DESCRIPTION OF THE SEWICKLEY QUADRANGLE.

By M. J. Mues.

INTRODUCTION. LOCATION AND AREA.

The Sewickley quadrangle is in western Pennsylvania, northwest of Pittsburgh. (See fig. 1.) It extends from latitude 40° 30' on the south to latitude 40° 45' on the north and from longitude 80° on the east to 80° 15' on the west, covering one-sixteenth of a square degree—an area of nearly 227 square miles. It includes parts of three counties—Allegheny, Beaver, and Butler, in its southern, northeastern, and northwestern portions respectively. The quadrangle is named from the town of Sewickley, which is in its southwestern part, on Ohio River.

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

GEOGRAPHY AND GEOLOGY OF THE APPALACHIAN PROVINCE.

GENERAL FEATURES.

With respect to topography and geologic structure, the Appalachian province may be divided into two nearly equal parts by a line following the seaward-facing escarpment known as the Allegheny Front through Pennsylvania, Maryland, and West Virginia and the eastern escarpment of the Cumberland Plateau (fig. 2) from Virginia to Alabama. East of this line the rocks are greatly disturbed by faulting and folding. West of the line the strata are but slightly disturbed, the irregular folds in them decreasing in intensity toward the west.

The general surface of the Appalachian Plateau rises from an altitude of 1700 feet in southern Tennessee to 4000 feet in central West Virginia, and thence descends to an altitude of 2200 feet in southern New York. The surface also slopes in a general way to the northwest and southwest and narrows into the Mississippi and Gulf plains. In the southeastern part of the plateau region, in Tennessee and Alabama, lies the Highland Rim, at an altitude of about 1000 feet above the sea. The region north of these well-defined plateaus as far as southern New York is greatly disturbed and its plateau character is apparent only to one who takes a wide view from some elevated point and notes the nearly uniform height of the ridges and hills.

The surface of the Cumberland Plateau and perhaps also the summits of the higher ridges and hills, as well as early terraces of level surfaces at high altitudes, constitute the Appalachian coal field.

The Sewickley quadrangle is drained by Ohio River, which traverses its southwestern portion from the head of Neville Island to the town of Freedom, and by tributaries of the Ohio, which are over 2000 feet above sea level at the Allegheny Front and less than 500 feet in the central part of the basin.

TOPOGRAPHY.

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...the peneplain nature of the surface. An area in the eastern part of the quadrangle is drained by Crows Run, Sewickley and its affluents in Cattaraugus and Chautauqua counties, N. Y., and Erie County, Pa., have their sources on the southern slopes of an upland that overtops Lake Erie, and points on the western slopes of the St. Lawrence highlands. This ancient surface is probably equivalent to the Harrisvillian and Mississippian series of the Carboniferous system. The rocks in the Sewickley quadrangle comprise those not exposed at the surface and those that outcrop. An unconformity in this intermediate interval is shown by the well sections given in the outcrop sheet. The well logs from which these sections have been made were selected from more than a thousand records of wells drilled within the quadrangle. All these bore holes penetrated rocks not exposed at the surface, but records of only a few were kept with sufficient accuracy to determine the character of the formations penetrated. The data are not sufficient to enable us to form any opinion concerning the rocks not exposed at the surface, but records of only a few were kept with sufficient accuracy to determine the character of the formations penetrated.
can not be determined from the data available, but, as stated
either Pottsville or an isolated patch of Mauch Chunk. If it is
shale mentioned above as probably belonging to the Pocono is
650 feet at the western margin to about 900 feet along the
quadrangle, as nearly as can be determined, ranges from about
laid down during a phase of sedimentation that was very dif­
regarded as the upper limit of the Catskill, for in that region
sedimentation occurs between the Pocono rocks and those of
usage among geologists. Farther east in Pennsylvania, where
the Pocono formation, which is here assumed to include all the
in the following discussion of the Pocono.

Although about 2000 feet of red shales and sandstones
below the Potreville pinchout, the Pocono were removed in the region
north and northwest of the Sewickley quadrangle and prob­
ably in the Sewickley quadrangle as well. A few miles to the
east and southeast of the quadrangle a red sandstone, which
occur also thin lentils of sandstone, limestone, coal, and, more
rarely, fine clay. Below these shales lies 5 to 100 feet of light­
tone to white shales, in which occur small patches of small white and yellow quartz pebbles and in many places large quantities of salt water. This is probably the Con­
omorphic sandstone member.

MAUCH CHUNK SHALE.

The period of degradation was so long that the entire Musch Chunk and portions of the Pocono were removed in the region
north and northwest of the Sewickley quadrangle and prob­
ably from the west.

In this area the lowest important producing oil or gas sand
is the Middle Kittanning, in which case the lowest member of the
basal member of the Pottsville, in which case the lowest mem­bers of the Pottsville present within the quadrangle, and the
base of that formation, must then be somewhere in the upper part of this and that is called by the drillers in this region the
Big Injun.

Hundred-foot sand. It is gray to white in color and contains conglo­meric streaks of small white quartz pebbles; its thick­ness is very irregular, ranging within relatively short distances from 5 to 80 feet.

This is the “Smiths Ferry” sand of the Beaver quadrangle
above the Middle Kittanning coal and according to
the Coal measures of Perry County. The lower member of this sand is the Seventy-foot sand or Darlington coal seems to have a fairly uniform thickness of
17 to 19 inches. It outcrops on both sides of the valley of
Crows Run near its mouth and upstream to a point within
half a mile of Parks Quarries. From Freedom to Baden the
shales and sandstones are called the Nineveh Thirty-foot, Snee, Bowlder,
and clay constituting only a relatively small percentage of the
section.

CARBONIFEROUS SYSTEM.

ALLEGHENY FORMATION.

A general statement relative to the rocks of the Allegheny
formations has been given under “Rocks not exposed.” The
upper 180 feet of these rocks outcrop as a narrow belt along
the hill slopes on both sides of Ohio River at Freedom and extend upstream to the vicinity of the Bethel Church.

Middle Kittanning, the formation at this locality is represented by figure 8, on page 14. From Freedom to Baden the
shales and sandstones are called the Nineveh Thirty-foot, Snee, Bowlder,
and clay constituting only a relatively small percentage of the
section.

Middle Kittanning (Darlington) coal and clay.—At the
Cros Run locality described above the Middle and Lower
Kittanning coals are 40 feet apart, the interval being made up of
25 feet of dark and brown shale at the base and 15 feet of
Middle Kittanning fire clay above. The Middle Kittanning
or Darlington coal seems to have a fairly uniform thickness of
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KV, SYSTEM.

Pennsylvanian Series.

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Woolsey is separated from it by an interval of 13 to 20 feet. No bed found in the northwestward quadrangle seems to be the Upper Kittanning coal, though this coal may be present as a thin local seam. There is some doubt whether the 6-inch coal mentioned as extending 130 feet above Ohio River at the pikes east of Freedom may not be Upper instead of Middle Kittanning or correlated with it. Elsewhere, however, the Upper Kittanning is probably absent and its horizon is carried out in most places by the Freedom sandstone member.

Freepart sands. - The base of the valley of Crows Run, opposite the Pennsylvania Railroad, the Middle Kittanning coal outcrops in the bluff at street level and is directly overlain by 30 feet of thin-laided sandstone identified as the Freepart sandstone member. This sandstone thickens to 80 feet within a few hundred feet to the north and grades into sandy shale and thin sandy layers within half a mile. From this locality on Crows Run westward along the street to Freedom its lower portion changes rapidly into sandy shales, but it reappears as a sandstone on the bluff at Freedom with a total thickness of 60 feet. Wherever observed the characteristics of this sandstone are as follows:

- **Lowest Freepart coal, limonite, and clay.** - The Lowest Freepart coal extends from 70 to 80 feet above the Middle Kittanning coal in the few sections where measurements could be secured. The rocks below it to the top of the Freepart sands are shale but include one or two thin limonites. The coal is generally underlain by 1 to 30 feet of soft and flint clays, which at some places include the upper layer of limonite. The clay is variable, changing to shale in short horizontal distance. The limonite ranges from 1 to 2 feet thick and are separated by 2 to 10 feet of sand. The coal is dark gray to brown in color. These limonite and coal beds can be observed on the west side of Crows Run from its mouth to the railroad station, and on the east side of the river just below the point where the Crows Run bluff about 100 yards west of the store at Parks Quarries. In this vicinity the coal is probably absent, unless it is represented by a small coal blanketing the top of the northerly edge of the quadrangle. Half a mile east of Oakesville a bank in which the coal has changed into sandstone is 7 feet above stream level. Here the coal is 2 feet thick, with a massive sandstone overclay and a soft clay foot. No other exposure of the Upper Freepart coal was observed in this valley, though a thin streak of plastic fire clay and one or two small coal mantles were found at about this horizon.

- **Upper Freepart coal.** - The upper coal is exposed at about the same horizon as the lower coal, though its thickness varies inversely with that of the other. Mahoning deposition was extremely variable, and the clay is thin and persistent in the northwestern part of the quadrangle. The base of the Freepart coal is exposed from the northern edge of the quadrangle and appears to be somewhat thicker at Oakgrove, Unionville and appears to be somewhat thicker at Oakgrove, Unionville and appears to be somewhat thicker at Oakgrove, Unionville and Unionville. No other exposures of the coal were found in the valley, except as 2 inches of coal at the mouth of the tunnel. In some places along the railroad cut, it is exposed at valley level in the shale, and clay. Three well-known sandstone beds are sufficiently thick and persistent to make good stratigraphic markers and to distinguish beds therefore present many local features probably not repeated elsewhere. In the northwestward quadrangle the thickness of this member has not been determined at all, but one or two places with certainty, because of the indistinct line at denudation at the top and the fact that the lower portion is usually below drainage level. The combined thickness varies from 40 to 100 feet, though in a few places one or the other sandstone alone measures more than 90 feet. In such places, however, the thickness of one varies inversely with that of the other.

The base of the lower division of the Mahoning sandstone member rests directly upon the Upper Freepart coal or upon the upper part of the lower Pennsylvanian coal which is exposed in the northwestern part of the quadrangle. At Freedom it is 60 feet or more in thickness, and at the locality of the section given above, it contains many small quartz pebbles and rests directly upon the Upper Freepart coal. A mass of exposed pebbles, 2 feet in diameter, is quarried in the Mahoning sandstone member. Among these are fragments of a typical section occurring on the Freedom road bridge over Crows Run at Parks Quarries. The limestones are not present here, and at no place have both limestones and coal been found in exposure.

Southward from the mouth of Crows Run to the vicinity of Unionville the Lower Freepart coal is exposed as a number of phases along the railroad and is overlain by a sandy shale until a small run 200 yards north of the post-office at Beden and at street level opposite the railroad station. There the coal is 1 foot thick and has the limestone below. Outcrops of this coal are found on the west side of Ohio River. What the writer considers to be the coal is exposed near a bank in the pike on Freedom Hill about 100 yards west of the entrance to the cemetery. It is here 1 foot thick and occurs at the base of a 6-foot dark shale, which is overlain by 20 feet of blue and yellow shales to the base of a massive sandstone. Reddish shales with thin lenses of sandstone prevail for 40 feet below the coal. This coal, the coal in the same direction as the run back of Freedom, and at the point where it goes under cover to the east of the Allegheny is underlain by 1 foot of yellowish to gray coal. On this pike one-eighth mile west of Parks Quarries the remarkably persistent Mahoning sandstone member. Of these the Ames is remarkably persistent and is located at the base, below the middle, and some distance above the middle of the formation. Portions of these sandstones are found to be massive at nearly all places of exposure, but locally they change greatly in thickness, different parts of each grade in many places into sandy shales. The formation also contains six or more coal beds of irregular occurrence called in ascending order the Mahoning, Brussell Creek coal (or Gallatin), Baskinsville, Harlem, Elk Lick, and Little Cambria sandstone. These coal beds range from thin films to beds about 2-foot thick. The coal beds are 10 to 30 feet thick, and they are unimportant except as easily recognized stratigraphic markers, and to the topographic changes of the valley. North of Freedom, at the locality of the section exposure of the Upper Freepart coal and the base of the Pittsburg coal. The rocks are prevailingly shale but include one or two thin limonite, and clay. Three well-known sandstone beds are sufficiently thick and persistent to make good stratigraphic markers and to distinguish beds therefore present many local features probably not repeated elsewhere. In the northwestward quadrangle the thickness of this member has not been determined at all, but one or two places with certainty, because of the indistinct line at denudation at the top and the fact that the lower portion is usually below drainage level. The combined thickness varies from 40 to 100 feet, though in a few places one or the other sandstone alone measures more than 90 feet. In such places, however, the thickness of one varies inversely with that of the other.

Near the western edge of the quadrangle, 2 miles north of Freedom, the following section is exposed:

<table>
<thead>
<tr>
<th>Section of Mahoning sandstone member 2 miles north of Freedom.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
</tr>
<tr>
<td>Upper Mahoning</td>
</tr>
<tr>
<td>Lower Mahoning</td>
</tr>
</tbody>
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GEOLOGICAL SURVEY.

General statement. - Except for local inconsiderable due to the fact that the lower portion is usually below drainage level. The combined thickness varies from 40 to 100 feet, though in a few places one or the other sandstone alone measures more than 90 feet. In such places, however, the thickness of one varies inversely with that of the other.

The coal is exposed in the valley of Legtown Run, near the Beaver-Pittsburg pike, less than one mile from dam No. 4. Here it is about 25 feet thick and is underlain by 10 feet of shale and overlain by 35 feet of clay, with 2 feet of iron ore near the middle and thin-bedded sandstone. At Shousetown the horizon is below water level, and it may be found near the mouth and opposite the railroad station at that place. The coal is exposed at valley level in the shale, and clay. Three well-known sandstone beds are sufficiently thick and persistent to make good stratigraphic markers and to the topographic changes of the valley. At Unionville the horizon of the Upper Freepart is marked by a 2-foot bed of watery clay and one of limy limestone and clay. Outcrops of this coal are found on the west side of the valley from that place to the northern edge of the quadrangle.

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The core from a diamond-drill hole at Sewickley was examined by I. C. White, who included the following section in the Mahoning limestone.

at Bellevue the base of the upper sandstone, resting over the lower part of the Mahoning. A thin white flint clay about 20 feet thick, resting over reddish shale constitutes the sandstone phase of the Mahoning at Unionville. Where the Buffalo sandstone is thickest the coal is 130 feet below the Ames and 85 feet above the Brush Creek coal, which is exposed in the same section. It was possible to trace the two horizons northward across the quadrangle in such way as to identify the coals positively as the Brush Creek and the Bakerstown, but the evidence on hand indicates that in Cranberry and Adams townships the interval between the Ames limestone and the Bakerstown coal is less than 100 feet and probably not much over 60 feet.

The Black Creek coal is exposed in the quarry at the end of the railroad switch up Legionville Hollow, east of Route No. 4; it has maximum thickness of 18 feet but pinches out within the length of the quarry. The coal is underlain by 18 feet of clay and sandy shale above 10 feet of Buffidelberg limestone; it lies above 80 feet above the lower Mahoning limestone. The Bakerstown coal at Union ville is doubtful, for little sandstone is found there at this horizon. (See surface sections 1 and 2 on map.) In this part of the quadrangle the coal is generally 10 to 20 feet above the Ames limestone and 85 feet above the Brush Creek coal. It is exposed in the same section.

The Buffalo sandstone is extremely varied in character, ranging from sandy shales to massive sandstones within short horizontal distances. It is prevailingly gray or greenish, where thin bedded or sandy the surfaces of the layers oxidize to a characteristic red. It is thinnest in the southwestern part of the quadrangle, where it consists of sandy reddish shale interbedded with thin reddish sandstone lenses. Toward the coast and north it increases in thickness. Rock of Emsworth, on the first road north of the valley of Lower Emsworth, it is 50 feet thick and massive at the base. It overlies 10 feet of reddish shale above and 15 feet of red shale below by about 90 feet of yellow to light-brown shale. On the road from Rehoboth Church to Crown Run, in Emsworth Township, 20 feet of reddish thin-beded sandstone lying just below the horizon of the Bakerstown coal represents the entire thickness of sandstone at the Buffidelberg horizon. Below are reddish shales with a few sandstone lenses.

In the vicinity of Unionville the Buffalo sandstone is in place massive but generally consists of thin-bedded, closely laminated sandstones, reddish on exposed edges and gray to greenish on fresh surfaces. It is from 50 to 90 feet thick and forms the clamping strata for a number of isolated ridges that have an elevation of about 1200 feet. Between the Buffidelberg and the Bakerstown coal at some places a thin dark to gray fissile burrhausite is embedded in light-brownish or yellow shales. Where the Buffidelberg sandstone is thickest the limestone seems to be absent. It is believed to represent the Upper Cambridge limestone (Pine Creek limestone of White). The Buffalo sandstone coal and the Carboniferous limestone member as 90 feet in the type locality. In the Sewickley quadrangle this bed is generally thin and of little importance but in places reaches a maximum thickness of about 3 feet. It is very irregular and appears in relatively few exposures. In the southern part of the quadrangle it lies from 60 to 90 feet above the Brush Creek coal and 120 to 145 feet below the Ames limestone. It is in many places accompanied by 1 foot of reddish shale and by dark to reddish shales above.

In many places a thin clay to gray limestone occurs from 5 to 10 feet below the Buffalo sandstone limestone member as 90 feet in the type locality. In the Sewickley quadrangle this bed is generally thin and of little importance but in places reaches a maximum thickness of about 3 feet. It is very irregular and appears in relatively few exposures. In the southern part of the quadrangle it lies from 60 to 90 feet above the Brush Creek coal and 120 to 145 feet below the Ames limestone. It is in many places accompanied by 1 foot of reddish shale and by dark to reddish shales above.

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however, can not now be given. Many more data should be
obtained so exactly duplicate the Ames might be mistaken for it.
material deposited with the sediments. With the thick red
thickness from 2 to 24 inches or more. The topmost of these,
the Ames limestone member. It is commonly embedded in a
dark-blue to greenish coarse granular
yellow to light-brown fissile shale and has a maximum thick­
ness of about 1 to more than 5 feet thick. This coal has also been opened at a number of places above the Ames limestone member seems to range from 10 to
ranges from 1 to more than 5 feet in thickness, the maximum
exposure being on the Beaver-Pittsburg pike half a mile southe­
west of Bayes. It has been mined at several banks north of
Pleasant Hill Church in Marshall Township, north of Mount
Pleasant Church in the southeast corner of Cranberry Town­
hop, and on a number of other high hills in the
northern part of the quadrangle. The altitude of this coal
ranges from 1 to more than 5 feet in thickness, the maximum
exposure being on the same ridge road north of West Economy, in Hopewell Township.

Elk Lick coal.—The name Elk Lick was first applied by
Lesley to a coal lying 30 to 40 feet above the Ames lime­
stone member on Elk Lick Creek, Monongaheela County. In
the recent localities it is red to reddish brown in color but
above the river. The largest areas covered by this deposit in
the whole region, including the
Permian time. The glacial epoch marks the formation of the
glacial epoch, embracing the present-day flood plains. The
Sewickley quadrangle shows a history of uninterrupted deposition since
the Permian time. The glacial epoch marks the formation of the
high and low terraces of this region, and the material they
are laid down under the sea, constitutes a deposit. Such deposits
laid down under the sea, constitutes a deposit. Such deposits
are of sufficient volume and permanency to justify special notice.

The Permian epoch marks the formation of the
large gravel plains, which is represented by old shores of former valleys,
and lying in broad gravel terraces in the present valleys. These
terraces are not generally mapped, for obvious reasons, but some of
them are due to certain peculiar structural conditions are of sufficient volume and permanency to justify special notice.

Except for temporary accumulations along Ohio River during
the glacial epoch and for recent flood plains, the Sewickley
quadrangle shows a history of uninterrupted deposition since
the Permian time. The glacial epoch marks the formation of the
high and low terraces of this region, and the material they
are deposited in are either occupying the rock shelves,
which represent parts of the old floors of former valleys,
and lying in broad gravel terraces in the present valleys. These
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them are due to certain peculiar structural conditions are of sufficient volume and permanency to justify special notice.

ERSHARD! GLACIAL GRAVEL.

The earlier glacial deposits of the Sewickley quadrangle occupy the highest gravel-covered areas above Ohio River and
are the remnants of the glacial valley train brought down
by streams from the terminal moraines of the Kansas ice sheet. The
formation which comprises the gravel beds of glacial, stream, and lake. Most of the pebbles are of quartz, granite,
sandstone, and sandstone, and have been transported for long distances from
the source and subsequently deposited. Some of the pebbles are
also found near the coast, as well as along the
fluvial plains of the Ohio River. These exceptional localities at which pebbles are found is
near the eastern border of the quadrangle, due east of Perryville,
along the ridge west of the Shing coal bank, at an elevation of
about 1300 feet above sea. No indications of a terrace
deposits were observed. The pebbles were found along the top
of a narrow level ridge on the upper layers of the Morgantown
sandstone. The horizon of the parker sand is at an elevation of about 1715
feet above sealevel and 500 feet above Ohio River. The

Within the Sewickley quadrangle, small pebbles of quartz, granite,
and sandstone were seen at two places much higher than the
gravel terraces mentioned above. One of these localities is on the
ridge near southeast of West Economy, in Hopewell Township, Beaver County. At this point a number of granite
pebbles the size of an egg and larger were found scattered on the
top of the broad, flat terrace, at an elevation of about 1175
feet above sea and about 500 feet above Ohio River. The
other exceptional locality at which pebbles are found is near the
eastern border of the quadrangle, due east of Perryville,
along the ridge west of the Shing coal bank, at an elevation of
about 1300 feet above sea. No indications of a terrace
deposits were observed. The pebbles were found along the top
of a narrow level ridge on the upper layers of the Morgantown
sandstone. The horizon of the parker sand is at an elevation of about 1715
feet above sealevel and 500 feet above Ohio River. The

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tributary streams not carrying glacial material. This resulted in the silting up of the mouths of many of these streams and the formation of gravel-covered terraces when the streams resumed their downward cutting. These terraces along tributary streams of the Ohio are composed of pebbles, sand, and clay of local origin. On streams not directly tributary to the Ohio, such as Brush Creek, the effect of the valley train on lateral stream cutting and gravel deposition is not evident. In such streams the later gravel terraces are generally considered to belong to the Carmichaels formation, though they may differ considerably both in age and in character from place to place over western Pennsylvania and adjacent regions.

The only deposits of this formation mappable size in the Sewickley quadrangle are located along the lower portion of Brush Creek, on terraces ranging in altitude from 940 to 1000 feet above sea level. The lowest limit of the Carmichaels deposits in the valley is not clearly marked, since at places they seem to merge into the alluvium of the present flood plain. The lowest terrace, generally 40 to 50 feet in depth, is composed principally of sand, with some pebbles and clay, the pebbles showing little effect of stream action and some of an older river stage.

At Carmichaels, on Monongahela River, in the type locality, the formation consists of unconsolidated clay, with some sand, gravel, and coarse bowlders. The proportion of these materials varies from place to place and also in vertical section, owing doubtless to variations in the strength of the currents which transported the sediments and in the local character of the rocks from which they were derived. In the Sewickley quadrangle the Carmichaels deposits noted are made up largely of yellowish sand and muddy clay, with interbedded sandstones and bowlders and gravels of local derivation.

No Carmichaels deposits of mappable size were noted along the streams tributary to Ohio River. It is possible, however, that a number of small deposits of this formation occur along Sewickley Creek, Locust Run, Musquhon Run, and Flinthopper Run.

**GLOACIAL GRAVELS.**

Gloacial material is not confined to the terraces of the Parkersburg strath but is abundantly distributed upon most of the better-preserved terraces below this old valley floor. Much of this material is double-rolled gravelly wash derived by the river from the recently flooded valleys. No distinction is made between local and foreign material, and it is assumed that in general the material between high-water mark and the rock floor of the valley belongs under this classification; this despite the fact that there seems little doubt that if this valley was cut to the present depression, the alluvium of the Ohio River would have reached this material with the wash derived by the river from the recently flooded valleys.

Much of this latter material is doubtless reworked glacial wash derived by the river from the recently flooded valleys. The whole rock mass of the Sewickley quadrangle is slightly folded during the early Pottsville uplift of this region, and is composed of sand, gravel, and local rock debris which cover the surface of the rocks beneath the Pottsville era. The strata of the Ohio beds are slightly more folded than the surface beds. Whether the thickness of a stratum is indicated by the dip of its horizontal surfaces or by the dip into which the strata pitch toward the south is of interest. This variation in intensity of folding is consequently fairly well represented by them.

The only deposits of the Sewickley quadrangle which have their origin in post-Hoicean glacial movements and have developed gradually with subsequent movements that have affected the area in such a way as to account for the difference in the amount of folding is the area of the Ohio bed and the Carmichaels member, though most of such depressions might easily have been in error by more than twice the contour interval because of rapid changes in distance between these beds in relatively small areas. The two sets of contours are therefore drawn from practically independent data; and the difference in the intensity of folding is consequently fairly well represented by them.

**CONVERGENCE BETWEEN THE AMES LIMESTONE MEMBER AND THE HUNDRED-FOOT SAND.**

It is true that the principal structural features of the Sewickley quadrangle had their origin in post-Hoicean crustal movements and have developed gradually with subsequent movements that have affected the area in such a way as to account for the difference in the amount of folding in the Ames limestone member and the Hundred-foot sand. If it should be supposed that there exists a reciprocal difference in the distance between these beds, due to variations in the rate of deposition. Theoretically the interval between them should be greatest on the axes of the synclines and smallest along the anticlines. If variations in deposition had a tendency to produce such differences in interval, the very small dip at any one time reduced it to a minimum, and all traces that might have been detected by the available means are obscured by unconformities. Figure 5 shows lines drawn through points of equal distance between the beds. These lines are not contours showing the shape of a surface but lines which show the thickness of the rocks lying between these horizons. The numbers on the map give the distance by actual measurements, but those are far too few to give much of any value in determining the relations of structure to rate of deposition, even if other factors were favorable. Figure 6 shows the position of the axes of the principal anticlines and synclines in the Hundred-foot sand and in the Sewickley quadrangle. The lines here shown are drawn on the assumption that the boundary between the Happy Valley and the Pottsville rocks is everywhere at right angles to the direction of the prominent anticlines and synclines. This outline has been approximated by cross-sections of the whole rock mass of the quadrangle records of deep wells drilled through this material for oil or gas are not in sufficient detail to be of much value. It is generally mentioned as sand and gravel or "drift," but in a few it is simply divided as "sand and gravel." The whole rock mass of the Sewickley quadrangle is slightly folded during the early Pottsville uplift of this region.
of the two beds that shown is probably an exaggeration of the true difference because of the unequal distribution of elevations taken on them. It if bad been possible to secure elevations on both beds at exactly the same points, the variations in the structural contours would have been due mainly to the difference in the degree of wrinkling of the two beds, and it is probable that if elevation of all points on both horizons were known the axes of the folds of each would almost or exactly coincide on the map. This, therefore, is a fair illustration of the accuracy of the degree of wrinkling of the two beds, and it is probable that the map probably shows a greater degree of variation than actually exists.

Wildwood anticline.—The axis of the Wildwood anticline which lies to the east of the Mount Nelo syncline, enters the quadrangle from the east about half a mile south of Pine Creek. It trends southwest, passing to the east of the Mount Nelo trough and being usually less than 1½ miles from the axis of that fold. It crosses the plank road less than a mile south of theCertificates and there is a prominent minor Nelo anticline pitches off to the south and across the Ohio in the vicinity of Athens, and from the eastern and another anticline minor projects to the southeast, passing a mile or more to the east of West View.

Nineveh syncline.—Southwest of the Wildwood anticline a syncline and plants made their appearance from time to time and in the southeast of Belle Vue. This is a part of the Nineveh syncline, which is the principal structural feature in the Carnegie quadrangle, to the south of the Wildwood, though its main axis probably passes farther to the southeast.

GEOLGYHIC HISTORY.*

The geologic history of this region resolves itself, in general terms, into two great cycles—one of construction and one of erosion. The first of these cycles, extending from the Precambrian time to the termination of the Appalachian province, was the time in which we are now living belongs to the latter, still unclassified cycle. Neither has of course been completed, each of these cycles having, short intervals, been interrupted by reverses to the opposite; nor has both been of equal duration, for it is undoubtedly that the cycle of construction continued during a period very much longer as long that so far concerned by the present cycle of destruction. The events of the former are recorded in the consolidated rocks of the region, and the history of the latter may be read in the surficial rocks and in the topography.

SEDIMENTARY RECORD.

The strata forming the consolidated rocks of western Pennsylvania are composed chiefly of sandstones, shales, and limestones, with scattered beds of coal and clay. The sea in which these rocks were deposited was covered mostly of the Appalachian province and the Mississippi basin. The oldest rocks known in the Appalachian province are the crystalline rocks of the Blue Ridge province. These are believed to have formed part of the oldest land on this continent of which there is any record. The western shore of this land area by east of the present position of the Blue Ridge and the east extended to an unknown distance eastward, possibly for beyond the present shore of the Atlantic. To the northeast, in the Alleghany Mountain range, by another area of crystalline rocks. North and west of the Alleghany, reaching to the vicinity of Lake Superior, was the valley of a vast land area, now occupied by the crystalline rocks of Canada. The rocks of the two regions having the same characteristics, are known as the same name as one of Blue Ridge. Thus in earliest geologic time these existed a land mass having a roughly wedge-shaped form and including within its surface a body of water known to geologists as the Interior Palaeo sea.

Into this Palaeo sea discharged rivers bearing the sediments of which the sedimentary rocks of the Appalachian province are composed. While these rocks were accumulating to the thickness of several thousand feet new species of animals and plants arose. One important gulf approached the formation of a new variety of plant producing from Alabama to eastern New York and which is now appropriately called the Cincinnatian gulf. In this gulf sedimentation continued for a long period of time, especially in the Cincinnatian and a large quantity of fine sediment was laid down. The sea bottom was slowly subdividing during most of this period, and the separating parts of the sea became shallow either from crustal movements or from the accumulation of sediments, or both, so that most of the rocks of that period were deposited in shallow water. In regions where the Cincinnatian sea exists the surface of the sea is composed in large part of Cincinnatian sediments and imparts
Sewickley quadrangle.

The submergence which brought the clear ocean water of the Allegheny stage to the region of the Sewickley quadrangle may be inferred from the evidence of the glacial deposits, which were laid down during the last epoch in which the earth was covered by ice. The glacial deposit in western Pennsylvania is the Clarion till, which is a coarse, light gray glacial till. Its principal characteristics are its uniformity of texture and its great extent. The Clarion till is found in western Pennsylvania and extends across the Allegheny Front. From this land area the Mauch Chunk glacial deposits were spread, forming a large part of the sedimentary basins of the Allegheny province.

The Allegheny stage was marked by very rapidly alternating strata and layers of the formation. In the Allegheny stage, the sedimentation was very rapid, and the strata had been laid down in the southern anthracite field. From the east to the west, the strata were composed of gray clay and sandstones.

While 800 or 900 feet of the Pottsville sediments were accumulating in the northeastern Pennsylvania field, the deposition of these coal beds and their associated shales was followed by another subsidence, apparently of great extent and southeastern side of the trough, because there is no evidence of clay-shale beds in the area. The subsidence was apparently of great extent and time, and it is believed that the suspension of the sedimentation in the Sewickley quadrangle was caused by the subsidence of the Clarion till.

The Allegheny stage was marked by a great deal of variation in the amounts of material removed and deposited, which is evident from the variation in the thickness of the strata. The highest member of the Pottsville in the Sewickley quadrangle was deposited in a shallow sea, and the lower member of the Pottsville in the Sewickley quadrangle was deposited in a deeper sea. The thickness of the strata varied greatly from one part of the quadrangle to another, and the variation in thickness is evident from the nature of the coal seams. The origin of the coal and the method of its accumulation were subjects of great interest, and the question of the cause of the coal seams being formed was discussed.

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The most remarkable coal-forming period in the history of the
thousands of feet of rocks had accumulated. From the close
and a long-continued series of events of a totally different kind
had been deposited the bottom of the basin was again brought
formed, and at other places the water was sufficiently deep and
rence of marine conditions in the Appalachian basin.
ceeded by marine conditions of very widespread extent in
strata having a thickness of 100 to 150 feet were laid down,
feet of sand and mud was laid down.
The Conemaugh formation. At isolated points there were small
followed by widespread marsh conditions of short duration; at
conditions and long duration of luxuriant vegetation resulted
30 to 70 feet of strata at the base of the Monongahela, have been
by that of the Monongahela formation and the Dunkard group
ations continued throughout the deposition of 50 to 70 feet of

CONEMAUGH DEPOSITION.

UPLIFT AND EROSION.

to the northwest by Salamanca to Gowanda and thence down
the Cattaraugus Valley into Lake Erie (see fig. 3, p. 1); the
filled to great depths. This valley filling was so great in many
of rock debris from the region over which it passed and depos­
ing a short following substage that the valleys of Pine, Brush,
and Breakneck creeks were brought to their present width.
before the end of Cretaceous time at least, for in New Jersey it
ually uplift was arrested, a long period of quiescence ensued,
apparent uplift of the Allegheny Front. This was followed by continental uplift and tilting of
cliiies in the bituminous coal fields west of the Allegheny
Appalachian Valley into a series of high anticlines and deep

KANSAS OR PRAIRIE-KANSAN DEPOSITION.
The further development of the Parker strath was arrested,
progress of the glacier, owing to the narrowness of
sandstones of the Pocono and Catskill (?) formations, known
from Venango County, Pa., where the first large oil pools dis­
pared on them. Of the 227 square miles embraced by the
n the southern divide in the vicinity of New Martins­
Breakneck creeks, had steeper gradients and were more active
th the old valley. These streams continued their course northward along their present courses into Beaver River at

ECONOMIC GEOLOGY.
MINERAL RESOURCES.
The more important mineral resources of the Scowickley
are petroleum, natural gas, and coal; others of less importance are clay, feldspar, building stocks, sand, and

PETROLEUM AND NATURAL GAS.

General statement.—The principal mineral products of the Scowickley
are petroleum and natural gas, which are of such importance that a special bulletin has been pre­
pared on them. Of the 227 square miles embraced by the
quantity about 25 have been found to be underlain by pools of
with or more gas and about 12 additional square
miles have produced gas without oil. This productive territory
in a depth of more than 90 separate pools varying in size from

The oil and gas have been found to occur in seven or more
sandstones of the Pocicisco and Oocenite (?) formations, known
produces the Venango oil sands. This name is derived from
covered by surface waters. The scowickley
have a vertical range of less than 500 feet and are reached
the quadrangle by more than 3000 wells from 1300 to 2100
foot deep. In descending order, names have been given to
as the Hundred-foot (divisible in places into the
and Fifty-five-foot), Nineteen Thousand, Eleven Mon­
Monday, Bowler, Gordon Colony, Third or Gordon, Fourth, and
Fifth sands.

The general character of these beds has already been dis­
classified under "Descriptive geology."

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As a whole the oil sands are of medium grain and porosity, but each of them includes peculiar masses of coarse, more or less conglomeratic sandstone, usually very much softer and more friable than the surrounding sand within which they consist of poorly cemented sand are from a few square feet to a square mile in area and usually range from 100 to 2000 feet in thickness. (see fig. 7.) They constitute the "pays" or "pay streaks" in which the oil and gas are found, though the softer sandstone occurs there to contain oil and gas throughout their thickness.

Most of these pools have been producing for 8 to 20 years or more, and nearly all of them have been thoroughly studied. The production of each has long since reached its maximum, from which it is gradually declining as the pools approach exhaustion. The total production of the pools, however, has been very large, many of them when at their maximum yielding from 1000 to several thousand barrels a day. Some single wells flowed as much as 2500 barrels a day. Outside of the production of oil, the pools are noted for the quantity of salt water which may accompany the oil, the thickness and porosity of the beds. The thicker and more open type of the pay streak generally furnishes a greater quantity of water to oil. On the other hand, the amount of oil produced by a well is in direct ratio to the amount of salt water it pumps. As a rule, the best wells are those that produce the most water, and when the water is exhausted the oil production also begins to fall off.

The logical explanation of the origin and behavior of the salt water pools is that of providing a field for gas to accumulate. Where the gas pressure has become so reduced that salt water has begun to flow on the surface, the gas pressure has become so reduced that salt water has begun to flow on the surface of these pools. Where the gas pressure has become so reduced that salt water has begun to flow on the surface of these pools.

The Fourth sand has yielded considerable quantities of gas from most of the Coraopolis pool and from an area northwest from most of the Coraopolis pool and from an area northwest. The Field has been noted in the Hundred-foot sand and is pumped out with the oil. The production of each has long since reached its maximum, from which it is gradually diminishing as the pools approach exhaustion. The Fifth sand has been noted in the Hundred-foot sand and is pumped out with the oil. The production of each has long since reached its maximum, from which it is gradually diminishing as the pools approach exhaustion. The Fourth sand has yielded considerable quantities of gas from most of the Coraopolis pool and from an area northwest from most of the Coraopolis pool and from an area northwest.
The Hundred-foot sand, which is from 100 to 140 feet thick in the Wildwood pool, is the richest and most productive part of the Hundred-foot sand, but the ratio of salt water to oil varies greatly in different wells in this pool but seems to have no direct relation to structure. In a few wells more oil than is pumped, but usually the proportion is from 5 to 20 barrels of water to 1 oil. Some of the wells in the Ingomar pool made as much as 40 barrels of water to 1 oil. Many wells in the Hummockshunt, Snee, Leetstond, and other pools in this sand with practically the same thickness of pay streak have made from one-half to one-tenth as much oil as water, though these pools are situated at points from 50 to 200 feet lower than the slope of the sand. The Hundred-foot sand is double-named continuous throughout the distance between these pools.

The pool is considered to be of the largest ever found in the Wildwood and is the main oil field in the northeastern quarter of the quadrangle. This pool is considered as the most productive part of the Duff City field, which is tentatively considered as merging into the Brush Creek field at about the southern end of Franklin Township, though no arbitrary line can be drawn between the two.

The first well in this vicinity getting oil in the Snee sand, and the one in which the sand first received this name, is located in the southern portion of the Duff City field. The Snee sand is believed to be the same as the Blue Monday sand of other parts of the field, though it is more productive. In the Duff City field it ranges from 5 feet to probably less than 20 feet in thickness, though it has been said to be very soft and porous where it carries oil and has furnished a number of good wells. The Thirty-foot sand in this field is thicker than the Snee, but its pay streak is less continuous than that of the Snee sand, and its occurrence is less even. It has been, however, a prolific producer in parts of the field. The Hundred-foot sand has shown more or less oil in a great many of the holes in which it has been found, and it apparently carries less than the usual amount of salt water. In a number of wells the Bowlder sand has produced considerable oil. Perhaps the best well in this sand is the J. Swistin No. 1, which is said to have yielded 400 barrels a day. This well is still pumping after producing for 18 years. The Bowlder sand also contained more or less gas. Records of wells in this field are very incomplete and much valuable information has been lost beyond hope of recovery.

Though the Duff City field has been producing oil for several years, a little development work is still being continued by operators in the field, and it is probable that a few more producing wells will be added in that direction.

Attention is again called to the fact that in this field the Thirty-foot, Bowlder, and Snee sands, which furnish nearly all the oil, are reported to be water; the wells are not closed pressure varied considerably within relatively short distances, the maximum being about 300 pounds to the square inch. The field is very thin over eastern Franklin Township, generally measuring not more than 15 feet in many places north and west of the top of the sand, and the sand and the pay's productivity, the gas, holds up remarkably; in many that have been drilled from 10 to 15 years the rocks are good; many of these wells have been propped out, and the rock pressure between one-half and less than one-third the initial pressure.

The Bowlder, Snee, and Thirty-foot sands are thin or entirely absent in Pleasant Township. In the northern part of the pool the Snee and Bowlder have furnished oil in a number of wells. In a number of wells the Bowlder sand has furnished sufficient oil to make a well, and the Snee sand was found to be from 4 to 10 feet thick, with a show of oil in a few wells.

The fields of the Wildwood pool are very incomplete and much valuable information has been lost beyond hope of recovery. The Hundred-foot sand has the largest in the Sewickley quadrangle. Broadly, it includes a belt of productive territory from three-fourths of a mile to 11 miles wide stretching along the crest and eastern flank of the Brush Creek field. The Snee and Bowlder, Thirty-foot sands have also been found. The Snee and Bowlder have furnished oil in a number of wells. In a number of wells the Bowlder sand has furnished sufficient oil to make a well, and the Snee sand was found to be from 4 to 10 feet thick, with a show of oil in a few wells.

The ratio of water to oil throughout the field varies considerably even in adjacent wells. A well on the G. S. Richer farm which had an initial production of 61 barrels of oil to 75 to 100 feet of water yielded after seven years fifteen times as much water as oil. Another well on the same farm made 7 barrels of oil to 2 of water, however, seems to have been in wells along the southern margin of the pool that have been pumped dry of oil and abandoned. If the Thirty sand is really void of water, there seems to be no evidence to the contrary, a theory of accumulation somewhat different from that applied in the Coraopolis pool, where it is still a controversy of salt water as a transporting agent, through difference in gravity. In the Thirty-foot sand and the Bowlder sand the oil is high, there are few producing wells. The Thirty-foot sand is also a more or less continuous pool of oil in the Hundred-foot sand, which contains salt water.
Beds of the Snee sand in this vicinity were obtained, but southward in this field to the township line the Hundred-foot, Bowlder, and Thirty-foot sands are oil bearing in a general way. Five or six wells in this area were found, and the detailed history of this portion of the field is given in another paper (13). In this area the Norwood sand is the most prominent oil producer in the eastern part of the field. Some of the wells shows on the map have been drilled within the last 10 or 12 years, some have been drilled to a depth of 1,500 feet, and the record of the initial production is, it is said that many of the earlier ones may have produced hundreds of barrels a day. The total output of the pool is great.

All of the oil comes from the Hundred-foot sand, which has a total thickness of about 90 feet. This pool is also bearing salt water, the ratio of oil to water being about the same as that already described for the Brush Creek field. This pool probably has a greater proportion of gas to oil than all of the other Dewey and Snee sand pools in New Stevick Township, especially the Cookson pool, which is about 250 feet lower on the sand. The principal pay streak is probably not the same as that of the Dewey and Cookson pools. It occurs from 55 to 70 feet below the top of the Hundred-foot sand in this pool. In a few wells another pay from which considerable quantities of oil have been produced occurs near the top of the sand. In this pool from 10 to 30 feet of dark sand is reported at the top of the Hundred-foot sand, with grey or white sand below. The pays are composed of coarse sand and small quartz pebbles.

**Order oil fields** — The Crider field contains two pools, one in the Hundred-foot sand, the other in the Bowlder sand. The Hundred-foot sand is productive only for a short distance to the northwest. The Fourth sand is gas bearing over much of the producing area.

In the extreme south and southeast, and the top of the Hundred-foot sand is between 35 and 40 feet higher at the southern end and 150 to 200 feet higher at the northwestern end. The trend of this belt is northeast and southwest, and the top of the Hundred-foot sand is about 250 feet lower on the sand. The principal producing area lies west of this axis, the highest ratio near the center of the field. The best wells produce 10 to 30 feet of dark sand and are about 250 feet lower than the top of the sand, with the oil. Water was also found, with a show of oil, in this sand in the Brush Creek field of Marshall Township, near the map. The pool occupies the pitching crest of an anticlinal nose which juts out to the southeast from the Crows Run anticline. The pool is now thoroughly developed, and the new wells are all producers and are down to a settled production.

Here is another pool in a comparatively dry sand occupying the crest of an anticline with a border of apparently dry sand surrounding it. It is the Hundred-foot Oil field.

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Here is another pool in a comparatively dry sand occupying the crest of an anticline with a border of apparently dry sand surrounding it. It is the Hundred-foot Oil field.
good, it is reasonable to suppose that if all the oil that would have eventually been pumped from these wells was in the pay streak when the invasion began, the accumula-
tion of oil and salt water above this fresh water would have reduced the amount of oil and salt water, and the invasion would have been more or less advance of the fresh water. It was learned that difficulty had been experi-
cenced with an invasion of fresh water similar to that in the Duncannon field, but no data regarding it were obtained.

The writer doubts if all the oil was forced out of the pay streak in the time of the invasion all the oil and salt water that even­
sibly that in pools of the type common to the Hundred-foot sand of this quadrangle the total amount of oil to be produced would rapidly increase to 100 or even 200 barrels of oil per well. It is apparent that the writer's visit to this field not more than four or five of these wells were producing and no records of them could be obtained. It is very profitable. The pool is now down to a settled production, as it doubtless does over most if not all of the quadrangle.

The Mars pool is situated about three-fourths of a mile west of the Ramsay oil pool. It is exposed on both sides of the valley at the mouth of Crows Run and on the north side of the Beaver pike from that point to Con­veny. At all points where exposed it is from 17 to 30 inches thick. This coal has been mined in connection with its under clay on the west side of Crows Run and at an old bank opened on the south side of the valley level on Crows Run, about half a mile south of Paris Quadrant. This coal was long aban-
doned. It was being operated in 1876, however, when I. C. White found it to be 20 to 22 inches thick, of good quality, with 6 inches of clay "external" coal above. The coal is also exposed in the run back of Freedom, where it lies unform-
ately beneath the Pennsylvania sandstone member. (See fig. 8.)

It is apparently variable in thickness and quality, and in the diamond-drill hole at Sewickley above mentioned it was found to be entirely absent, the horizon being represented by a thin bed of gray clay lying interbedded 16 feet above a 12-inch coal in the Lower Kittanning formation. Upper Kittanning coal.—No exposures of the Upper Kittan­ning coal were noted in the Sewickley quadrangle, though it is possible that there may be some break in the coal horizon near a few points along the steep ravines in the river hills from Baden northward. If present, it is doubtless of no commercial value.

Lower Freeport coal.—The Lower Freeport coal seems to be one of the thickest and best seams of the Allegheny formation within the quadrangle. No outcrops are known except along both sides of Ohio River from Loganville northward. It is exposed in a bluff on the west side of the Pennsylvania Rail-
road north of Legonville, where it is 16 inches thick. In the valley of the Desn the south end of Big Bend, 50 yards north of the Pennsylvania Railroad tracks, it is exposed at flood level, and is 30 inches thick and apparently of good quality. It has been opened at several places along this run, but the workings are now in disuse. I. C. White who visited these banks in 1876, reported it as being from 18 to 30 inches thick, with a local parting of shale 6 inches from the top, and of fair quality, though somewhat hard in sulphur. It is exposed in the bluff north of the Pennsylvania Railroad tracks, opposite Bellefonte Gauley Academy, where it is 22 to 35 inches thick. No outcrop of the coal was seen in the vicinity of Unionville, though the Lower Freeport is about 45 feet above the bed of Crows Creek at that point.

Chester and Clarion creeks, where the Brookville and Clarion beds are of considerable value, though generally thinner than they are of the Pennsylvania Railroad tracks, it is exposed at flood level, and is 30 inches thick and apparently of good quality. It has been opened at several places along this run, but the workings are now in disuse. I. C. White, who visited these banks in 1876, reported it as being from 18 to 30 inches thick, with a local parting of shale 6 inches from the top, and of fair quality, though somewhat hard in sulphur. It is exposed in the bluff north of the Pennsylvania Railroad tracks, opposite Bellefonte Gauley Academy, where it is 22 to 35 inches thick. No outcrop of the coal was seen in the vicinity of Unionville, though the Lower Freeport is about 45 feet above the bed of Crows Creek at that point.
Upper Freeport coal.—The Upper Freeport is one of the most valuable coals exposed within the quadrangle. Its variability seems due in a great measure to slight unconformities at the base of the Mazonia sandstone, which in numerous places is found to rest upon the dark to reddish shales of the Conemaugh formation. It is probable that in such places these beds were depoited but were subsequently removed by streams or wave erosion and the sandstone redeposited in their stead. The coal is usually found to be of mining in a number of places along Black Creek north of Callery, where it appears to be from 2 to 3 feet thick, though the banks were abandoned and the seams below could be secured. On Brush Creek this coal was once mined a mile east of Callery, in a bank at the old mine site, where it is 25 feet thick. It is said to be high in sulphur but otherwise of good quality and of unsual thickness. Westward from this point on the upper Black Creek the coal is hardly above creek level, and at the dam it is not more than 6 inches thick. Two or more banks have opened up this seam in the vicinity of Unionville, where it is reported to be from 18 to 20 inches thick. On Breakneck Creek, at Callery, it was formerly mined at a number of places on both sides of the valley and is reported to have been from 24 to 30 inches thick, with 18 to 24 inches of very fair coal at the base and 4 to 6 inches of inferior coal above. The Upper Freeport is also exposed at a few places along Ohio Valley (see p. 4), but no place has been worked in even small quantities. Energy have been driven at several places along Crow Run and in the river hills, but the coal has invariably been found to be too thin and of too poor quality for profitable working. No banks are now (January, 1909) taking coal from this seam within the quadrangle.

Coal of the Conemaugh formation. The coal beds of the Conemaugh formation are of little or no importance economically as being confined to local areas, where the scarcity of coal of better quality may sometimes justify the mining for homes use of small quantities of the best portions of some of the thicker beds. Only a few of the more important beds deserve more space than that devoted to them under "Descriptive geology." Brush Creek coal.—The Brush Creek coal is generally too thin and too impure to be of value. Local pockets may be devoted to them under "Descriptive geology." Brush Creek coal.—The Brush Creek coal is generally too thin and too impure to be of value. Local pockets may be devoted to them under "Descriptive geology." Brush Creek coal.—The Brush Creek coal is generally too thin and too impure to be of value. Local pockets may be devoted to them under "Descriptive geology." Brush Creek coal.—The Brush Creek coal is generally too thin and too impure to be of value. Local pockets may be devoted to them under "Descriptive geology." Brush Creek coal.—The Brush Creek coal is generally too thin and too impure to be of value. Local pockets may be devoted to them under "Descriptive geology." Brush Creek coal.—The Brush Creek coal is generally too thin and too impure to be of value. Local pockets may be devoted to them under "Descriptive geology." Brush Creek coal.—The Brush Creek coal is generally too thin and too impure to be of value. Local pockets may be devoted to them under "Descriptive geology."
dated these into hard sandstones and shales, effects changes in the clay areas. This clay, therefore, is in point of structure and hardness likely to differ from the terraces and basalt clays, which are set in clay plateaus. Therefore, a considerable amount of sand association with clays is always used in the manufacture of certain kinds of brick, though it may contain a prohibitive amount of sand. This clay is especially prominent in the vicinity of Parks Quarries and directly overlies the thick lower sandstone of the Mahoning member, which is quarried at this point for use. Shale has been found that a mixture of clay and stone give a better brick when strength and lasting qualities are desired than clay alone does. Therefore, a considerable amount of sand association with clays is always used in the manufacture of certain kinds of brick, though it may contain a prohibitive amount of sand. This clay is especially prominent in the vicinity of Parks Quarries and directly overlies the thick lower sandstone of the Mahoning member, which is quarried at this point for use.

Small deposits of clay of Quaternary age may exist within the old terraces gravel along Ohio River, but if any are present, they are not now being developed and will probably be found to be of small extent.

**Shale.**

Through different degrees of induration clay passes insensibly into shale. It has been found that a mixture of clay and shale gives a better brick when strength and lasting qualities are desired than clay alone does. Therefore, a considerable amount of sand association with clays is always used in the manufacture of certain kinds of brick, though it may contain a prohibitive amount of sand. This clay is especially prominent in the vicinity of Parks Quarries and directly overlies the thick lower sandstone of the Mahoning member, which is quarried at this point for use.

Small deposits of clay of Quaternary age may exist within the old terraces gravel along Ohio River, but if any are present, they are not now being developed and will probably be found to be of small extent.

**Sandstone.**

Abundance of sandstone suitable for reliable quarrying is found in the Sewickley quadrangle in both the Allegheny and Conemaugh formations. Each of the principal sandstones affords an ample supply of such material along its line of quarry, and where needed for local building purposes this abundant supply is sufficient to supply the demand for building stone in the Pittsburgh district. Transportation is effected by railroads but with poor success.

**Limestone.**

The limestone in the Sewickley quadrangle is composed largely of limestone, and many beds of it are very friable and suitable for making building brick and stone, when mixed with local residual clays, for making good grades of, brick. Within the Sewickley quadrangle these shales have been put to economic use in but few places. The shale overlying the Old Allegheny (Conemaugh) member, which is coarse, somewhat conglomeratic in places, and gray to yellowish in color, is in point of structure very much deeper and more fertile than would be expected in a shallow deposit of such origin. In many places the crumbly nature of the limestone makes it unsuitable for use in building brick. For these and other equally vital reasons it seems very probable that except on Ohio River the obtainable water power is not large. In general, the tributaries to the Ohio are short and have narrow valleys of practically uniform grade. The gradient, therefore, changes materially within short distances, for the underlying rocks may vary from sandstones to clays, or vice versa. As a rule, the soil is much deeper and more fertile than would be expected in a region of such bold relief.