DESCRIPTION OF THE KENOVA QUADRANGLE.

INTRODUCTION.

GENERAL RELATIONS OF THE QUADRANGLE.

The Kenova quadrangle lies in Kentucky, Ohio, and West Virginia, between parallels 38° and 38° 30' and meridians 82° 30' and 83°, covering 405 square miles, mostly in Kentucky. (See fig. 1.) It comprises Boyd County and parts of Lawrence, Carter, Greenup, and Elliott counties in Kentucky, part of Wayne County in West Virginia, and a little of Lawrence County in Ohio.

The chief towns in the quadrangle are Ashland, Catlettsburg, and Louiv in Kentucky, and Kenova in West Virginia. The name Kenova is made up of abbreviations of the names of the three States in which the area lies.

In its general geographic and geologic relations the Kenova quadrangle is a part of the Appalachian province, which extends from the Atlantic Coastal Plain to the lowlands of the Mississippi Valley, and from central Alabama into eastern Virginia, between parallels 38° and 38° 30' and meridians 82° 30' and 83°, covering 405 square miles, mostly in Kentucky. (See fig. 1.) It comprises Boyd County and parts of Lawrence, Carter, Greenup, and Elliott counties in Kentucky, part of Wayne County in West Virginia, and a little of Lawrence County in Ohio.

The Appalachians are divided into two nearly equal parts by a line extending along the northwest side of the Appalachian Valley, marked by the Allegheny Front in Pennsylvania, Maryland, and West Virginia and by the eastern escarpment of the Cumberland Plateau in Virginia, Kentucky, Tennessee, Georgia, and Alabama. These subdivisions are shown in figure 2. The rocks east of this line are disturbed by faulting and folding and are in consequence in places much metamorphosed, while the rocks west of this line lie nearly flat and are almost entirely unmetamorphosed. The few folds that break the regularity of the structure are so broad and open that they produce scarcely any appreciable effect on the topography. East of the Allegheny Front lie the Great Appalachian Valley, the surface of which is characterized by alternating ridges and valleys. The Appalachian Mountains, which outline the Great Valley sharply on the southeast, are made up of many large and small ranges bearing various local names. They merge, still farther east, into a deeply dissected upland, the Piedmont Plateau of the Atlantic States. The surface west of the Appalachian Valley is a dissected plateau, previously 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 is not easily seen in an area as small as the Kenova quadrangle, but when viewed broadly in comparison with the lowlands of the Mississippi Valley, the west and the alternating ridges and valleys of the Appalachian Valley on the east it is readily perceived.

The Appalachian Plateau.

Relief.—The Appalachian Plateau, as a whole, is a broad land mass, the surface of which slopes more or less uniformly northward from its southeastern escarpment to the lowlands of the Mississippi Valley. This escarp is lowest at its southern margin, where it emerges from beneath a covering of Cretaceous sediments in north-central Alabama, at an altitude of about 400 feet. From this region it gradually rises toward the near the southeast to 4000 feet in West Virginia and then gradually descends to about 2400 feet in southwestern New York.

The plateau differs widely in character in different parts of the province, its nature depending on the character of the underlying rocks, the crustal movements that have affected them, and the drainage consequent to both of these factors. That part of it which lies in the southern part of the quadrangle is well preserved, and conditions for its preservation have been almost ideal, but the part further north is greatly dissected and its plateau character is correspondingly obscured. When viewed broadly from one point, however, the summits of the highest ridges and hills are seen to reach about the same altitude and appear to merge in the distance into a nearly horizontal surface, which is approximately that of an old peneplain.

That part of the old surface that lies in the northeastern part of the plateau has been named the Schooley peneplain, from its typical development on Schooley Mountain, New Jersey. The tops of many ridges in Pennsylvania, especially those in the valleys of Allegheny and Monongahela rivers, represent another and younger peneplain, which stands at a lower level. This peneplain has been named the Harrisburg, on account of its extensive development near Harrisburg, Pa. A similar topographic feature found farther south in the Appalachian province has been called the Highland Rim. In Kentucky and Tennessee, where this later peneplain has been but developed, it lies about 1000 feet above sea level and is separated from the Allegheny Plateau on the east by a more or less regular westward-facing escarpment. Its surface slopes gently toward the east. That part of it which lies in Kentucky has been called the Red Clay, in all the county of its basin, and the divide between it and Guyandot River has an estimated length of about 70 miles, almost wholly within this quadrangle, and East Fork of the Little Sandy are the main drainage channel of the area, is formed by the confluence at Louisa of Tug and Levisa forks. After flowing northward 27 miles it joins Ohio River at Catlettsburg. Levisa Fork is often referred to as Big Sandy River.

A common characteristic of the surface of the Kenova quadrangle is due to the long-continued erosion of rocks of different degree of hardness. This erosion has been accomplished by streams.

The present drainage of the general region, including that of the Kenova quadrangle, is chiefly inherited from an ancient drainage and exhibits many features that indicate the course in this area, but the difference between the width of the eastern and that of the western sides of its valley is not nearly so striking as the difference along Twelvpole Creek. The basin of the Allegheny on the east is readily perceived, for reasons that will be given later (p. 8). In the basin of Tygarts Creek, which flows across the extreme northwest corner of the quadrangle, the lack of symmetry is notable, but the asymmetry is opposite in kind to that in the basins of Big Sandy River and Twelvpole Creek. (See fig. 3.)

RELIEF.

The Kenova quadrangle lies near the western side of the Appalachian Plateau, in the lowland section, which contrasts with the upland section to the east. The upland rocks are exposed about the margins of the plateau and also where erosion has out most deeply, and they extend under the Carboniferous rocks throughout the plateau. The Carboniferous strata are subdivided into these series—the Mississippian below, the Pennsylvanian in the middle, and the Permian above. The Permian and Pennsylvanian series are coal-bearing; the Mississippian series is a coal line. The rocks of these three series are chiefly alternating layers of shales and sandstones, although they comprise many layers of limestone, especially in the southwestern and southern parts of the plateau, where the Mississippian rocks include some thick limestone beds. The Pennsylvanian rocks cover the major part of the surface in the coal fields and contain most of the coal beds.

Structure.—Structurally the northern part of the Appalachian province is a great faulted mass, the axial line of which extends southwestward from Pittsburgh across West Virginia to the Ohio at Huntington. The rocks southeast of this line dip northwest; those northeast of it dip southeast. The deepest part of the trough is near central West Virginia, toward which the beds generally dip. Around the northern and southern ends of the trough the beds outcrop in rude escarpments or in oval hills. The Kenova quadrangle is situated at the extreme southwest end of this trough.

TOPOGRAPHY.

Drainage.

General features.—The topography of the Kenova quadrangle is due to the long-continued erosion of rocks of different degree of hardness. This erosion has been accomplished by streams.

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that each well up to their heads. The relief though not great is pronounced, ranging from about 350 to 500 feet.

The lowest points in the quadrangle are those furthest down-stream on Ohio and Big Sandy rivers and on Tug Fork and Tygarts Creek.

The flood plain of the Ohio slopes from about 500 feet above sea level at the eastern side of the quadrangle to about 200 feet at the western side. The flood plain of the Big Sandy has an elevation of about 600 feet at the south edge of the quadrangle and about 500 feet when it enters the Ohio near Cabellsburgh. It then has a gradient of about 1.1 feet per mile within the quadrangle.

This is slightly less than the gradient of Little Sandy River.

The flood plain of the Ohio in this area averages three-fourths of a mile in width. On its margins are older gravel and silt terraces, splendidly developed in Ashland, Ky., and beyond the eastern limits of the area in Huntington, W. Va., and these two cities being in part built on them. These terraces have not been shown on the map, owing to their small scale.

The flood plain of the Big Sandy ranges in width from one-half to three-fourths of a mile. The flood plain of the Little Sandy from Grayson to Argillio is wider, but along the upper part of this river there is no flood plain, the stream flowing through a gorge in the Shawanese conglomerate member of the Potomac formation. The flood plains of both Big and Little Sandy rivers are termed, the vertical distance between the terraces on Big Sandy River ranging from 8 to 10 feet.

Eight has given a very complete description of many of the modifications of the drainage in this general area, and some of his descriptions apply especially to localities in the Kanawha quadrangle. Beck of Ashland, for example, is a district known as the “Flatwoods.” This can be readily made out on the topographic map from the absence of contours, which indicates a flat country.

The flat lands represent the flood plains of the streams. Similar remnants of old valleys occur along Big and Little Sandy rivers and are shown on the areal geology map as areas of high gravel deposits. Where the present streams follow the old valley floors they have cut narrow gorges. These old valley floors slope gradually from the hands of the rivers to their mouths, so that the valleys of the present streams. In Tug Fork is the “Flatwoods” area and of Terys Valley, in the Huntington quadrangle, on the east, the gravel and silt deposits are minutely described.

CULTURE.

Settlement.—The largest towns in the area are Ashland; Cabellsburgh, the county seat of Boyd County, and Huntington, the county seat of Lawrence County; Grayson, the county seat of Ohio and Kenton; and Kenova, in West Virginia. It is doubtful whether the combined population of the larger towns equals the entire rural population.

Soil and general cultivation. The flood plains of the streams are subject to periodic overflows and hence are very fertile. In the valleys of the larger streams some wheat is grown, but the principal crop is corn. Tobacco is cultivated on many of the hillsides in Carter County. The large meadows and the small gardens crops sometimes admit the principal products of the soil. The timber resources of the area are rather limited, and some of the timber have been removed during the days of the old charcoal iron furnaces, in the seventies and early eighties of the nineteenth century.

Rocks.—The drainage of the “Flatwoods” area is illustrated in figure 3, has produced sharp ridges, many of them hardly wide enough for wagon roads, alternating with rather narrow V-shaped valleys having narrow flood plains and hence are very fertile. In the valleys of the larger streams some wheat is grown, but the principal crop is corn. Tobacco is cultivated on many of the hillsides in Carter County. The large meadows and the small gardens crops sometimes admit the principal products of the soil. The timber resources of the area are rather limited, and some of the timber have been removed during the days of the old charcoal iron furnaces, in the seventies and early eighties of the nineteenth century.

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In most of the records the rocks are described as sand and shale, the latter commonly light gray or gray, but in some cases black. Local limestone beds are also recorded.

**Carboniferous:**

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**Devonian:**

In the Devonian, the rocks are described as sandstone and shale. The sandstone is usually light gray or gray, and the shale is black or dark gray. Local limestone beds are also recorded.

**Conclusions:**

The Devonian rocks in this area are generally described as sandstone and shale. The sandstone is usually light gray or gray, and the shale is black or dark gray. Local limestone beds are also recorded.

**ROCKS EXPOSED:**

- **Coal**
- **Sandstone**
- **Limestone**
- **Shale**
- **Slate**
- **Shale and sandstone**
- **Slate and sandstone**
- **Sand and lime**
- **Lime and shale**
- **Slate, black**
- **Sand, gray**
- **Sandstone**
- **Limestone**
- **Sand and lime**
- **Limestone, blue**
- **Sandstone, gray**
- **Sandstone, conglomeratic**
- **Slate, white**
- **Sandstone, shaly**
- **Sandstone, massive**
- **Coal, black**
- **Sandstone, shaly**
- **Coal, black**

**Geological Section:**

The following section, compiled from barometric measurements, shows the stratigraphic relationships of the distal beds of the formation in this area with those in Pennsylvania, and the general thickness of the beds. The section is given to show the character of the formations below and above by both its lithologic and fossil character. It is correlated with the Sciotoville formation of Ohio, which has been correlated with the Maxville limestone of Ohio.

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**Pennsylvania Series:**

The top of the Maxville limestone marks the base of the Pennsylvania series, and the overlying red sandstone occurring in some wells follows the Pennsylvania. As other parts of the northern Appalachian bituminous coal field, the Pennsylvania series contains four formations, the Potomac, Allegheny, Conemaugh, and Monongahela, each made up of a number of members.

**Maxville Formation:**

The Potomac formation is a massive limestone, which has been correlated with the Maxville of Ohio. Its outcrop in the Kanawha quadrangle is small and is restricted to its northern part, two areas appearing in the valley of the Kanawha River, close to the west edge of the quadrangle, and one on the Rock of Oldtown Creek.

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**Seventy-four feet**

The section shows several sandstone members separated by beds of shale and sandstone, and also limestone, coal, and iron ore, the total thickness being 700 feet. The general sandstone character of the formation is noteworthy. The correlation of the members of this formation in this area with those in Pennsylvania is based on the studies of David White, who has published a map of the Potomac shale in the Cuyahoga section and the Pocahontas section of the Potomac shale in the Cuyahoga section.

**Pottsville Formation:**

The Pottsville formation is a thick bed of sandstone and shale, overlain by 28 feet of shale, is recorded as 177 feet thick, showing that it extends eastward beyond this horizon. The rock at this horizon is sandstone, overlain by 28 feet of shale, and a series of carbonaceous shales and some sandstone just described as occurring beneath the Maxville limestones in the deep wells.

**Maxville Limestone:**

Upon the Logan formation lies a massive limestone, the Upper Carboniferous limestone of the Kentucky Geological Survey, which has been correlated with the Maxville limestone of Ohio. Its outcrop in the Kanawha quadrangle is small and is restricted to its northern part, two areas appearing in the valley of the Kanawha River, close to the west edge of the quadrangle, and one on the Rock of Oldtown Creek.

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of Pennsylvania. If this provisional correlation is correct, the sandstone it is 50 feet thick. The section below the sandstone is characterized by dark shales and gnarly “cauda-galli” represent the Sharon coal in this part of the quadrangle. At Gallup the sandstone below this coal is provisionally correlated

Kentucky Geological Survey it is often referred to as the “conglomerate formation” or “conglomerate rock.” On Eimer Creek there are two conglomeratic sandstones separated by a thin black shale which in places contains coal. The fossils obtained from this shale indicate that the coal is equivalent to the Jackson Shale coal of Pennsylvania. If this provisional correlation is correct, the lower of the two conglomerates represents the Sharon conglomerate of Pennsylvania.

In the southwestern part of the quadrangle the Sharon strata in places thicken to 100 feet and are more massive and conglomeritic. It appears in the valley of Little Sandy River, along Brusley, Hood, and Lower Laurel creeks, and on Field Branch.

Barrett Creek or “Little Cassell” and associated coals. Most of the coals of the Pottsville formation are locally workable. They were named by R. A. Casad and the names given by him appear in the section along Levisa Fork goes on the Coal Exhibit to David Wilson, the only member of this group of thin coals, of which the “Little Cassell” is one, in the section along Levisa Fork, to the Sharon coal does not appear to be fully substantiated by palaeontological evidence. This group of coals, which occurs within a height of 33 feet near railroad level just north of Turlough, may be at a horizon higher than the Sharon. The “Little Cassell” coal corresponds with the Barrett Creek coal of the northeastern part of the quadrangle, which is coal No. 1 of the Geological Survey.

The Coal Measures (Q.c.).—What appears to be the Quay counties coal occurs in the northern part of the quadrangle, between Argyle and Hood Creek, where it lies 110 feet below the Homewood sandstone member. It is locally known as the “Clod” seam and has been extensively opened but only for local use.

The Mercer coals. The main coal worked at Torchlight, Ky., has been correlated by David Wilson with the lower worked at Boggs, Ky., and is provisionally correlated by R. A. Casad. The two most important parts of importance at Turlough corresponds with the upper coal worked at Boggs, Ky., on Simon Creek, corresponds to coals Nos. 3 and 4 of the Geological Survey of Kentucky, and according to White they are correlated with the lower and Mercer coals, respectively, of western Pennsylvania. The positions of these two coals in the geologic column and their relation to the other important members along Levisa Fork are shown in the section along Levisa Fork south of Louisa, given on page 3. It will be observed that the Upper Mercer coal occurs directly below the Homewood sandstone. The Lower Mercer coal is found 30 to 75 feet below the Upper Mercer coal.

The Homewood sandstone member. The Homewood sandstone is the top member of the Pottsville formation. In the southeastern part of the quadrangle it is massive and ranges from 40 to 90 feet thick. In the north it is nearly at Coal Grove depth, but here it is not prominent, for it is not fully exposed. Along the Ohio near Ashland and Clayside Park the Homewood sandstone occurs directly below the Homewood sandstone. The Lower Mercer coal is found 30 to 75 feet below the Upper Mercer coal.

The Allegheny formation overlies the Pottsville and is in turn succeeded by the Cambrian. It includes the beds from the base Coal No. 1 of the Fort Jackson Survey, which, according to Stenhouse corresponds to the Brookville coal of Pennsylvania, to the top of the No. 7 or Watercoal coal of Ohio, which is the Lost of the Upper Passaic coal of Pennsylvania. The formation is distinguished from the Pottsville by a difference in lithologic character, and its fossil plants are of the genus Lycostachys. In the western and southern parts the thickness is less and is far from uniform. Along Big Sandy River north of Louisa the thickness is about the same as in the northern part of the area, near Ashland, Ky., and Cosgrog, Ohio, usually, 150 to 180 feet. At the Chapman & Ohio Railway and in the region drained by East Fork of Little Sandy River and its tributaries, the Allegheny ranges from 180 to 200 feet thick. Near Willard, Carter County, the formation generally ranges in thickness from about 120 to 200 feet, but in places it lies at 130 feet thick, on one side of a hill near the town in measuring about 130 feet and on the other side less than 100 feet. In general it may be said that the formation is thinnest where the underlying Homewood sandstone member of the Pottery is thickest. The distribution and character.—In the Kentucky coal there is a greater thickness of the coal and beds of sandstone, shale, limestones, and iron ore. It is less coarsely sandy and the underlying Pottery is thicker. In Ohio the Allegheny coal at its base, is fairly well developed, as will be observed from the section near Cosgrove given below. It outcrops in all the hills in Upper and Lower Township and apparently dips to dip to disappear near Knox cast one of the Norfolk & Western Railway.

A section of the formation may be observed along the road northeast of Louisa from a point on the contour of Cassia Branch and west of the Pennsylvania coal. In this region the Allegheny coal occurs in the same general position. The coal losses some of the distinctiveness that characterizes it in the northern part of the quadrangle, and its upper limit is somewhat indistinct. South of Louisa the Allegheny ranges in thickness from 4 to 6 feet. On a map with 100-foot

coal. The Brookville coal is the lowest bed of the Allegheny formation and is generally of workable thickness. It corresponds to No. 5 of the Kentucky Geological Survey. In Ohio the Allegheny formation is fairly uniform. In the area under discussion the coaloutcrops at the base of the formation. It is the lowest coal and its horizon on this account has an economic interest. The coal at the base of the section corresponds to the Brookville. It does not outcrop, or at least was not observed, in Ohio in this quadrangle, but in parts of the quadrangle it is of great stratigraphic as well as economic importance.

The Devonian members.—The next higher important member of this formation has been called the "Ottawa" or Devonian limestone by Andrews in the reports of the Ohio Geological Survey, and the Hanging Rock limestone by Orton. As it is equivalent to the Vanport (“Terrebonne”) limestone of western Pennsylvania and that term will be used in the following. Its occurrence in the Kenwood quadrangle are well displayed at Cosgrove, Ohio, opposite Ashland, where the following section was measured:

The Vanport limestone member in most places lies from 10 to 20 feet above the top of the Homewood sandstone. It ranges in thickness from 4 to 6 feet. On a map with 100-foot

contour intervals, such as the map in this file, it is impossible to show separately the lines of outcrop of this limestone and its associated five clay and that indicating the base of the formation. The limestone in many places rests directly on the Homewood sandstone, especially where the Brookville coal is absent. An important clay bed is generally associated with it, and the horizon on this account has an economic interest. In Ohio this clay and limestone occur together capped by a massive 40-foot sandstone, shown in the section above.

Lower Kittanning coal.—At the top of the formation is found the Lower Kittanning coal. This coal corresponds with coal No. 8 of the Kentucky Geological Survey and with coal No. 9 of the Ohio Geological Survey. In Kentucky it is also known as the Limestone, the Keyes Creek and the River Hill coal, and in Ohio as the Newcast coal. It is commonly found 30 feet above the Vanport limestone, but in Ohio it lies about 40 feet above. Northwest of Louisa, near the confluence of Cassia Branch and Town Creek, the Lower Kittanning coal is present in workable thickness 20 feet above the top of the Homewood sandstone, which is well exposed here in the road bed at drainage level. Between the river above the dam the bed of the coal is thinnest, and here the Middle Kittanning coal is found, a bed of stratigraphic im-
20 to 25 feet above the Lower Kittanning coal and about the same distance below the Middle Kittanning coal. It was formerly of economic importance, but is not now worked.

Lower Kittanning coal.—The next higher bed of importance is the Middle Kittanning coal. This is coal No. 7 of the Kentucky Geological Survey, the No. 6 of Allegheny County, and the No. 5 of the Pennsylvania Geological Survey. It is a very persistent and valuable coal in the eastern part of the quadrangle, but at the back of Cassville, W. Va., its average thickness is between 35 and 40 feet, but averages about 35 feet. It is generally overlain by a massive sandstone, which serves as a close lenticular seal. Above this massive sandstone is a thin bed of red or purple shale, which is well exposed on the county road east of Summit. Above middle level between this coal and the next higher coal is a bed of lime­stone, in places altered to iron ore, commonly known as the red kidney ore. This ore is at present of no economic importance but serves as a convenient stratigraphic marker.

From the top of the sandstone overlying the Middle Kittanning coal to the base of the next higher formation the beds are preval­ently shaly and include the Lower and Upper Freeport coals.

Lower Freeport coal.—The next higher beds of importance in the Allegheny formation are two coals. The lower of these is found about 45 feet above the Middle Kittanning coal and from 30 to 60 feet below the next higher coal. This lower coal is the Hatcher coal of both the Ohio and Kentucky geological surveys. In Kentucky it is No. 8, in the section near New Albany, Ind., it is No. 6A. E. McMillen has cor­related it with the Lower Barren coal of the Ohio Survey, the middle Barren of the Pittsburgh Survey, and the St. Croix sandstone of Wisconsin, the last named member of the Sandstone formation. In the Allegheny formation it is overlied by a thin bed of sandstone, in places altered to iron ore, which is commonly known as the red kidney ore. This ore is at present of no economic importance but serves as a convenient stratigraphic marker.

No. 9 of the Kentucky Survey, but instead of coming within the Mahoning sandstone, where coal No. 9 was placed by Converse, it is in the Coal measures of western Pennsylvania.

Thickness.—The last section of the Conemaugh obtainable in the area is that seen along the tracks of the Norfolk & Western Railway in Va. west of the mouth of the Big Sandy River to and including the hilltops west of Dry Fork Conemaugh rocks are also seen. Here it is 45 feet thick and probably not all present, for there seems to be a local erosional unconformity at or near its base and the upper Freeport coal does not show. This coal, however, is present along the railroad, south to the Big Sandy River. This thickness is not the maximum thickness of the formation, as the Mahoning sandstone is thickest than the freeport sandstone and its overlying rocks up to 350 feet above the bed of the Mahoning sandstone. The thickness given for the Upper Freeport coal is the thickness of the Conemaugh measured by S. L. McAllister in 1913, east of Kenova, and west of Dale Fork in the mouth of the Big Sandy River, and is therefore somewhat greater than the thickness measured by the general staff, where the Mahoning sandstone is thickest.

The Mahoning sandstone, as already indicated, outcrops in a belt about 30 feet to the east of this coal. Here it is 45 feet thick and probably not all present, for there seems to be a local erosional unconformity at or near its base and the Upper Freeport coal does not show. This coal, however, is present along the railroad, south to the Big Sandy River. This thickness is not the maximum thickness of the formation, as the Mahoning sandstone is thickest than the freeport sandstone and its overlying rocks up to 350 feet above the bed of the Mahoning sandstone. The thickness given for the Upper Freeport coal is the thickness of the Conemaugh measured by S. L. McAllister in 1913, east of Kenova, and west of Dale Fork in the mouth of the Big Sandy River, and is therefore somewhat greater than the thickness measured by the general staff, where the Mahoning sandstone is thickest.

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Assumptions:

A. The formation is 100 feet thick.
B. The formation is overlain by limestone.
C. The formation is underlain by sandstone.
D. The formation is associated with coal seams.

The highest rocks of Pennsylvania age in the Kanawha quadrangle belong in the Menomonee formation. This formation, named from Monongahela River in Pennsylvania, was formerly included in the Upper Pennsylvanian Coal Measures, but it includes several workable beds of coal. In accordance with I. Ch. White's correlation, the coal bed at the top of the bed south of the M. V. near the bank of the Monongahela River, is accepted as the Pittsburgh coal, marking the base of the Menomonee formation. *This is the only place in the quadrangle where beds of rocks of this formation occur. The Pittsburgh coal is the most important bed of the formation and is capped by the sandstone member, which is about 30 feet thick and very massive. The remainder of the formation is composed of reddish sandstone with thin beds. About 100 feet of the formation is preserved in the hills.

QUAKERTOWN SYSTEM.

PIKESTOCEAN DEPOSITS.

Structure.

1. The beds are horizontal or dip 1 to 2 degrees to the south.
2. The beds are thickening to the south.
3. The beds are thinning to the north.
4. The beds are locally faulted.

Soil Drainage.

The drainage is controlled by the underlying bedrock.

Fluvial Deposits.

The bedrock is covered by a thin layer of sand and gravel.

Lacustrine Deposits.

The lacustrine deposits are thin and discontinuous.

Quaternary Deposits.

The Quaternary deposits are thin and discontinuous.

Other Deposits.

The other deposits are thin and discontinuous.

Geologic History.

The geologic history of the area is characterized by:
1. Deposition of fluvial and lacustrine sediments.
2. Deposition of marine sediments.
3. Deposition of periglacial sediments.
4. Deposition of glacial sediments.

Eolian Deposits.

The eolian deposits are thin and discontinuous.

Structural History.

The structural history of the area is characterized by:
1. Fold formation.
2. Faulting.
3. Tectonic activity.

Vegetation.

The vegetation is characterized by:
1. Deciduous forest.
2. Coniferous forest.
3. Savanna.

Soil Development.

The soil development is characterized by:
1. Leaching.
2. Weathering.
3. Erosion.

Climatic History.

The climatic history of the area is characterized by:
1. Warm and humid.
2. Cold and dry.
3. Humid and subtropical.

Geophysical Survey.

The geophysical survey is characterized by:
1. Magnetometry.
2. Gravity survey.

Further Reading.

2. *Journal of Geology*, vol. 1, p. 120.
this way, for the intervals assumed are not uniform throughout the region, especially in areas underlain by the formations above the Home-wood. Furthermore, the altitudes were determined with material barometers, which are subject to sudden variations and have to be checked repeatedly by spirit-level determinations. In spite of these shortcomings, it has been thought advisable to draw structure-contour lines. These show the generalized surface formed by the top of the Home-wood series and, less precisely, the loci of other synclines and anticlines. This mode of presentation, in addition to showing the structure of the beds, enables one to estimate the depth to the top of the Homewood strata where it is below drainage level. For example, near Zebulon, the 400-foot contour line was drawn. The elevation of Zelda is 580 feet; therefore the top of the Homewood sandstone should be at a depth of 180 feet. The distances of the several coal beds above or below the top of this sandstone are known, the depth of each bed below the surface at this place may be estimated in like manner.

Detailed Description of Structure.

The Kenvor quadrangle lies at the southwest end of the region, near the overthrusting rocks of the northern Appalachian field. The axis of this trough extends southwestward from a point near Pittsburgh, Pa., across Ohio River and a little off the quadrangle and reaches Big Sandy River, 8 or 10 miles above its confluence with the Ohio. The axial line of the Appalachian syncline is shown by the dip of the formations and the trend of the surfaces of the beds. The structure is best seen northwestward around the head of the basin. The dips in the southern and southwestern parts of this area are steeper than in the northern end of the basin was removed. Subsidence took place, and erosion on the valley, by which the syncline was formed, during the apparently coincident with the boundary between Carter County and Elliott and Lawrence counties.

The beds -south of the axial line dip north and northwest, and those on the northern side dip southeast. The dips in most of the area are not very steep. In the northern two-thirds of the quadrangle, with a few exceptions, they do not average as high as 50 feet to the mile. Near Cadizville the upper part of the Pottsville formation is exposed to view, but even, and the syncline is more apparent than the contours coincident with the boundary between Carter County and Elliott and Lawrence counties.

The dips on both sides of the trough are not uniform, and those on the northern side dip more steeply. The steepest dips are on the northern side of the area. This belt of sharp dips is about 4 miles broad south of Louisa, but it narrows westward and is little more than a mile in width. West of this the beds curve gently northward near the Ohio River. The dips in the northern end of the basin are more steeply east of the Ohio River, where the beds dip no more than 15 feet to the mile. The steepest dips in the Kentucky Valley are near the mouths of the Ohio River.
sediments eastward against the land mass or a thrust of the land mass due to contraction may also have influenced the formation of the Appalachian province. There are no indications of such deformation and metamorphism in this region, and it is known that they are most pronounced in the Appalachian province, which are believed to have been formed at a much later time.

Farther west, in the great Appalachian Valley, the rocks are greatly folded and faulted, but not greatly metamorphosed, so that in many parts of this zone the original character of the sediments has been partly obliterated. Further west, in the great Appalachian Valley, the rocks are greatly folded and faulted, but not greatly metamorphosed, so that in many parts of this zone the original character of the sediments has been partly obliterated.

The effect of these movements is to warp the strata into notable uplifts and overthrusts of the Great Valley, where the Kinsman quadrangle is situated.

**History of erosion and deposition.** The drainage of the Appalachian region is well known, and it is evident that the drainage has been modified by various factors, including the movement of the land mass and the folding of the rocks. The Appalachian region is divided into two main physiographic provinces: the Appalachian Uplift and the Appalachian Valley. The Appalachian Uplift is characterized by a series of folded and faulted anticlines and synclines, while the Appalachian Valley is characterized by a series of long, narrow valleys.

The Kinsman quadrangle is located within the Appalachian Valley, and it is evident that the drainage of this area has been modified by the movement of the land mass and the folding of the rocks. The drainage of the Kinsman quadrangle is characterized by a series of long, narrow valleys, which are oriented in a north-south direction.

**Economic geology.** The mineral resources of the Kinsman quadrangle are notable, and they are well known to geologists. The most important economic bed is the coal, which is found in the Lower Carboniferous and Upper Carboniferous formations. The coal is of the Bituminous type, and it is found in the following strata: Big Sandy Group, Twelvepole Creek, and the Huntington quadrangle. The coal is of the Bituminous type, and it is found in the following strata: Big Sandy Group, Twelvepole Creek, and the Huntington quadrangle.

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The lowest coal beds exposed in the Kanawha quadrangle appear in the region west of Gallipolis, in Lawrence County. As

...
Below the lowerrmost worked bench there are in many places one or two smaller benches of coal, which are separated from the main bed by a clay or lime parting (sections 1 and 2). The floor of the coal, as a rule, is clay.

**UPPER MERCER COAL (NO. 4 OF KENTUCKY SURVEY).**

**Extant coal development.**—The Upper Mercer coal is 55 to 75 feet above the Lower Mercer coal in the valley of Big Sandy River. It is locally known as the “Five-foot vein” but it is sometimes called the “Big vein.” The area of its maximum development is the upper part of Little Creek and between Lick Creek and Levisa Fork. It has been prospected between Threemile Creek and Living Fork, where it is of workable thickness, and in this area it is about 60 feet above the Lower Mercer coal. Prospects have been opened on it on Dunlith Branch, east of Threemile Creek, where it is also workable.

A thickness of 4 feet 10 inches to 5 feet is reported from other country banks. On Coalgrove Flat, where it has been worked with it, locally, however, the lower bench is badly split by bony partings. In many places between Levisa and Donithon there is a clay parting that ranges in thickness from a few inches to 2 to 3 feet. In West Virginia, near the mouth of Big Sandy River, the coal is worked along the banks of the river and increases in thickness from 2 to 3 feet. It is mostly broken, the higher part of the bench has been opened at several places and shows a thickness of 2 to 3 feet or more. Here in this area the coal is reported to be workable for considerable distances in the upper part it commonly contains a lower bench of bright limestone bituminous coal of good quality, ranging in thickness from 2 to 3 feet.

**UPPER FREEPORT COAL.**

**Extant coal development.**—In the valley of Big Sandy River the Upper Freeport coal has been prospected in many places. The size of the bench in the river here is large did not work the locality is not large, as the northward dip carries the bed below the mouth of Big Sandy River. On the headwaters of Right Fork of Hurricane Creek, and still further northeast, its thickness is on average 2 feet thick in thickness. From this section eastward it is apparently local. The coal is a hard, bituminous, scaly coal with splinty partings, and is highly external for fuel and for domestic use. Its chief drawback is its thinness. Its quality appears to be a strong relation to the thickness of the bench, the larger coal at the mouth of Big Sandy and Tabor creeks is reported to be of poorer quality.

**OHIO DISTRICT.**

**UPPER FREEPORT COAL (NO. 5 OF OHIO REPORT).**

**Extant coal development.**—The lower of the workable coals in Ohio has been called in the State reports the Newcastle or the Upper Freeport coal (see column section). As it is the first coal bed of importance above the Veintarp (“Mangumite”) it is called locally in Kentucky the limestone coal, a name that is applied to it also about Coalgrove, Ohio. It is found at various heights above the Veintarp, but averages about 60 feet above this bed and 30 feet below the next higher coal. From section 1 in figure 9 it will be seen that this coal lies below a heavy sandstone at Coalgrove. It has been opened in many places and is now mined on a commercial scale near the base of the hill northwest of Coalgrove depot. It is worked in several country banks near Westfall, of which it lies below drainage level.
The bed is irregular in thickness, and each of the maximum figures given above was obtained at only one place. The average total thickness is 3 to 3\(\frac{1}{2}\) feet. The massive sandstone that overlies the bed furnishes an admirable roof, so that little caving is necessary. On the other hand, this sandstone mills locally and in places cut out the coal completely. The coal is dry, of good quality, and well adapted for heating. It does not yield much coke, for it contains a large amount of sulphur, but north of South Fork it lies below drainage level. Near Argillite it appears 150 feet above railroad grade and has, as far as known, always been mixed with some standard coke, such as Pulaski or Lebanon, because of its high coking characteristics. The coal is of the best bituminous variety. The upper bench is perhaps generally more lustrous than the lower, but contains splinty bands and is on this account rather hard. The lower bench locally breaks out into blocks and contains splinty bands. The thinness of this bed and the presence of the clay parting will be serious hindrances to its commercial development so long as thicker coals remain in the region, although it is conveniently situated for transportation. It is reported to be an excellent stove and steam coal and is widely used by the farmers.

**Figure II**—Sections of Lower Kittanning, and (No. 4 of Kentucky Survey) end of (Brickfield) coal.

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**Upper coal in the Alleghany formation and the coal in the Cornwall are of little or no importance in this part of the district.**

The Lower Kittanning (No. 2 of Ohio Survey) has been opened in a few places on Beech Creek, about 15 miles east of Ashland, and in the hills near Shut-In, western Kentucky.

Character.—The coal generally ranges in thickness from about 3 to more than 4 feet. (See fig. 6, sections 3 to 7.) As a rule it has a honeycomb structure, and in places a coal seam and underlying ashstratified bed occur in a broad area along the Ashland Coal governmental.

The overburden in the valley of Little Sandy River, the bed occurs in continuous line of country banks on the outcrop where it is above drainage level on Culp Creek and Henry Branch, and nearly everywhere along the valley of the coal is very pure.
drainage level also on Chadwick Creek. On Garnet Creek it has been opened at a few country banks. In general the west
end of the quadrangle is the irregular quadrilateral square included draining the mines comparatively easy. A small bed of quartzite or quartzite-like micaceous sandstone which, associated with the black shale lying between the basal conglomerates on Evannex Creek appears to contain a small grain of the same type as that of the Jackson Shaft (Sharon) coal of Ohio and hence is probably more nearly the stratigraphic equivalent of the Ohio coal than the bed 50 to 60 feet higher in the Kentucky
section.

Development.—The coal has been developed on Barrett Creek at many points. It has also been opened on Walden Fork, Highland Fork of Evannex Creek. On Crane Creek, about 3½ miles west of Hopeville, it has been opened, and though reported thick is of excellent quality for smelting. Near Sulphur on Lost Creek it has also been opened. It occurs on Oldtown Creek and on its north fork. It is present in all the hills in this district west of Little Sandy River and will be found in workable thickness, at least for local use, over almost all of Little Sandy River the coal is not so extensively distributed above drainage level owing to the eastern dips. Between Argilli and Reelsburg a blain is in a few paces on the pike along the Eastern Kentucky Railway but has not been opened so far as known. It is probably this coal that is opened in a few places on Coal Creek, south of Hannawell, where it is about a foot thick. The coal has been opened at a few points on Deer Creek northwest of Willard. Its position, about 60 feet above the Sharon conglomerate, which is prominent along Little Sandy River in this region, serves to identify it. The section of the old R.T. Berry southeast of Blaine and east of Flood Creek may belong at this horizon. It measures 26 inches in thickness and is worked for local use. The coal along Coal Creek near its mouth are referred to the lower horizons in the Petticoat. They are reported to be workable in one or two places, but the writers did not have an opportunity to verify these reports. The only point for which lower coals are in places partly cannel.

Character.—Sections 3 to 8 in figure 5, p. 9, give an idea of the character of the coal in this district. It is probably more nearly the stratigraphic equivalent of the Ohio coal than the bed 50 to 60 feet higher in the Kentucky

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The analyses numbered 1 to 12 were made by Robert Peter Willard.
It has been opened in several places and generally is of workable thickness. It is found in most of the hills west of Little Sandy River.

** character.—As will be seen from the sections in figure 12 the coal in some places consists of two benches of three or even four benches. Southeast of Grayson, at coal mine banks, it consists of two benches (fig. 12, sections 2 and 3) separated usually by a thin bone parting. Each bench ranges in thickness from about a foot to 15 inches. The coal differs in character in the two benches. In places there is a layer of coal from 1 to 2 inches thick at the top of the upper bench, and at one bank a 6-inch layer of coal was observed at the top of the lower bench. As a rule, the lower is more splint and harder than the upper bench. This bed averages about 2 feet of excellent coal in the region southeast of Grayson. On the Rio Grande River district (fig. 12, section 8) it consists more coal but also has a thick bony parting.

Where worked at Boghead and Hammewell, the bed usually consists of three benches. The topmost bench is ordinary lustrous bituminous coal and varies in thickness, being about 5 inches thick at Boghead and slightly less than a foot at Hammewell. It is separated from the next lower coaly bench by a bone or clay parting, which is from 1 to 9 inches thick, being thicker near Cat Creek and Barbours Creek. Boghead bench is similar in character to the top bench. At Boghead it ranges from 12 to 15 inches in thickness, and at Hammewell it is slightly thinner. It is separated from the middle coal bench by an irregular clay parting, which at Boghead reaches a thickness of about 10 inches. The middle coal bench of coal is the most valuable part of the bed at Boghead and Hammewell and at both places is about 15 inches thick.

The same coal has been worked at Boghead and Boghead mines have been examined by G. E. Halsey. The results of the examinations made indicate that the coaly coals of this district, worked by the Kentucky Coal Co., are of high grade, the only drawback to mining being that they underlie only small areas, in which respect they are like most other coaly coals. The following rating is based on Mr. Halsey's sample of this coal:

**Analysis of Lower Mercer coal.**

<table>
<thead>
<tr>
<th>Character</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>7.64</td>
</tr>
<tr>
<td>Volatile matter</td>
<td>54.92</td>
</tr>
<tr>
<td>Fixed carbon</td>
<td>25.30</td>
</tr>
<tr>
<td>Ash</td>
<td>8.08</td>
</tr>
<tr>
<td>Brightness</td>
<td>5.98</td>
</tr>
</tbody>
</table>


**Upper Mercer coal (No. 4 of Kentucky Survey).**

**Extent and development.—** The Brookville coal is the most important coal in the southwestern part of the quadrangle. It reaches its greatest thickness along Dry and Cones Forks, along Cherokee Creek, and in the hills northwest of Willard, at the head of Johns Branch. In this district it may be regarded with fair certainty as the western continuation of the coal that occurs on Cat Creek. It has been carefully prospected in the hills about the head of Cherokee Creek, Dry Fork, and Equal Fork, and has been opened and worked at many places. It outcrops in the hills between Straight Creek, Belle Trace Creek, and Lost Branch, disappearing at the drainage level on Lost Branch near the mouth of Crooks Creek. Many country banks show this coal to be of fair thickness for about a mile above the mouth of Belle Trace Creek, the middle bench of Coal, west of Willard. South of Westerfield the coal is present in the hills along Cones, Dry, and Equal Forks, rising toward the south. It has not been opened in this region. West of Dry Fork and Cherokee Creek the ridge rises in such a way that the coal is present only in the tops of the hills and comparatively only in small bodies. It is found in the ridge between Equal Fork and Blaine Trace Branch and on the west in the ridge between Dry Fork and Little Fork, where benches are only a few inches of coal are present; it is also present in the hills north of Cherokee Creek. West and northeast of Willard the beds rise so steeply that the coal is present only here and there in the tops of the highest hills. The center of development of this bed lies about Willard and Westerfield and at or near the mouth of Lost Branch, Blaine Trace, and Belle Trace Creek. The only large commercial operation on this district is that of the East Kentucky Railway on Lost Branch. This company formerly mined this bed extensively south of Willard, but at present all the old mines are closed.

**Middle Kittanning coal (No. 5 of Kentucky Survey).**

**Extent and development.—** About Willard and north of Webbville, the Middle Kittanning coal has been opened and worked at many places. It outcrops in the hills between Straight Creek, Belle Trace Creek, and Lost Branch, disappearing at the drainage level on Lost Branch near the mouth of Crooks Creek. Many country banks show this coal to be of fair thickness for about a mile above the mouth of Belle Trace Creek, the middle bench of Coal, west of Willard. South of Westerfield the coal is present in the hills along Cones, Dry, and Equal Forks, rising toward the south. It has not been opened in this region. West of Dry Fork and Cherokee Creek the ridge rises in such a way that the coal is present only in the tops of the hills and comparatively only in small bodies. It is found in the ridge between Equal Fork and Blaine Trace Branch and on the west in the ridge between Dry Fork and Little Fork, where benches are only a few inches of coal are present; it is also present in the hills north of Cherokee Creek. West and northeast of Willard the beds rise so steeply that the coal is present only here and there in the tops of the highest hills. The center of development of this bed lies about Willard and Westerfield and at or near the mouth of Lost Branch, Blaine Trace, and Belle Trace Creek. The only large commercial operation on this district is that of the East Kentucky Railway on Lost Branch. This company formerly mined this bed extensively south of Willard, but at present all the old mines are closed.

**Figure 13. Sections of Middle Kittanning coal (No. 7 of Kentucky Survey).**

**The analysis shows this coal to be of very high grade. The moisture is rather high, but the ash is low. No sulphur is given, and this constituent was probably not determined, as it is quite likely that none is present.**

**LOWER KITTANNING COAL (NO. 6 OF KENTUCKY SURVEY).**

In the southwestern part of the quadrangle the Lower Mercer coal occurs 100 feet below the top of the Homestead sandstone member. It is found in this position along Right Fork of Elkins Creek and on the streams that flow into it from the north, also in the headwaters of Little Fork. Further north it lies not so far below the Homestead sandstone. At the head of Field Branch this coal is out of workable thickness, but it is of more than ordinary interest from the fact that it consists largely of cannel. The coal here has a shaly roof and measures approximately 2 feet thick. Near Buckhannan and Stephens it is found near the bed of the creek and has been worked on a small scale for local needs. South of Cherokee Creek it is found near the level above the mouth of the creek and is not conspicuous. Except where the coal is of the cannel type it is of the same character as the rest of the coal in this district, namely, partly splinty and partly soft lustrous bituminous coal.

**Middle Kittanning coal (No. 5 of Kentucky Survey).**

**Extent and development.—** The Brookville coal is the most important coal in the southwestern part of the quadrangle. It reaches its greatest thickness along Dry and Cones Forks, along Cherokee Creek, and in the hills northwest of Willard, at the head of Rocks Branch. In this district it may be regarded with fair certainty as the western continuation of the coal that occurs on Cat Creek. It has been carefully prospected in the hills about the head of Cherokee Creek, Dry Fork, and Equal Fork, and has been opened and worked at many places. It outcrops in the hills between Straight Creek, Belle Trace Creek, and Lost Branch, disappearing at the drainage level on Lost Branch near the mouth of Crooks Creek. Many country banks show this coal to be of fair thickness for about a mile above the mouth of Belle Trace Creek, the middle bench of Coal, west of Willard. South of Westerfield the coal is present in the hills along Cones, Dry, and Equal Forks, rising toward the south. It has not been opened in this region. West of Dry Fork and Cherokee Creek the ridge rises in such a way that the coal is present only in the tops of the hills and comparatively only in small bodies. It is found in the ridge between Equal Fork and Blaine Trace Branch and on the west in the ridge between Dry Fork and Little Fork, where benches are only a few inches of coal are present; it is also present in the hills north of Cherokee Creek. West and northeast of Willard the beds rise so steeply that the coal is present only here and there in the tops of the highest hills. The center of development of this bed lies about Willard and Westerfield and at or near the mouth of Lost Branch, Blaine Trace, and Belle Trace Creek. The only large commercial operation on this district is that of the East Kentucky Railway on Lost Branch. This company formerly mined this bed extensively south of Willard, but at present all the old mines are closed.
of these two worked benches rarely reaches 45 inches and averages most commonly about 3½ feet. From 40 to 45 inches of workable coal in the upper two benches may therefore be considered a maximum for this bed. From these thicknesses it is clear that nothing of such place where there are ribs in the roof or in the backbone.

The roof is a true fairly massive shale of irregular thickness, mostly mottled in color, and is a massive sandstone. The top of the coal is generally bumpy. The coal is bumpy, and the shale is full of fine, red, splintery, and spiny. The thickness of this horizon is indicated by the analyses given on page 12. These figures are for the most part those of coal collected about Rush Corners and analyse 11 and 12, respectively, collected from Lost Creek and west of Dry Fork near Willard and may be taken as typical of the coal in this vicinity. The output of the Eastern Kentucky Railway mine at Pottsburg is used exclusively along the railway for staining and domestic purposes.

COALS OF THE CONNAGHAN AND MONOGAHLA FORMATIONS.

Although the coal of the Connagahan and Monogahla Formations is not extensively mined, it is worth considering the occurrence of the coal in these beds. The Connagahan coal occurs in the Black Fork of the Tug River near Willard, and the Monogahla coal occurs in the Black Fork of the Kanawha River near Ashland. The Connagahan coal is a fine-grained black coal, while the Monogahla coal is a fine-grained gray coal. The Connagahan coal is found in a series of thin beds, while the Monogahla coal is found in a single, thick bed. The Connagahan coal is found in the eastern part of Kentucky, while the Monogahla coal is found in the western part.

THE POTTSVILLE FORMATION.

This formation is widespread and occurs in several parts of Kentucky. The Pottsville formation is divided into three members: the Vanport limestone member, the Allegheny sandstone member, and the Mahoning sandstone member. The Vanport limestone member is the uppermost and is characterized by the presence of a thick bed of limestone. The Allegheny sandstone member is the middle member and is characterized by the presence of a thick bed of sandstone. The Mahoning sandstone member is the lowermost and is characterized by the presence of a thick bed of sandstone. The Pottsville formation is the most extensive coal bed in Kentucky and is the source of most of the coal mined in the state.

CLAY AND SHALE.

This formation is characterized by the presence of a thick bed of clay and shale. The clay is dark brown and is characterized by the presence of a high clay content. The shale is dark gray and is characterized by the presence of a high shale content. The clay and shale are interbedded in the formation, and the clay is often found in thin beds.

DIVISION OF THE CLAYS.

This formation is divided into three classes: (1) Clays closely associated with coal beds and (2) Recent sediments. The clays associated with coal beds are of two grades: the plastic clay and the flint clay. The plastic clay is dark brown and is characterized by the presence of a high plasticity content. The flint clay is bluish and is characterized by the presence of a high quartz content. The Recent sediments are of two grades: the clays and the sandstones. The clays are dark brown and are characterized by the presence of a high clay content. The sandstones are light brown and are characterized by the presence of a high sand content.

CLAY ASSOCIATED WITH THE VANTPORT LIMESTONE MEMBER.

The clay associated with the Vanport limestone member is characteristic of the formation. The clay is dark brown and is characterized by the presence of a high clay content. The clay is found in thin beds and is often associated with the limestone. The clay is used for the manufacture of pottery and is characterized by the presence of a high plasticity content.

CLAY ASSOCIATED WITH THE ALLEGHENY SANDSTONE MEMBER.

The clay associated with the Allegheny sandstone member is characteristic of the formation. The clay is dark brown and is characterized by the presence of a high clay content. The clay is found in thin beds and is often associated with the sandstone. The clay is used for the manufacture of pottery and is characterized by the presence of a high plasticity content.

CLAY ASSOCIATED WITH THE MAHONING SANDSTONE MEMBER.

The clay associated with the Mahoning sandstone member is characteristic of the formation. The clay is dark brown and is characterized by the presence of a high clay content. The clay is found in thin beds and is often associated with the sandstone. The clay is used for the manufacture of pottery and is characterized by the presence of a high plasticity content.

SANDSTONE, sand, and sand shales. The sandstones of the Pottsville formation are characteristic of the formation. The sandstones are light brown and are characterized by the presence of a high sand content. The sandstones are found in thin beds and are often associated with the clay. The sandstones are used for the manufacture of concrete and are characterized by the presence of a high sand content.

RIVER CLAY. This formation is characterized by the presence of a thick bed of clay and shale. The clay is dark brown and is characterized by the presence of a high clay content. The shale is dark gray and is characterized by the presence of a high shale content. The clay and shale are interbedded in the formation, and the clay is often found in thin beds.

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LIMESTONE, lime, and lime shales. This formation is characterized by the presence of a thick bed of limestone. The limestone is dark gray and is characterized by the presence of a high lime content. The limestone is found in thin beds and is often associated with the clay. The limestone is used for the manufacture of cement and is characterized by the presence of a high lime content.

OTHER CLAYS IN THE POTTsville FORMATION.

There are other clay beds in the Pottsville formation, but they are not important. One of these is the clay associated with the Upper Mercer coal, which has been extensively mined and is characterized by the presence of a high clay content. Another is the clay associated with the Kittanning coals, which is found in thin beds and is characterized by the presence of a high clay content.

THE WILLS collect at that time that the Wills are having the workable clay above the limonite, and not both above and below it.

The Willard section differs from that at Ashland in having the workable clay above the limonite, and not both above and below it.

Section of the clay pit of the Wills Brick Co., Asbell, Ky.

Clay, upper.-darks 6

Clay, middle. 6

Clay, lower. 6

Limonite. 6

Chalk (No. 1). 6

It is reported that the beds occupy these relative positions for several miles toward the west in Ohio. In the eastern part of Ashland the following section was measured:

Section of the clay pit of the Wills Brick Co., Asbell, Ky.

Clay, upper.-darks 6

Clay, middle. 6

Clay, lower. 6

Limonite. 6

Chalk (No. 1). 6

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Limestone ores, (2) block ores, (3) kidney ores, and (4) black.

taking of the roof, have been altered to the hydrous ferric

stone. In eastern Kentucky ores of this class occur at two

openings are now fallen in, and many have entirely dis­

Limestone ore:.

The shales in this formation are abundant and widespread.

The iron ores of the Hanging Rock region of Kentucky

percentage of ferric oxide and iron carbonate in the

The limonite ore occurring at the outcrop is commonly brown

Per cent.

The percentages of ferric oxide and iron carbonate in the

per cent.

going outside these limits. In the unaftered ores the metallic

content is much lower, ranging from 25 to 40 per cent. The

ing the writer reached certain conclusions which are summarized

The shales in this formation are abundant and widespread.

an extended description of the origin of the limestone

ores occur directly upon the Maxport limestone.

Limestones of Kentucky. In the Hanging Rock region of

mume, that are used commercially for transportation.

The iron ores of the Hanging Rock region of Kentucky

Iron ore and associated limestone. Per cent.

The iron ores of this region are chiefly carbonate, epidote, or, olivine, which on the one hand depends to a different
distance in, depending largely on the porosity or numberous
channel of the red, have been altered to the hydrous ferric


After the iron bearing bed, a nearly horizontal and steeply

Limestone around the edges of the Hanging Rock formation is still

The iron ores of the Hanging Rock region of Kentucky

Like the limestone ores the block ores may consist either of unaltered carbonate or of limonite. They are

per cent.

The lower of the important limestone

Block ores and kidney ores are so called from their physical appearance. The former consists into roughly rectangular

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The shales in the Hanging Rock formation are abundant and widespread.

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The iron ores of the Hanging Rock region of Kentucky

An extended description of the origin of the limestone

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Limestones of Kentucky. In the Hanging Rock region of

iron ores are those that occur upon or very near the top

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Most of the sandstone in this area is micaceous, much of it is feldspathic, and as a rule it contains iron oxide. Its texture ranges from very fine-grained quartz sandstone, but, as the line of quartz pebbles in the conglomerates exceed an inch in largest dimension, it should be considered as subconglomeratic sandstone. Such rock was used in constructing buildings in Ashland and so far as known proved satisfactory. It would appear, therefore, that the quartzite blocks, even of this friable sandstone, wear fairly well and become resistant. In the Conemaugh formation the most important sandstone lies at base and is an indurated and silicified sandstone member. This sandstone is well exposed along Big Stony River near its mouth, in both Kentucky and West Virginia. New Kenton it appears to be sufficiently thick bedded for dimension stone. At this point, besides being very massive, it is very coarse grained and here and there is conglomeratic. It has been used by the Norfolk & Western Railway in this locality. Further south, along Big Stony River, it is above drainage level nearly to the mouth of Dock Creek in West Virginia and to Sycamore in Kentucky. In building the Norfolk & Western Railway and in recent changes in the grading of the Conemaugh & Ohio Railway north of this rock has been used. A higher sandstone in the Conemaugh formation has been quarried for local purposes on White Creek, near Egypt. The Conemaugh also contains other sandstones, which, though suitable for local use, are not sufficiently valuable for shipment.

Salt sand.—Fresh water is reported in the Summit well (No. 3) in the Carboniferous 425 feet above the top of the Maxill limestone, and also in the Strickland well (No. 4), 441 feet above the same datum plane. The first mentioned gas and salt-water horizon lies within 200 feet above the Maxill, in the lowermost part of the Sunbury shale. The oil and salt-water "sands" resting directly upon the Maxill limestone may be regarded as the equivalent of the Salt sand on the north bank of the Monongahela River and the Ohio sandstone to the south of that river. The Bonaire sand is reported in the Conemaugh & Ohio Railway and in recent changes in the grading of the Charleston and Charleston & Norfolk railways. This sandstone is well exposed along Big Sandy River near Zelda. The oil in the Bonaire sand is not continuous, but it is sufficiently valuable for local use. A few of the wells in the Bonaire sand have proved to be oil producers. One of the most important wells in the Bonaire sand is the J. A. Young well (No. 4) it is reported to be more than 100 feet thick. In Both County, in the Logan field, none of the wells show a thickness of the oil-bearing horizon of less than 25 feet. This sand contains the high-pressure gas on Culbertson Creek, but there the sandstone occurs in two benches. At the Jerron well, on Cane Creek, Lawrence County, gas containing much hydrogen sulphide was encountered at this horizon.

GLASS SAND.

Some of the sandstone in this quadrangle may be of sufficient purity to yield sand for making glass, but most of these appear to be too ferruginous for this purpose. Sandstone from the Jackson County, has been used in the Pottsville formation. Some of the sandstones of this formation have been investigated, to practically pure limonite on the outcrop. Analyses of five samples of oxidized sandstone collected in this region give the following averages: Metallic iron, 49.4 per cent; sulphur, 0.049 per cent; phosphorus, 0.166 per cent. These figures show that these are comparable with the limonite phases of the limestone and iron ore.

Black-sand ore.

The term black-band ore is applied to beds of iron carbonate associated with more or less bituminous and earthy matter. There is a noticeable occurrence of this ore on the property of the "Ragland Coal Co., on Levisa Fork, in Lawrence County. The deposit lies about 15 feet below the Upper Mereval coal and is from 6 to 12 feet thick. It consists of layers of black or carbonaceous siderite from 1 inch to 3 inches thick, alternating with thin layers of bituminous shale. The ore carries 55 to 60 per cent of iron carbonate and is economically valuable in content of iron with the Scotch black-band ores.

SUMMARY.

The ore of this part of Kentucky is not now being used, as the ore is of low grade and is not of sufficient value. As a rule the rock will not bear the cost of transportation, but locally it has proved valuable for constructing culverts for railroads that pass through it, as well as for building chimneys, fireplaces, and the walls of some dwellings. Very little of it, if any, can be cut into large blocks, but being cheap and very accessible it serves as a satisfactory material for rough structural work.