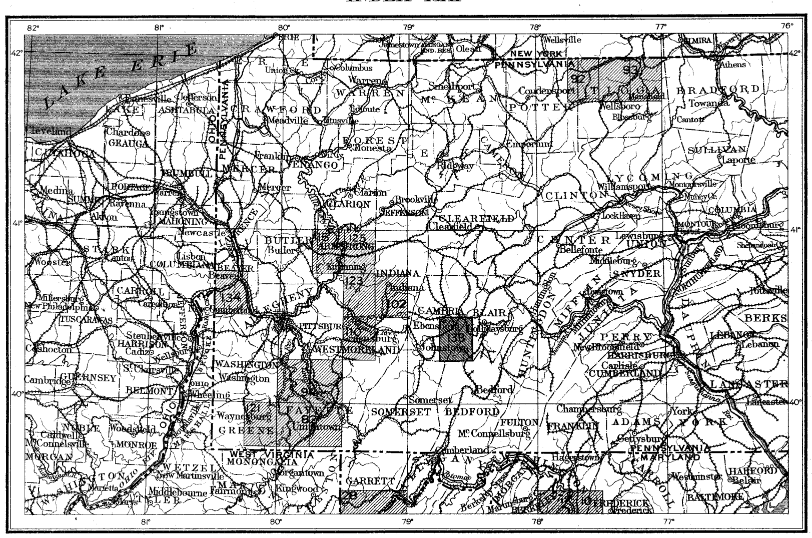
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

GEOLOGIC ATLAS
OF THE
UNITED STATES

EBENSBURG FOLIO
PENNSYLVANIA

INDEX MAP



SCALE: 40 MILES = 1 INCH

EBENSBURG FOLIO

OTHER PUBLISHED FOLIOS

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WASHINGTON, D. C.
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GEORGE W. STOSE, EDITOR OF GEOLOGIC MAPS S. J. KUBEL, CHIEF ENGRAVER
1905

GEOLOGIC AND TOPOGRAPHIC ATLAS OF UNITED STATES.

The Geological Survey is making a geologic map of the United States, which is being issued in parts, called folios. Each folio includes a topographic map and geologic maps of a small area of country, together with explanatory and descriptive texts.

THE TOPOGRAPHIC MAP.

The features represented on the topographic map are of three distinct kinds: (1) inequalities of surface, called *relief*, as plains, plateaus, valleys, hills, and mountains; (2) distribution of water, called *drainage*, as streams, lakes, and swamps; (3) the works of man, called *culture*, as roads, railroads, boundaries, villages, and cities.

Relief.—All elevations are measured from mean sea level. The heights of many points are accurately determined, and those which are most important are given on the map in figures. It is desirable, however, to give the elevation of all parts of the area mapped, to delineate the outline or form of all slopes, and to indicate their grade or steepness. This is done by lines each of which is drawn through points of equal elevation above mean sea level, the altitudinal interval represented by the space between lines being the same throughout each map. These lines are called *contours*, and the uniform altitudinal space between each two contours is called the *contour interval*. Contours and elevations are printed in brown.

The manner in which contours express elevation, form, and grade is shown in the following sketch and corresponding contour map (fig. 1).

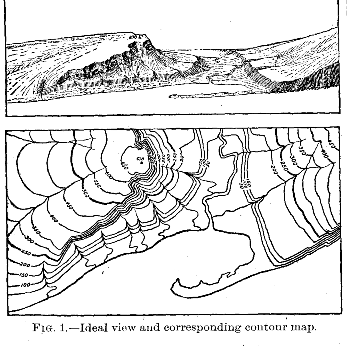

FIG. 1.—Ideal view and corresponding contour map.

The sketch represents a river valley between two hills. In the foreground is the sea, with a bay which is partly closed by a hooked sand bar. On each side of the valley is a terrace. From the terrace on the right a hill rises gradually, while from that on the left the ground ascends steeply, forming a precipice. Contrasted with this precipice is the gentle slope from its top toward the left. In the map each of these features is indicated, directly beneath its position in the sketch, by contours. The following explanation may make clearer the manner in which contours delineate elevation, form, and grade:

1. A contour indicates a certain height above sea level. In this illustration the contour interval is 50 feet; therefore the contours are drawn at 50, 100, 150, and 200 feet, and so on, above mean sea level. Along the contour at 250 feet lie all points of the surface that are 250 feet above sea; along the contour at 200 feet, all points that are 200 feet above sea; and so on. In the space between any two contours are found elevations above the lower and below the higher contour. Thus the contour at 150 feet falls just below the edge of the terrace, while that at 200 feet lies above the terrace; therefore all points on the terrace are shown to be more than 150 but less than 200 feet above sea. The summit of the higher hill is stated to be 670 feet above sea; accordingly the contour at 650 feet surrounds it. In this illustration all the contours are numbered, and those for 250 and 500 feet are accentuated by being made heavier. Usually it is not desirable to number all the contours, and then the accentuating and numbering of certain of them—say every fifth one—suffice, for the heights of others may be ascertained by counting up or down from a numbered contour.

2. Contours define the forms of slopes. Since contours are continuous horizontal lines, they wind smoothly about smooth surfaces, recede into all reentrant angles of ravines, and project in passing about prominences. These relations of contour curves and angles to forms of the landscape can be traced in the map and sketch.

3. Contours show the approximate grade of any slope. The altitudinal space between two contours is the same, whether they lie along a cliff or on a gentle slope; but to rise a given height on a gentle slope one must go farther than on a steep slope, and therefore contours are far apart on gentle slopes and near together on steep ones.

For a flat or gently undulating country a small contour interval is used; for a steep or mountainous country a large interval is necessary. The smallest interval used on the atlas sheets of the Geological Survey is 5 feet. This is serviceable for regions like the Mississippi delta and the Dismal Swamp. In mapping great mountain masses, like those in Colorado, the interval may be 250 feet. For intermediate relief contour intervals of 10, 20, 25, 50, and 100 feet are used.

Drainage.—Watercourses are indicated by blue lines. If a stream flows the entire year the line is drawn unbroken, but if the channel is dry a part of the year the line is broken or dotted. Where a stream sinks and reappears at the surface, the supposed underground course is shown by a broken blue line. Lakes, marshes, and other bodies of water are also shown in blue, by appropriate conventional signs.

Culture.—The works of man, such as roads, railroads, and towns, together with boundaries of townships, counties, and States, are printed in black.

Scales.—The area of the United States (excluding Alaska and island possessions) is about 3,025,000 square miles. A map representing this area, drawn to the scale of 1 mile to the inch, would cover 3,025,000 square inches of paper, and to accommodate the map the paper would need to measure about 240 by 180 feet. Each square mile of ground surface would be represented by a square inch of map surface, and one linear mile on the ground would be represented by a linear inch on the map. This relation between distance in nature and corresponding distance on the map is called the *scale* of the map. In this case it is "1 mile to an inch." The scale may be expressed also by a fraction, of which the numerator is a length on the map and the denominator the corresponding length in nature expressed in the same unit. Thus, as there are 63,360 inches in a mile, the scale "1 mile to an inch" is expressed by $\frac{1}{63,360}$.

Three scales are used on the atlas sheets of the Geological Survey; the smallest is $\frac{1}{250,000}$, the intermediate $\frac{1}{125,000}$, and the largest $\frac{1}{62,500}$. These correspond approximately to 4 miles, 2 miles, and 1 mile on the ground to an inch on the map. On the scale $\frac{1}{62,500}$ a square inch of map surface represents about 1 square mile of earth surface; on the scale $\frac{1}{125,000}$, about 4 square miles; and on the scale $\frac{1}{250,000}$, about 16 square miles. At the bottom of each atlas sheet the scale is expressed in three ways—by a graduated line representing miles and parts of miles in English inches, by a similar line indicating distance in the metric system, and by a fraction.

Atlas sheets and quadrangles.—The map is being published in atlas sheets of convenient size, which represent areas bounded by parallels and meridians. These areas are called *quadrangles*. Each sheet on the scale of $\frac{1}{250,000}$ contains one square degree—i. e., a degree of latitude by a degree of longitude; each sheet on the scale of $\frac{1}{125,000}$ contains one-fourth of a square degree; each sheet on the scale of $\frac{1}{62,500}$ contains one-sixteenth of a square degree. The areas of the corresponding quadrangles are about 4000, 1000, and 250 square miles.

The atlas sheets, being only parts of one map of the United States, disregard political boundary lines, such as those of States, counties, and townships. To each sheet, and to the quadrangle it represents, is given the name of some well-known town or natural feature within its limits, and at the sides and corners of each sheet the names of adjacent sheets, if published, are printed.

Uses of the topographic map.—On the topographic map are delineated the relief, drainage, and culture of the quadrangle represented. It should portray to the observer every characteristic feature of the landscape. It should guide the traveler; serve the investor or owner who desires to ascertain the position and surroundings of property; save the engineer preliminary surveys in locating roads, railways, and irrigation reservoirs and ditches; provide educational material for schools and homes; and be useful as a map for local reference.

THE GEOLOGIC MAPS.

The maps representing the geology show, by colors and conventional signs printed on the topographic base map, the distribution of rock masses on the surface of the land, and the structure sections show their underground relations, as far as known and in such detail as the scale permits.

KINDS OF ROCKS.

Rocks are of many kinds. On the geologic map they are distinguished as igneous, sedimentary, and metamorphic.

Igneous rocks.—These are rocks which have cooled and consolidated from a state of fusion. Through rocks of all ages molten material has from time to time been forced upward in fissures or channels of various shapes and sizes, to or nearly to the surface. Rocks formed by the consolidation of the molten mass within these channels—that is, below the surface—are called *intrusive*. When the rock occupies a fissure with approximately parallel walls the mass is called a *dike*; when it fills a large and irregular conduit the mass is termed a *stock*. When the conduits for molten magmas traverse stratified rocks they often send off branches parallel to the bedding planes; the rock masses filling such fissures are called *sills* or *sheets* when comparatively thin, and *laccoliths* when occupying larger chambers produced by the force propelling the magmas upward. Within rock inclosures molten material cools slowly, with the result that intrusive rocks are generally of crystalline texture. When the channels reach the surface the molten material poured out through them is called *lava*, and lavas often build up volcanic mountains. Igneous rocks thus formed upon the surface are called *extrusive*. Lavas cool rapidly in the air, and acquire a glassy or, more often, a partially crystalline condition in their outer parts, but are more fully crystalline in their inner portions. The outer parts of lava flows are usually more or less porous. Explosive action often accompanies volcanic eruptions, causing ejections of dust, ash, and larger fragments. These materials, when consolidated, constitute breccias, agglomerates, and tuffs. Volcanic ejecta may fall in bodies of water or may be carried into lakes or seas and form sedimentary rocks.

Sedimentary rocks.—These rocks are composed of the materials of older rocks which have been broken up and the fragments of which have been carried to a different place and deposited.

The chief agent of transportation of rock débris is water in motion, including rain, streams, and the water of lakes and of the sea. The materials are in large part carried as solid particles, and the deposits are then said to be mechanical. Such are gravel, sand, and clay, which are later consolidated into conglomerate, sandstone, and shale. In smaller portion the materials are carried in solution, and the deposits are then called organic if formed with the aid of life, or chemical if formed without the aid of life. The more important rocks of chemical and organic origin are limestone, chert, gypsum, salt, iron ore, peat, lignite, and coal. Any one of the deposits may be separately formed, or the different materials may be intermingled in many ways, producing a great variety of rocks.

Another transporting agent is air in motion, or wind; and a third is ice in motion, or glaciers. The most characteristic of the wind-borne or eolian deposits is loess, a fine-grained earth; the most characteristic of glacial deposits is till, a heterogeneous mixture of bowlders and pebbles with clay or sand.

Sedimentary rocks are usually made up of layers or beds which can be easily separated. These layers are called *strata*. Rocks deposited in layers are said to be stratified.

The surface of the earth is not fixed, as it seems to be; it very slowly rises or sinks, with reference to the sea, over wide expanses; and as it rises or subsides the shore lines of the ocean are changed. As a result of the rising of the surface, marine sedimentary rocks may become part of the land, and extensive land areas are in fact occupied by such rocks.

Rocks exposed at the surface of the land are acted upon by air, water, ice, animals, and plants. They are gradually broken into fragments, and the more soluble parts are leached out, leaving the less soluble as a *residual* layer. Water washes residual material down the slopes, and it is eventually carried by rivers to the ocean or other bodies of standing water. Usually its journey is not continuous, but it is temporarily built into river bars and flood plains, where it is called *alluvium*. Alluvial deposits, glacial deposits (collectively known as *drift*), and eolian deposits belong to the *surficial* class, and the residual layer is commonly included with them. Their upper parts, occupied by the roots of plants, constitute soils and subsoils, the soils being usually distinguished by a notable admixture of organic matter.

Metamorphic rocks.—In the course of time, and by a variety of processes, rocks may become greatly changed in composition and in texture. When the newly acquired characteristics are more pronounced than the old ones such rocks are called *metamorphic*. In the process of metamorphism the substances of which a rock is composed may enter into new combinations, certain substances may be lost, or new substances may be added. There is often a complete gradation from the primary to the metamorphic form within a single rock mass. Such changes transform sandstone into quartzite, limestone into marble, and modify other rocks in various ways.

From time to time in geologic history igneous and sedimentary rocks have been deeply buried and later have been raised to the surface. In this process, through the agencies of pressure, movement, and chemical action, their original structure may be entirely lost and new structures appear. Often there is developed a system of division planes along which the rocks split easily, and these planes may cross the strata at any angle. This structure is called *cleavage*. Sometimes crystals of mica or other foliaceous minerals are developed with their laminæ approximately parallel; in such cases the structure is said to be schistose, or characterized by *schistosity*.

As a rule, the oldest rocks are most altered and the younger formations have escaped metamorphism, but to this rule there are important exceptions.

FORMATIONS.

For purposes of geologic mapping rocks of all the kinds above described are divided into *formations*. A sedimentary formation contains between its upper and lower limits either rocks of uniform character or rocks more or less uniformly varied in character, as, for example, a rapid alternation of shale and limestone. When the passage from one kind of rocks to another is gradual it is sometimes necessary to separate two contiguous formations by an arbitrary line, and in some cases the distinction depends almost entirely on the contained fossils. An igneous formation is constituted of one or more bodies either containing the same kind of igneous rock or having the same mode of occurrence. A metamorphic formation may consist of rock of uniform character or of several rocks having common characteristics.

When for scientific or economic reasons it is desirable to recognize and map one or more specially developed parts of a varied formation, such parts are called *members*, or by some other appropriate term, as *lentils*.

AGES OF ROCKS.

Geologic time.—The time during which the rocks were made is divided into several *periods*. Smaller time divisions are called *epochs*, and still smaller ones *stages*. The age of a rock is expressed by naming the time interval in which it was formed, when known.

The sedimentary formations deposited during a period are grouped together into a *system*. The principal divisions of a system are called *series*. Any aggregate of formations less than a series is called a *group*.

(Continued on third page of cover.)

As sedimentary deposits or strata accumulate the younger rest on those that are older, and the relative ages of the deposits may be determined by observing their positions. This relationship holds except in regions of intense disturbance; in such regions sometimes the beds have been reversed, and it is often difficult to determine their relative ages from their positions; then *fossils*, or the remains and imprints of plants and animals, indicate which of two or more formations is the oldest.

Stratified rocks often contain the remains or imprints of plants and animals which, at the time the strata were deposited, lived in the sea or were washed from the land into lakes or seas, or were buried in surficial deposits on the land. Such rocks are called fossiliferous. By studying fossils it has been found that the life of each period of the earth's history was to a great extent different from that of other periods. Only the simpler kinds of marine life existed when the oldest fossiliferous rocks were deposited. From time to time more complex kinds developed, and as the simpler ones lived on in modified forms life became more varied. But during each period there lived peculiar forms, which did not exist in earlier times and have not existed since; these are *characteristic types*, and they define the age of any bed of rock in which they are found. Other types passed on from period to period, and thus linked the systems together, forming a chain of life from the time of the oldest fossiliferous rocks to the present. When two sedimentary formations are remote from each other and it is impossible to observe their relative positions, the characteristic fossil types found in them may determine which was deposited first. Fossil remains found in the strata of different areas, provinces, and continents afford the most important means for combining local histories into a general earth history.

It is often difficult or impossible to determine the age of an igneous formation, but the relative age of such a formation can sometimes be ascertained by observing whether an associated sedimentary formation of known age is cut by the igneous mass or is deposited upon it.

Similarly, the time at which metamorphic rocks were formed from the original masses is sometimes shown by their relations to adjacent formations of known age; but the age recorded on the map is that of the original masses and not of their metamorphism.

Colors and patterns.—Each formation is shown on the map by a distinctive combination of color and pattern, and is labeled by a special letter symbol.

Symbols and colors assigned to the rock systems.

	System.	Series.	Symbol.	Color for sedimentary rocks.
Cenozoic	Quaternary	Recent; Pleistocene	Q	Brownish-yellow.
	Tertiary	Pliocene; Miocene; Oligocene; Eocene	T	Yellow ocher.
Mesozoic	Cretaceous		K	Olive-green.
	Jurassic		J	Blue-green.
	Triassic		Ꞧ	Peacock-blue.
Paleozoic	Carboniferous.	Permian; Pennsylvanian; Mississippian	C	Blue.
	Devonian		D	Blue-gray.
	Silurian		S	Blue-purple.
	Ordovician		O	Red-purple.
	Cambrian	Saratogan; Acadian; Georgian	Є	Brick-red.
	Algonkian		A	Brownish-red.
	Archean		Æ	Gray-brown.

Patterns composed of parallel straight lines are used to represent sedimentary formations deposited in the sea or in lakes. Patterns of dots and circles represent alluvial, glacial, and eolian formations. Patterns of triangles and rhombs are used for igneous formations. Metamorphic rocks of unknown origin are represented by short dashes irregularly placed; if the rock is schist the dashes may be arranged in wavy lines parallel to the structure planes. Suitable combination patterns are used for metamorphic formations known to be of sedimentary or of igneous origin.

The patterns of each class are printed in various colors. With the patterns of parallel lines, colors are used to indicate age, a particular color being assigned to each system. The symbols by which formations are labeled consist each of two or more letters. If the age of a formation is known the symbol includes the system symbol, which is a capital letter or monogram; otherwise the symbols are composed of small letters. The names of the systems and recognized series, in proper order (from new to old), with the color and symbol assigned to each system, are given in the preceding table.

SURFACE FORMS.

Hills and valleys and all other surface forms have been produced by geologic processes. For example, most valleys are the result of erosion by the streams that flow through them (see fig. 1), and the alluvial plains bordering many streams were built up by the streams; sea cliffs are made by the eroding action of waves, and sand spits are built up by waves. Topographic forms thus constitute part of the record of the history of the earth.

Some forms are produced in the making of deposits and are inseparably connected with them. The hooked spit, shown in fig. 1, is an illustration. To this class belong beaches, alluvial plains, lava streams, drumlins (smooth oval hills composed of till), and moraines (ridges of drift made at the edges of glaciers). Other forms are produced by erosion, and these are, in origin, independent of the associated material. The sea cliff is an illustration; it may be carved from any rock. To this class belong abandoned river channels, glacial furrows, and peneplains. In the making of a stream terrace an alluvial plain is first built and afterwards partly eroded away. The shaping of a marine or lacustrine plain is usually a double process, hills being worn away (*degraded*) and valleys being filled up (*aggraded*).

All parts of the land surface are subject to the action of air, water, and ice, which slowly wear them down, and streams carry the waste material to the sea. As the process depends on the flow of water to the sea, it can not be carried below sea level, and the sea is therefore called the *base-level* of erosion. When a large tract is for a long time undisturbed by uplift or subsidence it is degraded nearly to base-level, and the even surface thus produced is called a *peneplain*. If the tract is afterwards uplifted the peneplain at the top is a record of the former relation of the tract to sea level.

THE VARIOUS GEOLOGIC SHEETS.

Areal geology map.—This map shows the areas occupied by the various formations. On the margin is a *legend*, which is the key to the map. To ascertain the meaning of any colored pattern and its letter symbol the reader should look for that color, pattern, and symbol in the legend, where he will find the name and description of the formation. If it is desired to find any given formation, its name should be sought in the legend and its color and pattern noted, when the areas on the map corresponding in color and pattern may be traced out.

The legend is also a partial statement of the geologic history. In it the formations are arranged in columnar form, grouped primarily according to origin—sedimentary, igneous, and crystalline of unknown origin—and within each group they are placed in the order of age, so far as known, the youngest at the top.

Economic geology map.—This map represents the distribution of useful minerals and rocks, showing their relations to the topographic features and to the geologic formations. The formations which appear on the areal geology map are usually shown on this map by fainter color patterns. The areal geology, thus printed, affords a subdued background upon which the areas of productive formations may be emphasized by strong colors. A mine symbol is printed at each mine or quarry, accompanied by the name of the principal mineral mined or stone quarried. For regions where there are important mining industries or where artesian basins exist special maps are prepared, to show these additional economic features.

Structure-section sheet.—This sheet exhibits the relations of the formations beneath the surface. In cliffs, canyons, shafts, and other natural and artificial cuttings, the relations of different beds to one another may be seen. Any cutting which exhibits those relations is called a *section*, and the same term is applied to a diagram representing the relations. The arrangement of rocks in the earth is the earth's *structure*, and a section exhibiting this arrangement is called a *structure section*.

The geologist is not limited, however, to the natural and artificial cuttings for his information concerning the earth's structure. Knowing the manner of formation of rocks, and having traced out the relations among the beds on the surface, he can infer their relative positions after they pass beneath the surface, and can draw sections representing the structure of the earth to a considerable depth. Such a section exhibits what would be seen in the side of a cutting many miles long and several thousand feet deep. This is illustrated in the following figure:

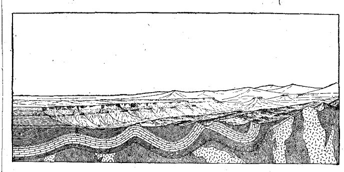

Fig. 2.—Sketch showing a vertical section at the front and a landscape beyond.

The figure represents a landscape which is cut off sharply in the foreground on a vertical plane, so as to show the underground relations of the rocks. The kinds of rock are indicated by appropriate symbols of lines, dots, and dashes. These symbols admit of much variation, but the following are generally used in sections to represent the commoner kinds of rock:

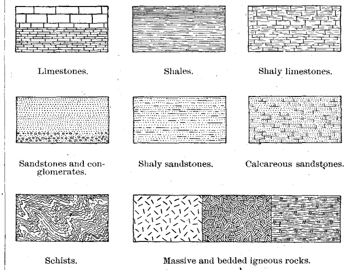

Fig. 3.—Symbols used in sections to represent different kinds of rocks.

The plateau in fig. 2 presents toward the lower land an escarpment, or front, which is made up of sandstones, forming the cliffs, and shales, constituting the slopes, as shown at the extreme left of the section. The broad belt of lower land is traversed by several ridges, which are seen in the section to correspond to the outcrops of a bed of sandstone that rises to the surface. The upturned edges of this bed form the ridges, and the intermediate valleys follow the outcrops of limestone and calcareous shale.

Where the edges of the strata appear at the surface their thickness can be measured and the angles at which they dip below the surface can be observed. Thus their positions underground can be inferred. The direction that the intersection of a bed with a horizontal plane will take is called the *strike*. The inclination of the bed to the horizontal plane, measured at right angles to the strike, is called the *dip*.

Strata are frequently curved in troughs and arches, such as are seen in fig. 2. The arches are called *anticlines* and the troughs *synclines*. But the sandstones, shales, and limestones were deposited beneath the sea in nearly flat sheets; that they are now bent and folded is proof that forces have from time to time caused the earth's surface to wrinkle along certain zones. In places the strata are broken across and the parts have slipped past each other. Such breaks are termed *faults*. Two kinds of faults are shown in fig. 4.

On the right of the sketch, fig. 2, the section is composed of schists which are traversed by masses of igneous rock. The schists are much contorted and their arrangement underground can not be

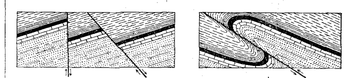

Fig. 4.—Ideal sections of strata, showing (a) *normal* faults and (b) a *thrust* fault.

inferred. Hence that portion of the section delineates what is probably true but is not known by observation or well-founded inference.

The section in fig. 2 shows three sets of formations, distinguished by their underground relations. The uppermost of these, seen at the left of the section, is a set of sandstones and shales, which lie in a horizontal position. These sedimentary strata are now high above the sea, forming a plateau, and their change of elevation shows that a portion of the earth's mass has been raised from a lower to a higher level. The strata of this set are parallel, a relation which is called *conformable*.

The second set of formations consists of strata which form arches and troughs. These strata were once continuous, but the crests of the arches have been removed by degradation. The beds, like those of the first set, are conformable.

The horizontal strata of the plateau rest upon the upturned, eroded edges of the beds of the second set at the left of the section. The overlying deposits are, from their positions, evidently younger than the underlying formations, and the bending and degradation of the older strata must have occurred between the deposition of the older beds and the accumulation of the younger. When younger rocks thus rest upon an eroded surface of older rocks the relation between the two is an *unconformable* one, and their surface of contact is an *unconformity*.

The third set of formations consists of crystalline schists and igneous rocks. At some period of their history the schists were plicated by pressure and traversed by eruptions of molten rock. But the pressure and intrusion of igneous rocks have not affected the overlying strata of the second set. Thus it is evident that a considerable interval elapsed between the formation of the schists and the beginning of deposition of the strata of the second set. During this interval the schists suffered metamorphism; they were the scene of eruptive activity; and they were deeply eroded. The contact between the second and third sets is another unconformity; it marks a time interval between two periods of rock formation.

The section and landscape in fig. 2 are ideal, but they illustrate relations which actually occur. The sections on the structure-section sheet are related to the maps as the section in the figure is related to the landscape. The profile of the surface in the section corresponds to the actual slopes of the ground along the section line, and the depth from the surface of any mineral-producing or water-bearing stratum which appears in the section may be measured by using the scale of the map.

Columnar section sheet.—This sheet contains a concise description of the sedimentary formations which occur in the quadrangle. It presents a summary of the facts relating to the character of the rocks, the thickness of the formations, and the order of accumulation of successive deposits.

The rocks are briefly described, and their characters are indicated in the columnar diagram. The thicknesses of formations are given in figures which state the least and greatest measurements, and the average thickness of each is shown in the column, which is drawn to a scale—usually 1000 feet to 1 inch. The order of accumulation of the sediments is shown in the columnar arrangement—the oldest formation at the bottom, the youngest at the top.

The intervals of time which correspond to events of uplift and degradation and constitute interruptions of deposition are indicated graphically and by the word "unconformity."

CHARLES D. WALCOTT,

Director.

Revised January, 1904.

DESCRIPTION OF THE EBENSBURG QUADRANGLE.

By Charles Butts.

INTRODUCTION.

Location.—By reference to the key map on the cover of this folio, it will be seen that the Ebensburg quadrangle is located along the Allegheny Front in the southern-central part of Pennsylvania. It extends from latitude 40° 15′ on the south to 40° 30′ on the north, and from longitude 78° 30′ on the east to 78° 45′ on the west. It includes one-sixteenth of a square degree of the earth's surface and its area is approximately 228 square miles. The larger part of the quadrangle is in Cambria County, but it includes a wide strip of Blair County on the east and a considerable area in Bedford County on the southeast. It takes its name from Ebensburg, the most important town within its boundaries.

Relation to the Appalachian province.—In its physiographic and geologic relations this quadrangle forms a part of the Appalachian province, which extends from the Atlantic Coastal Plain on the east to the Mississippi lowlands on the west, and from central Alabama to Canada.

GEOGRAPHY AND GEOLOGY OF APPALACHIAN PROVINCE.

With respect to topography and geologic structure, the Appalachian province may be divided into two nearly equal parts by a line following the eastward-facing escarpment known as the Allegheny Front through Pennsylvania, Maryland, and West Virginia, and the eastern escarpment of the Cumberland Plateau from Virginia to Alabama (see fig. 1). East of this line the rocks are greatly

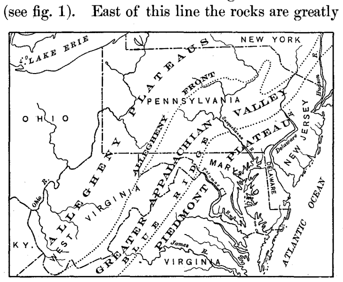

Fig. 1.—Diagram of northern portion of the Appalachian province, showing physiographic divisions.

disturbed by faulting and folding; west of the line they lie nearly flat, the few folds that break the regularity of the structure being so broad that they are scarcely noticeable.

Immediately east of the Allegheny Front are alternating ridges and valleys, designated the Greater Appalachian Valley, and still farther east is a slightly dissected upland known as the Piedmont Plateau. West of the Allegheny Front are more or less elevated plateaus which are greatly dissected by streams and broken by a few ridges where minor folds have affected the rocks. In contradistinction to the lowlands of the Mississippi Valley on the west and the ridges and valleys of the Appalachian Valley on the east, this part of the province has been called by Powell (Nat. Geog. Mon. No. 3, p. 80) the Allegheny Plateaus. The Ebensburg quadrangle is situated mainly in the Allegheny Plateaus; its southeast corner lies in the Greater Appalachian Valley.

ALLEGHENY PLATEAUS.

The Allegheny Plateaus are characterized by distinct types of drainage, surface features, and geologic structure, which are described below.

Drainage.—The drainage of the Allegheny Plateaus is almost entirely into Mississippi River, but in the northeastern part it is either into the Great Lakes or into the Atlantic Ocean through Susquehanna, Delaware, and Hudson rivers.

In the northern part of the province the arrangement of the drainage is largely due to former glaciation. Before the Glacial epoch all the streams north of central Kentucky probably flowed northwest and discharged their waters through the St. Lawrence system. The encroachment of the great ice sheet closed this northern outlet, and new drainage lines were established along the present courses of the streams.

In the southern half of the province the westward-flowing streams not only drain the Allegheny Plateaus, but many of them have their sources on the summits of the Blue Ridge and cross the Greater Appalachian Valley.

Relief.—This division of the Appalachian province is highest along its southeastern margin, where the general surface rises from the altitude of 1700 feet in southern Tennessee to 4000 feet in central West Virginia. From this region it descends to 2200 feet in southern New York. The surface also slopes in a general way to the northwest and southwest, and merges into the Mississippi and Gulf plains. In the southeastern part of the plateau region, in Tennessee and Alabama, is the Cumberland Plateau; in Tennessee and Kentucky the Highland Plateau lies about 1000 feet above the sea. North of these well-defined plateaus to southern New York the region is greatly dissected and its plateau character is apparent only in a view from some elevated point, from which the summits of the highest ridges and hills, rising to about the same height, appear to merge in the distance into a nearly horizontal surface, which is approximately the surface of the old plateau.

The surface of the Cumberland Plateau and perhaps also the summits of the higher ridges and hills, as well as extensive tracts of level surface at high altitudes in a broad belt along the southeastern margin of the plateau region from the Cumberland Plateau to New York, are probably remnants of a peneplain, possibly the Schooley peneplain, developed on Schooley Mountain, in northern New Jersey, where it has been studied and named by W. M. Davis (Proc. Boston Soc. Nat. Hist., vol. 24, p. 377). In the Allegheny and Monongahela valleys of western Pennsylvania the higher divides and ridges probably approximately coincide with the surface of a second peneplain, younger than the Schooley and at a lower level. This peneplain has recently been studied by Campbell (Bull. Geol. Soc. America, vol. 14, pp. 277–296), and named by him the Harrisburg peneplain because it is well developed near Harrisburg, Pa. Along the Monongahela, Allegheny, and Ohio valleys a third peneplain has been recognized. This is lower, younger, and less extensive than the Harrisburg peneplain. It has been named by the writer (in the Kittanning folio) the Worthington peneplain because it is well developed between Worthington and Allegheny River, in Armstrong County, Pa.

Stratigraphy.—The rocks of this region are mostly of Carboniferous age. Around the northern end and along the southeastern margin of the plateaus the Carboniferous rocks are bordered by the upper formations of the Devonian system, which extend beneath the Carboniferous throughout the northern half of the region. The Carboniferous rocks are divided into two series, the Mississippian below and the Pennsylvanian above. The rocks of the Mississippian series are mainly sandstones and shales in the northern part of the region, but include thick limestones in the southeastern and southwestern parts. They outcrop around the margins of the plateaus and underlie the rocks of the Pennsylvanian series in the interior of the region. The Pennsylvanian rocks are coextensive with the Appalachian coal fields. This series consists essentially of sandstones and shales, but contains extensive beds of limestone and fire clay. It is especially distinguished by its coal seams, one or more of which are present in nearly every square mile of its extent from northern Pennsylvania to central Alabama. The Devonian and Carboniferous systems are both represented in the rocks of the Ebensburg quadrangle, the former outcropping in the southeast quarter and the latter in the remainder of the quadrangle.

Structure.—For the purpose of this folio the discussion under this head may be confined to the Appalachian coal field.

The geologic structure of the Appalachian coal field is very simple, since the strata form, in a general way, a broad, flat, canoe-shaped trough. This is particularly true of the northern extremity. The axial line of the trough runs southwest from Pittsburg across West Virginia to Huntington, on Ohio River. To the southeast of this line the rocks dip northwest and to the northwest they dip southeast. In Pennsylvania the deepest part of the trough is in the southwest corner of the State, and the inclination of the rocks is generally toward that region. About the northern end of this canoe-shaped trough the rocks outcrop in a rudely semicircular belt and at all points dip toward the lowest part of the trough.

Although in general the structure is simple, the eastern limb of the trough is crumpled into a number of parallel wrinkles or folds that make the detailed structure somewhat complicated and interrupt the regular westward dip. These undulations are similar to the great folds east of the Allegheny Front, but are on a very much smaller scale and have not been broken by faults. These minor folds are present along the southeastern margin of the basin from central West Virginia to southern New York. Across the northern extremity of the basin they are developed in large numbers and the folded region extends at least halfway across Pennsylvania near its northern boundary. In the southern part of the State there are only six pronounced anticlines, two of these disappearing near the West Virginia line. Farther south the number is less, until, on Kanawha River, the regular westward dip is interrupted by only one or two folds of small proportions. West of the Allegheny Front each trough, as well as each arch, lies lower than the one on the east, so that the rocks which are over 2000 feet above sea at the Allegheny Front lie below sea level in the central part of the basin.

TOPOGRAPHY.

DRAINAGE.

Since the Ebensburg quadrangle lies across the main watershed between the Atlantic Ocean on the east and the Gulf of Mexico on the west, it is not traversed by streams of any magnitude. A small area on the north is drained northward by Clearfield Creek into West Branch of the Susquehanna. Sugar Run, Poplar Run, South Poplar Run, and Beaverdam Creek are small streams draining eastward into Frankstown Branch of the Juniata. Bobs Creek drains a small area on the south into Raystown Branch of the Juniata. On the west Little Conemaugh River and its tributaries, North Branch and South Fork, drain the greater portion of the quadrangle. South Fork joins the main stream at the town of South Fork, 2 miles west of the quadrangle.

RELIEF.

General character.—In detail the surface of this quadrangle is hilly, and in its eastern part is even mountainous, with steep and high slopes. In the western two-thirds the slopes are gentler, and to an observer standing in the vicinity of Ebensburg and looking southeastward the inequalities caused by the valleys are invisible and the surface appears to be fairly even, rising gently to the southeast. In this view the surface has the aspect of a plateau, and such it really is, though it has been deeply dissected by the larger streams. An eastward view from one of the higher knobs near the eastern margin of the quadrangle shows a different type of country. The region to the east is distinctly lower, even valley-like. Its highest ridges lack several hundred feet of reaching the elevation of the knob on which the observer stands. One thousand to 1200 feet below him the foothills stretch away to the valley of Frankstown Branch of the Juniata, which flows nearly 2000 feet below. If he descends to the foothills or to the valley and looks back toward the heights from which he came he finds the surface features even more striking. The knobs tower above him like mountains and the steep eastern sides present the appearance of a great wall. This is the escarpment known as the Allegheny Front, which separates the Greater Appalachian Valley on the east from the plateau on the west. To the earlier settlers of the country, approaching from the east, this great escarpment with the conspicuous knobs surmounting its crest presented a decidedly mountainous appearance, and to that fact is doubtless due the name Allegheny Mountains, by which the escarpment is universally known.

The Allegheny Front has some special features of interest. The group of summits in Freedom and Greenfield townships, Blair County, and in Union Township, Bedford County, are striking objects in the landscape when viewed from any direction. The top of Blue Knob in the latter township is by spirit level 3136 feet above sea level—probably the highest measured elevation in the State. The extreme relief of the quadrangle is measured by the difference—1846 feet—between the altitude of this knob and that of the village of Queen, in the southeast corner of the quadrangle. This group of summits is separated from the eastern edge of the main plateau by the gorges of Bobs Creek and Poplar Run. While the eastern declivities of these knobs undoubtedly are to be considered as marking the position of the Allegheny Front, since they separate the valley region on the east from the plateau region on the west, yet the range of summits west of the deep and picturesque Bobs Creek gorge is generally regarded as a part of the Allegheny Mountains proper.

Peneplains.—With one exception it is doubtful whether the peneplains described in the "Introduction" can be recognized in this quadrangle. In the Allegheny and Monongahela valleys, as described in preceding folios, it has been possible to make out with a good degree of certainty two distinct levels resulting from former long-continued subaerial erosion. Portions of these old surfaces or peneplains have been preserved and in each case are now represented by divides, hilltops, and level spurs found at approximately the same altitudes in the regions mentioned above. In the Ebensburg quadrangle, however, no such uniformity of heights prevails at any level and it is to be doubted whether extensive peneplanation ever took place here. Since regions near the mouths of streams are the first and those at their headwaters the last to be reduced, none of the cycles of erosion during which the peneplains already described were developed in other regions may have lasted long enough for the reduction of this region which lies at the headwaters of the principal drainage lines of eastern United States.

Notwithstanding the general conditions set forth above, it seems possible that certain limited areas lying at two levels represent the surface of preexisting peneplains. The higher of these is in Bobs Creek Valley. A considerable area of comparatively flat land near Blue Knob post-office and farther southward along the road lies 2300 to 2400 feet above sea. The 2400-foot level is particularly noticeable. West of Pavia is a long, level-crested spur at 2450 feet. Viewed from one of the high knobs near Blue Knob post-office the deep, narrow gorge of the creek hardly appears, the minor irregularities become inconspicuous, and the region has the appearance of a broad, flatbottomed valley bordered by walls 500 to 600 feet high, and such a valley probably existed before the erosion of Bobs Creek gorge. This ancient valley bottom will be called the Bobs Creek strath, this being a Scotch term for such a feature (Geikie, Scenery of Scotland, p. 156). The significance of this feature lies in the fact that its elevation is in general the same as that of the ridges of the Greater Appalachian Valley on the east, where the higher crests range from 2200 to 2400 feet. The summits of these ridges are regarded as approximately representing the surface of the Schooley peneplain, and it seems highly probable that the Bobs Creek strath represents the same surface. It is doubtful, however, whether the Schooley peneplain can be recognized elsewhere in the quadrangle, such surfaces at that level as may occur being more probably attributable to the presence of a thick sandstone by which they have been preserved from erosion. The flat-topped hill north of Gallitzin is an example of the latter case, its surface being coincident with the top of a sandstone stratum.

The lower of the two levels of possible peneplanation is indicated by spurs between the streams along the foothills of the Allegheny Front. It will be seen by examining the map that these almost invariably lie at elevations running from a little below 1700 to 1800 feet. The meaning of this is not clear. The spurs may be portions of a widely extended peneplain of which there are no other traces in the region. No attempt is made here to correlate this feature with any previously described peneplain, since the data at hand are insufficient for that purpose.

DESCRIPTIVE GEOLOGY.

STRATIGRAPHY.

The rocks of the Ebensburg quadrangle are included in the Devonian and the Carboniferous systems. Each system is here divided into formations, and some of the formations are further subdivided into members.

DEVONIAN SYSTEM.

General statement.—Within this quadrangle the Devonian system comprises five formations, which, named from below upward, are as follows: Hamilton, Genesee, Nunda ("Portage"), Chemung, and Catskill. The lower four formations outcrop over a comparatively small area in the southeast corner of the quadrangle, while the fifth covers a much

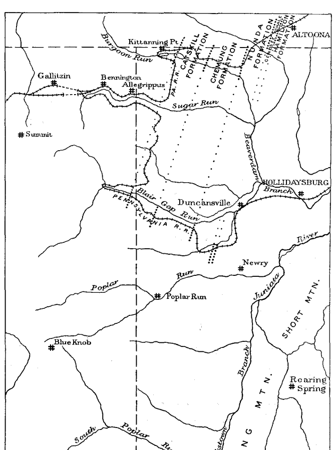

FIG. 2.—Sketch map of area adjoining Ebensburg quadrangle on east, showing formations along Pennsylvania Railroad west of Altoona and along New Portage branch of Pennsylvania Railroad west of Hollidaysburg.

larger area to the northwest. These rocks are very poorly exposed within the quadrangle, so it is necessary to study and describe them as they occur farther east and north. They are best exposed along the Pennsylvania Railroad west of Altoona and along the New Portage branch of the same railroad west of Hollidaysburg, and in the following description frequent reference will be made to the sections in these localities (see fig. 2). On account of the northeast strike prevailing in this region the rocks crossed along the Pennsylvania Railroad between Altoona and Kittanning Point correspond with those crossed in going from the southeast corner of the Ebensburg quadrangle through Queen to Blue Knob summit, so that a description of the rocks in the railroad section will answer for those of the section northwestward through Queen.

In previous surveys of this region it was recognized that the mass of shale and thin sandstones between the Oriskany sandstone below and the bottom of the Catskill above represents the Marcellus, Hamilton, Genesee, Nunda ("Portage"), and Chemung formations, yet on account of the generally homogeneous character of the mass as a whole no effort was made to discriminate and map the individual formations. It has been found possible, however, by taking careful note of the lithologic and paleontologic characters of the rocks, to identify the main formations recognized in New York State and to establish and map the limits of the same with a fair degree of precision, as will appear in the following description.

HAMILTON FORMATION.

The lowest and oldest rock of the Ebensburg quadrangle belongs to the Hamilton formation. It is predominatingly a very dark-green clay shale, which weathers to a dull-brown or blackish color and breaks up in weathering or under the hammer obliquely to the bedding planes into very irregularly shaped pieces. In addition to such rock there is more or less shale approaching olive-green and gray tints and also some dark-green sandy and slightly micaceous shale. Bands of fine-grained bluish sandstone occur, but they are infrequent and rarely a foot thick. These sandstone layers are often very uniform in thickness and are divided by jointing into regular prismatic blocks of very characteristic appearance. The formation is moderately fossiliferous, the forms most common in the upper part being *Tropidoleptus carinatus, Chonetes mucronatus, Chonetes coronatus, Spirifer tullia, Grammysia arcuata,* and *Grammysia bisulcata.* The thickness of the Hamilton in this region has not been determined, but the part of the formation occurring in the Ebensburg quadrangle is about 1300 feet thick, calculated from the dip and the width of outcrop. Its areal extent is less than 1 square mile in the extreme southeast corner of the quadrangle.

The bottom of the formation does not outcrop in the quadrangle and has not been definitely determined in the region. The top is well marked by the Genesee shale and has been located within narrow limits from the vicinity of Bellwood, on the Pennsylvania Railroad, 6 miles northeast of Altoona, to Queen, in the southeast corner of the Ebensburg quadrangle. In a railroad cut 1 mile southwest of Bellwood, at the point where the present main tracks of the Pennsylvania Railroad diverge from the old tracks, the contact between the Hamilton and Genesee is well exposed. The topmost layer of the Hamilton is an impure limestone 2 to 4 feet thick, crowded with Hamilton fossils, and immediately overlying it is the characteristic black Genesee shale. At Altoona the contact is not exposed, but its position can be closely determined. Along the Pennsylvania Railroad track, beginning about 2375 feet west of the Logan Hotel, and just west of the underground crossing of the electric road to Hollidaysburg, is an exposure of shale extending westward for 540 feet. Hamilton fossils were found in these rocks practically to the top. West of this exposure is a concealed space of 630 feet to the point where Twenty-first street intersects the track. At this point is the beginning of an outcrop of rocks bearing a Nunda ("Portage") fauna throughout. At the intersection of Fourteenth street and Thirteenth avenue in Altoona the Genesee shale is exposed with overlying shale identical in character and fossils with that at the base of the outcrop beginning on the railroad track at Twenty-first street as mentioned above. At this street intersection the Genesee shale is at least 80 feet thick, and the strike of the rocks is such as to carry it through the concealed space along the railroad. The thickness of the rocks in this space is about 140 feet, from which 80 feet may be deducted for the thickness of the Genesee shale, leaving 60 feet of Hamilton rocks at the bottom of the concealed space. This would extend the Hamilton formation 230 feet beyond the west end of the first cut west of Altoona station, so that its top would cross the track 2600 feet west of the Logan Hotel.

On the New Portage branch of the Pennsylvania Railroad the contact of the Hamilton and the Genesee shale can be closely located about 1 mile northwest of Newry, where fragments of limestone full of Hamilton fossils were found at the base of an outcrop of the Genesee black shale. The same contact is well exposed in the road between Claysburg and Queen on the crest of a spur one-half mile northeast of Smoky Run. At this point also a thin, impure limestone with Hamilton fossils occurs at the base of the black shale. In the Ebensburg quadrangle the top of the Hamilton lies near the farmhouse one-fourth mile southeast of the road intersection at Queen. In the bank of the creek back of the house the Genesee and Nunda shales are exposed, and about 250 feet east of the house shale with Hamilton fossils is exposed in such a position that the northwestward dip would bring it to creek level about 180 feet east of the house, and through that point the boundary is drawn.

GENESEE SHALE.

The Genesee formation is a well-defined stratum of black shale lying conformably between the Hamilton below and the Nunda above. On account of its distinctive character it is important as a horizon marker in the region. The shale is very fissile, cleaving easily into thin plates and flakes. Its black color is probably due to the presence of carbonaceous matter, as in the type region of western New York. It contains also, as in the type region, rather plentiful calcareous concretions. It is very sparingly fossiliferous, a few goniatites only having been found. Indeed, the formation preserves to a remarkable degree the characteristics by which it is distinguished in western New York. As already stated in the description of the Hamilton formation, the Genesee shale has been seen between Bellwood and Altoona, at the intersection of Fourteenth street and Thirteenth avenue in the latter place, on the New Portage Railroad 1 mile northwest of Newry, on the road midway between Claysburg and Queen, and near Queen. It crosses the Pennsylvania Railroad in the concealed space between a point 2375 feet west of the Logan Hotel and Twenty-first street, Altoona. At the above-mentioned intersection of Fourteenth street and Thirteenth avenue in Altoona a thickness of 80 feet was measured and, as the base of the shale was apparently not exposed, its thickness may be greater. The upper part of the formation is exposed in the bank of Beaverdam Creek one-fourth mile southeast of Queen; there is evidence that its width of outcrop at this point is 180 feet, and as the dip is 25° the thickness is 75 feet. The shale was not seen elsewhere in the quadrangle, but it is assumed to hold that thickness across the southeast corner, outcropping in a narrow strip approximately as mapped.

NUNDA FORMATION.

The Nunda formation has been known in previous reports on the geology of Pennsylvania as the Portage. According to the usage of the United States Geological Survey, however, the term Portage should be restricted to the Portage sandstone of the Genesee River section in New York, and the term Nunda, which was introduced in the early New York reports, should be applied to the rocks generally designated as the Portage group or beds.

The basal 100 or 200 feet of the Nunda formation are composed of soft, pale-brown clay shale which weathers to a dove color and has a very perfect cleavage, splitting easily into large, thin, smooth plates. In this shale *Paracardium doris* and *Pterochænia fragilis* are relatively abundant immediately above the Genesee shale. In passing upward through the formation the rocks gradually change from the shale above described to a pale, greenish-gray, sandy shale, which makes up the greater part of the formation. This shale generally cleaves easily into thin laminæ, but there are beds of coarser character and less perfect cleavage. Evenly bedded layers of hard, bluish, fine-grained sandstone occur, with some thin irregular layers. These layers are generally from 1 to 6 inches thick and rarely 1 foot. They are especially abundant through the 100 feet of strata beginning about 350 feet above the base of the formation and are well exhibited on the Pennsylvania Railroad in the third cut, about 1 mile west of the station at Altoona. In the fourth cut, 7750 feet west of the station, a few bands up to 1 foot thick of compact or shaly chocolate-colored rock occur, and similar rock is exposed in a cut along incline No. 10 on the old Portage Railroad. The thickness of the formation measured along the Pennsylvania Railroad appears to be about 1400 feet, and the thickness calculated from the dip and width of outcrop in the Ebensburg quadrangle is about 1600 feet. The formation outcrops in a belt about a mile in width across the southeast corner of the quadrangle.

The upper beds are very sparingly fossiliferous, such forms occurring as *Buchiola retrostriata, Ontaria accincta, Phragmostoma natator, Styliolina fissurella, Coleolus aciculum,* and *Probeloceras lutheri.* No effort was made to collect exhaustively from these rocks, and doubtless the above list could be considerably increased if thorough search were made. The forms found are enough, however, to demonstrate the presence of a typical Nunda fauna closely related to the fauna of the Naples subprovince in western New York.

In Blair County the bottom of the Nunda formation is sharply marked by the top of the Genesee shale. The top of the Nunda is, however, very indefinite. No persistent and easily recognized stratum separates this formation from the succeeding Chemung, nor is there any distinct lithologic change to mark the boundary. The rocks of the one merge into those of the other by imperceptible stages. The boundary, as established by the writer, rests on a paleontologic basis. All the beds above the Genesee and below the horizon at which the lowest Chemung fossils are found are here considered to be Nunda. On the Pennsylvania Railroad the lowest Chemung fossils were found about $2\frac{1}{2}$ miles west of the Logan Hotel, Altoona, in a cut near the beginning of the curve at which, in going westward, the track turns into the valley of Burgoon Run. In this cut is a thin band of sandstone full of *Leiorhynchus mesocostale* and *Productella lachrymosa* or a closely allied form. Underlying the fossil-bearing band nearly 100 feet of rocks are exposed, but no fossils could be found in them. On the New Portage Railroad the lowest Chemung fossils found were the same as those just mentioned. These were collected in a cut about one-half mile west of the foot of incline No. 10, where the recently constructed branch of the Pennsylvania Railroad diverges from the line of the old Portage road. East of this point also are almost continuous exposures of the underlying rocks for a thickness of many hundred feet, but in these no Chemung fossils could be found. No effort was made to locate this boundary between the last-mentioned point and the southeast corner of the Ebensburg quadrangle. Within the quadrangle the lowest Chemung fossils were found in place on the eastern point of the spur just north of the road one-half mile northwest of Queen, at the point marked by the 1380-foot contour, and the boundary is located at this point. Loose fossils were found lower down, however, and Chemung fossils may occur in lower rocks, in which, on account of lack of exposures, they were not found. There is doubt, therefore, as to the actual position of the boundary in this locality, a fact that is expressed on the map by the absence of a sharp boundary line. Nevertheless, the main bodies of the two formations are well differentiated by both lithologic and paleontologic characters.

CHEMUNG FORMATION.

The total thickness of the Chemung formation measured along the Pennsylvania Railroad track west of Altoona is over 2500 feet, but the thickness calculated from the dip and the width of outcrop in the Ebensburg quadrangle is about 2400 feet. In the lower 1400 feet the rocks are gray or green sandy or clay shale, with a small proportion of gray sandstone, generally in thin layers, but occasionally in a stratum 50 feet thick. In the upper 1000 feet the rocks are characterized by a large proportion of chocolate shale and by thin layers of chocolate sandstone. The rocks of the formation are steeply inclined and their outcrop is confined to a belt about 1 mile wide extending across the southeast corner of the quadrangle.

The formation is moderately fossiliferous throughout, fossils being found up to within a few feet of the Catskill rocks. The fauna is distinctly Chemung, *Spirifer disjunctus*, *Sp. mesocostalis*, *Sp. mesostrialis*, *Schuchertella chemungensis*, *Stropheodonta cayuta*, *Atrypa hystrix*, *Ambocœlia umbonata*, and *Camarotœchia contracta* var. being common forms.

CATSKILL FORMATION.

The Catskill formation is about 2000 feet thick in this region. Probably 80 per cent of its rocks are red shale and red or brown sandstone, the rest of the formation being gray or green shale or sandstone. The red shale predominates. It is mainly argillaceous and is bright red in outcrop, while the red sandstone generally weathers to a gray or dull-brown color and is red only on a newly broken surface. The sandstone is medium to fine grained and may be thick or thin bedded or even laminated. It usually occurs in thin layers interbedded with shale, but may be thick bedded. The whole thickness is generally about 50 feet. No fossils were found in the formation, and their absence or rarity sharply distinguishes it from the Chemung.

The Catskill has an extensive outspread in the southeastern part of the quadrangle. Although its thickness is less than that of the Chemung formation and but little greater than that of the Nunda, the width of its outcrop is much greater than that of either, a fact due to the existence of the Pavia syncline, which is described on page 6.

The Catskill overlies the Chemung conformably. The top of the formation is well exposed in the Hollidaysburg quadrangle at the curve on the Pennsylvania Railroad where, in going westward, it turns into the gorge of Sugar Run. This point is $1\frac{1}{2}$ miles south of the horseshoe curve at Kittanning Point and $1\frac{1}{4}$ miles east of Allegrippus station. In a cut at this point a stratum of bright-red shale is exposed, the top of which is taken as the top of the Catskill, since the rocks below to the top of the Chemung are prevailingly red, while the overlying 1000 feet of rocks are prevailingly gray. Although the top of the Catskill can be definitely located at this point, it is difficult to trace it across the Ebensburg quadrangle, on account of the total lack of exposures along the contact between the Catskill and the overlying formation. This makes it necessary to trace the contact by the color of the soil, but owing to the occurrence of bands of red shale in the overlying Pocono formation and to possible variations in the proportion of red and gray rocks in the upper part of the Catskill, this criterion for distinguishing the two formations is rather unreliable, and probably the boundary as mapped is not everywhere located at the same horizon. The general structure of the region has, however, been considered in drawing the boundary, which can hardly be far from its true position at any point.

CARBONIFEROUS SYSTEM.

General statement.—The Carboniferous rocks overlie the Devonian conformably and comprise the Mississippian series below and the Pennsylvanian series above. From below upward the Mississippian series is divided into the Pocono and Mauch Chunk formations, and the Pennsylvanian series is divided into the Pottsville, Allegheny, Conemaugh, and Monongahela formations.

The rocks of the Pocono, Mauch Chunk, and Pottsville formations are well exposed only in the cuts along the Pennsylvania Railroad east of Bennington station, and our best knowledge of them has been obtained from the study of that section. Fig. 3 shows the profile section of these rocks as exposed along the railroad and fig. 4 the columnar section derived therefrom. The thickness and character of the formations as determined in this section are assumed to hold for the whole quadrangle. The areal distribution of the formations in the quadrangle can be fairly well determined by surface indications, but exposures are too scattering and too thin away from the railroad to afford a more detailed knowledge of the rocks.

In the report of the Second Geological Survey of Pennsylvania on Blair County was published a detailed section including the Pocono, Mauch Chunk, and Pottsville rocks, as measured along the Pennsylvania Railroad. The sections of these formations as measured by the geologists of that Survey and by the writer are shown in fig. 4. A comparison of the two sections will show that they differ somewhat in detail and in total thickness. The discrepancy is especially great in the upper two formations. The writer's measurements were made with great care and are believed to be very nearly correct. A detailed description of the formations is given below.

POCONO FORMATION.

General features.—The Pocono lies conformably upon the Catskill formation and is mainly made up of gray sandy shale and thick strata of rather coarse and thick-bedded gray sandstone. Bands of red clay shale from 10 to 40 feet thick also occur. The formation is well exposed along the Pennsylvania Railroad from the curve above mentioned, where the railroad enters the gorge of Sugar Run from the east, to Allegrippus station. The rocks dip westward from 10° at the beginning of the section to 5° at Allegrippus, and the whole formation outcrops between these points. As measured by the writer and by Mr. W. C. Phalen, the formation is 1030 feet thick, and that is taken as the thickness of the formation in the quadrangle. The Pocono formation as a whole outcrops in a broad belt traversing the quadrangle from near the northeast corner southwestward to the middle of the southern boundary. It caps the line of summits west of Bobs Creek and also the high summits along the main line of the Allegheny Front east of Bobs Creek. The presence of Pocono

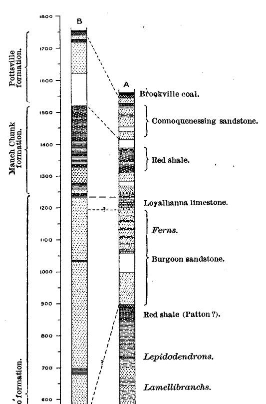

Fig. 4.—Columnar section of Mississippian and Pottsville rocks along Pennsylvania Railroad on the Allegheny Front west of Altoona.

A, as measured by Charles Butts and shown in profile section fig. 3; B, as measured by Pennsylvania Second Survey and published in Report I, pp. 12-13.

rocks on these summits is due to the Pavia syncline, and the height of the knobs is due to the presence of a hard sandstone and conglomerate that lies at the base of the formation here. This becomes a true conglomerate on Blue Knob summit and on the summits to the northeast. It is especially heavy on the former, and great masses of it are conspicuous objects in the fields on the mountain side northwest of Queen.

The Pocono section, as exposed along the railroad, is described in detail below. At the base of the section at the curve mentioned lies 50 feet of soft red shale, already described as forming the top of the Catskill. Above this shale is 180 feet of coarse sandstone, separated into two parts by a thin bed of red shale 50 feet from the bottom. The sandstone is followed by about 530 feet of alternating shale and sandstone, prevailingly gray, but containing bands of red shale and red sandstone and occasional beds of clay.

Patton shale.—At the top of the group of shales and sandstone just mentioned and included therein lies a bed of red shale about 40 feet thick. This has the same stratigraphic relations as the Patton shale of the Allegheny Valley, described in folios Nos. 102, 110, and 115, and may be the representative of that stratum, which, as will be shown later, is of considerable importance as a horizon marker. The top of this red shale is at track level 3000 feet east of Allegrippus.

Burgoon sandstone.—Immediately overlying the red shale are apparently 300 feet of coarse and very thick-bedded gray sandstone, which is continuously exposed along the track for the 3000 feet between the top of the Patton shale at its base and Allegrippus, with the exception of a concealed interval of about 60 feet in a ravine east of that place. Some shale may occur in this concealed interval, though it is probably filled with sandstone. Thin layers and lenses of gray sandy shale occur throughout the sandstone, and in one of these, about 100 feet above the base, a small lens of coal 8 inches thick was seen. The top of this sandstone, very definitely demarcated by the bottom of a calcareous stratum of highly characteristic appearance to be described later, is 10 feet above the track at the east side of the ravine at Allegrippus station. The sandstone is a well-defined lithologic unit in this section, and the name Burgoon is here applied to it because it is cut through by the valley of Burgoon Run above Kittanning Point. No considerable exposures of the sandstone were seen on the valley walls, but on the south side abundant bowlders of coarse siliceous sandstone and a soil that is almost pure sand indicate the presence of the stratum close beneath the surface.

The Burgoon sandstone caps the range of summits west of Bobs Creek to the southern margin of the quadrangle. It yields a large number of coarse bowlders and may be seen in place on some of the knobs. At various points the bowlders contain quartz pebbles of small size, indicating a gritty character of the sandstone that does not appear in the railroad section.

Loyalhanna limestone.—Immediately overlying the Burgoon sandstone on the east side of the ravine at Allegrippus is a stratum of coarse calcareous sandstone. This stratum is marked by strong cross-bedding and a surface pitted by differential erosion, and these features give it a very distinctive appearance, by which it is recognized at widely separated points in western Pennsylvania. These characters distinguish the stratum sharply from the Burgoon sandstone below, and, as before stated, the boundary between the two is plainly apparent 10 feet above the track at the west end of the cut just east of Allegrippus station. On account of the westward dip, the limestone descends so that its top is 10 feet above the track on the west side of the ravine at Allegrippus and at track level about 100 feet farther west. It is rather more calcareous at this point than on the east side of the ravine, and this may indicate that it is more calcareous toward the top than lower down. It is closely overlain by a few feet of rock composed of thin bands of red shale and layers of gray sandstone, and these beds are in turn overlain by a considerable thickness of coarse, thick-bedded, gray sandstone.

The stratum is universally known in the region of its occurrence as the "Siliceous" limestone, though generally it is rather a calcareous sandstone. In deference to general usage it is here called a limestone and the name Loyalhanna has been applied to it, from its good development along the gorge in which that stream flows across Chestnut Ridge in Westmoreland County, and from the extensive exposures in the quarries at Long Bridge, between Latrobe and Ligonier.

At the top of the cut immediately east of Allegrippus the thickness of the Loyalhanna limestone exposed is 40 feet. It is uncertain, however, whether this is the full thickness of the stratum, since it could not be determined whether its top is exposed at that point. It is probably not much over 40 feet thick. A small exposure of the limestone was seen on Redlick Run and bowlders of considerable size lie by the roadside on Blairs Gap Run near the mouth of the deep ravine on the north, 1 mile above the Pennsylvania Railroad bridge. It is also exposed in the road on Burgoon Run, near the northeast corner of the quadrangle.

Limits of the Pocono.—In the western Pennsylvania folios already published by the Survey the top of the Loyalhanna limestone has been taken as the top of the Pocono formation, and that usage is followed here. There is uncertainty as to the bottom of the Pocono. A few fossil plants, mainly lepidodendra, were found in places down to a point about midway between the top of the Loyalhanna limestone and the top of the red shale underlying the section. These are regarded by David White as of Pocono age. About 100 feet lower some fragments of a lamellibranch were found, and still lower, at semaphore tower No. 237, several specimens of a lingula were found in a green clayey layer. These were examined by Dr. George H. Girty with indefinite results. He expresses the opinion, however, that they exhibit Devonian rather than Carboniferous affinities. Associated with the lingula found at the semaphore tower were a number of species of ferns which David White thinks may be either Carboniferous or Devonian. From this point to the bottom of the section, at the top of the red shale, no fossils were found and it does not seem possible at present to fix, on paleontologic grounds, the bottom of the Pocono with any degree of definiteness. On lithologic grounds, however, there seems but one place to draw the boundary between that formation and the underlying Catskill, and that is at the top of the red shale already described. The top of this shale lies stratigraphically about 380 feet below the clay bed in which the fossils occur and descends below the level of the railroad track at a point about 2000 feet east of the above-mentioned semaphore tower. As already stated, probably 80 per cent of the rocks from the top of this shale downward for 2000 feet are of red color, which sharply distinguishes them from the overlying and underlying rocks. For that reason the lower limit of the Pocono and the boundary between the Carboniferous and the Devonian is placed at the top of the red rocks.

MAUCH CHUNK FORMATION.

The Mauch Chunk formation lies conformably upon the Pocono. The only satisfactory exposure of the formation is along the Pennsylvania Railroad, and its character can best be described by giving a description of the railroad section. It extends along the railroad from the west side of the ravine at Allegrippus to a point about 3000 feet southeast of Bennington station. The lower part of the formation is well exposed west of Allegrippus and consists of 5 to 6 feet of interbedded red shale and sandstone immediately overlying the Loyalhanna limestone and then of 80 feet of mostly

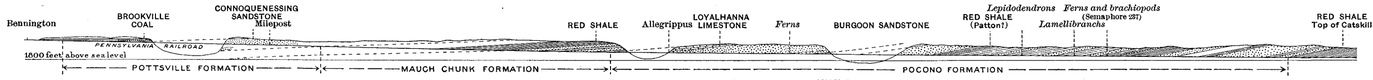

Fig. 3.—Profile section of Mississippian and Pottsville rocks along Pennsylvania Railroad on the Allegheny Front west of Altoona.

thick-bedded gray to greenish sandstone. In the section just west of Allegrippus is a bed of conglomerate 2 to 3 feet thick in the sandstone. At a point 1 mile east of Bennington the sandstone is succeeded by overlying red shale, which outcrops thence westward along the track for the distance of one-half mile. The lower part of the shale is exposed; the presence of the upper part is indicated by red débris on the bank above the track. The red débris occurs along the track to within 200 feet of the point (farther west) at which Pottsville sandstone is exposed at track level, and, on account of the low western dip of both shale and sandstone, the top of the shale and, therefore, of the Mauch Chunk can lie but a short distance below the lowest sandstone exposed. Within the limits described above not over 100 feet of shale can be made out by the writer. This makes the total thickness of the Mauch Chunk 180 feet, which is 100 feet less than the thickness given in the report of the Second Geological Survey of Pennsylvania on Blair County. Inasmuch as the upper 100 feet of shale is nowhere fully exposed, it is not known to be all red. Some green shale occurs at the bottom. The proportion of red shale is sufficient to impart a bright-red color to the soil along the outcrop of the formation. The red shale is soft and some of it appears to be of an earthy character. It is crumbly and often weathers into small cubical fragments, unlike most other shale, which weathers into small flakes.

This formation outcrops in a generally narrow belt diagonally across the quadrangle from Sugar Run on the northeast to the head of South Fork of Little Conemaugh River on the southwest. Its outcrop can be easily traced by the red soil which everywhere results from the decomposition of the shale. Even in the forests its presence beneath the surface is indicated by the character of the vegetation. The dense undergrowth that characterizes the sandy soils of the Pocono and Pottsville formations below and above is absent along the belt of red shale, where the forest is of a more open character and the undergrowth largely herbaceous. In such a spot a stroke of the hammer rarely fails to reveal the red soil.

POTTSVILLE FORMATION.

The Pottsville formation lies unconformably upon the Mauch Chunk. Along the Pennsylvania Railroad just east of Bennington it is about 130 feet thick and is composed of two sandstone members separated by shale and fire clay. These are the Connoquenessing sandstone, the Mercer shale and clay, and the Homewood sandstone, the three members recognized in the western part of the State.

A rather thick-bedded sandstone outcropping near the bottom of the ravine just east of Bennington, as shown in the profile section, fig. 3, is regarded as the bottom of the Connoquenessing sandstone; its top is about 30 feet above the track at the west end of the cut just east of this ravine. The face of sandstone, about 50 feet high, at the east end of this cut, near the end of the above described Mauch Chunk outcrop, is Connoquenessing. This member is 80 to 100 feet thick. It is a rather coarse, gray sandstone with small lenses or layers of gray sandy shale. Above the Connoquenessing are 6 feet of shale overlain by 9 feet of fire clay, at the top of which, partially included in the overlying Homewood sandstone, are small pockets of coal 2 inches thick. Some small specimens of Mercer plants were found in the shale, and these beds constitute the Mercer member of the Pottsville. Above the fire clay is the Homewood sandstone, coarse, thick bedded, and 15 feet thick. It shows well in the first cut east of Bennington and dips below track level 400 feet east of the station. Neither the Connoquenessing nor the Homewood sandstone is conglomeratic in this section. The Pottsville formation outcrops across the quadrangle in a generally narrow belt parallel to the other formations described. Its position is usually indicated by coarse white bowlders. On the ridge north of Big Spring Gap the surface is covered with very large masses of Pottsville sandstone. On the westward slopes south and east of Onnalinda are many large bowlders of conglomerate with quartz pebbles as large as a walnut. These are possibly derived from the Connoquenessing member, which contained conglomerate beds in that locality.

The Mercer coal occurs as thin streaks in the base of the Homewood sandstone at Bennington. Just beyond the northern margin of the quadrangle, at Glenwhite, this coal is a thick workable bed between the Connoquenessing and Homewood sandstones. It has been mistaken for the "A" or Brookville coal, but its stratigraphic relations, as well as its fossil plants, clearly show it to be Mercer. What is probably the same coal is mined at the Eleanor mine at Martindale. A coal regarded in the neighborhood as the "A" or Brookville was once opened above Lloydell at railroad grade near the tipple of the Cambria mine. The same line of evidence stated above shows that this coal is Mercer instead of Brookville. It contains a characteristic fern which, according to David White, has never been found at a horizon that is certainly known to be higher than that of the Mercer coal. On the Bedford road, where it crosses the southern margin of the quadrangle, is an opening in what is probably this seam.

ALLEGHENY FORMATION.

General features.—The Allegheny formation overlies the Pottsville conformably and extends upward to the top of the Upper Freeport coal. It includes the lower coal-bearing rocks of western Pennsylvania, and was formerly known as the Lower Productive Measures. In this quadrangle the formation is mainly shale, but comprises also several coal seams of greater or less persistence and thickness and locally includes thick strata of heavy sandstone. Roughly speaking, the coal seams lie 20 to 40 feet apart vertically throughout the formation and are separated by shale where sandstone is not locally developed. Fig. 5 shows the general section of the coals. Unimportant beds of limestone and fire clay also occur. The thickness of the Allegheny formation, as determined along the Pennsylvania Railroad from Bennington to the eastern portal of the tunnel at Gallitzin, is 270 feet. It is believed that this thickness will not vary greatly throughout the quadrangle. The formation as a whole outcrops across the quadrangle from the northeast to the southwest corner in a strip of irregular width and varying direction, extending westward into the valleys and eastward onto the high upland.

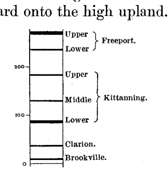

FIG. 5.—Section showing coal beds of Allegheny formation in Ebensburg quadrangle.

Brookville coal.—This coal lies near the base of the formation. It is exposed at the cut just east of Bennington and is 5 feet thick. It is reported of good thickness at the base of the culvert over the old Portage Railroad on Blairs Gap Run and has been mined a short distance below. Near the head of Bear Rock Run it has recently been opened and found too thin to be minable. Nothing definite of it elsewhere is known to the writer.

Clarion sandstone.—Apparently close above the horizon of the Brookville coal on South Fork of the Little Conemaugh above Lloydell is a massive conglomeratic sandstone 30 to 40 feet thick that probably represents the Clarion sandstone. It was not identified elsewhere.

Clarion coal.—Above the Brookville coal at Bennington lie 12 to 15 feet of sandy shale or laminated sandstone and then a thin seam, about 15 inches thick, of coal which is regarded as the Clarion coal. It was not seen elsewhere, but is reported at a number of points.

Lower Kittanning coal ("B" or Miller seam).—Overlying the Clarion coal or sandstone occur from 40 to 60 feet of shale, at the top of which lies the Lower Kittanning coal. This seam is very persistent along its outcrop in the quadrangle and is everywhere found to be 3 to 4 feet thick. Its line of outcrop can be best made out by consulting the map showing the economic geology.

From 14 to 20 feet above the Lower Kittanning coal lies a rather persistent but generally thin seam of coal. This is reported in the Bennington shaft of the Cambria Iron Company at Bennington, in the Dennison & Porter shaft farther south, and at a number of points near the head of Blairs Gap Run. It is reported 4 feet thick on Bear Rock Run at its junction with Burgoon Run, and on Bens Creek at the Piper No. 2 mine it is 5 feet thick and 14 feet above the Lower Kittanning coal. It is not known whether this seam is the equivalent of any of the well-known seams of the Allegheny Valley. If it be accepted, as is generally done, that the "B" seam is the equivalent of the Lower Kittanning, then the full number of coals in the Allegheny Valley above the Lower Kittanning are represented in this quadrangle without counting the seam just described. Moreover, the intervals at which the seams occur, neglecting the one under consideration, are very much the same as in the Allegheny Valley. Either there is one more seam in this region above the Lower Kittanning coal or there has been a mistake in the identification of that seam. The former assumption is adopted here, and the seam now under consideration is regarded as an extra member of the coal series of the Allegheny formation.

Middle Kittanning coal.—In the Bennington shaft and in the Dennison & Porter shaft a coal $2\frac{1}{2}$ feet thick occurs 40 feet above the Lower Kittanning coal and 20 feet above the coal last described. The average interval between this coal and the Lower Kittanning coal is 35 feet, which is largely filled with sandstone. The position of this coal corresponds with that of the Middle Kittanning coal in the type region and it is here considered as that seam.

Llanfair sandstone.—At Llanfair a heavy sandstone crops out in the gorge opposite the Henriette shaft No. 1 and, as shown in the shaft section, extends to within 40 feet of the Lower Kittanning coal. It has a considerable extent in this region and is called the Llanfair sandstone. Its top is exposed along the track near the Llanfair shaft No. 2, about 2 miles south of Llanfair, where it is very coarse and heavy. The slopes and the crest of the ridge between Yellow Run and South Fork of the Little Conemaugh east of Llanfair are densely covered with white bowlders of coarse sandstone derived from this stratum, which apparently coincides with the slopes. On Bens Creek the Lower Kittanning coal is closely overlain by a heavy sandstone that may be a downward extension of the Llanfair.

Upper Kittanning coal.—About 50 feet above the Middle Kittanning coal occurs the Upper Kittanning coal, the interval being filled with sandstone and shale or with shale alone, according to locality. This coal shows as a bed 2 feet thick in the road at the bridge across Yellow Run, at Dunlo. On Trout Run it reaches minable proportions, being 6 feet thick at the pit mouth of one mine, but thinning along the main entry to less than 4 feet. Probably the thickness here is only a local development.

Lower Freeport coal.—This coal lies about 50 feet above the Upper Kittanning, and the intervening rocks are probably mostly shale. The seam shows in the cut at each end of the eastbound tunnel at Gallitzin and is about 18 inches thick. What is apparently this seam has been opened near the Dennison & Porter shaft about 1 mile southeast of the tunnel, where it is called the white-ash vein. It is opened on Bens Creek near Cassandra, and is found in a number of shaft sections and diamond-drill holes to the southern boundary of the quadrangle.

Freeport limestone.—This was observed only in the northeastern part of the quadrangle. In the cut at the east end of the tunnel above mentioned it occurs about 15 feet above the Lower Freeport coal and about the same distance below the Upper Freeport coal. The limestone is bedded in layers that may reach 2 feet in thickness, but are generally thinner. Its color is yellow.

Freeport fire clay.—This clay is not worthy of special notice except in the vicinity of Dunlo, where there is evidence of a bed of flint clay of some thickness below the Upper Freeport coal. Abundant débris of this clay occurs in the road northeast of Dunlo below the reservoir and also on the spur southwest of the Henriette No. 2 shaft.

Upper Freeport coal ("E" or Lemon seam).—This bed lies at the top of the Allegheny formation. It is, like the Lower Kittanning coal, a persistent bed along its eastern outcrop, and is, at all points observed, 3 to 4 feet thick, being generally near the latter figure. In the southwest corner of the quadrangle it appears to thin out. It can always be identified by a slaty binder 1 to 2 inches in thickness occurring from 8 to 18 inches above the bottom. Its outcrop corresponds with the boundary line between the Allegheny and Conemaugh formations, and its position can be most easily ascertained by an examination of the map.

CONEMAUGH FORMATION.

General features. — The Conemaugh formation is about 770 feet thick in this quadrangle. Its lower two-thirds contains four distinct sandstone strata of considerable thickness and persistence. These sandstones are separated by shales and fire-clay shales containing locally, in the upper portion, thin beds of limestone. Thin coal seams, probably of local extent as a general rule, occur at various horizons. The upper third of the formation consists mostly of gray sandy shale. In contradistinction to the Allegheny formation, it was formerly known as the Lower Barren Measures. It forms most of the surface of the quadrangle.

Mahoning sandstone.—Much confusion exists as to what beds should be included in this sandstone. So far as the writer can discover, the name was first used by Lesley (Manual of Coal and its Topography, 1856, p. 97) for a sandstone composed of two beds 35 feet thick, separated by 25 feet of shale. I. C. White (Bull. U. S. Geol. Survey No. 65, p. 95) describes it in almost identical terms, but makes the sandstone members 40 to 50 feet in thickness, with a bed of shale between, the whole varying in thickness from 100 to 150 feet. In an earlier work (Second Geol. Survey Pennsylvania, Rept. Q, p. 36) the same writer restricts the name to the lowest member of the triple group.

One difficulty in determining the usage to be adopted arises from the fact that the type locality of the sandstone is not known. In a cut on the Pennsylvania Railroad at Bens Creek and also in a mine shaft at Cresson the section immediately above the Upper Freeport coal agrees almost exactly with the description of the Mahoning sandstone given by Lesley. The section in the mine shaft is given in fig. 6.

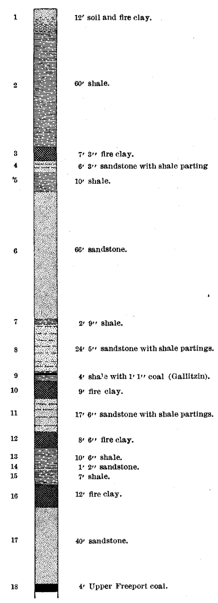

FIG. 6.—Section of Cresson mine shaft, Cresson, Pa.

The section in the railroad cut at Bens Creek between the Gallitzin and the Upper Freeport coals is the same as the above except that the upper bed of sandstone at Bens Creek is thicker and fills the whole of the interval here occupied by beds Nos. 13 to 16, inclusive, of the Cresson section. In this section the Mahoning lies in the interval between the Upper Freeport and Gallitzin coals, and it would seem to be judicious to limit the application of the name to sandstone falling within these limits. The sandstone may occur as a double bed nearly filling that interval or a single bed almost anywhere in the interval; it may be thin and inconspicuous or absent altogether.

In this quadrangle it is well developed at Cresson, as shown by the Cresson shaft section. It is also well displayed in the first cut north of Bens Creek station, where it is heavy, coarse, and even conglomeratic, and in two parts about 35 to 40 feet thick, separated by a bed of fire clay. It immediately overlies the Upper Freeport coal exposed at the north end of this cut, its top being 90 feet above the coal. In the next cut above Bens Creek station, near the Moshannon mine, the lower bed seems to be wanting. In the cut west of Bens Creek station the upper part of the Mahoning sandstone, conglomeratic and very heavy, rises from beneath the surface. It is exposed along the old track of the Pennsylvania Railroad where it crosses westward below Bens Creek station. It probably yields the abundant bowlders of conglomeratic sandstone so conspicuous in the valley of Bens Creek.

Gallitzin coal.—In the Cresson shaft 107 feet above the Upper Freeport coal lies a coal 1 foot 3 inches thick known as the Gallitzin coal. This coal shows in the railroad cut west of the eastbound tunnel at Gallitzin, where it is 6 inches thick. It is exposed in the first cut east of Bens Creek station about 100 feet above the Upper Freeport coal, and also in the cut next below Bens Creek station at Cassandra, being here about 15 inches thick. It has been opened between Bens Creek and Lilly, but while it may be locally of greater thickness than noted above, it is probably nowhere thick enough to be minable. This coal also occurs near Ebensburg.

Saltsburg sandstone.—In the Cresson shaft section the 66 feet of sandstone with its top about 200 feet above the Upper Freeport coal probably corresponds to the Saltsburg sandstone of the regions farther westward, described in preceding folios. This sandstone is composed of thick and thin flags which are very compactly bedded, being without conspicuous shale partings or layers. This is a distinctive character of the stratum, by which it may be surely identified. The texture is generally medium grained. It is exposed along the track between Cresson and Lilly and the cuts between Myra and Portage are made in it. The peculiar character of its bedding is well exhibited in the cut just west of Myra. The sandstone coincides with the slope east of Cresson on which the Mountain House stands, and it yields the bowlders that so thickly strew the slope close to the town. It is exposed as a heavy, and in places conglomeratic, sandstone on the long western slope between Trout Run and South Fork of the Little Conemaugh and forms the ledge of white sandstone which is so conspicuous from Beaverdale north of Beaverdam Run near its mouth. It yields the abundant bowlders of conglomeratic sandstone on the slopes north of Dunlo. An exposure occurs at the sharp bend of the road just north of Roaring Run, south of Ebensburg.

Ebensburg sandstone.—This name is given to the sandstone upon which the town of Ebensburg is built. It is generally a rather coarse, thick-bedded, gray sandstone, locally containing layers of conglomerate. What is believed to be the same sandstone occurs at Summerhill, one-half mile beyond the western margin of the quadrangle, where it outcrops in the river bluff to the east and also on the top of a knoll just northwest of that place. It is here coarse, thick bedded, and 50 feet thick. The top of the Saltsburg sandstone is also exposed at the base of the knoll, and an almost direct measurement gives the interval between the two sandstones as 100 feet. This makes the bottom of the Ebensburg sandstone at this point 300 feet above the Upper Freeport coal. The interval between the two sandstones is mostly occupied by shale. A thin coal occurs 30 feet above the Saltsburg sandstone, and thin beds of impure limestone also occur. About 40 feet below the Ebensburg sandstone is a bed of red shale, and a red shale that is probably at the same horizon occurs at many points throughout that part of this quadrangle covered by the Conemaugh formation. This serves to identify the Ebensburg sandstone. About one-fourth of a mile northwest of Ebensburg a deep well passed through a sandstone that seems to occupy the interval just described as being occupied by shale at Summerhill and at many points in this quadrangle. This probably indicates that the Ebensburg sandstone is much thicker at Ebensburg than elsewhere. It underlies the town, and according to the record of the well mentioned is about 150 feet thick. It may be seen at the quarry just above the railroad on the eastern outskirts of the town. In the valley of Roaring Run it has thinned to a bed locally 5 feet thick. Its position, however, is established by the red shale already described, which is conspicuous in the road on both sides of the run, particularly on the north side, where it is about 20 feet thick. About 20 feet above this shale is a 5-foot bed of flaggy sandstone. The Ebensburg sandstone caps the flat-topped hill north of Gallitzin, where it is 40 to 60 feet thick and where its bottom is almost exactly 300 feet above the Upper Freeport coal in the underlying part of the Bennington No. 19 mine. The sandstone in this locality is very heavy and includes thick layers of small-pebble conglomerate. Great bowlders of it occur on the top and sides of the hill. West of Cresson its débris occurs on the knoll on which St. Aloysius Academy stands, as well as on others in the immediate vicinity. Its outspread in the region can be best understood by a study of the map. The sandstone may be seen dipping beneath the track just below the water-supply station west of Portage and also dipping below the wagon road between Portage and Wilmore. It appears again at track level in the west end of the cut just at the margin of the quadrangle, where it is rising westward from the Wilmore syncline. Just east of Lovett it crops out in a conspicuous ledge in the woods between the railroad and wagon road on the north. It is also well exposed at the junction of the railroad tracks going to Windber and Dunlo.

Summerhill sandstone.—This sandstone, generally laminated, though in places partly heavy bedded, outcrops in a bold ledge about 50 feet high in the bluff east of Summerhill, and is called the Summerhill sandstone on account of its good exposure there. It shows at the top of the railroad cut beginning just at the western margin of the quadrangle, and a portion of it, of strongly laminated character, crops out in places on the hillside west of the track between this cut and the next one to the east. It dips strongly eastward and comes down below railroad grade at the west end of the latter cut. It crops out along the wagon road following the bend of the river below Wilmore and is also well exhibited along the old railroad track south of the river, where it can be followed across the axis of the Wilmore syncline. It is well exposed at Wilmore, where the Catholic church stands upon it. It was traced continuously through many exposures up North Branch of the Little Conemaugh to a point west of Munster and also along the streams on the west just above Wilmore. It shows in part along the railroad track from Wilmore northward to the curve where the old track leaves the present main line. Just east of this point it rises above the track and is 30 to 40 feet thick.

Wilmore sandstone.—This is a sandstone varying in character from thin bedded and micaceous to thick bedded and coarse. It shows at the top of the first railroad cut west of Wilmore and also crops out on the hillside west of Wilmore, where it may be seen from the village. Its bottom is about 60 feet above the Summerhill sandstone or 520 feet above the Upper Freeport coal. In this locality it is thin bedded. About 3 miles southwest of Wilmore it is well exposed for about one-fourth of a mile along the road running east. It may be seen at points on the ridge between the river and North Branch, its character here being similar to that at Wilmore. It is exposed in a cut where the road along North Branch crosses the point of a spur about 2 miles above Wilmore. At this point the sandstone is heavy or even massive. The phase is more strongly developed northward, and on the knob at 2033 feet in the southeast corner of Cambria Township the sandstone becomes very coarse and heavy and yields large bowlders. This character seems to prevail to the west, for all along the western margin of the quadrangle from Roaring Run to the road running northwest from Wilmore the surface is strewn with similar bowlders that appear to be derived from this stratum. Such bowlders also occur on the spur between Sanders Run and North Branch. On the northern margin of the quadrangle the sandstone has resumed the character shown at Wilmore. It is exposed at several points along the railroad in the vicinity of Winterset, just inside the Patton quadrangle.

The distribution of these sandstones can be best understood by consulting the map, which will also aid in their identification. One must not expect to find sandstone or even good evidence of its presence wherever mapped, for these beds are very variable and may run out to nothing in a short distance. These sandstones are given so much attention here because they have been depended upon almost entirely for making out the structure of the Wilmore basin. The accuracy with which this structure has been mapped depends in part on the accuracy with which the intervals between these sandstones were determined, the constancy of those intervals throughout the area in which they occur, and the correctness of the identification from point to point.

There is nothing of special interest in the remaining rocks of this formation. The rocks between the Ebensburg and Summerhill sandstones and those between the latter and the Wilmore are shale and a sort of fire-clay shale of nondescript character, in which in some localities, especially near Wilmore and northward, occur beds of impure yellow limestone varying from a few inches to a few feet in thickness, but generally thin. Thin seams of coal also occur. The character of these rocks is well exhibited in the railroad cuts west of Wilmore. The rocks between the top of the Wilmore sandstone and the top of the formation seem to be mostly shale, with occasional thin limestones, sandstones, and thin coals.

MONONGAHELA FORMATION.

The presence of the Monongahela formation has not hitherto been recognized in the Wilmore basin. If the position of the Upper Freeport coal, as expressed by the structure contours, is correct, there are on the knob having 2045 feet elevation, 2 miles south of Wilmore, 845 feet of rocks above that coal bed. The thickness of the Conemaugh formation at Blairsville, Westmoreland County, the nearest point at which it has been determined, is 700 feet, that being the interval between the Upper Freeport coal and the Pittsburg coal. On the high hill just mentioned occurs a workable coal seam about 2½ feet thick, which is opened at the altitude of about 1950 feet. As shown by the structure contours, the elevation of the Upper Freeport coal beneath this point is 1180 feet, making the interval between the two coals 770 feet, or 70 feet more than the interval between the Upper Freeport coal and the Pittsburg coal at Blairsville. There is no reason, then, why the coal opened at the point described should not be regarded as Pittsburg except the fact that it is not nearly so thick as that seam at its nearest point, about 50 miles to the west. This does not seem a valid objection in view of the other circumstances of the case, so it is concluded that the coal in question is Pittsburg and that the overlying rocks, apparently mainly shale, amounting to about 100 feet in thickness, are a part of the Monongahela formation.

STRUCTURE.

Method of representing structure.—The method employed in this folio for representing basins and arches is as follows: The upper or lower surface of a particular stratum of rock is selected as a reference surface. The form of reference surface is ascertained, first, from the outcrop of the chosen stratum, and second, from the depth of that stratum beneath beds above it. In the first case the stratum outcrops and is observed. In the second case it lies underground and the outcrop of some higher bed is observed; the thickness of rocks between the two being known, the depth of the reference surface can be estimated. In many cases the depth is measured directly in a deep well boring.

By reference to the topographic map the altitude of any outcrop can be ascertained, and thus the height above sea for a corresponding point of the reference surface can be determined. This is done for hundreds of points along a very large number of sections taken in various directions Points which have the same altitude are then connected by a line, which gives the form of the reference surface at that elevation. Many such lines are drawn at regular vertical intervals. They are contour lines, and as printed on the geologic structure sheet they show, first, the horizontal contour of the troughs and arches; second, the relative and also the actual dip of the beds; and third, the height of the reference surface above the sea at any point. The depth of the reference horizon may be determined by substracting its elevation from that of the surface of the ground.

As a rule these structure contours are generalized and are only approximately correct. Being estimated on the assumption that over small areas the rocks maintain a uniform thickness, the position of a contour is uncertain to the degree that that thickness is approximate. Moreover, while in many instances topographic altitudes are determined by spirit level, in most cases geologic observations are made with aneroid barometers. The barometers are constantly checked against precise bench marks, and the instrumental error is probably slight, but it may be appreciable. Finally, the observations of structure at the surface can be extended to buried or eroded strata only in a general way; the details probably escape determination. These sources of error may combine or they may compensate one another, but in any case it is believed that their sum is probably less than the amount of the contour interval: that is to say, the absolute altitude of the reference surface will not vary more than 50 feet from that indicated by the contours; and the relative altitudes for successive contours may be taken as approximating the facts very closely.

Reference surface.—The structure of this quadrangle is represented by contours supposed to be drawn on the top of the "E" or Upper Freeport coal. The contour interval over that part of the quadrangle underlain by the Upper Freeport and the "B" or Lower Kittanning is 50 feet, and this interval is used up to the 3000-foot contour on the flank of the Negro Mountain anticline. East of this line the contour interval is 200 feet. East of the outcrop of the reference surface on the western slope from the Allegheny Front the contours are based on the calculated position which that surface would have if it and a great thickness of underlying rocks had not been removed by erosion. This position is calculated from the thickness of the rocks removed as measured along the Pennsylvania Railroad, and while not absolutely accurate it is probably a fair approximation to the facts.

Over much of the territory east of Little Conemaugh River the Upper Freeport coal is exposed in the deep valleys trenching the long western slope from the crest of the Allegheny Front to the river. It is revealed in several mines and drill holes in the areas between these valleys. In addition the "B" or Lower Kittanning coal is exposed or revealed in the same way. The elevation of points on the coal in this part of the quadrangle is in many cases determined by direct observation at points of outcrop, or obtained from mine maps. The elevation of other points is calculated from the position of the Lower Kittanning seam, using the known interval between the two. West of the river the depth of the reference stratum below the surface is calculated from the more or less accurately determined interval between it and several sandstone strata that can be traced at the surface with a reasonable degree of certainty. The reliability of the contouring of the reference stratum depends on the constancy of the interval between it and the various sandstone strata and upon the correct identification of any bed at different points. Allowing for all sources of error, it is confidently believed that the inaccuracy will not exceed a contour interval, or, in other words, that the elevation of the coal shown by the contours at any point will not differ from the true elevation by more than 50 feet.

General outline of structure.—The originally horizontal rocks of the quadrangle have been thrown by the forces to which they have been subjected into approximately parallel folds running in a general northeast-southwest direction. Beginning on the northwest these folds are named in order as follows: The Ebensburg (Viaduct) anticline, the Wilmore syncline, the Negro Mountain anticline, and the Pavia syncline.

Bradley syncline.—This is a strongly developed syncline in the Patton quadrangle to the north, but it is only a slight depression in the extreme northwest corner of this quadrangle.

Ebensburg anticline.—The axis of this anticline crosses the northwest corner of the quadrangle, passing about one-half mile west of Ebensburg. This is probably the same as the Viaduct anticline of previous reports. This name was given because the axis crosses Little Conemaugh River at a viaduct of the Pennsylvania Railroad west of South Fork. It is desirable that it be named from a better-known locality, hence it is here called the Ebensburg anticline. The elevation of the Upper Freeport coal on this axis is given in a deep well boring for the Ebensburg waterworks.

Wilmore syncline.—This is the principal structural feature of the region. The position of its axis is very definitely fixed south of Wilmore by the opposing dip of the rocks along the old track of the Pennsylvania Railroad, and also by the same evidence at the point where the axis crosses South Fork of the Little Conemaugh, three-fourths mile southeast of the site of the old Conemaugh reservoir dam. North of Wilmore its position can not be so precisely determined; still it is fixed within comparatively narrow limits and can not vary much from the location shown on the map. The Upper Freeport coal lies at about 1100 feet above sea level in the lowest part of the syncline, south of Wilmore. From this locality it rises in both directions along the axis. On South Fork it is between 1200 and 1250 feet above the sea, showing a rise of over 100 feet from the bottom of the basin. Northward the strata rise very regularly, as is shown by the outcrop of the Summerhill sandstone. This rock can be traced continuously along North Branch from Wilmore, where the elevation of its bottom is about 1560 feet, to the point at which the Ebensburg pike crosses North Branch. Just west of this crossing the sandstone is exposed in the road, its bottom lying at an altitude of about 1700 feet. The strata apparently maintain this regular rise to a point about 1 mile north of Munster, where the altitude of the coal is 1350 feet. Northeastward from this locality the rocks rise very slowly along the axis of the syncline, the coal reaching the altitude of 1400 feet in the Patton quadrangle to the north.

The rocks rise regularly on the sides of the syncline. Northwestward the dips do not exceed 2°, while southeastward the dips in the southern two-thirds of the quadrangle increase fairly regularly as the Allegheny Front is approached, but in the northern one-third remain constant at from 1° to 2° as far as the eastern boundary. In the vicinity of Puritan and Lloydell the dips reach 5°, and along the ridge road 2 miles southeast of Martindale dips of 10° were measured. Along the southern margin of the quadrangle the dips seem to decrease southeastward from a point about 1 mile east of Dunlo.

Negro Mountain anticline.—The existence of this anticline is well established by the occurrence of southeastward dips in the vicinity of Blue Knob summit. Its position is determined by the distribution of a conglomerate which closely overlies the red rocks of the Catskill formation in this region. This rock is a heavy conglomeratic sandstone, or even a conglomerate, and is included in the base of the Pocono formation. It yields many large bowlders that strew the hillsides over an extensive territory, extending nearly as far north as Freedom Township. Northwest of Queen this bed yields masses of great size which are conspicuous objects on the hillsides. On the knob 2 miles northeast of Mount Hope Church this stratum lies at 2900 feet; about 2½ miles south, on the knob terminating the northwestern spur of Blue Knob, it has the same elevation; on the southern spur of Blue Knob, above the road intersection at 2303 feet, its elevation is 2800 feet, and on the eastern spur of Blue Knob, just south of Smoky Run, it outcrops at about 2200 feet, showing a descent of about 700 feet from its altitude along the road from Mount Hope Church southward. The exact position of the axis of the Negro Mountain anticline could not be determined from direct observation, since not a single exposure was found in the whole of Bobs Creek Valley north of Pavia from which a reliable determination of the dip could be made. Its position as mapped was obtained by projecting the slopes of the rocks on the east and the west until they intersected and locating the axis at the point of intersection. This was done along two lines, one through Blue Knob summit and the other near Blue Knob post-office. The location of the axis thus obtained is such as to warrant the conclusion that it is the extension of the Negro Mountain axis in Somerset County as located by the geologists of the Second Pennsylvania Survey. The axis is drawn on their geologic map of Somerset County as a full line up to a point a few miles south of this quadrangle, and is then continued as a broken line, showing that its position was not well determined in this region. The axis pitches northward and the anticline dies out in the vicinity of Blue Knob post-office. North of this point the rocks continue their southeastward rise without interruption.

Pavia syncline.—This is apparently an oval depression of small extent. Its axis appears to lie about 1 mile east of Pavia, extending northeastward and dying out near the southern border of Freedom Township, east of the locality in which the axis of the Negro Mountain anticline dies out. Part of the evidence for this syncline has been given above in connection with the description of the Negro Mountain anticline. Additional evidence consists in northwestward dips in the vicinity of Queen and southwestward dips along Poplar Run in the Hollidaysburg quadrangle to the east. These last-mentioned dips are associated with structural complications in the Hollidaysburg region that need not be described here. Southeast of the axial line of this syncline the rocks abruptly resume their southeastward rise and the dips reach 30° to 40° NW. While the form of the Pavia syncline as mapped is not based on many good observations, except on the eastern side, it accords well with all the evidence in hand and is probably nearly correct. This syncline accounts for the presence of the heavy Pocono sandstone that caps the high knobs of the region and has preserved them from erosion.

GEOLOGIC AND GEOGRAPHIC HISTORY.

It is proposed to present here in broad outlines the common belief of geologists concerning the geologic and geographic development of the Appalachian province in its earlier stages, and then to give in greater detail the history of the northern end of the bituminous basin in which the Ebensburg quadrangle is situated.

SEDIMENTARY RECORD.

PRE-HAMILTON DEPOSITION.

The oldest rocks known in the Appalachian province are the crystalline rocks of the Blue Ridge Mountains and of the Piedmont Plain on the east. These are believed to have formed the oldest land of which there is any record on this continent. The western shore of this land area lay in the present position of the western flank of the Blue Ridge, and the land extended to an unknown distance eastward, possibly far beyond the present shore of the Atlantic. To the northeast lay another area of crystalline rocks, forming a land area in the Adirondack Mountain region. Extending west of the latter region to the vicinity of Lake Superior was the southern shore of a vast land area, now occupied by the crystalline rocks of Canada. The rocks of the two regions last mentioned are of the same age as those of the Blue Ridge. Thus the most ancient outlines of the eastern United States had a rudely V-shaped form, inclosing within its arms a body of water known to geologists as the Interior Paleozoic Sea. Into this sea flowed rivers bearing the sediments of which the sedimentary rocks of the Appalachian province are composed. While these rocks were accumulating to the thickness of many thousand feet, new species of animals and plants made their appearance from time to time, and the earlier forms became extinct. These earlier organisms were chiefly animals or the lower forms of plants, such as sea weeds. Later, land plants made their appearance and the conditions began which eventually resulted in the formation of the coal beds of the province. After a great thickness of sediments had been accumulated an uplift occurred, the axis of which extended from the Great Lakes to western Tennessee. This is known as the Cincinnati uplift. The sea bottom along a part or the whole of the axis was probably raised into dry land. A barrier was thus formed that still more completely inclosed the interior sea, which now approached the form of a narrow embayment extending from Alabama to eastern New York and which is appropriately called the Appalachian Gulf. In this gulf sedimentation continued, in the progress of which the earliest rocks known in the Ebensburg quadrangle were accumulated.

HAMILTON, GENESEE, NUNDA, AND CHEMUNG DEPOSITION.

The rocks of the Hamilton, Genesee, Nunda, and Chemung formations were laid down in a more or less completely landlocked bay or gulf, being apparently derived from land to the northeast and southeast, whose western shore probably extended from the Adirondack region southward along the present line of the Blue Ridge.

The character of these formations indicates a long period of repose or of gentle oscillations throughout the Appalachian Gulf and the bordering lands. The fine sediments of which the rocks are generally composed are apparently due to one or both of two conditions. They may have been derived from a land surface of low relief, or they may have been transported a long distance from shore and deposited in water of considerable but not great depth. In the first case, on account of the low gradient and slow current of the streams, only comparatively fine material would have been discharged into the gulf. In the second case, whatever may have been the character of the sediment discharged by the streams, only fine material that could be held in suspension a long time would be transported by the existing currents to the area of deposition, the coarser material, if any, being deposited near the shore. The black Genesee shale is believed to be a deposit in comparatively deep water, and it may be that during Hamilton time subsidence exceeded upbuilding by sedimentation, until the depth of water was suitable to the deposition of the Genesee. A deepening or at least a clearing of the water is indicated by thin impure limestones at the top of the Hamilton. The absence of Hamilton fossils from the Genesee and higher rocks is good evidence of a change of conditions, or that the character of the Genesee sediment was unfavorable to the Hamilton forms and caused their extinction or migration to more favorable regions.

It has been suggested by Clarke (Mem. N. Y. State Mus. No. 6, pt. 2) that, after the analogy of deposits now forming in the Black Sea, the Genesee shale was deposited in deep water with imperfect vertical circulation and the carbonaceous matter to which it owes its color was supplied by the abundant vegetation of marsh lands from which the sediment was derived.

The conditions existing during Genesee time continued into Nunda time, as is indicated by the character of the rocks, the scarcity of fossils, and the probable entire absence of truly littoral or shallow-water forms. The steady accumulation of fine sediment, however, gradually raised the sea bottom, and there are many evidences that the succeeding Chemung rocks were accumulated in comparatively shallow water. The relative abundance of fossils also indicates that the conditions prevailing throughout Nunda time had passed away.

CATSKILL DEPOSITION.

Before the beginning of Chemung deposition—indeed, soon after the close of Hamilton time—the Catskill phase of sedimentation began at the northeast extremity of the Appalachian Gulf, in eastern New York, with the deposition of the Oneonta beds. From this time onward the deposition of these rocks continued, being contemporaneous at first with the marine Portage, later with the Chemung, and at the top probably with the bottom of the Mississippian deposits.

Thus it happens that the Catskill rocks, which have a probable thickness of several thousand feet in the Catskill Mountain region, where sedimentation was continuous, grow thinner from the bottom upward as they extend westward, until they are represented in western Pennsylvania and New York by only a few hundred feet of rocks characterized by beds of red shale. The Appalachian Gulf was apparently deeper along the eastern shore and became shallower westward at the beginning of the Catskill deposition. The great thickness of these sediments in the east seems to indicate that during this period differential subsidence carried the eastern marginal area constantly deeper as compared with the area to the west. This movement of subsidence may have been accompanied by an elevation of the land still farther east, from which the sediments of the Catskill rocks were derived, for these rocks are coarser along their eastern margin and bear evidence of rapid accumulation, such as would result from their deposition by swift streams flowing from a land mass more elevated than that from which the sediments composing the underlying rocks were derived.

A notable characteristic of the Catskill rocks is the general absence of fossils, except in the lower part of the formation in eastern New York, where fresh-water forms occur in considerable abundance. Remains of what are regarded as fresh-water fishes also occur locally at other points and at higher horizons. These fossils may indicate bodies of fresh water, or they may have been washed in from the rivers in which they lived. The general absence of life during the deposition of these beds, whether they were laid down in fresh, brackish, or salt water, may be due to the rapidity of sedimentation, which made the conditions unfavorable to life.

The origin of the red deposits is a question of interest that has not received a satisfactory solution. It may be surmised that they were derived from an area of rocks like red granite, or from the highly oxidized residuum of the deeply decayed crystalline rocks of a very old land surface, such as exists to-day in parts of the Southern States.

POCONO DEPOSITION.

The deposition of the Carboniferous rocks of this region, as generally the world over, succeeded that of the Devonian rocks without a break. After the Catskill rocks were laid down fresh-water conditions probably continued throughout the north end of the Appalachian Gulf, but there was a decided change in the character of the material brought in. The succeeding rocks are prevailingly gray instead of red. During the latter part of Pocono time vast quantities of coarse sand were brought into the Appalachian Gulf and spread widely over the sea bottom to form the coarse Burgoon ("Mountain" or "Big Injun") sandstone. As the deposition of this coarse, sandy material was drawing to a close a large quantity of carbonate of lime accompanying the sand made the Loyalhanna ("Siliceous") limestone, which is a widely extended and highly characteristic stratum at the top of the Pocono throughout southwestern Pennsylvania. Possibly the source of the lime was the same as that of the great limestone formations of the Mississippi Valley, which are probably contemporaneous in part with the Pocono formation in the Appalachian trough. One of the most striking and persistent features of the Loyalhanna limestone is its cross-bedding, which shows that the limestone is of clastic origin and indicates that the material was distributed by powerful currents. The carbonate of lime in suspension may reasonably be assumed to have been carried from its source by oceanic currents sweeping up from the southwest into the probably very shallow waters of the Appalachian Gulf. It may afterwards have been worked over by wave action or by tidal currents, which developed the cross-bedding.

One of the most interesting and significant features of Pocono history was the accumulation of coal seams of considerable extent and thickness in Virginia and West Virginia. These coal seams herald the approach of the biologic and physiographic conditions under which the great deposits of coal in the later formations were accumulated.

MAUCH CHUNK DEPOSITION.

The deposition of the prevailingly gray Pocono was succeeded by a second extensive deposition of red beds. These compose the Mauch Chunk formation. The change in the kind of sediments was probably gradual, for in the region of the Allegheny Front the bottom beds of the Mauch Chunk are sandstone very much like the top sandstone of the Pocono. The great mass of the formation, however, is red shale. In eastern Pennsylvania it reaches a thickness of over 2000 feet, a fact which indicates continued subsidence along the axis of the Appalachian Gulf. The conditions during Mauch Chunk time seem to have been unfavorable for life, for the formation contains no coal beds and shows but little evidence of the presence of either plants or animals.

EARLY POTTSVILLE EROSION INTERVAL.

The thickness of the Mauch Chunk formation reaches over 2000 feet in northeastern Pennsylvania, but diminishes from this locality westward. On the Allegheny Front west of Altoona it is 180 feet. At Blairsville it is recorded in deep wells as about 50 feet. On the Allegheny River in Armstrong County and farther west the formation is probably absent.

These facts indicate an uplift that raised above water a large land area extending from southern New York at least to Armstrong County and probably as far east as the Allegheny Front. From this land area in the Allegheny Valley and to the west the Mauch Chunk and possibly the top of the Pocono were eroded before the deposition of the overlying Pottsville. The region of the Allegheny Front, including the Ebensburg quadrangle, was probably dry land during most of Pottsville time, and the erosion of the greater part of the Mauch Chunk formation before the deposition of the Pottsville rocks resulted in an unconformity between the two formations in this region. Just when the uplift occurred can not be definitely determined, but presumably it was during the latter part, or at the close, of Mauch Chunk time. It may have been contemporaneous with an uplift of the region east of the Blue Ridge which led to the discharge of the coarse sand and gravel of the Pottsville rocks in the anthracite basins of eastern Pennsylvania.

POTTSVILLE DEPOSITION.

The Pottsville was one of the most important and interesting epochs in the history of the province, since in it the accumulation of coal on a large scale began. If we assume such movements in this part of the earth's crust as are indicated in the preceding paragraph, there would exist at the beginning of Pottsville deposition a deep and deepening trough in eastern Pennsylvania and southward, bordered around the northern end by land on both sides and farther south by land, probably high, on the southeast. From these border lands the rapid streams brought in immense quantities of coarse material, including a large proportion of quartz pebbles, which occur in the thick, extensive, and coarse conglomerates of the Pottsville formation. It is believed that the Pottsville sediments were largely derived from the northern end and southeastern side of the trough, because there is no near-by source of quartz pebbles on the other side. This deposition of coarse material went on until 1000 feet of strata were laid down in the Southern Anthracite field. At times conditions were favorable to a luxuriant growth of plants, and thick, extensive, and valuable beds of coal were accumulated, parts of which are now preserved in the Southern Anthracite field.

While 800 or 900 feet of the Pottsville sediments were accumulating in the Southern Anthracite field erosion had probably been going on from central Pennsylvania westward, and the land surface had been worn down nearly to sea level and then submerged, so that toward the close of Pottsville time sedimentation was resumed over the former land area. Thus it happened that the Connoquenessing sandstone, the lowest Pottsville stratum of Allegheny Valley and also of the Ebensburg quadrangle, was in the former region deposited on the surface of the Burgoon ("Mountain") sandstone at the top of the Pocono formation, and in the latter on the probably eroded surface of the Mauch Chunk formation. After the deposition of the Connoquenessing there was a change to more quiet conditions and the Mercer shale, limestone, clay, and coal were accumulated. This period was followed by one of more active sedimentation and the Homewood sandstone was laid down, marking the last episode in Pottsville history in western Pennsylvania.

ALLEGHENY DEPOSITION.

The Allegheny epoch was marked by very rapidly alternating conditions. Its distinguishing characteristic was the formation of the coal seams. The origin of the coal and the method of its accumulation in seams of great areal extent are subjects that have provoked much discussion. That coal is of vegetal origin hardly anyone would now venture to question. As to the method of accumulation of the vegetal matter there is greater difference of opinion. It seems safe to say that in the main the coal seams of the Appalachian province were formed in marshes near sea level and often extended over thousands of square miles. Plants of various types grew very luxuriantly in these marshes. Their remains fell into the water and were preserved from decay until vast accumulations of vegetal matter resulted, not unlike the peat bogs in various parts of the world at the present day, but much greater in extent. It is believed that the plants grew in or near water or very damp places, because this was necessary for the preservation of their remains from subaerial decay. That the water was shallow seems obvious, because the plants grew in the air with their roots in the soil below, which would have been impossible in deep water. That the water was fresh is evident from the fact that plants of the same classes at the present day do not grow in salt water. Finally, that the vegetation grew and accumulated over tracts of great extent is shown by the fact that one and the same coal bed is continuous over thousands of square miles. The Pittsburg coal is an example. It is known over an area exceeding 10,000 square miles and in all probability originally extended over an area several times as great, from which it has been eroded. It is further evident that these marshes were near sea level and separated from the sea by barriers that were low, at least in places, for thin beds bearing marine fossils are frequently found throughout the coal-bearing formations in close proximity to coal seams, and even, in rare cases, in the midst of the coal seams themselves, thus showing that there were temporary incursions of sea water. That the coal beds accumulated near water level is further shown by the fact that partings of fine shale and clay and other material are often present and in some cases traceable over thousands of square miles. These partings indicate temporary floodings of large areas and the deposition of fine silts while the coal beds were in process of accumulation, and such extensive floodings of quiet water could take place only over areas standing approximately at water level. Along certain lines the coal-forming material might be eroded away at such times by a stream and the channel be subsequently filled with sand to form a "horseback" or roll in the coal bed.

With the foregoing discussion in mind, the sequence of events during the deposition of the Allegheny formation may be conceived to have been somewhat as follows: After the Homewood sandstone was laid down there was a slight subsidence and an accumulation of from 10 to 30 feet of clayey sediments, which raised the bottom approximately to water level and caused marshy conditions over a large area. The vegetation of the time established itself on this marshy land and continued until the remains of many generations of plants had formed an extensive area of peat moss. From time to time different parts of this marsh were flooded and thin layers of sediments were deposited, which form the partings or binders of the resulting coal bed. The accumulation of vegetal matter varied in amount at different places, causing coal beds of varying thickness. After a long period of comparative quiescence the region was depressed, sedimentation was resumed, the plants were killed, the vegetal matter was buried, and, under the pressure of the superincumbent rocks subsequently deposited, it was compressed and hardened into the coal seam now known as the Brookville (or "A") coal. The subsidence which led to the burying of the Brookville coal was accompanied by a deposition of shale and sandstone; the sea bottom was again raised to water level, coal-forming conditions were restored, and the Clarion coal bed was laid down. By a repetition of such periods of oscillation and repose the Lower Kittanning, Middle Kittanning, Upper Kittanning, Lower Freeport, and Upper Freeport coal beds with their under clays were accumulated, with the intervening beds of sandstone, shale, and limestone.

While there may have been uplifts at times during the deposition of the Allegheny formation, the prevailing movement was evidently one of subsidence, for each coal seam was accumulated at the surface and then buried.

Certain practical deductions are derivable from an understanding of the formation of coal seams. It is a rather current belief in western Pennsylvania that the thickness of a coal seam is proportionate to the size of the hill containing it. Another belief held by even intelligent men is that a bad streak in a coal seam is in some way related to an adjacent valley, and that better conditions will be encountered on the opposite side. The fallacy of such ideas is at once apparent when it is understood that the thickness, quality, and condition of the coal seams were determined ages before the hills and valleys were formed.

CONEMAUGH DEPOSITION.

A marked change in the conditions of vegetation and deposition took place at the close of Allegheny time and continued during the laying down of the 600 feet or more of the sediments of the Conemaugh formation. Marine conditions seem to have prevailed locally after the formation of the Upper Freeport coal seam, for salt-water fossils are occasionally found in the roof shales of that bed. In the Ebensburg region coal-forming conditions were reestablished for a brief time after about 100 feet of sands and clays had been deposited. At this time the Gallitzin coal was accumulated. Other thin seams throughout the formation indicate brief recurrences of coal-making conditions. The predominating accumulations in the Ebensburg quadrangle were sands and muds, the former making the sandstones already described and the latter becoming the shale which forms so large a portion of the beds. Thin limestones of probably nonmarine origin were also deposited locally, indicating small basins from which muddy and sandy sediments were excluded for a short time.

MONONGAHELA DEPOSITION.

The beginning of the Monongahela deposition was marked by another great period of coal formation—that of the Pittsburg coal. At this time the vegetation that was the characteristic feature of the Carboniferous period reached its culmination. The peculiar conditions requisite for the growth and accumulation of the vegetal matter of this great coal bed were long continued and widespread, as is indicated by its thickness and great extent. Most of the Monongahela formation has been eroded from the Ebensburg quadrangle and no further account of it is needed here. The accumulation of the Pittsburg coal was followed by a series of events similar to those outlined in the history of the Allegheny formation, and the minor coal beds of the Monongahela formation were laid down.

DUNKARD DEPOSITION.

The deposition of the Monongahela was succeeded by that of the shales, sandstones, limestones, and thin coals of the Dunkard group, which have no existing representatives in this quadrangle. The luxuriant vegetation so characteristic of the Carboniferous period gradually diminished and finally became extinct, and this great period, so important in the history of the earth, came to an end.

THE APPALACHIAN UPLIFT.

With the termination of the Dunkard epoch, sedimentation in the northern end of the Appalachian trough came to a close, and a long-continued series of events of a totally different kind began. From the beginning of sedimentation in the interior sea intermittent subsidence of the region had been going on, and water had covered the surface in which the sediments from the surrounding land were deposited until tens of thousands of feet of rocks had accumulated. From the close of Carboniferous deposition until the present time the reverse movement of elevation has prevailed and dry land has existed in the northern end of the Appalachian coal field.

The period of uplift was inaugurated by an epoch of mountain making and the sedimentary rocks of the Appalachian province were folded, in the Greater Appalachian Valley, into a series of high anticlines and deep synclines and, west of the Allegheny Front, into the low anticlines and shallow synclines of the bituminous coal fields.

Schooley peneplain.—With the emergence of dry land degradation began. Eventually elevation was arrested; a long period of quiescence ensued, and it is believed that the surface of the Appalachian province was eroded approximately to a horizontal plain near to sea level. This is called the Schooley peneplain because remnants of it are well preserved in Schooley Mountain, New Jersey. The level crests of many of the ridges of the Greater Appalachian Valley, of which those just east of the Allegheny Front in Blair County are good examples, may approximately represent the surface of this peneplain. It was completed before the end of Cretaceous time at least, for in New Jersey it is found extending beneath deposits of Cretaceous age. The Bobs Creek strath is apparently the only surface in the Ebensburg quadrangle representing the Schooley peneplain.

Harrisburg peneplain.—After the reduction of the Appalachian province to form the Schooley peneplain, an uplift occurred and erosion once more became active. Later the uplift ceased and extensive areas were again reduced to a plain, already described as the Harrisburg peneplain. It is believed that this was formed in early Tertiary time. It can not be recognized in this quadrangle. Since Cretaceous time the course of events in this region has apparently been a steady denudation that has left no traces of even incipient peneplanation, such as in other regions marks a succession of uplifts separated by periods of repose.

ECONOMIC GEOLOGY.

MINERAL RESOURCES.

COAL.

The principal mineral resource of the Ebensburg quadrangle is coal, which occurs in eleven seams, as follows, named from below upward: Mercer, Brookville ("A"), Clarion ("A′"), Lower Kittanning ("B" or Miller seam), an unnamed seam close above the Lower Kittanning, Middle Kittanning ("C"), Upper Kittanning ("C′"), Lower Freeport ("D"), Upper Freeport ("E" or Lemon seam), Gallitzin, and Pittsburg. The first occurs in the Pottsville formation, the next eight in the Allegheny, the Gallitzin in the Conemaugh, and the last in the Monongahela. Of these seams only two are generally workable—the Lower Kittanning and the Upper Freeport; the Mercer, the coal close above the Lower Kittanning, the Upper Kittanning, and the Pittsburg are worked locally.

In this quadrangle, these coals, except the Pittsburg, are known only along their outcrop on the southeastern side of the Wilmore syncline. Their character in the deeper part of the Wilmore basin is conjectural. Both the Upper Freeport and the Lower Kittanning are as thick and good on the northwestern side of the basin, at South Fork and along Black Lick Creek west of Ebensburg, as on the southeastern margin of the basin, and a well record shows that the Upper Freeport is of good thickness beneath the surface at Ebensburg. It is a fair assumption that both seams preserve their thickness and quality beneath the Wilmore basin.

MERCER COAL.

The coal worked at the Eleanor mine, above Martindale, appears to be the Mercer. The writer did not visit this mine and consequently knows nothing about the character of the seam. Its stratigraphic relations, as will be seen by the map, point to the fact that it is in the Pottsville formation. A coal opened at railroad level above Beaverdale, near the tipple of the Cambria mine, and locally regarded as Brookville ("A"), is also probably Mercer, since fossil plants occur in association with it that have not been found at horizons certainly determined to be higher. On the Bedford road, almost at the margin of the quadrangle, what appears to be the same seam has been opened and is reported to be 2 feet thick.

BROOKVILLE ("A") COAL.

The Brookville coal is in some localities a bed of considerable thickness. The accompanying section

Brookville ("A") coal at Bennington (fig. 7, a).

	Feet.	Inches.
Coal and bone	0	7
Coal with thin partings of pyrites	1	9
Shale	0	2
Coal	1	3½
Coal with thin partings	0	3
Total	4	0½

measured at Bennington, where it is exposed in the railroad cut just east of the station, represents the seam probably in its best development:

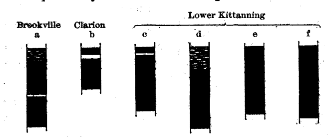

FIG. 7.—Sections of Brookville, Clarion, and Lower Kittanning coals.

Efforts are said to have been made to work the seam in this vicinity, but they were abandoned on account of the large amount of sulphur in the coal, which rendered it practically worthless. This coal is reported 6 feet thick at the foundation of the culvert over the old Portage Railroad near the head of Blairs Gap Run, and it has been worked to some extent at an old opening near by. It was prospected at the head of Bear Rock Run and found too thin to work. It is probably worthless throughout most of the quadrangle.

CLARION COAL.

The Clarion coal appears as a bed about 1 foot thick in the cut at Bennington. It is about 15 feet above the Brookville. On Bens Creek 1½ miles above Cassandra the following section was measured:

Clarion coal on Bens Creek (fig. 7, b).

	Feet.	Inches.
Coal	0	3½
Shale	0	3
Coal	1	6½
Total	2	1

In the Sonman shaft above Cassandra on Bens Creek this coal was penetrated and found 3 feet 10 inches thick, but its character is not stated. It probably is of little value in the quadrangle.

LOWER KITTANNING COAL ("B") SEAM.

So far as known this is a workable seam throughout its outcrop across the quadrangle and is very uniform in character and composition. It averages over 3½ feet thick, mostly clean coal. At some points, as on Bear Rock Run, there is a layer of bone at the top which may reach a thickness of 1 foot; at other points a thin parting, shale or slate, occurs in the middle of the seam. The coal is relatively soft, very lustrous, and of a strongly prismatic structure, cleaving readily into long, narrow prisms. The composition of this coal is shown by the analyses at the end of the text. Comparison shows that it has a higher degree of purity, so far as ash and sulphur are concerned, than average coal. It is highly esteemed for steam, fuel, and smithing purposes, and much of the output goes to the Atlantic seaboard for use on ocean steamers. Its excellence as a smithing coal is attested by the fact that the coal from the Lilly Mining Company's mine is shipped to Alaska for that purpose. The character of the seam is indicated by the sections given below.

In the Reed & Bradley mine at Bennington the coal exhibits the following section:

Lower Kittanning coal at Reed & Bradley mine, Bennington (fig. 7, c).

	Feet.	Inches.
Coal	0	3
Slate	0	1½
Coal	2	10½
Total	3	3

This coal is mined at several points on Bear Rock Run above Lilly.

At the Lilly Mining Company's mine, 1 mile above Lilly, the coal has the following section:

Lower Kittanning coal, Lilly Mining Company's mine, Bear Rock Run (fig. 7, d).

	Feet.	Inches.		Feet.	Inches.
Bone	1	1½			
Coal	2	8	to	3	6
Total	3	9½	to	4	7½

On Bens Creek this coal is worked at several mines. At the Piper No. 1 mine, 1 mile above Cassandra, its section is as follows:

Lower Kittanning coal at Piper No. 1 mine, Bens Creek (fig. 7, e).

	Feet.	Inches.
Coal, average	3	6

On Trout Run the Lower Kittanning coal shows the following section in the Cambria mine:

Lower Kittanning coal at Cambria mine, Trout Run (fig. 7, f).

	Feet.	Inches.
Coal (clean)	3	8½

On South Fork of the Little Conemaugh at Lloydell the seam is 3 feet 7 inches thick in the Alton mine, as is shown by the following section:

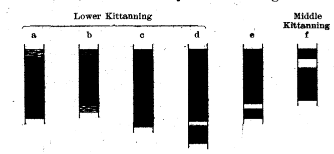

FIG. 8.—Sections of Lower and Middle Kittanning coals.

Lower Kittanning coal at Alton mine, Lloydell (fig. 8, a).

	Feet.	Inches.
Bone	0	5
Coal	3	2
Total	3	7

In the Loyal Hanna mine at Onnalinda the section is as follows:

Lower Kittanning coal at Loyal Hanna mine, Onnalinda (fig. 8, b).

	Feet.	Inches.
Coal	0	1
Bone	0	2
Coal	2	8
Bone	0	4
Total	3	3

In the vicinity of Dunlo the coal is reached by shaft and slope. The following sections illustrate the character of the seam in this region:

Lower Kittanning coal at Yellow Run shaft, Dunlo (fig. 8, c).

	Feet.	Inches.
Coal	4	0

Lower Kittanning coal at Henriette No. 1 shaft, Llanfair (fig. 8, d).

	Feet.	Inches.
Coal	3	9
Slate	0	3
Coal	0	11
Total	4	11

At the Piper mine on Bens Creek is a coal 14 feet above the Lower Kittanning coal that shows the following section:

Coal close above the Lower Kittanning coal at Piper mine, Bens Creek (fig. 8, e).

	Feet.	Inches.
Coal	2	10
Clay	0	3½
Coal	0	5½
Total	3	7

At the time of visit preparations were in progress to mine this coal. Only the upper bench is to be taken out. No. 8 of the table below is an analysis of the coal from this mine. It does not differ materially in composition from the other coals of the region except that it contains a higher percentage of ash than most others. This coal is reported 4 feet thick on Bens Creek about 1 mile above Lilly. It is a persistent seam, being shown in nearly every diamond-drill hole and shaft section that has penetrated to the "B" coal. It generally lies less than 20 feet above the latter. It is known to be workable, however, only in the locality described above.

MIDDLE KITTANNING COAL.

The Middle Kittanning coal was penetrated in the Bennington shaft of the Cambria Iron Company at 35 feet above the Lower Kittanning coal. It shows the following section:

Middle Kittanning coal in Bennington shaft, Cambria Iron Co. (fig. 8, f).

	Feet.	Inches.
Coal	0	6
Clay	0	6
Coal	1	8
Total	2	8

This coal is generally noted in this position in diamond-drill holes and shaft sections throughout the quadrangle, but rarely is it of sufficient thickness to be regarded as workable.

UPPER KITTANNING COAL.

The Upper Kittanning coal reaches a good development locally on Trout Run. At Pearse & Sons' Excelsior mine it shows the preceeding and following sections:

Upper Kittanning coal at Excelsior No. 1 mine, Trout Run, from pit mouth (fig. 9, a).

	Feet.	Inches.
Coal and bone	1	2
Slate	1	1½
Coal	0	10½
Slate	0	5
Coal	3	7
Total	7	2

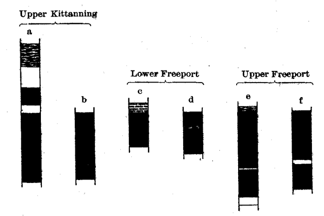

FIG. 9.—Sections of Upper Kittanning, Lower Freeport, and Upper Freeport coals.

Upper Kittanning coal near end of main heading (fig. 9, b).

	Feet.	Inches.
Coal	3	5

These sections show a diminution in thickness along the main heading by the disappearance of the upper benches, and it seems not unlikely that the seam will be found too thin to work within a comparatively short distance in that direction. Analyses Nos. 9 and 10 are of samples of coal from this mine. In the Bennington shaft section this coal is 2 feet 10 inches thick; in the Sonman shaft it is 2 feet thick; in the Yellow Run shaft, 2 feet 6 inches thick, and in diamond-drill hole of the Henriette Mining Company south of Llanfair, 1 foot thick. The preceding descriptions show that this coal is of workable thickness in certain localities and probably over small areas, but it does not appear to be generally valuable.

LOWER FREEPORT COAL.

The Lower Freeport coal is probably a persistent seam, but it is doubtful whether it reaches workable thickness. Nothing is known of its quality. It shows at track level in the cut at the east end of the east-bound tunnel at Gallitzin, where it has the following section:

Lower Freeport coal at Gallitzin (fig. 9, c).

	Feet.	Inches.
Black shale	0	6
Coal	1	9
Total	2	3

What is apparently this coal has been opened above the Dennison shaft southeast of Gallitzin, where it was called the white-ash vein. Near Bens Creek just above Cassandra it shows the following section at an old opening:

Lower Freeport coal at Bens Creek (fig. 9, d).

	Feet.	Inches.
Coal	0	8
Bone	0	1½
Coal	1	4
Total	2	1½

In the Sonman shaft section it is 2 feet thick; in the Yellow Run shaft, Dunlo, it is 3 feet thick, and in the diamond-drill hole south of Llanfair, already mentioned, it is 3 feet 6 inches thick.

UPPER FREEPORT COAL ("E" OR LEMON SEAM).

The Upper Freeport is everywhere a workable and valuable seam along its outcrop. It lies from 180 to 200 feet above the Lower Kittanning seam and can always be identified by the presence of a hard parting, generally 12 to 18 inches above the bottom.

In its physical and chemical character it closely resembles the Lower Kittanning, though the analyses in the table below show a generally higher percentage of sulphur than the Lower Kittanning. It is much used for steam and domestic purposes and is in addition a good coking coal, the output of several mines at Gallitzin being made into coke. The character of the seam is shown by the accompanying sections.

At the Webster No. 11 mine, southeast of Gallitzin, the coal shows the following section:

Upper Freeport coal at Webster No. 11 mine, southeast of Gallitzin (fig. 9, e).

	Feet.	Inches.
Bone	0	3
Coal	2	11½
Slate	0	1
Coal	1	5
Bone	0	5
Total	5	1½

The coal is exposed at the base of the Mahoning sandstone at the east end of the cut just east of Bens Creek station, where it is 4 feet 6 inches thick.

At the Shoemaker mine at Sonman the seam presents the following section:

Upper Freeport coal at Shoemaker mine, Sonman (fig. 9, f).

	Feet.	Inches.
Coal	2	6½
Slate	0	3
Coal	1	3½
Total	4	1

On Trout Run this coal is mined at several places. At Hopfer's mine, 1 mile above Portage, the coal has the section given below.

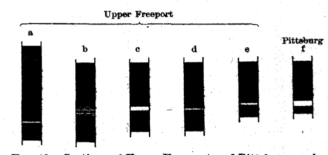

FIG. 10.—Sections of Upper Freeport and Pittsburg coals.

Upper Freeport coal at Hopfer's mine, Trout Run (fig. 10, a).

	Feet.	Inches.
Coal	0	6¾
Parting	0	3¾
Coal	3	0
Slate	0	1
Coal	0	11
Total	4	10½

Farther up Trout Run this seam has the following section, in George Pearse & Sons' new mine at Puritan:

Upper Freeport coal at Pearse & Sons' mine, Puritan (fig. 10, b).

	Feet.	Inches.
Coal	2	3
Coal, bone, and slate	0	6
Coal	1	4
Total	4	1

On Beaverdam Run near the crossing of the Pavia road is an old opening in this coal at which the following section is reported:

Upper Freeport coal on Beaverdam Run near Pavia road (fig. 10, c).

	Feet.	Inches.		Feet.	Inches.
Coal	2	0	to	2	6
Shale	0	2	to	0	4
Coal	1	0	to	1	2
Total	3	2	to	4	0

At Beaverdale the coal is opened by the Logan Coal Company and exhibits the following section:

Upper Freeport coal at Logan Coal Co.'s opening, Beaverdale (fig. 10, d).

	Feet.	Inches.		Feet.	Inches.
Coal	2	4			
Slate	0	1	to	0	2
Coal	1	0	to	1	2
Total	3	5	to	3	8

In the Mountain Coal Company's mine at Dunlo the average of three measurements gave the following:

Upper Freeport coal at Dunlo (fig. 10, e).

	Feet.	Inches.
Coal	2	1½
Slate	0	1½
Coal	0	7½
Total	2	10½

These measurements indicate a thinning of this seam in this direction, while preserving its characteristic two benches. South of Llanfair there is evidence that the seam becomes still thinner. Analyses of this coal from several points are given in the table at the end of the text.

GALLITZIN COAL.

The Gallitzin is a persistent coal varying from 73 to 107 feet above the Upper Freeport coal. The former interval exists in the Sonman shaft on Bens Creek, and the latter in the Cresson shaft at Cresson. The coal is not known to be minable, though it has been opened midway between Lilly and Cassandra, where it appears to be thicker than usual, reaching 15 inches.

PITTSBURG COAL.

The occurrence of the Pittsburg coal in this quadrangle has been discussed in the section on stratigraphy, and that discussion need not be repeated here. What is regarded as this coal occurs near the top of a high hill south of Wilmore and close to the axis of the Wilmore syncline. It is opened at one point and has the following section:

Pittsburg coal south of Wilmore (fig. 10, f).

	Feet.	Inches.
Coal	2	0
Slate	0	4
Coal	0	4
Total	2	8

There is but a small area of this coal at most, and it is not known to be as good over the whole of that area as is shown by the above section. It is reported only 2 feet thick, on the average, in the bank referred to.

MINING OPERATIONS.

Mining operations are confined almost exclusively to two seams—the Upper Freeport and the Lower Kittanning. Both of these seams run from 3 to 4 feet in thickness. In addition the Upper Kittanning coal is mined on Trout Run. Mining is at present confined to the regions of outcrop of the coal beds, and, with the exception of the operations at Cresson and Gallitzin, mainly to the valleys cut into the mountain side by Bear Rock Run, Bens Creek, Trout Run, South Fork of the Little Conemaugh, and Yellow Run. These streams have deeply trenched the coal-bearing strata, and also opened a way by which the coal beds can be easily reached by spurs from the main line of the Pennsylvania Railroad, thereby facilitating the transportation of the coal from the mines on either side of the narrow valleys. Accessibility to the railroad has determined the location of operations at Gallitzin and Cresson. In this general locality are seven mines, five in the Upper Freeport coal and two in the Lower Kittanning, the latter two being small.

Bear Rock Run, which enters the Little Conemaugh at Lilly, has cut deep into the flank of the mountain, making easily accessible a large body of coal in the hills on both sides of the valley. The Upper Freeport coal comes to the surface from the Wilmore syncline along the Little Conemaugh from near Bens Creek to the village of Lilly, and rises thence rapidly along both sides of the valley of Bear Rock Run, finally outcropping high up on the mountain side. Much of the Upper Freeport coal made accessible along this valley has already been worked out and the old workings may be seen in the vicinity of Lilly, as well as southward along the Little Conemaugh nearly to Bens Creek. Mining on Bear Rock Run is therefore confined to the Lower Kittanning coal, which is worked at four mines. On the Little Conemaugh there is one mine in the Upper Freeport between Lilly and Cassandra.

On all the other streams previously mentioned the conditions of physical geography are similar to those on Bear Rock Run. On Bens Creek there are five mines in the Lower Kittanning and one in the Upper Freeport. In October, 1903, preparations were being made at one point to mine the seam heretofore described as occurring 14 feet above the Lower Kittanning. At Sonman, midway between Bens Creek and Portage, are two mines in the Upper Freeport and one in the Lower Kittanning. On Trout Run are four mines in the Upper Freeport, four in the Lower Kittanning, two in the Upper Kittanning, and one in the Mercer. On South Fork of the Little Conemaugh, at Beaverdale and Lloydell, are five mines in the Lower Kittanning, and in October, 1903, another mine was being opened in the same seam, and three in the Upper Freeport. On Yellow Run, from Dunlo southward, are four mines in the Lower Kittanning coal and one in the Upper Freeport.

CLAY AND SHALE.

The clay and shale deposits of the quadrangle are not utilized. On Bens Creek a bed of clay several feet thick under the Clarion coal has been prospected. On Trout Run clay is reported several feet thick underneath the Upper Kittanning coal, and is said to be suitable for brickmaking. In the vicinity of Dunlo, as already stated, a bed of flint clay occurs below the Upper Freeport coal. Its position is indicated on the map by the line showing the outcrop of that coal. It has never been opened up, however, and nothing is known of its value. On the hill south of Gallitzin a clay apparently associated with the Gallitzin coal was stripped from the surface during the construction of the first tunnel at Gallitzin and made into brick for use in the tunnel. On the hill south of Blairs Gap are old pits below the Upper Freeport coal at which it is reported that clay was dug for brick to be used in building the old Portage Railroad. Whether any of the abundant shale of the Allegheny and Conemaugh formations is especially suitable for brick or tile making is not known.

LIMESTONE.

The Freeport limestone occurs at a few points in this quadrangle. It is about 10 feet thick in the cut at the east end of the east-bound tunnel at Gallitzin. It also occurs south of Blairs Gap, where it has been thrown out from old pits. At these points it is yellow and apparently impure. It is found in a few diamond-drill holes in the southeast corner of the quadrangle. It does not appear to be generally present, however, and probably has but little value. In the Conemaugh formation thin bands of yellow limestone occur between the Ebensburg and Wilmore sandstones. These limestones may be seen in the cuts between Portage and the western margin of the quadrangle. They also crop out in the ravines along North Branch of the Little Conemaugh. In but few places do they reach a thickness of 5 feet or over. They might be utilized in a limited degree for lime to make fertilizer, in case they were found cropping out in a favorable situation for quarrying. It is not likely, however, that they will ever be developed to any great extent.

BUILDING STONE.

Abundance of stone for coarse masonry can be had all over the quadrangle. Good quarry rock for dimension stone, however, is not common. The Ebensburg sandstone has been quarried to some extent for this purpose at Gallitzin. It is coarse and rather thick bedded here and seems to work well. At present the Clarion sandstone above Lloydell is being used. It is favorably located for quarrying and shipping and may afford a basis for a profitable industry. Great quantities of it are in sight.

SOILS.

The soil of the quadrangle is somewhat varied in character. The Conemaugh and Allegheny formations generally yield a light sandy loam which is rather easily tillable and of moderate fertility. It produces fairly good crops of cereals and makes good grass land. The red shale of the Mauch Chunk formation also yields good soil which can be easily tilled. The outcrop of this formation is in many places shown by clearings in the forests. The areas underlain by the Pottsville and Pocono formations, on the other hand, which generally yield a stony, sandy, and comparatively sterile soil, have been but little cleared. The Catskill formation yields the strongest and naturally most productive soil of the quadrangle, apparently a red clay loam. Wherever the surface is suitable the areas underlain by this formation are cleared and cultivated. The Devonian formations also yield a clayey loam of medium fertility, which is generally cultivated. Cereals, grass, and fruits are the principal crops.

WATER RESOURCES.

The water resources of the Ebensburg quadrangle include streams, springs, and wells.

All the streams maintained a good flow of water during the summer of 1903. That was said to be a rather wet season, however, and it is likely that some of them would run with diminished volume in a dry season. The streams heading in the generally forested country along both sides of the Allegheny Front were especially noticeable for the abundance of clear, cool water, and probably this supply would continue good during a dry season. The water supply of Hollidaysburg, to the east of this quadrangle, is obtained from Blairs Gap Run, the water being of excellent quality. The Pennsylvania Railroad Company had one large reservoir near the head of Bear Rock Run and was building the dam for another in 1903. From these reservoirs water is conducted by gravity to Gallitzin for locomotive use. About 2 miles north of Cresson, Clearfield Creek supplies a good-sized reservoir from which ice is taken.

Springs are fairly abundant, though generally they do not appear to be large. The most noted are at Cresson, and Cresson Springs water is said to be served in some of the hotels at Altoona and it is sold extensively in Pittsburg. The principal spring at Cresson seems to be the one near the station, and a summer resort of some importance with a large hotel was once conducted there. This is a magnesian spring, issuing from the shale between the Saltsburg and Ebensburg sandstones. Other springs in this vicinity supply the town of Cresson with water. Midway between Summit and Dysertown, issuing at the outcrop of the Upper Freeport coal bed, are two springs within a few feet of each other that are known as "the iron spring" and "the sulphur spring." Analyses of these waters were published by the Second Pennsylvania Survey (Report HH, p. 36) and republished by the United States Geological Survey (Water-Sup. and Irr. Paper No. 110, p. 161.)

A good water supply can usually be procured from wells varying in depth from a few feet along streams to 100 feet or more on the uplands. The latter wells have to be drilled into the solid rock. In one case a good supply was obtained from the horizon of a thin coal seam about 100 feet deep, and it seems not unlikely that as a general rule in the Wilmore basin the water of wells that penetrate solid rock is obtained at the level of some clay seam associated with a thin coal bed. The water supply of Ebensburg comes from wells; that of Gallitzin was formerly obtained in the same way, but the supply was cut off by mining out the Upper Freeport coal at the point where the wells were located. It seems that the water was retained in the overlying rocks by the impervious layer of clay under the coal seam. Near Wilmore a deep well was drilled many years ago in search of oil, and a good, though not strong, stream of water has been flowing from it ever since. This is a true artesian well with a head of probably 1000 feet, due to the high land along the Allegheny Front. Unfortunately the depth of the well is not known, nor is it known what is the water-bearing stratum or strata. There are a number of good sandstone beds beneath the Wilmore basin favorably situated to be water carriers, chief among which is the Burgoon sandstone, whose depth below the surface at Wilmore is approximately 1000 feet. It seems highly probably that an abundant supply of water can be derived from such sources in the Wilmore basin.

August, 1904.

Analyses of coals in the Ebensburg quadrangle.

	Name of seam.	Locality.	Owner.	Analyst.	Collector.	Fixed carbon.	Volatile hydro-carbons.	Moisture.	Ash.	Sulphur.	Phosphorus.	Total.	Color of ash.	Character of coke.	Fuel ratio.
1	Lower Kittanning	Bennington	Reed & Bradley	W. T. Schaller	Charles Butts	63.52	26.90	0.53	9.05	1.21	......	101.210	Brown	Good	2.36+
2	...do	Bear Rock Run	Lilly Mining Co.	...do	...do	71.38	21.97	0.32	6.33	0.68	......	100.680	White	...do	3.24+
3	...do	...do	...do	...do	...do	69.64	23.52	0.57	6.27	0.99	......	100.990	...do	...do	2.95+
4	...do	Bens Creek	A. C. Blowers	...do	...do	74.28	19.44	0.38	5.90	0.72	......	100.720	...do	...do	3.82+
5	...do	Lloydell	Alton Coal Co.	...do	...do	72.76	20.46	0.36	6.42	1.74	......	101.740	Gray	...do	3.50+
6	...do	...do	...do	...do	...do	74.28	17.81	0.35	7.56	3.14	......	101.140	Brown	...do	4.17+
7	...do	Llanfair (one-half mile above)	Henriette Coal Co.	...do	W. C. Phalen	75.78	19.41	0.43	4.38	0.76	......	100.760	White	...do	3.90+
8	Fourteen feet above Lower Kittanning	Bens Creek	A. C. Blowers	...do	Charles Butts	72.26	18.24	0.35	9.15	0.96	......	100.960	Gray	...do	3.96+
9	Upper Kittanning	Puritan	G. Pearse & Sons	...do	...do	71.19	19.28	1.70	7.83	1.60	......	101.600	Light brown	...do	3.69+
10	...do	...do	...do	...do	...do	67.49	22.00	0.52	9.99	3.47	......	103.470	Brown	...do	3.06+
11	Upper Freeport	Gallitzin	Pennsylvania Coal & Coke Co.	...do	...do	66.00	26.59	0.52	6.89	1.21	......	101.210	Gray	...do	2.52+
12	...do	...do	...do	...do	...do	64.43	27.92	0.63	7.02	0.94	......	100.940	...do	...do	2.31+
13	...do	Sonman	Shoemaker Coal Co.	...do	...do	74.71	19.41	0.41	5.47	1.38	......	101.280	Brown	...do	3.84+
14	...do	Puritan	G. Pearse & Sons	...do	...do	71.26	20.05	1.41	7.28	3.34	......	103.340	Light brown	...do	3.55+
15	...do	Dunlo	Mountain Coal Co.	Metallurgical Laboratory, Pittsburg, Pa.	...do	72.89	17.77	0.43	8.91	1.83	0.003	101.833	......	......	4.10+
16	...do	...do	...do	...do	...do	74.17	18.44	0.47	6.92	1.71	0.005	101.715	......	......	4.02+
17	...do	...do	...do	...do	...do	73.17	17.83	0.41	8.59	1.53	0.005	101.535	......	......	4.10+

TOPOGRAPHY

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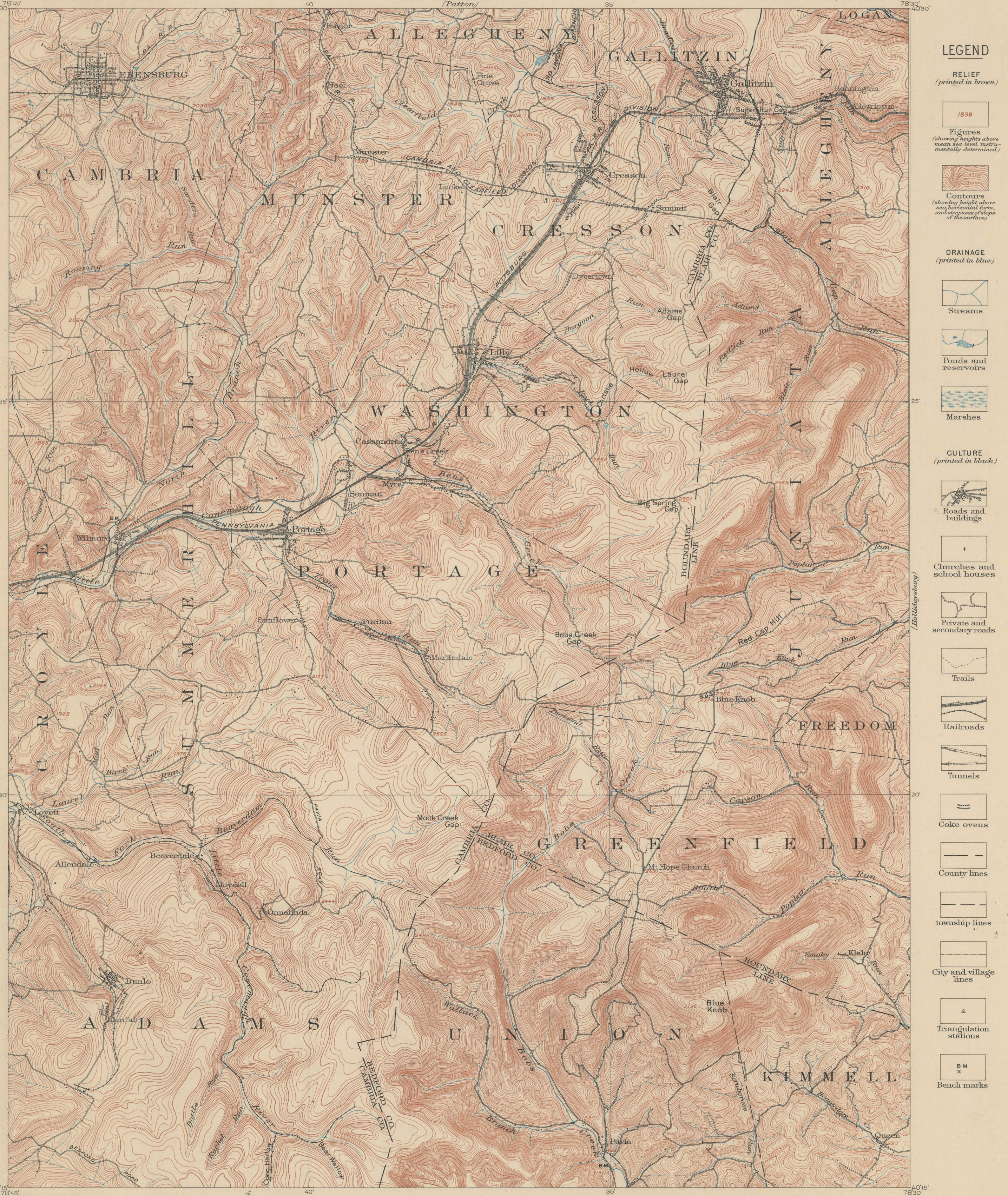
PENNSYLVANIA
EBENSBURG QUADRANGLE



H. M. Wilson, Geographer in charge.
Control by S. S. Gannett and H. B. Paige.
Topography by Frank Sutton, R. D. Cummin,
T. G. Basinger, and J. S. B. Daingerfield.
Surveyed in 1901-1902

SURVEYED IN COOPERATION WITH THE STATE OF PENNSYLVANIA.

TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION 1902.

Scale $\frac{1}{62500}$

1 ½ 0 1 2 3 4 Miles

1 ½ 0 1 2 3 4 5 Kilometers

Contour interval 20 feet.

Datum is mean sea level.

Edition of Feb. 1904, reprinted Nov. 1905.

AREAL GEOLOGY

U.S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

STATE OF PENNSYLVANIA
TOPOGRAPHIC AND GEOLOGIC SURVEY COMMISSION
JOSEPH N. PEW, CHAIRMAN

PENNSYLVANIA
EBENSBURG QUADRANGLE

LEGEND

SEDIMENTARY ROCKS

(Areas of subaqueous deposits are shown by patterns of parallel lines, subaerial deposits by patterns of dots and circles)

QUATERNARY — *Recent*

- Qal — **Alluvium** *(in flood plains of present streams)*

CARBONIFEROUS — *Pennsylvanian*

- Cm — **Monongahela formation** *(shale and thin sandstone)*
- Cw, Csh, Ccm, Ce, Csb — **Conemaugh formation with Saltsburg, Ebensburg, Summerhill, and Wilmore sandstone lentils** *(principally gray sandy shale with sandstone beds, Csb, Ce, Csh, and Cw respectively)*
- Ca — **Allegheny formation** *(chiefly gray and dark clay shale with beds of coarse gray sandstone, locally developed, and several valuable coal beds; Upper Freeport coal at the top)*
- Cpv — **Pottsville formation** *(two beds of thick-bedded sandstone, separated by shale, bearing locally a thin coal bed)*

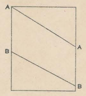
CARBONIFEROUS — *Mississippian*

- Cmc — **Mauch Chunk formation** *(soft red shale in upper part, greenish to gray heavy-bedded sandstone in lower part)*
- Cpo — **Pocono formation** *(principally gray sandy shale and coarse gray sandstone, with several bands of red clay shale)*

DEVONIAN

- Dck — **Catskill formation** *(predominatingly red shale and red sandstone, with some bands of gray and green shale)*
- Dch — **Chemung formation** *(gray and green shale with sandstone layers in lower part; chocolate shale and sandstone in upper portion; fossiliferous throughout)*
- Dn — **Nunda formation** *(thinly laminated, drab, clay shale at bottom, merging into gray sandy shale containing thin, gray and bluish sandstone layers and a few bands of reddish rock; fossils rare)*
- Dg — **Genesee shale** *(soft, black, clay shale with limestone nodules; sparingly fossiliferous)*
- Dh — **Hamilton formation** *(mostly olive and dark-green clay shale and sandy shale, with a few thin bands of gray sandstone; fossils abundant)*

Sections



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1 ½ 0 1 2 3 4 Miles

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Contour interval 20 feet.
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Edition of Dec. 1905

Geology by Charles Butts, assisted by W.C. Phalen, under the direction of Marius R. Campbell.
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SURVEYED IN COOPERATION WITH THE STATE OF PENNSYLVANIA.

ECONOMIC GEOLOGY

STATE OF PENNSYLVANIA
TOPOGRAPHIC AND GEOLOGIC SURVEY COMMISSION
JOSEPH N. PEW, CHAIRMAN

U. S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

PENNSYLVANIA
EBENSBURG QUADRANGLE

(Barnesboro) (Patton) (Hollidaysburg) (Everett)

78°45′ 40°30′ — 40′ — 35′ — 78°30′ 40°30′

LEGEND
(continued)

Sections

A — A
B — B

⚒ *Coal mines*
× *Coal prospects*

NAMES OF MINES.

Location indicated on the map by numbers.

1. Reed and Bradley.
2. Reed and Bradley.
3. Bennington No. 19.
4. Webster No. 11.
5. Taylor and McCoy.
6. Webster No. 10.
7. Webster No. 9.
8. Kokomo.
9. Sonman No. 4.
10. Lilly.
11. Piper.
12. Bear Rock.
13. Moshannon.
14. Metzger.
15. Webster No. 4.
16. Laughman.
17. Sonman Shaft.
18. Piper No. 1.
19. Webster No. 1.
20. Shoemaker.
21. Sonman Shaft.
22. Hopper.
23. Lukens and Haupt.
24. Toy Ridge.
25. Puritan.
26. Excelsior.
27. Pearse and Sons.
28. South Fork.
29. Wintersen.
30. Cambria.
31. Plymouth.
32. N. Y. Coal and Transportation Co.
33. Eleanor.
34. Beaverdam.
35. Logan.
36. Beaverdam No. 15.
37. Wagner.
38. Alton.
39. Cambria.
40. Loyal Hanna.
41. Yellow Run Shaft.
42. Mountain Coal Co.
43. Dunlo Slope.
44. Henrietta No. 1.
45. Henrietta No. 2.

LEGEND

SEDIMENTARY ROCKS

(Areas of subaqueous deposits are shown by patterns of parallel lines, subaerial deposits by patterns of dots and circles)

QUATERNARY

Recent

Qal — Alluvium *(in flood plains of present streams)*

CARBONIFEROUS

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Cm — Monongahela formation *(shale and thin sandstone)*

Ccm (Cw, Csh, Ce, Csb) — Conemaugh formation with Saltsburg, Ebensburg, Summerhill, and Wilmore sandstone lentils *(principally gray sandy shale with sandstone beds, Csb, Ce, Csh, and Cw respectively)*

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Dg — Genesee shale *(soft, black, clay shale with limestone nodules; sparingly fossiliferous)*

Dh — Hamilton formation *(mostly olive and dark-green clay shale and sandy shale, with a few thin bands of gray sandstone; fossils abundant)*

Economic and structural data

Coal *(area underlain by Allegheny formation which contains several beds of coal of workable thickness)*

Coal outcrops *(coal beds of probably workable thickness)*

uf, *Upper Freeport coal*
uk, *Upper Kittanning coal*
lk, *Lower Kittanning coal*

1700 — *Structure contours* *(showing the elevation above sea and the lay of the Upper Freeport coal contour interval is 50 feet up to 3000 feet elevation; above 3000 feet it is 200 feet)*

Legend is continued on the left margin.

40°15′ 78°45′ — 40′ — 35′ — 40°15′ 78°30′

H. M. Wilson, Geographer in charge.
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SURVEYED IN COOPERATION WITH THE STATE OF PENNSYLVANIA.

TRUE NORTH — MAGNETIC NORTH — 4½°
APPROXIMATE MEAN DECLINATION 1902.

Scale $\frac{1}{62500}$

1 ½ 0 1 2 3 4 Miles
1 ½ 0 1 2 3 4 5 Kilometers

Contour interval 20 feet.
Datum is mean sea level.

Edition of Dec. 1905

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SURVEYED IN COOPERATION WITH THE STATE OF PENNSYLVANIA.

U.S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

GEOLOGIC STRUCTURE

STATE OF PENNSYLVANIA
TOPOGRAPHIC AND GEOLOGIC SURVEY COMMISSION
JOSEPH N. PEW, CHAIRMAN

PENNSYLVANIA
EBENSBURG QUADRANGLE

LEGEND

SEDIMENTARY ROCKS

SHEET SYMBOL / SECTION SYMBOL

QUATERNARY

Recent

Qal — Alluvium *(in flood plains of present streams)*

CARBONIFEROUS

Pennsylvanian

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Dh — Hamilton formation *(mostly olive and dark-green clay shale and sandy shale, with a few thin bands of gray sandstone; fossils abundant)*

2250 — *Structure contours*
(showing the elevation above sea and the lay of the Upper Freeport coal. Contour interval is 50 feet up to 3000 feet elevation; above 3000 feet it is 200 feet. Where the coal has been removed by erosion, the lines are determined by the calculated position of the beds)

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TRUE NORTH / MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION 1902.

Scale $\frac{1}{62500}$

1 ½ 0 1 2 3 4 Miles

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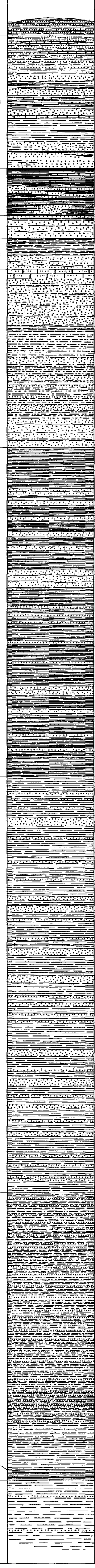
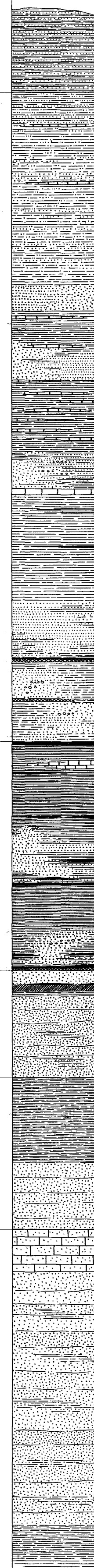
COLUMNAR SECTIONS

GENERALIZED SECTION FOR THE EBENSBURG QUADRANGLE.
SCALE: 1 INCH = 500 FEET.



System.	Series.	Formation Name.	Symbol.	Thickness in Feet.	Character of Rocks.
CARBONIFEROUS	PENNSYLVANIAN	Monongahela formation.	Cm	100	Shale and thin sandstone.
		Conemaugh formation.	Ccm	770	Prevailingly shale with heavy sandstone strata in lower two-thirds.
		Allegheny formation.	Ca	270	Prevailingly gray and dark clay shale with beds of heavy gray sandstone locally developed. Valuable seams of coal.
		Pottsville formation.	Cpv	130	Two beds of heavy sandstone, separated by shale, bearing locally a seam of coal.
	MISSISSIPPIAN	Mauch Chunk formation.	Cmc	180	Soft, red shale at top, coarse greenish to gray heavy-bedded sandstone at bottom.
		Pocono formation.	Cpo	1030	Prevailingly gray sandy shale and coarse gray sandstone. Several bands of red shale.
DEVONIAN		Catskill formation.	Dck	1900	Predominantly red shale and red sandstone. Probably 80 per cent red. Some bands of gray and green shale.
		Chemung formation.	Dch	2400	Lower 1400 feet gray and green shale with sandstone layers; upper 1000 feet prevailingly chocolate shale and sandstone. Rather abundantly fossiliferous throughout.
		Nunda formation.	Dn	1600	Very thinly and evenly laminated pale-brown clay shale, at bottom merging into greenish-gray, sandy, unevenly laminated shale with thin, fine-grained, gray and bluish sandstone layers above. Bands of reddish and chocolate rock up to 1 foot thick occur at a certain zone in upper half. Very sparingly fossiliferous throughout. Minute forms occur characteristic of western Nunda ("Portage") rocks only.
		Genesee shale.	Dg	60	Very soft, black clay shale with limestone nodules; sparingly fossiliferous.
		Hamilton formation.	Dh	1300	Mostly olive sandy and clay shale, frequently with characteristic fracture across lamination planes. Thin, very evenly bedded, and jointed gray sandstone layers. Fossils fairly abundant; characteristic Hamilton forms.

DETAILED SECTION OF CARBONIFEROUS ROCKS OF THE EBENSBURG QUADRANGLE.
SCALE: 1 INCH = 100 FEET.



System.	Series.	Names of Formations and Members.		Thickness in Feet.	Character of Rocks.
CARBONIFEROUS	PENNSYLVANIAN	Monongahela formation.	Pittsburg coal.	2	Occurs only on ridge 3 miles south of Wilmore.
		Conemaugh formation.	Wilmore sandstone.	20-30	Laminated to flaggy and coarse, thick bedded.
			Summerhill sandstone.	40-60	Laminated to heavy bedded.
			Ebensburg sandstone.	40-50	Coarse grained, locally conglomeratic and massive.
					Red shale (local).
			Saltsburg sandstone	40-60	Evenly bedded flags.
			Gallitzin coal.	½-1½	Generally thin.
			Mahoning sandstone.	0-90	Generally heavy bedded, in places conglomeratic; sometimes in two benches.
		Allegheny formation.	Upper Freeport coal.	3½-4	Valuable, persistent seam.
			Freeport limestone.	0-12	Locally developed; of little value.
			Lower Freeport coal.	0-2	Generally thin.
			Upper Kittanning coal.	2-5	Only locally developed; generally worthless.
			Llanfair sandstone.	40	Coarse gray sandstone.
			Middle Kittanning coal.	0-2½	Not persistent.
			Lower Kittanning (Miller or B) seam.	1½-5 3½-4	Thin coal overlies Lower Kittanning seam; persistent. Persistent and valuable.
			Clarion sandstone.	40	Locally developed, coarse, conglomeratic.
			Clarion coal.		Thin, not persistent.
			Brookville coal.	1-5	Persistent seam; poor quality.
		Pottsville formation.	Homewood sandstone.	15+	Coarse, thick bedded.
			Mercer coal, clay, and shale.		Coal generally worthless, locally minable.
			Connoquenessing sandstone.	100+	Coarse, heavy bedded.
	MISSISSIPPIAN	Mauch Chunk formation.			
		Pocono formation.	Loyalhanna ("Siliceous") limestone.	40-60	Heavy bedded and siliceous; characteristically cross-bedded.
			Burgoon sandstone.	300	Coarse, heavy bedded.
			Patton shale.	40	Red shale below Burgoon sandstone.

CHARLES BUTTS,
Geologist.

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57	Telluride	Colorado	25
58	Elmoro	Colorado	25
59	Bristol	Virginia-Tennessee	25
60	La Plata	Colorado	25
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95	Columbia	Tennessee	25
96	Olivet	South Dakota	25
97	Parker	South Dakota	25
98	Tishomingo	Indian Territory	25
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101	San Luis	California	25
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103	Nampa	Idaho-Oregon	25
104	Silver City	Idaho	25
105	Patoka	Indiana-Illinois	25
106	Mount Stuart	Washington	25
107	Newcastle	Wyoming-South-Dakota	25
108	Edgemont	South Dakota-Nebraska	25
109	Cottonwood Falls	Kansas	25
110	Latrobe	Pennsylvania	25
111	Globe	Arizona	25
112	Bisbee	Arizona	25
113	Huron	South Dakota	25
114	De Smet	South Dakota	25
115	Kittanning	Pennsylvania	25
116	Asheville	North Carolina-Tennessee	25
117	Casselton-Fargo	North Dakota-Minnesota	25
118	Greeneville	Tennessee-North Carolina	25
119	Fayetteville	Arkansas-Missouri	25
120	Silverton	Colorado	25
121	Waynesburg	Pennsylvania	25
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‡ These folios are out of stock.

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