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, or sheets. Each sheet 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 estuaries; and (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 outlines or forms 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. These lines are called contours, and the uniform altitudinal interval represented by the space between lines being the same throughout each map. These lines are called contour intervals; and the uniform altitudinal space between two contours is called the contour interval.

Contours and elevation

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

2. Contours define the forms of slopes. Since contours are continuous horizontal lines, they wind smoothly about smooth surfaces, weave into all the angles and indentations of property; and maps show the kind of land, the kind of soil, the kind of rocks, and the kind of vegetation of the land better than any other kind of map. Contours indicate the slope of the land, the grade of the land, the direction of the slope, and the general direction of the flow of water. They show the kind of land, the kind of soil, the kind of rocks, and the kind of vegetation of the land better than any other kind of map.

The GEOLoGIC MAPS

The maps representing the geology show, by the use of signs and symbols, the location of the topographic base map, the distribution of rock masses on the surface of the land, and the structure shows 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 been formed within the earth. They are formed by the cooling or crystallizing of magma that has risen to the surface of the earth. These rocks are usually called intrusive or extrusive rocks. When the magma cools slowly, the minerals form large crystals and the rock is called intrusive. When the magma cools quickly, the minerals form small crystals and the rock is called extrusive. Law's cooling rapidly in the earth, and allowing it to grow, or slowly, or more a partially crystalline condition in their outer parts, but more finely crystalline in their inner portions. The outer parts of these flows are usually more or less porphyritic. Explosive action often accompanies volcanic eruptions, causing ejection of dust, ashes, and scoriae. These materials, when consolidated, constitute breccia, agglomerates, and scoriae. Volcanic ejecta may fall in bodies of water near the shore and form sedimentary or rock.

Sedimentary rocks—These rocks are formed by the accumulation and cementation of sediments. They are made up of rocks and sediments that have been weathered and transported to other places. These include rocks of various kinds, such as sandstone, shale, limestone, and dolomite. These rocks are usually found on the surface of the earth, but some may be found in the subsurface.

Metamorphic rocks—These rocks are formed by the alteration of pre-existing rocks due to changes in temperature, pressure, or chemical conditions. They are usually found on the surface of the earth, but some may be found in the subsurface.

FORMATIONS

For purposes of geologic mapping, rocks of all the kinds above described are divided into formations. A formation is a geological term used to describe a group of rocks that are similar in composition, texture, and structure. The formation is usually named after a nearby locality or feature.

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

The rock formations deposited during a period are grouped together into a system. The principal divisions of a system are called series, and the formations less than a series is called a group.

(Continued on next page of atlas.)
DESCRIPTION OF THE ACCIDENT AND GRANTSVILLE QUADRANGLES.

Prepared under the supervision of William Bullock Clark, supervising geologist.
By G. C. Martin.

INTRODUCTION.

LOCATION AND AREA.

The Accident and Grantsville quadrangles are adjacent and are situated for the most part in the northwest corner of Maryland. They are bounded by parallels of latitude 39° 30' and 39° 45' and by meridians of longitude 78° 30' and 78° 30'. Each quadrangle covers an area of about 230 square miles.

The greater part of these quadrangles lies in Garrett County, Md. A strip about 2 miles wide extending across the northern edge of both quadrangles is in Fayette and Somerset counties, Pa., and another strip two-thirds of a mile wide on the western edge of the Accident quadrangle is in Allegany County, Md.; the southwestern corner of the Accident quadrangle lies in Allegany County, Md., and the eastern part of the Grantsville quadrangle lies in Allegany County, Md. The largest towns are Cumberland, Md., and Accident, Md., in the Accident quadrangle, and Elkton, Pa., Grantsville, Md., and Ranson, Md., in the Grantsville quadrangle.

RELATION TO SURROUNDING REGIONS.

These quadrangles are but a small portion of a large area of Appalachian Province—of which part of which it has much in common. It is consequently necessary to note these broader features in order to grasp the significance of the more detailed local descriptions which follow.

APPALACHIAN PROVINCE.

The Appalachian Province consists of three well-marked physiographic and geologic subdivisions which form parallel belts, each being more or less continuous from north to south throughout the greater part of the province. These divisions are a moderately high plateau region on the west, which includes the Allegheny Plateaus in the northern part of the province; a ridge-and-valley region (the “Appalachian valley”) in the center, and a region of much dissected mountains and low plateaus on the east. Only the first district is represented in these quadrangles.

The rocks of the Appalachian Province are in large part Paleozoic, of sedimentary origin, and are all metamorphosed and include both phyllosilicates and unmetamorphosed types. All the rocks of the Allegheny Plateaus are of Paleozoic age, chiefly Carboniferous, and are unmetamorphosed. The structure is comparatively simple. The strata lie in the main nearly flat and are disturbed by only small faults and by low, broadly folded, which, compared with the larger folds farther east, usually have but slight effect on the general geologic features and topography. East of the Allegheny Plateaus, throughout much of the province, are areas of alternating ridges and valleys, where the rocks are metamorphosed phyllosilicates, and are largely unmetamorphosed. Most of these rocks are pre-Cambrian in age, some of them being of Precambrian age, some of them being of Paleozoic age, and some of them being of Mesozoic age.

GEOLOGIC STRATA.

The structure of the Allegheny Plateaus is comparatively simple. The strata lie nearly flat, are broken only by small faults and low, broad folds which rarely have little effect on the general features of the surface. The general theory of the Allegheny Plateaus is that of a northeast-southwest striking fold, its axis near the center of the State. From Cincinnati the anticline passes due south through Lexington, Ky., and there comes to the surface, parallel with the Appalachian Valley, as far as near Nashville, Tenn. Its maximum development is in the vicinity of Lexington, where it is given a thrust on the Allegheny Plateaus, the surface at an altitude of 1000 feet above sea level; but in Tennessee it again swells into a domical structure which is represented topographically by the central basin of the State.

This anticline separates the Allegheny Plateaus from the Allegheny Valley into two structural basins, which are brought to the surface by the Allegheny Plateaus. The Allegheny Valley is generally known as the Allegheny Plateaus. Since the Allegheny valley is a structural basin of the Allegheny Plateaus, it is also known as the Allegheny Valley. The Allegheny Plateaus is a structural basin of the Allegheny Plateaus, and the Allegheny Valley is the Allegheny Plateaus. The Allegheny Plateaus is a structural basin of the Allegheny Plateaus, and the Allegheny Valley is the Allegheny Plateaus.

The plateau slopes westward, but it is generally separated from the Allegheny Plateaus by a more or less regular western forested. This feature is most pronounced in Kentucky, where it has a height of over 1000 feet above sea level. The height of this feature is very high, falling rapidly to the north and south. In Pennsylvania and West Virginia, the irregularity of the plateau is most pronounced where the hard rocks of the Allegheny Plateaus are exposed, and the surface of the plateau is most irregular where the hard rocks of the Allegheny Plateaus are exposed. The irregularity of the plateau is most pronounced where the hard rocks of the Allegheny Plateaus are exposed, and the surface of the plateau is most irregular where the hard rocks of the Allegheny Plateaus are exposed. The irregularity of the plateau is most pronounced where the hard rocks of the Allegheny Plateaus are exposed, and the surface of the plateau is most irregular where the hard rocks of the Allegheny Plateaus are exposed.

The plateau surface is best developed on the Allegheny Plateaus, and is most developed on the Allegheny Plateaus. The plateau surface is best developed on the Allegheny Plateaus, and is most developed on the Allegheny Plateaus. The plateau surface is best developed on the Allegheny Plateaus, and is most developed on the Allegheny Plateaus. The plateau surface is best developed on the Allegheny Plateaus, and is most developed on the Allegheny Plateaus.

TOPOGRAPHY.

The divide between the Ohio and the Potomac drainages passes through the Grantsville quadrangle. The waters of the Accident quadrangle, which are ultimately north and west in Youghiogheny and Castlemont rivers, which join the Ohio, are ultimately south and east in Youghiogheny River. The Accident quadrangle, which is drained by the Youghiogheny River, is part of the Ohio drainage basin, which is divided into the Youghiogheny and Castlemont tributaries of the Ohio drainage basin, and is drained by the Youghiogheny River, which flows into the Potomac.

There is in general a close relationship between the position of the larger stream and the geologic structure and attitude of the underlying rocks. The Ohio, at Cumberland, and a large part of the course of the Youghiogheny River flows to the west, and the Potomac, which flows in a more direct line between the Allegheny and the Castlemont rivers, which have courses that are independent of the present surface distribution of the rocks.

None of the streams of this region are navigable, and none are used for waterpower, except on a small scale, although the best power which is on Youghiogheny River, is not utilized.

Youghiogheny River basin.—Youghiogheny River crosses the Accident quadrangle from south to north. The basin of this drainage, which drain the greater part of this quadrangle. To the south of this quadrangle the Youghiogheny Valley is situated for the most part on the site of an ancient loop of the Potomac in ancient times, where the river has a low grade and the valley is broad, with gentle slopes. Where it
enters the quadrangle, however, it has left those rocks and is flowing through the more resistant Potomac sandstone. For this reason the river has a steep and irregular grade, often with cut banks, and is in a deep and rugged valley. The Potomac is entirely cut out through and the Mount Chink shales and Greenbrier limestones on the eastern side of the valley and the Potomac sandstone on the western side. The river has a rugged and narrow canyon-like appearance, except for the bend at the mouth of Goose Creek, where its course is cut through the underlying rocks and emerges into the valley of the Potomac River. At this point the Potomac is about twice as wide as it is deep, and the water flows in a series of rapids and small waterfalls. The river continues to flow in a generally northwesterly direction and is bordered on the south side by a narrow strip of upland, which is composed of the Mount Chink sandstone and shale.

The Potomac River rises in the Allegheny Mountains in Virginia, where it is formed by the confluence of the North and South Branches. It flows northeastward through the Allegheny Plateau, passing through the Allegheny Mountains and the Allegheny Front, before entering the Potomac Valley. The river is about 410 miles long and has a drainage area of about 15,900 square miles. It is divided into three main sections: the Upper Potomac, the Middle Potomac, and the Lower Potomac. The Upper Potomac flows through the Allegheny Mountains, the Middle Potomac flows through the Allegheny Plateau, and the Lower Potomac flows through the Potomac Valley.

The Potomac River is a significant waterway in the eastern United States. It was an important route for trade and transportation, and played a crucial role in the history of the region. It was also a major waterway for the transportation of goods and people between the eastern and western parts of the country. Today, the Potomac River is used for recreation and fishing, and is an important source of water for the region.
almost no grade. The greater part of the present Greenbrier areas still remain near the position of this old surface. It is in general only where the country is deeply incised by youthful streams which cut the Potomac ridges that this old surface on the Greenbrier has been destroyed and the limestone exposed at the surface.

The Potomac valley.—It has already been stated in the chapter on drainage that Youghinghney River is the branch of the Potomac River that flows south into the lower Potomac. The western end of Youghinghney valley is entirely lined with an impressionistic character and the Lockhaves congloscone of western Pennsylvania. A conglomerate also occurs at approximately the same position for many miles east and west.

Catalina formation. —The Catalina formation, which derives its name from the Catalina Mountains, rising as it does upon the Jennings formation with apparent conformity, forms the eastern boundary of the areas of that formation on either side and surrounds the western area. These large areas of Catalina are described. The outer boundaries of these belts follow parallel and very close to the coast of two ridges or lines of hills which are uplifted by the more resistant rocks of the Congloscone formation.

The Devonian rocks exposed in these quadrangles consist of the Catalina and Jennings formations.

Jennings formation. —The rocks of the Jennings formation, named from the type locality near Jennings, a village in the vicinity of the southern extremity of the range, consist of gray sandstones and siltstones of various colors, including red, green, yellow, and brown. The sands are well sorted and the pebbles are generally small. The pebbles are mostly of quartz and feldspar, but there are also small amounts of chert and quartzite. The pebbles are well rounded and frequently biangular in shape. The rocks of the Jennings formation are exposed along the eastern edge of the area, and only a small portion of the area is covered by the Congloscone formation.

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The equivalent of a part at least of the Castkill beds of New York and Pennsylvania. The Castkill of the type region is a lithological unit which is syn-
chronous wholly or in part with the Chieming and with the lowest Carboniferous. The formation in this area is younger than the highest Chieming and
other than the lowest Carboniferous of this region. Whether it may be synchronous with any beds of the Carboniferous age of other regions and
how much of the typical Castkill in any region may exist cannot be determined until more work has been done in the intermediate region in Pennsylvania. No fault exists between the Carboniferous beds, and the beds probably have been authigenically restored from the Castkill of these quadrangulums.

CARBONIFEROUS SYSTEM

The Castkill facies of these quadrangulums consist of the following formations:

<table>
<thead>
<tr>
<th>Formations</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Castkill</td>
<td>Broad formation, not unlike the Pennsylvania system.</td>
</tr>
<tr>
<td>Pennsylvanian series</td>
<td>Mesiferous sandstone, 240-275 feet.</td>
</tr>
<tr>
<td>Coal Measures</td>
<td>Allochthonous formation, 230-240 feet.</td>
</tr>
<tr>
<td>Pennsylvanian series</td>
<td>Pottsville formation, 240-255 feet.</td>
</tr>
<tr>
<td>Mississippian series</td>
<td>Mouth of Kish formation, 60 feet.</td>
</tr>
<tr>
<td>Pennsylvanian series</td>
<td>Pocono sandstone, 450 feet.</td>
</tr>
</tbody>
</table>

These formations can all be recognized in the adjoining region, except, perhaps, the Castkill, which may be removed by erosion. They hold their general lithographic characters for considerable distances, the more marked changes being due to the changing of the Pocono to the east, the thickening of the Green-

The thickness of the formation is apparently about 450 feet.

**Distribution.**—The Pocono sandstone, named from the Pocono Mountains, Pennsylvania, out-

crops in four areas in these quadrangulums. The most easterly extends across the 

The lower limestone member rests with a slight contact conformity upon the Pocono formation. There are a few feet of transition beds from the upper beds of the Pocono into the carbonaceous sandstones and siliceous limestones of the basin, Greenbrier. It is very difficult to draw an exact line between the formations. The lower member is well exposed in the valley of Deep Creek about 2.5 miles east of Franklin. The middle member is nowhere very well exposed in the area flanks, however, and is not of sufficient economic value for good artificial exposures to be made in it. Lithologically it is very much like the Muskingum Chalk, except that it contains some carbonaceous beds. The Stony Run section contains the most complete representation of the beds of this member known in this region.

The upper limestone member consists largely of limestones and contains the bony and the most valuable limestone in the entire formation. Most of the limestone quarried in Garrett County is from this member. For this reason it is not a very good limestone, but of the same thickness as the underlying member.

**Distribution.**—The Muskingum Chalk formation consists of thinly bedded greenish sandstones at the base, overlain by a considerable thickness of green gray and greenish sandstones and green sandstones. These beds apparently contain no characteristic species upon which any subdivision of the formation can be based. The limestone is very thick, either green or dark green, and are micaceous, thinly bedded and cross-bedded. The shales are of variable shale of green, and are arenaceous and argillaceous.

The thickness of the formation is about 650 feet.

Correlation—The Muskingum Chalk formation of Maryland is the equivalent of the upper part of the Muskingum Chalk shale of the typical locality in the southwestern Pennsylvania. The change which takes place in the formation in passing southwestward across Pennsylvania has been referred to as the "Huntington Green-

Neither the top nor the bottom of the bed is clear, though the base is in the following section. In the

The Greenbrier consists of an upper calcareous member, 65 to 85 feet thick; a middle sandy and shale member, 58 to 95 feet thick; and a lower calcareous member, about 60 to 90 feet thick, into members appears to be constant in the region here studied.

**Distribution.**—The Greenbrier limestone carries the fauna of the Mississippi Valley. It is the equivalent of the Maxville limestone of Ohio and of part of the Greenbrier and Newark limestones of the southern Appal-

The lower limestone member rests with a slight contact conformity upon the Pocono formation. There are a few feet of transition beds from the upper beds of the Pocono into the carbonaceous sandstones and siliceous limestones of the basin, Greenbrier. It is very difficult to draw an exact line between the formations. The lower member is well exposed in the valley of Deep Creek about 2.5 miles east of Franklin. The middle member is nowhere very well exposed in the area flanks, however, and is not of sufficient economic value for good artificial exposures to be made in it. Lithologically it is very much like the Muskingum Chalk, except that it contains some carbonaceous beds. The Stony Run section contains the most complete representation of the beds of this member known in this region.

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The upper part of the Rengar and Newman limestone of the southern Appalachian region may be partially correlative with the lower part of the Muschelkalk of Maryland.

**Pettawe Formation**

**Areal distribution.**—The Pettawe formation, named from Pettawe, Pa., outcrops in three important areas in this region. The most eastern of these extends along the crest of Savage Mountain. The western border of this area lies a short distance (possibly 100 yards) west of the crest of the mountain; the eastern border lies a distance varying from one-fourth to one-half mile east of it. A second belt extends in a northerly direction along the crest and western flank of Mount Savage from the northern limit of the quadrangle to the southern end of the quadrangle in the valley of Deep Creek, where it joins a similar belt which extends northerly in a northern direction along the crest and western flank of Negro Mountain in the Pennsylvania quadrangle. A third belt extends along the crest and western slope of Winding Ridge from the north edge of the Accident quadrangle to the Youghiogheny River between Kung and Snag Run. Here it joins a large area of very irregular outline which covers only a small part of the southwest corner of the Accident quadrangle. Four outliers occur along the margin of this belt.

**Lithological character.**—The Pettawe formation consists of a series of coarse and medium conglomerate, sandstone, shale, fire clay, and coal. The character of the formation is best described in the following section, which was measured in the Youghiogheny gorge at and below Swallow Falls, a short distance south of the margin of the Accident quadrangle.

**Section of Pettawe formation near Swallow Falls, Garrett County, Md.**

<table>
<thead>
<tr>
<th>Sandstone</th>
<th>Shale</th>
<th>Coal</th>
<th>Fire clay</th>
<th>Conglomerate</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swallow Falls</td>
<td>150 yds.</td>
<td>30 yds.</td>
<td>25 yds.</td>
<td>10 yds.</td>
<td>5 yds.</td>
<td>205 yds.</td>
</tr>
</tbody>
</table>

This section shows the relationships of the divisions of the Mercer coal group to one another and the underlying strata. The Lower Mercer coal is usually absent in Maryland, having been reported only from Swallow Falls and on the Henry be Milk. The formation is predominantly a conglomerate, which is identical with the Upper Mercer (where there are two Mercers) of Pennsylvania, it may be identified in Maryland as the Middle Mercer. The conglomerate is usually a very short distance under the Swallow Falls conglomerate. Below the Shale is a series of coarse and medium conglomerate, sandstone, and coal. The Mount Savage fire clay is approximately one of the most prominent members of the "Mountain Zone" even where its outcrop is concealed its presence being revealed by the occurrence of fault bowlders in the soil. The Mercer limestones, which are very characteristic of this horizon in Pennsylvania, have not been recognized in Maryland.

Resting conformably upon the shale at the top of the Mercer is a very quartzite and schistose, which is the equivalent of the Housewood sandstone of Pennsylvania. It was formerly called the "Pickford sandstone" in representation of the Housewood sandstone and is now inaccurately called the "Upper Mercer sandstone." It consists of a series of coarse and medium conglomerate, sandstone, and coal. The Shale is the upper part of the Pettawe formation of this region represents the upper part of the formation and is a continuation of the Missionary of the "Coal Mountain." Two hypotheses have been suggested by David White (Twentieth Ann. Rept. U. S. Geol. Survey, 1915). One is that the Mount Savage fire clay of the Pettawe and the absence of its lower members in the bituminous coal fields of western Pennsylvania, Maryland, and West Virginia. While he regards the problem as still an open one, Mr. White is inclined to believe that the oldest Pettawe beds are very thin sections rests upon the underlying Muschelkalk conformably, and is contemporaneous with the youngest Muschelkalk of those regions where the Pettawe is thin, and that the Pettawe of the latter regions was deposited in an environment more favorable to deposition of the Pettawe by overtopping. It is probable that the Pettawe and Muschelkalk of Maryland are not deformable. Whether or not the unconformity represents the shearing.

**Subdivision.**—The subdivision of the Allogynus formation in this region have been classified as follows:

<table>
<thead>
<tr>
<th>Subdivision</th>
<th>Coal &amp; Shale</th>
<th>Fire clay</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Mercer</td>
<td>20 yds.</td>
<td>15 yds.</td>
<td>5 yds.</td>
</tr>
<tr>
<td>Middle Mercer</td>
<td>50 yds.</td>
<td>15 yds.</td>
<td>5 yds.</td>
</tr>
<tr>
<td>Lower Mercer</td>
<td>100 yds.</td>
<td>15 yds.</td>
<td>5 yds.</td>
</tr>
</tbody>
</table>

As far as is known the shale which forms the base of the Allogynus formation lies conformably upon the underlying Pettawe. A few feet above the base of the Pettawe there is sometimes found a coal seam which is the equivalent of the Brockville coal of Pennsylvania. Here, as in other cases, the coal is very irregular and uncertain in its occurrence.

The Clifton coal is one of the most persistent in many quadrangles in this region. Its position varies from 15 to 45 feet above the top of the Pettawe. It usually occurs about 10 feet thick which contains very abundant nodules of siderite overlies the Clifton.
coal. At places these are abundant enough to suggest the possibility of profitable mining.

This shale is usually of a thick and massive sandstone which resembles the underlying Homewood sandstone and is known as the Clarion sandstone. This sandstone is usually present both to the north and to the south of it. The Vaaport limestone in southwestern Pennsylvania and in Ohio carries a marine sandstone fauna. This fauna is absent to the south and southeast of this region, in West Virginia and Maryland, and in some cases replaced by a fresh-water fauna, indicating a change in character of deposition from the north and west to the south and east. These sandstones are in this transition area, and if the limestone is discovered here it may be of either character or of both.

The Splitlox coal occurs as an interbed of 65 to 115 feet above the Clarion coal, and a short distance above the Vaaport limestone. In its normal position with reference to the next higher coal it has been seen on only two localities in this area, one of which is in the south bank of White Rock Run. Here it is 21 feet below the Lower Kittanning. In the locality of Franklin, Allegheny Co., Pa., this interbed is somewhat greater (28 feet).

The Middle and Lower Kittanning coals in the southern part of the George Creek basin are separated by less than a foot of shale and constitute one workable seam. In the northern part of the George Creek basin the intervening shale is usually about 3 feet in thickness. In the lower Youghiogheny basin it varies from 1 to 10 feet. In the Caddo stray the Kittanning (and in fact the entire Allegheny formation) is known in continuous section only from the bore hole at Johnson's Mill. Here the Kittanning coals are all thin and occur within a total thickness of about 15 feet. In the George Creek basin this coal is locally known as the Six-foot, Five-foot, or Dave's coal. It was called by the last name in the report on the Geology of Allegheny County, but is now known to be the equivalent of either the Lower or the Middle and Lower Kittanning. Frequently it is absent or represented by black shale or a few coal streaks. No good exposure of it has been seen within these sandstones. The best development of it in this region is at Harrison, W. Va., where it has a thickness of 45 inches.

The strata between the Upper Kittanning coal and the top of the Allegheny formation consist of the Allegheny sandstone. The lithologic character of the members are well shown in the following section:

### Section of Kittanning, W. Va.

1. Coal, Upper Kittanning (Coal...), 48 ft.
2. Coal, Middle Kittanning (Coal...), 14 ft.
3. Coal, Lower Kittanning (Coal...), 14 ft.
4. Coal, Un(striped...), 6 ft.
5. Shale, Middle... 5
6. Coal, Lower... 3
7. Coal, Upper... 3
8. Shale, Smith... 15
9. Coal, Lower... 110
10. Thin... 5
11. Sandstone, lenticular... 1
12. Shale, sandstone, and... 5
13. Coal, Upper... 110

### Section of Allegheny Formation at Horner, Allegheny County, Pa.

1. Coal, Kittanning... 110
2. Coal, Middle Kittanning... 14
3. Coal, Lower Kittanning... 14
4. Coal, Un(striped...), 6
5. Coal, Sandstone... 1
6. Coal, Limestone... 1
7. Coal, Shale... 1
8. Coal, Sandstone... 1
9. Coal, Limestone... 1
10. Coal, Shale... 1
11. Coal, Sandstone... 1
12. Coal, Limestone... 1
13. Coal, Shale... 1
14. Coal, Sandstone... 1
15. Coal, Limestone... 1
16. Coal, Shale... 1
17. Coal, Sandstone... 1
18. Coal, Limestone... 1
19. Coal, Shale... 1
20. Coal, Sandstone... 1
21. Coal, Limestone... 1
22. Coal, Shale... 1
23. Coal, Sandstone... 1
24. Coal, Limestone... 1
25. Coal, Shale... 1
26. Coal, Upper Kittanning... 1
27. Sandstone... 1
28. Limestone... 1
29. Shale... 1
30. Coal, Kittanning... 1
31. Coal, Middle Kittanning... 1
32. Coal, Lower Kittanning... 1
33. Coal, Un(striped...), 6
34. Coal, Sandstone... 1
35. Coal, Limestone... 1
36. Coal, Shale... 1
37. Coal, Sandstone... 1
38. Coal, Limestone... 1
39. Coal, Shale... 1
40. Coal, Upper Kittanning... 1

### Subdivisions.

- The character of the coals in the Kittanning formation are as follows:
  - Little Pittsburg and Pittsburg sandstone
  - Coshocton and Mount Vernon sandstone
  - Little Kittanning and Franklin sandstone
  - Clarion sandstone
  - McKeesport sandstone
  - Beaver sandstone

- The Middle Kittanning coal is a thin coal and is known to be the equivalent of the Clarion sandstone.

- The Upper Kittanning coal is a thin coal and is known to be the equivalent of the Middle and Lower Kittanning.

- The Allegheny sandstone is a thick and massive sandstone which resembles the underlying Homewood sandstone and is known as the Clarion sandstone.

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The Mahoning coal is present in many places in the Potomac basin. In the lower Youghiogheny basin it is thicker and more persistent than elsewhere in the region and is a valuable fuel for local use.

The strata immediately underlying the Mahoning section, or the beds which replace the upper part of the Mahoning, consist of 15 to 25 feet of very argillaceous sandstone.

The Brash Creek coal, which overlies this shale, is one of the most persistent and characteristic strata in the entire region. It has been observed at various localities in each coal basin except in the upper Youghiogheny basin, where it has been almost entirely removed by erosion.

In the Brash Creek coal, the bed of sandy black shale from 5 to 8 feet thick, which is in turn overlain by the Lower Cambrian limestone. This limestone is of distinctly marine origin and is filled with marine fossils. It is thickest in width of 6 inches to 3 feet. Considering the extreme thinness of this stratum, its persistence is remarkable. In not a single known instance has the position of this bed been changed.

The Brash Creek coal was exposed without both the limestone and the coal being present. Above the limestone is a series of black shales which carry the same plant remains and are sandy above and finally grade into a fairly persistent and massive sandstone which is the equivalent of the Rutland. The sandstone is largely known as the Rutland and is in many localities formed on the top of a black member which is in turn overlain by the Upper Cambrian limestone. The flat, broad plateaus from Cinnaminson to Niverton are held up by this sandstone, and the top of the Kittanning Hill is probably capped by it.

Above the Rutland sandstone is a succession of strata which have as yet been seen only in the river bluff north of Greenwich, which are described as Nos. 24 to 32 of that section, and which are described in somewhat greater detail below:

The three limestones with the 7 to 8 feet of shales probably represent the Upper Cambrian limestone. In the bore hole at Jennings Mill, this interval is represented by a series of alternating red and green shales.

These beds are succeeded by about 35 feet of shales and sandstones, the latter predominating. Then comes a coal which is not shown on the section, given above, but of considerable value. This is the Berkersont coal of Pennsylvania, or, as it was called in the Geology of Allegheny County, the Berkerson coal. The Berkerson coal is known in Rept. K.K. of Pennsylvania Geological Survey, pp. 67, 68.

In the George Creek basin, the Berkerson coal is locally known as the Four-foot and sometimes as the Three-foot. In the Castleton basin it is locally known as the Honeynut. There is another bed in the Castleton basin which is locally known as the Barnley bed or Four-foot coal; this may be a local development of the Honeynut or Berkerson, or may belong as much as 90 feet below that bed. It is, however, more than 80 feet above the Brash Creek coal. The various possibilities in regard to the actual local position of this coal will be discussed under the heading of "Mineral resources." In regard to its correlation, it may be said that if it is not a local phase of the Berkerson it has no equivalent in the other coal basins except in the Berkshire basin of Pennsylvania, of which the Castleton basin is the southern continuation, there are three coal beds below the Berkshire and the Brash Creek which have no recognized equivalent elsewhere. The Barnley coal is probably one of these beds, which is in turn overlain by the Brash Creek coal, of which it is. It has been named the Stambaughville coal, from its typical development near the town of that name.

The strata immediately underlying the Berkerson coal are well exposed in the Castleton Valley on the railroad cut on the south side of the National Road. This section is part (Nos. 24 to 34) of the Assistant and Stambaughville.

The limestones underlying the Berkerson coal have not been recognized in Maryland outside of this basin, but the coal at least appears to be very constant within the basin. The main Mahoning coal was given its present development in the Kittanning district in Pennsylvania, and the depositional interval is generally conceded or only poorly exposed.

In the river bluff north of Greenwich there are good exposures of a fine-grained cross-bedded sandstone about 30 feet thick, probably the full thickness of the coal, which is not shown on the section, given above. These beds contain a number of fine fossils and are called the Brash Creek sandstone. This bed is overlaid by the Larcen coal.

The Larcen coal is of the equivalent of the Conemaugh sandstone of the Older-Creek basin and is in many localities formed on the top of a black member which is in turn overlain by the Upper Cambrian limestone. The flat, broad plateaus from Cinnaminson to Niverton are held up by this sandstone, and the top of the Kittanning Hill is probably capped by it. In the Youghiogheny basin the flat plateau which overlooks the valley on the eastern side of the river from Greenwich to Winterset is determined by the presence of this sandstone, which outcrops along the top of the black and whose talus contains much of the underlying beds.

The Conemaugh sandstone is overlain by a group of rocks of slight resistance, which consist of bedded sandstone, fine-grained black sandstone, and black shale, with the sandstone the most continuous of the three. This section is usually shown as a group of two beds only; the strata are shown in the following section:

The strata from the upper Little Pittsburgh coal to the top of the formation consist of shale and have a thickness varying from 35 to 60 feet.

Correlation.—The Conemaugh formation is the same as the formation mapped by that name and is the "Lower Barren Coal Measures" by the Pennsylvania Geological Survey. The correlation of the continuity of the beds in the northern part of Pennsylvania with those mapped in the adjacent part of Pennsylvania, on the seashore of the individual beds with those of the type region on Conemaugh River, and on the presence of identical fossils in the Amos and Cambrian limestones. The formation is clearly defined here, as in Pennsylvania, between the Upper Fortop coal below and the Pittsburgh coal above.

The formation is identical with that mapped in Ohio and West Virginia as the "Lower Barren Measures." In both of these States, as in the western part of Pennsylvania, the Amos and Cambrian limestones have been followed as cartographic markers of the greatest value in correlation.

The fossil formation and the upper part of the Bearford formation of Dorr and Taff are identical with this formation.

Monongahela formation.

Areal distribution.—The Monongahela formation, named from Monongahela River, in Pennsylvania, comprises eighteen small areas in the Greeneville quadrangle, fourteen being in the George Creek Valley, in Maryland, and four in the Castleton Valley in Pennsylvania.

Lithologic character.—The Monongahela formation consists of a series of sandstones, shales, limestones, and coal beds, many of them having a total thickness of about 300 feet. Sections of this formation are so poor and incomplete that it will be necessary to follow the correlation from the region adjacent to this one, in order to describe the formation in detail.

The Monongahela formation is conformable upon the underlying Conemaugh. The base of the formation is the floor of the Pittsburgh coal.

This division plane is everywhere present and everywhere easily recognized.

Section of Monongahela formation inoping shaft 5 miles south of South Pittsburgh, Allegheny County, Pa.

<table>
<thead>
<tr>
<th>Coal</th>
<th>Shale</th>
<th>Limestone</th>
<th>Sandstone</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>.....</td>
<td>......</td>
<td>..........</td>
<td>...........</td>
<td>.......</td>
<td>.......</td>
</tr>
</tbody>
</table>

The Pittsburgh (or Elk gland, Big vein, or Four-foot, as it has been locally called in this region) is the thickest, most constant, and best known coal not only in this region but in the entire northern Appalachian field. Because of the shallowness of the other beds and the amount of erosion, its occurrence in these quadrangles is limited almost exclusively to the George Creek basin. In this coal and in the Potomac basin south of it there is a geographic variation in the character of the coal. In the northern end of the basin the Pittsburg and the shale and the coal together form a rock consisting of about 70 feet in thickness, and the strata remain constant or decrease somewhat in thickness, with the coal becoming very thin in the central part of the Potomac basin. South of here the tendency was evidently for the shales and sandstone to thicken enormously while the coal remained very thin and almost constant. In the Castleton Valley (Salisbury basin of Pennsylvania) the Pittsburgh coal varies in thickness from 5 to 11 feet, exclusive of the red or rider beds.

The strata overlying the Pittsburgh coal are typically shown in the following section:

The Redstone limestone is well developed in the Castleton Valley, but has not been recognized in the George Creek basin. The overlying Redstone coal appears to be generally present in both basins. A short distance above the Redstone coal is a thin limestone (the Fishport limestone), which is the only representative of the great thickness of limestones in the bonito position in southwestern Pennsylvania. This and all higher beds have been removed by erosion except in the George Creek valley. In western Allegheny County there is a bed of coal about 20 feet above this limestone, which is the Monongahela coal, which represents the Lower Swickwick coal. This bed has not been exposed in the Garrett.
County part of the Granville quadrangle, but may be confidently expected there. About 45 feet above the Lower Swickley coal, and separated from it by shales and sandstone, is the Middle Swickley, or Tycon bed, as it has been called in Allegany County. A sandstone about 40 feet thick is in the Swickley coal, here called the "Long Swickley" sandstone. A short distance above the same is found in western Allegany County the very thin representative of the Unington coal, gobs to include in the Unington sandstone, but this has not been seen in Garrett County. About 50 feet higher is the Waynesburg, a very constant sandstone, but its area in Garrett County is small and exposures of it are infrequent. It was called the Koonz coal in the report on the geology of Allegany County. The roof of this coal marks the top of the Monongahela formation.

Correlation.-The strata here mapped and called the Monongahela formation are correlated with the restricted formation which was long ago given the name and mapped by the Pennsylvania Geological Survey. They have also been called, in Pennsylvania, West Virginia, and Ohio, the "Upper Productive Coal Measures." The correlation of the rocks of the type section of the Monongahela formation with the general similarity of stratigraphic succession, on the presence of the large coal at the base, which constitutes the Koonz coal in the Pittsburg coal, and on the presence of the underlying beds, which, not only in their stratigraphic sequence but in their fossils, are proved to be the equivalent of the Conemaugh formation.

The question has been raised (West Virginia Geol. Survey, vol. 1, 1904, pp. 145-146) whether the writer has correctly correlated the coal which is here and has been previously (geology of Garrett County, Mary A. E. Crooks, 1902, pp. 140-141) referred to the Waynesburg. I. G. White suggests that this coal may be the Unington, while the writer is the representative of the Washington. The possibility of this interpretation is admitted, but the correct correlation can be proved only by paleontologic evidence, which is not now at hand.

The "Elkridge formation" of Dorton and Tuff was named and mapped in the field (No. 29) that describes the Piedmont quadrangle, which adjoins these quadrangles on the north, and is the exact equivalent of the beds here referred to the Monongahela formation.

**BECKLAND FORMATION**

**Areal distribution.** - The Beckland formation occupies four small areas in the Granville quadrangle, one of which is close to the Allegheny-Garrett County line; three are on the summit of Deer Hill, and the fourth is on the summit of Stogner's Hill.

**Lithologic character.** - The Beckland formation consists of a uniform conformity upon the Monongahela formation. The area is all small and as near to the summit of gently rounded hills above the drainage lines that there are no good exposures. Consequently it is impossible to say anything definite about the strata, except that they are apparently shales or limestones which do not show through the soil.

The following section gives the best known sequence of the strata composing the Beckland formation in this region.

**Section of Beckland formation on hill east of Pumping Shaft station, Allegany County.**

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper</td>
<td>Black shale</td>
</tr>
<tr>
<td>Middle</td>
<td>Sandstone, and crossbedded Coal, Jetalianite</td>
</tr>
<tr>
<td>Lower</td>
<td>Limestone,</td>
</tr>
<tr>
<td></td>
<td>Erratic,</td>
</tr>
<tr>
<td></td>
<td>Clays,</td>
</tr>
<tr>
<td></td>
<td>Shales,</td>
</tr>
<tr>
<td></td>
<td>Limestone,</td>
</tr>
<tr>
<td></td>
<td>Coal</td>
</tr>
</tbody>
</table>

**THE WAYNESBURG STRAND.** - The Waynesburg sandstone, which almost always seen a short distance above the base of the formation in other regions, has not been recognized in Maryland. The thickness of the part of the formation exposed in the Waynesburg quadrangle is here\(\) 225 feet above the Pittsburg coal. The strata exposed in this quadrangle are not at all distinct from the upper part of the Monongahela formation. The writer has described the general use of the name for the lower part of the Beckland formation in the upper part of the Monongahela formation, and it is possible that this name is applicable to the strata in the Waynesburg quadrangle. The Beckland formation is about 400 feet, and in southwestern Pennsylvania it is more than 1000 feet thick in this region but the lowest beds have been removed by erosion.

**Correlation.** - The correlation of these rocks with the Beckland formation of southwestern Pennsylvania is difficult. The strata upon the supposed identity of the coal bed 225 feet above the Pittsburg coal at Koonz with the Waynesburg coal. The doubt as to the correctness of this identification has already been mentioned. The rocks above the bed referred to the Washington coal are, in any case, part of the Beckland. These strata may be a small part of the thick of Beckland which remains in southwestern Pennsylvania, and all are the equivalent of beds belonging in lower division, the Washington formation. These rocks, together with the 210 feet of which occurs the kocconyite and other mineral matter, which extends from the base of the coal to the base of the Waynesburg coal, from the 210 feet of the Beckland formation can be 400 feet, and in southwestern Pennsylvania it is more than 1000 feet thick in this region but the lowest beds have been removed by erosion.

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The axis extends 8.35 ft. from the Pennsylvania line, midway between Big Savage and Greene mountains, through Avilla to Tom Ridge.

General features.—This is a long, approximately straight place, where the rocks stand vertical.

The surface of the valley is dissected into many small valleys and streams. The surface of the stream is very irregular and is characterized by a large number of small springs and seeps. The stream is bordered by a narrow strip of forest.

The surface rocks are composed of sandstone and shale. The sandstone is dark gray and fine-grained, while the shale is dark blue and soft. The surface of the valley is covered with a thin layer of soil, which is composed of sandy loam.

The surface of the valley is relatively flat, with a slight upward slope to the west. The stream flows through the valley in a generally southwesterly direction, with a slight bend to the west.

The surface of the valley is characterized by a series of small hills and ridges, which are composed of sandstone and shale. The hills and ridges are generally low, with a maximum height of about 500 feet per mile northward.

The surface rocks in the part of the field which lies within the quadrangles are those of the Upper Youghiogheny syncline. The syncline is bounded by a series of small anticlines and synclines which are known as the Jackson, Isaac, and Park synclines. These synclines are characterized by a series of small folds, which are composed of sandstone and shale.

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The beginning of the Carbonek time was marked by the invasion of this part of the sea in which the present Muck Chanak shales of this region are found. The deposits which accumulated in this time were similar to that from which time to time reached it during the Greenbeek epoch. The clear sandstone believed to be a part of the Carbonek time is described and brought to the region by deposition within the zone which could receive muddy sediments, but not enough to deposit coarse unsorted material at the waves. The conditions of the Carbonek time were reversed. The area was already weathered and oxidized soil was stripped off and carried to the sea, but on the way the coast material was deposited and a new floodplain and coastal-plain sediments were not to be formed until the next epoch.

Monongahela epoch

The beginning of the Monongahela epoch was marked by the invasion of that part of the sea in which the present Muck Chanak shales of this region are found. Fine sand and silt were deposited, however, for shores and limestone predominated over sandstones. The Monongahela time, which marks the beginning of the Monongahela time, is of wide extent and great regularity. The marsh in which it was formed covered a large area and lasted under very nearly uniform conditions for a long time. The formation of coal beds occurred during this epoch, which increased the thickness of the formation consisting of coal.

Dunkard epoch

Dunkard time began with the gentle subsidence during which the Waynesburg marl was covered. The events of this epoch in those sandstones are not well known because the rocks are not well exposed. It was evidently a time of gentle and continuous subsidence and of slow sedimentation in fresh or brackish water.

There is no record preserved, in the local rocks, of the erosion and formation of the Carboniferous period. Adjoining regions show that sedimentation probably continued in this region until the Appalachian system was finally filled. This ended the Paleozoic sedimentary record in the part of the world.

Post- Carboniferous epoch

Widespread and continuous erosion presumably began near the close of Paleozoic time and has continued with slight periods of deposition until the present. Erosion was probably contemporaneous with all the folding which the region has undergone, the surface is now at or near the plate of either the beginning of the ocean or folding, whether it was slow or rapid, continuous or intermittent, or restricted to areas or lagged behind.

Consequently the topography of the Paleozoic or early Mesozoic sands can not be restored. The earliest record, while the physiography of this region reveals is shown in the surface uplift and topography already described. These features show that the region was never flat, but that the process of erosion and deposition was a function to a condition of far less relief than it now has. This condition represents, in at least the broader sense of that term, a peat swamp. Whether the stream of this peat swamp had reduced their channels nearly to a surface level, or whether the northern Appalachians consisted of a series of local basalt-levels, each behind a ridge of resistant rock, and the higher ones at a considerable vertical distance above sea level, is, in the mind of the writer, an open question. There may be a question as to whether the crests of the higher basalt-levels represented by these ridges today are the results of erosion or deposition. The evidence is ambiguous.

The elevation of the region was lowered and the next step in the history of the region reveals in the lower streams to cut quickly from 200 to 300 feet deeper. This may have been brought about by general uplift, by local differential uplift or subsidence, by climatic changes, or by changes in stream course or grade, or by a combination of these causes. Regardless of the cause, the streams in the area were cut to a lower level than that on the land draining it. Whatever the cause, the streams cut the protective geologic conditions which opposed to their courses quickly to a depth of several hundred feet, then came to banded and reduced large areas at the present 1200 to 2000 feet elevation.

The areas of deposits followed by another stream quickening, whose vertical belt is recorded in surrounding regions by a peat swamp at the present 1200 to 1500 feet. This peat swamp is not known to have been cut into the region now under discussion. At the time of the formation of the streams of this peat swamp, the elevations of the surface of the ground were considerably lower, or if they had, warping and subsequent erosion have destroyed the evidence.

At the present time, as far as so far evidence is concerned, is one of continued erosion, retarded here and there by migrating barriers of sandstone sediments...
and culmaceous sediments accumulate. Behind these barriers local base-levels were formed and local and temporary deposits of clay, sand, and gravel accumulated. Gradually conditions approached those now existing, and probably not for a long time have been as nearly as well-defined as they are a whole century ago.

MINERAL RESOURCES.

INTRODUCTION.

The mineral resources of the Accident and Granville quadrangles are largely confined to those extremities which are to be found in the Carboniferous and Silurian rocks. As these rocks cover more than half the area of the quadrangles, and as the Carboniferous areas are distributed rather uniformly in the various sections, it is certain that all parts of the region will be benefited by a development of the mineral industries. All of these industries are as yet in a very youthful stage of development. Coal is now the chief product, and the supply is such that it will probably continue to be the most important product until it is exhausted. Deposits of fire clay have been found which are extremely promising, and it is not unlikely that this and other important clay and cement industries will be developed in the future.

The supply of limestone is inexhaustible, but it has not yet been exploited for local use. The rocks of this region contain deposits of iron ore similar to those which in neighboring regions have been of great value in the past, and the time may possibly come when the deposits of this region can be worked in a small way with profit. None of these iron ores and limonite can be used as building stone and as road metal.

Between the areas of Carboniferous rocks with their rich mineral resources are Devonian areas, which, though poorer in mineral resources, contain rocks which by disintegration have furnished a rich soil. These regions will be benefited by the development of the mining regions, because of the market which they will give for agricultural products, while the mining regions in turn will be benefited by being surrounded by rich and prosperous farming regions.

The areal distribution, sequence, and structure of the rocks have already been described in the preceding pages. The valuable minerals contained in these formations will now be described in the order of present importance.

COAL.

GEOGRAPHIC OCCURRENCE.

The coal of the Accident and Granville quadrangles is confined to the synclines, or "coal basins," as those portions of bed which are cuestas are called. The synclines of this region are all coal basins. There are four of these coal basins, each of which is closed by faulting within these quadrangles. The George Creek basin lies in the southwestern part of the Granville quadrangle, east of Big Swallow Mountain. The most important part of this basin lies to the east of the area here described. The Castleton basin lies in the northeastern part of the Granville quadrangle and the southeastern part of the Accident quadrangle, between Meadow and Negro mountains. It is the continuation of the Pottsville basin of Pennsylvania. The lower Youghiogheny basin lies in the southwestern part of the Accident quadrangle, to the west of Winning Hill, and to the north of Dog Edge. It is the continuation of the Confluence basin of Pennsylvania. The upper Youghiogheny basin lies in greater part to the south of the region here described, but a very small portion of it lies in the extreme southern end of the Accident quadrangle.

STRATIGRAPHIC OCCURRENCE.

The coal beds occur in the Pottsville, Allegheny, Conemaugh, and Monongahela formations, which collectively are called the "Coal Measures."
The extent of this coal, as can be seen on the recent mapping plans, is not large, and it will probably soon be worked out. Many mines have been abandoned because of the supposed exhaustion of the coal now being or will be worked after the coal contained in the roof, floor, and interburdens. Considerable coal—This bed occurs 20 to 30 feet above the Pittsburg coal. The quality and thickness of the coal are not very well known. The bed is so near to the pit in the coal that when it comes to the surface it will be impossible to mine this, no matter how valuable it might otherwise be. For this reason the bed can not be worked.

Lower Shycock coal—This bed occurs at an interval of 10 to 20 feet below the pit. It is known as the leadhead coal. It has been worked within these quadrangles, but is exposed at many points in the immediate vicinity.

Upper Shycock coal—This bed, which is best known as the Tyan or Tuscan coal, occurs 105 to 120 feet above the Pittsburg coal and about 150 feet above the Lower Shycock coal. It is locally restricted to the Crandall; containing the most complete sequence of the Coal Measures in this region. The axis of this syncline lies for the most part west of the Pittsburg coal, and almost wholly to the forear.

The Coal Measures formation contains six beds of coal in these quadrangles, and the immediately adjoining regions. Five of these beds are considered workable, while three of them have been mined on a commercial scale at one time or another. However, it is due entirely to the presence of one bed that the Coal Measures have outranked the others of this region in importance. This is the Pittsburg coal, from which nearly all the coal now being mined in Maryland is taken.

The roof of this bed is the top of the Coal Measures, and it is a very little coal in the adjacent region, but there is no evidence that there is any workable coal above the Wyanopin in these quadrangles.

STRUCTURAL OCCURRENCE

GEORGE'S CREEK RAVINE

The George's Creek bed is a broad, deep syncline and is the most continuous of the Coal Measures in this region. The axis of this syncline lies for the most part west of the George's Creek Ravine, and it is only toward the southern part of the basin, where the eastern edge of the George's Creek quadrangle approaches the syncline, that the George's Creek quadrangle contains any large areas of the Pittsburgh coal.

The Conemaugh and Allegheny coals are so overlapped in importance by the Pittsburgh coal that they have not been prospected to any great extent in this basin. Consequently our knowledge of them is far less in this region than it is in the more western basins where the Pittsburgh coal is absent and the lower beds are depended upon for local use. The coals of the Alleghany and Conemaugh formations underlie a large area in the part of the basin discussed in this book, and it is highly probable that when the Pittsburgh coal is exhausted the Baketours, Upper Freeport, and Lower Kittanning coals will support an important mining industry.

The dip of the part of this basin here under discussion increases from almost nothing in the portion nearest the axis (near Wyanopin) to about 10° along the western outcrop of the Lower Kittanning coal. The strike averages N. 30° E.

The Alleghany coals can be worked in the eastern part of the George's Creek Valley on most of the tributaries of that river. In the George's Creek bed it is known as the Dinky Mine.

The division of the coal into three members, known as the "top" or "roof" coal, "burrst" coal, and "bottom" coal, is a constant and characteristic feature. The great variations in the thickness of the beds from the northern to the southern end of the George's Creek Basin is due entirely to the variations in the "burrst" or "roof" coal. The "burrst" or "roof" coal is the most productive of the three. In the George's Creek basin it is known as the Dinky Mine. In the George's Creek basin it is known as the "burrst" coal.

The dimensions of the bed range from 10 to 20 feet in thickness, and its strike is N. 30° E.

At the bottom of the George's Creek bed there are two major breaks in the coal, and these are known as the "burrst" and "bottom" coal. The upper break is known as the "burrst" coal and the lower break is known as the "bottom" coal.

The Coal Measures formation contains six beds of coal in two quadrangles, and the immediately adjoining regions. Five of these beds are considered workable, while three of them have been mined on a commercial scale at one time or another. However, it is due entirely to the presence of one bed that the Coal Measures have outranked the others of this region in importance. This is the Pittsburg coal, from which nearly all the coal now being mined in Maryland is taken.
**History and Condition of the Coal Industry.**

Coal has been mined in the George Creek basin since 1846. Until recently only the Pittsburg bed has been mined, but with the approaching exhaustion of this coal, development of the thinner beds is rapidly increasing. The Waynesburg, Upper Sewickley, Middle Sewickley, Upper Freeport, and Lower Kittanning beds are at present being mined on a commercial scale in the George Creek valley. The coal in the Caumsett and Lower Youghiogheny basins has been mined only for local use, except in the small areas of Pittsburg coal in the Pennsylvania portion of the Caumsett basin.

It is probable that within a few years there will be very extensive developments in the Caumsett and Youghiogheny valleys. Development has been retarded in the Caumsett basin by lack of means of transportation, and by the fact that the Allegeny coal beds are buried in the central part of the basin. Now that a railroad has been constructed along Caumsett River, development of the coal may be expected.

Ownership of the smaller coal beds is principally in the hands of the farmers. Few large tracts have been acquired except in the George Creek basin.

**Character of the Coal.**

Average of proximate analyses of the coals of these quadrangles are given in the following table, which is compiled from the more complete tables of analyses of these coals given in volume 5 of the reports of the Maryland Geological Survey. These analyses show the variation in character from semicoalious coal in the George Creek basin to ordinary bituminous coal in the Caumsett and Youghiogheny basins.

**Reckoning Materials.**

This region contains a great abundance of valuable clay of various kinds. These resources are entirely undeveloped within these quadrangles, but they promise great possibilities for the future, and are extensively developed in the adjacent region. These materials include fire clays of the highest grade, shales of various kinds, roadbed clays, and sedimentary clays.

**Fire Clay.**

Frequently any clay or shale which underlies a bed of coal is spoken of as a fire clay. But there are many clays which, although they have all the external appearance of a fire clay, will not stand a high enough temperature to be used as fire clay.

The only satisfactory means of telling whether a clay is a fire clay or not is by testing its fusibility; if it melts from fusion it is not suitable for the manufacture of fire brick, and it is therefore, no matter what its occurrence or appearance, a fire clay. Not all fire clays, nor even all those of this region, underlie coal beds. There are at least two very valuable fire clay beds now known in this region.

-Mount Savage fire clay.-The Mount Savage fire clay occurs at a constant location in the Mount coal group, near the top of the Pittsburg formation and immediately under the Homestead sandstone. Its stratigraphic position is shown in the sections of the Pittsburg formation indicated in the text figure on page 13. The first bed does not show at the surface as well as it should, because its position is more or less masked by the overlying sandstones. Fragments of the first fire clay may be usually found in the soil. It is not, however, always present in the normal stratigraphic position, and could, with great facility, at a great many localities, be identified as one of these sandstones. The general location of the beds where it is found is along the eastern edge of the Parrett Formation, near the Allegheny Mountains. Their location can be readily identified from the accompanying geologic map.

In the vicinity of the Union Mining Company and the Susquehanna Mountain Brick Works in the northeastern part of Garrett county, not far east of the Caumsett quadrangle, the clay has a thickness of 9 to 14 feet, averaging about 10 feet. It is overlain within a short distance by a coal bed about 3 feet thick, above which is the Homestead sandstone. There are usually two kinds of clay, the soft or plastic and the first or non-plastic. Both are essential in the manufacture of the bricks, and it is necessary that both should be refractory. There is no regularity in the occurrence of the two kinds of clay in relation to each other. In most places the plastic clay is shown, but this is not everywhere the case.

Another locality where the same clay was observed is in the transect at swallow falls, where the following section is exposed:

**Analysis of first clay from Caumsett River near Garrett County, Md.**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unshrinkable</td>
<td>58.4</td>
</tr>
<tr>
<td>Shrinkage</td>
<td>0.8</td>
</tr>
<tr>
<td>Temperature</td>
<td>1910</td>
</tr>
<tr>
<td>Hardness</td>
<td>3.7</td>
</tr>
</tbody>
</table>

- At no other place has the clay been observed above the coal, as it is here. In this vicinity there is a large deposit of clay, which can be easily worked by the usual methods of mining by drift, and the dip is slight. Transportation can be completed by the nearest grade road which extends from the first showed a thickness of 3 feet, with both top and bottom covered. The character of the clay is such not to show such as whether or not a plastic clay is present in association with the first.

The material is a first clay which in general appearance is an ordinary clay of that region. It is probable the first or non-plastic clay is present in the following:

**Analysis of first clay from Caumsett River near Garrett County, Md.**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unshrinkable</td>
<td>58.4</td>
</tr>
<tr>
<td>Shrinkage</td>
<td>0.8</td>
</tr>
<tr>
<td>Temperature</td>
<td>1910</td>
</tr>
<tr>
<td>Hardness</td>
<td>3.7</td>
</tr>
</tbody>
</table>

- Being a first clay it naturally has practically no plasticity when gathered. It has, however, been mixed with water and consequently is shown in the test as the plastic clay, which is also excessively low, showing that it would have to be mixed with a plastic clay in making it into fire bricks.

- The refractoriness of the clay is, however, the most important quality. The Caumsett clay is very refractory, and probably no other clay of this nature could be used in the Caumsett Valley.

- There is a large area in the vicinity in which this clay could be mined, either by drifts or in open pits. The clay would be easily worked by a short-cut, having almost no grade, from Jennings Brothers Railroad. Abundant coal, and excellent sites for manufacturing plants are at hand. This clay is worthy of immediate development and it is probable it would be found of better location in the Caumsett Valley.

**Shale and Brick Clay.**

The shales of this region which are suitable for brickmaking have wide geographic and geologic distribution. The activities for transportation of these clays, and of local markets has, however, made it unprofitable to work them.

There are probably large areas in the "shale" regions which are underlain by thick and extensive deposits of residual clay, but these too are not favorable conditions for development.

**Limestone.**

This region contains extensive deposits of lime-stone suitable for burning and agricultural or building purposes or for use in fluxes. It is probable that part of at least this limestone is suitable for the manufacture of cement, although it has not yet been tested for this purpose.

The Greenbrier limestone, whose occurrence has been described in the preceding pages, is composed largely of limestone, the most valuable deposits of which occur in the upper member of the formation.

This member is about 65 feet thick and consists predominantly of lime-stone with a few shale partings. Almost the whole thickness can be quarried.

This rock has already been opened for agricultural and building activities, and is in demand. It is probable that cement can be made in this region. Enough lime-stone that it can be worked anywhere except where the covering of soil and rock debris is too thick, are found elsewhere. The middle member of the Greenbrier contains a few thin beds of limestone, but these should always be neglected for the lower member of the Greenbrier, which are much thicker and much more.
capacity is far in excess of any probable demand. The only contamination of the main stream comes from the villages of Oakland, Sung Run, Krog, Friendsville, and Selbyport, and from a few swamplands.

Cumberland River.—This stream drains the northwest half of the Grantsville quadrangle. It is a large, uncontaminated stream, but there is no demand for its waters in the agricultural region through which it flows in this quadrangle.

Sever River.—This stream drains the central part of the Grantsville quadrangle. It is a large, relatively pure stream and furnishes the water supply for the towns of Piedmont, W. Va., and Westminster, Md.

George Creek.—This stream drains the southeast corner of the Grantsville quadrangle. The main stream and the lower courses of its tributaries are so polluted by sewage and mine water as to be unfit for ordinary uses. The headwaters of the tributaries would furnish good supplies for the many mining villages in the Georgea Creek valley.

SEWER WATER.

There are four main large, pure springs along the belts of outcrop of the Greenbrier limestone: These belts extend (1) along the western foot of Big Savage Mountain; (2) along the eastern front of Meadow Mountain; (3) along the eastern front of Negro Mountain; (4) along the eastern foot of Windlow Ridge; (5) along the valleys of Deep Creek and Marsh Run from Thurmont to McHenry, thence westward to Sung Run and along Youghiogheny River for a distance of 2 miles north and south of Sung Run; and (6) along the northern and eastern edges of the Grantsville Valley.

These springs are similar, both in geologic relations and in the properties of their water, to the group of springs from which the celebrated Deer Park spring water is obtained. The Deer Park springs are about 6 miles south of the southern limit of these quadrangles, and are situated along the direct continuation of the line of springs at the western foot of Big Savage Mountain.

ARTESIAN WATER.

The possibility of obtaining artesian water has never been properly tested in this region. It is, however, probable that the synclines that underlie the valleys of George Creek, Cuddeback River, and Youghiogheny River are artesian basins and would yield plenty of good artesian water from various horizons.

Several bore holes made in the coal-bearing portions of the synclines have yielded flows of water. This water came from the “Coal Measures,” and was therefore strongly impregnated with sulphur and iron. It is probable that deeper holes would yield better water from the purer porous sandstones which underlie the “Coal Measures.” There is, however, no present demand in the region for artesian wells, for the numerous pure streams and springs yield sufficient water for all needs.

September, 1907.
### Generalized Section for the Accident and Grantville Quadrangles

<table>
<thead>
<tr>
<th>Formation Name</th>
<th>Symbol</th>
<th>Generation of Rock</th>
<th>Character of Rocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washington Formation (of the Millard group)</td>
<td>Cw</td>
<td>240-210</td>
<td>shale with thin sandstone beds, nodules, water limestone, and acalcar done beds</td>
</tr>
<tr>
<td>Monongahela Formation</td>
<td>Co</td>
<td>150-20</td>
<td>shale and sandstone beds, some thin water limestone, and acalcar done beds</td>
</tr>
<tr>
<td>Conemaugh Formation</td>
<td>Cc</td>
<td>50-60</td>
<td>shale and sandstone, thin water limestone, and thin water limestone</td>
</tr>
<tr>
<td>Allegheny Formation</td>
<td>Cc</td>
<td>200-220</td>
<td>shale and sandstone beds, some thin water limestone, and thin water limestone</td>
</tr>
<tr>
<td>Potomac Formation</td>
<td>Cc</td>
<td>202-205</td>
<td>sandstone and conglomerate with some shale, coal, and for clay</td>
</tr>
<tr>
<td>Machias Chalk Formation</td>
<td>Cc</td>
<td>400</td>
<td>red and green shale with some sandstone</td>
</tr>
<tr>
<td>Greenbrier Limestone</td>
<td>Cc</td>
<td>500</td>
<td>sandstone and conglomerate, thin water limestone, and thin water limestone</td>
</tr>
<tr>
<td>Pennsylvanian</td>
<td>Cc</td>
<td>450</td>
<td>sandstone and conglomerate, some gray shale, especially near base</td>
</tr>
<tr>
<td>Catskill Formation</td>
<td>Dc</td>
<td>100-90</td>
<td>red and green sandstone and sandstone</td>
</tr>
<tr>
<td>Olive-green to gray shale alternating with thin fine-grained sandstone beds. Probably not exposed at the surface in these quadrangles.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jennings Formation</td>
<td>Dc</td>
<td>200-205</td>
<td>thick sandstone beds, representative of the Greenhouse Shale, not exposed in these quadrangles.</td>
</tr>
</tbody>
</table>

### Detailed Section of the Coal-Bearing Rocks of the Accident and Grantville Quadrangles

<table>
<thead>
<tr>
<th>Name of Member</th>
<th>Character of Rocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washington coal</td>
<td>8%</td>
</tr>
<tr>
<td>Manus clay coal</td>
<td>7%</td>
</tr>
<tr>
<td>Washington sandstone</td>
<td>8%</td>
</tr>
<tr>
<td>Washington limestone</td>
<td>8%</td>
</tr>
<tr>
<td>Conemaugh sandstone</td>
<td>1%</td>
</tr>
<tr>
<td>Conemaugh limestone</td>
<td>1%</td>
</tr>
<tr>
<td>Allegheny sandstone</td>
<td>8%</td>
</tr>
<tr>
<td>Allegheny limestone</td>
<td>8%</td>
</tr>
<tr>
<td>Allegheny sandstone (upper part)</td>
<td>8%</td>
</tr>
<tr>
<td>Allegheny sandstone (lower part)</td>
<td>8%</td>
</tr>
<tr>
<td>Potomac Formation</td>
<td>8%</td>
</tr>
<tr>
<td>Potomac sandstone</td>
<td>8%</td>
</tr>
<tr>
<td>Potomac limestone</td>
<td>8%</td>
</tr>
<tr>
<td>Catskill Formation</td>
<td>8%</td>
</tr>
<tr>
<td>Catskill sandstone</td>
<td>8%</td>
</tr>
<tr>
<td>Catskill limestone</td>
<td>8%</td>
</tr>
<tr>
<td>Jennings Formation</td>
<td>8%</td>
</tr>
<tr>
<td>Jennings sandstone</td>
<td>8%</td>
</tr>
<tr>
<td>Jennings limestone</td>
<td>8%</td>
</tr>
</tbody>
</table>

### Millard Coal Field

- **Washington coal**: Usually thin, gray, and sparsely banded. Thin and not well defined.
- **Conemaugh sandstone**: Thin and brown, friable, and sparsely banded.
- **Conemaugh limestone**: Thin and brown, friable, and sparsely banded.
- **Allegheny sandstone**: Thin and brown, friable, and sparsely banded.
- **Allegheny limestone**: Thin and brown, friable, and sparsely banded.
- **Allegheny sandstone (upper part)**: Thin and brown, friable, and sparsely banded.
- **Allegheny sandstone (lower part)**: Thin and brown, friable, and sparsely banded.
- **Potomac Formation**: Thin and brown, friable, and sparsely banded.
- **Potomac sandstone**: Thin and brown, friable, and sparsely banded.
- **Potomac limestone**: Thin and brown, friable, and sparsely banded.
- **Catskill Formation**: Thin and brown, friable, and sparsely banded.
- **Catskill sandstone**: Thin and brown, friable, and sparsely banded.
- **Catskill limestone**: Thin and brown, friable, and sparsely banded.
- **Jennings Formation**: Thin and brown, friable, and sparsely banded.
- **Jennings sandstone**: Thin and brown, friable, and sparsely banded.
- **Jennings limestone**: Thin and brown, friable, and sparsely banded.
As sedimentary deposits or strata accumulate the younger rock on those that are older, and the relative ages of the deposits are determined in part by observing their positions. This relationship holds except in regions of intense disturbance; in such regions sometimes the deposits have been reversed, and it is often difficult to determine their relative ages from their positions; thus fossils, or the remains and imprints of plants and animals, indicate which of two or more formations is the older.

Stratified rocks often contain the remains or imprints of plants and animals, and at the time the strata were deposited, lived in the sea or were eroded from 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 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 they 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 or rock in which they are found. Other types passed on from period to period, and thus linked the systems together, forming a chain of generations. Of the oldest fossiliferous rocks to the present. When two sedimentary formations are from each other and are alike in character, the relative positions of the characteristic fossil type found in them may determine which was deposited first. From the time of the existence of different life forms in different provinces, and continents affords the most important means for obtaining an historical record of a great variety of life forms.

It is often difficult or impossible to determine the age of an igneous formation, but the relative age of such a formation can be determined by chemical analysis. 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 ones is sometimes shown by their relation to adjacent formations of known age; but the age recorded on the map is that of the original ones and not of their metamorphism.

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

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 coal beds. Patterns of triangles and rhombohedra are used for igneous formations. Metamorphic rocks of unknown origin are represented by small irregularly placed; if the rock is obsidian the dashes may be arranged in wavy lines parallel to the strata.

**Structure section.—**This exhibit illustrates the relations of the formations beneath the surface. It represents the geologic subsoil, and other natural and artificial cuttings, the relations of different beds to one another may be seen. Any cutting which exhibits these relations is called a section, and the section is applied to any diagram representing the relations. The arrangement of rocks in the earth is the structure section, and an exhibition of the 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 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 shown in the side of a cutting many miles long and several thousand feet deep. This is illustrated in the following figure:

![Graph showing a vertical section at the front and a horizontal section at the right.](image)

The figure represents a landscape which is cut sharply in the foreground so as to show the underground relations of the rocks. The kinds of rocks are indicated by approximate color and pattern of the section, and the relations between the two is an approximate form, and their surface of contact is an uncontinuous one. The map of the surface is a series of bounded contours. The map of the surface is a series of forms which are more or less continuous and which have been removed by denudation. The bed, like those of the first set, are conformable. The horizontal strata of the phanerites rest upon the upturned, eroded edges of the beds of the second set at the left of the section. The overlying deposits rest upon the eroded edges of the older beds and the accumulation of the younger. When younger rocks rest upon an eroded surface bed, they are not conformable. The contact between the second and third strata is another unconformity; it marks a finite interval between two periods of rock formation.

The section and bedding slope is in fig. 2 are ideal, but they illustrate relations which actually occur. The surface section and structure section are related to the maps as the section is to the figure is related to the landscape. The profile of the surface in the landscape is shown by the actual surface features, and the horizontal plane at the edge of the section, the profile is shown by the map of the surface of any mineral-producing or water-bearing strata which appears in the section may be measured by using the scale of the map.

**Columnar section.**—This section 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 characteristics are indicated by the columnar diagram. The thickness 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 deposits is shown by the column arrangement. The order of succession of the oldest formation at the bottom, the youngest at the top. The intervals of time which correspond to events of uplift and denudation and continuous interruptions of deposition are indicated graphically and by the word "unconformity."

**Geologic age.**—Each formation is shown by a distinctive color and pattern, and is indicated by a special letter symbol.

![Graph showing various formations on the map.](image)

On the right of the sketch, fig. 2, the section is composed of schists which are traversed by masses of sandstones and shales which are much contorted, and their arrangement undergound can not be inferred. However, the knowledge of the section delineates what is probably true but is not known by observation or well-founded inference.

**Shale sandstone.**—In the structure section, fig. 2, it shows the arrangement of rocks in the earth is the structure section, and an exhibition of the arrangement is called a structure section.
<table>
<thead>
<tr>
<th>No.*</th>
<th>Name of folio</th>
<th>State.</th>
<th>Price.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Livingston</td>
<td>Montana</td>
<td>$5</td>
</tr>
<tr>
<td>2</td>
<td>Ringgold</td>
<td>Oregon-Tenn.</td>
<td>$6</td>
</tr>
<tr>
<td>3</td>
<td>Pikes Peak</td>
<td>Tenn.</td>
<td>$5</td>
</tr>
<tr>
<td>4</td>
<td>Piute</td>
<td>Colo.</td>
<td>$5</td>
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* Order by number.
* Payment must be made by money order or in cash.
* These folios are out of stock.

Corrections showing the location of the area covered by any of the above folios, as well as information concerning topographic maps and other publications of the Geological Survey, may be had on application to the Director, United States Geological Survey, Washington, D. C.