DESCRIPTION OF THE JOHNSTOWN QUADRANGLE.

By W. C. Phalen.

GEOGHAPHY.

INTRODUCTION.

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 in Virginia, Tennessee, Georgia, and Alabama. (See fig. 2.) The rocks east of this line lie nearly flat and are entirely unshaded, and the few folds that break the regularity of the structure are so broad and open that they produce a scarcely appreciable effect on the topography. East of the Allegheny Front, or, as it is sometimes called, especially in Pennsylvania, the Allegheny Mountains, lie the great Appalachian Valley, the surface of which is characterized by alternating ridges and valleys. The Appalachian Mountains limit the Great Valley sharply on the north and on the east its termination is abrupt. They are made up of many ranges, large and small, to which have been applied various local names. Further east they merge gradually into a deeply dissected upland, the Piedmont Plateau of the Atlantic States, and still further east, bordering the Atlantic Ocean, lie the low sandy regions known as the Coastal Plain. The surface west of the Appalachian Valley is an elevated plateau, formerly called as a whole the Allegheny Plateau, but now known as the Appalachian Plateau. The different parts of this plateau have received distinct names. The plateau character of this region can not readily be discerned in so small a part of it as the Johnstown quadrangle but may be more readily appreciated if the surface is viewed broadly in comparison with the lowlands of the Mississippi on the west and the series of alternating ridges and valleys of the Appalachian Valley on the east. The Johnstown quadrangle is situated in that division of the province which is characterized by the distinctive features of surface drainage, rocks, and geologic structure described below.

APPALACHIAN PLATEAU.

The surface of the Appalachian province is composed of a number of plateaus. These represent the remnants of a broad land mass which sloped more or less uniformly from its eastern escarpment northwestward toward the lowlands of the Mississippi Valley. The plateau is therefore highest along its southeast margin. Where it emerges from beneath the Coal Measures in the northwest and the rocks northwest of it dip southeast. The southern part of the plateau is about 500 feet above sea level. From this region it gradually increases in altitude toward the northeast into West Virginia. From this highest point, over 4000 feet above the sea, it descends to an elevation of 2200 feet in southern New York. In the southern part of the plateau there is a gentle slope from north-central Alabama toward the southeast. The character of the plateau differs greatly in different parts of the province, depending upon the character of the underlying rocks, on the nature of the drainage movements which have affected them, and upon the drainage consequent on both these factors. In its southern part the conditions for its preservation have been almost ideal, but toward the north the region is greatly dissected and its plateaus character can not be readily made out. As viewed broadly from some elevated point, however, the summits of the highest ridges and hills rise to about the same altitude and appear to merge in the distance into a nearly horizontal line, which is approximately the surface of the old peneplain. This expanse of semiconsolidated rock in most of the northern part of the plateau, where the old surface was a peneplain to which the name Schooley peneplain has been applied on account of the good preservation of its eastern part in Schooley Mountain, New Jersey. To the west, especially in the valleys of Allegheny and Monongahela rivers, the tops of the ridges correspond with the surface of another and younger peneplain. This plateau or peneplain, situated at a lower level than the remnants of the Schooley peneplain, has been named the Worthington plateau by Worthington, in the Allegheny Valley. This quadrangle forms a part of the Appalachian province, which extends from the Atlantic Coastal Plain on the east to the lowlands of the Mississippi Valley on the west, and from central Alabama on the south to eastern Canada.

DRAINAGE.

The Appalachian Plateaus drain almost wholly into Mississippian River, except the northwestern part, from which some streams flow into Great Lakes and come into the Atlantic Ocean. In this northeastern part of the province the arrangement of the drainage lines has been determined by the position and movements of the ice sheets during the Pleistocene glaciation. It is supposed that all the streams north of central Kentucky flow northward into St. Lawrence River or its tributaries before glacial time, but an advancing ice sheet acted as a barrier, closing this northern outlet and establishing the drainage systems in substantially their present form. In the southern half of the province a few of the western-flowing streams have their sources at the summit of the Blue Ridge and flow across the Appalachian Valley as well as the plateaus into the Mississippi drainage system.

STRUCTURE.

The rocks of the plateaus are mostly of Carboniferous age. Devonian rocks are exposed along the northern and eastern margins of the plateaus, where the strata are sharply flexed upward, and they lie beneath the Carboniferous rocks throughout the plateau. The Carboniferous rocks are subdivided into two series—Depositional and Coal Measure; the latter is composed of alternating beds of shale and sandstone, but in the southwestern and southern parts of the plateau the Mississippian rocks include thick limestones. The Pennsylvanian rocks cover the greater part of the surface in the coal fields and contain practically all the coal beds. Both series are represented in the Johnstown quadrangle, the Pennsylvania series being by far the greater part of its area and the Mississippian rocks appearing at the surface only along the anticlines that have been deeply eroded.

Structure.

The Appalachian Plateaus is structurally a great basin or trough. The axial line of this trough extends southwestward from Pittsburg, Pa., across West Virginia to Ohio River at Huntington, W. Va. The rocks southeast of this line dip northwest and the rocks northwest of it dip southeast. The deepest part of the trough in Pennsylvania is the southeast corner of the State, and the beds generally dip toward that point. Around the north and south edges of the trough the beds outcrop in rude semicircular or elliptical areas and dip toward the center of the trough. Viewed thus broadly the structure is comparatively simple; in detail it is more complex. The Johnstown quadrangle is situated on the southeastern flank of this structural trough. On this limb the beds are involved in a number of parallel wavy or folds having the same general trend as the major axis of the trough itself. They dip in the northwest course. Though the beds are thus wavy or bent this structure does...
not affect the general westward dip and, in general, west of the Allegheny Front such recurring arch and trough lies lower than the one immediately east of it, so that both sides which are more than 2000 feet above sea level west of the Allegheny Front are below sea level on the west side of the great trough. The dips along the northwest side of the trough are involved in a structural uplift known as the Cincinnati arch or anticline.

DRAINAGE.

The surface of the Johnstown quadrangle was shaped by long-continued erosion acting on rocks of differing hardness. This work has been done by streams, and so in discussing the topography the drainage may be considered first. As the Johnstown quadrangle lies near the Allegheny Front, which is the main watershed between the Atlantic Ocean and the Mississippi River system, the streams in it are not of the first magnitude. They may be divided into two systems, the Conemaugh River system and the Blacklick Creek system. These two streams unite west of the quadrangle near Blairsville and are really parts of the same drainage system. In the Johnstown quadrangle, however, they are distinct.

In relation to the geologic structure of the area, the streams may be grouped into two great classes—(1) those which flow along or near the structural axes of the region and (2) those which apparently flow regardless of the structure. The main streams, Conemaugh and Little Conemaugh rivers, Stony Creek, South Fork, and Blacklick Creek with its South Branch, belong to the latter class, though in part of their courses some of them seem to follow the structural axes. Saltlick Run, Hutchinson Run, and Laurel Run are examples of streams flowing parallel with the structural axes. Little Conemaugh River and Blacklick Creek are of interest in this respect. In part of their courses they follow the structure more or less, but the Little Conemaugh River rises from a place west of Mineral Point to Johnstown and Blacklick Creek and its South Branch from a point south of Vinmonto to a nearly 5 miles southwest of Wehrum.

The great bulk of the surface water of this area is carried off through Conemaugh River and its principal tributaries—Little Conemaugh (including Little Point Creek) and South Fork. Little Conemaugh River rises in the Ebensburg quadrangle, which lies east of the Johnstown quadrangle, and the greater portion of which is drained by this stream and its South Fork. The courses of Conemaugh, Little Conemaugh, and Stony Creek are extremely irregular, and that of the Conemaugh near the west side of the Johnstown quadrangle is marked by a gorge several miles in length, in which the lowest strata of the quadrangle and the geologic structure are well exposed.

The course of Conemaugh and Little Conemaugh rivers is independent, except as indicated above, of the present structural features and of the character of the rocks. This, in regard to utility, is most fortunate, for the rivers, cutting across the major structural features, have exposed valuable coal and clay beds in such position as to render them readily workable.

The resistant character of the rocks across which the stream flows denotes that the cutting process must have proceeded slowly. The gorges therefore must have originated well back in geologic time. The course of these streams dates back at least to a time when the surface of the quadrangle stood as high as the present higher knolls of Laurel Ridge. The down-cutting has proceeded with many periods of quiescence and quickening and is in progress at the present time.

The streams course of Little Conemaugh River and Stony Creek are noteworthy being almost throughout characterized by meanders. These meanders, with certain exceptions, are apparently also independent of the structure and hardness of the rocks. Their steep interchannel is somewhat characteristic. (See fig. 3.) At some of their turns they are encroaching on the rocks and not receding. This encroachment is fairly well shown at the southwest turn of the first meander west of South Fork, and still better at the northeast turn of the second meander west of East Conemaugh. This stream is also well shown by Stony Creek and by South Branch of Blacklick Creek at Twin Rocks. As mentioned in another place, the streams in this area lie near the Allegheny Front—the main watershed between the Atlantic Ocean and Mississippi River systems—and so are not of the first magnitude. The grades of the streams, especially in their upper parts, are fairly steep, but they have neither falls nor rapids of great size. The amount of water carried varies extremely with the amount of the year and the local weather conditions. Water entering the streams in great quantity is carried off rapidly, with disastrous results to portions of towns lying along the flood plains. To insure an adequate and uniform water supply the larger towns, such as Johnstown, South Fork, Vinmonto, and Wehrum, have been forced to construct storage reservoirs.

RELIEF.

This quadrangle, as already mentioned, lies entirely within the Appalachian Plateau and very near its eastern margin, which is but a few miles from the southeast corner of the quadrangle.

In surface, that of at least of the plateau, is decidedly irregular. The lowest point in the area is on Conemaugh River at the western border of the quadrangle; on Conemaugh Furnace station of the Pennsylvania Railroad, where the altitude is 1314.25 feet. The hills on either side of the river a short distance to the east are between 2000 and 2704 feet high and this portion of the river valley is therefore gorgelike. In the southeast quadrant of the quadrangle the highest hills are almost the same as those near the west side of the quadrangle. The rest of the surface ranges in altitude between the extremes just mentioned, but most of the hill slopes are rather gentle, especially back from the main drainage channels, for a reason that will be stated later. The surface of the quadrangle, almost all of it being on the lower stretch of Blacklick Creek and Stony Creek, is characterized by a great quantity of streams, some of which are extremely resistant and difficult to cross. Such, for instance, are the sandstones of the Pocano and Potterville formations. Even the Conemaugh formation, generally devoid of cliff-making sandstones, contains in the Johnstown quadrangle two notably resistant sandstone members—the Buffalo sandstone and the northern part of the area, in the hills bordering Blacklick Creek, and the Morgan- town sandstone member in the southeast part of the area. This accounts for many of the more elevated parts of the quadrangle and also for many of the larger areas of comparatively level ground. The large area of comparatively level land along the Ebensburg antiformal axis is more satisfaction achieved in being held up by these sandstones than by remnants of an ancient low-level peneplain.

RELATION OF TOPOGRAPHY TO CULTURE.

The relation of topography, including drainage, to human activities is admirably illustrated in many phases in the Johnstown quadrangle. Conemaugh and Little Conemaugh rivers traverse the area from east to west near the middle and Stony Creek from the southern border to the north. Along the Conemaugh River at the western border of the quadrangle and also for many of the broad areas of comparatively level ground. The largest area of comparatively level land along the Ebensburg antiformal axis is more satisfactorily explained as being held up by these sandstones than by remnants of an ancient low-level peneplain.
surface, much of it is under cultivation. Where the harder rocks, such as the Pennsylvanian, cover the surface north of Summerhill the conditions are similar.

descriptive geology.

The surface rocks of the Johnstown quadrangle are entirely of sedimentary origin and were deposited in or by water. They consist of sandstone, shale, limestone, coal, iron ore, gravel, etc., and taken together have a total thickness of 1200 to 3200 feet. These rocks belong to the Devonian and Carboniferous systems, except the imperfectly consolidated gravel of the river terraces, which is considered as Pleistocene age, and the recent alluvial deposits of the flood plains. The two great geologic systems have been subdivided into numerous formations and these in turn into smaller members, according to their lithologic aspect and the fossil faunas and floras which they contain. Not all the rocks in this particular area belong to the Carboniferous system. The Devonian is represented along Conemaugh River, the principal drainage channel, where it removes the axis of the Laurel Ridge anticline, and just over the border of the Ebensburg quadrangle to the east. The Devonian rocks underlie the Carboniferous surface rocks throughout the Johnstown quadrangle.

devonian system.

Though much of the Devonian system is not exposed in the Johnstown quadrangle, brief descriptions will be given of the parts of it that do not appear above drainage level. In subsequent years deep drillings will probably reach these lower beds, and as it seems advisable to record their characteristics as obtained from the sections measured between Altoona and Bennington.

Hamilton formation.

The Hamilton is the lowest and oldest formation exposed in the Ebensburg quadrangle, east of the Johnstown area. A total of 1300 feet of beds has been measured, but the formation is known to be thicker. It is composed mainly of dark-gray shale which does not appear above drainage level. In subsequent years deep drillings will probably reach these lower beds, and as it seems advisable to record their characteristics as obtained from the sections measured between Altoona and Bennington.

Genesee shale.

The Genesee shale lies conformably on the Hamilton. Owing to its thick, color, and fossil character it is a distinctive lithologic type and hence is readily recognized as a characteristic horizon of considerable economic consequence and is spatistically fossiliferous, and on the whole it is similar to the Genesee at the type locality in western New York. In Altoona 80 feet of Genesee shale have been measured, but as the base of the shale was not seen, it does not represent the full thickness of the formation.

Pottsville formation.

The lower 100 or 200 feet of the Pottsville formation is composed of soft pale-brown shalloys weathered to a dove color and possessing a very perfect claypan. Upward through the formation the rocks gradually change to a pale greenish-gray sandy shale, clayey into this limina and associated with beds of different character and of lens perfect claypan. This sandy shale makes up the greater part of the formation. The thickness measured along the Pennsylvania Railroad is 1400 feet.

Catskill formation.

The total thickness of the Catskill formation, as measured along the Laurel Ridge Railway, is 1300 feet, but it has been calculated from the width of outcrop and dip in another place in the Ebensburg Valley, and the 1300 feet is not for the fact that the timber has been largely removed. Laurel Ridge, which is generally a wilderness, is an excellent example of the influence of the rocks on animal's activities. The ridge is covered in large part with massive sandstone boulders and is practically uninhabited. Where the Mergersands sandstone member covers the surface north of Summerhill the conditions are similar.

catskill formation.

The Catskill formation consists of the lowest and oldest rocks exposed in the Johnstown quadrangle. Only 800 feet of the top of the formation is exposed where the axis of the Laurel Ridge anticline crosses the gorge of Conemaugh River west of Johnstown, and it appears at no other place in the Johnstown quadrangle. Here, as on the Allegheny Front to the east, the Catskill rocks are prominently red and green shales and red sandstone. A section of the upper 100 feet of this formation, measured on the eastern flank of the Laurel Ridge anticline, on the main line of the Pennsylvania Railroad, is as follows: Section of upper part of Catskill formation.

Soil development.

The formation is a whole, measured on the Allegheny Front, is about 2000 feet thick: 80 per cent of it is made up of red shales and sandstone, 20 per cent of dark green or gray shale and sandstone. Red sandstone predominates and is generally bright red; the red sandstone usually weathered to a gray or dull-brown color and is red only on freshly broken surfaces. The sandstone is medium to fine grained and thick to thin bedded or even laminated. The formation contains but few fossils, none was found in it on Allegheny Mountain; this fact sharply distinguishes it from the underlying Chemung. The top of the section at the crest of the Pennsylvania Railroad where westbound trains turn into the valley of Burgoon Run. Notwithstanding the obscurity of the boundary between the Catskill can be traced to the southwest entirely across the Allegheny Valley, as described in the ton shale member in the Allegheny Valley, described in the ton shale member in the Allegheny Valley, described in the ton shale member in the Allegheny Valley, described in the ton shale member in the Allegheny Valley, described in the ton shale member in the Allegheny Valley, described in the ton shale member in the Allegheny Valley.

carboniferous system.

The rocks of the Carboniferous system conformably overlie those of the Devonian system and comprise the Mississippian series below, which is not coal bearing in this area, and the Pennsylvanian or coal-bearing series above. The Mississippian series is divided into two formations, the Pottsville and the Mauch Chunk, and the Pennsylvanian is represented by the Pottsville, Allegheny, Conemaugh, and Monongahela formations. It is questionable whether the Monongahela is represented in the Johnstown quadrangle.

Mississippian series.

General description.—The entire Pottsville formation is exposed in the gorge of Conemaugh River between Johnstown and Conemaugh Furnace, along both banks of the Laurel Ridge anticline. It is 500 to 600 feet thick near Altoona, but it merges gradually into the underlying Burgoon sandstone member.

Loyalhanna limestone member. This member of the Pottsville is sharply differentiated from the underlying members of the Pottsville and from the overlying Mauch Chunk shale by its peculiar lithologic characteristics. It consists of layers in which silica predominate alternating with those in which calcareous material is in excess. The calcareous part weathered more rapidly and leaves the siliceous layers in relief. This unequal weathering in conjunction with the cross-bedded character of the rock gives it a highly distinctive appearance, which is well brought out in the exposure near Mineral Point. (See fig. 4.) At one place near the mouth of Findley Run the Loyalhanna limestone member is separated into two parts by a thin layer of red shale near its middle. The member is often referred to as the “Silicene” limestone, but it is more appropriate to regard it as a calcareous sandstone, as the siliceous portion is far in excess of the calcareous. In deference to general usage, however, it will be called a limestone. The name Loyalhanna is derived from the exposure of the member along the gorge in which Loyalhanna Creek flows across Loyalhanna Ridge in Wmshard County. In the reports of the Second Geological Survey of Pennsylvania it was regarded as part of the overlying Mauch Chunk, but it merges gradually into the underlying Burgon sandstone member and is now regarded as forming the top of the Pottsville formation.

Mauch Chunk shale.

General description.—The Mauch Chunk shale derives its name from Mauch Chunk, in the eastern part of Pennsylvania.
In that part of the State it is many thousands of feet thick, but in the Johnstown quadrangle its thickness is less than 300 feet. It lies conformably upon the Potsylvania formation and is exposed at several points in the quadrangle. Along the Potsylvania Railroad, in the valley of Little Conemaugh River, it is exposed on the banks of the Ebensburg (Viaduct) anticlinal axis, appearing close to the town of South Fork and in the hills along the river westward beyond Mineral Point. In this region the exposure of the Mauch Chunk is good. The formation consists of three distinct members, two shale members separated by a 45 to 50 foot body of sandstone. The combined section of the Mauch Chunk obtained here and near the southern border of the quadrangle is as follows:

<table>
<thead>
<tr>
<th>Formation</th>
<th>Thickness (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercer shale</td>
<td>100</td>
</tr>
<tr>
<td>Mauch Chunk</td>
<td>50</td>
</tr>
</tbody>
</table>

The clay and shale underlying the coal bed have been preserved both in character and thickness, but that it is sensibly characterized by the presence of coal and valuable clay and shale.

**Homewood sandstone member** — The upper member of the Potsville formation, known as the Homewood sandstone member, is 60 feet thick along Stony Creek beyond the southern border of the Johnstown quadrangle, but near the mouth of Paint Creek it is slightly thicker and may be as much as 30 feet at South Fork. The thickness of the Homewood sandstone member is less than 65 feet and may be as little as 35 feet. Hence the complete section of the Potsville for the Johnstown quadrangle is as follows:

<table>
<thead>
<tr>
<th>Formation</th>
<th>Thickness (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercer shale</td>
<td>100</td>
</tr>
<tr>
<td>Mauch Chunk</td>
<td>50</td>
</tr>
<tr>
<td>Homewood sandstone</td>
<td>60</td>
</tr>
</tbody>
</table>

The Homewood sandstone member, like the Conocoquimming, is marine and course grained but rarely conglomerate. The two make heavy blocks of stone, and the country covered by this formation as a whole is generally a wilderness. This is the principal coal-bearing formation of Laurel Ridge crossed by the Pittsburg and Philadelphia pike. This formation covers a large part of Laurel Ridge and it also outcrops in the valley of Longravine near the south of South Fork nearly to East Conemaugh. It is also above drainage level along Chestboard Run. In the southern part of the quadrangle, along Stony and Little Paint Creek, the Potsville is also exposed, but it is confined to the valley, and hence the thin part of the section, as it is covered by its massive debris. The Potsville decreases below drainage level on Stony Creek a short distance south of Kring and on Little Paint Creek near the point where the trolley line crosses the creek at the town of Scalp Level.

**Allegheny formation**

General description — The Allegheny formation, which conformably overlies the Potsville formation, was originally known as the "Lower Productive Coal Measure." It is distinguished from the overlying formation, as may be inferred from the name, by the presence of several workable coal beds. It is the most important formation in the Johnstown quadrangle, as it is found all the workable coal beds. The section which will follow gives an idea of its character in different parts of the area. The first section was prepared by John Fulton of Johnstown, and shows the character of the rocks east of the city, marked by the thickness of the Allegheny formation about the city.
As follows:

Kittanning coal beds is 84 feet 2 inches; near the mine of the
feet thick.

All the data in the foregoing sections considered, the distance from the Upper Freeport coal to the Lower Kittanning coal is 260 feet. This interval determines northward toward South Fork, north of which, in the valley of the Pennsylvania, Creek, and Eastern Coal Company's mine at New Oxford, the Lower Kittanning is 145 feet. The Allegheny there is about 220 feet thick, if the
Freeport or D coal is fairly uniform, varying only from 150 to 190 feet. A coal bed regarded as bed E occurs about 50 feet above the D coal, and the distance from the B coal down to the top of the Pittsville is about 80 feet; so the Allegheny in that region is 280 to 300 feet thick. The thickness of the Allegheny formation therefore between 230 and 290 feet in the Johnstown quadrangle. The more persistent and characteristic divisions of the Allegheny formation occurring in the Johnstown quadrangle are the following, the highest being named first:

Coals between the Lower and Upper Kittanning coals.

If the lowest coal in the section is the Brookville and near that on the Pittsville, the Allegheny in this part of the quadrangle is about 282 feet thick. In this section the distance from the Upper Freeport coal to the Lower Kittanning is 260 feet. The massive sandstone closely underlying the Lower Kittanning coal bed is also well exposed near Twin Rocks, in a small cut on the Pennsylvania Railroad south of the town.

The section containing Brookville (A) and Clarion (A') coal beds of pumping station of Cambria Steel Company, west of Cooperstown.
The section at the place shown in the next column.
The lower coal bed, consisting of two benches, is the Brookville and the higher is the Clarion. Representatives of these lower Allegheny coal beds also occur on Cleophas Run and near Twin Rocks.

The massive sandstone closely underlying the Lower Kittanning coal bed is also well exposed near Twin Rocks, in a small cut on the Pennsylvania Railroad south of the town.

The next higher coal in the Allegheny is known under various names, as the Lower Kittanning, Miller, White Ash, or B coal. It is the most persistent and valuable coal bed in the area. It lies about 180 to 200 feet below the Upper Freeport or E (except north of South Fork, where the distance is only 145 feet) and about 65 to 100 feet above the top of the Pittsville.

The next higher coal in the Allegheny formation is underlain by a limestone that is suitable for the manufacture of cement. This limestone is best developed along South Fork and may be seen to advantage in the cuts on the Baltimore and Ohio Railroad north of Kings station. Here it is 6 feet thick and is separated from the coal by 8 to 12 inches of shale. Along the spur track leading from the north end of the tunnel in the Valley Coal and Stone Company's mine it is also conspicuous but slightly thinner. The cement bed is well exposed in the bluffs along Clear Creek River between Johnstown and East Connemara and still farther east and in present about South Fork. The upper most important of the Upper Kittanning or C coal, known near Johnstown as the "cement coal bed." It is an important coal near Johnstown, Windber, and South Fork and is one of the persistent and valuable coals in the quadrangle. It occurs generally from 40 to 105 feet below the Upper Freeport coal, but near South Fork this interval is slightly less. Above the Upper Kittanning coal (the "cement bed") near Johnstown and to the west on Dalton River above there occur two or three small coals. One of these was observed 5 feet above railroad level near the residence of J. L. Prosser, north of Ton Acre Bridge, west of Johnstown, where it measured 10 inches. Sections showing this coal bed and its relations to the Upper Kittanning coal are given on the following page.

Top of Pittsville.

Kittanning sandstone member.—On the Baltimore and Ohio Railroad between Fourwoods and north of Point Creek, on the west flank of the Allegheny anticline, the top of the Pittsville formation and the beds between it and the Lower Kittanning coal are well exposed. North of the tank and culvert about a mile east of the bridge over Stony Creek the following section was measured:

The bottom sandstone closely underlying the Upper Kittanning coal bed is also well exposed near Twin Rocks, in a small cut on the Pennsylvania Railroad south of the town.

The section containing Brookville (A) and Clarion (A') coal beds of pumping station of Cambria Steel Company, west of Cooperstown.
The section at the place shown in the next column.
The lower coal bed, consisting of two benches, is the Brookville and the higher is the Clarion. Representatives of these lower Allegheny coal beds also occur on Cleophas Run and near Twin Rocks.

The massive sandstone closely underlying the Lower Kittanning coal bed is also well exposed near Twin Rocks, in a small cut on the Pennsylvania Railroad south of the town.

The next higher coal in the Allegheny is known under various names, as the Lower Kittanning, Miller, White Ash, or B coal. It is the most persistent and valuable coal bed in the area. It lies about 180 to 200 feet below the Upper Freeport or E (except north of South Fork, where the distance is only 145 feet) and about 65 to 100 feet above the top of the Pittsville.

The next higher coal in the Allegheny formation is underlain by a limestone that is suitable for the manufacture of cement. This limestone is best developed along South Fork and may be seen to advantage in the cuts on the Baltimore and Ohio Railroad north of Kings station. Here it is 6 feet thick and is separated from the coal by 8 to 12 inches of shale. Along the spur track leading from the north end of the tunnel in the Valley Coal and Stone Company's mine it is also conspicuous but slightly thinner. The cement bed is well exposed in the bluffs along Clear Creek River between Johnstown and East Connemara and still farther east and in present about South Fork. The upper most important of the Upper Kittanning or C coal, known near Johnstown as the "cement coal bed." It is an important coal near Johnstown, Windber, and South Fork and is one of the persistent and valuable coals in the quadrangle. It occurs generally from 40 to 105 feet below the Upper Freeport coal, but near South Fork this interval is slightly less. Above the Upper Kittanning coal (the "cement bed") near Johnstown and to the west on Dalton River above there occur two or three small coals. One of these was observed 5 feet above railroad level near the residence of J. L. Prosser, north of Ton Acre Bridge, west of Johnstown, where it measured 10 inches. Sections showing this coal bed and its relations to the Upper Kittanning coal are given on the following page.
Freeport coal.

In some recent excavations made along the Pennsylvania Railroad near Ebensburg, the Upper Freeport sandstone corresponds with the Bolivar sandstone. It covers only small areas and is best exposed along Stony Creek and the Allegheny River near Johnstown. The Upper Freeport coal is known as the "limestone" coal, from the mass of sandstone lying above the Mahoning sandstone member. The best exposures of this sandstone occur a bed of flint clay which does not occur elsewhere in the Ebensburg quadrangle. The lower bench is worked.

The Mahoning coal occurs in this section, as in that near Johnstown, in two benches and at approximately the same distance above the Upper Freeport coal. The lower bench is thickest but not so thick as the lower bench near Johnstown in a similar position with respect to the Lower Freeport sandstone of the Mahoning member. The best exposures of this flint clay observed in the quadrangle is west and southwest of Ebensburg, in the Blacklick Creek district and is thick bedded.

The Mahoning coal is about a foot thick in the hills bordering Blacklick Creek near Ebensburg, and is thickest in the Allegheny valley. It is closely overlain by old ore benches, which give evidence of the extensive former working on the Johnstown ore bed. The upper clay, which is a thin flint clay, is present north, west, and southwest of Ebensburg and is to be correlated with the flint clay occurring near Johnstown in a similar position with respect to the lower sandstone of the Mahoning member. The best exposures of this flint clay observed in the quadrangle is west and southwest of Ebensburg, where it occurs at many points and has in places the uncommon thickness of 7 to 8 ft. It is a typical thin clay in appearance but contains a rather high percentage of iron oxide. It will be considered further in the discussion of clays. The lower sandstone of the Mahoning member is persistent in the Blacklick Creek district and is thick bedded.

The Johnstown iron ore lies a few inches below the Mahoning coal, next to be described, and about 50 feet above the Upper Freeport coal. This ore will be considered more fully in the discussion of mineral deposits. The upper sandstone of the Mahoning member is fine grained, weathering into extensively thin beds, but in places where it is about 20 ft. The underlying coal, exposed in the middle of the road above the tunnel where the section given above was measured, has in places the unusual thickness of 20 feet. So far as known it is nowhere thick enough to be worked. Near South Fork the base of the Conemaugh is well shown in recent cuts on the Pennsylvania Railroad near Ebensburg. A hand-leveled section opposite the station is as follows:

<table>
<thead>
<tr>
<th>Layer</th>
<th>Thickness (Ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>2</td>
</tr>
<tr>
<td>Shale</td>
<td></td>
</tr>
<tr>
<td>Coal</td>
<td>1-2</td>
</tr>
<tr>
<td>Shale</td>
<td></td>
</tr>
<tr>
<td>Upper Freeport coal</td>
<td>2</td>
</tr>
</tbody>
</table>

More than 900 feet thick just east of the Johnstown quadrangle, near the mouth of the Wilmeris Basin. This thickness is considerably greater than that measured elsewhere in the Ebensburg quadrangle, but the figures are believed to be approximately correct, provided that the coal at the top in the Ebensburg area is the true representative of the Pittsburg coal. All other measurements of the Conemaugh in this part of Pennsylvania show a considerably less thickness. The formation is known, however, to thicken toward the east. At Steubenville, Ohio, it is less than 500 feet thick; in the Pittsburg district, it is about 600 feet; near Saltsburg it is about 700 feet; near Ebensburg, 760 feet, showing a tendency to thicken outward. Flutes give the thickness of the Conemaugh at 770 ft. in the Ebensburg quadrangle, but more complete data gathered in the Johnstown area show that this figure is too small.

The lower sandstone of the Mahoning member outcrops in all the hills north of Johnstown. It is a very massive, decidedly fine-grained interbedded sandstone. It ranges from 20 to 80 feet in thickness and is separated from the Upper Freeport coal by an interval of 20 to 50 ft. of dark-brown shale. In the shale above this sandstone occurs a bed of flint clay which does not show in the section given above. It lies close to the top of the lower sandstone, from which it is separated by the Upper Freeport coal. The position of this flint clay is shown in the section in the hill east of Johnstown (fig. 6).

The Johnstown iron ore lies a few inches below the Mahoning coal, next to be described, and about 50 feet above the Upper Freeport coal. This ore will be considered more fully in the section. The upper sandstone of the Mahoning member is fine grained, weathering into extensively thin beds, but in places where it is about 20 ft. The underlying coal, exposed in the middle of the road above the tunnel where the section given above was measured, has in places the unusual thickness of 20 feet. So far as known it is nowhere thick enough to be worked.
...the Johnstown quadrangle, it is a conspicuous member, anding quadrangle/ 1 In this folio it will be termed the Mor­ which the name "Ebensburg" has been applied in the adjoin­...Fork. It is possible that this coal corresponds with the B coal. This coal outcrops near the old dam site on South...limestone is about a foot thick and is separated by 11 feet of...part of the State.

ranging up to 30 feet in thickness. This shale occurs in nearly...the Upper Cambridge limestone. Both these sandstone mem­...sandstone member by 30 to 40 feet of shales containing a coal...as about 50 feet thick, separated from the underlying Buffalo...coal and the Johnstown ore bed. This sandstone corresponds...the town of Ebensburg has been built upon it. To the west,...of the Morgantown member is mapped and the sandstone is...west of Wilmore, also in the neighboring hills between that...of the town of that name in the Johnstown quadrangle.

Modifications. — The strata of this region are involved in a series of parallel folds having a general northeast-southwest trend. Viewed broadly, the structure in the Johnstown quadrangle is very regular, as will be seen from the structure contours, but in detail it may be decidedly irregular. The structure as worked out differs in some particulars from that described by the Second Geological Survey of Pennsylvania. Perhaps the most...be readily computed from the known distance at which..."coal" of the Conemaugh formation. There is regard as belonging to the Carmichaels formation. There is...beds of the Conemaugh formation in the Johnstown quadrangle are much in thickness within short distances it may be...coal bed. In the Ebensburg field this coal is 17 feet thick. It is......the approximate depth of other coals at any particular point...may be readily computed from the known distance at which...of the coal above the Upper Freeport coal. Where measured along the Pennsylvania Railroad it is 17 feet thick. It is...red shale appears below it. In the southeastern part of the...beds below the Lower Freeport and the Juniata. It is regarded as the equivalent of the Ebensburg sandstone member.

...are obtained by means of sound barometers, which are liable to sudden varia­...dips are so great as to carry the horizon of the coal above the...altitudes.

The higher portion of the Conemaugh for­...of the Conemaugh formation in the Johnstown quadrangle is much in thickness within short distances it may be more...coal above the Upper Freeport coal. Where measured along the Pennsylvania Railroad it is 17 feet thick. It is...a coal bed. In the Ebensburg field this coal is 17 feet thick. It is...red shale appears below it. In the southeastern part of the...beds below the Lower Freeport and the Juniata. It is regarded as the equivalent of the Ebensburg sandstone member.

...in the Johnstown quadrangle it is not more than 50 feet thick where opportunity was afforded to judge of its thickness, but to the north, in the Harnsford quadrangle, it is defi­...thick sandstone member. In this region it is a thin and insignificant member. From the town of Ebensburg the Johnstown quadrangle is it not more than 50 feet thick where opportunity was afforded to judge of its thickness, but to the north, in the Harnsford quadrangle, it is defi­...thick sandstone member. In this region it is a thin and insignificant member. From the town of Ebensburg the Johnstown quadrangle is...folds west of the Allegheny Front, of which those in the Johns­...ago meters. Perhaps the most...regard as the equivalent of the Ebensburg sandstone member.
The Viaduct anticline was called a subaxis and the Laurel Ridge anticline was designated as the "first grand axis of the bituminous coal region." In 1895, however, some geologists suggested that the axis of the basin is definitely fixed near the northeast corner of the quadrangle and continues southeastward, passing near Elton. It leaves the quadrangle almost in a line coincident with the South Fork branch of the Pennsylvania Railroad. On the southwest side of this axis the beds dip northward and on the northwest side the beds dip southeast. In this area all the beds along the axis dip northward, as the axis plunges in that direction. The rise of the beds southward is rapid, amounting to 900 feet in 16 or 17 miles, so that the Lower Kittanning coal is down to a level of 300 feet below drainage level along the axis of the basin, outcrop in the valley of the Conemaugh River, between 2000 and 2100 feet in 9 miles.

The Lower Kittanning coal and associated beds, deeply buried in the center of the Willmore Basin, rise rapidly and with great regularity westward and outcrop in the valley of Little Conemaugh River at South Fork. The coal bed from its deepest point in the Willmore Basin rises more than 1000 feet to its highest point in the axis of the basin. The lowest bed brought above drainage level by this rise is the one at the top of the Pennsylvanian, namely, the Loyalhanna limestone member, which may be seen outcropping along the axis of the basin between the viaduct and Mineral Point.

The Johnstown syncline is the next structural feature on the west. It comprises the area from the viaduct to the axis of the basin, and as it extends westward it becomes more symmetrical, narrowing down to a point of inflection near the northeast corner of the quadrangle. It is composed of two basins in this quadrangle, one in Cambria County and one in Somerset County. It has a general trend of northeast-southwest, but is sharply off the axis of the basin in the vicinity of Johnstown, as may be seen by the structure map. The axis in Somerset County in this quadrangle trends in the usual northeast-southwest course. The dip of the beds on the eastern side of the basin is comparatively gentle, the fall being approximately 900 feet in 8 miles, or at the rate of 100 feet to the mile, from the summit of the Ebensburg anticline at the viaduct to the deepest part of the axis of the basin north of Little Conemaugh River. In the southern part of the quadrangle the corresponding dip is only 700 feet. The rise west of the axis of the basin to the apex of the Ratherus anticline is, along Conemaugh River, between 2000 and 2000 feet in 9 miles. In addition to their general northwest and southeast trend toward the center of the basin, the beds north of Conemaugh and Little Conemaugh rivers rise gently to the northeast; the Johnstown axis and the Ebensburg anticlinal axis approach each other near the northeast corner of the quadrangle and continue within 2 miles of each other to a considerable distance in the Patton quadrangle, which lies northeast of the Johnstown.

The Greater Buffington Formation. The main structural feature in the Johnstown quadrangle is the Great Buffington Formation, an older stratum of the upper Devonian system, though some authorities hold the opinion that it may continue in the future to be found partly or wholly in the Mississippi series of the Cambrian. From the axis of the basin the beds rise gently northward and along the axis of the Nolo anticline, which lies well north of the northeast corner of the quadrangle.

Minor structural features. The principal faults there are many minor faults in this area. A small arch or anticline is exposed along Little Conemaugh River about a mile east of Conemaugh station, which is between 900 and 1000 feet above sea level, and hence far below drainage level, in the center of the basin, outcrop at an elevation of about 1700 feet in the mines along Little Conemaugh River.


The Lower Kittanning coal and associated beds, deeply buried in the center of the Willmore Basin, rise rapidly and with great regularity westward and outcrop in the valley of Little Conemaugh River at South Fork. The coal bed in its deepest point in the Willmore Basin rises more than 1000 feet to its highest point in the axis of the basin. The lowest bed brought above drainage level by this rise is the one at the top of the Pennsylvanian, namely, the Loyalhanna limestone member, which may be seen outcropping along the axis of the basin between the viaduct and Mineral Point.

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A very decided change in physical conditions must have occurred after the deposition of red coal of the Mauch Chunk. It is believed that subsidence must have taken place rapidly in the northeast and along the southeastern margin of the Paleozoic gulf, possibly accompanied by a warping and deepening of the shallow Mauch Chunk sea. At the same time mountain building took place to the east, by which the Carboniferous systems were repeatedly and brought in immense quantities of the coarse material characteristic of the Pottsville Formation. This coarse material, composed of clear quartz, had been directly eroded from the land, like the material of the Pocoe sandstone, and which had been worn and mixed at the base of the coastal plains which existed during Mauch Chunk time. During the subsidence there were periods of relative stability in which the conditions were favorable for a luxuriant growth of vegetation, which gave rise to coal beds. The Potterville is of further interest, inasmuch as during Potterville time those peculiar conditions which resulted in the deposition of the coal of Pennsylvania and adjoining States.

The Potterville formation, which followed the Mauch Chunk, is a remarkable example of the laterally thickening of the shallow Mauch Chunk sea. At the same time mountain building took place to the east, by which the Carboniferous systems were repeatedly and brought in immense quantities of the coarse material characteristic of the Pottsville formation. This coarse material, composed of clear quartz, had been directly eroded from the land, like the material of the Pocoe sandstone, and which had been worn and mixed at the base of the coastal plains which existed during Mauch Chunk time. During the subsidence there were periods of relative stability in which the conditions were favorable for a luxuriant growth of vegetation, which gave rise to coal beds. The Potterville is of further interest, inasmuch as during Potterville time those peculiar conditions which resulted in the deposition of the coal of Pennsylvania and adjoining States.

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the rocks are also greatly faulted and folded, but they are not highly metamorphosed. The effects of the movement died out in small fields west of the Allegheny Front, where the Johnstown quadrangle is located.

**SUCCESSIONAL GEOLOGIC HISTORY.**

Since the emergence of the land degradation of the surface has been in progress, and it was going on during deformation. At several stages the land was worn down to a nearly level surface, and the summit of Laurel Hill and the highest points along the Allegheny Front in the southwestern part of the Johnstown quadrangle are thought to represent the remnants of one of these old and thoroughly rounded surfaces, the Sinksdale peneplain.

This peneplain was formed before or during Cre­

The coals of the Johnstown quadrangle belong to the soft, dusty, plastic clays, shales, and coals, cement material, building stones, glass sand, and iron ore. In the following descriptions no attempt will be made to present very detailed information. Only general facts regarding the important coals of the quadrangle will be given. For details as to the composition of the different coal beds of the area the reader is referred to a forthcoming bulletin of the United States Geological Survey.

**CHEMISTRY AND USES OF THE COALS.**

PHYSICAL PROPERTIES.

Analyses of coal samples from Johnstown quadrangle, Pennsylvania—

Continued.

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Name of Mine</th>
<th>Location</th>
<th>Coal</th>
<th>Volatile matter</th>
<th>Fixed carbon</th>
<th>Sulphur</th>
<th>Ash</th>
<th>Moisture</th>
<th>Calorific value</th>
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</table>

**LOWER ABBEYHEAD COAL (CLAYTON AND BROOKVILLE).**

Three of the coal beds or seams of importance in the Johnstown quadrangle are the Brookville (A) and Clarion (A) coals. These are found near Marble Run along the top of the Pottsville formation. The Brookville coal is usually bony and has to be discarded. In appearance the coal is lustrous and much of it is iridescent. Its columnar structure make it easily recognizable. It is usually found in small quantities and is rarely worked. The Clarion coal is usually found in large quantities and is extensively worked. The Clarion coal varies in thickness from 6 to 12 inches and is usually bony and has to be discarded. Its columnar structure make it easily recognizable. It is usually found in small quantities and is rarely worked.

**LOWE KITTANNING COAL.**

This coal is usually found in small quantities and is rarely worked. It is usually bony and has to be discarded. Its columnar structure make it easily recognizable. It is usually found in small quantities and is rarely worked.

**LOWER KITTANNING COAL.**

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**BLACKROCK COAL.**

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**THE SOUTHORK COAL.**

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**THE MILLER COAL.**

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**THE BLACKFOOT COAL.**

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**THE NORTHWEST COAL.**

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**THE SOUTH BEND COAL.**

This coal is usually found in small quantities and is rarely worked. It is usually bony and has to be discarded. Its columnar structure make it easily recognizable. It is usually found in small quantities and is rarely worked.

**THE RED_ROCK COAL.**

This coal is usually found in small quantities and is rarely worked. It is usually bony and has to be discarded. Its columnar structure make it easily recognizable. It is usually found in small quantities and is rarely worked.

**THE BIG_FOOT COAL.**

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**THE BIG_FOOT COAL.**

This coal is usually found in small quantities and is rarely worked. It is usually bony and has to be discarded. Its columnar structure make it easily recognizable. It is usually found in small quantities and is rarely worked.
The coal is coked, but it does not rank as high as a coking coal as it does in a steam driver. A test was made on a sample of this coal with the following results:

<table>
<thead>
<tr>
<th>Coal Diph.</th>
<th>Coke produced</th>
<th>Moisture</th>
<th>Fixed carbon</th>
<th>Ash</th>
<th>T.G.</th>
<th>Volatile matter</th>
<th>Total recoverable</th>
<th>Coke</th>
<th>Total recoverable</th>
</tr>
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<tr>
<td>1</td>
<td>3.85</td>
<td>7.35</td>
<td>84.19</td>
<td>1.36</td>
<td>74.06</td>
<td>18.66</td>
<td>92.73</td>
<td>76.98</td>
<td>92.73</td>
</tr>
<tr>
<td>2</td>
<td>4.05</td>
<td>7.68</td>
<td>84.22</td>
<td>1.39</td>
<td>73.54</td>
<td>18.48</td>
<td>92.64</td>
<td>78.67</td>
<td>92.64</td>
</tr>
<tr>
<td>3</td>
<td>4.03</td>
<td>7.70</td>
<td>84.26</td>
<td>1.37</td>
<td>73.60</td>
<td>18.46</td>
<td>92.68</td>
<td>78.71</td>
<td>92.68</td>
</tr>
</tbody>
</table>

The yield of coke from this test is comparatively high, but the poor quality of the coke shows that this coal does not belong among the best coking coals of western Pennsylvania and West Virginia. The coal mined at Franklin (analysis K, p. 19) is coked by the Cambria Steel Company in its fourteen-oven process for use in the company's plant near Johnstown and gives satisfactory results, but before the coal is coked it is washed and the cost of the coke is thereby increased. Even with this additional item of cost, it is found cheaper to coke this coal on the ground than to buy coke of better quality from the Connellsville region. Tests have been made by the Cambria Steel Company with the coal mined from this bed about Erenfeld, and the resulting coke proved well adapted to metallurgical purposes. The yield also was satisfactory. The coal mined at Nanty Gis from this bed has been tested in both the domestic and foreign markets. It produced coke of good structure but of a rather dull appearance. As was to be expected, an insufficient amount of sulphur was volatilized. At Bennington this coal, like the Upper Freport, shows a higher content of volatile matter than it does about South Fork and Johnstown. The Lackawanna Coal and Coke Company has experimented with it about Weirton, but the washeries are now shut down and the results of the coking tests were not learned. The Vincent Colliery Company has recently completed a large by-product plant at Vintondale, and much of the coal mined from colliery No. 9 during 1907 was coked.

THE KOOLING KITTANNING COAL.

As a rule the Middle Kittanning coal is not workable in this district, though it is very persistent and hence serves as an additional check on the identity of the beds above and below. It has been opened at Somonolens, where it is about 25 feet above the Lower Kittanning coal at the brick plant of A. J. Hove & Sons (fig. 8) and shows a thickness of 30 inches, with more coal. It is also of workable thickness at the head of Somonolens Dam. Though it is locally workable about Johnstown it can not be classed among the future commercial coals of the Johnstown district.

A little more than 100 feet below the Upper Freport or D bed and about 30 feet above the Middle Kittanning coal occurs a coal which is fairly persistent along Blacklick Creek and South Branch. Though it is not of useful thickness in the Middle Kittanning simply because it is the first bed above the Lower Kittanning coal, it has been seen about Nanty Gis, Twin Rocks, and Whitley, and at Vintondale a section showed 33 inches of coal with a thin parting of shale near its base.

TABLE XII.—The Upper Kittanning coal, also called the "consent" coal, outcrops at a height above drainage level that is convenient for exploitation at practically all points along Johnstown. The characteristics of the Cambria Steel Company in the Rolling Mill mines have been pushed westward in Upper Yoder Township beyond Mill Creek, and the coal to the northeast has shown no indication of being too thin to work. Where observed along Rons Creek in Somerset County it is also of workable thickness. The westward dips toward the Johnstown Basin carry this bed below drainage level less than a mile east of the Baltimore and Ohio Railroad tunnel south of Monroh. This coal is the most extensively exploited of all the beds in this district. It is worked on a commercial scale from Franklin or for west as Compendere and to the south beyond Monroh. Many small operations are conducted along Stony and Sassa runs. The mines in operation about Johnstown are noted on the accompanying economic map. One of these mines—the Rolling Mill mine of the Cambria Steel Company—is the largest in the area and one of the largest in the State, having a daily output of about 3000 tons.

The thickness of this coal can be seen from the sections in figure 16. This bed varies somewhat in thickness about Johnstown but contains on an average between 3 and 3.5 feet of coal. It rarely exceeds 4 feet, and at a few mines less than 3 feet has been found. South of the city it becomes thinner, and along Stony Creek, on the Baltimore and Ohio Railroad, the sections show on an average about 5 feet of coal. This thick coal continues southward to the Windber district. There is generally a thin lumpy strata at the top of this bed that is disordered in parting, and locally a few inches of shale at the bottom; but the rest of the bed is good clean coal, generally of uniform quality throughout. In a few mines the upper foot is reported to contain a few inches of flint shale. The roof of the coal is very dense shale or sandy shale and sandstone and gives no trouble whatever. The floor is generally a few inches of flint shale, closely underlaid by the bed of limestone that has been mentioned as suitable for making cement. The coal is made up of a main bench 3^- to 4 feet thick, and the westward dips toward the town are not more than a few inches at a time. The walls are reported to be free from gas. Clay veins are, however, rather numerous and occasionally considerable annoyance is caused by gas, necessitating the use of safety lamps.

The coal is called the "consent" bed about South Fork, probably corresponds to the Upper Kittanning or "consent" bed of Johnstown. It has been opened by H. C. Kittsman and O. M. Stifterman on the south side of town. This coal is workable and contains a few inches of shale near its base.
been greater than the supply. The six analyses given above, lettered E to J, show a high-carbon coal with correspondingly low volatile matter. The moisture is low, but the ash and sulfur are rather high. The coal mined from this bed at Franklin mine No. 1 of the Cambria Steel Company is washed and coked at the Franklin plant. It makes a coke of good grade, but owing to its low volatile matter it is not considered as so well adapted for blast-furnace use as some of the richer gas coals of the district farther west. When the coke is shipped from the coal from this bed near Johnstown the sections in figure 12 should be consulted. The coal as mined from this bed at Franklin mine No. 1 of the Cambria Steel Company is washed and coked at the Franklin plant. It makes a coke of good grade, but owing to its low volatile matter it is not considered as so well adapted for blast-furnace use as some of the richer gas coals of the district farther west. When the coke is shipped from the mine it should be readily marketable.

Chemical properties.

In the sample of the Lower Freeport coal collected near Johnstown, the analysis of which is given in the foregoing table, the ash was almost entirely composed of sandstone, except for a small amount of clay which was present. The coal was washed and coked at the Franklin plant. It makes a coke of good grade, but owing to its low volatile matter it is not considered as so well adapted for blast-furnace use as some of the richer gas coals of the district farther west. When the coke is shipped from the mine it should be readily marketable.

FLINT CLAY ON MARDIS RUN.

Fragments of flint clay have been seen in several localities in the hills surrounding Windber. In fact, it has been found to be unsuitable, owing to expansion, which quickly ruined the ovens and made it very difficult to fuse the lime before it was cooled. The analysis indicates a clay of high grade, containing more than 97 per cent of clay substance and free alumina. The amount of siliceous material is very small. The clay is smooth, hard, and compact and is light to dark gray in color. It forms a strong clay.

FLINT CLAY NEAR Windber.

The analysis indicates a clay of high grade, containing more than 97 per cent of clay substance and free alumina. The amount of siliceous material is very small. The clay is smooth, hard, and compact and is light to dark gray in color. It forms a strong clay.

FLINT CLAY NEAR Johnstown.

The highest flint clay in the quadrangle occurs in the Cambria Steel Company at Johnstown and have proved highly satisfactory. The analysis indicates a clay of high grade, containing more than 97 per cent of clay substance and free alumina. The amount of siliceous material is very small. The clay is smooth, hard, and compact and is light to dark gray in color. It forms a strong clay.

FLINT CLAY NEAR Monongahela.

The analysis indicates a clay of high grade, containing more than 97 per cent of clay substance and free alumina. The amount of siliceous material is very small. The clay is smooth, hard, and compact and is light to dark gray in color. It forms a strong clay.


FLINT CLAY NEAR Windber.
this first clay was seen on the road leading to Greenview Cemetery. Here the clay was about 65 feet above the Upper Freeport coal, a light straw color, and appeared to be of good quality, as it is sometimes used at the Fernvale-Johnstown road, a short distance north of the Eighth Ward mine of the Citizens Coal Company. A remnant of flint clay occurs along the road near the top of the massive Mahoning sandstone member. In the hill above the Baltimore and Ohio Railroad tunnel east of Island Park, on the new county road, a clay was observed about 40 feet above the Upper Freeport coal and near the top of the lower sandstone of the Mahoning member. Northwest of Johnstown, in the hills bordering Laurel Run and its branches on the east, a short distance east of the old coal mines from which the Upper Freeport gets its lease name, this first clay is exposed, indicating a probable continuity of the bed as far west as the valley of Laurel Run. Here again the first clay is about 50 feet above the Upper Freeport coal. Northwest of Johnstown, on the road proceeding Pleasant Hill from the valley of Conemaugh River, a first clay occurs also at the localities described above, it could be marketed, as most of these localities are conveniently situated with respect to transportation. Deposits of this clay too for removal from north and south on the Baltimore and Ohio Railroad show have also been observed on the headwater of Mill Creek and Delano Run. It should be added that the occurrence noted above are largely roadside outcrops, at which it is impossible to determine the true thickness and nature of the clays. Only careful prospecting can determine these points, but the fact that one of the first clays is being exploited at one place is significant.

The first clay in the Blacklick Creek district occurs at two locations. The highest first clay is found in the lower part of the Conemaugh formation. A remnant of the upper sandstone of the Mahoning member and a few feet below a small coal bed, possibly the Gallitzin coal. This first clay has been observed in many places north, west, and south of Wehrum, but the rise of the beds toward the east gradually increases its distance from the valley and from railroad tracks and finally results in its disappearance from the hills. West of Wehrum, however, it occurs at many points both north and south of Blacklick Creek, in places having the common thickness of 7 to 8 feet. It is a typical first clay in its content of iron oxide seems to be very high. A sample collected from a roadside exposure west of Dilltown gave the following analysis:

<table>
<thead>
<tr>
<th>Analysis of first clay from a roadside exposure near Dilltown</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Siltstone (Silt)</td>
<td>16.3</td>
</tr>
<tr>
<td>Feldspathic substance</td>
<td>12.4</td>
</tr>
<tr>
<td>Alumina (Al₂O₃)</td>
<td>46.9</td>
</tr>
<tr>
<td>Magnesia (MgO)</td>
<td>29.2</td>
</tr>
<tr>
<td>Lime (CaO)</td>
<td>3.6</td>
</tr>
<tr>
<td>Feldspar (Feldspar)</td>
<td>1.6</td>
</tr>
<tr>
<td>Titaniferous oxide (Tio₂O₃)</td>
<td>2.5</td>
</tr>
<tr>
<td>Loss on ignition</td>
<td>1.7</td>
</tr>
</tbody>
</table>

The percentage of clay minerals, principally iron oxide, indicated in this analysis is so high as to prohibit the practical use of the clay.

The use of the clay.

The clay in appearance, though its content of iron oxide seems to be high, is not exposed immediately above the hills lying east of Stony Creek south of Kring, on the Baltimore and Ohio Railroad, this member has been prospected and some clay and shale beds have been found, but they have not been worked. At one exposure the Mercer coal south of the quadrangle, on the west flank of the Elkton sandstone unit, more than 11 feet of clays and shales were measured. First clay was not observed in connection with the Mercer at any of the old prospect pits. The most valuable clay in the Allegheny formation is that underlying the Lower Kittanning or Miller coal. Many of the mines working this coal around Johnstown produce also considerable amounts of this clay. The clay bed in this district ranges from less than 2 to about 6 feet in thickness, but locally it may be even thicker. It generally underlies the lower bench of the coal and is occasionally concealed by a few inches of shale; in the absence of the lower bench it occurs below the main coal itself and is separated from it by a thin gravel or sand. The clay is dark-brown, not very hard, of irregular fractures, and gray to the touch, and slakes on exposure to the weather. Its composition is indicated by the following analyses:

<table>
<thead>
<tr>
<th>Analysis of clay underlying the Lower Kittanning coal.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>L.</td>
<td>100.00</td>
</tr>
<tr>
<td>Loss on ignition</td>
<td>2.56</td>
</tr>
<tr>
<td>Siltstone (Silt)</td>
<td>15.89</td>
</tr>
<tr>
<td>Feldspathic substance</td>
<td>1.58</td>
</tr>
<tr>
<td>Alumina (Al₂O₃)</td>
<td>48.72</td>
</tr>
<tr>
<td>Lime (CaO)</td>
<td>1.31</td>
</tr>
<tr>
<td>Magnesia (MgO)</td>
<td>1.66</td>
</tr>
<tr>
<td>Titaniferous oxide (Tio₂O₃)</td>
<td>1.77</td>
</tr>
</tbody>
</table>

"Beds worked for brick material."

This analysis, as high as to prohibit the practical use of the clay.

The most important shale beds about Johnstown are within the lower 300 feet of the Conemaugh formation. Some of these are worked in the hill along the Frankstown road west of the city. From a horizon about 50 feet above the top of the Upper Freeport coal to the top of the hill numerous promising beds of shale are exposed. Most of these beds lying between 165 and 210 feet above the Upper Freeport or Coke Yard coal are being worked by the Johnstown Press Brick Company into a building brick of good grade, of both the buff and red varieties. The fuel used in burning the brick is obtained from the Upper Freeport coal, which company works in the same hill. The shales are ground so as to pass through a 12-mesh sieve, or to a size to make them "ball." From the grinder the material is handled by a bucket-carry conveyor to the stew, thence going through a hopper to the press, after which it is pressed into brick, the dry-press process being used.

The composition of the shale employed is indicated by the analyses on page 14. The shale was first air dried, and then mixed with the overlying clay in the proportion of two parts of shale to one of clay. The sample was analyzed by P. H. Bates, of the structural-materials laboratory of the Survey at St. Louis, with the following results:

<table>
<thead>
<tr>
<th>Analysis of shale and clay from Johnstown shale member.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultimate analysis:</td>
<td></td>
</tr>
<tr>
<td>Moisture</td>
<td>0.98</td>
</tr>
<tr>
<td>Ash</td>
<td>15.10</td>
</tr>
<tr>
<td>Alumina (Al₂O₃)</td>
<td>22.34</td>
</tr>
<tr>
<td>Feldspar (Feldspar)</td>
<td>13.66</td>
</tr>
<tr>
<td>Lime (CaO)</td>
<td>3.56</td>
</tr>
<tr>
<td>Magnesia (MgO)</td>
<td>2.37</td>
</tr>
<tr>
<td>Silicon (SiO₂)</td>
<td>35.49</td>
</tr>
<tr>
<td>Sulfate of iron (Fe₂O₃)</td>
<td>10.98</td>
</tr>
<tr>
<td>Total iron calculated as Fe₂O₃.</td>
<td>100.00</td>
</tr>
</tbody>
</table>

"Beds worked for brick material."

The shale is being extensively worked in the valley of Blacklick Creek is regarded as the equivalent of the Lower Kittanning, Miller, or B bed of the Johnstown and South Fork districts. In the Blacklick Creek district, as well as along Conemaugh River, this coal is underlain by a promising clay bed. This clay is not exploited at present, and no certain measurement of its thickness was obtained. At many of the mines about 2 feet or more of good clay was seen, comparable, in appearance at least, with that in the Johnstown district.
the separating beds as a rule being black shale. It varies from below or within a foot of the base of the Lower Freeport coal, here it is a bluish limestone with some streaks of calcite. It must be thick in all the intermediate territory. Its outcrop is seen to advantage on the Baltimore and Ohio Railroad north of Kring station. To the east on Little Conemaugh River it is exposed just at the northwest apex of the first big meander. Of the limestones in the Johnstown quadrangle, only those which are found in the surrounding hills, conveniently situated with respect to railroads. Their appearance indicates that they are all of the same formation, namely, the Johnstown limestone member, the Lower Freeport limestone member, and the Upper Freeport limestone member.

The Lower Freeport limestone member occurs either directly above the Upper Kittanning or 5 or 6 feet below the Upper Kittanning limestone. Its base is conformable and its thickness is from 100 to 200 feet. The texture is a fine argillaceous limestone, which gives satisfaction. The crushed material is also used for acid washings, some of it probably is and much of it may be suitable for the manufacture of bottles, jars, and rough structural material. The amount of cherty material is very small, and as the amount of magnesia. The sandstone of the Pottsville formation is not likely to present any serious obstacle to being ground in the molasses furnace, say in a 30 to 50 mesh size. In prospecting for glass sand, only the fines and coarse material should be selected, and before exploitation complete quantitative analyses and furnace tests of representative samples should be made.

The Lower Freeport limestone member near the south fork of the Potomac River has a pleasing appearance. After cutting it seasons sufficiently, and is capable of being sawn into building stone. This sandstone has been quarried along the main line of the Pennsylvania Railroad and used in construction and in the manufacture of concrete. The sandstone of the Pottsville formation is not likely to present any serious obstacle to being ground in the molasses furnace, say in a 30 to 50 mesh size. In prospecting for glass sand, only the fines and coarse material should be selected, and before exploitation complete quantitative analyses and furnace tests of representative samples should be made.

Another rock which is used in the manufacture of concrete is the Lapeyrouse sandstone member of the Potomac formation. It is about 45 feet thick in the Johnstown quadrangle. It is not a true limestone but rather a sandy limestone, with a concretionary or brecciated or brecciated manner. The siliceous limestone is quarried and split into paving blocks, which gives satisfaction. The crushed material is also used for acid washings, some of it probably is and much of it may be suitable for the manufacture of bottles, jars, and rough structural material.
CHARACTER OF THE ORE.

The ore bed at the opening of the Cambria Company's mine on the west bank of Hinckston Run was divided into two bands by a stratum of fire clay or shale, which ranged from an inch to a foot in thickness and which crumbled when exposed to the weather, losing its water slowly and changing in color. The upper bench was much richer in iron than the lower, the latter being calcareous; but both benches contained sufficient lime to flux, and the ore and coke were introduced into the furnace without limestone. The ore contained on an average about 30 per cent of metallic iron when carefully treated in the furnace, but sometimes fell below this figure and occasionally rose above it. The character of the ore is expressed by the following analysis furnished by T. T. Morrell:

<table>
<thead>
<tr>
<th>Substance</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>4.950</td>
</tr>
<tr>
<td>Alumina</td>
<td>1.552</td>
</tr>
<tr>
<td>Carbonate of iron</td>
<td>52.330</td>
</tr>
<tr>
<td>Sesquioxide of iron</td>
<td>15.230</td>
</tr>
<tr>
<td>Carbonate of lime</td>
<td>15.285</td>
</tr>
<tr>
<td>Carbonate of magnesia</td>
<td>9.390</td>
</tr>
<tr>
<td>Phosphoric acid</td>
<td>53.0</td>
</tr>
<tr>
<td>Sulphuret</td>
<td>0.850</td>
</tr>
<tr>
<td>Water</td>
<td>100</td>
</tr>
</tbody>
</table>

Metallic iron, 30.930.


WATER RESOURCES.

The Johnstown quadrangle is a well-watered region. Most of the towns derive their water from the headwaters of the smaller creeks flowing into the main drainage channels—Stony Creek, Conemaugh and Little Conemaugh rivers, and Blacklick Creek with its North and South branches. These streams are fed by multitudes of springs as well as by the ordinary rainfall. This water is stored in reservoirs to insure a constant and adequate supply. The water is excellent, because the slopes from which most of it comes, though of small extent, are in general well wooded and comparatively free from habitation. The city of Johnstown obtains its water chiefly from three storage reservoirs, two on Mill Creek and one on Dalton Run. South Fork obtains its supply from a storage reservoir on Rummel Run, and it is understood that the town of Vintondale also has a reservoir on a stream to the southeast. The town of Windber and associated mining villages, lying in part within the Johnstown quadrangle, are supplied partly from a storage reservoir on Little Paint Creek. For industrial purposes the Cambria Steel Company has constructed a large reservoir on Hinckston Run. During most of the year the flow of the streams is fairly adequate, but in the dry season of the autumn the supply is likely to run low. During the summer of 1906 the streams all maintained a good flow of water.

Away from the railroads the inhabitants of the region depend mostly on wells. Many of these wells have been driven as far down as coal beds, which are almost universally in water-bearing zones. The water obtained from such beds is commonly sulphurous and generally considered very wholesome. Springs are very abundant but do not appear to be large. They generally issue from coal beds or just above impervious clay beds. Though the volume in most such springs is not large, in purity the water can not be excelled. Many of the drill holes put down in this area have tapped water-bearing beds, but almost all the drillings have been made in search of coal beds and little or no attention has been paid to the water-bearing strata. These usually have been either sandstone beds or coal beds. Such a hole was drilled near the confluence of North Fork and South Fork of Bens Creek in Somerset County near Mahler. The locality is known as Sulphur Springs. The water probably issues from the Upper Kittanning coal bed, as the drill hole is understood to be very shallow.

December, 1909.