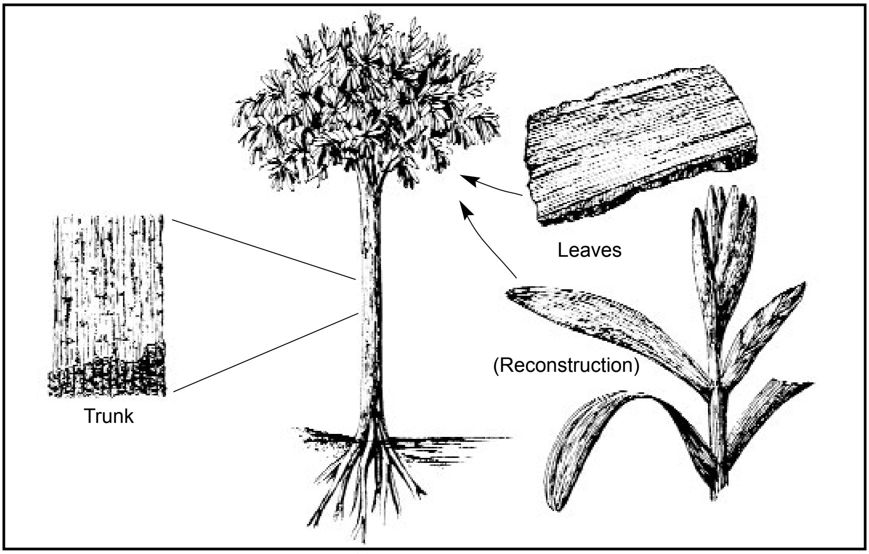


Figure 8. *Cordaites,* a coal-age tree.

that formed much of the underbrush of Pennsylvanian time. The true ferns (*Pecopteris* of Figure 11), like their modern relatives, were also found in the underbrush, although a few giant ferns grew to 40 feet high. The

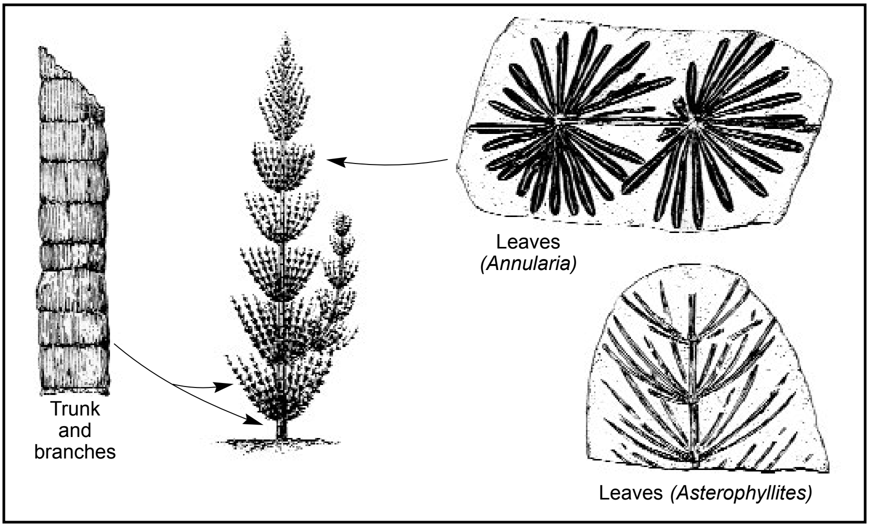


Figure 9. *Calamites,* a coal-age tree.

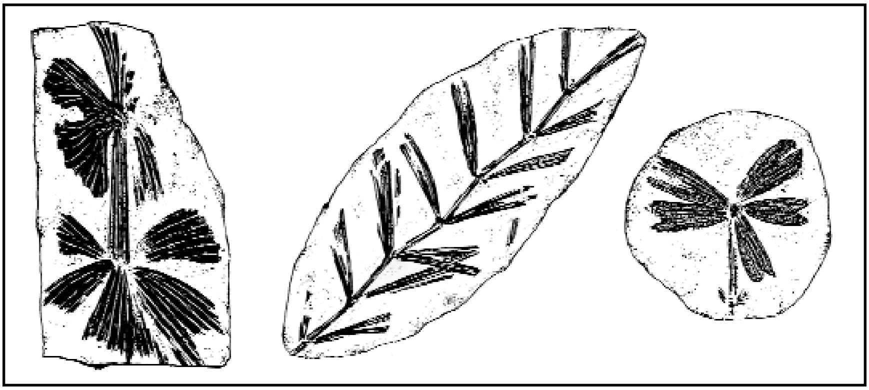


Figure 10. *Sphenophyllum,* a coal-age bush.

seed ferns (remainder of Figure 11), having foliage resembling that of true ferns, were both vines and moderate-sized trees.

Although the Pennsylvanian Period is known as the Age of Plants, many varieties of abundant animal life existed as well. Amphibians and reptiles were just beginning to make their appearance on land. Insects such as cockroaches and dragonflies thrived in the lush swamp forests, although very few were preserved as fossils.

The great majority of animal fossils found in the rocks of the coal-bearing sediments are hard-shelled forms, such as clams and corals, that lived in the shallow seas and lakes. Examples of some of the more common fossil animals found in the rocks associated with coal seams in Pennsylvania are shown in Figure 12. Most of these have close relatives living today.

WHERE DOES COAL OCCUR IN PENNSYLVANIA?

As mentioned earlier, all of the principal economic coal seams in our state are confined to rocks of the Pennsylvanian Period (see Figure 3). The distribution of the important coals across Pennsylvania, therefore, is limited to that part of the Commonwealth underlain by rocks of Pennsylvanian age. As can be seen from the colored map in the centerfold, this includes most of the western part of Pennsylvania plus four large areas in the eastern part. Much of the remainder of the state was originally covered by the coal-bearing rocks as well, but erosion has long since stripped them away, leaving older (lower) rocks exposed at the surface.

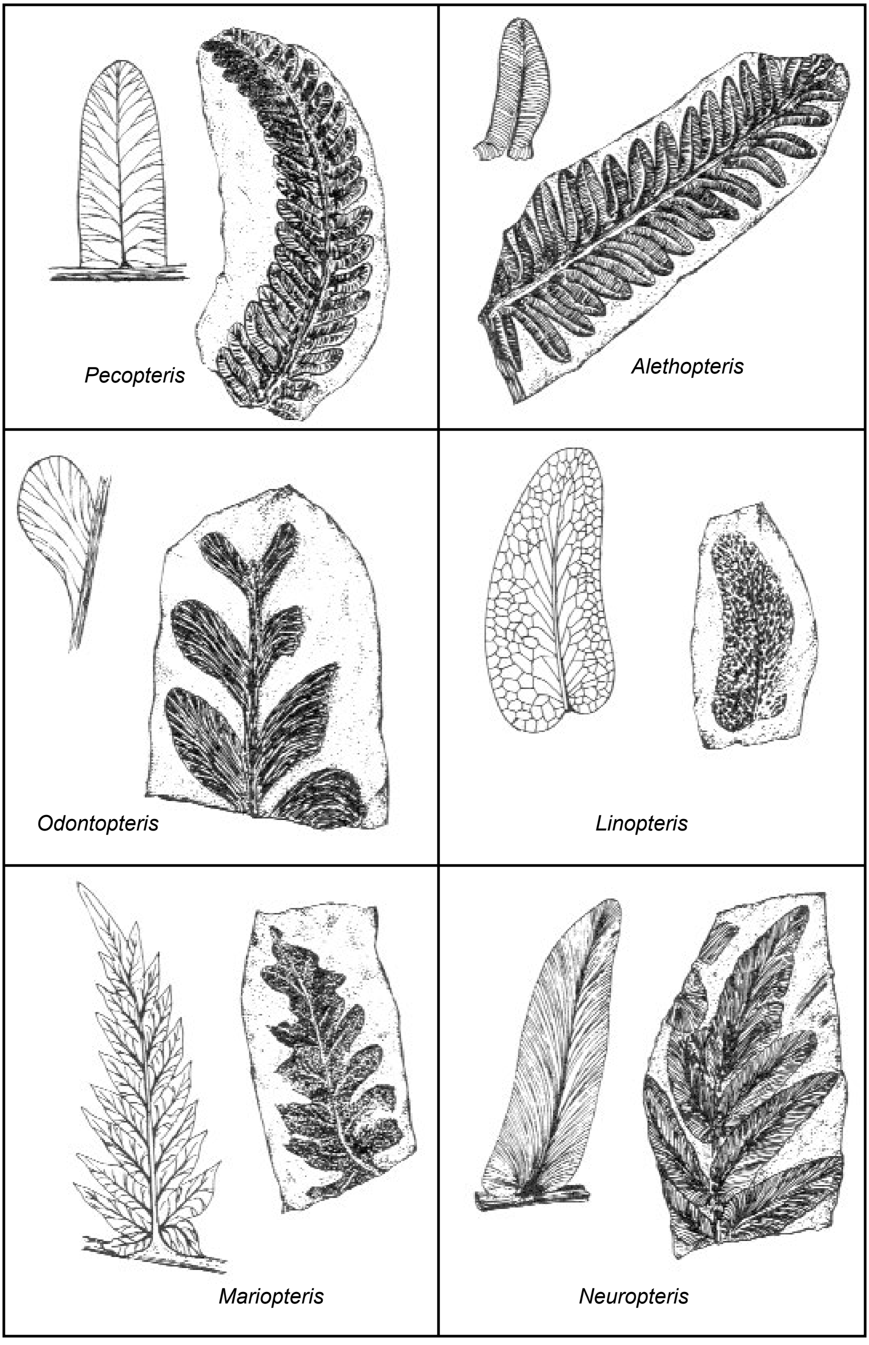
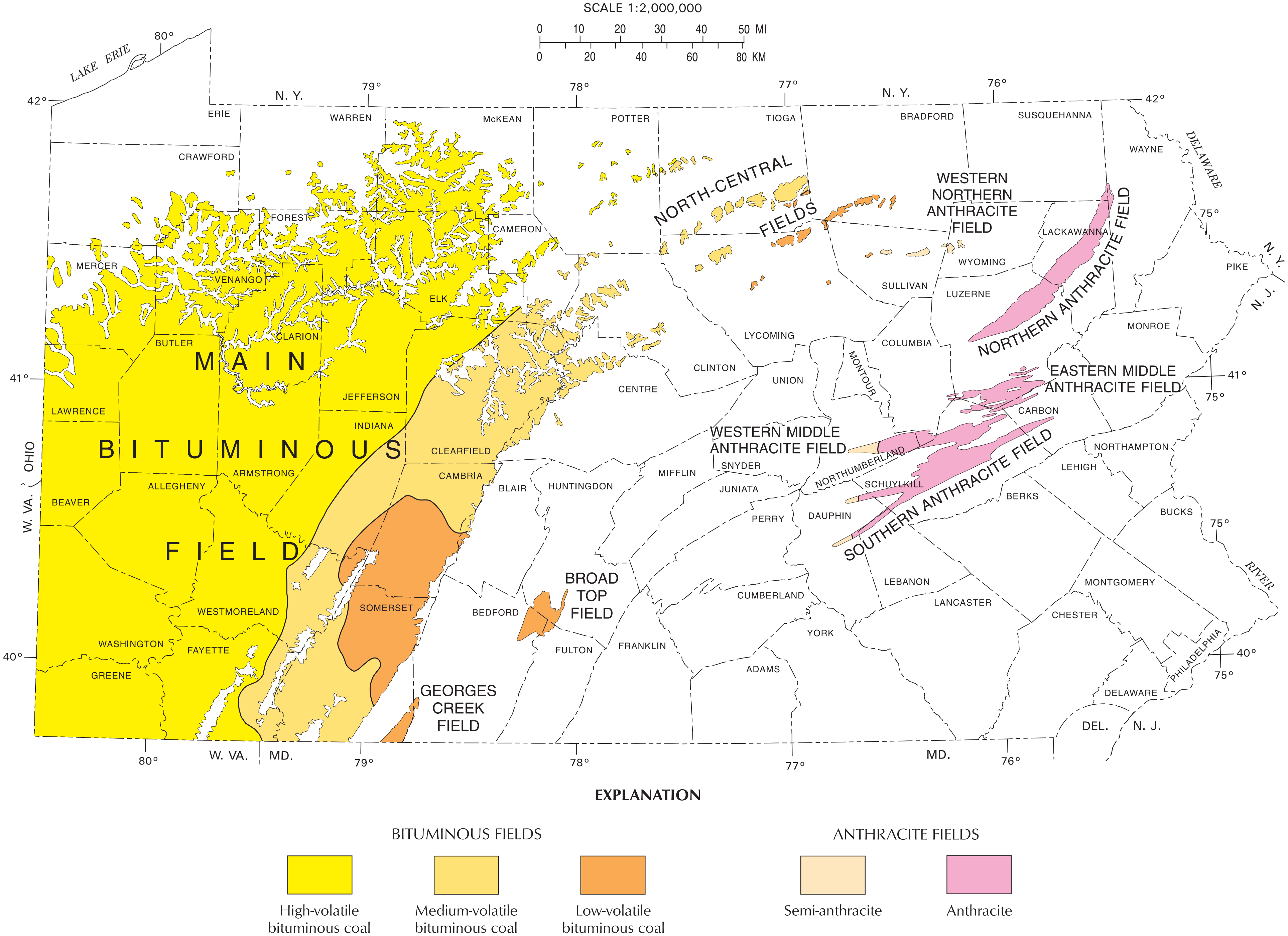


Figure 11. Ferns and fernlike leaves of the coal-forming period.

DISTRIBUTION OF PENNSYLVANIA COALS



EXPLANATION

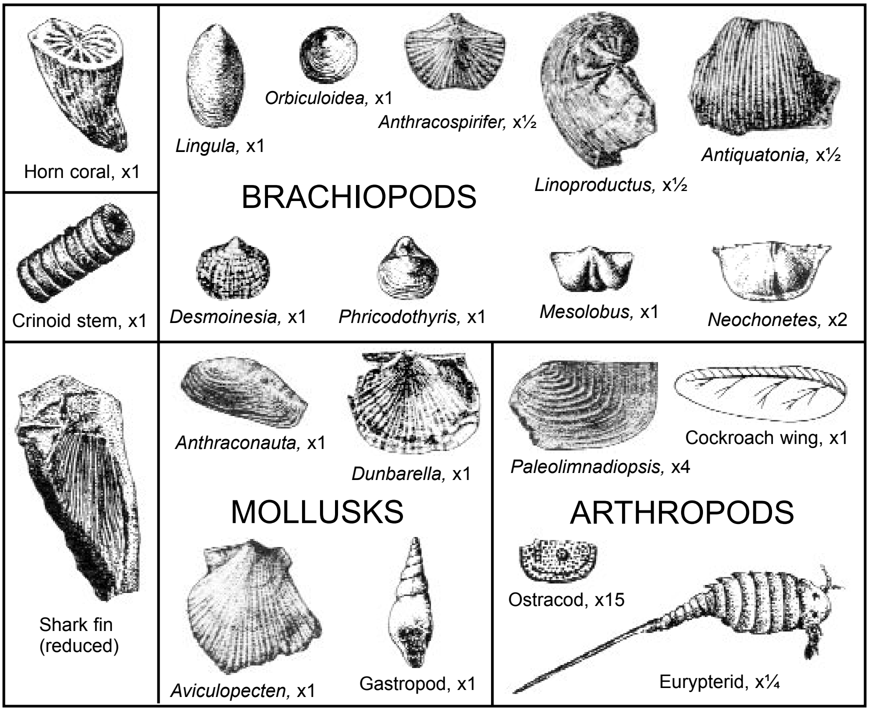


Figure 12. Animals of the coal-forming period.

VARIATIONS IN PENNSYLVANIA'S COALS

The most striking and only large-scale variation in Pennsylvania's coals is the rank or degree of coalification (see section on "How is Coal Formed?"). As shown in the centerfold map, the rank increases from high-volatile bituminous in the west to anthracite in the east. This is believed to reflect the effect of exposure to higher temperatures associated with increasingly greater original depth of burial from west to east.

The amount of heat that a coal produces upon burning (its heating value) and the weight of a particular volume of coal (its specific gravity) both vary with coal rank. Heating value increases to a maximum in low-volatile bituminous coal and then declines somewhat into the anthracite range (see Table 1). Similarly, the specific gravity generally increases with increasing rank. A lump of anthracite will be distinctly heavier than an equal-sized lump of high-volatile bituminous coal.

Other factors of economic or scientific importance, such as coal-bed thickness, sulfur content, and ash content (nonburnable mineral matter), vary locally from one coal bed to another and from place to place within a single coal bed.

Coal thickness is directly related to the original thickness of peat deposited in the swamp, a factor that will vary widely from place to place. Coals having the highest sulfur content appear to be those that are directly overlain by shales and other rocks that were deposited in seawater (salty water). High ash content indicates that much clay and silt was washed into the coal swamp at the time of original deposition.

HOW IS COAL MINED?

At present, there are three methods of extracting coal from the ground—underground, open-pit, and auger mining. The particular method employed depends on a number of factors, such as surface topography, nature of the coal seam, property ownership, and ultimately, the economics of each situation.

Underground mining is the oldest method and historically has produced by far the greatest tonnage. Most of the largest coal companies in Pennsylvania are primarily operators of underground mines. In underground mining, a primary tunnel is driven along a coal bed either from a point on the surface of the ground where the coal is exposed or from a shaft that is excavated down to the coal from above. As mining progresses, more and more secondary tunneling is extended throughout the coal bed.

Until recent years, most underground mines employed the room-and-pillar mining method in which large "rooms" of coal are excavated, and intervening "pillars" of coal are left to hold up the roof. The room-and-pillar method recovers only about 50 to 60 percent of the original coal; the rest is left in pillars and effectively lost.

Since 1985, another system of underground mining, termed the longwall method, has been increasingly used by larger companies. In longwall mining, a single block of coal, sometimes exceeding 1,000 feet wide and 10,000 feet long, is isolated and mined along the short side by equipment that continuously shears off the coal face across the entire width of the block. After each pass across the operating face, the mining equipment is advanced forward, ready to make a new cut. All of the coal is removed and the mine roof is allowed to collapse behind in a carefully controlled manner. Where a coal bed is sufficiently thick and continuous, longwall mining is very efficient and can produce a large amount of coal in a short time.

In open-pit mining (strip mining) the rocks overlying a coal seam are first broken up by blasting and then removed by giant power shovels. The exposed coal is then removed with smaller equipment. Open-pit mining, though highly efficient and able to recover virtually all the coal, is usually limited to those areas where the rock cover over the seam is less than 50 to 100 feet thick. The economics of open-pit mining are enhanced if multiple coal beds can be mined in the same operation.

In auger mining, the coal is removed by use of giant drills much like the drill portion of a brace-and-bit used by carpenters when drilling holes in wood. The drills, driven horizontally into a coal seam, feed the coal out much as wood chips are fed out by a wood drill. Augers are most commonly employed to drill into the coal seam exposed at the base of the excavation made in open-pit mines that have reached the maximum economic size.

COAL RESOURCES OF PENNSYLVANIA

It has been calculated that prior to any mining, Pennsylvania had reserves of more than 84 billion tons of bituminous coal and almost 23 billion tons of anthracite and semianthracite coal, for a grand total of more than 107 billion tons (Table 2). Prior to January 1, 2005, more than 20 billion tons of bituminous coal and almost 11 billion tons of anthracite had been mined or made unavailable to future recovery by being left in such things as pillars that support the roofs of the mines.

A total of 76 billion tons of coal remain (64 billion bituminous and 12 billion anthracite) in Pennsylvania. The coal mined first was the thickest and most easily accessible. The remaining coal seams are thinner and more difficult and expensive to recover. Much of what remains will be very difficult to utilize in the foreseeable future.

Table 2. *Estimated Coal Resources of Pennsylvania in Billions of Tons*

Type of coal	Estimated original resources	Approximate mined out and otherwise lost	Approximate remaining resources (as of January 1, 2005)
Bituminous coal	84.6	20.6	64.0
Anthracite	22.8	10.8	12.0
Total	107.4	31.4	76.0

To help us visualize how much coal the figures above represent, let us imagine it as all together in one solid block. The original size of the block would have been 1 mile high, 1 mile wide and about 17 miles long. Even if we remove the coal already mined, it would still be about 12 miles long.

HOW IS PENNSYLVANIA'S COAL USED?

Pennsylvania's coal is put to dozens of different uses, and these can be summed up in four main categories—electric power generation, coke for iron making, retail sales to small consumers, and miscellaneous industrial uses.

The biggest and only growing market for Pennsylvania coal is electric power generation. Approximately 77 percent of our coal (mostly bituminous) is burned for this purpose. Some of our giant mine-mouth electric power plants (plants built at the openings to mines to avoid hauling coal to city generating plants) consume up to 10,000 tons of coal each day—7 tons every minute. Between 1985 and 1995, a number of small plants were constructed that generate electricity by burning the waste material left in abandoned piles from past coal-processing operations. In addition to removing several million tons of toxic and unsightly waste material from the landscape each year, these plants expel a much smaller amount of sulfur and nitrogen oxide gas into the atmosphere.

About 4 percent of Pennsylvania coal production (mostly bituminous) is employed in the manufacture of coke. Coke is the residue obtained from heating coal in the absence of sufficient air to cause burning. Coke is used in blast furnaces in the production of iron from iron ore. In addition to coke, many different by-products come from the coke-making process. Among the more familiar by-products are asphalt, explosives, dyes, drugs, ammonia, fertilizer, creosote, and synthetic fibers. Many more basic chemicals used by other industries are also produced. This market has declined greatly over the years as the domestic iron and steel industry has lost market share to foreign competition. Much remaining domestic production now comes from plants that use recycled iron and steel scrap as their raw material. In addition, considerable coke is now imported, and environmental regulations inhibit domestic coke production.

Retail and commercial sales of coal account for less than 1 percent of the total coal use. This market, primarily limited to the heating of individual homes and small commercial and public buildings, has almost vanished.

Industrially consumed coal includes a wide variety of uses that accounts for about 6 percent of Pennsylvania's production. Among the industries represented in this group are the various metal-producing and metalworking industries (use of coal other than as coke), the cement industry, the chemical industry, the paper industry, and others. For the most part, industrial use of Pennsylvania coal is slowly declining.

In addition to domestic use of Pennsylvania coal, about 12 percent of production is exported to Canada and Europe. The amount of coal exported varies considerably from year to year depending upon market conditions.

For the future, it is likely that the amount of coal used in electric power generation will increase slowly while the other markets remain static or decline. Considerable research has been done on the conversion of coal to gasoline and methane gas, and the technology is well advanced. Whether or not the commercial utilization of this technology comes to pass is largely an economic matter requiring a very large permanent increase in the cost of oil and natural gas.

REFERENCES AND ADDITIONAL READING

Ashley, G. H., 1928, Bituminous coal fields of Pennsylvania—General information on coal: Pennsylvania Geological Survey, 4th ser., Mineral Resource Report 6, pt. 1, 241 p.

Darrah, W. C., 1960, Principles of paleobotany (2nd ed.): New York, The Ronald Press, 295 p.

Eavenson, H. N., 1942, The first century and a quarter of American coal industry: Pittsburgh, Pa., private printing, 701 p.

Edmunds, W. E., 1999, Bituminous coal, chap. 37 *of* Shultz, C. H., ed., The geology of Pennsylvania: Pennsylvania Geological Survey, 4th ser., Special Publication 1, p. 470–481. [Co-published with Pittsburgh Geological Society.]

Eggleston, J. R., Kehn, T. M., and Wood, G. H., Jr., 1999, Anthracite, chap. 36 *of* Shultz, C. H., ed., The geology of Pennsylvania: Pennsylvania Geological Survey, 4th ser., Special Publication 1, p. 458–469. [Co-published with Pittsburgh Geological Society.]

Majumdar, S. K., and Miller, E. W., eds., 1983, Pennsylvania coal—resources, technology, and utilization: Easton, Pa., Pennsylvania Academy of Science, 594 p.

Sisler, J. D., 1932, Bituminous coal fields of Pennsylvania—Detailed description of coal fields: Pennsylvania Geological Survey, 4th ser., Mineral Resource Report 6, pt. 2, 511 p.

Socolow, A. A., Berg, T. M., Glover, A. D., and others, 1980, Coal resources of Pennsylvania: Pennsylvania Geological Survey, 4th ser., Information Circular 88, 49 p.

APPENDIX

BITUMINOUS AND ANTHRACITE COAL NAMES

When mining began, the widespread occurrence of the coals was not recognized, and the beds mined were assigned local names. Detailed regional geological surveys have made possible the correlation of most of the local names, but even today, true correlations are not known for all the coals, and local names are still in use in some areas.

In the following list are some of the various names that have been, and in some cases are now being, applied to coal beds. The list is not complete, nor are all of the correlations certain. It is a compilation of data from several published sources and from information in the files of the Pennsylvania Geological Survey. The anthracite coal names were supplied by G. H. Wood, Jr., of the U.S. Geological Survey.

Bituminous Coal Names

Dunkard Group Coals

PRINCIPAL NAMES	OTHER NAMES
Ten Mile	
Jollytown	
Washington	
Little Washington	
Waynesburg "B"	
Waynesburg "A"	
Waynesburg	

Monongahela Group Coals

PRINCIPAL NAMES	OTHER NAMES
Little Waynesburg	
Uniontown	
Benwood	
Sewickley	Mapleton (Greene Co.); Meigs Creek, No. 8b (Ohio); Five-foot (Fayette Co.); Tyson, Berlin, Gas (Somerset Co.).
Redstone	Eighty-foot (Westmoreland Co.); Pine Hill No. 1 (Somerset Co.); No. 8a, Four-foot, Pomeroy (Ohio).

Bituminous Coal Names (Continued)

Monongahela Group Coals (Continued)

PRINCIPAL NAMES	OTHER NAMES
Blue Lick	
Pittsburgh rider	
Pittsburgh	Youghiogheny, Penn Gas (Irwin Basin); Murrysville (Westmoreland Co.); River (Washington and Greene Cos.); Irwin Gas, Greensburg, Connellsville (Fayette Co.); Big Vein, Pine Hill No. 2 (Somerset Co. and Maryland); Lisbon Gas, No. 8 (Ohio).

Conemaugh Group Coals

PRINCIPAL NAMES	OTHER NAMES
Little Pittsburgh	
Franklin	Barington, Six-foot (Somerset Co.); Dirty Nine-foot (Maryland); Little Clarksburg (W. Va.).
Hoffman	
Lonaconing	
Upper Clarysville	
Lower Clarysville	
Wellersburg	Berlin, Weller, Top Seam (Somerset Co.).
Barton	Elk Lick (W. Va.).
Federal Hill	
Duquesne	
Harlem	Platt, Weller, Fossil (Somerset Co.); Crinoidal (Ohio).
Upper Bakerstown	Elk Lick (Somerset Co.); Barton (Allegheny Co.).
Lower Bakerstown	Silver Valley (Somerset Co.).
Brush Creek	Farmington (Fayette Co.); Twin (Bedford Co.); Summit (Armstrong Co.); Mason (Ohio).
Mahoning	Speer (Broad Top Basin); East Palestine (Lawrence Co.).
Upper Freeport rider(s)	Piedmont (Somerset Co. and Maryland).

Bituminous Coal Names (Continued)

Allegheny Formation Coals

PRINCIPAL NAMES	OTHER NAMES
Upper Freeport	E; Cap Seam (Centre and Clearfield Cos.); Lemon (Cambria and Blair Cos.); Kelly (Broad Top Basin); Coke Yard, Johnstown, Four-foot, Ried, Lockport, Bolivar (Westmoreland, Indiana, and Cambria Cos.); Hugus (Somerset Co.); Thick Freeport, Double Freeport (Allegheny Co.); No. 7 (Ohio).
Lower Freeport rider(s)	
Lower Freeport	D; Moshannon (Centre and Clearfield Cos.); "M" (Elk Co.); Limestone (Cambria Co.); Reynolds Gas, Helvetia (Jefferson Co.); Schanz (Butler and Beaver Cos.); Dudley (Broad Top Basin), No. 6a (Ohio).
Upper Kittanning rider	
Upper Kittanning	C'; Johnstown, Cement, Cannel, Split C, Dirty C (Clearfield and Cambria Cos.); Blacksmith (Beaver Co.); Creek Vein, No. 4, Big Red, Rock Vein (Butler Co.); Barnettstown (Broad Top Basin).
Middle Kittanning rider(s)	
Middle Kittanning	C; Slate Vein (Centre Co.); Twin Bed (Broad Top Basin); No. 4, Sheridan (Ohio).
Lower Kittanning rider(s)	
Lower Kittanning	B; Miller, White Ash, Johnstown, Blacklick, Sonman (Cambria Co.); Dagus (McKean and Elk Cos.); Barnett (Broad Top Basin); Sulphur Vein (Beaver Co.); Kane Gas (Elk Co.); Big Bed (Lycoming Co.); Bloss (Tioga Co.).
Scrubgrass	Upper Clarion (Clarion, Butler, and Venango Cos.); Clarion No. 3 (Clearfield and Centre Cos.).

Bituminous Coal Names (Continued)

Allegheny Formation Coals (Continued)

PRINCIPAL NAMES	OTHER NAMES
Clarion	A'; Lower Clarion (Clarion, Butler and Venango Cos.); Sulfur Vein, Craigsville (Clarion Co.); Clarion No. 2 (Clearfield and Centre Cos.); No. 4a (Ohio).
Brookville	A; Lower Clarion; Pardoe (Mercer Co.); Craigsville (Clarion Co.); Clarion No. 1 (Clearfield and Centre Cos.); No. 4 (Ohio).

Pottsville Formation Coals

PRINCIPAL NAMES	OTHER NAMES
Upper Mercer, Middle Mercer, Lower Mercer	Brookville; Tionesta (Forest Co.); Maple Grove (Mercer Co.); Alton Coals (McKean Co.); No. 3, No. 3a (Ohio).
Quakertown	No. 2 (Ohio).
Sharon	No. 1 (Ohio).

Anthracite Coal Names

Llewellyn Formation Coals

Northern Anthracite Field

PRINCIPAL NAMES	OTHER NAMES
No. 7	No. 2, No. 1 (Luzerne Co.).
No. 6	No. 3, No. 2 (Luzerne Co.).
No. 5	No. 4, No. 3 (Luzerne Co.).
No. 4	No. 5, No. 3 (Luzerne Co.).
No. 3	No. 6, No. 5, No. 2, Top George (Luzerne Co.).
No. 2	Top Snake Island (Luzerne Co.).
Snake Island	George, No. 1 (Luzerne Co.).
Abbot	Orchard (Luzerne Co.); Eight-Foot (Lackawanna Co.).
Kidney	Mills, Bowkley (Luzerne Co.); Five Foot (Lackawanna Co.).

Anthracite Coal Names (Continued)

Llewellyn Formation Coals (Continued)

Northern Anthracite Field (Continued)

PRINCIPAL NAMES	OTHER NAMES
Hillman	Hillman (Luzerne Co.); Hillman, Four Foot, Thirty Inch (Lackawanna Co.).
Upper Stanton	Top Stanton, Top Five Foot, Top Orchard, Rock, Top Diamond (Luzerne and Lackawanna Cos.).
Diamond or Lower Stanton	Lower Stanton, Lance, Baltimore, Stanton, Bottom Stanton, Five Foot, Orchard, Bottom Five Foot, Four Foot, Top Five Foot, Bottom Diamond (Luzerne and Lackawanna Cos.).
Upper Lance	Cooper, Top Forge, Top Four Foot, Top Checker, Rock, Top Rock (Luzerne and Lackawanna Cos.).
Lower Lance	Forge, Five Foot, Sump, Lance, Stanton, Checker, Bottom Checker, Rock, Bottom Rock (Luzerne and Lackawanna Cos.).
Upper Pittston	Top Twin, Cooper, Top Baltimore, Four Foot, Upper Baltimore, Checker, Pittston, Top Pittston, Big, Top Big, Top Grassy (Luzerne and Lackawanna Cos.).
Lower Pittston	Pittston, Twin, Bennett, Bottom Twin, Bottom Baltimore, Red Bennett, Six Foot, Lower Baltimore, Big, Bottom Big, Grassy (Luzerne and Lackawanna Cos.).
Upper Skidmore	Checker, Top Eleven Foot, Top Marcy, New County (Luzerne and Lackawanna Cos.).
Middle Skidmore	Bottom Checker, Top Marcy, Top Skidmore, Top Ross, New County, Top New County (Luzerne and Lackawanna Cos.).
Lower Skidmore	Skidmore, Forge, Checker, Twin, Eleven Foot, Marcy, Top Skidmore, Bottom Eleven Foot, Ross, Nine Foot, New County, Bottom New County (Luzerne and Lackawanna Cos.).

Anthracite Coal Names (Continued)

Llewellyn Formation Coals (Continued)

Northern Anthracite Field (Continued)

PRINCIPAL NAMES	OTHER NAMES
Upper Ross	Top Ross, Twin, Middle Skidmore, Bottom Skidmore, Top Clark, Three Foot, Clark (Luzerne and Lackawanna Cos.).
Middle Ross	Bottom Split, Top Ross, Bottom Skidmore, Middle Clark (Luzerne and Lackawanna Cos.).
Lower Ross	Ross, Bottom Ross, Ross Split, Top Ross, Three Foot, Bottom Clark, Clark (Luzerne and Lackawanna Cos.).
Upper Red Ash	Top Red Ash, Chauncey, Ross, No. 1 Dunmore, Bottom Ross, Babylon, Stark, Nigger (Luzerne and Lackawanna Cos.).
Middle Red Ash	Top Lee, No. 2 Dunmore, Fifth, Five Foot (Luzerne and Lackawanna Cos.).
Lower Red Ash	Red Ash, Lee, Bottom Red Ash, Sixth, No. 3 Dunmore (Luzerne and Lackawanna Cos.).
Coal Bed A	"A," No. 4 Dunmore, China (Luzerne and Lackawanna Cos.).

Southern, Western Middle, and Eastern Middle Coal Fields

PRINCIPAL NAMES	OTHER NAMES
Faust	No. 21 (Schuylkill Co.).
Rabbit Hole	No. 20 (Schuylkill Co.).
Tunnel	No. 19 (Schuylkill Co.).
Peach Mountain	Spohn, Lewis, Black Mine, Gate, and No. 18 coal beds (Schuylkill, Northumberland, Columbia Cos.).
Little Tracy	No. 17 (Schuylkill, Dauphin, Northumberland, and Columbia Cos.).
Upper Four Foot	No. 16½ (Northumberland, Schuylkill, Columbia, Dauphin, and Carbon Cos.).

Anthracite Coal Names (Continued)

Llewellyn Formation Coals (Continued)

Southern, Western Middle, and Eastern Middle Coal Fields (Continued)

PRINCIPAL NAMES	OTHER NAMES
Tracy	No. 16, Salem, Tunnel, Cockle (Schuylkill Co.); No. 16 (Northumberland and Schuylkill Cos.).
Little Clinton	No. 15½ (Schuylkill and Carbon Cos.).
Clinton	No. 15¼ (Schuylkill and Carbon Cos.).
Little Diamond	No. 15 (Schuylkill, Dauphin, Carbon, Northumberland, and Columbia Cos.).
Diamond	No. 14 (Schuylkill, Dauphin, Carbon, Northumberland, and Columbia Cos.).
Little Orchard	Upper Split Twin coal bed, No. 13 (Schuylkill, Dauphin, Carbon, Northumberland, and Columbia Cos.).
Orchard	Lower Split Twin coal bed, No. 12 (Schuylkill, Dauphin, Carbon, Northumberland, and Columbia Cos.).
Primrose	No. 11 (Schuylkill, Carbon, Dauphin, Northumberland, Columbia, and Luzerne Cos.).
Rough	No. 10½ (Schuylkill, Northumberland, and Columbia Cos.).
Holmes	No. 10, Church, Black Heath, Pat Martin, Little Orchard, Twin, No. 1, Peacock, Black Mine (Schuylkill Co.); No. 10 (Schuylkill, Carbon, Dauphin, Northumberland, and Columbia Cos.).
Lower Four Foot	No. 9½ (Schuylkill, Carbon, Northumberland, and Columbia Cos.).
Mammoth coal zone	
Top Split	No. 9, Crosby, White Ash, Four Foot, Pitch, Dan's, Dirt, Barclaugh, and White (Schuylkill Co.); No. 9 (Northumberland, Columbia, and Carbon Cos.); Mammoth wherever exceptionally thick.

Anthracite Coal Names (Continued)

Llewellyn Formation Coals (Continued)

Southern, Western Middle, and Eastern Middle Coal Fields (Continued)

PRINCIPAL NAMES	OTHER NAMES
Middle Split	No. 8½, Lelar, Middle Branch, Seven Foot, Big Dirt, White Ash, Four Foot, Barclaugh (Schuylkill Co.); No. 8½, Holmes (Dauphin Co.); No. 8½ (Northumberland, Columbia, and Carbon Cos.); Mammoth wherever exceptionally thick.
Bottom Split	No. 8, Mammoth, Buck Mountain, Daniel, Jugular, Black Heath, White Ash, Big Dirt, Heister, and Barclaugh (Schuylkill Co.); No. 8 (Carbon, Northumberland, Columbia, and Luzerne Cos.); No. 9½ (Dauphin Co.).
Skidmore	No. 7, White Ash, Dirt, Barclaugh, Billy Best (Schuylkill Co.); Wharton (Luzerne, Schuylkill, and Columbia Cos.); No. 7 (Northumberland Co.); No. 9 (Dauphin Co.).
Seven Foot	No. 6 (Schuylkill, Carbon, Dauphin, Columbia, and Northumberland Cos.); Gamma (Luzerne, Carbon, and Columbia Cos.).
Buck Mountain (Buck Mountain, Schuylkill Co.)	No. 5, Twin, Umbahawer, Scotty Steel 3, Skidmore (Schuylkill Co.); No. 5, Twin, Little Buck Mountain (Northumberland, Columbia Cos.); No. 7 (Dauphin Co.); No. 5 (Carbon Co.).

Pottsville Formation Coals

PRINCIPAL NAMES	OTHER NAMES
Little Buck Mountain (Northumberland Co.)	Buck Mountain (Northumberland and Schuylkill Cos.); "A" (Carbon Co.); No. 4 (Northumberland, Columbia, and Schuylkill Cos.); Alpha (Luzerne, Carbon, and Schuylkill Cos.).
Scotty Steel No. 3 (Darkwater, Schuylkill Co.)	Buck Mountain (Schuylkill Co.).

Anthracite Coal Names (Continued)

Pottsville Formation Coals (Continued)

PRINCIPAL NAMES	OTHER NAMES
Scotty Steel No. 2 (Darkwater, Schuylkill Co.)	
Campbells Ledge (Duryea, Luzerne Co.)	Present only in Northern field. Also only Pottsville bed in that field.
Lykens Valley No. 1 (Lincoln Colliery, Schuylkill Co.)	Lykens Valley No. 2 and 3 (Schuylkill Co.).
Lykens Valley No. 2 (Lincoln Colliery, Schuylkill Co.)	Lykens Valley No. 1 and 3 (Schuylkill Co.).
Lykens Valley No. 3 (Lincoln Colliery, Schuylkill Co.)	Lykens Valley No. 1 and 2 (Schuylkill Co.).
Lykens Valley No. 4 (Lykens, Dauphin Co.)	Lykens Valley No. 2 (Northumberland Co.); Whites (Schuylkill Co.).
Lykens Valley No. 5 (Lykens, Dauphin Co.)	Lykens Valley No. 3 (Northumberland Co.); Big (Schuylkill Co.).
Lykens Valley No. 6 (Lykens, Dauphin Co.)	Lykens Valley No. 4, Little, Lykens Valley No. 7 (Schuylkill and Northumberland Cos.).
Lykens Valley No. 7 (Lykens, Dauphin Co.)	Lykens Valley No. 6 (Schuylkill Co.); “O” (Northumberland Co.).

PENNSYLVANIA GEOLOGICAL SURVEY
EDUCATIONAL SERIES

ES 7

https://elibrary.dcnr.pa.gov/GetDocument?docId=1752502&DocName=ES7_Coal_Pa.pdf

COPIES OF THIS PUBLICATION
MAY BE OBTAINED FROM
PENNSYLVANIA GEOLOGICAL SURVEY
3240 SCHOOLHOUSE ROAD
MIDDLETOWN, PA 17057-3534
717-702-2017

An Equal Opportunity Employer