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UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

ECONOMIC GEOLOGY

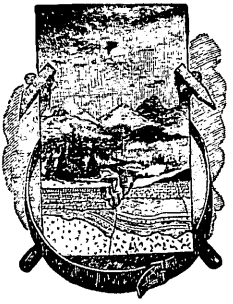
OF THE

BEAVER QUADRANGLE, PENNSYLVANIA

(SOUTHERN BEAVER AND NORTHWESTERN ALLEGHENY COUNTIES)

BY

LESTER H. WOOLSEY



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ECONOMIC GEOLOGY OF THE BEAVER QUADRANGLE, PENNSYLVANIA.

By LESTER H. WOOLSEY.

PREFACE.

The field work on the area covered in this report was begun early in July, 1902, and continued throughout the summer. Early in September Mr. M. I. Goldman joined the writer and assisted in the areal mapping for one month. During the following winter the instrumental results were found to be too much in error for drawing structural contours at 20-foot intervals. Consequently in the spring of 1903 the field was again taken by the writer and Mr. F. G. Clapp, and the elevations on outcrops of the key strata previously determined by aneroid were checked by level. The results were surprising and gratifying. The larger part of this work was accomplished by Mr. Clapp, who also collected other geologic data and several hundred records of wells in Beaver and Allegheny counties. In August, 1903, the writer was transferred to western work, and his time has since been divided between two areas. The engraved topographic map of the Beaver area was finished in March, 1904. In the summer of 1904 Mr. Clapp spent a few days in obtaining special information on the clay industries of Beaver quadrangle. This data has by correspondence been brought up to date (May, 1905), and enlarged so as to cover most of Beaver County.

From Mr. M. R. Campbell, geologist in charge of fuels and other natural hydrocarbons, the writer has received such oversight and criticism as makes mention of gratitude here totally inadequate. The preparation of the report has been facilitated by various courtesies of the oil, gas, and clay companies operating in this region. Special acknowledgment is due to Mr. R. R. Hice, of the Fallston Fire Clay Company, a member of the Pennsylvania Topographic and Geologic Survey Commission, for data on the New Sheffield gas field and other valuable information.

GEOGRAPHY.

LOCATION.

The Beaver quadrangle is located in western Pennsylvania, with its western boundary about 1 mile from the Ohio State line. The whole area, except the southeast corner, which includes a triangular portion of Allegheny County, lies in Beaver County, and through its middle in a general westerly direction flows Ohio River. Near the junction of Ohio and Beaver rivers is situated the town of Beaver, which gives its name to the quadrangle. The quadrangle extends from latitude 40° 30′ on the south to 40° 45′ on the north, and from longitude 80° 15′ on the east to 80° 30′ on the west, including one-sixteenth of a square degree of the earth's surface, or an area of about 227 square miles.

DRAINAGE.

The Beaver quadrangle is drained by Ohio River and its tributaries, the Ohio cutting the quadrangle into northern and southern portions. The drainage of the northern portion is mainly through Beaver and Little Beaver rivers. The former, entering the Ohio near Beaver, drains the larger part through Brady and Blockhouse runs. Little Beaver River, on the other hand, lying mostly in Ohio, controls the drainage of the smaller part through Brush, Bieler, and Island runs. Besides these streams, several small runs enter Ohio River and drain a narrow belt along its northern bank.

The drainage of the southern portion is carried chiefly by Raccoon Creek, which is the outlet for over two-thirds of this portion. The remainder is drained by smaller streams which enter the Ohio.

FIG. 1.—Map showing position of Beaver quadrangle.

RELIEF.

The cutting of these streams has formed the hills and valleys of this region, whose local difference in elevation constitutes the relief of the country. Thus, north of the Ohio the highest land, or main divide, rising about 600 feet above the river, lies in general near the Lisbon road and extends from near Beaver through Fairview and Blackhawk. Spurs from this divide offer minor divides for small streams. The relief of the area lying between Beaver River and Crow Run is about 550 feet above Ohio River. The tributaries south of the Ohio form a main divide which extends in general from Kendall northeastward through McCleary and rises at most 650 feet above the river. The spurs lying between laterals of Raccoon Creek and small streams entering the Ohio are of uncommon length and make the relief of most of the country north of the divide about 450 feet above the river and southwest of the divide 550 feet above. The region within the quadrangle east of Raccoon Creek has an extreme relief of 550 feet, but, as it is deeply dissected, there is very little flat land.

The smaller streams of this quadrangle, as will be seen from the topographic map,

have in general rather narrow, precipitous valleys, displaying but a small expanse of flood plain. But ancient flood plains are still preserved as a peculiar feature of the surface relief in terraces along Ohio and Beaver rivers and Raccoon Creek. These will be discussed in detail later, but it may be stated here that the river terraces show two well-marked levels about 150 and 250 feet, respectively, above water level. The abandoned valley of Raccoon Creek, in which New Sheffield is situated, lies at about the latter elevation.

EFFECT ON HUMAN AFFAIRS.

Topographic features control in a large measure man's activities. Beaver and Ohio rivers, exposing beds of valuable mineral deposits, such as clay and coal, offer facilities for mining operations; broad terraces provide admirable sites for large plants and towns; the even grade of the river valleys influences their selection for lines of railway; narrow, swift streams furnish cheap water power for various industries, and the flat divides and level flood plains invite farming. All these natural advantages are illustrated and utilized in the Beaver quadrangle to a degree so evident by the map that description is unnecessary.

GEOLOGY.

STRATIGRAPHY.

The consolidated rocks exposed at the surface in the Beaver quadrangle are entirely of the Carboniferous age. There are, however, certain unconsolidated rocks, such as glacial deposits and river gravels, which belong to the Quaternary age. The Carboniferous rocks are divided into the Mississippian and Pennsylvanian series. For convenience of economic and scientific study, geologists early divided these series into separate formations, based on fossil and lithologic characteristics. In this quadrangle the Mississippian series is represented by the Pocono formation, while the Pennsylvanian is represented by the Pottsville, Allegheny, Conemaugh, and Monongahela formations. The general characteristics of these formations are only outlined, especial attention being here given to various members of local importance. Not all the Carboniferous rocks are exposed, while the Devonian rocks, immediately below, have not been uncovered by erosion, and all that is known of the unexposed rocks of these systems is secured from records of deep wells.

ROCKS NOT EXPOSED.

POTTSVILLE FORMATION.

In the Beaver quadrangle this formation lies conformably beneath the Allegheny formation above and unconformably upon the Pocono below. It is named from Pottsville, in the anthracite coal field, where it is 1,200 feet thick. Toward the east, in the bituminous coal field, it has thinned to about 200 feet. Both in the anthracite and bituminous coal fields it generally carries some workable coal, clay, or limestone. In eastern Pennsylvania these lie between two heavy conglomeratic members, which there form the top and bottom of the formation; in western Pennsylvania coals occur not only between these members, but between the lower one and a third sandstone bed which here is developed at the base of the formation. The upper group of coal, clay, and limestone has been named the Mercer group, from Mercer County, where they are typically developed, while the lower coal is designated Sharon coal, because of its good development at Sharon, Mercer County. The three sandstone members have been named, from the top downward, Homewood, Connoquenessing, and Sharon, respectively.[a]

[a] Second Geol. Survey Pennsylvania, Bull. Q4, p. 55.

In the counties north of Beaver, where the whole section of this formation is exposed, I. C. White has found a total thickness of 250 to 275 feet. In the Beaver quadrangle, however, not much of the formation is exposed, and information regarding its character and thickness is gathered from the logs of deep wells. In this region complete well records, carefully kept, are the exception. Mr. F. G. Clapp and the writer have collected about 700 records in Beaver county, of which nearly 300 belong to wells within the Beaver quadrangle. Of the latter number only 14 have been selected for study. These, together with a few complete records from wells outside but near the boundaries of the quadrangle, are published on Pls. I and II. These sections show great apparent variations in the thicknesses and kinds of rocks encountered at the same horizon. Such variations are due in part to the difficulty of recognizing the kind of rock by the action of the drill while passing through it, and also, seemingly, to the rather careless manner in which records are kept.

Nevertheless, the Pottsville and its members may be recognized in a more or less general way. If its thickness here be assumed to be nearly the same as farther north—that is about 250 feet—it seems usually to include two sandstones, between which occur coals and shales. Sometimes, however, a third lower sandstone appears also to belong to this formation. The shales separating the beds may be overlooked in drilling and the well logs may consequently show different numbers of sandstones. Naming the sandstones Homewood, Connoquenessing, and Sharon, from the top downward, may therefore quite as often be wrong as right. For convenience of description, however, the name Homewood is applicable to the topmost bed, Connoquenessing to the one next below, and Sharon to the third when present. In the southern part of the quadrangle, in Hanover township, well logs show two rather distinct beds of sandstone which may perhaps be correlated with the Homewood and Connoquenessing members of the Pottsville. In the Nelson well, for example, the upper bed has a thickness of 80 feet and the lower bed a thickness of 50 feet. The Lee well also shows two beds at this horizon, but they have nearly twice the thickness of those just described, and it is a question whether both belong to the Pottsville. The lower bed, however, seems, from stratigraphic relations, certainly to belong to the Pottsville, and may, indeed, represent both Homewood and Connoquenessing, the separating shale being either absent or disregarded in the record. Normal conditions recur in the records of Moon, Independence, and Hopewell townships. The Bridgewater, Vandergrift, and McElhaney wells indicate two sandstones separated by a black slate or coal member, which perhaps represents the Mercer coal horizon. No coal, however, was noticed in the Johnston well, though the record carefully details three sandstone members.

Records from wells on the Hamilton and Poe farms, near Georgetown, in the west-central part of the quadrangle, do not distinguish clearly between the members of the Pottsville formation, though at this horizon there is a sandy member (probably two in the Poe well) 25 to 75 feet thick. Near the mouth of Raccoon Creek, however, the Charles Deens well reveals in this position several distinct sandstone beds separated by dark shale. The upper two, and perhaps three, probably belong to the Pottsville formation, while the dark slates may represent the Pottsville coals. In this record the sandstone members, from the top downward, have a thickness of 50, 75, and 30 feet. Still farther north a line of wells extending from Ohioville through Beaver Falls into New Sewickley Township show the Pottsville formation more or less distinctly. Of these sections, those between Ohioville and Beaver Falls represent the Pottsville, with no additional details, merely as a single or double bed of sandstone about 75 feet thick. But the records at Beaver Falls and farther east show two distinct and well-marked sandstone members. A coal above the uppermost is probably the Brookville. Between the two members themselves is an interval of about 100 feet, containing in the upper part sometimes a bed of coal or black slate, toward the middle one of iron ore or limestone, and elsewhere shale. The thickness of the

two sandstone beds varies from 20 to 50 feet in the case of the Homewood and from 25 to 100 feet in the case of the Connoquenessing. In nearly all the sections throughout the quadrangle a shale bed of variable thickness occurs at the base of the formation. Whether this belongs to the Pottsville or to the Pocono can not, without fossil and other stratigraphic evidence, be stated with certainty.

MAUCH CHUNK FORMATION.

Below the Pottsville formation, in some parts of western Pennsylvania, occurs the Mauch Chunk formation, containing 150 to 250 feet of red and green shale, with a green flaggy sandstone and a blue fossiliferous limestone near the base. Where this formation is present it is usually shown in well records, because its red color makes it easily recognized by drillers. In this quadrangle, as will be seen from the sections (Pls. I, II), no such red beds seem to occur immediately below the Pottsville formation. This appears to be good evidence therefore that the Mauch Chunk formation is absent. It has also been shown to be absent or patchy farther north, in the Kittanning and Rural Valley quadrangles; and from all the evidence now available it seems a rather well-established fact that there is an unconformity at the base of the Pottsville formation.

POCONO-CATSKILL ROCKS.

Introduction.—The Mauch Chunk being absent the Pocono-Catskill rocks lie unconformably beneath the Pottsville. In eastern Pennsylvania the Pocono rests conformably upon the Catskill red beds (uppermost Devonian), but is easily separable from them by lithologic characters. There the Pocono, named from the Pocono Mountains, measures over 1,000 feet and consists largely of sandstones; while the Catskill is about 2,000 feet thick and is composed chiefly of red and greenish rocks. Toward the west, however, distinction is less certain, for the reason that red shales of Catskill character interbed with rocks of Pocono type. This is the condition disclosed by logs of deep wells in the Beaver quadrangle, where thin beds of red rocks are distributed through a considerable thickness of sandstones, with no sharp dividing plane between them. Since from well records alone the only means of identifying the Catskill formation is by the presence of red rocks, it is manifestly impossible to draw a definite boundary between the Catskill and Pocono. For this reason no such line has been attempted and the rocks of both formations are discussed together. In general this group appears to consist of alternating sandstone and shale. Certain of these, namely, the Burgoon, Berea, and Hundred-foot sandstones and the red shale, can be easily traced and are important enough both stratigraphically and economically to deserve separate discussion.

The top of this group—that is, the top of the Pocono—is well marked throughout much of Pennsylvania by a sandy calcareous member commonly designated the "siliceous limestone," but named Loyalhanna limestone in the Kittanning folio.[a] The well records of the Beaver region, with the possible exception of the Vandergrift well in Independence Township, do not show this limestone, but it might be easily overlooked in drilling. If part of the shale member referred to above as possibly belonging to the lower shales of the Pottsville formation is not a part of the Pocono, the latter formation, as shown in the well sections, has in the Beaver quadrangle as its topmost member a heavy sandstone. This sandstone will be called in this report the Burgoon sandstone, the term being used in the same sense as in the Kittanning folio.

Burgoon sandstone.—This member is named from Burgoon Run, in the Kittanning region. It is variously known among drillers of this quadrangle as the "Mountain" or "Big Injun" sand, and in a few instances has been called "Glass Rock" or "Mur-

[a] Geologic Atlas U. S., folio 115, U. S. Geol. Survey, 1904.

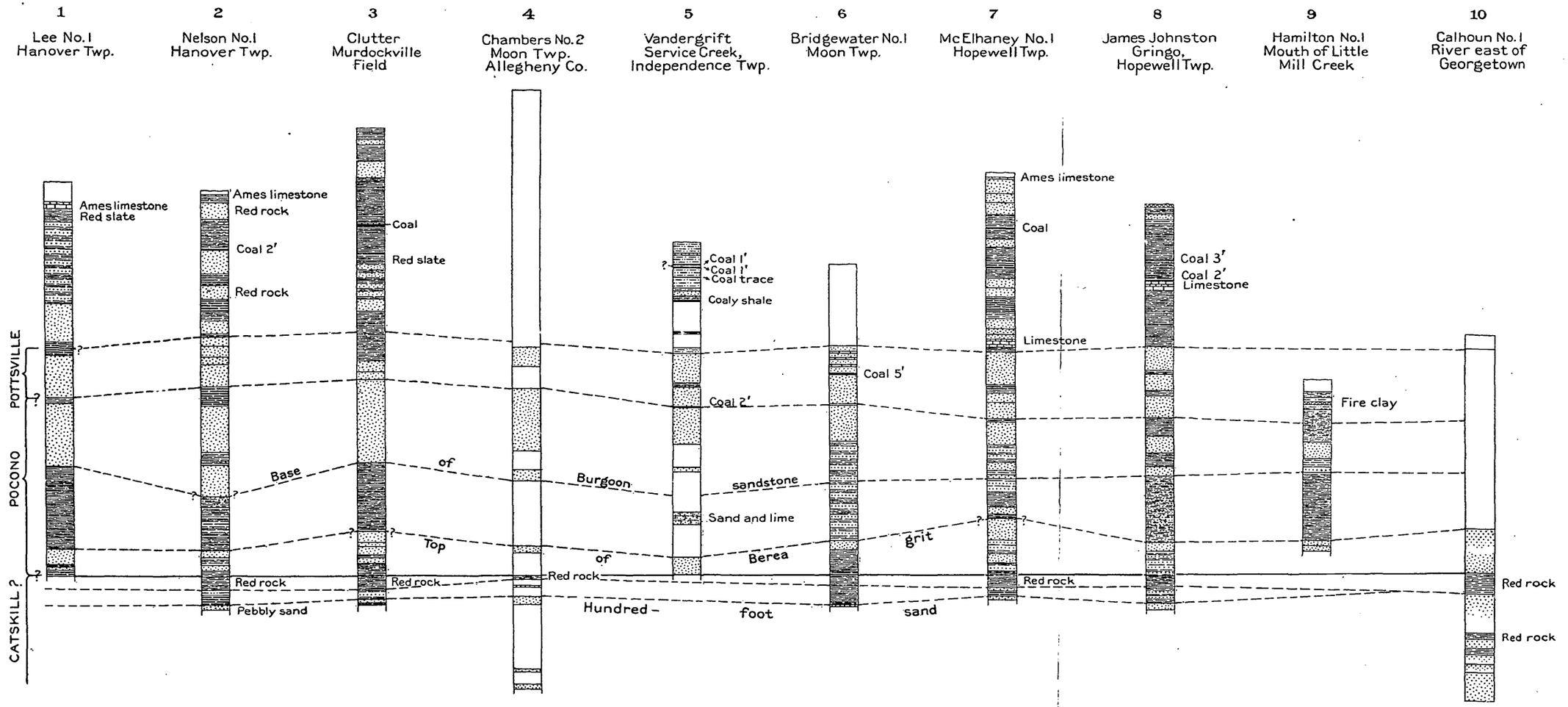
dockville" sand. This sandstone is at an average distance of 525 to 600 feet below the Upper Freeport coal. Among drillers it is usually thought to consist of one member, but a lower and accompanying bed may be considered as belonging to it. The thickness of the upper member, according to the well records, is extremely variable, apparently ranging from a knife-edge to 150 feet. Records from two wells in the southern part of the quadrangle (Clutter and Lee wells, Pl. I) indicate a thickness of 200 to 300 feet; but in other sections and in many skeleton records at hand the usual thickness is given as about 75 feet. It is possible, therefore, that instances of extreme thickness are due either to faulty records or to the fact that this sand is separated from a Pottsville member by an interval too small for the driller to recognize, as may be expected along an unconformity. The lower member is a thin sandstone bed accompanying the Burgoon sandstone proper. It is usually about 25 feet thick, rarely increasing to 100 feet, and is separated from the upper member by 30 to 50 feet of shale. The base of the lower member approaches the base of the Pottsville (Pls. I and II) toward the north, perhaps because of the unconformity under the latter. The Burgoon sandstone is characterized by drillers as being gray or white, varying from a hard, fine-grained to a soft, medium coarse rock. It is generally persistent throughout the oil and gas regions of this territory, so far as partial records show, but the greater number of records give only the sand at the bottom of the well, which is usually below the Burgoon horizon.

Underlying the Burgoon sandstone and extending about 300 to 350 feet below its top is a series of beds usually composed of shales and shaly sandstones, with here and there a sandstone lens. This series rests upon the Berea sand and seems to thin somewhat toward the north, bringing the base of the Burgoon and the top of the Berea closer together.

Berea sandstone.—The Berea sandstone takes its name from Berea, Ohio. From this place it has been traced in deep wells, by drillers, across the State into Beaver County, Pa., and the stratum there called Berea is supposed to be the same as that outcropping at the type locality which is commonly referred by paleontologists to the Pocono formation. It is a white or gray sandstone, varying from a hard, fine-grained rock to one coarse and loose. One section, that of the Economy No. 2 well (Pl. II), records it as a pebbly sandstone. Though somewhat variable in character, it is particularly persistent throughout the drilled portions of the quadrangle, and its position in the formation is between 825 and 900 feet below the Upper Freeport coal, the most reliable data averaging 880 feet. It is not certain, however, from skeleton records that drillers in all cases identified the same stratum as Berea. They may occasionally have correlated it with the so-called "gas sand," 40 to 80 feet below. Nevertheless, the names Berea and "Smiths Ferry" appear to be used interchangeably for the same bed in Ohio, Greene, and Hanover townships. A few records also show a coal at 700 to 750 feet above the sand, which is very probably the Lower or Middle Kittanning.

The Berea sand has a thickness varying from 25 to 50 feet. In some instances, however, as much as 150 feet is recorded, though the majority of the best records show the usual thickness. Exceptional thicknesses, as in the Cookson, Economy No. 2, and Calhoun wells (Pl. II), may be due to its merging with a lower sandstone. A lower bed, indeed, occurs, according to good records, at 15 to 30 feet below the Berea proper, and varies in thickness from 15 to 75 feet. This bed scarcely deserves separate mention and is discussed with the Berea, but its position is relatively that of the Butler gas sand of northern fields. In fact both members hold a position corresponding to that of the Butler gas sand as described in the Kittanning region.

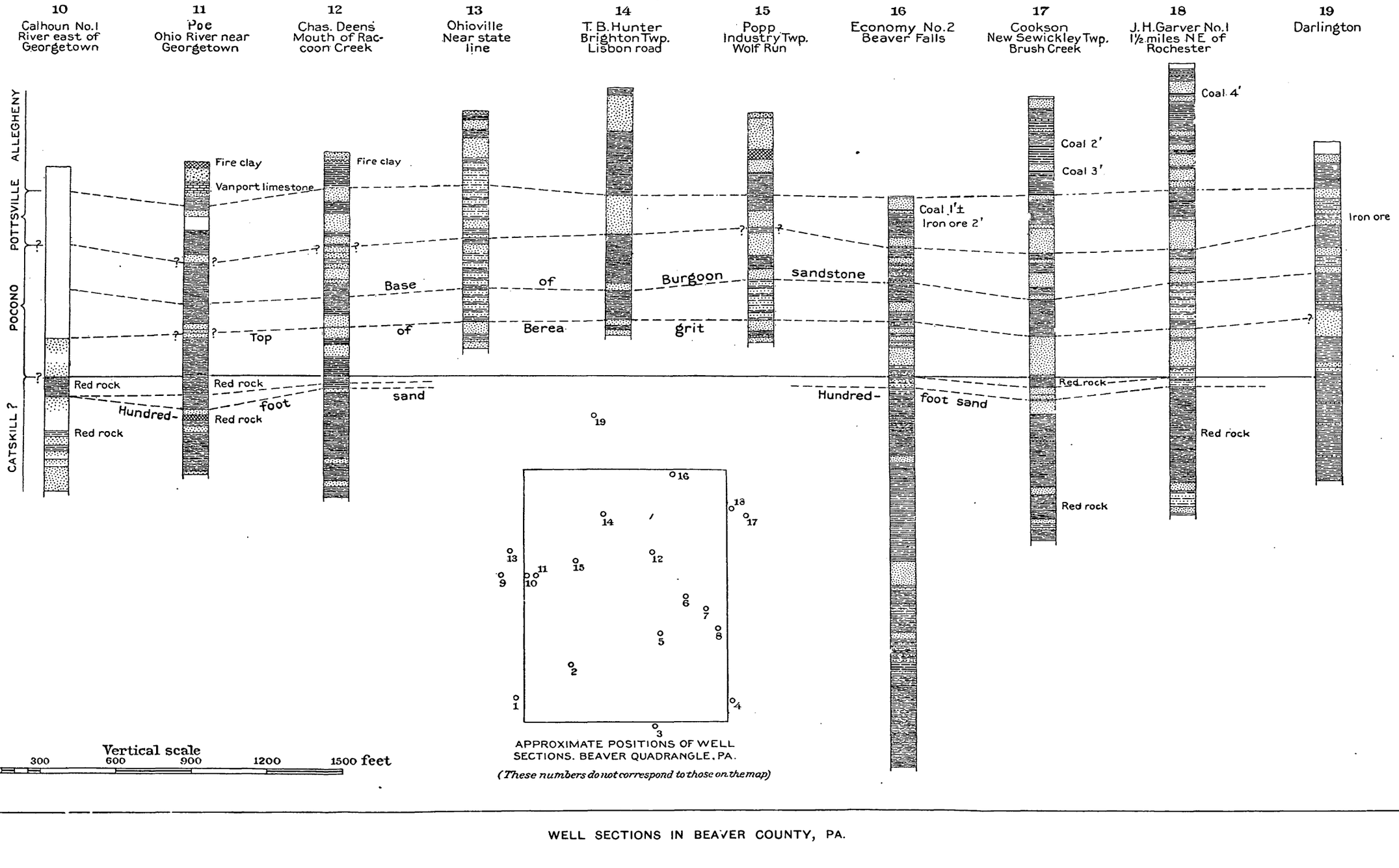
Below the lower sandstone lentil shales or shaley sandstones, sometimes developing into distinct beds, extend to a well-marked red member 100 to 150 feet below the



These numbers do not correspond to those on the map
See diagram on plate II

Vertical scale
0 300 600 900 1200 1500 feet

WELL SECTIONS IN BEAVER COUNTY, PA.



WELL SECTIONS IN BEAVER COUNTY, PA.

top of the Berea sand. In the McElhaney well (Pl. I) this distance seems increased to 200 feet. Conditions are not very clear here, which may be due to wrong identification by drillers of the top of the Berea sandstone. But this interval, as the well sections show, apparently increases to the north, compensating the decrease between the Berea and Burgoon.

Red shale.—This member, as shown in well records, occurs in Greene, Hopewell, Hanover, and Moon townships, but the writer has no record of it north of Ohio River except in the Cookson well in New Sewickley Township. It has a thickness of 25 to 75 feet and is usually shaly, but in some records it is given as somewhat sandy. It is a transition member of the Pocono-Catskill group and can hardly be above the Bedford shale of Ohio, which paleontologists are now inclined to believe is Catskill. Consequently the division line between the Pocono and Catskill seems in this region to lie between this red shale and the Berea, but, as shown below, there is reason for putting it lower. This member is not the Patton shale of the Kittanning region of northern Butler County, for that bed lies immediately under the Burgoon sandstone. This fact has been established by carefully correlating a series of well sections extending from the Kittanning region to Beaver quadrangle. They show the red bed absent in northern Butler County, though present in the vicinity of Cove Hollow and Muddy Creek. Wells here, reported by Carll, show the stratum with the same thickness and in the same position as in Beaver County.

A series of shales or shaly sandstones 25 to 70 feet in thickness separate the bottom of the red shale from the top of the "Hundred-foot sand."

Hundred-foot sandstone.—To this member, which is equivalent to the "First Oil" sand of more northern oil regions, the name "Shannopin" sand is locally applied. It is also designated "Hundred-foot," which is a misnomer in this region since the sand rarely attains a thickness greater than 25 feet. In two cases, however (the Calhoun and Johnston wells, Pls. I and II), it is much thicker and begins just under the first red shale. This may also be true in a few other wells whose records give the full thickness of 100 feet. This sandstone, like the others, varies from fine grained to pebbly and in the southeast corner of the quadrangle seems composed of two parts—a hard, siliceous, impervious cap a few inches thick, and a lower portion consisting of an open mealy sandstone containing many white, pink, and yellow pebbles. It seems to be generally present wherever drilling has been carried sufficiently deep.

This is perhaps another of the transition members, for the base of the Pocono has been variously placed at the base of the Hundred-foot sand, or tentatively, on lithologic grounds, at the top of the first red bed below the Hundred-foot.[a] Red beds having this relation are shown in the Calhoun, Garver, and Poe well records (Pl. II), and in these they vary 200 feet in relative position. An extreme variation of 400 feet is seen in the Cookson well (Pl. II), while other wells show no red beds at all. It is likely that these variations no not represent the same bed, but rather different lenses of possibly the Catskill formation, and they thereby show the difficulty of drawing adequate boundaries.

Gordon sandstone.—So few records within the quadrangle show the other sands of the Venango group besides the Hundred-foot that little can be said of them except that they seem generally thin when found and often some of them are absent or not recorded. As is shown in the table on page 95, however, the "Gordon" and "Fourth" sands have been very generally noted in certain townships. The "Gordon" has been struck rarely in Economy, Franklin, Greene, Hanover, and New Sewickley townships, but seems to be a productive stratum in Moon Township, Allegheny County. Here it is found at an average of 225 feet below the top of the

[a] For a discussion of these and other views see Butts, Charles, Description of the Kittanning quadrangle: Geologic Atlas U. S., folio 115, U. S. Geol. Survey, 1904, p. 5.

Hundred-foot, and ranges from 6 to 15 feet in thickness. No details of its character are given.

Fourth sandstone.—The "Fourth" sand has been less widely met with in this region than the Gordon. In Greene, Economy, and New Sewickley townships it is seldom reported, probably because drilling was not carried sufficiently deep, but in Moon Township, Allegheny County, it is frequently noted. In that locality it averages 60 feet below the top of the "Gordon" sand, but no descriptive details are mentioned except thickness, which varies from 6 to 17 feet. Other names common among drillers, such as "Blue Monday," "Bowlder," "Third," etc., are, as shown in the table on page 95, applied to these and other less prominent sandstones.

Depths of oil and gas sands.—The accompanying table is not completed because of the evident variation in thickness of strata between the middle portion of the county, where the measurements to the Berea were made, and the southern portion, where the distance to the Hundred-foot was measured.

Depths of oil and gas horizons below prominent strata.

Sand.	Average distance below—			
	Pittsburg coal.	Ames limestone.	Upper Freeport coal.	Lower Kittanning coal.
	Feet.	*Feet.*	*Feet.*	*Feet.*
Burgoon (Big Injun or Mountain)	.....	.....	565	400
Berea	.....	.....	880	720
Hundred-foot (Shannopin)	1,810	1,580	.....	.....
Gordon	2,035	1,805	.....	.....
Fourth	2,095	1,865	.....	.....

According to plotted well logs the distance between the top of the Berea and the top of the Hundred-foot averages 230 feet throughout the region. This taken from 1,580 would leave 1,350 feet as the average distance between the Berea and the Ames limestone, which is 180 feet greater than the average distance between these two strata obtained by adding 290 feet, the average interval between the Ames limestone and the Upper Freeport coal along the overlap, to 880, the average depth of the Berea below the Upper Freeport coal. A corresponding discrepancy is found in similar calculations with the Pittsburg coal. The explanation of this seems to be that the interval between the Pittsburg coal and the Berea sand increases to the south. This is confirmed by measurements of this interval in Greene County by R. W. Stone, which show the Gantz (Hundred-foot) 1,916 feet, and the Gordon 2,147 feet, below the Pittsburg coal. These measurements are about 100 feet greater than those found in the Beaver region. Since the variation in this region seems referable to the interval between the Ames limestone and the Berea, it is probable that the cause of the variation lies between these two beds, and is due to the unconformity at the base of the Pottsville.

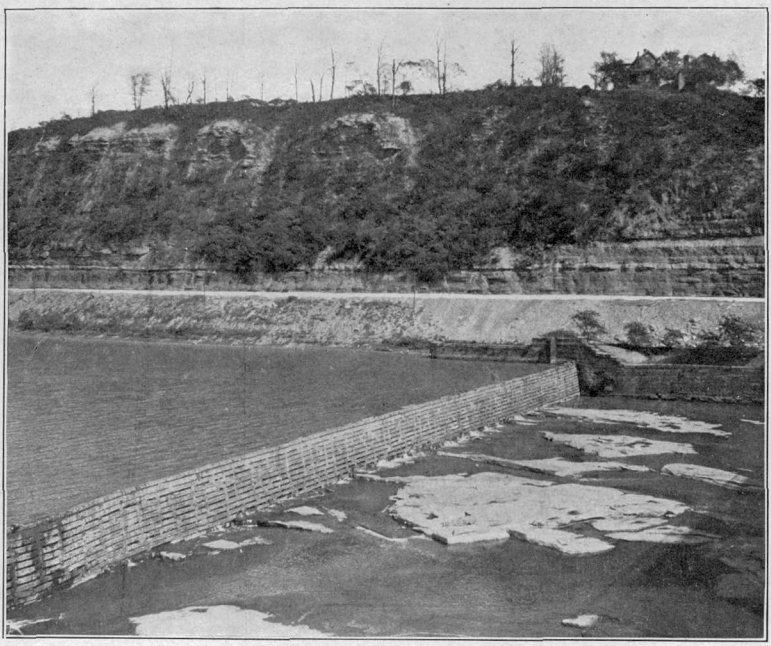
ROCKS EXPOSED.

Carboniferous System.

PENNSYLVANIAN SERIES.

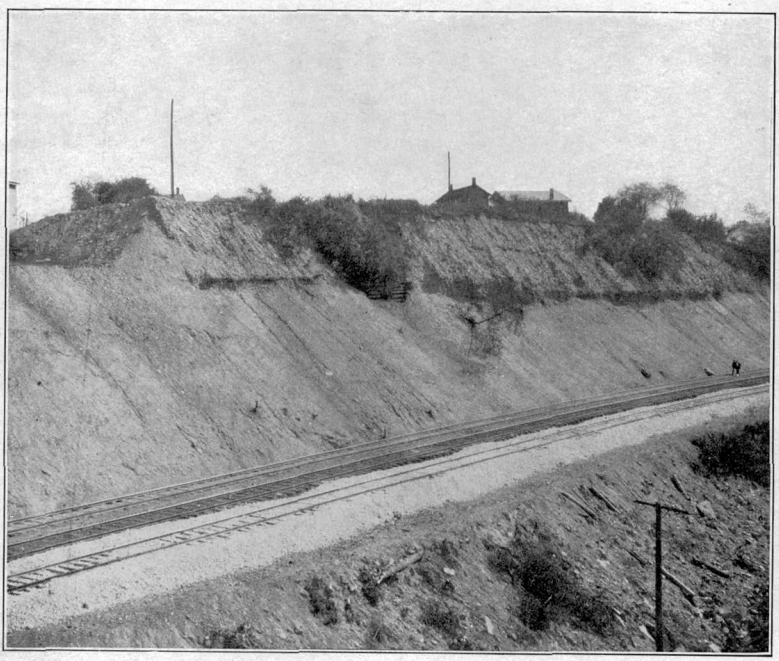
POTTSVILLE FORMATION.

The Pottsville formation occupies the base of the Pennsylvanian series or true coal-bearing rocks. It is also the lowest formation exposed in the quadrangle, being seen near water level in Beaver and Ohio rivers. The topmost bed of the formation, called the Homewood sandstone, is all that comes to the surface in this quadrangle.



A. UPPER DAM ON BEAVER RIVER, NEW BRIGHTON.

Looking east; Pottsville below dam; thin Vanport limestone ledge above railroad.



B. WISCONSIN GRAVEL TERRACE AT NEW BRIGHTON.

East end of Beaver Falls bridge.

In the limited exposures of this bed, though fossil evidence is wanting, it can be distinguished from the succeeding formations by its lithologic character. It is in general a gray, hard, massive sandstone, usually coarse to conglomeratic and often cross-bedded. Its first occurrence in the Beaver Valley is visible at low water immediately below the lower dam opposite New Brighton, and thence it rises to within 10 feet of the Pittsburg and Lake Erie Railroad near the New Brighton and Beaver Falls toll bridge. Here its contact with the gray sandy shales of the Allegheny formation above is clearly seen. At the same level on the opposite river bank, and apparently forming the floor of the New Brighton terrace, the same sandstone is traceable to the Pittsburg, Fort Wayne and Chicago Railroad bridge, and below the next dam it shows at low water as a hard, massive sandstone, containing numerous potholes of various sizes. Above the dam the Homewood sandstone is covered by the pool, but finally rises above the tracks of the Pennsylvania Railroad near Fetterman. Its contact here with overlying thin shales is well marked.

On Ohio River the Pottsville occurs half a mile above Smiths Ferry, where it is visible in the river bed at low water. In Little Beaver Creek, however, its outcrop is much more extensive. Beginning at the road bridge near its mouth it rises rapidly northward above the creek, but does not enter the quadrangle. At both localities the sandstone maintains its massive character, and on Little Beaver Creek huge dislodged blocks of the hard white rock lie in the creek.

The Homewood sandstone is an excellent building stone in other regions where accessible, but because of its low position within this quadrangle it is not of practical interest.

Such is the extent and character of the Pottsville formation at the surface. Beneath the surface, to judge from its customary persistence elsewhere in western Pennsylvania and from records of deep wells within the quadrangle, there is reason to believe that the Pottsville formation is present throughout this region. Further discussion of its underground extent and character has been given under "Rocks not exposed" (p. 3).

ALLEGHENY FORMATION.

Introduction.—This formation was previously known as the "Lower Productive Measures," and later as the "Allegheny River series." The latter name, like the one it now bears, is derived from Allegheny River, along which the formation is exposed in typical form. This is by far the richest group of rocks along upper Ohio River, containing, as it does, most of the workable coals, clays, limestones, and sandstones of central-western Pennsylvania. It was for the single purpose of including these economic beds in one group of rocks, in contradistinction to a "barren" group above, that the upper boundary of this formation was early set as the top of the Upper Freeport coal. It shows in outcrop as a narrow belt, with its base in most places just below river level bordering the river hills and extending up the lateral streams until it disappears under cover of the Conemaugh formation. It underlies the whole of the Beaver quadrangle and has an average thickness of about 310 feet, but the limits of variation are from 280 to 345 feet. The full thickness is exposed along the rivers near Beaver Falls and Smiths Ferry.

The individual beds vary greatly in character and thickness throughout the quadrangle, as will be seen on Pls. IV to VII. The sections there represented were measured in ravines along the rivers and elsewhere, the exact localities being indicated by corresponding numbers on the map (Pl. VIII). No one section can be regarded as typical of the region, and therefore a generalized section, compiled from these detailed sections and embodying many of the variations which occur in the stratigraphy of this formation, is presented below, in the natural order, from the top downward:

Generalized sections of Allegheny formation.

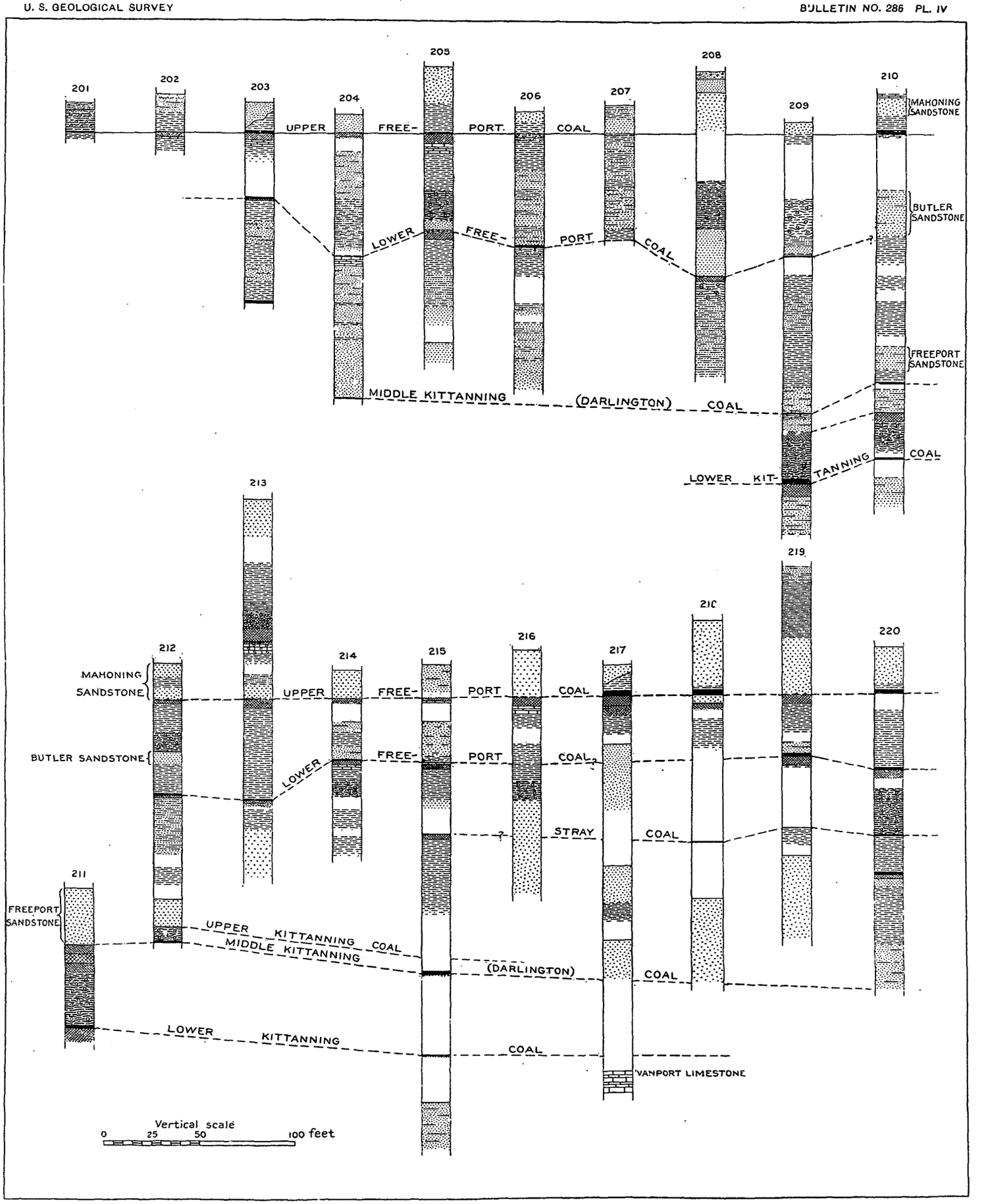
(Mahoning sandstone.)	Feet.	Average.
Upper Freeport coal, "Four-foot" or "Hookstown" vein	0–4	
Fire clay	3–5	
Limestone	0–7	
Shale, Sandstone (Butler)	35–85	
Lower Freeport coal (usually absent)	0–3	
Fire clay	0–5	
Limestone	0–9	177
Sandstone, or sandstone and shale (Freeport)	35–60 (80)	
Upper Kittanning coal	0–1½	
Shale	15–30 (45)	
Darlington coal, "block vein" at Smiths Ferry	½–2	
Fire clay	4	
Black shale, with iron nodules	20–45	
Lower Kittanning coal, "sulphur vein"	1–2½	
Fire clay	2–11	
Sandstone, Shale	35–80	
Vanport limestone, "Ferriferous limestone"	0–19	
Black shale, with sandy shale and clay	15–35	
Clarion coal	0–1	130
Fire clay	0–6+	
Sandstone, Shale	50–60	
Brookville coal	½–3	
Fire clay	3	
Shale	5–7	
(Pottsville.)		

This section is of value chiefly in showing the interrelation of the different coals and their under clays and in giving generally the characteristics of the Allegheny formation. As a whole, the formation is composed of repeated groups of coal, clay, and limestone, separated by shales and lenticular sandstones of greatly varying character. The economic members warrant separate descriptions, which are given below, beginning with the Brookville coal, near the base.

Brookville coal.—The base of the formation is best exposed on Beaver River at the mouth of Brady Run and above, where sections 234 and 236 were measured. These sections show at least 10 feet of gray shale (with 3 feet of fire clay at the top) intervening between the top of the Pottsville and the first coal shown in section 236 (Pl. V). This coal is 6 inches thick, and another coal of similar thickness occurs about 5 feet higher up. One or both of these seem to be in the horizon of the Brookville coal and may represent one seam split by an enlarged parting. At another locality, a short distance above the railroad bridge over Brady Run, the coal is about 5 feet above the Pottsville, which lies near by in the bed of the run. The coal, here about 3 feet thick, dips under Beaver River just below the mouth of Brady Run; thence it rises gently up the Beaver Valley; but in most places, except at sections 234 and 236 and on the railroad above New Brighton, it is covered by river deposits.

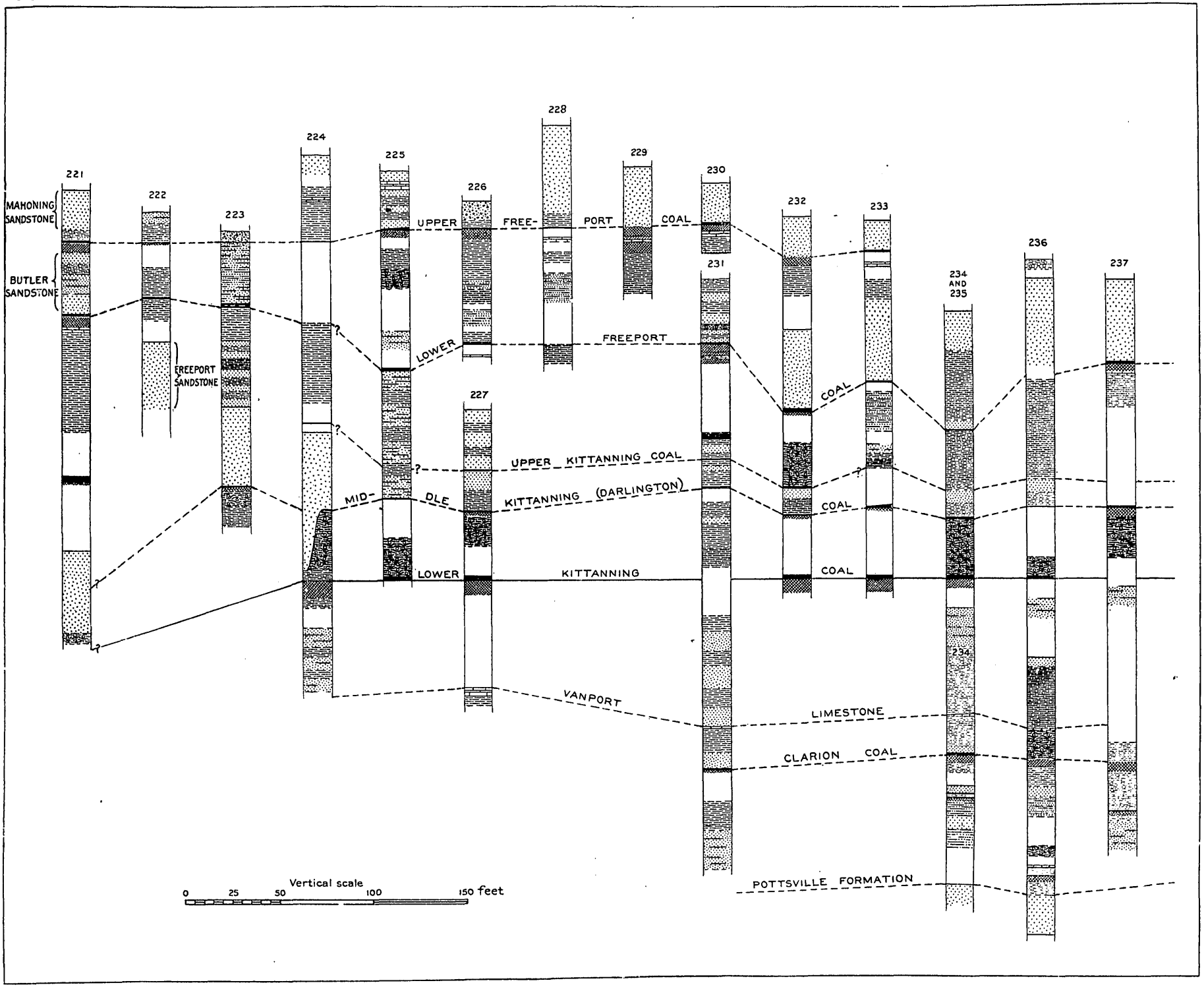
In general, a variable bed of 50 or 60 feet of shale and sandstone separates the Brookville coal from the Clarion coal and clay above. (See sections 234 and 236, Pl. V.) Above New Brighton (section 234), however, a stray coal appears, only 20 to 30 feet below the Clarion coal. It is possible that this may represent the Brookville coal, but no decisive evidence on this point was obtained. Near the mouth of Island Run another doubtful coal 6 inches thick occurs about 180 feet below the Upper Kittanning coal and seems to be in the right position for the Brookville.

Clarion coal.—The horizon of this coal is exposed within the quadrangle for only a short distance on Beaver River and Brady Run. It dips under the former stream



COLUMNAR SECTIONS OF ALLEGHENY FORMATION.

Numbers refer to map (Pl. VIII) and text.



COLUMNAR SECTIONS OF ALLEGHENY FORMATION.

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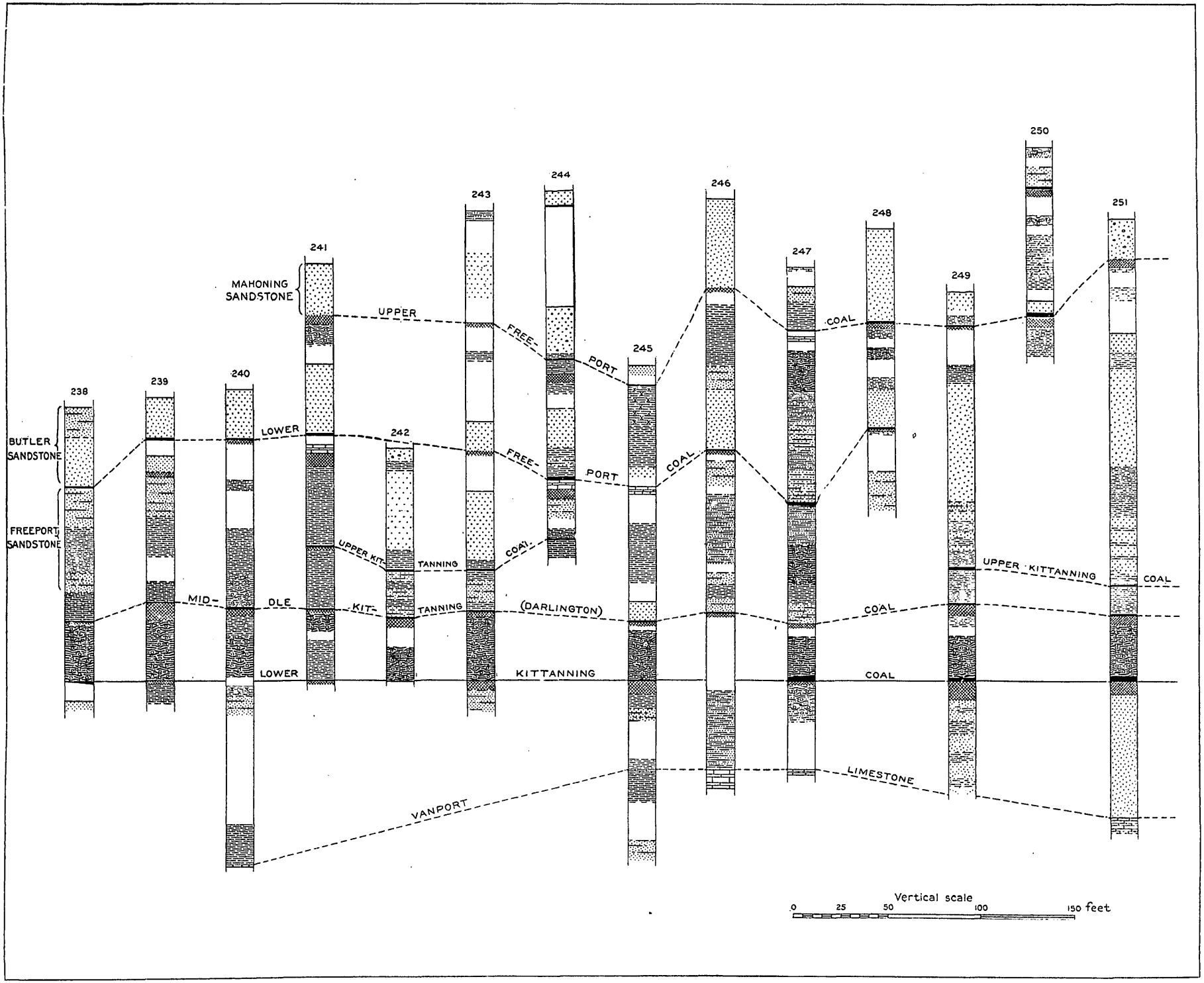
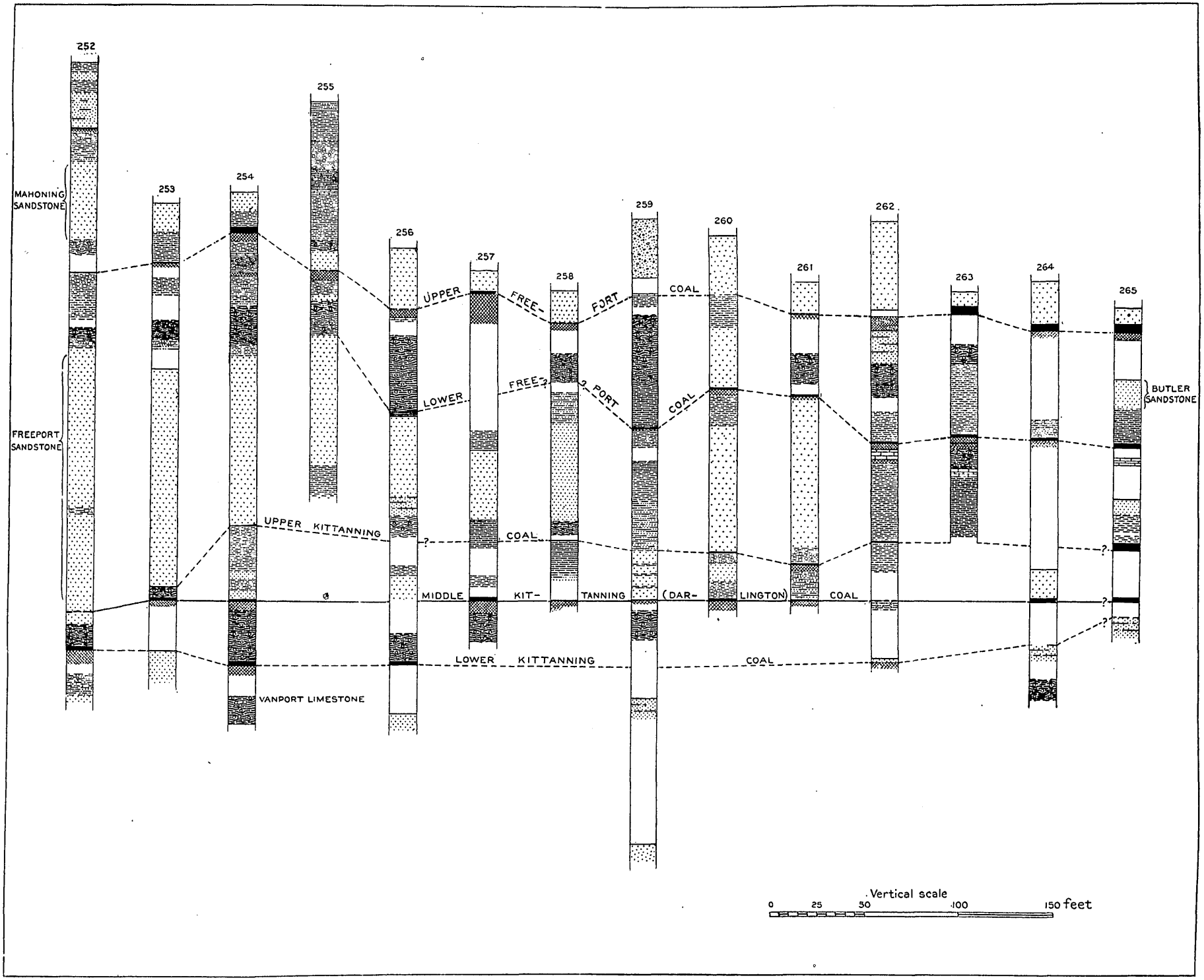


COLUMNAR SECTIONS OF ALLEGHENY FORMATION.

Numbers refer to map (Pl. VIII) and text.



COLUMNAR SECTIONS OF ALLEGHENY FORMATION.

Numbers refer to map (Pl. VIII) and text.

about opposite S. Barnes's brick works above Rochester. From this point northward it rises in the same manner as the Brookville coal, being visible east of New Brighton on Blockhouse Run above the Sherwood pottery, on the railroad above New Brighton (section 234, Pl. V), and, as Hopkins reports, in Paved Run. It is further exposed in the ravines along the railroad south of Beaver Falls (section 236, Pl. V) and thence runs under Beaver Falls terrace.

An excellent bed of fire clay in some instances underlies the Clarion coal.

On Brady Run opposite Fallston the clay has been opened by the Fallston Pottery Company, but the coal above was reported absent. Thence the horizon extends up Brady Run a short distance above the mouth of North Branch. The average thickness of this coal is about 9 inches, when present, but it may be cut out locally by an overlying sandstone, which probably is the case at the Fallston pottery pit. Between 15 and 35 feet of clays and dark shales, often bearing iron nodules, intervene between the Clarion coal and the Vanport limestone.

Vanport limestone.—This limestone was formerly called the "Ferriferous limestone," from the fact that in western Pennsylvania and Ohio it is generally overlain with "Buhrstone" iron ore, which in the early days was largely used as a source of iron. The latter name has clung to it for over half a century, but in this report it will be spoken of as the "Vanport limestone." The name is taken from a town on Ohio River, on the Cleveland and Pittsburg Railroad, where it outcrops in typical form. Here it has a face of about 19 feet, the extreme thickness known in this quadrangle.

The limestone in general is characterized by its wealth of fossil mollusks and crinoid stems and its wavy, shriveled appearance on weathering, called "cone-in-cone" structure. It is very brittle, fractures irregularly, and often has a reddish tinge to its prevailing gray or blue color.

The limestone in this area varies greatly in thickness, owing to its occurrence in irregular lenses. It is therefore absent in many places, but in others has been observed to range from a few inches to 19 feet. When thick it is usually comprised of two or more layers a few feet thick separated by thinner beds of calcareous shale. Its areal distribution is limited to isolated outcrops along Ohio and Beaver rivers (see map), of which the thickest occurrences are at Fallston, Vanport, Merrill, and opposite Industry.

Being even more fragmental in occurrence than the limestone and having a position immediately over it, the "Buhrstone" iron ore, a few inches thick, rarely occurs. So far as observed within the quadrangle quantities sufficient for economic purposes are not present.

Between the base of the Vanport limestone and the first coal above is an interval of 35 to 80 feet, containing at the bottom dark and sandy shale and at the top, just underneath the Lower Kittanning clay, shaly to heavy sandstone. The variability of this interval and the rocks which it covers are graphically represented in sections 235, 236, and 245, Pls. V and VI. In some cases, notably that shown in section 251, the lower sandstone, which may be called the Lower Kittanning sandstone, fills the entire interval. Elsewhere the sandstone gives way, at least in part, to nodular shale, as shown in sections 247 and 254, Pls. VI and VII.

Lower Kittanning coal and clay.—From characteristic stratigraphic associations there seems little doubt that this coal is the same as the Lower Kittanning of the type region on Allegheny River, as mentioned in the reports of the first and second Geological Surveys of Pennsylvania.

The Lower Kittanning coal, popularly known as the "sulphur vein" or "blacksmith vein," is usually 1½ to 2½ feet thick and very persistent. The fire clay beneath shows an equal persistence throughout the quadrangle and varies in thickness from 2 to 11 feet, being usually 6 to 9 feet. As a whole, the clay everywhere is of a drab-gray color when fresh and creamy white on long exposure. Locally the lower part

seems to grade insensibly into a sandy clay below, which may acquire a hard shaly character. The coal and accompanying clay are found throughout the quadrangle above and on both sides of Ohio and Beaver rivers. Their elevation above low water varies from about 180 feet at New Brighton to a few feet at Freedom, below which they disappear under the river; and from about 150 feet at the State line they undulate gently eastward, being 60 feet above the river at Phillis Island, 50 feet at Industry, 100 feet at Vanport, and 80 feet at Beaver. The coal is not, however, actually exposed throughout this whole extent, but is covered by broad, flat, gravel terraces at Rochester, northeast of New Brighton, at Beaver, at Monaca, west of Bellowsville, east of Industry, at Shippingport, north of Phillis Island, and at Georgetown. Elsewhere it is exposed along the more precipitous banks of the rivers and on some of their tributaries. Of the latter, Brady Run, though not the largest tributary, uncovers the greatest extent—about 4 miles—along the stream. North Branch of Brady Run exposes this coal for an almost equal distance. Blockhouse Run, on the contrary, exposes the Lower Kittanning for only a mile east of New Brighton, while on Raccoon Creek this horizon, though covered at several points by stream gravels, presumably remains above water level to the mouth of Fishpot Run, about 2½ miles from Ohio River. Near Georgetown the same horizon is further exposed for about a mile from the river on both Mill Creek and Little Mill Creek. On the opposite side of the Ohio the Lower Kittanning coal extends several miles up Little Beaver River; and on Island Run, a tributary, disappears just outside the western boundary of the quadrangle.

This interpretation of the coal on Island Run differs from that of the Second Survey of Pennsylvania, whose map indicates that it disappears under Island Run at the State line. Stratigraphic conditions at this locality are shown in sections 262, 263, and 264, Pl. VII. The map of the Second Survey also shows the Lower Kittanning horizon disappearing at the Lisbon road on Twomile Run, whereas by the present survey it seems on this stream to disappear under the Beaver terrace about half a mile above Vanport.

Between the Lower Kittanning coal and the next higher seam invariably occur dark shales carrying iron nodules and having a thickness of 20 to 45 feet, averaging 35 feet. This band is one of the most characteristic stratigraphic landmarks in this region, for these dark nodular shales always occur, at least to some extent if not throughout the interval, between the Lower Kittanning and Middle Kittanning coals. In a few cases, however (sections 209 and 210, Pl. IV), the upper part of the interval takes on a sandy character, becoming shaly sandstone or sandy gnarly clay. The interval seems to decrease to the east, for the minimum measurement of 20 feet was obtained on Mill and Little Mill creeks.

Middle Kittanning (Darlington?) coal.—The first coal above this well-marked shale interval was correlated by the Second Geological Survey of Pennsylvania with a coal near Darlington in Beaver County from which it was locally named. It was also termed "Upper Kittanning," but later, when the Kittanning region became better known, it was considered the equivalent of the Middle Kittanning of that locality, and the latter name therefore has been retained in this report. This horizon, being a short distance above the Lower Kittanning, has practically the same geographic distribution in the quadrangle as the latter, and the coal, which is generally known at Smiths Ferry as the "block vein," together with the clay underneath, are very persistent throughout this region. The clay has an average thickness of nearly 4 feet, but rarely reaches 10 or 15 feet. It is in general impure, becoming clouded on the weathered surface by iron oxides and in places containing more or less sand. In thickness the coal varies from 4 to 26 inches. In one or two instances, however (sections 224, 252, Pls. V and VII), this coal bed has been cut out by an overlying sandstone, in a manner similar to the instance cited under "Clarion coal" (p. 11). Section 252 shows at the proper position in the sandstone for the Darlington coal,

bituminous layers interbedded with sand. This condition seems to indicate a contemporaneous deposition of coal and sandstone. In the neighborhood of section 224, however, the coal-making material either was not deposited or was deposited and subsequently eroded by a stream whose channel was later filled with sand.

On Brush Run the identification of this coal is questionable. The lowest seam there opened was apparently taken by I. C. White for the Lower Freeport and the bed 30 feet above it for the Upper Freeport.[a] That the latter identification is probably wrong is shown under "Upper Kittanning coal" below, and it follows for the same reasons that the former is also wrong. Though this coal can hardly be the Lower Freeport, but is doubtless some lower coal, it can not be definitely stated that it is the Middle Kittanning. It is at least 135 feet and at most 150 feet below the Upper Freeport, as identified by this survey. It would seem, therefore, to correspond to the Middle Kittanning, but for the fact that the Lower Kittanning has not been found in this valley. It may therefore possibly belong to the Lower Kittanning horizon, but its distance below the Upper Freeport is less than it is anywhere else in this quadrangle.

Upper Kittanning coal.—The Upper Kittanning coal, which in this report is the name given to the "local" coal described by I. C. White, is the first coal above the Darlington and is separated from the latter by an interval of 13 to 30, and in a few cases perhaps 45, feet. As shown in Pls. IV to VII, this interval in every case where exposed is made up of shales, occasionally nodular, except in Dry Run (section 260), where a sandstone occupies the upper part of the interval. The coal, as seen from the sections, is in the majority of cases absent; when present, however, it has been seen not only to vary from 2 to 18 inches in thickness, but to present the peculiar feature of seldom carrying an underclay.

On Brush Run there is confusion regarding the position of this coal. A coal locally called the "dirt vein" has been opened on several properties and seems to be the one taken by I. C. White for the Upper Freeport.[a] It is uniformly reported 4 feet thick, with a parting 6 to 12 inches thick. White's identification does not seem correct, for adjoining this region and having all the stratigraphic relations of the Upper Freeport is a coal bed which White himself called Upper Freeport and which corresponds to a coal lying about 110 feet above the "dirt vein." Indeed, this coal bed lies at an interval of not over 160 feet above the true Lower Kittanning on Brush Run just beyond the margin of the quadrangle, so that apparently this could not be a lower coal than the Upper Freeport. Moreover, 50 feet above the "dirt vein" is another coal with all the stratigraphic relations of the Lower Freeport coal. The "dirt vein," therefore, would seem to correspond to the Upper Kittanning coal, or, as we have seen under "Middle Kittanning coal" (p. 12), possibly to the latter.

Freeport sandstone.—At about this horizon the prominent sandy part of the Allegheny formation first makes its appearance as lenticular bodies of heavy sandstone. The lowest member, which has been named the Freeport sandstone, when massive, is usually a moderately coarse, micaceous gray rock, often exhibiting false bedding. A glance at the different sections shows the extreme variability of the thickness and base of this sandstone. Its normal position is above the Upper Kittanning coal, from which it is separated by shales, or upon which it rests conformably, as in sections 249, 251, 253, etc., Pls. VI and VII. It may in some instances replace the coal, and hence in places, as shown in sections 211, 259, 264, etc., Pls. IV, VI, and VII, its base lies immediately above or near the Darlington coal. It has indeed been observed to begin even below the Darlington coal, as shown in sections 224 and 252, Pls. V and VII. A study of the sections will show that, on the other hand, it is often absent altogether and replaced by shales. The edge of the lenticular bodies thus formed is exposed somewhat as follows: South and east of a line drawn from the forks of

[a] Second Geol. Survey Pennsylvania, Rept. Q, p. 242.

Blockhouse Run through New Brighton to Fallston, thence making a loop about Rochester and Monaca through Dam No. 5, and crossing the river opposite Beaver on a westward course through Vanport. From Vanport westward along the river it thickens, attaining just below Industry a maximum of 140 feet of unbroken sandstone. Thence it thins westward to the edge of the quadrangle, where it has a thickness of about 50 or 75 feet (sections 255–261, Pl. VII), while to the north, on Island Run, it has thinned still more (sections 262, 263, Pl. VII). South of Vanport it thins between Bellowsville and Raccoon Creek (sections 212, 213, 215, Pl. IV). It soon thickens, however, as the creek is followed southward (sections 218, 219, 220, etc., Pl. IV) and disappears beneath water level not far above Gums Run.

The spur of another lens, coming in from the west, exposes its edge 2½ miles above Fallston, on Brady Run, and then taking a southeasterly course toward Fallston turns sharply to the south about half a mile west of the village.

As seen in the sections, especially those near Vanport, the lower part of the Upper Freeport sandstone is irregularly interbedded with shale, often for as much as 50 feet (sections 249, 251, Pl. VI).

Lower Freeport coal.—The horizon of this coal is properly above the Freeport sandstone, when the latter is present. When the Freeport sandstone is absent, this horizon is separated from the Darlington coal by a shaly interval averaging 82 feet. This interval varies from 60 to 85 feet, as shown in sections 209, 241, etc.; Pls. IV and VI, and perhaps in two or three cases reaches 105 feet. The shales sometimes become sandy (section 251, Pl. VI), and infrequently carry iron nodules (section 247, Pl. VI). The Lower Freeport coal is not persistent throughout the quadrangle, and so far as observed seems to be lacking in about 50 per cent of the exposures. At Industry, where the Freeport sandstone attains its greatest thickness, this coal is reciprocally absent. The thick sandstone perhaps formed in the surrounding swamps, where coal-making plants grew, an island whereon little or no carbonaceous material was deposited. Its absence in other cases is possibly due to erosion of the coal-producing vegetation by strong currents which deposited sand instead. The sand so laid down may therefore correspond to the Butler sandstone described on page 15. In still other cases the coal-making material was not entirely removed, and after a deposition of sand or mud carbonaceous material was again laid down. Thus partings from a few inches to several feet in thickness may split the coal seam into unminable proportions (sections 33, 91; figs. 17 and 18).

The Lower Freeport coal varies in thickness from a knife-edge to 34 inches, averaging 12 inches, and the fireclay beneath ranges up to 5 feet. The fire clay on weathered exposure is usually light colored and plastic, but in certain localities it contains iron, which gives it a streaked brownish appearance. Sometimes, as will be seen in the sections, a limestone occurs underlying the fire clay. The limestone is very impure, being usually a hard, fine-grained, nonfossiliferous rock of buff color. At times it is ferruginous. When present, a thickness of 1 to 9 feet was observed. The average thickness, however, is about 4 feet; but, like the coals, its occurrence is lenticular, and therefore it can not be regarded as a key rock for purposes of identifying the coal. Though in places somewhat stratified, it is practically a solid bed.

The horizon of this coal, being much above the Lower Kittanning, has therefore a somewhat more extended and sinuous crop line, but practically the same distribution. In addition, however, should be mentioned the valleys such as those of Brush and Bieler runs, which, heading in the northwest corner of the quadrangle, though not uncovering the Lower Kittanning coal within its boundaries, do expose the Lower Freeport coal. Here indeed this coal and limestone show the best development.

An interval averaging 60 feet separates the Lower Freeport coal from the Upper Freeport coal, which forms the top of the Allegheny formation. This interval, whose extreme variation is from 38 to 85 feet, may in its typical form be said to consist of sandstone in the lower part and shale in the upper part.

Butler sandstone.—The basal member, called the Butler sandstone, is, like the Freeport sandstone, lenticular in form, varying in thickness from a knife-edge to about 40 feet (sections 232, 233, 241, 244, 246, 257, 259, 261, 263, etc., Pls. V to VII). In character it is a very compact, coarse, yellowish-white rock which attains its most typical thickness along Beaver River and Brady Run. On thinning it gives way to shales which, as shown in sections 207, 259, 261, 262, and 263, Pls. IV and VII, take up the whole lower part of the interval. Above the sandstone, when present, or in any case toward the middle of the interval, usually occur about 20 feet of dark shales bearing iron nodules. Above these lie generally drab caky shales. Either of these two kinds of shales may be absent or replaced by sandy members, as shown in sections 204, 207, 221, 233, 260, etc., Pls. IV, V, and VII.

Upper Freeport coal.—This coal here lies about 177 feet above the Lower Kittanning coal, and its line of outcrop therefore occurs near the top of the irregular river bluffs and in general follows the undulations of the latter coal. For example, from an elevation of 350 feet above Beaver River, at Beaver Falls, it dips southward to 260 feet above the Ohio at Rochester and 190 feet at Crow Run, thence becoming lower toward Pittsburg. From 240 feet at Beaver it undulates westward, being 270 feet at Vanport, 250 at Merrill, 295 a mile below Merrill, 235 at Industry and Phillis Island, and rising to 290 feet at Stateline. Occurring at a greater elevation than the Lower Kittanning, the Upper Freeport horizon has also a correspondingly greater exposure on all the tributaries to the rivers. For example, it dips under Raccoon Creek near Independence, under Mill Creek near Hookstown, under Dry Run and Island Run near Ohioville, and under Brady Run about a mile east of Blackhawk (see map, Pl. VIII).

The upper Freeport coal, with its underlying fire clay and limestone, forms along Allegheny River, a most valuable deposit, but within the quadrangle the group shows extreme variability (see Pls. IV to VII), the coal being absent in about one-third of the exposures and the limestone absent in about one-half. The coal, varying in thickness from a knife-edge to something over 4 feet, with an average of about 2 feet, reaches its best development, as the geologic map (Pl. VIII) shows, in Greene and Raccoon and portions of Industry, Ohio, and South Beaver townships; elsewhere, so far as observed, it assumes proportions which unfit it for profitable mining. This is due to unevenness of the floor of the coal, irregularities in the roof, and unusually thick partings (sections 149, 153, fig. 30; 201, Pl. IV)—features noted under the head of "Lower Freeport coal" (p. 14).

While the coal is many times absent and often represented by papery layers of bituminous matter, the underlying clay is much more persistent. It is generally present in thicknesses of 3 to 5 feet, and frequently is a clay of pale-bluish color and excellent appearance. In many places, however, it is pregnant with nodules of iron, which discolor it and render it of little value. The limestone is usually impure, being buff-colored and ferruginous, often brecciated, and generally nonfossiliferous. Occasionally, however, the bed occurs as a bluish rock of pure quality. Owing to its lenticular mode of occurrence, which is common with the limestones of this region, it may or may not be present at any one place. Wherever found, it averages 4 feet in thickness, with extremes of 6 to 7 feet observed on branches of Brush and Dry runs, and, though in places somewhat stratified and rarely nodular, it is practically everywhere a solid bed.

The stratigraphic succession about the Upper Freeport coal is in most places sufficient for its identification, but in portions of South Beaver and Ohio townships exposures are poor and associations are abnormal. In this region there are often two limestones, one above and one below a lenticular coal, which is probably the Upper Freeport. In addition, the Mahoning sandstone, which forms the basal member of the overlying formation, has a variable development. It is evident, then, that in a section where the Mahoning sandstone is shaly and the coal absent the presence of a

limestone does not render much aid in identifying the position of the Upper Freeport horizon. This is the case on portions of Brady Run in South Beaver Township and along the Lisbon road in Ohio Township, where a limestone a foot or more thick outcrops at several points. The horizon of the Upper Freeport coal is a short distance above or below this limestone, but the coal may be absent.

The Second Survey of Pennsylvania mapped the Upper Freeport coal on Island Run as crossing the Ohioville-Blackhawk road, whereas in reality it goes under Island Run some distance west of the road. It has also mapped this coal as outcropping on Bieler Run almost in the town of Blackhawk, but the outcrop actually lies about 1 mile west of Blackhawk.

CONEMAUGH FORMATION.

Introduction.—This formation was named by Rogers from Conemaugh River, along which it is exposed in typical form. Originally the coal-bearing rocks of Pennsylvania were subdivided with reference to the coal beds which they contained. Therefore, the rocks of this formation, lying between the Upper Freeport and Pittsburg coals and containing only a few small coals or other economic beds, were grouped together and variously named "Barren Measures," "Elk River series," etc. The distinction was based merely on noneconomic content, for between these rocks and the Allegheny formation below and Monongahela formation above there is no lithologic, fossil, or other stratigraphic break.

The base of the formation, which rests upon the Upper Freeport coal, follows the undulations of that bed, as described above. The river bluffs do not rise much above this line, and therefore catch only the lower portion of the Conemaugh formation, but, notwithstanding the fact that the rocks in general rise to the northwest, this formation forms all of the high country within this quadrangle, except the few isolated areas of Pittsburg coal in the southeast corner.

The formation varies somewhat in thickness, but its range is not great, and 520 feet may be regarded as the average. It is composed largely of shale, but carries two beds of sandstone—the Mahoning near the base and the Morgantown above the middle of the formation. These in places are massive and have had some influence in shaping the topography of the region. The shales are somewhat variegated, but the prevailing tint is green or gray. The formation has infrequent limestones, three insignificant beds being known in this territory. The most important of these is the greenish fossiliferous bed known as the Ames limestone, which usually occurs 30 or 40 feet below the Morgantown sandstone. Of coal there is here and there a small seam which attains workable proportions over very limited areas.

Owing to lack of good exposures, but few detailed measured sections of any length can be given in this report. However, a very careful compilation of short sections throughout this formation put together in their natural order, and the whole thickness of the formation checked by level, gives the following somewhat generalized section:

Generalized section of Conemaugh formation.

(Pittsburg coal).	Feet.	Average feet.
1. Shale	25	
2. Limestone	½–2	
3. Shale	15	
4. Limestone	0–2	
5. Shaly sandstone and shale	35	230
6. Red shales	40	
7. Morgantown sandstone	65	
8. Elk Lick coal	0–3	
9. Variegated shale	40	

	Feet.	Average feet.
10. Ames limestone, "Crinoidal,"	½– 6	
11. Coal (Platt?)	1	
12. Red shale	30	
13. Green shale	50	
14. Red shale	15	
15. Bakerstown coal (cannel)	0– 7	
16. Sandy shale and laminated sandstone	75	
17. Brush Creek limestone, dark	1	290
18. Dark shale	20	
19. Brush Creek coal	0– 1½	
20. Shale	35	
21. Yellow and red caky shale	20	
22. Sandy shale	10	
23. Mahoning sandstone (sometimes containing in upper part a local limestone 1 to 8 feet thick)	30–50	
(Upper Freeport coal.)		

This section is believed to show as nearly as practicable the interrelation and thickness of the most important members, which are described in detail below.

Mahoning sandstone.—This sandstone forms the basal member of the Conemaugh formation and overlies the Upper Freeport coal of the Allegheny measures. It is usually yellowish to brown in color and coarse grained. Conglomeratic phases are common and are generally marked by the presence of white quartz pebbles (sections 249, 251, 259, Pls. VI and VII). This character seems rather persistent on the north side of Ohio River, from Phillis Island westward, in the vicinity of Dam No. 6, and east and north of the town of Freedom (sections 223, 226, Pl. V). At Dam No. 6 and near Freedom the pebbly sandstone contains at its base rounded nodules of clay and papery bituminous fragments representing the Upper Freeport coal. It usually is in direct contact with the coal, but occasionally the coal and sandstone are separated by a few feet and rarely as much as 15 feet of shale. These general relations may be more specifically studied in Pls. IV to VII.

Where the Mahoning sandstone lies immediately over the Upper Freeport coal the contact, as noted above, is in many places very irregular and locally, as on Island Run, the sandstone and coal are interbedded. Very often, too, as shown in many of the sections, the Mahoning sandstone rests directly upon the clay beneath the Upper Freeport coal, which then is absent. In some such instances fragments of bituminous matter and pebbles of clay, as noted above, are mingled with the coarse sand at the base of the Mahoning. These irregularities at the base of the sandstone include cases where not only the coal, but the clay also is absent. Notable instances were observed on North Branch of Blockhouse Run, and perhaps on Raccoon Creek near Independence.

In general this sandstone caps the river bluffs and walls many of the lateral streams; thus it follows up the course of Raccoon Creek and disappears at Independence, and forming the bluffs of Mill Creek it underlies the village of Hookstown as a heavy sandstone. The sandstone is not, however, everywhere persistent, being frequently replaced wholly or in part by softer material (sections 213, 222, 247, 255, Pls. IV to VII). Near the State line, for example, it changes from a massive rock near Smiths Ferry (sections 260, 261, Pl. VII) to a shaly sandstone, becoming heavy toward the base, south of Ohioville; but it becomes thicker and more massive north of Ohioville, on Island (section 264, Pl. VII) and Bieler runs. A similar variation is exhibited on Brady Run, while on Blockhouse Run and the east bank of Beaver River, it is more constant as a thin but coarse, heavy bed. Not only the character, therefore, but the thickness also varies greatly, ranging from a knife-edge to 50 feet.

Within the Mahoning sandstone member, and about 30 feet above the Upper Freeport coal, not infrequently is found from 1 to 8 feet of limestone, as shown in

section 225, Pl. V. This limestone is extremely variable in occurrence, its habit being that of small lenses. It is locally developed east of Rochester, west of Monaca (section 210), perhaps on the Lisbon road 2 miles east of Blackhawk, and on the Smiths Ferry road just south of Ohioville. It has, indeed, been found, though somewhat thinner, on the north side of Brady Run, in South Beaver Township. The limestone at Monaca and along the Lisbon road is of light-blue color, but at Rochester it has buff, ferruginous phases and in most occurrences it seems to be more or less brecciated.

Brush Creek coal.—The Mahoning sandstone grades at the top into shales, which continue upward about 55 feet to the Brush Creek coal. This horizon varies in its distance above the Upper Freeport from 75 feet on Brady Run to 110 feet at Hookstown, averaging 95 feet (sections 244, 252, 268, Pls. VI and VII). The lower part of this interval, above the Mahoning sandstone, is composed of yellow and red cakey shale, which is a very marked stratigraphic key rock in this quadrangle, and seems to be almost everywhere present at 50 to 60 feet above the Upper Freeport coal. It may thicken and extend almost to the Brush Creek horizon or be replaced by shale. The Brush Creek coal, usually being observed merely as a small blossom, is of small importance (sections 250, 252, Pls. VI and VII). At only one place on Brady Run does it attain any considerable thickness. Here it reaches a maximum of 20 inches of coal, separated into two benches by a seam of slate. The horizon of the Brush Creek coal is better marked by 20 feet of dark shale, which is almost everywhere present and carries at the top very often the Brush Creek limestone, a black-blue fossiliferous rock about a foot thick. An interval, averaging 75 feet and containing sandy shales and laminated sandstones, separates the Brush Creek limestone from the Bakerstown coal.

Bakerstown coal.—The horizon of this coal is 190 to 200 feet above the Upper Freeport. The coal derives its name from Bakerstown, Allegheny County, where it has been extensively mined, but in the Beaver quadrangle it occurs very irregularly. It is best developed in a reported 2 to 7 foot bed of cannel and bituminous coal in the river bank southeast of Georgetown, where it was mined about 1875 on the property of Mr. Peters. Here "the upper half is an impure cannel, while the lower half approaches more nearly to semicannel."[a] It is reported that oil was made from this coal before the discovery of petroleum. When visited by the writer, the opening had caved in and no observations could be made. On the lower part of Little Service Run an old opening was observed on a coal about 60 feet below the Ames limestone, but no idea of its thickness could be obtained. Near the head of Frames Run a similar cannel-like coal, about 40 feet befow the Ames limestone horizon, has been opened. A ferruginous nonfossiliferous limestone occurs about 20 feet above it. It is very probable that neither of these coals is an occurrence of the Bakerstown coal, as they are not low enough in the series. Aside from these localities the writer does not know that any coal which might be mistaken for the Bakerstown seam has been opened in the Beaver quadrangle, and the only other evidences of its presence are infrequent coal blossoms at this horizon on the country roads. Along the Lisbon road, half a mile off the quadrangle, a slaty coal has been opened which measures 2 feet 6 inches. Its distance of about 150 feet above the Upper Freeport coal, however, gives it a position intermediate between the Brush Creek and the Bakerstown coal, and it is a question to which horizon it belongs. It probably does not belong to either, but represents one of the local coals common in the Conemaugh formation.

Variegated red and green shales of an argillaceous character, occasionally carrying iron nodules, extend for about 70 feet above the Bakerstown coal. The red band of the outcrop is a conspicuous feature on farms and along roads where it occurs,

[a] Second Geol. Survey Pennsylvania, Rept. K, p, 348.

and generally throughout the southern part of the quadrangle it may be seen just below the outcrop of the Ames limestone.

Platt (?) coal.—Above the shales and below the Ames limestone a thin coal bed is infrequently seen. It has been observed at only two or three places in the qnadrangle, being best exposed along the hill road a mile and a half north of Hookstown. It seems, when present, generally to be quite pure, but unfortunately has an unworkable thickness of about 1 foot. On the whole, it is of no importance. I. C. White has tentatively correlated this coal with the Platt coal of Somerset County, and has therefore provisionally called it by that name in Beaver County. The name was taken by the Second Survey from the Platt mine, near Berlin, Somerset County, where the bed was 7 feet thick and locally known as the "Platt vein."[a]

Ames limestone.—This limestone was named from Ames Township, Athens County, Ohio, by Andrews, who first described it at this locality in 1873.[b] In previous reports of Pennsylvania it has been called the Green Crinoidal or Berlin limestone. This stratum may be taken as the approximate middle of the Conemaugh formation, for in this district it averages 290 feet above the Upper Freeport coal and 230 feet below the Pittsburg seam. These intervals in reality vary from 20 to 25 feet in either direction. It is the most persistent member of the formation and is present not only throughout the southern half of the quadrangle, but in several counties in Pennsylvania and Ohio. It is also very constant in character and seems to retain its peculiar appearance wherever known. It has been described by Stevenson as a "dark, bluish or greenish-gray, tough" rock, breaking with a "granular surface, much resembling that of a coarse sandstone."[c] The weathered rock has a singularly rough aspect, due to small protuberances or crinoid stems, with which it is crowded, besides shells of brachiopods and gasteropods. The general effect, in fact, is far from the usual appearance of a limestone, and consequently it is a stratum which is easily recognized and therefore valuable as a key rock in determining the geologic structure.

North of Ohio River in this quadrangle the Ames limestone is rare and occurrences are limited chiefly to the river hills west of Industry, but it also forms the cap of a small knob along the Lisbon road in Brighton Township. South of the Ohio such isolated areas become larger and more numerous toward Service Creek, as at McCleary, Green Garden, and Bunker Hill, until finally, as it dips lower, it forms one continuous though irregular blanket over the southern third of the quadrangle. Its ordinary occurrence is that of a single bed, but in a few instances there seem to be two separate beds. This is notably so on the western edge of the quadrangle, opposite Hookstown, where the interval between the two beds is 31 to 35 feet. The persistent bed has a thickness varying from 1½ to 6 feet, but averaging about 3 feet. Typical exposures may be seen at Harshaville, south of Green Garden, Bunker Hill, and north of Hookstown.

Elk Lick coal—The Ames limestone is overlain by variegated shale and shaly sandstone extending upward about 40 feet to a thin coal seam which lies near the base of the Morgantown sandstone. This is probably the Elk Lick coal, definitely located by Franklin Platt, at 30 or 40 feet above the Ames limestone.[d] The name Elk Lick was first used, by Lesley in 1840 for a coal in this stratigraphic position which was then opened on Elk Lick Creek, Somerset County, Pa.[e] This coal, like others of the Conemaugh formation is not persistent and generally is of no importance. It is reported, however, to have been mined years ago at two localities in the Beaver quadrangle, namely, in the northwestern part of Independence Township, about half a mile south of Service Creek, and on the Georgetown-Shippingport road in Greene Township. At the former place it is said to have been 1 to 3 feet thick, and

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[a] Second Geol. Survey Pennsylvania, Rept. H3, p. 29.
[b] Ohio Geol. Survey, vol. 1, pt. 1, p. 235.
[c] Second Geol. Survey Pennsylvania, Rept. K, p. 80.
[d] Second Geol. Survey Pennsylvania, Rept. H3, pp. xxxiii, 60.
[e] Idem, p. 60.

of excellent quality for blacksmith's use, but unprofitable to mine on account of the variability in thickness.[a] At the latter locality, the coal being only 2 feet thick, its exploitation was abandoned.[b] Along this same road, due north of Hookstown, it may still be seen as a 1-foot coal 20 feet above the Ames limestone. This interval expands to 32 feet on Tramp Mill Run, where the seam is a cannel 1 foot or more thick. Elsewhere in the quadrangle it infrequently shows as a mere blossom under the Morgantown sandstone. In some instances the Morgantown sandstone seems to lie very close to the Ames limestone, if not in direct contact with it. In that case the coal and shale just described are absent, but in the far southern part of the quadrangle sandstone débris conceals the exact manner of such occurrences.

Morgantown sandstone.—This sandstone was named by Stevenson, in early reports, from Morgantown, W. Va., where it has a marked development and is extensively exploited for building purposes. It is generally found present in the southwestern part of Pennsylvania wherever its horizon is exposed and is probably the most persistent sandstone in the region. It has an average thickness of 65 feet within the quadrangle and its top is about 125 feet below the Pittsburg coal. It varies in character from a coarse massive sandstone, which is, however, rather soft, to a thin-bedded rock, and sometimes appears to be replaced by sandy shale; but it is massive over large areas and often has a decided effect on the topography of the region. The bed is perhaps of sufficient importance here to deserve mapping, but because of its proximity to the outcrop of the Ames limestone, it has not been represented on the geologic map. In the vicinity of Harshaville and toward the western edge of the quadrangle it often attains a thickness of 100 feet. Though to the northwest it thins to 65 feet or less, it maintains a thickness of about 80 feet on the east side of Raccoon Creek, but farther south, in Allegheny County, it becomes a very thin-bedded or shaly sandstone.

For 90 feet above the Morgantown sandstone the rocks are poorly exposed and of great variability. In general, however, red shales grading upward into shaly sandstone and shales overlie the sandstone, but it was impossible to fill out the interval with quite so much definiteness as either White or Stevenson has done from a much larger territory.

Pittsburg limestones.—Above the interval just mentioned lie the highest limestones of the Conemaugh formation, called the Pittsburg limestones by I. C. White. The first limestone, in ascending order, occurs about 40 feet below the Pittsburg coal. It is best exposed on the highways in the southeast corner of the quadrangle, but it is of little importance, not being observed more than 2 feet thick. Separated from the horizon of this bed by an interval of about 15 feet of shale occurs a more persistent bed, 25 feet below the Pittsburg coal. This limestone was observed wherever the Pittsburg coal occurs in the southeastern part of the quadrangle, but is even thinner than the last and of no importance. Above it 25 feet of shale lie at the top of the Conemaugh formation.

MONONGAHELA FORMATION.

Introduction.—The Monongahela formation overlies the Conemaugh conformably. It derives its name from Monongahela River, where it is well exposed and contains most of the coal beds of the upper part of the series, including the Waynesburg coal at its top and the valuable and well-known Pittsburg seam at its base. Because of these and its other economic beds this formation was early thought of as the counterpart of the "Lower Productive Measures" and therefore was called the "Upper Productive Measures." For this reason only has it been retained as a separate formation.

Pittsburg coal.—Unfortunately only a few hilltops in the southeast corner of the quadrangle are high enough to include the Pittsburg coal and some of the overlying sediments at the base of this formation. The coal is 5 to 6 feet thick and the over-

[a] Second Geol. Survey Pennsylvania, Rept. K, p. 338, [b] Idem, p. 346.

lying rocks little over 50 feet. The croppings of the latter disclose merely remnants of the Pittsburg sandstone, which is a yellowish-brown heavy or thin-bedded sandstone, grading downward perhaps into a shaly base.

Quaternary System.

The unconsolidated gravels of this region were largely deposited by streams during the Glacial epoch, when a huge ice sheet covered the northern part of North America and extended nearly to the Beaver quadrangle. Since that time no deposition but that of the present flood plains has taken place. The deposits of the Glacial epoch belong to the Pleistocene series and those since that time to the Recent series.

PLEISTOCENE SERIES.

The Pleistocene gravels occupy the high and low terraces of this region, which represent parts of old valley floors. These gravels are divided, according to age, into two classes—(1) Kansan (?) deposits, occurring on the higher or Kansan terraces and (2) Wisconsin deposits, occurring on the lower or Wisconsin terraces.

KANSAN (?) DEPOSITS.

The deposits of Kansan age include the Carmichaels formation described in other geologic literature on western Pennsylvania. They are differentiated from other deposits both in mode of occurrence and character. In this area such deposits occur on rock shelves bordering the larger streams and ranging in elevation from 920 to nearly 1,000 feet. The material varies in character according to its origin.

The deposits along the rivers were outwash from the ice sheet and consequently are characterized by pebbles of foreign origin, such as granite, gneiss, etc. They are distinguished from pebbles of the Wisconsin deposits by being deeply weathered and decomposed. They are poorly assorted, ranging to nearly a foot in diameter, and occur in a sandy or clayey matrix. In some places, as at Rochester, Beaver, etc., the gravel is covered by 8 or 10 feet of red sandy clay. The whole may be capped by a pale-colored silt sprinkled with very small fragments of quartz and flinty materials. The best exposures at present are seen east of New Brighton, where the clay has been utilized in the manufacture of brick and plant pots. On the other terraces the filling appears to be of much the same character at the surface, but it is generally so soft that exposed sections are difficult to find.

The deposits at this elevation along the lateral streams are largely if not entirely of location derivation and lie on rock shelves corresponding to those on the rivers carrying the material described in the preceding paragraph. No vertical section of these beds was open for study, and the following description is gathered mostly from surface appearances. The deposits are composed at the top chiefly of sand, in which are distributed waterworn pebbles of local rocks, generally sandstones. On some of the shelves a light-yellowish silt replaces part of the sand. On the New Sheffield plain sand is particularly abundant and apparently deep, and here were observed the largest native pebbles, a few inches in diameter. It is reported that clay underlies the sand in this locality and it would, therefore, seem that the deposit is stratified, as it should naturally be. The thickness of the material at this point is estimated to average 20 or 30 feet, and probably the same depth covers another spur 2 miles south of Bocktown. Elsewhere no good exposures showing the depth of the filling were seen. Of lateral streams showing such gravel terraces, Raccoon Creek and perhaps Brady Run are the most prominent examples, the former having the best marked terraces. Possibly the under portion of the gravel filling in small streams such as Mill Creek, Logtown Run, etc., may represent similar deposits which have not yet been terraced by the streams.

WISCONSIN DEPOSITS.

Deposits presumably of Wisconsin age cover the northern portion of Beaver County, valleys and uplands alike. The southern border of the upland deposits extends southwestward across the county, crossing Beaver River 10 miles above its mouth and leaving the State just beyond the northwest corner of the Beaver quadrangle. South of this line other material of Wisconsin age within the county is practically limited to the valleys of Beaver and Ohio rivers and some of the lateral streams. The best examples are the broad, flat terraces along the rivers, such as those occupied by the towns of Beaver, Monaca, and New Brighton.

The mode of occurrence and character distinguish these deposits from those of Kansan age. Wells sunk through these terraces at Beaver, Shippingport, and Georgetown show that the rock bottom approaches water level toward the river front. They do not, therefore, occupy rock shelves like the Kansan gravels, but are built on the present rock floor of the valleys. Along the rivers they reach a thickness of 70 to 150 feet (Pl. III, *B*), but probably grow thinner back from the river as the rock floor rises. On lateral streams they approach water level toward the head, but wherever found are not above 800 feet in elevation.

In character they differ, like the Kansan gravels, according to their origin. The deposits along the rivers are glacial outwash and consequently contain much foreign material. The pebbles and bowlders are well rounded, consist of granite, gneiss, diabase, quartzite, etc., varying in size up to 10 inches in diameter, and may be distinguished from the Kansan gravels by their fresh, undecomposed appearance. The material, according to reports from well diggings, is composed at the bottom of a very coarse mixture of sand and large bowlders, becoming finer and more sandy upward. On the Beaver terrace the sandy deposit is very even and thick and has been considerably used for building sand. At other localities the terraces appear to be of much the same character, but in general coarse material seems to grow more prominent to the east and north.

The deposits of this age along some of the smaller streams, most notably Raccoon Creek, are of local derivation and may not be clearly distinct in character from the local Kansan deposits. But the difference in mode of occurrence and elevation is often sufficient to distinguish them.

These broad, flat terraces, affording a level but easily excavated surface with plenty of sand and bowlders for building purposes, form admirable sites for towns and large plants. The porous character of the terrace material insures good drainage, but lessens its value for agricultural purposes.

ALLUVIAL DEPOSITS.

The large streams of this region are bordered in many places by narrow flood plains which are the work of the present streams. Some of the flood plains are above high-water level and represent the condition of the streams at a slightly earlier period of their history, but most of such material is reworked at every flood stage of the river and the plains are consequently in process of construction to-day. Along the rivers flood plains are not conspicuous except near Montgomery Island, at Bridgewater, and at the mouths of Blockhouse and Crow runs, but some of the smaller streams, notably Raccoon Creek, have developed plains larger in proportion to their size than the river. These alluvial deposits may contain material of both glacial and local origin, but much of it, especially near the top, is a mixture of fine sand and silt. In some places pockets of red brick clay have been discovered and utilized to good advantage. Being frequently inundated, these plains furnish very productive farming land which is able to weather severe droughts.

STRUCTURE.

INTRODUCTION.

The structure or lay of the beds of this quadrangle is very simple, consisting of many low folds. In describing these folds the upward-bending arch is called an anticline and the downward-bending trough a syncline. The axis of a fold is that line which at every point occupies the highest part of the anticline or the lowest part of the syncline, and from which the strata dip in an anticline and to which they dip in a syncline.

METHOD OF REPRESENTING STRUCTURE.

The method of representing the basins and arches employed on the accompanying map (Pl. VIII) is as follows: The upper or lower surface of a particular stratum of rock is selected as a reference surface. The form of the reference surface is ascertained, first, from the outcrop of the chosen stratum; second, from the depth of that stratum beneath beds above it; and third, from the height of that stratum above beds beneath it. In the first case the stratum outcrops and is observed. In the second case it is underground and the outcrop of some higher bed is observed. The thickness of rocks between the two being known, the depth of the reference surface can be estimated. In many instances the depth is measured directly in a deep-well boring. In the third case the reference surface is in the air—that is, the chosen stratum has been eroded—and the outcrop of an underlying bed is observed. The thickness of the intervening rocks being known, the height of the reference surface can be determined.

By reference to the topographic map the altitude of any outcrop can be ascertained and thus the height above sea for a corresponding point of the reference surface can be determined. This is done for hundreds of points along a very large number of sections taken in various directions. Points which have the same altitude are then connected by a line, which gives the horizontal form of the reference surface at that elevation. Many such lines are drawn at regular vertical intervals. They are contour lines and as printed on the geologic map (Pl. VIII) they show, first, the horizontal contour of the troughs and arches; second, the relative and also the actual dip of the beds; and third, the height of the reference surface above the sea at any point. The depth of the reference horizon may be determined by subtracting the elevation of the reference horizon from that of the surface of the ground.

As a rule, these structure contours are generalized and only approximately correct. Where mines have been opened on the chosen stratum, as on the Upper Freeport coal—which, however, in the Beaver quadrangle unfortunately has no large mines—the contours may be drawn precisely and in detail, but in other cases they are liable to error from several conditions. Being estimated on the assumption that over small areas the rocks maintain a uniform thickness, the position of a contour will be out by the amount by which the actual thickness varies from the calculated thickness. Being measured from the altitude of observed outcrops, the position of the contour is uncertain to the degree that that altitude is approximate. While in many instances topographic altitudes are determined by spirit level, geologic observations are located by hand level or aneroid barometers. The aneroids are constantly checked against precise bench marks and the instrumental error is probably slight, but it may be appreciable. Most observations on coal beds in the Beaver quadrangle were located by hand leveling to precise or temporary bench marks; but in the Ames limestone area, where bench marks are less numerous, leveling was in many cases confined to road intersections. Finally, the observations of structure at the surface can be extended to buried or eroded strata only in a general way. The details probably escape determination. These sources of error may combine or may compensate one another, but in any case it is believed that their sum is probably less than one contour interval; that is to say, the absolute altitude of the reference sur-

face will not vary from the estimated altitude more than 20 feet anywhere in the quadrangle; and the relative altitudes for successive contours may be taken as very closely approximating the facts. That a stratum many hundred feet below the reference surface, as an oil or gas bearing sandstone, has exactly the same structure as the reference surface is doubtful. Stratigraphic irregularities, as already pointed out, may conspire to produce nonconformity between the structures of the two beds. A syncline or an anticline, in either the Upper Freeport coal or Ames limestone, may not exactly overlie similar folds in the Berea grit. It is believed, however, that such discrepancies are not great, and that the axes of corresponding folds are in general not far removed from coincidence. Nevertheless, wherever the structure of a certain bed is desired, as in oil or gas regions, the better method is to contour that bed from accurate well logs; but where deep wells are inadequately distributed over an area, as in this quadrangle, it is inadvisable if not impossible to do so.

DETAILED GEOLOGIC STRUCTURE.

In the Beaver quadrangle the reference stratum in the northern half is the Upper Freeport coal and in the southern half the Ames limestone. The purpose of using two reference strata in different parts of the quadrangle is to prevent the possible error referred to above, due to nonuniformity of thickness between two such strata. That is to say, the contours thus drawn on the Ames limestone probably give a more accurate representation of the structure than if these contours were made to represent the roof of the Upper Freeport coal by subtracting from each elevation on the limestone an arbitrary and, through nonuniformity, perhaps inaccurate interval. Where these two strata overlap near the middle of the quadrangle, parts of some of the contours south of the overlap have, however, been calculated on the assumption that the interval between the two beds is uniformly 290 feet. It is believed, nevertheless, that the error introduced is small, for the reason that 290 feet is the average of five or six leveled measurements of the interval which were made along the overlap and which were used in the calculation of the contours in the central part of the quadrangle.

The contours most likely to be in error lie in regions such as parts of Ohio, Brighton, and Moon townships, where exposures of the reference strata are scanty. In the first two, recourse for structural indications was limited to blossoms of the variable Brush Creek coal, changeable sandstone beds, and a few deep wells. The evidence was thus meager and the contouring necessarily generalized. Moon Township, though containing more reliable upper coals, was deficient in sandstones and deep wells.

The geologic map (Pl. VIII) shows that there are no definitely marked anticlines or synclines of great extent in this quadrangle, but that the reference surfaces show rather smooth, fluted slopes breaking into small domes and basins. Perhaps these have favored the accumulation of oil and gas in certain parts of the quadrangle, such as the Shannopin, Hookstown, and Smiths Ferry oil fields and the New Sheffield gas pool.

The domes and basins are most numerous near a line drawn from the northeast corner of the quadrangle southwestward near Ohio River to the vicinity of Hookstown. In this district the extreme relief from the pits of the basins to the peaks of the domes is rarely more than 60 feet, and generally much less. Their interrelation is so irregular as to defy intelligible description without the aid of the geologic map (Pl. VIII). Reference to this map shows a small ellipsoidal basin east of New Brighton, having a northeasterly trend. To the southeast of it, at the edge of the map, are shown traces of a dome which is not complete within the boundaries of the quadrangle. Southwestward from these there is a gentle dip to McDonaldtown, where a small dome (too small to be represented on the map) rises at Dam No. 5, in sympathy with a more extended arch which crosses Moon and Poorhouse runs and

has a basin on the north in the vicinity of Beaver. Near the mouth of Raccoon Creek this anticline splits into two small domes, one on either side of the river. The one on the north side rises northward in a gentle slope, while the one on the south heads a series of three small domes extending in a line toward Hookstown. The last of this series breaks off into a side dome near McCleary, but the strength of the southwest axis is maintained in a small hook on the 920-foot contour. At Industry begins another basin, which, after following the flow of the river a short distance, splits, one fork extending toward Georgetown, the other toward Hookstown, and both inclosing a final dome on Mill Creek. This arch has a slight northwest-southeast trend parallel with Mill Creek.

From this diagonal area of mingled domes and basins the strata, corrugated with small anticlines and synclines having a general northwest-southeast trend, dip away to the south in gentle slopes. The anticlines are usually spurs shot off from the domes, while the synclines lie between these spurs and sometimes coincide with the depressions between the domes. One of these spurs brings up the Upper Freeport coal on Service Creek. A marked syncline of the latter type develops near Gringo and extends to Raccoon Creek, where it forks; one branch extending westward south of Green Garden fades into the McCleary dome, while the other branch, extending northwestward to Gums Run, again splits. One trough extends through Holt and crosses the domal ridge into the Industry Basin, while the other follows Raccoon Creek, turns the west flank of the Moon-Poorhouse anticline, and ends in the Beaver basin. In the extreme southeast corner of the quadrangle the general southeastward dip gives way to another dome lying in Allegheny County. This dome, so far as can be made out on this map, has an east-west trend, while the syncline inclosing it is semicircular.

North of the domal region along Ohio River the rocks rise in fluted slopes northwestward to a rather well-marked anticline in the northwest corner of the quadrangle. This anticline, which has a northeast-southwest trend, seems to be the extension of the Fredericktown arch recognized by I. C. White. The arch sends out a spur southward, which culminates in a small dome near Fairview, and one northward along Brush Run.

USE OF STRUCTURE CONTOURS.

Structure contours are of value in determining, at any point, the depth to the key rock or other stratum whose distance below the surface has been accurately measured. Thus the distance a well must be driven to strike the well-known oil or gas sands may be determined. For instance, the collar of the J. H. and M. J. Brown well No. 1, half a mile northwest of Hookstown, has, according to the map, an elevation of 1,015 feet above sea level. The Berea grit was reported found in this well at 967 feet. Subtracting this from the elevation of the well head gives 48 feet as the elevation above sea level for the Berea grit at this point. The structure contours on the Upper Freeport coal show that this coal is about 950 feet above sea level at the well. Subtracting the elevation of the Berea grit just determined from the elevation of the Upper Freeport coal gives the interval between the two as about 900 feet. Now, with this fact determined, suppose that a well is to be driven to the Berea grit at the crossroads in Fairview, at what depth will the Berea be struck? As shown on the topographic map, the elevation of the crossroads is about 1,270 feet. The structure contours on the Upper Freeport coal show that its elevation immediately under the crossroads is about 1,080 feet, or 190 feet beneath the surface at this point. Adding to 190 feet the 900 feet previously found to be the interval between the Upper Freeport coal and the Berea grit gives 1,090 feet as the probable depth at which the Berea grit will be struck in the proposed well. This calculation is, of course, subject to the errors mentioned above, but it is believed to be accurate within about 20 feet. A similar calculation may be made for any other stratum beneath the reference surface, after

its distance above or below either reference stratum has once been determined. Structure contours are also convenient in operating mines.

Economic mining must always consider drainage and underground haulage. In disposing of these matters the principle of gravity should be employed wherever possible. Contours are eminently valuable in determining that location of a mine which will allow the greatest use of this principle, for they show the lay of the beds which coal or clay mines must follow. For example, suppose a mine on the Lower Kittanning clay is to be opened on Brady Run, 2½ miles above its mouth. From the structural map it is seen that the 1,100-foot contour on the Upper Freeport coal swings in toward the run near this point, and that to the north are the 1,120, 1,140, and 1,160 contours and to the south the 1,080, 1,060, 1,040, etc. This shows, therefore, that at this point the strata rise to the northwest and dip to the southeast. If, then, a mine is opened on the south side of Brady Run, a tunnel driven southeastward on the clay bed will accumulate water, necessitating a pumping plant or siphon to keep the mine dry. In addition the grade of the tunnel will require haulage of outgoing loaded cars. On the other hand, if the mine is opened on the north side of the run, a tunnel driven to the north or northwest on the clay bed will rise inward and consequently not only drain out the water, but offer a down grade for loaded cars.

The use of structure contours as further aids in the development of oil and gas territory is discussed under "Petroleum and natural gas" (p. 76).

MINERAL RESOURCES.

COAL.

INTRODUCTION.

In undertaking the present geologic survey of a region so well known as western Pennsylvania, it was considered unnecessary to duplicate the work of former surveys except so far as to test, by modern methods, the results previously obtained. The aim, therefore, of the present survey was to devote more time to features which received least attention in previous reports. Under this general plan the geologic structure, or lay of the beds, and the detailed distribution of various kinds of rocks, including coal and clay, have been carefully studied in the field and, so far as practicable, recorded on maps. In a full discussion of the geology some detailed sections of coal beds and some other facts, which abound in former reports, have been incorporated in this bulletin. For this information special acknowledgment is due I. C. White and J. J. Stevenson.

Bituminous coal, next to clay and oil, is the most important mineral resource of the Beaver quadrangle. All the rocks occurring above the base of the Pottsville are coal-bearing, but the beds are much thicker and more abundant in certain parts of the series than in others, and in this region the Allegheny formation is in this respect the most important group of rocks. By analogy to areas where the Allegheny coals are well developed, the coals of the Beaver region might be supposed to equal those of such areas in value. That this is not the rule is shown by the detailed description below.

The most important coals of the Allegheny formation are the Lower Kittanning and Upper Freeport, separated, as we have seen, by an interval averaging 177 feet. The area of these coals within the quadrangle is shown on the geologic map (Pl. VIII). No other coal beds are mined at present on a large scale, but there are a few which have some prospective value. These are the Brookville, Darlington, and Lower Freeport coals. The coals of the Conemaugh formation, such as the Brush Creek, Bakerstown, Platt, and Elk Lick beds, are at present of little value. The Pittsburg seam of the Monongahela formation has such a small area within the quadrangle and is so deeply weathered that it is not so valuable as farther south. Its extent within this quadrangle is indicated on the geologic map.

The coals in this region, except the Pittsburg and possibly the Lower Kittanning seams, occur in irregular lenses. The lenses vary greatly in size for the different beds, but they are generally the same in character. They are described in detail below for the various coals of the Allegheny, Conemaugh, and Monongahela formations. For convenience in describing coal outcrops, the quadrangle is treated in four divisions, based largely on surface features, as follows: (1) The region north of Ohio River and east of Beaver River; (2) the region north of Ohio River and west of Beaver River; (3) the region south of Ohio River between Raccoon Creek and the eastern edge of the quadrangle, and (4) the region south of Ohio River and west of Raccoon Creek. These four divisions will be called the northeast, northwest, southeast, and southwest regions, respectively, and this order will be followed in treating the areal distribution of each coal bed. In this description, as in that of the geologic formations, the oldest and lowest beds will be described first and the others taken up in sequence until all the coals of the quadrangle have been described. The section numbers refer to the accompanying text figures and also to the map (Pl. VIII), on which they indicate the points where the sections were taken.

COALS OF ALLEGHENY FORMATION.

BROOKVILLE COAL.

The Brookville coal bed is of little importance in the Beaver quadrangle. Generally its horizon is below water level, but in conformity with the northward rise of the strata it appears slightly above water level in Beaver River north of Bolesville. From this place to the edge of the quadrangle, however, it is frequently covered by terrace deposits and for this reason does not outcrop on the east bank of the river, though its horizon in the vicinity of New Brighton is slightly above the level of Beaver River for at least a mile. It does not, therefore, rise above the Pittsburg, Fort Wayne and Chicago Railroad, but may be found by shafting to river level.

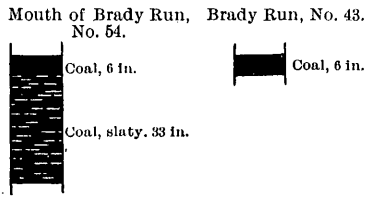

FIG. 2.—Brookville (54) and Clarion (43) coal sections.

On the west side of the river, however, the Brookville coal is exposed near the mouth of Brady Run, where it measures 39 inches (section 54, fig. 2). The coal is very slaty and of little value, but it has been mined to some extent. It was once opened also below the Pittsburg and Lake Erie Railroad track just south of the mouth of the run, but at the time of visit it was not open to measurement. From this elevation it rises to the north, but is hidden opposite Fallston by terrace deposits. It is exposed, however, at railroad level 1 mile above Fallston (section 236, Pl. V). At this point it is 6 inches thick and separated from the top of the Pottsville by 10 feet of chiefly gray shales. Thence northward, though buried below the Beaver Falls terrace, the coal may be reached by shafting 20 to 50 feet through loose gravels. On Brady Run its only occurrence is that already noted at its mouth, and thence its horizon soon passes beneath the run not to appear again. No other occurrence of the Brookville coal in the northwest region is exposed, to the knowledge of the writer. West of Ohioville, however, a few hundred feet above the mouth of Island Run, and at the proper distance below the Upper Freeport coal for the Brookville horizon, occurs a 6-inch coal in the bed of the stream. In the southeast and southwest regions this horizon is not exposed at any locality and along the river west of Monaca is probably 90 to 100 feet below water level, growing deeper south of Monaca with the dip of the rocks. The bed may, however, if necessary, be exploited by shaft, but this method would probably necessitate some means of pumping to keep the mine dry.

CLARION COAL.

This seam is of no commercial importance within the quadrangle, being very thin and in places shaly. Its position averages about 60 feet above the Brookville coal and its extent is somewhat greater than that of the latter. Still its exposures are limited to Beaver River above Rochester and to Brady Run below the forks.

In the northeast region it outcrops in two or three places on the east side of Beaver River, all of which are above the railroad track. On Blockhouse Run, just above Sherwood's pottery, it is a shaly coal but 6 inches thick; thence northward it is hidden 20 feet beneath the rear edge of the New Brighton terrace as far as the New Brighton and Beaver Falls wagon bridge. Here it emerges 1 foot thick and lies about 35 feet above the railroad. With a few minor rolls and a constant thickness it passes out of the quadrangle about 30 feet above the track. Though present on the west side of Beaver River, its horizon was uncovered at only one place, a few hundred feet below the railroad bridge at Beaver Falls, but the coal was absent. On Brady Run the clay underlying this coal was once opened back of the porcelain works, but here, too, the coal is reported to have been absent. Farther up Brady Run, however, a coal, probably the Clarion, is exposed on the western bank in two places, one a mile and the other a mile and a half above its mouth. Both localities show a thickness of 6 inches (section 43, fig. 2). The Clarion horizon disappears beneath Brady Run near the forks, and though its position must be but a few feet below the bed of the north fork for a mile and a half above its mouth, it does not appear again on either fork.

In the southeast and southwest regions this coal is not above water level at any point. At Monaca and westward along the Ohio it is probably present 25 to 40 feet below river level.

LOWER KITTANNING COAL.

The Lower Kittanning is the most important horizon in this region, not so much because of the coal as of the excellent clay bed accompanying it; for this reason it is

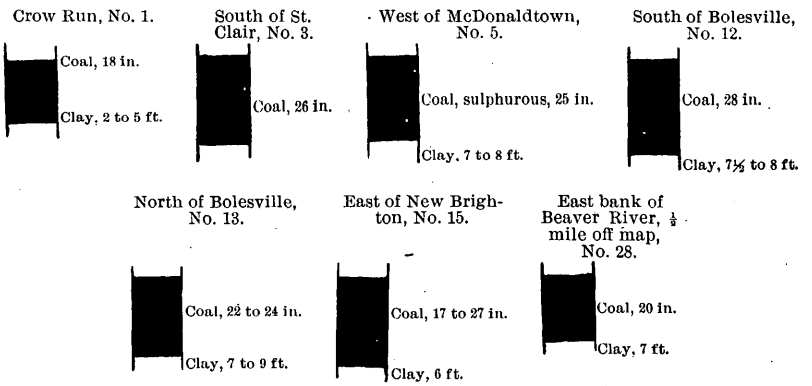

FIG. 3.—Lower Kittanning coal sections, northeast region.

outlined on the geologic map (Pl. VIII). Where the outcrop is hidden by terraces, as at Monaca, Beaver, and elsewhere along the rivers, it may be found by shafting through loose gravels to a depth of 30 to 60 feet along the rear edge of the deposits. At present the coal is rarely worth removing by itself except for limited local use, but it may be profitably taken out in conjunction with the underlying clay. Its value as a fuel depends, however, on its quality and thickness, which vary considerably.

Detailed description.—In the northeast region the coal is fairly uniform in thickness. On Crow Run it is of excellent quality, and, though thin, is removed in conjunction

with the clay and used for steam purposes. It measured 8 inches thick at the Pennsylvania Clay Company's mine, where it is 37 feet beneath the surface and has been opened by a shaft. In the switch yard above Freedom it comes to the surface, above the railroad at this point, and at railroad level shows a thickness of 26 inches (section 3, fig. 3). Near the mouth of the run, which enters the river at Freedom, it is reported to be 1½ feet thick. In the vicinity of the Miller brick works, just below Dam No. 5, it thickens to 25 inches (section 5, fig. 3), but is very sulphurous and unfit for use in the brick works.

Above Rochester, on Beaver River, the coal is of good quality and is used in S. Barnes & Co.'s brick works. Here it shows 28 inches thick (section 12). Half a mile beyond, at the old Ingram fire-brick works, the coal preserves its good quality and exhibits a thickness of 22 to 24 inches (section 13, fig. 3). East of New Brighton, near Sherwood's pottery, it has a greater range—17 to 27 inches (section 15, fig. 3)—but at this locality it is unfit for use. Near the American porcelain works also it shows the latter thickness, but on the road to the New Brighton Kansan terrace it outcrops merely as a small blossom near the top of the hill. It has, therefore, risen in elevation from railroad level at the switch yard to 50 feet above at Paved Run and thence abruptly to 140 feet. Farther north, while undulating slightly, it is hidden by the New Brighton Kansan terrace until it passes out of the quadrangle at about the same elevation above the track. Beyond the boundary, at McDonald's clay mine, it has a thickness of 20 inches (section 28, fig. 3).

East of New Brighton, on Blockhouse Run, the Lower Kittanning coal is mined in conjunction with clay at the mines of the Smith Brick Company and the Brighton Fire Brick Company. It is of good quality and the thickness varies but slightly—20 to 22 inches (section 19, fig. 4). It dips under Blockhouse Run near the American Sewer Pipe Works, but a few hundred feet above the works this company reaches the horizon by a 40-foot shaft and removes the coal and clay together. The coal is rather sulphurous and of only fair quality, but still it is used. It is 18 inches thick (section 22, fig. 4).

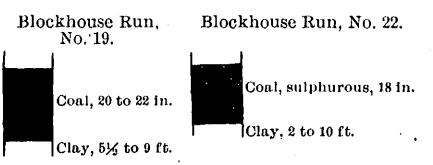

FIG. 4.—Lower Kittanning coal sections, northeast region.

In the northwest region this seam is well exposed in a ravine just below the Pittsburg, Fort Wayne and Chicago Railroad station at Beaver Falls, where it measures 24 inches (section 30, fig. 5). The quality of the coal is excellent and it has been mined here on the Jones and Paris properties. In a ravine half a mile below it has also been mined by Mr. Watson and is 22 inches thick (section 44, fig. 5). The coal dips southward from 135 feet above the Fort Wayne tracks at Beaver Falls to 55 feet above the Pittsburg and Lake Erie tracks near Bridgewater, where it has been extensively mined on the Wolf property and is reported to be 24 to 36 inches thick.

On Brady Run and its forks the Lower Kittanning horizon lies above water for several miles and has been drifted on in many places. Very few of these country pits are now in operation, but the coal is generally of a very fine quality and was at one time very much sought for by smiths. Thus it received the name of "blacksmith's vein." Ascending the run the first opportunity for measurement is at the clay mine of the Fallston Fire Clay Company, where it is 18 inches thick (section 51, fig. 5). On the opposite side of the run it is opened by the Standard Fire Brick Company and is 26 inches thick (section 47, fig. 5). A few miles beyond the coal is mined for home use along the highway and is reported to be 36 inches thick. A mile above this, however, it shows only 14 inches in thickness (section 39, fig. 5). Within half a mile the horizon disappears beneath the South Branch of Brady Run and is reported to have been at one time stripped from the bed of the stream. On

North Branch the Lower Kittanning coal is uncovered for about 3 miles. About half a mile above the mouth of this fork the coal is mined by Mr. Watson and hoisted by steam about 100 feet to the Patterson Heights road. It has at this point a thickness of 30 inches (section 32, fig. 5), and half a mile farther north, on the east branch of the fork, it is reported to maintain the same thickness, including a 6-inch parting. On the West Branch, however, it shows a thickness of 18 inches (section 34, fig. 6), which is maintained half a mile beyond on the south side of the stream, but on the north

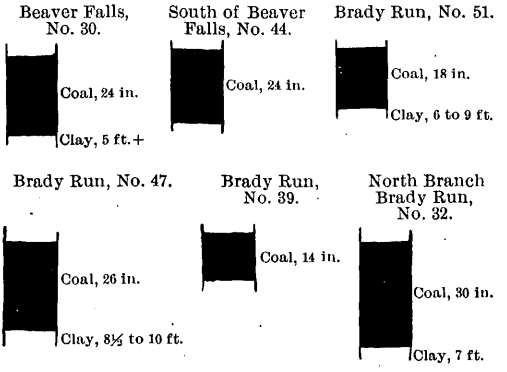

FIG. 5.—Lower Kittanning coal sections, northwest region.

side it is reduced to 12 inches on the Moore farm. The horizon probably continues above stream level to the edge of the quadrangle.

At Beaver the Lower Kittanning horizon is buried, at some points 50 feet, but generally not more than 25 feet, by terrace gravels. The coal and clay beneath may therefore be easily reached by a short shaft or incline. The horizon emerges from the terrace covering at Vanport, where it is reported 18 inches in thickness on the Latcham property (section 62, fig. 6). Half a mile down the river it is well

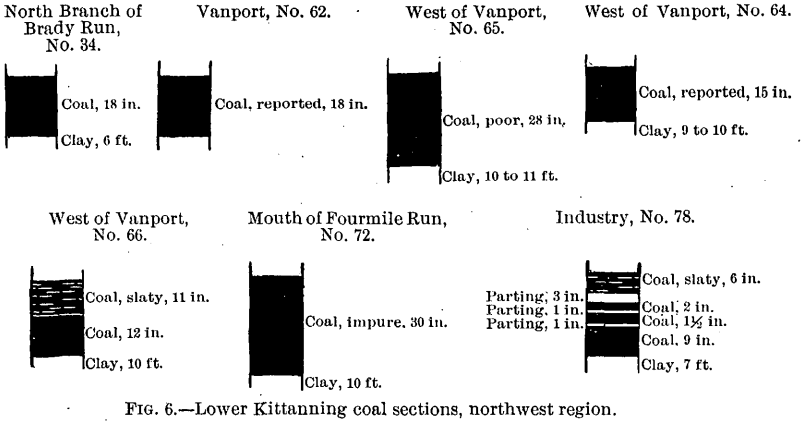

FIG. 6.—Lower Kittanning coal sections, northwest region.

exposed in clay mines and a near-by ravine. In the Vanport Brick Company's mine it measures 15 inches (section 64, fig. 6), but thickens in the Miller-Hummel Clay Company's mine to 28 inches (section 65, fig. 6), while the adjoining ravine exposes 23 inches of coal (section 66, fig. 6). At both mines the coal is very sulphurous and unfit for use and at the latter is said to be somewhat irregular, in places becoming as thin as 4 inches. At the Gloninger mine it is reported 20 inches thick, and at the mouth of Fourmile Run, in Dando & McLain's mine, it measured 30 inches (section 72, fig. 6). Here the coal, though not very good, is used for steam

purposes in conjunction with imported fuel. A few hundred feet up Fourmile Run this coal thins to 12 inches and because of an unusually steep dip in this vicinity is 64 feet higher than at the Dando mine.

For a mile west of Fourmile Run the Lower Kittanning coal horizon lies about 50 feet above the Cleveland and Pittsburg Railroad and then is thinly covered by 10 to 20 feet of terrace gravel to Sixmile Run. The horizon lies above Sixmile Run for perhaps half or three-fourths of a mile, but has been opened only at the highway bridge over the run, where it is reported 36 to 44 inches thick. It has also been opened below the forks of Wolf Run, but at the time of visit no pit was open for measurement and it was said that the lower half is usually cannel. In the first ravine below the town of Industry, 27 feet above the railroad, a detailed measurement (section 78, fig. 6) shows the coal interbedded with thin partings and aggregating 24 inches in thickness. A mile to the west the Lower Kittanning coal is again hidden by 25 to 60 feet of terrace gravels, but opposite Georgetown Island it reappears about 50 feet above the railroad. From this point it gradually descends to 30 feet above the railroad at Smiths Ferry and thence rises toward the State line. Though at one time opened at several places in this vicinity, no exposures were found for measurement. Near the forks of Dry Run, however, it passes under the stream with an exposed thickness of 12 inches. Though the Lower Kittanning horizon does not appear elsewhere in the northwest region, west of Ohioville on Island Run it has an outcrop line at least a mile in length, but no good exposures were seen. Off the northeast corner of the quadrangle it occurs on Brush Run, where it has a reported thickness of 18 to 22 inches.

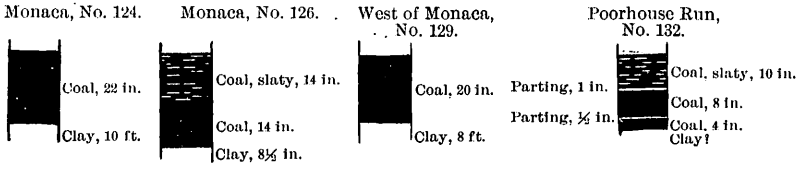

FIG. 7.—Lower Kittanning coal sections, southeast region.

In the southeast region this coal is not up to its customary grade, being impure and slaty, and consequently is not of general importance as a fuel. The horizon of the coal, as may be seen on the economic map (Pl. VIII), dips below river level near Hog Island. It does not come to the surface until it appears above the road bridge near the mouth of the small run emptying at the west side of Monaca. Thus far it is hidden by the Monaca terrace, and may be reached by shafting along the railroad. Moreover, a small anticline apparent in the overlying rocks probably brings it only a few feet below the surface at the mouth of the small ravine east of Doctor Heights. But between this point and the first outcrop it descends to an extreme depth of 35 feet below railroad grade, and has been reached by the Pennsylvania Clay Company in its 25-foot shaft to the underlying clay. At this point the coal measures 22 inches (section 124, fig. 7), but it is impure and is not removed with the clay. Near the Pittsburg and Lake Erie Railroad bridge the Welsh Brick Company drifts on the underlying clay and exposes the coal 28 inches thick (section 126, fig. 7). The upper half is slaty and sulphurous, and consequently is not used. Thence westward the horizon is marked not only by frequent coal blossoms along the river road, but by several abandoned brickyards. At one of these—the Reed property—the coal is still sulphurous and 20 inches in thickness (section 129, fig. 7). Within a mile to the west it passes beneath a gravel terrace, remaining covered to the mouth of Raccoon Creek. The horizon of the coal is usually less than 50 feet beneath the surface and may be found by shafting to this depth along the rear edge of the terrace. Rag and Poorhouse runs, however, cut down almost to this horizon, and where the road crosses the latter

Charles Deens has uncovered the Lower Kittanning coal at about stream level. In the prospect the seam aggregates 24 inches in thickness (section 132, fig. 7), but the upper part is slaty and the lower part split by partings.

In the vicinity of Raccoon Creek bridge there are several old pits on the Potter and Sprenger farms, but no measurements could be obtained. Along the east side of the creek, though the horizon is above water level, the only exposure occurs about half a mile above the bridge, where a coal 12 inches thick outcrops 5 feet above low-water level. This is very probably the Lower Kittanning coal, but not enough of the accompanying rocks are exposed to prove its stratigraphic position. It may therefore be the Darlington coal. A few hundred feet to the south it passes beneath water level, but a coal, perhaps the same one, is uncovered again in the next bend of the creek. Its several occurrences on the west bank will, with others, be noticed in the following paragraph, describing the southwest region.

The impure character of this coal to the east is continued into the southwest region and in places unfits it for use. It has been opened on the west bank of Raccoon Creek, but owing to the local westward dip of the beds its extent is less than on the east bank and a shorter column of accompanying rocks is exposed on the west bank. As a consequence the identification of the exposed coals, especially those south of Fishpot Run, is less certain. In this locality a sandstone, presumably the Freeport, lies near the outcropping seam, which, therefore, should normally belong to the Darlington horizon. The sandstone, on the other hand, may replace the Darlington coal, in which case the seam is referable to the Lower Kittanning.

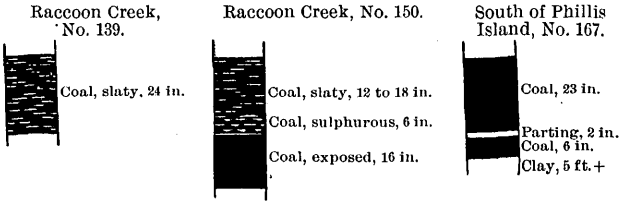

FIG. 8.—Lower Kittanning coal sections, southwest region.

Excavations beneath these coals to show the presence or absence of the characteristic Lower Kittanning clay bed would prove their identity. Whether Lower Kittanning or Darlington, the last exposure known to the south is a mile above the bridge, and shows a slaty coal 24 inches thick (section 139, fig. 8). Opposite this point was measured section 220 (Pl. IV), which shows no corresponding coal, and which therefore indicates that it has dipped beneath the creek in this short distance. To the south it passes under gravel terraces and does not appear again, but to the north it rises slightly, and at the mouth of Fishpot Run what is probably the same coal measures 34 to 40 inches (section 150, fig. 8). The upper part is inclined to be slaty, bony, and somewhat sulphurous. In the next bend the undoubted Lower Kittanning coal has been mined on the Braden farm and elsewhere, but at the time of visit was not open to measurement. It was reported as 36 inches thick and as overlying its characteristic clay bed. It occurs as a coal blossom on the highway to the north beyond which it disappears beneath the Bellowsville terrace, but it is not deeply covered, and probably within half a mile reappears along the rear edge of the terrace at an elevation of about 760 feet. Thus it possibly continues near terrace level for a mile, but in this distance it has not been opened. Where the terrace becomes narrow the horizon descends beneath the gravels and remains just below the surface as far as Squirrel Run. Within this distance it is said to have been found on the Carpenter property and at the mouth of Squirrel Run, but no measurement of its thickness was obtainable. Beyond Squirrel Run the horizon lies above water level in the precipitous river bank, but is unexploitable on account of its unfavorable

position. It finally disappears beneath the Shippingport terrace, below which it may be found by shafting probably not more than 60 feet. But, to judge from an exposure of the Darlington seam near Shippingport, the Lower Kittanning probably lies nearer the river front of this terrace than is supposed to be the case beneath other terraces of this kind. Nearly opposite Phillis Island the horizon reappears about 40 feet above low-water level and bears a coal 31 inches thick (section 167, fig. 8). To the west of this point it is not well exposed but is known on the Fergensen and Potts farms and the seam was reported 24 inches thick. After some distance it again disappears beneath a river terrace, gaining a depth of about 70 feet, but rising very near the surface and finally emerging on Mill Creek. Beyond Mill Creek on the river front the horizon is near the surface as far as Little Mill Creek and may be drifted on, through a thin covering of gravels. On both streams the horizon continues above water level for nearly three-fourths of a mile, but was not open to measurement at any point.

Summary.—The Lower Kittanning coal is at present chiefly valuable when removed in conjunction with the overlying clay, but in the past it has been largely mined alone for local use. Its present use is restricted by its varying quality and thickness. In some localities it is a good steam coal, but in others it is dirty and sulphurous and can not be used. It was not observed less than 14 nor more than 30 inches thick except where separated by partings. The average thickness, however, is about 24 inches, and this measurement is most uniform in the valleys of Beaver River, Brady and Blockhouse runs, and the north side of Ohio Valley to Vanport. In these localities also the coal is singularly free from partings, though often rendered poor in quality by the presence of sulphur and other impurities. This is particularly true in certain areas east of Beaver River, where it is known as the "sulphur vein," while in Brady Run this coal was once so especially sought by smiths as to receive the appellation of "blacksmith's vein." Elsewhere in the quadrangle the greatest variations both in thickness and partings occur. The partings consist of clay and slaty lenses, and seem confined to the upper portion. They are most prevalent on the north side of Ohio River west of Vanport, on the south side, and in Raccoon Creek, so that at places in this general region the Lower Kittanning seam has been abandoned for the Darlington coal above.

MIDDLE KITTANNING (DARLINGTON?) COAL.

The Middle Kittanning coal averages 35 feet above the Lower Kittanning and consequently has nearly the same geographic distribution, but is not so deeply covered by terrace deposits. Though persistent throughout the quadrangle, it is on the whole of less importance than the Lower Kittanning, being more variable in thickness and underlain by a less valuable clay bed.

Detailed description.—In the northeast region this coal is generally thinner than the Lower Kittanning seam; consequently, it is of less importance in this section of the quadrangle and is seldom, if ever, used. On Crow Run, between the two shafts of the Pennsylvania Clay Company, it is 12 inches thick near stream level, but above the road east of the switch yard it is 14 to 20 inches thick (section 2, fig. 9), and 45 feet above the Lower Kittanning seam. Except at Dam No. 5, where it shows as a thin coal, in places cut out by Freeport sandstone (section 224, Pl. V), the coal is not known as far as Bolesville, with possibly one exception. In the bed of the run, back of Rochester, a 6-inch coal outcrops which very probably represents the Darlington. At Bolesville it occurs 90 feet above the railroad track and is only 9 inches thick. Thence northward to the margin of the quadrangle it shows only as a blossom on the road back of Sherwood's pottery. Outside of the quadrangle, however, 35 feet above McDonald's clay mine, already referred to, the section is 18 inches thick (section 27, fig. 9).

On Blockhouse Run east of New Brighton the Darlington horizon, being higher than the Lower Kittanning, has, of course, a greater extent, but here too it varies from a thin coal of 6 inches near the Brighton Fire Brick Company's works, to one with a reported thickness of 16 to 24 inches near the forks of the run. At the latter point, however, it measures only 14 inches (section 23, fig. 9) and beyond the boundaries of the quadrangle it shows 1 foot thick.

In the northwest region the Darlington seam in certain localities is well developed and becomes a valuable coal. On the west side of Beaver River, at Beaver Falls, it occurs 30 feet above the Lower Kittanning coal on the Paris property, referred to above, where it is 14 inches thick (section 31, fig. 10). A mile south of this exposure

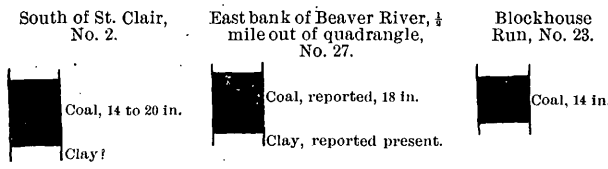

FIG. 9.—Middle Kittanning coal sections, northeast region.

it thins to 12 inches, and at the foot of the bluff between Bridgewater and Beaver it is 8 inches thick (section 56, fig. 10).

On Brady Run it is present as a very thin coal, usually not exceeding 12 inches in thickness. Thus in the first ravine above the Fallston Fire Clay Company's mine it shows a thickness of 6 inches (section 50, fig. 10), and 2½ miles above this point, on the north side of the run, it has thinned to 4 inches. On North Branch of Brady Run it increases somewhat in thickness, being a slaty coal 16 inches thick on the Mahoney farm, near the head of the stream (section 35, fig. 10), and 12 inches thick a mile farther down.

On Ohio River, at Beaver, the horizon of the Darlington coal occurs north of town at an elevation of about 800 feet, making it nearly on a level with the Beaver terrace. It remains at about this elevation as far as the ravine near the Miller-Hummel clay

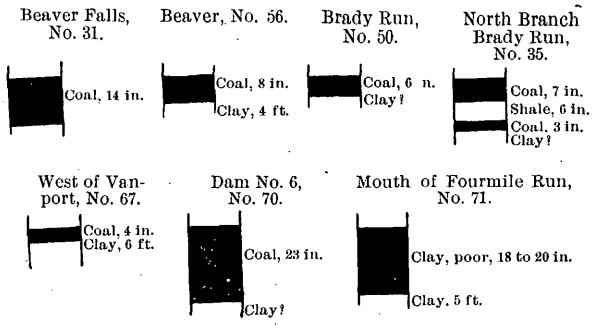

FIG. 10.—Middle Kittanning coal sections, northwest region.

mines, where it is 4 inches thick (section 67, fig. 10). In the next ravine west, however, it is 20 feet higher and measures 23 inches (section 70, fig. 10). Near the mouth of Fourmile Run Dando & Co. have uncovered the coal while exploiting its under clay, and though of poor quality it measures 18 to 20 inches (section 71, fig. 10). A few hundred feet up the run it follows the sudden rise of the Lower Kittanning coal and is represented by coal and bituminous shale 12 inches thick. Thence to Sixmile Run it is not well exposed, but may be seen on the Run road as a large coal blossom. A short distance up a branch run toward Engle's coal mine it has been opened and shows a section with 30 inches of bituminous shale at the top and 18 inches of coal at the base (section 77, fig. 11). The coal continues to descend west-

ward, but is not exposed as far as Wolf Run. On the west fork of this run a few hundred feet above the mouth occurs a doubtful coal measuring 9 inches. It probably belongs to the Darlington horizon, but the accompanying rocks do not give sufficient data to prove its identity, and it may belong to the Upper Kittanning horizon. Just below Industry (section 252, Pl. VII) this coal, as well as the Upper Kittanning, is cut out entirely by Freeport sandstone. It still dips steadily westward and near Cooks Ferry lies 25 feet above the Cleveland and Pittsburg tracks, being more or less slaty and 18 inches thick (section 80, fig. 11). A short distance west of the depot a coal is exposed at railroad level 14 inches thick (section 81, fig. 11), but at this point the evidence is not sufficient to determine to which horizon the coal belongs. The bed shown in section 80 seems certainly Darlington, with the coal bloom and clay of the Lower Kittanning 30 feet below and the Freeport sandstone a few feet above. The sandstone shown above section 81 is assumed to be the same and therefore, unless it has cut away the Darlington coal, as in section 252 (Pl. VII), the coal exposed should belong to the Darlington horizon.

From this point westward it is covered by a gravel terrace as far as the vicinity of Georgetown Island. It may be found by shafting through not more than 35 feet of loose gravels at the rear edge of the terrace, and may, indeed, be drifted on where streams have incised the terrace to 75 feet above railroad level. From Georgetown

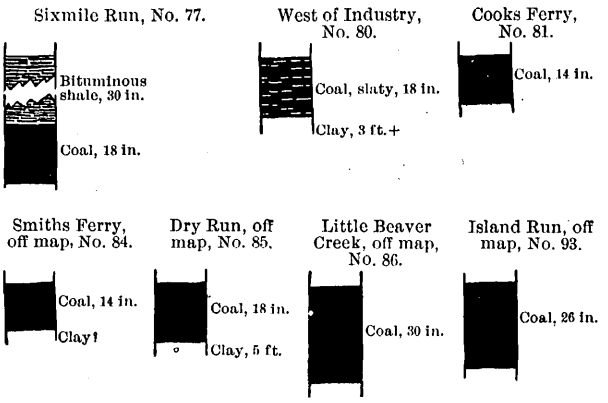

FIG. 11.—Middle Kittanning coal sections, northwest region.

Island to Smiths Ferry, though the horizon lies above the railroad in the precipitous river bank, it was exposed for measurement only on the Smiths Ferry and Ohioville road, where it shows a thickness of 14 inches (section 84, fig. 11). At this point it is 60 feet above railroad level, while about half a mile up Dry Run, where it has been mined on the Thompson property, it is higher and measures 18 inches (section 85, fig. 11).

No other occurrences of the Darlington coal are known to the writer in this portion of the quadrangle; but on Little Beaver Creek, beyond the boundary, it has been opened on the Jesse Smith property, and measures 30 inches (section 86, fig. 11). The same seam was at one time extensively exploited back of Glasgow, and is reported both of excellent quality and of unusual thickness—28 to 30 inches. In this locality especially it is known, presumably from the characteristic shape of the mined product, as the "block vein." Two other occurrences of this horizon in Island Run, though outside the quadrangle, may be mentioned here. One on the north side of and 100 feet above the run, near the Ohio State line, measures 26 inches (section 93, fig. 11); the other, in the bed of the run to the east, is 18 inches thick.

In the southeast region the Middle Kittanning horizon is 35 to 45 feet above the Lower Kittanning coal, and hence remains above river level throughout the region,

but it is commonly too thin to mine. To begin at Hog Island, it first appears in an old pit along the road at the mouth of the run south of Stobo, but was not exposed for measurement. The next occurrence is at the mouth of Moon Run, where it measures 16 inches (section 118, fig. 12); but a short distance above this point, at the mouth of Elkhorn Run, it thins to 6 inches (section 117, fig. 12). A few feet beyond, with the same thickness, it passes beneath the stream. From Moon Run, where it is about 20 feet below railroad level, it steadily rises to nearly track level at Colonial, but from this point northwestward it follows the rise and fall of the Lower Kittanning coal, and in general is above or near railroad grade to the railroad bridge over the Ohio. At the Welsh brick works the coal lies 35 feet above the Lower Kittanning, and still retains its thin character, measuring 9 inches (section 125 fig. 12). For some distance beyond it maintains the same thickness, and at the Reed

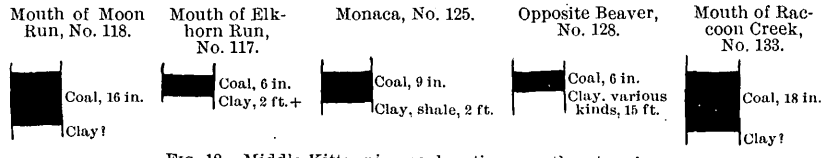

FIG. 12.—Middle Kittanning coal sections, southeast region.

brick yard it is reduced to 6 inches (section 128, fig. 12). West of this point the horizon lies above road level until it disappears beneath the Bellowsville terrace. The terrace material has been removed in the ravine south of Bellowsville and the Darlington horizon uncovered at an elevation of 777 feet. The coal has been opened here, but when visited the prospects were caved in. Both Rag Run and Poorhouse Run also cut below the horizon, but at no place was the coal exposed for measurement. Thence westward it is hidden by terrace deposits nearly to the bridge over Raccoon Creek. At this point it probably lies above the gravels, but it was not seen except in a ravine south of the bridge, where it shows a thickness of 18 inches (section 133, fig. 12). Along Raccoon Creek it is not exposed, unless the outcrops noted under the Lower Kittanning (p. 32) belong to this horizon.

In the southwest region the Darlington seam has been little opened except in the western portion, where it is of excellent quality. On Raccoon Creek no other

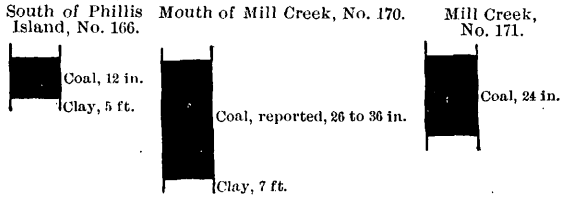

FIG. 13.—Middle Kittanning coal sections, southwest region.

exposures than those described above as possibly belonging to the Lower Kittanning horizon are known. Though the Darlington coal in this region lies 20 to 30 feet above the Lower Kittanning and westward along the river as far as Industry Ferry is uncovered by terraces, no exposures nor openings were seen in this distance. It lies not more than 30 feet beneath the Shippingport terrace, and is uncovered by Haden and Peggs runs. On the former it occurs as an 8-inch coal in the bed of the stream at the township line, with the Freeport sandstone beginning 10 feet above it; and on the latter stream, at the rear of the terrace, it has the same thickness, with the Freeport sandstone in a similar position. It leaves the terrace deposits near Phillis Island, where it is exposed 12 inches thick (section 166, fig. 13). From this locality to Georgetown terrace it is not known. No doubt it follows the Lower Kittanning coal and lies beneath terrace deposits east of Georgetown, but west of town

it should leave the terrace and rise to an elevation of 770 feet, in accordance with the interval between it and the Lower Kittanning. This interval indeed has decreased from 30 feet at Phillis Island to 20 feet on Mill Creek, where the coal has been extensively mined. In this locality, as on the opposite side of the river, it is known as the "block vein," and openings near the mouth of Mill Creek on the Lake and Spence farms are said to have shown 26 to 36 inches of excellent coal (section 170, fig. 13). Farther up the creek it was being mined at the time of visit by Hoalcroft & Jones, who removed 24 inches of block coal for local use (section 171, fig. 13). Beyond this point it continues at about the same elevation, but grows thinner, and near the schoolhouse was only 12 inches thick. A short distance beyond it passes beneath the creek.

Summary.—Though persistent throughout the quadrangle, the Darlington seam is on the whole of less importance than the Lower Kittanning because it is more variable in thickness, the limits being 4 to 36 inches, and because it is underlain by a less valuable clay bed. There are, however, restricted areas in which the coal itself equals or surpasses in quality the Lower Kittanning of the same area. One area includes the Ohio Valley west of Dam No. 6. In this general region the usual thickness of the coal is between 14 and 30 inches, free from partings and apparently increasing in quality and thickness toward the west, so that on both sides of the river in the vicinity of Georgetown it is 24 to 30 inches thick. Here it is an excellent block coal (the "block vein"), which has in the past been largely opened for local consumption.

Another area in which the coal is somewhat uniform in thickness, of fair quality, and free from partings, lies east of Beaver and Ohio rivers. In this locality it ranges generally from 14 to 20 inches, but it is likely to be cut out by the Freeport sandstone, and it is not at present of commercial importance.

The exposures in the remainder of the quadrangle seldom reveal a thickness greater than 6 to 9 inches.

UPPER KITTANNING COAL.

This seam is of no importance within the quadrangle, except possibly in one locality on Brush Run. Elsewhere it is very thin, usually impure, and in 50 per cent of the exposures of this horizon is absent altogether.

In the northeast region it has not been observed thicker than 12 inches at any locality, and it is generally much thinner. Just below Bolesville it is 6 inches thick, and near the Brighton Fire Brick Company's mine, on Blockhouse Run, it measures 12 inches (section 21, fig. 14). Here it is 13 feet above the Darlington seam. Outside of the quadrangle, but near the boundary, is a coal about 38 feet below the Lower Freeport, which may here be mentioned. It is 38 inches in thickness (section 231, Pl. V), but seems too high in the series to be the Upper Kittanning. About 20 feet above the Darlington coal, at McDonald's clay mine, occurs a 5-foot bed of cannel coal, which presumably belongs to the Upper Kittanning horizon. Though at one time mined for the local market, it is not now exploited (section 233, Pl. V).

In the northwest region this seam seldom reaches a thickness greater than 1 foot, and exhibits its usual poor quality over most of the area. On the west side of Beaver River, for example, the horizon, though present a few feet above the Darlington coal, was not coal bearing where exposed and often was concealed. On Brady Run, however, the coal is present as a thin seam rarely reaching 12 inches in thickness. This thickness is shown on the northeast side of the run, a mile above Fallston, and also on South Branch a mile above the forks (sections 41 and 46, fig. 14). In a ravine a few hundred feet to the northwest of the latter point, however, it thins to 6 inches and a mile to the west measures 10 inches (section 40, fig. 14). Another occurrence a mile still farther west shows a 6-inch slaty coal, and along the road half a mile beyond, the extreme thickness—12 inches—recurs (section 38, fig. 14).

Along the north bank of Ohio River the horizon, though seldom coal bearing, in some instances carries an augmented seam, for example, in a ravine near the Gloninger clay mines it is exposed 18 inches thick (section 68, fig. 14), but is slaty. Near the same place, on the road leading up the ravine, it measures 12 inches, while the next exposure, in a ravine just east of Cooks Ferry station, it is not over 2 inches thick (section 79, fig. 15). No other exposures were observed as far as Dry Run, where on both forks it is not known over 8 or 10 inches in thickness (sections 87, 89, fig. 15). Outside of the quadrangle, on Island Run, it becomes still thinner, and was not found over 6 inches thick (section 95, fig. 15).

In the extreme northwest corner of the quadrangle, however, a coal at probably this horizon is well represented on Brush Run. It has been opened on the Tinnis,

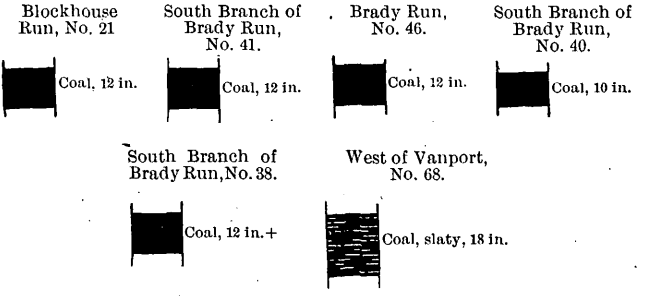

FIG. 14.—Upper Kittanning coal sections, northeast and northwest regions.

Blagg, and other properties, showing a uniform thickness of 48 inches with 6 to 12 inches of parting (section 108, fig. 15). In this vicinity it is known as the "dirt vein" and seems to have been correlated with the Upper Freeport seam by the Second Geological Survey of Pennsylvania.

In the southeast and southwest regions the Upper Kittanning seam is extremely thin and poorly exposed. East of Raccoon Creek it was observed only in a ravine south of Bellowsville, where it is 2 inches thick. On the west bank of Raccoon Creek it is not known and seems to be cut out by the Freeport sandstone, while along

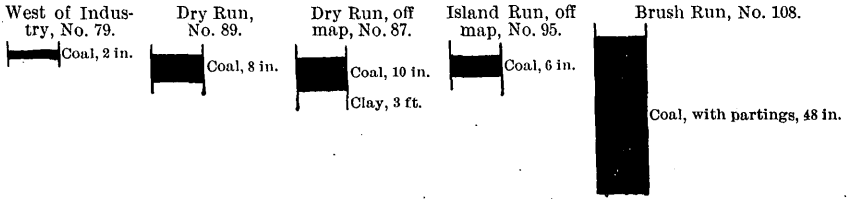

FIG. 15.—Upper Kittanning coal sections, northwest region.

the Ohio it first shows near Phillis Island (section 254, Pl. VII) as a thin coal ranging up to 6 inches in thickness and occurring 40 feet above the Middle Kittanning. No other exposure is known except on Little Mill Creek outside of the quadrangle, where it was seen 2 inches thick.

LOWER FREEPORT COAL.

The Lower Freeport seam is in places of some value in this territory, but on the whole it probably ranks below the Darlington coal. Its position averages 60 feet below the Upper Freeport coal, whose crop line is shown on the map. It therefore lies high up on the sides of the river valleys and extends considerable distances up the lateral streams.

Detailed description.—This seam is rather well developed in the northeast region, but the coal is of very inferior quality. Along the hill road east of St. Clair a slaty coal outcrops 24 inches thick (section 4, fig. 16), whose stratigraphic position is doubtful. It seems too far above the Lower Kittanning (165 feet) to be Lower Freeport, but has neither the elevation nor the stratigraphic associations of the Upper Freeport (section 223, Pl. V). About a mile north of this locality, however, on the edge of the quadrangle, the true horizon is recognizable and shows 12 inches of coal. East of Rochester, near the bed of the run which flows back of town, this coal is 24 inches thick (section 10, fig. 16). On an eastern fork of the same run is a slaty coal 4 feet thick which has been mined to some extent. Both its position—about 80 feet below the Upper Freeport, which is at least 20 feet lower than the usual position of the Lower Freeport coal—and its character make its identification uncertain. It may be another of the isolated cannel-like deposits, common in the Beaver quadrangle. On the property of Mott Muller, on McKinley Run, the Lower Freeport coal is exposed 18 inches thick (section 9, fig. 16). Thence northward to New Brighton the coal does not show, but it is known in Smith's quarry, on the hill east of New Brighton, where it is said to lie beneath the sandstone of the quarry and to have a thickness of 16 inches. On Blockhouse Run, back of the American Sewer Pipe Works, it is reported 10 inches thick, and near by measures 14 inches. On the opposite side of the run it is still thicker—20 inches (section 20,

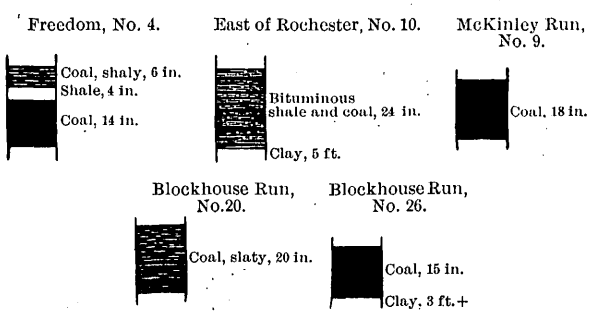

FIG. 16.—Lower Freeport coal sections, northeast region.

fig. 16). Though the horizon is present elsewhere on Blockhouse Run, the coal was not observed to outcrop except on the north fork, just beyond the boundary of the quadrangle, where it is 15 inches thick (section 26, fig. 16).

These are all the occurrences of this coal which have been observed in this part of the quadrangle, but beyond the boundary, near the highway on the bluff above McDonald's clay mine, it has a thickness of 1 foot.

In the northwest region this coal is in general thicker than the Upper Kittanning, and in a few localities much thicker than any other coal so far described. On the west side of Beaver River it maintains a medium thickness of not more than 18 inches. Between West Bridgewater and Beaver, for example, where the coal is exposed on the river bluff 80 to 100 feet above the road, it is scarcely more than 12 inches thick and of very inferior quality, being slaty and bony. The next deep ravine to the north exposes this coal at about the same elevation, but with an increased thickness of 18 inches (section 55, fig. 17). Thence to the dam opposite New Brighton the Lower Freeport horizon rises about 100 feet, and at this point measures 16 inches (section 45, fig. 17).

On Brady Run, owing to the elevation of this coal, it is found high up on the sides of the valley. An occurrence on the west side of the run a mile from its mouth was partly concealed, but the exposed section was shaly and 16 inches thick (section 49, fig. 17). In the same ravine, 25 feet below this coal, is a 6-inch

coal which can not be identified with any horizon, being too near the Lower Freeport horizon to be called the Upper Kittanning. At other exposures a mile farther west on Brady Run the coal is still impure and only 12 inches thick (section 42, fig. 17). Thence westward the horizon continues to rise and probably disappears beneath Brady Run just over the line in South Beaver Township. This statement can not be proved on the ground, because the Butler and Freeport sandstones are here so well developed that débris from them conceals the horizon. The fact may

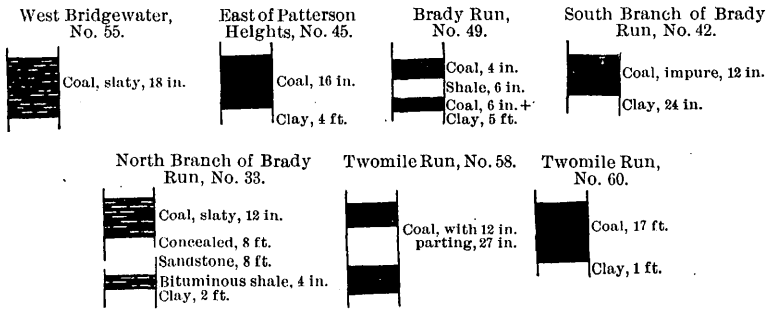

FIG. 17.—Lower Freeport coal sections, northwest region.

be fairly well established, however, by correlating the Upper Freeport coal, which is better exposed, and subtracting from its elevation the average interval to the Lower Freeport coal.

On North Branch of Brady Run the horizon begins high above stream level and holds this relation till it passes out of the quadrangle; but exposures are scarce, and one locality near the forks of North Branch shows the seam split into two thin

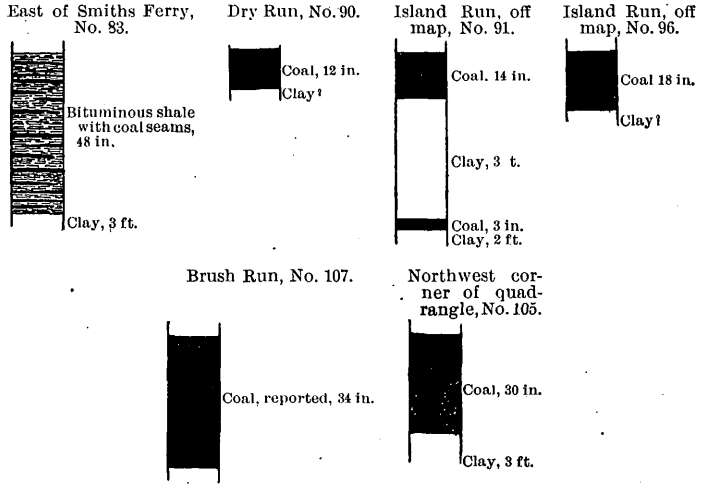

FIG. 18.—Lower Freeport coal sections, northwest region.

benches 16 feet apart, with some sandstone between (section 33, fig. 17). It is a question here whether the coal or the bituminous shale represents the Lower Freeport, and perhaps it is a "split vein," like section 91 (fig. 18) above.

Along the north side of Ohio River this coal shows great variability at several points in the vicinity of Twomile Run. For example, back of Beaver the coal is about 75 feet above the Beaver terrace and 9 inches thick, while on Twomile Run it has been opened on the Bolland property with a thickness of 27 inches (section 58,

fig. 17). This is not all clear coal, however, being separated by a 12-inch parting. On the Morgan property, a mile to the north, the coal thins to 17 inches (section 60. fig. 17).

Westward along the river, to Georgetown Island, the Freeport sandstone, as we have seen, is exceptionally developed and the Lower Freeport coal reciprocally absent. Opposite Georgetown Island the sandstone thins and the coal begins to reappear as a bituminous shale with coal seams, the whole being 48 inches thick (section 83, fig. 18). Midway between this point and Smiths Ferry it becomes a shaly coal 12 inches thick, and this character and thickness are generally maintained north of Smiths Ferry throughout the valley of Dry Run (section 90, fig. 18).

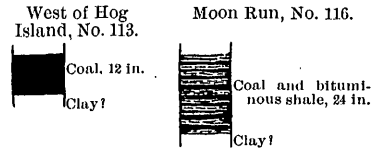

FIG. 19.—Lower Freeport coal sections, southeast region.

West of Ohioville, on Island Run, half a mile beyond the edge of the quadrangle, the Lower Freeport is exposed for measurement at several points. One near its mouth shows an impure coal 12 inches thick, while of two others half a mile upstream, one shows 17 inches of coal separated by a seam of clay (section 91, fig. 18) and the other 18 inches of solid coal (section 96, fig. 18).

The streams to the north, such as Bieler and Pine runs, uncover this horizon 60 feet below the Upper Freeport, but the coal for some reason is not now exploited. In the northwest corner of the quadrangle a coal correlated with this seam has been opened on Brush Run, but the pits are fallen in and the reported thickness is 34 inches (section 107, fig. 18). To the west of Brush Run this coal is locally well developed. For example, just beyond the edge of the quadrangle it is exposed 30 inches thick in a ravine on the Elton property (section 105, fig. 18). On the west branch of Brush Run, however, it is unknown unless a 12-inch seam on the north side belongs to this horizon.

In the southeast region the Lower Freeport horizon averages 75 feet above the Darlington coal, and as a rule is a few inches thicker. West from Hog Island it is first exposed as a blossom along the river road at an elevation of about 850 feet. From this point it ascends slightly to the northwest, and is exposed at an elevation of about 860 feet in the run south of Stobo, where it measures something over 12

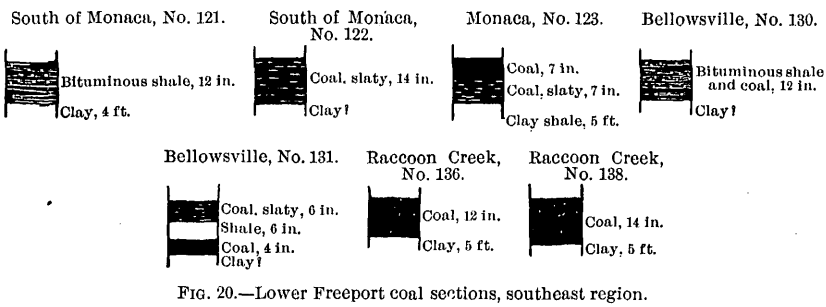

FIG. 20.—Lower Freeport coal sections, southeast region.

inches (section 113, fig. 19). At this point a slaty coal of doubtful horizon and perhaps 18 inches thick occurs about 65 feet lower, in the bottom of the run. It may be the true Lower Freeport, but in this region, where the interval between the Lower and Upper Freeport is about 35 feet (section 203, Pl. IV), it seems too low.

No other outcrops of the Lower Freeport are known in either this run or Elkhorn Run. On Moon Run, however, it is exposed on the south fork and measures 24 inches (section 116, fig. 19). Here it is partly a bituminous shale and consequently of little value. The same character continues along the river front to Monaca and

even beyond, in which distance the coal seldom reaches a thickness greater than 12 inches (sections 121, 122, 123, 130, fig. 20.) Greater dimensions, however, are assumed in a ravine south of Bellowsville, where the seam, though still very slaty, is 16 inches thick (section 131, fig. 20). Outcrops on Rag and Poorhouse runs are rare, and the only one observed was a mile above the mouth of the latter, where the coal had thinned to 4 inches.

The Lower Freeport horizon lies about 75 to 100 feet above the Bellowsville terrace, but is not exposed along the river front. On the east bluff of Raccoon Creek, however, several sections of coal were measured which increase in thickness toward the south. The first, in a ravine above the bridge and about 165 feet above the creek, shows an impure coal 6 inches thick, while the second, a mile beyond and at about the same elevation, measures 12 inches (section 136, fig. 20), and the third, still farther up stream and somewhat lower, is 14 inches thick (section 138, fig. 20). No other exposures of this coal were seen to the south except scattering blossoms along the highways, and the horizon finally dips beneath Raccoon Creek about 3 miles above Gums Run. This seam is inclined to be slaty and promises little good coal in this section of the quadrangle.

In the ravine just mentioned, where section 136 was measured, and about 80 feet lower, occurs a shaly coal of doubtful horizon with a thickness of 36 inches (section 221, Pl. V). It may be the Lower Freeport overlying the Freeport sandstone, in which case the seam shown in section 136 is equivalent to the Upper Freeport or a local coal, instead of Lower Freeport. Or it possibly represents the Upper Kittan-

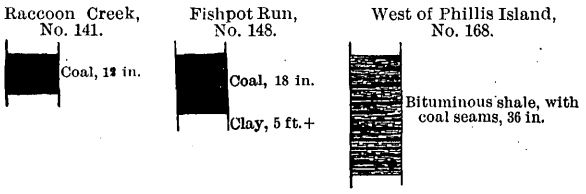

FIG. 21.—Lower Freeport coal sections, southwest region.

ning, but this seems rather unlikely. At any rate a stray coal appears along Raccoon Creek, which, when the Lower Kittanning horizon is covered, makes the other coals difficult of identification (section 220, Pl. IV).

The Lower Freeport coal is seen at only three localities in the southwest region, and the thicknesses observed are not encouraging. On Raccoon Creek it is exposed near the mouth of Gums Run, where it occurs at an elevation of about 800 feet and with a thickness of nearly 12 inches (section 141, fig. 21). On Fishpot Run, in accordance with the northward rise of the rocks, it is somewhat higher—900 feet—and here the coal is of better quality and reaches a thickness of 18 inches (section 148, fig. 21). The third occurrence, which is below Phillis Island on the river, is still thicker—36 inches—but consists of bituminous shale with thin coal seams (section 168, fig. 21). At the first two localities the interval between the Upper and Lower Freeport is 30 feet, but at the last it is 55 feet. Elsewhere in the region, therefore, the Lower Freeport may be looked for within 30 to 55 feet below the Upper Freeport coal.

Summary.—The Lower Freeport coal probably ranks in value below the Darlington, for the reason that it is very irregular in occurrence. Of localities where the horizon was exposed, 50 per cent showed no coal, while of the coal-bearing exposures observed half were inclined to be slaty, even becoming merely bituminous shale with thin coal seams. Locally, however, it clears up to good coal, ranging from 12 to 30 inches in thickness, but averaging 15 inches. Such areas are restricted to Blockhouse, McKinley, Brady, and Twomile runs, Raccoon Creek, Island Run, and Brush

Run. Even where good, the coal is often separated by clay or shale partings into two main benches, which destroys its value. Moreover, as stated above, it is likely to thin out or be absent over considerable areas. From one or two croppings, therefore, no conclusions can be drawn as to its quality, regularity, or character.

UPPER FREEPORT COAL.

Of seams valuable for their coal alone, the Upper Freeport is the most important in the Allegheny measures. The horizon of the coal, therefore, and the localities in which it is presumably of a workable thickness, are indicated on the map (Pl. VIII). Its mode of occurrence is lenticular, like many of the coals of this region, and this habit, as already stated, seems to have some relation to the overlying sandstone.

Detailed description.—In the northeast region this is the highest workable coal, but it has been opened in only a few places. It is well exposed at two localities between Freedom and Rochester, about 225 feet above the railroad track, where it measures 18 to 22 inches thick (section 6, fig. 22). Section 225, Pl. V, shows the relations at this point. It also outcrops as a large blossom on the hill road above McDonaldtown, and a mile to the northeast, near the crossroads at the edge of the quadrangle, it is exposed in the run 8 to 10 inches thick (section 7, fig. 22). Thirty-seven feet above this seam, a few hundred feet to the east, in the bed of a branch run, occurs

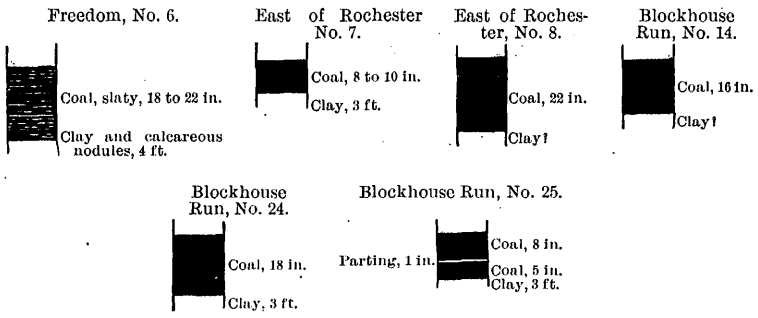

FIG. 22.—Upper Freeport coal sections, northeast region.

another coal 18 inches thick, which very probably is not the same bed, but a local coal of the Conemaugh formation. Along the highway, half a mile east of Rochester, there are openings on the Upper Freeport seam in which the coal measures 22 inches thick (section 8, fig. 22). To the north, on McKinley Run, it thins to 6 inches on the farm of Mott Muller, while near the Rochester and New Brighton road, opposite Bolesville, it has an exposure of 12 inches and has been stripped out of the run. From this point the horizon continues along the hills above the road, sometimes showing as a small blossom, but at the old Fish quarries the coal seems to be entirely absent. At the head of a run to the southeast, however, it reappears and measures 16 inches (section 14, fig. 22). On the opposite side of Blockhouse Run it is reported 12 inches thick on the McClellan farm, while half a mile to the east it outcrops in the bed of Blockhouse Run and measures 18 inches (section 24, fig. 22). Elsewhere on Blockhouse Run within the quadrangle no coal was observed, even where its horizon was well exposed; but on the north fork at the edge of the quadrangle it is present 14 inches thick (section 25, fig. 22). In this locality, therefore, the Upper Freeport coal varies greatly in thickness, and, though hardly of commercial value, it is, whenever present, of good quality.

In the northwest division of the quadrangle the Upper Freeport coal is of little value except in portions of South Beaver, Ohio, and Industry townships. On the west side of Beaver River it is not so well developed as on the east side. Its horizon

is present, however, but being at an elevation of 300 feet or more above the river it outcrops high in the hills, and is, therefore, likely to covered by débris. The only measurement secured on this bank of the river was in the ravine above West Bridgewater (section 247, Pl. VI), where it is 6 inches thick. From this point northward the horizon rises, crosses the Fallston and Patterson Heights road at an elevation of 1,009 feet, follows the top of the river bluff, and outcrops as a coal blossom, at an elevation of 1,077 feet, on the Beaver Falls and Patterson Heights road.

On Brady Run also exposures are scarce. A thickness of 4 to 20 inches (section 52, fig. 23) was reported on the property of the Fallston Fire Clay Company, where the clay beneath has been mined, but its extreme irregularity renders it of no practical value. Half a mile west of this point it thins to 12 inches (section 48, fig. 23), and thence westward along Brady Run, though its horizon may be detected on highways by infrequent coal blossoms, the exposures at the heads of ravines are generally covered. The small size and scarcity of the coal blossoms, together with the fact that no coal of any size has been found in prospects, leads to the belief that the Upper Freeport coal is either a very thin seam or absent altogether, at least as

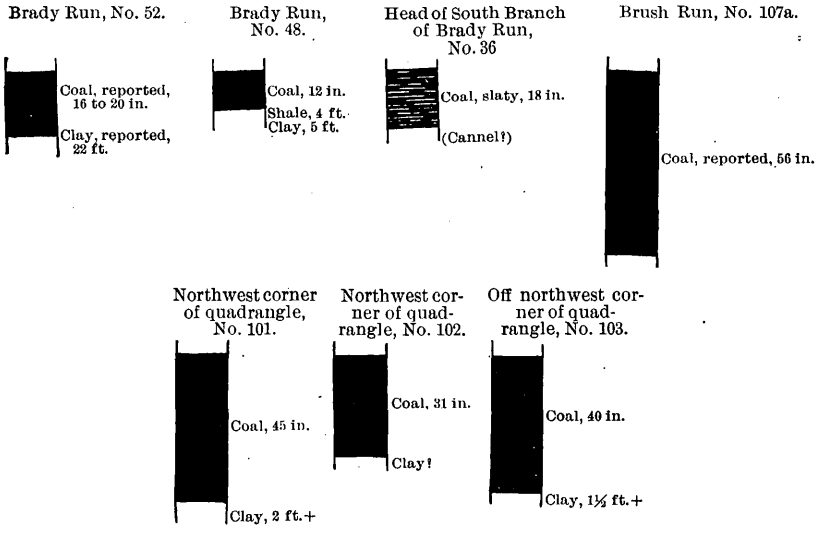

FIG. 23.—Upper Freeport coal sections, northwest region.

far as the eastern part of South Beaver township. In this locality, including the head streams of Brady Run, the horizon itself becomes rather dubious because of the appearance of local cannel seams and stray limestones, as explained elsewhere. Here a stray seam of slaty coal or cannel, which might ordinarily be taken for the Upper Freeport, though apparently 25 feet below its true horizon, measured 18 inches (section 36, fig. 23). Toward the western part of South Beaver Township, however, the horizon becomes recognizable and the coal grows more valuable. For instance, at the head of the stream northeast of McElroy Run the coal has been opened on the Thompson farm and a thickness of 36 inches is reported. Across the divide between this stream and Brush Creek the same thickness is reported on the Calvin farm. Here it has been opened, but when visited could not be measured. To the west, on Brush Run, a coal referable to this horizon has also been mined, but the opening had caved in when visited; the thickness is reported as 56 inches (section 107a, fig. 23). It is said, however, to be unprofitable to mine because it is so frequently cut out by "horsebacks." Several other openings have been made on Brush Run at about this horizon, but they show nothing but a black cannel-like

slate. A mile south of this point, on a west branch of Brush Run, the coal is reported 36 inches thick in an old opening on the Blatter property, but where the highway crosses the head of this branch the coal is absent beneath the Mahoning sandstone. It reappears, however, on the McCloy, Smith, and Moore farms, half a mile to the north, where the coal is opened and measures 45 inches (section 101, fig. 23). The coal in this vicinity is of excellent quality and furnishes the neighborhood with fuel. On the Freeborn farm to the west it is somewhat thinner—31 inches (section 102, fig. 23); but on the neighboring farms of Brown and Wilson it increases to 40 inches (section 103, fig. 23), which is about the thickness found on the Cowan (section 106, fig. 24) and the Elton (section 104, fig. 24) properties. It has been opened on other farms in this vicinity, but measurements could not be obtained, and their location in many cases is outside of the quadrangle. The coal may be seen, however, on the Fredericktown road as a blossom at an elevation of about 1,030 feet. Farther south, near the head of Pine Run, it is reported 36 inches thick, but for some reason is not mined.

On the upper portion of Bieler Run, however, the Upper Freeport seam is opened on the Welk and Moore farms and a thickness of 24 to 47 inches is removed (section 98,

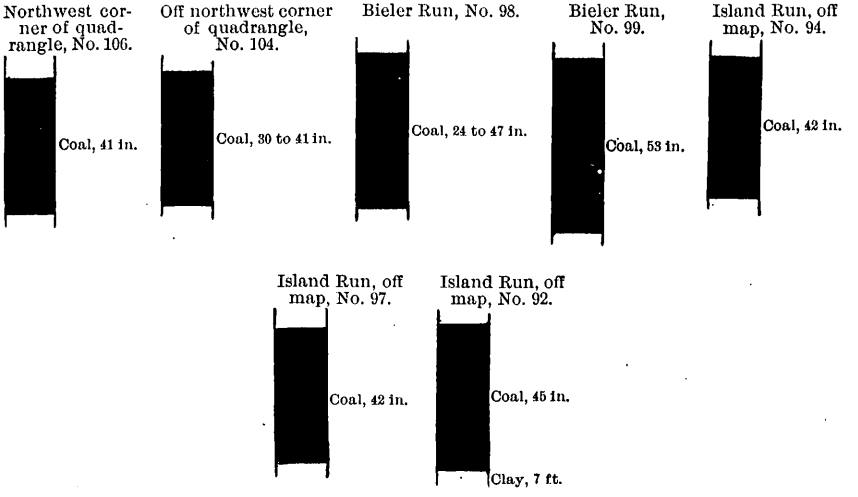

FIG. 24.—Upper Freeport coal sections, northwest region.

fig. 24). Where the road crosses the run a mile above this locality the coal is also present, showing in outcrop 30 inches thick and being mined 51 inches thick by R. L. Guyaux (section 99, fig. 24), but it seems to be either very thin or entirely absent between these two points, as well as on the lower course of the north branch. Near the head of the branch, however, a thin seam has been opened.

The coal on Bieler Run and in South Beaver Township is usually of good quality, but irregularities are common and the coal in many cases thins to a feather-edge. This is generally so when, as on the Welk, Moore, Brown, Wilson, and Freeborn farms, it has a heavy sandstone roof, which in a few hundred feet often cuts out the coal entirely or reduces it to an unminable thickness. On many of the other farms noted in this part of the quadrangle the coal supports a shale roof, which on the whole is much more to be desired, as the coal beneath is more likely to remain of uniform thickness.

A few hundred feet west of "Five Points," on Island Run, the Upper Freeport horizon is marked by interbedded layers of coal and sandstone, each a few inches thick, but the whole aggregating 10 feet. To the west this phenomenon disappears, for beyond the boundary of the quadrangle a thickness of 43 inches is removed in

the Davis mine (section 94, fig. 24). The coal is of fine quality and has been opened at several other places on Island Run, some of which show similar dimensions (sections 97 and 92, fig. 24). On the north fork of Dry Run the Upper Freeport seam is reported 48 inches thick on the Davison farm, but to the south near the road forks it seems to be absent and at the mouth of McLoughlin Run is represented by merely a few inches of bituminous shale. Elsewhere on the main run it is probably absent (section 260, Pl. VII), and on a western branch it measures less than 2 inches thick (section 88, fig. 26; 261, Pl. VII). From Smiths Ferry to Cooks Ferry this horizon lies high in the river bluffs, averaging 250 feet above the river, but the coal is either absent or represented by a small blossom not more than 12 inches thick. For example, in the ravine immediately west of Cooks Ferry the coal is about a foot thick, while a short distance to the east Mr. Zuerner has tried in vain to find it and in the next ravine it outcrops as a small blossom. On the hill road west of Industry, however, it thickens, it is said, to 48 inches and has been mined on the Russell property. It has also been exploited on Wolf Run and many openings were once in operation, but most of them are now closed. The thickness is generally reported as 48 inches on the Potter and Popp farms, a mile and a half from Industry, and in an opening at run level a partially exposed section measured 36 inches (section 82, fig. 25), but on the north side of the valley the coal perhaps thins out, as no evidence of it was seen. On the east fork of the run, however, half a mile from Industry, it was once opened on the Wallace property, and is reported 36 inches thick, but this lens also is probably of small extent to the north, as no blossoms were seen on the roads in

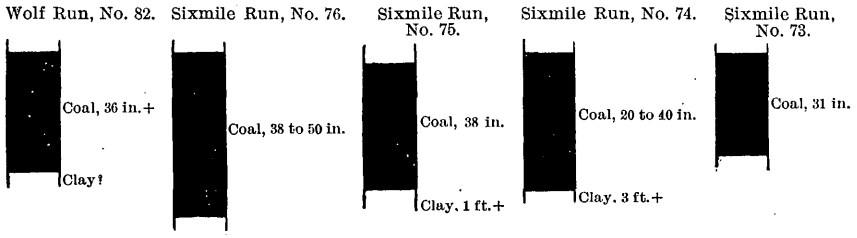

FIG. 25.—Upper Freeport coal sections, northwest region.

that direction. Between this point and Engle's coal mine to the east the Upper Freeport horizon is more or less concealed by débris and little is known of it. At Engle's mine, however, the coal is present in considerable thickness—38 to 50 inches (section 76, fig. 25)—and is overlain by 9 or 10 feet of shale which makes an extremely good roof. Up Sixmile Run the coal in places maintains a minable thickness, especially in the vicinity of the schoolhouse at the road forks, where McGaffic's mine enters on a thickness of 38 inches (section 75, fig. 25). McGaffic's pit shows a shale roof 1 foot thick, but farther up the run, on the Swager property, the shale is sometimes absent, and the coal consequently varies from 20 to 42 inches (section 74, fig. 25). At neighboring points it is thinner and perhaps disappears to the north. On the east fork of Sixmile Run, however, an old pit near the mouth revealed a thickness of 31 inches (section 73, fig. 25). Farther up the fork the Upper Freeport horizon rises suddenly, while the coal thins to 24 inches and finally disappears near the road crossing. Down Sixmile Run the coal was once opened on the east bank, on the Boyd Jack farm, at an elevation of about 940 feet. It was reported to run into slate and to be unprofitable digging. From this point eastward nearly to Vanport the horizon may be identified at several places, but it is practically barren (sections 249, 251, Pl. VI) and the coal seems to be cut out by the Mahoning sandstone. A mile below Vanport the coal reappears with a thickness of 9 inches (section 69, fig. 26), and thence eastward it is generally present and somewhat thicker, but to the north it remains thin and is often absent. For example, three-fourths of a mile

northwest of Vanport it is no more than 12 inches thick (section 63, fig. 26) and near the head of the run which empties at Vanport the coal, impure and slaty, is but 6 inches thick on the Sutherland property. On the upper course of Twomile Run also it is apparently absent. To the east, on the other hand, it is reported 27 inches (section 61, fig. 26) on the Owen property, between Vanport and Twomile Run, while on the lower portion of the run it is reported 14 to 16 inches thick (section 59, fig. 26) on the Boland farm. To the southeast of a line connecting these two properties the coal becomes thinner, for beneath the Mahoning sandstone of Wilson's

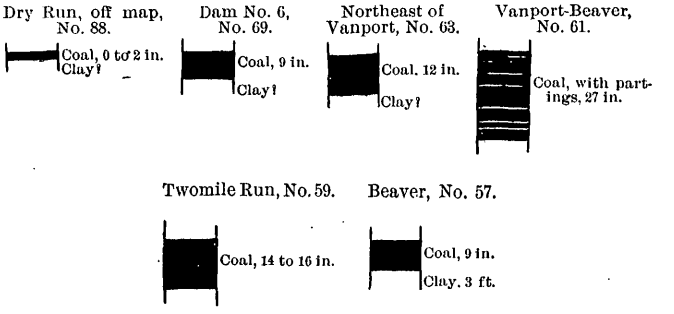

FIG. 26.—Upper Freeport coal sections, northwest region.

quarry on the Lisbon road it is said to be only 6 inches thick, whereas opposite the Boland pit on the east side of Twomile Run it measures 12 inches and back of Beaver 9 inches (section 57, fig. 26).

The Upper Freeport coal is very irregular in the southeast region, but in certain places it is well developed and of considerable value. The greater elevation of its horizon gives it a broader area of exposure than any other seam so far described. It is, for example, the only coal of this series exposed on Logtown Run within the quadrangle. On the lower course of the run it is very thin, measuring at the margin of the quadrangle, immediately under a massive sandstone, only 2 inches. Half a mile above this, however, it thickens greatly and was once opened on the Snyder

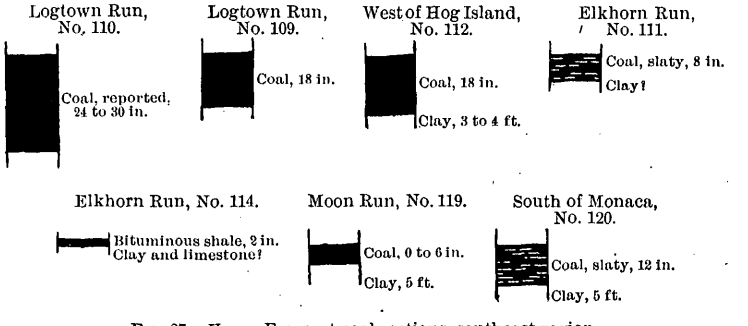

FIG. 27.—Upper Freeport coal sections, southeast region.

farm with a reported thickness of 24 to 30 inches (section 110, fig. 27). Some distance to the west, on the New Sheffield road, it becomes somewhat slaty and measures over 18 inches (section 109, fig. 27). At Aliquippa it is reported 30 inches thick, but within the quadrangle, in the run south of Stobo, it is much thinner. For example, near the head of the run the thickness is 18 inches (section 112, fig. 27), while near its mouth the Mahoning sandstone cuts the coal down to 4 inches or less (section 204, Pl. IV). On Elkhorn Run it is also of unminable proportions, being 8 inches thick (section 111, fig. 27) where it disappears beneath the run, 12 inches a

few hundred feet farther downstream, even with 1 foot of shale between it and the Mahoning sandstone, and 2 inches still farther down (section 114, fig. 27). From this point to the mouth of the run the coal is no doubt very thin or absent, for opposite the mouth on Moon Run the Mahoning sandstone cuts it down from 6 inches to a feather-edge (section 119, fig. 27). No minable proportions are known on Moon Run, except on the south fork, where, though the coal thickens to 35 inches, it is too slaty to be of much value (section 115, fig. 28).

In the river bluffs along the Monaca terrace, where the coal occurs 150 to 175 feet above the railroad, the only section obtained gave 12 inches of slaty coal (section 120, fig. 27). But in the bluffs opposite Beaver the coal becomes thicker than usual in the southeast region, measuring 31 inches (section 127, fig. 28). At this point the coal lies at nearly the same elevation as the exposure at Monaca and continues so to Bellowsville, in which distance its horizon is concealed by sandstone débris. On Poorhouse Run, however, the horizon may be recognized beneath the Mahoning sandstone and where it passes beneath the run it bears a coal 12 inches thick (section 134, fig. 28). Elsewhere along the stream, though extensively prospected, the horizon is barren, being represented only by papery bituminous leaves at the top of a clay bed. The same is true on Rag Run and this character not only prevails on the river bluffs above the Bellowsville terrace, where the horizon occurs at an eleva-

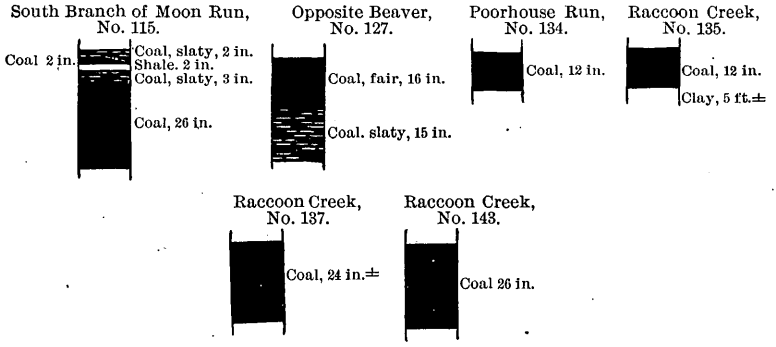

FIG. 28.—Upper Freeport coal sections, southeast region.

tion of 920 feet, but continues on the lower portion of Raccoon Creek. A coal lens, whose edge is 12 inches thick (section 135, fig. 28), appears a mile above the lower bridge over Raccoon Creek, and in a short distance increases to 24 inches (section 137, fig. 28). On the hill road east of the second bridge the seam was once opened at an elevation of nearly 860 feet and reported 22 inches thick. From this point southward to the third ford no exposures were visible and the coal possibly thins out, but near the road forks at the ford it reappears as a large coal blossom, which has been opened by drifts along the north side of the creek on the Shaffer, Steen, and Zimmerly properties. In this vicinity the coal has a shale roof, and though reported to average 30 inches in thickness, it measured at one pit 26 inches (section 143, fig. 28). To the south it outcrops on the creek road at a few points and finally, on the John Zimmerly farm, disappears, but whether beneath terrace deposits or talus float the absence of exposures renders it impossible to determine. According to the elevation of the Ames limestone, however, the coal should appear above the terrace, and on this evidence it has been provisionally so mapped. The horizon seems to reappear at the mouth of Trampmill Run, for coal is said to have been taken from the bed of Raccoon Creek at this point, but it is soon lost beneath terrace deposit and débris. In this locality the Mahoning sandstone has become greatly attenuated, being merely a shaly laminated sandstone. The spur opposite the mouth of Frames Run, as shown in section 201, Pl. IV, exhibits a series of thin coals and

black shales, having no heavy sandstones above. It seems, considering the shaly condition of the Mahoning in this locality, that this coal series may represent the Upper Freeport horizon. From this point these coals pass beneath the flood plain and it is reported that good coal has been stripped from the creek bed half a mile above on the Figley farm. This was probably the Upper Freeport seam.

This seam is better developed in the southwest region than any other so far described, and it has been opened at many places. Where it first appears above Raccoon Creek, however, it is thin and the horizon is somewhat indefinite, owing to irregularities of the Mahoning sandstone and the tendency of the seam to split in this locality (section 201, Pl. IV). Near the bridge at Independence no coal was observed, and the first occurrence, near the point where the Upper Freeport coal is said to have been taken from the creek bed, is an 8-inch seam (section 147, fig. 29), exposed about 10 feet above creek level. This may be one of the thin seams which represent the Upper Freeport coal in section 201, but whether so or not the Upper Freeport horizon must approach water level toward Service Creek and lie beneath the flood plain, since the Mahoning sandstone occurs in the bed of that stream. In this position the horizon probably continues till beyond Frames Run, where it begins to rise, near the bridge over Raccoon Creek, occurring a few feet above the road as a thin seam 6 inches thick (section 146, fig. 29). At this point the Mahoning sand-

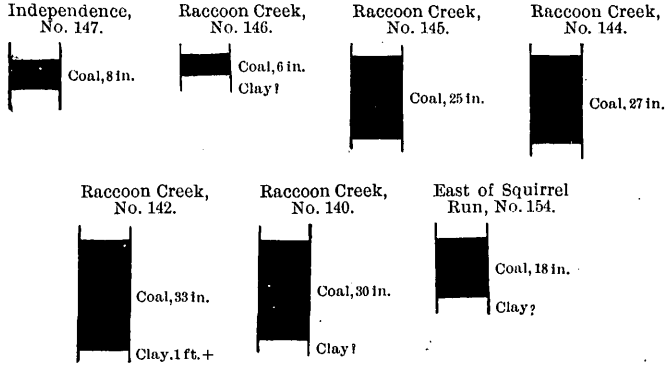

FIG. 29.—Upper Freeport coal sections, southwest region.

stone is reduced to sandy shale, but to the north it grows more prominent and gradually rises with the Upper Freeport horizon, which reaches 250 feet above creek level at Fishpot Run. At the bridge a few hundred feet beyond the outcrop near Frames Run the under clay and limestone are present, but the coal is absent, while a short distance below the bridge the coal reappears, and openings on the Todd farm show a good seam 25 inches thick (section 145, fig. 29). This thickness is maintained or increased northward on this side of Raccoon Creek, for openings on the Penny, Kennedy, and Smith farms show 27 inches of good coal (section 144, fig. 29). Some distance farther down the creek it thickens to 33 inches (section 142, fig 29), and is mined, but a near-by ravine shows 28 inches. As far as the mouth of Gums Run the coal continues generally present, as shown by coal blossoms and prospects. Prospects on the east side of the run show coal 30 inches thick (section 140, fig. 29). At the head of Gums Run, however, the coal seems to have pinched out, but along the west bank of Raccoon Creek it is present, and on the Tucker farm measures 24 inches, with a shale roof. North of this point the coal is not known, except on the upper portion of Fishpot Run, where a rather thick lens appears. Near the eastern limit of this lens (section 149, fig. 30) the coal is interbedded with sandstone, but the upper bench is 36 inches thick. This fact adds more evidence to that already found at the head of Island Run bearing on the contemporaneous deposition of coal and

sandstone at various localities in this quadrangle. Where the road crosses Fishpot Run the same coal occurs as a solid seam, and openings show a thickness of 33 inches (section 151, fig. 30). From this thickness the coal thins in the next run north of Fishpot to a few bituminous leaves at the top of the Upper Freeport clay bed, and this condition continues nearly to Squirrel Run, where the horizon lies about 300 feet above the Ohio. In this vicinity an old pit on the Carpenter farm reveals a thickness of 18 inches of coal (section 154, fig. 29). At the Emerick bank near by the seam was split into thin benches by shale and clay partings (section 153, fig. 30), resembling the exposure opposite the mouth of Frames Run (section 201, Pl. IV).

At the head of Squirrel Run both forks expose the coal, and the partings have grown much thinner (secs. 152, 156, fig. 30), but the coal is not very minable, the whole seam ranging somewhat over 36 inches. To the west the same thickness is maintained, the partings tending to disappear, and opposite Industry one opening shows 36 inches of coal with one very thin parting (section 155, fig. 30).

Coal seems to be continuously present westward to Haden Run, and maintains about the same elevation, 100 feet above Shippingport terrace. It has been opened

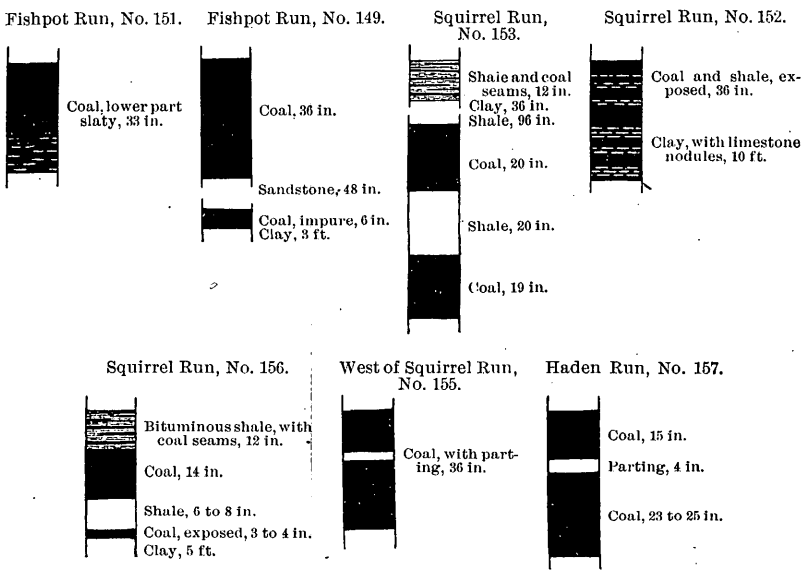

FIG. 30.—Upper Freeport coal section, southwest region.

in this stretch, but all workings are now abandoned. On Haden Run also many old pits scar the hillsides, but among them are some that are still active. Of those closed down a number on the Clear and Hendricks farms, along the east side of the run, are said to contain coal 42 to 44 inches thick (section 157, fig. 30), separated into two benches by a thin parting. Beyond the church, however, an abandoned pit is reported to have been opened on a good thickness of coal, which was shortly cut out by "hogbacks." On the west fork of the run the coal is more even and is now mined at several places, among which the Green pit shows a thickness of 33 inches (section 158, fig. 31). In this locality the coal is 50 feet higher than on the river bluff east of Haden Run, while on the bluff to the west one or two abandoned pits mark the Upper Freeport horizon a few feet lower, but no measurements could be secured. Toward Peggs Run the horizon descends about 30 feet, and though on either fork it rises again 10 or 20 feet it does not attain its elevation on Haden Run.

Peggs Run, like Haden Run, lies in a locality where a lens of the Upper Freeport coal is well developed. On the east fork the Jake pit near the junction is in 44 inches

of coal (section 159, fig. 31). The coal is of excellent quality, and has for many years furnished the fuel of the neighborhood. The Bird and Calhoun properties also show a good thickness—38 inches (section 161, fig. 31); and on the opposite side of the run the Kennedy coal bank enters on 44 to 46 inches of coal, with a thin parting near the base (section 160, fig. 32). This seam has been opened on many other properties, of which some still produce good coal. These properties were visited, but do not add any information to that already given. On the west fork of Peggs Run mining, though once extensive, is not now so active as on the east fork. Many old pits were caved in at the time of visit, but an outcrop in a ravine measured 44 inches (section 162, fig. 32). The upper 10 inches were bony and slaty, and the base of the seam was concealed. In another ravine on the west side the coal measured only 16 inches (section 164, fig. 31), but probably the whole section was not exposed, for near this point, along the road, a working pit is in 60 to 70 inches of coal (section 163, fig. 32). Rather extensive operations were once carried on farther up the run, but at the time of visit the mines were idle, in poor repair, and apparently abandoned.

In the river bluffs the Upper Freeport coal, with the accompanying clay and limestone, may be seen as a blossom on the hill road to Hookstown, and some dis-

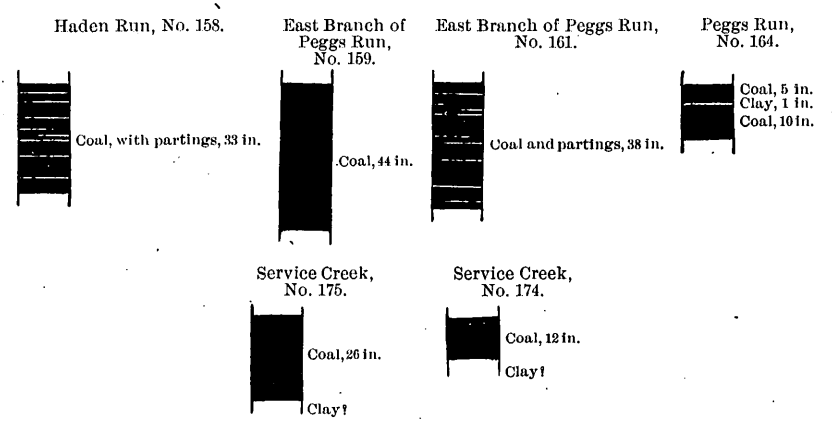

FIG. 31.—Upper Freeport coal sections, southwest region.

tance beyond in a ravine opposite Phillis Island, at an elevation of about 910 feet, it measures 42 inches (section 165, fig. 32). Within a mile to the west the lens of coal which occupies Peggs and Haden runs and extends to Phillis Island thins out to a few bituminous leaves above the Upper Freeport clay. The Beaver County Coal Company was an unfortunate victim of its irregularity, for though at the mouth of the mine the seam measured 38 to 47 inches (section 169, fig. 32), at the end of a 200-foot drift the coal had pinched to 8 inches and could not be found of greater thickness. This example shows the infeasibility of beginning extensive mining operations on the Upper Freeport seam before the property to be exploited has been thoroughly tested by diamond-drill borings for the purpose of locating lenses of this illusive bed. A short distance beyond this mine the seam was years ago extensively opened at several points on the Simpson, Calhoun, and Brown farms, but no measurements could be obtained. The coal is uniformly reported, however, to be 48 inches thick. Beyond these openings and above Georgetown terrace little is known of the coal. It is probably absent or very thin, for the Mahoning sandstone becomes coarse and on Smiths Run cuts the coal down to a few inches. This condition apparently continues for a mile along the east side of Mill Creek, but beyond this on the west bank and to the south the seam thickens to minable proportions. The

seam rises southward, so that toward Hookstown it becomes 40 to 60 feet higher than at Georgetown. On the lower course of the creek the coal was once opened on the Bryan property on the west bank, where it is reported to be 48 inches thick, and half a mile above this, on the east bank, 24 inches of coal were uncovered in a small ravine, but the Swerngan pit along the road halfway to Hookstown shows both thicknesses (section 172, fig. 32). In some old pits on the Wright and Swerngan farms, a short distance beyond, 36 inches of coal were seen, but in a ravine on the west side opposite the Stewart mine the coal varies from a feather-edge to 2 feet. In fact, the coal on the west bank seems much less regular than on the east bank and possibly indicates a thinning of the lens toward the west. Stewart's mine, on the east side of the creek, enters on 44 inches of coal (section 173, fig. 32) and Mr. Stewart reports that the coal varies in general from 41 to 48 inches in thickness. The coal from this mine is of excellent quality, and for many years has supplied the local market. This is the largest and best developed coal mine known in the quadrangle. Opposite the mine on the west side of Mill Creek the coal is not so thick, but the horizon continues up the creek a third of a mile beyond the mine and then

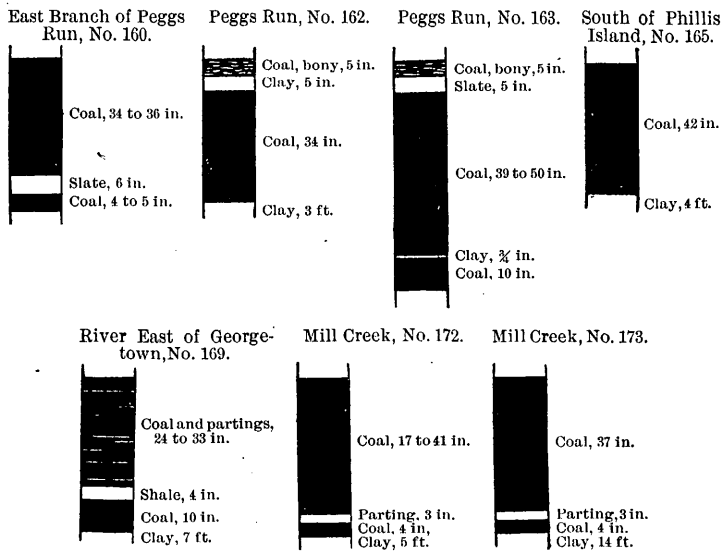

FIG. 32.—Upper Freeport coal sections, southwest region.

disappears beneath the stream. At Hookstown a shaft was sunk 40 feet through massive Mahoning sandstone in the hope of striking this seam. The horizon seems to have been found, but reports are dubious as to the thickness and quality of the coal. Operations, moreover, have been suspended and probably the coal found was of little value.

The Mill Creek lens of coal, as suggested above, evidently thins westward; for on Little Mill Creek outside of the quadrangle it averages 12 inches, but ranges between a knife-edge and 24 inches.

The only other occurrence of the Upper Freeport coal in the southwest region is on Service Creek, 4 miles from Raccoon Creek. In this locality an anticlinal arch brings the coal a few feet above the bed of the stream for a distance of half a mile. Good exposures were difficult to find, but on the south side of the creek one section exhibited 26 inches of coal (section 175, fig. 31). The same thickness is reported nearly opposite this point, below the road on the north side of the creek, and to the west near the mill, where it disappears beneath the stream, but to the east it becomes slaty and the good coal thinner. Near the point where it disappears on the east it measures only 12 inches (section 174, fig. 31).

Summary.—The Upper Freeport coal occurs in numerous irregular lenses, some of which are thick enough to be of considerable value. As a rule, applicable to this seam in particular, the coal is more likely to maintain a uniform thickness when it supports a shale roof than when the roof is a coarse sandstone. In the latter case coal several feet thick may thin out to a few inches or to a knife-edge within two hundred feet, as at the Beaver Coal Company's mine. For this reason calculations on the amount of coal in a given area are valueless except as a maximum, unless the area is thoroughly prospected by test holes.

North of the Ohio, in the northeast region and eastern part of the northwest region, this coal is of no commercial importance at present. The observed croppings range in thickness from a few inches to 27 inches, averaging about 17 inches, and in many instances the coal is entirely absent beneath the Mahoning sandstone. Moreover, the seam is more or less slaty and parted. The western portion of the area, however, including the valleys of Brush and Sixmile runs and all runs west of the latter, contains more or less restricted patches of excellent coal. It is still true that the patchy occurrence of the coal is due to irregularities in the Mahoning sandstone roof and that for this reason conclusions as to the extent of minable coal in this region are of little value; nevertheless, this area includes several irregular lenses of coal ranging between 30 and 53 inches in their thicker parts and thinning marginally to a few inches and in places to a knife-edge. The coal in these localities is usually pure ar d free from partings and is an excellent fuel.

South of the Ohio, in the southeast region, this seam is in places considerably thicker than in the northeast region, but less uniform. In this area it ranges from a feather-edge or 2 inches of bituminous shale to 35 inches of coal and partings together. Obviously this variation greatly destroys the value of the coal in this area. In general, however, the thin and irregular coal is restricted to the river front and to the lower courses of Logtown, Elkhorn, and Moon runs. In these localities the Mahoning sandstone is well developed and often lies upon the coal, thus affording an example of the irregularity of coals having a sandstone roof. But near the heads of these streams and along Raccoon Creek it averages about 26 inches and has been worked by country banks for years. In general the quality of the coal is good, but it may at times run shaly at the top or bottom, or disappear altogether.

In the southwest region the lenses of this coal seem more extensive than usual, but the coal is not so clear as north of the river. Along the river and its small laterals this seam is much broken by partings and slaty coal. The benches of coal, however, are generally sufficiently thick to overcome this disadvantage. In this district the observed exposures range from 16 to 70 inches, including partings. On Raccoon Creek and its western tributaries, on the other hand, the coal is thinner and free from partings. In this basin the thicker portion averages 24 inches, but where observed it varies from 6 to 33 inches.

In the southwest region, as a whole, the Upper Freeport coal, when of minable dimensions, is of excellent quality and rarely inclined to be slaty. It has, therefore, been worked for many years for local consumption. Mill Creek is the only locality, however, where a regular mine is operated throughout the year.

As shown in the sections from Squirrel and Fishpot runs (sections 49, 153), near the mouth of Service Creek (section 201), on Island Run, and elsewhere, the partings in some instances become thick enough to produce a "split vein." This phenomenon leads to the belief that deposition of the coal-making material of this period was locally interrupted for a considerable time, during which sandstone, shale, or clay was deposited. Thus a single coal seam may split, the benches becoming widely separated, but both still belonging to the same geologic horizon.

COALS OF CONEMAUGH FORMATION.

The coals of the Conemaugh formation, except perhaps the Brush Creek coal, have already been given as much space as their importance deserves. They are, within the quadrangle, thin, impure, and extremely variable in thickness.

BRUSH CREEK COAL.

This seam is of no general importance, but it has been opened in two or three instances, and other local pockets may be found in which it is thick enough to serve a very limited demand. The occurrence 5 miles up Brady Run has already been mentioned. Here the seam lies about 75 feet above the Upper Freeport coal and consists, it is said, of 20 inches of coal split by a parting near the top (section 37, fig. 33).

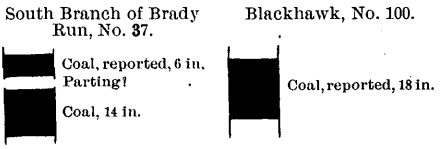

FIG. 33.—Brush Creek coal sections.

At Blackhawk, a coal in the same stratigraphic position, has been opened west of the blacksmith shop. The pit was caved in at the time of visit, but the coal is reported 18 inches thick (section 100, fig. 33). This exposure is about 90 feet above the Upper Freeport horizon, but the interval shortens near Industry, where the coal measures scarcely 6 inches (section 252, Pl. VII). The same interval and thickness are also maintained on Rag Run, while on Sixmile Run the coal measures 12 inches (section 250, Pl. VI) and occurs only 65 feet, by aneroid, above the Upper Freeport. Besides these exposures, the Brush Creek horizon is frequently marked on highways by a blossom, which probably is as often due to the accompanying black shale as to the coal itself.

COALS OF MONONGAHELA FORMATION.

PITTSBURG COAL.

This is the only coal seam of the Monongahela formation which occurs in the Beaver quadrangle. About a dozen hilltops in the southeastern part of the quadrangle show this coal and it has been opened in all of them, but at the time of visit none of the pits was open for measurement. The coal is reported, however, to be 5 or 6 feet thick, including shale partings, but owing to the fact that the rock covering is too thin to shield it from the deteriorating action of surface waters, it is deeply weathered and generally considered of poor grade. To the south, however, as the seam becomes more deeply covered by overlying rock, the coal improves in quality. A measured section taken just outside of the quadrangle, a mile west of Frankfort Springs, may be offered to show the relation of the two benches so characteristic of this coal (section 171, fig. 34).

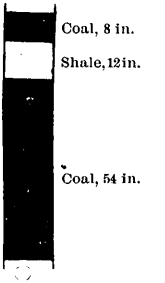

FIG. 34.—Pittsburg coal section.

ANALYSES OF COALS.

No new analyses of coals from this region are available. Old analyses, therefore, which were made by A. S. McCreath for the Second Geological Survey of Pennsylvania and which, perhaps, will be of some value, are here appended. Most of the mines named below have changed hands and, if indeed they are in operation at all, are not now known by these names.

Analyses of coals from Beaver quadrangle.

	Lower Kittanning coal (upper bench).			Lower Kittanning coal (lower bench).			
	1.	2.	3.	4.	5.	6.	7.
Water	1.850	2.080	2.200	2.270	2.370	2.400	2.160
Volatile matter	41.260	39.250	39.440	38.870	36.470	38.110	40.885
Fixed carbon	43.263	48.818	50.705	50.173	51.845	54.619	49.488
Sulphur	4.177	1.927	.825	2.322	1.770	.791	1.767
Ash	9.450	7.925	6.830	6.365	7.545	4.080	5.700
	100.000	100.000	100.000	100.000	100.000	100.000	100.000
Coke	56.89	53.67	58.36	58.860	61.16	59.490	56.955

	Lower Kittanning coke (lower bench).	Darlington coal.			Upper Freeport coal.			
	8.	9.	10.	11.	12.	13.	14.	15.
Water	0.010	2.680	1.770	2.090	1.660	2.080	1.500	1.530
Volatile matter	0.633	36.205	38.628	35.700	37.065	39.520	39.870	41.380
Fixed carbon	84.727	53.804	56.333	59.685	51.351	54.691	46.960	49.798
Sulphur	1.994	2.391	.717	.580	2.709	1.249	4.595	2.467
Ash	12.636	4.920	2.560	1.945	7.215	2.460	7.075	4.825
Total	100.000	100.000	100.008	100.000	100.000	100.000	100.000	100.000
Coke		61.115	59.610	62.210	61.275	58.400	58.630	57.090

1 and 4. Pulaski Township, near New Brighton; Mendenhall & Chamberlin's mines.
2 and 5. Pulaski Township, near New Brighton; Couch's mine.
3 and 6. Patterson Township, near Beaver Falls; Hulmes's mine.
7. Pulaski Township, Blockhouse Run; Fish's mine.
8. Patterson Township, Beaver Falls; Hulmes's coke ovens.
9. Brady Run, 1 mile west of New Brighton; Middleton mine.
10 and 11. Georgetown; Diehl's and Bryan's banks, respectively.
12. Raccoon Township, Service Creek; Cotter's bank.
13 and 14. Greene Township, Mill Creek, near Hookstown; Swearingen's and Todd's banks, respectively.
15. Near Shippingport; Wilson's bank.

CLAY.

INTRODUCTION.

The clay industries of this region, as well as of this particular part of the State, are at present practically confined to the valleys of Ohio and Beaver rivers. For the purpose of comparing the clays of this locality with others in the western part of the State, analyses and notes of clays in other districts have been included. The mining and working of clay ranks as the foremost industry in this region, but it is placed after coal in this report in order that advantage might be taken of the discussion of that product, since the clay horizons are practically the same as those of the coals.

In the following discussion of the occurrence of these clays there is some repetition of the matter given under coals, but, if any description of the extent of the clays is to be given, this can not be avoided, since the two are so closely associated. On the other hand, it is not desirable to repeat the detailed method of discussion followed in the section on coals for the reason that definite measurements of clay outcrops are difficult to obtain, except in or near mines. Approximate thicknesses were generally obtained near coal outcrops and in ravine sections, to which references will be made in order to show detailed dimensions and to indicate on the map (Pl. VIII) the exact position of such measurements; but prospecting is the best method of determining the thickness as well as the quality of clay.

ORIGIN AND GENERAL COMPOSITION.

Clay is commonly understood to originate chiefly from rocks of the granitic and gneissic varieties which contain minerals made up largely of alumina and silica, such as the feldspars and allied minerals, the amphiboles, micas, etc. On the disintegration of such rocks the minerals decompose and the resulting products, together with fragments of the minerals themselves, are in many cases washed away, sorted by water, and deposited in favorable places much after the manner of river silts. In other cases these materials remain near the original rocks from which they are derived, consequently are not sorted, and are subject only to the deteriorating action of percolating waters. Since kaolin is a common decomposition product of many alumina-silica rocks, it seems that it should be present in most clays, and formerly kaolin was supposed to form the basis of all clays. But now it seems that the presence of kaolin depends on the absence of alkalies, with which it usually combines to form other minerals, chiefly mica. Thus clays overlain by coal seams are said to show much kaolin present, owing to removal of alkalies by vegetation, while in clays not overlain by coal no kaolin was recognized.[a] On the other hand, some clays, such as china clay and the like, are composed almost entirely of kaolin. Besides varying amounts of kaolin, minute flakes and grains of the original minerals may be present, such as feldspar, quartz, mica, etc.

KINDS OF CLAY.

Nearly all the clays mined in the Ohio Valley in this State are of sedimentary origin. This includes the regularly-bedded deposits, such as usually occur in association with beds of coal. These have received the general designation of fire clays, though they vary greatly in their refractoriness—that is, in their ability to withstand intense heat. The less pure and uniformly graded deposits in the present and abandoned channels of the streams, especially Ohio and Beaver rivers, are also sedimentary clay, which locally bears the name of "terrace clay." Similar deposits were formed in temporary lakes of the Glacial epoch and are sometimes designated "basin clay." The fire clays of the quadrangle have experienced in their present situation a vastly longer and more eventful history than either the terrace or the basin clays. They have been exposed to the leaching action of waters and often to the absorbent action of a dense vegetation which grew upon them and now remains as coal seams. As a result of these conditions fire clay is poorer in alkalies and iron than most terrace or basin clays. In addition fire clay has been subjected to various other influences. It has become covered with hundreds of feet of other deposits and the dynamic forces which consolidated them into hard sandstones and shales perhaps effected a similar change in the clay. This clay, therefore, in point of structure and hardness is likely to differ from the terrace and basin clays, which are yet in a primitive state.

The residual clays are found in the uplands, back from the rivers, but are not common in this region. Small quantities, however, are sometimes present on the outcrop of limestone and certain shale beds, but since the upland rocks are of a generally sandy character, such clay is of little commercial importance and has never been utilized.

In age all the clays within the quadrangle are either Carboniferous or Quaternary. To the former belong the fire clays, occurring chiefly in the Allegheny formation, and to the latter the terrace, basin, and other clays.

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[a] Hutchings, W. M., Geol. Mag., new ser., decade 3, vol. 8, 1891, pp. 164 et seq.; idem, decade 4, vol. 1, 1894, pp. 36 et seq.

CLAYS OF ALLEGHENY FORMATION.

The workable bedded clays or fire clays are largely confined to the Allegheny formation, and the infrequent clay beds of the Conemaugh formation will be discussed under "Shale" (p. 65). In the Allegheny measures clays occur at several horizons, which are usually the same as those of the coals whose names they bear. The relative position of the beds is represented in the section on page 10, and the same order will be followed in this discussion.

BROOKVILLE CLAY.

Within the quadrangle the deposit of clay underlying the Brookville coal, being the lowest clay bed exposed, is known only on the west side of Beaver River; but elsewhere it can, like the coal, often be reached by shafting or drifting short distances through unconsolidated gravels. The horizon first comes to the surface near the Pittsburg and Lake Erie Railroad bridge over Brady Run and is again exposed farther up the river (section 236, Pl. V), but in most places it is covered by river deposits. Where seen it ranges from 3 to 5 feet in thickness. So far as known, however, nothing has been done toward exploiting the Brookville clay in this county, nor are analyses of the clay from this vicinity available, but an analysis from a near-by locality is here appended.

Analysis of Brookville clay.[a]

SiO_2	62.05
Al_2O_3	27.71
Fe_2O_3	0
FeO	.60
MnO_2	0
CaO	.15
MgO	.20
Alkalies	2.40
H_2O, organic	6.67
	99.78

At Haydenville this clay is used in manufacturing paving bricks, fireproofing, and sewer pipe. The Brookville clay has been mined for thirty-five years in Indiana County, where it is a plastic clay of good quality, varying in thickness from 3 to 11 feet. It contains, however, many iron balls and has to be hand picked.[b] In Fayette County, also, where it is a flint clay of excellent quality, it has been extensively used for refractory materials.[c] At the typical locality of the overlying coal (Brookville, Jefferson County), the clay beneath is 15 feet thick, but only the upper 6 feet are used.[d] It seems, therefore, that the Brookville horizon in Beaver County may yet become a producer of workable clay where the bed can be profitably mined.

CLARION CLAY.

This bed underlies the Clarion coal, which it follows throughout the quadrangle. It disappears beneath river level nearly opposite S. Barnes's brick works and beneath Brady Run near the forks, but even where above water (sections 234, 237, Pl. V) it is generally covered by terraces and stream deposits. As to its character, it is reported to be in many respects superior to the Lower Kittanning clay. It contains, says Mr. Hice, who has worked this clay in the past, a smaller percentage of iron and probably of alkalies, than the Lower Kittanning, and certainly stands more firing, burning to a much whiter color than any other clay in the quadrangle. It resists weathering, however, much more than the Lower Kittanning, which, clay workers believe, ren-

[a] From Haydenville Mining and Manufacturing Company, Haydenville, Ohio. Geol. Survey, Ohio, vol. 7, 1893, p. 139. E. M. Reed, analyst.
[b] Ries, H., Prof. Paper U. S. Geol. Survey No. 11, 1903, p. 218.
[c] Campbell, M. R., Geologic Atlas U. S., folio 82, U. S. Geol. Survey, 1902, p. 20.
[d] Second Geol. Survey Pennsylvania, Rept. H, p. 225.

ders it less adaptable to the manufacture of stoneware. On account of the unfavorable position of the outcrop, except in small areas along Beaver River and Brady Run, it can not be so easily nor cheaply mined as higher clays. It has been opened, however, on Brady Run, back of the porcelain works, and was once used, together with Lower Kittanning clay, by the Fallston Pottery Company (now out of business). In a drift 150 feet long the clay is said to maintain a uniform character and thickness, but has been variously reported 6, 10, and 12 feet thick, with no coal above. Only contradictory reports in regard to its quality at this point could be obtained. It is said, however, to make fine brick. Though it comes to the surface wherever the coal is exposed, it has never been opened elsewhere in this region, and few observations were obtained as to its thickness. Among these are sections 234, 236, and 237, where it is 4 to 5 feet, with the coal in places absent. No analysis of this clay is available, but it has been used with good results at Bolivar, Pa. The thickness of the Clarion clay at three localities in Pennsylvania is here given.[a]

Thickness of Clarion clay in Pennsylvania.

	Ft.	in.
Johnstown, Cambria County	3	6
Bens Run, Cambria County	6	0
Pinkerton Point, Somerset County	6	0

LOWER KITTANNING CLAY.

The Lower Kittanning is the most valuable clay horizon of this region. It is the source of practically all the clay mined along Ohio River in Pennsylvania and Ohio, as well as in West Virginia, where I. C. White says it attains its maximum thickness.

As the Lower Kittanning lies considerably above the clays last mentioned, it has accordingly a larger area of exposure above river level. It is, in short, to be found throughout this region above and on both sides of Ohio and Beaver rivers, immediately underlying the Lower Kittanning coal, represented on the map (Pl. VIII). It is not, however, actually exposed throughout this whole extent, but is covered for half the distance by broad, flat gravel terraces. Where thus covered, it may be reached by excavations through loose gravels to depths varying for the different terraces, as previously discussed under Lower Kittanning coal (pp. 28–33). Elsewhere it is exposed usually 7 to 10 feet thick, in the same manner as the coal along the more precipitous banks of the rivers and on some of their tributaries. Of the latter Blockhouse Run, in the northeast region, ranks first, not in the extent of outcrop, which covers only a mile and a half, but in the number of operating plants which use this clay. This run has, indeed, been the site of clay-mining operations ever since the infancy of the industry. The clay bed in this vicinity (sections 15, 19, and 22, figs. 3 and 4) varies in thickness from 2 to 10 feet. At McDonald's clay mine, outside the quadrangle, it is also 7 feet thick. This, as seen from the tables on page 72, is the average thickness of good clay found in the mines on Blockhouse Run, but it varies a few feet at different points. As a whole, the clay everywhere is of a drab-gray color when fresh and creamy white on long exposure. The lower part at times seems to grade insensibly into a sandy, siliceous clay below, which may acquire a hard, shaly character, while the upper part remains a purer clay of more plastic quality. Different thicknesses are therefore mined, according to the purpose for which the material is to be used. For instance, Sherwood Brothers remove only the upper 6 feet, because below this depth the bed is too siliceous for stoneware. The other companies on Blockhouse Run mine a greater thickness, varying from 8 to 10 feet, according to the results desired. In the mine of the American Sewer Pipe Company the clay proper sometimes thins to 1 or 2 feet, but the impure material underneath, mixed with some good clay, is suitable for the company's requirements, and hence a greater thickness is removed.

[a] Ries, H., Prof. Paper U. S. Geol. Survey No. 11, 1903, p. 222.

Southward along the river many other companies are exploiting the same clay seam and the various thicknesses used are indicated in the accompanying table (p. 72). The clay at the Ingram mine, for example, is most plastic at the top, being hard and sandy toward the bottom, while the base for 2 feet is mixed with iron and is not removed. At the S. Barnes Company's mine, on the contrary, the soft clay occurs both at the top and bottom, the toughest clay being in the middle. At both mines, however, the whole bed is used after thorough mixing. At the Miller brick works and the Pennsylvania Clay Company's mine, on Crow Run, the clay displays the same characteristics. At the former place the upper 7 feet are good plastic clay, while the rest is sandy and shaly. For colored paving brick the lower part is used and for white fire brick only the upper, plastic portion. Practically the same is true of the Pennsylvania Company, for the upper, plastic clay, which varies from 2 to 5 feet, is used for fire brick, while for paving brick, where iron is needed for colors and silica for strength, a mixture of the upper and lower parts is necessary.

The northwest region also is noted for its many clay plants. Here Brady Run might be made the counterpart of Blockhouse Run, for it exposes an extent of clay six times that of the latter. In addition, Brady Run is a straight stream of the low-grade, open-valley type, with its mouth near a railroad, and offers exceptional facilities for the manufacture of clay products. Moreover, mining here may be carried on by drifts instead of shafts. Nevertheless, as seen from the table, but three companies operate on this run, as against six on Blockhouse Run. These have opened the clay near Fallston and use its full thickness, together with some of the sandy clay shales at the base. For instance, the upper 8 feet at the Standard fire-clay mine and 6 feet, more or less, at the Fallston fire-clay works, show the thickness of the plastic clay. Below this, as at other places, the clay is sandy, but is, nevertheless, removed and mixed with the upper part for most purposes. The Pennsylvania mine here takes out the greatest thickness, the lower part being added, it is said, to aid in fluxing.

Elsewhere on Brady Run no good opportunities for measurement were found, but the clay was noted present wherever the overlying coal was observed (sections 239, 241, 243, 245, Pl. VI) and measurements of the best exposures, which in cases approximate the truth, show the thickness to vary from 6 to 7 feet or more (sections 32, 34, figs. 5 and 6). On the west bank of Beaver River, though the clay is generally present, full exposures are still less frequent and the greatest thickness seen was 5 feet (section 235, Pl. V).

Along the Ohio the horizon follows the undulations of the Lower Kittanning coal and is exploited at several places in the vicinity of Vanport. As shown in the table (p. 72) thicknesses varying from 7 to 12 feet are removed, but the latter amount no doubt includes not only the lower, siliceous layer, but also 2 or 3 feet of basal shales. The Spear Clay Manufacturing Company, for instance, used an average of 1 foot of basal shales, which is mixed with other clay for paving brick. Of the other plants only Gloninger & Co. use exclusively what is probably the plastic part of the clay. West of Fourmile Run (section 251, Pl. VI) this seam has not been opened, and its thickness and quality are judged from a single exposure near Industry (section 252, Pl. VII), where 7 feet of good clay were uncovered in a ravine. Blossoms of the clay were seen at many points farther west, and it is safe to assume that it may be found wherever the Lower Kittanning coal comes to the surface. It extends several miles up Little Beaver River and its tributaries, which for the most part lie in Ohio, but some of the eastern branches, as Island Run and Little Beaver Creek, head in Beaver County, Pa. So far as known, this clay has not been opened on these streams, but at Darlington it has been reported 10 feet thick.[a]

South of the Ohio this seam has been exploited only in the vicinity of Monaca.

[a] Second Geol. Survey Penn., Rept. Q., p. 232.

It might, nevertheless, be uncovered at many points south of town until it reaches water level near Hog Island. The Pennsylvania Clay Company, at Monaca, in the manufacture of paving brick, utilizes the whole thickness of clay, to which is added some shale, while the Welch Fire Brick Company, at the west end of town, is endeavoring to use only the upper 7 feet of the seam. This, being the plastic portion of the clay, is said by this company to be best for fire brick, but for paving brick the lower, sandier portion is generally added.

Westward along the river the horizon lies near the road and is marked by two old brickyards. One owned by Mr. Reed shows clay from 5 to 8 feet thick (section 129, fig. 7). These works are now inactive, it is said, for the lack of transportation facilities. The Bellowsville terrace covers the horizon to Raccoon Creek, and the dubious extent of the Lower Kittanning on this stream has already been discussed under "Coal" (p. 32). Shallow excavation, however, at the rear of the terrace, may uncover the clay, as the Deens pit, on Poorhouse Run, definitely proves; while near the bridge over Raccoon Creek (section 215, Pl. IV) no excavation is necessary. Nevertheless, it is probable that not until avenues of transportation have been perfected can operations on clay seams south of the river be profitably carried on. Owing to breadth of flood plain, conditions on the west side of Raccoon are more favorable to exploitation; furthermore, facing Ohio River the horizon lies above terrace level for at least a mile. No exposures, however, were seen as far as Phillis Island, and within this distance opportunities for mining the clay vary extremely. Between Squirrel Run and Industry Ferry, for example, river cliffs prevent all access to the bed, whereas the Shippingport terrace, like the Bellowsville and Georgetown terraces, offers admirable sites for plants. Opposite Phillis Island the clay was seen over 5 feet thick (section 254, Pl. VII), but here, too, as well as westward to the Georgetown terrace, though the horizon is uncovered in several ravines, the river does not allow room for large brickyards.

Analyses of Lower Kittanning clays.

	1.	2.	3.	4.	5.	6.
SiO_2	61.970	61.750	62.890	62.260	66.610	56,670
Al_2O_3	22.940	23.660	21.490	23.890	18.390	26.560
FeO	1.818	1.930	1.818	1.408	1.964	2.106
TiO_2	1.975	1.780	1.825	1.780	2.810	1.790
CaO	.440	.455	.380	.470	.490	.260
MgO	.522	.353	.569	.309	.547	.277
Alkalies	1.750	2.418	2.525	1.977	1.079	3.790
H_2O (hygroscopic)	1.480	.680	1.160	7.640	7.495	8.360
H_2O (combined)	7.370	7.200	7.580			
	100.265	100.226	100.237	99.734	99.385	99.813

	7.	8.	9.	10.	11.	12.	13.
SiO_2	57.670	60.190	61.980	68.920	56.37	61.86	67.50
Al_2O_3	27.520	24.230	23.880	22.380	29.62	26.02	25.70
FeO	1.494	2.097	1.395	.980	[a]1.14	.63	3.76
TiO_2	2.540	2.345	1.830	.....	.....	.....	.....
CaO	.380	.850	.040	.190	.45	.19	.60
MgO	.122	.036	.281	.172	.14	1.26	1.55
Alkalies	.619	1.669	2.677	.....	1.08	.31	.....
H_2O (Hygroscopic)	9.680	9.015	7.820	6.140	1.92	9.98	Loss .35
H_2O (combined)	.....	.....	.....	.....	8.71		
	100.025	100.432	99.903	98.782	99.43	100.25	99.46

[a] As sesquioxide.

1 to 4. From Elverson & Sherwood's mines, near New Brighton, Beaver County, being, respectively, first, second, and third grades of clay and the raw clay. Analyses by D. McCreath. Second Geol. Survey Pennsylvania, Rept. MM, p. 262.
5. Mendenhall & Chamberlin mines, near New Brighton, Beaver County. Analysis by D. McCreath. Ibid.
6. Coale's clay, near New Brighton, Beaver County. Analysis by D. McCreath. Ibid.
7. Couch's clay, New Brighton, Beaver County. Analysis by D. McCreath. Ibid.
8. Severn's clay mines, near Vanport, Beaver County. Analysis by D. McCreath. Ibid.
9. S. Barnes & Co.'s clay, Bridgewater, one mile north of Rochester, Beaver County. Analysis by D. McCreath. Ibid.
10. Brady Run Fire Brick Company, Beaver County. Analysis by F. G. Frick. Mineral Resources U. S. for 1896; Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 5 (continued), 1897, p. 1155.
11. Flint clay from Mineral Point. Analysis by N. W. Lord. Geol. Survey Ohio, vol. 7, 1893, p. 221.
12. Haydenville, Ohio. Analysis by E. M. Reed. Geol. Survey Ohio, vol. 7, p. 139.
13. Average of six analyses made for Vanport Brick Company, Vanport. Analyses by Hunt & Clapp, Pittsburg Testing Laboratory.

A comparison of the analyses of Beaver County clays with those of clays of the same horizon in Ohio makes evident their similarity. The Lower Kittanning bed in Ohio is used by the finer pottery manufactories for saggers, also in part for the manufacture of yellow and Rockingham ware, and even for stoneware, besides sewer pipe and fire, building, and paving brick.[a]

In a similar manner the Lower Kittanning clay of Beaver County supplies all the potteries and the hollow ware, fire, building, and paving brick factories at New Brighton and the brickyards south of that place on Beaver and Ohio rivers.

MIDDLE KITTANNING (DARLINGTON?) CLAY.

The Middle Kittanning clay bed is persistent throughout the region, with a thickness generally of 5 to 7 feet, and occurs immediately under the Darlington coal. It therefore has the same extent and lies covered or uncovered in the same manner as the coal which has been described on page 33. The clay, however, is rarely worked, containing, it is said, too many iron nodules for most wares. The iron on weathering clouds the clay a rusty brown, and seems more evenly distributed through it than is the case with the Lower Kittanning, which carries most iron in its lower part. No analyses are available, nor does the clay seem to be in general use; its quality therefore can only be inferred. In 1902, however, it was being opened by the American Sewer Pipe Company and by A. F. Smith, but the latter has discontinued prospecting on it. No good section for measurement was exposed in the northeast region, but it was generally present as a blossom wherever the Darlington coal was seen (sections 227, 232, 233, Pl. V).

In the northwest region the clay, though scarcely developed by workings, is much better exposed than in the northeast region. For instance, along Beaver River and on Brady Run it is well shown (sections 237, 239, 240, 242, 243, and 247, Pls. V and VI). In these sections it is seen to attain 5 feet in thickness, and possibly in one case 10 feet (section 239). In section 240 the clay outcrop is distinctly ferruginous. Along the Ohio measurements of several exposures were obtained, all of which are comparable to those given above (sections 249, 251, 253, 259, 260, Pls. VI and VII). In these the range is from 3 to 6 feet (sections 56, 71, 85, figs. 10 and 11). At one point, near Merrill, where the clay was once opened by Geo. Dando & Co., it measured 5 feet, but was of an impure, ferruginous character.

South of the river no openings are known on this seam; a few sections, however, are well exposed in ravines, of which the best in the southeast region may be seen opposite Beaver (section 128, fig. 12). Here the clay is 15 feet thick, but not all of good appearance, and it is a significant fact that it has never been used in the neighboring clay yards. Elsewhere clay is always present where the Darlington coal is exposed, but full measurements are not uncovered. For instance, thicknesses of 2 feet were observed on Moon Run (section 117, fig. 12), and near the Welch Brick Works (section 125, fig. 12). In the southwest region it is well shown at only two places, and here, too, as well as east of Raccoon Creek, has never been opened. In a ravine south of Phillis Island it may be seen 5 feet thick (section 166, fig. 13), and on Mill Creek, outside the quadrangle, 7 feet (section 257, Pl. VII).

[a] Orton, Geol. Survey Ohio, vol. 7, 1893, p. 47.

LOWER FREEPORT CLAY.

The clay underlying the Lower Freeport coal has the same crop line as the coal and is equally variable in occurrence. In the outcrop it is a light-colored plastic clay of good appearance, but it has not been exploited to any extent within the quadrangle, perhaps because it contains, as it is said, too much iron to be of high grade. Its usual thickness is 3 to 5 feet, though at one place on Blockhouse Run, where it has been developed for sewer pipe, it is reported to be locally 12 to 14 feet thick, but this may include some of the basal shales. Exposures in two or three ravines in the northeast region display typical sections. One back of Rochester (section 10, fig. 16) uncovers a thickness of 5 feet, while in another, on the north fork of Blockhouse Run, only 3 feet of clay are exposed.

Similar dimensions were also observed generally throughout the northwest region, but in the river bluff opposite New Brighton it reaches the maximum of 4 feet (section 45, fig. 17). On Brady Run, however, it exhibits a thickness of only 2 feet (sections 33, 42, fig. 17,) in its usual position under the Upper Freeport coal, but in some places a clay occurs under the Lower Freeport limestone, as at section 42, where 10 feet of clay shale was found. A similar manner of occurrence is represented in section 241, Pl. VI, where 7 feet of clay underlie the limestone. Except a blossom 1 foot thick on Twomile Run (section 60, fig. 17), no good showing was seen as far as Georgetown Island. From this locality northward on Dry and Island runs and on the Elton farm, off the northeast corner of the quadrangle (sections 83, 91, 105, fig. 18, and section 260, Pl. VII), the observed thickness varies from 2 to 3 feet.

Although in the southeast region the clay shows more prominently in the outcrop, it can not, without prospecting, be said to maintain a thickness greater than actually exists north of the Ohio. It is in general present, at least as a blossom, wherever the coal is seen, and near Monaca (sections 121, 123, fig. 20) was uncovered for 4 to 5 feet. The east bank of Raccoon Creek shows the next best outcrops. Near the bridge the clay is 3 feet thick, while farther south (sections 136, 138, fig. 20) 5 feet were observed.

In the southwest region exposures are very poor and scarcely any data on the thickness of the clay were obtained. In fact, in some places where the Freeport sandstone was abnormally developed both coal and clay were absent. An infrequent blossom, however, was seen, and a single outcrop on Fishpot Run measures 5 feet (section 148, fig. 21).

UPPER FREEPORT CLAY.

The Upper Freeport clay, averaging 177 feet above the Lower Kittanning coal, underlies the Upper Freeport coal and has, therefore, a very irregular and extended crop line near the top of the river bluffs and along all lateral streams. Since the horizon of the Upper Freeport coal may, for all practical purposes, be considered that of the clay, reference to the geologic map (Pl. VIII) will show more in detail its extent. It will be found, for example, to disappear finally under Raccoon Creek near Independence, under Mill Creek at Hookstown, under Dry Run and Island Run near Ohioville, and under Brady Run near Blackhawk. Its extent on smaller streams can be similarly traced.

Along the rivers, where transportation is established, both the Upper and Lower Freeport clays are at a disadvantage, not only because of their high elevation but because the Lower Kittanning seam, a clay commonly of greater thickness and superior quality, is much more accessible.

The Upper Freeport clay is more persistent than the overlying coal, which in places is present simply as thin, papery layers of bituminous matter. Generally in such sections the clay is of a pale-blue color and excellent appearance. In many places, however, the clay holds nodules of iron ore which stain it considerably and which must be removed before using. Usually the clay shows in outcrop 3 to 5 feet

thick, but a detailed description will give approximate thicknesses in specific localities.

In the northeast region exposures are well distributed. The easternmost outcrops (sections 7, 24, 25, fig. 22) are uniformly 3 feet thick, except one (section 6) which is 4 feet and pregnant with calcareous nodules. The other exposures (sections 226, 229, Pl. V) range from 5 to 6 feet, and the last has in addition a 5-foot bed of clay underlying the limestone.

The northwest region is not proportionately so rich in good outcrops, but exposures display a greater range in observed thickness. This region is also marked by the only opening on this clay known in the quadrangle, the Fallston Fire Clay Company having drifted on the seam in the hillsides directly above its works (section 52, fig. 23). It is said to be inferior as a brick clay when used alone, but since its plasticity renders it an excellent bond clay, and its ferruginous character makes it a suitable ingredient when colors are desired, it is here mixed with clay from the Lower Kittanning seam for building brick. It is reported to be locally 22 feet thick and the mouth of the tunnel cuts about 10 feet. In a near-by ravine (section 245, Pl. VI) this thickness is confirmed by 20 feet of variegated clay shale. In the next ravine west, however (section 48, fig. 23), the section has thinned to 4 feet and is occupied by a more shaly member, while a 5-foot bed of clay occurs below the limestone. No other good croppings were seen in the valley of Brady Run, but along Ohio River representative sections are well scattered between Beaver and Georgetown. They do not, however, reach the thicknesses of the Brady Run beds. At Beaver, for example, 3 feet were uncovered (section 57, fig. 26), while on Twomile Run (Sutherland farm) and Fourmile Run (section 251), it reaches 4 and 5 feet. On Sixmile Run only 1 to 3 feet (sections 74, 75, fig. 25) were seen, but north of Georgetown Island 10 feet of drab clayey shale represent the horizon on the Bryan property. On Little Beaver Creek it is 7 feet thick, with limestone fragments, while to the north, near the corner of the quadrangle, only blossoms measuring 1½ to 2 feet were found.

South of the Ohio similar croppings appear on Elkhorn Run (sections 111, 114, fig. 27), but in the immediate vicinity the thickness increases to 5 feet (sections 203, 204, 205, Pl. IV). Westward to Bellowsville there are no good exposures, but between that place and Raccoon Creek several partial sections of clay, also ranging from 2 to 5 feet (sections 212, 213, 214, 215, 221, Pls. IV and V) were seen. Generally on the west side of this creek only blossoms of clay (sections 140, 142, 146, fig. 29) are exposed, but Fishpot Run uncovers from 3 to 5 feet (section 149) and section 216, Pl. IV, shows a like amount. Aside from small showings, Squirrel Run next displays an encouraging thickness of 5 feet (section 156, fig. 30), and perhaps the upper part of the nodular clay at this point might be available. Westward no good croppings are in evidence as far as Peggs Run. In this valley and along the river to Georgetown the clay seems to thicken from 3 feet on Peggs Run (section 162, fig. 32) to 7 feet at the mine of the Beaver Coal Company (sections 165, 169, fig. 32), reaching a reported maximum of 14 feet near the mouth of Mill Creek (section 257, Pl. VII). Near the Stewart mine the same extreme thickness exists, but a mile below (near section 172) and also on Little Mill Creek (section 258, Pl. VII), the bed has apparently thinned to its usual thickness of 4 or 5 feet. On Service Creek, however, merely blossoms of the clay are uncovered.

Except the tunnel of the Fallston Fire Clay Company the Upper Freeport clay has not been exploited, so far as known, along Ohio or Beaver rivers in this county, but in Big Beaver Township it has been extensively mined for fire brick. There it ranges in thickness from 2 to 10 feet, though in places it may be replaced by limestone and iron ore, as at Adams.[a]

[a] Ries, H., Prof. Paper U. S. Geol. Survey No. 11, 1903, p. 230.

No analysis of the Upper Freeport clay from Beaver County is available, but analyses from other places follow:

Analyses of Upper Freeport and Bolivar clay.

	1.	2.	3.	4.
SiO_2	57.80	57.64	50.840	59.830
Al_2O_3	25.54	27.86	30.745	24.580
TiO_2	.....	.....	1.260	1.170
FeO	2.51	1.22	3.213	1.655
CaO	.25	.37	.160	.280
MgO	.61	.12	.288	.872
Alkalies	2.69	.06	.541	3.114
H_2O (combined)	8.35	12.97	13.050	7.830
H_2O (uncombined)	2.25			
	100.00	100.24	100.097	99.331

1. East Palestine, Ohio. Paving-brick clay, Upper Freeport horizon, N. W. Lord, analyst. Geol. Survey Ohio, vol. 7, 1893, p. 137.
2. Summit Cut, Big Beaver Township, Beaver County, Pa., Professor Wuth, analyst. Second Geol. Survey Pennsylvania, Rept. Q, 1878, p. 46.
3 and 4. Bolivar, Indiana County, Pa., Bolivar clay, McCreath, analyst. Second Geol. Survey Pennsylvania, Rept. H 4, 1877, p. 90. No. 3, is hard clay; No. 4, plastic clay.

BOLIVAR CLAY.

The Upper Freeport clay in Beaver County, lying immediately under the Upper Freeport coal, is not at the horizon of the famous Bolivar clay. The latter horizon is in fact beneath the limestone which usually occurs just under the Upper Freeport clay, but in general on Ohio and Beaver rivers it seems occupied by a less refractory shale. Logtown, Brady, and Blockhouse runs furnish a few exceptions, and south of Phillis Island a clay occurs at the Bolivar horizon (sections 229, 244, 254, etc., Pls. V–VII). It ranges from 2 to 5 feet thick, and in some places it would make, practical men believe, a fairly good fire brick, perhaps superior to that made from the Lower Kittanning clay. When the limestone is absent, moreover, both clays may lie together, as at Salina, Westmoreland County, without a distinct line of demarcation.

QUATERNARY CLAYS.

Within the quadrangle Quaternary clays are largely confined to the stream terraces. Of these the highest, or Kansan terraces, and lowest, or alluvial plains, bear clays which, being generally impure, highly ferruginous, and frequently sandy, are adapted chiefly to the manufacture of common brick, though when the clays are fine and homogeneous, pressed brick and even crude pottery are made from them. Often they are mixed with shale, producing excellent results. Of the flood plains, those carrying clay are unknown outside of the river valleys, though it is possible that others may be found in tributary streams. But the Kansan terraces carry clay on both rivers and lateral streams. For instance, the abandoned channel of Raccoon Creek, in which New Sheffield is situated, is said to carry considerable clay, but its character on burning is unknown. The spurs bordering the creek at this level, which are the extension of this old channel, may also possibly carry clay, but they are of small extent. Moreover, exploitation at this point is hindered by lack of transportation facilities.

For many years an important deposit has been worked on the Kansan terrace near New Brighton and Rochester, At the former place the deposit, which was used for terra cotta and, by mixing with Lower Kittanning clay, for flower pots, shows the following composition:

Analyses of terrace clays.

	1.	2.
SiO_2	46.160	67.780
Al_2O_3	26.976	16.290
Fe_2O_3	7.214	4.570
TiO_2	.740	.780
CaO	2.210	.600
MgO	1.520	.727
Alkalies	3.246	2.001
Water	11.220	6.340
	99.286	99.088

1. From the pit of the old Mendenhall & Chamberlin works. 2. Elverson & Sherwood works. Both analyses from Second Geol. Survey Pennsylvania, Rept. MM, p. 257. A. S. McCreath, analyst.

At present clays from the Parker strath are used only by the Elverson pottery near New Brighton; while those from the flood plain were, until recently, utilized at the Agner brickyards near Rochester in the manufacture of red building brick. A similar deposit, it is said, was also once used near Vanport.

So far as known, clays of value have not yet been discovered on the intermediate terraces of Wisconsin age.

Across the northern part of Beaver County lies the great terminal moraine of the Glacial epoch, within or near the margin of which the Second Geological Survey reports irregular beds of impure clay, but so far as known none have yet been found in Beaver County. The irregular lenses in the morainal deposits may vary greatly in character and are apt to be strong, while the "basin deposits" formed in local lakes are likely to be finer and more homogeneous. Such clays must, from their origin, be mixed with more or less extraneous matter, but screening and washing often produce a good quality of clay for red bricks, flower pots, and, if mixed with other clays, even for terra cotta.

SHALE.

INTRODUCTION.

As has already been intimated, clays, through different degrees of induration, pass insensibly into clay shale and shale. It has been found that a mixture of shale and clay gives a better brick, when great strength and lasting qualities are desired, as in paving brick, than fire clay alone. Accordingly, the shale overlying and underlying the clay beds is used considerably in the brick industry of this region.

SHALES OF ALLEGHENY FORMATION.

Generally the shales most extensively employed in this region are those nearest the Lower Kittanning clay. For example, the Fallston Fire Clay Company uses the shale between the Lower Kittanning clay and the Clarion coal; the Vanport Brick Company uses the same shale and also that between the Darlington and Lower Freeport coals. Analyses from near-by localities show, with little doubt, that still higher shales might also be utilized if necessary. The drab shales, for instance, sometimes present under the Upper Freeport clay, appear to be worth prospecting. But it is a recognized fact that from shales alone of the Allegheny formation no good colored brick are made.

Analyses of shale and clay.[a]

	1.	2.	3.	4.	5.
SiO_2 (total)	58.20	49.30	57.45	55.60	57.15
Al_2O_3	22.47	24.00	21.06	24.34	20.26
Fe_2O_3	5.63	8.40	7.54	6.11	7.54
CaO	.62	.56	.29	.43	.90
MgO	.98	1.60	1.22	.77	1.62
K_2O	3.08	3.91	3.27	3.00	3.05
Na_2O	.42	.19	.39	.09	.58
H_2O (combined)	6.15	9.40	5.90	6.75	5.50
H_2O (uncombined)	1.65	1.20	1.90	2.65	2.70
	99.20	98.56	99.02	99.74	99.30

[a] Orton, Geol. Survey Ohio, vol. 7, pt. 1, 1893, pp. 133, 134.

1. Shales and fire clays mixed, from the T. B. Townsend Brick Company, Zanesville, Ohio; Freeport shales and Kittanning fire clay. N. W. Lord, analyst.
2. Shale from Waynesburg Brick and Clay Manufacturing Company; Middle Kittanning (Darlington?) horizon. N. W. Lord, analyst.
3. Shale from the Ohio Paving Company, Columbus, Ohio, mined at Darlington, Ohio; Lower Kittanning horizon. Average sample. N. W. Lord, analyst.
4. Shale and fire-clay mixture, from the A. O. Jones Company, Zanesville, Ohio; Kittanning horizon. N. W. Lord, analyst.
5. Shales used by Bucyrus Brick and Terra Cotta Company, mined at Glouster, Ohio; horizon of Cambridge [near Ames] limestone. Average sample. N. W. Lord, analyst.

SHALES OF CONEMAUGH FORMATION.

The Conemaugh formation caps all of the high country back from the rivers and accordingly forms the heads of most ravines where slopes are gentle and débris accumulates, so that clean exposures are rare. Few if any beds of fire clay, therefore, such as were described in the Allegheny formation, were observed. Many of the conspicuous residual clays and variegated shales, however, may be found valuable for brick purposes. The most common varieties are yellowish, drab, or bluish gray, and all show evidence of more or less iron, ferrous in fresh shale and ferric in weathered. Red shales are not very abundant and where occurring have generally disintegrated on the outcrop to red residual clay. Analyses of many such shales compare favorably with those of high-grade clays; indeed, the yellowish clay shales so persistent throughout this region above the Mahoning sandstone were formerly used on Blockhouse Run for sewer pipe. Clays and shales of this formation have also been used in Ohio; at Glouster they are made into paving brick and terra-cotta ware, and at Bellaire 20 feet of shale just under the Pittsburg coal are used for sewer pipe and paving brick. Building brick have recently been manufactured from shales by M. Lantz & Sons, of Pittsburg.[a] In fact, nearly all the shales except the very sandy types may be adapted to the manufacture of colored brick. Of the fifty-seven clay yards mentioned in Hopkins's report,[b] over two-thirds use shale wholly or in part, making chiefly red brick, but also paving and pressed brick.

CLAY INDUSTRIES.

INTRODUCTION.

The clay industries along Ohio and Beaver rivers may, for convenience of description, be classed according to products as follows: Pottery, refractory materials, tubular ware, building materials, and paving materials. In all these, except some kinds of pottery, refractory clays are utilized, at least to some extent. The chief source of

[a] Ries, H., Prof. Paper U. S. Geol. Survey No. 11, 1903. p. 233.
[b] Hopkins, T. C., Clays and Clay Industries of Pennsylvania—Clays of Western Pennsylvania, Appendix to Ann. Rept. Pennsylvania State College for 1897, 1898.

supply is the Lower Kittanning clay seam. With this are sometimes mixed, in varying quantities, accompanying shales, and rarely clay from other horizons, such as the Darlington, Lower or Upper Freeport, or perhaps imported clays.

HISTORY AND DEVELOPMENT.

POTTERY.

The first attempt at pottery making in the Beaver Valley, so far as can be ascertained, was about the year 1834, when Thomas Jackson started a small pottery at New Brighton. The panic of 1837, so disastrous to the commercial interests of the country, caused Mr. Jackson to suspend business. Perhaps the next venture was by Hamilton Brothers, at West Bridgewater, but the exact date of their operations is not known. They obtained clay on the west side of Brady Run near its confluence with Beaver River. Their chief products were crocks and jugs. Mackenzie Brothers, at possibly the same date, manufactured pottery at Vanport and procured their clay from the Beaver Valley:[a]

The present large pottery and kindred industries at New Brighton date from 1862, when Thomas Elverson began making Rockingham and yellow ware in a little pottery on the hillside above the present site of the old New Brighton Pottery, now owned by Sherwood Brothers. This little pottery, which was the nucleus of all the large works now in the valley, continued operations until 1890, when it was absorbed by the Pittsburg Clay Manufacturing Company. During this time, as the business expanded, it held various names, such as Elverson & Son, Elverson & Sherwood, Elverson, Sherwood & Barker. Under the last firm new buildings were erected, which later became factories of other companies. For example, when the American Sewer Pipe Company was formed from the Pittsburg Clay Manufacturing Company in 1899, it bought from the latter two of its present factories; and next year the stoneware factory (called New Brighton Pottery), was sold to Sherwood Brothers, who had also been long established. Then W. H. Elverson secured the flower-pottery portion of the works and removed to his present location. Twenty years prior to this dissolution in 1880, Mr. Mayer had begun operations under the present name, Mayer Pottery Company (Limited), and a little earlier, about 1877, Sherwood Brothers laid the foundation of the present large pottery on Blockhouse Run. They started with one kiln and one small building, enlarging their facilities from time to time, as indicated above by the purchase of the New Brighton Pottery. Since that time the Enterprise Pottery, Fallston Pottery Company, Keystone Pottery, and American Porcelain Company have been established, though all but the last have discontinued business in recent years.

Data concerning the potteries still in business are given in the table (p. 72). The kinds of clay used for pottery are almost infinite in variety, according to the grade of ware desired. Earthenware is often made from very impure clay, which is sometimes glazed to conceal imperfections, and at other times, as in flower pots, is not. Such material consists of fire clays, shales, or glacial clays. Sherwood Brothers, for instance, manufacture preserving jars from the upper part of the Lower Kittanning seam, the lower part being too siliceous and hard, while W. H. Elverson uses for flower pots instead of fire clay, terrace clays which do not contain much sand. Porcelain and china ware, however, require white clays, such as are not found in Beaver County. Small quantities of fire clay, however, may be mixed with them to aid in obtaining the proper degree of plasticity. The American Porcelain Company uses a mixture of Lower Kittanning and imported clays. The latter in part is blue Jersey clay, added in very small quantities to regulate shrinkage, which is also modified by certain quantities of burnt clay, perhaps as much in weight as raw clay. In addition another clay which is suitable for the white outer coating is imported from Florida.

[a] Hopkins, T. C., op. cit., p. 87.

The Mayer Pottery uses no domestic materials, even saggers being made chiefly of clays from Woodbridge, N. J., and Akron, Ohio. The materials used in the ware are, for plasticity, ball clays from England and Tennessee; and for body, kaolin from England and North Carolina; flint (ground sand) from Wilmington, Ill.; and feldspar from Brandywine Summit, Pa., and Canada. The usual proportions of these constituents for underglazed printed ware are as follows: Ball clay, 16 per cent; kaolin, 34 per cent; flint, 35 per cent; feldspar, 15 per cent. A minute proportion of cobalt oxide is added to secure a blue-white color. The Keystone Pottery, which has resumed operations under new management, also uses imported clays from England, Delaware, Florida, and Kentucky.

REFRACTORY MATERIALS.

These consist chiefly of fire brick, but limited quantities of flue linings, mill brick, and mortared and raw clay are included. Fire brick were first made in this region by S. Barnes & Co., now known as The S. Barnes Company, on Beaver River, a mile above Rochester, as early as 1840, and this is said to be one of the oldest brick works in the State. Mr. Smith, the father of A. F. Smith, of the present A. F. Smith Company, followed soon after, in 1845, with the manufacture of fire and paving brick.[a] Two years later fire brick were produced opposite Beaver on the south side of Ohio River, where the abandoned works of the Stahl Fire Brick Company are situated.[b] Twenty years later the works of the present Vanport Brick Company were established and made some fire brick in connection with other kinds of brick.[c] Of these old-established plants all but the Stahl works are still active, and since 1867 the other companies now manufacturing fire brick have been organized, as will be seen in the table (p. 72). Mill brick is a refractory brick, used in rolling mills and similar factories, and for convenience may be classed as fire brick. Flue linings are not made to any great extent except by the American Sewer Pipe Company, but several plants which make fire brick produce also mortared clay and, rarely, raw clay.

Refractory materials require a high-grade clay in point of fusibility. Such a clay, suitable for ordinary refractory products, as common fire brick, mill brick, and flue linings, is found in the Lower Kittanning clay bed, from which fire clay is almost exclusively drawn in this region. The upper, more plastic, part of the bed is generally utilized for this purpose, the lower part being, it is said, too sandy. The Lower Kittanning clay, while of excellent refractory quality, can not, however, be used alone for the finer refractory products. To supply this need flint clay from within and without the State is imported. For example, the S. Barnes Company, which is the only importing company of its kind within the quadrangle, uses indurated clay from both Clarion County, Pa., and Tygart Valley, Kentucky. These imported clays bear the various names of "Hahn," "Shoop," "Kein," "W. & W.," "Huefner," "Lander," "Katterbach," etc. The Lower Kittanning is mixed with these flint clays to serve as a bond—that is, to introduce that plasticity which is required for molding, and which flint clays themselves do not have as an inherent quality. The proportions of flint to native clay are, of course, varied, according to the grade of refractory product (in this case fire brick) desired. As a result, this company obtains a high quality of fire brick in three grades, said to be the best refractory brick in the valley.

TUBULAR WARE.

This class includes sewer pipe, drain tile, and some kinds of flue linings. Of these, sewer pipe is extensively manufactured in this region. The industry was started, it is said, about August, 1887, by the Pittsburg Sewer Pipe Company (Lim-

[a] Hopkins, T. C., Clays and Clay Industries of Pennsylvania. Appendix to Ann. Rept. Pennsylvania State College for 1897, 1898, p. 66.
[b] Idem, p. 67.
[c] Idem, p. 69.

ited). Its works were situated on Blockhouse Run, and, though subsequently passing through several hands, as shown in the table on page 72, this site continues to be the present seat of the industry under the American Sewer Pipe Company. The pioneer company reorganized after two years and adopted the name of Pittsburg Sewer Pipe and Fire Clay Company. The next year this company consolidated with Elverson, Sherwood & Barker, already mentioned, into the Pittsburg Clay Manufacturing Company, which made extensive alterations in the plant. But when the American Sewer Pipe Company was organized in 1900 it bought of the Pittsburg Clay Manufacturing Company the two sewer-pipe works now running. While the present company is almost the exclusive manufacturer of sewer pipe and drain tile in the quadrangle, other companies put out small amounts of tubular ware. Among these is the A. F. Smith Company, which has recently taken up the making of hollow tile.

Sewer pipe and drain tile require an impure, siliceous clay, much like that used for paving brick and vitrified building brick. This is obtained chiefly from the Lower Kittanning clay bed, by means of a 40-foot shaft, which is located a short distance east of the works. Additional clay is taken from a drift said to be about 15 feet above water, on the south branch of Blockhouse Run. The opening has been made since the field work in this region was completed, but it seems to be at the elevation of the Darlington clay bed. Clay from this drift is mixed with that from the shaft in proportions of about 1 to 6 for ordinary sewer pipe. Similar material is generally used for flue linings, but these, unlike sewer pipe, are not salt glazed.

The Darlington seam was opened in this locality by a former company, but proved too impure for the purposes intended. The Lower Freeport clay bed, however, enjoyed better fame, for over ten years ago it was mined for a number of years back of the works. It was then used, it is said, chiefly for paving brick, of which small amounts were at that time burned.

BUILDING MATERIALS.

These materials include chiefly building brick of various styles and qualities, but also considerable amounts of roofing tile, decorative tile, and flue linings. The last have been noticed above under "Refractory materials" and "Tubular ware." Historically the building-brick industry made two products—red brick, manufactured from terrace clays, and variegated brick, from fire clays. When the manufacture of red brick first began is not definitely recorded, but it is known that A. F. Smith & Son operated red-brick works on the terrace east of New Brighton as early as 1852, which continued active until about 1892.[a] In the meantime A. Dewhirst & Bro., Levi Fish & Sons, and others, had established red-brick works on the same terrace, but all are now abandoned.

A brickyard owned by Mr. Agner and situated between the railroad and Ohio River, a short distance above the Monaca-Rochester bridge, produced, until 1902, red brick from the alluvium of the river bank. The brick was burned here, as is said to have been the case at all the other abandoned yards, in the ordinary open-top updraft kilns used in this industry. The Agner works also are at present shut down, and no red brick from terrace clay alone is now made within the quadrangle.

It is not known when the manufacture of building brick from fire clay in this region began, but the industry is much younger than that of red brick. Among the earliest manufacturers were probably Welch, Gloninger & Co. and the predecessors of the present Vanport Brick Company, at Vanport. These companies seem at first to have manufactured fire brick chiefly, if not exclusively, and building brick incidentally. Later building brick became the most important product at these works, and since then new companies have been organized for the purpose of carrying on

[a] Hopkins, T. C., Clays and Clay Industries of Pennsylvania, vol. 1, 1898, p. 120.

this industry chiefly, as in the case of the Fallston and Beaver Valley companies, or in connection with paving and other materials, as the Standard Fire Clay Company, Miller-Hummel Company, and A. F. Smith Company have done. On the whole, therefore, while during the last decade the fire-brick industry has nearly held its own, the manufacture of building brick has begun to approach it in both amount and value.

The Lower Kittanning fire clay is now used as the basis of all the commercial grades of building brick made in this region. The clay alone produces brick of various colors, depending on the amount of iron contained and the duration of firing. The iron, however, should not be present in large grains, as it then renders the brick blotchy and rough. A wider variety of color and quality is obtained by mixing other materials with the clay. The most common ingredient added is shale, which is used to a greater or less extent by practically all the plants. The shale commonly employed is, for economic reasons, that lying immediately above or below the Lower Kittanning clay bed, though higher shales have been used to equal advantage, as noted on page 65. Other more natural ingredients in the shape of clays are used for similar purposes. Terrace clay, which, as is well known, contains a large percentage of iron, has been employed at Vanport and elsewhere to produce red colors in the fired product. Similar results are obtained by the addition of fire clay from horizons other than the Lower Kittanning, such as the Darlington and Upper Freeport beds. The Fallston Fire Clay Company, for example, has the latter bed well opened, and is the only plant within the quadrangle now exploiting this horizon for brickmaking.

The building tile made in this region may be classed as decorative or plain. No decorative ware of this kind is known to be manufactured within the quadrangle, but at Beaver Falls the industry has long been established The Beaver Falls Art Tile Company, which began operations in 1887, makes chiefly decorative and plain glazed tile, noted for its great variety in size and color. Imported kaolin and ball clays from Florida, Georgia, North Carolina, and Tennessee are used exclusively for the ware, which is all burned in saggars made from New Jersey and Ohio clays.

The manufacture of plain tile is perhaps of more recent inauguration in this region. It is not, however, made exclusively by any plant, but is produced incidentally with other products. In this manner the American Sewer Pipe Company and the Beaver Valley Roofing Tile, Brick, and Terra Cotta Company are the chief producers of plain tile within the quadrangle.

PAVING MATERIALS.

This class of clay products is here restricted to paving brick or blocks. The manufacture of these materials is a younger industry than that of fire brick. It grew to recognizable proportions along with the building-brick industry, in connection with which it is commonly carried on. Only one plant within the quadrangle manufactures paving blocks exclusively, namely, the Pennsylvania Clay Company, which was among the earliest to introduce into this region the manufacture of paving materials. It includes three separate plants—on Crow Run, on Brady Run, and at Monaca, respectively—of which the last two formerly belonged to the Park Fire Clay Company, but in 1897 consolidated into the present concern. The other companies producing paving brick, together with building or fire brick, are the Miller Brick Company, Speer Clay Manufacturing Company, and Standard Fire Clay Company. Though younger than any other brick industry in this region, the output of paving materials is nearly a third greater than that of fire brick.

Paving brick requires a clay similar to that used in vitrified building brick and sewer pipe. It must thoroughly vitrify without melting out of shape, must be plastic for molding, and may contain iron for colors. All the plants just mentioned use clay from the Lower Kittanning horizon, mixed with more or less shale. In every case the clay is mined by drifting on the outcrop, except at the Monaca and Crow

Run works of the Pennsylvania Clay Company. At these mines the clay bed lies 25 feet below the Monaca terrace and about 40 feet beneath Crow Run, and consequently is exploited by means of a shaft.

SUMMARY.

It is seen that for all clay products made in this region, except some grades of pottery and tile, the source of the essential material is the Lower Kittanning clay bed. To this various materials, usually domestic, such as other fire clays, shale, or terrace clay, are added to produce certain effects of color and quality in the finished product. For pottery the Lower Kittanning horizon is used alone by the Sherwood Brothers Company, and is mixed with imported clays by the American Porcelain Company, while the W. H. Elverson Pottery Company employs only terrace clay, and the Mayer Pottery Company and perhaps others use no domestic clays in either the completed product or the saggers in which it is burned.

PRODUCTION.

In the clay industry of the United States Ohio ranks first, producing nearly 19 per cent of the total product, valued at over $28,000,000. Pennsylvania ranks second, with a product of over $19,000,000, which is nearly 13 per cent of the total.

Pennsylvania holds first place in the United States in the manufacture of fire brick, making almost one-half of the total product, and second place in the total output of the building-brick industry, producing over one-ninth. Ohio holds the second place in the former, and New York the first place in the latter. The preeminence of Pennsylvania in the fire-brick industry is probably due to the extraordinary demand for refractory materials within the State itself, as it is the chief metallurgical center of the United States. Enormous quantities of fire brick, fire-clay cement, and other refractory products are used as linings for blast furnaces, crucibles, and other articles in the metallurgical processes, and also as linings for coking ovens and house furnaces.

Of the total Pennsylvania production, Beaver County supplies an appreciable part. In 1905 it produced $420,500 worth of pottery, or 31 per cent of the State's product, all within a radius of a mile and a half from New Brighton; $103,603 worth, or nearly 14 per cent, of its paving brick, and $8,699 worth, or nearly 23 per cent, of its fancy or ornamental brick. Of the fire brick made in Pennsylvania, $228,413 worth, or nearly 4 per cent, come from Beaver County, which produces about half the same proportion of sewer pipe. But of building brick this county supplies somewhat more—$365,256 worth, or over 4 per cent, of the total amount manufactured in the State. Of the total clay products of the State, Beaver County furnishes about 7 per cent. This is a small percentage of what the county could produce if its clay deposits were developed in proportion to those in Ohio, where the geologic conditions are practically the same as in Beaver County. Further development, however, is greatly impeded by lack of transportation facilities.

Details of the clay industry in the Beaver quadrangle and vicinity.

Company.	Number of mine on map.	Location.	Material used.	Horizon.	Approximate thickness of "good" clay.	Thickness used.	Number of kilns.
					Feet.	*Feet.*	
American Sewer Pipe Co	22	Blockhouse Run	Fire clay	Lower Kittanning	2 –10	10	22
	22A	do	do	Darlington	(?)	8	
Brighton Fire Brick Co	19	do	Fire clay (and shale occasionally).	Lower Kittanning	5½– 9	5½–9	5
The A. F. Smith Co	17	do	Fire clay and shale	do	6½– 7½	9¼– 7½	5
American Porcelain Co	16	do	Mixed clays and imported	do	7 – 8	7– 8	5
Sherwood Bros. Co	15	do	Fire clay	do	6	6	13
W. H. Elverson Pottery Co	18	do	Red brick clay	Kansan terrace			3
Keystone Pottery Co		do	Imported clay from England, Delaware, Florida, and Kentucky.				3
Ingram & Co	13	Bolesville	Fire clay	Lower Kittanning	7 – 9	7– 9	4
The S. Barnes Co	12	Between Bolesville and Rochester.	Fire clay and imported	do	7½– 8	7½– 8	10
	12A						
Beaver Valley Roofing Tile, Brick, and Terra Cotta Co.	11	Rochester	Fire clay and shale	Lower Kittanning and accompanying clay shale.		9	2
The Miller Brick Co	5	do	do	Lower Kittanning and bottom shale.	7 – 8	7–13	6
Pennsylvania Clay Co	Not on map	Crow Run	do	do	2 – 5	16	13
	124	Monaca	Fire clay	Lower Kittanning	10 (?)	12–14	8
	53	Brady Run	Fire clay and shale	Lower Kittanning and bottom shale.		8–10	12
	Not on map	Conway	Fire clay	Lower Kittanning			10
The Mayer Pottery Co. (Ltd.)	(Works) 29	Beaver Falls	Imported clays only				9
Standard Fire Clay Co	47	Brady Run	Fire clay and shale	Lower Kittanning	8⅛	8–10	5
Fallston Fire Clay Co	51	do	Fire clay	Upper Freeport	6±	8– 9	12
	52					22	
Welch-Bright Co	126	Monaca	do	Lower Kittanning	7	7–8⅛	5
Miller-Hummel Clay Product Co.	64	Between Vanport and Merrill.	Fire clay and shale	Lower Kittanning and bottom shale.	10(?)	10–11	11

Vanport Brick Co	65	do	Fire clay, shale, and loam	Lower Kittanning	9–10	9–11	9
Gloninger & Co	66	do	Fire clay	do	7 – 8	7– 8	7
Geo. Dando & Co	72	Merrill	do	do	10(?)	10–12	5
Beaver Valley Pot Co	11 A	Rochester	Imported clay from Missouri and Germany.				1
Beaver Falls Art Tile Co	Not on map.	Beaver Falls	Imported kaolin and ball clays from Florida, Georgia, North Carolina, and Tennessee; sagger clays from New Jersey and Ohio.				5
Beaver Clay Mfg. Co	do	New Galilee	Fire clay	Lower Kittanning (?)		8–12	8
Darlington Brick and Mining Co.	do	Darlington	Domestic fire clay	(?)	6		9
Steffler & Brown Co	do	do	do	"No. 3" (?)	6 –10		7
Union Brick Co	do	Legionville	Shale				3
The Mound Brick Co	do	Beaver Falls	Domestic fire clay	Lower Kittanning (?)	(?)		4

Details of the clay industry in Beaver quadrangle and vicinity—Continued.

Company.	Approximate capacity.	Kind of product.	Date of establishment.	Successive firm names.	Date of present organization.
American Sewer Pipe Co.	100 tons of finished ware per day.	Sewer pipe, drain tile, building tile, flue linings.	1887 [a]	Pittsburg Sewer Pipe Co. (Ltd.) (1887–1889); Pittsburg Sewer Pipe and Fire Clay Co. (1889–90); Pittsburg Clay Mfg. Co. (1890–1900); American Sewer Pipe Co.	1900
Brighton Fire Brick Co.	Average, 30,000 brick per day	Fire brick, mortared clay	1897–98 [b]	A. F. Smith & Co., Brighton Fire Brick Co.	1903
The A. F. Smith Co.	10,000 brick per day. Ship nearly 400 tons raw clay per month.	Red brick, fire brick, hollow tile, raw clay, mortared clay.	1845 [b]	——; A. F. Smith & Co. (1888–1901); The A. F. Smith Co.	1901
American Porcelain Co.	20,000 pieces per year	Solid porcelain ware and enameled ware.	1894	American Porcelain Co	1894
Sherwood Bros. Co	2 carloads of pottery per day	Plain stoneware, especially preserving packages.	1877	Sherwood Bros. Co	About 1878
W. H. Elverson Pottery Co.	12,000–20,000 pieces per day	Flower pots	Several years before 1897.	D. G. Schofield & Co. (–1893); Pittsburg Clay Mfg. Co.; W. H. Elverson Pottery Co.	1900
Keystone Pottery Co		Semiporcelain	1902	Keystone Pottery Co	1902
Ingram & Co	10,000 brick per day	Fire and mill brick	1882–83	Ingram & Co	1882–83
The S. Barnes Co.	20,000 brick per day and 700 tons mortared clay per year.	Hand-made brick, fire brick, tile, mortared clay.	1840	S. Barnes & Co. (1840–1884); S. Barnes & Co. (Ltd.) (1884–1904); The S. Barnes Co.	1904
Beaver Valley Roofing Tile, Brick, and Terra Cotta Co.	15,000 brick per day	Building brick	1903	Beaver Valley Roofing Tile, Brick, and Terra Cotta Co.	1903
The Miller Brick Co.	18,000 brick per day	do	1890	Keystone Pottery Co. (1890–1895); The Miller Brick Co.	1900
Pennsylvania Clay Co.	150,000 brick per day	Paving brick and blocks	1886–87 1886–87 About 1885	Park Fire Clay Co.; Pennsylvania Clay Co. Park Fire Clay Co.; Pennsylvania Clay Co. Brady's Run Fire Clay Co.; Park Fire Clay Co.; Pennsylvania Clay Co.	1897
The Mayer Pottery Co. (Ltd.)	2 Glost kilns per week ($120,000–$125,000 worth per year).	All kinds of pottery, especially underglazed printed ware.	1880	The Mayer Pottery Co. (Ltd.)	1880
Standard Fire Clay Co	20,000 brick per day	Fire, paving, and building brick, mortared clay.	1902	Standard Fire Clay Co	1902

Fallston Fire Clay Co	30,000 brick per day	Fancy colored building brick, chimney blocks, paving brick.	1891	Fallston Fire Clay Co	1891
Welch-Bright Co	20,000 brick per day	Fire brick	1880	Welch Bros.; Welch, Palmer & Maxwell; Welch, Gloninger & Co.; Welch Fire Brick Co. (1899–1905); Welch-Bright Co.	1905
Miller-Hummel Clay Product Co.	35,000 brick per day	Paving brick, building brick.	About 1897	Douglas Whistler Brick Co.; Speer Clay Mfg. Co. (1901–1905); Miller-Hummel Clay Product Co.	1905
Vanport Brick Co	16,000 brick per day	Building, Roman, and mill brick.	About 1867[c]	S. R. Mitchell; John Russell(?); Russell, Young & Co.; Vanport Fire Brick Co. (1888–1893); Vanport Fire Clay Co. (Ltd.) (1893–1897); Vanport Brick Co.	1897
Gloninger & Co	25,000 brick per day	Impervious building brick	1886	Welch, Gloninger & Co.; Gloninger & Co	About 1899
Geo. Dando & Co	14,000 brick per day	Mill brick	1900	Geo. Dando & Co	1900
Beaver Valley Pot Co	1,000 pots for year, 1,000 tons of blocks.	Glass melting pots, bench clay, and furnace blocks.	1902	Beaver Valley Pot Co	
Beaver Falls Art Tile Co	350,000 square feet per year	Wall tiles, plain enamel, embossed and decorated tile.	1887	Beaver Falls Art Tile Co	1887
Beaver Clay Mfg. Co	25,000 brick per day	Paving and building brick	1902	Beaver Clay Mfg. Co	1902
Darlington Brick and Mining Co.	do	Face building brick, paving brick.	1893	Darlington Clay Working Co.; Darlington Brick and Mining Co.	1900
Steffler & Brown Co	18,000–20,000 brick per day	Paving and building brick	1889	Cook, Sturgeon & Co.; Steffler & Brown Co.	1898
Union Brick Co	20,000 brick per day	Red brick	1890	Hersperger Co.; Union Brick Co	1899
The Mound Brick Co	15,000 brick per day	do	1903	The Mound Brick Co	1903

[a] Hopkins, T. C., Clay and Clay Industries of Pennsylvania, vol. 1, 1898, p. 41. [b] Idem, p. 66 (in part). [c] Idem, p. 69.

PETROLEUM AND NATURAL GAS.

PETROLEUM.

INTRODUCTION.

Oil has been produced in the Beaver quadrangle for about forty-five years, during which period several pools have been opened and practically drained. The most important of these are in the Smiths Ferry, Shannopin, and Hookstown fields. Few large oil wells have been struck in this region recently and the production is now on the wane. Though not all the wells drilled for oil are represented on the map (Pl. VIII), a large proportion of them—enough at least to show something of the number drilled and to outline the pools—are shown.

HISTORY AND DEVELOPMENT.

Smiths Ferry field.—The first pool discovered, only a part of which is within the quadrangle, is known as the "Smiths Ferry field" and lies between Ohioville and Smiths Ferry, extending westward into Ohio. Long before any borings were made, oil is said to have oozed out on Ohio River, where it was collected in cloths and called "Seneca oil." The first well, put down by Patterson & Flinwell in December, 1860, struck some oil at 180 feet.

In the following February, says I. C. White, the Excelsior Company struck a heavy oil in the Piedmont sandstone at a depth of 72 feet, only a few feet below the level of Ohio River. This well produced 400 barrels of 29° oil, when it became completely exhausted. The ensuing excitement rapidly developed this field. Wells were drilled on every hand. It soon became known that a more productive oil rock was to be sought about 700 feet below the Lower Kittanning coal. Out of the hundreds of wells that have been drilled here the records of only two are known—the Ohioville well (Pl. II) and the one given below. The latter begins 100 feet below the Lower Kittanning coal, or immediately upon the Pottsville sandstone.

Log of oil well in Smiths Ferry field.

	Ft.	in.
1. Conductor	5	0
2. White sandstone (Homewood) (some oil)	15	
3. Black slate	2	4
4. Gray sandstone (oil show)	4	
5. Black slate (gas)	1	3
6. Fire clay	2	3
7. Gray and white sandstone	25	6
8. Black rock, hard	15	
9. Fire clay and shales	5	
10. Black slate (gas)	6	
11. Shale (gas and oil)	13	
12. Coal	1	
13. Fire clay	10	
14. Slate and shale	25	
15. Hard, white sandstone	61	
16. Black shale	10	
17. Fine-grained sandstone	19	
18. Shaly sandstone	49	
19. Hard, white sandstone	16	
20. Shale	2	
21. Hard sandstone	8	
22. Shales	17	
23. Hard, white sandstone	6	
24. Shales (salt water and oil)	40	
25. Hard sandstone	5	
26. Slate	7	
27. Sandstone (salt water and oil)	23	

	Ft. in.
28. Slate (oil)	28
29. Sand	5
30. Shale	2
31. Hard sandstone (strong salt water)	20
32. Slate	17
33. Sand (much gas and salt)	6
34. Hard sand rock	7

No. 15 is probably the bottom of the Pottsville formation, while No. 2 is the top.[a]

This record, White says, does not extend down to the main oil-bearing rock, but when plotted and compared with records of the Ohioville, Hamilton, and Poe wells (Pls. I and II), it appears to have reached both members of the Berea group. In the Ohioville well the oil seems to have come from the lower member. As to lower sands, White says that some wells were drilled 500 feet below the Berea grit, but no oil was obtained, as the lower oil sands of Butler County were in this locality mere shales or fine-grained sandstone, incapable of holding any oil.

The wells of this field were all small at first, none exceeding 25 barrels a day until March, 1877, when a 50-barrel well was struck on the Smith farm near Ohioville. The wells, whatever their initial production, soon ran out to 1 or 2 barrels a day.[b] In 1876 there were about 200 wells in this district from which oil was obtained, many of them yielding only 4 or 5 barrels a month. They were not generally pumped, as the accompanying gas was sufficient to force up the oil. Some, however, were pumped a few minutes a day. Previous to the strike of the 50-barrel well the production of this district was estimated at about 100 barrels per day and the annual production at 35,000 barrels.[c]

Other reports give the production of this field in 1869 as 250 barrels per day and state that in 1875 most of the wells were along the Smiths Ferry and Ohioville road, averaging 25 to 90 barrels a week. Reports of the same year differ as to the quality of the oil, variously stating 27° to 52° gravity, but all agree that it was of a light yellowish-amber color. Nearly all the oil was at first refined at Smiths Ferry, but the advent of the trans-State pipe lines, leading the oil to the great refineries on the coast, broke up this industry, and now all the crude oil leaves the field through these pipes.

In 1889 the field was still furnishing now and then a good well on its borders and some of the first wells in this district—notably on Island and Dry runs—are to this day pumping a little oil, but most of them have been abandoned and a broken bull wheel lies in nearly every fence corner. In recent years this field has been extended eastward to the head of Wolf Run, and many profitable though not large wells have been found.

Shannopin field.—This field lies near Shannopin, on Ohio River, and extends westward across the southeast corner of the Beaver quadrangle. The pool within the quadrangle is perhaps one of several more or less isolated pools of this field. The first well which led to the opening of this pool was, it is reported, drilled about 1883 by the Arbuckles of Pittsburg on the Langfitt farm, but the result is unknown. It is probable, however, that a little oil was obtained. From that time to 1886 apparently little was done in the way of test wells, but in the latter year a well was put down on the John Macurame farm and a trifle more oil than before was obtained. In the same year Sam Neil and others drilled farther west on the Agnes McCoy farm and found a good well, which gave impetus to further drilling. In August, 1886, a 400-barrel well was struck on the Marks farm and two wells on the A. P. Morrow farm, one producing 90 barrels an hour and the other 45 barrels. As a result in this year the Shannopin field increased its production over that of 1885 by 3,000 barrels, and on January 1, 1887, it showed a total yield of 483,000 barrels. The field has been a

[a] Second Geol. Survey Pennsylvania, Rept. Q, p. 270. [b] Idem, p. 271. [c] Idem, p, 272.

prolific one, but the production began to wane as early as 1889. At present considerable oil is being pumped from old wells, but few new ones are being drilled.

The first companies to operate in this field, it is reported, were the Raccoon and Shannopin oil companies. The latter, it seems, ceased to operate in this district and the former was absorbed by the Forest Oil Company, a branch of the Standard Oil, which now owns most of the present producing wells.

Records of the Johnston, McElhany, Chambers, and Nelson wells (Pl. I) seem to show the oil-bearing stratum in this field to be the "Hundred-foot sand," which is locally named the "Shannopin" sand and which is the same stratum as that producing the New Sheffield gas pool. This bed, occurring about 200 or 300 feet below the Berea grit, is usually 10 to 25 feet thick and composed of two parts—a cap of hard, siliceous, impervious rock, a few inches thick, and a lower portion of an open, mealy sandstone, containing many white, pink, and yellow pebbles.

Hookstown field.—This field lies between Hookstown and the State line and has a southern extension to the head of Tomlinson Run. It was discovered and first opened in 1889, the year in which the Shannopin field began to wane. Several wells, however, had been drilled before this date on the edge of the pool, in the vicinity of Georgetown, but with little success. Information concerning the first producing wells in the Hookstown field, drilled in May, 1889, was not obtainable, but it is known that during June of the following summer two wells were put down on the Milton Calhoun farm by the Forest Oil Company, one of which produced 150 barrels in the first twenty-four hours, the other only 10 barrels. In August a 120-barrel well was struck on the William Glenn farm. During the rest of the year many small wells were drilled which produced 10 to 30 barrels a day, while the William Glenn No. 4, drilled in September, came in at 100 barrels. The following year many more small wells of 15 to 50 barrels were struck and also a 106-barrel well on the Taylor farm. Very little accurate information was obtained concerning operations immediately after this period, though some scattered drilling is known to have taken place. In 1901 some excitement was aroused by a few 50-barrel wells alleged to have been struck along the hill road between Georgetown and Hookstown.

Though the Forest Oil Company is the largest company operating in the Hookstown district, many private operators own a considerable number of wells and have reaped a fair reward. The oil of this pool is found in the Berea grit, which has borrowed the name of Smiths Ferry sand from the near-by pool of that name. This stratum varies from 10 to 30 feet in thickness and the "pay," which is usually found from 5 to 10 feet below the top, is a white or gray, open, mealy rock. Where the entire stratum is close and compact it is barren.

Scattered wells.—Many wells have been drilled for oil elsewhere in the quadrangle, some of which are noted under "Natural gas" (p. 79), but so far no valuable wells outside of the fields already mentioned have come to light. Of the unsuccessful efforts near the Hookstown field, those near Georgetown are interesting. One of these wells, for example, on the edge of the Georgetown terrace, flowed 50 barrels the first day and the next day scarcely a barrel. Another early well, on the S. M. Boyd farm, was drilled in March, 1886, but struck nothing and was abandoned. The skeleton record of this well, reported by Carll,[a] seems to show that the drill was sunk not only through the Berea grit, but through underlying red beds and the Hundred-foot sand. Several other dry holes have been drilled within recent years east of Georgetown along the river.

PRODUCTION.

Since the boundaries of the quadrangle divide the Shannopin and Hookstown pools, no idea of the production of this area can be given. The yield of Beaver County, however, is generally calculated as a unit and for 1904 is given as nearly 395,000 barrels.

[a] Second Geol. Survey Pennsylvania, Rept. I5, 1890, p. 233.

NATURAL GAS.

INTRODUCTION.

In the Beaver quadrangle gas has been produced in considerable quantities for about twenty years and the wells have included several of exceptional volume and pressure. For information concerning the early wells special acknowledgment is due to Mr. R. R. Hice, of Beaver. The most productive field lies in the vicinity of New Sheffield, extending southwestward through Independence and Hanover townships. Some scattering wells have also been drilled elsewhere, especially along Ohio and Beaver rivers.

HISTORY AND DEVELOPMENT.

New Sheffield pool.—The New Sheffield pool, with its southwestward extension, is the largest and most important district, but at the present time it is practically abandoned and few if any wells are being put down. It is about 8 miles long within the quadrangle and covers a considerable area beyond the border. Unsuccessful drilling had been done in this field before 1884, but the first producing well was drilled in July of that year on the John Zimmerly farm. Its depth is 1,257 feet, reaching the gas-bearing sand at 1,250 feet. The first reports of which we have record give the minute pressure of this well as 320 pounds and the rock pressure as 480 pounds, but as the early wells were not at first gaged its initial rock pressure was presumably much higher. It is still producing some gas. During the next three years most of the wells of this district were drilled and in 1886 there were something like 110 wells in all, some much more productive than even the John Zimmerly well. One well on the Hugh Morrow farm, near Independence, gave a flow of 15,000,000 to 18,000,000 cubic feet. The following table shows a number of the early wells, with their pressures:

Early gas wells in Beaver quadrangle.

No. of well on map (Pl. VIII).	Farm.	Date drilled.	Date pressure taken.	Minute pressure.	Rock pressure.	Depth.
				Pounds.	*Pounds.*	*Feet.*
57	John Zimmerly (Bridgewater, No. 1).	July —, 1884	Unknown date	320	480	1,257
			Dec. 7, 1886	265	350	
50	Jane Bruce, No. 1	Oct. 5, 1884	(a)			1,187
51	Henry Zimmerly	Oct. 24, 1884	Dec. 7, 1886	215	350	1,206
52	McCormick	Feb. 28, 1885	Apr. 7, 1885	60 on casing		1,218
			Oct. 23, 1886	220 on 2″ tubing		
46	George Baker	Apr. 7, 1885	Apr. 8, 1886	270	575	1,442
47	Arthur White	July 30, 1885	Aug., 1885	275	525	
			Jan. 27, 1887		400	
54	W. L. Calvert	Aug. 4, 1885	Early	420	480	
			Dec. 7, 1886	372	398	
			Sept., 1887	320		
53	J. F. Cooper, No. 1	Nov. 7, 1885	Early	260	540	
			Dec. 7, 1886	155	450	
56	John Born	Nov. 15, 1885	Early	420	600	
			Oct. 23, 1886	420		
48	W. W. Irons	May 4, 1886			550	
58	R. L. Sterling	Spring, 1887 (?)			600	

a Small well.

Many other wells were drilled about Independence and elsewhere in Independence and Hanover townships, but most of them are now abandoned and their locations are not distinguishable.

The gas in this district comes from the Venango oil group, and particularly from the Hundred-foot sand (see table, p. 95), which is also the productive stratum of the Shannopin oil field to the southeast. The gas was of excellent quality, but very oily near the southeastern edge, where it bordered the oil pool.

The Bridgewater Gas Company was the first to operate in this field, but it later became consolidated with the Fort Pitt Gas Company, and is now the Manufacturers' Light and Heat Company. It piped Sheffield gas to the towns of the Beaver Valley and later to East Liverpool and Wellsville, Ohio, and New Cumberland, W. Va. The Standard Oil people soon after entered the field, drilled about Independence and farther east, and laid a 10-inch pipe to Youngstown, Ohio. The Ohio Valley Gas Company followed and drilled many of the wells in the vicinity of the Hanover-Independence township line, piping the product to East Liverpool and vicinity. It was at this time that the Gringo oil field was opened and the gas pressure reduced by drawing out the oil. This event, together with the increased consumption and the numerous new pipe lines from the field, caused the gas pressure to fail rapidly and the wells were soon abandoned. So rapidly did the pressure decrease that the R. L. Sterling well, though having an initial pressure of 600 pounds, had only 100 to 200 pounds some months later, when attached to the pipe line.

Scattered wells.—Many scattered wells have been drilled for gas or oil at several localities in the quadrangle. Those put down to the Berea at Georgetown and to the east have been mentioned. At Industry an old well, near the mouth of Wolf Run, in operation in 1876 but now abandoned, struck a large flow of salt water 310 feet feet down and a show of oil and gas in the Berea. The water was utilized for its salt. At the mouth of Brady Run the Deens heirs' well gave 5 barrels of oil from the Hundred-foot sand, while a few others gave less. Wells at Monaca and Rochester, most of which were put down in 1886, produced small amounts of oil. The Tumbler Works well, for example, produced in 1874 chiefly salt water, a little oil, and gas enough to aid in firing the furnaces. Wells near the mouth of Brady Run furnished a little gas, with a trace of oil, but the chief product was salt water. Other wells at Beaver Falls, drilled in the early years of inexperience, were not properly cased to keep out the water; otherwise they might have given a fair flow of gas. A number of years later they were cleaned and put in shape and then, together with some new holes, furnished gas to the Beaver Falls Cutlery Works for forging and tempering. The small values in the wells at Monaca and to the north along Beaver River seemed in general to accompany the salt water and to enter at several horizons. From the meager accounts it is difficult to say which sand produced the greatest values. It seems, however, that they came chiefly from both Berea and Hundred-foot. Still other wells east of New Brighton have been put down within the last ten years with small results. The operators themselves can not give very satisfactory information concerning them. A few wells north of Traverse Creek in the Hundred-foot and some near Brush Run in the Berea were, so far as known, at least unprofitable and probably dry.

PRODUCTION.

As is the case with oil, the production of gas can not be calculated for so limited an area as a quadrangle. In fact, statistical reports give only the gas production of the State as a whole.

CONCLUSIONS.

GENERAL.

In order that the above data may be of economic value conclusions should be drawn therefrom and applied to new fields. The conclusions may not go further than to establish the fact that well-known geologic principles apply to this region as well as to others, but even this is of value as showing that the Beaver region is not an exception to the general rule. The above facts concerning the oil and gas fields of this area, studied both by themselves and in relation to geographic distribution, show that productive pools once tapped begin to wane after a few years of constant production and finally become abandoned, except by a few pumping wells. This is apparently due both to the exhaustion of supply and to the resulting loss of pressure. In regard to the "pay" sands, it is seen that the same stratum is not productive in all fields, the Berea group being valuable in the northwestern part of the quadrangle and the Hundred-foot in the southern part. Several causes may be brought forward to explain this: The sands are no doubt more or less lenticular and may therefore be present in some localities but absent in others; or when present they may be too fine and compact to contain oil or gas in paying quantities; or, though coarse and open, these products may never have reached them or remained in them, as will be noted below. This brings us to the discussion of a third conclusion—a marked relation between the distribution of oil and gas and the structure of the rocks.

RELATION TO STRUCTURE.

A study of the structural map with regard to the position of the oil and gas fields of this quadrangle shows that the Hookstown field lies on the sides of the arch near Mill Creek; the Smiths Ferry pool on the flanks of the Fairview dome, with the unproductive wells at Georgetown and Industry in a trough; and the Shannopin field for the most part near the bottom of a shallow syncline, with the New Sheffield gas pool above it on the steep side of a flat anticline. Relations like those at Smiths Ferry and Hookstown were early recognized by operators and geologists and have become formulated into what is generally known as the anticlinal theory regarding the occurrence of oil and gas. Salt water is often associated with oil and gas in a single area and these three products are known to have a definite relation of occurrence. That relation seems to depend on their respective densities, according to which they apparently arrange themselves in the containing stratum. On the flank of a syncline or anticline, therefore, salt water should occur lowest of the three, then oil, then gas at the top. Oil probably rests upon the surface of a denser liquid—salt water—when present, and gas upon the oil. Gas no doubt expands and fills the space above the oil in the inclosing stratum except where the closeness of the sand or a bend in the rock forbids further expansion. Thus it seems that gas does not become separated from oil by an interval of barren sand, depending on the height of salt water and the height to which gas may ascend, as might be supposed. The height of the salt water and the consequent position of the oil on the flank of an anticline is said to depend on the amount of water present. If the sand holds much water oil should occur high on the flank; if little water, low on the flank; if none, near the bottom of the syncline. The last postulate would explain the condition in the Shannopin field.

It therefore follows that if a well is driven for oil and salt water is struck the well should have been drilled structurally higher up. Also if gas is found oil may be struck by drilling structurally lower down. And finally, all things being equal, gas is most likely to occur in the summits of domes and anticlines. That oil follows the water line in this region has not been definitely proved. In some sands it is believed

that it does, but in others this fact is not clear from the information at hand. In the case of the Berea, oil probably follows the water line, but in the Hundred-foot little or no water seems to be present in this area. By bearing in mind these general relations between structure and product and between the different products themselves, which have been worked out in detail by I. C. White, Orton, Griswold, and others, not only may intelligent prospecting for gas and oil be carried on, but new fields may be discovered.

POSSIBLE NEW FIELDS.

The notes under this heading are merely suggestions based on the above facts considered in their relation to the structure worked out in this quadrangle. The localities here indicated for testing are, therefore, only those which the writer believes to be the most promising, if tests are to be made anywhere.

With regard to oil in the Berea, it appears that most of the wells of the Smiths Ferry pool lie between the 940 and 1,040-foot structure contours, and that its modern extension eastward lies chiefly between the same boundaries, or perhaps, because of the dome at Fairview, slightly higher. The area between these boundaries, as we have seen, has been prospected with little success in the vicinity of Fallston. But so far as known to the writer no wells have been sunk within these limits either between the Smiths Ferry extension and Fallston or at the edge of the quadrangle northeast of New Brighton. While it is not believed that large wells would be struck in these districts, it appears that if oil is to be sought at any place north of the river these are promising areas. The most productive locality may possibly be the east and west flanks, near the 980-foot structure contour of the southward-pointing anticline just east of Sixmile Run. The boundaries above set by structure contours 940 and 1,040 are not meant, however, to include the dome on the south side of the river, inclosed by the 940-foot contour. In regard to the possible extension of the Hookstown field, what might be suggested from the structure has already been anticipated and accomplished by the drilling of wells in the vicinity of the 920-foot contour along the hill road beween Hookstown and Georgetown. The writer, however, with some hesitation, suggests a possible new field in the vicinity of the structural terrace a mile and a half east of south from Hookstown. The flanks of this terrace, near or below the 1,180-foot structure contour and extending half a mile from the west edge of the quadrangle along Service Creek, may be worth prospecting, but successful drilling may possibly be carried as far down as the 1,120-foot contour in the vicinity of Little Service Run.

Concerning the extension of the Shannopin field in the Hundred-foot sand little of value can be said. Its extension westward between the 980-foot and 1,020-foot contours may possibly be found in the synclines near the mouths of Little Traverse and Little Service runs. Some drilling has already been done on the intermediate anticline, but unfortunately with little success. Possibly some of the other synclines of the area contain oil in the Hundred-foot sand.

As to gas, the wells near the mouth of Raccoon Creek and at Monaca do not encourage prospecting in the dome-basin region. The Hookstown dome has also been prospected with little success as regards gas. However, since a show of oil and gas, with salt water, was found near Monaca, prospect wells on the summits of the domes might, nevertheless, yield good results.

In addition some prospecting of the anticlines radiating from the domes, especially those from the McCleary dome toward the New Sheffield gas pool, might be worth while. If gas is found in the domes or radiating spurs, judicious drilling along the deeper troughs radiating from the domes might also tap small oil pools. If the well-marked basins, such as those at Industry, Beaver, and east of New Brighton, contain salt water, possibly small oil wells, such as the former 5-barrel well on the Deens farm near Dam No. 6, may be found on the sides of the basins. It is doubtful, how-

ever, if the dome at Fairview would yield any gas of value, for the surrounding wells are not encouraging. But so far as known no wells have been drilled on the axis of the Fredericktown anticline, and hence the summit of this arch, extending northwestward through South Beaver and Chippewa townships, gives good opportunity for prospecting.

Reference to the geologic map (Pl. VIII) shows that the cross-like shape of the New Sheffield gas pool is closely related to the structure. The gas wells have followed the northeast flank of the Raccoon Creek syncline and also the slight bulge between Gringo and New Sheffield. This produces the short axis of the cross, while the main axis has followed the more general strike of the rocks in a northeast-southwest direction. The largest and most numerous wells in this district seem to have been found between or near the 1,080-foot and 1,140-foot structure contours, and the structural terrace south of Hookstown may likewise yield gas in the Hundred-foot sand.

In general, if salt water be found in any well, oil may perhaps be found structurally higher—that is, above the salt-water level, and gas still higher up and above the oil line. When the salt-water limit has been established it should in general be followed at nearly the same structural elevation in the same basin unless it has been disturbed by the condition of the sand. The above suggestions, however, are of no value if the sand supposed to contain oil or gas is barren or of such a character as to preclude their presence. These facts, unfortunately, can be ascertained only by sinking the drill.

LIST OF GAS AND OIL WELLS.

A list of oil and gas wells in and near the quadrangle, together with such data in regard to them as are available and seem of importance, will be found on pages 95–123.

LIMESTONE.

INTRODUCTION.

Limestone is not very abundant in this region, nor is much of it favorably located for working. The Allegheny formation carries the largest beds, and since this formation is overlain by the Conemaugh rocks, limestone may be said to be most abundant in valleys of the deeper streams which incise the Allegheny. Since many of the limestones occur near the coal seams from which they are named, references here, as under "Clay," are made to coal-section and ravine-section numbers in order to show on the map (Pl. VIII) localities where observations were taken.

VANPORT LIMESTONE.

The position of the Vanport limestone bed, as shown in the detailed sections (Pls. IV to VII) averages 65 feet below the Lower Kittanning coal, consequently its occurrences are limited to the deeper valleys of the quadrangle (Ohio, Beaver, and Brady valleys), where it is often covered still more deeply than the Lower Kittanning coal by gravel terraces. It is the thickest and most largely exploited bed of limestone in the quadrangle, but because of its lenticular occurrence, which is common with all the limestones of this region, it is not everywhere sufficiently thick for working. At only three points is it known to measure 8 feet or over.

In the northeast region in the upper Beaver Valley this limestone is very thin. North of New Brighton, along the railroad, it may be seen 1 foot thick about 45 to 50 feet above the track (section 231, Pl. V), and in New Brighton it shows the same thickness on the road at the foot of the southern spur of the Kansan terrace. Farther south it thickens and back of the Sherwood pottery reaches 2 feet 6 inches. Near

this place, says White, it was once quarried and burned for cement, which was used in building the locks on the Pittsburg and Erie Canal. It seems to be sandy and rather impure, but filled with fossils. In Paved Run the following section is exposed:

Section of Vanport limestone in Paved Run.

	Ft.	in.
Limestone	3	0
Calcareous shale	1	6
Limestone	1	6

The limestone part of this section is a very compact, hard, bluish-gray rock. I. C. White reports it also present at the mouth of Whistlers Run, where it weathers to a peculiarly shriveled and wavy appearance. Farther down the river, at Bolesville, it is 4 feet thick, is rather impure, and carries its usual fossils. All of these occurrences lie above the railroad level, but below this point it is not known.

In the northwest region the variations are still more remarkable. Near Beaver Falls, above the terrace, it varies from 3 inches to 1½ feet (section 236 and the ravine opposite the lower wagon bridge) and in some instances seems to be altogether absent, while at the road forks in Fallston it shows as a 10-foot bedded limestone (section 246, Pl. VI), but it thins to the south, and on the Wolf property in West Bridgewater, where it is at railroad grade (section 247, Pl. VI), it is only 3 feet thick. On Brady Run it is still thinner; indeed, it thins from 10 feet in Fallston to 1 foot 6 inches at the Fallston Clay Company's works. A quarter of a mile above this point the same thickness is maintained (section 245, Pl. VI), but farther upstream it is not known on Brady Run, except on North Branch, where it lies in the stream bed 1 foot thick (section 240). Here it shows the "cone-in-cone" structure seen in the Beaver Falls exposures and found so commonly in this limestone.

On the north side of the Ohio the horizon is covered by the Beaver terrace, but Sixmile Run cuts through it and uncovers at Vanport, in the following section, the type exposure from which it is named:

Type section of Vanport limestone at Vanport.

	Ft.	in.
Blue limestone	4	0
Shale		4
Blue limestone	8	0
Shale		6
Limestone		6
Shale	2	2
Hard ferruginous limestone	1	0
Shale		6
Fossiliferous limestone	2	0

This section was measured almost beneath the road bridge at Vanport. The beds of limestone differ very much both in color and quality. For the first 9 inches it is too impure to burn, and is therefore stripped off and thrown away. The 3-foot bed coming next is a bluish-gray rock, extremely brittle, and is burned for lime, together with the 8-foot layer below the shale parting so persistent in all the quarries here. The top layer, says White, is of the proper quality for fluxing iron, and was once shipped to the Pittsburg and Mingo furnaces. The 8-foot layer, light gray or blue in color, is the purest and most compact linestone in the section, burning to a very good white lime. The other thin beds of the section are not used for lime, being good, it is said, only for cement. The 1-foot layer is a very impure, hard, ferruginous limestone, but all the rest of the section is richly fossiliferous. In this vicinity the upper part is now quarried and burned in the Courley and Dunn kilns. In general, the Vanport limestone is characterized by its wealth of fossils; by its brittleness, breaking with irregular fractures; by often having a reddish tinge to its prevailing gray or blue color, and, when thin, by the "cone-in-cone" structure.

The two strata which are used for burning were analyzed by the Second Geological Survey of Pennsylvania, as shown below. The specimen for analysis from the upper bed (No. 1) was taken from the old Severn quarry, half a mile below Vanport, and the sample from the lower bed (No. 2) came from the old Powers quarry.

Analyses of Vanport limestone.[a]

[Analyst, A. S. McCreath.]

	1.	2.
$CaCO_3$	93.482	91.607
$MgCO_3$	1.544	1.566
Iron oxide and alumina	1.823	1.291
S	.030	.290
P	.047	.030
Insoluble residue	2.770	4.780
	99.696	99.564

[a] Second Geol. Survey Pennsylvania, Rept. Q, 1878, p. 283.

The next occurrence north of the river is below the Gloninger clay works, where the limestone shows as a 5-foot bed just above the railroad. Above it occur less than 3 inches of iron ore. At the mouth of Fourmile Run a greater thickness of limestone is exposed, as follows (section 251):

Section of Vanport limestone at mouth of Fourmile Run.

	Feet.
Hard limestone	3
Shale	1
Limestone	4

A few hundred feet west it begins to dip beneath the track, exposing only 2 or 3 feet of its entire thickness.

South of the Ohio it is rarely observed. Above Monaca it is not exposed, nor is it seen north of town, where it probably lies beneath the river level (section 209). To the west along the Ohio it first appears opposite Montgomery Island, where it is 16 feet thick and lies near river level. At this point it measures 222 feet below the Upper Freeport coal. A short distance below it is said to become shaly and arenaceous, and finally to thin to 1 foot. Stevenson reports that 6 inches of iron ore rest uniformly upon the limestone in this vicinity. To the west of this outcrop no other occurrences were observed by the writer, owing to the fact that its low-lying horizon is covered by terrace deposits or talus. At one locality, however, south of Phillis Island (section 254, Pl. VII), the horizon is exposed, but the limestone is absent or nodular.

LOWER FREEPORT LIMESTONE.

The Lower Freeport is the next higher limestone which is of any value within the quadrangle, but compared with the Vanport limestone it is very impure, being usually a hard, fine-grained, buff-colored rock, in places carrying iron ore. Its horizon is a few feet below the coal from which it is named. In the greater part of this region it is of little value, owing not only to its unfavorable location and thick covering, but to its occurrence in isolated lenses. Indeed within this area only three lenses of workable dimensions (3 to 9 feet) were found.

In the northeast region this limestone is not abundant; at least it is not exposed in many places. On the Muller property, in McKinley Run, it is 1 foot thick (section 9), while farther north, just outside the quadrangle, it thickens to 6 feet on the east bank of Beaver River (section 246). At other points it shows as a few fragments.

In the northwest region it is more prevalent, and in places thicker. Near Beaver Falls it measures 3 feet (sections 45, 237), while on Brady Run it ranges from 4 to 8 feet (sections 241, 244, 245, Pl. VI), the maximum thickness occurring in the first ravine above section 241. On North Branch of Brady Run it is unknown.

In the extreme northwest corner of the quadrangle, on a branch of Brush Run, the Lower Freeport limestone attains the greatest thickness known in this region—9 feet (section 105). In the bottom of the same branch it outcrops near the schoolhouse, and is said to have been burned at one time for fertilizer, producing lime of fairly good quality. To the south, on Bieler and Island runs, this limestone is unknown within the quadrangle, but beyond the boundary it is exposed on the latter stream 4 to 5 feet thick (sections 262, 263, Pl. VII). Toward the river it grows less frequent, showing on Dry Run merely as a thin bed or a few fragments, and on the river front, though the horizon is often exposed, no limestone was observed as far as Fallston.

South of the Ohio, in both the southeast and southwest regions, it is of no importance, except possibly at one locality east of Hog Island. Here it is 5 feet thick (section 204) and has the appearance of a pure blue limestone. Elsewhere it is represented by a few fragments or a thin bed a few inches thick, as on Poorhouse Run.

UPPER FREEPORT LIMESTONE.

The Upper Freeport limestone, which, as already stated, varies in thickness from a feather-edge to 7 feet, occurs a few feet below the Upper Freeport coal. It is usually impure, being buff colored and often brecciated. The buff color is due to the presence of iron, which, indeed, is sometimes so abundant as to constitute an ore. This ore in some counties has been of commercial value, but within the Beaver quadrangle it does not occur in sufficient quantity for exploitation. Occasionally, however, the limestone occurs as a purer rock of bluish color. Though often attaining a thickness of 3 feet or more, at only one locality in this region—namely, in South Beaver Township—do its thickness and location favor quarrying. This is due to the fact that at this point the horizon attains its greatest elevation and therefore has the thinnest covering. Dry Run also uncovers, near its head, a considerable thickness of this rock.

A more detailed description will bring out the specific thicknesses of this bed at different localities. In the northeast region it is of very little importance, occurring, with three or four exceptions, only as a few nodules at the bottom of the Upper Freeport clay. Sometimes it is difficult in such instances to tell the exact thickness of the limestone, for the reason that a considerable part of it may have been reduced by weathering to residual clay containing the nodules mentioned. This is particularly the case in McKinley Run (section 226) and to the north; but near the eastern edge of the quadrangle, on the Hayes heirs' farm, the limestone occurs in two solid beds 3 and 2 feet thick, respectively, separated by 2 feet of clay and nodular limestone. On Blockhouse Run also the limestone shows a development of 2 to 3 feet at points near the head of the south fork (sections 24, 228) and on the north fork near the quadrangle boundary (sections 229, 230, 233).

On the west side of Beaver River, in the northwest region, it is of no importance (sections 52, 247), and in the valley of Brady Run, including North Branch, the only occurrences of note are a mile above Fallston (sections 48, 244), where the limestone is 3 feet thick. Elsewhere in this valley, though the horizon was seen at many places, no limestone was observed, except the dubious occurrence (section 36) near the eastern margin of South Beaver Township. To the northwest, in the same township, limestone is reported present on the Calvin and Blatter farms, and partial sections were seen on the Elton, McCloy, Smith, Moore, and Brown & Shively farms, but no good measurement was obtained. Mr. Elton, who has burned some of this

limestone, reports the product to be a strong lime of good quality. It is probably well developed in this locality; for near the schoolhouse, on Brush Run, it is 4 feet thick (sections 107, 265), and below the Cowan pit (section 106) 6 + feet thick. Southward to Dry Run very little is known of this horizon, since it is represented only by occasional fragments along highways and streams. South of Ohioville, on Dry Run, however, limestone 2 to 7 feet thick occurs near the coal pits, but farther down the run, as shown in sections 260 and 261 (Pl. VII), it is absent altogether. On the river and lateral streams it is very thin or absent, showing 1 foot thick at section 259, as a few fragments on Sixmile Run, and reported though not seen on Wolf Run.

In the southeast region it reaches a thickness of 5 feet, but generally it is much thinner. On Logtown Run, while this bed is present, it is probably not more than 1 foot thick, but east of Hog Island and on Elkhorn Run it measures 2 to 3 feet (sections 112, 203), though it is often absent or represented by a very impure bed. On the river front it attains a thickness of 5 feet above the Monaca terrace (sections 120, 205), but opposite Beaver only a few fragments were observed, and the only other occurrence, one on Poorhouse Run and another on Raccoon Creek (section 215), measure 1 foot each.

In the southwest region, while it is 4 feet thick near the mouth of Raccoon Creek (section 216), it is represented on Fishpot Run and near the mouth of Gums Run by only a few fragments, and the same condition prevails southward to Independence (section 202). On the river front the limestone is represented on Squirrel Run by considerable clay mixed with calcareous nodules, but westward to Peggs Run, including Haden Run, no limestone is known, though on Peggs Run and on the river to Georgetown (sections 254, 256, Pl. VII) it is in places present in small amounts. In the valleys of Mill Creek, Little Mill Creek, and Service Creek this limestone is unknown.

LOCAL LIMESTONE.

The limestone occurring 30 feet, more or less, above the Upper Freeport coal will be described here, since it is locally developed to a valuable thickness. This bed, usually of a bluish-gray color, has the appearance of a fairly pure limestone. A lentil of it is best developed east of Rochester, where it is 5 to 8 feet thick and has been quarried to some extent. In the ravines to the south it is 2 to 4 feet thick (sections 224, 225, Pl. V). Its stratigraphic relations at this point are clear, and indicate that it is a lentil in the Mahoning sandstone. The pure character of this rock is here preserved only in its upper portion, while the lower part becomes a yellow ferruginous impure lime, resembling that underlying the Upper Freeport coal. On the hillsides and highways in this vicinity it may be seen as fragments of blue limestone 20 to 30 feet above the Upper Freeport coal blossom.

In several other places fragments of it may be seen along the country roads and prospecting may expose workable thicknesses. In South Beaver Township, for example, it is quite prevalent, being seen 28 feet above the Upper Freeport coal in the northeast corner of the township; about a mile and a half northeast of Blackhawk on the Thompson farm; on the Lisbon road east of Blackhawk; and on other roads to the northwest.

South of the river fragmental outcrops were noted on the terrace road west of Monaca (near section 220), at Bellowsville (section 223), and near Phillis Island (section 287).

AMES LIMESTONE.

The characteristics and distribution of this limestone have already been described (p. 19), together with localities showing typical exposures. As it is a persistent characteristic stratum throughout the southern portion of the quadrangle, it is outlined on the map (Pl. VIII) as a key rock to the structure. It varies greatly in

thickness, but its limits are 2 and 6 feet, and 3 feet may be taken as an average. It has been quarried for fertilizer at various localities on the northern branches of Traverse Creek, but it is reported not to burn well because of excessive impurities which it contains. Picked fragments containing numerous crinoid stems make, it is said, a good quality of cement for limited household purposes. It can be most easily stripped for use near streams of gentle grade, which have incised it for long distances. Among such localities the best are Flaugherty, Raredon, and Little Service runs, the head of Big Traverse Creek, Little Traverse Run, etc. Other areas where the limestone occurs near the surface, and may therefore be easily uncovered, are at McCleary, Green Garden, and Bunker Hill.

SANDSTONE.

INTRODUCTION.

Except sandstone hardly any rock suitable for building is found in this territory, and while sandstone is abundant, not all the beds can be used for this purpose. As a rule, Coal Measures sandstones are suitable only for rough masonry and very few are regular enough in their bedding to supply dimension stone. The only beds which have been quarried in a commercial way are those of the Allegheny and Conemaugh formations. These two formations contain the following well-marked sandstones: Morgantown, Mahoning, Butler, and Freeport. A study of Pls. IV to VII shows the thickness and variability of the last three strata. The Kittanning sandstone, lying beneath the Lower Kittanning coal, while generally of no importance, has a considerable development at the mouth of Raccoon Creek, on Sixmile Run, and at Smiths Ferry. At Industry it attains a maximum thickness of 50 feet. But so far as known it has never been used for building purposes within the quadrangle, though, apparently, its character seems not to warrant this neglect.

FREEPORT SANDSTONE.

The character and distribution of the Freeport sandstone have already been described, and Pls. IV to VII show these facts graphically. When massive it is usually a moderately coarse, micaceous, gray rock, often exhibiting false bedding. Its best development is below Industry, where it has been largely quarried for railroad purposes. This is the only place within the quadrangle where this bed has been worked, for owing to its hard and micaceous character, which makes dressing in certain directions difficult, it is seldom used for dimension stone.

BUTLER SANDSTONE.

The Butler sandstone, which is also represented in Pls. IV to VII, is a very compact, coarse, yellowish-white rock, and makes a fine building stone. It has been somewhat extensively exploited along the rivers in the eastern part of the quadrangle, but in the western part it becomes shaly, or merges into the Freeport sandstone. East of New Brighton it is being quarried by Mr. Smith, and many old quarries opened by Mr. Fish still remain as scars on the hillsides in this vicinity and on Blockhouse Run. On the west bank of the Beaver it was formerly mined just below the mouth of Brady Run and also above Beaver Falls, but neither of these quarries was active at the time of visit.

MAHONING SANDSTONE.

The Mahoning sandstone has been more extensively worked within the quadrangle than any other. It resembles very closely the Butler sandstone, being coarse grained, and yellowish to brown in color, but, unlike the latter, it frequently contains small pebbles of quartz. It was once highly prized as a building stone, and for that

purpose was largely quarried in the eastern part of the quadrangle. But unfortunately for this industry the greater cheapness and convenience of concrete, combined with an equal durability, have caused it to supplant sandstone for many building purposes. In the western part of the quadrangle, along Ohio River, the Mahoning sandstone is conglomeratic and perhaps for this reason, together with its unfavorable position, has never been much worked.

Many remains of old quarries on this bed may be seen on the river bluffs west and south of Monaca and north and south of Rochester. North of Rochester one or two quarries were at the time of visit still removing stone, but most of them were idle. Blockhouse Run was also at one time a site of this industry, but few if any quarries are now actively worked. On the west side of Beaver River and on the Ohio west of Beaver this bed has scarcely been opened. I. C. White reports that the Mahoning sandstone was once worked in the Walton quarry on Sixmile Run, a mile above McGaffic's coal pit.[a]

MORGANTOWN SANDSTONE.

The Morgantown sandstone is present only in the southern part of the quadrangle, where in places it has a large development. At some localities in Pennsylvania it is a very durable stone, but in this region its friability increases on exposure and, probably for this reason and the lack of transportation facilities, it is not exploited. It is possible, however, that on prospecting compact portions of this stratum might be discovered; in this case it would make a good building stone, for it has the requisite color, grain, and quarrying qualities.

SAND.

A systematic search made on the Kansan and Wisconsin terraces of this quadrangle might reveal pockets of sand which would be of considerable value for the manufacture of glass. Such sand is worked on the river terraces of Monongahela River near Belle Vernon. In this locality the upper bed of the Pottsville formation is also crushed for glass sand, and though it could hardly be so used within the Beaver quadrangle, still farther to the north it may be found pure enough for the purpose.

AGRICULTURE.

With the exception of flood plains and the lower line of terraces, the farming districts in this quadrangle are restricted to the uplands, which, as we have seen, are capped by the Conemaugh formation, containing chiefly shales and sandstones. Limestone beds are particularly scarce, and, except the Ames and the "local" limestones, practically no beds of thickness and extent sufficient for fertilizing are known. The soils of this district, being either clayey or sandy, are thus essentially without a natural fertilizer. Moreover, under present conditions the land receives the least of what it most lacks; for very little lime is either burned or applied as a dressing. On page 83 is given a description of limestone beds which might be used to some extent for this worthy purpose. Soil of such a character does not naturally lend itself to heavy crops and seems most suitable for stock raising.

TRANSPORTATION.

Ohio River is the only navigable stream in the quadrangle, and even this, being dependent on heavy precipitation for a boating stage, can be used as a rule during only the spring and fall months. The dams across the river, now in process of construction by the Government, will furnish a permanent boating stage, which will be very advantageous to the industries of the Ohio and Beaver valleys. Then steamboats and coal barges will make the passage from Pittsburg to the Mississippi

[a] Second Geol. Survey Pennsylvania, Rept. Q, p. 258.

throughout the year, except when prevented by ice. The entire system of dams will not be completed for many years, but the construction of dams from Pittsburg to the State line will render that portion of the river at once navigable.

Beaver River, not in itself navigable, is paralleled by the Pittsburg and Erie Canal which formerly furnished transportation facilities throughout Beaver Valley, but since the introduction of railroads it has been allowed to fall into disuse. Along the rivers the quadrangle is rather well provided with railroads, but not in such a manner as to allow the advantages of competitive rates. The Buffalo, Rochester and Pittsburg Railroad occupies within the quadrangle the west bank of both Beaver and Ohio rivers, while the Pennsylvania lines follow not only the east bank of both rivers, but the north bank of the Ohio. The south bank of the latter, however, though rich in latent resources, is yet untouched by any railroad line. But both sides of the river will in time, when the Government dams are completed, enjoy not only transportation by water but competition in rates.

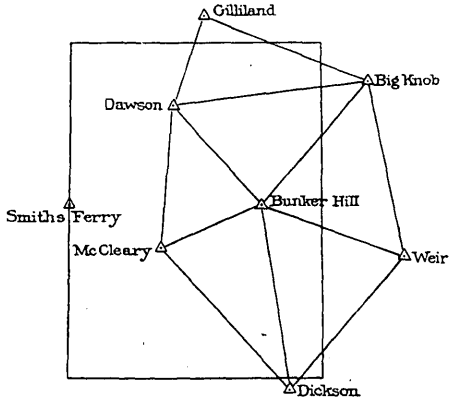

FIG. 35.—Triangulation stations controlling Beaver quadrangle.

WATER POWER.

The narrow, declivitous valleys of this region are usually occupied by streams of steep grade which are capable of furnishing considerable water power. A practical example of such utilization of streams is given by the dams on Beaver River. Other streams which have a flow of water throughout the year, such as Brady Run and Raccoon Creek, may also be made to furnish water power for mills, electric lighting, and other purposes.

APPENDIX.

TRIANGULATION POINTS.

The exact location of this quadrangle with reference to latitude and longitude is determined from certain points whose positions have been ascertained accurately by triangulation. Eight triangulation stations—three within the quadrangle and five outside, but near its boundaries—control the survey of this area. Each station is marked by a square sandstone post about 3 feet long, of which all but 2 inches is set in the ground. In the center of the top of the post is cemented a bronze tablet marked "U. S. Geological Survey—Pennsylvania." For the convenience of engineers, locations of these stations, together with the triangulation data from which their positions have been determined, are given below.

DAWSON, BEAVER COUNTY.[a]

Seventy yards west of a brick schoolhouse, on a cleared knob in the western part of Brighton Township, 5 miles west of Beaver, near the forks of the road, on land owned by G. W. Dawson, of Beaver.

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[a] Wilson, Renshawe, Douglas, and Goode, Results of primary triangulation and primary traverse, 1900-1901: Bull. U. S. Geol. Survey No. 181, 1901, p. 119.

Triangulation data, Dawson station.

[Latitude 40° 42′ 16.02″. Longitude 80° 24′ 11.53″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	*Meters.*
McCleary	3	49	22.4	183	49	00.5	4.0733912
Gilliland	201	49	57.4	21	51	14.9	3.8743981
Big Knob	263	47	05.7	83	55	01.0	4.2355940
Bunker Hill	317	39	11.8	137	42	41.5	4.0500887

M'CLEARY, BEAVER COUNTY.[a]

On a hill in Raccoon Township, 1 mile southwest of McCleary post-office, on land owned by A. L. Moore. Summit of hill has a few trees on its western side.

Triangulation data, McCleary station.

[Latitude 40° 35′ 52.99″. Longitude 80° 24′ 45.11″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	*Meters.*
Dawson	183	49	00.5	3	49	22.4	4.0733912
Bunker Hill	247	07	52.4	67	11	43.7	3.9571732
Dickson	315	41	54.9	135	46	56.7	4.1945450

BUNKER HILL, BEAVER COUNTY.[b]

On the highest point of a cleared hill in Moon Township, one-half mile south of Shaffer post-office and 6 miles south of Beaver, 200 yards south of Bunker Hill schoolhouse, on land owned by the Misses Good.

Triangulation data, Bunker Hill station.

[Latitude 40° 37′ 47.00″. Longitude 80° 18′ 49.87″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	*Meters.*
McCleary	67	11	43.7	247	07	52.4	3.9571732
Dawson	137	42	41.4	317	39	11.8	4.0500887
Big Knob	223	16	22.2	43	20	47.5	4.1441156
Weir	290	47	55.1	110	53	26.0	4.1068604
Dickson	350	06	53.6	170	08	04.4	4.1745591

GILLILAND, BEAVER COUNTY.[c]

On a cleared hill 4 miles west of Beaver Falls, on land owned by Sarah J. Gilliland. Theodolite elevated 33 feet.

[a] Idem, p. 120. [b] Idem, p. 117. [c] Idem., p. 118.

Triangulation data, Gilliland station.

[Latitude 40° 46′ 01.35″. Longitude 80° 22′ 12.78″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	*Meters.*
Dawson	21	51	14.9	201	49	57.4	3.8743981
Big Knob	289	35	24.5	109	42	02.6	4.1816755

WEIR, ALLEGHENY COUNTY.[a]

On a hill in Sewickley Township about 3 miles north of Sewickley depot and 3 miles southeast of Economy, northwest of point of road called the "Three-mile post," at the head of Turkey Run, on land owned by James F. Weir, 10 feet south of an east-west fence.

Triangulation data, Weir station.

[Latitude 40° 35′ 19.45″. Longitude 80° 10′ 21.45″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	*Meters.*
Dickson	42	46	12.4	222	41	52.7	4.1415223
Bunker Hill	110	53	26.0	290	47	55.1	4.1068604
Big Knob	170	47	47.7	350	46	41.6	4.1726934

BIG KNOB, BEAVER COUNTY.[b]

Near the north end of summit and about 40 feet south of an east-west rail fence, on a prominent, partly timbered hill known locally as the "Big Knob," in Sewickley Township, on land owned by Joseph Powell, who lives at the south end of the knob, 4 miles northeast of Freedom, 6 miles east of Rochester, and 7½ miles east of Beaver court-house. Theodolite elevated 30 feet.

Triangulation data, Big Knob station.

[Latitude 40° 43′ 15.73″. Longitude 80° 12′ 02.87″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	*Meters.*
Weir	350	46	41.6	170	47	47.7	4.1726934
Bunker Hill	43	20	47.5	223	16	22.2	4.1441156
Dawson	83	55	01.0	263	47	05.7	4.2355940
Gilliland	109	42	02.6	289	35	24.5	4.1816755

DICKSON, ALLEGHENY COUNTY.[c]

On a hill in Findley Township, 1 mile northeast of Clinton, on land owned by Prof. James Dickson.

[a] Idem, p. 112. [b] Idem, p. 113. [c] Idem, p. 115.

Triangulation data, Dickson station.

[Latitude 40° 29′ 49.59″. Longitude 80° 17′ 00.90″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	*Meters.*
McCleary	135	46	56.7	315	41	54.9	4.1945450
Bunker Hill	170	08	04.4	350	06	53.6	4.1745591
Weir	222	41	52.7	42	46	12.4	4.1415223

SMITHS FERRY, BEAVER COUNTY.[a]

An astronomic station of the United States Coast and Geodetic Survey, situated on the north bank of Ohio River, in front of the hotel at Smiths Ferry.

Triangulation data, Smiths Ferry station.

[Latitude 40° 38′ 48.07″. Longitude 80° 30′ 05.06″.]

To station—	Azimuth.			Back azimuth.			Log. distance.
	°	′	″	°	′	″	*Meters.*
Graveyard	1	00	27.20	181	00	26.70	3.0124143
Island	59	02	52.20	239	01	44.40	3.4552858

BENCH MARKS.

The topography of the quadrangle is controlled by lines of levels, having mean tide level at Sandy Hook as datum, extending over the main highways of the region. These levels are of two kinds, according to the accuracy sought—primary or precise levels and secondary or flying levels. The primary levels are run within a limiting error of nearly one-third of a foot for every 50-mile circuit, i. e., the limit of error in feet should not exceed $0.05\sqrt{\text{distance in miles}}$. Permanent and temporary bench marks are set along the line of traverse at convenient intervals. Secondary level lines are extended more hastily on either side of the primary level line, and elevations are marked in white paint at frequent points along the road. For the use of engineers a description is given here of the permanent and temporary bench marks of the primary levels on the Beaver quadrangle.[b]

BEAVER FALLS, PA.

	Elevation (feet).
Beaver Falls: B. M. No. 1596, Pittsburg, Fort Wayne and Chicago Railroad, precise levels...	789.366
Beaver Falls: Pittsburg, Fort Wayne and Chicago Railroad bridge over Eleventh street, west end of south abutment of, in coping stone; aluminum tablet marked "789.8 Pittsburg, 1901"	789.479

BEAVER, PA., ALONG HIGHWAYS WEST, VIA DAWSON TRIANGULATION STATION, TO BLACKHAWK; THENCE SOUTH, VIA FAIRVIEW, TO INDUSTRY, PA.

	Elevation (feet).
Beaver, U. S. Eng. B. M. "25 C," Pittsburg and Lake Erie Railroad bridge over Ohio River, land pier on right shore of river, 3 inches below top of nineteenth course of stone from top of pier and 3 feet east of west side of pier; seat on southwest end of land pier marked "U. S. B. M."	686.444
West Bridgewater, Cleveland and Pittsburg Railroad west-bound track at station; top of north rail	708.7

[a] Idem, p. 121.

[b] Gannett, S. S., and Baldwin, D. H., Results of spirit leveling in Pennsylvania, 1899–1905: Bull. U. S. Geol. Survey No. 288, 1906, p. 49. Final adjustment, 1903.

	Elevation (feet).
West Bridgewater, opposite Piersel's Academy, on curb corner	704.12
Beaver, court-house, in foundation stone of east entrance to; aluminum tablet marked "798 Pittsburg"	797.654
Beaver, 0.25 mile west of; iron bridge over Twomile Run, floor of	769.
Beaver, 1 mile west of, 300 feet below stone quarry, on sandstone east of road; projection made with chisel	893.93
Beaver, 3 miles west of, on south side of road; large oak, nail in projecting knot	1,167.04
Beaver, 4 miles west of, in road 1,000 feet east of Scott's house, on rock	1,192.12
Beaver, 5 miles west of, near Dawson triangulation station; white oak, nail in projecting knot	1,297.04
Blackhawk, 2 miles east of, on south side of road opposite watering trough; nail in stump	1,152.81
Esther, 2 miles south of; white oak at road intersection, nail in root of	1,107.01
Blackhawk, at Crossroads, at corner of barn, on large rock; aluminum tablet marked "1,169.3 Pittsburg"	1,169.013
Blackhawk, 0.5 mile south of, 200 feet north of road intersection, on left of road; oak tree, nail in	1,182.00
Blackhawk, 1 mile south of, 150 feet north of bridge, in field left of road; locust stump, nail in	1,103.40
Smiths Ferry, 3 miles northeast of, 100 feet north of oil derrick in woods, at left of road; stump, nail in	1,220.90
Industry, 2.5 miles north of, at right of road above bend; locust root, nail in	1,163.08
Industry, 1.5 miles north of, opposite coal bank; elm, nail in root of	937.10
Industry, Cleveland and Pittsburg Railroad bridge No. 117 over State road, south end of west abutment of, in end of second stone from top; bronze tablet marked "696 Pittsburg".	696.060
Industry, U. S Eng. B. M. "32 B," 600 feet above landing, 400 feet above Safe Harbor ferry landing, on left shore of river, on large rock under bank; seat cut	673.344

INDUSTRY, SOUTH ALONG HIGHWAYS, VIA HOOKSTOWN, TO KENDALL; THENCE EASTERLY TO PATTON'S BRIDGE, AND NORTHEASTERLY, VIA NEW SHEFFIELD, TO WOODLAWN.

	Elevation (feet.)
Industry, 3 miles south of, Minnesinger Hill, left of road; locust tree, nail in	935.18
Hookstown, stone bridge on Washington road over small stream, on southwest corner of (corner by the Robertson House); aluminum tablet marked "988.6 Pittsburg"	988.220
Hookstown, 1 mile south of, 600 feet south of fair grounds, right of road; white oak, nail in.	1,032.18
Kendall, 200 feet north of post-office, road fork to Harshaville, northeast corner of, on leaning rock	1,220.78
Kendall, 1 mile east of (about 5 miles southeast of Hookstown), on Big Traverse Creek, red brick house of James Buchanan, in foundation stone; aluminum tablet marked "1,069.7 Pittsburg"	1,069.360
Kendall, 2.5 miles east of, at road intersection, on rock	998.66
Frankfort Springs, 2 miles north of, at road fork; Keifer's bridge	923.33
Frankfort Springs, 2 miles north of; Keifer's bridge, floor	924
Clinton, 4 miles north of (6 miles east of Frankfort Springs) Patton's bridge over Raccoon Creek, in south end of west abutment of; aluminum tablet marked "848 Pittsburg"	847.022
Bocktown, 1.5 miles south of, near bridge over Longs Run; tree, nail in	820.30
Bocktown, near old fair grounds, at road fork; ground	811
Bocktown, 0.5 mile north of; small bridge at road to east, nail in	826.70
New Sheffield, Johnston's mill, in northeast corner of; aluminum tablet marked "943.7 Pittsburg"	943.666
New Sheffield, 0.5 mile northeast of, on left of road; nail in stump	921.76
Woodlawn, U. S. Eng. B. M. "18 B," Pittsburg and Lake Erie Railroad culvert over Logstown Run, on northeast coping stone of; chiseled square	715.793

Gas and oil wells in and near Beaver quadrangle.

BEAVER COUNTY.

Map number.	Name.	Township.	Farm.	Owner.	Approximate elevation.	Name of oil and gas sands.	Depth.	Thickness.	Total depth of well.	Driller's interpretation.	Remarks.
					Feet.		*Feet.*	*Feet.*	*Feet.*		
167	Economy No. 2	Beaver Falls				Berea	550	3	2,330		The original "Economy No. 2," drilled in 1877; perhaps same as "Beaver Falls well."
	McCormick lots, No. 1	do[a]	McCormick lots	Fort Pitt Gas Co.		do Hundred-foot Gordon	532 750 1,009	28 1,019	1,019	Berea Hundred-foot Bowlder	Gas at 1,009.
	Hunter, T. B	Brighton	T. B. Hunter			Berea	950	25	1,015	Sand	Salt water.
	Boyle, David, No. 7	College Boro[a]	David Boyle	Fort Pitt Gas Co.		Burgoon Berea	180 570	45 29	1,089	Big Injun Berea	Gas at 800 and 975 (very little).
	Collegeboro, No. 1	do		Beaver Falls Gas Co.		do Hundred-foot Gordon (?)	562 856 995			do Hundred-foot Bowlder	
	Darlington	Darlington[a]	Fergus Johnson	Gillespie & Armstrong.		Burgoon Berea	420(?) 670(?)	30 20	2,440	Sand	Dry; 4 feet coal at 154 (Lower Kittanning?).
	McGeorge, John	do	John McGeorge	John McGeorge.		do Hundred-foot	633 872			Berea Hundred-foot	
	Bock, No. 1	Economy[a]	Bock	Forest Oil Co		do	1,406		1,516	Gas sand	Pay at 1,480, 1,495.
	Bock, No. 2	do	do	do		do	1,538		1,550	Sand	Pay at 1,542.
	Bock, No. 3	do	do	do		do	1,606		1,623	do	
	Bock, No. 4	do	do	do		do	1,575		1,605	do	
	Bock, No. 5	do	do	do		do	[b]1,570		1,595	Pay sand	
	Bock, No. 6	do	do	do		do	1,567	26		Sand	
	Bock, No. 7	do	do	do		do	1,585		1,609	Sand through break.	

[a] Outside of quadrangle.

[b] Pay.

Gas and oil wells in and near Beaver quadrangle—Continued.

BEAVER COUNTY—Continued.

Map number.	Name.	Township.	Farm.	Owner.	Approximate elevation.	Name of oil and gas sands.	Depth.	Thickness.	Total depth of well.	Driller's interpretation.	Remarks.
					Feet.		*Feet.*	*Feet.*	*Feet.*		
	Bock, No. 8	Economy	Bock	Forest Oil Co		Hundred-foot	1,574	27		Pay sand	
	Bock, No. 9	do	do	do		do	1,500		1,576	Sand through break.	
	Bock, No. 10	do	do	do		do	1,618	30		Pay sand	
	Bock, No. 11	do	do	do		do	1,559	70		Sand	
	Bock, No. 12	do	do	do		do	1,462	38	1,508	Pay sand	A little oil.
	Bock, No. 13	do	do	do		do	1,455			Hundred-foot	Oil at 1,480.
	Bock heirs, No. 14	do	do	do		do	1,503	42		do	Oil at 1,518.
	Bock heirs, No. 15	do	do	do		do	1,487	46	1,535	do	Oil at 1,487.
	Bock heirs, No. 19	do	do	do		do	1,509	7	1,574	do	Pay at 1,509; break 26 feet; pay at 1,536; oil at 1,538.
	Bradford, Thos., No. 1	do	Thos. Bradford	do		do	1,436	57	1,505	do	Oil at 1,482.
	Bradford, Thos., No. 4	do	do	do		do	1,481	69	1,580	do	Salt water at 1,296.
	Bradford, Thos., No. 5	do	do	do		do	1,473	73	1,561	do	Oil at 1,474; salt water at 1,290.
	Bradford, Thos., No. 6	do	do	do		do	1,425	95	1,531	do	Salt water at 1,280.
	Bradford, Thos., No. 7	do	do	do		do	1,442	39	1,481	do	Oil at 1,459; salt water at 1,273.
	Bradford, Thos., No. 8	do	do	do		do	1,390	48	1,450	do	Oil at 1,417; salt water at 1,230.
	Bradford, Thos., No. 9	do	do	do		do	1,480	43	1,542	do	Oil at 1,481; salt water at 1,328.
	Bradford, Thos., No. 10	do	do	do		do	1,373 (?)	60 (?)		do	Gas at 1,365; oil at 1,373; salt water at 1,190.
	Bradford, Thos., No. 11	do	do	do		do	1,417	32	1,462½	do	Oil at 1,418 and 1,436; salt water at 1,230.

Bradford, Thos., No. 12	do	do	do		do	1,475	56	1,536	do	Oil at 1,479 (little) and 1,530; salt water at 1,297.
Bradford, Thos., No. 13	do	do	do		do	1,405	60	1,465	do	Little oil; salt water at 1,275.
Bradford, Thos., No. 14	do	do	do		do	1,432	30	1,495	do	Salt water at 1,330.
Bradford, Thos., No. 15	do	do	do		do	1,370	55		do	Salt water at 1,270.
Bradford, Thos., No. 16	do	do	do		do	1,443	8	1,487	do	Oil at 1,443 and 1,457; salt water at 1,340; two pay sands separated by 6 feet of shale.
Bradford, Thos., No. 17	do	do	do		do	1,457	5	1,511	do	Oil at 1,457; salt water at 1,360.
Bradford, Thos., No. 18	do	do	do		do	1,375	15	1,462½	do	Oil at 1,375; salt water at 1,282.
Bradford, Thos., No. 19	do	do	do		do	a 1,270		1,280	Salt sand	Gas at 1,280.
Bradford, Thos., No. 20	do	do	do		do	1,451	55		do	Gas at 1,624 and 1,665; salt water at 1,380.
					Gordon	1,624	41		Bowlder	
Brown, Morton, No. 1	do	Morton Brown	do		Hundred-foot	1,532	49	1,597	Hundred-foot.	
Bryant, No. 1	do	½ mile north of Baden.	do		Berea	1,120	42	1,366	Sand	99 feet red slate above Hundred-foot.
					Hundred-foot	1,349	17			
Church, Rehoboth, No. 1	do	R. Church	do		Gordon (?)	1,613	21	1,668	White sand	
Church, Rehoboth, No. 2	do	do	do		do	1,625		1,652	Sand	Oil at 1,639.
Downey, Jno., No. 1	do	John Downey	Fort Pitt Gas Co.		Hundred-foot	1,470	92	1,800	Hundred-foot	Gas at 1,793; coal 435 (Lower Kittanning?); salt water at 1,290.
					Fourth (?)	1,792	8		Bowlder	
Economy, No. 1	do	Economy	P. M. Shannon		Hundred-foot	1,558		1,947	Hundred-foot	Some gas at 1,841.
Economy, No. 2	do	do	do		do	1,526	10	1,536	Sand	Oil at 1,528; good sand 6 feet; 100 barrels per day.
Economy, No. 3	do	do	do		do	1,693		1,723	do	10 barrels first day.
Economy, No. 4	do	do	do		do	1,544		1,843	do	Gas at 1,830; light pressure.
Economy, No. 5	do	do	do		do	1,670	30	1,995	Hundred-foot	Gas at 1,967.
Economy, No. 6	do	do	do		do	1,518	18	1,536	Sand	100 barrels per hour; 1,600 barrels first day.

a Estimate.

Gas and oil wells in and near Beaver quadrangle—Continued.

BEAVER COUNTY—Continued.

Map number.	Name.	Township.	Farm.	Owner.	Approximate elevation.	Name of oil and gas sands.	Depth.	Thickness.	Total depth of well.	Driller's interpretation.	Remarks.
					Feet.		*Feet.*	*Feet.*	*Feet.*		
	Economy, No. 7	Economy	Economy	P. M. Shannon		Hundred-foot	1,441		1,497	Sand	Small showing of oil.
	Economy, No. 8	do	do	do		do	1,626		1,939	do	Oil at 1,628; gas at 1,939; 100 barrels first day.
	Economy, No. 9	do	do	do		do	1,568	30	1,598	do	Oil at 1,569; 75 barrels first day.
	Economy, No. 10	do	do	do		do	1,396	16	1,717	do	
						Fourth (?)	1,717				
	Economy, No. 11	do	do	do		Hundred-foot	1,424	20	1,740	do	Sand hard.
						Fourth (?)	1,740				
	Economy, No. 12	do	do	do		Hundred-foot	1,466	17	1,483	do	Oil at 1,469; 300 barrels per day; sand hard at top.
	Economy, No. 13	do	do	do		do	1,522		1,535	do	65 barrels per hour; sand pebbly.
	Economy, No. 14	do	do	do		do	1,556		1,578	do	Oil at 1,556.
	Economy, No. 15	do	do	do		do	1,431		1,465	do	
	Economy, No. 16	do	do	do		do	1,478		1,496	do	Oil at 1,483; 360 barrels first day.
	Economy, No. 17	do	do	do		do	1,570	41	1,886	Hundred-foot	Light gas pressure.
	Economy, No. 18	do	do	do		do	1,500		1,539	Sand	Gas.
	Economy, No. 19	do	do	do		do	1,576		1,612	do	15 barrels first day; sand loose.
	Economy, No. 20	do	do	do		do	1,237	25	1,262	Hundred-foot	Pebbles at 1,540.
	Economy, No. 21	do	do	do		do	1,526		1,561	Sand	Oil at 1,539; sand close.
	Economy, No. 22	do	do	do		do	1,265	27	1,642	Hundred-foot	Sand hard and dry.
	Economy, No. 23	do	do	do		do	1,521	26	1,553	do	Little oil; sand hard.
	Economy, No. 24	do	do	do		do	1,595	30	1,634½	Sand	Oil at 1,600; sand hard on top.

Economy, No. 25	do	do	do	do		do	1,622	29	1,661	do	2 barrels first day.
Economy, No. 26	do	do	do	do		do	1,525	30	1,565	do	Dry; sand hard and close.
Economy, No. 28	do	do	do	do		do	1,450	32	1,490½	Hundred-foot	
Economy, No. 29	do	do	do	do		do	1,423	32	1,460	do	Dry; sand limy.
Economy, No. 30	do	do	do	do		do	1,266	24	1,296	do	Dry.
Economy, No. 31	do	do	do	do		do	1,267	23	1,299	do	Small gas.
Economy, No. 32	do	do	do	do		do	1,574	30	1,622⅔	do	Dry.
Economy, No. 33	do	do	do	do		do	1,267	25	1,307	do	Oil at 1,280; gas at 1,267–1,274.
Economy, No. 34	do	do	do	do		do	1,270	23	1,305	Sand	Much oil at 1,280.
Economy, No. 35	do	do	do	do		do	1,279	21	1,310	Hundred-foot	Much oil at 1,288.
Economy, No. 36	do	do	do	do		do	1,261	27	1,296⅔	do	Oil at 1,274; 18 barrels first day.
Economy, No. 37	do	do	do	do		do	1,278	32	1,335⅓	do	
Economy, No. 38	do	do	do	do		do	1,220	25	1,256	do	Oil at 1,229.
Economy, No. 39	do	do	do	do		do	1,275	25	1,309	Sand	Oil at 1,285; 60 barrels first day.
Economy, No. 40	do	do	do	do		do	1,290	26	1,324	Hundred-foot	Oil at 1,300; some pebbles; gas at top; 5+ barrels first day.
Economy, No. 42	do	do	do	do		do	1,342	24	1,372	do	Oil at 1,356; 18+ barrels first day.
Economy, No. 43	do	do	do	do		do	1,423	30	1,467	do	Sand, calcareous.
Economy, No. 44	do	do	do	do		Hundred-foot Fourth (?)	1,352 1,600		3,393	do Fourth	
Economy, No. 46	do	do	do	do		Hundred-foot	1,311		1,352	Sand	Gas at 1,322.
Economy, No. 47	do	do	do	do		Hundred-foot(?)	1,628		1,658	do	Oil at 1,628.
Gross, Wm., No. 1	do	Wm. Gross	Fort Pitt Gas Co.			Burgoon Berea (?) Hundred-foot Gordon	705 1,220 1,390 1,640	135 90 4	1,646	Mountain Salt sand Hundred-foot Bowlder	Show of oil at 1,410; oil at 1,642; gas at 1,640; 3 feet coal at 465 (Lower Kittanning?).
Gross, Wm., No. 2	do	do	do			Burgoon Berea (?) Hundred-foot Gordon (?)	675 1,200 1,420 (?) 1,594	135 120 6	1,600	Mountain Salt sand Hundred-foot Bowlder	Show of oil at 1,420; gas at 1,595; 3 feet coal at 415 (Lower Kittanning?).
Hartling, Jno. F	do	John F. Hartling	Forest Oil Co			Hundred-foot	1,437	33	1,524	Hundred-foot	

Gas and oil wells in and near Beaver quadrangle—Continued.

BEAVER COUNTY—Continued.

Map number.	Name.	Township.	Farm.	Owner.	Approximate elevation.	Name of oil and gas sands.	Depth.	Thickness.	Total depth of well.	Driller's interpretation.	Remarks.
					Feet.		*Feet.*	*Feet.*	*Feet.*		
	Hoenig heirs	Economy	Hoenig heirs	Fort Pitt Gas Co.		Berea (?) Hundred-foot Gordon	1,160 1,330 1,568	100 120 5	1,610	Salt sand Hundred-foot Bowlder	Little gas at 1,568.
	Reed, Hugh, heirs, No. 1	do	Reed heirs	Forest Oil Co		Hundred-foot	1,440			Hundred-foot	Gas at 1,480; oil at 1,486.
	Wretzler, Frank, No. 1	do	Frank Wretzler	Fort Pitt Gas Co.		do Gordon	[a] 1,598 1,757	5	1,764½	do Bowlder	Dry.
	Wilson heirs, No. 5	Franklin [b]	Wilson heirs	Forest Oil Co		Hundred-foot	1,030	54		Hundred-foot	Oil at 1,042
	Wilson heirs, No. 6	do	do	do		do	1,022		1,075	do	Oil at 1,022
	Wilson heirs, No. 7	do	do	do		do	1,024		1,050	do	Oil at 1,024
	Wilson heirs, No. 8	do	do	do		do Gordon Fourth (?)	1,012 1,222 1,258	10 10	1,273	do Bowlder Third	Gas at 1,222.
45	Blackledge, W. C., No. 1	Greene	W. C. Blackledge	do	1,120	Berea	1,098			Smiths Ferry	5 feet coal at 120.
	Boyd, S. M	do	At Georgetown	S. M. Boyd		do Gordon	730 1,303	30 15	1,430(?)	do Sand (oil)	Record unreliable. 10 feet red rock 110 feet above Gordon (?).
32	Brown, J. H. & M. J., No. 1.	do	Brown	Forest Oil Co	1,015	Berea	967		1,000	Smiths Ferry	Oil at 980; 24 barrels first day.
28	Captain Calhoun	do	Captain Calhoun			do Gordon Fourth	704 1,225 1,280	20	1,280	Berea Third Fourth	
38	Calhoun, Milton, No. 1	do	Milton Calhoun	Forest Oil Co		Berea	1,066	28	1,094	Sand	Oil at 1,079; 150 barrels first day.
39	Calhoun, Milton, No. 2	do	do	do	1,120	do	1,084		1,118	do	Oil at 1,094; 10 barrels first day.
30	Calhoun, Milton, No. 3	do	do	do	1,045	do	998		1,020	Smiths Ferry	Oil at 1,007; 10 barrels first day.

40	Calhoun, Milton, No. 4	do	do	do		do	1,060	24	1,084	do	Oil at 1,070; 60 barrels first day.
37	Calhoun, Milton, No. 5	do	do	do		do	1,074	31	1,105	do	Oil at 1,087; 20 barrels first day.
29	Calhoun, Milton, No. 6	do	do	do	1,060	do	1,015		1,040	do	Oil at 1,026.
	Campbell, J. Y., No. 1	do	J. Y. Campbell	do		do	1,254	27	1,281	Sand	Oil at 1,254; 50 barrels per day after 5 months.
	Campbell, J. Y., No. 2	do	do	do		do	1,241	24	1,265	Smiths Ferry	Oil at 1,246; 25 barrels first day.
	Campbell, J. Y., No. 4	do	do	do		do	1,302	26		Sand	Oil at 1,306.
	Campbell, J. Y., No. 6	do	do	do	1,245	do	1,205		1,234	Smiths Ferry	Oil at 1,210; coal at 480 (Lower Kittanning ?).
	Campbell, J. Y., No. 7	do	do	do		do	1,265	25	1,297	do	Oil at 1,271; salt water at 920.
	Campbell, No. 10	do	do	do		do	1,290			do	4 feet coal at 600 (Lower Kittanning).
	Cready, Elizabeth R. and Jane M., No. 1.	do	Cready	do		do	1,260	20		Sand	Oil at 1,265.
	Gailey, Silas, No. 4	do	Silas Gailey	do		do	1,109	36		Smiths Ferry	
	Glass, D. K., No. 2	do	D. K. Glass			do	941			do	Coal at 365 (Lower Kittanning).
41	Glenn, Josephine	do	Josephine Glenn	Forest Oil Co	1,144	do	1,100		1,126	Sand	Oil at 1,110.
35	Glenn, Wm. and Thos., No. 3.	do	Glenn	do		do	1,068	17	1,085	Smiths Ferry	Oil at 1,073; 120 barrels first day.
34	Glenn, Wm. and Thos., No. 4.	do	do	do		do	1,087	29	1,116	do	Oil at 1,100; 100 barrels first day.
36	Glenn, Wm. and Thos., No. 5.	do	do	do		do	1,047	28	1,075	do	Oil at 1,055.
33	Glenn, Wm. and Thos., No. 6.	do	do	do		do	1,095	21	1,116	do	Dry.
	Hamilton, No. 1	do	Mrs. Hamilton	Puritan Oil Co		Burgoon Berea	230 590	20	630	Big Injun Berea	
	Hays, R. and E., No. 3.	do	R. and E. Hays	Forest Oil Co		do	1,229			Smiths Ferry	5 feet coal at 465 (Lower Kittanning).
	Laughlin, Dr. Francis, No. 1.	do	Dr. Francis Laughlin.			do	1,090			Berea	

[a] Bottom.

[b] Outside of quadrangle.

Gas and oil wells in and near Beaver quadrangle—Continued.

BEAVER COUNTY—Continued.

Map number.	Name.	Township.	Farm.	Owner.	Approximate elevation.	Name of oil and gas sands.	Depth.	Thickness.	Total depth of well.	Driller's interpretation.	Remarks.
					Feet.		*Feet.*	*Feet.*	*Feet.*		
31	Loughlin, T. S., No. 1.	Greene	T. S. Loughlin	Forest Oil Co		Berea	948	20	968	Smiths Ferry	Oil at 953; 30 barrels first day.
	Mackall, B., No. 1	do	Mackall	do		do	1,069	33	1,102	Sand	Oil at 1,075.
	Montgomery, John, No. 1.	do	John Montgomery	do		do	1,095	45	1,140	Smiths Ferry	Oil at 1,110.
42	Montgomery, John, No. 1.	do	John Montgomery	Duff Bros		Burgoon	a 800			Big Injun	
						Berea	1,108	20		Berea	
	Montgomery, John, No. 2.	do		do		Burgoon	a 725			Big Injun	
						Berea	1,034	30		Berea	
	Montgomery, J. and N. J., No. 3.	do	J. and N. J. Montgomery.	Forest Oil Co		do	1,135			Smiths Ferry	5 feet coal at 395 (Lower Kittanning).
	Nickel, Mathew, No. 1.	do	Mathew Nickel	do	1,128	do	1,105	16	1,121	do	Oil at 1,110.
	Nickel, Mathew, No. 2.	do	do	do		do	1,132	22	1,154	do	Oil at 1,140.
	Nickel, Mathew, No. 3.	do	do	do		do	1,139	22		do	Oil at 1,145.
	Nickel, Mathew, No. 4.	do	do	do		do	1,122	18	1,148	do	Oil at 1,130.
	Nickel, Mathew, No. 5.	do	do	do		do	1,145	19	1,164	do	Oil at 1,150.
	Nickel, Mathew, No. 6.	do	do	do		do	1,150	17	1,173	do	Oil at 1,167.
	Nickel, Mathew, No. 7.	do	do	do		do	1,174	16	1,194	do	Oil at 1,180.
	Nickel, Mathew, No. 8.	do	do	do		do	1,124	16	1,144	do	Oil at 1,130; little salt water at 760; 50 barrels first day.
	Nickel, Mathew, No. 9.	do	do	do		do	1,120	8	1,135	do	Oil at 1,120.
	Nickel, Mathew, No. 10	do	do	do		do	1,092	8	1,100½	do	Oil and gas at 1,097.
	Nickel, Mathew, No. 11	do	do	do		do	1,112	13	1,131½	do	Oil at 1,116.
	Poe, ——	do	Poes	Dawson Oil Co		Berea (?)	700 (?)	20	1,277	Big Injun	Oil at 660 and 1,100; oil and gas from Fourth.
						Hundred-foot	1,010	22		Gantz	
						Fourth	1,260	16		Gordon	
	Spence, No. 1	do	Spence			Berea	625			Berea	

	Spence, No. 2	do	do	Edward Spence.		Burgoon	370	60		Big Injun	
						Berea	670	21		Berea	
	Spence, No. 3	do	do	Puritan Oil Co.		do	700			do	
	Stewart, Frank, No. 1	do	Frank Stewart	Forest Oil Co		do	921	9	960	do	
	Stewart, Jas. R., No. 1	do	Jas. R. Stewart	do		do	1,016	18	1,710	Smiths Ferry	Dry.
44	Stewart, Robt., No. 1	do	Robt. Stewart	do		do	1,120	30		Sand	Oil at 1,128.
43	Stewart, Robt., No. 2	do	do	do		do	1,070	23	1,093	Smiths Ferry	Oil at 1,082; 30 barrels first day.
	Stewart, Robt., No. 3	do	do	do		do	1,068			do	4 feet coal at 339 (Lower Kittanning).
	Stewart, Robt., No. 5	do	do	do		do	1,114			do	2 feet coal at 380 (Lower Kittanning).
	Taylor, Wm., No. 1	do	Wm. Taylor	do		do	1,145	22	1,167	do	Oil at 1,154; 20 barrels first half day.
	Taylor, Wm., No. 2	do	do	do					1,137		
	Taylor, Wm., No. 3	do	do	do		Berea	1,100		1,125	Smiths Ferry	Gas at 1,106; oil at 1,125; 25 barrels first day.
	Taylor, Wm., No. 4	do	do	do		do	1,200	23	1,223	do	Oil at 1,207; 30 barrels first day.
	Taylor, Wm., No. 5	do	do	do		do	1,128	27		Sand	Oil at 1,135.
	Taylor, Wm., No. 6	do	do	do		do	1,149	30	1,179	do	Oil at 1,158.
	Taylor, Wm., No. 7	do	do	do		do	1,146	21		do	Oil at 1,155.
	Taylor, Wm., No. 8	do	do	do		do	1,185	20		Smiths Ferry	Oil at 1,195; 15 barrels first day.
	Taylor, Wm., No. 9	do	do	do		do	1,165	28	1,193	do	Oil at 1,170; 106 barrels first 13 hours.
	Taylor, Wm., No. 13	do	do	do		do	1,173	12	1,199	do	Gas at 1,178; oil at 1,180.
	Thompson, Eleanor	do				do	1,132	12	1,900		
	Armor, J. R., No. 5	Hanover	J. R. Armor	Forest Oil Co		do	734	14	1,762	Sand	10 barrels first day.
	Brunton, J. P., No. 1	do	Near center of east line.	United Natural Gas Co.		Berea (?)	1,470	25	1,644	do	Record unreliable; 55 feet of red rock 47 feet above Hundred-foot.
						Hundred-foot (?)	1,622	22		Oil sand	
	Carson, No. 1	do	Carson	Murray & Miller		Burgoon	813	30	1,208	Big Injun	Pay 18 feet; coal at 450 (Lower Kittanning).
						Berea	1,162	29		Berea	
	Cooley, Joe, No. 4	do	Joe Cooley	Forest Oil Co		Hundred-foot (?)	1,866	15	1,905	Sand	
	Cooley, Joe, No. 5	do	do	do		Hundred-foot	1,778	6	1,795	Murdockville	Dry; coal at 600 (Lower Kittanning).
	Cooley, W. B., No. 1	do	W. B. Cooley	do		do	1,618	12	1,632	Sand	

[a] Bottom.

Gas and oil wells in and near Beaver quadrangle—Continued.

BEAVER COUNTY—Continued.

Map number.	Name.	Township.	Farm.	Owner.	Approximate elevation.	Name of oil and gas sand.	Depth.	Thickness.	Total depth of well.	Driller's interpretation.	Remarks.
					Feet.		*Feet.*	*Feet.*	*Feet.*		
	Cooley, W. B., No. 2	Hanover	W. B. Cooley	Forest Oil Co		Hundred-foot	1,706	15	1,729	Sand	
	Cooley, W. B., No. 3	do	do	do		do	1,754	16	1,775	do	
	Cooley, W. B., No. 4	do	do	do		do	1,808	13	1,833	do	
	Cooley, W. B., No. 5	do	do	do		do	1,754	14	1,779	do	
	Cooley, W. B., No. 6	do	do	do		do	1,622	13	1,644	do	10 barrels first day.
	Crooks, W. & J., No. 2	do	W. & J. Crooks	do		do	1,615	11	1,645	do	6 barrels first day.
	Crooks, W. & J., No. 3	do	do	do		do	1,674	16	1,705	do	Do.
163	Elder, Wm	do	Wm. Elder	Ohio Valley Gas Co.		do	1,685	13	1,701	do	
165	Gerrow, G. C	do	G. C. Gerrow	do		do	1,488	12	1,500	do	
166	Gorsuch, G. M	do	G. M. Gorsuch	do		do	1,655	10	1,670	do	
	Gorsuch, G. M	do	do	do		do	1,675	10	1,690	do	
	Hoge, John and Alice, No. 1.	do	John and Alice Hoge.	Forest Oil Co		Berea	1,147			Smiths Ferry	5 feet coal at 390 (Lower Kittanning).
	Hoge, John and Alice, No. 2.	do	do	Forest Oil Co							Coal at 430 (Lower Kittanning). (H. H. Mills.)
	Hunter heirs	do	Hunter heirs	Ohio Valley Gas Co.		Hundred-foot	1,742	14	1,781	Hundred-foot.	
	Keifer, R. S. & W. F	do	Keifer	do		Burgoon	850	180	1,635	Big Injun	
						Hundred-foot(?)	1,400			Thirty-foot	
						Gordon (?)	1,592	11		Hundred-foot.	
	Lee, No. 1	do	W. A. Lee	South Penn Oil Co.		Burgoon	815		1,450	Big Injun	Show of oil at 640.
						Berea	1,350	57		Sand	
	McConnell heirs	do	McConnell heirs	Ohio Valley Gas Co.		Hundred-foot	1,437	10	1,483	Hundred-foot.	
	McDole, No. 1	do	Mathew McDole	Forest Oil Co		Berea	1,301			Smiths Ferry	5 feet coal at 530 (Lower Kittanning?). (H. H. Mills).

164	Martin heirs	do	Martin heirs	Ohio Valley Gas Co.		Hundred-foot	1,538		1,560	Sand	
	Nelson, No. 1	do	Nelson	Lawrence Natural Gas Co.		Burgoon	792		1,543	do	Salt water at 600; fair gas well in Hundred-foot(?).
						Berea	1,325	25		do	
						Hundred-foot	1,525	18+		Shannopin	
	Patterson, Jas., No. 1	do	Jas. Patterson	Forest Oil Co		Berea	1,060	2+	1,114	Sand	
161	Reed, R. A. and T. G.	do	Reed	Ohio Valley Gas Co.	1,180	Hundred-foot	1,664	16	1,725	do	
	Stephenson, W. H., No. 1.	do	W. H. Stephenson.	Forest Oil Co		Berea	1,175			Smiths Ferry	5 feet coal at 425 (Lower Kittanning); 5 feet coal at 730.
	Strouse, John, No. 1	do	John Strouse	do		do	1,250			do	5 feet coal at 440.
162	Strouse, W. G	do	W. G. Strouse	Ohio Valley Gas Co.		do	1,398	16	1,418	Sand	
	Swearengen, W. H., No. 1.	do	W. H. Swearengen	Forest Oil Co		do	1,353			Smiths Ferry	5 feet coal at 211; 4 feet coal at 576 (Lower Kittanning?).
	Echel & Ritchie, No. 1	Harmony[a]	Echel & Ritchie	do		Hundred-foot(?)	1,366		1,390	Sand	Oil at 1,376.
	Echel & Ritchie, No. 4	do	do	do		Hundred-foot	1,470		1,880	do	Pay 3 feet; gas well.
						(?)	1,771	10		Gas sand	
	Echel & Ritchie, No. 5	do	do	do		Hundred-foot	1,435	6	1,457	Sand	Some oil at 1,435, 1,438; more oil at 1,440.
	Echel & Ritchie, No. 6	do	do	do		do	1,503		1,518	do	Oil at 1,503–1,508.
	Echel & Ritchie, No. 8	do	do	do		do	1,647		1,970	do	Oil at 1,649; gas at 1,947.
	Echel & Ritchie, No. 10	do	do	do		do	1,581		1,602	do	Oil at 1,581–1584.
	Echel & Ritchie, No. 11	do	do	do		do	1,621		1,651	do	Oil at 1,629–1,639.
	Echel & Ritchie, No. 12	do	do	do		do	1,524		1,537	do	Oil at 1,524–1,531.
	Economy, No. 1	do	At Fair Oaks	Economy Society.	710±	do	1,298	62	1,645	Pebbly sand	63 feet red rock above Hundred-foot: a small gas well.
						Fourth (?)	1,625	20		Gas sand	
	Economy Tract, No. 12	do	Economy Tract	Eachel & Ritchie		Hundred-foot	1,524			Hundred-foot or Shannopin.	50 barrels per hour.
	Economy Tract, No. 13	do	Economy	Forest Oil Co		do	1,476		1,497½	Hundred-foot.	Oil and gas at 1,476; best pay at 1,479–1,485; 15 barrels first day, 24 barrels second day.

[a] Outside of quadrangle.

Gas and oil wells in and near Beaver quadrangle—Continued.

BEAVER COUNTY—Continued.

Map number.	Name.	Township.	Farm.	Owner.	Approximate elevation.	Name of oil and gas sands.	Depth.	Thickness.	Total depth of well.	Driller's interpretation.	Remarks.
					Feet.		*Feet.*	*Feet.*	*Feet.*		
	Frederick, L., No. 1	Harmony (below Butler).	L. Frederick	Westerman Bros.		Hundred-foot	1,121			Hundred-foot.	
	Frederick, L., No. 2	do	do	do		Berea (?) Hundred-foot	1,060 1,231			Gas sand Hundred-foot.	
	Frederick, L., No. 3	do	do	do		do	1,192	37		do	
	Frederick, L., No. 4	do	do	do		do	1,125	51		do	
	Frederick, L., No. 5	do	do	do		do	1,128			do	
	Frederick, L., No. 6	do	do	do		do	1,141			do	
	Frederick, L., No. 7	do	do	do		do	1,215			do	
	Hugh & Moore	do	Near Fair Oaks	Fort Pitt Gas Co.		do	1,275	25	1,606	Shannopin	6 feet coal at 150 (Upper Freeport?); 60 feet of red rock overlying Hundred-foot.
55	Calvert, W. M., No. 2.	Hopewell	W. M. Calvert		907	Burgoon Hundred-foot	400 (?) 1,340	 20	1,365	Big Injun Hundred-foot.	Coal at 125.
82	Cartney, Robt. M., No. 1.	do	Robt. M. Cartney.	Forest Oil Co		do	1,711		1,730	Sand	
85	Cartney, Robt. M., No. 2.	do	do	do	1,100	do	1,688		1,746	do	
69	Cartney, Robt. M., No. 3.	do	do	do		do	1,732		1,747	do	
84	Cartney, Robt. M., No. 4.	do	do	do		do	1,702		1,714	do	
81	Cartney, Robt. M., No. 5.	do	do	do		do	1,795			do	
83	Cartney, Robt. M., No. 6.	do	do	do		do	1,718	12		do	
68	Cartney, Robt. M., No. 7.	do	do	do		do	1,720	16		do	

67	Cartney, Robt. M., No. 8.	do	do	do		do	1,702	13		do	
63	Eacher, Chas., No. 1	do	Chas. Eacher	do	1,123	do	1,690		1,720	do	
62	Eacher, Chas., No. 2	do	do	do		do	1,792		1,810	do	
	Eacher, Chas., No. 3	do	do	do		do	1,729		1,743	do	
	Eacher, Chas., No. 4	do	do	do		do	1,694		1,729	do	
65	Hood, No. 1	do	Hood	do	1,138	do	1,695		1,725	do	
66	Hood, No. 2	do	do	do	1,230	do	1,770		1,795	do	
64	Hood No. 3	do	do	do	1,170	do	1,706		1,720	do	
	Hood No. 4	do	do	do		do	1,712		1,750	do	
49	Irons No. 1	do	J. D. Irons	Citizens Gas Co.	1,027	Burgoon Hundred-foot	750 1,458	 17	2,659	Big Injun Shannopin	7 to 9 feet coal at 325; salt water in Burgoon; little gas in Hundred-foot.
113	Kirk No. 2	do	Kirk	Forest Oil Co		do	1,665		1,684	Sand	
59	Johnston, James, No. 1	do	James Johnston	Bridgewater Gas Co.	1,050	Berea Hundred-foot	1,240 1,466	35 24?	1,490		
	McAllister, David, No. 1.	do	David McAllister.	Forest Oil Co		do	1,626	27		Sand	
	McAllister, David, No. 2.	do	do	do		do	1,712	36		do	
	McAllister, David, No. 3.	do	do	do		do	1,671	27	1,718	do	
73	McAllister, Mary, (No. 5) ?.	do	Mary McAllister	do		do	1,753	26	1,784	do	
52	McCormick	do	McCormick		770				1,218		Large quantity of gas in Hundred-foot.
	McElhaney No. 1	do	McElhaney			Burgoon Berea Hundred-foot	917 1,270? 1,557	 15	1,572	Sand	
	McKee, Jno., No. 2	do	John McKee	Ohio River Improvement Co.		Burgoon Hundred-foot	370 1,163	20		Big Injun Shannopin	5 feet coal at 270; gas, but horizon not given.
96	Morrow, A. P., No. 1	do	A. P. Morrow	Forest Oil Co	1,105	do	1,676			Sand	
98	Morrow, A. P., No. 2	do	do	do		do	1,645		1,672	do	
100	Morrow, A. P., No. 3	do	do	do		do	1,650		1,670	do	
	Morrow, A. P., No. 4	do	do	do		do	1,732		1,773	do	
86	Morrow, A. P., No. 5	do	do	do		do	1,731		1,748	do	
87	Morrow, A. P., No. 6	do	do	do		do	1,678		1,692	do	

Gas and oil wells in and near Beaver quadrangle—Continued.

BEAVER COUNTY—Continued.

Map number.	Name.	Township.	Farm.	Owner.	Approximate elevation.	Name of oil and gas sands.	Depth.	Thickness.	Total depth of well.	Driller's interpretation.	Remarks.
					Feet.		*Feet.*	*Feet.*	*Feet.*		
79	Morrow, A. P., No. 7	Hopewell	A. P. Morrow	Forest Oil Co		Hundred-foot	1,169		1,796	Sand	
80	Morrow, A. P., No. 8	do	do	do		do	1,775		1,816	do	
	Morrow, A. P., No. 9	do	do	do		do	1,776		1,797	do	
70	Morrow, A. P., No. 10	do	do	do		do	1,741		1,764	do	
167	Morrow, A. P., No. 11	do	do	do	1,252	do	1,795		1,860	do	
	Morrow, A. P., No. 12	do	do	do		do	1,762		1,814	do	
	Morrow, A. P., No. 13	do	do	do		do	1,682		1,726	do	
90	Morrow, A. P., No. 14	do	do	do		do	1,677		1,691	do	
	Morrow, A. P., No. 15	do	do	do		do	1,767		1,786	do	
	Morrow, A. P., No. 16	do	do	do		do	1,661		1,711	do	
92	Morrow, A. P., No. 17	do	do	do		do	1,693		1,714	do	
91	Morrow, A. P., No. 18	do	do	do		do	1,590		1,626	do	
75	Morrow, A. P., No. 19	do	do	do		do	1,702		1,782	do	
71	Morrow, A. P., No. 20	do	do	do		do	1,772?		1,750?	do	
78	Morrow, A. P., No. 21	do	do	do		do	1,715		1,750	do	
88	Morrow, A. P., No. 22	do	do	do	1,120	do	1,690		1,730	do	
89	Morrow, A. P., No. 23	do	do	do		do	1,785		1,840	do	
72	Morrow, A. P., No. 24	do	do	do	1,260	do	1,765			do	
77	Morrow, A. P., No. 25	do	do	do	1,070	do	1,621		1,678	do	
94	Morrow, John, No. 6	do	John Morrow	do		do	1,662	23	1,688	do	Best sand at 1,672; gas fairly good.
95	Morrow, John, No. 7	do	do	do		do	1,737	25	1,772	do	
60	Stevenson No. 1	do	Stevenson	do		do	1,736		1,772	do	
	Stevenson No. 2	do	do	do		do	1,809		1,826	do	
	Stevenson No. 3	do	do	do		do	1,681		1,720	do	

104	Thompson No. 1	do	Thompson	P. M. Shannon		do	1,662	25	1,697	Hundred-foot.	"Hundred-foot" is 1,800 feet below Pittsburg coal.
106	Thompson No. 2	do	do	do		do	1,704		1,722	do	Oil at 1,722.
	Thompson No. 3	do	do	do		do	1,740		1,759	do	Oil at 1,759.
108	Thompson No. 4	do	do	do		do	1,655		1,698	do	Oil at 1,666.
	Thompson No. 5	do	do	do		do	1,699	23	1,743	Sand	Oil at 1,710.
	Thompson No. 6	do	do	do		do	1,692	28	1,750	Third	Oil at 1,707
101	Thompson No. 7	do	do	do		do	1,739	26		Sand	
102	Thompson No. 8	do	do	do		do	1,788			do	
	Thompson No. 9	do	do	do		do	1,754		1,805	do	
103	Thompson No. 10	do	do	do		do	1,799	26	1,831	Third	
105	Thompson, W. P., No. 12.	do	W. P. Thompson	Forest Oil Co		do	1,769	24	1,805	Sand	
61	Wallace, Rev. J. R., No. 1.	do	Rev. J. R. Wallace	do		do	1,702	26	1,738	Hundred-foot.	Oil at 1,708.
51	Zimmerly, Henry	do	Henry Zimmerly		780				1,206		Large gas well; producing sand: Hundred-foot.
50	Bruce, Jane, No. 1	Hopewell-Moon	Jane Bruce		770				1,187		Small amount of gas in Hundred-foot.
119	Alexander, Jas., No. 1	Independence	Jas. Alexander	Forest Oil Co	920	Hundred-foot	1,482		1,506	Sand	
114	Alexander, Jas., No. 2	do	do	do		do	1,652		1,665	do	
112	Alexander, Jas., No. 3	do	do	do		do	1,543		1,559	do	
117	Alexander, Jas., No. 4	do	do	do		do	1,736		1,754	do	
118	Alexander, Jas., No. 7	do	do	do		do	1,583	13		do	Best sand at 1,581.
	Alexander No. 4	do	Alexander	do		do	1,524	18	1,576	do	Dry.
	Beegel, S., No. 1	do	S. Beegel	do		do	1,586	23	1,615	do	
146	Beegel, S., No. 2	do	do	do		do	1,519	23	1,552	do	
147	Beegel, S., No. 3	do	do	do		do	1,520	19	1,552	do	
	Beegel, S., No. 4	do	do	do		do	1,663	5		do	
	Beegel, S., No. 5	do	do	do		do	1,683	11		do	
	Beegel, S., No. 8	do	do	do		do	1,676	23	1,704	do	
	Beegel, S., No. 9	do	do	do		do	1,755	19?	1,774	do	
	Connell, Frank, No. 1	do	Frank Connell	do		do	1,799	23	1,825	do	
	Connell, Frank, No. 2	do	do	do		do	1,750	8	1,758	do	
	Connell, Frank, No. 3	do	do	do		do	1,782	23		do	Do.

Gas and oil wells in and near Beaver quadrangle—Continued

BEAVER COUNTY—Continued.

Map number.	Name.	Township.	Farm.	Owner.	Approximate elevation.	Name of oil and gas sands.	Depth.	Thickness.	Total depth of well.	Driller's interpretation.	Remarks.
					Feet.		*Feet.*	*Feet.*	*Feet.*		
	Connell, M., No. 1	Independence	M. Connell	Forest Oil Co		Hundred-foot	1,510	11	1,526	Sand	Dry.
157	Connell, S., No 1	do	S. Connell	do		do	1,806	20	1,831	do	
155	Connell, S., No. 2	do	do	do		do	1,775	23	1,802	do	
156	Connell, S., No. 3	do	do	do	1,190	do	1,796	20	1,821	Shannopin	Dry; sand close and hard.
	Cool heirs	do	Cool heirs	do		Burgoon	[a] 1,025		1,675	Big Injun	Oil in Burgoon at 1,025; Shannopin dry.
						Hundred-foot	1,649	20		Shannopin	
123	McConnell, J. B., No. 1	do	J. B. McConnell	do		do	1,769	25	1,799	Sand	
132	McConnell, J. B., No. 1	do	do	P. M. Shannon	930	do	1,516			do	
127	McConnell, J. B., No. 2	do	do	Forest Oil Co		do	1,741	25	1,772	do	
133	McConnell, J. B., No. 2	do	do	P. M. Shannon		do	1,502	28	1,547	do	
124	McConnell, J. B., No. 3	do	do	Forest Oil Co		do	1,701	20	1,727	do	
134	McConnell, J. B., No. 3	do	do	P. M. Shannon		do	1,607	26	1,647	do	Oil at 1,614.
	McConnell, J. B., No. 5	do	do	Forest Oil Co		do	1,569	21	1,604	do	
129	McConnell, J. P., No. 1	do	J. P. McConnell	P. M. Shannon	990	do	1,580	18	1,624	do	
130	McConnell, J. P., No. 2	do	do	do		do	1,617	20	1,660	do	Oil at 1,621.
126	McConnell, J. P., No. 12	do	do	Forest Oil Co	1,140	do	1,720	25	1,749	do	
111	McCoy, Robt., No. 3	do	Robt. McCoy	do	1,100	do	1,658	22	1,693	do	
	McCoy, Robt., No. 4	do	do	do		do	1,620	18	1,647	do	Dry.
	McCoy, Robt., No. 5	do	do	do		do	1,690	20	1,719	do	Do.
	Marks, J. A. & W., No. 1.	do	J. A. & W. Marks	do		do	1,761			do	
	Marks, J. A. & W. G., No. 3.	do	J. A. & W. G. Marks	do		do	1,758	38		do	
148	Miller, Jas., No. 1, well No. 1.	do	Jas. Miller	do	980	do	1,589	11	1,600	do	

149	Miller, Jas., No. 1, well No. 2.	do	do	do	1,100	do	1,737	29	1,775	do	
151	Miller, Jas., No. 1, well No. 3.	do	do	do		do	1,797		1,803	do	
153	Miller, Jas., No. 1, well No. 5.	do	do	do		do	1,792	22	1,820	do	
	Miller, Jas., No. 1, well No. 6.	do	do	do		do	1,792	20	1,816	do	
150	Miller, Jas., No. 1, well No. 4.	do	do	do	1,160	do	1,780	29	1,816	do	
154	Miller, Jas., No. 1, well No. 7.	do	do	do		do	1,783	21	1,804	do	
	Miller, Jas., No. 1, well No. 8.	do	do	do		do	1,628	18	1,650	do	
	Miller, Jas., No. 2, well No. 1.	do	do	do		do	1,678	20	1,707	do	
	Miller, Jas., No. 2	do	do	do		Hundred-foot(?)	1,417	20	1,443	do	
158	Miller, Jas., No. 12	do	do	do		Hundred-foot	1,682	17	1,701	do	
159	Miller, Jas., No. 13	do	do	do		do	1,767	22	1,801	do	
	Morrow, A., No. 1	do	A. Morrow	do		do	1,337	16	1,363	do	Do.
125	Morrow, Wm., No. 2	do	Wm. Morrow	do	990	do	1,571	23	1,607	Shannopin	Gas at 1,571; oil at 1,578; 22 barrels first day, 50 barrels after shot.
	Morrow, Wm., No. 3	do	do	do		do	1,555	20	1,580	Sand	
120	Morrow, Wm, No. 4	do	do	do		do	1,493	24	1,527	do	Short strong gas in top, salt sand.
139	Potts, Noah, No. 1	do	Noah Potts	do		do	1,529	22	1,561	do	Oil at 1,544.
140	Potts, Noah, No. 2	do	do	do	895	do	1,495	25	1,527	do	
138	Potts, Noah, No. 3	do	do	do		do	1,635	30		do	
137	Potts, Noah, No. 4	do	do	do		do	1,481	24	1,515	do	
145	Potts, Noah, No. 5	do	do	do		do	1,419	97(?)	1,521(?)	do	
142	Potts, Noah, No. 6	do	do	do		do	1,458	25	1,488	do	
144	Potts, Noah, No. 7	do	do	do		do	1,776	24	1,806	do	
141	Potts, Noah, No. 8	do	do	do		do	1,450	20	1,475	do	
	Potts, Noah, No. 9	do	do	do		do	1,537	22	1,564	do	
143	Potts, Noah, No. 10	do	do	do	1,135	do	1,726	22	1,767	Shannopin	Salt water at 740; oil and gas at 1,734.

[a] To oil.

Gas and oil wells in and near Beaver quadrangle—Continued.

BEAVER COUNTY—Continued.

Map number.	Name.	Township.	Farm.	Owner.	Approximate elevation.	Name of oil and gas sands.	Depth.	Thickness.	Total depth of well.	Driller's interpretation.	Remarks.
					Feet.		*Feet.*	*Feet.*	*Feet.*		
	Potts, Noah, No. 11	Independence	Noah Potts	Forest Oil Co		Hundred-foot	1,593	23	1,634	Shannopin	Coal at 590 (Lower Kittanning?); gas at 1,600; oil at 1,601; 25 barrels first 24 hours.
	Purdy, Arch., No. 2	do	Arch. Purdy	do		do	1,636	25	1,670	Sand	
116	Purdy, Wm., No. 1	do	Wm. Purdy	P. M. Shannon		do	1,774	21	1,805	Third	
115	Purdy, Wm., No. 2	do	do	Forest Oil Co	1,240	do	1,727	25	1,772	Sand	
122	Purdy, No. 3	do	Purdy	P. M. Shannon		do	1,789	18	1,877	do	
131	Purdy, No. 4	do	do	do	1,010	do	1,594	16	1,660	Third	
128	Purdy, No. 7	do	do	do		do	1,573	27	1,621	do	Oil at 1,581.
121	Purdy, Wm., No. 12	do	Wm. Purdy	Forest Oil Co		do	1,605	20	1,636	Sand	
93	Solar, No. 26 (Morrow)	do	A. P. Morrow	do	1,150	do	1,694		1,721	do	Best sand at 1,711 to 1,717.
76	Solar, No. 27 (Morrow)	do	do	do		do	1,674	29	1,718	do	Best sand at 1,690.
	Solar, No. 28	do	do	do		do	1,653	23	1,684	do	
110	Stone, Rachel, No. 7	do	Rachel Stone	do		do	1,515	17	1,544	do	Best sand at 1,520.
74	Stone, Rachel, No. 8	do	do	do	1,129	do	1,678	24	1,711	do	
	Trotter, No. 1	do	Trotter	do		Hundred-foot(?)	1,200	10	1,837	do	
	Vandergrift	do				Burgoon	610		1,223	do	Dry.
						Berea	1,160	63			
135	Wallace, Cynthia, No. 1	do	Cynthia Wallace	Forest Oil Co	1,170	Hundred-foot	1,762	24	1,795	do	
136	Wallace, Cynthia, No. 2	do	do	do		do	1,586	23	1,615	do	
109	Wallace, Jos., No. 1	Independence and Hopewell	Jos. Wallace	do		do	1,503		1,545	do	
99	Wallace, Jos., No. 2	do	do	do		do	1,673		1,686	do	

107	Wallace, Jos., No. 3	do	do	do	1,105	do	1,674		1,688	do	
	Wallace, Jos., No. 4	do	do	do		do	1,650		1,665	do	
	Wallace, Jos., No. 6	do	do	do		do	1,749	24	1,784	do	
	Wallace, Jos., No. 7	do	do	do		do	1,675	23	1,705	do	
21	Gailey, Silas, No. 1	Industry	Silas Gailey	do	1,080	Berea	952	26		Smiths Ferry	Oil at 968
22	Gailey, Silas, No. 3	do	do	do		do	1,013	25		do	
26	Heinman, No. 1	do	Heinman		1,176	do	1,030			Berea	
	Kirk, Jas	do	Jas. Kirk			Sand Burgoon Berea	340 765 1,095		1,125	Mountain Big Injun Berea	
25	Marks, No. 5	do	Marks		1,180	Burgoon Berea	732 1,020		1,065	Big Injun Berea	Oil in Berea.
	Popp	do	Popp, Wolf Run	South Penn Oil Co.		Berea	850	45	950+	do	Gas at 510; much salt water at 940.
24	Thompson, W. R	do	W. R. Thompson	Forest Oil Co		do	983	19		Smiths Ferry	Oil at 987.
46	Baker, Geo	Moon	Geo. Baker						1,442		
57	Bridgewater, No. 1	do	J. Zimmerly	Bridgewater Gas Co.	800	Berea Hundred-foot	1,015 1,250	25 7+	1,257	Sand	Some gas in Berea; much gas in Hundred-foot; pay at 1,257.
27	Deens, Chas	do	Chas. Deens	Oak Oil Co		Berea Hundred-foot Gordon Fourth	715 964 1,252 1,367	45 16 20 25	1,410	Berea Hundred-foot Gordon Fourth	5 barrels of oil per day from Hundred-foot.
168	Meany, John	do	John Meany	Forest Oil Co	1,019	Berea Hundred-foot	1,094 1,295	10	1,622	Berea Hundred-foot	Little gas in Berea.
	Baker heirs, No. 1	New Sewickley[a]	Baker heirs	Fort Pitt Gas Co.		do	1,397	5	1,452	Sand	Oil at 1,397.
	Baker heirs, No. 2	do	do	do		do	1,440	12	1,465	Hundred-foot	Gas and oil at 1,440; 90 barrels first 24 hours; coal at 585.
	Baker heirs, No. 3	do	do	do		do	1,423	17	1,440	do	Gas and oil at 1,423; 18 barrels per hour; coal at 600.
	Baker heirs, No. 4	do	do	do		do	1,412		1,436½	do	Gas and oil at 1,413; through pay at 1,422.
	Barto, Jno. & Wm., No. 1.	do	Barto	do		do Sand (Thirty-foot).	1,478 1,548	65	1,548	do Thirty-foot	Coal at 395.

[a] Outside of quadrangle.

Gas and oil wells in and near Beaver quadrangle—Continued.

BEAVER COUNTY—Continued.

Map number.	Name.	Township.	Farm.	Owner.	Approximate elevation.	Name of oil and gas sands.	Depth.	Thickness.	Total depth of well.	Driller's interpretation.	Remarks.
					Feet.		*Feet.*	*Feet.*	*Feet.*		
	Black, Dan	New Sewickley	Dan Black	Fort Pitt Gas Co.		Hundred-foot	1,340	12	1,400	Hundred-foot	Gas and oil at 1,342.
	Blink, John, No. 4	do	John Blink	do		do	1,368	7	1,408	do	Dry.
	Blinn, Adam, No. 1	do	Adam Blinn	do		Burgoon (?)	180	40	1,070	Mountain	Dry; other sands not correctly given.
	Bunzo, H., No. 1	do	H. Bunzo	Forest Oil Co		Hundred-foot	1,172	28	1,238	Hundred-foot	Pay at 1,200.
	Cookson	do	Cookson	Bridgewater Gas Co.		Berea	983	160 (?)	1,820	Sand	
						Hundred-foot	1,223	78			
	Daniels Bros., No. 2	do	Daniels Bros.	Forest Oil Co		do	1,205	80	1,590	Hundred-foot Bowlder Third	Hundred-foot sand poor.
						Gordon	1,440				
						Fourth	1,481				
	Daniels Bros., No. 3	do	do	do		Hundred-foot	1,405	80	1,505	Hundred-foot Bowlder Third	
						Gordon	1,440				
						Fourth	1,481				
	Dunlap, E. & G., No. 1	do	Elizabeth Dunlap	Fort Pitt Gas Co.		Berea (?)	1,168	102	1,355	Salt sand Hundred-foot	Gas at 1,351; salt water at 1,175.
						Hundred-foot	1,350	5			
	Dunlap, E. & G., No. 4	do	Dunlap	do		Burgoon	650	190	1,443	Big Injun Hundred-foot	Pay at 1,405; Hundred-foot white and hard; coal at 385 (Lower Kittanning?).
						Hundred-foot	1,394				
	Dunlap, Graham, No. 1	do	Graham Dunlap	do		do	1,350	41	1,391	do	Gas at 1,350; oil at 1,356.
	Dunlap, Graham, No. 2	do	do	do		do	1,380		1,383		Gas at 1,380; coal at 380 (Lower Kittanning?).
	Dunlap, Graham, No. 2	do	do	do					1,267		Salt water at 1,237.
	Eachel & Ritchie	do	John Eckhert	Eachel & Ritchie		Hundred-foot	1,250		1,360	Hundred-foot	Oil at 1,320; 50 barrels per day.
	Eckhert, John, No. 1	do		Forest Oil Co		do	1,280	80	1,371	do	Oil at 1,320.
	Eckhert, John, No. 2	do		do		do	1,250	83	1,341	do	Oil at 1,305.

Eckhert, John (?)	do		do		do	1,259		1,336	do	Sand, black.
Eckhert, John, No. 3	do	John Eckhert	do		Hundred-foot (black).	1,397	47	1,506	do	Oil at 1,478; two Hundred-foot sands, black and white.
					Hundred-foot (white).	1,437				
Eckhert, John, No. 4	do	do	do		Hundred-foot (black).	1,343		1,638	do	Gas at 1,638.
					Hundred-foot (white).	1,386				
Garver, J. H	do (?)	J. H. Garver			Burgoon	800		1,845	Sand	Oil and water at 1,140; show of oil at 1,300.
					Berea	1,085	35			
					Hundred-foot	1,322	8			
					Fifth (?)	1,812	28			
Goehring, C. A., No. 4	do	C. A. Goehring	Forest Oil Co		Hundred-foot	1,220		1,288	Hundred-foot	Oil at 1,223.
Goehring, C. H., No. 1	do	C. H. Goehring	Fort Pitt Gas Co.		do	1,424	6+	1,485	do	Oil at 1,424.
Goehring, Zeno, No. 2	do	Zeno Goehring	Forest Oil Co		Hundred-foot (black).	1,407		1,496	do	Oil at 1,470.
					Hundred-foot (white).	1,432	54			
Goehring, Zeno, No. 2	do	do	do		Hundred-foot(?)	1,415		1,480	White sand	Oil at 1,447 and 1,478.
Goehring, Zeno, No. 3	do	do	do		Hundred-foot (black).	1,355		1,453	Hundred-foot	Oil at 1,417.
					Hundred-foot (white).	1,395	43			
Goehring, Zeno, No. 5	do	do	do		Hundred-foot(?)	1,375		1,387	Gas sand	Oil and gas at 1,322.
Morgan, W. J., No. 3	do	W. J. Morgan	Fort Pitt Gas Co.		do	1,355	92	1,447	Hundred-foot	Oil at 1,367; gas sand at 1,305.
Morgan, W. J., No. 4	do	do	do		do	1,288	34	1,322	do	Oil at 1,288; gas sand at 1,249.
Phillips, Wm., No. 1	do	Wm. Phillips	do		do	1,464	30	1,494	do	Oil at 1,474; gas sand at 1,315.
Phillips, Wm., No. 2	do	do	do		do	1,472	7	1,504	do	Oil and gas at 1,472.
Phillips, Wm., No. 3 (4)	do	do	do		do	1,450		1,462	do	Oil and gas at 1,450.
Phillips, Wm., No. 5	do	do	do		do	1,452	15	1,467½	do	Oil and gas at 1,452; fine well.
Phillips, Wm., No. 6	do	do	do		do	1,475	10	1,492	do	Oil and gas at 1,475.
Schaffer, H., No. 1	do	H. Schaffer	Forest Oil Co		do	1,280	63	1,343	do	Oil at 1,310.
Schaffer, H., No. 1	do	do	do		do	1,135 or 1,280	80		do	Oil at 1,292 and 1,310.

Gas and oil wells in and near Beaver quadrangle—Continued.

BEAVER COUNTY—Continued.

Map number.	Name.	Township.	Farm.	Owner.	Approximate elevation.	Name of oil and gas sands.	Depth.	Thickness.	Total depth of well.	Driller's interpretation.	Remarks.
					Feet.		*Feet.*	*Feet.*	*Feet.*		
	Teats, Geo., No. 1	New Sewickley	Geo. Teats	Forest Oil Co		Hundred-foot	1,271		1,341	Hundred-foot.	Oil at 1,300; sand white.
	Teats, Geo., No. 2	do	do	do		Hundred-foot (black).	1,297		1,411	do	Oil.
						Hundred-foot (white).	1,347	53			
	Teats, Geo., No. 3	do	do	do		Hundred-foot	1,330	57	1,451	do	Oil at 1,385; sand black.
	Teats, Geo., No. 4	do	do	do		do	1,322	48		do	Sand, white.
	Wagner, Christ., No. 1	do	Christ. Wagner	Fort Pitt Gas Co.		Berea (?)	1,255		1,484	Gas sand	4 feet of coal at 470 (Lower Kittanning?).
						Hundred-foot	1,482	2+		Hundred-foot	
	Wagner, Christ., No. 2	do	do	do		Berea (?)	1,230		1,453	Gas sand	Gas at 1,418; oil at 1,423; coal at 310 (Lower Kittanning?).
						Hundred-foot	1,418	35		Hundred-foot	
	Wagner, Christ., No. 3	do	do	do		Burgoon	780	190	1,695	Big Injun	Coal at 350 (Lower Kittanning?).
						Berea (?)	1,274	141		Salt	
						Hundred-foot (?)	1,470	72		Hundred-foot	
						Gordon (?)	1,685			Bowlder	
	Zeigler, J. B., No. 2	do	J. B. Zeigler	Forest Oil Co		Hundred-foot (?)	1,355		1,393	First pay	Oil at 1,355.
	Zeigler, J. B., No. 3	do	do	do		do	1,412 or 1,350		1,428	Sand	Oil at 1,385 and 1,396.
	Zeigler, J. B., No. 5	do	do	do		Hundred-foot	1,381		1,458½	Hundred-foot	Oil at 1,420.
	Zeigler, J. B., No. 8	do	do	do		do	1,237	97	1,334	do	Oil at 1,268.
	Zeigler, J. B., No. 9	do	do	do		Hundred-foot (white).	1,373		1,446	do	Oil at 1,421.
						Hundred-foot (black).	1,340				
4	Anderson, Geo	Ohio	Geo. Anderson		1,162	Berea	969			Berea	

	Burrell Oil Co	do	At Smiths Ferry	Burrell Oil Co		Burgoon(?)	430	43	500	Gas sand	Gas and salt water; coal at 90 (Lower Kittanning?); drilled 1861.
16	Chaney, John, No. 1	do	John Chaney		1,190	Berea	1,120			Berea	
15	Chaney, John, No. 2	do	do		1,130	do	1,058			do	
13	Chaney, John, No. 4	do	do		1,120	do	1,084			do	
14	Chaney, John, No. 5	do	do		1,130	do	1,059			do	
	Chaney, John, No. 6	do	do								Record lost; dry.
	Chaney, John, No. 7	do	do	Florence Oil Co		Berea	1,041			Berea	
8	Davidson, L. R., No. 1	do	L. R. Davidson		1,070	do	940		959	do	Oil at 946; coal at 38–58 (?).
9	Dawson, S., No. 1	do	Dawson	Gailey Bros		do	1,073			do	
	Dawson, S., No. 2	do	do	do		do	1,075			do	
	Dawson, W. W., No. 3	do	W. W. Dawson	do. (?)							Record lost.
11	Eliott, No. 1	do	Laughlin Eliott	Ferguson & Willson.	1,060	Berea	967			Berea	
10	Eliott, L., No. 2	do	do		1,060	do	965			do	Producing sand is Berea.
12	Eliott, L., No. 4	do	do		1,130	do	1,042			do	Do.
	Ferguson, No. 1	do	Ferguson			do	1,054			do	
18	Ferguson, No. 4	do	John Ferguson	Ferguson Bros	1,230	Burgoon Berea	760 1,100		1,102	Big Injun Berea	Coal at 330 (Lower Kittanning).
17	Ferguson, Jno. No., 5	do	do	do	1,226	Burgoon	a 800		1,145	Glass Rock, or Big Injun.	Coal at 355.
23	Ferguson, Jno., No. 6	do	do	do	1,140	do	585		1,010	Big Injun	
	Ferguson, Jno., No. 7	do	do	do	1,090	do	625		990	do	
19	Ferguson, Jno., No. 13	do	do	F. R. Anson & Co	1,240	do	710 (910?)		1,152	do	
20	Gailey, Silas, No. 2	do	Silas Gailey	Forest Oil Co	1,110	Berea	966	18	993	Smiths Ferry	Oil at 972.
7	Graham, Wm	do	Wm. Graham	Hayes Bros	1,139	Burgoon Berea	587 975(?)		995	Big Injun Berea	Oil at 982; salt water.
5	Hunter, S.	do	Stanley Hunter		1,130	do	970				
	Kirk, Jas., No. 1	do	Jas. Kirk			do	1,024			Berea	
	Kirk, Jas., No. 2	do	do	Puritan Oil Co		do	1,098			do	
	Kirk, Jas., No. 3	do	do	Forest Oil Co		do	1,103			do	
6	Laughlin, Jas	do	James Laughlin		1,245	do	1,032			do	

Gas and oil wells in and near Beaver quadrangle—Continued.

BEAVER COUNTY—Continued.

Map number.	Name.	Township.	Farm.	Owner.	Approximate elevation.	Name of oil and gas sands.	Depth.	Thickness.	Total depth of well.	Driller's interpretation.	Remarks.
					Feet.		*Feet.*	*Feet.*	*Feet.*		
	McLaughlin, W. H., No. 1.	Ohio	W. H. McLaughlin	Forest Oil Co		Berea	974	15	992¼	Sand	
	McLaughlin, W. H., No. 2.	do	do	do		do	973	13	996½	do	
	McLaughlin, W. H., No. 4.	do	do	do		do	1,103	20	1,137	Smiths Ferry	Oil at 1,108.
	Mattox, Jno. H., No. 1.	do	John H. Mattox	do		do	1,060	19	1,110½	do	Gas and oil at 1,067.
	Mattox, Jno. H., No. 2.	do	do	do		do	1,027	66	1,093	do	Gas at 1,028.
	Mattox, Jno. H., No. 3.	do	do	do		do	1,036	21		do	
	Mattox, Jno. H., No. 4.	do	do	do		do	1,093	27		do	4 barrels first day.
3	Moore, C.	do	Chester Moore	S. E. Duff	1,086	do	896	27	923	Berea	
	Ohioville well	do				do	885	30	975	Big Injun	Oil at 975.
	Popp, John H., No. 1.	do	John H. Popp			do	972			Berea	
	Popp, John H., No. 2.	do	do			do	978			do	
	Popp, John H., No. 3.	do	do			do	1,009			do	
	Popp, John H., No. 4.	do	do			do	1,045			do	
	Popp, John H., No. 5.	do	do			do	1,058			do	
	Popp, John H., No. 6.	do	do			do	1,048			do	
	Puritan, No. 1	do	Jas. Kirk			do	1,054			do	
	Red Bird Oil Co., No 8	do	John H. Popp			do	980			do	
	Wilson, No. 1	do	Wilson			do	982			do	
	Wilson, No. 2	do	do			do	1,040			do	
	Wilson, No. 3	do	do			do	995			do	
	Wilson, No. 4	do	do			do	1,030			do	
	Wilson, No. 5	do	do			do	1,025			Sand	
	McCullough, No. 1	Raccoon	McCullough	Forest Oil Co		Hundred-foot(?)	1,343	7	1,506	do	Dry.

	Rochester Brewing Co	Rochester	Near river bank at Rochester.	Rochester Brewing Co.		Burgoon	325		1,319	Big Injun	Do.
						Berea	695			Berea	
						Hundred-foot	927	11		Hundred-foot	
	Rochester Tumbler Co., No. 1.	do	do	Rochester Tumbler Co.		do	900	40	965	Mountain	Salt water, oil, and gas; record from memory; drilled 1874–1876.
	Bradshaw, Thos., No. 1	South Beaver	Thos. Bradshaw	Duff Bros	1,142	Burgoon	a 530			Big Injun	
						Berea	815	38		Berea	
	Dunlap heirs, No. 1	do	Dunlap heirs	do		Burgoon	a 500			Big Injun	
						Berea	830	25		Berea	
	Graham, Wm	do	Wm. Graham	Ohio Valley Gas Co.		Burgoon or Berea.	650			Smiths Ferry	Gas at 673 and 778.
	Grosscost, Isaac	South Beaver–Ohio line.	Isaac Grosscost			Berea	896			Berea	
	Jenkins, Wm. and R.	South Beaver	Jenkins	Ohio Valley Gas Co.	1,020	Berea (?)	755		778	Smiths Ferry	Gas at 771 and 778; finished Jan. 20, 1898.
	Jenkins, Wm. and R.	do	do	do	1,020	do	751		778	Gas sand	Gas at 775; finished Feb. 18, 1898.
1	Reed, J. Q., No. 2	do	J. Q. Reed	Fort Pitt Gas Co.	1,150	do	801 (?)		833	Sand	Dry.

ALLEGHENY COUNTY.

	Aten, J. S	Findley b	J. S. Aten	Ohio Valley Gas Co.		Hundred-foot	2,127			Sand	
	Gross, No. 1	do	Gross	Forest Oil Co		do	2,005	14	2,037	do	
	Gross, No. 3	do	do	do		do	2,072	12	2,084	do	
	Imperial Coal Co., No. 1	Findley and Moon.	Imperial Coal Co	do		Hundred-foot (?)	c 1,623		1,709	do	Oil.
	Linton, No. 1	do	Linton	do		Hundred-foot	2,034	22	2,069	do	
	McCutcheon, Jas., No. 1.	Findley	Jas. McCutcheon	do		do	1,998	17	2,025	do	
	McCutcheon, Jas., No. 2.	do	do	do		do	1,995	17	2,024	do	
	McCutcheon, Jas., No. 3.	do	do	do		do	2,042	16	2,067	do	
	McCutcheon, Jas., No. 4.	do	do	do		do	2,000	21		do	

a Bottom.

b Partly outside of quadrangle.

c Oil.

Gas and oil wells in and near Beaver quadrangle—Continued.

ALLEGHENY COUNTY—Continued.

Map number.	Name.	Township.	Farm.	Owner.	Approximate elevation.	Name of oil and gas sands.	Depth.	Thickness.	Total depth of well.	Driller's interpretation.	Remarks.
					Feet.		*Feet.*	*Feet.*	*Feet.*		
	McCutcheon, Jas., No. 5.	Findley	Jas. McCutcheon.	Forest Oil Co		Hundred-foot	2,035	12	2,062	Hundred-foot	
	McFadden, No. 2	do	McFadden	do		do	2,085	15	2,117	do	
	McMinn, Geo	do	Geo. McMinn	Ohio Valley Gas Co.		Berea (?)	1,690		2,010	Hundred-foot	Oil at 1,721; drilled deeper.
	do	do	do	do		Hundred-foot	2,002		2,010	Sand	
152	Purdy, Geo., No. 1	do	Geo. Purdy	Forest Oil Co	1,000	do	1,635		1,644	do	
	Purdy, Geo., No. 2	do	do	do		Hundred-foot(?)	1,708	24		do	Dry well.
	Purdy, Geo., No. 3	do	do	do		do	1,708	24	1,732	do	
160	Purdy, Joe, No. 1	do	Joe Purdy		960	Hundred-foot	1,598		1,630	do	Salt water; show of oil 1,612.
	Springer, Geo., No. 1	do	Geo. Springer	Forest Oil Co		do	2,054		2,074	Gordon	Gas on top of sand.
	Springer, Wm	do	Wm. Springer	Ohio Valley Gas Co.		do	2,046	4	2,050	Third sand	
	Aten, No. 1	Moon a	Aten	Forest Oil Co		do	1,804	13	1,817	Hundred-foot	Oil at 1,806.
	Aten, No. 1	do	do	do		do	1,796	20	1,816	do	Oil at 1,800.
	Aten, No. 2	do	do	do		Hundred-foot Gas sand (Fourth?).	1,849 2,163	20 12	2,191		Small show of oil and gas.
	Aten, H. A., No. 3	do	H. A. Aten	do		Hundred-foot Gordon Fourth	1,819 2,056 2,128	38 (?) 6	2,179½		Gas at 1,820 and 1,828; little oil at 1,820.
	Brown, H., No. 1	do	H. Brown	do		Gordon Fourth	1,843 1,904	11	2,020		All dry.

Chambers, No. 2	do	Chambers	Lawrence Natural Gas Co.	Burgoon	1,095		2,199	Big Injun	Big gas well, but productive sand not recorded.
				Berea	1,675	25		Bowlder	
				Hundred-foot	1,860	30		Hundred-foot	
				Fourth	2,125	11		Gordon	
				Fifth	2,180	18		Fifth	
Cooper, Wm., No. 1	do	Wm. Cooper	Forest Oil Co	Gordon (?)	1,879	6	1,914	Sand	
Cooper, Wm., No. 2	do	do	do	do	1,936	10	1,956	Third sand	Oil at 1,936.
Cooper, Wm., No. 3 (?)	do	do	do	do	1,965	7	2,034	Sand	Dry.
				Fourth	2,028	6		Fourth	
Cooper, Wm., No. 4	do	do	do	Gordon	1,977	10	2,010	Gordon	Oil at 1,977.
Cooper, Wm., No. 5	do	do	do	do	1,989	9	2,113½	do	Oil.
Curry heirs, No. 1	do	Curry heirs	do	do	2,046	10	2,063	do	Oil at 2,046.
Curry heirs, No. 2	do	do	do	do	2,000	12	2,035	do	
Curry heirs, No. 3	do	do	do	do	2,050	11	2,078	do	Pay at 2,055.
Curry heirs, No. 4	do	do	do	do	2,080		2,153	do	Dry.
				Fourth	2,140			Fourth	
Curry heirs, No. 5	do	do	do	Gordon	2,056	15	2,082	Gordon	Oil at 2,064; 5 barrels per day.
Ehrhardt, P., No. 1	do	P. Ehrhardt	do	do	2,040	9		do	Oil at 2,040.
Ehrhardt, P., No. 2	do	do	do	do	2,074		2,246	do	Well mouth 15 feet below Pittsburg coal.
				Fourth	2,134			Fourth	
				Fifth	2,180			Fifth	
Ehrhardt, P., No. 3	do	do	do	Gordon	2,048	6	2,054	Gordon	Oil at 2,048.
Getty, M., No. 1	do	M. Getty	do	do	2,037	13	2,067	Sand	
Getty, Martha, No. 2	do	Martha Getty	do	do	2,044	12	2,070⅝	Gordon	Oil at 2,044.
Getty, M., No. 3	do	M. Getty	do	do	2,045	9	2,072⅝	do	Oil at 2,045.
Getty, M., No. 4	do	do	do	do	2,124	11	2,151	do	Oil at 2,124.
Getty, M., No. 5	do	do	do	do	2,089	11		do	Oil at 2,089; estimated production 10–15 barrels.
Getty, M., No. 6	do	do	do	do	2,080	9	2,103	do	Oil at 2,080; 5 barrels per day.
Glenn, Margaretta, No. 5	do	Margaretta Glenn	do	Salt sand	990		2,128	Big Injun	Well mouth 10 feet below Pittsburg coal.
				Burgoon	1,100	123		Hundred-foot	
				Hundred-foot	1,850	100 (?)		Gordon	
				Gordon	2,105	23			

a Chiefly outside of quadrangle.

Gas and oil wells in and near Beaver quadrangle—Continued.

ALLEGHENY COUNTY—Continued.

Map number.	Name.	Township.	Farm.	Owner.	Approximate elevation.	Name of oil and gas sands.	Depth.	Thickness.	Total depth of well.	Driller's interpretation.	Remarks.
					Feet.		*Feet.*	*Feet.*	*Feet.*		
	Gordon, G. G., No. 1	Moon	G. G. Gordon	Forest Oil Co		Gordon	2,079	13	2,108	Gordon	Oil at 2,079.
	Gordon, G. G., No. 2	do	do	do		do	2,063	12	2,097½	do	Oil at 2,063.
	Gordon, G. G., No. 3	do	do	do		do	2,077	12		do	Gas and oil at 2,082.
	Guy, Wm. H., No. 1	do	Wm. H. Guy	do		Gordon (?)	2,094		2,117	Fourth	"Estimated from Guy" No. 2.
	Kerr heirs, No. 1	do	Kerr heirs	do		Gordon Fourth	1,829 1,893	14 7	1,906	Sand Fourth	Dry.
	Kerr heirs, No. 2	do	do	do		Gordon (or Fourth).	1,896	10	1,921	Sand	
	Kerr heirs, No. 3	do	do	do		do	1,947	27	2,000	do	
	Kerr heirs (Barbara), No. 4.	do	Barbara Kerr heirs.	do		Gordon	2,062	13	2,091	do	
	Kerr heirs (Barbara), No. 5.	do	Kerr heirs	do		do	2,055	10	2,075	Gordon	Oil.
	McClinton, No. 1	do	McClinton	do		do	2,037	12	2,063	Sand	
	McClinton, M.E., No. 2	do	M. E. McClinton	do		do	2,053	10	2,080	Gordon	
	McClinton, M.E., No. 3	do	do	do		do	2,083	9	2,110	do	Oil at 2,083.
	Markle, C., No. 1	do	C. Markle	do		do Fourth	2,057 2,118		2,131	do Fourth	Gas in Fourth, half minute pressure, 45 pounds.
	Meeks, No. 1	do	Meeks	do		Gordon Fourth	2,003 2,060		2,139	Sand Gas sand	Gas.
	Meeks, B., No. 2	do	B. Meeks	do		Gordon	2,065	6	2,105	Gordon	Dry.
	Neeley heirs, No. 1	do	Neeley heirs	do		do	2,037	8	2,060	do	
	Neeley heirs, No. 2	do	do	do		do	2,034	13	2,062	do	Oil at 2,034.
	Neeley heirs, No. 3	do	do	do		do	2,037	12	2,063	Third	Oil at 2,037.
	Neeley heirs, No. 4	do	do	do		do	1,948	10	1,974	do	Oil at 1,948–1,951; 30 barrels first 24 hours.

Neeley heirs, No. 5	do	do	do		do	2,057	13	2,070	Gordon	Oil at 2,057.
Neeley heirs, No. 6	do	do	do		do	2,076	12	2,104½	do	Oil at 2,080; 24 barrels first 24 hours.
Neeley heirs, No. 7	do	do	do		do	2,088	10	2,119½	do	Oil at 2,088; 35 barrels first 24 hours; after shot 110 barrels.
Neeley sisters, No. 1	do	Neeley sisters	do		do	2,037	8	2,060	Sand	
Neeley sisters, No. 2	do	do	do		do	2,034	13	2,062	do	
Neeley, J. H., No. 1	do	J. H. Neeley	do		do	2,036	10	2,065	Gordon	Oil at 2,036.
Neeley, S. B., No. 1	do	S. B. Neeley	do		do	1,934	10	1,958	do	Oil at 1,934.
Neeley, S. B., No. 2	do	do	do		do	2,044	18	2,071	do	Oil at 2,044.
Rouser, J. A., No. 1	do	J. A. Rouser	do		do	2,078	9		do	Oil at 2,078; 25 barrels first 24 hours.
Rouser, W. A., No. 1	do	W. A. Rouser	do		do Fourth	2,078 2,140	9 6	2,144	do Fourth	Oil at 2,078; small gas at 2,140. Probably this is the J. A. Rouser, No. 1; drilled deeper.
Snowhite, No. 1	do	Snowhite	do		Gordon	1,945	12	1,969	Sand	
Snowhite, A. W., No. 3	do	A. W. Snowhite	do		do	2,007		2,034	Gordon	Oil at 2,007.
Snowhite, W. A., No. 2	do	W. A. Snowhite	do		do	2,050	10	2,099	do	Oil at 2,050.
Stoops Ferry well	do	Stoops Ferry	do		Burgoon Hundred-foot Fourth (?)	785 1,500 1,805		1,894	Big Injun Hundred-foot Sand	Little gas in Burgoon; some gas and salt water in Hundred-foot.
Tepker, E., No. 1	do	E. Tepker	do		Hundred-foot Gordon Fourth	1,852 2,090 2,151	42 19 17	2,168	Hundred-foot Gordon Fourth	
Weeks, B., No. 3	do	B. Weeks	do		Gordon Fourth	2,035 2,095	7 9	2,112	Gordon Fourth	Gordon; dry.
Wilson, No. 1	do	Wilson	do		Gordon (?)	2,050			Sand	
Imperial Coal Co., No. 2	Moon and Robinson.	Imperial Coal Co	do		Hundred-foot (?)	1,617	23	1,654	do	Oil at 1,618 and 1,637.
Work, W. S	Robinson	W. S. Work	Ohio Valley Gas Co.		Burgoon (?)	710		794	do	First gas at 784.
Work, W. S	do	do	do		do	a 758	16	774	do	Water at bottom of sand.
Work, W. S	do	do	do		do	817	14	831	do	First gas at 817.

a Gas.

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