DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

GEOLOGIC ATLAS

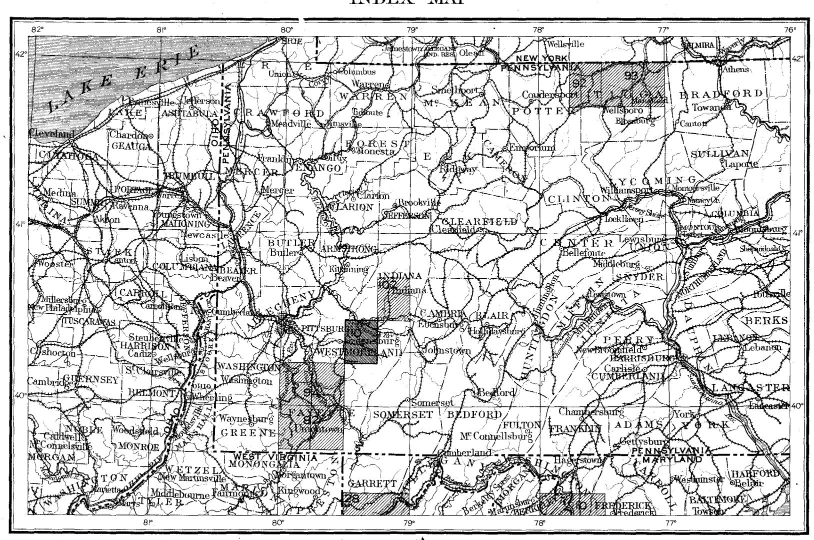
OF THE

UNITED STATES

LATROBE FOLIO

PENNSYLVANIA

INDEX MAP



SCALE: 40 MILES-1 INCH

LATROBE FOLIO

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CONTENTS

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1904

OHIO STATE UNIVERSITY

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).

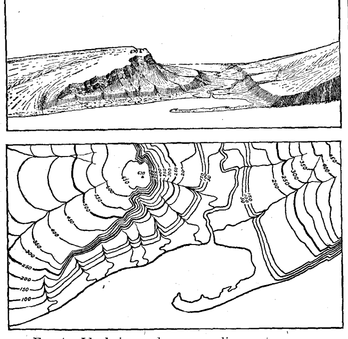

FIG. 1.—Ideal view and corresponding contour map.

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		Ћ	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:

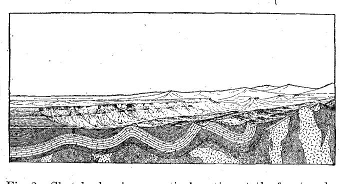

Fig. 2.—Sketch showing a vertical section at the front and a landscape beyond.

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:

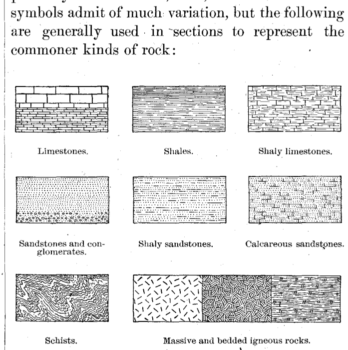

Fig. 3.—Symbols used in sections to represent different kinds of rocks.

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

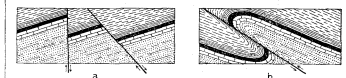

Fig. 4.—Ideal sections of strata, showing (a) *normal* faults and (b) a *thrust* fault.

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 LATROBE QUADRANGLE.

By Marius R. Campbell.

GENERAL RELATIONS.

Position and area.—By reference to the key map on the cover of the folio it will be seen that this quadrangle is located in the Conemaugh Valley in western Pennsylvania. That part of the territory lying north of the river embraces the southwestern part of Indiana County and in it are located the towns of Blairsville, Saltsburg, and Tunnelton; the area south of the river, which is by far the larger part of the quadrangle, is in Westmoreland County and includes the towns of Latrobe, Bradenville, Derry, Millwood, Livermore, New Alexandria, Georges Station, and various mining towns that have sprung up in the vicinity of the larger coal mines. The most important town south of the river is Latrobe, from which, on account of its size and central location, the quadrangle has been named. The area of the quadrangle is 227.6 square miles.

Triangulation stations.—The exact latitude and longitude of the boundaries of the quadrangle (latitude, 40° 15′–40° 30′; longitude, 79° 15′–79° 30′) have been determined from stations located upon some of the most prominent hilltops of the region. These have been connected by triangulation with astronomical stations at Washington, D. C., Cumberland, Md., Grafton, W. Va., and Pittsburg, Pa., and the accuracy of the work has been checked by a carefully measured base line along the Pennsylvania Railroad on the eastern margin of the quadrangle (see Bull. U. S. Geol. Survey No. 181).

All surveys for the maps of this folio are based upon six triangulation stations located within the quadrangle and four other stations in close proximity thereto. Each station is marked by a stone post set firmly in the ground, on the top of which is cemented a bronze tablet marked "U. S. Geological Survey-Pennsylvania." The accompanying diagram (fig. 1) shows the relative positions of

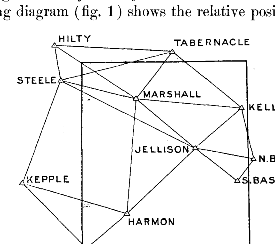

FIG. 1.—Sketch map showing location of triangulation stations on which the survey of the Latrobe quadrange is based.

these stations, and the following descriptions will enable engineers to identify them on the ground.

HILLSIDE, NORTH BASE, WESTMORELAND COUNTY.

[Latitude 40° 23′ 27.97″. Longitude 79° 14′ 32.56″.]

On prolongation of Hillside tangent of Pennsylvania Railroad, in field owned by John Bridges, about one-third mile south of Gray railroad station.

HILLSIDE, SOUTH BASE, WESTMORELAND COUNTY.

[Latitude 40° 21′ 46.78″. Longitude 79° 16′ 10.68″.]

On a level railroad dump, in field owned by George Piper, three-fourths mile southward from Hillside railroad station, 16 feet west of fence.

JELLISON, WESTMORELAND COUNTY.

[Latitude 40° 24′ 07.35″. Longitude 79° 19′ 57.99″.]

On a bare, sharp hill near Salem Church, 5 miles southwest of Blairsville. Land is owned by Mr. Jellison, who lives on the north side of hill.

KELLY, INDIANA COUNTY.

[Latitude 40° 27′ 14.03″. Longitude 79° 15′ 28.54″.]

About 1½ miles north of Blairsville, in a cultivated field owned by James Kelly, 6 feet north of fence running east and west. A few small trees near summit of hill.

HARMON, WESTMORELAND COUNTY.

[Latitude 40° 19′ 47.78″. Longitude 79° 26′ 19.91″.]

In Unity Township about 3 miles north of west of Latrobe, on a high ridge known locally as Dry Ridge. The ridge is flat on top and the station is near the center of a cleared field.

MARSHALL, WESTMORELAND COUNTY.

[Latitude 40° 27′ 32.39″. Longitude 79° 25′ 08.15″.]

In Loyalhanna Township, about 3½ miles southwest of Saltsburg, on the highest part of a bare, flat hill, which is the southwestern one of three hills that stand near together. The land is owned by Mrs. William Marshall.

STROBLE, WESTMORELAND COUNTY.

[Latitude 40° 17′ 11.77″. Longitude 79° 29′ 51.34″.]

About 4 miles southeast of Greensburg, on a cleared ridge having timber on its western end. There is a higher summit 1 mile eastward. The land is owned by John Stroble.

STEELE, WESTMORELAND COUNTY.

[Latitude 40° 29′ 00.34″. Longitude 79° 31′ 34.73″.]

About 4 miles west of Saltsburg, on the southern part of the summit of a high, bare hill in Bell Township, on land owned by John Steele.

TABERNACLE, INDIANA COUNTY.

[Latitude 40° 30′ 54.57″. Longitude 79° 21′ 49.71″.]

About one-half mile east of Clarksburg post-office and about 6 miles by road north of Saltsburg, on the highest part of a bare cultivated round-top hill owned by the heirs of S. W. Coleman.

ROSE, WESTMORELAND COUNTY.

[Latitude 40° 23′ 03.83″. Longitude 79° 41′ 36.25″.]

About 4 miles north of Irwin, on a cleared ridge owned by the Rose heirs.

Level lines.—The general altitude and configuration of the surface of the quadrangle is shown by means of contour lines which are based upon precise levels run by the Pennsylvania Railroad engineers and by the United States Geological Survey. During the course of this work numerous bench marks were established (see Bull. U. S. Geol. Survey No. 185).

Bench marks in the Latrobe quadrangle.

	Feet above sea level. (1903 adjustment.)
Blairsville, Pennsylvania Railroad passenger station, northeast corner of, on foundation offset (Pennsylvania Railroad bench mark No. 60), chiseled square	1,011.909
Blairsville, Walnut Street Bridge; northeast wing, wall of, on coping stone, aluminum tablet marked "1003 PITTSBURG"	1,003.077
Blairsville, Maple street crossing, top of rail at	1,010.
Georges station, overhead bridge, on north pier of, aluminum tablet marked "1199 PITTSBURG"	1,199.180
Latrobe high school building; aluminum tablet marked "1026 PITTSBURG"	1,026.206
Livermore, 0.25 miles north of; at intersection of roads, on rock, chiseled mark	932.89
Livermore, at north side of; covered bridge over Conemaugh River, north end of	905.
Livermore, 0.2 mile east of; overhead bridge, in southeast wing wall, copper bolt (Pennsylvania Railroad bench mark No. 56)	933.50
Livermore, 0.2 mile east of; overhead bridge, southeast wing, wall of, on coping stone, aluminum tablet marked "934 PITTSBURG"	933.462
Millwood, overhead bridge; south abutment, on southwest coping stone, marked "1175 PITTSBURG"	1,175.286
New Alexandria, 2 miles north of; covered bridge over Loyalhanna Creek, north end of	935.
New Alexandria, covered wooden bridge over Loyalhanna Creek; southeast wing wall, on coping stone, tablet marked "945 PITTSBURG"	944.980
New Alexandria, 500 feet north of Pennsylvania Railroad station; east side of road, nail in root of large oak tree (Pennsylvania Railroad bench mark No. 407)	975.43
Saltsburg, Pennsylvania Railroad passenger station; baggage-room door sill	855.57
Saltsburg, covered wooden bridge over Kiskiminetas River; on northeast wing wall, west end, aluminum tablet marked "849 PITTSBURG"	848.567

PHYSIOGRAPHY.

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 lowland on the west, and from central Alabama northward beyond the boundary of the United States.

SUBDIVISION OF APPALACHIAN PROVINCE.

With respect to topography and geologic structure the Appalachian province may be divided into two nearly equal parts by a line which follows the Allegheny Front through Pennsylvania, Maryland, and West Virginia, and the eastern escarpment of the Cumberland Plateau across Virginia, Tennessee, Georgia, and Alabama (see fig. 2).

East of this line the rocks are greatly disturbed by faults and folds, and in many places they are so metamorphosed that their original characters can be determined with difficulty. West of the dividing

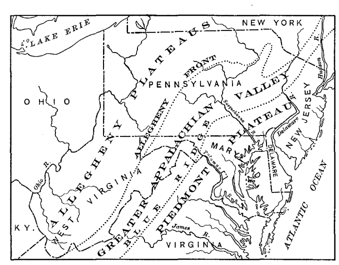

FIG. 2.—Diagram of northern portion of the Appalachian province showing physiographic divisions.

line the rocks are entirely unaltered; they lie nearly flat, and the few folds which break the regularity of the structure are so broad and open that they produce scarcely an appreciable effect.

The general topographic features are well illustrated by fig. 41, illustration sheet, which is a relief map of the northern part of the province. The plateau which constitutes most of the northwestern part of the State is bounded on the southeast by a sharp escarpment which extends from Williamsport, in the north central part of the State, to the head of Potomac River, in western Maryland. This escarpment, which is known as the Allegheny Front, is a great dividing line between the principal geologic as well as the physiographic divisions of the State.

East of this line the surface consists of alternating ridges and valleys, as shown in the Greater Appalachian Valley, and of a slightly dissected upland like the Piedmont Plain of eastern North Carolina and Virginia. West of the dividing line the surface is composed of more or less elevated plateaus, which are broken by a few ridges where minor folds have affected the rocks, and which are greatly dissected where they have been raised high above drainage level. In contradistinction from the lowlands on the west and the regularly alternating ridges and valleys on the east, it has been called by Powell the Allegheny Plateaus (Mon. Nat. Geog. Soc., No. 3).

ALLEGHENY PLATEAUS.

This region is characterized by distinctive types of geologic structure, of surface features, and of drainage arrangement.

Geologic structure.—The structure of the Allegheny Plateaus is comparatively simple. The strata lie nearly flat, and their regularity is broken only by small faults and low, broad folds which usually have little effect upon the general structural features and the topography.

The most pronounced fold is a low, broad arch known as the Cincinnati anticline. The main axis of this fold enters the Allegheny Plateaus from the direction of Chicago, and a minor fold from the western end of Lake Erie joins the major axis near the type locality. From Cincinnati the anticline passes due south to Lexington, Ky., and there curves to the southwest, parallel with the Appalachian Valley, as far as Nashville, Tenn. Its maximum development is in the vicinity of Lexington, where the Trenton limestone is exposed at the surface at an altitude of 1000 feet above sea level; but in Tennessee it again swells into a dome-like structure which is represented togographically by the Central Basin of Tennessee.

This anticline separates the Allegheny Plateaus into two structural basins, which are best known by the coal fields that they contain. The western basin extends far beyond the limit of the province and contains the Eastern Interior coal field of Illinois, Indiana, and Kentucky. The eastern basin lies entirely within the limits of the Allegheny Plateaus and is generally known as the Appalachian coal field. By reference to the map, fig. 42, illustrations sheet, it will be seen that the Latrobe quadrangle is situated in this basin, near its northern extremity. A more detailed description is necessary in order to convey a thorough understanding of the local geology and topography.

Since the Appalachian coal field is a structural basin or trough, the strata around its margin generally dip toward the center of the field. This is particularly noticeable on the two sides, the rocks on the northwestern side dipping gently but regularly to the southeast and those of the southeastern side dipping more strongly to the northwest. In Pennsylvania and West Virginia the regularity of the dip on the southeastern limb of the trough is interrupted by parallel folds which, where hard rocks are involved, give rise to anticlinal ridges and synclinal valleys. These undulations are similar to the great folds east of the Allegheny Front, except that they are developed on a very much smaller scale and have not been broken by faults as have many of the folds farther east. Across the northern extremity of the basin, where the rocks are nearly flat, there are a great many of these minor folds, which extend southwestward at least half way across Pennsylvania from its northern boundary. In the southern part of the State there are only six pronounced anticlines, and two of these disappear near the West Virginia line. Farther south the number is reduced, until on Kanawha River the regular westward dip is interrupted by only one or two small folds.

Drainage.—Most of the surface water of the Allegheny Plateaus finds its way into the Mississippi, but that which drains the northeastern end flows either northwestward into the Great Lakes or southeastward through Susquehanna, Delaware, and Hudson rivers into the Atlantic Ocean.

The arrangement of the drainage lines in the northern part of the province is largely due to the advance of the ice sheet during the Glacial epoch. Before that time, it is supposed, all the streams north of central Kentucky flowed northward 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 have their sources on the summit of the Blue Ridge and flow across the Greater Appalachian Valley as well as the Allegheny Plateaus.

Surface relief.—The surface of this division of the province is composed, as its name implies, of a number of plateaus of different altitude and extent. The most pronounced of these occupies the southeastern portion of the division and extends nearly the whole length of the province. This plateau is very old, and its surface is so greatly dissected that its plateau character is not always apparent. It emerges from beneath the Cretaceous cover in central Alabama at a height of 500 feet above sea level. From this altitude it ascends to 1700 feet at Chattanooga, 2400 feet at Cumberland Gap, 3500 feet at New River, and probably 4000 feet at its culminating point in central West Virginia. From this point it descends to about 2600 feet on the southern line of Pennsylvania and to 2100 or 2200 feet in the central part of the State. North of this point the plateau increases in width, including most of the northern counties of Pennsylvania and the southern counties of New York, and ranges in altitude from 2000 to 2400 feet.

The character and altitude of this plateau vary greatly in different parts of the province, depending upon the character of the underlying rocks, the general drainage conditions, and the crustal movements which have affected this region. In its southern part conditions have been very favorable to the preservation of the plateau, and large areas of its even surface are still visible in Lookout and Sand mountains and in the Cumberland Plateau. North of Tennessee the cap of hard sandstone which protects the Cumberland Plateau is lacking and the surface is completely dissected, showing only rounded hilltops as the possible representatives of its once even surface. In northern West Virginia a few remnants of the original plateau are preserved where conditions are especially favorable, but generally the surface is so deeply eroded that it is difficult to realize that it was once approximately flat and extended over most of the Appalachian region. In the northern part of Pennsylvania conditions are similar to those prevailing in Tennessee, and areas of considerable size are still preserved intact where they are protected by the massive sandstones of the Pottsville formation.

Throughout most of the province knobs and ridges rise to a greater height than the old surface of this plateau. Usually these may be distinguished by the fact that they stand above the general level of the surrounding hills.

The plateau slopes westward, but it is generally separated from the next lower plateau by a more or less regular westward-facing escarpment. This feature is most pronounced in Tennessee, where it has a height of 1000 feet, and separates the Cumberland Plateau on the east from the Highland Plateau on the west. Its height diminishes toward the north, falling to 500 feet in central Kentucky; and north of Ohio River it is so indistinctly developed that it is doubtful whether it has been recognized. In southern Pennsylvania it becomes more pronounced where the hard rocks of Chestnut Ridge rise abruptly above the plain formed on the soft rocks of the Monongahela Valley, but the surface of the upper plateau is so greatly dissected that it can be recognized with difficulty. Toward the central part of the State the plateau surfaces that usually are separated by this escarpment approach each other, and the escarpment is merged in a mass of irregular hills which seem to represent all that is left of the higher plateau.

The lower plateau surface is best developed as a distinct feature in Tennessee and Kentucky. In the former State it is known as the Highland Plateau, and in the latter as the Lexington Plain. Its surface slopes gently to the west, but along its eastern margin throughout these States it holds a constant altitude of about 1000 feet above sea level. North of Ohio River it is less perfectly developed, but presumably it constitutes most of the surface of Ohio, eastern Indiana, western Pennsylvania, and southern New York. Throughout most of this territory the plateau was developed on harder rocks than in Kentucky and Tennessee, and the result is that the surface is less regular and the position of the base-level of that epoch is difficult to determine. It seems to rise eastward from an altitude of 700 or 800 feet in Indiana to 1000 feet in central Ohio, 1200 to 1300 feet in southwestern Pennsylvania, and probably reaches 2200 feet at its culminating point in the northern part of the State.

The surface features of this plateau are variable, but there is not so much diversity as is shown in the surface of the higher plateau. In Kentucky and Tennessee it is preserved over large areas as a nearly featureless plain, but in other States it was less perfectly developed, and it has suffered greatly from dissection since it was elevated to its present position.

West of this intermediate zone there is a third plain, which is developed only in the great Central Basin of Tennessee and in the western parts of Kentucky and Indiana.

TOPOGRAPHY.

The topography of the Latrobe quadrangle is due to long-continued subaerial erosion of rocks of different hardness, disposed along certain structural lines. In this work the streams are important factors, since they are the principal agents by which the material weathered from the rocks is carried away. In a discussion of the topography it is therefore necessary first to consider the drainage of the region.

DRAINAGE.

Allegheny River basin.—The surplus waters of the Latrobe quadrangle are carried off almost entirely by Kiskiminetas River, which is formed at Saltsburg by the junction of Conemaugh River and Loyalhanna Creek. Kiskiminetas River is a tributary of Allegheny River, and consequently most of this territory belongs to the drainage basin of the Allegheny.

Conemaugh River has its source on the southeastern edge of the Allegheny Plateaus and flows northwestward through this territory. It is a rapid mountain stream and is at present actively engaged in deepening its channel throughout this region. East of Blairsville it crosses a number of long, parallel ridges which give to this portion of the State its mountainous topography. The pathway of the stream through these ridges is marked by deep and picturesque gorges, in which the geologic structure and the character of the rocks are well displayed. Just below Blairsville the main stream is joined by Blacklick Creek. This stream has its source in Cambria County, nearly as far east as the headwaters of Conemaugh River, but its drainage basin is not so large as that of the main stream.

The most important tributary of Conemaugh River in this quadrangle is Loyalhanna Creek, which has its source in the Ligonier Valley a few miles southeast of this territory. Instead of following this broad valley to the northeast or southwest and uniting with other streams, Loyalhanna Creek has cut a deep gorge directly across Chestnut Ridge, which forms the western front of the valley. This gorge lies wholly within the boundaries of the quadrangle, and is excellently shown on the topographic map. It is wild and rugged, and near the center of the ridge is about 1000 feet deep. After emerging from this gorge the stream pursues a general northwestward course to Saltsburg, where it joins the Conemaugh, and eventually its waters find their way to Allegheny River.

A striking feature of the stream courses is their apparent disregard for ridges of hard rock. All of the streams mentioned trench Chestnut Ridge, although this ridge is capped by one of the most massive and resistant sandstones known in the region. It is apparent that the streams could not have selected such courses recently, for the cutting of the rocks has been slow and the gorges had their origin well back in geologic history. The present courses seem, then, to date back to a time when the entire surface of the quadrangle stood as high as the summit of Chestnut Ridge, or else the anticlinal fold forming the ridge has been produced in comparatively recent time and the streams have persisted in their courses despite the obstacle which arose across their pathway. The latter supposition does not agree with the generally accepted idea that the folds of the region were produced at the close of the Carboniferous period, and, consequently, the hypothesis that the courses of the streams were established by downcutting from a higher level will be accepted as the best explanation.

Another interesting feature of these streams is their sinuous courses in the comparatively low land west of Chestnut Ridge. Conemaugh River in particular is characterized by broad, almost continuous meanders throughout this territory. Along Loyalhanna Creek likewise are a number of sharp bends which apparently have no relation to the hard and soft beds of rocks now showing at the surface, or to the geologic structure of the region. These bends originated a considerable distance back in geologic time; they will be more fully explained under the discussion of the surface relief.

Monongahela River basin.—Although by far the larger part of the quadrangle is included within the hydrographic basin of the Kiskiminetas, there is a small area in the southwest corner where the streams are tributary to Sewickley Creek, which belongs to the Youghiogheny or Monongahela river system. A part of this territory, therefore, lies upon one of the principal divides of the region, namely, that which separates the waters of the Allegheny from those of the Monongahela. Although this divide separates such large drainage systems, it is no higher than the hilltops in the surrounding region. This is an important fact and will be discussed more fully on a succeeding page.

SURFACE RELIEF.

General features.—The Latrobe quadrangle lies on the northwestern margin of what is usually regarded as the mountainous part of the State. Chestnut Ridge, which crosses its southeast corner, is the westernmost outlier of this more rugged region. In a general way the surface of the mountainous section is composed of high ridges with deep longitudinal valleys between, and the ridges are cut transversely by streams which have their sources on the summit near the Allegheny Front and flow westward into the Ohio basin. The country west of Chestnut Ridge is decidedly hilly, but the hills generally rise to a common level, and from the higher points one sees a country that resembles a gently rolling plain. The streams have dissected this region to depths ranging from 300 to 500 feet, and flow generally in narrow valleys that afford little room for the establishment of mines and manufacturing plants such as characterize this part of the country, and for the large population that inhabits it.

Schooley peneplain.—So small a part of the mountainous region is included within the boundaries of the Latrobe quadrangle that it is impossible to make definite statements regarding its characteristic topography.

Chestnut Ridge forms the western limit of the mountainous region. It is the most striking topographic feature of the quadrangle, standing about 1000 feet above the general upland level. The ridge is due to the heavy sandstone beds of the Pottsville formation, but in many places, especially away from the main drainage lines, softer overlying rocks are preserved, and the ridge attains an altitude of from 2200 to 2300 feet above sea level. From the general accordance in height of the mountainous ridges it seems probable that the summit of Chestnut Ridge is a remnant of an early peneplain surface, and provisionally this surface is correlated with the Schooley peneplain recognized by Davis in the eastern part of the State (Proc. Boston Soc. Nat. Hist., vol. 24).

Harrisburg peneplain.—Looking to the northwest from some of the projecting spurs of Chestnut Ridge one is apt to be impressed by the apparent flatness and evenness of the country. In passing through it, however, the traveler sees only the hills which beset him on all sides, and is scarcely conscious that their tops rise to a common level, forming a fairly even surface, like the surface of a plain. When the country is viewed from the slopes of Chestnut Ridge the only feature that serves to break the monotony of the even expanse of hilltops on the west is a low ridge northwest of Latrobe whose summit in places rises from 200 to 300 feet above the common level. This is known as Dry Ridge, and is formed of coarse, resistant sandstone which is brought up on the crest of the Fayette anticlinal fold.

If the valleys cut by the present streams were filled to a height of 1200 to 1300 feet above sea level, the country west of Chestnut Ridge would then, indeed, be almost a plain. This plain was produced by the dissection of the Schooley peneplain down to a common level when the surface of the earth stood at an altitude of from 1200 to 1300 feet lower than at the present time. During this period of erosion the crust of the earth remained stationary, and the result is a peneplain of wide extent. From its development in the vicinity of the capital of the State the writer has named it the Harrisburg peneplain (Bull. Geol. Soc. America, vol. 14, pp. 277–296). Proof that this feature is due to long-continued and undisturbed erosion is found in the absence of any evidence tending to show that the area has been occupied by the sea, and in the reduction of the divide before mentioned, which separates the drainage basins of Allegheny and Monongahela rivers. This divide crosses the southwest corner of the Latrobe quadrangle, and ranges generally from 1200 to 1300 feet in elevation. At no point is it below 1200 feet, but many of the principal saddles on soft rocks are reduced nearly to this altitude. When this divide is compared with the general upland, even near the principal drainage streams, it is found that the altitudes are nearly the same, and consequently the general reduction of the region was not controlled so much by the main drainage lines or by hard and soft rocks as it was by the position of the base-level of that time, which permitted erosion to go to a certain depth regardless of the other factors in the problem. The date of the formation of this lower surface has not been definitely determined. In this folio it is impossible to enter into a complete discussion of the evidence bearing upon this question, but there are certain facts which seem to indicate that the peneplain was formed during the early stages of the Tertiary period.

The same feature has been observed in the Monongahela Valley and is described in the Masontown-Uniontown, Brownsville-Connellsville, and Kittanning folios. It appears to have about the same elevation in this region, and undoubtedly was the result of general rather than local conditions.

Worthington peneplain.—In the folios just mentioned a still lower feature is described which, along the Monongahela Valley, is marked by a great many divides. The existence of these divides at a common altitude seems to indicate that there was a second stage during which the stream valleys were broadened and the divides near the major streams, were cut down to a fairly constant level. In the Allegheny Valley the features indicating this stage are very conspicuous in the vicinity of Worthington, and from that fact it has been named by Butts the Worthington peneplain in the Kittanning, Pa., folio (soon to be published).

In the Latrobe quadrangle these features are not so apparent as in the Allegheny Valley, but a close study of the topographic map shows that the valleys of Conemaugh River and Loyalhanna Creek, where they cut the softer rocks of the synclines, are of unusual width, and that the general altitude of these broadened portions is about 1100 feet above sea level. This horizon appears to be about 100 feet below that of the Harrisburg peneplain, and this relation seems to be maintained generally throughout the Allegheny and Monongahela valleys, so far as they have been studied.

Parker strath.—Following the production of the Worthington peneplain there was an elevation of at least 200 feet. The streams were rejuvenated and again began to dissect the upland plateau, but erosion conditions did not remain constant for any great length of time and the result was simply a broadening of the principal drainage channels of the region. During this stage Conemaugh River cut the broad valley which is so conspicuous a feature of its course from Blairsville to Tunnelton, and Loyalhanna Creek also spread itself over wide areas on the outcrops of the softer rocks from Latrobe to Saltsburg.

These broad valley floors seem to correspond with similar features observed on Monongahela and Youghiogheny rivers south of McKeesport, and also on Allegheny River in the vicinity of Kittanning and Parker. Owing to the extended development of this feature in the latter locality it has been called by Butts, in the forthcoming Kittanning folio, the Parker strath. Since all of the streams in this part of the State are similarly affected, it is probable that these features are the results of a subcycle of erosion which was of such short duration that no general reduction of the surface was accomplished, but along the major streams the valleys were broadened and the slopes were reduced to a comparatively easy grade.

The date of origin of this feature has not been definitely determined, but the occurrence of early glacial gravels on similar high rock shelves along Allegheny River seems to indicate that it is pre-Quaternary in age. Its formation, however, did not far antedate the first ice invasion, and therefore the general conclusion that its age is late Tertiary may be considered as fairly well established.

The Parker strath is more extensively developed on Conemaugh River than on any other stream yet studied in this part of the State. In the Latrobe quadrangle it shows to good advantage in the vicinity of Blairsville, constituting the terrace upon which the major portion of the town is built. It is visible on Blacklick Creek and also along the river as far as Tunnelton. Its altitude throughout this stretch ranges from 1000 to 1040 feet.

The great development of the terrace in this region is probably due to peculiar conditions. Above Blairsville the river, even during the formation of the broad Harrisburg peneplain, was flowing in a comparatively narrow gorge through a mountainous region. The stream was confined to narrow limits, and its carrying power was sufficient to transport all of the detritus supplied by the general erosion of the region. Where the stream emerged from the mountainous region it found a lower grade, and its waters were not confined to a narrow channel by the presence of hard rocks on either side. Under such conditions it naturally dropped its load of coarse material and aggraded its channel. During this period of aggradation the stream was blocked by the rock débris which it carried and this caused it to wander widely over its flood plain. In thus wandering it was thrown repeatedly against the bounding bluffs, and these were cut back to a considerable distance from their original positions. This process, carried on for centuries, resulted in the formation of the present valley, which ranges from 1 to 2 miles in width.

The aggradation of the channel extended only a few miles downstream from the edge of the mountains, and consequently the channel below was little obstructed and not broadened to the same extent as where the stream dropped its load. This erosion, however, marked a stage of general reduction toward base-level, and consequently there were places here and there where the width of the valley was increased, and to some extent these places are indicated by rock terrraces that still remain on the sides of the valley. A good example is to be found at Saltsburg where the highest terrace is of this age. Just back of White the river during this stage of its existence swung to the northeast just above the station and returned to its present course at the sharp bend of the river just below. For some reason, possibly the lateral swing of the stream, this oxbow was abandoned, but it is clearly visible today, at an altitude of about 1025 feet. An extensive terrace at this height occurs back of Avonmore, below Saltsburg, but it is north of the boundary line of the Latrobe quadrangle, and hence does not show on the map.

On Loyalhanna Creek the early terrace is fairly well developed, but in many places it merges with later features and their separation is difficult. Its most noticeable development is opposite New Alexandria, where there is an abandoned oxbow at an altitude of a little over 1000 feet above sea level. Three miles above this point traces of a terrace are also visible on the east side of the creek, at an altitude of about 1050 feet, but the Saltsburg sandstone is massive at this locality and the reduction of the valley floor was not very complete. A noticeable feature along this stream is the convergence between the high terrace and the present flood plain of the creek. At Saltsburg the two features are separated by an interval of about 160 feet, but near Latrobe they are so close together that it is difficult to differentiate them. The town of Latrobe is built on an extensive flat, the higher part of which is a remnant of this terrace, the lower part coinciding with the flood plain of the stream. At the foot of Chestnut Ridge the two features are practically at the same level, and can not be separated.

The horizontality of the uppermost bench seems to indicate that the late uplift of the region has been general, and that it was accompanied by little if any warping of the surface. Since this uplift occurred, small streams like Loyalhanna Creek have not been able to cut their channels back to the foot of Chestnut Ridge, and consequently the present flood plain of the creek merges with the stream deposits of the old, broad terrace.

Peculiar features of this terrace, apparently abnormal and calling for special explanation, are the abandoned oxbows previously described. The abandoned channel above Saltsburg may be explained on the assumption that the spur which projects into the bend was cut through by the lateral swing of the stream, in which case the abandonment is perfectly normal. The channel opposite New Alexandria also may be explained on the same hypothesis, although the probabilities do not seem to be so strong here as at Saltsburg. It is possible that the stream originally flowed across the point of land now occupied by the village of New Alexandria and curved back in a sharp bend to the site of Shieldsburg. From this point it swung westward, cutting the low valley now used by the railroad, and then turned northward into the present channel. It is possible that the stream in the vicinity of New Alexandria continually encroached upon the point of land extending into the bend, and ultimately cut through along its present line. Although this explanation may apply to the principal abandoned channels in this vicinity, it is difficult to account in this way for the small apparent cut-off which the railroad follows above the station at New Alexandria. This slight depression is occupied by rounded material and at one time undoubtedly marked the position of the stream channel. Its abandonment for the present sinuous course is hard to explain by any of the natural processes of stream erosion.

Along Monongahela and Youghiogheny rivers occur numerous abandoned channels which are of such a nature as to preclude the idea of their formation by lateral cutting of the stream. They have been explained by Dr. I. C. White as due in some way to the draining of Lake Monongahela, which is supposed to have occupied this valley in early Glacial time. It is impossible here to present all of the evidence, but that explanation seems inadequate, since such changes imply the filling of the entire valley, so that the drainage became superimposed, but in that case all of the original channels would have been silted up, and to-day they would be found deeply covered by silty material. In many cases, however, the abandoned valleys are practically free from stream deposits except a thin layer of gravel and sand, which evidently was laid down by the rapid streams that occupied them before their abandonment. Therefore it is apparent that the explanation offered by Dr. White is not sufficient to account for them.

From the occurrence of early glacial gravel on what are presumably corresponding terraces of Allegheny River, it seems highly probable that the abandonment of the valleys occurred during the first great ice invasion of the Kansan or some other early stage of the Glacial epoch. The abandonment of these stream channels can not be attributed to the direct action of the ice sheet, for it did not reach this locality, but during the existence of the ice sheet across the northwestern corner of Pennsylvania the climate of this region must have been much more severe than it is now. The summers were doubtless short, and since the stream flowed directly toward the ice front, it seems probable that the breaking up of the stream ice at the advent of summer would occur first near the head of the stream. Under such condititions it seems probable that large jams of drifting ice occurred, similar to, but very much larger than the gorges that now form in the streams of the far north. It is possible that these ice jams may have been of such extent as to be held in place until the advent of winter, when they would be firmly frozen into position, and thus remain as a barrier to the flow of the stream. The water would be ponded behind such a barrier, and spillways would be formed over which the stream would take its course. If the dam were firmly fixed in position the stream might establish itself in its new course, and on the melting away of the ice barrier would leave a certain part of its old channel unoccupied. The amount of cutting necessary to intrench a stream in its new position was probably not very great, since it would have to cut only low enough to run below the top of the silt which would inevitably accumulate in the ponded waters above the dam.

In this way it seems possible to account for many of the abandoned channels in this part of the State that otherwise are inexplicable.

Thus in the case of the abandoned valley near New Alexandria, it is possible to suppose an ice gorge in the bend back of Shieldsburg of such proportions as to force the water over a low divide just west of New Alexandria, and it is possible to suppose that the ice dam was held in position long enough to allow the stream to intrench itself in its new position.

The peculiar topography on Blacklick Creek may be explained in a similar manner. The topographic map shows an isolated knob over 200 feet in height, standing upon a fairly level platform just above Greys Run. This isolated knob is surrounded on all sides by what appears to be remnants of the highest rock shelf, and on that rock shelf are well-rounded gravel and fine silt, evidently brought down by Blacklick Creek. Since such isolated knobs do not occur in the surrounding region, it seems necessary to account for this by supposing that Blacklick Creek formerly flowed on the north side of the knob and down the valley now occupied by Greys Run. The abandonment of this course may be accounted for by the jamming of local ice, as in the case of the bend at New Alexandria.

Conemaugh River and Loyalhanna Creek are characterized by a lower rock terrace than the one just described. This terrace is well developed in the vicinity of Saltsburg, where it has an altitude of 940 to 960 feet. Upon this terrace the upper part of the town of Saltsburg is built, and the academy across the river is commandingly placed upon the same rock shelf. This terrace may be seen on Loyalhanna Creek at the great bend about a mile from the mouth of the stream, but the rounded material with which it is covered extends up the slopes and probably merges into similar material on a small remnant of the higher terrace which is preserved along the road south from Saltsburg. The lower rock terrace is also well shown at the mouth of Whitethorn Creek, where it seems to merge into the present flood plain below, and the materials extend upward to small remnants of the higher rock shelf. Upstream the flood plain and the lower rock terrace approach each other until they merge just above New Alexandria, where it is impossible to distinguish one from the other.

In places these two terraces appear to be sharp and distinct, but they are not always so, and consequently no attempt was made on the geologic map to differentiate the deposits laid down upon them. Thus at Saltsburg they could be mapped as separate deposits of different ages, but in the vicinity of Whitethorn Creek the materials covering the terraces blend and the two can be separated only in an arbitrary manner.

On Conemaugh River the lower terrace is not so well developed above Saltsburg, but in places it may be unmistakably identified, as in the vicinity of Livermore, where, on the north side of the river, it is seen at an altitude of about 940 feet in a large amphitheater, which presumably marked a broad meander of Aultman Run. The road that follows the north side of the river valley above Livermore climbs to the upland on a long, narrow spur which is gravel covered up to an altitude of over 1000 feet above sea level. This upper level presumably represents a small fragment of the higher strath and the amphitheater which lies back of it marks a later subcycle of reduction. The deposits laid down at this later stage also mantle the slope northward from Social Hall down to the level of the present flood plain of the river. Until the lower rock shelf, with its accompanying stream deposit, was recognized it was difficult to account for the long, gentle, drift-covered slope which unites the upper rock terrace with the present flood plain, but if there was an intermediate stage of cutting and deposition, it is seen that these slopes were produced during the purely normal development of the valley.

This mode of transition between the high rock terrace and the present flood plain is characteristic of all the spurs projecting into the bends above the mouth of Blacklick Creek. On the east side of this creek, about a mile by air line from its mouth, there appears to be a well-preserved remnant of the lower terrace. Over this broad flat the waters of the Johnstown flood passed, but since this flood was not due to natural causes, it does not seem necessary to consider this the living flood plain of Blacklick Creek. Its floor is approximately 940 feet above tide, and consequently it falls in line with the lower terrace as defined in the vicinity of Saltsburg.

The convergence of the lower terrace and the flood plain is also noticeable along Conemaugh River, and in the vicinity of Blairsville it is difficult to separate one from the other.

From the lower terrace just described there is generally a sharp descent to the present flood plains of the streams. At Saltsburg, owing to the extreme hardness of the sandstone forming the floor of the terrace, the modern stream channel very much resembles a gorge, but in localities where the rocks are softer the slopes are less abrupt, and the two rock terraces merge by a gentle slope into the present flood plain of the river.

The stream channels are generally narrowest where they cross the anticlines, for the anticlines generally bring to the surface harder rocks than are found in the synclinal basins. This is particularly noticeable on the Jacksonville anticline, which crosses Conemaugh River about a mile above White, and Loyalhanna Creek about a half mile below the mouth of Serviceberry Run. Loyalhanna Creek also passes through a narrow gorge where it crosses the Fayette anticline north of Latrobe, but this anticline dies out before it reaches Conemaugh River and consequently has little or no effect upon the slopes of the channel of that stream.

Age of the river terraces.—Although the terraces on the Conemaugh have not been traced continuously to the Allegheny it seems probable that the terraces of the two streams may be correlated.

The two terraces on Allegheny River are covered by glacial gravel brought down during the advent of the Kansan or some other early ice sheet, and since the gravel covers both terraces, it seems probable that they are both of pre-Pleistocene age. If the terraces of the Conemaugh are the same they were formed during the closing stages of the Tertiary period.

The present gorge of the Conemaugh below the lowest rock terrace doubtless corresponds with a similar gorge on the Allegheny and is therefore of inter-Glacial age. The Wisconsin drift left a distinct built terrace along Allegheny River, but no such feature has been recognized on the Conemaugh.

RELATION OF TOPOGRAPHY TO MAN'S ACTIVITIES.

The Latrobe quadrangle affords an interesting field for the study of the close relation which exists between the character of the topography and the activities of man. Since the occupation of this country by white men dates back more than 100 years, many changes are noticeable in the modes of transportation and communication that have been available in the various parts of the country.

The region west of Chestnut Ridge is generally a rich agricultural district. The surface is gently rolling, affording free drainage and easy communication. This condition led to its early settlement, and since it lay along the principal lines of communication between Pittsburg on the west and Philadelphia on the east, it soon became populous and prominent.

During the first half of the century it was crossed by two great lines of transportation, the Philadelphia and Pittsburg turnpike, which extended from Pittsburg to Greensburg and thence through the gorge of Loyalhanna Creek to the East, and the canal along Conemaugh River, which for a long time was the main highway between the East and the West. During the period of its greatest activity the turnpike was one of the principal lines of communication in the country, and along it passed to market much of the produce of the West. The canal was one of the most daring enterprises of the early part of the century, since it involved not only the construction of a canal along a very rough mountain route, but also the portage of the canal boats across the Allegheny Front, an enterprise which at that time must have been of considerable magnitude. Since the slopes along Conemaugh River in this quadrangle are comparatively gentle, the presence of this canal assisted in building up in early days the towns of Blairsville and Saltsburg, and probably smaller towns which have disappeared since its abandonment. The remains of the canal are at present visible in many places, but its right of way has generally been utilized by the railroad, which is now the only line of communication along the valley.

The turnpikes and canals soon gave way to railway lines, and the building of the main line of the Pennsylvania Railroad through this section has completely changed the routes of travel and has built up new towns along a line which in the early days offered no advantages to settlers. The gap of the Conemaugh through Chestnut Ridge is now the principal route of travel between the East and the West, but instead of following Conemaugh River, the main line of the Pennsylvania Railroad turns to the southwest along the foot of Chestnut Ridge nearly to Latrobe, and then crosses the general upland westward to Greensburg and Pittsburg. This, together, with the development of extensive mines in the Connellsville basin, has led to the establishment of many towns in the south-central part of the quadrangle, and the river towns are of not so much importance as they were in the early days. In recent years extensive mines have been established in the Greensburg coal basin, and this has led to the building of towns in the region southwest of New Alexandria.

Agricultural industries still continue to be of great importance in this region, but they are greatly overshadowed in the estimation of the public by the mines of the great coal basins which cross the territory.

GEOLOGY.

STRUCTURE.

GENERAL STATEMENT.

Broad features.—The geologic structure of the Appalachian coal field is very simple, consisting, in a general way, of a broad, flat, canoe-shaped trough. This is particularly true of the northern extremity, a generalized map of which is shown in fig. 41 on the illustration sheet. The deepest part of the trough is along a line extending southwest from Pittsburg across West Virginia. On the southeastern side of this axis the rocks dip to the northwest, and on the northwestern side they dip toward the southeast. About the canoe-shaped northern end the strata are exposed in rudely semicircular lines of outcrop, and generally dip toward the lowest part of the trough, which is in the southwest corner of the State.

Although the structure of the region in general is of this simple character, the eastern limb of the trough is crumpled into a number of parallel wrinkles or folds that make the details somewhat complicated and break up the regular westward dip of the rocks so that at first sight it is not apparent. Close examination, however, shows that from the Allegheny Front westward each succeeding trough is deeper than the one on the east and that the arches are correspondingly lower until beds that have an altitude of over 2000 feet at the Allegheny Front extend below sea level in the central part of the basin.

In describing these folds the upward-bending arch is called an anticline and the downward-bending trough is called a syncline. The axis of a fold is that line which at every point occupies the highest part of the anticline or the lowest part of the syncline, and from which the strata dip in the anticline and toward which they dip in the syncline.

In this folio the geologic structure is represented graphically in two ways on the accompanying geologic structure map: First, by a structure section which shows the rocks as they would appear if cut by a deep trench across the quadrangle; and, second, by a system of structure contours which represent the attitude of certain strata throughout the area.

Structure section.—The structure section shows the geologic structure along the line A–A. This section is drawn in natural proportions and shows the actual profile of the surface along the line of the section and also the thickness of the geologic formations, with their actual dips both at the surface and where they are under cover. It shows the exact attitude of the rocks along the line of the section, but is deficient for practical purposes in that it is applicable only to this particular line and does not show the geologic structure at other points.

Structure contours.—In order to represent the attitude of the strata at all points in the quadrangle structure contours are employed as follows: The most pronounced and persistent stratum in the region is selected as a key rock. The top or bottom of this bed is called the datum surface, and the form of this surface is ascertained, first, from observations of its outcrop; second, from its depth below the surface as calculated from the higher rocks that are exposed; and third, from its former position, where it has been removed by erosion, as calculated from the beds now at the surface. In the first case the stratum outcrops and the altitude of the datum surface is determined by observation. In the second the datum is underground, and its position is calculated by subtracting from the surface altitude the thickness of the intervening beds that separate the datum surface from the rocks observed in outcrop. In the third case the datum surface is "in the air"—that is, it has been eroded away, and its position is determined by adding to the surface altitude the estimated thickness of the beds that intervene between the stratum showing in outcrop and the datum surface, this estimate being based upon the interval actually found between the beds as seen elsewhere.

From a topographic map can be ascertained the approximate altitude of any outcrop and thus the height above sea level of a corresponding point on the datum surface. In this manner the altitudes of hundreds of points on the datum surface are obtained in each quadrangle. Points having the same altitude are then connected by a contour line, which gives the form of the datum surface at that altitude. Many such lines are drawn at regular vertical intervals, and, as printed on the topographic map, they show, first, the horizontal contours of the troughs and arches; second, the dip of the beds; and, third, the depth of the datum surface below or its height above the surface at any point.

The accuracy of the structure contours varies from place to place, depending upon local conditions. Where the altitudes of the outcrops have been ascertained by spirit level the positions of the contours are well determined. This is especially true where mines have been operated on the reference bed, as in the case of the Pittsburg coal, for the State law of Pennsylvania requires that the altitude of the coal bed be determined at frequent intervals in the large commercial mines. Where this has been done the contours are accurate to within less than one foot.

In most cases, however, the determination of the position of the contours is subject to slight errors, depending upon the inaccuracies of the base map and upon possible errors in the geologic work. These errors are thought to be generally small, and presumably they do not anywhere exceed in amount the contour interval.

CHESTNUT RIDGE ANTICLINE.

In the Latrobe quadrangle the most pronounced structural feature lies southeast of Latrobe. The parallel mountains, of which Chestnut Ridge is the most conspicuous, are made up of anticlines of hard rock that have been exposed to and have withstood long erosion, while the softer rocks that once overlay them, and the adjacent synclines, have been in large part carried away.

In this mountainous region the most prominent and most easily determined stratum is the Pottsville sandstone, and consequently its upper surface is taken as a datum horizon, and its position is represented by contour lines drawn at intervals of 100 feet. This stratum is well exposed in most of the ravines that have been carved on the flanks of the anticline and also in the deep gorge of Loyalhanna Creek. Generally its position is easily determined near the top of the ridge, but low down on the flanks it is obscured by the overlying formations, and its position has to be calculated from the observed outcrops of higher rocks. This is particularly true in Ligonier Valley, and the estimated position of the Pottsville is based upon the assumption that the intervals between it and higher beds are the same as they are west of Chestnut Ridge.

Chestnut Ridge is a prominent anticline, the axis of which corresponds in a general way with the summit of the ridge. The highest point of the fold in this territory is east of Derry, where the top of the Pottsville attains an altitude of 2400 feet above sea level. At the Loyalhanna gorge it is approximately 1900 feet, and this height seems to hold to the southern margin of the quadrangle. From the crest of the anticline the rocks dip rapidly to the northwest, and the Pottsville is not again exposed in this territory. West of Chestnut Ridge the contours show the elevation of the Pottsville sandstone to a line where that formation has a height of 300 feet above sea level, beyond which they are drawn upon the floor of the Pittsburg coal. The anticline is approximately symmetrical and the rocks dip to the southeast into the Ligonier Valley syncline at about the same rate as on the western flank of the fold. The total descent is not so great as on the northwestern side, and at the lowest point of the syncline, which is located near the southeast corner of this quadrangle, the datum surface has an altitude of about 600 feet above sea level.

As previously stated, the anticline is approximately symmetrical where it is cut by Loyalhanna Creek, but northeast of this line the rocks on the Ligonier Valley side are considerably disturbed and the dip is much greater than on the opposite side of the ridge. Just off this territory dips as high as 70° were observed and it is possible that this strong dip is associated with some faulting, but it probably does not extend into this territory, and the exact relations were not determined.

LATROBE SYNCLINE.

West of Chestnut Ridge the structure is not so pronounced; the strata lie in gentle folds across the territory. The most pronounced feature from both a structural and economic standpoint is the long, narrow basin which lies immediately northwest of Chestnut Ridge. In previous geological reports this has been called the Blairsville or Connellsville basin, but during the surveys made in preparing this folio it was found that the basin is divided at Scottdale by a cross anticline into two synclinal basins. The basin lying southwest of Connellsville is called the Uniontown syncline and that to the northeast is called the Latrobe syncline. The floor of the latter basin is slightly irregular, dipping occasionally into slightly lower pools and again rising as though affected by slight cross anticlines, but in a general way it is a narrow trough-like depression extending from Scottdale to beyond Conemaugh River.

In the territory west of Chestnut Ridge the Pittsburg coal is the most prominent member of the stratigraphic series and consequently the structure contours have been drawn upon the floor of this great bed. Data for the determination of these contours are much more abundant and reliable in this area than in the mountainous region farther southeast, and the contour interval, which is 100 feet in the area east of Chestnut Ridge, is here fixed at 50 feet. The contours are based upon the altitude of the outcrop of the coal beds as determined at the surface at many places and upon mine levels at various points within the basin. The mines are fairly well distributed over the territory, so that the contours have generally great accuracy, but in certain places there are large areas in which the coal has not been opened, and in these places the positions of the contours are in large measure hypothetical. One of these areas lies southwest of Latrobe, extending along the basin from the Dorothy mine to the Marguerite mine, and from the western line of outcrop to the Hostetter and Whitney mines on the southeast. In this territory the only data regarding the depth of the coal are those afforded by a deep well drilled for water at the St. Xavier Academy several years ago. No record of this well was kept, but the sister superior gave from memory the depth of the coal as 370 feet. According to the map the altitude of the well head is about 1180 feet, hence the floor of the coal lies about 810 feet above sea level if the report is correct. This is the lowest point yet recorded for the Pittsburg coal in the Latrobe syncline in this territory.

Northeast of Latrobe is an area, bounded on the southwest by the great mines along the line of the Pennsylvania Railroad and on the northeast by the Millwood mine north of New Derry, in which it is also difficult to determine the exact depth of the coal, and the contours have a correspondingly hypothetical value. Another area in which its depth is unknown extends from the Millwood mine to the vicinity of Conemaugh River. This area is not so extensive as either of those just described and the contours are drawn with greater certainty, but they may be misplaced to the extent of about the contour interval. Most of the mines of this region are working down on the outcrop of the coal, but several have sunk shafts in the center of the syncline and have taken advantage of the dip of the bed to deliver the coal by gravity to the foot of the shaft. There are several mines of this character in the vicinity of Latrobe and also along Conemaugh River. The shaft at Millwood, northeast of Derry, near the main line of the Pennsylvania Railroad, is also on the axis of the syncline.

FAYETTE ANTICLINE.

Northwest of the Latrobe syncline there is a large anticlinal fold which has been traced continuously from the southern line of the State to Conemaugh River. In previous reports this fold has been variously called by different geologists the Blairsville, Indiana, and Fayette anticline. As shown on the structure map, the town of Blairsville is not situated on this fold, and consequently this name is not applicable. Recent work by Mr. George B. Richardson (Geologic Atlas U. S., folio 102, Indiana, Pa.; and The misnamed Indiana anticline, Jour. Geol., vol. 10, pp. 700-702) has shown that this fold dies out in the vicinity of Conemaugh River and is not present under the town of Indiana, as was formerly supposed; therefore this name also is inadmissible, and the term Fayette, used by Stevenson (Second Geol. Survey Pennsylvania, Rept. K2), is therefore adopted. The Fayette anticline has its maximum development in the vicinity of Jacobs Creek, west of Connellsville, but toward the northeast it holds nearly the same altitude into the Latrobe quadangle. If the Pittsburg coal were restored over this anticline it would have an altitude of 1800 feet west of Latrobe, where the anticline has greater development than in the surrounding region. It descends to an altitude of about 1480 feet at a cross syncline about 2 miles northeast of Loyalhanna Creek. Northeast of this point it rises into an elongated dome that has an altitude of about 1660 feet and then plunges rapidly and disappears, seeming to turn slightly to the north and to unite in a cross anticline with the Jacksonville axis in the northern part of the quadrangle.

Within this anticlinal area the data for calculating the original position of the Pittsburg coal are not so exact as in the synclines on either side. This is especially true of the territory lying between Conemaugh River and Loyalhanna Creek, where the rocks are prevailingly shaly and no key rock could be found.

Southwest of Loyalhanna Creek the contours are calculated from the outcrop of the Saltsburg sandstone on the assumption that the top of the sandstone is about 400 feet below the floor of the Pittsburg coal. The sandstone may be traced with a fair degree of certainty as far as Loyalhanna Creek, but beyond that point it soon disappears, breaking up into a shaly mass that can not be distinguished from the surrounding rocks. On Loyalhanna Creek the Upper Freeport coal occurs, and this serves as an additional check on the structure contours, the interval between this and the Pittsburg coal being a little more than 600 feet. Near Conemaugh River the Saltsburg sandstone again becomes prominent and its position is verified by the reported records of two old salt wells, drilled many years ago about 2½ miles below Blairsville.

The Fayette anticline, as outlined by the structure contours, shows its maximum development in an elongated dome just west of Latrobe, and this uplift doubtless has determined the location of the gas field which is found in this area. The map shows a similar structure north of Loyalhanna Creek, but the data for its determination are not entirely satisfactory and the extent of the fold in that region may perhaps be somewhat exaggerated by the contours given. So far this field has yielded no large amount of gas and this in itself throws some doubt upon the existence of so pronounced a dome.

GREENSBURG SYNCLINE.

West of the Fayette anticline is a short synclinal basin which has its greatest development at Greensburg, west of the Latrobe quadrangle, and from this fact is known as the Greensburg syncline. The basin extends from Conemaugh River on the northeast to Sewickley Creek on the southwest, its total length being about 26 miles. At its southwestern extremity this fold appears to develop as a minor wrinkle on the northwestern limb of the Fayette anticline, and reaches its maximum just west of this quadrangle and then gradually diminishes to the northeast, extending around the northern point of the Fayette anticline and connecting in a general way with the Blairsville syncline, at the eastern margin of the Latrobe quadrangle. At its deepest point in this quadrangle the Pittsburg coal has an altitude of a little less than 850 feet. At its farthest outlier north of New Alexandria the coal lies at an altitude of nearly 1300 feet, and at its point of junction with the Blairsville syncline its calculated position is about 1400 feet above sea level.

The structure along the southeastern margin of the basin is well known and is accurately represented by the contours, which are based upon mine levels and upon well-determined outcrops of the coal bed. Along the center of the basin and on its northwestern flank little mining has been done and the contours are controlled by surface observations, the Jamison No. 3 mine, and a few bore holes put down to determine the position of the coal.

JACKSONVILLE ANTICLINE.

Beyond the synclinal basin lies an anticlinal arch, the axis of which enters the territory a little northwest of New Alexandria; and extends northeastward, crossing Conemaugh River near the mouth of Elders Run, whence it turns sharply to the east, in harmony with the disappearance of the Fayette anticline and the Greensburg syncline. This fold has its greatest development in Indiana County, north of this region, and for that reason is called the Jacksonville anticline.

The structure contours representing this anticline, were determined largely from the outcrop of the Saltsburg sandstone (which is generally massive and forms a prominent feature in the landscape), from the outcrop of the Upper Freeport coal, and from deep wells that have been drilled for gas at several points on the anticline. The interval between the Upper Freeport and Pittsburg coal beds in this region is about 680 feet, and the contours were determined by adding this amount to the altitude of the Upper Freeport bed. This fold is plainly apparent on Conemaugh River and Loyalhanna Creek. Under its influence the Upper Freeport coal bed rises above river level on the eastern flank of the anticline near Tunnelton, and descends on the western side a little below White. The Saltsburg sandstone also shows the effect of this fold, for it rises from water level at the mouth of Loyalhanna Creek, extends over the axis of the fold, and descends to water level at the mouth of Aultman Run; but on the south side of the river it fades out toward the east and does not completely encircle the arch. On Loyalhanna Creek the Upper Freeport bed shows in outcrop from near the mouth of Serviceberry Run downstream for a distance of about 2½ miles. The Saltsburg sandstone also outlines the arch, and in passing along the west side of the stream one may see almost the exact axial line, for the road rises on the heavy sandstone from the west and then descends for some distance over the same bed on the eastern limb of the fold.

The occurrence of the Upper and Lower Freeport coal beds where this axis is cut by the major drainage lines of the region gives the fold considerable economic importance, but at the present time it does not compare with the synclinal basins on either side.

ELDERS RIDGE SYNCLINE.

West of the Jacksonville axis the beds dip rapidly down Kiskiminetas River into a synclinal basin, the axis of which crosses the stream at Edri, about 2 miles north of the boundary line of this quadrangle. In previous reports this has been called the Irwin (Lisbon) basin. From the apparent offset in the outcrop of the Pittsburg coal, shown by Professor Stevenson in his map of Westmoreland County, it seems probable that the axis is not continuous from Kiskiminetas River to the line of the Pennsylvania Railroad, and consequently the northern basin is here named the Elders Ridge basin from a town on the axis a few miles north of this quadrangle. After crossing the river at Edri the axis swings toward the south and passes through the the northwest corner of the Latrobe quadrangle on a line bearing about N. 25° E. This basin is not so deeply depressed as the Greensburg basin, and the Pittsburg coal is present only in the hilltops west of Saltsburg, on the ridge which marks the dividing line between Bell and Loyalhanna townships. Owing to the presence of this coal the data for drawing the structure contours are here much more definite than they are over the Jacksonville anticline on the east.

STRATIGRAPHY.

GENERAL STATEMENT.

The rocks exposed at the surface in this quadrangle range in thickness from 2200 to 2300 feet. They are probably all of Carboniferous age, and include representatives of each of the three series of that system. The underlying Devonian shales and sandstones have been so well prospected by drillers in search of gas and oil that it seems desirable to include them in a description of the rocks of the region. On the columnar section sheet a generalized section of all the rocks present at the surface is given.

Although sections obtained in drilling deep wells are not always satisfactory, many such sections in this region show remarkable agreement in the succession and character of the underlying rocks and seem to afford reliable evidence for subdivision of the strata on purely lithologic grounds.

On the well-section sheet 14 records of wells drilled in or near the Latrobe quadrangle are shown. Most of the wells were drilled by the Conemaugh Gas Company and the records are given on the authority of Mr. J. Watson Stuart.

Section No. 1 is from the Pickles No. 1 well of the Conemaugh Gas Company, located near the axis of the Chestnut Ridge anticline, east of Blairsville. Section No. 2 is from notes of a well drilled by the Columbia Plate Glass Company in the bend of the river south of Blairsville. Section No. 3 represents the McClelland well (J. F. Carll, Second Geol. Survey Pennsylvania, Rept. I5, p. 223), drilled a number of years ago near Latrobe. Its exact position is not given, but presumably it is located on Dry Ridge, on the Fayette anticline. Section No. 4 is from the Lawrence well, drilled by the Conemaugh Gas Company, near the head of Greys Run, in the northeast corner of the quadrangle. Section No. 5 represents the Uncafer well, owned by the same company and located near Jacksonville, north of this quadrangle. Section No. 6 is from the Jellison well, drilled by the Conemaugh Gas Company near the mouth of Spruce Run, 2 miles southwest of Livermore. Sections Nos. 7 and 8 are from the Miller and Nesbitt wells, owned by the same company and located north of Tunnelton and near the northern edge of the quadrangle. Section No. 9 represents the William Waddle well, recently drilled near the old salt works at the mouth of Elders Run. Record is given on the authority of Mr. John M. Leech, Indiana, Pa. Sections Nos. 10, 11, and 12 are from wells drilled by the Conemaugh Gas Company. No. 10 is the Shoup well, located on the main road about 2 miles southeast of Saltsburg. No. 11 is on the property of the Waddle heirs, in the same locality. No. 12 is the Bartley well, located on Serviceberry Run just above the schoolhouse, about 2½ miles from the mouth of the run. Section No. 13 is the well of the American Sheet Steel Company, on Kiskiminetas River opposite Avonmore, a few miles beyond the northern boundary of this quadrangle, it is made up from a record furnished by the owners. Section No. 14 is from the Walker well, drilled in Bell Township, Westmoreland County, west of this quadrangle, by the Conemaugh Gas Company. The exact position of this well is not known, but the record is so complete and detailed that it is introduced for the purpose of comparison. The records given on the well-section sheet, form a complete section extending from the summit of Chestnut Ridge along Conemaugh River to and beyond the western limit of the quadrangle.

In these well records it is possible, in almost every case, to identify the Mauch Chunk formation. It has accordingly been taken as a key rock in the interpretation of the sections. Where it is composed of red shale or sandstone there can be no question of its identity, but where the shale bed is not marked by this color, the identification is less certain. Even in such cases, however, a bed of shale generally is noticeable below heavy sandstones that are regarded as belonging to the Pottsville formation. The measures below the Mauch Chunk are extremely variable in detail, but the Sub-Blairsville and Patton red shales are two striking beds which serve as key rocks and render correlation and identification possible throughout this entire area.

DEVONIAN ROCKS.

So far as known Devonian rocks do not appear at the surface in the Latrobe quadrangle. The oldest strata exposed are in the Loyalhanna gorge through Chestnut Ridge, but these generally have been regarded as belonging to the Carboniferous system. There is, however, a strong resemblance between the rocks of the two systems, and it is difficult to draw a definite line of separation between them. Such a line can be drawn only on evidence of fossils, and no collections have yet been made that are adequate to settle the question. In this folio the dividing line between the Devonian and Carboniferous is placed somewhere between the two red shales which have been already referred to as occurring below the Mauch Chunk and which are discriminated in the well records.

CHEMUNG FORMATION.

Character and thickness.—The lowest beds shown in these well records are not well known. Only a small number of wells have penetrated them to any considerable depth. The material may be described as a somewhat calcareous shale formation, in which there are a number of thin sandstone lenses. To the driller these sandstone lenses are of the greatest importance, and consequently they are usually recorded in his notes. Well No. 11 penetrates this series to a depth of about 120 feet; well No. 12, 150 feet; well No. 6, 290 feet; well No. 10, 560 feet; well No. 9, 620 feet; well No. 1, 800 feet. The last mentioned well reveals the oldest rocks known in the region.

Sub-Blairsville shale member.—The most striking feature brought out by comparison of the sections given on the well-section sheet is the presence of a great mass of red shale lying above the beds just described and from 930 to 1070 feet below the top of the Pocono sandstone. This red shale is recorded in every section except the Miller (No. 7), which presumably failed to reach its uppermost limit. Its best development is in the Pickles No. 1 well, where it shows a thickness of 450 feet. In the other sections it ranges as follows: 380 feet in No. 10, 375 in No. 9, 350 in No. 6, 340 in Nos. 3, 5, and 11, and 320 in No. 12. It is also present in sections Nos. 2, 4, 8, and 14, but the drill did not penetrate to the bottom of the bed, and the full measure is not known.

This bed is not known at the surface west of the Allegheny Front, and since it presumably underlies the entire region, it has been designated the Sub-Blairsville shale member of the Chemung formation.

Intermediate beds—The material lying above the Sub-Blairsville and between it and the next higher red shale, which is now known to be of Pocono age, is somewhat variable in composition. In some sections it is largely sandstone; in other sections it is prevailingly shale. In a general way it seems to consist of shale in which there are many lenticular masses of sand, the latter in places thickening and constituting almost the entire section. These are the beds in which many of the gas sands of this part of the State occur, and it seems highly probable that the individual beds of sand are not continuous and can not be identified from place to place. How much of this section belongs to the Devonian and how much to the Carboniferous can not be definitely stated at present.

The regularity of the interval between the top of the Pocono sandstone and the top of the Sub-Blairsville red shale is shown in the table:

Interval between top of Pocono sandstone and top of Sub-Blairsville red shale, as shown by well records in Latrobe quadrangle.

Section No.	Feet.
1	930
2	970
3	970
4	990
5	1,050
6	1,070
7	980
8	1,050
9	970
10	1,050
11	1,040
12	1,040
13	1,010
14	1,070

CARBONIFEROUS ROCKS.

POCONO SANDSTONE.

Name.—This formation was named from the Pocono Plateau and is a prominent feature in the topography of the northeastern part of the State, where the sandstone is particularly well developed.

Character and thickness.—In the type locality the formation is composed almost entirely of coarse sandstones and conglomerates, but toward the south and west it becomes more complex, consisting of interbedded shale, sandstone, and conglomerate. Within the quadrangle it includes beds of similar character. In the drill records already given an important shale horizon belonging to this formation has been designated as the Patton shale member.

The thickness of the formation as given in geological reports differs greatly in the various synclines in which it is preserved in the eastern part of the State and along the Allegheny Front, but it is probable that the variations in estimate are due to the indefiniteness of the division plane between the Devonian and Carboniferous rocks rather than to actual variations in the thickness of the Pocono formation. The more conservative estimates of its thickness in the eastern part of the State are from 1100 to 1300 feet (Summary Final Rept. Second Geol. Survey Pennsylvania, vol. 3, part 1, pp. 1635-1678).

West of the Allegheny Front the same uncertainty exists regarding the base of the Pocono, but it seems probable that the thickness of the formation decreases rapidly to the west and that at Chestnut Ridge it is not more than one-half as thick as on the Allegheny Front.

According to Professor Stevenson (Second Geol. Survey Pennsylvania, Rept. K2, p. 106) the following section is exposed where Conemaugh River cuts Chestnut Ridge, east of Blairsville:

Section on Conemaugh River in gorge through Chestnut Ridge east of Blairsville.

	Feet.
1. Flaggy sandstone	250
2. Shale	3
3. Argillaceous sandstone	40
4. Shale	10
5. Sandstone, conglomerate toward the base	140
6. Shale and sandstone	125
7. Sandstone with conglomerate layers	20
8. Sandy shale (red)	100
9. Concealed to the river	150
Total	838

In his original report Professor Stevenson does not say definitely which beds are Pocono and which belong to the Catskill formation, but he regarded No. 7 as the probable base of the Carboniferous system. In a recent publication (Lower Carboniferous of the Appalachian Basin, Bull. Geol. Soc. America, vol. 14, pp. 15–96) he reclassifies the rocks of this section and places Nos. 1, 2, 3, 4, and 5, or the essentially sandy part, having a thickness of 443 feet, in the Pocono formation and relegates the other to the uppermost formation of the Devonian system.

From the close agreement in character and thickness between the Pocono sandstone of Conemaugh Gap, as now recognized by Professor Stevenson, and the sandstone showing in the well records between the Mauch Chunk and Patton red shales it seems probable that they are equivalent, although the latter band of red was not noted in the exposed section.

The lowermost beds of the Pocono can not with certainty be discriminated from the Devonian. In the well records, however, there is generally recognized a thin and somewhat irregular band of red shale or sandstone that occurs a few hundred feet below the top of the Pocono or "Big Injun" sand. This band of red rocks is well shown in sections Nos. 2, 4, 5, 6, 9, 11, 13, and 14. In the other records it does not appear, but whether it is wanting or its apparent absence is due to imperfection of the records is not known. The bed is generally thin, and it seems possible that in many places it may be wanting. It is the first bed of red material occurring below the top of the Pocono sandstone, and presumably it corresponds with a bed of red shale showing in outcrop on Redbank Creek at Patton, near the west line of Jefferson County, and is here referred to as the Patton shale lentil.

This outcrop of red shale was discovered by Mr. W. G. Platt in 1879 and by him was referred to the Pocono formation (Second Geol. Survey Pennsylvania, Rept. H5, p. 188), but in a later report (Rept. H6, p. 84) he seems to regard it either as Mauch Chunk or Pottsville. Mr. H. M. Chance (Rept. V2, p. 58), called it Mauch Chunk, and from well records in this vicinity gave its position as from 325 to 400 feet below the Vanport ("Ferriferous") limestone. Recently Mr. David White has shown that the Patton shale is associated with some green sandy shale from which he obtained a good Pocono fern flora. From the evidence it is clear that this red shale is of Pocono age and belongs below the heavy beds of Mountain sand of the oil drillers, and consequently corresponds in position with the red shale shown in the well-section sheet. The interval between the Vanport limestone and the Patton red shale as shown on Redbank Creek is not so great as the interval shown in the well sections, but this may be explained by the erosional unconformity at the base of the Pottsville and the cutting away in the northern part of the State of all of the siliceous limestone and the upper part of the Pocono sandstone.

Since the Patton shale carries a Pocono flora it is evident that this bed is a part of the true Pocono and it is therefore treated as a red shale lentil in that formation.

This lentil is under cover in the Latrobe quadrangle, but from well records in adjacent localities it seems probable that it may be identified over a considerable territory to the north and northwest, and consequently its definition will materially assist in the correlation of the oil and gas sands of the Allegheny Valley. So far as noted in this region its thickness nowhere exceeds 80 feet, and, as previously described, it is absent or not noted in many of the well sections. Its distance below the top of the Pocono sandstone is fairly constant, ranging from 350 to 500 feet, and its horizon where the red shale is absent may be determined arbitrarily by measuring downward the same number of feet from the top of the sand.

In the Loyalhanna gorge southeast of Latrobe Pocono strata are fully exposed, but they seem to consist largely of sandstone, sandy shale, and irregularly bedded conglomerate. The total thickness exposed in the center of the arch is 550 to 600 feet, and the lowest bed, showing at the mouth of a small branch that enters from the east about 2 miles above the waterworks at Kingston, is a conglomerate that probably corresponds with No. 7 of the Conemaugh Gap section. If this identification is correct it is probable that the Patton shale occurs in this gap, but since it was not observed, the rocks will be classed as belonging to the Pocono formation without any attempt at closer discrimination.

Economically the most important member of the Pocono is the siliceous limestone which occurs at the top of the formation and which heretofore (Second Geol. Survey Pennsylvania, Rept. K2, p. 97 and Rept. K4, p. 57) has been grouped with the Mauch Chunk shale.

Owing to the apparent gradation from the limestone to the underlying sandstone, their separation in the field was found to be impracticable. The siliceous limestone is in fact a sandstone whose grains are cemented by carbonate of lime, and consequently on a weathered surface the rock appears to be distinctly sandy and is scarcely distinguishable from the ordinary sandstones of this group. The topmost layer of the limestone generally contains more lime than the lower part of the formation, which grades by almost insensible degrees into the underlying sandstone that makes up the bulk of the Pocono formation.

The siliceous limestone is extensively quarried in the gorge of Loyalhanna Creek above Latrobe. It is dressed into blocks for paving and is also crushed for railroad ballast. Usually this bed is immediately overlain by red shale of the Mauch Chunk formation, but in the quarry face along Loyalhanna Creek about 25 feet of sandstone overlies the siliceous limestone. In places these two beds are separated by 4 or 5 feet of red shale, but the interval is variable, and in places the limestone and sandstone are in direct contact. Although the sandstone is similar to the bulk of the Pocono formation, it presumably should be classed with the Mauch Chunk, and the line of subdivision between the two formations should be drawn at the top of the siliceous limestone.

This bed generally is not recognized in drilling deep wells, but in the Waddle well (No. 9), which recently was drilled on Elders Run north of Conemaugh River, the siliceous limestone was recognized by the driller in its proper position. Its thickness in this well is given as 50 feet, and it was noted by the driller as "sand and lime." Since it is present at this distance from Chestnut Ridge, presumably it underlies the entire Latrobe quadrangle, but has been classed by the drillers generally with the "Big Injun" sand.

The northwestward thinning of the Pocono sandstone previously mentioned, is not apparent in the records on the well-section sheet. That part which lies above the Patton red shale is remarkably regular in thickness, as is shown by the following measurements:

Thickness of Pocono sandstone above Patton shale.

Section No.	Feet.
2	370
4	410
5	400
6	440
9	380
11	460
13	420
14	410

Distribution.—The Pocono sandstone is poorly exposed in the Latrobe quadrangle, showing only in the Loyalhanna gorge, in the southeastern part of the territory.

MAUCH CHUNK FORMATION.

Character and thickness.—The Mauch Chunk formation, which in the eastern part of the State has a thickness of many thousands of feet, is poorly represented in the Latrobe region. About one-half mile above the waterworks at Kingston, a complete section may be obtained from the base of the Pottsville to the top of the siliceous limestone, already discussed, as follows:

Section of Mauch Chunk formation in Loyalhanna gorge.

	Feet.
Red shale	100
Impure, blue, fossiliferous limestone (Greenbrier)	4
Red shale	20
Red earthy limestone	3
Red shale	10
Total	137

The section is interesting as showing the extreme feather edge of the Greenbrier limestone lentil, which is so prominent a feature of the Mississippian series farther to the south and west.

The color of the rocks is an important guide to the driller for oil or gas, and consequently red shales or limestones generally are noted in records that are at all complete. For this reason the Mauch Chunk shale is easily recognized where it has its customary red tint, but it is not uniformly of this color, and in many localities it is identified entirely by its relation to the associated rocks and by its generally shaly or calcareous character. In section No. 1 it seems to be as follows:

Section of Mauch Chunk formation as shown by the record of Pickles No. 1 well east of Blairsville.

	Feet.
Black shale	15
Red sand	65
White sand	5
Red sand	24
Total	109

In this section the Mauch Chunk is probably correctly identified by its red color. The same is true of section No. 2, from a well in the bend of Conemaugh River south of Blairsville, where it seems to be present as a red sandstone 54 feet in thickness. In section No. 3 it presents more of the details that may be observed on the outcrop in this vicinity, as follows:

Section of Mauch Chunk formation in well on McClelland farm, near Latrobe.

	Feet.
Black shale	30
Gray limestone	25
Red sandstone	35
Total	90

The identification of this formation in section No. 4 is somewhat doubtful, since there is no indication of red material at its horizon. Its sole representative seems to be a dark shale, 21 feet in thickness, which separates the heavy sandstone of the adjacent formations. In section No. 5 it is also represented by dark shale, about 35 feet thick. In section No. 6 it again shows its red color, the material which resembles the Mauch Chunk being shown below:

Section of Mauch Chunk formation in Jellison well near mouth of Spruce Run.

	Feet.
Red rock	15
Black shale	24
Total	39

No record was made of the material at this horizon in section No. 7, so its character is unknown, but in section No. 8, which is from a well in the same neighborhood as No. 7, the Mauch Chunk is reported as shale with a thickness of 40 feet. In section No. 9 there is a slight indication of red material, as shown by the following section:

Section of Mauch Chunk formation in well of William Waddle, near mouth of Elders Run.

	Feet.
Red rock	5
Sandstone	45
Total	50

This identification seems to be correct since the rocks above are undoubtedly Pottsville and the sandstone just noted is underlain by the siliceous limestone composing the top of the Pocono formation. In section No. 10 limestone was noted, which seems to strengthen the identification. The section shown by the well record is given below:

Section of Mauch Chunk formation in Shoup well, 2 miles southeast of Saltsburg.

	Feet.
Shale	15
Impure limestone	20
Total	35

In section No. 11 the only representative of the Mauch Chunk appears to be a red sandstone 15 feet in thickness, but since this agrees in position with the adjacent sections, it seems entirely probable that it is the representative of this formation. In section No. 12 the Mauch Chunk is hard to identify, for either one or both of the two shale beds near this horizon may be included in the formation. Judging from the adjacent sections it seems probable, however, that the shale bed at a depth of 600 feet is the one which customarily occurs between the two benches of Pottsville sandstone, and that the black shale 8 feet in thickness, which occurs at a depth of 650 feet, represents the Mauch Chunk formation. In section No. 13 it has a better representation, consisting of the beds named below:

Mauch Chunk formation in well of American Sheet Steel Company, on Kiskiminetas River, opposite Avonmore.

	Feet.
Shale	5
Lime	30
Sandstone	40
Shale	8
Total	83

The sandstone and underlying thin shale bed may belong to the Pocono instead of the Mauch Chunk formation, but judging from the intervals between beds above the Patton red shale it seems probable that all the beds given belong to the Mauch Chunk formation.

In section No. 14 the Mauch Chunk is well represented. In fact, this is one of the most detailed well records that has been made in the region, and presumably it is thoroughly reliable. The section as shown by this well is as follows:

Section of Mauch Chunk formation in Walker well, Bell Township, Westmoreland County.

	Feet.
Black shale	8
White shale	30
Red rock	28
Limestone	20
Red rock	8
Total	94

From the sections of the Mauch Chunk observed at the surface and disclosed by the drilling of deep wells it is apparent that the formation is variable in thickness and composition. The variation probably is due to a period of elevation and erosion which marked the beginning of Pottsville time and which constitutes one of the most interesting episodes in the Paleozoic history of this region. It will be more fully discussed under the heading "Geologic history."

Distribution.—The Mauch Chunk is a thin formation and shows in outcrop only in a narrow band in the Loyalhanna gorge between Kingston and Long Bridge.

POTTSVILLE SANDSTONE.

Character and thickness.—Owing to its resistance to erosion the Pottsville sandstone is one of the most important beds of the Carboniferous system in western Pennsylvania. Its outcrops are almost always conspicuous, and the so-called mountains of this part of the State are usually due to the upturning of this hard bed.

The thickness of the formation ranges from 1200 feet (Summary Final Rept. Second Geol. Survey Pennsylvania, vol. 3, p. 1854) in the Southern Anthracite basin to 65 feet (Second Geol. Survey Pennsylvania, Rept. H4, p. 61) in the Conemaugh gap through Chestnut Ridge, east of Blairsville. From this minimum it increases westward to nearly 400 feet (Rept. Q2, p. 52) on the Ohio State line.

In the Latrobe quadrangle the Pottsville sandstone is exposed in the Loyalhanna gorge through Chestnut Ridge and also along the ridge. It appears to consist of two beds of coarse sandstone, the upper bed being generally more massive and conspicuous in the topography than the lower bed. These two beds are usually separated by 10 or 15 feet of sandy shale, but the shale is rarely seen, as it is usually covered by débris from the more massive bed above. These massive beds give the topography a rugged appearance, and frequently afford picturesque scenery where they are cut by the small streams on the flanks of the ridge.

They also have an economic value, since they are quarried in places and crushed for sand to be used in the manufacture of glass.

West of Chestnut Ridge the Pottsville has been penetrated by the drill at a number of places, and its composition is roughly shown in the records on the well-section sheet. In section No. 1 the Pottsville seems to be represented by a single bed of sandstone 75 feet in thickness. This identification is open to question but seems to be correct, because the sandstone is overlain by the softer rocks of the Allegheny formation and rests upon the well-marked red shale and sandstone of the Mauch Chunk, and also because the aggregate thickness of the sandstone agrees with that showing in outcrop along Conemaugh River. In section No. 2 the Pottsville is not so easily identified. The presence of some sandstones in the lower Allegheny formation makes the identification of the Pottsville difficult. Its base, however, is marked by a bed of red sandstone which undoubtedly represents the Mauch Chunk formation. In section No. 3 the Pottsville consists of an upper member of white sandstone 75 feet in thickness, and a lower member of gray sandstone 20 feet in thickness. This is underlain by 30 feet of black shale which may belong to the Pottsville, but is here considered as part of the Mauch Chunk. The upper limit of the Pottsville in this section is somewhat uncertain, since it may include 50 feet more of beds which were noted by the driller as slate and shales. In section No. 4 the Pottsville is sharply differentiated from the rocks above and below, but in this case the underlying rocks contain no red shale, and are simply correlated with the Mauch Chunk on account of their shaly character and their position in the series. According to the drill record the Pottsville is made up of 63 feet of white sandstone and 28 feet of dark sandstone. In section No. 5 the Pottsville appears to have a thickness of about 150 feet, but from the apparent decrease in the thickness of the overlying Allegheny measures it seems probable that some sandstone beds of the lower part of the latter have been confused with the true Pottsville. In section No. 6 the Pottsville is again present in its typical development, consisting of two sandstone members separated by a shaly interval, the whole resting upon the shale of the Mauch Chunk formation. The section as noted by the driller is as follows:

Section of Pottsville formation in Jellison well, near mouth of Spruce Run.

	Feet.
White sandstone	32
Black slate	35
White sandstone	61
Total	128

In section No. 7 the top of the Pottsville is clearly identified at a depth of 525 feet from the surface, but it seems probable that there is a lower member which was not noted, since there is a break in the section from 600 to 700 feet below the surface. In section No. 8 the Pottsville seems to have been merged with some of the lowest beds of the Allegheny formation, since it is thicker than in the surrounding wells. In section No. 9 the Pottsville has the following section:

Section of Pottsville formation in William Waddle well, at mouth of Elders Run.

	Feet.
Sandstone	55
Sandstone and gray slate	5
White sandstone	40
Slate	15
Hard sandstone	10
White sandstone	25
Total	150

This shows a total of 150 feet, which is nearly the maximum measure in this quadrangle. Its upper limit seems to be clearly defined by the softer rocks of the Allegheny, and it rests upon distinct red beds of the Mauch Chunk formation. In section No. 10 the Pottsville is not subdivided, but the well record is evidently not so detailed as that of section No. 9, and it is probable that beds of shale exist which were not noted by the driller. Its total thickness in this well as reported is 165 feet. In section No. 11 the Pottsville is again represented by a single sandstone 150 feet in thickness. Its upper and lower limits are apparently well defined by the characteristic soft rocks above and the red rocks below. In section No. 12 the Pottsville is subdivided into two benches with the following sections:

Section of Pottsville formation in Bartley well, on Serviceberry Run.

	Feet.
White sandstone	92
Black and white slate	26
Black sandstone	12
Light sandstone	20
Black sandstone	16
Total	166

According to this interpretation the Mauch Chunk is represented only by a bed of light slate 8 feet in thickness. It is possible that the Mauch Chunk should include the lowest sandstone, which has just been designated as the lower part of the Pottsville formation. It seems probable, however, from the total thickness of the assumed Pottsville, that all of the rocks except the 8 feet of shale should be considered as belonging to the Pottsville formation. In section No. 13 the Pottsville is again noted as a single sandstone bed having a thickness of 145 feet. Its limits are fairly well determined in this section, for it is underlain by calcareous rocks of the Mauch Chunk and the interval from the top of the sandstone up to the Freeport coal is about normal for this region. Section No. 14 shows the Pottsville present in its typical development of two hard sandstone members and a soft shale and coal interval between. The detailed section according to this well record is as follows:

Section of Pottsville formation in Walker well, Bell Township, Westmoreland County.

	Feet.
White sandstone	40
Black slate	8
Hard shells	5
Black slate	6
Coal	5
White sand	6
Black slate	12
Brown sand	12
Black slate	6
White sand	36
Total	136

This is underlain by 38 feet of shale which is noted as either black or white. This bed of shale may belong to the Pottsville formation or it may be a part of the Mauch Chunk, which is clearly represented by the red rock that underlies it. This record is exceedingly interesting since it shows the presence of the Mercer coal group in good development, the coal itself being noted as 5 feet in thickness.

From the sections just described it is apparent that the Pottsville varies little in thickness in this territory. It is true that the sections on the western side of the quadrangle show somewhat greater thickness than those on the east, but the increase is not particularly marked. It ranges, as shown, from 65 to 165 feet, but on the western edge of the quadrangle it is presumably made up of the same number of beds that show in outcrop in the Chestnut Ridge region, the uppermost of these beds being equivalent to the Homewood sandstone and the lower bed to the Conoquenessing sandstone of the Beaver Valley.

Distribution.—In the Latrobe quadrangle the Pottsville sandstone shows in outcrop only on Chestnut Ridge, the mountainous character of the ridge being due largely to the great arch formed by this bed. Where the ridge is cut by Loyalhanna Creek the rocks are well exposed, and the cut edges of the Pottsville sandstone may be followed from water level on one side to the summit of the mountain, and then again to the lowest point on the opposite side of the ridge. Besides its outcrop on the sides of Loyalhanna gorge the Pottsville sandstone has been exposed at many places along the summit of Chestnut Ridge by the small streams. The most important of these outcrops are the one on the summit of the ridge east of Derry and the one which shows continuously from Loyalhanna Creek to the south line of the quadrangle.

On the west flank of Chestnut Ridge the Pottsville sandstones dip rapidly to the northwest and pass under the Latrobe syncline at a depth of about 1000 feet below the surface, or at about sea level. The succeeding anticlines are not of sufficient magnitude to bring this rock to the surface, and it continues under cover to the northwestern side of the Appalachian coal basin.

ALLEGHENY FORMATION.

Character and thickness.—In a general way this formation consists of soft material, being composed mainly of shale, fire clay, coal, and limestone, with beds of sandstone occurring indiscriminately throughout the mass. It directly overlies the upper massive bed of the Pottsville sandstone and as a rule its base is easily determined. Owing to its soft character its natural exposures are generally poor, and it is difficult to obtain a detailed section of the measures.

This formation contains most of the workable coal beds that lie well down in the Pennsylvanian series, and for that reason was long known as the Lower Productive Measures, in contradistinction from the Upper Productive Measures the principal member of which is the Pittsburg coal. In the Allegheny Valley, which is regarded as the type locality for the formation, it carries seven coal beds, as illustrated in fig. 3, which, although frequently thin and unimportant, are at some points, of workable thickness.

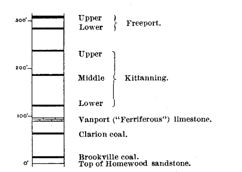

FIG. 3.—Section showing coal beds of the Allegheny formation in the Allegheny Valley.

The Upper Freeport coal bed constitutes the uppermost member of the Allegheny formation. It is one of the largest coal beds of the formation and has been generally recognized throughout western Pennsylvania wherever its horizon comes to the surface. In the Latrobe quadrangle this bed has been opened in many places for supplying the local needs of the people. One of these banks on the flank of Chestnut Ridge, in a ravine entering Miller Run one-half mile north of Loyalhanna Creek, is still in operation and supplies considerable fuel to the people of the surrounding region. This coal bed also is present on Loyalhanna Creek where it crosses the Fayette anticline. It is reported to run from 2 to 4 feet in thickness, but the mines have been abandoned and it is difficult to obtain an accurate idea of the character of the coal. The bed is well exposed where Loyalhanna Creek and Conemaugh River cut the Jacksonville anticline. It is of workable thickness in this area, and mines are being rapidly developed along the line of the western division of the Pennsylvania Railroad on Conemaugh River.

The Lower Freeport coal is also present in this locality, occurring about 60 feet below the upper bed. This coal is probably present in Chestnut Ridge, but it was not postively identified during the present survey.

Of the Kittanning group of coal beds the lower is decidedly the most important. It is extremely persistent and furnishes a high-grade fuel, and and though it rarely exceeds 4 feet in thickness, its regularity gives it a high value. The Upper Kittanning coal in places is thicker, but it is so extremely variable in thickness that it has acquired the name "pot seam," and its value generally is much below that of the Lower Kittanning bed. The Middle Kittanning coal bed is the least important of the group and is rarely of workable thickness.

The Kittanning group of coal beds is present in the Latrobe quadrangle, but it is doubtful whether the coals exposed there can be correlated definitely with the beds of the type locality.

One of the most important key rocks of this formation in the Allegheny Valley is the Vanport limestone, which normally occurs about 40 feet below the Lower Kittanning coal. From its association with a widely extended deposit of iron ore this bed has long been known as the "Ferriferous" limestone, but according to the practice of giving geographic names to all important stratigraphic units it is here called the Vanport limestone, from a small town on Ohio River in Beaver County, Pa. East of Allegheny River this bed is irregular in its occurrence and is not known in outcrop in the Latrobe quadrangle. It is largely because of the absence of this important key rock that the Kittanning coal beds can not be correlated with those of the type locality. Although the Vanport limestone is not known in outcrop it has been noted in some of the well records and consequently is present under some parts of the quadrangle.

Below the Vanport limestone are normally two coal beds which in places attain workable proportions. The uppermost is the Clarion coal, which has been worked to some extent along Allegheny River. Below this and within a few feet of the top of the Pottsville sandstone is the Brookville coal, which attains some prominence in the region north of Latrobe and east of Allegheny River. Farther south it has been impossible to trace and correlate the Brookville and Clarion coal beds. In Fayette County only one coal bed appears in the interval which is normally assigned to these two, and considerable difference of opinion has developed as to whether it represents the Clarion or the Brookville coal. In the Masontown-Uniontown folio the coal at this horizon is called the Brookville-Clarion, and it may represent either the Brookville or Clarion beds. Since the Latrobe quadrangle lies between the region in which these beds are typically developed and the doubtful area in Fayette County it is uncertain which condition prevails. They have not been differentiated, and it seems quite possible that the conditions that prevail in Fayette County also exist in this locality.

No complete section of the Allegheny formation was obtained on its surface outcrop. The best measures are probably those which are shown in the well-section sheet. In several records the rocks belonging to the Allegheny formation have apparently been confused with the overlying or underlying formations, and consequently the exact limits are not well shown. In the discussion these sections will be omitted.

One of the best sections is that obtained from the Lawrence well (No. 4), which shows the following detailed structure:

Section of Allegheny formation in Lawrence well near head of Greys Run.

	Feet.
1. Coal (Upper Freeport)	6
2. Limestone (Upper Freeport)	15
3. White slate	47
4. Dark slate	30
5. Dark sand	60
6. Dark slate	18
7. Limestone (Vanport)	28
8. White sand	58
9. White slate	14
10. Dark slate	29
Total	305

In this section it is easy to recognize the Upper Freeport coal bed, the underlying Freeport limestone, and the Vanport ("Ferriferous") limestone, and the total thickness agrees with what is generally assumed for this region.

In the Jellison well (No. 6) the key rocks are not so well shown, but it seems probable that the Upper Freeport coal occurs at a depth of 320 feet, and that the total thickness of the Allegheny formation is 265 feet. The section in detail is as follows:

Section of Allegheny formation in Jellison well near mouth of Spruce Run.

	Feet.
1. Coal (Upper Freeport)	7
2. White slate and fire clay	25
3. Dark slate	70
4. Limestone	20
5. Slate and shale, hard	30
6. Sand, black and hard	20
7. Slate, dark	26
8. Sand, white	32
9. Slate, black	35
Total	265

The Miller well (No. 7) shows this formation in considerable detail with the following section:

Section of Allegheny formation in Miller well north of Tunnelton.

	Feet.
1. Coal (Upper Freeport)	5
2. Limestone (Upper Freeport)	5
3. White slate	20
4. Gray sand	20
5. Black slate	65
6. Coal	5
7. Limestone	12
8. Black slate	10
9. Pink slate and shells	48
10. Limestone (Vanport)	20
11. Black slate	30
12. Fire clay	30
Total	270

The coal bed, 5 feet in thickness, noted as No. 6 in the above section belongs doubtless to the Kittanning group. It occurs 70 feet above the Vanport limestone and presumably represents one of the upper beds of the group.

In section No. 8 the formation is poorly shown. The only thing that can be recognized is the Upper Freeport coal bed, at a depth of 275 feet below the surface with a reported thickness of 5 feet.

The Waddle section (No. 9) is one of the best well sections in this quadrangle. The well begins at the horizon of the Lower Freeport coal, and the only doubt regarding the identity of the measures is as to the basal portion of the formation. The section of the formation as shown in this well is as follows:

Section of Allegheny formation in William Waddle well near old salt works at mouth of Elders Run.

	Feet.
Interval above well mouth to Upper Freeport coal	60
1. Conductor	13
2. Sand, gray	17
3. Slate, sandy	21
4. Coal, trace	..
5. Slate, black	35
6. Slate, white, soft fire clay	5
7. Slate	10
8. Shale, brown	25
9. Slate, black	5
10. Slate, white	10
11. Slate, sandy	15
12. Limestone	10
13 Slate, white	26
14. Slate, gray, possibly fire clay	28
15. Sand, white	35
16. Coal	5
17. Slate, possibly fire clay	10
18. Sand, white	17
19. Shale	5
20. Slate, white	8
Total	360

This section is particularly interesting, since it shows the Brookville-Clarion coal in its normal position about 40 feet above the Pottsville sandstone.

In the Shoup well (No. 10) the members of the Allegheny formation are not differentiated, except in the Freeport group. The section as reported is as follows:

Section of Allegheny formation in Shoup well on the main road 2 miles south of Saltsburg.

	Feet.
1. Coal (Upper Freeport)	4
2. Limestone (Upper Freeport)	6
3. Slate	315
Total	325

The Waddle heirs well (No. 11) gives more details, especially with regard to the coal beds. This section is as follows:

Section of Allegheny formation in Waddle heirs well about 2 miles south of Saltsburg.

	Feet.
1. Coal (Upper Freeport)	4
2. Slate and shales	56
3. Coal (Lower Freeport)	3½
4. Slate and shells	107½
5. Coal	4
6. Slate and shells	86
7. Slate and lime	40
8. Coal	5
9. Slate	55
Total	361

Coal bed No. 8, occurring 55 feet above the top of the Pottsville formation, seems probably to be the Clarion coal, which is closely overlain by what the driller noted as slate and lime. This doubtless includes the Vanport limestone, which was not differentiated from the adjacent shale beds. The 4-foot coal, No. 5, is presumably one of the Kittanning group, and from its high position in the series seems to correspond more nearly with the Upper Kittanning coal than either of the other beds.

The Bartley well (No. 12) gives the following section of the Allegheny formation:

Section of Allegheny formation in Bartley well on Serviceberry Run.

	Feet.
1. Coal (Upper Freeport)	7
2. Limestone (Upper Freeport)	18
3. Sand, white	80
4. Slate, dark	43
5. Coal	4
6. Slate, white	43
7. Limestone	12
8. Sand, dark	8
9. Slate and shells, dark	28
10. Lime and slate, white	35
11. Slate and shells	45
Total	323

The 4-foot coal, No. 5, is doubtless equivalent to the 4-foot coal noted in section No. 11, and quite possibly corresponds to the Upper Kittanning bed. The position of the Vanport limestone in this section is uncertain. It may be represented by limestone No. 7 or by the bed which is noted as lime and slate, No. 10. The bed first mentioned seems to be at too great a distance from the Pottsville to be the Vanport, whereas the lower bed appears to be a little too near the Pottsville to correspond with the same horizon.

In section No. 13 the Allegheny formation is not well shown. The Upper Freeport coal and its accompanying limestone are the only beds that can be identified.

In the Walker well (No. 14), the Allegheny shows in great detail with the following section:

Section of Allegheny formation in Walker well in Bell Township, Westmoreland County.

	Feet.
1. Coal (Upper Freeport)	4
2. Slate, white	30
3. Limestone	12
4. Slate, white	9
5. Sand	10
6. Slate, white	6
7. Sand	8
8. Slate, dark	12
9. Coal	5
10. Slate, white	12
11. Limestone	6
12. Slate, white	10
13. Sand	18
14. Sand, dark	5
15. Limestone	9
16. Sandstone	12
17. Slate, white	32
18. Slate, dark	8
19. Coal	2
20. Slate, white	40
21. Sand	5
22. Slate, white	24
23. Sand	8
24. Slate, dark	32
25. Slate, white	10
26. Slate, dark	16
Total	345

As before stated, this is one of the most detailed well records that has been obtained in this district. It is extremely interesting on this account, since it shows the absence of any important sandstones in the Allegheny formation. In this section the Lower Freeport coal appears to be absent, or it was not noted by the driller. The 5-foot coal bed, No. 9, presumably represents the Upper Kittanning and the bed 2 feet in thickness the Lower Kittanning coal. The Vanport limestone is normally due from 40 to 50 feet below it and 80 to 100 feet above the Pottsville, but it is either absent or was not noted by the driller.

The details of the Allegheny formation vary somewhat in the well sections, but they are no greater than the observed variations on the outcrop of the formation. Those who are unacquainted with oil-well and gas-well records may need a word of caution in regard to the thickness of coals reported by well drillers. It is extremely difficult, if not impossible, for a well driller to differentiate between bony coal, carbonaceous shale, and pure coal. It is also impossible for him to recognize shale partings that have a thickness of only a few inches, and consequently his reported thicknesses of coal may include not only the coal itself but also all partings, and possibly some of the roof. From knowledge which we have of these coals in outcrop it seems extremely improbable that they should be so thick under cover as is represented by these sections.

Some interesting facts regarding the total thickness of the Allegheny formation are brought out by the well sections as follows:

Thickness of Allegheny formation.

Section No.	Feet.
1	300
3	254
4	305
5	248
6	265
7	270
9	360
10	325
11	361
12	323
13	340
14	345

In all the sections in the eastern half of the quadrangle with the exception of wells Nos. 1 and 4 the thickness of the Allegheny formation is less than 300 feet and averages 270 feet. In the sections in the western half it ranges from 325 to 361 feet, the average being 340 feet.

Distribution.—The Allegheny formation has a limited distribution in this quadrangle. It is best exposed on Chestnut Ridge, where it extends in several places from the base to the summit of the ridge, but locally it has been removed by erosion, and its outcrop is extremely irregular.

West of Chestnut Ridge it dips below the surface and appears again only where the Jacksonville anticline is cut by Conemaugh River and Loyalhanna Creek. These outcrops are small but they are of considerable importance, for they bring to the surface some of the principal workable coal beds of the formation.

CONEMAUGH FORMATION.

Character and thickness.—The rocks overlying the Allegheny formation generally contain no workable coal beds, and for that reason they have long been known as the Lower Barren Measures, in contradistinction from an upper series of like composition. They extend from the roof of the Upper Freeport coal bed to the floor of the Pittsburg coal, including a heterogeneous series of beds which vary from the softest shales and impure limestones to the hardest quartzitic conglomerates.

The rocks composing this formation are so variable in composition and geographical development that it is extremely difficult to obtain a section that may be regarded as at all characteristic of the area. If an observer confines his attention to any one section he may be inclined to doubt this statement and to think that there are several very distinctive beds in the Conemaugh formation, but if an attempt is made to trace these distinctive members it will be found that they have only local development and that it is almost impossible to follow them continuously across the quadrangle. For this reason also it is difficult to determine the entire thickness of the formation. Surface measures are notably unreliable, for the dips generally are too light to be measured. An observer must depend upon the sequence of the rocks as they are exposed at the surface, and his measure will consist largely of estimates both as to the position of the beds and as to their thickness. The most reliable measure of the total thickness of the formation is afforded by the deep wells which have been sunk at various places along Conemaugh River. One of the best sections is that obtained in the Columbia Plate Glass Company's well on the river bottom south of Blairsville (section No. 2 of well-section sheet). This well is nearly in the center of the Latrobe syncline and the Pittsburg coal is well exposed just across the river. The well mouth is less than 100 feet below the Pittsburg coal, and while the Upper Freeport coal is not noted in the well section, it may be placed with considerable accuracy at about 650 feet below the surface of the ground. This gives somewhat less than 750 feet for the total thickness of the Conemaugh formation. This is a larger measure than is usually assigned to this formation, the average for western Pennsylvania being about 600 feet. If the determination depended entirely upon this one section it might be open to question, but it has been verified by a number of wells in the northeast corner of the quadrangle, so that it seems certain that the thickness of the formation is not less than 700 feet in Blacklick and Burrell townships of Indiana County.

Another measure is afforded by the Lawrence well (section 4), located near the head of Greys Run, in the northeast corner of the quadrangle. In this well the position of the Upper Freeport coal bed is given as 402 feet below the surface, while the hill immediately north rises to a height of about 280 feet above the well mouth. This hill shows no trace of the Pittsburg coal, but its summit is composed of sandy material which possibly represents the Connellsville sandstone. If this is the case the interval between the Freeport and Pittsburg coal beds at this point can not be less than 700 feet.

An approximate measure of the thickness of the Conemaugh formation may also be obtained in the vicinity of Saltsburg by a combination of well sections and surface data. In the deep well which was drilled a number of years ago about three-quarters of a mile below the station, the Freeport coal is reported at a depth of 310 feet below the well mouth, which is approximately at railroad level. Although the Pittsburg coal does not outcrop in the immediate vicinity, its position along the strike of the rocks is about 370 feet above railroad grade, and consequently the total thickness of the formation at this point is about 680 feet. If, therefore, the structure contours of this quadrangle, which are drawn upon the floor of the Pittsburg coal, are compared with those of the Elders Ridge quadrangle to the north, which are drawn upon the roof of the Upper Freeport coal, an interval of 680 feet must be allowed at the western edge of the quadrangle and 700 feet at the eastern edge.

Little information is available regarding the Conemaugh formation in the southern part of the quadrangle, but the record of a salt well drilled many years ago near Latrobe furnishes a very good section of the upper part of the formation. This well was located on Saxman Run and its record, as given by Mr. Shafer (Proc. Am. Philos. Soc., vol. 10, p. 67) is as follows:

Section of upper part of Conemaugh formation in Saxman salt well, near Latrobe.

	Thickness in feet.	Depth in feet.
1. Well mouth below Pittsburg coal	0	10
2. Soil	15	25
3. Slate, blue	1	26
4. Sandstone	6	32
5. Slate	7	39
6. Sandstone	7	46
7. Coal, or black slate (1' 10")	2	48
8. Limestone	19	67
9. Slate and sandstone	69	136
10. Coal, etc. (coal 8")	8	144
11. Slate and limestone	7	151
12. Sandstone	5	156
13. Slate, sandy	113	269
14. Slate, hard, blue	35	304
15 Sandstone, dark blue	4	308
16. Slate, brownish and black	28	336
17. Slate and limestone	2	338
18. Limestone with some sandstone	5	343
19. Slate	34	377
20. Limestone	1	378
21. Slate, dark blue, sandy	2	380
22. Coal (1' 4")	1	381
23. Slate	66	447
24. Slate, sandy	16	463
25. Sandstone (salt water)	35	498
26. Slate, blue and black	33	531

The sandstone (No. 25) in which brine was obtained at a depth of 463 feet below the Pittsburg coal is doubtless the Saltsburg sandstone. The interval between the top of the Saltsburg sandstone and the Upper Freeport coal, as determined by some of the gas wells on Dry Ridge, is 210 feet. If these two numbers are added it gives 673 feet as the thickness of the Conemaugh formation in the vicinity of Latrobe.

In previous reports concerning this region several members of the Conemaugh formation have been identified and named. The most prominent of these are certain sandstone beds which attain considerable thickness and massiveness in parts of the quadrangle, but they are variable in composition and stratigraphic importance and attempts to identify them in all parts of the area have led to considerable confusion.

Mahoning sandstone member.—The lowest and one of the most important sandstone members of this formation was recognized by Professor Lesley in 1856 (Manual of Coal and its Topography), but it seems probable that the name was in common use prior to this date. No original and definite description of the Mahoning sandstone appears in print, so each geologist has used the term as he saw fit. Generally the name has been applied to two or more of the beds of sandstone overlying the Upper Freeport coal, or, in other words, to a group of sand beds occurring within about 200 feet of the coal.

This application of the name necessitates the use of the terms Upper, Middle, and Lower Mahoning to designate the different members of the group. In order to simplify the above classification the writer proposes to limit the term Mahoning to the first heavy bed of sandstone above the Upper Freeport coal, where such a bed occurs within an interval of about 100 feet; the second sandstone bed, where present, is called the Saltsburg and is described as a separate member of the Conemaugh formation.

Although the Mahoning sandstone is at least of the same degree of importance as the other members of the formation it has not been shown on the geologic map for the reason that it lies next to a mapped horizon—the Upper Freeport coal—and the representation of the outcrop of the Mahoning sandstone would add little to the value of the map.

The Mahoning sandstone is fairly well developed in the Latrobe quadrangle. In many places it is massive and sometimes conglomeratic, but on the whole it is not particularly conspicuous. Its best known development is along Conemaugh River on the Jacksonville anticline, where it is particularly massive and has furnished a large amount of stone for heavy masonry work. Its character and position at this point are best shown by the record of a diamond-drill hole which recently was put down above one of the quarries north of Tunnelton. This record is as follows:

Section showing Mahoning sandstone in boring at quarry north of Tunnelton.

	Feet.	Inches.
1. Clay and gravel	9	0
2. Sand, coarse (quarry rock) (Mahoning)	54	0
3. Shale and sand, light	11	6
4 Sandy rock mixed with coal	1	0
5. Fire clay and soapstone	9	0
6. Shale, light, sandy	21	0
7. Shale, dark	4	8
8. Coal (Upper Freeport)		
Total	110	2

It will be seen from this section that the Mahoning sandstone does not rest directly upon the Upper Freeport coal bed, but is separated by a shale interval of about 47 feet. These rocks are also well exposed in natural outcrop at the extreme northern end of the sharp bend of Conemaugh River east of Tunnelton, where the Upper Freeport coal has been prospected to some extent. It seems probable that in previous reports this has not been recognized as the Upper Freeport bed, although its occurrence was known at the time of the first survey of the State by Rogers in 1858. The section at this point is as follows:

Section on Conemaugh River about 2 miles northeast of Tunnelton.

	Feet.	Inches.
1. Sandstone (Saltsburg)	30	0
2. Concealed	100	0
3. Sandstone, coarse, massive (Mahoning)	60	0
4. Coal (Upper Freeport)	2	0
5. Concealed	40	0
6. Coal	0	10
7. Concealed to water level	60	0
Total	292	10

Downstream from Tunnelton the Mahoning sandstone appears to break up and to be overshadowed by the massive Saltsburg sandstone, which comes in above. In previous reports it has been stated that the Saltsburg and Mahoning merge in this locality, but it seems more probable that the Mahoning changes to a shaly mass and the Saltsburg becomes the more prominent member of the formation. The section in the vicinity of Saltsburg is as follows:

Section near Saltsburg.

	Feet.
1. Sandstone (Saltsburg)	120
2. Sandy shale	15
3. Coarse sandstone	30
4. Fine shale	15
5. Sandstone	15
6. Shale	20
7. Sandstone	5
8. Shale	30
9. Sandstone	15
10. Shale	20
11. Coal (Upper Freeport)	
Total	285

From this section it is apparent that the Mahoning sandstone is badly broken and is represented only by some thin and irregular beds that appear in the lower half of the section. This apparent disappearance of the Mahoning west of the Jacksonville anticline is confirmed by the Walker well record, section No. 14. As previously mentioned this is a very detailed record and has all the appearance of being thoroughly reliable. That part of the section which lies above the Upper Freeport coal is as follows:

Partial section of Walker well, Bell Township, Westmoreland County.

	Feet.
1. Conductor	12
2. Slate, white	6
3. Sand	5
4. Slate, dark	30
5. Slate, white	22
6. Sand	8
7. Slate, dark	14
8. Red rock	15
9. Slate, dark	24
10. Slate, white	9
11. Red rock	12
12. Slate, white	26
13. Sand	7
14. Slate, white	16
15. Sand	5
16. Red rock	10
17. Slate, black	18
18. Slate, white	12
19. Sand	5
20. Slate, white	30
21. Sand	8
22. Slate, dark	45
23. Sand	7
24. Slate, white	55
25. Slate, dark	16
26. Coal (Upper Freeport)	
Total	417

The striking feature of this section is the paucity of sandstone, only 4 beds with thicknesses of 5, 5, 8, and 7 feet, having been noted in an interval of 200 feet above the Upper Freeport coal. It thus seems that there is scarcely a representative of either the Saltsburg or the Mahoning sandstone in Bell Township, Westmoreland County.

East of Tunnelton the Mahoning seems to be present in full force. It was noted in natural outcrop in a number of tributary ravines of Aultman Run near the northern edge of the quadrangle, and it is also shown in two diamond-drill holes on Stewart Run.

Saltsburg sandstone lentil.—The second sandstone bed of importance in the Conemaugh formation generally has been designated the Upper Mahoning sandstone. Lesley called it the "Saltsburg sandstone" and his suggestion was accepted by Professor Stevenson (Second Geol. Survey Pennsylvania, Rept. K3, p. 22, 1878) in his report upon this region. Professor White (Rept. Q, p. 35, 1878), in his survey of the Allegheny Valley, used the name "Buffalo sandstone" to designate what appears to be the same bed of rock. Since the name "Saltsburg" was applied by Professor Stevenson in this region it is desirable to retain that name for the sandstone which is so extensively developed throughout a large part of Westmoreland and Fayette counties.

The Saltsburg sandstone probably reaches its greatest development at the town of Saltsburg on Kiskiminetas River, at the mouth of Loyalhanna Creek. At this point it is at least 120 feet thick, and in places is massive and forms prominent cliffs along the river. This phase is particularly noticeable on the west side of the river, in the Academy grounds.

In a general way the top of the Saltsburg sandstone may be regarded as occurring 200 to 250 feet above the Upper Freeport coal. Its maximum thickness is about 120 feet, and, like all the sandstones of the region, it is variable in composition, changing from massive sandstone to thin-bedded sandstone and sandy shale in a short distance. On the whole it is probably no more prominent than the Mahoning sandstone below, but its position in the series makes it important in geologic mapping, and its separation has, therefore, been attempted in this quadrangle.

The Saltsburg sandstone was identified along the southeastern side of the Latrobe syncline from the southern margin of the quadrangle to beyond Loyalhanna Creek. It is not particularly prominent in this region, and north of the creek it becomes so indistinct that its mapping was discontinued. As shown by the Saxman well section, the Saltsburg sandstone carries the brine that was sought so eagerly in the early days. Its thickness in this section is noted as 35 feet and its position as 463 feet below the Pittsburg coal.

This sandstone is very prominent on the Fayette anticline west of Latrobe. Along Dry Ridge it forms the crest of the arch, and it can be traced continuously from near the southwestern corner of the quadrangle to Loyalhanna Creek. A short distance north of this point it changes to sandy shale, which becomes indistinguishable from the adjacent beds. The stratigraphic position of its upper limit on Dry Ridge, as determined by gas-well records, is 210 feet above the Upper Freeport coal bed. This sandstone bed is easily identified along the Pennsylvania Railroad. On the west side of the arch it rises to the surface near Donohoe and forms the roof of the railroad tunnel just east of this point. It is above railroad level for some distance and then it descends on the other side of the arch, passing below railroad grade near Carney. It is also prominent on the Philadelphia and Pittsburg Pike at Denison, where it corresponds with the long slope on the southeastern side of the anticline. Along Loyalhanna Creek it is thin, but is prominent on account of its massive character.

On the Fayette anticline the Saltsburg sandstone again appears in the vicinity of Blairsville. It is particularly prominent along the river at and above the mouth of Blacklick Creek. It rises rapidly to the south under the influence of the rising Fayette anticline, and reaches the Northern turnpike 2 miles west of Blairsville, where it lies nearly flat on the axis of the fold. In the direction of Blairsville it dips rapidly and is seen for the last time at the crossing of Stony Run, a mile west of town. This bed is best exposed along the line of the old canal which followed the left bank of the river. The presence of this heavy bed made the construction of the canal particularly difficult at this place, for throughout a distance of 2 miles the sandstone had to be blasted away, and today it is exposed as a cliff having a vertical face ranging from 20 to 50 feet in height. The sandstone is exposed up Blacklick Creek for a distance of about 1½ miles, but at that point it passes below water level. Its stratigraphic position in this locality is determined by an old well which was drilled many years ago at the mouth of a small ravine about a mile and a quarter above Social Hall. According to the reported record of this well the Upper Freeport coal lies at a depth of about 90 feet below the canal, and consequently the top of the Saltsburg sandstone is about 240 feet above the Upper Freeport coal. The stratigraphic position of this bed was also determined in the Jellison well (No. 6) to be 235 feet above the same horizon.

Along the Jacksonville anticline the Saltsburg sandstone is well exposed. Its best development, as previously mentioned, is at the town of Saltsburg. At this point its upper limit, as determined by the Leach well, located about three-quarters of a mile below the station, is 310 feet above the Upper Freeport coal bed. This interval is probably extreme and does not hold where the sandstone is not so well developed.

On Loyalhanna Creek the Saltsburg sandstone is exposed for a distance of about 4 miles above Saltsburg. From the mouth of the creek to the axis of the anticline it rises steadily, reaching at the latter point an altitude of about 1120 feet. It then descends rapidly and passes under water level below the mouth of Whitethorn Creek. Its stratigraphic position is shown by the Shoup well (section No. 10) to be 200 feet above the Upper Freeport coal bed. In passing to the north along the Jacksonville anticline this bed is less prominent, and in a measure is replaced by the great development of the Mahoning sandstone which occurs on Conemaugh River. It is probable that the Saltsburg sandstone is present east of Conemaugh River, but its condition is such that it is not observable in outcrop. It is, however, 30 feet thick on the north side of the river in the great bend above Tunnelton, as shown on page 8. It develops to the northeast, and along Roaring Run and its various branches is present in typical form, rising to the crest of the Jacksonville anticline at the northern extremity of the quadrangle. East of this point the Saltsburg sandstone was not observed, and it seems probable that it entirely disappears from the section.

Limestone beds in the Conemaugh formation.—In a general way the Conemaugh formation consists of a matrix of variegated shale inclosing several beds of sandstone. There are also in this aggregate a number of small coal beds and several bands of impure limestone. One of the latter seems to be more persistent than the others and has become widely known as the Ames or green Crinoidal limestone. Its position in the series is about the middle of the Conemaugh formation, lying between the Morgantown sandstone above and the Saltsburg sandstone below. This limestone bed is of great importance west of Allegheny River, but east of that line it seems to be absent in many places, and consequently its value as a key horizon is greatly reduced. It is present in the Latrobe quadrangle, but presumably it can not be traced throughout the entire extent of the field. It is well developed just north of the quadrangle and about 3½ miles east of Saltsburg. At this point it has a thickness of about 2 feet, is abundantly fossiliferous, and shows its typical green color.

The limestone was also observed on the Fayette anticline east of New Alexandria, but in this locality it consists largely of soft calcareous shale and is rarely exposed in outcrop. The peculiar characteristics of this bed generally make it useful for purposes of correlation, but in the Latrobe quadrangle its inconstancy renders it of little value.

Besides this more important bed there are several impure limestones noted at various horizons and in several localities, but probably none of them are extensive in their development, and their use as key horizons is very limited. One of these limestone layers is found in association with some coal beds along Conemaugh River about 2 miles below Blairsville. The stratigraphic position of this limestone is between the Mahoning and Saltsburg sandstones, but it is probable that its occurrence is limited to this locality.

Morgantown sandstone member.—This bed is one of the most prominent sandstones of the Conemaugh formation in western Pennsylvania. It is generally present west of Chestnut Ridge, but occasionally it becomes a thin-bedded sandstone or sandy shale, and as such can not be traced. Its stratigraphic position varies from 150 to 180 feet below the Pittsburg coal, and it ranges in thickness from 0 to 60 feet.

The best development of the Morgantown sandstone in the quadrangle is probably in the Latrobe syncline at Blairsville, where it forms prominent cliffs along the river above the bridge and may be seen rising in the hill west of the town. It is probably present at many other localities, but it does not form a conspicuous feature of the topography. In the southern part of the quadrangle a good section is exposed along the Pennsylvania Railroad from Latrobe to the western margin of the quadrangle, but the Morgantown sandstone is not present in its typical form. Apparently it is represented by sandy shale which can not be distinguished from the adjacent beds.

This condition seems to prevail also in the Latrobe syncline. According to the Saxman well record there is no heavy bed of sandstone at the horizon of the Morgantown, but it may be represented by a bed of sandstone 5 feet in thickness, underlain by 113 feet of sandy shale. The top of this slightly sandy series is 151 feet below the Pittsburg coal and corresponds with the position of the Morgantown sandstone in the type locality.

Connellsville sandstone member.—The Connellsville sandstone occurs usually within 30 or 40 feet of the base of the Pittsburg coal. This bed is particularly well developed on Youghiogheny River, and its name was derived from the city of Connellsville, in which it shows in its best form. This sandstone is poorly developed in the Latrobe quadrangle. Generally it is of such a shaly character that it can not be distinguished from the adjacent beds.

Distribution.—The Conemaugh formation shows in outcrop on almost all of the pronounced anticlines of the region and even in some of the synclines the basins lie so high that the Conemaugh rocks form the floor. On the Chestnut Ridge anticline, however, the arch is so pronounced that these rocks have been eroded from the crest and show in outcrop only on the flanks of the ridge. On the northwest side of the ridge they dip rapidly beneath the surface and outcrop in a comparatively narrow band along the foot of the ridge; on the southeast side of the ridge the descent of the rocks is not so great and the Conemaugh formation outcrops at the surface throughout most of the great Ligonier Valley syncline.

In the Latrobe syncline the Conemaugh formation lies at a considerable depth below the surface except in the vicinity of Blairsville, where, owing to the shallowness of the trough, it is exposed in continuous outcrop by the cutting of Conemaugh River across the basin.

West of the Latrobe syncline this formation shows in a wide band that extends along the Fayette anticline from the southwest corner to the northeast corner of the quadrangle. Along Loyalhanna Creek the arch rises so high that the Allegheny formation is exposed on the axial line, and the entire lower half of the Conemaugh formation is visible in Dry Ridge. Northeast of this point the axis rises into an elongated dome and then plunges rapidly, and where it is crossed by Conemaugh River the rocks are so low that the Upper Freeport coal is not exposed by the stream. The Fayette anticline is bordered on the northwest by the Greensburg synclinal basin, but in this territory it is so shallow that it is trenched by Loyalhanna Creek, which exposes nearly 100 feet of the Conemaugh measures. A little farther northeast the Pittsburg coal is carried to the tops of the hills and disappears, leaving the Conemaugh formation at the surface throughout the northeast corner of the quadrangle.

Northwest of this basin the quadrangle is traversed by the Jacksonville anticline, which again carries this formation above drainage level, and it is cut by both Conemaugh River and Loyalhanna Creek, which expose the Allegheny formation for a thickness of over 100 feet. Northwest of this axis the rocks dip into a shallow synclinal basin which lies so high that the Conemaugh rocks are exposed everywhere except upon the highest hills.

MONONGAHELA FORMATION.

Character and thickness.—This formation overlies the Conemaugh formation, extending from the floor of the Pittsburg coal to the roof of the Waynesburg coal. The presence of a large amount of calcareous matter in the rocks of this formation, together with the absence of any massive or heavy-bedded sandstones, renders them an easy prey to the action of the elements, and as a consequence they form a gently rolling country, in which it is exceedingly difficult to determine the stratigraphic succession of the rocks. The total thickness of the formation is present only in the Latrobe syncline, west of Loyalhanna Creek. Just east of Klondike the Waynesburg coal, together with its overlying heavy sandstone, is present along the highest ridge of the region for a distance of about a mile. The exact interval between the roof of the Waynesburg and the floor of the Pittsburg bed is difficult to determine but from the structure contours drawn on the floor of the Pittsburg coal it seems probable that the altitude of this bed is about 900 feet above sea level directly beneath the outcrop of Waynesburg coal on the ridge just mentioned. Since the latter outcrops at an altitude of about 1300 feet, the thickness of the Monongahela formation is approximately 400 feet.

From the data at hand it seems probable that the individual members of the Monongahela formation vary greatly throughout this region. It is true that detailed and well-exposed sections are scarce, but at the same time those that have been compiled show great variation in the arrangement and character of the members. The most constant and decidedly the most important member from an economic standpoint is the Pittsburg coal, which constitutes the base of the formation. It is present in workable thickness wherever its horizon is exposed, and its thickness varies from 6 to 9 feet. The details of this remarkable bed will be more fully described later under the heading "Mineral resources." Throughout this quadrangle the Pittsburg coal is generally overlain by a few feet of sandy or carbonaceous shale, and that in turn is covered by a coarse sandstone which has long been known as the Pittsburg sandstone. This bed is extremely variable, and it is not a common feature in that part of the Connellsville trough which lies to the southwest of this quadrangle. It is, however, present in many places along Monongahela River, but the details of its distribution have not been worked out with sufficient care to determine the areas over which it is present and the peculiar conditions which permitted of its deposition. In thickness it varies greatly, reaching a maximum of 60 feet, and in character it ranges from a sandy shale to a coarse, irregularly bedded sandstone.

The Redstone coal bed, which normally belongs about 80 feet above the base of the Pittsburg coal, is very poorly developed in the Latrobe quadrangle. It has been noted at a few points where exposures are good, but its thickness at no place seems to amount to as much as 12 inches. Along the Pennsylvania Railroad near Loyalhanna Creek it is about 70 feet from the top of the Pittsburg coal. In the type locality in Fayette County the coal is generally underlain by a very pure limestone, which is known as the Redstone limestone. In this region also it lies above a small bed of limestone or calcareous nodules which, although different in character from the bed in the type locality presumably is the representative of the Redstone limestone. The interval between the Redstone coal and the top of the Pittsburg sandstone is usually occupied by shale, which varies in character from place to place, but which has no striking characteristics.

A small coal bed consisting of two benches, each a few inches thick, was noted along the Pennsylvania Railroad, about 110 feet above the Pittsburg coal. This probably represents the Sewickley coal, which is one of the most important members of the formation in the southwest corner of the State. This coal bed is underlain at a short distance by a bed of limestone, 3 or 4 feet in thickness, which is supposed to represent the Fishpot limestone of the Monongahela Valley. In this locality the limestone is of no practical importance, but the coal bed is of interest as it shows the widespread distribution of some of these minor features. One of the most important members of the Monongahela formation is a bed of sandstone that occurs about 10 feet above the Sewickley coal horizon. This bed was not noticed in the Latrobe syncline, but is very prominent in the Greensburg basin, and has been quarried for a number of years just east of the town. Its thickness is about 40 feet and it furnishes a building stone of fair quality.

Above the sandstone just noted occur several beds of limestone, separated by bands of shale. These are common features in the Latrobe and Greensburg synclines, and presumably they are the representatives of the Benwood (Great) limestone of Fayette County. The details of this part of the section are probably best represented by a section obtained from a well on the property of George F. Huff, located just north of the railroad station in Greensburg. This record, according to Mr. Charles Fogg, is as follows:

Section of well of George F. Huff, near Pennsylvania Railroad station at Greensburg, Westmoreland County.

	Feet.
Clay	10
Shale	10
Limestone	25
Slate, black	18
Limestone	12
Fire clay	15
Slate, black	27
Limestone	19
Sandstone	44
Slate, white with hard shells	25
Slate, black	35
Slate, brown, slightly gritty	8
Slate, white, soft	12
Limestone	6
Slate, black	21
Sandstone, hard	5
Slate, black	6
Coal, Pittsburg (?)	
Total	298

In this section a generally calcareous interval extends for a distance of 120 feet above the top of the sandstone just described. As shown by the section it consists of three layers of limestone, the middle one of which is well shown in the tunnel just east of the station at Greensburg.

The interval above the Benwood limestone is not represented in the Greensburg basin, but is present in the Latrobe syncline south of Loyalhanna Creek. From the exposures in this locality it seems probable that most of the interval is made up of sandy shale in which there are two thin beds of sandstone, one lying just below the Waynesburg coal and one about 60 feet lower in the series. The two sandstone beds are separated by a shale interval in which there are from 10 to 15 feet of impure limestone or calcareous nodules, which doubtless represent the Waynesburg limestone of the type locality in Greene County.

The Waynesburg coal, the roof of which marks the upper limit of the Monongahela formation, is present only in the Latrobe syncline near Klondike. In Professor Stevenson's reports upon this region it is stated that the Waynesburg coal is present along the synclinal axis north of New Derry. In order to account for its presence here it was necessary to assume that the interval between this bed and the Pittsburg coal is very much less than at any other locality. There seems to be no evidence for this assumption, and it is altogether probable that the coal which Professor Stevenson mistook for the Waynesburg coal belongs at a lower horizon. It was not seen by the writer and consequently its exact position can not be determined, but from the mine data at hand it seems hardly possible that the Waynesburg coal should occur in the syncline east of Latrobe.

Distribution.—The part of the Latrobe quadrangle underlain by the Monongahela formation is of small extent, being limited to the three synclinal basins which cross this territory west of Chestnut Ridge. Its greatest area is in the Latrobe syncline, where it extends in unbroken outcrop from the southern edge of the quadrangle to Conemaugh River. Northeast of this point it is found only in the hilltops, and beyond a distance of 5 or 6 miles it is altogether wanting, having been removed in the general degradation of the region. The rocks in the Greensburg syncline lie so high that the Monongahela formation is largely eroded. Its greatest development in this basin is west of Loyalhanna Creek, where it extends in continuous outcrop from near the creek to beyond the city of Greensburg. East of Loyalhanna Creek there are a few remnants capping the highest hills, but the syncline rises so rapidly in this direction that these remnants extend for a distance of only about 4 miles. In the Elders Ridge syncline the rocks are still higher where the formation crosses the quadrangle and only a small part of it remains on the hilltops west of Saltsburg.

DUNKARD FORMATION.

Where the rocks are well preserved, the Dunkard formation overlies the Monongahela formation, and extends from the horizon of the Waynesburg coal to the highest rocks known in southwestern Pennsylvania. Its base is usually formed by the Waynesburg sandstone, which either directly overlies the coal or is separated from it by only a few feet of sandy shale.

In the Latrobe quadrangle this formation is generally eroded, being preserved only in the southern extremity of the Latrobe syncline, about 5 miles southwest of Latrobe. The formation is represented here only by the Waynesburg sandstone, which is found in a few of the highest hills just east of Klondike.

Generally the sandstone is coarse and micaceous, and it may be easily identified, since the outcrop of the coal is generally visible at its base. Its total thickness does not exceed 60 feet.

QUATERNARY DEPOSITS.

CARMICHAELS FORMATION.

This name is given to the unconsolidated sand and clay which occurs upon the rock shelves that border most of the large streams. The material generally consists of sand and gravel, with sometimes accumulations of clay and large bowlders of sandstone that have been carried down from Chestnut Ridge. The coarsest material occurs near the eastern limit of the quadrangle, but large bowlders are found even as far west as the western boundary of the area.

The deposits on the two terraces already described are of the same general composition and age. Their separation was found to be impracticable, and so they are represented on the geologic map as one formation.

So far as known the deposits contain no inherent evidence regarding their geologic age, but from correlation with similar features in the Allegheny Valley it seems probable that they are of Pleistocene age, and correspond with gravel deposits that are referred to the Kansan or some other early stage of glaciation.

The Carmichaels formation is limited almost exclusively to the two major valleys of the quadrangle. It is most extensively developed on the broad rock terraces of Conemaugh River between Tunnelton and Blairsville. Below Tunnelton the valley is narrow and only scattering remnants of the terrace gravel remain in protected localities. In the vicinity of Saltsburg there are extensive terraces and they are all covered by the Carmichaels formation.

On Loyalhanna Creek deposits of this character show continuously from Chestnut Ridge west, except where the stream cuts the hard rocks of the Jacksonville and Fayette anticlines. They are particularly well developed in the vicinity of New Alexandria and Latrobe.

Along the northwestern foot of Chestnut Ridge there are extensive deposits of gravel that have been derived from the hard rocks composing the ridge. The date of accumulation of these is not well known, but those occurring above the level of the streams in the vicinity of Derry have been called the Carmichaels formation.

RIVER ALLUVIUM.

The latest deposit in the region is the alluvium which is found on almost all the streams. It is particularly prominent on the large streams, where it makes up the bottoms that form almost the only level land in the quadrangle. These bottoms or flood plains are composed of sand and silt dropped by the streams and they are cut and rebuilt by every flood that affects the stream. The streams are constantly though slowly lowering their channels so that level areas that formerly were flood plains are now abandoned and lie above the highest known water mark. Several well-developed flood plains on Conemaugh River are of this class, but most of them are subject to inundation at each flood.

Owing to the large amount of sand carried by the streams, the flood plains are frequently not so productive as the more clayey upland, but they are easily cultivated and are largely used for farming purposes.

GEOLOGIC HISTORY.

Paleozoic Era.

Since the Latrobe quadrangle is located near the center of the great Appalachian synclinal basin none of the rocks below the Devonian are exposed at the surface. For this reason the history of the area during the Cambrian, Ordovician, and Silurian periods is little known and can be inferred only from the character of the rocks in other parts of the country. Such an inference would have little value here and will not be attempted.

DEVONIAN PERIOD.

As previously stated, the oldest rocks exposed at the surface belong near the base of the Mississippian series of the Carboniferous, but, through the exploration for gas and oil that has been carried on extensively throughout western Pennsylvania, the underlying rocks of the Devonian system are fairly well known and the sequence of events can be determined with considerable accuracy.

No very deep boring has been made in this immediate locality, but in the vicinity of Pittsburg wells have been sunk to a depth of nearly 5000 feet and these have penetrated a thickness of Devonian shales amounting to at least 3000 feet without reaching their bottom. From other deep wells drilled near the margin of the basin it is known that the shales are underlain by a bed of limestone which may be taken as a starting point in our interpretation of the geologic history of the Latrobe quadrangle.

Paleontologists are not agreed regarding the lower limit of the Devonian system, but, as commonly understood, this period was inaugurated by the deposition of the Oriskany sandstone and the Onondaga (Corniferous) limestone. The conditions that attended the formation of these beds are not well known, but from their contained fossils it is apparent that they were marine sediments and were deposited in deep water or along the sandy shore of an open sea.

At the close of the period of limestone deposition conditions changed radically. The clear water which permitted the accumulation of calcareous matter was changed to muddy water by the influx of great quantities of sediments derived from a land located somewhere to the east, and it is probable that this change was accompanied by elevation of the land surface, which permitted more active erosion than had occurred during the previous cycle. The supply of waste material, however, was not sufficient to seriously interfere with the growth of marine organisms, and consequently the lower part of the Devonian shales throughout most of Pennsylvania and New York is characterized by an abundant marine fauna. In the western part of these States it is probable that open sea conditions continued throughout most of the Devonian period, but in the eastern part coarse (Catskill) sediments began to accumulate in great abundance near the middle of the Hamilton epoch, and as time passed they gradually extended westward until nearly the whole of New York and Pennsylvania and the western parts of Maryland and Virginia were covered to a great depth with this material. The nature of the deposit suggests the mouth of a large river, and it is probable that these coarse sediments are a delta-like deposit which rose practically to the surface of the water and that the great amount of fresh water poured out in this locality changed the conditions from marine to fresh or brackish water.

The sea in which these deposits were laid down was bounded on the north by the Archean highland of Canada, and on the east by a land lying somewhere along the Atlantic slope and apparently crossing New England near its western border. This continental area extended far to the south and it seems probable that it reached westward across the lower Mississippi Valley. Surrounded thus by land areas the sea formed a sort of Devonian Mediterranean in the heart of the United States. The land on the east appears to have been raised to a considerable height and the rejuvenated streams from this high land brought in the sediments just described. Previous to the elevation of this continental mass it seems probable that it was in a base-leveled condition, and the upward movement, which permitted the removal of a large amount of waste, affected only the northern part of the area, leaving the southern extremity in its original base-leveled condition. As a result, the sediments decrease rapidly in thickness toward the south until near the north line of Tennessee the coarse material disappears entirely, leaving nothing but a thin formation of carbonaceous shale, which probably was laid down in a shallow sea bordered by coastal plain swamps.

In northern Pennsylvania there appears to have been a series of oscillations by which at times marine conditions extended far to the east, and then again the red sediments of the Catskill were spread over the region, extending to the western part of the State. These great deposits of red material have been penetrated by deep drillings, and are shown in the well-section sheet, where they are designated the Sub-Blairsville red shale.

After the deposition of the red material the sediments grew more sandy, either on account of the supply of coarser material from the land or on account of the shallowness of the sea and the frequent reworking of the material by the waves, and the result is a series of sandstone deposits which now serve as reservoirs for great quantities of oil and gas.

CARBONIFEROUS PERIOD.

Pocono epoch.—It is probable that the beginning of the Carboniferous period was marked by shallower water, and as a consequence the sediments passed upward by gradual transition from occasional beds of sand interbedded with mud to a body of almost pure sand. This has been described as the Pocono sandstone. Owing to this gradual transition from Devonian to Carboniferous rocks, and to the impossibility of obtaining fossils from these beds in the Latrobe quadrangle, no definite line of separation can be drawn. There is, however, a thin band of red material well down in the Pocono which possibly marks the recurrence of Catskill conditions, but only for a short interval, as the bed is generally thin and in many places is not red.

Much more is known of the geologic history of the Pocono epoch, for the sandstone beds outcrop at the surface and it is possible to determine somewhat definitely the conditions under which they were deposited. From the presence of fossil plants associated with thin seams of coal, it is thought probable that these rocks were formed under fresh-water conditions, and it is possible that at certain stages they constituted a land surface rather than a water area.

In the extreme northwestern part of the State and also in Ohio, rocks of this age carry a marine fauna, and so it is certain that there was an open sea to the west, but throughout much of the coal field of Pennsylvania and along the center of the Appalachian province as far south as Tennessee fresh-water conditions prevailed and sandstone and coal beds were deposited.

Toward the close of this stage of deposition, conditions again changed and siliceous limestone was deposited, but so far no traces of fossils have been found in the limestone, and its origin remains to some extent a mystery.

Mauch Chunk epoch.—An abrupt break in sedimentation occurred at the close of the Pocono epoch. and red shales interbedded with sandstone and some limestone were deposited, The repetition of conditions which favored the accumulation of red sediments is not well understood. It is supposed that red material generally has been derived from a deeply oxidized land surface on which the conditions are much like those which prevail to-day in the southern part of the United States, but why such conditions occurred only during Catskill and Mauch Chunk time has not yet been explained. From the great increase in the thickness of these sediments toward the east it is thought that the land area from which they were derived lay in that direction and that the materials were swept from this shore westward and southward into the great interior sea.

Although definite correlations have not yet been made, it is probable that the inauguration of Mauch Chunk deposition in the Latrobe quadrangle was coincident with the beginning of deposition of the great limestone mass of the Mississippi Valley, but these limestones lie south of the Latrobe quadrangle, and are represented locally by a bed only a few feet in thickness. Therefore, it seems probable that this quadrangle lay in a zone of transition between the sandy and argillaceous sediments characteristic of the northeastern part of the province and the calcareous sediments of the southwest. The Greenbrier limestone lentil, described on a previous page, is the local representative of the great Mississippian limestones and probably it marks a short period of open sea and clear-water conditions in which the calcareous sediments extended nearer to the shore than before or than was possible at a later stage.

Up to the close of the deposition of the Mauch Chunk shale there is no indication of any break in the sedimentary record. It is true the change from Pocono to Mauch Chunk is abrupt, but so far as known there is no hiatus between them, and the change is only of depositional conditions.

Pottsville epoch.—As stated in the description of the Pottsville sandstone, it lies unconformably upon the Mauch Chunk shale. This contact contains the record of one of the most interesting periods of Appalachian history, so far as it is now known. It records a period of elevation or erosion and of subsequent depression and sedimentation.

Formerly it was supposed that the great difference in thickness of the Pottsville formation in the Southern Anthracite basin and in the bituminous field of the western part of the State was due to different amounts of material having been supplied to the two areas; in other words, that the thin sections of the western part of the State represent the same time in their deposition as the thick sections of the Southern Anthracite basin. From the work of Mr. David White on the fossil plants (Fossil floras in the Pottsville formation in the Southern Anthracite field, Pennsylvania, Twentieth Ann. Rept. U. S. Geol. Survey, part 2, pp. 751–930; and Notes on the deposition of the Appalachian Pottsville, Bull. Geol. Soc. America, vol. 15, pp. 267-282) it is now known that in the Southern Anthracite basin sedimentation occurred continuously from the close of the Mauch Chunk to the beginning of Allegheny time, whereas in the western part of the State the close of the Mauch Chunk epoch was marked by an uplift which raised the main part of the bituminous field above the level of sedimentation, and hence no rocks of corresponding age were deposited.

After about two-thirds of the formation had been laid down in the eastern trough the land in western Pennsylvania and Ohio subsided and deposition was resumed in that part of the province. During this time the region along the Allegheny Front, and at least as far west as Allegheny River, remained dry land and the beds that were deposited in the western part of the State have no representatives in this area. The most important of these beds is the Sharon conglomerate, which is a prominent feature of the stratigraphy of the Beaver Valley. This bed is not known to occur in Chestnut Ridge or in any of the intervening territory between this ridge and the Allegheny Front. According to the evidence afforded by deep wells along Conemaugh River, this bed is absent toward the interior of the basin at least as far as the northwest corner of the Latrobe quadrangle.

After the deposition of the Sharon conglomerate and the overlying Sharon coal of western Pennsylvania, the Chestnut Ridge region was depressed and sedimentation extended entirely across the bituminous field, and the Connoquenessing sandstone was deposited on what had previously been dry land in the Latrobe quadrangle. From this time on, the local sequence of events is the same as in the western part of the State, and the Pottsville epoch closed with the deposition of the Homewood sandstone over almost the entire area.

Since the northern end of the bituminous basin was dry land during the early stages of the Pottsville epoch, erosion must have been taking place and the beds which formerly had been deposited were in part at least removed. For this reason the Mauch Chunk shale generally is irregular in thickness and sometimes wanting, and it seems probable that at a number of points erosion removed not only all of the Mauch Chunk shale but much of the Pocono sandstone. On account of this break it is not surprising to find the Pottsville sandstone resting upon any part of the older formations. In fact, recent work in the Allegheny Valley shows that Pottsville sandstone is in contact wth Pocono sandstone in the vicinity of Bradys Bend, and Dr. George H. Girty recently has demonstrated that in southern New York the Olean conglomerate, which is of Pottsville age, rests upon the highest known Devonian rocks, or rather upon the transition series between the Carboniferous and Devonian systems.

Allegheny epoch.—The coarse sediments of the Pottsville sandstone are succeeded by the shales, sandstones, limestones, and coal beds of the Allegheny formation. These are variable in composition, thickness, and geographic extent. The conditions under which the Allegheny formation was deposited were peculiar, for they allowed not only great irregularities in the sediments, but also great regularity and continuity in the coal beds. These variations indicate that there were periods in which large amounts of coarse sediments were swept into the basin, and then periods in which little or no material was supplied, except that which resulted from the enormous growth of plants which flourished in the extensive swamps that must have prevailed.

The thin limestone beds which occur in the Allegheny formation contain marine fossils and indicate open-sea conditions, but these periods were transient, and at the time of the widest extent of limestone deposition the sea did not reach so far east as the Latrobe quadrangle. It, therefore, seems probable that most, if not all, of these rocks in the Latrobe quadrangle were laid down in fresh or brackish water.

Conemaugh epoch.—Little is known regarding the physiographic conditions which attended the deposition of the Conemaugh beds. They carry red material and hence it might be inferred that they are the result of waste from a very old land surface, but this has not been fully demonstrated. The formation usually consists of shale with occasional heavy beds of sandstones, and generally it is marked by an absence of coal beds. It is well developed in Pennsylvania, Ohio, and West Virginia, and it has about the same general composition throughout this territory. The Ames limestone, which occurs near the middle of the formation, and which is poorly developed in the Latrobe quadrangle, marks the last known incursion of sea water into this region.

Monongahela and Dunkard epochs.—The formations deposited during these epochs are poorly represented in the Latrobe quadrangle, but originally they probably were deposited over much of the bituminous coal fields of the State. They contain many beds of limestone, but generally these are destitute of fossils, and hence they are supposed to have been deposited in fresh or brackish water. Interbedded with the limestones are beds of coal which point to land conditions. The deposition of these beds marks the close of the Paleozoic era in Pennsylvania.

Appalachian revolution.—Although it is certain that folding and faulting took place contemporaneously with the deposition of many of the early Paleozoic beds here mentioned, it is probable that the folds which show in the Latrobe quadrangle are all due to movements that occurred during the closing stages of the Carboniferous period or at the beginning of the Jurassic. Frequently this has been termed the Appalachian revolution.

The crustal movements which resulted in the Appalachian revolution were the result of compressive strains which threw the rock into great folds. The movement was most severe along the eastern side of the Greater Appalachian Valley, there the rocks were not only thrown into great folds, but the pressure was so great that cleavage was induced, and, in many cases, the rocks were completely metamorphosed. West of this greatly disturbed zone the movement was less severe and the folds are of smaller magnitude, but they continue with only slightly diminished size as far as the Allegheny Front. In a measure the coal basin seems to have acted as a buttress against which the rocks were crushed, but in so doing the buttress itself was affected and the rocks west of the Allegheny Front were thrown into low folds, which are well exemplified by the anticlines and synclines of the Latrobe quadrangle.

Mesozoic Era.

The geologic history of the interior portion of the northern Appalachian region during Mesozoic time is not recorded in any sediments laid down in the region itself, for this part of the province was dry land. The history of that time, if preserved at all, is to be found in the geographic forms then produced, but so much erosion has taken place since the close of the Mesozoic era that it is doubtful whether any of the surface forms of that time are still recognizable. There are, however, certain topographic forms which seem to have been modified only slightly since that time, and it is possible that from them may be determined some of the important geologic changes.

The immediate topographic effect of the Appalachian revolution is a somewhat doubtful question. In the early days it was assumed that these movements resulted in mountainous folds many thousands of feet in height, but at present the tendency is to believe that erosion nearly kept pace with elevation, and that the folds were worn down almost as rapidly as they were formed.

It is probable that most of the present major drainage lines of the region were determined in Mesozoic time, but the evidence is so nearly obliterated that sometimes it is extremely difficult to discriminate the original characteristics of the streams from those which have been acquired during a later cycle.

The oldest topographic record in the region is supposed to be contained in the even-crested monoclinal ridges in the central part of the State and in anticlinal ridges in the bituminous coal fiel l. It is thought that the summits of these ridges once formed parts of the surface of an extended peneplain which was produced by subaerial erosion during Cretaceous time. The peneplanation is supposed to have been so extensive as to reduce almost all of the surface to a fairly common level, regardless of the character of the underlying rocks. Such a cycle of erosion demands an extremely long period of time, and it is probable that the formation of this peneplain occupied most of the Cretaceous period.

From its extensive development in the highlands of northern New Jersey this feature has been named by Davis the Schooley peneplain (Proc. Boston Soc. Nat. Hist., vol. 24, pp. 365-423).

The peneplain which was formed near sea level was elevated and the streams were at once rejuvenated and began the dissection of its once even surface. This process has now gone so far that it is doubtful if any of the original surface remains, but it is probable from the fairly constant altitude of the ridges that at one time their summits were either at the surface of this plain or that they have been reduced only slightly below it. If this hypothesis is correct, it seems probable that the altitude of the Cretaceous peneplain in the Latrobe quadrangle is now about 2000 feet above sea level, and coincides approximately with the summit of Chestnut Ridge.

Cenozoic Era.

TERTIARY PERIOD.

Following the epoch of long-continued erosion, in which was produced the Schooley peneplain, there came an uplift in this region of not less than 800 feet, and again the crust of the earth remained stationary long enough for the somewhat softer rocks west of Chestnut Ridge to be reduced to a common level. This surface is now represented by the general hilltops which stand at an altitude of from 1200 to 1300 feet above sea level and it is called by the writer the Harrisburg peneplain, from its extended development about the capital of the State (Geographic development of northern Pennsylvania and southern New York, Bull. Geol. Soc. America, vol. 14, pp. 227-296).

The date of origin of this surface is not well determinined. Evidently it is later than the Schooley peneplain and earlier than some of the features already described, which seem to mark the closing stages of the Tertiary period. For these reasons it is provisionally referred to early Tertiary time, and it probably represents the Eocene epoch.

After the formation of the Harrisburg peneplain the surface again was raised and again dissection began to destroy the evidence of its existence. The next succeeding stage is not well marked, but there are traces along the major drainage lines and in other favorable localities of a surface about 100 feet below the general hilltop level. This partial peneplanation is thought to indicate another pause in the movement of the earth's crust, and the production of local peneplains where conditions were most favorable. From its development in the Allegheny Valley it has been named Worthington by Butts in the Kittanning folio (soon to be published.) Its date of origin can not be assigned definitely, but probably it marks the later portion of Tertiary time.

This slight period of undisturbed erosion was followed by another uplift of about 100 feet, and again the earth's crust remained stationary until the streams had cut broad valleys on the soft rocks, or where they were obstructed by the material brought down from Chestnut Ridge. The duration of this period was not so great as that which preceded it, and consequently did not result even in the production of a local peneplain, but only in broad valley floors which mark the development of a stream after it has passed its maturity. This feature is well developed along Allegheny River near Parker, and for that reason it is called by Butts in the Kittanning folio the Parker strath. On account of its relation to the Kansan drift, its date of origin may be assigned to the closing stages of the Tertiary period.

After the formation of the Parker strath, the region again was elevated at least 60 or 80 feet, and the streams cut deeper trenches in the bottoms of their broad valleys, but the duration of this subcycle was not sufficiently long to permit them to enlarge these except under the most favorable conditions.

QUATERNARY PERIOD.

After the short period of quiescence noted above which also is of pre-Pleistocene date, the region again was elevated, and the present channels were eroded. There are no features that indicate a cessation of this process, and presumably it has been in progress from the earlier part of the Pleistocene epoch down to the present day.

MINERAL RESOURCES.

COAL.

SCOPE OF THE DISCUSSION.

In undertaking the present geological survey of a region so well known as southwestern Pennsylvania it was considered unnecessary to duplicate work previously done, except to test by modern methods the results already obtained, and the aim of the present workers has been to devote most of their time to those features which received least attention in the previous reports. Under this general plan the geologic structure or lay of the beds, the detailed distribution of the various kinds of rock, including coal, and the physiographic history of the region have been studied carefully in the field and recorded on the maps so far as has been practicable. Detailed sections of coal beds and some other facts have been taken largely from previous reports, which abound in such information. Special acknowledgment is due to Stevenson and Platt for the data thus obtained.

Coal is the most important mineral resource of the Latrobe quadrangle. For a long time it has been mined and coked on a large scale in the Latrobe syncline and lately extensive developments have been undertaken in the Greensburg basin and along Conemaugh River. Coal occurs at intervals throughout the Pennsylvanian series, but it is most abundant in the Allegheny and Monongahela formations, although occasionally workable beds are found in the Conemaugh and Pottsville formations. The general positions of the coal beds are indicated on the columnar section sheet.

The Pittsburg coal, which occurs at the base of the Monongahela formation, is the most important bed in the Latrobe quadrangle and has brought this region into prominence as one of the great producing centers of the State. Although the Pittsburg coal is far from being exhausted, practical operators are looking ahead to a great decline in the production from that wonderful bed and are making preparations to utilize other beds in the near future. The Upper Freeport coal, lying at the top of the Allegheny formation, is the second most promising bed, and it is being prospected and mined at a number of places. Other beds doubtless will be developed as the demand for coal increases, so that many which are now regarded as worthless may come to have a fair market value.

COAL IN THE POTTSVILLE FORMATION.

Mercer coal.—The Pottsville formation is poorly exposed in the Latrobe region, and it is difficult to determine whether or not it carries a coal in its natural outcrop. Generally in the Chestnut Ridge region the formation is composed of two benches of sandstone separated by a small interval of shale and coal, but the shale is exceedingly irregular in thickness and the coal bed also is variable and in many places appears to be absent from the section. From the evidence afforded by fossil plants the coal horizon of the Pottsville in this region corresponds with the Mercer coal group of the Beaver Valley and also is of the same age as the Mount Savage coal of Maryland.

The only place in the Latrobe quadrangle where the Pottsville formation is cut by the streams is in the gap of Loyalhanna Creek through Chestnut Ridge, but in this locality the débris from the upper massive bench has obscured the rocks below and no trace of coal was seen. Professor Stevenson, in his examination of this region also failed to find any Pottsville coal exposed in natural outcrop. Although the Pottsville formation is fairly well shown on the well-section sheet, only a few of the individual sections are sufficiently detailed to exhibit coal beds. Section No. 14, however, is a very detailed record, and shows a coal bed at this horizon having a thickness of 5 feet. This well is located in Bell Township, Westmoreland County, somewhat beyond the northwest corner of the Latrobe quadrangle, and consequently can not be used as evidence regarding the existence of the Mercer coal in this area.

COAL IN THE ALLEGHENY FORMATION.

In its normal development in the Allegheny Valley this formation is supposed to contain 7 coal beds as shown in fig. 3.

In the Latrobe quadrangle the principal exposures of Allegheny formation are on the flanks of Chestnut Ridge, where the country is so broken that it is extremely difficult to obtain an accurate section of the coal beds.

Brookville-Clarion coal.—The lower coals of this formation are poorly exposed. They have not been extensively prospected, and the probabilities are that they are generally too thin to be of commercial importance. Stevenson (Second Geol. Survey Pennsylvania, Rept. K3, p. 134), reports that the Brookville coal is present in Ligonier Valley southeast of the town of Ligonier. He did not obtain a measurement of the bed, but states that it occurs within 20 feet of the top of the Pottsville formation. A coal at about this horizon has been prospected on the summit of Chestnut Ridge about 2½ miles southeast of Derry. No coal is now visible there, but the farmers in the vicinity report that it once showed a thickness of 4 feet. Coal at this horizon was not observed at any other point in the Latrobe quadrangle, but it seems to be noted in some of the sections, shown on the well-section sheet. Although the Brookville and Clarion coals are distinct and are widely separated in the Allegheny Valley, one of them appears to be absent in the southern part of the State where there is only one coal bed within the interval usually assigned to the two beds. Sufficiently detailed work has not been done to enable the geologist to correlate definitely the beds in the Allegheny Valley with the bed in the southern part of the State, and hence in the Masontown–Uniontown folio No. 82, this bed was called the "Brookville-Clarion coal."

Sections Nos. 9 and 11 on the well-section sheet show a coal bed within 50 feet of the top of the Pottsville formation. While in both sections this is noted as 5 feet in thickness, of course, allowance must be made for the inaccuracies of the driller's determinations, but it seems reasonably certain that in the northwestern part of the Latrobe quadrangle there is a coal bed not more than 50 feet above the top of the Pottsville. This may represent the Brookville or the Clarion coal, and it is quite possible that it corresponds with the bed just noted on Chestnut Ridge southeast of Derry.

Kittanning coal beds.—This group of coal beds is fairly well represented in the Allegheny Valley. As shown in fig. 3 it consists of three beds, called Lower, Middle, and Upper Kittanning coals, which lie from 120 to 240 feet above the top of the Pottsville formation. Of these three beds the lowest is most important in the type locality. It is very regular in thickness and composition, while the Middle and Upper beds are very irregular and uncertain in their occurrence. From the evidence at present available it is impossible to correlate the various outcrops with individual coal beds of the type locality, but it is possible to refer them to the group. On Chestnut Ridge a coal is reported from near the southern margin of the quadrangle at about 160 feet below the Upper Freeport coal bed. This was not seen in outcrop, but was reported to be 3 to 4 feet in thickness. From its great distance below the Upper Freeport coal it seems probable that it belongs to the Lower Kittanning horizon.

The same bed has been opened on the crest of Chestnut Ridge about 3 miles north of Long Bridge, where it shows a thickness of 3 feet 3 inches of coal (fig. 4). At this opening the coal is 70 feet vertically above the outcrop of the Homewood sandstone, but the beds dip strongly to the southeast and the interval between them is probably about 100 feet.

A coal bed which seems to occur near the Upper Kittanning horizon was observed at two points on Chestnut Ridge southwest of Loyalhanna Creek. One of these openings is on the slope of the ridge half a mile southeast of Youngstown, where the coal shows the following section (fig. 5):

Section at coal opening on Chestnut Ridge one-half mile southeast of Youngstown.

	Feet.	Inches.
Coal	1	6
Shale	2	0
Coal	1	6
Total	5	0

Probably the same coal was observed on the summit of the ridge not far from the southern margin of the quadrangle, where it attains a thickness of 3 feet (fig. 6). These two exposures seem to occur from 100 to 130 feet below the Upper Freeport coal bed, and presumably belong to the Upper Kittanning horizon.

Some of the coal beds of this group are recorded in a number of the sections shown on the well-section sheet. In section No. 5 a coal 2 feet in thickness is reported 148 feet below the roof of the Upper Freeport coal, and a bed 6 feet in thickness 39 feet lower in the series. It seems probable that both these coal beds belong to the Kittanning group, and presumably the bed last mentioned occurs at the Lower Kittanning horizon. In section No. 7 a coal 5 feet in thickness occurs 115 feet below the Upper Freeport horizon. It seems probable that this is the representative of either the Middle or Upper Kittanning coal of the type locality. In section No. 9 a trace of coal is reported at a depth of 51 feet below the Lower Freeport horizon. This undoubtedly is at the horizon of the Upper Kittanning coal, but none of the lower bed is reported from the well. Section No. 11 shows four coal beds in the Allegheny formation. The second one from the top undoubtedly belongs to the Kittanning group. Its reported thickness is 4 feet, and its depth below the Upper Freeport coal is 166 feet. The same coal is undoubtedly present in the Bartley well (section No. 12), with a thickness of 4 feet and at a distance of 148 feet below the roof of the Upper Freeport bed.

From the above facts it seems highly probable that the Kittanning coal group is represented in this region by at least one bed of workable thickness and it seems probable that this is the uppermost bed of the group. Consequently the coal which is most irregular and uncertain in the Allegheny Valley is the most reliable one in this region.

Lower Freeport coal.—The Lower Freeport coal is not well represented in this region, or at least has not been extensively prospected and worked. It is doubtless present in the Chestnut Ridge region, but no detailed sections could be obtained. One old pit was seen southwest of Loyalhanna Creek 50 feet below the country bank on the Upper Freeport coal bed, but the lower opening was completely filled and it was impossible to determine the thickness of the coal.

Where the Jacksonville anticline brings to light the Allegheny formation on Conemaugh River and Loyalhanna Creek the Lower Freeport coal bed is exposed at several points. An opening on Elders Run in Indiana County (see fig. 7) shows the following section:

Section of Lower Freeport coal on Elders Run.

	Feet.	Inches.
Coal	1	6
Shale	0	8 to 12
Coal	2	6
Total	4	10

At this point the bed appears to be about 70 feet below the Upper Freeport horizon. The coal is rather impure and presumably is not of very great commercial importance. At the time of the present survey the openings on Loyalhanna Creek were inaccessible, but Professor Stevenson gives the section of the Lower Freeport coal bed in this vicinity as 3 feet (fig. 8).

Upper Freeport coal.—This is decidedly the most important coal bed in the Allegheny formation. It has been extensively prospected and worked along both sides of Chestnut Ridge and at many points on its crest. It has also been developed to some extent on the Jacksonville arch where it crosses Conemaugh River and Loyalhanna Creek, and in the latter locality extensive mining operations are being undertaken which doubtless will make this one of the important mining regions of the quadrangle.

In the Ligonier Valley the Upper Freeport coal bed has been opened at a number of places along the southeastern front of Chestnut Ridge. In the gap of Loyalhanna Creek its outcrop may be observed just below the bridge at Darlington. At present the coal is inaccessible in this opening, but at the time of the Second Geological Survey of the State it was measured by Professor Stevenson, who gives the following section (see also fig. 9):

Section of Upper Freeport coal in gap of Loyalhanna Creek below bridge at Darlington.

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

About a mile and a quarter southwest of Darlington this coal has been opened in several places. Two exposures gave the coal a thickness of 4 feet (fig. 10), but the quality was not determined, and it is possible that the uppermost bench is poor as represented in the Darlington section. The Upper Freeport coal bed has been extensively mined for local use in a small knob on the crest of Chestnut Ridge, on the southern margin of the quadrangle. On the east and west sides of this knob openings show the coal to have a thickness of 4 feet (fig. 11). In passing north of Loyalhanna Creek the coal seems to be more broken, as is shown by the following section, measured on a small stream about 1 mile northeast of Darlington (fig. 12):

Section showing Upper Freeport coal 1 mile northeast of Darlington.

	Feet.	Inches.
Coal	0	6
Shale	0	5
Coal, bony	0	4
Coal	2	8
Total	3	11

Still farther northeast and near the eastern edge of the quadrangle a coal bed has been prospected in many places, but most of the prospect holes are now closed and it is impossible to obtain a measure of the coal or to determine its horizon. At a point just east of the road from Derry to Ligonier, on a tributary to Trout Run, there was observed the following section of a coal bed that appears to occur at the horizon of the Upper Freeport coal (fig. 13):

Section of coal bed near road from Derry to Ligonier.

	Feet.	Inches.
Coal, bony	0	6
Shale	0	4 to 6
Coal	1	6
Total	2	5

Along the northwest margin of Chestnut Ridge the Upper Freeport coal bed has been mined in many places to supply local needs. An opening just north of Kingston, within about 100 yards of Loyalhanna Creek, shows the following section (fig. 14):

Section of coal opening north of Kingston, near Loyalhanna Creek.

	Feet.
Sandstone roof.	
Coal	4
Fire clay	3
Limestone reported in branch.	

On the south side of the creek an opening was observed about 310 feet above water level which also shows the same thickness.

In the vicinity of Youngstown Professor Stevenson noted an outcrop of this coal which shows the following section (fig. 15):

Section of Upper Freeport coal near Youngstown.

	Feet.	Inches.
Coal	2	10
Clay	0	1
Coal	1	6
Total	4	5

This coal is reported as sulphurous and much broken by shale partings. North of Loyalhanna Creek the coal has been opened in almost every ravine which exposes its horizon. On Miller Run Professor Stevenson reports the following section (fig. 16):

Section of Upper Freeport coal on Miller Run.

	Feet.	Inches.
Coal	3	2
Clay	0	2
Coal	1	0
Total	4	4

This is also reported to contain a large amount of sulphur and to be high in ash on account of the numerous thin partings which it contains. About 1 mile due south of Derry the Upper Freeport coal has been opened in a small ravine in which the following section is exposed (fig. 17):

Section of Upper Freeport coal 1 mile south of Derry.

	Feet.	Inches.
Coal	3	3
Shale	1	2
Coal	2	4
Total	6	9

North of Loyalhanna Creek the coal increases considerably in thickness. This is shown by the section just given and also by the following section (fig. 18) of an opening in the ravine just east of Derry. This mine is operated at present to supply fuel for the stone-crusher which is located at this point.

Section of Upper Freeport coal in ravine east of Derry.

	Feet.	Inches.
Coal		7
Shale	0	1
Coal	2	6 to 3 feet
Shale	1	6 to 2 feet
Coal, bony, of inferior quality	2	6 to 3 feet

Professor Stevenson reports an opening near the Derry and Ligonier road with the following section (fig. 19):

Section of Upper Freeport coal on road from Derry to Ligonier.

	Feet.	Inches.
Coaly shale	0	6
Coal	3	0
Shale	1	6
Coal	3	1
Total	8	1

Owing to the sharp rise of the rocks to the southeast the outcrop of the Upper Freeport coal bed runs far up the mountain side. At an opening about 1 mile southeast of the last-mentioned locality and high on the ridge the following section was obtained (fig. 20):

Section of Upper Freeport coal on summit of Chestnut Ridge.

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

Northeast of this point the coal has been opened in almost every ravine, but no detailed sections were obtained.

On the northwestern side of Chestnut Ridge the Upper Freeport coal dips far below the surface in the Latrobe syncline and it appears at only one point on the next succeeding anticline. This point is where the anticline is cut by Loyalhanna Creek 4 miles northwest of Latrobe. Many years ago a mine was opened on it at this place and considerable coal was removed. According to report the bed is 4 feet thick in places, but it is irregular, sometimes running as low as 2 feet of merchantable coal. The mine has been abandoned for some time and it is impossible to obtain reliable information regarding the coal.

West of the Fayette anticline the Upper Freeport coal is under cover in the Greensburg basin, but it again rises to the surface where the principal streams are crossed by the Jacksonville anticline. It is exposed for a distance of 3½ miles along Conemaugh River between Tunnelton and White station and also on Loyalhanna Creek for a distance of about 2½ miles below the mouth of Serviceberry Run. On Conemaugh River the Upper Freeport was once extensively worked to supply fuel for Waddle's old salt works near the mouth of Elders Run. The section of the coal bed at this point is as follows (fig. 21):

Section of Upper Freeport coal on Conemaugh River near mouth of Elders Run.

	Feet.	Inches.
Coal	2	0
Local knife-edge parting	0	0
Coal	0	9
Bony coal	0	0
Coal	1	0
Total	3	9

The composition of the coal of the upper bench, as determined by Mr. McCreath and given by Mr. Platt, is as follows:

Analysis of Upper Freeport coal.

	Per cent.
Moisture	1.220
Volatile matter	32.570
Fixed carbon	59.689
Ash	4.370
Sulphur	2.151
Coke	66.710
Fuel ratio, 1.830	

Recently mining operations have been undertaken in this region by the Kiskiminetas Coal Company and the Mitchell-Watson Coal and Coke Company. The former has opened a mine in the first ravine below Tunnelton, in which the coal is reported to have a maximum thickness of 3 feet 8 inches, the average thickness being probably about 3 feet 6 inches. The Mitchell-Watson Coal and Coke Company has opened a mine just below White station on the same bed of coal, which here ranges from 3 feet 3 inches to 3 feet 6 inches in thickness.

The Freeport coal also shows in the great bend which the river makes east of Tunnelton. Its exposure at this point is due to the eastward swing of the Jacksonville anticline, which carries the coal bed above water level in the extreme northwestern point of the bend. No measures of the thickness of the bed could be obtained, but old prospect pits show that it has been worked. Although this bed was not noted in the reports of the second geological survey of Pennsylvania, it is mentioned by Rogers in the report of the first geological survey (vol. 2, pt. 1, p. 601), where it is stated that "it is commonly reported that a thick coal outcrops somewhere along the river below Livermore." Rogers did not visit the locality, but inclines to the opinion that it is one of the coals belonging to the Conemaugh formation. Forty feet lower in the section is a coal bed showing a thickness of 8 or 10 inches, which probably is the Lower Freeport coal.

At the present time no coal is being mined on Loyalhanna Creek, and consequently the openings are in such a condition that the thickness can not be determined. Professor Stevenson, however, gives two sections which show the composition of the bed in great detail. The first (fig. 22) is from an opening near the bridge about 2 miles southeast of Saltsburg, and is as follows:

Section of Upper Freeport coal 2 miles southeast of Saltsburg.

	Feet.	Inches.
Coal	2	2
Clay	0	1
Coal	1	2
Clay	0	2
Coal	0	4
Total	3	11

The second section was measured at an opening near Snodgrass mill, and is as follows (fig. 23):

Section of Upper Freeport coal on Loyalhanna Creek near Snodgrass mill.

	Feet.	Inches.
Coal	2	6
Clay	0	1
Coal	0	5
Clay	0	1
Coal	1	6
Clay	0	2
Coal	0	4
Total	5	1

In addition to its surface exposures the Upper Freeport coal bed occurs in most of the deep wells that have been sunk in this region, at the depth and with the thickness recorded below:

Upper Freeport coal bed in well sections.

	Depth below surface.	Thickness.
No. 4	402	6
No. 5	145	4
No. 6	320	7
No. 7	245	5
No. 8	275	5
No. 10	220	4
No. 11	130	4
No. 12	169	7

Besides occurring in the deep wells whose sections are given on the well-section sheet the Upper Freeport coal has been noted in other wells as follows: In the William Stett well No. 1, located near the river about 2 miles below Blairsville, the Upper Freeport coal is reported at a depth of 90 feet and with a thickness of 5 feet. The Lower Freeport also occurs in this well at a depth of 140 feet and with a thickness of 7 feet. In the Orr well, which was drilled in 1887 in Conemaugh Township near Saltsburg, the Upper Freeport is reported to have a thickness of 4 feet and to occur 48 feet below the surface. It is also reported from three wells drilled on Loyalhanna Creek a short distance above its mouth. In the M. J. and J. K. Johnson well the coal is at a depth of 275 feet. In the J. M. Lemon well the coal is reported to have a thickness of 4 feet and to occur 296 feet below the surface. In the Patrick Welch well the coal is reported to have a thickness of 4 feet and a depth of 140 feet. In the Leech Brothers well, three-quarters of a mile below Saltsburg, the Upper Freeport coal was encountered at a depth of 310 feet.

From the above-mentioned facts regarding the thickness and distribution of the Upper Freeport coal bed it seems to promise well as a source of supply when the larger and better beds are exhausted; but the chemical composition is more important than the thickness of the bed, and in this respect the coal is not all that could be desired. The coal has not been tested sufficiently to determine its exact value in this quadrangle, but from the analyses at command its percentages of ash and sulphur seem to be too high for a first-class coal. The coal will coke and presumably it might be extensively used for this purpose were its percentage of sulphur below one per cent. At Homer, on the branch railroad from Blairsville to Indiana, the Upper Freeport coal is successfully coked after being washed to remove shale impurities and sulphur. It seems possible that the coal in the Latrobe quadrangle might be treated in the same manner and become a valuable substitute for Pittsburg coal.

COAL IN THE CONEMAUGH FORMATION.

Although the Conemaugh formation is generally regarded as barren of workable coals, there are occasional beds in this series which are thick enough to mine under favorable conditions. One of these coal beds, which appears to have a wide geographic range in western Pennsylvania, occurs just above the Mahoning sandstone, at a distance of about 90 feet above the Upper Freeport coal. This bed was seen in Fayette County and in the Masontown-Uniontown folio was given the local name of the Farmington coal. Presumably it corresponds in stratigraphic position with the bed in West Virginia which Prof. I. C. White has called the Masontown coal. Since the latter name has long been used it is probable that its use in this region is better than the local name which was used in Fayette County. This coal was noted only in one locality—on Chestnut Ridge just off the southern margin of the quadrangle. At this point it appears 90 feet above the Upper Freeport coal and has a thickness of approximately 2 feet. Presumably it is not of workable proportions in this region, but its presence is interesting, since it seems to show that the coal has a wide geographical range.

Elklick coal.—This coal bed was recognized by Professor Stevenson in the Ligonier Valley, near the southeast corner of the Latrobe quadrangle. In a section which he measured near the town of Ligonier (Second Geol. Survey Pennsylvania, Rept. K3, p. 131) he reports the coal 290 feet below the Pittsburg coal bed with a thickness of 3 feet 6 inches (fig. 24). Its position as determined in this section is 20 or 30 feet below the Morgantown sandstone and from 40 to 60 feet above the Saltsburg sandstone.

During the present survey the Elklick coal was not noted in the quadrangle in the Ligonier Valley nor at any point east of the Latrobe syncline, but on the Fayette anticline on Dry Ridge it was seen at two points. It shows in the cuts of the Pennsylvania Railroad just west of Donohoe, where it seems to occur about 50 feet above the Saltsburg sandstone. It is only from 14 to 16 inches thick in this region, and consequently is not of workable thickness. On the east side of Dry Ridge, west of Latrobe, the coal occurs 40 feet above the Saltsburg sandstone. It has been opened in this locality, where it shows the following section (fig. 25):

Section of Elklick coal on east side of Dry Ridge, west of Latrobe.

	Feet.	Inches.
Coal	2	4
Coal	1	2
Coal	0	3
Total	3	9

The Elklick coal bed is presumably limited to the southern half of the Latrobe quadrangle, at least with a thickness which might under ordinary conditions be considered workable. Its absence in the northern half of the quadrangle is clearly shown by the record of two diamond-drill holes on Stewart Run, north of Blairsville. In these wells no coal exceeding 18 inches in thickness was encountered for a distance of 350 feet above the Upper Freeport coal.

COAL IN THE MONONGAHELA FORMATION.

This is by far the most important coal-bearing formation of the Latrobe quadrangle, and although normally it carries 5 coal beds which are locally of workable thickness, it derives its importance wholly from the fact that it contains the great Pittsburg bed, which has given this region its prominence in economic products.

Pittsburg coal.—The Pittsburg coal is persistent throughout all of western Pennsylvania, where its horizon is at or below the surface. In that respect it is exceptional and its regularity renders it of great importance, since it is not necessary to prospect in advance of mining developments.

Fig. 43 is a map showing the Pittsburg coal where it is under cover west of Chestnut Ridge. The great bulk of the coal lies southwest of the Latrobe quadrangle, but three isolated areas extend into this territory from that direction. The Connellsville basin is economically the most important of these isolated areas and is also the largest, extending from near the southern line of the State to beyond Conemaugh River.

Besides the large areas shown on this map there is a small field in Ligonier Valley east of Chestnut Ridge. This small remnant of Pittsburg coal lies east of the margin of the Latrobe quadrangle. The rocks of the syncline lie so high that most of the coal bed has been eroded, but a few fragments still cap the highest hills in the center of the basin.

In the Latrobe syncline the Pittsburg coal is present continuously from the southern margin of the quadrangle to Conemaugh River. The syncline rises to the northeast and at Blairsville the river has eroded its broad valley through the coal. It comes in again on the north side of the stream, but there are no large areas, its outcrop being limited to isolated patches in the higher hilltops.

In the Greensburg syncline the coal is present from the line of the Pennsylvania Railroad northeastward as far as Loyalhanna Creek. This syncline also rises to the northeast, and has been deeply trenched by the creek, leaving the Pittsburg coal exposed only on the higher summits. East of Loyalhanna Creek the coal is preserved in only a few isolated remnants, and these disappear in a distance of 3 or 4 miles.

The Elders Ridge syncline is not so deep as either of the basins just described, and consequently the coal is limited almost entirely to the high summits west of Saltsburg. The area remaining uneroded in this basin is so slight that the part which belongs in this quadrangle has little commercial importance.

The Latrobe syncline includes the northeastern extremity of what is generally spoken of as the Connellsville coking basin. In a commercial sense this is limited by the Pennsylvania Railroad, though strictly speaking the basin extends beyond Conemaugh River, but northeast of Latrobe the quality of the coal is not equal to that in the type Connellsville field, and for commercial reasons it is excluded.

The Pittsburg coal bed is very uniform in character throughout the whole of western Pennsylvania. It consists in a broad way of a roof division, made up of a number of alternating bands of coal and clay, a main clay parting which separates this worthless roof division from the valuable coal below, and a lower division which consists of a number of benches of variable quality. In places the coal is overlain by the Pittsburg sandstone, and in such occurrences the roof division is frequently wanting, the sandstone resting in many places on the lower division, and in some cases replacing a part of the uppermost bench of that division. The details of the roof division vary greatly from place to place, but the main clay parting is generally persistent. The benches into which the lower division is divided are also generally recognizable in every outcrop of the region. In a general way the lower division consists of an upper bench, called the breast coal, which ranges from 3 to 4 feet in thickness. Underlying this is usually a small bench, from 2 to 4 inches in thickness, separated from the coal above and below by knife edges of slate. This thin bench is known as the bearing-in coal, since it is the bench upon which the mining is done. This bearing-in coal is underlain generally by a bench about 1 foot in thickness, which, from its block character, is generally known as the brick coal. This in turn is separated from the bottom bench by a knife edge of slate. The bottom bench is generally from 12 to 18 inches in thickness and frequently is made up of bony coal which is so impure that it is not removed.

The structure of the Pittsburg coal in the Latrobe basin is well illustrated by the following sections. Fig. 26 is from an opening about one-half mile southwest of Klondike, the details of which are as follows.

In this section the roof division shows more and thicker benches of coal than usual, but in all cases they are too thin and too much involved with the clay partings to be of value. The variations of the roof division are shown by a comparison of the section just given with fig. 27, which was

Section of Pittsburg coal at opening one-half mile southwest of Klondike.

	Feet.	Inches.	Feet.	Inches.
Roof division:				
Coal	1	3		
Shale and coal	1	0		
Coal	2	0		
			4	3
Main clay			1	9
Lower division:				
Coal	0	8		
Coal	1	1		
Coal	3	0		
Bearing-in coal	0	3		
Brick coal	0	10		
Bottom coal	1	6		
			7	4

measured at an old opening near the Marguerite mine at Klondike. Its section is as follows:

Section of Pittsburg coal at opening near Marguerite mine at Klondike.

	Feet.	Inches.	Feet.	Inches.
Roof division:				
Coal	0	4		
Clay	0	2		
Coal	0	2		
Clay	0	2		
Black shale	1	0		
Coal	0	2		
Sandy shale	0	6		
Coal	0	5		
Black shale	0	6		
Coal	0	3		
			3	8
Main clay			1	3
Lower division:				
Coal, bony	0	8		
Coal	2	4		
Coal	2	6		
Clay	0	1		
Coal	0	10		
Clay	0	1		
Coal	1	3		
			7	9

The coal has been opened at a number of places along the western outcrop, but most of the banks are closed and the coal is not now accessible. North of the Philadelphia and Pittsburg pike country banks are still in operation on Fourmile Run, which show the following section (fig 28):

Section of Pittsburg coal on Fourmile Run.

	Feet.	Inches.	Feet.	Inches.
Roof division:				
Coal			1	0
Main clay			1	6
Lower division:				
Coal, bony	0	8		
Breast coal	4	4		
Bearing-in coal	0	3		
Bottom coal	3	2		
			8	5

The chief difference between this section and the sections obtained south of this point is in the roof division, and this is probably accounted for by the presence of the heavy Pittsburg sandstone on Fourmile Run, which presumably cuts out a portion of the roof, leaving only one bench, 1 foot in thickness. This condition is illustrated also by a section in the railroad cut at Beatty, where the roof division is reduced to a single coal bed 5 inches in thickness (fig. 29):

Section of Pittsburg coal in railroad cut at Beatty.

	Feet.	Inches.	Feet.	Inches.
Roof division:				
Coal			0	5
Main clay			0	4
Lower division:				
Breast coal	4	0		
Slate	0	1		
Bearing-in coal	0	3		
Slate	0	1		
Bottom bench contains many slate binders	3	6		
			7	11

On the eastern side of the basin three large mines, Whitney, Hostetter, and Baggaley, are located between the southern margin of the territory and Loyalhanna Creek. North of this point the mining operations are generally restricted to the center of the basin, and in the vicinity of Latrobe they consist of the Dorothy, Loyalhanna No. 2, Monastery, Latrobe, Saxman, Loyalhanna No. 1, Pandora, Derry, Atlantic, and St. Clair.

On the eastern edge of the basin on Saxman Run

Section of Pittsburg coal on Saxman Run.

	Feet.	Inches.	Feet.	Inches.
Sandstone.				
Main clay			0	7
Lower division:				
Coal	1	0		
Clay	0	6		
Coal	1	11		
Coal and slate	0	4		
Coal	4	5		
			8	2

the sandstone apparently cuts out the entire roof division, leaving the following section (fig. 30).

To the north the roof division continues thin, as shown by an opening on the New Alexandria and New Derry road on the head of Union Run. The section is as follows (fig. 31):

Section of Pittsburg coal at opening near head of Union Run.

	Feet.	Inches.	Feet.	Inches.
Roof division:				
Coal			0	3
Main clay			0	5
Lower division:				
Coal	4	1		
Coal and partings	0	4		
Brick coal	0	10		
Coal and partings	0	3		
Clay shale	0	10		
Coal	1	2		
			7	6

In this section the lower division is more broken than usual, a clay shale 10 inches in thickness separating the bottom bench from the beds above. In this case the bottom bench is not removed, mining operations being confined to the breast and brick coals, which have a total thickness of about 5 feet. Between Saxman Run and Conemaugh River mines are not abundant, the Millwood shaft being the only commercial mine in operation in this region. There are, however, a number of country banks which are worked for the local trade. One of these on Stony Run, gives the following section, which appears to consist entirely of the lower division of the coal (fig. 32).

Section of Pittsburg coal on Stony Run.

	Feet.	Inches.
Coal	3	8
Clay	0	1
Coal	0	3
Clay	0	1
Coal	1	10
Clay shale	0	10
Coal	1	6
Total	8	3

On Conemaugh River the roof division of the coal is represented by a single bench 3 inches in thickness and the partings in the lower division are less conspicuous. A section of the lower division measured by Mr. Platt just north of Blairsville (fig. 33) is as follows:

Section of Pittsburg coal near Blairsville.

	Feet.	Inches.		Feet.	Inches.
Coal	3	8	to	3	10
Slate	..	..		0	1½
Coal	1	10	to	2	0

The composition of the coal in the vicinity of Blairsville is shown by the following analysis, which was made by McCreath of the second Pennsylvania geological survey:

Analysis of Pittsburg coal.

	Per cent.
Water	.850
Volatile matter	27.385
Fixed carbon	49.748
Sulphur	3.017
Ash	19.000
Total	100.000

In the Greensburg basin the coal is somewhat more impure than in the Latrobe syncline, but by special treatment a fair quality of coke may be produced which meets with ready sale. The structure of the coal bed is much the same as in the Latrobe syncline. In the vicinity of Georges station its section is as follows (fig. 34):

Section of Pittsburg coal near Georges station.

	Feet.	Inches.	Feet.	Inches.
Roof division:				
Coal			0	3
Main clay			0	6
Lower division:				
Coal	2	0		
Coal	2	6		
Bearing-in coal	0	3		
Brick coal	0	10		
Coal	0	7½		
Coal	1	3		
			7	5½

Within the last few years several large mines have been established in this basin which are now producing a great amount of merchantable coke and lump coal for fuel purposes. The field is reached by a branch railroad which leaves the main line at Donohoe, and it is probable that connection will soon be made with the Western Pennsylvania division of the Pennsylvania Railroad at Saltsburg. The mines in this basin are as follows: Jamison Nos. 1 and 2, Alexandria, Donohoe, Salem, and Huron. The structure of the coal on the west side of the basin is shown by fig. 35 which represents a section on Whitethorn Creek near the western boundary of this quadrangle. In this it will be seen that the lower division is about the same as that already noted, and that the roof division includes two bands of coal above the main clay parting:

Section of Pittsburg coal on Whitethorn Creek.

	Feet.	Inches.	Feet.	Inches
Roof division:				
Coal	0	2		
Shale	1	0		
Coal	1	0		
			2	2
Main clay			1	2
Lower division:				
Breast coal	4	1		
Bearing-in coal	0	3		
Brick coal	0	8		
Bottom coal	1	8		
			6	8

Even in this region the roof division is extremely variable as shown by comparison of fig. 35 with the following section (fig. 36), which was measured on the west side of the basin near New Alexandria:

Section of Pittsburg coal near New Alexandria.

	Feet.	Inches.	Feet.	Inches.
Main clay			1	6
Lower division:				
Breast coal	4	11		
Bony coal	0	1		
Coal	0	3		
Coal	0	10		
Brick coal	0	7		
Bottom coal	1	4		
			8	0

In the vicinity of New Alexandria the coal has long been worked to supply local needs. Its section in this vicinity is as follows (fig. 37):

Section of Pittsburg coal near New Alexandria.

	Feet.	Inches.	Feet.	Inches.
Roof division:				
Coal			0	6
Main clay			1	6
Lower division:				
Breast coal	3	2		
Bearing-in coal	0	4		
Brick and bottom coal	2	4		
			5	10

The Pittsburg coal in the Elders Ridge syncline was extensively worked by the Saltsburg Coal Company, which had large mines just west of Saltsburg in the vicinity of Fairbanks. The coal from this field is largely removed, but its section as noted by Professor Stevenson is as follows (fig. 38):

Section of Pittsburg coal near Fairbanks.

	Feet.	Inches.		Feet.	Inches.
Roof division:					
Coal	1	0	to	3	0
Clay	0	2			
Coal	0	4			
Main clay	3	0	to	0	1
Lower division:					
Coal	2	2			
Parting	2	0	to	0	1
Coal	3	2			
Parting	1	0	to	0	1
Coal	0	8			
Coal	1	6			

Another measurement, near the western corner of Loyalhanna Township, shows that the roof division is very much thinner than in sections previously given, that the partings in the Lower division are very much thinner, and consequently that the coal is in better condition. Recently this property has been acquired by a new company, and the probabilities are that active operations will again be carried on in this quadrangle and that the remainder of the Pittsburg coal in this syncline will be removed(fig. 39).

Section of Pittsburg coal near western corner of Loyalhanna Township.

	Feet.	Inches.	Feet.	Inches.
Roof division:				
Coal			1	0
Main clay			1	0
Lower division:				
Breast coal	5	0		
Bearing-in coal	0	3		
Brick coal	1	0		
Bottom coal	1	6		
			7	9

Coal beds above the Pittsburg horizon.—In the type section of the Monongahela formation there are a number of beds of coal that are locally of considerable importance. The first of these in ascending order is the Redstone coal, which in the vicinity of Uniontown—the type locality—occurs about 80 feet above the floor of the Pittsburg bed. This coal in places attains a thickness of 4 to 5 feet, but in the Latrobe quadrangle it is thin, and presumably at no point attains a workable thickness. Its bloom was noted in a number of places, but a measure was obtained only along the railroad in the vicinity of Saxman Run, where it has a thickness of only 4 inches.

The Sewickley coal bed normally occurs about 120 feet above the floor of the Pittsburg bed, at the base of the Benwood limestone. This bed was not noted in the Latrobe quadrangle, and presumably it is not present in sufficient thickness to be of commercial importance.

In Fayette County the Uniontown coal bed marks the top of the Benwood limestone, but its development appears to be limited to the type locality, and it is not known in the Connellsville basin north of this point.

Waynesburg coal.—The uppermost member of the Monongahela formation is the Waynesburg coal, which is more generally persistent than any of the intermediate beds of the formation. It is limited entirely to a small area near the southern margin of the quadrangle, in the Latrobe syncline. It shows only as a bloom by the wayside, but at the time of the second geological survey a country bank was opened from which Professor Stevenson obtained the following section (fig. 40):

Section of Waynesburg coal.

	Feet.	Inches.
Coal	1	0
Clay	0	8
Coal	1	0
Clay	0	4
Coal	1	0
Total	4	0

This coal is noted as being slaty throughout and of little value.

In general the coal beds above the Pittsburg horizon are thin and poor in the Latrobe quadrangle and in an estimate of the coal resources they may be omitted.

COKE.

Latrobe syncline.—The Latrobe quadrangle includes the northeastern extremity of the famous Connellsville coking field. Structurally this basin extends entirely across the quadrangle, but commercially it is divided in the vicinity of Latrobe. That part of the basin lying southwest of Loyalhanna Creek is considered as belonging to the Connellsville field, while that lying to the north of this line is classed commercially as the Upper Connellsville district. The reason for this division is found in the quality of the coke produced from the two parts of the synclinal basin. Northeast of Loyalhanna Creek the coal contains more earthy impurities and the sulphur content is more irregular, consequently the coke is of a somewhat inferior grade. For that reason the basin is separated in the commercial classification.

Only a small area of the Connellsville field is included within the boundaries of this quadrangle. It includes the Humphreys, Marguerite, Whitney, Hostetter, Baggaley, Dorothy, Monastery, and Latrobe mines, which have an aggregate of about 2200 ovens.

The Upper Connellsville district includes the Saxman, Superior, Loyalhanna No. 1, Atlantic, St. Clair, Derry, and Isabella mines, which have about 1200 ovens in general use. Recently coke production at the Isabella mine has been abandoned, owing to the inferior quality of the coke produced, so that at present there are only about 950 ovens in actual use.

Greensburg syncline.—Coke has been produced in a small way in this field since 1889, but at first only the slack coal was used and a few ovens sufficed to convert it into coke, which was regarded as a by-product in the operation of the mines. The coking industry was first developed in the vicinity of Greensburg, but since 1899 great activity has been manifest in this field and large mines have been opened in the eastern end of the basin within the limits of the Latrobe quadrangle. The names of these plants are as follows: Jamison Nos. 1 and 2, Alexandria, Donohoe, and Salem. They are almost entirely devoted to the manufacture of coke and have an aggregate of about 1200 ovens.

The coal in the Greensburg basin is slightly inferior to that in the Latrobe syncline, carrying a higher percentage of ash, and in order to produce merchantable coke it is necessary to crush and wash the coal before charging the ovens. When this is done the product is only slightly inferior to the type Connellsville coke and finds a ready sale.

The Pittsburg coal has not been coked in the Elders Ridge syncline. It was formerly extensively mined by the Saltsburg Coal Company at Fairbanks, but the product was used exclusively for steaming purposes. So highly was this coal valued by the Pennsylvania Railroad Company that the Western Pennsylvania division consumed almost the entire product of the mine.

At the present time the Pittsburg coal is the only coal that is mined for coking purposes. This is due to the exceptional size of the bed and the quality of the coal. The coal from the Upper Freeport bed will produce a coke of fair quality, but it is generally too poor to be used in the blast furnace. If, however, the coal is carefully washed a large percentage of the ash and sulphur is removed and the coal produces a fair quality of coke. This is illustrated by a plant at Homer, south of Indiana, which is now producing considerable coke from the Upper Freeport coal bed.

The prospect for the extension and development of the coking industry in the Latrobe quadrangle is not particularly good. The quality of the product is the chief drawback, but it is possible that with care in preparing coal for the ovens the industry may be extended and much more coke produced.

NATURAL GAS.

The Latrobe quadrangle is not particularly noted for its production of natural gas, but it is not very far removed from gas fields which have been famous in the commercial history of this part of the State. The old Grapeville field was located upon the extension of the Jacksonville anticline west of Greensburg, and still farther west on the Roaring Run anticline, was the Murraysville field, which for a long time was the greatest producer in western Pennsylvania. The only field which has proved productive in the Latrobe quadrangle is the Fayette anticline west of Latrobe. A large number of wells have been drilled on Dry Ridge which, as shown by the geologic structure, is one of the culminating points of the Fayette anticline. These wells are the property of the Latrobe Steel Company and have furnished that company with gas for a number of years.

In the northern part of the quadrangle considerable prospecting has been done for oil and gas, with but slight results. The locations of the deep wells are shown on the map, but none of these wells are at present productive.

Aside from the drilling on Dry Ridge, most of the prospecting has been done along Conemaugh River, where the anticlinal structures are comparatively small—that is, each anticlinal fold crossed by the river develops either to the north or south into a much more pronounced fold, and consequently the gas does not accumulate along this low part of the anticlines. If the structure had been well determined in the early days of gas production little drilling would have been done in this region. The most favorable localities are on Dry Ridge west of Latrobe, where the Fayette anticline has a notable development, and also in the vicinity of Salem Church, at the head of Spruce Run, where it also has a local development nearly equal to that on Dry Ridge. Beyond this point a number of wells have been drilled along the supposed line of the anticline, but they have shown that the anticline does not extend beyond Conemaugh River, and consequently the wells are in the synclines and contain no gas. The Jacksonville anticline reaches its maximum development north of this territory, and the rocks rise rapidly in that direction. Under such conditions gas does not readily accumulate, and consequently the field is barren.

BUILDING STONE.

Many of the sandstone beds outcropping in this region would make a fair quality of building stone, but in most cases the irregular bedding that characterizes them renders them rather expensive and unsatisfactory for use. At certain localities where they become more massive this objection does not apply and stones of excellent quality may be obtained.

One of the best quarry rocks known in this quadrangle is the Mahoning sandstone, on the Jacksonville anticline. During the construction of the old canal along Conemaugh River this sandstone was extensively quarried for the construction of locks, but since that date the quarries have fallen into disuse, and until within the last year or two this stone has not been utilized. Recently the Kiskiminetas Quarries Company has developed two big quarries on this rock north of Tunnelton and is shipping large-sized stone for rough work. The stone is well adapted for piers, abutments, and retaining walls, and for this purpose is extensively used.

The massive beds of the Pottsville sandstone also afford good building stone, but they are not utilized at any point in this quadrangle.

GLASS SAND.

Although the Pottsville sandstones are not used for building purposes, they are quarried and crushed for glass sand at many points throughout western Pennsylvania. One of these plants is located at Derry, and the raw material is derived from a quarry on the Homewood sandstone half way up the western slope of Chestnut Ridge. This bed contains only a small percentage of iron and consequently is well adapted to the manufacture of glass. The stone is taken from the quarry by a tram road to the crusher which is located in the ravine just back of the village of Derry. The stone is crushed and washed and the sand is shipped to various glass plants throughout the country. The fuel for this plant is obtained from the Upper Freeport coal bed, which is mined just back of the stone crusher. It furnishes a cheap and effective fuel for this purpose.

PAVING BLOCKS AND BALLAST.

The bed of siliceous limestone which is here regarded as the uppermost member of the Pocono sandstone is quarried for paving blocks and crushed for ballast at a great many points along Chestnut Ridge. Crushers are in operation on the Conemaugh east of Blairsville, on Loyalhanna Creek in this quadrangle, and on the Youghiogheny above Connellsville.

The rock quarried for these plants is overlain by the red shales of the Mauch Chunk formation and at its base grades into the siliceous sandstone of the typical Pocono. It is strongly calcareous in its upper part but toward the base it becomes more sandy, and finally changes by imperceptible degrees into the sandstone below. At the quarries on Loyalhanna Creek, which are located on the southeastern side of the anticline, the quarry rock has the following section:

Section at stone quarries on Loyalhanna Creek.

	Feet.
Red shale	10+
Sandstone	25
Red shale	0 to 5
Siliceous limestone	45
Red shale	0 to 3
Siliceous limestone	12
Sandstone.	

The uppermost bed of red shale noted in the section appears to be constant throughout these quarries, but the lower band is variable, appearing in certain places on the quarry face, but in others being absent. The stone from the quarry is delivered to crushers in the valley at creek level and is there reduced to a size suitable for railroad ballast. Some of the better layers are made into paving blocks, but most of the rock is used only for ballast. The advantage which this stone possesses for railroad ballast lies in the fact that it contains lime enough to cement the broken fragments and still allow free circulation, so that the roadbed has free drainage.

This bed of siliceous limestone has a wide geographical development throughout the mountainous region of Pennsylvania, and a large amount of it is available for use.

LIMESTONE.

Beds of limestone are of common occurrence, especially in the formation which lies above the Pittsburg coal. In the Conemaugh formation limestone layers are less abundant, and consequently are more in demand than in other parts of the country. It is probable that in this region none of the limestone beds is sufficiently even in composition to form good building stone, but many of them are pure enough to be burned into lime for agricultural purposes. The bed of siliceous limestone which is crushed for railroad ballast may also be burned into lime, but the amount of sand present is so great as to render it practically valueless for fertilizing purposes. It is claimed that when burned it makes a natural mortar, but presumably the sand would not compensate for the extra cost of burning.

SALT.

The town of Saltsburg owes its name to the early production of salt along Conemaugh River. There are today remains of salt works along the old canal but they ceased operations long ago and no salt is now produced in the region. According to report the brine was derived from the Pocono sandstones, which were productive wherever they were tested, but the strength of the brine was not sufficient to render the industry permanent. During the flourishing period of salt manufacture the Upper and Lower Freeport coal beds on the Jacksonville anticline were extensively worked for fuel for evaporating the brine, and at that time the coal beds were much better known than at present. The conditions are such that it is extremely doubtful if salt making will ever be resumed in the Conemaugh Valley.

FIRE CLAY.

The Latrobe quadrangle is situated in a region which is marked by the occurrence of many valuable beds of fire clay, but at present they are not utilized. Three horizons are generally clay bearing in this part of the State. The uppermost bed is extensively developed on Conemaugh River above the gap through Chestnut Ridge and is widely known as the Bolivar fire clay. This bed occurs a few feet below the Upper Freeport coal and carries in places extremely valuable refractory fire clay. The bed varies in composition from place to place, consisting in part of high-grade refractory clay and in part of plastic clay. As this bed is known east of this region, at Bolivar, and on the southwest, at Connellsville, it seems probable that it is present in the Latrobe quadrangle. The second clay horizon in descending order occurs in the Kittanning group of coals. This is not so extensively developed east of Allegheny River as the Bolivar clay, and consequently its occurrence in the Latrobe quadrangle is doubtful. The third important bed of clay in Chestnut Ridge occurs below the Brookville-Clarion coal bed and almost immediately above the Pottsville sandstone. South of Connellsville this clay bed is of great thickness and importance and is extensively used in the manufacture of fire brick, but it is not known north of Youghiogheny River, and its occurrence in the Latrobe quadrangle can be determined only by careful prospecting.

The main clay parting of the Pittsburg coal bed is utilized at Manown, on Monongahela River, for the manufacture of various clay shapes that are used in the production of steel. It seems possible that the clay in this region might be used for a similar purpose. So far as known it has never been tested, but its availability for this use could easily be determined by practical test.

June, 1903.

U.S. GEOLOGICAL SURVEY
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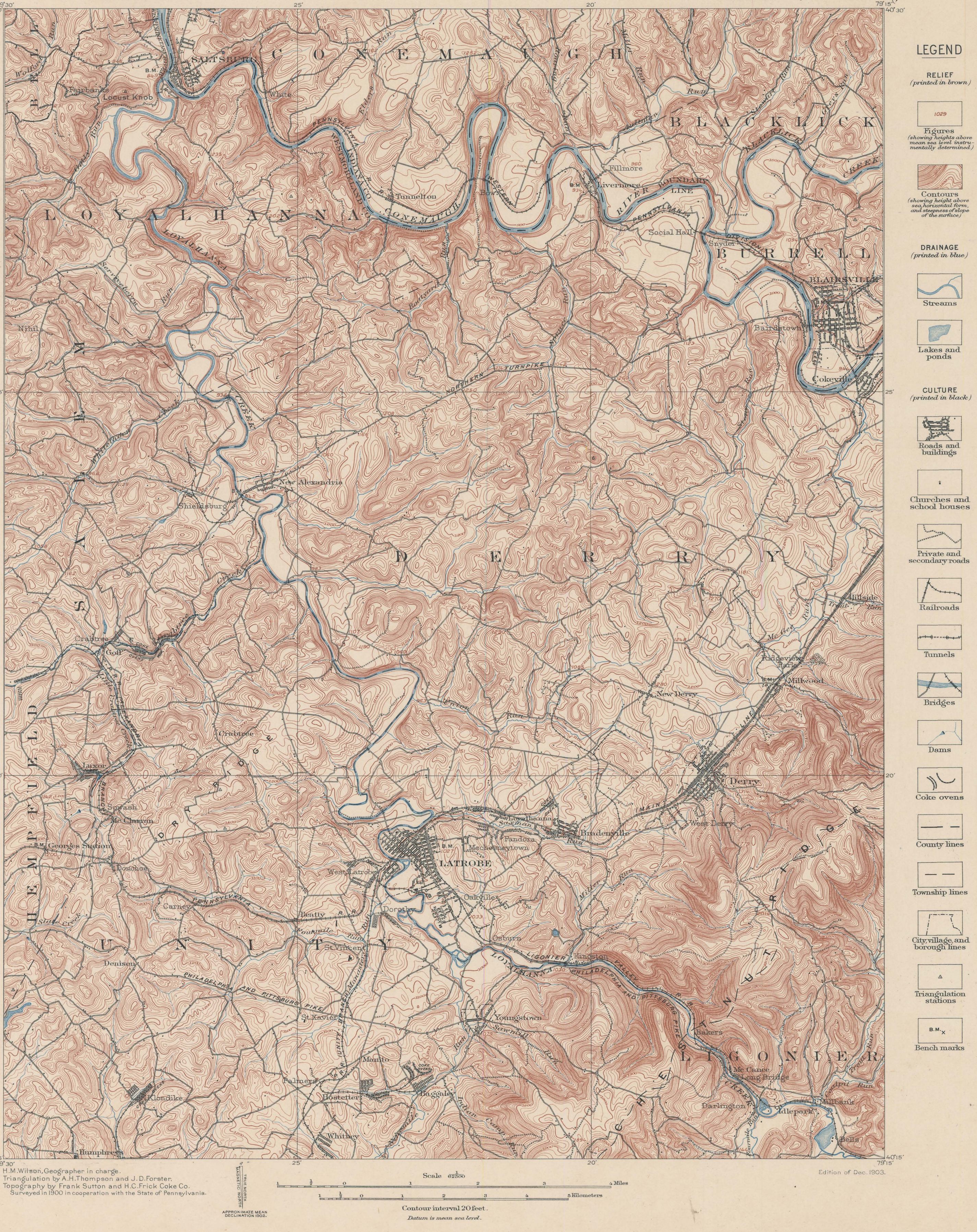
TOPOGRAPHY

PENNSYLVANIA
LATROBE QUADRANGLE



H. M. Wilson, Geographer in charge.
Triangulation by A. H. Thompson and J. D. Forster.
Topography by Frank Sutton and H. C. Frick Coke Co.
Surveyed in 1900 in cooperation with the State of Pennsylvania.

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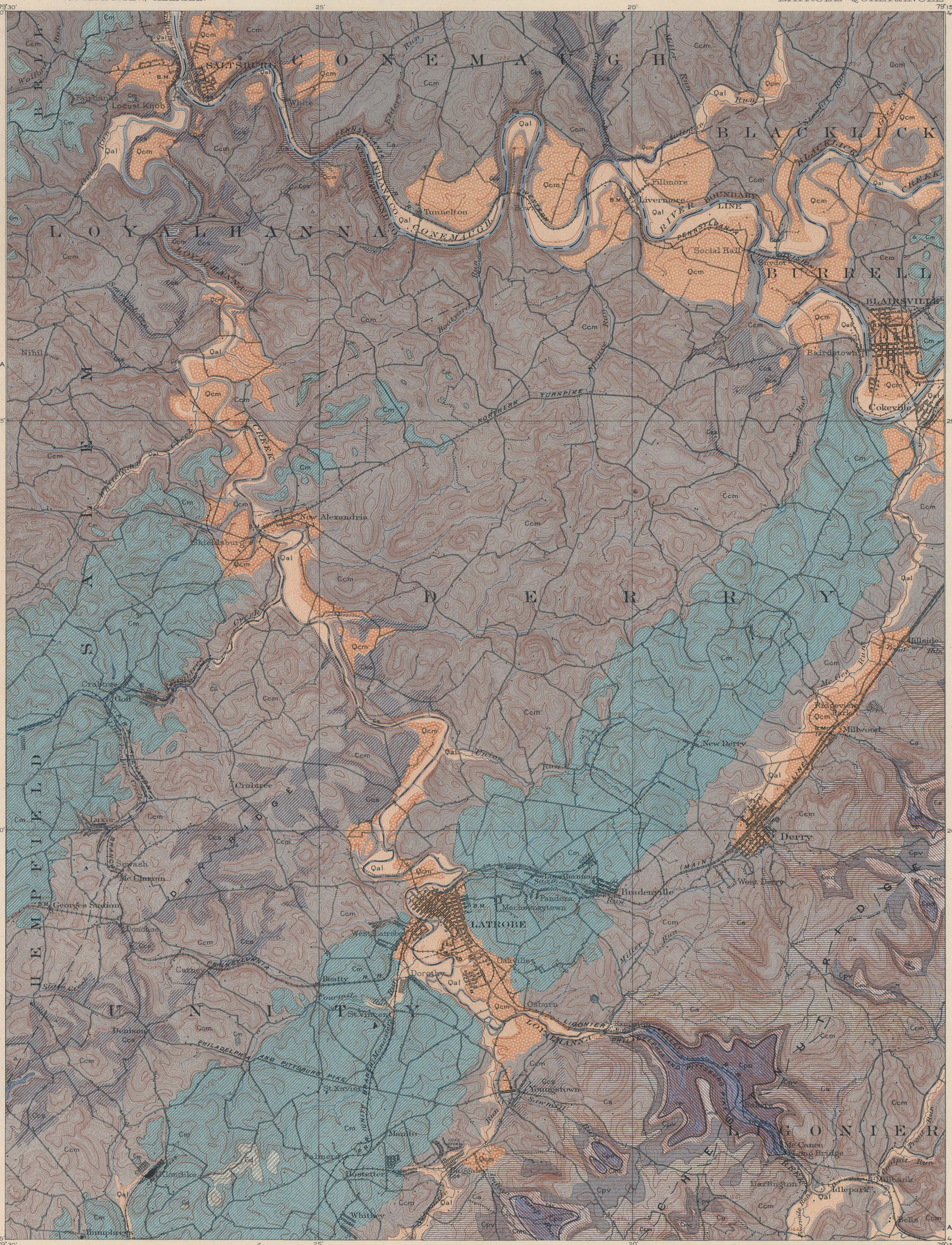
AREAL GEOLOGY

PENNSYLVANIA
LATROBE QUADRANGLE



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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 Jan. 1904.

Geology by Marius R. Campbell.
Assisted by George B. Richardson
and Lester H. Woolsey.
Surveyed in 1901-02 in cooperation
with the State of Pennsylvania.

LEGEND

SEDIMENTARY ROCKS

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

QUATERNARY

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

Qcm — Carmichaels clay *(clay, sand, and bowlders on terraces and in abandoned channels of the larger streams)*

CARBONIFEROUS

Permian series ?

Cd — Dunkard formation *(only the lowest member, Waynesburg sandstone, occurs in this area)*

Pennsylvanian series

Cm — Monongahela formation *(shale, limestone, and occasionally coarse sandstone; Pittsburg coal at the bottom, Waynesburg coal at the top, and coal beds of local importance between)*

Ccm — Conemaugh formation exclusive of the Saltsburg sandstone *(sandstone, shale, small amount of limestone, and a few small coal beds)*

Ccs — Saltsburg sandstone lentil in the Conemaugh formation *(coarse, thick-bedded or massive sandstone in the Conemaugh formation)*

Ca — Allegheny formation *(shale, sandstone, and clay with several workable coal beds; Upper Freeport coal at the top)*

Cpv — Pottsville sandstone *(coarse massive sandstone or conglomerate with some shale and usually a coal bed at the middle)*

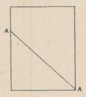
Mississippian series

Cmc — Mauch Chunk formation exclusive of the Greenbrier limestone *(red and green shale and thin-bedded green sandstone)*

Cgr — Greenbrier limestone lentil in the Mauch Chunk formation *(thin blue fossiliferous limestone)*

Cpo — Pocono sandstone *(coarse sandstone grading into very sandy limestone at the top and usually containing sandy shale)*

Section

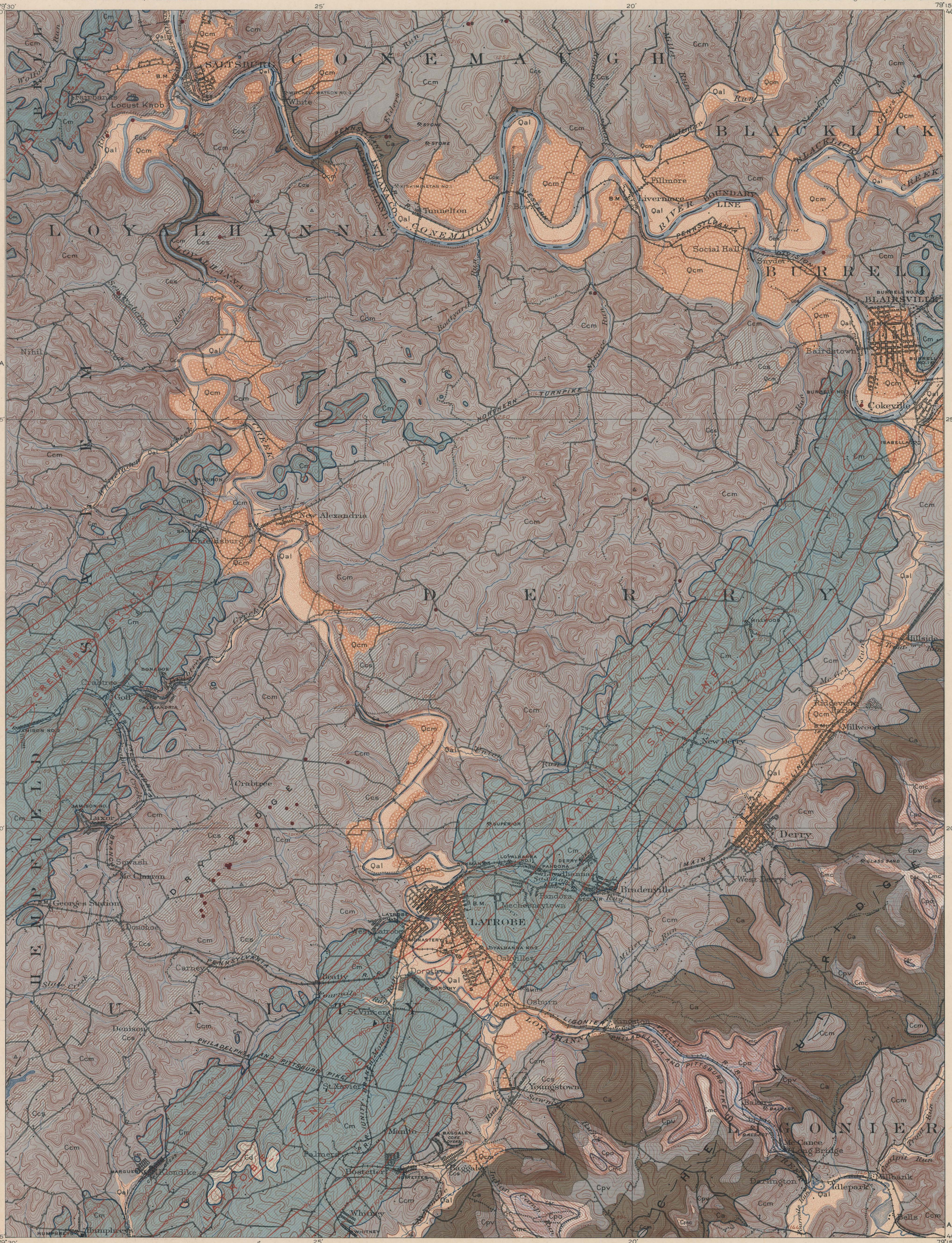


U.S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR.

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

ECONOMIC GEOLOGY

PENNSYLVANIA
LATROBE QUADRANGLE



H.M. Wilson, Geographer in charge.
Triangulation by A.H. Thompson and J.D. Forster.
Topography by Frank Sutton and H.C. Frick Coke Co.
Surveyed in 1900 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 Jan. 1904.

Geology by Marius R. Campbell.
Assisted by George B. Richardson
and Lester H. Woolsey.
Surveyed in 1901-02 in cooperation
with the State of Pennsylvania.

LEGEND

SEDIMENTARY ROCKS

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

QUATERNARY

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

Qcm — Carmichaels clay *(clay, sand, and bowlders on terraces and in abandoned channels of the larger streams)*

CARBONIFEROUS

Permian series ?

Cd — Dunkard formation *(only the lowest member, Waynesburg sandstone, occurs in this area)*

Pennsylvanian series

Cm — Monongahela formation *(shale, limestone, and occasionally coarse sandstone; Pittsburg coal at the bottom, Waynesburg coal at the top, and coal beds of local importance between)*

Ccm — Conemaugh formation exclusive of the Saltsburg sandstone *(sandstone, shale, small amount of limestone, and a few small coal beds)*

Ccs — Saltsburg sandstone lentil in the Conemaugh formation *(coarse, thick-bedded or massive sandstone in the Conemaugh formation)*

Ca — Allegheny formation *(shale, sandstone, and clay with several workable coal beds; Upper Freeport coal at the top)*

Cpv — Pottsville sandstone *(coarse massive sandstone or conglomerate with some shale and usually a coal bed at the middle)*

Mississippian series

Cmc — Mauch Chunk formation exclusive of the Greenbrier limestone *(red and green shale and thin-bedded green sandstone)*

Cgr — Greenbrier limestone lentil in the Mauch Chunk formation *(thin blue fossiliferous limestone)*

Cpo — Pocono sandstone *(coarse sandstone grading into very sandy limestone at the top and usually containing sandy shale)*

⚒ *Coal mines and stone quarries*

● *Wells drilled for gas*

Section

A — A

Known productive formations

Coal outcrops *(beds of probably workable thickness; dashed lines indicate outcrops beneath surficial deposits)*

Cm — *Most important coal* *(Monongahela formation contains the Pittsburg, Waynesburg, and other coal beds)*

Ca — *Coal* *(Allegheny formation contains the Freeport, Kittanning, and other coal beds)*

Ccm Cpv — *Coal* *(Conemaugh formation and Pottsville sandstone contain thin coal beds)*

1000 — *Contour lines showing lay of Pittsburg coal bed* *(elevation above sea level is shown by figures on contour lines; contour interval is 50 feet)*

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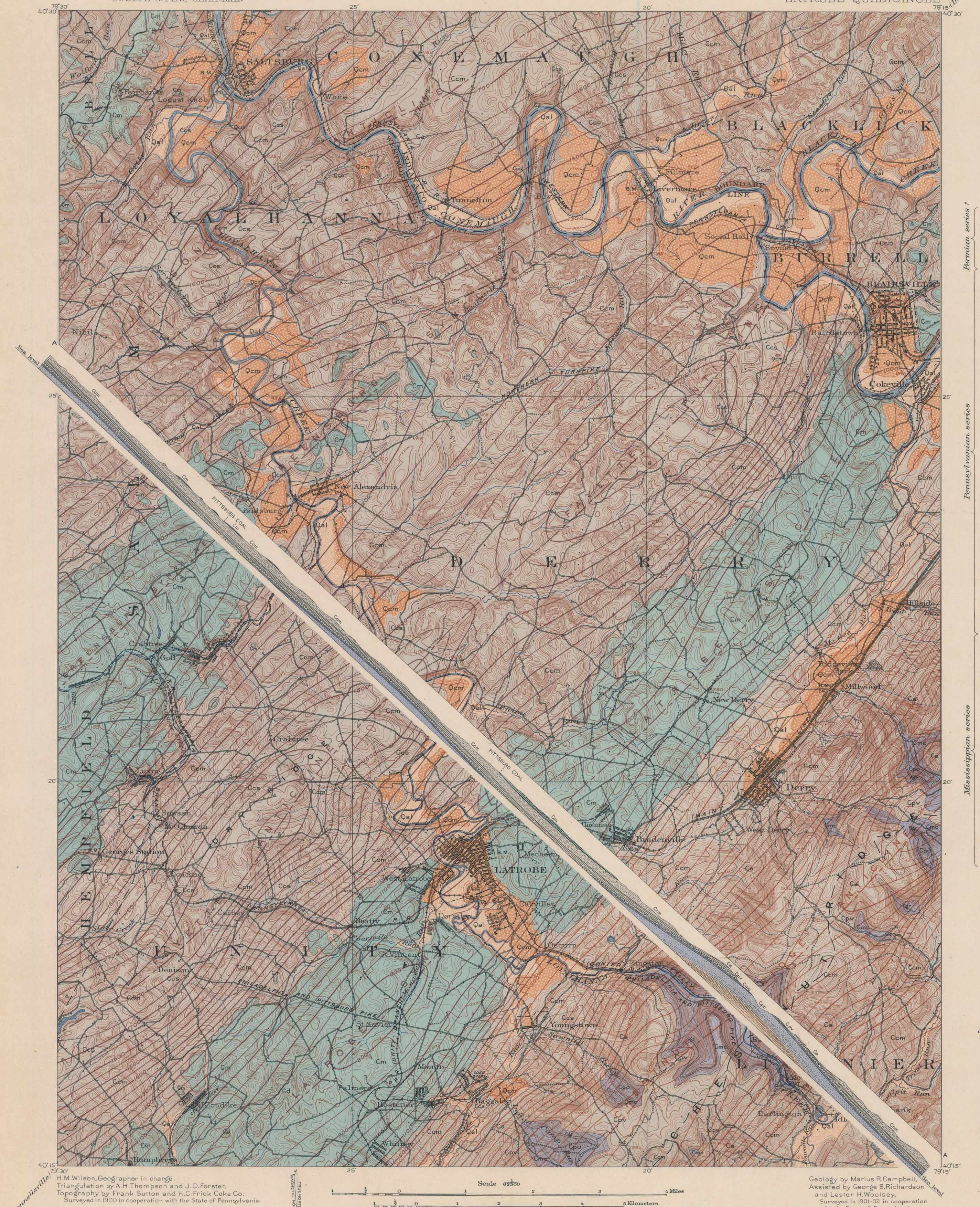
GEOLOGIC STRUCTURE

PENNSYLVANIA
LATROBE QUADRANGLE



LEGEND

SEDIMENTARY ROCKS

SHEET SYMBOL / SECTION SYMBOL

QUATERNARY

- Qal — **Alluvium** *(in flood plains of present streams)*
- Qcm — **Carmichaels clay** *(clay, sand, and bowlders on terraces and in abandoned channels of the larger streams)*

CARBONIFEROUS

Permian series ?

- Cd — **Dunkard formation** *(only the lowest member, Waynesburg sandstone, occurs in this area)*

Pennsylvanian series

- Cm / Cm — **Monongahela formation** *(shale, limestone, and occasionally coarse sandstone; Pittsburg coal at the bottom, Waynesburg coal at the top, and coal beds of local importance between)*
- Ccm / Ccm — **Conemaugh formation** exclusive of the Saltsburg sandstone *(sandstone, shale, small amount of limestone and a few small coal beds)*
- Ccs — *Included in Conemaugh formation on section* — **Saltsburg sandstone** lentil in the Conemaugh formation *(coarse, thick-bedded or massive sandstone in the Conemaugh formation)*
- Ca / Ca — **Allegheny formation** *(shale, sandstone, and clay with several workable coal beds; Upper Freeport coal at the top)*
- Cpv / Cpv — **Pottsville sandstone** *(coarse massive sand stone or conglomerate with some shale and usually a coal bed at the middle)*

Mississippian series

- Cmc / Cmc — **Mauch Chunk formation** exclusive of the Greenbrier limestone *(red and green shale and thin-bedded green sandstone)*
- Cgr — *Included in Mauch Chunk formation on section* — **Greenbrier limestone** lentil in the Mauch Chunk formation *(thin blue fossiliferous limestone)*
- Cpo / Cpo — **Pocono sandstone** *(coarse sandstone grading into very sandy limestone at the top and usually containing sandy shale; underlying shales of Devonian age shown on the section)*

1400 — *Contour lines drawn upon floor of Pittsburg coal at base of Monongahela formation*
(contour interval is 50 feet. Datum is mean sea level. Where the coal has been removed by erosion the lines are determined by the calculated position of the bed)

1000 — *Contour lines drawn upon upper surface of Pottsville sandstone approximately 950 feet below the Pittsburg coal horizon*
(contour interval is 100 feet. Datum is mean sea level. Where the sandstone has been removed by erosion the lines are determined by the calculated position of the formation)

The axes of the folds are represented by heavy broken lines drawn along the lowest parts of the synclines and the highest parts of the anticlines.

H.M.Wilson, Geographer in charge.
Triangulation by A.H.Thompson and J.D.Forster.
Topography by Frank Sutton and H.C.Frick Coke Co.
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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

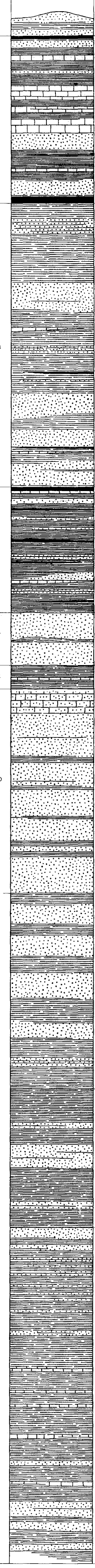
Contour interval 20 feet.
Datum is mean sea level

Edition of May 1904

Geology by Marius R. Campbell.
Assisted by George B. Richardson and Lester H. Woolsey.
Surveyed in 1901-02 in cooperation with the State of Pennsylvania.

GENERALIZED SECTION FOR THE LATROBE QUADRANGLE.

SCALE: 1 INCH=200 FEET.



System.	Series.	Formation Name.	Symbol.	Thickness in Feet.	Names of Members.	Character and Distribution of Members.	General Character of Formations.
CARBONIFEROUS	PERMIAN	Dunkard formation.	Cd	65+	Waynesburg sandstone.	Coarse sandstone and interbedded sandy shale; present only in Latrobe syncline near Klondike.	Only the basal, Waynesburg, sandstone present in the quadrangle.
	PENNSYLVANIAN	Monongahela formation.	Cm	400	Waynesburg coal.	Present only in Latrobe syncline near Klondike.	The most important coal-bearing formation of southwestern Pennsylvania. The rocks are decidedly calcareous, but beds of sandstone locally develop in thickness until they become prominent members of the formation. The Pittsburg sandstone is the most notable lentil of this character.
					Benwood limestone.	Blue limestone and earthy calcareous nodules, interbedded with shales and occasionally with beds of sandstone. Present in all synclines of the quadrangle.	
					Sewickley coal.	Not well developed.	
					Redstone coal.	Not well developed.	
					Pittsburg sandstone.	Coarse sandstone. Occurs on west side of Latrobe syncline in the vicinity of Latrobe.	
					Pittsburg coal.	Six to eight feet of available coal of great value.	
		Conemaugh formation.	Ccm	650-700	Connellsville sandstone.	Not well developed.	Composed chiefly of shale, but also includes several beds of coarse sandstone, a few thin layers of impure limestone, and small coal beds. The shale is of various colors, but green and red predominate; the sandstones are fairly persistent, but in places they lose their distinctive characters and can not be identified; the limestones are irregular in thickness and distribution; and the coal beds are small and of slight economic importance.
					Morgantown sandstone.	Generally coarse sandstone, but in places represented only by thin flags and sandy shale. Best developed in the vicinity of Blairsville.	
					Saltsburg sandstone.	Coarse sandstone, sometimes massive and conglomeratic, but in most places it is replaced by sandy shale. Saltsburg is the type locality.	
					Mahoning sandstone.	Coarse sandstone or conglomerate. Best shown on Conemaugh River and Loyalhanna Creek above Saltsburg.	
		Allegheny formation.	Ca	250-360	Upper Freeport coal.	Four to six feet in thickness. Probably present throughout the quadrangle, except on Chestnut Ridge.	Generally less sandy than either of the contiguous formations. Composed largely of shale, but in places the Freeport sandstone is well developed above the Upper Kittanning coal, and another sandstone is present below the same horizon. Two prominent coal beds occur in this formation.
					Lower Freeport coal.	Not very important.	
					Kittanning coal.	Probably of workable thickness. Generally present.	
					Vanport limestone.	(Known only from well borings).	
					Brookville-Clarion coal.	Probably present on Chestnut Ridge and noted in a few drill records.	
		Pottsville formation.	Cpv	75-170	Homewood sandstone.	Coarse, massive sandstone.	Generally coarse, hard sandstone or conglomerate inclosing a thin irregular bed of shale.
					Mercer coal?	Little known in this quadrangle.	
					Connoquenessing sandstone.	Coarse, irregularly bedded sandstone.	
	MISSISSIPPIAN	Mauch Chunk formation.	Cmc	30-140	Greenbrier limestone.	Variegated fossiliferous limestone, approximately four feet thick.	Red and green shales inclosing a lentil of variegated fossiliferous limestone.
		Pocono sandstone.	Cpo		Siliceous limestone.	Bluish-gray, sandy limestone grading downward into calcareous sandstone.	Sandstones varying from thin-bedded, flaggy rock to coarse, irregularly bedded conglomerate. Bed of siliceous limestone at the top.
				(0-80)	Patton shale.	Red or green shale. Not known in outcrop in this quadrangle.	
		(Base not determined.)		930-1070		(Rocks below this horizon not exposed in the quadrangle, and known only from borings.)	
DEVONIAN		?					Alternating bands of shale and sandstone.
				320-450	Sub-Blairsville shale.		Red shale and sandstone.
				800+			Shale with thin beds of sandstone and occasional beds of limestone.

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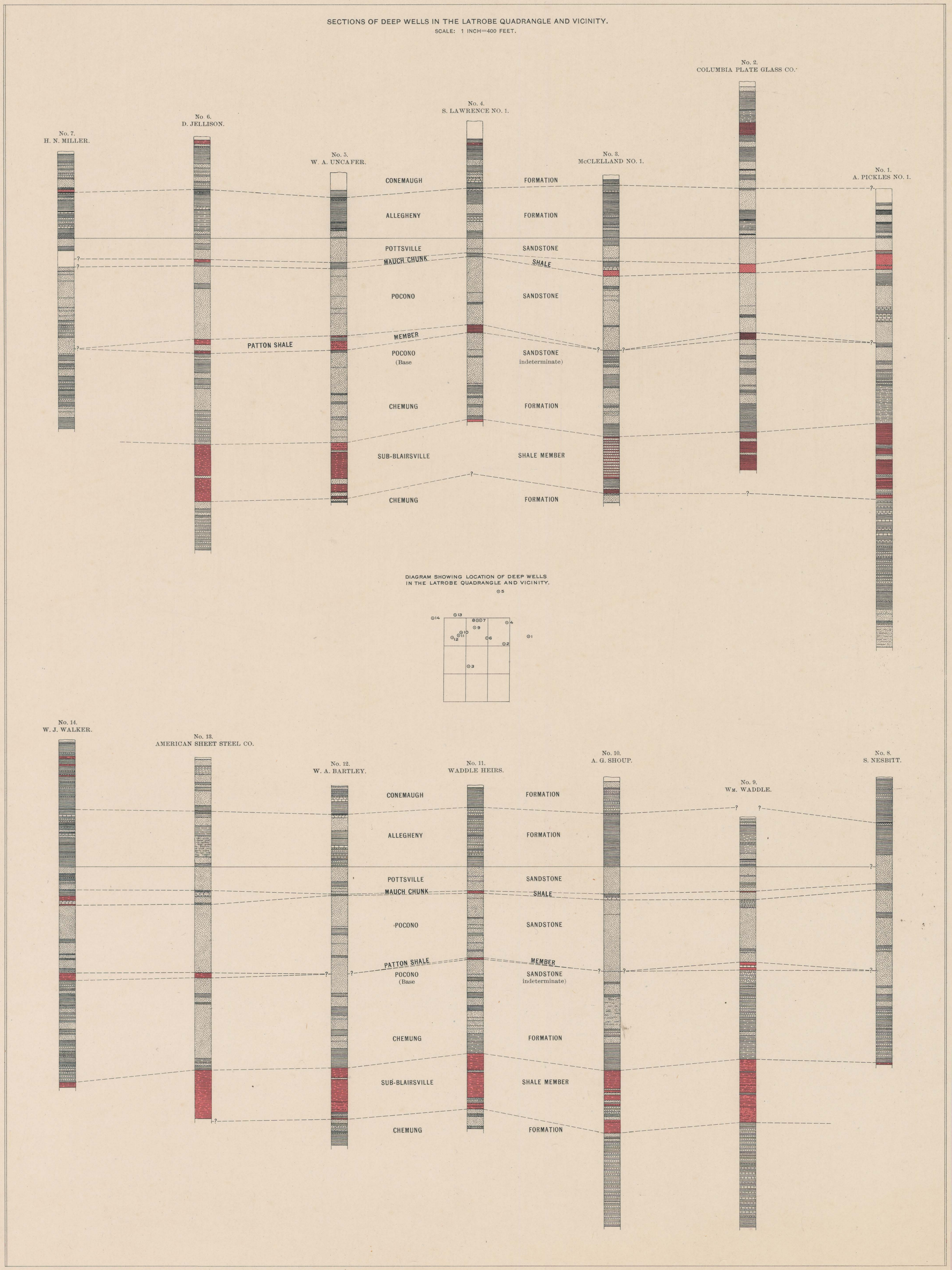
Geologist.

WELL SECTIONS

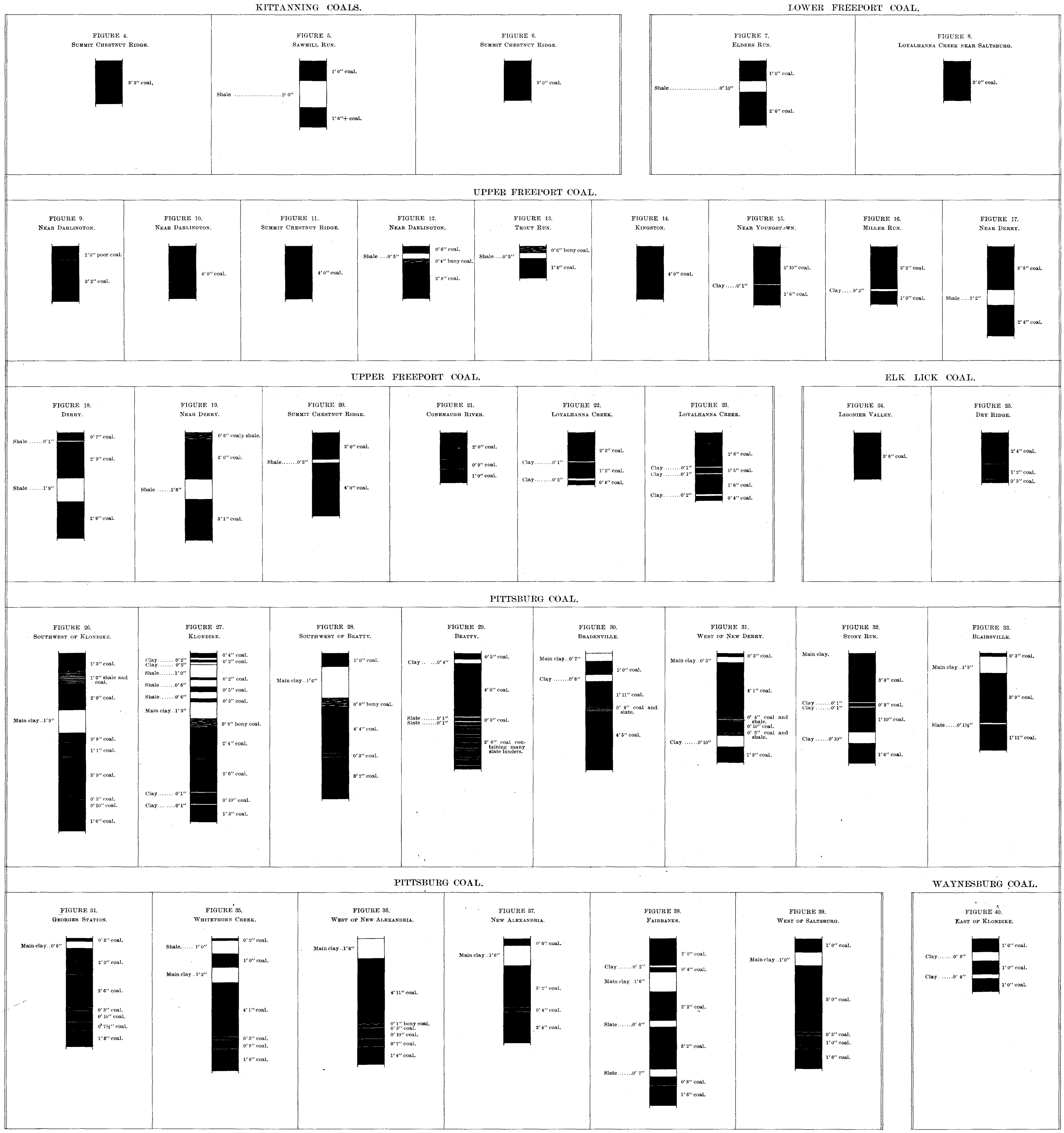


MARIUS R. CAMPBELL,
Geologist.

COAL SECTIONS

SECTIONS OF COAL BEDS IN THE LATROBE QUADRANGLE.

SCALE: 1 INCH=5 FEET.



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ILLUSTRATIONS

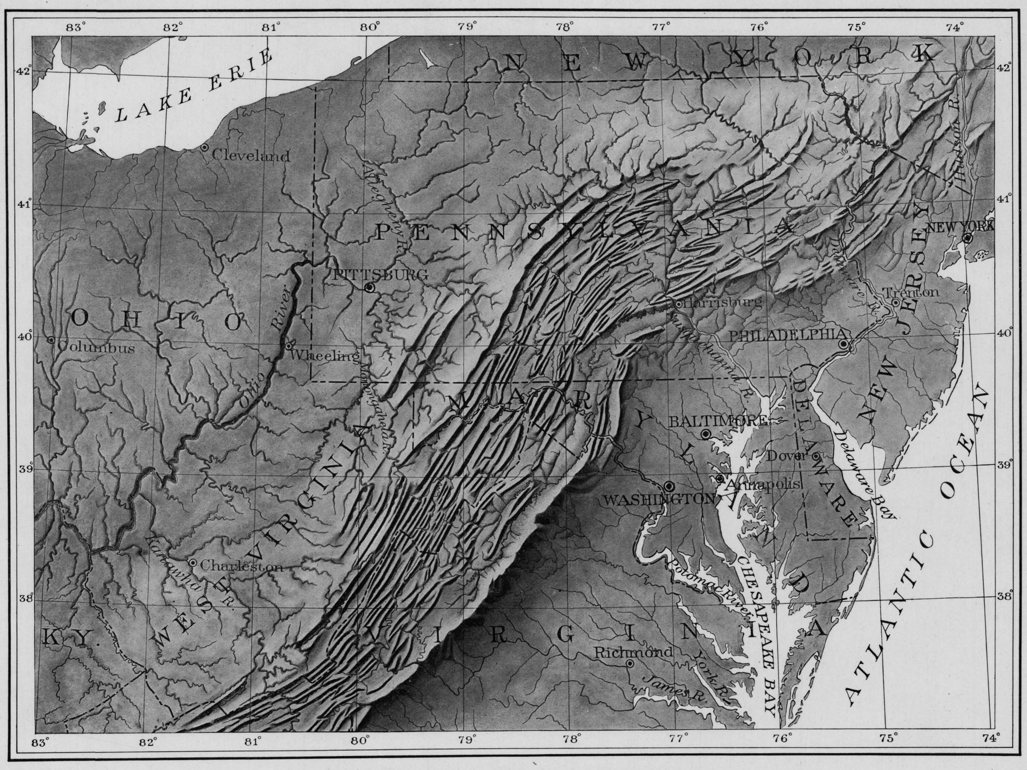

Fig. 41.—RELIEF MAP OF THE NORTHERN APPALACHIAN MOUNTAINS.

The Latrobe quadrangle is situated on the plateau lying west of the belt of valley ridges, in the southwestern part of Pennsylvania.

Fig. 42.—MAP SHOWING THE EXTENT OF THE NORTHERN PART OF THE APPALACHIAN COAL FIELD.

The position of the Latrobe quadrangle within the coal field is shown by the rectangle.

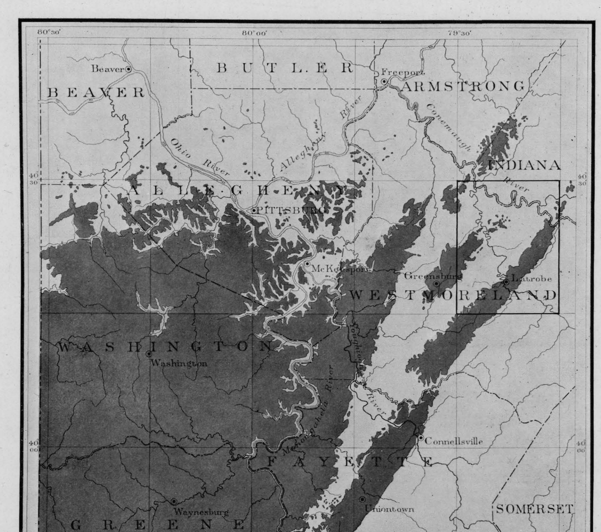

Fig. 43.—MAP SHOWING THE AREA OF THE PITTSBURG COAL IN PENNSYLVANIA.

The Latrobe quadrangle is situated on its eastern border.

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58	Elmoro	Colorado	25
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