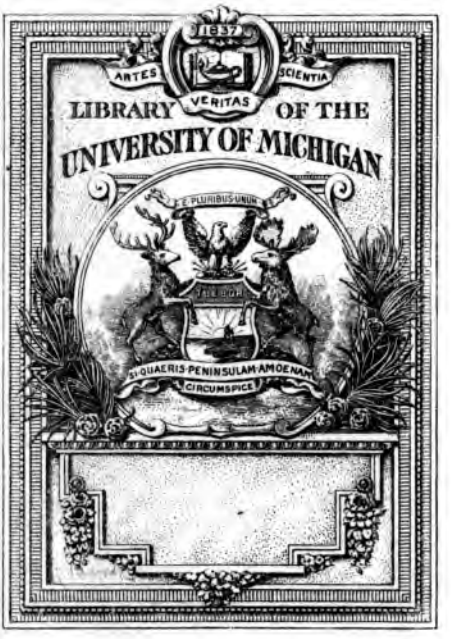
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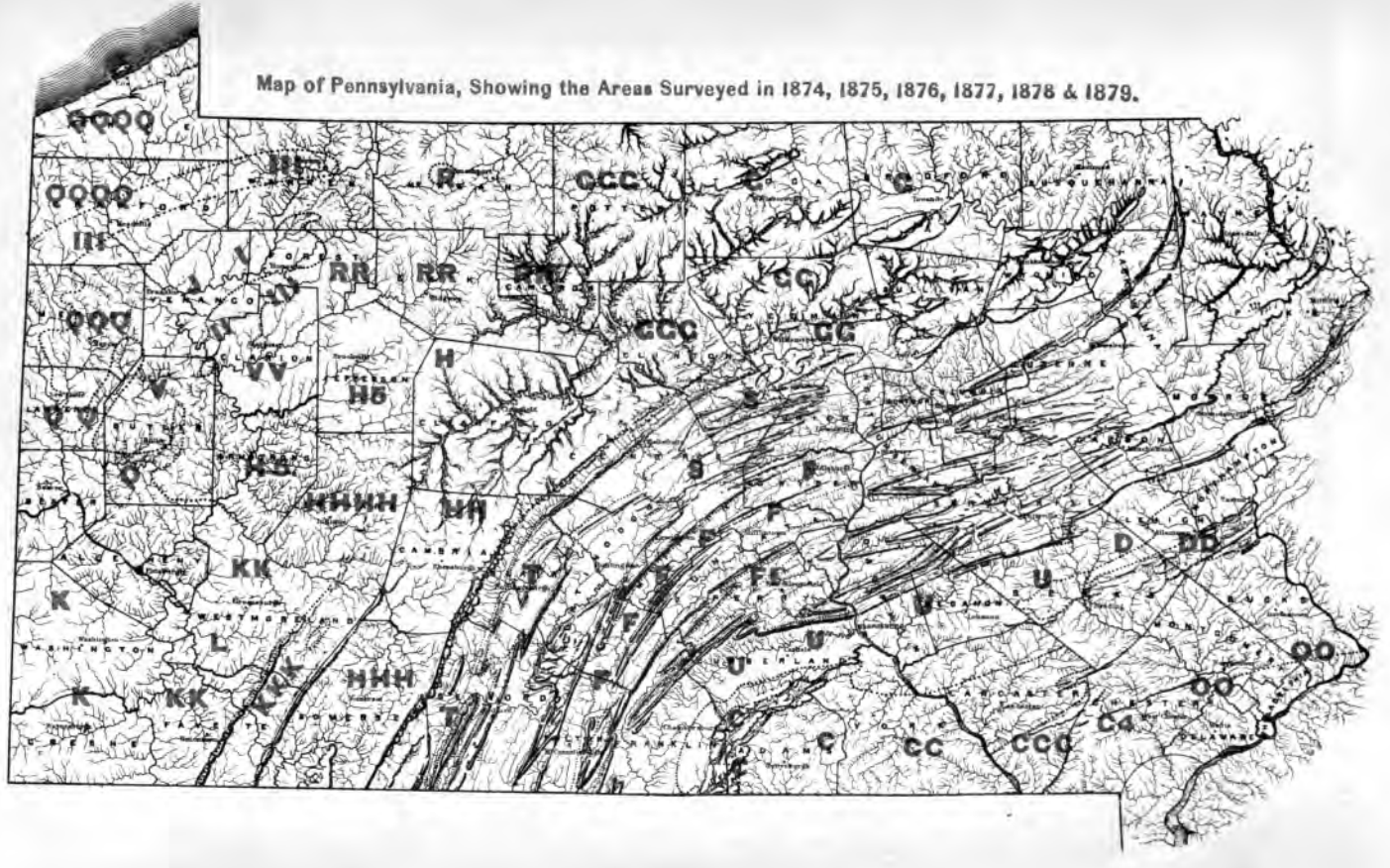
Map of Pennsylvania, Showing the Areas Surveyed in 1874, 1875, 1876, 1877, 1878 & 1879.

SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA:
1879.

REPORT OF PROGRESS

IN

ARMSTRONG COUNTY

BY

W. G. PLATT,

WITH A COLORED MAP OF THE COUNTY.

HARRISBURG:
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LETTER OF TRANSMISSION.

PHILADELPHIA, *October 31, 1880.*

To His Excellency HENRY M. HOYT, *Chairman ex-officio of the Board of Commissioners of the Second Geological Survey of Pennsylvania.*

SIR: I have the honor to transmit the Report on the Progress of the Survey in Armstrong county, by Mr. W. G. Platt, who surveyed and reported on Indiana county, and assisted Mr. Franklin Platt in the surveys and reports of Cambria and Somerset counties. His last work has been a detailed resurvey of Jefferson county, a full report of which I will have the honor to transmit when the text is written and the illustrations drawn.

To the citizens of Armstrong county this report will commend itself by its thoroughness. Each valley or water basin has been surveyed and is described by itself, in order from south to north thus: the Kiskiminitas, Crooked creek, the Cowanshannock, Pine creek, the Mahoning and the Red Bank; then the valley of the Allegheny downwards; and finally Glade run and Buffalo waters on the Butler county side.

The geologically colored map which accompanies the report is satisfactory, and will make the report easily intelligible.

The tide-level data of Armstrong topography may be found in Report of Progress N, from which extracts have been made to illustrate this report. They consist of railway grade levels along the Kiskiminitas and Allegheny rivers and Red Bank creek, and oil pipe-line levels across the northern uplands of the county; and they will be found in the Introduction.

Armstrong county, being situated midway between the oil regions of Clarion and Butler and the Pittsburgh coal region of Westmoreland, relies for its mineral prosperity on the lower coal beds which outcrop along all its valleys; on its universal outspread of Ferriferous limestone which sometimes becomes very thick; on the overlying Buhrstone brown hematite iron ore, which has supplied in past years numerous small charcoal furnaces; and on some local outcrops of valuable fire and pot clays. Building and flag stone outcrops are only too numerous for the agricultural interest of the district; many of the valleys being turned into wildernesses by towering cliffs and innumerable blocks of fallen stone.

Local coal mines, ore beds, limestone quarries, and clay pits are then the topics of this report, which, consequently, is of a thoroughly prosaic and practical character;* but the geologist, and even the artist seeking for indications of the picturesque, will find matter of reflection in its pages, and in one respect its geological lessons are of exceptional importance.

From the beginning of the Survey, and at every stage of its progress, a question respecting the character of the sub-coal-measure formations has obtruded itself. It has been necessarily referred to in every report on Western Pennsylvania, and is now so well understood by geologists, that it need not be re-stated here in a general way. But its aspect in Armstrong county is peculiar, possesses a special signification, and demands precise description. I may depict it thus:

The shales of dark color, sometimes Bituminous, sometimes containing local layers of coal, and with one coal bed 1′ thick around Parker's on the Allegheny river,† are considered by Mr. Platt, without doubt, to underlie the Pottsville Conglomerate No. XII, and to be the equivalent of the Mauch Chunk red shale formation No. XI.

*I have taken extra pains with the construction of Index B and C of this volume, referring to every mention of these deposits.

†See Section, Fig. 41, p. 207, and §§ 339, 340.

These shales and this coal bed are considered by Mr. Chance to be of the Mercer Group, lying between the Upper and Middle divisions of the Pottsville Conglomerate No. XII, and therefore to lie 200′ above the Mauch Chunk formation No. XI.*

Mr. Platt has approached this meeting place of two extensive independent surveys of Western Pennsylvania from the east; Mr. Chance has approached it from the west.

The question thus raised is very interesting to the systematic geologist, in respect of the proper naming of our formations, and would be of considerable practical importance to working geologists and mining engineers were they dealing with coal measures beneath river level in this district of the State. But if the facts of the case be clearly comprehended the difference between the two statements will cause no inconvenience.

The question is merely one of names, and this can easily be made apparent, but it is needful to explain its nature as well as to show how much ground it covers, and which of the reports of progress of the Survey have the reading of their text affected by it.

Mr. Platt has reported on Cambria, Somerset, Indiana, and Armstrong counties.† In all these reports the relations of the Pottsville (XII) and Mauch Chunk (XI) are described in the same language; the Conglomerate as a *unit*, without included coals, and the shales beneath it as a *unit*, including two thin fossiliferous limestones, and based on a thick silicious limestone.

Professor Stevenson, in his Report on Westmoreland and Fayette counties, (K^2, K^3,) where the *upper* limestones (and ore) are well developed, defines these formations in the same terms.

Mr. Chance has reported on the valleys of the Beaver and Mahoning rivers and Slippery Rock creek; on northern Butler county; and on Clarion county.‡

In these reports he has spoken of the Conglomerate as

* See Section, Fig. 4, page 32, Report V, North Butler.

† Reports H^2, H^3. H^4, H^5.

‡ See Reports V, V^2.

triple in structure, 300′ to 350′ thick, and as including two coal groups—the Mercer and the Sharon. This language is used also by Prof. White, in his reports on Beaver, south Butler, Lawrence, and Mercer counties. (Q, Q^2, Q^3.)

The Conglomerate sub-divisions are named *Homewood Sandstone* at the top; *Mercer coal and limestone group; Connoquenessing Sandstone; Sharon coal group;* and *Sharon Conglomerate* at the bottom. Beneath the last ought to lie the Mauch Chunk formation, No. XI.

This triple sub-division of the Conglomerate has been extended eastward through Venango and Warren counties by Mr. Carll, who, however, calls the Sharon Conglomerate by its local name in his district the *Garland Conglomerate;* and identifies the Connoquenessing sandstone with the First Mountain Sand of the Upper Oil Belt.*

The same triple sub-division of No. XII is carried still further east by Mr. Ashburner, in his reports on McKean, Forest, Elk, and Cameron counties (R, R^2) but under different local names, viz, *Johnson run rock*, at the top, for the Homewood; *Alton* coal group for the Mercer; *Kinzua creek rock* for the Connoquenessing; *Marshburg* coal group for the Sharon; and *Olean Conglomerate* for the Sharon or Garland. Beneath the last he does not recognize the Mauch Chunk shales (XI), but the middle division of the Pocono (X).

Mr. Chance, in his report on Clinton county (G^4), finds No. XI underneath the Conglomerate.

In Potter, Tioga, and Bradford, Lycoming and Sullivan counties, still further east along the New York State line, no such sub-division of the Conglomerate has been attempted by Mr. Franklin Platt, in his reports G, G^2, G^3; but his sections show that, if the coal areas were not so widely scattered apart, such a sub-division would be quite possible; and in the anthracite region it has been long known as a fact.

The case may then be thus stated: In all the counties lying to the west and north of Armstrong, along the Ohio and New York State lines, i. e., in Butler, Beaver, Law-

*See Reports I and I^3.

rence, Mercer, Crawford, Venango, Warren, Potter, Tioga, Bradford, Clarion, Forest, Elk, Cameron, Clinton, Lycoming, and Sullivan—from the Ohio river round to the North Branch of the Susquehanna—the *triple sub-division of the great Conglomerate*, with included Mercer and Sharon coal groups, has been established by thousands of local sections, on a continuous survey, made by four independent geologists, who entirely agree, although applying different local names for the same work; all of them placing the Mauch Chunk red shale formation (XI) underneath the lowest (Sharon-Garland-Olean) sub-division of the Conglomerate, wherever they find this to exist, for it is often very thin and of a gray color.

On the other hand, in the counties lying to the east and south of Armstrong, viz: in Indiana, Westmoreland, Fayette, Somerset, and Cambria counties, the Conglomerate, carefully studied at a few exposures far apart from one another, has been accounted a single solid deposit, without included coal groups, and resting on a considerable thickness of shales, largely red, with upper and lower limestones, as above stated.

These two extensive and independent groups of surveys meet in Armstrong county along the Allegheny river and Mahoning and Red Bank creeks. At certain points along the deep valleys of these streams great rolls in the earth crust bring to the surface a coarse sandstone which everyone has recognized since 1841 as belonging to the P ottsville Conglomerate formation No. XII. It varies in thickness from 60 to 75 feet, and all agree that it is the Homewood sandstone of the Beaver river valley country, and the Johnson run rock of the upper Allegheny, Clarion, and Sinnemahoning river region. If so, the Middle (Connoquenessing) and Lower (Sharon) sub-divisions of the Conglomerate ought to underlie it. Accordingly there appear beneath it in some places 150′ to 200′ of sandstones, forming high cliffs along the Red Bank creek, and elsewhere. Under the sandstone and above the cliffs, appear black shales and thin streaks of coal which ought to represent the Mercer group; and in one or two places similar shales and thin streaks of coal

appear at the foot of the cliffs, and these should represent the Sharon coal bed, thinned towards the east, as it thickens westward into Ohio.

As such these exposures are named and referred to in Index B to the beds mentioned in this volume; and by consulting that index the reader will find on page 207, Fig. 41, and elsewhere, descriptions of the rocks and coals, and can compare them with similar descriptions and figured sections in other reports.

But in the *text* of this volume, Mr. Platt has *not* used the names given in the index, but names by which, in his other reports, he has distinguished what he considers to be the same rocks where they appear in the gaps of the Conemaugh, Loyalhanna, and Youghiogheny rivers through Chestnut ridge and Laurel hill in Indiana, Westmoreland, Fayette, Somerset, and Cambria counties, in the ravines along those ridges, and along the summit of the Allegheny mountain in Blair county.

By reference to Reports H^2, H^3, H^4, K^2, and K^3, the reader will see the striking difference between the exposures of Conglomerate (XII) and underlying Mauch Chunk shales (XI) and Pocono sandstone (X) in the Chestnut ridge and Laurel hill gaps, and those upon the western and northern borders of Armstrong county, (see especially Fig. 10, p. 97, Report KK, and Plate I, p. 107, Report KK.)

The Conglomerate along Chestnut ridge is nowhere more than 70 feet and sometimes only 40 feet thick, facing the mountain sides, appearing in all the ravines, and exhibiting great arches in the gaps. In Virginia it increases southward to 100′ on Cheat river, 350′ in Decker's gap, 600′ in Rich mountain gap, and 1200′ on the Great Kanawha,* and contains coal beds.

The Conglomerate in the Conemaugh gap at Bolivar is 65 feet thick, and diminishes westward (for in a well on Beaver run, in Westmoreland county, it seems to be only 30 feet thick.) In the gap it consists of an upper and lower sandstone (25′ and 30′,) separated by 10′ of shales. It increases eastward to 100′ to 150′ at Conemaugh furnace in

* Chapter VIII, p. 91, KK.

the Laurel Hill gap, but varies northward, being 60′ to 100′ in Black Lick gap,† and apparently solid, and 75′ at Heshbon,‡ where it is sub-divided by 25 feet of shales. Elsewhere in the wilderness of ravines it cannot be measured. In fact, very little can be made out respecting its condition and the character of its underlying rocks throughout the range of the Chestnut ridge, except in the two fine exposures along the Conemaugh, and a section of inferior value in Black Lick gap in Indiana county. And these are distant 40 or 50 miles in a direct line southeast from its exposures in western and northern Armstrong county. What changes it undergoes in passing this interval underground cannot be known, for it is not a country of oil wells. It is very certain however that the 30′, 50′, or 70′ of Conglomerate along the Chestnut ridge represents the 60′ or 70′ of Conglomerate at Brady's Bend and Parker's on the Allegheny river, and the top cliff rocks along the Mahoning and Red Bank creeks, as well as the Homewood sandstone on the Beaver waters, and the Johnson run rock of McKean county. So far all agree.

The triple or rather quadruple structure of the Conglomerate worked out by Mr. Chance in the second part of his Report V, on the Beaver river country (see chapter 2 on the Beaver river or Conglomerate Series (No. XII), pp. 221 to 226), and illustrated by his profile section from Homewood to Sharon (Plate 7 of that volume), has a most remarkable counterpart in Great Britain.

In the Geology of the Yorkshire Coal Field, by A. H. Green and others, a memoir of the Geological Survey of England and Wales, published in 1878, will be found (pp. 27 *et seq.*) a description of the Millstone Grit and its subdivisions, as follows:

Rough Rock, or Topmost Grit.

Shales (with coal beds).

Middle Grits.—A group of sandstones, gritstones, and

† P. 187, 188, H⁴. ‡ P. 108.

shales, variable in the number, thickness, and character of the sandy beds.

Shales (with coal beds).

Kinder-scout, or Lowest Grits. (Page 32).

The resemblance of the "diagrammatic section of the Millstone Grit of Derbyshire and the West Riding of Yorkshire" (Plate 1, facing p. 32) to Mr. Chance's Profile Section (Plate 7, V), is astonishingly close. In the Rough Top rock, of wonderfully even thickness and perfect lateral continuity, we recognize our Homewood Sandstone. In the Middle variable group we recognize the Connoquenessing sandstones, described as very variable. In the Kinder-scout lower grit we recognize our Sharon Conglomerate.

The closer differentiation on p. 27 makes the coincidence still more astonishing.

"*Rough Rock.*—Almost invariably a coarse and massive feldspathic grit, about 100 feet thick. A band of flagstone frequently at the base. Called also *First Grit.*

"Shales.

"*Second Grit.*—A somewhat variable group of finely grained sandstones and shales.

"Shales.

"*Third Grit.*—A coarse massive gritstone between 200 and 300 feet thick, remarkable for its regular jointing and bold wall-like escarpments. Fine flaggy beds at the base, and a coal on the top frequently.

"Shales.

"*Kinder Scout Grit.*—Coarse, often conglomeratic, very massive, with occasional beds of flagstone. Where most largely developed in two beds with shale between. Up to 500 feet thick. Also called *Fourth Grit.*"

The Second and Third Grits here correspond to the Connoquenessing Upper and Lower Sandstones, and the Coal between them to the Quakertown Coal; the coals under the First Grit to our Mercer group; and the coals over the Fourth Grit to our Sharon.

The great development of the Fourth Grit from 20 feet at the north end of the English profile to 120 feet at the south end, a distance of 60 miles, is paralleled in a reverse

geographical direction by the thickening of the Sharon Conglomerate from almost nothing in parts of Pennsylvania to . . feet in parts of Ohio. The irregularity of its floor also resembling that of its American analogue.

The whole English Conglomerate is 110 feet at the north end and 290 feet at the south end; the general total thickness of our Conglomerate varying between 250 and 350 feet.

Dr. Green describes admirably well the local value of such a classification when he says (p. 28):—"Over many a mile of country and for many a month of field work this simple classification served us admirably, and the mapping and correlation of the different beds was a remarkably easy task. But as the examination of the Grits was pushed further to the north, the group was found to grow more and more complicated and changeable, and it became evident that the classification which was perfectly adapted to the simple type of Derbyshire, was altogether inapplicable to the series where it was much more largely developed and much more variable. The old nomenclature has been hitherto retained, even in some districts to which it could scarcely by any possibility be made to apply, because no opportunity has yet been offered of explaining in the pages of a Survey publication the reasons for abandoning it and substituting a more suitable terminology in its place; now that an opening presents itself, we gladly avail ourselves of it to explain the changes in nomenclature which it has been found necessary to introduce, and we propose to append to these explanatory remarks some hints as to the probable manner in which certain variations in the character and thickness of some members of the Grit series were brought about.*

* "After these introductory observations we pass to our own immediate district. * * * * * * * * * * * * * *

The Rough rock never failed us: the Third Grit maintained its characteristic stamp and could be recognized and followed without any risk of error; the Kinder Scout Grits were equally unmistakeable. The only subdivision that could possibly cause trouble was the somewhat changeable Second Grit, but as this always lay between the two readily recognizable horizons of the Rough Rock and the Third Grit, there was never any real difficulty in determining whether any sandstone was to be assigned to it or not.

The underlying measures in Black Lick gap are given in the section (Fig. 50. p. 187, H⁴) as "Shales and concealed rocks" (XI) 100′ to 150′; Mountain Limestone 50′; Pocono Sandstones (X) 100′ visible above water. The limestone is cherty and makes a bold cliff. From Coal Bed A down to the *base* of the Limestone measured vertically is 310′.

In the Conemaugh gap (Bolivar section Fig. 10, p. 97, KK) the underlying measures are given by Prof. Stevenson thus: Red shales (XI) 100′; fossiliferous limestone 2′; red

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"This desirable state of things lasted as far north as the neighborhood of Bradfield; thereabouts difficulties began to make their appearance.

The Rough Rock and the Kinder Scout Grit luckily we could still make sure of, but this was no longer the case with the Third Grit. That bed had hitherto been by far the most strongly marked of all the Grit-stones, but after passing Crow Chine every one of the distinguishing characteristics, which had served us so far in such good stead, began one by one to fail; the rock lost in a large measure its coarseness, and though coarse portions were still met with in it, a great part of it was finely grained and flaggy, and in consequence of this change in the lithological character we began to miss the bold wall-like escarpments, which from Chatsworth northwards had everywhere marked its outcrop. In spite, however, of these alterations there was good reason to look upon the rock of Strines Edge, Bole Edge, and Emlin Hill as the equivalent of the Chatsworth Grit; and we now think that the grit of Smallfield Ridge and Herculean Edge, northwest of Bradfield, may very probably be assigned to the same horizon. So far then the Grit group can still be arranged in conformity with the Derbyshire type. But a little further to the north fresh troubles were in store for us. When we pass to the country south and west Penistone, the Rough Rock and Kinder Scout Grit can still be identified both by character and stratigraphical continuity, but the sandstone beds between these rocks are all finely grained and flaggy, and there is not one among them that bears the least resemblance to the strikingly characteristic Third Grit of the country to the south. Still as this bed has already undergone considerable changes, we saw no improbability in its becoming still further altered in its course northward, and we agreed to look upon these fine sandstones provisionally as the equivalent of the Third Grit, and wait and see what further light would be thrown upon the subject when our work should have been pushed on further to the north.

The results of that work have not confirmed our hypothetical identification, and we must now explain the conclusions they have led us to, and the changes in nomenclature which these conclusions require. * * *

The following nomenclature will for the present at least better meet the requirements of the case.

ROUGH ROCK OR TOPMOST GRIT.
SHALES.
MIDDLE GRITS.—A group of sandstones, grit stones variable in number, thickness and character of the sandy beds.
SHALES.
KINDER SCOUT OR LOWEST GRITS."

shales 35′; fossiliferous limestone 1′ 6″; red shale 25′; alternations of red shale, clay, and calcareous sandstone layers, in all 10′; Siliceous (Mountain) limestone 40′.* Counting then the Conglomerate at 50′, the vertical distance from its top down to the base of the Mountain limestone will be 250′.

Now Mr. Platt's discovery of a siliceous limestone bed 6′ thick at McCree's furnace on Mahoning creek at the mouth of Camp run in northern Armstrong county, lying 95′ below the top of the Conglomerate (Homewood SS.), and precisely resembling in character the limestone in Black Lick and Conemaugh gaps, has governed him in the naming of the other measures of that section, as will be seen in the text of the section Fig. 32, p. 143, of this volume, and in its description on pp. 144, 145. The sandstones under the limestone he consequently looks upon as representing the great Pocono sandstone cliffs of the Conemaugh gap under the 60′ Mountain Limestone there.

The objections to this view may be stated thus:

1. The Mahoning creek limestone is only 6′ thick; the Conemaugh Gap and Black Lick Gap limestone is 40′ to 60′ thick.

2. It lies only 95′ beneath Coal A. The other lies 310′ below Coal A in Black Lick gap, and more than 250′ in the Conemaugh gap.

3. It is seen nowhere else in Armstrong county except at this one locality on Mahoning creek (p. 144) although careful search has been made for it along Red Bank (p. 185.)

4. It exactly corresponds to the Mercer limestone of the western counties *in situation*, underlying the Homewood sandstone, and accompanied by black shales and thin (Mercer?) coals; and is underlaid by a 175′ of (Connoquenessing) sandstones, *under which again* lie a group of black slates and coal streaks finely shown in the section at the mouth of the Mahoning (Fig. 46, p. 231 of this report,) which are in exactly the right position for the Sharon group.

5. No red shales (of XI) are visible anywhere in said section; but on the contrary the only shale which can be

*See a discussion of this section, and its fossils on pp. 290, 291, KK.

referred by color to the Mauch Chunk (XI) is a thin bed of red shale at Patton's station, (page 188,) lying 290′ beneath the Ferriferous Limestone (or say 250′ beneath Coal A,) and overlaid by a massive sandstone 20′ thick, which is in the proper place for the Sharon Conglomerate, the bottom member of No. XII. Therefore Mr. Chance, in speaking of this red shale in Report VV calls it the Mauch Chunk, (No. XI.) To the same formation (No. XI) must be referred the still deeper underlying 7′ red bed 400′ beneath the Ferr. L. in the Snydersburg well; the 2′ red bed, 410′ below the Ferr. L. in the Sligo well; and the 36′ gray shales and 4′ red shales, 340′ below the top of the Homewood Sandstone, in the Beaver Falls well, noticed by Mr. Carll.

One of three conclusions then must be adopted; either 1, the siliceous nonfossiliferous character of the McCree furnace limestone, so strongly resembling the Mountain limestone of the gaps of Chestnut ridge, must be a mere curious coincidence, the Mercer limestone having assumed this character at this one locality; or 2, the Mahoning furnace limestone is a small local deposit by itself, unrelated to any other; or 3, considering it to be really the Mountain limestone, there must then be a wonderful local nonconformability at this place, the middle and lower subdivisions of No. XII thinning out before reaching it. The first supposition is certainly the simplest, especially in view of the extreme variability of the Mercer limestone deposits wherever they have been certainly recognized and studied.

For the present therefore the exposures of so called XI along Red Bank creek mentioned on pages 134, 135, 144 and 185 may safely be considered exposures of the Mercer group; as well as those about Parker in Bear creek gully (pages 210, 211) where the Mercer coal beds appear, but no limestone.

It is interesting to note that Mr. Chance finds the mountain limestone near the bottom of the red shales of XI as far north as Tangascootic in the valley of the West Branch of the Susquehanna in Clinton county, (see Report G⁴,) where XI varies in thickness from 100′ to nothing, while XII retains its thickness of 200 or 300 feet.

The Mountain limestone of England is described by English geologists as suffering a remarkable change of character in the northern or Scottish parts of its area. "It is found," says Dr. Green, (Geol. Yorkshire Coal Field, 1878, page 22,) "to lose altogether the uniformity of composition which in Derbyshire and Yorkshire is its distinctive characteristic. Partings of shale and sandstone come in between the limestone beds, and increase in number and thickness the further north we go, while the limestones themselves grow thinner and more and more earthy. To such an extent is the transformation carried when we reach Scotland, that it seems almost absurd to apply the term Carboniferous Limestone to a group of rocks which consists of a few insignificant seams of impure limestone buried among hundreds of feet of shale and sandstone."

This is precisely the change observable in the Mountain Limestone of our Southern and Western States when followed into Middle and Northern Pennsylvania. The many hundreds of feet of limestone in Virginia, and south of Piedmont, in Maryland, are represented by two very thin layers and one solid siliceous mass from 40 to 60 feet thick in Westmoreland and Indiana counties, by 30 feet of limestone in the face of the Allegheny mountain in Blair county, by five thin layers of colored shaly limestone parted by shales in a total thickness of 49 feet in Huntingdon county, by a single thin bed of clay limestone in Clinton county, and by calcareous concretions further to the north and east. So that the Mountain limestone is entirely lost in the 3000 feet of Mauch Chunk red shale of Eastern Pennsylvania, as it seems to be in the shales beneath the Sharon Conglomerate of our northwestern counties. But as it exists in Middle Ohio and in the States to the south and west of it, and increases in that direction, we must regard its line of disappearance as essentially directed towards the northeast. And, therefore, it is to that quarter of the compass we must look for the source of the Mauch Chunk red shales which supplant or envelope it.

"The mud and sand," continues Dr. Green, "of which these shales and sandstones are composed, was brought into

the sea by rivers, and when we find beds of this character growing thicker and thicker as we go in a certain direction, we know that we are approaching the points where these rivers emptied themselves into the sea, or in other words, we are drawing near an old coast line. One shore then of the Carboniferous limestone sea lay north of the Lowlands of Scotland, and was probably formed by land occupying pretty much the same position as the Grampians.

"A similar change is observed when the limestone is traced southwards towards Leicestershire, and a southern coast line can be approximately fixed running through Leicestershire and Staffordshire into North Wales."

A similar line of argument would locate the feeding rivers of our Mauch Chunk age in New England. But our problem is more extensive and complicated than the English. For the thickening of the Mauch Chunk is not merely northeastward, but in a strikingly lopsided manner on the right hand side of such a direction. The red shales, which are 3000 feet thick on the Schuylkill and Lehigh rivers, are 1100′ on the upper Juniata, 3500′ on the upper Potomac, and at least 1000′ on the New river in Montgomery county, Virginia; and we have no opportunity for seeing how thick they were along a line lying nearer to the South Mountain—Blue Ridge range, because their erosion has been complete. The direction of increase where we can follow and measure them is always from the northwest southeastward, against this old mountain range; and in this high land and in the formerly no doubt very elevated mountain region of the Philadelphia-Baltimore azoic belt, we should probably be safe in imagining the ancient rivers which carried down the ferruginous clays and sand *northwestward* along an extensive sea coast into a oceanic gulf which headed up in New England.

Perhaps the closest analogue to this that we can find at present, is the small bay of Fundy, heading up in the same direction between the mountains of Nova Scotia and the hill country of New Brunswick; and a deposit of similar red shales is taking place now on a great scale in this tide-invaded gulf of the Atlantic ocean, into which flow numer-

ous large rivers, carrying into it, to be re-adjusted by the tide, the fine detritus of the same very ancient formations which occupy the area of southeastern Pennsylvania and the eastern half of each of the southern Atlantic States.

The variations of character and thickness exhibited by the *Ferriferous limestone* of the Coal Measures in Armstrong county, are as striking as they are in the counties to the west. By consulting Index B the reader will see that this curious deposit has been laid down in some parts of the district and not in others, and that it varies from nothing up to 27 feet; is sometimes solid, and sometimes subdivided into layers separated by shales; in some places is richly fossiliferous, and elsewhere exhibits scarcely a trace of animal forms. At Bagdad and at Townsend's station for instance, it cannot be found, but re-appears at the Leechburg tunnel; around Leechburg it goes and comes and is quite non-fossiliferous; it hardly appears anywhere on Roaring run, but is seen on Rattling fork; is variable at Apollo, and for four miles on a stretch is replaced by shales. In Indiana county, (see Report H⁴,) it was deposited only in the western half of the county and can not be found anywhere to the eastward. On the other hand it becomes persistent, thick, pure, and highly fossiliferous towards the west, in the Allegheny river valley, and in the valleys of Buffalo creek, and continues as a great geological formation, the key to the geology, and the guide of the oil-well sinker, throughout Butler, Beaver, and Lawrence counties into Ohio, everywhere carrying more or less of the Buhrstone carbonate and limonite iron ore on its upper face. Towards the north, also, it persists through Clarion, Jefferson, and Forest into McKean county, and may have once extended far towards or even beyond Lake Erie, for all that we can tell about it.

The occasional replacement of this interesting limestone deposit by iron ore, and its occasional erosion in Palæozoic times, shown by the descent of the sandstone or shale layers which usually lie above it to a lower level than its base,

are facts which bear upon the question of the character and extent of the waters in which the coal measures were deposited.

Those who are interested in this question will do well to study carefully Index B, where every instance of it observed in Armstrong county is referred to, especially the Palæozoic erosion of the different coal beds underlying the great sandrocks, and the suggestive variations of intervals between coal beds which take place in surprisingly short distances; as for example, the interval between the Kittanning Lower coal and the Ferriferous limestone below it on page 241. On one side of the Allegheny river near Kittanning these beds are 13′ apart, and on the other side of the river 35′; at another place they are 30′ apart, and in the hill directly opposite 50′.

The erosion of the Kittanning Upper coal bed (cannel) on Red Bank creek, evidently by streams of water flowing through the coal marsh, is shown at page 242.

The far more modern *erosion of the surface*, preglacial and postglacial, previous to the appearance of man, and continued to the present day, which is elaborately discussed by Mr. Carll in his Report III, finds some additional illustrations in these pages, as in the description of the Cove at Mahoning Furnace (pages 155, 156,) with its island, and terrace plain and deposit of gravel, 115′ above the present water course; of similar gravels 100′ above the stream at Eddyville, (page 147,) and of the gravels on the terrace of Ferriferous limestone, 220′ above the Allegheny river bed at Logansport. In Index C references will be found to other phenomena of this class, and to ancient now deserted river channels.

For the argument in favor of a late submergence of the continent beneath ocean level, or perhaps of the Allegheny and Monongahela river country by a possible temporary ice dam thrown across the Ohio valley by the projecting front of the Beaver river glacier, derived from the character of the Mahoning creek gravels, see page 156.

The relation of *anticlinals* to river bends, as cause and effect, is signified on pages 2, 18, and elsewhere in this volume.

As to the numerous names given to the anticlinals and synclinals in Armstrong county, a glance at the little map (given at the end of these remarks) will suffice to show their necessity, and the difficulties attending their selection and application. A separate list of them is given in Index C.

The First Geological Survey of Pennsylvania recognized only two great anticlinal rolls crossing Armstrong county, called the Fourth Axis and the Fifth Axis; separating the Fourth Bituminous Coal Basin from the Sixth, and enclosing the Fifth. It now appears that the Fourth Axis is not continuous; that the Fifth was wrongly located;* and that there are a number of others, some longer, some shorter, rising, running on and flattening out in the middle of the basins. And other Reports of the progress of the Survey show that what is true of Armstrong is true of every other county in the Bituminous Coal Field of western Pennsylvania. The uniform simplicity of structure formerly ascribed to it is lost to view, and it takes its regular place now with other complicated regions of the earth's surface.

The *nomenclature* of the column of coal measures is not yet complete. Especially is it desirable to find good names for some of the sandstones. For example, there is in Armstrong county a well-marked and sometimes important horizon of massive sandstone over the Kittanning Lower Coal bed. This might receive the name of the Pine Creek Sandstone, east of the river, or of the Worthington Sandstone west of the river (see pages 109, 283) because of the fine exhibitions which it makes in those localities. But the inconvenience of multiplying synonyms is exemplified by the application of the term Buffalo Sandstone to the fine cliffs of Mahoning Sandstone along Buffalo creek and through the region described by Mr. White in Report Q and by Mr. Platt on page 287 of this volume.

* In the place of a synclinal at Brady's Bend; see page 187.

One more reference, to show the value of a *detailed survey* of a restricted district, like Armstrong county, to the right establishment of the order of the rocks over a wide area:—the *Johnstown cement bed* (a limestone underlying the Kittanning Upper Coal) was mistaken for the Ferriferous Limestone (underlying the Kittanning Lower Coal) by the First Geological Survey, not only in the Cambria, Somerset, and Westmoreland counties, and the eastern half of Indiana county, where the lower rock was never deposited as a limestone; but even in Armstrong county, where both rocks exist, the one above the other; because the separate existence of the upper limestone was not understood. The characteristic differences of the two rocks, when seen one in one place and the other in another place, was explained (on the assumption that they were one and the same) by the supposition that the bed varied in composition in different parts of its area. The Putneyville section, on page 148, shows the two beds one above the other, and their different qualities are apparent. It shows also how far towards the northwest the Johnstown cement bed was deposited.

For other evidences of the systematic value of this report the reader is referred to the indexes B and C.

It only remains to correct a slight misstatement of my views respecting the origin of *cannel coal*, in the text of page 179, which was printed in my absence. In describing the settling of floating islands of vegetation I have never referred to any but bituminous coal layers. *Cannel coal* I regard as vegetable matter macerated in water, mixed with gelatinous *water-plants*, and with the fine sedimentary clay which even the purest current-water always holds in suspension; and I ascribe the origin of the petroleum in cannel, as I do the origin of the well-oils, to such water-plants, and to gelatinous water animals.

Very respectfully,

J. P. LESLEY.

TABLE OF CONTENTS.

PHILADELPHIA, *Nov. 16, 1880.*

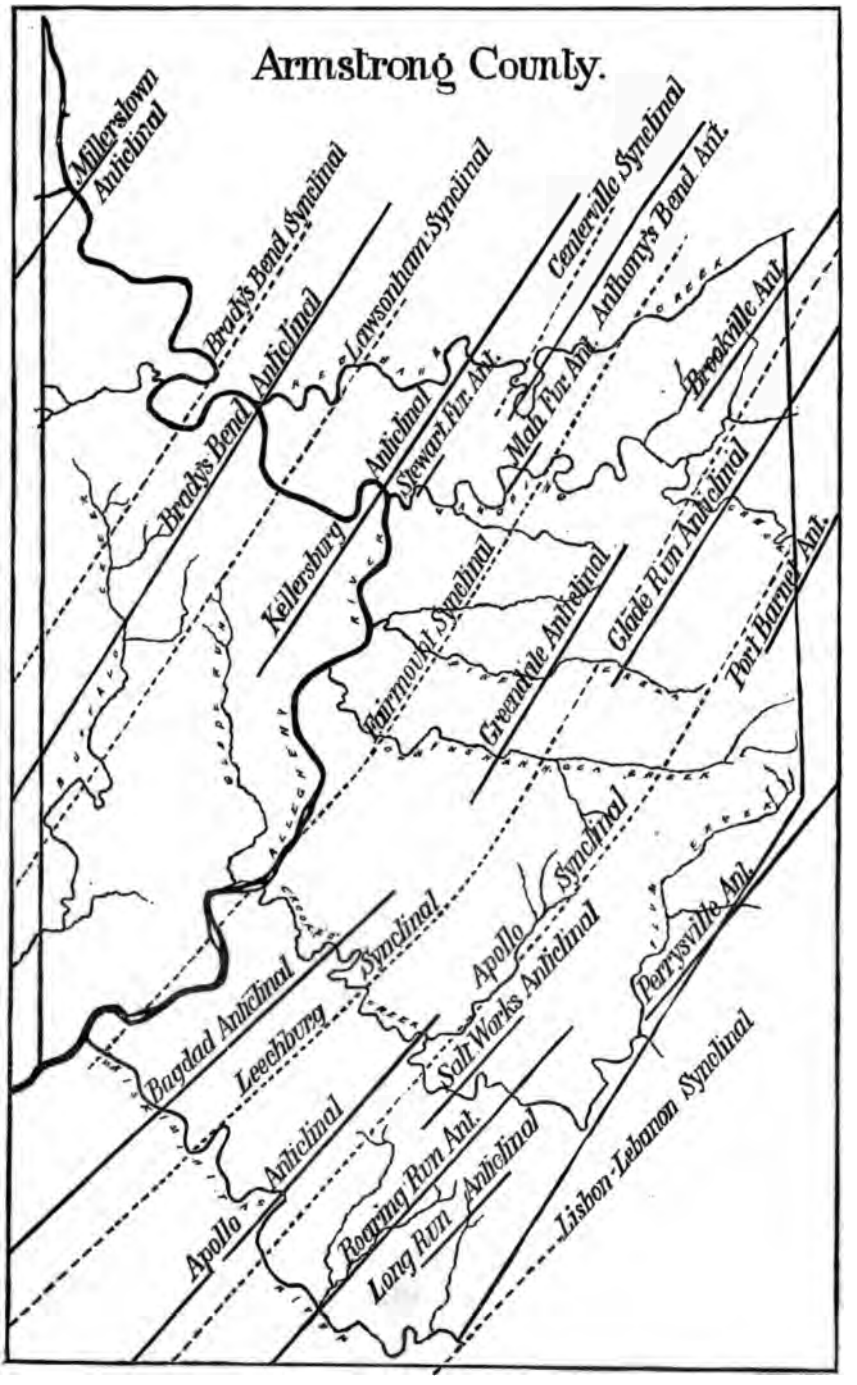
Prof. J. P. LESLEY, *State Geologist:*

SIR: I have the honor to submit my report of the survey of Armstrong county; and in doing so I desire to acknowledge the uniform courtesy with which I was received by the citizens throughout the district. My thanks are especially due for much kind assistance and valuable information, to Messrs. Jas. E. Brown, R. W. Smith, Jno. A. Colwell, Henry Colwell, Alex. Reynolds, Ross Reynolds, David Stewart, Hon. Jas. Mosgrove, and Judge Neale, of Kittanning; Mr. Thompson, of Templeton; Mr. Geo. Reichert, of Manorville; Dr. Maxwell, of Worthington; Messrs. Graff, of Buffalo Mills; Messrs. Laufman & Co., of Apollo; Messrs. Kirkpatrick and Beale, of Leechburg; Mr. Jno. Cooper, of Cochran's Mills; Hon. Geo. S. Putney and Mr. Wm. Hamilton, of Putneyville; Mr. Jno. Zimmerman, of Pine Creek; Mr. P. Hoch, of New Salem; Messrs. Laughlin, of Stewardson Furnace; Mr. Creighton, of the Pennsylvania R. R. Co.; Mr. Jno. Scott, President of the Allegheny Valley R. R. Co., and many others.

Very respectfully,

Your obedient servant,

W. G. PLATT.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REPORT OF PROGRESS, H^5.

ARMSTRONG COUNTY.

1879.

INTRODUCTION.

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Kiskiminitas.

Armstrong county was set off from Lycoming, Westmoreland, and Allegheny, in 1800, receiving its name from Gen. Armstrong, who distinguished himself in the border warfare of Colonial times. Its population in 1800 was 2,399, which in 1810 had increased to 6,143; to 10,324 in 1820; 17,625 in 1830; 28,365 in 1840; 29,560 in 1850; 35,797 in 1860; 43,382 in 1870; and at the present time amounts to (1880) 47,638 or an average of nearly one person to eight acres. Kittanning, the county seat, was laid out in 1805, and is prettily located on the left or east bank of the Allegheny river, 45 miles above Pittsburg. The same site was previously occupied by an Indian settlement of considerable size and importance. The people are mainly of German and Scotch-Irish extraction, intelligent, and thrifty. They are chiefly engaged in agricultural pursuits. The production of petroleum is confined to the northwest corner of the county, and gives employment only to a small percentage of the population. The iron industry has received more or less attention since the early part of the century, being at present conducted with quite as much vigor, and certainly with as much success as at any previous period in its history. Coal mining, aside from that needed for local supply, is little prosecuted. The other industries relate to the production of salt and fire-brick.

2. Its topographical features.

The topography of Armstrong county consists of easy-rolling hill and valley surface, in great variety of aspect, but without especially commanding features. There are here no ridges of mountain land, and no extensive gorges similar to those which control the topography in the counties to the east and southeast. It belongs, in fact, to the open country of Western Pennsylvania—a region of deep valleys with broad, undulating uplands between; a broken table-land, upon which the erosive agencies have acted unceasingly since Palæozoic times.

The main valleys are, for the most part, narrow and tortuous. Their sides range from 300 to 600 feet in height, sometimes steep and precipitous, and having long lines of cliffs; at other times the slopes are gentle, and rise slowly towards the dividing watersheds. In this respect moreover the topography often unmistakably reveals the geological structure; but only in the valleys. There the steep and narrow stretches of surface indicate the anticlinals, and the more open country with gentle declivities, the synclinals. On the uplands this distinction is obliterated, and the arrangement of the hills fails, in every case, to give expression to the geology.

With respect to the topography of the county in detail, so much has been said upon that subject elsewhere in this Report, in treating each of the main valleys separately, that additional comment is here unnecessary. It may, however, be noted that the glacial age, whose effect upon the topographical features of the northwest counties was to exert a radical change there, straightening the valleys, and planing down the hills, modified but little if any of the then existing outlines of Armstrong. The great sheet of southward moving ice, which, coming from far distant northerly regions, crossed northwest Pennsylvania during that time, passed close to Armstrong county, but wholly west of it. No marks of glacial action therefore appear in any of its valleys; and no rolled pebbles on its uplands; the crystalline pebbles of the northern drift in the bottom lands of the

Allegheny river have come from the abundant masses of morainic matter, which the receding ice left about the heads of that stream at the close of the glacial age.

Referred to ocean level the elevation of the upland region ranges from 1500 to 1600 feet. Occasionally an isolated knob or "round top," as for example Concord Hill, rises from 75 to 100 feet still higher, and stands forth then as a prominent feature in the landscape. The elevations along some of the principal lines of drainage are shown in the following tables of railroad levels, extracted from Report of Progress N. The elevations are in each case referred to ocean level.

1. West Pennsylvania RR.; Kiskiminitas Valley.

Helena,	above tide,	1017′
Salina,		955′
North-West,		894′
Roaring run,		827′
Apollo,		823′
Townsend's,		887′
Grinder's,		827′
Bagdad,		780′
A. V. RR. crossing,		791′
Freeport,		770′

(NOTE. The elevations are of the top of the rail, which is located on the left bank of the river, from 20 to 30 feet above the channel of the stream.)

2. Allegheny Valley RR.; Allegheny Valley.

West Penn Junction,	above tide,	791′
Aladdin Station,		793′
White Rock,		782′
Kelly,		781′
Logansport,		785′
Rosston,		788′
Manorville,		798′
Kittanning,		810′
Cowanshannock,		809′
Pine creek,		812′
Templeton,		824′
Mahoning,		824′
Reimerton,		837′
Red Bank Junction (B. B. RR.),		851′
Phillipsburg,		855′
Brady's Bend,		857′
Catfish,		859′
Sarah Furnace,		861′

Hillville,	865′
Montery,	875′
Parker City,	889′

3. *Bennett's Branch Extension RR.; Red Bank Valley.*

Red Bank Junction (as above),	above tide,	851′
Mortimer run,		848′
Lawsonham,		919′
Buck-Lick run,		939′
Rock run,		964′
Leatherwood,		1027′
Anthony's Bend (west end of tunnel),		1051′
Bostonia Junction (Bostonia Branch RR.),		1074′
New Bethlehem,		1080′
Fairmount,		1086′
Indiantown run,		1090′
Millville,		1093′
Pine run,		1101′
Maysville,		1108′
Patton's,		1131′

4. *Bostonia Branch R.R.;* Bostonia Valley.*

Bostonia Junction, (as above,)	above tide,	1074′
Bridge,		1075′
2000 feet,		1100′
3000 feet,		1122′
4000 feet,		1143′
5000 feet,		1153′
6000 feet,		1186′

3. *Its drainage; rivers and streams.*

The Allegheny river, flowing from north to south through Armstrong county, and dividing it into two unequal parts, receives all of the surface water. The drainage system of the county is thus greatly simplified, consisting in brief, of two sets of tributary streams, of which one flows west, and the other east to join the main river flowing south.

But while the system in its general features is thus easily comprehended, in detail it is vastly more complex. Each main tributary stream has its own intricate system of branch

* This branch connects the Bostonia mines with the main road. There are no stations. The levels are given at thousand feet from the point of divergence near New Bethlehem.

valleys and ravines, with an endless variety of runs and rills. Of such tributary streams and systems there are six in the eastern subdivision of the county, and five in the western, those in the eastern being nearly all large and important streams, whereas those in the western are uniformly small and insignificant in comparison.

This marked difference in the volume of water coming into the Allegheny from the east and from the west relates directly to the question of preglacial topography and drainage, and shows that Western Pennsylvania, at the period of its uplift, though much in the nature of a lofty plateau, had yet distinguishing topographical lines to direct and determine its drainage. One of these lines clearly followed the Brady's Bend axis of upheaval, which between Brady's Bend and Pittsburgh turned the water east into the Allegheny and west into the Beaver, restricting the water basin of the Allegheny throughout that region to a very small area. South of the Ohio the same divide separates Chartier's Creek from Racoon creek.

It is unnecessary here to follow minutely the water sheds of Armstrong county, inasmuch as the geological map accompanying this volume, is sufficiently expressive of the topography in this respect. The principal tributary streams which enter the left or eastern bank of the Allegheny river are arranged in the following order from south to north.

Kiskiminitas river. This flows along the southern boundary line of the county. In point of size and in the amount of water it carries, it is next in importance to the Allegheny, which latter it meets near Freeport. Along its left bank is the old abandoned State canal; along its right bank is the West Pennsylvania railroad.

Crooked creek, which joins the river at Rosston, heads in Indiana county, and in Armstrong drains a narrow zone extending west from Idaho and South Bend.

Cowanshannock creek, draining a still smaller area than Crooked creek, but following a much more direct course than the latter, comes into the county east of Barnard, and empties into the river a few miles north of Kittanning.

Pine creek, whose two branches, called North and South

Fork, head in the vicinity of Dayton near the Indiana county line, and occupy a narrow belt extending thence west to the river at Pine creek station, 6 miles north of Kittanning.

Mahoning creek comes from the mountain region of Jefferson and Clearfield counties, and usually carries a considerable volume of water. It is third in size in the Armstrong county drainage system.

Red Bank creek, also from Jefferson county, and also of importance for rafting purposes and floating logs during the floods, traverses the northern border of Armstrong, from where it crosses the Jefferson line to where it joins the Allegheny river below Brady's Bend.

The following enter the Allegheny river on the right bank from the west:

Buffalo creek comes into the river at Freeport. It is the largest of the western tributaries in Armstrong county; it heads in Butler county, where its springs interlock with those of the Connoquenessing, flowing west into the Beaver; flows a southerly course along the flank of the Beaver-Allegheny divide before alluded to; and carries only a small volume of water, except in time of flood.

Glade run is the next large stream north of the Buffalo.

Limestone run enters further north.

Sugar creek drains the Brady's Bend region.

Bear creek from Butler county comes in below Parker City.

4. Its soils.

Nearly every part of Armstrong county is cultivable. There are few sterile tracts, and few swamps or waste places of any size.

With the exception of the "bottom lands" of the Allegheny river, which have been formed partly from the Drift material, the soils of Armstrong county are the product of the disintegration of local rocks; and as the geology varies greatly at different localities, so the soils present many varieties of composition. In the main however they are fairly good; the very fact that the farming in most cases is badly

done, and yet, on the whole is remunerative, is proof enough that the soils, if properly treated, are capable of handsome returns.

The Upper Productive Coal Series contains proportionately a so much greater amount of limestone among its strata than the other rock groups, that those regions which it overspreads are the most fertile in the county. Moreover the *lay* of the country in which it is found, is especially adapted to advantageous cultivation, being an easy rolling upland, well drained, and abounding in never failing springs,

The soil resulting from the Lower Barren Series, is not only leaner than the others, but as a general thing is shallower, and thus requires more careful nursing in its treatment. But though inferior by comparison, none of it is too unproductive for cultivation. One ingredient essential to strength which its composition lacks is lime, owing to the almost total absence of limestone among the Lower Barren series.

The Lower Productive Series, on the other hand, contains much calcareous matter and also much sand. Its soils therefore are strong; but often the surface is so encumbered with rock fragments from the coarse sandstone strata of the group, that the cultivation of grain is hardly renumerative. In the regions of the Pottsville Conglomerate the same objection applies, and with even greater force; which causes a very marked distinction to exist between the smooth upland surface of the south, and the somewhat inhospitable townships of the north.

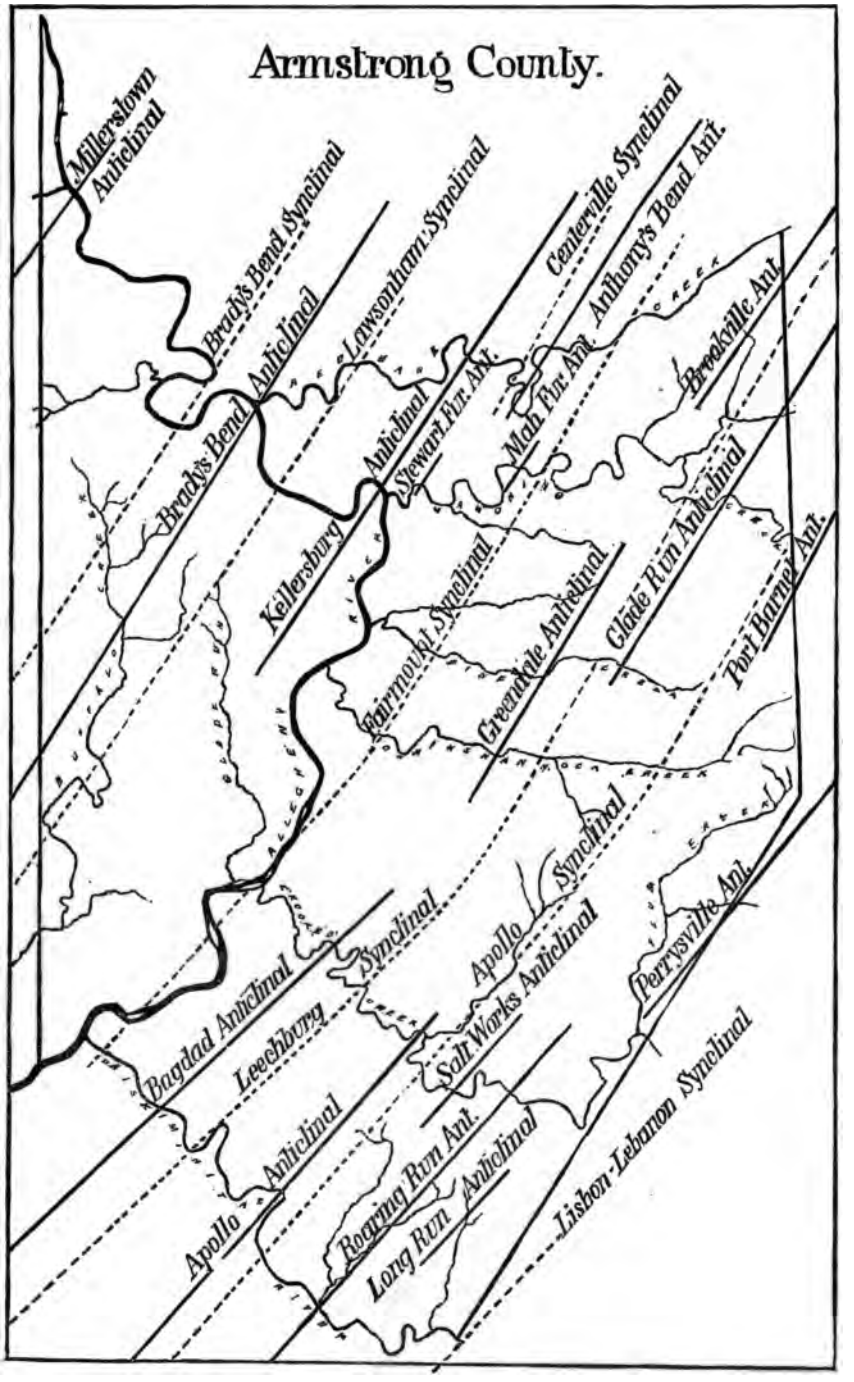
Where the cultivation of grain is rendered inadvisable by the roughness of the surface, there the land can be advantageously applied to grazing purposes. Indeed in nearly every part of the county the business of farming can now be more profitably conducted in connection with cattle-raising than without it. It pays vastly better to market the grain through the medium of fattened cattle, than to bring it into direct competition with the abundant products from the great grain fields of the West and Northwest. Many of the farmers of Armstrong county have already appreci-

ated this fact, and are turning their attention more and more to the raising of cattle and horses.

So long as new land could be obtained by clearing the forests, the most ruinous system of farming prevailed, destructive of the fertility of the soil. Exhaustive crops were produced in continued succession upon the same fields with only the application of a small amount of barnyard manure, which in many cases was little better than nothing. Until recently almost no use was made of the boundless stores of limestone; but of late years, since nearly all of the available land has been brought under the plow, an important change in this respect has taken place, although even yet its value as a fertilizing element is not fully appreciated, nor the method of its application rightly understood.

The subject of irrigation has as yet received almost no attention whatever, because the expense involved in such operations is usually too great for farmers whose working capital is small. The losses experienced from long and severe droughts are often quite serious, as are also those arising from the washing of the steep hillsides in time of flood. To overcome to any extent the former difficulty, would require the construction of works to collect the water from the springs and brooks in elevated reservoirs, from which afterwards, in time of drought, the lowlands could be flooded. No such arrangement, however simple, is at present undertaken; but the washing of floods can easily be remedied, ditches only being required in the fields to carry off the water.

The large size of the farms is, in most cases a serious drawback to the success of the farmers. Considering how small comparatively is the farming population of the county the statement may be ventured that the amount of land under cultivation is more than double what it should be. No decided success can attend the agricultural interests until a different idea is entertained of the amount of labor required to properly till a given number of acres. The gradual growth of the farms to their present size has naturally followed the wretched system of farming before alluded to, namely of clearing new land as the energies of the old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1. The Physical features of the district.

Armstrong county is in the central part of Western Pennsylvania, being in shape an irregular pentagon of 612 square miles, with Clarion county on its north, Jefferson and Indiana on its east, Westmoreland south, and Butler west.

The Kiskiminitas river is its southern boundary from Indiana county to the Allegheny river—15 miles in a straight line; whence to Butler county, two miles more, the Allegheny river is the boundary. The western boundary line is a straight line running due north from where it crosses Buffalo creek at Freeport, to where it intersects the Allegheny river near Foxburg, a distance of 33¼ miles. The northern boundary line follows the Allegheny river from Butler county to the mouth of Red Bank creek, 14½ miles in a direct line, but nearly double that distance as the stream runs; thence up Red Bank creek to Jefferson county—18 miles. The east boundary line runs due south from Jefferson county 18 miles to the top of the divide overlooking the north fork of Plum creek; whence to the Kiskiminitas river, 20½ miles, it has a course of S. 35° W.

The surface area is subdivided irregularly into twenty-four townships,* fifteen of which are east of the Allegheny

* This statement is based upon the county survey of 1876. By a recent partition of Allegheny township into three portions, the county now contains twenty-six instead of twenty-four townships.

river, and nine west of it, in the following order of arrangement:

Hovey.

Perry.

Brady's Bend.

Madison. Mahoning. Red-Bank.

Sugar Creek. Washington. Pine.

Boggs. Wayne.

W. Franklin. E. Franklin. Valley.

Cowanshannock.

North Buffalo. Manor. Kittanning.

Plum Creek.

South Buffalo. Burrell.

South Bend.

Allegheny.

Kiskiminitas.

Armstrong county was set off from Lycoming, Westmoreland, and Allegheny, in 1800, receiving its name from Gen. Armstrong, who distinguished himself in the border warfare of Colonial times. Its population in 1800 was 2,399, which in 1810 had increased to 6,143; to 10,324 in 1820; 17,625 in 1830; 28,365 in 1840; 29,560 in 1850; 35,797 in 1860; 43,382 in 1870; and at the present time amounts to (1880) 47,638 or an average of nearly one person to eight acres. Kittanning, the county seat, was laid out in 1805, and is prettily located on the left or east bank of the Allegheny river, 45 miles above Pittsburg. The same site was previously occupied by an Indian settlement of considerable size and importance. The people are mainly of German and Scotch-Irish extraction, intelligent, and thrifty. They are chiefly engaged in agricultural pursuits. The production of petroleum is confined to the northwest corner of the county, and gives employment only to a small percentage of the population. The iron industry has received more or less attention since the early part of the century, being at present conducted with quite as much vigor, and certainly with as much success as at any previous period in its history. Coal mining, aside from that needed for local supply, is little prosecuted. The other industries relate to the production of salt and fire-brick.

2. *Its topographical features.*

The topography of Armstrong county consists of easy-rolling hill and valley surface, in great variety of aspect, but without especially commanding features. There are here no ridges of mountain land, and no extensive gorges similar to those which control the topography in the counties to the east and southeast. It belongs, in fact, to the open country of Western Pennsylvania—a region of deep valleys with broad, undulating uplands between; a broken table-land, upon which the erosive agencies have acted unceasingly since Pa'æozoic times.

The main valleys are, for the most part, narrow and tortuous. Their sides range from 300 to 600 feet in height, sometimes steep and precipitous, and having long lines of cliffs; at other times the slopes are gentle, and rise slowly towards the dividing watersheds. In this respect moreover the topography often unmistakably reveals the geological structure; but only in the valleys. There the steep and narrow stretches of surface indicate the anticlinals, and the more open country with gentle declivities, the synclinals. On the uplands this distinction is obliterated, and the arrangement of the hills fails, in every case, to give expression to the geology.

With respect to the topography of the county in detail, so much has been said upon that subject elsewhere in this Report, in treating each of the main valleys separately, that additional comment is here unnecessary. It may, however, be noted that the glacial age, whose effect upon the topographical features of the northwest counties was to exert a radical change there, straightening the valleys, and planing down the hills, modified but little if any of the then existing outlines of Armstrong. The great sheet of southward moving ice, which, coming from far distant northerly regions, crossed northwest Pennsylvania during that time, passed close to Armstrong county, but wholly west of it. No marks of glacial action therefore appear in any of its valleys; and no rolled pebbles on its uplands; the crystalline pebbles of the northern drift in the bottom lands of the

valleys and ravines, with an endless variety of runs and rills. Of such tributary streams and systems there are six in the eastern subdivision of the county, and five in the western, those in the eastern being nearly all large and important streams, whereas those in the western are uniformly small and insignificant in comparison.

This marked difference in the volume of water coming into the Allegheny from the east and from the west relates directly to the question of preglacial topography and drainage, and shows that Western Pennsylvania, at the period of its uplift, though much in the nature of a lofty plateau, had yet distinguishing topographical lines to direct and determine its drainage. One of these lines clearly followed the Brady's Bend axis of upheaval, which between Brady's Bend and Pittsburgh turned the water east into the Allegheny and west into the Beaver, restricting the water basin of the Allegheny throughout that region to a very small area. South of the Ohio the same divide separates Chartier's Creek from Racoon creek.

It is unnecessary here to follow minutely the water sheds of Armstrong county, inasmuch as the geological map accompanying this volume, is sufficiently expressive of the topography in this respect. The principal tributary streams which enter the left or eastern bank of the Allegheny river are arranged in the following order from south to north.

Kiskiminitas river. This flows along the southern boundary line of the county. In point of size and in the amount of water it carries, it is next in importance to the Allegheny, which latter it meets near Freeport. Along its left bank is the old abandoned State canal; along its right bank is the West Pennsylvania railroad.

Crooked creek, which joins the river at Rosston, heads in Indiana county, and in Armstrong drains a narrow zone extending west from Idaho and South Bend.

Cowanshannock creek, draining a still smaller area than Crooked creek, but following a much more direct course than the latter, comes into the county east of Barnard, and empties into the river a few miles north of Kittanning.

Pine creek, whose two branches, called North and South

Fork, head in the vicinity of Dayton near the Indiana county line, and occupy a narrow belt extending thence west to the river at Pine creek station, 6 miles north of Kittanning.

Mahoning creek comes from the mountain region of Jefferson and Clearfield counties, and usually carries a considerable volume of water. It is third in size in the Armstrong county drainage system.

Red Bank creek, also from Jefferson county, and also of importance for rafting purposes and floating logs during the floods, traverses the northern border of Armstrong, from where it crosses the Jefferson line to where it joins the Allegheny river below Brady's Bend.

The following enter the Allegheny river on the right bank from the west:

Buffalo creek comes into the river at Freeport. It is the largest of the western tributaries in Armstrong county; it heads in Butler county, where its springs interlock with those of the Connoquenessing, flowing west into the Beaver; flows a southerly course along the flank of the Beaver-Allegheny divide before alluded to; and carries only a small volume of water, except in time of flood.

Glade run is the next large stream north of the Buffalo.

Limestone run enters further north.

Sugar creek drains the Brady's Bend region.

Bear creek from Butler county comes in below Parker City.

4. Its soils.

Nearly every part of Armstrong county is cultivable. There are few sterile tracts, and few swamps or waste places of any size.

With the exception of the "bottom lands" of the Allegheny river, which have been formed partly from the Drift material, the soils of Armstrong county are the product of the disintegration of local rocks; and as the geology varies greatly at different localities, so the soils present many varieties of composition. In the main however they are fairly good; the very fact that the farming in most cases is badly

done, and yet, on the whole is remunerative, is proof enough that the soils, if properly treated, are capable of handsome returns.

The Upper Productive Coal Series contains proportionately a so much greater amount of limestone among its strata than the other rock groups, that those regions which it overspreads are the most fertile in the county. Moreover the *lay* of the country in which it is found, is especially adapted to advantageous cultivation, being an easy rolling upland, well drained, and abounding in never failing springs,

The soil resulting from the Lower Barren Series, is not only leaner than the others, but as a general thing is shallower, and thus requires more careful nursing in its treatment. But though inferior by comparison, none of it is too unproductive for cultivation. One ingredient essential to strength which its composition lacks is lime, owing to the almost total absence of limestone among the Lower Barren series.

The Lower Productive Series, on the other hand, contains much calcareous matter and also much sand. Its soils therefore are strong; but often the surface is so encumbered with rock fragments from the coarse sandstone strata of the group, that the cultivation of grain is hardly renumerative. In the regions of the Pottsville Conglomerate the same objection applies, and with even greater force; which causes a very marked distinction to exist between the smooth upland surface of the south, and the somewhat inhospitable townships of the north.

Where the cultivation of grain is rendered inadvisable by the roughness of the surface, there the land can be advantageously applied to grazing purposes. Indeed in nearly every part of the county the business of farming can now be more profitably conducted in connection with cattle-raising than without it. It pays vastly better to market the grain through the medium of fattened cattle, than to bring it into direct competition with the abundant products from the great grain fields of the West and Northwest. Many of the farmers of Armstrong county have already appreci-

ated this fact, and are turning their attention more and more to the raising of cattle and horses.

So long as new land could be obtained by clearing the forests, the most ruinous system of farming prevailed, destructive of the fertility of the soil. Exhaustive crops were produced in continued succession upon the same fields with only the application of a small amount of barnyard manure, which in many cases was little better than nothing. Until recently almost no use was made of the boundless stores of limestone; but of late years, since nearly all of the available land has been brought under the plow, an important change in this respect has taken place, although even yet its value as a fertilizing element is not fully appreciated, nor the method of its application rightly understood.

The subject of irrigation has as yet received almost no attention whatever, because the expense involved in such operations is usually too great for farmers whose working capital is small. The losses experienced from long and severe droughts are often quite serious, as are also those arising from the washing of the steep hillsides in time of flood. To overcome to any extent the former difficulty, would require the construction of works to collect the water from the springs and brooks in elevated reservoirs, from which afterwards, in time of drought, the lowlands could be flooded. No such arrangement, however simple, is at present undertaken; but the washing of floods can easily be remedied, ditches only being required in the fields to carry off the water.

The large size of the farms is, in most cases a serious drawback to the success of the farmers. Considering how small comparatively is the farming population of the county the statement may be ventured that the amount of land under cultivation is more than double what it should be. No decided success can attend the agricultural interests until a different idea is entertained of the amount of labor required to properly till a given number of acres. The gradual growth of the farms to their present size has naturally followed the wretched system of farming before alluded to, namely of clearing new land as the energies of the old

fields became destroyed. Such defects, however, remedy themselves. The exhaustion of the land compelled a resort to the neglected fertilizer; just so, increasing population demanding increased returns, will work the necessary improvements in the other directions.

5. Its Railroads.

The county possesses abundant means of access to all the important commercial markets. The *Allegheny Valley railroad* traverses the left bank of the Allegheny river, and with its connections opens up this country to the region of the lakes and Canada. Southward it connects with the *Pennsylvania RR.* at Pittsburg. Its *Bennett's Branch extension*, 110 miles long, affords another outlet north and east, as well as also southward; it occupies the Red Bank Valley, passing subsequently at easy grades across the mountain region of Jefferson and Clearfield, and on thence to Driftwood where it intersects with the *Philadelphia and Erie RR.*

The *Butler and Karns City RR.* starts at Parker City on the Allegheny river, and follows thence up Bear creek across the oil fields of northern Butler. It is of narrow guage.

The *West Pennsylvania RR.* (standard guage) occupies the valley of the Kiskiminitas river, whose left bank it follows until it crosses the Allegheny river above Freeport. It belongs to the Pennsylvania RR. system, and runs from Blairsville Junction to Pittsburgh. The *Butler Branch of the West Pennsylvania RR.* extends from Freeport to the county seat of Butler.

The question of *slack water navigation* on the Allegheny river has recently received some discussion, as also that of re-opening the old line of water communication between Pittsburgh and the east; but neither project is likely to be undertaken at present, certainly not the latter.

6. Its structural geology; anticlinal axes and synclinal basins.

The geological structure of Armstrong county consists

briefly of a series of anticlinal and synclinal flexures arranged in nearly parallel order across the map from northeast to southwest. The *line of strike*, therefore, is uniform, and when unaffected by local causes, is not far from N. 35° E. and S. 35° W.

But in the *length* of the axial lines, as well as in the vertical energy of the anticlinals, and in the *depth* of the intermediate basins there is a wide margin of difference. Some of the axes are of strictly local occurrence, beginning and ending inside the county limits; others again have a more extended range, being the equivalents of similar axes found in adjoining districts. These features are best expressed by the small *skeleton map* of the county shown on page xxvi.

The strength of the axes varying, the *dips* vary. The latter are in all cases extremely gentle. The normal incline is towards the northwest and southeast, affected, however, often by local causes, producing local dips. There are no faults in the strata, or other serious disturbances. The beds of coal, iron ore, &c., being usually above the drainage lines, and lying nearly horizontal, mining is of the simplest description.

The axes are briefly described in succeeding paragraphs. The order of arrangement is from southeast to northwest, across the basins. The axis lines are followed from southwest to northeast.

Previous, however, to that description, it is desirable to state the extent to which former interpretations of the geology of this county have been modified by the recent survey.

Fifth Basin.—By the geologists of the First Survey,* nearly the whole of Armstrong county was included within what was called the Fifth Great Basin, which had for its southeast boundary the Fourth Great Axis, crossing the Kiskiminitas at the mouth of Roaring run; and for its northwest boundary, the Fifth Great Axis, which, coming southward from Clarion county, was thought to cross the Allegheny river between the mouths of Red Bank and Mahoning creeks. Within this great basin, twenty miles wide,

* See Geology of Pennsylvania, Vol. II, 1858.

other flexures, called subordinate axes, were known to traverse the strata in the same direction, generally as the marginal lines; but owing to the wilderness condition of the region in the time of the First Geological Survey, the course of all the axes, large and small, could be only vaguely determined.

Fourth and Fifth Axes.—From previous remarks it will readily appear that the main features of this interpretation have been confirmed; although it is now known that no marginal lines of such commanding importance as that ascribed by the First Geological Survey, either to the Fourth or Fifth Axis, exist throughout Armstrong county. With exception of a few local flexures, one axis is of as much importance as another. Moreover there is not that unbroken continuity in the main marginal lines which was supposed to exist. Thus for example the Fourth Axis, the Waynesburg (or Roaring run) anticlinal of the Kiskiminitas, so quickly loses force when traced northeastward from that river that all hold is lost of it before crossing into Indiana county. For convenience sake it may be considered as the equivalent of the Port Barnet anticlinal of the Sandy Lick creek, in Jefferson county; but the actual junction of the two lines cannot be made out in the exposures. Moreover it was wrongly located by the First Survey where it crosses the Allegheny river at Brady's Bend, because its duplex character was not then recognized.

The Fifth Axis.—Instead of a single great axis of uplift crossing the river between the mouths of Red Bank and Mahoning, there are two anticlinals in that neighborhood of about equal strength and importance, one at the mouth of each of those streams; while between the two, where the crown of the anticlinal was originally located, there is a shallow but well-defined synclinal. The anticlinal at the mouth of Red Bank, now called the Brady's Bend axis, must be considered the Fifth axis of the Old Survey.

Names of the Anticlinals.—In this Report, therefore, the old *numerical nomenclature* for the axes has been of necessity abandoned. Both the anticlinals and synclinals are herein described by geographical names, selected, in those

cases where the axes have been hitherto unnamed, from localities in the county near which they pass; for those axes whose equivalents in other districts have already been described, the names there given to them are here retained.

The Lisbon - West Lebanon synclinal touches only the extreme southeast corner of the district. It crosses the Kiskiminitas from Westmoreland county, at the Indiana-Armstrong line, passing thence as a well defined trough under the village of West Lebanon, in Indiana county. Its course through the latter region was described in my report for 1877. Its course southwestward through Westmoreland, Fayette, and Greene counties, was described by Prof. Stevenson, in Reports K and KK.

Containing the Pittsburgh Coal Bed, it is the deepest of all the basins in Armstrong county.

Along the Kiskiminitas the western side of the trough extends to the arch of the Waynesburg anticlinal at Roaring run; but towards the north the basin is subdivided, first, for a short distance, by a *local anticlinal* at Maysville, and next by a more important arch, called the *Perrysville axis* (on nearly the same allignment as the other) which first rises as a well defined fold north of Idaho Mills.

The Maysville anticlinal is distinguishable only for about one mile along its line of strike, being most distinct where it crosses a small branch of Long run, one mile northwest of Maysville. At this point it lifts the Freeport Upper coal to daylight, over a narrow elliptical area, covering a few acres. Here also it has dips of 10° and more, which affect the topography of the hills quite as much as they do the geology. Northeast towards Crooked creek the anticlinal soon expires, all hold being lost of it in the region of nearly horizontal measures west of Olivet.

The Perrysville anticlinal may be considered for the sake of convenience in this description as the continuation northward of the same axial line of uplift as that followed by the Maysville arch. The Perryville anticlinal is first felt north of Idaho, near the mouth of Plum creek, whence strengthening rapidly, it pursues a course of N. 40° E. across the head of Dutch run, at the Indiana-Armstrong

line. In the Report of Progress for Indiana county, this course was shown to be continuous, until it crosses Mahoning creek at Perrysville in Jefferson county. Report H⁶ on Jefferson county will carry the same axis still further northward.

In Armstrong county it is a low narrow arch with very gentle dips. Geologically its affect is seen in the area of Lower Productive rocks, north of Idaho, and also in the finger points of the same strata projecting westward for a short distance from Indiana county down the North and South Forks of Plum creek.*

The Smicksburg Synclinal. Between the Maysville and Waynesburg (Roaring run) anticlinals there is a shallow synclinal, which further north becomes the Smicksburg synclinal of Indiana county. In Armstrong county it includes the villages of Atwood and Barnard, near which latter place it crosses the Indiana line.

The Waynesburg or Roaring run anticlinal. — The Waynesburg anticlinal of Prof. Stevenson, is the *Fourth axis* of the First Survey. Throughout the detailed chapters of this Report, the name Roaring run is usually applied to it as more explicit for the local geology; the name Waynesburg, however, was given to it by Prof. Stevenson in his report on Westmoreland county for 1875, and having precedence, should be retained.

The rapid sinking which takes place northeastward in the axis, is fully shown by the geological map, and the details with regard to the occurrence are expressed in subsequent pages of this volume. Upon the flattening out of the arch south of Elderton, a region of nearly horizontal strata intervenes, extending from the county line on the east to the Greendale axis of the Cowanshannock on the west, and northward through all of Plum creek and Cowanshannock townships.

The Waynesburg (Roaring run) anticlinal crosses the Kiskiminitas from Westmoreland county at the mouth of Roar-

*In preparing the geological map for publication the small area of Lower Productive strata here alluded to, was accidentally omitted from the valley of the South Fork.

ing run; extends thence up the valley of the run, past the village of Shady Plain; crosses Crooked creek *above* the Clayton Pottery; continues thence northeast for a short distance into Plum creek township; but there weakening rapidly its arch flattens out before reaching Elderton, and is not traceable through the Barren Measure upland of Cowanshannock township.

The Port Barnet anticlinal. Still further north is the Port Barnet axis of Indiana and Jefferson counties, the end of which sinking southwestward crosses into Armstrong county east of Dayton in Wayne township. This latter axis I have considered to be the equivalent of the Waynesburg anticlinal, although the ends of the two lines are left unjoined on the map, because no connection between the two exists in the exposures. East of the axis is the Smicksburg synclinal; west of it is the Apollo synclinal.

The Waynesburg or Apollo synclinal*, has a different width at different places. Thus along the Kiskiminitas it occupies the whole space between the Waynesburg anticlinal and the Apollo anticlinal, 3¼ miles.

Its center line at the Kiskiminitas river passes beneath the town of Apollo, passing thence northeastward in a straight line, and crossing Crooked creek east of Cochran's mills. Next it passes between the two branches of Cherry run, and so to the east of Whitesburg, through the upland region of Plum Creek township, and across the Cowanshannock valley at the village of Centreville† east of Rural village. It here begins a more northerly course which causes it to run close to the town of Dayton, passing out of the county where it meets Mahoning creek, east of Independence.

East of Cochran's mills it is subdivided by a feeble roll, called in the detailed account of the region the *Salt Works local anticlinal of Crooked creek.* The name *Apollo synclinal* is retained for that sub-divison of the basin lying

* So called by Prof. Stevenson in Report KK.

† This Apollo synclinal at Centreville, on the Cowanshannock, must not be confounded with the *Centreville synclinal* of Madison township, and Clarion county.

line. In the Report of Progress for Indiana county, this course was shown to be continuous, until it crosses Mahoning creek at Perrysville in Jefferson county. Report H⁶ on Jefferson county will carry the same axis still further northward.

In Armstrong county it is a low narrow arch with very gentle dips. Geologically its affect is seen in the area of Lower Productive rocks, north of Idaho, and also in the finger points of the same strata projecting westward for a short distance from Indiana county down the North and South Forks of Plum creek.*

The Smicksburg Synclinal. Between the Maysville and Waynesburg (Roaring run) anticlinals there is a shallow synclinal, which further north becomes the Smicksburg synclinal of Indiana county. In Armstrong county it includes the villages of Atwood and Barnard, near which latter place it crosses the Indiana line.

The Waynesburg or Roaring run anticlinal. — The Waynesburg anticlinal of Prof. Stevenson, is the *Fourth axis* of the First Survey. Throughout the detailed chapters of this Report, the name Roaring run is usually applied to it as more explicit for the local geology; the name Waynesburg, however, was given to it by Prof. Stevenson in his report on Westmoreland county for 1875, and having precedence, should be retained.

The rapid sinking which takes place northeastward in the axis, is fully shown by the geological map, and the details with regard to the occurrence are expressed in subsequent pages of this volume. Upon the flattening out of the arch south of Elderton, a region of nearly horizontal strata intervenes, extending from the county line on the east to the Greendale axis of the Cowanshannock on the west, and northward through all of Plum creek and Cowanshannock townships.

The Waynesburg (Roaring run) anticlinal crosses the Kiskiminitas from Westmoreland county at the mouth of Roar-

*In preparing the geological map for publication the small area of Lower Productive strata here alluded to, was accidentally omitted from the valley of the South Fork.

ing run; extends thence up the valley of the run, past the village of Shady Plain; crosses Crooked creek *above* the Clayton Pottery; continues thence northeast for a short distance into Plum creek township; but there weakening rapidly its arch flattens out before reaching Elderton, and is not traceable through the Barren Measure upland of Cowanshannock township.

The Port Barnet anticlinal. Still further north is the Port Barnet axis of Indiana and Jefferson counties, the end of which sinking southwestward crosses into Armstrong county east of Dayton in Wayne township. This latter axis I have considered to be the equivalent of the Waynesburg anticlinal, although the ends of the two lines are left unjoined on the map, because no connection between the two exists in the exposures. East of the axis is the Smicksburg synclinal; west of it is the Apollo synclinal.

The Waynesburg or Apollo synclinal,* has a different width at different places. Thus along the Kiskiminitas it occupies the whole space between the Waynesburg anticlinal and the Apollo anticlinal, 3¼ miles.

Its center line at the Kiskiminitas river passes beneath the town of Apollo, passing thence northeastward in a straight line, and crossing Crooked creek east of Cochran's mills. Next it passes between the two branches of Cherry run, and so to the east of Whitesburg, through the upland region of Plum Creek township, and across the Cowanshannock valley at the village of Centreville† east of Rural village. It here begins a more northerly course which causes it to run close to the town of Dayton, passing out of the county where it meets Mahoning creek, east of Independence.

East of Cochran's mills it is subdivided by a feeble roll, called in the detailed account of the region the *Salt Works local anticlinal of Crooked creek.* The name *Apollo synclinal* is retained for that sub-divison of the basin lying

* So called by Prof. Stevenson in Report KK.

† This Apollo synclinal at Centreville, on the Cowanshannock, must not be confounded with the *Centreville synclinal* of Madison township, and Clarion county.

west of the Salt Works axis, while east of it is the *Fagley's run sub-synclinal.* Northward, in the latitude of Elderton, the two synclinals merge again into one, and the Apollo basin occupies the whole space between the Waynesburg (Port Barnet) anticlinal and the Glade run anticlinal, 3½ miles.

The Fagley's run sub-synclinal is distinguishable only for a short distance beyond the region of the Clayton Potteries, near which it crosses Crooked creek. The passage of the axis across the creek is indicated on the geological map by the disappearance of the Ferriferous limestone stratum beneath the water level between the Waynesburg and Salt Works anticlinals.

The Salt Works local anticlinal is an extremely gentle fold, which lifts the rocks vertically only about 30 feet. It is local to the Crooked creek region, being observable only in this valley, and only at the old abandoned salt-works, where it causes the Ferriferous limestone to reappear above the creek.

*The Apollo anticlinal**, though a feeble undulation and affecting the strata but little in elevation, is yet of considerable importance in a mining sense. It crosses the Kiskiminitas at the mouth of a small nameless run, in the neck of the bend about one mile below Apollo; whence northeastward it pursues a straight line to Crooked creek, which it crosses about one half mile below Cochran's mills. There also its arch is feeble and indistinct, becoming even weaker towards the north, and disappearing totally under the high plateau about Whitesburg. No trace of it exists on the Cowanshannock; but still further north, in the vicinity of Echo, an anticlinal rises, which may be considered as the continuation northward of the Apollo arch. This line of continuation is the Glade run axis, of which frequent mention is made in the detailed description of the region.

The Glade run anticlinal, as just said, rises at Echo, first as an almost imperceptible roll with very gentle dips. After crossing both branches of the south fork of Pine creek, it

* Perhaps the same with the *Peters creek anticlinal* of Prof. Stevenson in Reports K and KK.

passes under the uplands of Wayne township as a strong, rather steep sided, regularly defined, broad and symmetrical arch. It crosses Glade run a short distance above its mouth, to pass thence across the southeast corner of Red Bank township, and across Pine run near Paul's saw mill at the Jefferson-Armstrong line.

The Leechburg Synclinal, like the Apollo basin, is not of the same width at all points. Along the Kiskiminitas the distance across it from the Apollo anticlinal to the Bagdad anticlinal is 4½ miles; at the northeast end of the county this distance is reduced to 2¼ miles.

The axis of the synclinal crosses the Kiskiminitas at Leechburg; follows thence a straight line through Allegheny township; and crosses Crooked creek near the mouth of Carnahan run, north of which, in Kittanning township, its course can be only indistinctly traced in the imperfect exposures round about Remaley's mill. In the region of the Cowanshannock it is still more indistinct; but north of this in Wayne township a well defined synclinal passes near Belknap, extending thence across the southeastern corner of Red Bank township, and east of both the villages of New Salem and New Freedom.

The Pin-hook, or Bagdad, or Brookville† anticlinal*, crosses the Kiskiminitas at Bagdad station, below Leechburg, and Crooked creek near Kough's mill, below the long bend. Hence northward through Manor and Kittanning townships its run is obscure. The axis here, in fact, seems to lose nearly all its strength.

Below Greendale, on the Cowanshannock, it reappears in force, lifting the Ferriferous Limestone to daylight. It crosses Pine creek at Oscar, beyond which place its course through Wayne township is again obscure; and on Mahoning creek, which it crosses between Eddyville and Putneyville, its arch is nearly flat.

Opposite New Salem, in Red Bank township, it reappears, rising sharply towards the northeast, with dips varying from 3° to 5° on its flanks. It passes west of New

* So called by Prof. Stevenson, in his Report on Westmoreland county, KK.
† So called by Mr. Chance, in his Report on Clarion county, VV.

Freedom; crossing next the Little Sandy creek at Langville in Jefferson county, and so runs on northeastward.

The Fairmount Synclinal includes the towns of Freeport, Kittanning, and New Bethlehem. Its central line enters the district a short distance above the mouth of the Kiskiminitas; crosses the Allegheny above the mouth of Knapp's run; crosses it again at Logansport; again at Rosston; and again below Manorville, whence its course is across the Cowanshannock above Nulton's tavern; across Pine creek below Pine Creek furnace; across the North Fork of Pine creek west of Slabtown, and across Scrubgrass west of Goheenville; across the Mahoning in the bend above Mahoning Furnace; and finally across the Red Bank at Fairmount. Here it received its name; and its course through Clarion county has been described by Mr. Chance, in Report VV.

The Anthony's Bend anticlinal is distinctly traceable only in the northern part of the county, on Red Bank creek, which it crosses at Anthony's Bend below New Bethlehem. Its importance through Clarion county disappears quickly on entering Armstrong. On Mahoning creek it is too faint to be recognized in the imperfect exposures at that point. No trace of it was detected along Pine creek.

The Centreville synclinal is likewise distinguishable only for a short distance. Its center line crosses Red Bank creek below Anthony's Bend, and runs thence straight on underneath the village of Centreville in Madison township, where its existence is indicated in the geological map by a few isolated areas of Barren Measures. Apparently also it crosses the Allegheny river at Barton's tavern, above the mouth of Pine creek. Southwest of this all hold is lost of it.

The Kellersburg anticlinal runs on the west side of the Centreville synclinal. Imperfect exposures and the absence of accurate levels render its course obscure through South Buffalo and North Buffalo townships. It is the probable equivalent of the axis which Mr. White mentions (in Report Q) as crossing Bull creek northwest of Tarentum in Allegheny county.

In its course northeastward through Armstrong county the arch is plainly distinguishable by the reverse dips on Limestone run, about one mile southeast of Montgomeryville in East Franklin township. It passes through the southeast corner of Washington township, and across the Allegheny river just above the mouth of Mahoning creek. At this place it is important enough to lift the Conglomerate rocks high above the water level.

Thence across Madison township it passes close to the village of Kellersburg, from which it has derived its name, and crosses Red Bank creek close to Broken Rock station, exposing there the same series of Conglomerate rocks that it does on the Allegheny river.

Its course through Clarion county has been described by Mr. Chance, in Report VV.

The Lawsonham synclinal is five miles wide, and occupies the space between the Kellersburg anticlinal on the southeast, and the Brady's Bend anticlinal on the northwest. Its center line enters Armstrong from Butler county near the head of Cornplanter run; crosses Buffalo creek three times before passing under the town of Worthington in West Franklin township; runs nearly under Middlesex; passes the Allegheny river above Reimerton; runs through the northwest corner of Madison township (where its presence is indicated on the geological map by three small detached areas of Barren Measure strata), and across Red Bank creek near Lawsonham station.

The Brady's Bend anticlinal (the Fifth Axis of the First Survey) is the last or northwesternmost *important* roll in the Bituminous Coal regions.

Throughout Greene and Washington counties it was described by Prof. Stevenson (in Report K.) under the name of the *Washington Anticlinal.* Prof. White has described its course through Allegheny and Butler in Report Q.

It enters Armstrong near the point at which Long Run crosses the Butler-Armstrong line; runs nearly underneath the village of Craigsville on the West Branch of the Buffalo in West Franklin township; crosses the North Branch 2½ miles north of Worthington, lifting the Conglomerate series

to daylight both on this stream and on the West Branch; ranges across the southeast corner of Sugar creek township, and the northwest corner of Washington; crosses the Allegheny river at the mouth of Red Bank; and passes on northeastward through Clarion county, beyond which in Forest county it still continues to be a distinct and important fold.*

West of the Brady's Bend anticlinal the rocks are nearly horizontal, being traversed only by feeble flexures, difficult to distinguish in the exposures, and in the absence of leveled lines still more difficult to trace under the uplands. Independent of these minor rolls the strata there rise slowly but persistently northward toward Lake Erie and the highlands of Crawford county.

The *Brady's Bend synclinal* occupies the interval between the Brady's Bend anticlinal on the southeast and the *Millerstown anticlinal* on the northwest. The center line of this basin enters Armstrong from Butler county with the west branch of Buffalo creek west of Craigsville, whence northeastward it makes a straight direct line to the center of Brady's Bend. The axis being shallow is easily overlooked even where best exposed.

All of Brady's Bend township, and nearly all of Perry are situated within this Brady's Bend basin.

The Millerstown anticlinal is an extremely gentle fold which crosses the Allegheny river below the mouth of Bear creek, being prolonged thence southwestward into Butler county, and northeastward into Clarion. Its dips in Armstrong county nowhere exceed one degree.

7. *Its geological formations.*

The Carboniferous system occupies the whole surface of Armstrong county.

The Upper Productive Coal Measures, including the Pittsburgh Coal bed at their base, form the high hills in the basin at the southeastern corner of the county.

The (Lower) Barren Measures spread widely through the uplands.

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*See Report VV.

The Lower Productive Coal Measures outcrop along the sides of all the valleys.

The (Pottsville) Conglomerate Series is brought up to daylight in the deep and rocky ravines of the main streams where these are crossed by the larger anticlinals.

About 1400 feet of Carboniferous strata are thus exhibited on the summits and slopes down to the valley bottoms.

The geological map which accompanies this report is colored to show the distribution of each of the above series or subdivisions in area; and it will be understoood without further explanation by remembering the almost perfect horizontality and conformity of the strata over the whole region, modified only slightly by the system of parallel shallow basins and separating gentle anticlinals; but sculptured deeply by erosion.

The Upper Productive Coal Measures at the top of the Armstrong county column of rocks is represented by a few insulated areas at the southeast corner of the county. The highest member of the series found in this county is the *Great limestone*, of which only a fragment is here preserved. Underneath it the strata observe the same general order of succession, and have the same intervals between them as prevail throughout southwestern Pennsylvania. Here also, as there, the *Pittsburgh coal bed* is economically the most important member of the series. (See Chap. II of this Report for generalized section and detailed description of these rocks in Armstrong county.)

The (Lower) Barren Measures, a group of non-productive strata consisting chiefly of alternate layers of sandstone and shales, 600 feet thick, and extending downwards from the base of the *Pittsburgh coal bed* to the base of the *Mahoning sandstone* (See Fig. 1 of this Report, H, § 7.) cover by far the greatest part of the surface of Armstrong county. Throughout all the southern townships they make the valleys as well as the uplands; but further north they are forced by the gradual rise of the stratification in that direction, anticlinal as well as synclinal, to retire from the valleys and to occupy only insulated patches on the uplands.

Only in the southern part of the county then is the entire (Lower) Barren group preserved. Its thickness there is found to correspond closely with the average thickness of the group throughout western and southwestern Pennsylvania, and its composition also is much the same. Shales and clay slates are its principal lithological features, sandstone being subordinate.

Those geological horizons of the series which have been recognized as stable and persistent elsewhere were recognized also in Armstrong county. No new features were observed. Both the *Crinoidal* and *Black limestones* were detected, as also the *Connellsville* and *Morgantown sandstones*. The *Mahoning sandstone*, the basal rock of the series, is at nearly all localities which include it a distinguishing feature.

The Lower Productive Coal Measures follow next in the order of succession downwards. They comprise the strata from the shales overlying the *Freeport Upper coal* to the shales underlying the *Brookville coal*. Where fully developed, they constitute a group about 300 feet thick. Their outcrop is in the valleys, excepting only a comparatively small territory in the northern part of the district, where they cover the uplands. In the detailed chapters of this Report complete sections are given of these rocks as they appear in each of the main valleys.

Throughout the district great uniformity prevails in the aggregate thickness of the group. Whether measured along the Kiskiminitas at the southern end of the district, or along the Red bank at the northern end, or along the Buffalo skirting the western border, the result is so nearly the same that for practical purposes the strata in their relative positions to one another may be considered as parallel. The trifling variations that here and there occur are but local exceptions to the general rule; shales interchange with sandstone and coal beds expand and diminish in thickness over short areas, without affecting much the face of the complete section. The same governing strata reappear in each of the valleys in relatively the same positions.

In previous Reports of Progress I have traced these strata, with the same results through Cambria, Somerset and In-

diana counties, which with the survey just completed give a continuous section line extending from the crest of the Allegheny mountain westward to the Allegheny river. We have, therefore, now all the data necessary to harmonize the hitherto conflicting and apparently irreconcilable sections of the mountain region and the river valley.

The Ferriferous limestone has been the chief stumbling block to this reconciliation. The early reports of the present survey clearly proved that this rock is absent altogether from the Allegheny mountain, Laurel Hill and Chestnut Ridge region; but to exactly what part of the column of rocks its horizon belonged could not be determined. It was supposed to underlie coal bed C of Prof. Lesley's Manual of Coal, which place also was accorded to it in the schedule presented in my report of Progress for Indiana county.* So long, however, as it remained in this position harmony between the river sections and those of the mountain was out of the question; because in the one case there were three persistent coal beds beneath it, and in the other only two, while above the limestone a confusion no less great prevailed. Arguing from the parallellism of the strata, I suggested in the Report of Progress above mentioned† that the place of the absent limestone was beneath coal bed B, which made bed B correspond with the Kittanning Lower coal of the Allegheny river region, supposed at that time to represent bed C of the Allegheny mountain region. This construction, based upon a supposed continuance of the parallellism already traced from the Allegheny mountain to the Allegheny river, has by the recent survey of that county been proved to be correct.

The following schedule (which includes also the nomenclature and classification adopted for the coal beds, &c., in the Reports of Progress above mentioned) will show the relative position of the strata, and their equivalents in other regions:

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*See HHHH, p. 22, ——.
†HHHH, p. 69.

Armstrong County.	*Indiana County.*	*First Basin, Cambria and Somerset.*
1. Freeport Upper Coal.	Upper Freeport Coal.	Upper Freeport Coal, Bed E.
2. Freeport Upper Limestone.	Freeport Limestone.	Freeport Limestone.
3. Freeport Lower Coal.	Lower Freeport Coal.	Middle Freeport Coal, Bed D'.
4. Freeport Lower Limestone.	" " Limestone.	Middle Freep't Limestone.
5. Freeport Sandstone.	Freeport Sandstone.	Freeport Sandstone.
6. Kittanning Upper Coal.	Coal bed D.	Freep't Lower Coal, D.
7. Johnstown Cement bed.	Johnsto'n Cement bed.	Johnst'n Cement bed.
8. Kittanning Middle Coal.	Coal Bed C.	Kittanning Coal C.
9. Absent.	Coal bed B'.	Coal Bed B'.
10. Kittanning Lower Coal.	Coal bed B.	Clarion Coal B.
11. Ferriferous Limestone.	Ferriferous Limestone.	Absent.
12. Clarion Coal.	Coal bed A'.	Coal bed A'.
13. Clarion Sandstone.	Sandstone.	Sandstone.
14. Brookville Coal.	Coal bed A.	Brookville Coal.

Thus Coal A of the Mountain region becomes the *Brookville coal* of the Allegheny river region; Coal A′ becomes the *Clarion coal;* the *Ferriferous limestone* follows next in ascending order; Coal B is the *Kittanning Lower coal*, or the Kittanning coal of the classification of the Old Survey; Coal C is the *Kittanning Middle coal;* Coal D is the *Kittanning Upper coal;* and the Freeport group remains unchanged.

By means of these identifications, moreover, it is made apparent that the principal coal beds of this group are the *Kittanning Lower* and the *Freeport Upper*. Both in the river region and in the mountain region they are the main sources of coal supply. Their eras of deposit were distinguished above others of the Lower Productive group for the uniformity with which the vegetable matter was distributed. The other coal beds are no less persistent, but are less regular, and hence less reliable for mining purposes. These two beds are everywhere about 200 feet apart.

The classification adopted by me for the Conglomerate series throughout the detailed portions of this Report, corresponds to that employed in my previous Reports of Progress. It was intended in this connection to discuss the relationship of these strata in Armstrong county to those in the gaps of the Conemaugh and Youghiogheny rivers;

but in view of the recent change by Prof. Lesley of my system of classification to correspond with that employed by Messrs. Carll, Chance, and White in the counties west of the river, the discussion is here omitted. The reasons which render such a change advisable are set forth by Prof. Lesley in his Preface to this volume.

8. Its Iron Manufacture.

The history of the manufacture of iron in Armstrong county from the native carbonate ores certainly begins as early as 1825, in which year *Rock Furnace* was built, on the Kiskiminitas river, east of Apollo. Possibly *Bear Creek Furnace*, on the Allegheny river, near Parker City, was built a few years earlier, but this is in doubt. To whichever one of the two furnaces seniority may belong the difference in age cannot amount to more than a year or two either way.

Bear Creek Furnace had a capacity of about forty tons of metal per week, and for a considerable period was the largest furnace in the county. *Rock Furnace* made only from 15 to 20 tons of iron per week. It continued in blast at intervals until 1855, having been rebuilt in 1847.

Allegheny Furnace was the third in the order of succession. It stood on the right or west bank of the Allegheny river, two miles north of Kittanning, and was built in 1827. Its capacity was about 15 tons of metal per week.

Until 1839 these three furnaces made all the metal produced in Armstrong county. The iron was shipped in flat boats down the Allegheny river to Pittsburgh, there being at that time no forges nearer than that point.

Buffalo Furnace, No. 1, was built in 1839, by P. Graff & Co., on Buffalo creek, at the crossing of the Kittanning and Butler Pike. It was distinguished, I believe, by being the first in the county to use the hot blast. It was 9 feet across the bosh, and 36 feet high; its capacity was about 45 tons of metal weekly. In spite of the difficulties attending the transportation of the iron from this place to market, having to be hauled in wagons 6 miles before being loaded on the river flats at Kittanning, the furnace was suc-

cessfully conducted by its owners. It was afterwards constructed to use coke, and was continued in blast until the close of the war, in 1865.

Following the completion of Buffalo Furnace was a period of considerable activity in the iron industry of Armstrong county, extending for nearly twenty years, until the financial crash of 1857. Many new furnaces were in that time added to the list. All used charcoal for fuel, although the use of coke had been in successful operation in Fayette county since 1836. The size of the furnaces, and their location, will appear from the following brief summary, taken mainly from the Iron Manufacturers' Guide, by Prof. J. P. Lesley, published in 1859.

Brady's Bend.—In 1840 the first of the *Great Western Furnaces* was built at Brady's bend by Philander Raymond, who subsequently erected here three additional furnaces, besides a rolling mill and a nail factory. In fact this plant ultimately became one of the most extensive in Western Pennsylvania, being among the first in America to make iron rails. Financial embarassment, however, in the end wrecked the enterprise, and both the furnaces and rolling mill are now dismantled and in ruins.

The Rolling Mill was built in 1841, and had at that time "12 puddling furnaces of a capacity to make two tons of iron per day each, and 1 scrap and 3 balling furnaces for merchant mill or finishing rolls. It was afterwards enlarged to double this capacity. The nail factory made 3 tons per day of assorted nails; there were sheet and boiler plate rolls, and a forge with hammer, squeezing, roughing and puddle rolls."*

Great Western Furnace No. 2 was an exact copy of the first, and was built in 1841. The capacity of each was 100 tons of metal per week. They employed the hot blast, but were chiefly distinguished by the large size of their boshes (14 feet) the poor success of which established later the 12 foot boshes as the favorite size for coke furnaces.†

* Pearce's Iron Manufacture in America, p. 149.
† Pearce's Iron Manufacture in America, p. 147.

No. 3 furnace was built in 1843, measuring 11 feet in the boshes, and 43 feet in height. Its capacity was nearly as great as that of the larger furnaces.

In 1845 three smaller stacks were erected in other parts of the county, viz:

Ore Hill Furnace, on the left bank of the Allegheny river 8 miles northeast of Kittanning. It used the hot blast, and measured 8½ feet across the boshes and 34 feet in height. Its capacity was between 35 and 40 tons per week.

Cowanshannock Furnace (called also Boner Furnace) was situated on Cowanshannock creek, three miles north of Kittanning. The bad location of the stack led to its abandonment after a few years of unsuccessful aotivity (see § 156 of this volume).

Mahoning Furnace, on Mahoning creek, below Putneyville, was built by Mr. John A. Colwell, of Kittanning, by whom it was most successfully conducted for more than 30 years. The stack originally, like all the furnaces of that time in the county, was built of stone. It was 10 feet in the boshes and 33 feet in height; used the cold blast, and made from 30 to 40 tons of metal per week. In 1860 the furnace was remodeled to use coak, at which time also the stack was not only enlarged to 11 feet in the boshes and 40 feet in height, but the stone structure was replaced by an iron jacket, lined with fire brick. The hot blast was applied at the same time. These alterations more than doubled the capacity of the stack. It went out of blast in September, 1878, in consequence of the depression then existing in the iron trade. Operations have not since been resumed. Until the completion recently of the new furnace at Kittanning, the Mahoning furnace was the best arranged iron plant in Armstrong county. (For further particulars see § 284 of this volume.)

In 1846 five new furnaces were erected, viz:

Brady's Bend Furnace No. 4 was completed. It made hot blast charcoal iron; was 11 feet in the boshes and 43 feet in height, and had a capacity of about 60 tons of iron per week.

Buffalo Furnace, No. 2, was completed by Mr. Graff, on

Buffalo creek. It was 8 by 35; made hot blast charcoal metal and had a capacity of from 40 to 50 tons per week.

America Furnace was built in the same year, on the east bank of the Allegheny river near the present village of Rimerton. It was 8 feet in the boshes and 28 feet in height; its capacity was about 40 tons of hot blast charcoal iron per week.

Phœnix Furnace (cold blast) stood on Mahoning creek below Milton. It was 8 feet in the boshes and 30 feet in height. Instead of smelting the usual "buhrstone" ore which is locally absent from that region, the furnace used a loamy hematite ore found near Milton. The ore being lean and poor the enterprise soon proved a failure.

Pine Creek Furnace owned by Messrs. Brown and Mosgrove of Kittanning, is one of the few original stacks in Armstrong county that were remodeled to use coke after the supply of charcoal had been exhausted. It occupies a site on the left bank of Pine creek, six miles northeast of Kittanning; was originally 10 feet in the boshes and 32 feet high; made at that time about 50 tons of hot blast charcoal iron per week; continued to make charcoal iron until 1865, when it was converted into a coke furnace. The height of the stack was then also increased to 40 feet, but the dimensions otherwise were unchanged. It continued in blast until the spring of 1879. (For further particulars see § 186 of this volume.)

In 1847 little additional capital was invested in the iron trade in Armstrong county.

Olney Furnace alone was built. It occupies a position on the left bank of Mahoning creek above Eddyville. It was enlarged in 1855 to 9 feet in the boshes and 32 feet high. Shortly afterwards it was abandoned, being in fact an unsuccessful enterprise from the outset.

In 1848 the *Kittanning Rolling Mill* was built at Kittanning. It had 20 puddling furnaces, 3 trains of rolls, and seven machines driven by water. In 1857 it made 2550 tons of bar iron, nails and castings.* Generally speaking its career was unsuccessful, and the mill brought little or no

*Iron Manufacturers' Guide p. 252.

profit to its owners. It was abandoned shortly after the financial break of 1873, remaining then idle until within a few months since, when after complete remodeling, operations in it were renewed in connection with the new furnace at Kittanning. It is reported in the "Directory to the Iron and Steel Works of the United States, Phila., 1880, (corrected to March 15, 1880,") as having 16 single puddling and 5 heating furnaces, 3 trains of rolls, 22 nail machines and 1 squeezer; product, muck bar and finished iron; annual capacity, 7000 net tons. Formerly called *Valley Rolling Mill.*

Between 1848 and 1851 no new iron works were undertaken.

Stewardson Furnace was built in 1851. It is situated on Mahoning creek 1½ miles from the Allegheny river; it was originally constructed to use coke, which, however, had little success here at first. The stack has remained almost continuously in blast from the time of its completion, and is still operated. It is built of stone, roughly constructed. Its dimensions are 11 feet in the boshes and 43 feet in height, and its capacity is from 75 to 80 tons per week. (For further particulars concerning Stewardson Furnace see below and § 273.)

In 1856 *the Apollo Rolling-Mill* was built at Apollo. The primary object of this enterprise was the manufacture of nails, which, proving unsuccessful, was abandoned about 1861, when the production of sheet iron was commenced. The mill was originally erected by the Kiskiminitas Iron Co. but subsequently passed out of their hands, and in the next ten years changed ownership several times, finally passing into bankruptcy in 1875; in 1876 it was purchased by Messrs. Laufman & Co., who have since conducted it with marked success and profit. The iron made is of excellent quality and finds a ready sale in all the markets.

The mill has seven puddling furnaces, and five charcoal fires for sinking wrought scrap iron; two trains of rolls; one steam hammer striking a fifteen ton blow; one set of bar rolls, and one pair of cold rolls. At the present time

the full capacity of the mill is 65 tons of finished iron per week.

The erection of this mill at Apollo in 1856 about completes the period of the production of charcoal iron in Armstrong county, which as we have seen flourished with considerable vigor between 1840 and 1850, rising perhaps to its maximum height between 1850 and 1856 and then rapidly declining. According to the statistics in the Iron Manufacturers' Guide 20,411 tons of pig iron were produced here in 1856 from eight furnaces. The iron made was never first-class, containing as did the coke iron afterwards made in the same stacks a preponderance of silica, which causes the metal to have great fluidity in the puddlers' furnace, and a brittleness when cold. The defective methods of making the iron ere never improved, and were in fact until very recently still in vogue.

Under such circumstances it was hardly to be expected that the manufacture of iron in Armstrong county during the charcoal period could be attended financially with much success, and in point of fact it was not. Some few of the ventures were fortunate, as for example Mahoning Furnace, and Pine Creek and Stewardson; but considering all of of them, and the Brady's Bend enterprise in particular, more money was lost here in the attempt to manufacture iron than ever was made from it. The ill-success of many of the smaller furnaces was oftentimes due to the bad location of the stacks in out-of-the-way places which necessitated long hauls for the metal, and consumed all the profits. Moreover the success of a furnace for an entire season not infrequently depended upon the accident of flood, during which time only the boats could be floated on the river to market, thus depriving small operators, pressed for money, of the advantages arising from the fluctuations in the price of the metal.

Abundant railroad facilities and the recent improved appliances for making iron have wholly changed these conditions. With prudent and intelligent management there is now no reason for the failure of a furnace in Armstrong

county, if well located. The use of coke began here in about 1859.

Monticello Furnace was built in this year (1859) by Mr. Robert E. Brown, of Kittanning, by whom it was successfully conducted for several years. It afterwards changed ownership, and the new direction becoming financially involved in an attempt to import high-grade lake-ores to mix with the native carbonates, the furnace was abandoned about 1873, and is now in ruins.

It stood on the left bank of the Allegheny river at the mouth of Cowanshannock creek, three miles north of Kittanning. It was eleven feet in the boshes and 55 feet in height; its capacity was 120 tons of metal per week.

The Leechburg rolling mill was built in 1872. It is distinguished for having been the first to successfully employ natural gas in iron making. Gas now constitutes its chief fuel, having proved not only economical but efficient. The iron produced is of excellent quality.

The mill is further distinguished for the manufacture of terne plate, with which also it has achieved much success. A full description is given elsewhere (see § 55) of the capacity of the plant, and the method employed in it of working the iron with natural gas.*

The Kittanning furnace, erected in the present year (1880) is not only the largest, but by far the most complete, in all its appointments, of any furnace plant in the Allegheny valley, out of Pittsburgh. It stands on the river bank at the southern end of Kittanning, close to the rolling mill. The stack is an iron jacket lined with fire brick; is 65 feet in height and 16 feet in the boshes. The blast is heated by Whitwell stoves. The product is said to be 70 tons of iron daily. Native ores alone are used in the stack.

Iron Ores.—The greater part of all the iron made in Armstrong county, either in times past or recently has been from the reduction of the so-called Buhrstone ore. The Brady's bend furnaces, and those also of Mr. Graff, on Buffalo creek,

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See "Natural Gas in Iron Making," by John B. Pearse, Appendix D, Report of Progress L. pages 173 *et seq.*, 1876.

used some *ore from the Freeport group*, of which, however, the outspread in workable thickness in Armstrong county, is confined to the neighborhood of those furnaces. Monticello furnace in its time, as already stated, attempted the importation of the *lake ores*, but without success.

Whatever importations of other ore may in future be made into the county, to improve the grade of the iron, the *Buhrstone stratum* will always remain the chief source of supply so long as furnaces are operated here. Its range of outcrop, as the geological map will show, extends over hundreds of miles in nearly horizontal rocks; its average thickness is about 8 inches; its character is singularly uniform; it can be easily and inexpensively mined; it is always accompanied by the *Ferriferous limestone* stratum which directly underlies it and which serves for flux in the furnace; it works easily in the stack; and when proper attention is paid to the assortment of the ores and their preparation for the stack, this Buhrstone stratum is capable of producing a pig metal containing about five tenths of one per cent of phosphorus.

Mr. McCreath analyzed samples of the ore, selected by myself from all parts of the county. The results being given elsewhere in tabulated form, need not here be repeated in detail. As a whole, however, they show not only the uniformity in the grade of the ore above alluded to, but they show the ores also to consist of three varieties, according to the amount of decomposition that has taken place, namely, limestone-carbonate ore, brown hematite, and an impure variety of red hematite. The carbonates unroasted average from 33 to 38 per cent of metallic iron; the brown and red ores contain as high 50 per cent of iron, the average being perhaps about 45 per cent. All of the ores are comparatively low in phosphorus—two tenths of one per cent being the usual amount, both in the carbonates and hematites. The sulphur is also low, amounting in many cases to scarcely more than a trace. The hematites contain none of the protoxide of iron.

The poor quality of iron made from these ores in the Armstrong county stacks has therefore been due to defective

methods of manufacture, rather than to the impurity of the ores. At the time the survey of the county was in progress, examination into the question of manufacture was confined to Stewardson Furnace, which was then the only stack in blast. The results, however, in this case, are sufficiently comprehensive to indicate what changes are necessary to improve the grade of the iron.

Mr. McCreath personally visited the furnace in order to select his own specimens for the test. His results, as told by his analyses, are as follows:

1. Red Ore.

Sesquioxide of iron,	70.714
Sesquioxide of manganese,	2.421
Sesquioxide of cobalt,	.010
Alumina,	1.491
Lime,	7.630
Magnesia,	.547
Sulphuric acid,	.010
Phosphoric acid,	.765
Carbonic acid,	5.230
Water,	7.465
Insoluble residue,	3.860
	100.143
Metallic iron,	49.500
Metallic manganese,	1.686
Sulphur,	.004
Phosphorus,	.334

2. Brown Ore.

Sesquioxide of iron,	73.928
Sesquioxide of manganese,	1.344
Sesquioxide of cobalt,	.020
Alumina,	1.582
Lime,	1.610
Magnesia,	.501
Sulphuric acid,	trace.
Phosphoric acid,	.740
Carbonic acid,	none.
Water,	12.615
Insoluble residue,	8.060
	100.350
Metallic iron,	51.750
Metallic manganese,	.936
Sulphur,	trace.
Phosphorus,	.323

3. *Blue Carbonate Ore.*

Protoxide of iron,	42.428
Sesquioxide of iron,	2.233
Bisulphide of iron,	.187
Protoxide of manganese,	.799
Protoxide of cobalt,	.010
Alumina,	.916
Lime,	7.150
Magnesia,	1.881
Sulphuric acid,	.030
Phosphoric acid,	.334
Carbonic acid,	32.622
Water,	1.950
Insoluble residue,	9.460
	100.000
Metallic iron,	34.650
Metallic manganese,	.619
Sulphur,	.112
Phosphorus,	.146

4. *Roasted ores.*

Protoxide of iron,	none.
Sesquioxide of iron,	65.928
Sesquioxide of manganese,	1.563
Sesquioxide of cobalt,	.020
Alumina,	2.688
Lime,	7.710
Magnesia,	.901
Sulphuric acid,	.580
Phosphoric acid,	1.074
Carbonic acid, Water, } absorbed,	5.365
Insoluble residue,	14.520
	100.349
Metallic iron,	46.150
Metallic manganese,	1.088
Sulphur,	.232
Phosphorus,	.469

5. *Ore screenings.*

Metallic iron,	24.600
Metallic manganese,	1.232
Sulphur,	.528
Phosphorus,	.544
Alumina,	14.328
Lime,	6.030
Magnesia,	.691
Silica,	31.800

6. *Ferriferous Limestone.*

Lime,*	53.500
Magnesia,	.432
Sesquioxide of iron,	1.114
Sesquioxide of manganese,	.206
Alumina,	.174
Sulphuric acid,	.064
Phosphoric acid,†	.082
Carbonic acid,	42.399
Silica,	2.030
Water,	.150
	100.151

7. *Coke.*

Water at 225°,	1.380
Volatile matter,	.794
Fixed carbon,	85.122
Sulphur,	.968
Ash,	11.736
	100.000
Color of ash,	reddish gray
Phosphorus,	.013

8. *Pig iron.—No. 1 Foundry.*

Silicon,	2.873
Sulphur,	.038
Phosphorus,	.852
Manganese,	2.068

9. *Slag.*

Silica,	31.800
Alumina,	12.580
Protoxide of iron,	.630
Protoxide of manganese,	.994
Lime,	48.663
Sulphide of calcium,	3.105
Magnesia,	2.101
	99.873
Sulphur,	1.378

It appears from these figures that one of the most necessary corrections at Stewardson is the regulation of the

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* Carbonate of lime, ... 95.535
† Phosphorus, ...036

roasting hearth. Indeed it is open to question, considering the small amount of carbonate ore here used, whether the roasting hearth might not to advantage be dispensed with altogether. Hitherto the practice has been to roast *all* the ores, irrespective of their condition; for until Mr. McCreath's analyses were completed it was not known that the greater part of the material which goes into this stack is hematite, the roasting of which is not only a needless expense, but of positive detriment to the ore in bringing it into contact with an ashy coal containing much phosphorus. The phosphorus does not enter directly into the ore during the process of roasting, but is carried to the stack in the small particles of clay and coal ash, which even the most careful screening cannot avoid. To appreciate the amount of phosphorus contained in these loose impurities, gathered up in the roasting hearth, it is only necessary to examine Mr. McCreath's analysis of the screenings, in which there are over five tenths of one per cent of phosphorus or nearly double as much as that contained in any specimen of the Buhrstone ore, so far analyzed from Armstrong county. The screenings are not used at Stewardson, and the accumulations of years lie stacked up below the furnace; if freed from their coal ashes by washing, thousands of tons of good ore might be rendered available at a low cost.

It will not be said that the roasting hearth may be dispensed with to the same advantage in other parts of the county as at Stewardson, for much of the ore from the Buhrstone stratum at some localities is strictly carbonate requiring roasting; but there is little doubt that less use of the hearth is in general required for these ores than is supposed by the furnace owners of the county, and moreover, where the roasting process is necessary, the ores should be afterwards promptly charged into the stack, as exposure to the atmosphere causes them to absorb water rapidly.

I have already said that the siliceous character of the Allegheny valley pig iron has interfered with the success of the iron industry of that region more seriously even than the phosphorus. This defect is easily remedied. Increased temperature in the stack, and the use of an increased

amount of limestone, will carry off the silica, reducing the proportion in the pig from 3 and 4 per cent, as it now frequently is, to 1½ and 2 per cent.

The fuel question is one that has hitherto been little regarded in Armstrong county. Coal was known to be even more abundant there than either the ore or limestone, and any seam of sufficient thickness to be mined profitably and sufficiently near to the furnace in question to dispense with transportation, supplied the coke, irrespective of its chemical composition. The damage done to the iron and the iron trade of this valley by such management is now evident. In future, before any coal is used in these furnaces, care will be taken to have it subjected to the necessary tests and analyses.

As regards Stewardson furnace in particular the coke, taking Mr. McCreath's analyses as the average, is ruinous to the iron only in connection with the roasting hearth; of itself in the stack it will not add more than from .015 to .020 of 1 per cent of phosphorus to the metal; and where the product is mill iron so small an amount of phosphorus is of little consequence. The coke might be improved in structure by a better system of coking; it might be made more tenacious, and thus be better able to bear a heavier burden, and a strong blast; but the small low stack at Stewardson, and the feeble blast employed there (1½ pounds pressure at most) require no more tenacious coke than that obtained from the open air pits.

The flux at Stewardson is from the Ferriferous limestone stratum, which carries too much phosphorus for Bessemer purposes, but adds too small an amount to the metal to condemn it where mill iron is produced. At Kittanning much better limestone can be obtained from the Upper Freeport stratum as quarried at Manorville.

Table No. 1.—Analyses of Coals in Armstrong County.

Name of Coal Bed.	Owner.	Locality.	Water.	Volatile matter.	Fixed carbon.	Sulphur.	Ash.	Fuel ratio.	Phosphorus in coal.	Phosphorus in coke.
Pittsburgh Coal bed,	Ewing,	Elder's Ridge,	.800	36.900	50.230	3.040	9.030	1:1.36		
Gallitzin Coal bed,	Patterson,	Rural Village,	1.020	36.995	53.569	2.641	5.775	1:1.45		
Freeport Upper Coal bed,	Kier Bros.,	Salina,	1.060	33.955	54.392	1.058	9.535	1:1.60		
" " "	Laufman & Co.,	Apollo.	1.410	38.560	52.249	2.381	5.400	1:1.35		
" " "	Beer Bros.,	North Star.	1.140	37.860	57.179	1.031	2.790	1:1.51		
" " "	T. H. Marshall,	Dayton,	1.040	32.330	49.450	2.000	15.180	1:1.53		
" " "	Jno. A. Colwell,	Mahoning Furnace,	1.450	34.810	54.996	1.054	7.690	1:1.58		
" " "	Laughlin,	Stewardson Furnace,	1.470	35.520	55.545	.835	6.630	1:1.56	.0684	.1085
" " "	Red Bank M. Co.,	Bostonia,	1.840	35.940	53.661	1.739	6.820	1:1.49		
" " "	Jno. Hagy,	Freeport,	1.430	39.835	50.206	2.819	5.710	1:1.26		
Freeport Lower Coal bed,	Schreckengost,	Rural Village,	.910	34.270	53.224	2.311	9.285	1:1.55		
" " "	Brown&Mosgrove,	Pine Creek Furnace,	1.820	34.185	58.301	.989	4.705	1:1.70		
" " "	John A. Colwell,	Mahoning Furnace,	1.070	37.110	50.265	3.225	8.330	1:1.35	.0092	.0148
" " "	Red Bank M. Co.,	Bostonia,	1.690	35.940	53.950	3.380	5.040	1:1.50		
" " "	Reed,	Centre Hill,	1.010	40.210	47.366	3.824	7.590	1:1.18		
Kittanning Upper Coal bed,	Thompson's,	New Salem,	1.220	37.930	52.757	1.388	6.705	1:1.39		
" " (cannel),	"	"	1.610	37.830	53.132	.678	6.750	1:1.40		
" " "	"	"	.810	34.465	54.482	.588	9.655	1:1.58		
" " "	Brooks,	Cathcart run,	.640	32.665	52.306	1.044	13.345	1:1.60		
" " "	Red Bank M. Co.,	Bostonia,	.510	30.490	46.194	.576	22.230	1:1.51		
" " "	" "	"	.730	31.680	49.815	.455	17.320	1:1.54		
Kittanning Lower Coal bed,	Mahoning Coal Co.	Mouth of Mahoning,	1.180	42.550	49.686	1.999	4.585	1:1.17	.0061	.0108
" " "	Ross Reynolds,	Kittanning,	.950	40.855	51.694	1.366	5.135	1:1.26		
" " "	Rodgers,	Butler Co. line,	1.160	42.720	48.742	2.313	5.065	1:1.14		
Clarion Coal bed,	Fox,	Parker City,	1.310	45.025	46.916	2.954	3.795	1:1.04		
" "	Winfield Furnace,	Rough Run,	1.010	42.650	48.661	1.644	6.035	1:1.14		
Brookville Coal bed,	Jno. Mortimer,	Slabtown,	.740	35.715	51.049	.936	11.560	1:1.43		

Table No. 2.—Analyses of Limestones.

Name of Stratum.	Owner.	Locality.	Carbonate of Lime.	Carbonate of Magnesia.	Oxide Iron & Alumina.	Phosphorus.	Insoluble residue.
Freeport Upper limestone,	John Reefer,	North Star,	88.839	1.513	2.557	.021	5.030
" " "	Wm. Marshall,	Dayton,	94.928	1.210	1.246	.018	1.920
" " "	Wm. Hamilton,	Putneyville,	84.857	1.868	2.568	.024	9.520
" " "	A. J. Dull & Co.,	Manorville,	89 303	1.900	2.002	.021	4.830
" " "	"	"	82.589	5.751	3.367	.063	7.310
" " "	"	"	89.857	2.898	1.860	.017	4.520
" " "	Mehaffey,	Logansport,	96.453	1.445	.964	.007	.830
" " "	"	"	93.214	2.065	1.340	.004	2.220
" " "	"	"	93.571	1.324	1.207	.029	3.170
" " "	Monroe,	Buffalo creek,	94.642	1.574	1.182	.012	1.850
Johnstown Cement bed,	Davis,	Cochran's Mills,	53.750	9.989	7.730	.131	23.840
" " "	Putney,	Putneyville,	64.160	1.838	7.450	.305	22.280
Ferriferous Limestone,	P. George,	Clayton Pottery,	94.185	1.483	2.089	.031	2.100
" "	Rhea,	Greendale,	93.246	1.740	1.667	.032	3.420
" "	Jno. A. Colwell,	Mahoning Furnace,	94.721	1.044	1.383	.047	2.300
" "	Laughlin,	Stewardson Furnace,	96.007	1.498	1.462	.034	.790
" "	Ross Reynolds,	Kittanning,	95.567	1.422	.930	.035	2.110

Table No. 3.—Analyses of iron ores.

Name of Stratum.	Owner.	Locality.	Protoxide Iron.	Sesquiodide Iron.	Bisulphide Iron.	Protoxide manganese.	Protoxide cobalt.	Alumina.	Lime.	Magnesia.
Freeport Iron ore, .	Brady's Bend Co.,	Brady's Bend, .	38.387	2.646	.090	1.153	trace.	1.223	10.840	2.666
Buhrstone Iron ore,	Zimmerman, . . .	Pine creek, . .	46.285	1.428	.118	1.655	trace.	.823	7.080	1.484
" "	Brown & Mosgrove,	Slabtown, . .	41.400	2.000	.041	1.896	trace.	1.184	8.920	1.801
" "	John A. Colwell, .	Mahoning Fur.,	41.464	10.310	.062	2.353	trace.	1.919	4.690	2.054
" "	Laughlin, ...	Stewardson Fur.,	42.428	2.233	.187	.799	.010	.916	7.150	1.881
						Sesquioxide manganese.	Sesquioxide cobalt.			
" (hematite,)	Barrett, ...	Kellersburg,	none.	68.928	. . .	2.048	trace.	1.358	8.670	.576
" "	Laughlin, ...	Stewardson Fur.,	none.	73.143	. . .	1.386	trace.	1.691	4.920	.800
" "	"	"	. .	70.714	. . .	2.421	.010	1.491	7.630	.547
" "	"	"	. . .	73.928	. . .	1.344	.020	1.532	1.610	.501

Name of Stratum.	Owner.	Locality.	Sulphuric acid.	Phosphoric acid.	Carbonic acid.	Water.	Insoluble residue.	Met. iron.	Met. manganese.	Sulphur.	Phosphorus.
Freeport Iron ore, .	Brady's Bend Co.,	Brady's Bend, .	trace.	.480	32.074	1.910	8.540	31.750	.893	.042	.224
Buhrstone Iron ore,	Zimmerman, . . .	Pine creek,	trace.	.600	35.358	2.019	3.150	37.050	1.282	.063	.262
" "	Brown & Mosgrove,	Slabtown, . . .	trace.	.346	34.208	1.774	6.430	33.620	1.469	.022	.151
" "	John A. Colwell,	Mahoning Fur.,	trace.	.623	31.450	1.315	3.760	39.500	1.828	.029	.272
" "	Laughlin, ...	Stewardson Fur.,	.030	.334	32.622	1.950	9.460	34.650	.619	.112	.146
" (hematite,)	Barrett, ...	Kellersburg, .	.012	.584	6.980	6.600	4.370	48.250	1.426	.005	.255
" "	Laughlin, ...	Stewardson Fur.,	.010	.636	3.980	8.800	4.800	51.200	.965	.004	.278
" "	"	"	.010	.765	5.230	7.465	3.860	49.500	1.686	.004	.334
" "	"	"	trace.	.740	none.	12.615	8.060	51.750	.936	trace.	.323

Table No. 4.—Analyses of Pig Iron.

Iron.	Furnace.	Silicum.	Sulphur.	Phosphorus.	Manganese.
Foundry,	Pine creek,	3.195	.043	1.035	2.306
"	Mahoning,	1.872	.072	.855	1.585
"	Stewardson,	3.407	.038	.912	2.139
"	"	2.873	.038	.852	2.068

Table No. 5.—Analyses of Fire Clays.

Name of Stratum.	Owner.	Locality.	Silica.	Alumina.	Protoxide iron.	Titanic Acid.	Lime.	Magnesia.	Carbonic acid.	Alkali.	Water.
Freeport Upper F. C.,	Kier Bros.,	Salina,	51.920	31.640	1.134	1.160	.030	.443	none.	.402	13.490
" " "	"	"	47.250	34.350	.693	1.990	.580	.090	.455	.261	13.695
" " "	"	"	40.720	37.280	2.448	2.280	.520	.002	.408	.570	15.002
" " "	"	"	60.520	24.970	1.650	1.220	.900	trace	.725	.218	9.395
" " "	"	"	55.330	27.841	2.916	1.140	.580	.756	.455	3.916	7.495
Ferriferous Coal, F. C.,	Stewart,	Kittanning,	55.960	28.415	1.641	1.010	.070	.396	. .	.615	12.690
" "	Brown & Neale,	Allegheny Furnace,	50.370	32.890	1.641	1.030	.310	.353	. . .	.290	13.760
Clarion fire clay,	Ross Reynolds,	Kittanning,	58.750	25.170	2.195*	1.050	.710	.936	. . .	3.585	8.110
Mercer group fire clay,	McCauley,	Anthony's Bend,	44.610	38.010	1.251	1.020	.080	.407	. .	1.735	13.630

* Protoxide of manganese, trace.

REPORT OF THE PROGRESS

OF THE

SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA,

IN

ARMSTRONG COUNTY,

By W. G. Platt.

PART I.

DETAILED GEOLOGY.

Chapter I.

The Valley of the Kiskiminitas River.

§ 1. *The Kiskiminitas* is the southern boundary line of that part of Armstrong county lying east of the Allegheny river.

This name (said to mean *Make-Daylight* in the language of the aboriginal tribes who inhabited its banks) is confined to the reach of the river below the confluence of its two main branches, the Conemaugh and the Loyalhanna, a few miles east of the Armstrong county line.*

§ 2. *The water level of the Kiskiminitas* from this point down to its mouth, a distance of about twenty-five miles,

*See Reports H^2 on Cambria, H^4 on Indiana, and KK on Westmoreland counties.

falls (in round numbers) one hundred feet, or at the rate of *four feet per mile*. Its bed has a shallow covering of gravel and rounded pebbles—chiefly sandstones, limestones, and fragments of coal and slate—all local rocks. No northern drift is found either in the river bed, or on the slopes, or on the high plateau dividing the waters of the Kiskiminitas and Crooked creek.

The river is not navigable, excepting in the sense of floating rafts and small barges, and then only during the floods. The average volume of water is small considering the extent of country drained; but it affords a superb water-power, ample, abundant, and obtainable at small cost.

§ 3. The valley presents a succession of steep slopes, broken by frequent lateral ravines. The slopes are from 300 to 400 feet in height, and support a smooth rolling upland which rises about one hundred feet still higher above the water line. On this plateau is some excellent farming country, situated at an elevation of from 1100 to 1300 feet above the ocean level.

The topography is governed by the geology. Where the river is crossed by the anticlinals the valley narrows into a gorge; where crossed by the synclinals it widens and expands, the hills on both sides retiring with more easy slopes towards the uplands. Moreover to the same cause the frequent long bends in the river are attributable, these being in close connection either with the anticlinals or synclinals.

§ 4. *The geology* consists of a succession of anticlinal and synclinal flexures. In descending the river the *Lisbon-West-Lebanon synclinal* is crossed near the boundary line between Indiana and Armstrong county; the *Roaring run anticlinal*, at the mouth of Roaring run; the *Apollo synclinal*, at Apollo; the *Apollo anticlinal*, at the mouth of a small nameless run in the neck of the bend about one mile below the town; the *Leechburg synclinal*, at Leechburg; the *Bagdad anticlinal*, at Bagdad station; the *Freeport synclinal*, at the mouth of the river.

The anticlinals being of unequal strength, the included basins are of unequal depth. The Roaring run anticlinal

is the most important; the Apollo anticlinal the most feeble.

The axial lines cross the valley at right angles, thus causing the rocks to dip either up or down the stream, southeast or northwest. The dips vary in strength from 5° on the flanks of the Roaring run anticlinal to ½° and even less in the synclinals.

No serious breaks or faults anywhere occur in the strata; the gentle folds above mentioned alone comprise the structural features.

§ 5. The hills of the valley, considering only those which border the river, are built up of Lower Barren rocks, and the Lower Productive Coal Measures. The Pottsville Conglomerate, underlying all, is partly exposed at the mouth of Roaring run; but it quickly disappears under the river on both flanks of the anticlinal arch, and is not again exposed in the valley. On the uplands back from the river the Upper Productive Coal Measures are represented along a narrow strip of country bordering the Indiana county line. These measures, overlying the Lower Barren group, comprise the top rocks of the Kiskiminitas section. Their outspread in Armstrong county is confined to this one locality, which, from their presence here, containing as they do the valuable Pittsburg coal bed, derives considerable local importance. Their discussion in detail is reserved for a subsequent chapter.

§ 6. *The Lower Barrens* are the surface rocks of the uplands west of Long run; and they likewise cover all the high ground of Allegheny and Kiskiminitas townships. The entire group, about 550 feet thick, is present only in the region of the Upper Productive Coal Measures, at the southeast corner of the county. There they make the hills from the river's edge to the summits.

The numerous exposures, natural and artificial, show well the variable nature of the Lower Barren rocks and the frequent changes and modifications which these strata undergo. Scarcely any two sections of the same geological horizon, made a few miles apart, will exactly agree; and often, indeed, the change is of so radical a nature that not a single

feature of the one section will appear in the other. It is this element of extreme variability that vitiates so often the identifications of the Lower Barren horizons.

The exposures along the Armstrong side of the river, though frequent, are too fragmentary and disconnected to enable an examination of the group to be made in connected sequence. For this purpose the bluffs between Saltzburg and Coalport, in Indiana county, offer much better facilities. The group is there naturally subdivided into two unequal portions, of which the lower consists almost entirely of sandstone, and the upper chiefly of variegated shales, with some few intervening layers of sandstone. No coal seams of any practical importance are found, nor is limestone represented in abundance.

§ 7. *The Lower Barrens* as exposed in the region of Saltzburg have already been described in the Report of Progress for Indiana county. What has there been said of them in detail need not here be repeated; but the general section may be reproduced in order to make clear what is to follow concerning the exposures of the different rock horizons along the lower waters of the Kiskiminitas.

Fig. 1 embraces all the rocks between the Pittsburg coal bed at the base of the Upper Productive group, and the Freeport Upper coal bed, at the top of the Lower Productive group. It is compiled from numerous small vertical sections, some of which appear in the Geology of Pennsylvania.

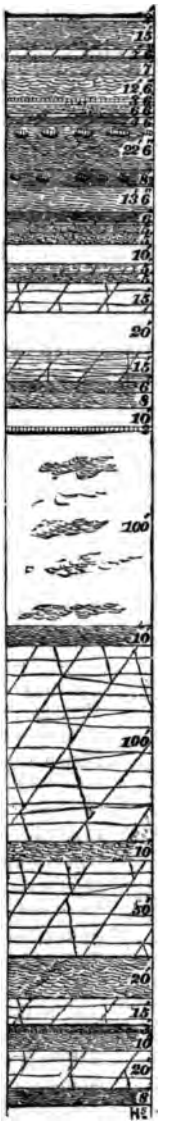
§ 8. *The great thickness of the Mahoning Sandstone* is an unusual feature belonging to the Saltzburg region. All the sandstone cliffs overhanging the river between Saltzburg and Coalport are made by one or the other of its subdivisions, which, moreover, are prominent still further west in the vicinity of Salina. But where the deposit begins its ascent to the uplands, on the flank of the Roaring run anticlinal, it gradually loses both its great thickness and its massiveness of bedding, becoming thin bedded and shaly. This change is at once evident from the appearance and condition of the highlands which it overspreads, and which, but for this previous change in the sandstone, must have been a sandy waste covered with enormous bowlders of rock

such as frequently mark the path of the Pottsville Conglomerate.

Fig. 1. The Lower Barren Measures.

Clay underlying PITTSBURG COAL,		2′ 0″
Slate, sandy		15 0″
Sandstone, micaceous, greenish grey,		4′ 0″
Limestone, impure,		1′ 3″
Shales, *calcareous*,		2′ 3″
Shales,		7′ 0″
Shale, greenish,		12′ 6″
Limestone, blue, non-fossilferous,		1′ 6″
Clay, impure,		2′ 0″
Slate, greenish, sandy,		4′ 6″
Clay, impure, with nodules,		2′ 0″
Slate, greenish,		3′ 6″
Sandstone,		1′ 0″
Shales, olive, with *limestone nodules* at top,		22′ 6″
Slate, greenish,		8′ 0″
Slate, grey,		13′ 6″
Shale, grey and purple,		5′ 0″
Sandstone,		1′ 0″
Shale, greenish,		5′ 0″
Shales, variegated, sandy,		5′ 0″
Concealed (sandstone?)		10′ 0″
Shales and S. S., light colored,		5′ 0″
Shales, reddish, ferruginous,		5′ 0″
Sandstone, forming cliff,		15′ 0″
Concealed; sandy shales?	Morgantown S. S.	20′ 0″
Sandstone, shaly,		15′ 0″
Shales, olive,		6′ 0″
Red shales,		8′ 0″
Concealed,		10′ 0″
Green Fossiliferous Limestone,		2′ 0″
Coal,		?
Concealed interval, consisting chiefly of Shales,		100′ 0″±
Red shales,		10′ 0″
Sandstone,		100′ 0″
Shales, sandy,	Mahoning Upper S. S.,	10′ 0″
Sandstone,		50′ 0″
Coal smut,		—
Shales, variegated,		20′ 0″
Sandstone, massive, Mahoning Middle S. S.,		15 0″
Coal smut,		—
Shales,		2′ 0″
Limestone, ferruginous and ore nodules,		1′ 0″
Shales,		10′ 0″
Sandstone, massive, Mahoning Lower S. S.,		20′ 0″
Slates, overlying Freeport Upper coal,		8′ 0″
Total thickness,		560′ 6″

Fig. 1. § 7.



§ 9. *The Lower Productive Coal* Measures occupy the lower levels of the valley from Salina down. At only one place in the valley is the entire series lifted to daylight—at the mouth of the Roaring run. There the group embraces some 300 feet of rocks; elsewhere only about one half this amount is above the water level.

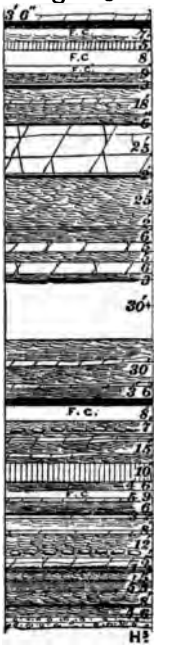
The frequent rock exposures enable exact measurements to be repeatedly made of each individual stratum of the series. The exposures, like those of the Lower Barrens are widely separated and fragmentary; but the much better recognized horizons of the Lower Productive series permit the different local exposures to be accurately joined together without difficulty, in their regular order of superposition. In such a manner the following section has been constructed. It is intended to represent the average condition of the group in the Kiskiminitas valley. Local changes often affect it in a mining sense, quite seriously; at what places such changes occur and wherein they consist will appear in the sequel. The section embraces the rocks between the Mahoning Sandstone and the Pottsville Conglomerate.

Fig. 2. §10. *Section of Lower Productive Coal Measures.*

Mahoning Sandstone,	——
Coal bed. *Freeport Upper*,	3′ 6″
Fireclay and shales,	7′ 0″
Limestone. Freeport Upper,	5′ 0″
Fireclay, impure, calcareous,	8′ 0″
Fireclay, good, worked at Salina,	4′ 0′
Shales with layers of thin sandstone,	5′ 0″
Slates, black,	1′ 0″
Coal bed. *Freeport Lower*,	2′ 0″
Clay shales and sandstone layers,	18′ 0″
Coal bed, irregular,	0′ 6″
Sandstone, massive, Freeport S. S.,	25′ 0′
Slates, dark,	1′ 0″
Coal bed. *Kittanning Upper*,	1′ 0″
Shales, grey,	25′ 0″
Slate, black,	2′ 0″
Slates, greyish,	6′ 0″
Sandstone,	5′ 0″
Shales,	5′ 0″
Sandstone,	6′ 0″
Slates, black,	3′ 0″
Coal?? *Kittanning Middle*,	——

Interval, concealed rocks,	30′	0″±
Slates and shales with layers of S. S.,	30′	0″
Coal bed. *Kittanning Lower*,	3′	6″
Fireclay, poor quality,	8′	0″
Shales, ferruginous with iron ore nodules,	7′	0″
Sandstone and shales,	15′	0″
Ferriferous Limestone,	10′	0″
Slates, black,	4′	6″
Fireclay,	4′	0″
Sandstone,	1′	9″
Slates, black,	6′	0″
Coal bed. *Clarion*,	1′	2″
Fireclay,	2′	0″
Slates and impure clay,	6′	0″
Sandstone,	2′	0″
Slates, variegated, with iron ore balls,	12′	0″
Sandstone, shaly, gray,	5′	0″
Iron ore,	0′	5″
Shales, sandy,	0′	7″
Iron ore,	0′	3″
Shales,	5′	0″
Iron ore,	0′	2″
Shales,	1′	0″
Sandstone, argillaceous,	0′	10″
Iron ore nodules,	0′	5″
Slates, black,	3′	0″
Shales,	7′	0″
Coal bed. *Brookville*,	1′	0′
Shales, bluish,	4′	0″
Slates, black,	1′	6″
Pottsville Conglomerate,		
Total thickness,	306′	1″

Fig. 2 § 10.



§ 11. This section will be found to apply not to the Kiskiminitas valley only, but in a general way to other parts of the county. And the same is true also if the comparison be extended to the upper waters of the Conemaugh, across Indiana county, and even beyond this through the Laurel Hill gap, into Cambria county. One new feature, however, unknown to the upper Conemaugh region, is introduced along the Kiskiminitas — the Ferriferous limestone. At what locality the rock first becomes a component part of the series cannot be located exactly on the Conemaugh, because the geological structure of that region places the horizon of the rock under the water level between the Roaring run arch and Packsaddle gap, east of Blairsville. In a

previous Report* I have expressed the belief that the limestone extends eastward to the Indiana anticlinal, there to fade out and disappear. It therefore underlies not only the Saltzburg region, but extends also to within a few miles of Blairsville, becoming gradually thinner and thinner as it approaches the point of its disappearance.

Along the Kiskiminitas it is above water level only in the region of Roaring run; west of this it is below the river bed.

§ 12. The only *coal beds of the Kiskiminitas section* of value in a mining sense, are the Freeport Upper and the Kittanning Lower. These are rarely more than four feet thick, and never of especially good quality, but they are at least uniform and persistent. The other seams are usually small and unreliable; they sometimes, however, expand into workable dimensions, but even when they do, they are of little practical value.

The area of the Kittanning Lower bed *workable from the outcrop*, is comparatively small, being confined to the arch of the Roaring run axis. The outcrop line of the Ferriferous limestone, as shown on the geological map, very nearly describes the outcrop limits of the coal bed.

The lower part of the valley, from Apollo down, is dependent on the Freeport Upper bed for its coal supply. This seam has a continuous range on both sides of the valley, from Salina to the mouth of the river; and its position is usually one favorable to its development, being within easy reach of the railroad along the left bank of the river. The amount of coal available from this one outcrop line is prodigious, leaving out of consideration the Westmoreland side, which contains an area no less great. Back from the river in Armstrong county the seam underlies continuously all the high plateau of Allegheny and Kiskiminitas townships; cropping out again towards the north in the deep valley of Crooked creek and towards the west in the valley of the Allegheny river. Here then are miles and miles of coal, lying in a nearly horizontal position, and lifted high above the main drainage lines of the region.

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*HHHH.

§ 13. *Iron ore* occurs only in small quantities. The Buhrstone stratum, *overlying* the Ferriferous limestone, was not seen, but is reported to exist at some localities. A small band of good ore *underlies* the limestone, but like the orebeds occurring still lower in the Clarion group, it is too thin to be profitably wrought. Many years ago a small furnace was established near the mouth of Roaring run, where these ores come to daylight; it was subsequently abandoned, and is now in ruins. This unsuccessful attempt to develop the ores is apparently the only one ever made along the lower waters of the Kiskiminitas.

Rolling-mills working metal brought from other localities have, for a considerable period, been conducted here with reasonable success. In fact at the present time the production of sheet iron and terne plate is the chief industry of the valley. The discovery of natural gas at Leechburg in sufficient quantities to enable it to be used for fuel in the heating furnaces of the Leechburg rolling-mill has very materially assisted and stimulated the business.

§ 14. *The fireclay deposits* have received little investigation. Much of the clay distributed through the strata is of poor quality and unfit for brick-making; but the deposit, which occurs in connection with the Freeport Upper coal, yields an admirable clay, which, when properly prepared, produces a brick of good refractory power. Small works have been established upon it at Salina and at Apollo, but at neither place is the business conducted very vigorously. In geological position the clay is identical with that worked at Bolivar, in Indiana county, and also with that once worked near Templeton, on the Allegheny river, in Armstrong county.

§ 15. The valley is most bountifully supplied with limestone by the Freeport Upper and the Ferriferous deposits. The latter especially is in excellent condition either for use as quarry lime or for plastering purposes.

The Johnstown Cement bed was nowhere observed along the Kiskiminitas; neither was the Freeport Lower limestone.

§ 16. *The Mahoning Sandstone* furnishes building material

without limit. It is suitable only for rough work, and for heavy masonry. Some parts of the deposit split easily, and would make good paving stone; none of it is pure enough for the glass-maker.

§ 17. *The manufacture of salt* along the Kiskiminitas was formerly more extensively carried on than now. Only one well is at present in working order, the others having from time to time been abandoned as the business became unremunerative. The salt water comes from the sandstones of the Pocono formation, the top of which underlies the river bed about 250 feet at the centre of the Roaring run anticlinal. From the same geological horizon the water is pumped that is used in the manufacture of salt near Saltzburg, in Indiana county.

For further particulars concerning the salt well at Northwest station, the reader is referred to the detailed description of that region.

§ 18. The valley of the Kiskiminitas is already supplied with all the *railroad facilities* it requires for the development of its natural resources. The West Pennsylvania RR., a branch of the Pennsylvania RR., skirts the left bank of the river, and furnishes an outlet towards the east and west and north. Recently some consideration was given to the question of reopening the old water communication of the region, connecting it with the east by means of an extensive tunnel under the Allegheny mountain. Competent engineers were commissioned by the United States Government to make a report upon the subject. They showed that the project could easily be accomplished at an outlay of sufficient capital. But the question, from the outset, was in reality not so much one of feasibility as desirability; and in this particular the small profits earned by the railroad company, without other competition, constituted a sufficient argument against it.

§ 19. In the following detailed description of the rock exposures and mining developments of the valley the order is from southeast to northwest, down the river. Beginning at the county line, the slopes are made of *Lower Barren rocks* with a coping of *Upper Productive Coal*

Measures on the uplands back from the river. The rocks are in nearly horizontal position; but being west of the Lisbon West-Lebanon synclinal (which crosses the valley just east of the Armstrong county line) they have a gentle dip towards the southeast.

This southeast dip continuing down the river, conformably to the Roaring run anticlinal, lower rocks come to daylight in that direction, the strata succeeding each other regularly in descending order. But the incline being gentle, the succession is very gradual. At the mouth of Long run, more than a mile below the county line, Lower Barren rocks still occupy the hills to the exclusion of all others, as they do also in the bend below the run. The Lower Productive Coal Measures first appear at the fording above Salina.

No good exposures of the Lower Barren strata are found in the region of Long run. *The Mahoning sandstone* cliffs out here and there, but the rock is by no means the prominent feature in this region that it is at Saltzburg. The hills have easy slopes on both sides of the valley, and are covered mainly with soft argillaceous shales. A stratum of *red shale* occurs in the measures from 225 to 250 feet above the Freeport Upper coal; it corresponds with a similar stratum found on the heights above Saltsburg.

§ 20. *At Salina* the Freeport group is lifted above the water line. The hills also contain some 300 feet of the Lower Barren series of which the greater part is concealed. Exposures near the railroad station show the *Mahoning sandstone* together with the underlying Freeport group. The succession is as follows:

Sandstone, massive,	15′ 0″
Slates, brown and gray,	15′ 0″
Sandstone,	4′ 0″
Slates, dark, holding balls of iron ore,	14′ 0″
Black slate,	1′ 0″
Coal bed. *Gallitzin?*	0′ 6″
Fireclay,	2′ 6″— 3′ 0″
Slates, gray with iron ore balls,	1′ 0″
Sandstone, thin bedded, *Mahoning S.S.*,	25′ 0″
Coal bed. *Freeport Upper*,	3′ 6″— 4′ 0″
Concealed, fireclay shales?	7′ 0″
Limestone, Freeport Upper,	5′ 0″—10′ 0″

Fireclay shales,	2′ 6″— 8′ 0″
Fireclay, good,	1′ 0″—11′ 0″
Clay shales,	?
Water level at Salina,	
Total thickness,	118′ 6″

§ 21. The attenuated condition of the *Mahoning sandstone* is evident here at a glance. The small coal bed locked up among the sandstone layers is perhaps the equivalent of the *Gallitzin seam*, which round about Salina is persistent but invariably small. Further west at Apollo, and at Townsend's it is of workable dimensions, and has frequently been mistaken at both places for the Freeport Upper coal.

§ 22. *The Freeport Upper coal* reappears above the water line, after its long journey under the Saltzburg basin, in much the same condition that it presents at Kelly's station in Indiana county on the opposite side of the basin. It has been worked along both banks of the river at Salina, but at present it is mined only on the Westmoreland side, supplying the brick works with fuel.

The mine operated by the Messrs. Kier Bro.'s is close to the railroad station. It has extensive gangways which are driven northwest along the rise of the coal. The bed is sometimes roofed by sandstone, but usually a stratum of tough slate intervenes between the rock and coal. Everywhere the coal is dry and hard.

Measurements made in different parts of the mine vary from 3 to 6 feet, with about 4 feet as the average. Small but persistent slate partings traverse the seam, materially affecting its value. The floor is even and regular; but the roof is so uneasy as often to occasion serious trouble in mining. Already a "clay vein" 75 feet wide, has been encountered in one of the rooms, cutting out the coal entirely. On the other hand the roof in places runs up suddenly and allows two feet of additional coal to appear on top of the main bench; but this top coal is so much broken by partings and is itself so slaty that it adds little value to the seam when present. The average section, taking the run of the bed is as follows:

Black slate,		—
Coal,	2′ 9″	
Slate,	0′ 0½″	
Coal,	0 5″	4′ 1½″
Slate,	0′ 1″	
Coal,	0′ 10″	
Fireclay,		—

Fig. 3. § 22.

The coal in its raw state is impure, having both iron pyrites and slate in considerable quantity. This is plainly evident from an examination of the hand specimens; and is still more evident from the amount of clinker and ash removed from under the boilers of the brick works where the coal is used for steam purposes and for drying the bricks. An average sample of the coal from the main bench gave the following constituents on analysis by Mr. McCreath:

Water at 225°,	1.060
Volatile matter,	33.955
Fixed carbon,	54.392
Sulphur,	1.058
Ash,	9.535
	100.000
Coke per cent.,	64.985
Color of ash,	grey.
Fuel ratio,	1:1.60

§ 23. *The Freeport Upper limestone*, here only seven feet below its coal, is finely exposed in the river bank a few hundred yards west of the clay mine. It is in one compact layer, ten feet thick, and composed of smooth dove-colored stone of good quality. It is not worked.

§ 24. *The Freeport fireclay* is of importance and value at Salina. How far it extends in the same condition up and down the river from that point has never been definitely determined. But it would appear that the clay fades out gradually in a westerly direction down the river. Southward as far as it has been followed under the hill at Salina it is persistent.

The clay deposit is separated from the overlying limestone by an irregular stratum of loose incoherent shale, to support which properly in mining the clay requires careful timbering. The main layer of clay, like the shales above it, is essentially irregular in point of thickness, varying, in-

deed, in this respect, from a few inches to eleven feet. But even in spite of such irregularities of thickness, it can be cheaply mined. Its average yield is about five feet of hard clay, in two layers, undivided by any parting, but readily distinguishable by their difference of texture and coarseness.

The average quality of the clay is excellent. Sometimes, however, it is affected by small lenticular masses of iron ore, to avoid which in the bricks, careful selection of the material used in the works is required. Five analyses were made of the clay at the laboratory in Harrisburg. One specimen, selected by myself, was analyzed by Mr. McCreath; it is marked No. 1 in the table below. The others were forwarded to the laboratory by the owners of the works; their analysis was made by Mr. S. S. Hartranft.

	No. I.	No. II.	No. III.	No. IV.	No. V.
Silica,	51.920	47.250	40.720	60.520	55.330
Alumina,	31.640	34.350	37.280	24.970	27.841
Protoxide of iron,	1.134	.693	2.448	1.650	2.916
Titanic acid,	1.160	1.990	2.280	1.220	1.140
Lime,	.030	.580	.520	.910	.580
Magnesia,	.443	.090	.002	trace.	.756
Carbonic acid,	none.	.455	.408	.725	.455
Alkalies,	.402	.261	.570	.218	3.916
Water,	13.490	13.695	15.002	9.395	7.495
	100.219	99.364	99.230	99.608	100.429

The clay is hard and brittle, and has an irregular fracture. Its color is dark pearl-gray.

§ 25. Before being used in the works it is dried either by roasting, or when the weather is favorable, by long exposure to the atmosphere. It is alone employed in the manufacture of bricks, &c., without admixture with other clay. Formerly a small amount of plastic clay (No. V of the above table) was used, in the belief that the hard clay of itself had not sufficient cohesiveness. But recent tests have shown that this idea was not justified, and the mixture with the plastic variety has since been abandoned to the infinite advantage of the ultimate product. The bricks and retorts made at the works are both well known in the market

where they have deservedly acquired a fair name. The works have a capacity of 5,000 bricks per day.

The Salina brick was not included in the series of fire-brick tests made in 1876, at Harrisburg, by Mr. Franklin Platt, for the Geological Survey.* But tests of a similar kind were instituted about the same time by the Messrs. Kier, in an experimental shaft-furnace at Salina. Besides the bricks of Salina manufacture, specimens of Scotch, Mt. Savage, Benezette, Clearfield, and other first-class brands were included in the test for purpose of comparison. The bricks were subjected to a temperature above that of molten steel for a period of thirty hours. All bore the test well; the Salina brick comparing favorably with the others, and showing first-class standing-up power.

Shales underlie the clay at Salina, extending to the water level. They are probably the roof rocks of the *Freeport Lower coal*, of which latter seam, however, nothing is seen here.

§ 26. Below Salina exposures are infrequent. The *Freeport sandstone* rises to daylight, and being in massive condition, the slopes are in places thickly covered with enormous bowlders of rock.

The vertical section at Northwest, about a mile below the brick works, begins at the top with a thin covering of Lower Barren Measures, and extends thence downwards nearly to the base of the Lower Productive group. *The Freeport Upper coal* is 260 feet above the channel of the river. It has been opened on both sides of the stream, but is not now mined in this vicinity. Operations were once begun here on an extensive scale by the Northwest Mining Co., whose colliery was situated on the left bank of the Kiskiminitas, directly above the railroad station. The mine was connected with the railroad by an incline plane, which has since been removed.

The bed, in nearly every respect, presents similar features to those at Salina. The coal is hard and firm, but impure by reason of its numerous small binders of slate and iron pyrites.

* See Report MM, p. 270, *et seq.*

§ 27. *The Freeport Upper limestone* is well exposed at a quarry only a few hundred yards removed from the Northwest Company's mine. The deposit is about five feet thick. It yields a stone of good quality, smooth, of very fine grain, and apparently non-fossiliferous. Formerly it was calcined in a small kiln near the railroad station, producing a good lime for agricultural purposes, but somewhat too impure for the plasterer's use.

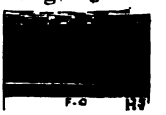
Crossing now to the opposite side of the valley, the same coal and limestone are found near the hilltop, above Mr. Gamble's salt works. Fifty-five feet below the Freeport Upper coal, is the Freeport Lower seam, of which latter, however, at this place, only the outcrop is seen; the bed is apparently about two feet thick.

Below it is the *Freeport sandstone*, which forms a bold cliff on the hillside nearly forty feet high. Underneath this rock the *Kittanning Upper coal* and the *Johnstown Cement bed* should occur; neither stratum however, was anywhere seen in the vicinity of Northwest.

§ 28. *The Kittanning Middle coal* is here also concealed. But the *Kittanning Lower seam* is mined for use in Mr. Gamble's salt works. It is about 3½ feet thick on the average, yielding a strong coal, firm and hard, which at the salt works is preferred for use under the boilers and drying pans to the coal from the Freeport Upper seam. Like the latter seam, however, it is both pyritous and slaty, and in its raw state is unfit for coking. The following section, from the Gamble mine, shows the average thickness of the bed, and the relative position of the small slate parting which persistently traverses the seam.

Slate,	—	
Coal,	2′ 10″—3′ 0″	3′ 8″
Slate,	0′ 1″—0′ 2″	
Coal,	0′ 6″	
Fireclay,	—	

Fig. 4. § 28.



The slates and brownish shales which overlie the coal for forty feet at the Gamble mine, pass gradually into thin-bedded sandstone towards the west. This replacement of shale and slate by sandstone is one of common occurrence

in the bituminous coal measures, but particularly so along the Kiskiminitas in this stratum above the Kittanning Lower coal.

Below the coal at Gamble's is a mass of fireclay of poor quality; below this are some shales with ore balls; then a thin stratum of sandstone, and then the *Ferriferous limestone*, the top of which is here exactly thirty feet below the base of the *Kittanning Lower coal*, and 225 feet below the base of the *Freeport Upper seam.*

§ 29. *The Ferriferous limestone* is of a dark greyish-blue color, compact, very hard and brittle, fine-grained, presenting a rough surface at the fresh fracture, and abounding in encrinite stems. Its weathered face, dark and rough, is easily distinguishable at a glance from the Freeport Upper limestone, which has a smooth surface and is of a light blue color.

The Ferriferous limestone is ten feet thick at Northwest. It is well exposed below the salt works, in a low cliff near the base of the slopes. In descending the river it remains above the water line for a distance of nearly three miles, presenting thus a considerable outcrop area. Elsewhere in the valley it is concealed; but northward in Armstrong county it is so continuously at the surface, as fairly to constitute there a geological landmark.

The limestone is not worked at Northwest, nor at any other point along its outcrop line in the Kiskiminitas valley. The *Buhrstone iron ore* which usually rests on top of the limestone, was not observed at any of the exposures; the stratum however is reported to have been once worked further down the river for the supply of the now abandoned Rough furnace of which more will be said presently.

§ 30. *A workable band of iron ore* outcrops underneath the limestone at Northwest. The stratum seems to attain its greatest development further west in the vicinity of Roaring run, where it was once worked. Some 15 feet still lower in the measures the *Clarion coal bed* occurs. It is only about one foot thick.

§ 31. *The salt well* of Messrs. Gamble & Son is situated on a plain about 20 feet above the river, and directly oppo-

site Northwest station. The bottom of the well, 630 feet below the surface, is in the sandstones of the *Pocono formation.* No record of the strata passed through in drilling the well was kept at the time the drilling was done; but in a general way the succession is described by those familiar with the work, as consisting mainly of sandstone after a depth of about two hundred feet had been passed, which corresponds precisely with what was established in drilling the wells at Kelly's station above Saltzburg; corresponding equally well also with the section made in the Packsaddle gap above Blairsville, where these rocks outcrop on the arch of the Chestnut Ridge anticlinal. As far west therefore as Northwest station the geological connection with the Allegheny mountain is unbroken, making the identification of the rock formations along the Kiskiminitas a matter of certainty.

The process employed in the manufacture of salt at Northwest, as well as the appliances for pumping the water, are precisely the same as at Kelly's station, of which a description was given in Report HHHH. The salt water though constant in its supply is weak, rendering the process of evaporation both tedious and expensive; and the final yield of salt being small, there is little margin of profit in its manufacture.

§ 32. Below Northwest the river makes a sharp bend to the south preparatory to crossing *the Roaring run anticlinal axis*,—the same axis that extends northeast through Kiskiminitas township and sustains the Freeport Upper coal above the waters of Roaring run nearly to Shady Plain. The axial line crosses the river at the mouth of the run.

The arch is not entirely symmetrical, as the dips on the southeast flank are somewhat steeper than those on the opposite side. The southeast dips are in places as much as 5°; those towards the northwest are never more than 3° and rarely more than 2°.

The strength of the uplift is shown by the changes of altitude which the strata experience in crossing the arch. To take the case of the Freeport Upper coal, this bed underneath the Saltzburg basin, is at a level of 450 feet above mean tide Atlantic ocean; at Salina, where the bed rises to

water level it is 835 feet above the same datum; 1036 feet at Northwest; 1152 feet at Roaring run, and 803 feet on the opposite side of the arch at Apollo. In other words the rocks are elevated 702 feet from the centre of the Saltzburg basin to the summit of the Roaring run anticlinal, while on the western side they are lifted 349 feet from their level at Apollo. These measurements not only indicate the strength of the uplift, but they also readily explain the absence of the Pittsburg coal bed from the region west of Saltzburg.

§ 33. *At the mouth of Roaring run* the hills contain in addition to the rocks already described as occurring at Northwest, the remainder of the Lower Productive group and the top of the Pottsville Conglomerate. Exposures are few in number and of an imperfect character. The Pottsville Conglomerate is represented by numerous bowlders of heavy sandstone at the base of the slopes. The rock is massive and coarse-grained. About one half of the formation is above the water level at the centre of the axis.

The Brookville coal seam, resting almost directly on top of the Conglomerate, is here small and unimportant. It makes a feeble outcrop on the right bank of the river below the mouth of the run. The underclay which separates it from the Conglomerate is of poor quality

§ 34. From the Brookville bed to the Clarion the rocks are mainly concealed; but from the Clarion bed to the Ferriferous limestone the succession is well exhibited in a railroad cut at Roaring run station. The measures here being exactly similar to those already given for this horizon in the general section (Fig. 2) need not be repeated.

But the railroad cut is interesting in exhibiting a subordinate flexure, such as are of frequent occurrence in these rocks, and which often cause considerable annoyance when met with in mining operations. The flexure is a regularly defined anticlinal arch whose length corresponds exactly with the length of the cut—300 feet. It raises the rocks seven feet out of level. The arch is prettily shown from end to end by a thin stratum of sandstone which stands out prominently in the soft shales of the cut.

The Ferriferous limestone makes the top of the cut, but is here seen only in part. Better exposures of the rock are found on the opposite side of the river. The stratum of carbonate iron ore, before mentioned as underlying the limestone is invariably present; it is directly underneath the limestone, no shale or parting of any kind intervening between the two. The ore stratum is 5 inches thick where once worked for Rough furnace.

§ 35. *The Kittanning Lower coal*, 3½ feet thick, has been opened at the mouth of Roaring run, but the drifts there are now closed. Lower down the stream, on the McLaughlin property, it is mined at the level of the old tow-path, being parted unevenly by a small band of slate which ranges near the top of the seam. The bed has a firm slate roof, and an even floor of coarse impure fireclay. The coal is pyritous, as at Gamble's, and compact and firm; shows numerous bands of bright crystalline coal, and also many knife-edges of slate.

No good exposures are here met with of the higher rocks of the section. The hilltop is crowned by the *Mahoning sandstone*, in massive condition, and in some places quite coarse-grained. It has covered the upper part of the slope with heavy bowlders of rock similar to those which mark the path of the Pottsville Conglomerate at the base of the hills.

§ 36. Descending the river from Roaring run the Lower Productive rocks are slowly carried under the river bed by the continued northwest dip. Of the Lower Productive group at Apollo, barely more than the Freeport Upper coal and limestone are above the water level. The hills consist mainly of Lower Barren measures, of which group nearly one half is contained in the sides of the valleys and on the uplands. Little change from this geology is introduced by the feeble anticlinal axis which crosses the valley between Apollo and the mouth of the river; the same Freeport group occupies the lower levels of the hills, and the same Lower Barren rocks overspread the uplands.

Among the Lower Barren measures at Apollo, the *Black Fossiliferous limestone*, eight inches thick, outcrops 134

feet above the Freeport Upper coal. It is filled with encrinites and univalve shells. Forty feet above it is a greenish, fossiliferous, argillaceous limestone, 19 inches thick. This latter stratum, resembling somewhat the *Green Crinoidal limestone*, has been mistaken for the latter, with which, however, it has no connection.

§ 37. *The mining developments at Apollo* exhibit two seams of coal, 55 feet apart usually, and separated mainly by sandstone. They are the *Gallitzin* and the *Freeport Upper seams*, respectively, with the *Mahoning sandstone* between them. In the Geology of Pennsylvania, (vol. II, p. 597,) the beds are wrongly identified as the Freeport Upper and Lower seams. The error of this identification easily arose from mistaking the concretionary limestone underneath the Gallitzin seam for the Freeport limestone, the latter stratum being, by a local irregularity, absent from the measures at Apollo.

§ 38. The greatest thickness of *the Gallitzin seam* along the Kiskiminitas valley is reached at Apollo. But even there it is too irregular and uncertain to justify any mining developments upon it.

On the Hildebrand property, in a small ravine, about one mile northeast of Apollo, the Gallitzin bed is from 2½ to 3 feet thick. It yields a compact coal, pyritous and slaty. A few hundred yards higher up the same ravine, the bed has again been opened on the D. Risher farm, where similar conditions to the above were found to exist.

At Hildebrand's the coal is roofed by compact slate 20 feet thick; below it, at an interval of about 10 feet, is a stratum of impure ferruginous limestone, worthless even for quarry lime, as the attempts to use it for that purpose have abundantly proved. Like the coal above it, the limestone is essentially irregular in point of thickness. These conditions are further repeated at the mouth of the run, just west of Apollo, where the coal bed was once mined by Mr. Williams, and where also it is exactly 55 feet above the Freeport Upper coal, the latter seam being at the level of the tow-path.

§ 39. Tracing the Gallitzin bed thence down the river, its

bench remains distinct along the right bank, but the coal gradually loses its thickness. It is the Gallitzin seam that runs through Capt. Kipp's orchard, as it is also the Gallitzin bed that was once opened on the hillside above the old canal lock, nearly a mile below Apollo. At the latter place it shows only 18 inches of coal, being yet thinner across the river, in the railroad cut at Townsend's, where the rocks above and below the coal are finely exposed, as follows:

Black slate,		6′ 0″
Coal,		0′ 1″
Clay and clay slate,		6′ 0″
Sandstone, (calcareous,)		1′ 6″
Black slate,		1′ 0″
Coal, Gallitzin,		1′ 0″
Fireclay, dark, coarse, with layer of coal,	0′ 2″—	4′ 0″
Slate, red and greenish,		6′ 0′
***Limestone,* impure, coarse, granular,**		3′ 0″
Sandstone,		4 0″
Slates, dark, with ore-balls,		10′ 0″
Slates and thin sandstone,		5′ 0″
Black slate, with trace of coal,		2′ 0″
Mahoning Sandstone,		22 0″
Freeport Upper coal,		—
Total,		71′ 7″

The Gallitzin bed further appears in the long side-cut, west of Townsend's station, but has there faded away almost entirely, being in places scarcely more than one inch thick, and never more than three inches thick. Finally as the railroad sinks to lower levels, the seam passes altogether out of the exposures, not having anywhere been observed in the vicinity of Leechburg.

§ 40. *The lower member of the Mahoning sandstone*, in the neighborhood of Apollo, frequently fills nearly all the interval between the Gallitzin and the Freeport Upper coal seams. This is the case in the railroad cuttings opposite and below the rolling mill. Loose, however, and shaly in structure, it makes little show there; and makes even less further down the river in the Townsend cut, where more than one half of it is composed of slate and shale, as shown in the above section. But growing compact again towards the west, it makes the continuous wall of sandstone that ap-

pears in the side-cuttings extending from Townsend's to the mouth of Pine run. At this latter place the display of rock is extremely fine.

The sandstone is usually fine-grained; in places much current-bedded, but sometimes very massive, and when massive often conglomeratic; its color is usually grayish; frequently its base rests directly on the Freeport Upper coal, as at Apollo; very often, however, black slates interpose between the rock and coal.

The upper members of the Mahoning sandstone are scarcely recognizable in the region of Apollo. Elsewhere an abundant deposit of thin shaly sandstone was observed about 50 feet above the Gallitzin coal.

§ 41. *The Freeport Upper coal bed* is so frequently exposed along the hills above and below Apollo, that no difficulty need be experienced in tracing it continuously from Roaring run to Leechburg.

On the hillside about 150 feet above the tow-path, and about a mile southeast of Apollo, a good exposure of the Freeport Upper coal occurs together with its roof-rocks and those underlying. The succession here is as follows:

Sandstone, massive, in cliff, *Mahoning SS.*,	20′ 0″
Coal,	2′ 0″
Fireclay, impure, coarse,	6′ 0″— 8′ 0″
***Limestone* with intermediate shale layers,**	15′ 0″—20′ 0″
Clay shales,	—
Total,	50′ 0″

§ 42. The coal bed is next seen in a railroad cutting east of the Apollo station where it is 2′ 4″ thick, and roofed by the same sandstone that appears in the above section, only less massive. The coal is just above the railroad track which it slowly sinks beneath going westward, past the station. Opposite the rolling-mill it is 20 feet below the track. It is opened and mined quite extensively for use in the heating furnaces of the mill, being there 3½ feet thick and very even and regular. It is parted by a small layer of slate which invariably accompanies the seam throughout all the gangways and entries of the mine. The section is as follows:

Fig. 5. § 42.

Black slate,		—
Coal,	2′ 4″—3′ 0″	4′ 2″
Slate,	0′ 1″—0′ 2″	
Coal often slaty,	1′ 0″	
Clay slate in floor,		—

The mine is connected with the rolling-mill by a small wooden bridge, over which the coal is transported in the mine carriages, directly from the mine to the boilers and heating furnaces of the mill. No other fuel is there used. The attempts made to supply the mill with natural gas were unsuccessful. Two wells were sunk, one to a depth of 1,300 feet, and the other nearly as far, and while some gas was found yet not in sufficient volume for the purpose required.

§ 43. The coal from the Freeport Upper bed at Apollo is so compact and firm that it can be mined in blocks of convenient size for transportation. But the coal is both pyritous and slaty, and while adaptable for mill use, it is too impure for gas making or for iron smelting unless previously washed. Mr. McCreath analyzed a specimen of it from the mine of Messrs. Laufman & Co. with the following results:

Water,	1.410
Volatile matter,	38.560
Fixed carbon,	52.249
Sulphur,	2.381
Ash,	5.400
	100.000
Color of ash,	cream.
Coke per cent.,	60.03
Fuel ratio,	1:1.35

"The coal is of a deep black color, and is seamed with mineral charcoal and iron pyrites. It carries an unusually large amount of carbonate of lime in thin scales disseminated throughout the mass."

§ 44. It has already been mentioned that the *Freeport Upper limestone* is a variable element of the section at Apollo. The irregularity consists in fact of a total replacement of the limestone by shale over an area extending east and west from a point about a mile above Apollo nearly to the Leechburg tunnel, in all not less than four miles. Irregularities, similar in kind, are of frequent occurrence

in the limestone deposits of the coal measures. Many such are, indeed, described in this report. In considering them, however, a distinction must be drawn between those cases where the result has been brought about by ancient sub-aerial erosion, on the one hand, and those in which the replacement has been effected by other agencies, by the action of subterranean waters, or, indeed, by conditions which prevented the rock originally from forming at the locality in question. Where the rocks immediately over and underlying the limestone have been removed along with it from a narrow area, there evidently the change is due to sub-aerial erosion of Paleozoic times. But to the case at Apollo no such explanation would apply, and if for no other reason than because the limestone is in this case alone affected, while the eroding current must have been a sheet of water four miles broad. It is much more probable that the limestone was never deposited at all at Apollo, but that an accumulation of mud and clay there took its place.

The gradual substitution of shale for rock, is prettily shown at the exposure on the hillside above the McLaughlin mine, where many years ago the rock was quarried in considerable quantity for use at the Soda works below Freeport on the Allegheny river. The rock was "stripped" from a face several hundred feet long. At the eastern end of the exposure the deposit is from 15 to 20 feet thick (see § 41). It is divided by bands of shale into separate layers of different thickness, and of different color and composition. The upper part is sandy; but the lower strata being free from this objection, yield an excellent stone, of a light gray color, smooth, compact and apparently non-fossiliferous. In general appearance, as well as in its greatly expanded proportions, the deposit here closely resembles its condition at Manorville, below Kittanning.

Following the deposit westward along the face of the exposure, the limestone becomes more and more argillaceous; and the shale masses, dividing the limestone layers, steadily increase in thickness until they finally unite around the edges of long thin finger points of impure earthy limestone.

Beyond this, towards the west, all is shale at the horizon of the limestone rock. So it runs past Apollo and past Townsend's station, at both of which places the farmers have searched in vain for it, and failing to find it, have been at great loss to understand the cause of its absence. Finally the rock reappears again in the cut at the Leechburg tunnel of which a description will be found on another page.

§ 45. Underneath the limestone above Apollo the *Freeport fire clay* is reported in workable condition. Some developments were once made on it here; but the exposures are now too imperfect to permit of a close examination of the deposit.

§ 46. *The Apollo anticlinal axis* crosses the valley near McIntyre's, at the boundary line between Allegheny and Kiskiminitas townships. The arch is about two miles broad, from end to end, with gentle dips which on either flank barely exceed 1°. At the most this Apollo anticlinal lifts the rocks only about 70 feet, which, however, is sufficient to enable the upper part of the Kittanning group to appear above the water level.

The arch of the axis is plainly revealed by the following exposures of the *Freeport Upper coal seam.* At the mouth of the small run, just west of Apollo, this bed is at the level of the tow path, twenty feet above the water level. Thence westward it rises steadily at an angle of something less than 1°. At the old canal lock one half mile below the town, it is forty feet above the river, permitting the Freeport Lower coal to come to daylight. The latter seam, indeed, is said to have been met with 5 feet thick, in laying the masonry of the lock; but aside from the outcrop no exposure of the coal now exists.

Sandstone roofs the Freeport Lower coal at the canal lock; and above the sandstone the Freeport fire clay was once mined for the clay works at Apollo. The Freeport Upper coal is 3 feet thick.

§ 47. Between the canal lock and the McIntyre mine at the western edge of Kiskiminitas township, the Freeport Upper coal rises 50 feet. The Freeport sandstone is raised to daylight and with it also the Kittanning Upper coal, the

latter seam being small and of no importance. Both strata quickly disappear again under the river going west. The section at McIntyre's is as follows:

Coal bed, *Freeport Upper*, McIntyre mine,	3′ 0″
Shale,	10′ 0″–15′ 0″
Sandstone and concealed rocks,	20′ 0″
Coal bed, *Freeport Lower*,	?
Clay, impure,	5′ 0″
Sandstone, *Freeport SS.*,	25′ 0″
Clay and slate,	1′ 0″
Coal, *Kittanning Upper*,	1′ 0″
Clay impure,	8′ 0″
Total,	78′ 0″

§ 48. At the McIntyre mine the dip changes from southeast to northwest, down the river. Followed in that direction the Freeport Upper coal remains singularly even and regular, undergoing almost no change of thickness. Its position also in the hills is little affected by the dips. At the Geiser mine, opposite Townsend station, it has fallen 40 feet from its elevation at McIntyre's; at Kepple's, in the bend of the river below Townsend's, it is still lower; but thence to Shaner's, at the mouth of Carnahan's run, it rises somewhat. The same northwest rise continues thence to the Leechburg tunnel, where another anticlinal crosses the river.

This undulation, being rather a local occurrence, was not included in the general description given above of the geology of the valley. An attempt to trace the movement northward under the uplands towards Crooked creek, though systematically pursued, was unsuccessful. In the Kiskiminitas valley besides lifting the rocks about 30 feet out of level, it has determined the long bend which the river makes above Leechburg. Its summit is at the tunnel, whence to the railroad station the dip is northwest, thus placing the town of Leechburg in a synclinal.

§ 49. *The vertical section at Leechburg* is about 350 feet in length, with Lower Barren rocks occupying all the upland country on both sides of the river, and extending also down the slopes of the valley to within about 75 feet of the water level. The Barrens, however, possess here no features

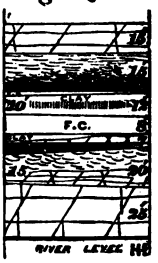
whatever of practical interest, and being very imperfectly exposed they afford no opportunities for close study.

The uncovered portion of the *Lower Productive series* relates mainly to the Freeport group, which largely occupies the interval between the railroad track and the river. In addition, however, to these strata, some members of the Kittanning group make their appearance above the water line on the arch of the small subordinate roll at the tunnel. Where best exposed the following rocks are visible:

Fig. 6. Freeport Group at Leechburg.

Sandstone, *Mahoning SS.* in part,	15′ 0″
Slates and shales,	15′ 0″
Coal bed, *Freeport Upper*,	4′ 0″
Fireclay, dark,	2′ 0″
Limestone and impure clay,	10′ 0″–12′ 0″
Fireclay, impure,	8′ 0″
Clay and sandstone layers,	5′ 0″
Slates and coal, *Freeport Lower*,	2′ 0″
Shales and SS. layers,	15′ 0″–20′ 0″
Sandstone, *Freeport*,	25′ 0″
Coal? *Kittanning Upper*,	—
River level,	—
Total thickness,	108′ 0″

Fig. 6. § 49.



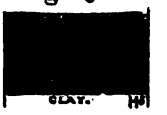
§ 50. With the exception of the Freeport Upper coal and the Freeport sandstone the strata of the above section preserve neither uniformity nor persistence at Leechburg. But the Freeport Upper coal bed is both continuous and regular, preserving here the same general features that it exhibits elsewhere in the valley. It is therefore a valuable bed either for steam purposes or for use in the rolling-mill. Its outcrop line is unbroken, and being high above the water level, it sends long projections up all the narrow lateral ravines extending into the upland country back from Leechburg.

It is mined at the Leechburg colliery on the Westmoreland side of the river at Grinder's station, being there quite extensively developed. The coal is of a deep black color, bright, shining, and rich in gas. It has some small knife-edges of slate and some iron pyrites, but neither impurity to an extent which would seriously effect the value of the

bed. It mines out in firm compact blocks which bear handling and transportation well. Most of the coal from the Leechburg colliery is used in the locomotives of the West Pennsylvania R. R. The following section represents the average thickness of the bed not only in the Leechburg colliery, but generally throughout that region.

Black slate,		—
Bony coal, sometimes slate,	0′ 2″	
Coal,	2′ 9″	
Slate,	0′ 2″	3′ 9″
Coal,	0′ 8″	
Clay,		—

Fig. 7. § 50.



§ 51. The bed has further been opened on the Beale property directly opposite Grinders, and again by Messrs. Rogers and Burchfield in the bluffs just back from Leechburg. The latter mine was formerly worked to a much greater extent than now, having supplied the rolling-mill with fuel before natural gas was discovered to supersede it. Lower down the river the Freeport Upper coal bed is worked in a small way for domestic supply.

§ 52. The measures underneath the coal bed undergo here such extremes of variability as fairly to bewilder the observer. The Freeport Upper limestone is perhaps the most variable of all, appearing and disappearing and presenting all varieties of composition. These changes and variations may here be briefly described. At the eastern end of the tunnel the exposure is as follows:

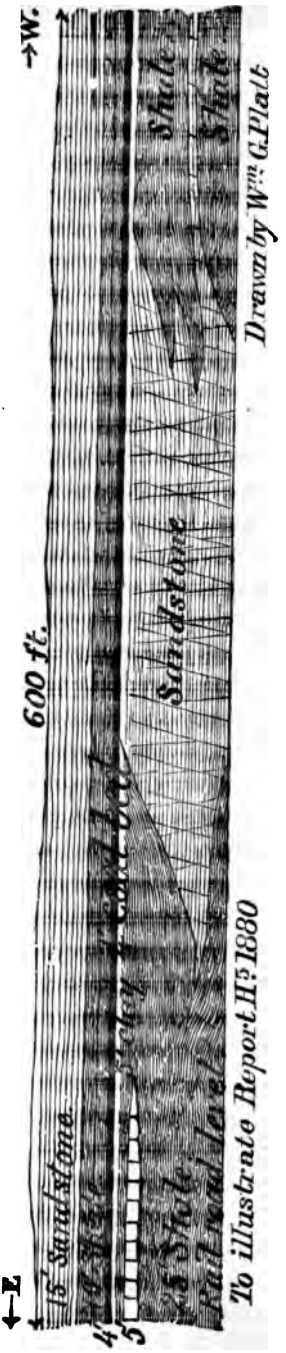
Freeport Upper coal,	—
Fire clay impure,	2′ 6″
Limestone,	2′ 6″
Clay with nests of limestone and ore balls,	5′ 0″
Limestone,	3′ 6″
Shales,	—
Total,	13′ 6″

The upper layer of limestone is irregular in thickness and very ferruginous; the lower layer is of much better quality and could be employed for fertilizing purposes. It is of a dark blue color, compact and apparently devoid of fossils.

§ 53. Advancing now through the tunnel, 1350 feet long, across nearly horizontal rocks, both layers of the lime-

stone thin away gradually, disappearing almost entirely from the measures before the western end of the tunnel is reached. Shales occupy its horizon. But the limestone reappears at Grinders station a few hundred yards beyond, being there impure and much mixed with clay. The deposit shows here the same subdivisions as at the eastern end of the tunnel. Opposite the Leechburg station only a single layer is found 3 feet thick, which further west, beyond the mouth of Brady's run, fades into shale. Where this last change occurs the exposures are otherwise unusually interesting. The Freeport Upper coal regularly roofed by sandstone and shale appears as a continuous line at the top of the cut. Below it 35 feet of measures are exposed, in which at the eastern end of the cut the limestone appears in place below its coal, narrowing off gradually however towards the west until it finally terminates in a thin point. Shales now for a short distance, comprise all the interval between the coal and the railroad when sandstone starts in near the base of the cut, first as a narrow projection, then more pronounced, and finally expand-

Replacement of Limestone and Sandstone by Slates and Shales



ing sufficiently to entirely replace the shales. The rock is massive and coarse grained. In the end it too fades out and shales and slates reappear. The accompanying sketch will illustrate the change more clearly.

In this connection also a sketch may be reproduced from the Geology of Pennsylvania by Professor H. D. Rogers, 1858; Vol. II, page 597, illustrating an instance of apparent unconformability in the rocks. It was originally observed near Leechburg, and speaking of it the report says: A slip appears to combine with the original oblique bedding of the sandstone to express to the eye of the spectator an unconformity of stratification at the upper limit of the sandstone; and upon its apparently upheaved edges rest the calcareous slates and coal above, as in the annexed wood cut. Something similar may be observed elsewhere along the Kiskiminitas, as at a point 7 miles below Saltzburg.

Geol Penna. 1858 Vol. II p. 596

FIG. 9.

§ 54. *The Freeport Lower coal* is too small to be of any value at Leechburg; and the *Kittanning Upper coal* underneath the Freeport sandstone, though lifted to water level is not well exposed. The section above given of the Lower Productive rocks at Leechburg, shows how reduced at this place is the usual interval between the Freeport Upper and Lower coals.

§ 55. *The discovery of natural gas at Leechburg* dates back to 1871. At that time a well was drilled opposite the town, at the mouth of a small run on the Westmoreland side of the river, for oil. It was continued to a depth of 1250 feet when gas poured out in great abundance, accom-

panied by salt water; but no oil being obtained, the well was abandoned.

Thus things remained for several years, during which time the gas issued in a steady and continuous stream, and in apparently undiminished volume. In 1874 the well was purchased by Messrs. Rogers and Burchfield, who at that time were the owners and proprietors of the Siberian rolling-mill, on the opposite side of the river, in Armstrong county. The gas, still abundant, was conveyed across the river by a 5-inch pipe and connected with all the fires of the mill. This was the first application of natural gas to iron making. Its economy and efficiency were at once recognized, and it has since been put to similar uses in other places, with equally favorable results.

§ 56. The rolling-mill at Leechburg subsequently passed out of the hands of Messrs. Rogers and Burchfield, becoming the property of Messrs. Kirkpatrick and Beale, who are its present owners. It was built in 1872; has 6 single puddling furnaces, 6 heating furnaces, 6 trains of rolls, 2 steam hammers, 1 refinery, and 2 "knobbling fires" or finery forges. No change was made by the present owners in the method of operating the mill. Natural gas is still almost the only fuel used, and it still (1879) flows abundantly from the well. Unfortunately no measurement was made of the amount of gas which first escaped from the well; but, apparently, since its first utilization in 1874 no appreciable diminution of volume has taken place, at least not enough, according to Mr. Beale, to be noticeable in the workings of the mill. When measured in 1874, the pressure was 70 pounds to the square inch.

To discuss fully the probable continuance of the gas would only be to re-open a question already treated at considerable length by Mr. Franklin Platt, in his report on that subject.* Gas wells, like oil wells, have their periods of activity and their periods of subsequent exhaustion. Ultimately this Leechburg well must cease to flow; but so long as it remains the only outlet for the gas in that immediate

region, its activity may continue for years without any noticeable symptoms of weakness.

§ 57. The method of working the gas in the mill at Leechburg has been so fully described by Mr. J. B. Pearce, in the Report of Progress above mentioned, that the reader must be referred to that volume for particulars. But I may here quote, briefly, what the same author (a high authority in such matters) has said of it in another place.* "In using the gas in the ordinary puddling furnace, the only change made was to brick up the bridge of the furnaces and let the gas in through iron pipes, supplying air by a blast. Blast pipes were also inserted in the crown of the furnace in such a way that the blast should strike the metal at an angle of 90°, blast being let on at the commencement of the boil. By this means iron could be made, from ordinary gray forge pig, equal in quality to that made from the best charcoal iron, and at a cost, as was claimed, of $50 per ton less, and without the use of the 'knobbling fire.'"

§ 58. Descending the river below Leechburg the rocks are nearly horizontal as far as Elwood's salt works, about a mile below the town. There the *Freeport Upper coal* is 70 feet above the level of the tow path, having been opened and worked. It shows its usual thickness. The *Freeport sandstone* is compact and very prominent, rising as a low cliff behind the derrick of the salt works. The salt well, though free from obstruction and in working order, is not at present operated; its depth is 649 feet. The salt water is therefore derived from the sandstones of the Pocono formation as at Saltzburg and North-West.

§ 59. Further down the river the Freeport Upper coal is repeatedly exposed along the right bank, usually about 80 feet above the tow path, which increase in elevation reveals a gentle rise in the rocks towards the northwest. The same rise is continuous until the coal bed is finally elevated to a point 135 feet above the river, or about 110 feet above the tow path. This is at Bagdad station, where the arch of a small and feeble anticlinal axis crosses the valley. Between

* Iron Manufacture in America, J. B. Pearce. Philadelphia, 1876.

Bagdad and the mouth of the Kiskiminitas scarcely any dip at all is felt, but what dip there is, is towards the northwest.

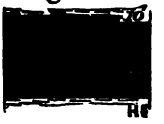
The Freeport Upper coal has been opened at Bagdad on the D. Hill property, directly opposite the grist-mill. It is three feet thick, consisting of good coal with a firm slate roof.

On the hill above the mine some few exposures of clay and clay slates are found, but nothing of any particular value or importance. *The Mahoning sandstone*, being massive, is a prominent feature of the geology, though not so much here as on the opposite side of the river, especially in a small ravine leading southward into Westmoreland county, towards the McClellan coal mine, and the McElroy farm. On top of the rock a small coal bed occurs at a distance of 125 feet above the Freeport Upper coal; it makes its appearance in the spring near Mr. McElroy's house. It is too small to be mined. The Mahoning sandstone largely fills the interval between this coal and the Freeport Upper seam.

§ 60. At the McClellan mine, the Freeport Upper coal shows as follows:

Dark slate,	10′ 0″	
Coal,	2′ 6″	
Parting, slate and mineral charcoal,	0′ 1″	
Coal,	0 6″	3′ 10″
Bony coal and slate,	0′ 1″	
Coal,	0′ 8″	
Clay slate,		—

Fig. 10. § 60.



At the Barnet and Jackson mine ¼ mile further up the run the lower parting disappears. The roof there is of sandstone.

The coal bed at both places is in good condition, being much the same as at Leechburg. So it runs also westward from Bagdad down the river into the valley of the Allegheny where it continues to preserve the same character and thickness.

§ 61. *The Freeport Upper limestone* is missing at Bag-

dad on both sides of the river; but its absence there is merely another local variation similar to those already described as occurring at Leechburg and Apollo. The limestone reappears further west in the exposures at the mouth of the Kiskiminitas.

The Freeport Lower coal is unimportant at Bagdad; so it is also west from this place nearly to the mouth of the river where it assumes a cannel feature, of which a description is given in another chapter.

The Freeport sandstone is the rock displayed in nearly all the side cuttings of the railroad between Elwood's salt well and Bagdad. It shows some curious variations of bedding and some sharp changes into shale.

The Kittanning Upper coal makes scarcely any show whatever. Possibly it is this seam that is exposed in the cut close to Bagdad station, where it appears in connection with heavy sandstone. The coal is only 3 inches thick, vanishing finally in the exposure below the station. Black slates replace it.

Between Bagdad and the mouth of the Kiskiminitas nothing of especial interest is exposed.

§ 62. The geology of the upland country tributary to the Kiskiminitas, may be studied in the lateral ravines leading northward from the river to the Crooked Creek divide. This divide pursues a northwest course across the northern edge of Kiskiminitas and Allegheny townships, to where it falls away towards the Allegheny river in the ravine of Taylor's run.

The whole upland region is one of Lower Barrens. So likewise are the small ravines, which, being shallow, descend into Lower Productive rocks only in the vicinity of the river. *Long run*, however, is an exception to this general statement, having a small area of Lower Productive rocks at a point quite removed from the Kiskiminitas valley, on the arch of a local anticlinal, not felt in the region of the river. And Roaring run is another exception, owing to causes already explained.

The geology of the Barren Measure-ravines is one of great uniformity. They all have gentle slopes covered mainly

with soft argillaceous shales; none of them contains coal or limestone strata of economic importance; all are comparatively fertile and easy of cultivation; and all narrow more or less into gorges where they break through the Mahoning sandstone into Lower Productive rocks.

§ 63. The hills skirting the left bank of Long run embrace the entire Lower Barren series. Concerning the imperfect nature of the exposures at the mouth of the stream, sufficient has already been said on a previous page; those higher up the run are little better. Three layers of red shale are conspicuous along the road leading from Mrs. Alcorn's house to Maysville (Long Run P. O.) These red shale layers occur at the following intervals below the Pittsburg coal.

First stratum,	60 feet below.
Second "	175 " "
Third "	225 " "

All are of considerable thickness and have an extended range in the Long run ravine, coloring the soil of the hills over which they pass. *The Morgantown sandstone* makes only a feeble show in the region.

Additional exposures may be had of the Lower Barren measures along the roadside leading northwest from Maysville, past the grist-mill. The rocks dip sharply towards the southeast at angles of 5° and 6°. Further west the incline grows even steeper, amounting finally to 10° and bringing up the Freeport Upper coal and limestone above the level of the run at Mr. Grey's. There the rocks roll over an anticlinal arch, on the opposite side of which they pitch at the same steep angles towards the northwest, thus burying again the Freeport Upper coal and limestone beneath the surface within a few hundred yards. The latter strata indeed are exposed only in a small branch ravine leading through Mr. Grey's fields. Search need not be made for them elsewhere on Long run, for nowhere else are they above the water level.

§ 64. Before describing the developments made upon the coal bed by Mr. Grey, it may be said of the anticlinal axis

that it is strictly a local occurrence, whose strength fades out so rapidly both towards the northeast and southwest, that it cannot be followed for any distance in either direction. It is not felt at all along the Kiskiminitas, not even as a faint roll. Indeed its extension at all towards the southwest would have the effect of making the ravine of Flat run a region of Lower Productive measures, instead of Lower Barrens, which are at present the surface rocks in that ravine until the run, at the river, reaches an area of Lower Productives whose uplift is due to the Roaring run anticlinal. In the opposite direction, towards the northeast, the axis is quickly lost under the Barren Measure uplands. The sharp dips subsiding, the rocks stretch in nearly horizontal sheets across the region through which its arch, if prolonged, should pass. On Crooked creek there is not a trace of it. Possibly there may be some connection between this uplift and the Perrysville (Plum creek) anticlinal, which in coming from the north loses it force rapidly and fades out before reaching Crooked creek. The lines of these axes if extended across the map very nearly join; but such connections though possible are in the highest degree doubtful; and particularly so in a case where, between the two localities an interval nearly ten miles long intervenes in which no trace of the junction appears. The Long run uplift is then rather to be regarded as a local occurrence of the same age doubtless as the other axes, and having the same strike as these, but otherwise separate and distinct from them. Brief in its continuance and with a vertical energy out of all proportion to its length, its dips far exceed in strength those on either flank of the Roaring run axis, and rival indeed those of the great anticlinals of Laurel hill and Chestnut ridge.

§ 65. *The Freeport Upper coal* has been opened at several places in the little ravine at Mr. Grey's. It shows the same section in all the mines. Its limestone, as already stated, accompanies it, but has not been fairly exposed. The section is as follows.

Shales and sandy slates.		
Clay, hard, iron stained, ...		0 3″
Coal, bony, ...		0′ 3″
Coal, ...	3′ 0″—	3′ 3″
Slate, ...		2′ 4″
Coal, ...		2′ 0″
Fire clay shale, ...		10′ 0″
Limestone, ...		5′ 6′
Total, ...		23′ 7″

Fig. 11. § 65

The upper bench of coal in the above section represents the average thickness of the seam throughout the Kiskiminitas valley. The lower bench is a feature local to the Long run region. It adds little value to the bed in a practical sense, being too small to be mined independently, and too far distant from the upper bench to be mined profitably in conjunction with the latter. Both benches are slaty and both have iron pyrites in considerable quantity.

§ 66. The sharp southeast dip carries the bed under the water level before reaching the mouth of the small run at the forks of the road, while in the opposite direction it disappears no less quickly, being concealed under the hill on whose top the run starts. The hill is crowned by the Mahoning sandstone in massive condition, bowlders of which appear on the surface west from Mr. Grey's house. In mining the coal the most available point of attack is at the bend of the road, where it has already been opened by Mr. Grey. Thence either towards the northeast or southwest it might be followed for any distance along its strike.

§ 67. *Roaring run* is the largest of all the Kiskiminitas tributaries from Armstrong county. It drains the greater part of Kiskiminitas township.

The trend of the valley corresponding nearly with the

strike of the rocks, the anticlinal axis which crosses the river at the mouth of the run follows the little ravine closely. Hence the rocks in the river hills are continuous above the water level for long distances up the run, disappearing only after their different levels have been reached. The Freeport Upper coal bed, as the geological map will show, continues above the water level nearly to the heads of the run.

§ 68. Only the top of the *Pottsville Conglomerate* being exposed in the river valley the run bed quickly rises above it. But a second sandstone stratum, no less massive than the other, and quite as prominent, fills a good part of the interval between the *Brookville* and *Clarion coal beds*. At the forks of the run, not quite a mile above the mouth, the *Ferriferous limestone* is under the water line sufficiently deep to bring the Kittanning Lower coal to the edge of the run. At this place stood Rough furnace, of which sufficient has been said on another page. Before the furnace finally went out of blast the *Kittanning Lower coal* was here mined to supply it with coke. The coal bed shows the same thickness and the same general features that it does along the river, and being both slaty and pyritous it is unfit for coking unless previously washed of its impurities. This fact seems abundantly to have been proved in the experiments here made in coking the raw coal.

§ 69. Continuing up the right fork of the stream, or Roaring run proper, the *Kittanning Middle coal* is just above the water's edge at McCartney's mill, about a mile above the forks. It is a small seam, from 0′ 6″–0′ 10″ thick, embedded in tough black slate. On the hill at this place, 160 feet above the run the *Freeport Upper coal* has been opened in workable condition, but the drift is now closed. It may however be seen at Hilty's in a small branch-ravine about a mile above McCartney's. The bed has a thickness of four feet, which, moreover, it maintains with great persistency throughout the Roaring run valley. In the region of the Upper School House it has been opened on nearly every farm. It carries a small parting slate, which is character-

istic of the seam in this region. The following section, made in the Hilty mine is typical:

Slate.		
Coal,	3′ 7″	4′ 6″
Slate,	0′ 1″	
Coal,	0′ 10	

The dip at Hilty's is 2° towards the S. E.

§ 70. *The Mahoning sandstone* at this place is massive and coarse grained. In weathering it breaks up into large blocks, which are abundant hereabouts in all the fields. But higher up the run, in the neighborhood of the School House, this compactness of the rock disappears, and the slopes there are in consequence smooth and unincumbered with bowlders. Otherwise the geology at this latter place is nearly the same as at Hilty's, the Freeport Upper coal, as opened by Guthrie and again at Hawks, showing little or no change. The Freeport Lower coal, occurring 30 feet below the Freeport Upper, has been opened on the Ridenour property. The Freeport Upper seam is last exposed on the Scott farm, being there close to the water level. Beyond this to the N. E. it is under the run bed, the Mahoning sandstone making the hill top at Shady Plain, and constituting a shallow covering, from beneath which the coal bed quickly reappears on the opposite side of the divide, in the ravines leading northward towards Crooked creek.

The Freeport Upper limestone is scarcely known at all throughout all the valley of Roaring run. It is probably of little value or importance there. The exposures at that horizon are too unsatisfactory in almost every instance to ascertain the exact condition of the deposit.

§ 71. *Rattling run* is the west branch of Roaring run. The names of both streams have been suggested by the miniature water falls and cascades, which have formed in the sandstones about the forks, and which have contributed a somewhat romantic feature to the region.

Rattling run heads beyond Spring Church in Allegheny township, and flows at first through a region in which Lower Productive rocks are above the water level, elevated to that point by the small anticlinal axis which crosses the river in

the bend below Apollo. The axis crosses Rattling run near the blacksmith shop.

§ 72. The area occupied by Lower Productive rocks in that vicinity, is indicated on the geological map. The Freeport Upper coal is the only seam of workable dimensions above the water level. It has been exposed, four feet thick near the blacksmith shop, and again at Klingensmith's near the Lutheran Church. Below the school house the run passes out of Lower Productive rocks into an area of Lower Barrens, in which it remains past Spring Church and thence southward until within about a mile of the forks. Where the Lower Productives re-appear above the water line the run turns southeastward to flow against the dip of the rocks, deepening the section rapidly. The Freeport Upper coal is here less thick than in the Roaring run valley, but is otherwise much the same. It has been opened at Miller's and at Jackson's; and making a distinct bench along the hillside, is easily followed from farm to farm. The dip is northwest under the highlands overlooking Apollo.

The Freeport Upper limestone is not worked, but good indications of the rock occur in the neighborhood of Mr. Jackson's house. The Freeport Lower coal likewise outcrops at the same place.

Chapter II.

The Upper Productive Coal Measures; Pittsburg Bed, &c.

§ 73. The map accompanying this report will best convey to the reader an impression of the extent of surface covered in Armstrong county by the Upper Productive Coal Measures. It will be seen that they are confined to the southeastern corner of the county—to Kiskiminitas and South Bend townships; that the entire length of the basin from southwest to northeast is six miles; that its average width is less than a mile; that its outcrop edge is of irregular contour; and finally that deep cutting ravines, extending across the basin, break it into detached areas of which the largest is that next the river.

The basin extends southward to the cliffs which overlook the Kiskiminitas at Coalport. Long run is its western boundary from end to end. At the north it terminates before reaching the valley of Crooked creek. On the east it continues across the Indiana county line. Indeed the Armstrong county area is but a part of the Saltzburg-West Lebanon basin,* of which it is the western side; and being thus situated on the western side of the synclinal, its dips are uniformly towards the southeast.

§ 74. The dips are extremely gentle. Even at the western limits of the basin, where the rocks rise into the air, the incline is never more than 2° and rarely that much. No faults occur, nor any irregularities, serious enough to affect the mining interests of the region.

The basin has a sloping floor tilted towards the southwest. The tilt itself is so faint as scarcely to be perceptible within the length of any one of the mines now being operated there, but when observed over long distances its geological effect becomes plainly apparent. *The continued deepening* of the basin southward across the river in

Westmoreland county, is due to the operation of this cause, just as the continuous *decrease of depth* which takes place towards the north in Armstrong county, is likewise produced by it. The altitude of the surface remains in effect the same in both directions; if anything there is perhaps a slight increase in elevation towards the north.

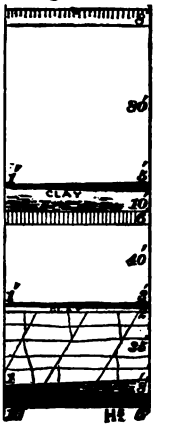
How far these Upper Productive rocks may have originally extended towards the northeast at the close of the Carboniferous epoch when this portion of the continent was for the last time lifted above the sea, cannot now be ascertained. Certainly, however, their outspread was much greater then than now; and it is no less certain that if the basin had a perfectly horizontal floor, it would at the present time extend not only to the Crooked creek valley, but far beyond this into the northern townships of Indiana county.

The basin, where deepest, includes only the lower half of the Upper Productive group. Usually little more than the Pittsburg coal bed is present; the Great Limestone is found only at one locality.

§ 75. The generalized section given below has been grouped from numerous local sections. Frequent variations from it occur, which materially change the face of the column; some of these are described in the sequel; others will readily reveal themselves to local geologists on close observation.

Great Limestone, present only in part,		8′ 0″
Concealed rocks,		80′ 0″
Coal bed, Sewickley,	1′ 0″—	5′ 0″
Black slate and clay,		10′ 0″
Limestone, Sewickley, (Fish pot limestone,		6′ 0″
Interval,		40′ 0″
Coal bed, Redstone seam,	1′ 0″—	3′ 0″
Clay, impure,		2′ 0″
Sandstone, *Pittsburg SS.*,		35′ 0″
Slates,	1′ 0″—	8′ 0″
Pittsburg coal bed,	6′ 0″—	10′ 0″
Total thickness,		207′ 0″

Fig. 12. §75.



§ 76. *The Great Limestone stratum* occurs only on the farm of Mr. R. Smith at Elders Ridge, being caught in the extreme hill top and covering but a few acres. Only a fragment of it is here preserved; but what is left of it, consists of good stone, smooth, compact, of a light grey color, and non-fossiliferous. Calcined, it makes strong lime, excellent for fertilizing purposes, as has been shown by its use on the Smith property. The rock can be quarried at little expense, no stripping being required. Across the Indiana county line the same stratum is found in several high knobs, adjacent to Elders Ridge.

The concealed interval below it, extending to the *Sewickley coal*, consists mainly of argillaceous slates and shales. These, being the country rock at Elders Ridge, have produced the smooth farming land for which that region is famous. The soil, though shallow, is yet productive, when assistance is had of the limestone.

§ 77. *The Sewickley coal bed* is nowhere worked. It is, however, invariably present in some form, wherever the basin is deep enough to include its horizon. In the cliffs overlooking Coalport the bed is three feet thick, which is, perhaps, about its general average. The bed should also occur in the prominent knob north of Mr. H. C. Ewing's house, but it is there only known by an outcrop of coal and slates. Where once opened, near Elder's Ridge, in Indiana county, it showed upwards of five feet of coal.

§ 78. *The Sewickley limestone*, as a general thing, is obscure. It is, however, well exposed in the Coalport cliffs, where it consists of good stone. The same rock may again be seen in the ravine below Mr. Ewing's house, near Olivet, having there been once opened and quarried.

§ 79. *The Redstone coal*, variable at all points, is nowhere of practical importance in the basin. It is entirely absent from the exposures along the Kiskiminitas, but reappears further north as a feeble outcrop on top of the Pittsburg sandstone. Thus it may be seen near the top of the hill, on the road leading south from Crawford's saw-mill. An examination of it there is reported to have shown three feet of coal. It twice appears at the northern end of the basin,

once in the high knob in Ewing's fields, and again in the road between Beighley's and Weaver's.

§ 80. *The Pittsburg sandstone* undergoes the greatest extremes of variation of any member of the section. At times it appears as a massive, compact rock, with scarcely a break from top to bottom. At other times it is current-bedded and flaggy; and again, it is so loose and shaly as scarcely to be recognizable. But on the other hand the changes of *thickness* which the deposit exhibits are in every instance too slight to affect materially the total length of the Upper Productive section. Identifications of the different strata can, therefore, be easily accomplished.

In this connection it is only necessary to describe the condition of the sandstone deposit at a few of the more prominent exposures. Above Coalport it makes a line of vertical cliffs near the top of the hill. It is there 35 feet thick, very massive, and rather coarse-grained. From it the numerous heavy bowlders, found at lower levels of the slopes have detached themselves and rolled to their present resting places.

In the same massive condition the rock reappears at the northern end of the basin, in the neighborhood of Weaver's, whose house stands at the top of the stratum. A fine display of the deposit is also found south of Beighley's, and east of Weaver's. Its thickness at the latter place is somewhat greater than along the Kiskiminitas.

In the neighborhood of Ewing's and Townsend's the deposit altogether loses its massiveness, becoming, indeed, a mass of loose shale and slate in its lower horizons. South of Olivet its condition is between these extremes, being there a current-bedded rock, from which good flagstone might be raised. Where its horizon crosses the fields, in the neighborhood of Olivet, the surface is thickly covered with small thin fragments of stone.

§ 81. *The Pittsburg coal bed*, though always from 8 to 10 feet thick in this basin, is so much broken by parting slates that, excepting for domestic supply, the bed has little value. To describe the course of its outcrop line in its run over the hills, and up and down the ravines, would be to

describe every farm in the region. The map shows the outcrop line; but even without this aid local geologists may readily recognize the seam by the plain bench which it makes on every hillside.

The bed exists in four distinct belts, each of which has its eastern terminus in Indiana county. The first, going north, stretches from the Coalport bluffs to a small nameless run, about two miles northeast of Maysville. It has three small outliers, all of which occur directly east of Maysville.

The second belt is a narrow prong, scarcely more than 800 feet wide, situated between the run last named and the Olivet run. The third belt is next in importance to the first. It includes the Elder's Ridge region, stretching also beyond this to the small run at Townsend's, which, being deep enough to break the outcrop line, makes the fourth belt. This fourth belt is the area embraced in the Beighley and Weaver farms.

§ 82. *The old works at Coalport* have long since ceased to exist. They operated the bed quite extensively for shipment eastward through the canal. The coal is both pyritous and slaty.

The Rhea and Smith mines, situated a short distance north of Coalport are likewise closed. But still further north beyond Maysville, the bed is mined both on the Carothers and Fairman farms. At neither place however, is all of the bed mined, only its lower portion being exposed. It is thus divided:

Coal in roof,		?
Slate and bony coal,	1′ 0″	
Coal,	1′ 2″	
Slate,	0′ 3″	6′ 8½′
Coal,	2′ 0″	
Slate,	0′ 0½″	
Coal,	1′ 10″	
Slate,		—

Directly south of this place are the three small detached outliers above mentioned, in which the coal has little or no cover. The township road between Mrs. Alcorn's house and the J. White farm, crosses one of the knolls, exposing in so doing all of the coal bed.

§ 83. *In the Elders ridge region* the seam is most extensively mined on the Ewing farm, which supplies a large local trade. Here the bed is at its thickest. The section is as follows:*

Slate and coal,	Roof division,	2′ 0″
Coal,		0′ 7″
Slate,		0′ 1″
Coal,		0′ 2″
Slate and clay, main parting,		0′ 10″
Coal,		1′ 6″
Slate,		0 1″
Coal, slaty,		0′ 10″
Slate,		0′ 1″
Coal,		1′ 3″
Slate,		0′ 4″–1′ 6″
Coal,		1′ 6″
Slate,		0′ 0½″–0′ 3½″
Coal,		1′ 8″
Slate,		—
Total,		12′ 4½″

§ 84. The coal in all the different benches is slaty and poor. Some of it is overloaded with iron pyrites, and none of it in its raw state could be considered marketable fuel, excepting for local supply. Being however compact and hard it comes out of the mine in firm blocks, which in spite of their impurities, are preferred by the farmers for use in the stoves and grates to the softer coal from the Freeport Upper seam as mined in the Crooked creek valley. This compactness of the Pittsburg coal, and not because of its supposed purity, is the reason of its large consumption in the Crooked creek region where the other seam is available. Mr. McCreath analyzed a specimen of the coal from the Ewing mine, with the following unfavorable result:

Water,	.800
Volatile matter,	36.900
Fixed carbon,	50.230
Sulphur,	3.040
Ash,	9.030
	100.000
Coal per cent.,	62.300
Color of ash,	pinkish gray.
Fuel ratio,	1:1.36

*For figure-section of this mine, see Report HHHH, p. 275, Fig. 84.

The bed is again mined in a small ravine on the Weaver property at the northern limit of the basin. It is there a trifle less thick than at Ewing's, but otherwise the seam is unchanged. Westward from the mine the outcrop line runs across the township road at which place it is again exposed; then it bends southward towards Mr. Weaver's house, beyond which in a northerly direction it overshoots the highest land.

Chapter III.

The Valley of Crooked Creek.

§ 85. *Crooked creek* and its branches drain South Bend, Plum creek and Burrell townships, with adjoining portions of Cowanshannock, Kittanning, Manor, Allegheny and Kiskiminitas townships.

The creek heads in the highlands of Indiana county, near the county seat, crossing over into Armstrong county at a point about twelve miles north of the Kiskiminitas river, measuring along the county line.

Its principal tributaries in Armstrong county come from the north, in which direction the larger part of the water basin is situated; towards the south the limits of the basin are confined very nearly to the hills which overlook the stream.

While the general trend of the valley is northwest, or parallel to the trend of the Kiskiminitas, the course of the creek as its name implies, is tortuous and irregular. In point of fact the frequent turns and bends more than double the distance which it otherwise would flow if its valley were a direct cut. The air line distance from where the creek enters the county to its mouth at Rosston is about 13 miles; the present water course is nearly 28 miles.

The creek has a total fall of 275 feet* in Armstrong county, evenly and regularly distributed. The water supply though generally ample for such uses as are now made of it in turning the few grist mills dependent upon it, is, from the nature of the county drained necessarily subject to changes which represent the extremes of severe drought and high flood. The floods sometimes rise within a few hours, filling the creek to its banks, to subside again nearly as quickly.

* This estimate being based on barometrical measurements is not exact; but it is not far from the truth.

§ 86. *The erosion of the valley* has been the work of ages, effected by the same agencies that now operate in a similar manner to widen the water basin and to deepen its channel. During the glacial period the valley was not materially affected by ice, at least no ice sheet ever passed down it. No glacial scratches are found there, nor is there any evidence of ice moraines. The northern drift never touched it, not a single crystalline pebble having been found within its limits. Its rock fragments on the hillsides even to the highest hill tops are everywhere of local Coal Measure origin; so are also the transported fragments in the creek bed, which at the most have come from no greater distance than Indiana county.

The region presents considerable variety of topographical aspect. The hills immediately bordering the stream frequently present high vertical cliffs on both sides; at other places the creek flows through a broad valley with meadow lands stretching far away to the base of hills with easy slopes; usually the conditions are a steep hill on the one side, and a more gentle declivity on the other, occasioned by the dips. On the top of all are the uplands, the summits of which are often 500 feet above the creek level.

§ 87. The hills of this upland region are invariably benched. So likewise are some of the lower hills, but the benches there are less distinct. Absolute uniformity of succession on every hillside is not to be expected; nor is it indeed found; but by grouping the observations made at different places a certain succession of horizontal benches is clearly recognizable. That the benches are horizontal may be verified by standing on any well defined plain, and casting a glance through the level glass around the horizon. The eye is repeatedly arrested either by a similar bench at the same level or by a hill summit. Moreover the barometer shows, when the conditions are favorable for close leveling, that the corresponding benches vary only a few feet in level, if they vary at all.

Without the aid of an accurate instrumental base line, from which to make calculations, any attempt to determine the actual altitude of the different benches by the barom-

eter, can only result in an approximation. Such an attempt was, however, made, with the results recorded below. Only the most prominent of the benches are here considered. The first four of the series are most distinct in the vicinity of the Cross-Roads west of the boundary line between Burrell and Allegheny townships; the last four are prominent about Elderton, and between that town and the mouth of Plum creek. In the detailed description of the region, attention is directed to the localities in which the different benches occur.

1.	Mrs. Kline and Klingensmith farms,	1.08	feet	above ocean level.
2.		1566	"	"
3.		1530	"	"
4.		1473	"	"
5.	Elgin's hill, N. of Elderton,	1448	"	"
6.	West Lebanon,	1348	"	"
7.	Elderton plateau,	1313	"	"
8.	Lutheran church, S. of Elderton,	1273	"	"
9.	Ralston farm, N. of Idaho,	1185	"	"
10.	Mouth of Plum creek,	1025	"	"

§ 88. *The geological structure* of the Crooked Creek region consists of a series of shallow synclinal basins, separated by low anticlinal arches. The dips are uniformly gentle; never more than 3° and seldom exceeding 1°. Some of the axes are but the prolongation northeastward of those described in Chapter I (Kiskiminitas valley); others again are first met with, going north, on the Crooked creek waters. Their passage across the valley has in great part determined the irregular course of the creek.

Proceeding from east to west the first axis is the *Perrysville anticlinal*, which displays itself along Plum creek (a branch of Crooked creek), east of Elderton. It makes its presence known in lifting Lower Productive rocks to daylight over a small area, as shown on the geological map. After crossing the county line from Indiana about the heads of Dutch run, its course is not far from S. 40° W. to the neighborhood of the Ralston school house, where its arch can be clearly made out in the exposures; but dying rapidly southward, it fades out totally before reaching Crooked creek, which, otherwise, it would cross below Idaho mills. With the flattening of the arch the rocks assume the hor-

izontal, and the anticlinal insensibly merges, westward, into the *low flat synclinal* in which the creek flows between Idaho and South Bend. This change of structure has in fact occasioned the long bend which the creek there makes. Further south the synclinal is shifted eastward somewhat, to pass through the West Lebanon region.

§ 89. The next axis to the west is the *Roaring Run anticlinal*, which crosses Crooked creek about midway between Mr. George's house and McKnees' pottery. It lifts the Ferriferous limestone above the water level, sustaining it above the creek for nearly a mile. The axis has dips amounting in places to as much as 3°; but its strength has greatly weakened in its run from the Kiskiminitas river across the uplands of Kiskiminitas township, while still further north there is a continued decrease of energy until the axis fades out and is lost under the Barren Measure uplands of North Plum Creek township and South Cowanshannock. Scarcely a trace of it exists west of Elderton, nor is anything seen of it west of Atwood.

Below the pottery the creek crosses the *Fagley's run synclinal*, a local axis, whose presence is indicated by the disappearance of the Ferriferous limestone under the stream bed. So shallow is this axis here that the rocks are lowered only about 30 feet in all. Its central line crosses the creek in the neck of the bend below the pottery, called the "Loop," whose curve it has determined. Traced northward through Plum Creek township, it merges into the Apollo synclinal.

At the old salt works, below the "Loop," the creek crosses a low feeble anticlinal arch whose maximum strength is there reached. Southward it quickly dies beneath the uplands of Kiskiminitas township, and northward, in South Bend township, all hold of it is lost no less quickly. Along the creek it lifts the rocks about 50 feet out of level, thus bringing the Ferriferous limestone again to daylight.

§ 90. *The Apollo synclinal* is crossed between the salt works and Cochran's mills. As along the Kiskiminitas, so also here it is a shallow trough with gently sloping sides. Northward it passes between Cherry run and Fagley's run,

beyond which it not only overrides the two small axes last described, but includes also the Roaring run anticlinal in addition, and covers, finally, nearly all Cowanshannock township with Lower Barren rocks.

Below Cochran's mills, the creek comes up against the *Apollo anticlinal* which it crosses in the first bend below the mills, at the mouth of a small nameless run. Feeble as is the axis in the Kiskiminitas Valley, it is even more feeble here. But the arch is, nevertheless, plainly discernable.

The Leechburg synclinal crosses somewhere near the mouth of Carnahan's run. West of it the creek makes a series of sharp bends preparatory to crossing the *Bagdad anticlinal* below Kough's mill. Both the synclinal and the anticlinal are feeble and indistinct; but both are, nevertheless, recognizable and continuous into the region to the north. In that direction the anticlinal rises rapidly, as will appear from the increased depth of the rock sections along Cowanshannock creek. Another anticlinal is suspected to cross Crooked creek between the Bagdad arch and the mouth of the stream. Its presence, however, was not made out with certainty. If it exists at all it is extremely feeble, and is of local occurrence like the axis at the salt works.

§ 91. *The surface rocks of the region* are substantially those of the Kiskiminitas country. Lower Barren Measures overspread all the highlands. Lower Productive rocks occupy the base of the hills from South Bend westward to the river.

Exception to this, however, is found over a narrow area east of South Bend, as well as north and south from it, where Lower Barren rocks cover all the surface from the highest land to the water level. In a southerly direction the succession is continuous until it receives a coping of Upper Productive Measures. A rough estimate of the thickness of the Barren group at this place gave 575 feet as the result, corresponding thus with the measurement made of the same series along the Kiskiminitas. In all other directions the Barren group is represented only in part.

Numerous local sections exhibit in a partial manner the different horizons of the Lower Barren group. In the present connection only the prominent features of the series

are enumerated, leaving the reader to consult subsequent pages for more detailed information. *The Pittsburg limestone*, near the top of the series, was seen near Mr. Weaver's house and again further south. *The Connellsville sandstone*, though shaly is recognizable in the township road north of Weaver's. It is too imperfectly exposed to measure its thickness. *The Morgantown sandstone* is so indistinct that it is little more than a mass of loose sandy shales. Below it are several bands of red shale, prominent on account of their color, and corresponding with similar shale layers seen east of Maysville on Long run, (§ 63.) A coal bed 100 feet above the Freeport Upper seam, and on that account identified as the *Philson seam* of Berlin, is of local importance along a small nameless run west of South Bend. *The Gallitzin bed* attains workable thickness in the ravine of Carnahan's run, and at other localities. Neither the *Green Fossiliferous limestone* nor the *Black Fossiliferous stratum* was observed. *The Mahoning sandstone*, though invariably present, undergoes wide extremes of variation, both in respect of thickness and form of bedding. In no case, however, is it so massive here, or so thick as along the Kiskiminitas river below Saltzburg.

§ 92. On the crown of the Roaring run arch and at the salt works, the Lower Productive group is above water level, with the exception only of its lowermost members. Elsewhere in the valley only about one half of the group is in the hills. The structure, however, enables the most valuable part of the series, the Freeport group, to have a continuous range along the slopes, westward from where these rocks first rise above the creek at South Bend to the river at Rosston. The Kittanning group contains little of practical interest. Its coal beds are usually present, but almost always too small to be available. The only reliable bed in all the list, on Crooked creek, is the Freeport Upper, and upon this seam the region largely depends for its supply of coal. The bed, 3½ feet thick on the average, is never especially pure, never free from slate and iron pyrites in moderately large quantity. Generally hard and compact, its condition much resembles that of the same seam along

the Kiskiminitas. At certain localities some of the other and lower coal beds expand into workable thickness, but at the best they are irregular and uncertain. The Kittanning Lower coal is above the water line only over a limited area, and where exposed is of little value. In all estimates of the productiveness of these coal fields the Freeport Upper bed is the first and main consideration.

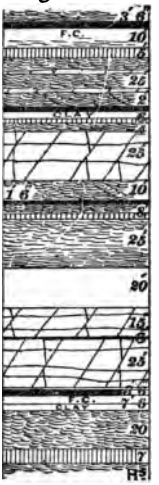
But while such variations take place in the coal beds the section, as a whole, bears the closest resemblance to that made of the same rocks along the Kiskiminitas. Not only are the interval distances between the different coal beds substantially the same, but the rocks which make those intervals undergo little or no change in passing under the highlands between Crooked creek and the Kiskiminitas. Little difficulty can attend the matter of identification when once the main features of the section are acquired.

§ 93. The following section of the Lower Productive rocks has been compiled from numerous small sections made at different parts of the Crooked creek valley. It is typical of the group as far as it goes. Subsequent pages will show how much of the column is above the water-line at each particular locality, and what local changes the different strata undergo:

Lower Productive Rocks on Crooked Creek.

Slate and shale,	—
Coal bed, *Freeport Upper*,	3′ 6″
Fireclay and clay shale,	10′ 0″
Limestone, *Freeport Upper*,	5′ 0″
Shales and thin SS. layers,	25′ 0″
Coal bed, *Freeport Lower*,	2′ 0″
Clay,	4′ 0″
Limestone, *Freeport Lower*, often missing,	2′ 0″
Shales,	4′ 0″
Sandstone, Freeport,	25′ 0″
Shales,	10′ 0″
Coal bed, *Kittanning Upper*,	1′ 6″
Shales,	5′ 0″
Limestone, Johnstown cement, often missing,	3′ 0″
Shales and slates,	25′ 0″
Concealed rocks,	20′ 0″
Sandstone,	15′ 0″
Coal bed, *Kittanning Middle*,	0′ 6″
Sandstone,	25′ 0″
Slate and clay,	1 0″

Fig. 13. § 93.



Coal, *Kittanning Lower*,	2′ 6″
Fireclay, impure,	4′ 0″
Potters' clay,	3′ 6″
Ferruginous shales,	20′ 0″
Ferriferous limestone,	7′ 0″
Shales,	—
Total thickness,	223′ 6″

§ 94. *The fireclay deposits* have never received investigation. At some localities, of which mention is made in the sequel, favorable outcrop indications were observed; but with the outcrops unopened, no correct estimate can be made of their value. The limestones have been similarly neglected, excepting in a few instances. Sandstone exists in boundless profusion, much of it valueless; some of it being jointed and fissured, can be raised for flagstones; still other of it, compact and moderately free from impurities, might be employed in building; but all of it, in its present remoteness from a market, is of little immediate value.

Although a considerable amount of timber is yet standing here and there through the valley, there is nothing deserving of especial mention. According to the statement of the oldest settlers, the valley originally contained neither pine nor hemlock The region was a wilderness of oak, the greater part of which has been destroyed in "clearing" the farms. What of it remains in the lowlands is chiefly chestnut-oak. White oak thrives on the smoother soil of the uplands, where also some good hickory is found, and some walnut. Chestnut exists both among the sandy soils of the Lower Productive rocks, and among the shales of the Barrens. Everywhere in the region there is abundant timber for mining props.

§ 95. Crooked creek, for several miles after entering Armstrong county, flows in Lower Barren rocks. At the county line, about two miles above Idaho Mills, the Freeport Upper coal and limestone are above the water level; and the same coal bed, though close to the water line, continues above it for nearly one half mile below the mouth of Plum creek. Its condition and thickness at the latter place are described on subsequent pages of this report. Though not here actually

exposed to view on Crooked creek proper, its outcrop line may be followed as far south as Mr. Clark's house, where it sinks below the stream.

Thence southward and westward past Idaho Mills and around the long curve to the village of South Bend, and beyond this, also, for at least a quarter of a mile, the surface rocks are of the Lower Barren group. Those here exposed present few features of interest. The *Mahoning sandstone* is indistinct at the mouth of Plum creek as it is also at Idaho; but where it re-appears beyond South Bend it is more compact, and is hence more prominent along its outcrop line. Above the sandstone are shales and slates, chiefly dark colored; above these is a deposit of sandstone, which as a cliff 50 feet high is the chief feature in the exposures at South Bend, where it makes the top of the hill overlooking the bridge. The base of the sandstone was estimated to be about 200 feet above the Freeport Upper coal.

The Black Fossiliferous limestone should occur in the shales below this sandstone, but was not detected in any of the exposures either at South Bend or Idaho. It may, however, be seen east of the county line, between Idaho and Shelocta, outcropping in the township road above the creek. It is one foot thick and highly fossiliferous.*

§ 96. Formerly the creek at Idaho, instead of flowing a direct westward course as it now does, described a long bend towards the north, which may without difficulty be traced in that direction around the base of a cone-shaped hill standing isolated on a broad plain northwest of the mills. The ancient course of the creek met the present one about a mile below the mills, near where the valley turns sharply towards the south. The small stream, which now unites with the creek at the mill, then extended further westward, being separated from the main valley only by a narrow projection of land, which latter being subsequently broken down, the creek forsook its long bend and occupied the more direct channel of the run.

§ 97. *The region of South Bend* village represents the

Report HHHH, p. 279.

point at which the Perrysville anticlinal would, if extended, cross Crooked creek. But this axis being here extinct, its flattened arch insensibly merges into the next basin to the west. The result of this change is seen at South Bend, where the dip is uniformly and very decidedly to the south-east. So it continues down Crooked creek past Coleman's saw-mill and nearly to the pottery, close to which place the Roaring run anticlinal as a symmetrical fold, crosses the stream. Under the influence of the latter the surface rocks constantly change in descending the creek. The Barren measures are quickly moved to the hilltops, and as they ascend the slopes, Lower Productive strata succeed them in regular order, until finally, the Ferriferous limestone comes to daylight.

§ 98. Below South Bend the *Freeport Upper coal* first makes its appearance in the "bottom" lands near Mr. Wherry's house. There it has been opened 3 feet thick; and there, also, the *Mahoning sandstone*, capping the coal, shows in the township road. The rock is fine grained, of a greenish color, and much cracked and broken by small vertical crevices. East of Mr. Wherry's it is in the bed of the creek.

So rapidly do the rocks rise northwestward that on the Barr property, barely one half mile below Wherry's, the Freeport Upper coal is 160 feet above the level of Crooked creek. Nor does this change of elevation express the full force of the rise, which is in the direction of N. 60° W. The exposures at Barr's are tolerably complete, beginning with the *Philson coal bed of Berlin*, and ending with the Kittanning Middle coal. Although in places the hills rise 100 feet above the Philson, they show nothing. The section is as follows:

Philson coal bed,	2′ 6″
Fire clay, good,	3′ 0″+
Interval, chiefly sandstone, *Mahoning*,	85′ 0″
Coal bed, *Freeport Upper*,	3′ 6″
Fire clay shales, impure,	12′ 0″
Limestone, Freeport Upper,	6′ 0″
Concealed,	5′ 0″
Sandstone,	10′ 0″
Concealed (shales?),	17′ 0″
Coal bed, *Freeport Lower*,	2′ 0″

Clay shales, calcareous,			10′ 0″
Sandstone,			10′ 0″
Coal,	*Freeport SS.*,		0′ 6″
Concealed, sandstone?			15′ 0″
Shales,			15′ 0″
Coal bed, *Kittanning Upper*,			0′ 6″
Concealed,			45′ 0″
Total thickness,			242′ 0″

Sandstone here makes the bed of Crooked creek, beneath which is the *Kittanning Middle coal.*

§ 99. Little information of a definite kind is known at this place of the Philson coal bed. It is the seam which outcrops on the Barr farm in the field above the orchard, where it makes a line of springs at the foot of a bench, and where also its underlying fire clay is partly exposed. Mr. Barr once opened the coal and claims to have found the thickness above given. The seam again appears in a small ravine a few hundred yards north of Mrs. Smith's house, where it was once mined; the old pits are now closed. The underlying fire clay has never properly been opened up for examination; judging from outcrop appearances the clay is of fair quality.

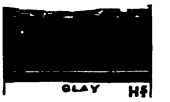
The Mahoning sandstone is here barely noticeable, fading out in places almost entirely into a mass of loose sandy shales.

§ 100. *The Freeport Upper coal* is the most important bed in the region, and the only one that is now mined. West of Barr's its outcrop line extends far up all the little ravines leading north and south from Crooked creek, in nearly all of which it has been opened up and found to possess the same average thickness that it does throughout the main valley.

That average thickness in the neighborhood of the Barr farm is a trifle over three feet. In some of the openings upwards of four feet of coal are mined; but such thickness is exceptional. The coal is not especially good, containing much slate and iron pyrites. The following section, taken from the Barr mine, about represents the average thickness of the seam:

Roof black slate,		—
Coal,	2′ 8″	
Slate,	0′ 0½″	3′ 2½′
Coal,	0′ 6″	
Clay,		—

Fig. 14. § 100.



§ 101. *The Freeport Upper limestone* is in the spring at Mr. Barr's house; and it is again exposed along the township road to the north, where it has been quarried. It is a compact hard stone, very pure and good. It slakes down readily, after light burning, into excellent lime.

The Freeport fire clay was not observed at this place. There is however a concealed interval of 5 feet beneath the limestone which may contain it.

The Freeport Lower coal rarely exceeds two feet thick in this neighborhood. Its outcrop is plainly discernible along the township road at the end of Mr. Barr's lane. At other points also it is equally distinct, occurring at an interval of from 40 to 50 feet below the Freeport Upper seam.

§ 102. The remainder of the section from the Freeport Lower coal to the water level at Barr's contains little of interest. The calcareous clay underlying the Freeport Lower coal undergoes little or no change; it is nowhere a limestone in the vicinity of Barr's as it is at other localities. The small coal seam ten feet lower in the column is a local occurrence; it is wedged between two layers of the *Freeport sandstone.* The latter rock is here shaly and current-bedded—in striking contrast to its condition a few miles further west, at Cochran's mills. *The Johnstown cement* is absent. *The Kittanning Middle coal* is beneath the creek; but where it appears further west it is small and worthless. Still further west the *Ferriferous limestone* comes to daylight on the property of Mr. P. George.

In a little ravine at George's the succession is thus continued from the lowest rock at Barr's to the Ferriferous limestone:

Sandstone in creek at Barr's,	12′ 0″
Coal bed, *Kittanning Middle*,	0′ 6″
Sandstone, partly thin bedded, used for flagstones,	25′ 0″
Slates and clay,	1′ 0″
Coal, *Kittanning Lower*,	2 5″

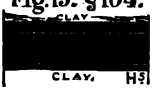
Clay, impure,	4′ 0″
Potters' clay,	3′ 6″
Shales, ferruginous,	25′ 0″
Ferriferous limestone,	7′ 0″+
Creek at George's house.	—
	80′ 5″

§ 103. The sandstone underlying the Kittanning Middle coal is not only a conspicuous feature of the local geology, but assumes practical importance. At George's its basal portion is so evenly bedded, and so regularly jointed and fissured that flagstones of convenient size can be obtained from it. A small quarry was opened on it many years ago to obtain paving and tombstones for use in the village of Elderton. The locality is referred to in the Geology of Pennsylvania, by Prof. H. D. Rogers.* Further down the creek, below the pottery, the rock makes high vertical cliffs; at the pottery it has scattered large bowlders of sandstone over the surface.

§ 104. *The Kittanning Lower coal* is concealed in the little ravine at George's. It outcrops, however, at the pottery, nearly opposite which, in the woods close to the bridge, it was once mined. It is so much broken by parting slates that the seam is nearly worthless for practical purposes. Moreover, the coal is highly pyritous. A detailed section of the bed will show in what manner it is subdivided:

Slate and clay,		—
Coal,	0′ 6½″	
Slate,	0′ 1 ″	
Coal,	1′ 6 ″	2′ 5″
Slate,	0′ 0½″	
Coal,	0′ 3 ″	
Clay,		—

Fig. 15. § 104.



The dip at the pottery is N. W. At George's it is S. E. By these reverse dips the arch of the Roaring run anticlinal is defined.

§ 105. The fireclay, which comes in directly below the coal bed, is coarse and impure. But below this is a mass of potters' clay, of fairly good quality, which, at Clayton, is mined and used in the pottery of Messrs. Mc-

* Vol. II, p. 592.

Knees & Son. Apparently the clay exists here in great abundance. On the flat at the pottery it can be raised at little cost. The articles made from it are much esteemed in the neighborhood, where they find an extensive sale among the farmers.

In the stratum of ferruginous shales between the clay and the limestone, nodules of carbonate iron ore occur in great abundance. The *Buhrstone ore stratum*, which should intervene between the shales and the limestone, was not detected, nor is anything known of its existence in the neighborhood. The *Ferriferous limestone* is above the water line for about two thirds of a mile; coming out, as before stated, on its southeast dip, at George's, and disappearing again, dipping northwest, before reaching the bridge at the pottery. At this latter place it is about 10 feet below the stream bed.

§ 106. The rock is uniform both in respect of thickness and composition. It is of a bluish-gray color, coarse, compact, and very brittle; it is richly fossiliferous. It has been quarried to a small extent in the creek bank, near Mr. George's house. The lime made from it is of a dark color, but good, breaking down into a soft fine powder. An analysis was made by Mr. McCreath, of a specimen from Mr. George's quarry, with the following results:

Carbonate of lime,	94.185
Carbonate of magnesia,	1.483
Oxide of iron and alumina,	2.089
Phosphorus,	.031
Insoluble residue,	2.100

The outcrop line of the Freeport Upper coal passes round the knob overlooking the Dunker church, north of Mr. George's house. An accurate measurement of the distance between the coal bed named and the Ferriferous limestone gave 243 feet as the result.

§ 107. Descending the creek below the pottery, very gentle northwest dips are continuous to the neck of the "Loop." These dips lower the strata 15 feet in level, burying the limestone about 10 feet under the creek bed. From the "Loop" the strata rise northwestward 30 feet to the salt works, which again brings the limestone out of the creek bed,

and places it high above the water line. Beyond the old salt works the dip again changing to northwest, the limestone quickly disappears, to remain concealed elsewhere throughout the Crooked Creek valley.

It is unnecessary to describe in detail all the exposures of the different strata between the pottery and the salt works. The measures indeed undergo little change. The outcrop line of the Freeport Upper coal being high above the water level, ascends the little ravines leading into the highlands from the main valley until it disappears under the Lower Barren rocks that here overspread the uplands. The *Mahoning sandstone* is massive only in the ravine east of the Ramaley school house, where also the Freeport Upper coal has been exposed. The Kittanning Lower sandstone is perhaps the feature of the greatest prominence. It is beautifully shown in the cliffs at the "Loop" where it is a solid mass 25 feet thick. It here directly overlies the Kittanning Lower coal, which latter is much injured by the contact. Above the sandstone is a concealed interval of 25 feet, consisting apparently of shales, above which is massive sandstone 50 feet thick. These two sandstone strata have made a wilderness of the "Loop," in which the creek bending to flow south, has the dip directly across it, thus making the right bank a nearly vertical wall.

At the old salt works the *Ferriferous limestone* has the same character and appearance that it bears at George's. The *Buhrstone ore stratum* is apparently absent. The *Kittanning Lower coal bed* has been opened 3 feet thick; it is overlaid by rusty shales for 10 feet, above which is the sandstone above mentioned, only much less massive here than in the "Loop."

§ 108. The hills have few good rock exposures along their upper levels. The outcrop line of the *Freeport Upper coal* crosses the road leading to Cochran's mills a short distance beyond Mr. George Cramer's house. Next it appears near W. R. Ramaley's, where, in the woods overlooking the creek west of the house, its underlying limestone appears, below which, at a distance of 30 feet, is a second and similar

limestone stratum. The latter is underneath the Freeport Lower coal. Neither stratum exceeds four feet in thickness; both are in good condition.

Around the point of the hill towards the west the Freeport Upper coal is mined on the farm of Mr. M. Davis. The bed has an irregular roof occasioned by "clay horses," which sometimes cut through to the under clay. Where regularly developed, the coal is three feet thick; it is both slaty and pyritous. The dip is N. W.

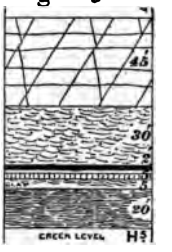
Two bands of red shale appear in the road near Mr. Davis' house, 30 feet apart; they are respectively 125 and 155 feet above the Freeport Upper coal. The Mahoning sandstone is shaly.

Some of the hills are prettily benched. At the cross-roads near A. J. Ramaley's house, there is an extensive plain which marks the level of the sixth bench of the Crooked creek series.

§ 109. Descending now into the valley at Cochran's mills, a fine display of the *Freeport sandstone* is seen in the bluff opposite the mill; below it is the *Kittanning Upper coal* with the *Johnstown cement.* The section is typical. A similarly typical section of the same geological horizon is found along the Allegheny river near Rosston, with which the reader will find it interesting to compare that here given for the Cochran's mills region:

Sandstone, *Freeport,*	45′ 0″
Sandy shales,	30′ 0″
Coal bed, *Kittanning Upper,*	2′ 0″
Fire clay, impure,	2′ 0″
Limestone, Johnstown cement,	3′ 0″
Clay and shales,	5′ 0″
Slates, dark,	20′ 0″
reek level,	—
	107′ 0″

Fig. 16. §109.



§ 110. *The Freeport Lower coal* which should appear almost directly above the Freeport sandstone, was not seen in the vicinity of the mills. *The Freeport sandstone* is the distinguishing feature of the local geology, cliffing out up and down the creek, and also along Cherry run. It is

usually massive, coarse grained and mottled with iron stains, but in places, like the Mahoning above it, it quickly changes into a loose bedded irregular mass of coarse sandy shale.

The shales underlying the sandstone at the mills are still more irregular, vanishing sometimes almost entirely and bringing the sandstone thus into direct contact with the coal. *The Kittanning Upper coal* is here also a variable quantity. It is repeatedly exposed. At Mr. Davis' above Cochran's mills its thickness is the same as in the section above given. So it is also along Cherry run, where it has been mined. Lower down the creek its thickness is diminished in places to a mere streak. It is nowhere a bed of practical importance in the region.

§ 111. *The Johnstown cement bed*, though tolerably persistent westward along the creek from Cochran's mills, is not always easy to detect. At Davis', as also in the exposure opposite the mill, it is a true cement deposit. To accurately determine its composition in this respect a specimen of the rock was analyzed by Mr. McCreath with the following results. The specimen was taken from the M. Davis property:

Carbonate of lime,	53.750
Carbonate of magnesia,	9.989
Oxide of iron and alumina,	7.730
Phosphorus,	.131
Insoluble residue,	23.840

The cement stratum is fossiliferous, showing the same minute univalve shells, which are so characteristic of the Freeport Upper limestone, for which stratum its outcrop at this place was, indeed, mistaken by Prof. Rogers, in the Geology of Pennsylvania.* The interval between it and the overlying Kittanning Upper coal, varies from two feet, (the distance in the section given above,) to eight feet.

§ 112. The creek road from the mills, westward along the right bank of the stream touches the outcrop line of the Freeport Upper coal at a point 138 feet above the water level. The dip is southeast and continuous also in that direction

* Vol. II, p. 592.

for about one third of a mile, when the incline is reversed on the arch of the Apollo anticlinal. The coal bed is lifted by this axis about 50 feet, or about the same as in the Kiskiminitas region.

A handsome display of the Freeport sandstone is found in the little ravine of Pine run, which comes into the creek, near where the Apollo anticlinal crosses the valley. The rock makes a wilderness of the ravine from Slease's sawmill to the creek. Towards the north the Freeport Upper coal outcrops on the King property, where it dips northwest, and where according to Mr. King the seam measures 4 feet thick. Still further west it is again mined near the Altman school house. There its underlying limestone may be seen 15 feet below it; underneath the limestone is the Freeport fire clay, apparently of good quality.

Crossing the creek and taking up the exposures along the left bank west from the mills, the township road skirts the outcrop line of the Freeport Upper coal. The bed runs through the fields of the Wm. Louden farm, where it is opened and shows four feet thick. Thence it passes above the Dunker church, and so on westward into the Carnahan ravine, in which, though increased somewhat in thickness, it is too impure to be of much value. Below it the Freeport sandstone makes high cliffs along the water line, while above it the Mahoning sandstone outcrops in a similar manner. The hillslopes are usually gentle, and in some cases prettily benched. On the Heilman (?) property due south of Cochran mills the 6th, 7th and 10th benches of the Crooked Creek series are distinctly marked.

§ 113. In the Carnahan ravine the section is varied by the introduction of two Barren measure coal beds into the column. The lower of these being 50 feet above the Freeport Upper, is in place for the *Gallitzin seam*, which also occurs in workable condition along Cherry run, as elsewhere described. The other of the Barren Measure seams is 175 feet higher, occurring in connection with a stratum of red clay shale, near Mr. Carnahan's house. It is doubtless identifiable with the seam once worked near Mrs. Cline's house, beyond the cross roads about a mile west of the oil

well derrick. Its outcrop on the Mrs. Cline property has the same red shale accompaniment that is seen at Carnahan's. The coal bed is reported to have a thickness of four feet where opened at Cline's, but undoubtedly such thickness is abnormal, for on the neighboring farms, and also at Carnahan's its outcrop is little more than a streak.

Variegated slates and shales separate it from the Gallitzin. The latter seam is scarcely more persistent than the other, being apparently only of workable thickness on the Carnahan property, near the oil well derrick. There it is 3½ feet thick, without parting slates. A small drift opened upon it at this place, has of late years largely supplied the coal needed for local use. So far as the bed has yet been followed in the mine, there is no material change either in its thickness or quality, but traced along the side of the ravine below the oil derrick, the dimensions are so much reduced that the bed can scarcely be recognized at all at the mouth of the run below the saw-mill.

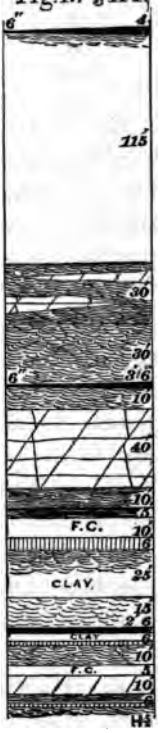
It rests on massive sandstone 40 feet thick. This sandstone is the Mahoning, which is handsomely shown in the sides of the ravine, where it makes tall cliffs. The Freeport Upper coal is so much subdivided by parting slates, that the seam is worthless for mining. The following section will exhibit its condition in this respect:

Coal,	1′ 4″	
Clay and slate,	1′ 10″	
Coal and slate,	1 8″	5′ 2″
Slate,	0′ 2′	
Coal,	0′ 2″	
Clay,		

§ 114. Its limestone on the contrary is in good condition for use as a fertilizer. It shows just below the coal, at the level of the run, where it has already been quarried to a small extent. Lower down the stream, at the saw-mill, the Freeport Lower coal is 2′ 6″ thick, having also its limestone underneath it, but impure. The Kittanning Upper coal has here a cannel structure, and is too slaty to be of value. At the mouth of the run it is sufficiently high above the stream to admit the Johnstown cement to daylight. The

latter stratum shows at this place as a small irregular band of highly ferruginous limestone. The entire section, beginning on the uplands with the Barren measure coals is as follows:

Fig. 17. § 114.



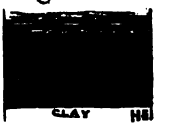
Coal bed,	0′ 6″ –	4′ 0″
Red clay shale,		—
Interval,		115′ 0″
Sandstone and shales,		30′ 0″
Shales,		30′ 0″
Coal bed, *Gallitzin seam*,	0′ 6″ –	3′ 6″
Shales,		10′ 0″
Sandstone, *Mahoning*,		40′ 0″
Black slates,		10′ 0″
Coal and slate, *Freeport Upper seam*,		5′ 0″
Fire clay,		10′ 0″
Limestone, Freeport Upper,		6′ 0″
Shales, ferruginous,		25′ 0″
Shales,		15′ 0″
Coal bed, *Freeport Lower*,		2′ 6″
Clay,		4′ 0″
Limestone, Freeport Lower,		2′ 0″
Shales,		10′ 0″
Fire clay, poor,		5′ 0″
Sandstone, *Freeport*,		10′ 0″
Cannel slate, *Kittanning Upper coal*,		3′ 0″
Shales,		1′ 0″
Limestone, ferruginous, *Johnstown cement*,		2′ 0″
Shales at run level,		—
Total,		343′ 0″

§ 115. Below the mouth of the run and around the long bend other exposures of the same rocks occur near Kough's mill. Trifling variations are noticeable, such for example as the reduction of the Freeport Lower coal to one foot thick, and the increase of its underlying limestone to 4 feet thick, and the increase also of the Freeport sandstone to 20 feet thick. The Freeport Upper coal and limestone may be seen at W. Heilman's, near the Union church, at which place they are exactly 15 feet apart; the limestone is 8 feet thick, and good. Fragments of the same rock are also seen along the township road in the neck of the bend.

The coal having here recovered from its slaty and worthless condition in the Carnahan ravine, shows as a good bed in nearly horizontal position. The section at Heilman's, is thus:

Fig. 18. §115.

Black slate,		—
Coal, bony,	0′ 5″	4′ 5″
Slate,	0′ 3″	
Coal,	3′ 9′	
Clay,		—



Below Heilman's the bed is little worked along the left bank of Crooked creek. In fact its existence there is scarcely known, owing to the wilderness condition of the north slope of the valley from Heilman's down. But on the opposite side, in Manor township, it is repeatedly exposed. It shows in the road near Mrs. Aiken's house, and again at the saw-mill, further west, near the house of Rev. Mr. Graves. Its thickness at the latter place is the same as at Heilman's. The Mahoning sandstone is here also finely exposed, forming as it does a prominent projection, on which Mr. Graves' house stands. The Freeport Upper limestone comes out in the mill race; it is between 4 and 5 feet thick; has some few fossils, and makes good lime. Fire clay apparently of good quality underlies the limestone.

§ 116. The Freeport Lower coal bed is exposed at the bridge, near the Methodist church, about a mile above the saw mill. Its thickness is greatly increased above the average. How far it may extend in the same expanded condition is a matter of uncertainty. To judge however from outcrop indications there is apparently little continuance of it either towards the east or west. The coal itself is both slaty and pyritous. It was once mined here to a small extent, but the drift is now closed.
The section at the bridge is as follows:

Thin bedded SS.,	10′ 0″
Black slates,	5′ 0″
Coal (parted),	4′ 6″
Shales,	5′ 0″
Sandstone,	15′ 0″
Shales, sandy,	10′ 0″
Concealed to creek,	20′ 0″
Total thickness,	69′ 6″

It will be observed that the Freeport Lower limestone is missing.

Westward from the saw-mill to the creek's mouth at Rosston, the same rocks as those above described are continuous along the hills. Only the Freeport Upper coal and limestone are of importance to the miner. Their condition at Rosston is described on another page of this report.

§ 117. *Plum creek* is the main tributary of Crooked creek. It is a small stream flowing a southward course, through a valley whose width and depth are out of all proportion to the volume of water it contains. The hills are usually about three hundred feet in height; the water supply, besides its irregularity, is capable only of very limited use.

Plum creek has two branches, a North and South fork, both of which head in Indiana county, the South fork near Marlin's mill, and the other beyond Plumville. The two unite in Plum creek township, of Armstrong county, about 2½ miles northeast of Elderton. The water flowing from the high plateau on which Elderton is situated, runs partly into Plum creek, and partly direct into Crooked creek.

The surface geology consists of alternations of Lower Barren and Lower Productive rocks, the Lower Barrens predominating. The creek, throughout nearly its entire course is in a synclinal, out of which it passes only just before uniting with Crooked creek. The anticlinal axis, whose force is felt in the uplift of Lower Productive rocks, is the prolongation southwestward of the Perrysville arch.

The same anticlinal axis crosses the valley of the North fork below Plumville, in Indiana county, where it also lifts Lower Productive rocks to daylight.* Following thence down the stream, the Freeport Upper coal continues above the water level for about a mile beyond the county line. The dip is N. W. and very gentle; so gentle, indeed, as scarcely to exceed the slope of the creek bed. At the county line the coal seam is 10 feet above the water's edge, an interval not sufficient to expose the Freeport Upper limestone, but yet sufficient to allow of easy drainage to all the mines run in upon the outcrop of the coal from either side of the valley.

* See Report HHHH, pp. 282–284.

§ 118. Where opened on the Anderson property, the bed differs somewhat from its condition in the mines below Plumville. The change is to its detriment. A parting of worthless bony coal is introduced near the top of the seam, necessitating a considerable amount of roof coal in mining, which could not profitably be removed. A vertical section, representing the average of two sections, will show the conditions more clearly:

Fig. 19. § 118.

Shales and slate,		—	—	
Coal,	roof division,	1′ 8″		6′ 6″
Slate and bony coal,		0′ 8″	1′ 0″	
Coal,		2′ 0″	3′ 10″	
Clay,		—	—	

The coal in the lower bench is both slaty and pyritous.

§ 119. *The Mahoning sandstone* is seen in the heavy bowlders of rock so abundant at the surface in the neighborhood of the Lutheran church at the county line, where it is conglomeratic and massive, but losing both these features, it is indistinct at Anderson's. Above it, northward to the divide overlooking Cowanshannock creek, and southward towards Atwood, are hills two hundred feet in height, containing Lower Barren rocks. No workable coal beds are contained in them, nor have any limestone strata of importance yet been discovered. The same conditions are found also in the valley itself after the disappearance of the Freeport Upper coal below the water level at Anderson's. Nor is there any change until near the Dunker church, below the forks, where the Freeport bed again re-appears. The hills have been carefully examined for coal by the farmers, not only on the uplands about Atwood, but along the creek, without anything of value being revealed. Some streaks of coal occur, but too small in every instance to be profitably followed under cover. The prevailing rock of all this Barren region is an argillaceous shale.

The South fork of Plum creek having a similar course to the North fork, repeats the geology just described. As in the former case, so here, the dips at the county line are N. W. in consequence of the Perrysville anticlinal crossing the ra-

vine in Indiana county. The axis passes near Rev. Mr. Brown's house, where the Freeport Upper coal is 30 feet above the water level. At the county line this interval is reduced to 10 feet, and the bed finally overtakes the creek below the cross-roads at Johnston's. The Freeport Upper limestone, which is exposed at Mr. Brown's, is concealed at the county line. The coal bed is 3′ 4″ thick. It has been opened on nearly every farm between Marlin's mill and Mr. Brown's,* and also in Armstrong county on the Schafer property. Its roof is tough slate, and its floor is clay. The coal is hard, compact, with small knife edges of slate and some pyrites, though sufficiently free from both impurities to make a fairly good fuel for domestic use. Below Schafer's the surface rocks are of the Lower Barren group, until beyond the forks of the creek. The Mahoning sandstone though indistinct, is yet recognizable.

§ 120. *Dutch run* is another tributary of Plum creek. Its ravine is important in exposing a long outcrop area of the Freeport Upper coal bed, lifted to daylight by the Perrysville anticlinal, whose arch entering the county near the head of the run, skirts the right bank of the ravine. At the mouth of the run the Freeport Upper coal is 25 feet above the water-level; its limestone underlies it 10 feet. Both strata are exposed on the Clark property, nearly a mile above the mouth of the stream. The limestone is there at the level of the run. It is four feet thick, very compact, of a bluish color, and fossiliferous. It makes good lime.

The coal bed has a firm slate roof and a regular floor of fireclay. The seam is divided into two benches, the upper of which is 2½ feet thick, and the lower about six inches thick. The parting slate is less than an inch in thickness. The coal is hard and compact.

Continuing northeast up the ravine the coal bed is at water-level at J. Ramsey's, beyond whose farm, to the north, it is concealed beneath a covering of Lower Barren rocks.

In these Barren measures a bed of coal four feet thick at the outcrop was discovered on the Beatty farm. Being 100 feet above the Freeport Upper bed, it is at the horizon of

* See Report HHHH, pp. 280, 281.

the Philson seam of Berlin. An opening was once made upon it with a view of development; but the bed proving irregular and uncertain in point of thickness, the attempt was abandoned. The trial drift is now closed. Vigorous search has been made for the same bed on the surrounding hills with little success; where discovered at all, it is only a small, worthless seam. Its expanded condition at Beatty's is therefore merely a local occurrence. It is overlaid by shales and sandstone, which latter rock makes an abundant display on the slopes at Beatty's.

§ 121. Along Plum creek proper the Freeport Upper coal is continuously above water level below the Dunker Church. Its outcrop line is easily discernible along the hills, from the bench which usually accompanies it; but exposures of the seam are rare. It may however be seen at the side of the township road near the mouth of Plum creek; while on the opposite bank it is mined on the Jas. S. Ralston farm. It is 3½ feet thick, increasing sometimes to 4 feet, and again dropping to 3 feet. The coal is not especially good; that from the Pittsburg seam, although requiring to be brought from the neighborhood of West Lebanon, six miles distant, finds a readier sale among the farmers, than the coal from the Ralston mine.

The Freeport Upper limestone is exactly the same here as at Clark's on Dutch run. Hitherto the farmers have given it but little attention. Abundant use of it would materially increase the profits of the soil. It goes under the water level at the mouth of Plum creek, where it may be seen outcropping just above the water's edge, at which place also some quarry lime has been obtained from it. The exposures here reveal the succession between the Mahoning sandstone and the limestone as follows:

Sandstone, thin bedded,		20′ 0″
Shales, sandy,		10′ 0″
Shales, grayish,		10′ 0″
Coal bed, *Freeport Upper*,		3′ 6″
Fire clay shales, impure,		12′ 0″
Limestone,	*Freeport Upper limestone*,	1′ 6″
Clay shales,		1′ 6″
Limestone,		2′ 6″
		61′ 0″

§ 122. *The town of Elderton* stands on a high table land, 275 feet above the level of Plum creek, measuring from where this stream is crossed by the Indiana road. The rocks are almost horizontal, curving however gently upward beyond Elderton to cross the nearly flattened arch of the Roaring run anticlinal. The curve is not sufficient to free the uplands of Barren rocks.

Few good exposures occur anywhere in the region. The measures, moreover, are devoid of practical interest. Two unimportant beds of limestone and two bands of red shale were observed, the latter strata being especially prominent on the uplands on account of the color they give to the soil. No coal beds are visible. The following section made between Plum creek and Elderton shows the position of the limestone strata and the shale layers relatively to the Freeport Upper coal:

Concealed measures,	28′ 0″
Red shale,	5′ 0″
Limestone and lean iron ore,	1′ 0″
Interval,	77′ 0″
Red shale,	6′ 0″
Interval,	33′ 0″
Limestone,	?
Interval,	103′ 0″
Sandstone, Mahoning,	20′ 0″
Shales,	20′ 0″
Freeport Upper coal bed,	—
	293′ 0″

Many of the benches enumerated in § 87 are handsomely shown in the neighborhood of Elderton. The town itself is built on the seventh bench of the series, which besides its prominence here, is no less distinct on the hills towards the west and south. The eighth bench makes an extensive plain in the region of the Lutheran church southwest of the town. The fifth forms a prominent hill summit beyond Mr. Elgin's house near the forks of the road, northwest of Elderton. The last four benches of the series may be seen in connected order on the Ralston farm north of Idaho mills.

§ 123. *The Cherry run valley* unfolds the geology of the country stretching north from Crooked creek to the top of

the divide between these latter waters and the Cowanshannock. The run has two branches of nearly equal length, which unite at the Miller school house, about three miles above the mouth of the stream. One branch, the west branch, leads to Blanket hill; the other drains the Barren measure country about Whitesburg. Both streams are small; but both flow through deep ravines.

The geology may be thus briefly stated: From the forks of the run to its mouth at Cochran's mills the valley is within *the Apollo synclinal.* The west branch is crossed by the *Apollo anticlinal;* the Whitesburg branch, though not actually crossed by the *Salt Works anticlinal* of Crooked creek passes so close to the arch that it feels the effect of the uplift in having Lower Productive rocks at the surface.

The rocks are but a repetition of those which outcrop in the Crooked creek valley. The Cochran's mills section, containing about one hundred feet of Lower Productive rocks at the base, and two hundred feet or thereabouts of Lower Barren rocks on top, applies to all the hills at the mouth of the run. As the stream is ascended the depth of section slowly diminishes, until finally at the heads of the stream the Lower Productives are beneath the water level, and only Lower Barrens are at the surface. The following brief description of the principal rock exposures will serve not only to make this structure clearer, but will also explain the most important features of the local geology.

At the mouth of the run, as well as above it, beyond the forks, the *Kittanning Upper coal bed* is above the water-level. It is of little importance, however, being only two feet thick. But occupying a more favorable location in the hills for mining than the Freeport Upper seam, it can be more conveniently worked, and on that account has been developed to a small extent near the mouth of the run, for household use. In some places the seam increases to three feet and upwards in thickness, but two feet may be considered as the general average.

The Johnstown cement shows in the road near Mr. Kin-

for about one third of a mile, when the incline is reversed on the arch of the Apollo anticlinal. The coal bed is lifted by this axis about 50 feet, or about the same as in the Kiskiminitas region.

A handsome display of the Freeport sandstone is found in the little ravine of Pine run, which comes into the creek, near where the Apollo anticlinal crosses the valley. The rock makes a wilderness of the ravine from Slease's sawmill to the creek. Towards the north the Freeport Upper coal outcrops on the King property, where it dips northwest, and where according to Mr. King the seam measures 4 feet thick. Still further west it is again mined near the Altman school house. There its underlying limestone may be seen 15 feet below it; underneath the limestone is the Freeport fire clay, apparently of good quality.

Crossing the creek and taking up the exposures along the left bank west from the mills, the township road skirts the outcrop line of the Freeport Upper coal. The bed runs through the fields of the Wm. Louden farm, where it is opened and shows four feet thick. Thence it passes above the Dunker church, and so on westward into the Carnahan ravine, in which, though increased somewhat in thickness, it is too impure to be of much value. Below it the Freeport sandstone makes high cliffs along the water line, while above it the Mahoning sandstone outcrops in a similar manner. The hillslopes are usually gentle, and in some cases prettily benched. On the Heilman (?) property due south of Cochran mills the 6th, 7th and 10th benches of the Crooked Creek series are distinctly marked.

§ 113. In the Carnahan ravine the section is varied by the introduction of two Barren measure coal beds into the column. The lower of these being 50 feet above the Freeport Upper, is in place for the *Gallitzin seam*, which also occurs in workable condition along Cherry run, as elsewhere described. The other of the Barren Measure seams is 175 feet higher, occurring in connection with a stratum of red clay shale, near Mr. Carnahan's house. It is doubtless identifiable with the seam once worked near Mrs. Cline's house, beyond the cross roads about a mile west of the oil

well derrick. Its outcrop on the Mrs. Cline property has the same red shale accompaniment that is seen at Carnahan's. The coal bed is reported to have a thickness of four feet where opened at Cline's, but undoubtedly such thickness is abnormal, for on the neighboring farms, and also at Carnahan's its outcrop is little more than a streak.

Variegated slates and shales separate it from the Gallitzin. The latter seam is scarcely more persistent than the other, being apparently only of workable thickness on the Carnahan property, near the oil well derrick. There it is 3½ feet thick, without parting slates. A small drift opened upon it at this place, has of late years largely supplied the coal needed for local use. So far as the bed has yet been followed in the mine, there is no material change either in its thickness or quality, but traced along the side of the ravine below the oil derrick, the dimensions are so much reduced that the bed can scarcely be recognized at all at the mouth of the run below the saw-mill.

It rests on massive sandstone 40 feet thick. This sandstone is the Mahoning, which is handsomely shown in the sides of the ravine, where it makes tall cliffs. The Freeport Upper coal is so much subdivided by parting slates, that the seam is worthless for mining. The following section will exhibit its condition in this respect:

Coal,	1′ 4″	
Clay and slate,	1′ 10″	
Coal and slate,	1 8″	5′ 2″
Slate,	0′ 2′	
Coal,	0′ 2″	
Clay,		—

§ 114. Its limestone on the contrary is in good condition for use as a fertilizer. It shows just below the coal, at the level of the run, where it has already been quarried to a small extent. Lower down the stream, at the saw-mill, the Freeport Lower coal is 2′ 6″ thick, having also its limestone underneath it, but impure. The Kittanning Upper coal has here a cannel structure, and is too slaty to be of value. At the mouth of the run it is sufficiently high above the stream to admit the Johnstown cement to daylight. The

nard's house, on the hill opposite the mining developments above mentioned.

The Freeport sandstone retains only for a short distance in the Cherry run valley the massive condition it presents at Cochran's Mills. Though not disappearing altogether, it becomes thin-bedded and otherwise obscure. At Mrs. McDonald's, about a mile and a half above the mills, it is still recognizable, but indistinct. Along the east branch it regains some of its prominence before disappearing under the water-level.

§ 124. The exposures at Mrs. McDonald's are further of interest, as they show the *Gallitzin seam* of coal in workable thickness. It is this bed that is mined on the McDonald property, near the top of the bluff at the bridge. It is 3′ 1″ thick; has no slate-partings; yields a firm, compact coal, which is, moreover, reasonably free from impurities. The roof is excellent, and the floor, so far as the mine has been driven, remains even and regular.

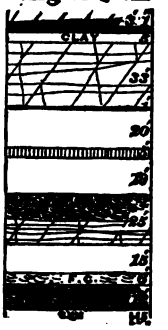
The Freeport Upper coal bed is here reduced to one foot thick. But the reduction is merely a local irregularity, as towards the north the bed quickly regains its usual thickness of 3½ feet.

The Freeport Upper limestone is also in poor condition at McDonald's. Like the coal above it, however, it, too, improves in the region to the north.

The Freeport Lower coal is not exposed nor does the outcrop of the Kittanning Upper seam appear. The section at McDonald's is as follows:

Sandstone,	—
Black slates,	—
Coal bed, Gallitzin seam,	3′ 1″
Clay, impure,	5′ 0″
Sandstone, *Mahoning*,	33′ 0″
Coal bed, *Freeport Upper*,	1′ 0″
Concealed,	20′ 0″
Limestone, impure,	5′ 0″
Concealed,	19′ 0″
Coal bed? *Freeport Lower*,	—
Shale and thin SS., *Freeport*,	25′ 0″
Coal bed? *Kittanning Upper*,	—
Concealed,	15′ 0″
Fireclay shales,	6′ 0″

Fig. 20. § 124.



Slates, compact, grayish,	12′ 0″
Run level at bridge,	—
	144′ 1″

§ 125. Ascending now the west branch of the run, the first exposure is that of the Freeport Upper coal, at Klingensmiths, beyond the school-house, and about one quarter of a mile above the forks. It is here twenty feet above the run level—interval enough to expose the underlying limestone deposit, which shows in the run bank, opposite Mr. Klingensmith's house. The limestone is of good quality and readily calcines at the kiln. The stratum is in the run bed at Held's, one half mile further up the ravine, beyond which place it is concealed.

The Freeport Upper coal remains above the water level nearly to the Heilman school-house, one half mile below Ramaley's mill, being continuous as a bed between 3 and 4 feet thick. It is divided into two benches, of which the upper is the important one. The roof varies from slate to dark clay shale.

The Apollo anticlinal crosses between W. Boart's and D. Held's. The passage of this axis across the little valley is the explanation of the long continuance of the Freeport Upper coal bed above the level of the run. The south-east dip from the centre of the arch to Held's is about equivalent to the incline of the run bed. The effect of the opposite dip towards the N. W. is quickly to carry the coal below the run.

Before its disappearance it is mined close to the water level by Mr. Jas. Wright, westward from whose farm the bed cannot be followed by drift under the hill without trouble from drainage water. The Mahoning Sandstone becomes more and more noticeable as it approaches the run level; bowlders of it are abundantly scattered over the surface between the school-house and Ramaley's mill. It is a massive, coarse-grained rock, upwards of 40 feet thick.

§ 126. *The Gallitzin seam* is found on top of the Mahoning sandstone, being the coal bed mined at Ramaley's mill for use in the engine house. It is a small but per-

sistent seam, measuring 2′ 7″ thick, and yielding good fuel. The roof is black slate and shale, and the floor is clay.

The very perceptible rise in the rocks which is felt towards the north-east carries the outcrop line of the Gallitzin bed nearly to Blanket Hill. It has been opened at J. Boart's, and again still higher up, at G. Blose's, at both which places its condition is the same as at Ramaley's. It supplies the country about Whitesburg with coal. Beyond Blose's it is below the surface, Blanket Hill being at least 200 feet above it.

In these 200 feet of rocks there is nothing of practical interest. A stratum of red clay shale is conspicuous in the roads and fields between Blanket Hill and Whitesburg, and also south of Whitesburg. Estimated to overlie the Freeport Upper coal by from 200 to 250 feet, it corresponds with the red shale layer on the bluffs at Saltzburg, which was also frequently observed at other localities, as noted throughout this Report.

Argillaceous shales are the prevailing surface rock in the region of Blanket Hill. Blanket Hill itself is a prominent rounded knob of local historical interest from a skirmish which took place there during the early border warfare, between a detachment of Gen. Armstrong's command and an encampment of Indians, which latter, from all accounts, overpowered their enemies on this occasion, and very decidedly worsted them. As the story goes, Lieutenant Hogg and his men neglected in their flight to carry off their blankets and other camp accoutrements, which fact is said to have afterwards suggested the name which the hill now bears.

§ 127. The surface rocks at Whitesburg are also of the Barren series. The geological horizon of this region corresponds very nearly with that of Blanket Hill. No workable coals are found in the neighborhood, nearer than Blose's mine above mentioned, nor need any be looked for on the uplands. But descending the run, (the east branch,) the Lower Productive measures are met with at Graham's. Their approach to the surface is anticipated by the Mahoning sandstone in massive condition. The Freeport Upper coal is opened and

mined at Blyston's, ¼ mile below Graham's mill. At an interval of 150 feet higher, another seam of coal occurs in the spring at Mr. Blyston's house; it is of no importance or value.

The Freeport Upper coal is again mined at Young's, and also near the McKee saw-mill further east. Its principal development is, however, at D. L. Schäfers, where it shows the following section:

Shales,	10′ 0″
Coal,	3′ 0″
Fireclay, impure,	—

The coal is pyritous. The rocks at this place dip quite sharply towards the N. W.

The Freeport Upper limestone comes out at the flood-gate in the race at McKee's mill. It has never been explored.

The Freeport Lower coal shows in the road near Mrs. Smith's house. It probably does not exceed 2 feet in thickness.

The Freeport sandstone forms a low cliff along the narrow side ravine which leads eastward from Roley's. The Kittanning Upper coal, two feet thick, outcrops directly under the rock.

Continuing eastward up the little ravine, Lower Barren rocks comprise the hills among which the run starts. Here, as at Whitesburg and Blanket Hill, they are without interest. The Gallitzin seam of coal, so important along the West Branch, was not observed, nor were any limestone strata detected. The supposed iron ore on the Howser property, east of Roley's, is a reddish ferruginous clay-shale of no value whatever, certainly not as an iron ore. Several pits have been sunk to a considerable depth upon it. It is the equivalent of the red shale elsewhere noted as occurring so persistently at an interval of from 200 to 250 feet above the Freeport Upper coal. It is at the hilltop on the Howser property, which summit corresponds very nearly with the level of the sixth bench of the Crooked Creek series.

Chapter IV.

The Valley of Cowanshannock Creek.

§ 128. Cowanshannock creek heads among the uplands of Indiana county between Plumville and Smicksburg, and within a few miles of where it enters Armstrong county above Barnards. It is a small stream without important tributaries, draining only a narrow zone from three to five miles wide; its course is west and northwest; its length between the county line and the river is a fraction over 20 miles; its fall in the same distance is, in round numbers, 400 feet, or at the average rate of about 20 feet to the mile; it meets the river at Cowanshannock station, three miles north of Kittanning.

The rapid flow of the creek consequent upon its short course, has from the earliest time led to more energetic erosion than took place along the larger streams, as for example along the Mahoning or the Red Bank, whose more sluggish flow rendered them more susceptible to the obstacles offered by the geological structure. Hence the valley of the Cowanshannock, like the valley of Pine creek (in which the same conditions have produced precisely the same results) is straighter than the others, with fewer bends and turns.

The Cowanshannock valley exhibits no marks of glacial action. Nor on the uplands is there any evidence of northern drift. The water-worn pebbles in the creek bed are all of local origin.

The valley is from 300 to 400 feet deep. Broad in places with extremely gentle slopes rising from fertile meadow lands; narrow in others, with steep and rugged hills closely skirting the creek. The latter feature expresses the region of the anticlinals, the other the synclinals.

§ 129. The upland country is a succession of high divides between small runs, which open northward and southward

into the main valley. Some of these ravines, as well as the hills of the valley itself are prettily benched, especially along their upper levels; other hillsides, again, are a more or less continuous slope, on which the benches were either never formed at all, or else have since been destroyed by erosion. Whether the succession here is the same as that along Crooked creek must remain an open question, until the levels of the benches in both places have been accurately determined by a close instrumental survey. Meanwhile, if the aneroid levels may be considered as approximately correct, then a partial correspondence will be seen to exist between these Cowanshannock benches and those along Crooked creek. The following incomplete list of the Cowanshannock benches, will serve to show that relationship as far as it goes. The benches were observed on the hills below Rural village, and along the ravine leading through the North Star settlement:

1.	1337	feet above ocean level:	6th	bench of	Crooked creek.
2.	1307	" "	7th	"	"
3.	1292	" "	8th	"	"
4.	1204	" "			
5.	1174	" "	9th	"	"
6.	1129	" "			
7.	1103	" "			

§ 130. *The geological structure of the valley* consists of two synclinal axes with an intermediate anticlinal arch. A second anticlinal begins to make itself felt along the lower waters of the creek, but its arch being west of the river, is, therefore, outside the limits treated of in the present chapter.

The structure, as thus outlined, differs very materially from that along Crooked creek, although the two valleys cross the same strata, besides being nearly parallel in their trend. Some of the axes of the latter valley have disappeared before reaching the Cowanshannock; others again have not only maintained themselves, but have developed increased strength. Further north still other changes occur in the geology, and the structure of the Pine Creek valley differs from that of the Cowanshannock as this differs from Crooked creek.

The first synclinal going west along the Cowanshannock

is that in which Rural village is situated. It is the continuation northeastward of the *Apollo synclinal* which, in its run from Crooked creek (§ 90) has broadened sufficiently to include within its scope nearly all of Cowanshannock township. The gentle dips into the basin on both sides, explain sufficiently the great outspread of Barren measure rocks. Extended towards the northeast the Apollo synclinal should pass near the town of Dayton, but in place of it there a distinct anticlinal arch is felt whose effect on the geology is seen in the finger-point of Lower Productive rocks, projecting westward from Indiana county up a small ravine towards Dayton. This anticlinal weakens so rapidly southward that it dies completely before reaching the Cowanshannock, which it otherwise would cross near Rural village, where not the faintest trace of it exists.

§ 131. Below Rural village the rocks begin to ascend northwestward out of the synclinal, at first at angles of 1° and less which afterwards sharpen to 3° and more. At Patterson mills (Greendale) an anticlinal arch is crossed. It is the *Kough's mill axis of Crooked creek*, and the *Oscar axis of Pine creek*. Its maximum strength is in the Cowanshannock region, where it lifts the rocks at least 400 feet from their level at the synclinal, thus freeing the country very nearly of Barren measure rocks, and bringing the Pottsville Conglomerate to daylight.

Thence westward the dip is down the creek, at very low angles to the second synclinal axis, *the Freeport synclinal* of the Kiskiminitas, which crosses the Cowanshannock near Nulton's tavern. The *Bagdad anticlinal*, which should appear in the region intermediate between Greendale and Nulton's, is not there perceptible, its arch having flattened out under the highlands of Manor township. The effect of the Freeport synclinal along the Cowanshannock, is to conceal the lower half of the Lower Productive column, and to increase proportionally the covering of Barren measure rocks on the uplands. Gentle dips prevail.

§ 132. Below Nulton's the rocks rise northwestward towards the *Kellersburg anticlinal*, which as before remarked, passes west of the mouth of the Cowanshannock. Its in-

fluence, however, both on the geology and topography of the lower part of that valley is considerable. Indeed the whole face of the region changes within the distance of a mile or so. The Barren measures which closely approach the water line at Nulton's are driven to the extreme hill-tops and the Pottsville Conglomerate re-appears again above the water line.

§ 133. *Of the Lower Barren Measure series* as much as 300 feet are represented in the neighborhood of Barnard's and along the county line east of that place. Further west the amount is greatly reduced. Usually, the group contains little of interest. The prevailing rock is shale. The *Gallitzin coal bed* may, however be mentioned as one feature of importance. *The Mahoning sandstone* is shaly and indistinct along the Cowanshannock. *The Black Limestone* was nowhere noticed; neither was the *Green Fossiliferous* stratum; but a deposit of non-fossiliferous limestone occurs on the top of a few high knobs in the region of Barnard's. Its geological horizon is close to that of the Green Fossiliferous stratum, with which, however, it has no other features in common.

§ 134. *The Lower Productive Coal Measures* constitute the main surface rocks of the valley below Rural village. The group twice appears in full above the water line: once on the arch of the Greendale axis at Patterson's mills, and again below Nulton's tavern. At both places its section is so similar in every respect to that along Crooked creek and along the Kiskiminitas, and indeed along every other valley in the county where its rocks are at the surface, that attention need here only be directed to the fact of the resemblance without further dwelling upon it. The close correspondence, even to minute details, will at once appear to the reader, on a comparison of the different vertical sections in the text. In the section given below of the Lower Productive measures along the Cowanshannock, an effort has been made to represent as nearly as possible *their average condition.* The hills here nowhere offer favorable opportunities for the construction, within a short distance of a continuous section from the top of the group to its base;

but the different rock horizons may be examined separately at multitudes of localities. Where these localities are to be found will appear in the sequel.

Incorporated also with the section is the underlying Pottsville Conglomerate, the condition of which in the region immediately south of the Cowanshannock and along all Crooked creek, is unknown, being there below the drainage line. Nor can comparisons of it be instituted with the Kiskiminitas region, as only the top of the deposit is at daylight in the latter valley; but comparing it with exposures in other valleys to the north, along Pine creek and the Mahoning and Red Bank, in each of which it has a long outcrop range, its condition there is much the same as along the Cowanshannock.

Its emergence above the water line at Patterson's mills is moreover of particular interest, being its first exposure after its disappearance in a north-west direction under the highlands of Indiana county at the Blairsville gap. A comparison of its condition at the two places* discloses the fact that during its long underground journey of nearly forty miles the deposit has undergone no material change in point of thickness.

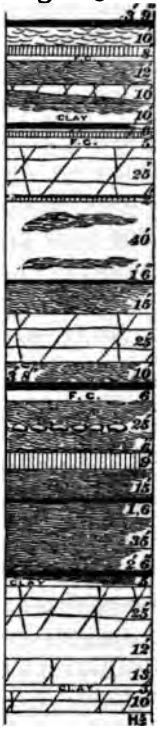
§ 135. *The important features* of the section, in an economic sense, are contained in the Freeport and Kittanning groups. The Clarion group is insignificant, both the Brookville and Clarion coal beds being of inferior thickness. Of the other coal beds of the section only the Freeport Upper and the Kittanning Lower could be profitably mined. Both beds are uniform and regular. No extensive developments it is true have yet been made upon them, but so far, at whatever points the outcrop of either has been opened into, it has been found to justify the search. The Freeport Upper has a greater outcrop area than the other, and, on the whole, is rather the better seam. Both, however, are impure, and the coal from either of them would require careful washing before good coke could be made from it.

* Report HHHH, p. 61.

§ 136. *Section of Lower Productive Coal Measures along Cowanshannock creek:*

Coal bed, *Freeport Upper*,		3′ 9″
Shales,		10′ 0″
Limestone, Freeport Upper,		5′ 0″
Fireclay, impure,		3′ 0″
Shales,		12′ 0″
Sandstone and shales,		10′ 0″
Clay and shales,		10′ 0″
Coal bed, *Freeport Lower*,		2′ 6″
Fireclay, impure,		2′ 0″
Limestone, ferruginous, Freeport Lower,		3′ 0″
Fireclay, very ferruginous,		5′ 0″
Sandstone, *Freeport*,		25′ 0″
Coad bed, *Kittanning Upper*,		thin.
Limestone clay, *Johnstown Cement*,		2′ 0″
Interval, chiefly black slate,		40′ 0″
Coal bed, *Kittanning Middle*,		1′ 6″
Shales,		15′ 0″
Sandstone, massive,		25′ 0″
Shales,		10′ 0″
Coal bed, *Kittanning Lower*,		3′ 8″
Fireclay, ferruginous,		6′ 0″
Shales, with ore balls,		25′ 0″
Iron ore, Buhrstone iron ore,		0′ 6″
Ferriferous limestone,		9′ 0″
Slates, grayish,		15′ 0″
Coal bed, *Clarion*,		1′ 6″
Slates,		35′ 0″
Coal bed, *Brookville*,		2′ 6″
Slates and impure clay,		5′ 0″
Sandstone, massive,	Pottsville Conglomerate,	25′ 0″
Concealed, shales, ?		12′ 0″
Sandstone, massive,		13′ 0″
Clay, ferruginous,		3′ 0″
Sandstone, massive,		10′ 0″
Total thickness,		350′ 11″

Fig. 21. §135.



§ 137. Of limestone there is a prodigious quantity in the Cowanshannock valley. The Freeport Upper deposit has an outcrop area greater even than that of its overlying coal bed. Its condition is usually good. The Ferriferous limestone is however of greater importance than the other, even though its area of outcrop is more limited. The farmers have hitherto been slow to recognize its claims to immediate development. Moreover it supports the Buhrstone iron ore, but of the latter stratum little is known.

Both the Freeport Lower limestone and the Johnstown cement, are present usually in some recognizable form, though often indistinct. Neither is of practical value at any of the exposures.

The Freeport fire clay is so little known in the Cowanshannock region that no fair estimate can be formed of its condition. The ferruginous appearance which it usually presents at the outcrop may be due to surface drainage.

The soil of the valley is fairly remunerative and supports a thriving population. Most of the original timber growth has been cleared away. Until proper railroad facilities are provided no attempt can be made to develop on an extended scale the mineral resources of the region, or to establish industrial enterprises of any kind. Possibly the sandstone formations underlying the valley may contain oil in paying quantities, but the question is one open to much doubt. The only test well that has yet been drilled to any depth in the Cowanshannock valley failed of success.

§ 138. Lower Barren Measures are the surface rocks along the upper waters of the Cowanshannock. At the county line the Freeport *Upper coal bed* is about 50 feet below the creek; the surrounding hills having a height of 250 feet, they, therefore, include one half at least of the Lower Barren series.

Exposures are rare. Nor are such as do occur of a kind to induce their further exploration. A small seam of coal, 1½ feet thick is reported in the well at Mr. G. A. Barnard's house. It is probably the *Gallitzin seam.*

On the top of a high knob near the county line and nearly a mile southeast of Mr. Barnard's, is a deposit of excellent limestone, the full thickness of which is not known, though this is not a matter of consequence, as there is obviously a considerable amount of the rock. Bare on the surface, and without cover, it can be easily and cheaply raised, and its freedom from impurities insures a good white lime adaptable even for plastering.

§ 139. In a ravine to the east, on Mr. Leuckart's land, in Indiana county, are exposed some of the rocks which intervene between the above mentioned limestone and the

Gallitzin coal. Among the strata is a considerable mass of impure cannel slate, the discovery of which being mistaken for pure cannel coal by its owner, recently gave rise to some local excitement. The deposit, however, may, in a word, be declared to be wholly valueless for fuel. The slates are ten feet thick. At the outcrop the deposit consists chiefly of a mass of black shales, with a layer of cannel slate at the base, which latter, under cover, slowly increases in thickness until it finally occupies all the space of the shales. Minute knife edges of bright bituminous coal traverse it. What the geographical limits of the deposit may be, is not known, nor is it a matter of importance in view of its worthless condition. A vertical section was constructed between Mr. Leuckart's and Barnard's, to show the relative position of the slate with regard to the overlying limestone and the underlying Gallitzin and Freeport coal seams:

Limestone, hilltop,	—
Interval, concealed rocks,	75′ 0″?
Cannel slate,	10′ 0″
Sandstone,	4′ 0″
Clay,	2′ 0″
Coal, bituminous,	thin.
Shales,	10′ 0″
Red shale,	8′ 0″
Sandstone and slates,	70′ 0″
Shales, gray,	30′ 0″
Interval,	50′ 0″?
Coal bed, *Gallitzin*,	1′ 6″
Interval, *Mahoning sandstone*,	50′ 0″
Coal bed, *Freeport Upper*,	—
Total thickness,	310′ 6″

§ 140. The same Barren Measure rocks overspread the upland country stretching southward towards Plum creek, and northward into the Pine creek region. They are the surface rocks also towards the west and southwest.

The Gallitzin coal bed is underneath Rural village, perhaps as much as 50 feet. But going westward towards the Greendale anticlinal, it rises above the creek at Ambrose's house, appearing as a workable bed without slate partings and of uniform thickness. Openings have been made upon it close to the water line at Ambrose's, and also at Carson's on the opposite side of the ravine, but the bed is now only

mined at Patterson's beyond the cross roads, where it is well up in the hills. The following measurement of the seam was obtained at Patterson's, from which mine also, a specimen of the coal was taken for analysis by Mr. McCreath, with results given below:

Slate, gray and black,	1′ 0″
Coal,	3′ 1″
Clay,	—

The coal is the same in all parts of the bed. The specimen selected for analysis was taken from the heap at the mouth of the mine.

Water,	1.020
Volatile matter,	36.995
Fixed carbon,	53.569
Sulphur,	2.641
Ash,	5.775
	100.000
Color of ash,	cream.
Coke, per cent.,	61.985
Fuel ratio,	1: 1.45

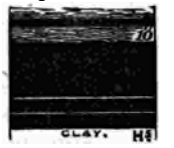
§ 141. The hills round about are prettily terraced, especially a high and prominent knob to the N. W. At the foot of one of the benches, 100 feet above the Gallitzin seam, indications of another, but unimportant coal bed were observed.

The Mahoning Sandstone is represented chiefly by loose shales with layers of thin bedded sandstone interleaved. It occupies all the interval between the Gallitzin and Freeport Upper coals, which interval at Patterson's amounts to exactly 40 feet.

§ 142. *The Freeport Upper coal*, though larger than the Gallitzin and larger also than the Freeport Lower presently to be mentioned, is of inferior importance to either, where opened on the property of Mrs. Caruthers, on the left bank of the creek, beyond the cross roads. Its condition, however, greatly improves towards the south, and where it reappears in the region of the North Star mills, it yields by far the best coal in Cowanshannock township. At Mrs. Caruthers the section is thus:

Slates,		—
Coal,	0′ 4″	
Slate,	0′ 10″	
Coal,	2′ 9″	
Slate,	thin.	5′ 4½″
Coal,	0′ 8″	
Slate,	0′ 0½″	
Coal,	0′ 9″	
Clay,		—

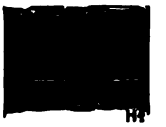
Fig. 22. §142.



At Beer's store, in the North Star ravine it is thus:

Slate roof,		—
Coal,	3′ 3″	
Slate,	0′ 1″	4′ 4″
Coal,	1′ 0″	
Slate in floor,		—

Fig. 23. §142.



Other openings beside that at Beer's have been made upon the seam at different parts of the North Star ravine, which show that the greatest regularity exists in the deposit at this place. Scarcely a change can be noticed in any of the mines, either with respect to the thickness of the bed or the character of its coal. The thickness has been shown above; the character will best be expressed by the following analysis, by Mr. McCreath, of a specimen from Mr. Beer's mine:

Water,	1.140
Volatile matter,	37.860
Fixed carbon,	57.179
Sulphur,	1.031
Ash,	2.790
	100.000
Color of ash,	cream.
Coke per cent.,	61.000
Fuel ratio,	1 : 1.51

§ 143. Both on the Cowanshannock, at Patterson's, and also in the North Star ravine, the Freeport Upper limestone, six feet thick, accompanies its coal which it here underlies about 10 feet. It yields good stone. An outcrop of it was seen in the township road near Mr. Schrecengost's house, and again on the opposite side of the creek in Mrs. Caruther's orchard; also, at Reefer's in the North Star ravine, where it is well exposed. It further appears on the Sower's property to the west.

A specimen of the rock from the quarry at Mr. John Reefer's analyzed by Mr. McCreath for the purpose of determining its principal constituents, resulted as follows:

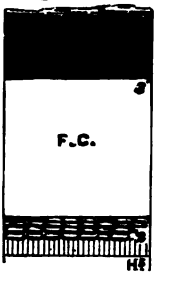
Carbonate of lime,	88.839
Carbonate of magnesia,	1.513
Oxide of iron and alumina,	2.557
Phosphorus,	.021
Insoluble residue,	5.030

§ 144. *The Freeport Lower coal* is 50 feet below the Freeport Upper. Where mined by Mr. B. Schrecengost near the school-house, it is 3 feet thick, underlaid by a ferruginous limestone, some of which is, in fact, a lean iron ore. The coal is hard and compact, but both pyritous and slaty. At Schrecengost's the rocks are tilted 2° towards the southeast. Further west near the centre of the Greendale arch, they are tilted still more, inclining sometimes at angles of 4°.

The mine at Schrecengost's being driven in the direction of the dip, considerable undercutting has been done to afford proper drainage, exposing in so doing not only the underlying fire clay, but also the limestone. The clay is worthless. It likewise accompanies the coal, in the North Star ravine, being there in much the same condition as at Schrecengost's. Its outcrop may be seen along with the coal, in the roadside near the mills. At Schrecengost's the section is as follows:

Fig. 24. § 144.

Slate,	—
Coal,	3′ 0″
Fire clay, impure,	7′ 0″
Iron ore and *ferruginous limestone*,	2′ 0″



A specimen of coal from the Schrecengost mine was analyzed by Mr. McCreath, with the following results:

Water,	.910
Volatile matter,	34.270
Fixed carbon,	53.224
Sulphur,	2.311
Ash,	9.285
	100.000
Color of ash,	grey.
Coke, per cent.,	64.820
Fuel ratio,	1:.155

§ 145. Descending the creek westward from the school-house, the outcrop edges of the Lower Productive strata are crossed in regular order as they slowly rise above the water line. At Patterson's mills (Greendale P. O.) the entire group is in the hills, supported by the massive Pottsville Conglomerate. On top of all is a thin covering of Barren rocks, the disintegration of which has made the smooth soil on the divide between the Cowanshannock and Pine creek.

Rock exposures, though occurring with considerable frequency, are rather of a partial kind, exhibiting the section only in disconnected fragments. But as the different strata faithfully preserve their usual features at all the exposures, little trouble will be experienced in the matter of identification. In the region between the school-house at Schrecengost's and Colwell's tavern, the following observations were made of the principal members of the Lower Productive group, including also the Mahoning Sandstone and the Pottsville Conglomerate.

The Mahoning Sandstone is uniformly thin-bedded and of a shaly structure. It is nowhere available for building stone; and being much impregnated with iron has little value for any purpose. Its average thickness is about 25 feet.

§ 146. *The Freeport Upper coal*, while undergoing some unimportant local changes, remains much in the same condition as in the North Star ravine. Its outcrop line being high up in the hills, each ravine opens up a large amount of available coal.

Where exposed on the J. C. Rhea property, 300 feet above the creek, it varies from 2½ to 4 feet thick. At H.

J. Schrecengost's, further west, it is uniformly 3½ feet thick. At the latter place it is near the summit of the upland, having only a scanty amount of cover.

The Freeport Upper limestone outcrops in the fields at Mr. Rhea's. At H. J. Schrecengost's it is opened and quarried. It is also known on the opposite side of the creek.

The Freeport Lower coal has in this neighborhood lost the thickness it exhibits below Rural village. It outcrops in the lane at Rhea's 40 feet below the Freeport Upper limestone. On the Powers farm, northeast of Patterson's mills, it was once mined. It is unaccompanied by limestone.

§ 147. *The Freeport sandstone* scarcely shows at all, being usually only a mass of loose shales. The same obscurity surrounds the outcrop of the Kittanning Upper coal. It was nowhere identified with certainty. A faint outcrop of coal on the Rhea property, from 15 to 20 feet below the Freeport Lower seam, may indicate it, though this is doubtful. At the same geological horizon and at the same place fragments of hematite iron ore are abundant on the surface, representing either a deposit of bog ore or the weathered fragments of carbonate ore. The outcrop has never received investigation. A surface specimen was analyzed at the instance of Mr. Smith, of Kittanning by Mr. F. A. Genth, Jr., of the University of Pennsylvania, with the following result:

Ferric oxide,	77.10
Ferrous oxide,	.43
Manganous oxide,	1.02
Alumina,	2.47
Silicic acid,	7.17
Phosphoric acid,	.47
Water and organic matter,	11.23
	99.89

§ 148. Thence downwards in the measures nearly to the *Kittanning Lower coal*, the exposures reveal little. In places the latter coal bed is roofed by massive sandstone, while in other places the roof consists of slate and shales.

Where opened on the Rhea property close to the township road, the bed is somewhat irregular in consequence of frequent swamps, which produce besides a varying thickness of coal, a bewildering confusion of dips. But the dips being gentle and the variations slight the obstructions thus offered to mining are of trifling importance.

The following analysis by Mr. McCreath of a specimen of coal from the Rhea mine will show the pyritous condition of the bed:

Water,	.960
Volatile matter,	38.205
Fixed carbon,	52.032
Sulphur,	3.663
Ash,	5.140
	100.000
Color of ash,	reddish gray.
Coke, per cent.,	60.835
Fuel ratio,	1: 1.36

The thickness of the bed at Rhea's varies from 2½ to 4 feet. Further west, where opened in the ravine north of Patterson's mills, it is subject to the same changes. In the neighborhood of Colwell's tavern the thickness is reduced to 16 inches, while in the ravine leading north from the tavern towards the Hall and Davis' properties it scarcely shows at all. It touches the creek level somewhere in the vicinity of the Douglass farm, to remain then concealed to the school-house below Nulton's, there, however, to re-appear with its thickness fully regained. Its condition at the latter place is described elsewhere.

At Rhea's the distance between the Kittanning Lower coal and the Ferriferous limestone is greatly in excess of the usual interval, being nearly 60 feet. Further down the creek, the same interval is reduced to 30 feet, and finally to 25 feet at Colwell's tavern.

§ 149. *The Ferriferous limestone* comes out of the creek, rising northwest, at the western edge of Cowanshannock township. It disappears again dipping northwest near the school-house beyond Colwell's.

The stratum has thus an outcrop area on the arch of the Greendale axis, nearly four miles long, in which interval it is uniformly from eight to ten feet thick, composed of coarse grayish limestone, and very fossiliferous. Its outcrop line is easily followed, being marked very frequently by copious springs issuing from the hillsides. The rock has been but little quarried by the farmers for use as a fertilizer. It makes a strong dark colored lime. The deposit is exposed in the road at Rhea's; at McAfoos' in the ravine back of the house; at Colwell's on the hill above the watering trough; and finally in the road beyond the school-house, where it is only a few feet above the creek. A specimen of the rock, taken from the quarry at Mr. Rhea's, was analyzed by Mr. McCreath with the following results. Only the important constituents were determined:

Carbonate of lime,	93.246
Carbonate of magnesia,	1.740
Oxide of iron and alumina,	1.667
Phosphorus,	.032
Insoluble residue,	3.420

§ 150. *The Buhrstone ore stratum* accompanies the limestone. It is, however, too imperfectly exposed to form an estimate of its condition.

The exposures below the limestone are still more unsatisfactory. *The Clarion coal* is reported to have been found close to the road at Colwell's. It is also reported at Rhea's, where its thickness is given as 18 inches. Both at Colwell's and Rhea's it is 15 feet below the limestone. In the ravine at Mr. McAfoos' it does not appear at all, nor was anything seen of it in the exposures north of Patterson's mills. The seam is clearly of no practical value anywhere in the region.

§ 151. Midway between Colwell's and Patterson's the following strata were observed:

Ferriferous limestone,	—
Interval,	35′ 0″
Sandstone,	10′ 0″
Slates,	3′ 0″
Coal bed, *Brookville,*	2′ 6″
Interval,	20′ 0″
Red and *olive clay,*	—

Interval,		10′ 0″
Gray shales,		12′ 0″
Coal,	0′ 6″	
Clay,	2′ 0″	3′ 0″
Coal,	0′ 6″	
Sandstone,		—
Total,		95 6″

The red and olive clay above mentioned, are produced by a local deposit of bog ore of no value. The small coal bed overlying the basal sandstone of the section is likewise a local deposit, which does not re-appear at the mouth of the creek. The sandstone alluded to represents the top layer of the Pottsville Conglomerate.

The presence of the latter rock above the water level is indicated by the bowlders of heavy sandstone which skirt the creek at Patterson's mills. So long as it remains at the surface, the region is wild and rugged. The rock is very massive and coarse grained. Few good exposures of the deposit, in place, are found in the vicinity of the mills. A partial one may be had in the small ravine above Mr. Colwell's tenant house.

§ 152. Near the school-house, below Colwell's tavern, a hole was drilled some years ago in search of oil. The drill was stopped at a depth of 1920 feet below the surface, having started on the bottom lands of the creek, at the base of the Ferriferous limestone. This depth was sufficient to test not only the condition of the Butler county oil group at this place, but that of sandstones at still lower levels. All the rocks pierced were dry of oil. Gas was met with at a depth of 1000 feet below the surface, rushing forth, it is said, when first struck in great volume, which, however, has since nearly exhausted itself. The drilling record is not now obtainable.

§ 153. Descending around the bend of the creek to the Robinson farm, some exposures of the Freeport group were observed in the ravine north of Mr. Robinson's house. The Freeport Upper coal is 3 feet thick, with a bad roof; the coal, moreover, is slaty and poor. The Freeport Upper limestone and the Freeport fire clay are both present; so also is the Freeport Lower coal, 18 inches thick, 55 feet be-

below the Freeport Upper. The Freeport Lower coal is mined in the ravine to the northeast about a mile away.

The same strata are easily followed westward along the creek hills, slowly sinking to lower levels under the prevailing northwest dip. The Freeport Upper coal is exposed on nearly every farm, with its underlying limestone as an unfailing attendant. The Freeport Lower coal being small, is neglected; the same is true also of the Kittanning Upper bed. Where the *Freeport synclinal* crosses the valley at Nulton's tavern, about 2 miles E. N. E. of Kittanning, the Kittanning Upper coal is close to the water line. It shows in the roadside at the bridge, being underlaid by a highly calcareous clay which represents the Johnstown cement. Above it, but exposed on the opposite side of the creek, is the Freeport sandstone 20 feet thick; above the sandstone is the Freeport Lower coal, with its underlying limestone, ferruginous and otherwise impure. Still higher the Freeport Upper coal is opened on the Nulton property south of the road, and again on the Buffington lands north of the creek. At both places it is 3′ 9″ thick, including a small bench of bony coal at the base of the seam. Its limestone is in the road at the watering trough west of the tavern, and also in the fields near the Nulton mine where it has been quarried.

§ 154. Along the roadside leading north from the bridge at Nulton's, there is a partial display of Barren rocks in which the Mahoning Sandstone, directly overlying the Freeport Upper coal, appears as a thin-bedded rock, loose and shaly. Such is its condition, also, along the creek hills towards the west. On the Fritz farm some flagstones have been obtained from it. The section exhibited north of the bridge is as follows:

Coal smut,	trace.
Shales, grayish, with ore lumps,	18′ 0″
Clay and shales, reddish,	2′ 0″
Sandstone,	8′ 0″
Shales, grayish,	10′ 0″
Sandstone,	20 0″
Clay and slate, ferruginous,	12′ 0″
Coal,	thin.
Clay,	2′ 0″

Sandstone,	3′ 0″
Shales,	10′ 0″
Concealed,	70′ 0″
Sandstone, *Mahoning*,	20′ 0″
Freeport Upper coal,	—
Total,	175′ 0″

§ 155. Along the lower waters of the creek the surface rocks are in effect the same as those at Patterson's mills: Barren Measures thinly overspread the uplands; Lower Productive strata succeed them at lower levels; and the Pottsville Conglomerate makes low cliffs at the base of the hills, along the water's edge.

The strata dip 2° and 3° towards the south-east; the same dips are continuous to the mouth of the creek.

In this connection it is necessary only to call attention to the leading features of the section, which in some respect differs from the generalized one. The Freeport Upper coal, however, and indeed all the Freeport group remains unchanged from its condition as previously described. The sandstone overlying the Kittanning Lower coal is perhaps the most striking feature of the local geology. It is very massive and heavy, being also coarse-grained. Thirty-five feet thick, it makes a line of cliffs below the Wallace school-house. On its top is the Kittanning Middle coal, which is best exposed where it emerges above the creek, between the bridge at Nulton's and the school-house above alluded to. It is 18 inches thick, roofed by compact black slate.

The Kittanning Lower coal is almost directly underneath the sandstone. It is mined by Mr. Patrick below the school-house, where it shows four feet of compact coal, bright and shining, but rather pyritous.

§ 156. *The Ferriferous limestone* is here absent totally from the measures, being replaced by shale, which replacement also is continuous westward to the mouth of the creek, and northward into the Pine creek region. Vigorous search was made for the rock, as also for the Buhrstone iron ore, at the time the Bonner furnace was in blast, but no trace of either stratum could be found. The absence of the limestone rock is due to ancient erosion, the

extent of which in removing other strata lower than the limestone is only imperfectly shown in the exposures at the mine. Better opportunities for making such observations were found near Monticello furnace, on the Allegheny river.

A bed of coal 5 feet thick is reported to have been found in the fields of the Mechlin farm, near the base of the Lower Productive strata. No openings on the seam now exist; its outcrop in the road at the end of Mechlin's lane indicates an inferior thickness to that reported. The bed may be an irregular one, subject to frequent "swamps," and horse-backs. It is the equivalent of the Brookville seam, the Clarion seam being absent, or if present at all, unrecognizable in the imperfect exposures.

The Pottsville Conglomerate is magnificently exposed in a series of cliffs extending from the grist-mill to the mouth of the creek. Much of the rock is conglomeratic; all of it is massive and heavy. The deposit is upwards of 60 feet thick, subdivided as shown in the generalized section (§ 135). It stretches clear across the creek at the grist-mill, where the scenery is otherwise wild and romantic.

CHAPTER V.

The Valley of Pine creek; North and South forks.

§ 157. *Pine creek* is formed from two streams called North and South fork, which together drain portions of Wayne, Cowanshannock, Boggs, and Valley townships. Pine creek itself is only a short outlet to the combined waters of the two forks, which at their junction are within a mile or so of the river. The mouth of the stream is at Brattonville, (Pine creek station,) 5 miles in a direct line north of Kittanning.

Both forks are of nearly equal length, and both head in Armstrong county, the one in Wayne and the other in Cowanshannock township; both have a similar rate of fall, amounting in each case to something more than 20 feet to the mile, or about 400 feet in all; neither receives important tributaries, and neither carries much water excepting when flooded. The valleys generally correspond in depth, though not always in topographical aspect; their geological structure, however, and their surface rocks are the same.

§ 158. *These surface rocks* chiefly consist of the Lower Productive Coal Measures. The Pottsville Conglomerate also comes to daylight, and the Lower Barren Measures usually overspread the uplands; but both of the latter formations are greatly subordinate to the other. The diminished amount of Lower Barrens, as compared with what is represented of the group in the Kiskiminitas region and along Crooked creek, will convey to the reader a correct impression of the force and effect of the rise which takes place in the strata along their strike towards the northeast. The average elevation of the upland country, relatively to sea level, undergoes no material change going north, certainly no decrease, so that the basins are unaffected by the

topography. It is the northeast rise alone that produces the continued diminution of depth, in evidence of which either the Apollo or Leechburg synclinals may be cited. All of the other basins are similarly affected, but in the cases named, the amount of Barren Measure rocks contained along Pine creek, is less than one third of that contained in the same basin along the Kiskiminitas. This reduction of depth requires an average rise in the strata towards the northeast of about 10 feet to the mile. It is not, however, evenly and regularly distributed or of uniform strength; in some places it is scarcely preceptible; at other points it is sufficiently pronounced to become an important factor in questions of mining, and even in such questions as are presented to the farmers in working their small drifts.

§ 159. The Barren Measure rocks along Pine creek are entirely devoid of practical interest. On top of the divide between the two forks in Boggs township, scarcely more than the Mahoning Sandstone has escaped erosion; in eastern Wayne, however, there is a greater accumulation, of which a partial description has been given in connection with Cowanshannock creek, and of which still more remains to be said, not only in the detailed account of the South fork, but also in that of the region of Glade run.

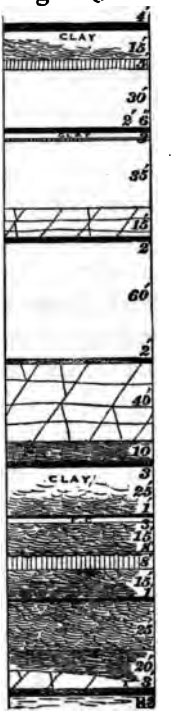
§ 160. *The Lower Productive section* is substantially the same along both forks of Pine creek; that here given as typical of the two has been compiled from exposures in both. The section is not complete in all its details; in some respects, indeed, it is little more than an outline; but enough is contained in it to show the close resemblance which these rocks, on the whole, bear to the same strata elsewhere in the county.

Other exposures than those observed by the writer during the examination of the region will enable local geologists to add such essential features as are not contained in the section, particularly that of the Johnstown cement, underlying the Kittanning Upper coal. It so happened that the exposures which came under the writer's notice were very incomplete at that horizon.

Section of Lower Productive Coal Measures along the Pine creek waters.

Coal bed, *Freeport Upper*,	4′ 0″
Shales and impure clay,	15′ 0″
Limestone, Freeport Upper,	5′ 0″
Interval,	30′ 0″
Coal bed, *Freeport Lower*,	2′ 6″
Clay,	3′ 0″
Limestone, impure, Freeport Lower,	?
Interval,	35′ 0″
Sandstone, *Freeport*,	15′ 0″
Coal bed, *Kittaning Upper*,	2′ 0″
Concealed rocks,	60′ 0″
Coal bed, *Kittanning Middle*,	2′ 0″
Sandstone, massive,	40′ 0″
Slate,	10′ 0″
Coal bed, *Kittanning Lower*,	3′ 0″
Shales and impure fireclay,	25′ 0″
Coal bed, *Ferriferous*,	1′ 0″
Fireclay, impure,	3′ 0″
Shales, greenish,	15′ 0″
Iron ore, *Buhrstone*,	0′ 8″
Ferriferous Limestone,	8′ 0″
Shale and black slate,	15′ 0″
Coal bed, *Clarion*,	1′ 0″
Shales,	25′ 0″
Slates and sandstone,	20′ 0″
Coal bed, *Brookville*,	3′ 0′
Clay slate,	—
Total thickness,	343′ 2″

Fig. 25. § 160



§ 161. The stratigraphy of the two valleys will be more readily understood if considered in connection with its effect in varying the surface geology. The structure, in brief, consists of three synclinals and two anticlinals, with the eastern side of a third anticlinal, the order being as follows from east to west:

The southeastern corner of Wayne township is occupied by a synclinal, in which the town of Dayton stands, as does also Rural village on the Cowanshannock, and Apollo still further south. It contains Barren Measure rocks, the area of which is narrowed towards the north by two anticlinal arches, whose strength diminishes so rapidly south from the Mahoning creek, that neither anticlinal exercises

much influence on Pine creek. Of these anticlinals, that next the east is in Indiana county, (it crosses Mahoning creek below Smicksburg,) and is apparently extinct before reaching the Armstrong county line; the other crosses the South fork of Pine creek about a mile east of Echo, where its feeble and nearly extinguished arch lifts only the upper horizons of the Lower Productive group to daylight. Feeble on Pine creek, it grows still more feeble towards the south under the highlands of Cowanshannock township, fading out entirely before reaching Cowanshannock creek; but towards the north it gains strength so rapidly, that it covers all the uplands of central Wayne with Lower Productive rocks, entirely freeing the Dayton region from the Barren Measures. It brings Conglomerate and Sub-Conglomerate rocks to daylight in the valley of the Mahoning, which it crosses near the mouth of Glade run.

§ 162. The sudden rise of this Glade run axis towards the north, (or if considered in the opposite direction, its sudden collapse) is one of the most interesting features in the geology of Armstrong county. It causes the outcrop of the Freeport Upper coal to run from Echo eastward in a line so straight, that at first sight of the conditions, an upthrow fault suggests itself. No such movement, however, has here taken place. The axis breaks down quickly but without any displacement of the strata, and the Barrens spread across the rapidly sinking arch in regular succession. The structure has naturally perplexed the farmers in their efforts to discover and trace the workable beds of coal; the confusion being further increased by some local changes in those strata, which usually act as guides to the farmer in determining his whereabouts in the rocks. In the detailed description of the region, the different exposures have, as far as possible, been classified and identified.

§ 163. The second synclinal crosses near Echo. Northwards it runs nearly under Bellknap, and still further north passes near Eddyville and New Salem. Southwards from Pine creek it is soon lost, having no equivalent along the

Cowanshannock. Its effect on the surface geology is seen in the isolated patches of the Freeport Upper coal, which it brings into the hilltops, north and northwest of Echo.

§ 164. The second anticlinal crosses the South fork at Oscar, and the north fork near Snyderville, lifting the top of the Pottsville Conglomerate to daylight at both places. It is the *Greendale axis* of the Cowanshannock, where it is much stronger than on Pine creek; and possibly it is the *Langville axis* of the Little Sandy, in Jefferson county; but the last identification is doubtful, as no satisfactory connection between the two could be made on Mahoning creek.

The path of the axis across the uplands of southwestern Wayne is indicated by the absence of the Freeport Upper coal over a narrow area, which becomes still more reduced by the weakening of the axis towards the north. The nearly exhausted condition of the anticlinal on Mahoning creek enables the coal bed named to reappear in the hills overlooking Putneyville.

§ 165. The western flank of the axis has such extremely gentle dips along Pine creek that only a slight increase in the depth of the section takes place between Oscar and the next synclinal to the west, which latter crosses the South fork below Pine creek furnace. It has the effect, however, of concealing the Ferriferous limestone under the water-level between the furnace and the junction of the two forks, while it covers the divide between the two streams with the Mahoning Sandstone. This structure gives a large and valuable area of the Freeport Upper coal to that region; just as still further north it covers nearly all of the western part of Boggs township with the same bed. The synclinal crosses the North fork below the bridge north of Mr. Mateer's house.

Northwestward from this synclinal a gentle rise is shown in the rocks, down the stream, towards the Kellersburg anticlinal, the force of which is here only feebly felt, as the arch is west of the river. It causes the outcrop line of the Ferriferous limestone to reappear above the level of the

creek below the forks, and to remain also in the hills westward to the river.

§ 166. The detailed description of the mining developments will sufficiently acquaint the reader with the character of the coal, limestone, and iron ore in both valleys. In general it may be said of the coal beds that the Freeport Upper is of the greatest importance, because of its usually greater thickness than the others, and its superior coking qualities. Along the upper waters of the creek, about Dayton, it is impure, with all the rest of the coal beds; but in the region of Pine creek furnace, as well also as in the highlands of Boggs township, its superiority over the other seams is an established fact. Its high position in the hills has led to its neglect by the farmers, especially along the South fork, where for local use the Kittanning Lower bed is more favorably situated. The coal from the Freeport Upper bed would require washing to make a strictly good coke of it.

The Freeport Lower bed, usually so uncertain, is generally available along the Pine creek waters, though small. It supplied the coke for Pine creek furnace while this stack was in blast; and it has been mined also at other localities.

Of the three beds of the Kittanning group only the lowest can be depended upon with reasonable certainty to maintain a condition of workable thickness. Its outcrop area in both valleys is considerable, being above the water level along the South fork from Echo westward, while along the North fork its range is no less extensive. But in both valleys it is impure, so much so indeed as to render doubtful whether even if washed it could be used for coking.

The coal beds of the Clarion group have little of practical interest. The Brookville is above the water line only over a limited area, and the Clarion is in every case too small to be mined to a profit.

§ 167. The main limestone stratum of both valleys is the Ferriferous which, from its being the most regular, and at the same time the most easily recognized member of the Lower Productive group is here the safest guide in determining the local geology, as it is also in all other parts

of the county where its horizon is above the water line. It makes admirable furnace flux, and is no less good in the kiln, and splitting easily in quarrying it can be raised at small expense, while its location on the hills is in almost every instance favorable for its development.

The Buhrstone iron ore is an unfailing attendant of the limestone, small usually, but large enough to be mined at a comparatively low cost. The mining operations are facilitated by the soft clay shales which overlie the ore. The ore is a carbonate, easily smelted. Pine creek furnace was run upon it for upwards of thirty years, making cold short iron. A description of the furnace together with the mining developments made upon the ore stratum will be found some pages onward.

§ 168. The remaining features of the Lower Productive section, the fire clays and the sandstones require little notice in addition to what is elsewhere said of them. So far as outcrops are indications of the condition of the clays, these are impure, but until further work of investigation has been done, no definite opinion can properly be formed of them.

The sandstones constitute a pronounced feature in the surface geology of both valleys. *The Mahoning* and the *Freeport*, though recognizable are everywhere subordinate both in thickness and in massiveness of bedding to the deposit overlying the Kittanning Lower coal. The same rock, it is true, occurs quite frequently elsewhere in the county, but at no place so persistently as in the two valleys of Pine creek, and nowhere of so pronounced a conglomerate type. Its prominence makes it the dominant rock of the region, superior even to the Pottsville Conglomerate where this latter formation is at the surface at Oscar. Care must then be exercised by local geologists not to confound the two. Of the Pottsville Conglomerate, only a part of the deposit rises to daylight on Pine creek, which part also is there less massive than on the Cowanshannock or on the Mahoning.

§ 169. *The headwaters of the South Fork of Pine creek* are in the Barren Measure highlands that make the southeast corner of Wayne township, and the northern part of

Cowanshannock township. One small branch comes from the neighborhood of Dayton; another from the north flank of the high plateau overlooking Barnards and Rural village; the two unite at Echo, whence westward the course of the stream is transverse to the stratification.

The little branch which drains the upper part of Cowanshannock township flows through a wide but shallow ravine in which the surface rocks are Lower Barrens. Only in the neighborhood of Echo does it pass out of these measures into Lower Productives.

This statement of the outspread of Barren Measure rocks sufficiently explains the absence of workable coal beds above the water level in the region of Gallagher's store, and east of that place. One small coal seam—the Gallitzin—is indeed contained in these rocks, but being near the base of the group, it is below the water level at Gallagher's store.

Otherwise than this one coal seam the Barren Measures are without interest. The *Black Fossiliferous limestone*, observed further north in the Dayton region, was not detected along this valley; nor have any other limestone strata yet been discovered by the farmers among the Barren Measure rocks. *The Mahoning Sandstone* is rather prominent as far up the ravine as the cross roads at Rev. West's house; but beyond this locality, the rock becomes looser and more shaly, causing it to fade from sight towards the east, before reaching the water level.

§ 170. *The Gallitzin coal*—identical with that mined at Patterson's in the Cowanshannock valley below Rural village—is thrice exposed on Pine creek, west from Gallagher's: at Gourley's where it has recently been opened; at Carson's on the opposite side of the creek, and at E. Schrecengost's in the next ravine to the west. At each of these places it is between three and three and one half feet thick, with a small slate parting near the floor. The roof is slate and the floor of hard clay. The coal is fairly good, being preferred to that from the Freeport Upper seam.

At Gourley's the Gallitzin is at the level of the road just above the creek, which it quickly passes beneath, going

southeast, dipping about 2°. At Gallagher's store it is certainly as much as 50 feet below the stream bed. Shales are the country rock.

§ 171. *The Freeport Upper coal* accompanied by its underlying limestone, comes out between Gourley's and the cross roads at West's. It has been opened on the J. R. McIlwain farm and also on the Cook farm, in the ravine south from the cross roads, showing the same section at both places, as follows:

Fig. 26. § 171.

Slate,		—
Coal,	3′ 8″	
Slate,	0′ 1″	4′ 1″
Coal,	0′ 4″	
Clay,		—

Between the two mines, situated about 1000 feet apart, is the Glade run anticlinal, the arch of which is shown by the well marked opposite dips in the two mines, the dip in Mr. Cook's mine being towards the southeast, while at McIlwain's it is towards the northwest. The northwest flank of the axis has here a sharp incline (at least 5° in the McIlwain mine) but is of such short continuance that on the opposite side of the ravine at Schrecengost's, the dip is again southeast, showing that a synclinal passes within a few hundred yards of the anticlinal.

§ 172. On the Schrecengost property the *Freeport Upper limestone* is exposed in a field near the house. Some of the upper layers of the deposit have been quarried, yielding a compact bluish stone, streaked with thin threads of calcite. The rock contains also some minute univalve shells. The full thickness of the stratum is not known, but it is certainly not less than 5 feet.

The Freeport Upper coal outcrops 10 feet above the limestone, and the Gallitzin coal 33 feet above the Freeport Upper. The Mahoning Sandstone occupies nearly all the interval between the two coal seams.

§ 173. Descending the creek from the cross-roads, Lower Productive rocks succeed the Lower Barrens at the surface until at Echo, the Barrens are at the hilltops and the Ferriferous limestone is above the water level.

But before describing in detail the geology at Echo, that displayed along the other branch of the South fork, the branch which comes from Dayton, must first be noticed. South from the town the region is one of Lower Barrens, consisting chiefly of soft argillaceous shales. Along a small tributary stream which heads among these highlands, the *Black Fossiliferous limestone* outcrops at the roadside, mid-way up the hill south from the Campbell school-house. The limestone is one foot thick, shows its usual black color, and is highly fossiliferous.

Thirty feet below it a coal bed 2′ 8″ thick has been developed near the level of the run. The deposit, however, being of a rolling and uncertain nature, no dependence can be placed upon it, and the attempts to develop it have wisely been abandoned. To continue them would undoubtedly only lead to additional expense and disappointment. Such irregular deposits of coal are of frequent occurrence among the Lower Barren strata.

No workable coal seams will be found on the divide overlooking the Cowanshannock and Glade run and Pine creek. Such outcrops as there appear among the hills, are only delusive. The region of the Borland settlement, as well, also, as that of the Russel settlement, contains, positively, nothing of interest to the miner. The soil is, however, smooth, and under proper cultivation, is capable of yielding fairly remunerative results.

§ 174. West from Dayton, Lower Productive rocks cover the surface. The mining developments along that part of Pine creek are confined mainly to the Freeport Upper coal and limestone. Exposures of the latter are found on the T. H. Marshall farm, the coal being opened at the roadside near Mr. Marshall's house. The bed is uniformly four feet thick with a small and unimportant slate parting within about one foot of the floor. The parting is persistent. The roof is hard black slate, compact and dry; the floor is of clay, no less even and regular. The coal is both pyritous and slaty, as the following analysis of a specimen, by Mr. McCreath, will show:

Water,	1.040
Volatile matter,	32.330
Fixed carbon,	49.450
Sulphur,	2 000
Ash,	15.180
	100.000
Color of ash,	gray.
Coke, per cent.,	66.630
Fuel ratio,	1: 1.53

§ 175. The limestone outcrops in a field to the south, being at least 20 feet below the coal. It is a compact grayish-blue rock, without fossils. The same deposit is also quarried in the small ravine east of Dayton.

The dip in the T. H. Marshall mine is sharp towards the southeast away from the Glade run anticlinal and under the town of Dayton. The country towards the northwest, the direction in which the rocks rise, is an undulating plateau, whose surface rocks are below the Freeport Upper coal until after the arch of the Glade run axis has been passed. West of that point the bed in question descends again into a few of the highest knobs. Concord hill is one of these knobs, of which more is said on another page.

§ 176. From the Marshall mine the outcrop line of the Freeport Upper coal runs northeast around the hill into the Glade run valley; southwest it follows the left bank of Pine creek. In the latter direction it quickly becomes indistinct in consequence of a change both in the thickness and character of the seam. Its horizon passes near Mr. Jos. W. Marshall's house, whence southward it runs up a small ravine for a short distance towards the Campbell school-house, but is there obscure beyond recognition. Nor does it appear along the face of the hill extending westward from the school-house towards the Episcopal church. Its absence is owing to ancient erosion, which also removed at the same time the Freeport Upper limestone, the latter being now represented by shale. Search, therefore, for either stratum should be abandoned along the hills overlooking Wadding's and Kirkpatrick's, and J. W. Marshall's.

Possibly the coal bed once opened two feet thick at S. L.

Marshall's, and also on the A. Campbell property, near Dayton, may represent the Freeport Upper seam. The identification is doubtful, but whether correct or not is immaterial as the bed is of little value. A small limestone outcrop is reported 40 feet below the coal, which may be the Freeport Lower limestone. Possibly the small coal is itself the Freeport Lower, the limestone being in that case the equivalent of the Johnstown cement.

§ 177. *The Glade run anticlinal* crosses the main branch of the upper waters of the South fork near Wadding's, where it lifts the Kittanning Lower coal to a point about 50 feet above the water line. The sandstone overlying the coal bed is massive and coarse-grained; large bowlders of it are abundant at the base of the slopes. The coal seam reported to have been once opened 3 feet thick, between McGaughey's and Wadding's, is the Kittanning Lower. The Ferriferous limestone, on the other hand, makes no show whatever, whether because of its replacement here by shale, or because of imperfect exposures, must be left undecided. Towards the north the section ends at the top with the horizon of the Freeport Lower coal, which spreads thence northward across the Bellknap road and into the hills overlooking the Mahoning creek.

Towards the west from Wadding's the section deepens sufficiently in consequence of the continuous dip in that direction, to include the Freeport Upper coal and limestone, both of which appear in the summits of the hills, in detached knobs, as shown on the map. One such knob is on the H. S. Rupp farm; another on the F. Rupp and Stewart farms. Further west the bed is found in nearly all of the prominent hills on the uplands between Pine creek and the Mahoning. It has been opened in several places by the farmers, as for example at Rupp's, at Mrs. Hiestly's, and again on the Bowser farm to the north of the last. Its average thickness is 3½ feet, and the coal is of fair quality.

§ 178. Its limestone regularly attends the coal throughout all the region between Echo and Bellknap. One point of exposure is in Mr. H. S. Rupp's well, where the deposit is in two layers, 8 feet asunder, the intervening rock

consisting of clay. The upper stratum of limestone is four feet thick, of good quality.

The coal beds below the Freeport Upper are partially displayed between Mr. H. S. Rupp's house and the creek; a further display of the same measures is also found along the township road between the J. Masters property and Jacob Kline's. The succession, which is only imperfectly shown, is as follows:

Freeport Upper coal,	3′ 6″
Interval,	30′ 0″
Freeport Lower coal,	thickness unknown.
Interval,	75′ 0″
Kittanning Upper coal,	2′ 10″
Interval,	65′ 0″
Kittanning Middle coal,	3′ 0″–6′ 0″
Interval,	45′ 0″
Kittanning Lower coal,	2′ 0″
Interval to creek level,	15′ 0″
Total,	244′ 4″

§ 179. *The Freeport Lower coal* is known hereabouts only as a faint outcrop; in the same condition it appears in the lane near Mr. Rupp's house, and again in the fields below the road at Mrs. Hiestly's.

The rocks intervening between the Freeport Lower and the Kittanning Upper seams are nowhere well exposed in this neighborhood. *The Kittanning Upper seam* outcrops near J. Garland's house, on the road leading north from Kline's. It was opened into by Mr. Garland, showing the thickness given to it in the section, and showing also good coal. Nowhere in the vicinity has it been fully exposed; nor was anything seen of the Johnstown cement which should underlie it.

§ 180. *The Kittanning Middle coal* is exposed on the Geo. Rupp farm, and also at Kline's. At Rupp's it is a much parted and slaty seam, 2½ feet thick. Its condition at Kline's is no better, but the seam there carries an important rider as follows:

Fig. 27. § 180.

Slate,	—	
Coal,	3′ 5″	6′ 0″
Slate,	1′ 0″	
Coal,	1′ 7″	
Clay,	—	

Neither bench yields coal of any value, the upper layer especially being slaty and poor. The upper bench is an abnormal feature, to which there is doubtless only a limited outspread.

§ 181. *The Kittanning Lower coal* is unexplored in this region, mainly because of its small size. Its outcrop in the road between the creek and the Geo. Rupp mine shows two feet of coal, but further up the creek, near the lane leading to Mr. H. S. Rupp's house, its dimensions are reduced to about one foot. Westward, however, the thickness increases to three feet, which is its height at Echo. Its outcrop, twenty feet above the road, is plainly marked on the hill north of the Echo store, where it was, at one time, opened into by Mr. McIlwain. Further west it shows in the road near the school-house, at which place also the Ferriferous limestone may be seen in the creek bank. The latter stratum comes to daylight at the Echo store, but is not fairly out of the creek until near the school-house. There it is about eight feet thick, consisting of good stone, grayish in color, and highly fossiliferous. It carries the Buhrstone ore, from four to six inches thick.

These conditions are again repeated lower down the creek at P. Beck's, where the ore has been developed for use in Pine creek furnace. Moreover, at Beck's a rich deposit of kidney ore occurs four feet above the Buhrstone, the interval rock being sandstone.

§ 182. The slow ascent of the rocks westward along the slopes indicates the gentle incline of the strata in that region. Between the school-house and S. Beck's the Ferriferous limestone rises only about 30 feet or to the level of the township road. At P. Beck's, one half mile further down, it is 80 feet above the water-level, and at Peart's, 115 feet. The Oscar axis crosses Pine creek at the latter place, and the dip changes from southeast to northwest; the angles in the latter direction are even more gentle than on the eastern side of the arch.

The axis lifts the *Pottsville Conglomerate* to daylight for a distance of about one quarter of a mile along the creek bottom. Only the top layers of the formation are above the

water-level, and these being shaly, are indistinct. No good exposure of the formation here exists, but its shaly condition is easily inferred from the character of the surface at the base of the slopes. The bowlders of sandstone which occur so abundantly along the *first bench above the stream* must not be mistaken for the Conglomerate, as these bowlders represent a higher deposit—that overlying the Kittanning Lower coal.

§ 183. Partial exposures of the Lower Productive strata may be found in ascending the south bank of the creek from the bridge at Peart's. Starting at the water-level and considering the exposures in the order of their occurrence, *the Brookville coal* is represented by a small outcrop which is seen in Mr. Peart's fields, about fifty feet above the creek. The *Clarion seam* is unknown, as is also the nature of the strata intervening between the latter bed and the Brookville. *The Ferriferous limestone* is exposed in Mr. McKinley's fields, where it carries the *Buhrstone iron ore.* The *Kittanning Lower coal* is fifty feet above the limestone—an unusually large interval. The coal has been opened by Mr. Peart on the hillside overlooking the creek above the bridge, measuring there 3′ 1″ thick, with a firm slate roof, and a smooth floor of clay. The same bed may also be seen in a ravine extending through the McKinley farm.

The sandstone overlying the coal is especially massive. It is prominent along the slopes southwest from Peart's, and also on the north slope near the bridge, as well as across the hill in the ravine of the North fork.

§ 184. Ascending to higher levels at Peart's, a small outcrop of coal is observable at the watering trough, near an old stable below McKinley's house. It is perhaps the equivalent of the Kittanning Middle seam; its reported thickness is 18 inches. Thence to the Freeport Lower bed, a distance here of only 70 feet, nothing of interest shows. The Freeport Lower seam makes a distinct outcrop, but is not now mined. It is reported to have been once opened on the McKinley lands, and to have shown a thickness of 2½ feet, corresponding in this respect with its condition at Pine creek furnace.

The Freeport Upper limestone outcrops in the road close to Mr. McKinley's house. *The Freeport Upper coal* outcrops near by and 15 feet above the limestone. The limestone is good and apparently several feet thick. The coal, on the other hand, proved irregular where opened by Mr. McKinley on the hill, back of the house. At the outcrop, the bed showed four feet of coal, which, however, steadily diminished under cover, until the roof and floor meeting, the coal was pinched out. But its absence here can prevail only a small area, as the bed has been found at its usual thickness on many of the adjoining farms. Ascending to the hilltop, a thin covering of Barren Measure rocks conceals the Freeport Upper coal bed southward to the edge of Cowanshannock valley.

§ 185. Passing now down Pine creek, three miles to Pine creek furnace the only change noticeable in the geology is the disappearance under the water level of the Pottsville Conglomerate and the lower horizons of the Lower Productive group. At the furnace the Ferriferous limestone begins the section at the bed of the creek, the hills above containing the remaining strata of the Lower Productive coal measures, with about 100 feet of the Lower Barrens besides.

§ 186. The now abandoned stack of *Pine creek furnace* stands on the right bank of the Pine creek, about three miles east of the Allegheny river at Pine creek station. It was built in 1845 by its present owners, Messrs. Brown & Mosgrove of Kittanning, to make hot-blast charcoal iron for which purpose it served until 1865, when it was remodeled to use coke. Until blown out in the summer of 1879 it was almost continuously in blast, excepting only during such stoppages as were necessary for renewal and repairs. The furnace is a stone stack 40 feet in height, 9′ 10″ wide in the boshes, and 4 feet square in the hearth. It was blown with three tuyeres, and the average product of metal was about 8 tons per day, or between 55 and 60 tons per week. A railroad of the standard guage connects the furnace with the Allegheny Valley RR. at the mouth of the creek.

Iron was always made here at a low cost. So prudently indeed was the furnace managed, that small as it is,

it was the source of considerable profit to its owners. It is said to have paid for itself over and over again during the course of its existence; and it went out of blast not so much because iron was not still being produced there at low figures, (for on the statement of one of its owners, metal was costing not above $13 per ton to make it in June, 1879,) but rather because the furnace had outlived the conditions by which it had previously been made successful. The cheapness of the metal depended for one thing upon the accessibility of the material used in smelting, and as all the ore easily available from the outcrop round about the stack, had in time been exhausted, the expenses of haulage had now to be added, increasing steadily, as the distances from the stack became greater. Moreover for some years past there had been so little demand in the market for iron of the character of that made at Pine creek, that the product of all those years was stacked up in the furnace yards; and as an additional inducement to the abandonment of the business the furnace itself was considerably in need of repair.

§ 187. The ore used at Pine creek was the native carbonate from the Buhrstone stratum. In its raw condition, the average yield was about 33 per cent. of metallic iron, or about 45 per cent. after roasting, to which process the ore was always subjected before being charged into the furnace. Mr. McCreath's analyses of the ore, in addition to confirming these figures, show it to contain an appreciable amount of manganese, though the amount of this metal is insufficient to affect the pig one way or the other. The iron produced was both cold short and silicious—more cold short it may be said and more silicious than would have resulted under a proper treatment of the ores. The subject of the iron manufacture in Armstrong county being elsewhere discussed in this Report, no additional comment upon the subject is here required. None of the metal made at Pine creek was adaptable for railroad iron; and none of it, when used alone could be successfully employed in the rolling-mills. Not however that it contained too much phosphorous for the latter purpose, but because the iron could not be puddled

satisfactorily. Its thin fluid nature when reduced largely confined its use to mixing in the puddling furnaces at Pittsburg with other and thicker irons, for which purpose I am told it answers very well.

§ 188. The average charge into the furnace for each ton of metal was 2¼ tons of roasted ore, one ton of limestone, and 100 bushels of coke. I am unable to give the cost of production in detail, together with such allowances as were made for labor, incidentals, &c., as these figures were not furnished me; but the aggregate cost of each ton of pig, at the time the furnace went out of blast in June, 1879, is stated by Mr. Mosgrove to have been not above $13.

Mr. McCreath made the following partial analysis of a specimen of the pig to show its principal constituents. The metal has an open appearance, and is of a grayish color:

Silicium,	3.195
Sulphur,	.043
Phosphorus,	1.035
Manganese,	2.306

§ 189. The ore has an extensive outcrop range above the furnace, extending eastward as already stated to the Echo store. Below the furnace it sinks underneath the creek, and where its geological horizon re-appears, about a mile further down, the ore itself cannot be found. The developments upon it were chiefly within sight of the stack, and the gangways advanced as far underground as the ore could be profitably mined. These pits are now all closed. Though persistent in its outspread on the furnace property, no regularity of thickness existed; in places one foot and more of ore was mined; in other places only a few inches. The average thickness of the stratum is stated by Mr. Painter, former superintendent at the furnace, to be about six inches. It rests almost directly upon the Ferriferous limestone, which when freshly mined it much resembles in appearance. The roof in all the old mines was uniformly of loose fireclay shales. The mining is easily accomplished, the system being to "bear in" on the shales, and then raise the ore by wedges. Before the recent advance in wages, the ore when mined close to the outcrop could be produced

at a cost of one dollar per ton. The cost at present is perhaps fifty per cent. more; and if transportation in wagons from any distance is to be added, the figures are doubled.

§ 190. Shortly before the furnace went out of blast, much of the ore charged into it came from other places—some from Sligo, in Clarion county, and some from the North fork of Pine creek. Some also was obtained from the Beck farm, already alluded to. Mr. McCreath analyzed two specimens—one from the furnace property, near the stack, and the other from near Slabtown, on the North fork. The latter analysis will be found in the description of the locality whence the specimen came; the other may be here given without further comment as to its character:

Protoxide of iron,	46.285
Sesquioxide of iron,	1.428
Bisulphide of iron,	.118
Protoxide of manganese,	1.655
Oxide of cobalt,	trace.
Alumina,	.823
Lime,	7.080
Magnesia,	1.484
Sulphuric acid,	trace.
Phosphoric acid,	.600
Carbonic acid,	35.358
Insoluble residue,	3.150
Water and carbonaceous matter,	2.019
	100.000
Metallic iron,	37.050
Metallic manganese,	1.282
Sulphur,	.063
Phosphorus,	.262

§ 191. *The Ferriferous limestone* was used for flux in the furnace. The deposit is from 6′ 0″–8′ 0″ thick at the place where it was quarried, on the right bank of the creek, just above the stack. It consists of grayish stone, coarse and rough at the fracture, and filled with fossil shells. The following analysis of a specimen of the rock from the furnace quarry was made by Mr. McCreath, at Harrisburg:

Carbonate of lime,	96.785
Carbonate of magnesia,	1.278
Oxide of iron and alumina,	1.000

Sulphur,	.060
Phosphorus,	.029
Insoluble residue,	.370
	99.522

§ 192. Being near the creek at the furnace and dipping northwest, the limestone soon disappears under the water-level, remaining then concealed until near the forks of the creek. Where its horizon reappears the limestone is absent from the measures, being replaced totally by shale. This irregularity is connected with the absence of the same rock along the river front at the mouth of Pine creek.

§ 193. Two small coal seams representing the Ferriferous bed appear in the steep bluff directly south from the furnace. Neither of the benches is of practical value, and both fade out towards the west. The following section, taken from the exposure in the bluff at the furnace, will show the position occupied by the Ferriferous coal bed relative to the Kittanning Lower seam and the Ferriferous limestone:

Kittanning Lower coal,			2′ 6″
Shales,			10′ 0″
Sandstone,			15′ 0″
Coal,	Ferriferous coal,		1′ 6″
Fireclay,			3′ 6″
Coal and slate,			1′ 0″
Fireclay shale, greenish,			10′ 0″
Iron ore, Buhrstone,			0′ 6″
Ferriferous limestone,			8′ 0″
Water level,			—
			52′ 0″

§ 194. The developments made upon the Kittanning Lower coal on the furnace property have exhibited it in very impure condition—too impure in fact for iron-making. The bed has not, therefore, been worked to any extent hereabouts. Its thickness of 2½ feet, as shown in the above section, is given on the authority of Mr. Painter.

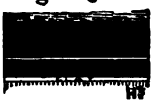
Overlying the coal is sandstone, above which there are few or no exposures until a small coal bed, two feet thick, is reached at a distance of exactly one hundred feet above the Kittanning Lower seam. Its outcrop was observed on

the hill to the north of the furnace, where it is reported to have been once opened, showing the thickness above named. It is the Kittanning Upper seam. The middle member of the Kittanning group, the Kittanning Middle seam, is concealed or perhaps here absent altogether, nothing having been seen of it in the explorations made by the owners of the property. Nor is anything known of the Johnstown cement.

The Freeport sandstone is likewise obscure by reason of imperfect exposures, as are also all the remaining strata intervening between the Kittanning Upper and the Freeport Lower coal beds. The latter is the seam that for years was mined to supply the furnace with coke. Its outcrop line passes up a small ravine just north of the furnace, whence it runs around the creek hill to the point where the bed was mined. The bed maintains a general average thickness of three feet, parted unevenly by a persistent band of slate. The following section will show how closely the conditions here correspond with those at B. Schrecongost's, on the Cowanshannock, near Rural village, where the same seam is mined:

Slate,	—	
Coal,	1′ 10″	2′ 8″
Slate and bony coal,	0′ 1″	
Coal,	0′ 9″	
Clay,	—	
Impure limestone,	—	

Fig. 28. § 194.



§ 195. In respect to the quality of the fuel, the bed is in much better condition at Pine Creek furnace than on the Cowanshannock. In the furnace mine some parts of the seam contain only a trifling amount either of slate or iron pyrites, while the average maintained is in general fairly good; but its coking properties are not of the best, the coke being dense and rather tender. Whether it contains enough phosphorus to contribute to any extent to the cold-shortness of the iron was not ascertained by analysis at the Laboratory. A proximate analysis of the coal by Mr. McCreath was attended with the following results:

Water, at 225°,	1.820
Volatile matter,	34.185

Fixed carbon,	58.301
Sulphur,	.989
Ash,	4.705
	100.000
Coke, per cent.,	63.995
Color of ash,	cream.
Fuel ratio,	1:1.70

§ 196. *The Freeport Upper coal* is far back from the creek on both sides of the valley in the region of the furnace. Although claimed to make a better coke than the Freeport Lower seam, it was never mined for that purpose, because of the greater accessibility of the latter seam to the furnace. It is mined in a small way on the Putsman farm where it is accompanied by its usual limestone. Towards the west from the furnace the bed presents a continuous line of outcrop on both sides of the valley to the mouth of the stream.

Below the furnace few rock exposures are met with until near the forks at Sloan's mill. In the interval the dip changes from north-west to south-east, in obedience to the Kellersburg anticlinal, the same axis that elevates the Pottsville Conglomerate to daylight on the Allegheny river above Kittanning. The axis is west of the river.

§ 197. At the forks of the creek the section extends nearly if not quite to the Brookville coal, which, however, is not exposed. A short distance above the forks the following rocks show in a side cutting of the furnace railroad, at a point nearly opposite Mr. McCaulley's tenant house:

Sandstone, massive,	25′ 0″
Coal, Kittanning Lower,	2′ 6″
Fireclay shales, impure,	25′ 0″
Place of Ferriferous limestone: Limestone absent, being represented by shales and slate,	10′ 0″
Sandstone,	15′ 0″
Creek,	—

No trace of the limestone is anywhere seen in this neighborhood, nor further down the creek at the forks, nor still further west at the mouth of the stream. The replacement here is a part of an extensive area, over which the same conditions prevail, extending in a southerly direction to

Monticello furnace and south-east into the Cowanshannock valley at the old Bonner furnace. Search has been carefully made for it along the lower waters of Pine creek, by the owners of Pine Creek furnace, with a view of working the overlying iron ore; but all efforts to find either ore or limestone have failed. Northward both strata soon reappear.

§ 198. *The Kittanning Lower coal* is exposed not only in the railroad cut above alluded to, but also in a steep bluff to the north, where it is mined, showing persistently 2½ feet of coal, with a massive sandstone roof. The same sandstone still further north makes a line of abrupt cliffs which once directly overhung the waters of Pine creek, but which now define the three sides a wide amphitheatre or cove, around the inner edges of which the creek at one time flowed, its ancient bed being yet distinctly visible; subsequently its course was changed to the present one, across the open end of the enclosure.

§ 199. Ascending the hill by the road leading eastward from the forks to the top of the plateau between the two forks of Pine creek, Lower Productive rocks are crossed in regular succession from the horizon of the Ferriferous limestone upwards. The sandstone above described as overlying the Kittanning Lower coal bed is the most prominent of all the strata, making, as it does, a wilderness of the slopes along their lower levels. The Kittanning Middle coal is not seen; but the Kittanning Upper shows a meagre outcrop, which in a small ravine near Mr. McCaulley's dwelling-house, develops into a bed 2 feet thick, being therefore the same here as on the hill at the furnace. The Freeport sandstone shows above it in a steep bluff.

The Freeport Lower coal is concealed along the road. But both the Freeport Upper coal and limestone make a distinct outcrop near Mr. Rowdybush's house. The limestone has been partially opened in Mr. McCaulley's fields, where it is in fairly good condition. The coal outcrops 10 feet above the limestone.

The Mahoning sandstone is so indistinct in all this region as scarcely to make any show at all. At no part of

the plateau between the forks is the Freeport Upper coal more than 100 feet below the surface, and rarely that much.

§ 200. The geology of the North Fork valley of Pine creek is in nearly every respect a repetition of that above described. Fewer mining developments, however, have been made in it than along the South Fork, and natural rock exposures are also less frequent.

The upper end of the valley is a narrow and shallow ravine, with a line of low hills bounding it on the north which act as a divide between it and the waters of Scrubgrass. Towards the south, along the dividing ridge between the North and South forks of Pine creek, the hills are somewhat higher but more broken. The surface rocks of each divide are Lower Productive Coal Measures. At the head of the North Fork ravine is Concord hill, an oblong knob of considerable prominence in the landscape, overlooking as it does, by at least 100 feet, the highest hills in the vicinity. It is, in fact, one of the highest points in Armstrong county, its summit being about 1600 feet above the ocean level. From the top of the hill, on a clear day, a superb view may be had of the rolling upland country stretching northward across the Mahoning creek and southward into the region of the Cowanshannock.

§ 201. *The Mahoning sandstone* covers the top of Concord hill with loose thin fragments of rock, which extend down to the church at the level of the road. The Freeport Upper coal is opened near by, being mined by Mr. R. Clever. It measures 4½ feet thick, without persistent partings of slate, but otherwise slightly impure from iron pyrites. The bed lies almost horizontally in the hill, the gangways of Mr. Clever's mine having been driven in nearly every direction without experiencing any trouble or inconvenience from the drainage water.

Tough black slates here overlie the coal for a few feet, above which are sandy ferruginous shales, and above these the Mahoning sandstone, the strata being well displayed along the roadside just east of the mine. Still further east, the road descending to Belknap crosses and leaves the

outcrop line of the Freeport Upper coal, which latter is not caught in the hills about Belknap.

§ 202. *The Freeport Upper limestone* accompanies its coal at the church, where the two strata are separated by an interval of about 20 feet. The limestone appears near Mr. Clever's house, showing as a grayish rock, very compact, and not more than 2 feet thick. It is fossiliferous.

After passing out of Concord hill, the coal and limestone under consideration leap across the headwaters of Scrubgrass, not to touch the surface again until caught in the high knobs overlooking the Mahoning creek and Camp run. Towards the south they are represented only in a few prominent hills, until they finally pass under the high land above Echo. Towards the west from Concord hill they are absent from the country nearly as far as Goheenville, from which place however westward to the river their outcrop lines have a continuous and unbroken run.

§ 203. Descending by the road into the valley from Concord church, *the Freeport Lower coal*, 28 inches thick, outcrops on the Snyder property, near the top of the hill north of the little village of Snyderville. Continuing thence down the creek few additional exposures are met with until the valley has deepened sufficiently to uncover the Kittanning Lower coal, which appears on the farm of Mr. D. White who opened a mine on it. The bed, where opened, is two feet thick with a massive sandstone roof.

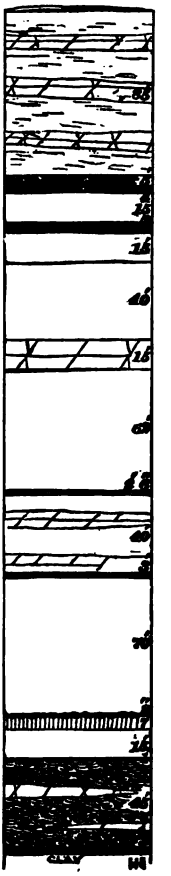
The rocks here rise rapidly towards the northwest to cross the anticlinal axis which passes about a mile west of the White school-house. The Ferriferous limestone is lifted 75 feet above the creek level on the crown of the arch, at which elevation it is exposed on the farm of Mr. J. White, near the line dividing Wayne from Boggs township. The heavy sandstone bowlders noticed here at the creek's edge are from the top layer of the *Pottsville Conglomerate* which is above the water line only for a distance of a few hundred yards.

§ 204. West of the quarry at White's the dip soon changes to northwest; and between that place and the hill tops about Slabtown, the scattered rock exposures reveal the

different members of the Lower Productive group, as these slowly descend to lower levels. By connecting the exposures and arranging the rocks in their proper sequence, the following section was constructed, for much of which I am indebted to the coöperation and kind assistance of Mr. Jno. Zimmerman. Besides the Lower Productive group the section embraces a small portion of the overlying Barren measures:

Hill top, high knob east of Zimmerman's house,	—
Bench just below summit, holding small *coal bed*,	—
Interval, chiefly sandstone,	85 0″
Slates,	5 0″
Coal bed, *Freeport Upper*,	4 0′
Interval, shales?	15′ 0″
Limestone, Freeport Upper,	5′ 0″+
Interval,	15′ 0″
Coal outcrop, *Freeport Lower*,	—
Interval,	40′ 0″
Sandstone, *Freeport*,	15′ 0″
Coal bed, *Kittanning Upper*,	?
Interval,	62′ 0′
Coal bed, *Kittanning Middle*,	2′ 6″
Interval, chiefly sandstone,	40′ 0″
Coal bed, *Kittaning Lower*,	3′ 0″
Interval,	70′ 0″
Iron ore, Buhrstone,	0′ 8″
Ferriferous limestone,	7′ 0′
Interval,	15′ 0″
Coal bed, *Clarion*,	1′ 0″
Shales and sandstone,	45′ 0″
Coal, *Brookville*,	3′ 0″
Clay, impure,	?
Total thickness,	433′ 2″

Fig. 29. § 204.



§ 205. Beginning at the top of the section and considering the strata in their succession downwards, the highest coal bed is a small and unimportant seam almost without

cover and occupying only a few acres of ground at the summit of the hill. In geological position it corresponds very nearly with the Philson seam of Berlin.

The Mahoning sandstone fills nearly all the interval between this small coal and the Freeport Upper. Being massive and compact it is prominent not only on the Zimmerman farm, but generally throughout the neighborhood wherever the uplands are high enough to include its upper layers. The lower part of the deposit is shaly.

§ 206. *The Freeport Upper coal* is opened on the Zimmerman property, where also its limestone shows close by. The coal is further exposed on the Secrist property to the east, being mined at the latter place; and again on the hills to the north of the creek, on the Oliver farm. Towards the southwest from Zimmerman's it may be seen on the Stewart property close to the hill top. The coal bed is in fairly good condition at all the places named, as is also the underlying limestone deposit.

The Freeport Lower coal, to judge from the outcrop in the road south from the blacksmith shop, is small and unimportant. No indications were observed of its limestone.

The Freeport sandstone is usually obscure by reason of its shaly structure. A partial display of the deposit was, however, noticed in the lane leading through Mr. Zimmerman's fields.

§ 207. *The Kittanning Upper coal* almost directly underlies this sandstone. The developments hitherto made upon it here were not satisfactorily determinative of its thickness. Where once opened at the blacksmith shop it is said to have shown nearly 6 feet of coal at the outcrop, but this thickness may be only of very limited extent, especially as the seam shows no such dimensions where it outcrops in the road near the school-house.

The Johnstown cement was not observed either at the school house, or at Zimmerman's, or at any other point along the North fork. The exposures, however, at that horizon being imperfect, the limestone may easily have been overlooked.

The Kittanning Middle coal, 2½ feet thick, is the seam

which outcrops at the level of Mr. Zimmerman's barn, where it was once opened into, but only far enough to ascertain its thickness. What the character of the coal may be is not known.

Sandstone chiefly occupies the interval between the Kittanning Middle and the Kittanning Lower seams—the same sandstone already mentioned as constituting so important a feature in the geology of Pine creek.

The Kittanning Lower coal may be seen in the small ravine which comes into the creek below the Slabtown bridge. The bed has not there been worked to any extent, as the coal from the Freeport Upper seam is much preferred for local use.

Thence downwards in the column to the *Ferriferous limestone* the interval is 70 feet, or double the usual distance. A small coal bed, representing the Ferriferous seam, occurs fifteen feet above the limestone. It outcrops in the ravine below Mr. Zimmerman's house.

§ 208. *The Buhrstone iron ore* has from time to time been quite extensively developed in the neighborhood of Slabtown to supply Pine creek furnace. And here as at the furnace it rests directly upon the limestone, while on its top is a mass of soft greenish fireclay shale. The old pits which worked it extend from Mr. Zimmerman's house to the creek, whence eastward to White's limestone quarry occasional openings have been made along the right bank of the stream. The average thickness of the ore stratum is about eight inches, varying, however, from three inches to eighteen inches. A specimen of the ore from this locality was analyzed by Mr. McCreath, with the following results, which will be found to correspond very closely with the analysis of the same ore at the furnace, both being a carbonate:

Protoxide of iron,	41.400
Sesquioxide of iron,	2.000
Bisulphide of iron,	.041
Protoxide of manganese,	1.896
Oxide of cobalt,	trace.
Alumina,	1.184
Lime,	8.920

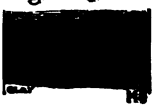
Magnesia,	1.801
Sulphuric acid,	trace.
Phosphoric acid,	.346
Carbonic acid,	34.208
Insoluble residue,	6.430
Water and carbonaceous matter,	1.774
	100.000
Metallic iron,	33.620
Metallic manganese,	1.469
Sulphur,	.022
Phosphorus,	.151

§ 209. *The Ferriferous limestone* exists here in one compact bench. Its outcrop line is so plainly indicated along the slopes by frequent exposures, that a detailed description of its course is unnecessary. The deposit can best be seen at White's quarry, where the stone is in good condition for use as a fertilizer.

§ 210. *The Clarion coal* is uniformly small. Its outcrop was noticed in Mr. Zimmerman's fields, but in the exposures on the Jacob Kimmel property, east of the Slabtown bridge, the coal could not be detected. *The Brookville coal* at the latter place, is of workable thickness, being mined close to the water-level, in the bluff opposite Mr. Jno. Mortimer's house. The coal, however, is bony throughout all parts of the mine, some of it, indeed, having a cannel structure. None of it is good fuel, although reasonably free from iron pyrites. The following section will show the structure of the bed, and the accompanying analysis by Mr. McCreath, its chemical composition:

Slates,	—	
Coal,	1′ 10″	3′ 2″
Slate,	0′ 1″	
Coal,	1′ 3′	
Clay and slate,	—	

Fig. 30. §210.



The analysis is as follows:

Water,	.740
Volatile matter,	35.715
Fixed carbon,	51.049
Sulphur,	.936
Ash,	11.560
	100.000

Color of ash,	cream.
Coke, per cent.,	63.545
Fuel ratio,	1:1.43

§ 211. The left bank of the creek below the Slabtown bridge is steep, with few side ravines; but along the opposite bank the hills, while none the less high, have a more easy slope, rising gently towards the uplands that overlook Scrubgrass creek and the Mahoning. Near the top of these uplands runs the irregular and waving outcrop line of the Freeport Upper coal, which in the Slabtown region is a mile north of the creek. Mention has already been made of the latter bed on the Oliver farm, where also its limestone is exposed. North of this locality, as well as west of it, the bed is under a heavy covering of Lower Barren rocks, until it reappears in the Scrubgrass valley towards the north, and the Allegheny valley towards the west.

A deep ravine, extending from the highlands at Best's, through the Cochran and Maginnis farms, exposes a long outcrop line of the same Freeport Upper coal bed. Where opened in this ravine, at the roadside east of the schoolhouse, it is four feet thick.

The geology at the forks of Pine creek has already been noticed. The Kittanning Lower coal, with heavy sandstone above it, is opened at the level of the road just above the forks. The Ferriferous limestone is absent.

Along the Templeton road, which ascends the hill from this place, a good section of the Lower Productive coal measures may be obtained; but as that section differs in no respect from the one above given, it need not here be reproduced. Between the forks of the creek and the mouth of the stream, one mile below, nothing of special interest was observed.

CHAPTER VI.

The Valley of the Mahoning creek in Armstrong county.

§ 212. *Mahoning creek* enters Armstrong county from the east at Independence, 26 miles by water, according to the county map from the Allegheny river. The head waters of the creek are in the wilderness region of Chestnut ridge in Clearfield county.

The fall in the creek between Independence and the river is, in round numbers, 250 feet, or 10 feet nearly per mile in Armstrong county. The creek's fall, however, though nearly uniform is not entirely so, the flow being somewhat more rapid between Independence and Putneyville, than between Putneyville and the river. The stream bed has usually a thin covering of gravel upon it, but in many cases the bed rock is exposed.

§ 213. *The course of the creek* is in the highest degree irregular, changing and shifting constantly. Away from the bends, (many of which are several miles in length,) the general trend of the valley is either west or northwest across the stratification. Where the creek crosses into Armstrong county its water basin, or the region tributary to it, embraces a scope of territory ten miles wide. Westward the basin narrows steadily, being finally reduced to the hills almost directly bordering the stream. The creek unites with the Allegheny river near Templeton, about midway between the mouth of Red Bank and the mouth of Pine creek.

Within the limits of Armstrong county the creek has several important tributaries, the most important of which are the Mud Lick, Pine run, Glade run and the Scrubgrass. Together with the main creek they drain portions of Wayne, Red Bank, Mahoning, Pine and Madison townships.

§ 214. *The surface rocks* consist chiefly of the Lower Productive coal measures, the Pottsville Conglomerate and some portions of the underlying sub-conglomerate strata,

(see map.) The Lower Barren measures are only sparsely represented, but of these their basal rock, the Mahoning sandstone, so called from its having first been studied along this creek, is a very distinctive feature in many localities. The neighborhood of Putneyville for example, affords some excellent opportunities for the study of the sandstone in compact massive condition.

§ 215. *The Lower Productive section* is so fully discussed in detail in the succeeding description of the exposures and mining developments of the valley, that little need here be said of it, in general. Nor is a typical section of the rocks required, as the local sections are sufficiently complete in this particular to enable the reader to make such comparisons with other sections of the same group as may suggest themselves. Attention, however, should be here directed both to the McCrea furnace section and that made at Putneyville, since both are of classical importance. The one shows the connection existing between these Lower Productive rocks and the underlying Conglomerate and sub-conglomerate strata, including the Mountain Limestone, while the other, exhibiting both the Ferriferous limestone and the Johnstown cement in connected succession, assists in finally disposing of the long misunderstood relationship between these two limestone strata.

Otherwise than this the sections so far as they relate to the Lower Productive coal measures are but a repetition of those with which the reader is already acquainted from foregoing pages. The Freeport Upper coal bed is here as in all the valleys to the south, the most uniform and regular of all the coal seams, and in nearly every instance it best repays development. The Kittanning Lower bed is scarcely less regular, with also a much greater area of outspread than the other, but is less pure. The Freeport Lower seam as well as the Kittanning Upper are of importance in places, but unreliable. The latter seam furnishes the impure cannel and cannel slate along the Mud Lick and at New Bethlehem on the Red Bank. The Clarion and Brookville seams are both of insignificant thickness.

The horizon of the *Buhrstone iron ore* is continuously

above the water line from Independence to the river, and generally speaking, so far as developments have been made upon it, it has proved of workable thickness and in good condition. The Mahoning furnace near Putneyville, and Stewardson furnace near the mouth of the creek have both used this ore, producing from it an iron similar to that made at Pine creek furnace.

§ 216. The Conglomerate and sub-conglomerate strata contain little or nothing of economic interest. They chiefly consist of sandstone. The small layers of coal here and there interleaved are mere streaks which nowhere become workable seams. Nor is the Mountain Limestone adaptable for quarry lime, being cherty and otherwise impure.

The Pottsville Conglomerate is a compact massive sandstone, rather coarse-grained, but not otherwise a conglomerate in the sense of pebbly. The deposit is usually in two layers of nearly equal size, whose aggregate thickness is about 60 feet. This, moreover, is its thickness and its condition not only here along Mahoning creek, but generally wherever its horizon is above the water level in Armstrong county. The rock is unmistakable, and in most cases little difficulty is experienced in distinguishing its upper and lower limits. At its top are the clays of the coal measures, while at its base begin the dark shales and slates of the next underlying Mauch Chunk formation.

Generally the two layers of the deposit make bold cliffs on the slopes. Such are the conditions below Milton, where the dip of the strata is shown by the inclination of the cliffs. Again at the old McCrea furnace the rock is beautifully exposed in a succession of cliffs overhanging the stream, and again at Stewardson furnace and at the mouth of the creek.

§ 217. *The Mauch Chunk Formation* (No. XI of Rogers' classification) consists of shales and slates with interleaved masses of sandstone. The reddish color which distinguishes the formation to a certain extent as far west as the Blairsville gap, has here disappeared, not again to re-appear either along the Allegheny river, or in still more westerly localities. Not a trace of red shale could anywhere be found in the

formation along Mahoning creek. Elsewhere in this volume I have endeavored to show that the substitution of carbonaceous matter for ferruginous material in the coloring of the strata of this Mauch Chunk formation is a gradual one. In other respects the formation has undergone little change between the Blairsville gap and its re-appearance on the flank of the Glade run axis. The thickness of the group is nearly the same, and the Mountain Limestone is here also present to distinguish it. The presence of the latter rock, indeed, reduces the question of the identification of the formation to an absolute certainty.

§ 218. The underlying rocks of the Pocono Formation consist, so far as exposed along the Mahoning creek, almost exclusively of sandstone, thin-bedded usually, and of a greenish color. At the McCrea furnace only the upper strata of the formation are above the water level; more of it is lifted to daylight at the mouth of the stream, as will appear from the detailed description of that locality.

§ 219. *The stratigraphy of the valley* is extremely simple, consisting, as in the case of the valleys before described, of a succession of gentle anticlinal and synclinal flexures, the trend of which being north-east and south-west, the strata dip either towards the north-west or south-east. Describing the axes in their order from east to west, the village of Milton at the county line lies within a synclinal, the centre of which crosses the creek in Indiana county just east of the Armstrong border. North-eastward the axis runs across Porter township of Jefferson county, while towards the south, by a sharp curve it runs under the town of Dayton. It is the Apollo synclinal of the Kiskiminitas.

The basin is not entirely symmetrical in shape, the western side being much more steep than the other. At Milton the rocks dip at angles of between 1° and 2° towards the southeast, sharpening, however, rapidly as the creek is descended towards the anticlinal which crosses the valley at the mouth of Glade run.

This Glade run anticlinal has elsewhere been shown to die southward in Cowanshannock township; northward also the same weakening process takes place with the same

result, the axis finally fading out across Pine run in Jefferson county. On the Mahoning creek it hoists the rocks 400 feet from their level at the synclinal east of Milton, producing an important effect upon the economic geology of the region. From the broad open valley above Milton, with Lower Productive rocks in the side-hills, it makes a wilderness of sandstone and conglomerate between Milton and the McCrea furnace, causing the valley also meanwhile to contract into a narrow ravine with steep precipitous sides. Conglomerate and sub-conglomerate strata, including one hundred feet and more of the Pocono sandstone, come to daylight on its arch, the effect of which is to force the Lower Productive Measures to the hill-tops. South from the creek at the mouth of Glade run only a part of the latter group is represented; north from it, in Red Bank township, the axis weakening, the entire group re-appears near the Jefferson county border. (See map).

§ 220. Between the mouth of Glade run and the McCrea furnace the dip is northwest, but so extremely gentle that scarcely any change takes place in the respective levels of the strata. Indeed, the measures are almost horizontal; so they are at Eddyville, and on thence westward beyond the mouth of Mud Lick, between which last two places the Langville axis of the Little Sandy, in Jefferson county, should cross the Mahoning. Its arch cannot be made out on the latter creek, but the effect of the axis is nevertheless clearly perceptible in the flattening of dips at Eddyville, and in the continued elevated position in which the rocks are sustained between the furnace and Putneyville. Along the same allignment further south rises the Oscar axis of Pine creek and the Greendale axis of the Cowanshannock.

§ 221. Putneyville is situated in a synclinal, the same which crosses the Red Bank at Fairmount, and the Kiskiminitas at the mouth of the stream above Freeport. On the Mahoning waters it is an extremely gentle flexure whose dips on either side scarcely exceed 1°. Yet its strength is sufficient to bring about important changes in the economic geology, one of which is seen in the outspread of Barren rocks over the greater part of the uplands of Mahoning

township. It has also caused the long bend in the creek at Putneyville.

A similar bend, described by the creek just above the Mahoning furnace has been induced by a feeble anticlinal axis, which there crosses the stream. At an earlier period of the creek's history, the stream curved towards the south instead of to the north, as shown by the little cove below the furnace, the outline of which is indicated on the map by the outcrop of the Ferriferous limestone. The facts connected with the occurrence are related elsewhere. The anticlinal, though feeble, is distinctly felt in the dips, whose changes and variations have, indeed, caused considerable trouble and annoyance in the mining operations north of the furnace. Southward the axis soon fades out and is lost; northward, on the other hand, it gains strength, crossing the Red Bank at Anthony's bend. It forces the Freeport Upper coal into the air along the so-called "Narrows" west of Oakland.

§ 222. A shallow synclinal crosses the creek south from Centreville, about midway between the Mahoning furnace and Stewardson. It causes the Freeport Upper coal to reappear in a few high knobs in the vicinity of Centreville.

Thence westward the rocks rise rapidly down the creek to arch across the *Kellersburg anticlinal*, which runs diagonally across the centre of Madison township, passing about one half mile west of Kellersburg. It crosses the Allegheny river at or near the mouth of the Mahoning.

The uplands of Madison township are by this anticlinal covered with Lower Productive rocks. In the Mahoning valley 300 feet of Conglomerate and sub-conglomerate measures are by it lifted to daylight. The display of these rocks between Stewardson furnace and the mouth of the creek is very complete, showing all the strata in their regular succession. The Ferriferous limestone is carried nearly to the summits on the crown of the arch. The dips on the eastern flank of the axis are in some cases as high as 5°.

§ 223. The rocks which occupy the deep valley of the Mahoning at Independence are mainly those of the Lower Productive group with a thin covering of the Lower Bar-

rens on top. These latter measures occur only on the uplands round about Dayton, west of which they are forced into the air by the rapid rise of the rocks northwestward towards the Glade run axis already mentioned. The effect of the anticlinal is more apparent along the creek as will appear presently.

The Pottsville Conglomerate is exposed in the creek bank at Independence where it acts as a natural abutment for the bridge. It appears as a cliff 45 feet high, supported by sandstone in the creek bed. At Milton the same rock is high above the water level, making nearly all the interval between the village and the creek. It is massive and coarse grained, evidence of which is seen in the huge bowlders along the water's edge below the mill. The deposit is 70 feet thick.

Below the sandstone are some slates and ferruginous shales which show in the bank directly opposite the mill. The slates are highly carbonaceous but contain no coal. Below them is sandstone again as follows:

Sandstone, Pottsville Conglomerate,	70′ 0″
Shales, ferruginous,	6′ 0″
Black slate,	5′ 0″
Fireclay, coarse and impure,	8′ 0″
Sandstone,	12′ 0″
Water level,	—
Total,	101′ 0″

In descending the creek below Milton still lower rocks rise out of the stream, until at the mouth of Camp run the top of the Pottsville Conglomerate is 240 feet above the water level; but no exposures occurring in the interval the different sub-conglomerate formations—the Mauch Chunk shales and the Pocono SS. cannot here be distinguished.

§ 224. The exposures also of the Lower Productive rocks are few in number and of an imperfect character round about Milton. *The Brookville coal* underlaid by impure fireclay is directly above the Conglomerate, in which position it may be seen in the creek bank at Independence. It is one foot thick. The Clarion coal, likewise small and

unimportant, is little known to the farmers; its outcrop was recognized in the road between Independence and Milton.

§ 225. *The Ferriferous limestone* as a *limestone* is here absent altogether from the measures. So is the *Buhrstone iron ore.* But in the place of both, and conforming in its dip to the other strata, is a deposit of impure hematite, said to be upwards of two feet thick. The deposit therefore is not merely a shallow pot of bog ore, but a continuous and persistent stratum, replacing the Ferriferous limestone over an area in which the latter rock has been decomposed, and a residuum of ore and clay left in its place. Further down the creek the limestone reappears in good condition.

The discovery of this ore at Milton, many years ago, led to the establishment of Phœnix furnace, a small stone stack, long since out of blast, and now in ruins. The enterprise was short-lived, for besides the difficulties attending the transportation of the metal to market, the ore itself proved lean and impure.

§ 226. *The Kittanning Lower coal* is forty feet above the ore. It was once mined on the Wheatcroft property, north of the village. The same bed was once opened, three feet thick, south of the village, at the point of the hill overlooking Independence. Towards the west, in the valley of Glade run, it is also mined.

Above the coal at Milton is a large deposit of thin-bedded shaly sandstone, which locally is a prominent feature of the geology. It is conspicuous on the slopes above the Wheatcroft mine, and also on the hills overlooking Milton.

Thence to the top of the Lower Productive section the measures are mainly concealed. Towards the east the *Freeport Upper coal and limestone* crown the McClelland hill, across the Jefferson county line. It was from this locality that the limestone used for flux in Phœnix furnace was obtained.

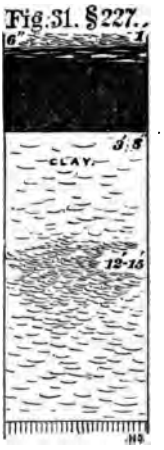
Southward from the creek towards Dayton the Freeport Upper coal is under ample cover. Its outcrop line crosses the Dayton and Independence road near S. M. Gourley's,

where the bed is mined, and where also the limestone is exposed. Thence westward it follows a belt of high land, into the valley of Glade run, which it then follows southward to the edge of Dayton, passing thence still further west into the valley of Pine creek, where its course has already been described.

§ 227. *The town of Dayton*, as before stated, lies in a shallow basin, with dips into the centre from either side. To the east of the town the Freeport Upper coal, dipping northwest, reaches nearly to the edge of the borough, passing thence under the town to rise again to water-level on the opposite side, dipping southeast. Its condition on the west side of the town has been described; on the east side it is unchanged, the section in the Wm. Marshall mine being as follows:

Shale,	—	
Bony coal,	0′ 6″– 1′ 0″	4′ 8″
Coal,	3′ 8″	
Shales and clay,	12′ 0″–15′ 0″	
Limestone,	—	

Fig. 31. § 227.



The limestone is exposed in the run bed, from whence some little of the rock has been removed for quarry lime. The deposit is very pure and good, as will be seen from the following analysis of it by Mr. McCreath:

Carbonate of lime,	94.928
Carbonate of magnesia,	1.210
Oxide of iron and alumina,	1.246
Phosphorus,	.018
Insoluble residue,	1.920

§ 228. *The Mahoning sandstone* shows in the road as-

cending to Dayton. Some of the deposit has here been quarried for flagstones and building purposes. The rock is partly current-bedded, and partly massive and compact.

Its dip carrying it under the town of Dayton, smooth argillaceous shales come in on top of it to make the surface at the village. Among the shales a small streak of coal outcrops in the road leading northward to the Lawson school-house. This coal is 125 feet above the Freeport Upper seam.

§ 229. Crossing now northwestward into the valley of Glade run, the Freeport Upper coal is exposed on both banks of the stream below Dayton; on the east bank by Good, and on the west bank by Rumbaugh. Above this point southward to the headwaters of the run, the surface rocks are of the Lower Barren group; but below Dayton Lower Productive measures occupy all the hills on both sides of the run as low down as Haines' grist-mill, where the Pottsville Conglomerate rises to daylight. Below the mill the run is continuously in Conglomerate and sub-conglomerate rocks, which make a wilderness of the ravine.

The Kittanning Lower coal is here accompanied by a massive sandstone, which overlies it. The coal itself is opened on the Bowser farm, and has been found also at Jewell's, a short distance west of the mill. It is further mined on the A. Hetrick farm, overlooking the Mahoning creek at the mouth of Glade run. At the latter place it is nearly at the hill top. It is three feet thick and pyritous.

The Ferriferous limestone is little known along Glade run, aside from its outcrop which appears in the fields 30 feet below the Kittanning Lower coal. The deposit has been partly exposed at Hetricks, where it yields good stone.

The Pottsville Conglomerate is exceedingly massive in the Glade run region. A good exhibition of the deposit may be had at Bowser's mill, between Haines' and the mouth of the stream.

§ 231.

Fig 32, §231.

Barren Measure rocks and Mahoning sandstone,		110′ 0″
Slates,		5′ 0″
Coal, *Freeport Upper*,		4′ 0″
Shales,		15′ 0″
Limestone, *Freeport Upper*,		5′ 0″
Interval,		25′ 0″
Coal, *Freeport Lower*, thickness unknown,		—
Interval, concealed rocks,		110′ 0″
Coal, *Kittanning Middle seam*,		2′ 0″
Interval,		63′ 0″
Coal, *Kittanning Lower coal*,		3′ 0″
Fireclay and shales,		10′ 0″
Shales,		12′ 0″
Ferriferous limestone,		8′ 0″
Shales, gray,		20′ 0″
Black slate,		10′ 0″
Coal and fireclay, *Clarion coal*,		?
Shales,		20′ 0″
Brookville coal not seen,		—
Sandstone, massive, coarse grained,	Pottsville Conglomerate, XII.	40′ 0″
Concealed; sandstone, ?		12′ 0″
Black slates,	Mauch Chunk Formation, XI.	10′ 0″
Sandstone,		10′ 0″
Fireclay shales,		3′ 0″
Concealed; shales,		14′ 0″
Mountain limestone,		6′ 0″+
Concealed, sandstone, ?	Pocono SS., X.	50′ 0″
Clay shales with ore lumps,		13′ 0″
Sandstone massive,		42′ 0″
Shales sandy,		10′ 0″
Water level,		—
Total thickness,		632′ 0″

NOTE —This section, requiring a full page for its insertion, is necessarily introduced somewhat in advance of the regular order.

§ 230. Descending the Mahoning creek from the mouth of Glade run the northwest dip is too gentle to effect much change in the surface geology. At the old McCrea furnace which stood at the mouth of Camp run, the opportunities for section making are unusually favorable, beginning at the water level with the Pocono rocks, and ending with the Lower Barrens on the high knobs at Milliron's and Reeseman's southwest from the old furnace. The section is of the utmost importance to geologists engaged in the study of the coal rocks of Pennsylvania, inasmuch as it contains the Mountain limestone, of which only this one exposure was found in Armstrong county. The exact dip not being known some of the intervals in the section may be reduced from their actual dimensions; but the difference is slight, and in the aggregate does not amount to more than 25 feet.

§ 232. Considering the strata in ascending order, the sandstones of the Pocono are a fine grained compact mass of rock, greenish in color. There is nothing special about them to distinguish them, and below the furnace they shortly disappear under the creek, being far below the water line at Putneyville. Beyond Stewardson furnace they rise again to make the base of the slopes at the mouth of the Mahoning, where in appearance and condition they are much the same as in the vicinity of the McCrea furnace.

§ 233. *The Mountain limestone* is exposed on the right bank of the creek directly opposite the old furnace. It is a compact grayish rock, very brittle, and of a sandy cherty nature. Its upper portion has some good limestone in it, but the most of it is too impure for use. No fossils were observed.

The rock so far as exposed is 6 feet thick, resting directly on top of the greenish sandstones of the Pocono formation. The only difference which the limestone here presents as compared with its outcrops in the great gaps of the Conemaugh and Youghiogheny rivers, through the mountains of Chestnut ridge and Laurel hill, is its diminished thickness. *Lithologically it is the same;* and as these lithological features are of a very pronounced type, (there is no other

limestone like it in all the coal measures,) they of themselves go far to identify the rock, especially when that identification, as in this case, does not conflict with the structural relations of the deposit relatively to other well recognized strata. In this detailed description the importance of the limestone as a key rock need not further be dwelt upon, but related as it is to the correct classification of the Conglomerate and sub-conglomerate strata of the county, and forming also one connecting link between those measures here and the same rocks in the Allegheny mountain region, its presence on Mahoning creek is particularly to be emphasized. West from McCrea's furnace the limestone is obscure, apparently thinning away entirely before reaching the Allegheny river.

But the overlying black slates of this formation and the clay shales, find their continuance westward in similar strata, which everywhere preserve their characteristic features. Along the river these slates play an important part in identifying and classifying the Conglomerate and sub-conglomerate formations. No iron ore accompanies the Mauch Chunk group. The sandstone which occurs 27 feet above the limestone is a compact fine-grained mass, very free from iron oxides and other impurities. In times past it was quarried near the old furnace for glass sand.

§ 234. *The Pottsville Conglomerate* is very massive and compact. It makes a wilderness of Camp run for a mile back from the creek, in places forming prominent cliffs, of which one is seen in the point of the hill southeast of the furnace. West of the furnace the rock is no less prominent until its continued northwest dip finally brings it to water level beyond Putneyville.

§ 235. Ascending into the coal measures from the creek level at McCreas', neither the *Brookville* nor *Clarion coal* is of importance; nor are they well exposed in the vicinity of the furnace. The Brookville bed, indeed, here entirely escaped notice, but was observed lower down the creek.

The Ferriferous limestone outcrops in Mr. Milliron's fields, 30 feet above what was considered to be the outcrop of the Clarion coal bed. The limestone was developed at

this place to a small extent at the time the McCrea furnace was in blast, having then been used for flux. It is at least 8 feet thick, of a dark gray color, highly fossiliferous, and makes good lime. Its outcrop line extends up Camp run nearly to Bellknap.

Nothing was observed of the *Buhrstone ore* in this vicinity, nor does it apparently exist here. The ore supply for the McCrea furnace was mainly derived from the hills about Putneyville. At H. Bargerstock's, one half mile northeast of Bellknap, the Buhrstone ore is represented by a deposit of impure hematite and clay, similar to that already described as occurring at Milton. It is a soft reddish-brown ore much intermixed with clay, and is of little value.

The Kittanning Lower coal has never been worked to any extent in the neighborhood of the furnace, the Freeport Upper seam being preferred to it for local use.

The Kittanning Middle seam is the bed exposed in the spring near Mr. Milliron's house. It is two feet thick.

The Kittanning Upper coal is not anywhere exposed hereabouts, nor does the Freeport sandstone make much display.

The Freeport Lower coal outcrops in a field to the south of Mr. Milliron's house, and near by, in the same field, the *Freeport Upper seam* was once mined. At this place the latter seam occurs only in a small knob, on the top of which is the Mahoning sandstone. Other and similar knobs are found on adjoining farms.

§ 236. The mine at Milliron's is now closed. As exposed on the John Reeseman farm near by, the Freeport Upper bed shows the following section:

Slate,		—
Coal,	2′ 3″	
Slate,	0′ 0¼″–0′ 1½″	4′ 0½″
Coal,	1′ 8″	
Clay,		—

The Freeport Upper limestone is exposed along the road near Mr. Reeseman's house. Southward from this place, towards Rupp's, it fades away and finally disappears from the measures, the coal bed meanwhile becoming consider-

ably expanded in thickness and carrying an important rider. The outcrop of the bed near Rupp's house shows nearly seven feet of coal, but is so much intermixed with slate, that as a general thing, the bed there is inferior to its condition at Reeseman's or on Concord Hill.

§ 237. *The McCrea furnace* long since went out of blast, and only the ruins of the stack now remain.

§ 238. After rounding the bend below the furnace, the creek flows past the little village of Eddyville, where Conglomerate rocks make the base of the slopes, and Lower Productive Coal Measures the summits. The section in all its essential features being the same as that above described, it is only necessary, for purposes of local identification, to point out those localities at which its principal features are exposed.

The heavy sandrocks at the base of the section are finely exhibited along the road leading west from Eddyville past the Lutheran church. Near the top of the bluff, about one hundred feet above the stream level, is an abundant deposit of rolled pebbles and gravel, indicating the ancient course of the creek across the projecting point of land on which the church now stands. Directly above this near Mr. R. Huffman's house, and within the rocks of the Mauch Chunk Formation (?), is a small coal seam, of no importance in a mining sense, but otherwise of interest in occurring at this horizon. The same bed was also observed lower down the creek at Putneyville.

On top of the Pottsville Conglomerate is the Brookville coal, one foot thick, which was seen in the woods below the road, west of Mr. Huffman's house. Underlying the coal is a deposit of fireclay, apparently of good quality.

§ 239. *The Ferriferous limestone* is exposed at the level of the road, 65 feet above the Brookville coal. The limestone may also be seen on the J. H. Huffman farm, on the opposite bank of the creek. It is about 6 feet thick.

The Kittanning Lower coal, 3 feet thick, is mined on the J. G. Walker property to the south-east of Eddyville; the same thickness is also claimed for it on the R. Huffman farm, where it was once opened 30 feet above the limestone.

Above this horizon the section is nearly a total blank, the higher rocks being concealed. The prominent knob northeast of Eddyville rises to a sufficient height to include the Freeport Lower coal, as does also the knob on the Walker farm east of Eddyville. This latter knob is prettily benched to its top. The anticlinal axis which on the Little Sandy and Red Bank creeks is of such prominence and importance, should cross the Mahoning between Eddyville and Putneyville, but little or no trace of it there appears.

§ 240. Descending now to Putneyville, the Pottsville Conglomerate is close to the water's edge, supporting hills that contain the entire Lower Productive group, dipping at gentle angles towards the north-west.

The neighborhood of Putneyville affords good opportunities for the study of the Lower Productive coal measures. Rock exposures are frequent. The little ravine extending from the highlands at Mr W. R. Hamilton's to the creek at the village has steep precipitous sides, in which the succession of the strata is prettily shown. Moreover the section, as it there exists, is of especial interest in in revealing not only the different coal beds, but all the limestone strata of the Lower Productive group, including the Johnstown cement bed. The connection between the strata is complete, the rocks being well exposed within a short distance of each other, on the face of a continuous hill-slope. Stratigraphical evidence long ago conclusively proved that the Ferriferous limestone and the Johnstown cement occupied different geological horizons; but the difficulty was to produce a satisfactory section in which *both rocks* should appear in their appropriate place. This difficulty was further enhanced either by the indistinctness or the total absence of one of the strata in those regions where the other is prominent. The Johnstown cement is a key-rock to the Lower Productive coal measures throughout the Allegheny mountain region; the Ferriferous limestone is a key-rock in the region of the Allegheny river; only in the intermediate ground can the connection between the two satisfactorily be made out. Armstrong county is a part of such intermediate ground, and there, as

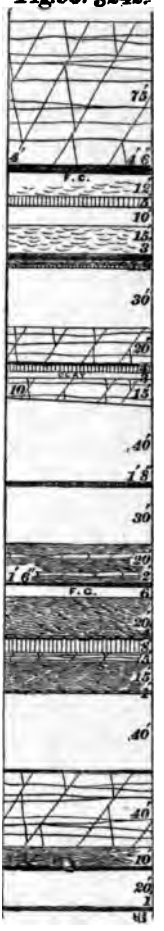
was to be expected, both rocks are found to exist. Similar conditions prevail in Jefferson county; and in Elk county, also, a similarly complete section has recently been constructed by Mr. Ashburner.

§ 241. These sections, however, connecting the Allegheny mountain region with the river, have yet a wider significance in revealing the remarkable uniformity and parallelism of the rocks of the Lower Productive group throughout all western Pennsylvania. No more remarkable fact than this is connected with the geology of that part of the State. In the section at Putneyville all the coal beds are there present that are found in these rocks throughout Clearfield, Cambria, Somerset, Indiana, Jefferson, and Clarion counties; and in Beaver and Butler counties, west of the Allegheny river. Nearly the same vertical intervals separate them in all cases, and the same limestones and sandstones exist at precisely the same geological horizons. Excepting the presence of the Ferriferous limestone, this Putneyville section might in fact have been made at Bennington, on the Allegheny mountain top, one hundred miles from Putneyville; or with trifling change it might stand for a typical section of the Lower Productive rocks at the south end of Somerset county, along the Mason and Dixon line. The Putneyville section further serves to identify positively the Kittanning Lower coal of the Allegheny river with coal bed B or the Miller seam of the Allegheny Mountain.

The section is as follows:

§ 242.

Fig. 33. §242.



Mahoning sandstone,			75′ 0″
Coal bed, *Freeport Upper*,			4′ 0″–4′ 6″
Fireclay and clay shales,			12′ 0″
Limestone, *Freeport Upper*,			5′ 0″
Concealed rocks,			10′ 0″
Clay slates,			15′ 0″
Coal bed, *Freeport Lower*,			3′ 0″
Slate,			1′ 6″
Iron ore,			0′ 3″
Limestone, Freeport Lower,			2′ 0″
Concealed rocks,			30′ 0″
Sandstone, *Freeport*,			20′ 0″
Coal, thickness unknown, *Kittanning Upper.*			
Limestone, Johnstown Cement,			4′ 0″
Clay,			3 0″
Sandstone, friable,			10′ 0″–15′ 0″
Concealed rocks,			40′ 0″
Coal bed, *Kittanning Middle*,			1′ 8″
Concealed rocks,			30′ 0″
Slates, with SS. layers,			20′ 0″
Coal bed, *Kittanning Lower*,			1′ 6″–2′ 0″
Fireclay, impure,			6′ 0″
Shales,			20′ 0″
Iron ore, Buhrstone,			0′ 4″
Ferriferous limestone,			8′ 0″
Sandstone, thin-bedded,			5′ 0″
Black slates,			15′ 0″
Cannel slate, *Clarion coal*,			1′ 0″
Interval, concealed rocks,			40′ 0″
Brookville coal, thickness unknown.			
Sandstone, *Pottsville Conglomerate*,			40′ 0″
Slate and dark shales,	*Mauch Chunk Formation, XI,*		10′ 6″
Coal,			?
Concealed,			20′ 0″
Coal,			1′ 0″
Total thickness,			460′ 3″

§ 243. The lowest coal of the section is at the level of the creek just above the bridge, where some investigation into it at one time, revealed its thickness. The next higher seam, 20 feet above, shows at the head gates of Putney's saw-mill, and again in the roadside near Putney's store. The latter seam is no doubt identical with that observed in the roadside at Mr. Huffman's, near Eddyville. The shales and slates above it correspond with the measures

which in the McCrea furnace section were regarded as belonging to the Mauch Chunk formation, No. XI.

The Pottsville Conglomerate is seen in the sandstone cliffs which line both banks of the creek above and below the village. It is a compact fine grained rock. In weathering it breaks into large blocks of the character of those seen along the creek bottom east of the village and below the school-house. For nearly one half mile below the village, the creek flows in the direction in which the rocks rise, towards the southeast, and the Conglomerate slowly creeps up the slopes, but falls again when the stream turns to run west into the basin, whose centre line is between the village and the Mahoning furnace. At that centre point the Conglomerate is beneath the creek bed.

§ 244. *The Brookville coal*, which should occur on top this sandstone, is not exposed in the vicinity of Putneyville. But the Clarion bed, 40 feet higher, shows in the Hamilton ravine where it is represented by a layer of tough cannel slate, roofed by black slate. Its impurity alone renders it valueless, apart from any consideration of its small size.

The horizon of the *Ferriferous limestone* may be easily traced along both banks of the creek by the quarries working it at short intervals. Thus it may be seen on Mr. Hamilton's property, below the mouth of Little Mud Lick, and again at the point of the hill where Hamilton's run comes into the Mahoning. It has also been exposed at the top of the narrow tongue of land called the "Loop," above the village; and again in the little ravine above the tannery. At each of these localities it is about eight feet thick, in one compact bench of good stone, easily quarried and crowded with fossils.

The Buhrstone ore, though small in the neighborhood of Putneyville, is invariably present.

§ 245. *The Kittanning Lower coal bed* is likewise of minor importance. It was opened into by Mr. Putney, in the Hamilton ravine, and again on the left bank of the creek, below the village, but at neither place did it show more than two feet thick, and this thickness, indeed, only

occasionally, the average being about 18 inches. Slates here chiefly replace the sandstone, which is of such prominence above this coal in the Pine creek valley.

The outcrop of the *Kittanning Middle seam* was opened by Mr. Putney in the Hamilton ravine, but merely with a view of determining the thickness of the bed, the results being as above recorded.

§ 246. *The Johnstown cement seam* is well exposed on the face of a sharp bluff, locally known as the "Point," north of the village. Although the deposit contains some layers of good stone, it is mainly of a cement nature, containing therefore too much iron and alumina for use as quarry lime. An attempt to develop it discovered its unavailability for the latter purpose, as the rock persistently defied the hardest burning. Its chemical composition here corresponding so closely to that which the rock usually presents, shows how uniform were the conditions which gave rise to it, and how widely these prevailed. Mr. McCreath analyzed a specimen of the cement from Mr. Putney's hill. It contains a trifle less magnesia than at Cochran's Mills, but otherwise the Putneyville analysis closely agrees with the other:

Carbonate of lime,	64.160
Carbonate of magnesia,	1.838
Oxide of iron and alumina,	7.450
Phosphorus,	.305
Insoluble residue,	22.280

In the neighborhood of Putneyville the cement seam is only exposed on the "Point;" but it is known to occur in the region of Mahoning furnace, lower down the creek, and it may also be seen on the highlands overlooking Anthony's Bend (of Red Bank creek), west of Oakland. It is usually of a light gray color, and has some few minute fossil shells, similar to those which characterize the Freeport Upper limestone.

§ 247. *The Kittanning Upper coal* does not show on the "Point," but its outcrop was seen along the road leading up the hill southeast from Putneyville. The same seam is enormously expanded towards the north and northeast, be-

ing there distinguished by its semi-cannel feature; but in the neighborhood of Putneyville the bed is obviously small, and of no importance whatever for mining.

Above it is the Freeport sandstone, which, though fine-grained and usually very friable, is plainly recognizable. It is certainly as much as twenty feet thick, and may be even more, none of the exposures revealing its true height.

The Freeport Lower coal, accompanied by a thin stratum of ferruginous limestone and a yet thinner stratum of lean iron ore, traverses all the hills at an interval of forty feet below the Freeport Upper coal. It was opened into, and at one time was mined by Mr. Putney, just below the road leading up the Hamilton ravine. The bank is now closed. It is said to have yielded good coal.

§ 248. *The Freeport Upper seam* is the main bed of the section. North from the creek it has an enormous outspread in Mahoning township, which it underlies in an unbroken and continuous sheet east of Oakland. The mines working it along the Red Bank and along the Mahoning show that at the edges of this great area, the bed maintains an even and regular thickness of four feet. Presumably the same state of regularity obtains over the centre of the area, as well as at its edges. Local irregularities occur, sometimes of a serious nature, of which an instance is seen in the Hamilton ravine, where the bed is entirely cut out by the Mahoning sandstone for a distance of at least 200 feet along the outcrop. How far the line of rock fault may extend under the hill in the direction in which it trends, north-east, is not known, as no investigations have been made of it underground. The rock fault represents a line of erosion which swept through the bed after its deposit, removing the strata nearly to the horizon of the limestone. But even if continuous to the opposite side of Mahoning township it can only affect a comparatively small amount of the coal.

Mr. Hamilton found the bed in good condition a short distance east of the ravine where it measures nearly 4 feet thick. West of the ravine its condition is equally good, and its thickness the same as at Hamilton's. Usually its roof is slate and its floor is clay.

In the country to the south-east of Putneyville the bed is represented only in detached areas, as the continuous rise of the rocks in that direction forces its horizon to the hill-tops. A small area of it is contained in the high knob to the north of the road on the Soxman farm; another is contained on the J. Foster property, and still another and more important one crowns the hill overlooking the creek in the bend below Putneyville. It has been opened into at each of these places, showing the same section as in the opposite hills.

Its underlying limestone is in good condition and of a sufficient thickness to make it an object of interest to those farmers whose lands are on the uplands. The limestone is partly exposed on the Hamilton property near the coal mine.

A specimen of the rock from this exposure was analyzed by Mr. McCreath, with the following results:

Carbonate of lime,	84.857
Carbonate of magnesia,	1.868
Oxide of iron and alumina,	2.568
Phosphorus,	.024
Insoluble residue,	9.520.

§ 249. *The Mahoning sandstone* acquires unusual prominence in the neighborhood of Putneyville, being in fact the chief feature of the geology there. It is this rock that has choked the ravine of Hamilton's run with huge bowlders of massive sandstone, and has further rendered untillable all the slopes over which it passes. So it appears also on the slopes overlooking New Bethlehem on the Red Bank, but losing its massiveness of bedding towards the east and west and south, it becomes gradually less and less distinct in consequence.

At Putneyville the deposit is not less than 75 feet thick in a nearly solid mass. It varies from coarse-grained to pebbly. From top to base the deposit is so much mottled with iron oxides as to unfit it for glass-maker's sand, but some portions of it would make excellent building stone.

§ 250. A deposit of ferruginous clay from which a rough brownish paint was made by mixing the pulverized clay

with oil, occurs along the roadside below the horizon of the Freeport Upper coal. The deposit could be utilized for painting by the farmers in the country round about, but otherwise it has no value.

A romantic feature of local interest deserving mention is what is known as the "cave." It is a vertical crevice in the Mahoning sandstone, 20 feet high and about 3 feet wide, formed by a large bowlder of rock having detached itself from the main mass. The line of break being irregular, and the bowlder itself shifted somewhat out of position, the chambers between the two widen and expand at times into capacious rooms.

Ascending above the Mahoning sandstone the surface stretches northward and north-eastward as smooth rolling uplands covered with a shallow but otherwise good soil. The rocks are mainly shales and slates, with an occasional trace of coal, as for example in the hill east of Mr. Hamilton's house. The coal seam in question is without value or importance, as are also the similar streaks of coal occurring on these Barren Measure uplands.

§ 251. Lower rocks are exposed in the Putneyville synclinal along Mahoning creek than in the same basin along the Red Bank, because of the greater depth of the Mahoning valley. After crossing the synclinal the Mahoning slowly works its way into still lower measures, the Conglomerate finally emerging again above the water line. The outcrop of the Freeport Upper coal is forced northward along the slopes to pass east of Oakland, and to arch in the air across the anticlinal that runs through the "Narrows" below the Mahoning furnace. (See map.)

§ 252. *The Mahoning furnace* stands in the bend of the creek above the "cove." The "cove" is a topographical feature of unusual interest, the existence of which is owing to previous erosion of the creek, which, at an early period, when 115 feet above its present level, flowed across the narrow neck of land south from the furnace, and on thence around through the "cove," which latter at that time constituted a bend similar to that which the stream now makes between Shoemaker's saw-mill and the furnace, only in an

opposite direction. The outcrop line of the Ferriferous limestone, as laid down on the geological map, shows not only the shape of the "cove" very plainly, with its island of limestone in the centre, but it shows also the narrow tongue of land projecting northward above the furnace into the present bend. The top of this promontory is on a level with the top of the island in the "cove," both being 115 feet above the present channel of the creek. Both are covered to a depth of about 25 feet with a deposit of gravel and loose sand and clay, extending below the horizon of the Ferriferous limestone, which latter rock, along with the Buhrstone iron ore, has been eroded from the entire area. The deposit of gravel and sand is not a heterogeneous mixture, but has, as I am informed by Mr. Henry Colwell, who, in his explorations for the ore, caused a shaft to be sunk through it, a certain order of succession, the gravel alternating with the sand, the sand with the clay, &c. I was unable to procure a vertical section to show the exact order of succession, no good exposures existing and the shaft being now closed, but the fact that such an order does exist is suggestive of the conditions which give rise to the formation of the deposit.

§ 253. The material must have been deposited out of standing water. It is impossible to understand how any such mass could have collected so long as the creek had any motion whatever, and I am disposed to regard such occurrences as evidence of the submergence of the region up to a certain level during the glacial epoch. If the course of the creek were now changed from its present bed, it would nowhere leave a *stratified mass of material*, but in most cases would be found to flow over solid rock, which it is eroding. Just so it did in the cove so long as it remained there, and when the period of submergence arrived, and water was backed up from the valley of the Allegheny, which was then also a lake, the process of sedimentation at once began. The flat surface of the promontory at the furnace, as well also as the bed of the cove, afforded not only a favorable resting place for the falling material, but also for its retention after the ice dam was broken and the valley had been drained. Without some such supposition of

standing water we must conclude that the creek first eroded at this place to the horizon of the Buhrstone iron ore, and then began a process of filling up, while it kept on eroding energetically below the cove which is absurd.

After the water had been let out of the valley, erosion was kept up along the floor of the "cove" by a small stream which comes from the highlands of Wayne township, and which, splitting at the head of the "cove," sends two small branches around the inner walls of the enclosure. In this manner the island in the centre of the "cove" has been formed.

§ 254. *The Mahoning furnace* is admirably situated with regard to its supply of material for smelting. The Buhrstone iron ore stratum is no thicker here than at many other localities, nor is its condition otherwise any better; but the frequent lateral ravines in the neighborhood of the furnace, open up such long lines of outcrop that a prodigious amount of cheap ore is afforded almost within sight of the stack.

The furnace is the property of Mr. Jno. A. Colwell, of Kittanning, by whom it was built, to make cold-blast charcoal iron, in 1845. Subsequently, in 1860, it was converted into a hot-blast coke furnace. The stack is 40 feet in height, and 11 feet in the boshes; its capacity is between 80 and 90 tons of metal per week, or about 4500 tons per annum.

The furnace was operated with much success and profit by its owner until September, 1878, when, owing to the depressed condition of the iron industry, it went out of blast, and operations have not since been renewed. A short time previous to its going out of blast the furnace had been placed in good condition, improved hot-blast stoves having at that time also been added.

§ 255. Iron was made here as cheaply as at any other point in the county. The only disadvantage of the location is its lack of railroad facilities for the transportation of the metal to market. Until the completion of the Low Grade RR. along Red Bank creek, the iron had to be carried in wagons to the mouth of the Mahoning; and even after the Low Grade road was opened for traffic, the high

divide between the two creeks had still to be crossed before the metal could be placed on the cars at New Bethlehem. And even then there was a distance of upwards of thirty miles to be overcome before it could begin to compete with its rivals, Stewardson and Pine Creek.

But in spite of these disadvantages, the competition was always fairly and profitably maintained. Such inquiries as I made of Mr. Colwell concerning the production of iron here, and its cost, were met in the frankest spirit, and the books of the concern were placed at my disposal for examination. From them I was enabled to see with what regularity the furnace worked for months and months, producing from the roasted ore a trifle over 40 per cent. of metal, some little iron also being allowed for loss in the slag. These figures were maintained with the utmost constancy, week after week, and month after month, the production of the furnace increasing or diminishing, accordingly as the charges of ore were more or less frequently made.

The cost of producing the metal at the time the furnace went out of blast, was about the same as at Pine creek. After adding all the charges of transportation to Pittsburg, there was still a small margin of profit when the metal was sold for $16 per ton. But so small was the demand for it, even at these low figures, and so uncertain its sale, that in 1878 the furnace could no longer be profitably conducted without some radical change in the method of making the iron. The objectionable feature which operated against the sale of the metal from Stewardson, Red Bank, and Pine Creek furnaces, applied also with equal force to that from the Mahoning stack; it was not only cold-short, but too silicious, and hence too fluid and too brittle to be worked alone in the puddling furnaces of the rolling mills.

§ 256. The specimen of the Mahoning iron analyzed by Mr. McCreath must be regarded as an exceptionally favorable one, as otherwise the metal from the Mahoning stack would have been entitled to far higher consideration in the Pittsburg market than it confessedly received. The specimen analyzed, if above the average, is nevertheless of importance in showing what these ores are capable of under

proper treatment. Doubtless the percentage of phosphorus might be still further reduced by a more careful selection of the ores from the roasting hearth.

The analysis is as follows:

Silicium,	1.872
Sulphur,	.072
Phosphorus,	.855
Manganese,	1.585

§ 257. A geological section of the rocks at Mahoning furnace is so nearly a *fac simile* of that above given (§ 242) for Putneyville that it is unnecessary to repeat it in detail. The reader has only to consult the other section for the interval distances between the different coal beds and limestones, or for the total aggregate thickness of the Lower Productive group. It will be sufficent in this connection if attention be directed to the chief features of the section, and their condition in the vicinity of the furnace.

§ 258. *The Freeport Upper coal bed* supplied the coke for the furnace. The hill in which it was mined, about one half mile north-west of the furnace, constitutes an outlying patch separated from the main body of the seam in Mahoning township by a narrow ravine. In a westerly direction from the Colwell hill the bed is absent from the highest summits of the "Narrows," and is not found again until it re-appears at Centreville. South from the creek it is represented in isolated areas on the highlands of Wayne and Pine townships.

Where mined by Mr. Colwell the bed is four feet thick, roofed by tough black slate, above which the hill rises to a sufficient height to include all of the Mahoning sandstone and some few layers of Barren Measure shales besides. The Mahoning sandstone, so massive and conspicuous at Putneyville, is in this Colwell hill shaly and indistinct.

The north-west dip unexpectedly encountered here in the mining operations is caused by a feeble anticlinal axis passing lengthwise through the hill. The dips are too gentle to be of serious consequence.

The coal was coked unwashed in open ricks at the mouth

of the mine. An incline plane connects the yards with a small tram-road, over which the coke was conveyed to the furnace. The coke, though tender, answered well enough the requirements made of it in the small stack of the furnace. The following analysis was made from a selected specimen by Mr. A. S. McCreath:

Water,	1.450
Volatile matter,	34.810
Fixed carbon,	54.996
Sulphur,	1.054
Ash,	7.690
	100.000
Color of ash,	gray.
Coke, per cent.,	63.740
Fuel ratio,	1:158

§ 259. The coal rests upon impure worthless fireclay, below which is the Freeport Upper limestone, also impure. It is exposed at the edge of the coke-yards, near the head of the incline plane, where the succession is as follows:

Slate,		—
Coal, Freeport Upper,		3′ 11″
Clay,		3, 6″
Limestone,	Freeport limestone,	2′ 0″
Clay,		2′ 6″
Limestone,		3′ 0″
Clay,		2′ 0″
Limestone,		1′ 0″
Clay,		—
		17′ 11″

The outcrop of the *Freeport Lower coal* below the coke yards was once opened into by Mr. Colwell; but the coal being overloaded with iron pyrites to an extent which renders it worthless the mine was abandoned.

It underlies the Freeport Upper seam by exactly 40 feet and like the latter seam, is nearly four feet thick with an excellent roof of tough slate. It is sub-divided by a small parting into two benches of nearly equal thickness. The section is thus:

Slate, highly fossiliferous,		—
Coal,	2′ 0″	3′ 10″
Slate,	0′ 2″	
Coal,	1′ 8″	
Slate		—

Mr. McCreath's analysis of the coal may be here appended without further comment:

Water,	1.070
Volatile matter,	37.110
Fixed carbon,	50.265
Sulphur,	3.225
Ash,	8.330
	100.000
Color of ash,	Pinkish gray.
Coke, per cent.,	61.820
Fuel ratio,	1 : 1.35
Phosphorus in coal,	.0092
Phosphorus in coke,	.0148

§ 260. Below the Freeport Lower coal, in the Colwell hill, there is an unusual development of clay shales, extending downwards below the horizon of the Kittanning Middle coal, and replacing all the intervening strata. There is no trace of the Kittanning Upper coal, nor of the Freeport sandstone. The shales are well exposed along a lane leading down the hill from the coal mines. Their occurrence, however, is local, being confined to this hill; the Kittanning group in regular order and containing the Johnstown cement is found in Spruce Hollow below the furnace.

The Kittanning Lower coal, though persistent at its usual horizon, two hundred feet below the Freeport Upper coal is small. Mr. Colwell opened into it at several places north and west of his furnace, but in no case was it found to exceed two feet thick.

§ 261. *The Buhrstone ore stratum*, which alone supplied the furnace with ore, rests directly on top of the limestone. Greenish clay shales are its roof. The mining operations were chiefly along the right bank of the creek and in Spruce Hollow, at both which places the outspread of the ore is persistent and the ore itself of good quality. The average thickness is from 6 to 8 inches. Its condition in a chemical sense, varies, being richer in iron in some places than in others, and containing less phosphorus, but the average, taking the run of the mines, is singularly uniform and constant

as has been expressed above. Mr. McCreath's analysis shows the ore at its best, containing in its raw state before roasting, nearly 40 per cent. of metallic iron, or a 50 per cent. ore nearly, when in a condition to be charged into the furnace. The analysis is as follows:

Protoxide of iron,	41.464
Sesquioxide of iron,	10.310
Bisulphide of iron,	.062
Protoxide of manganese,	2.353
Protoxide of cobalt,	trace.
Alumina,	1.919
Lime,	4.690
Magnesia,	2.054
Sulphuric acid,	trace.
Phosphoric acid,	.623
Carbonic acid,	31.450
Water,	1.315
Insoluble residue,	3.760
Metallic iron,	39.500
Metallic manganese,	1.823
Sulphur,	.029
Phosphorus,	.272

§ 262. On the narrow strip of ground in the neck of the "loop" south from the furnace, and also on the island in the cove, the ore and limestone have been replaced by a mass of loose hematite fragments in clay. Some of the ore was mined by Mr. Colwell with a view of determining its quality and behavior in the stack. Proving on trial both lean and siliceous, the attempt to work it was discontinued.

§ 263. *The Ferriferous limestone* was used as flux in the furnace, serving tolerably well for this purpose, though adding somewhat to the percentage of phosphorus in the iron. The rock is 6 feet thick, hard compact and brittle, and richly fossiliferous with its characteristic encrinite stems. It can be cheaply raised. A specimen selected for analysis gave Mr. McCreath the following constituents:

Carbonate of lime,	94.721
Carbonate of magnesia,	1 044
Oxide of iron and alumina,	1.383
Phosphorus,	.047
Insoluble residue,	2.300

§ 264. The lowest coals of the series, those of the Clarion group, are here known only so far as their outcrops reveal

them. The Clarion seam shows in Spruce Hollow, 25 feet below the Ferriferous limestone. The Brookville bed outcrops near the base of the slopes west of the incline plane.

The Pottsville Conglomerate makes the creek bed at the furnace, as well also as the side slopes of the valley for a few feet above the water line. It is rather compact, but being obliquely bedded weathers down into loose, thin fragments which make little display on the surface. Moreover, it is here a fine-grained rock, and not a conglomerate. The deposit is also well exposed in Spruce Hollow.

§ 265. Descending the creek below the furnace, scarcely any change occurs either in the geology of the hills or in the rocks of which these are built. The feeble anticlinal roll which is felt in the mines at the furnace, and which causes the confusion of dips there, crosses the Mahoning valley almost unnoticed. Its north-west dip, however, causes the Freeport Upper coal to return to the hills about Centreville, which latter village, moreover, about marks the centre of a shallow basin.

§ 266. The following section obtained on the farm of Mrs. Young shows the main features of the Lower Productive rocks in that locality:

Shales, purple and reddish,	1′ 0″–3′ 0″
Shaly SS., Mahoning SS.,	50′ 0″
Freeport Upper coal,	3′ 10′
Clay shales, with iron ore balls,	15′ 0″
Limestone,	5′ 0″
Interval, containing a thin layer of iron ore,	15′ 0′·
Coal bed, *Freeport Lower*,	3′ 6″
Interval,	22′ 0″
Iron ore, silicious,	—
Sandstone,	15′ 0″
Coal bed, *Kittanning Upper*,	5′ 6″ ??
Interval,	46′ 0″
Coal bed, *Kittanning Middle*,	1′ 0″
Interval,	27′ 0″
Coal outcrop, *Kittanning Lower*,	—
Interval,	65′ 0″
Buhrstone iron ore,	0 4″
Ferriferous limestone,	8′ 0″
Interval,	30′ 0″
Slate, cannel slate, *Clarion seam*,	—
Interval,	40′ 0″
Black slates, *Brookville coal*,	—

Interval, *Pottsville Conglomerate*, ...	70′ 0″
Creek level, ...	—
Total thickness, ...	425′ 2″

§ 267. The variegated shales at the top of the section have been exposed on the property of Mr. J. E. Shoemaker, at Centreville, by whom they have been worked to a small extent for the purpose of making from it a rough paint, similar to that used in many other localities in the coal regions where deposits of clay have been saturated with solutions of iron. Some of the shales in question have a purple color, while some are dark red according to the amount of iron in them and the degree of oxidation which has taken place. They are of little value, excepting as the paint may find favor in the neighborhood.

The Mahoning sandstone is little seen on these slopes. West of Centreville, in Madison township, the surface is not high enough to include it.

§ 268. *The Freeport Upper coal*, as already stated, occurs here only in a few isolated knobs. It has been exposed on the Mrs. Young property, where its thickness is that given in the above section. The same bed has also been opened on the Joshua Shoemaker property, where, being on the east side of the synclinal, it dips north-west. At Mrs. Young's, as in all the other mines at Centreville, the dip is south-east.

The Freeport Upper coal is in the hill at Mr. J. E. Shoemaker's, and again to the north of this on the Reedy property. A small area of it is further found at the extreme hill-top stretching northward a short distance from the Centreville school-house.

The Freeport Upper limestone is nowhere worked in this neighborhood, in spite of the fact that many of the farms would be vastly benefited by the addition of such fertilizer. The deposit is partly exposed on the Mrs. Young farm, and also on the property of S. Myers, Jr., at Centreville, where, having little cover above it, it could be cheaply quarried.

The Freeport Lower coal bed has nearly the same thickness as the Freeport Upper, but is a less valuable bed,

having a damaging parting of bony coal near the roof, and a similar parting near the floor. Moreover, the coal generally from this seam is more slaty than the other. It is mined at Centreville on the properties of Messrs. Shoemaker and Myers.

§ 269. *The iron ore* in the interval between the Freeport Lower and the Kittanning Upper seams was once opened into and mined on the Shoemaker property. It is a lean, sandy hematite, which, according to the analysis of it by Mr. Hay, of Pittsburg, contains only 28 per cent. of metallic iron. The percentage of phosphorus is not stated. Presumably, however, it is high; for the trial once given to the ore in Stewardson furnace resulted, it is said, to its disadvantage. The openings made upon the deposit are now shut. Mr. Shoemaker states that the stratum is 2 feet thick, with a thin layer of carbonate iron ore 6 inches thick at the base.

With regard to the ores noted in the section above and below the Freeport Upper limestone, it may be said that scarcely more than their outcrop has been uncovered, and that in neither case is this promising. The deposit above the limestone consists more of nodules and balls than a regular and persistent plate. The so-called "slab ore" under neath the limestone is highly silicious. The outcrops were seen on the Mrs. Young farm.

§ 270. The *Freeport sandstone*, in massive condition, is the rock seen along the run east of the village. The thickness given to the Kittanning Upper coal, in the above section, is based upon the statement of Mr. J. E. Shoemaker, who once opened into the outcrop of the bed, near the village store. A like thickness is claimed for it on the Mrs. Young farm. The openings are now closed, and aside from a shallow outcrop, nothing is visible.

The Kittanning Lower coal was not observed in the exposures at Mrs. Young's. In the next ravine to the west, it is only 18 inches thick. It there overlies the Ferriferous limestone 58 feet, as it does also at Centreville. Its usual thickness of 3 feet is regained in the vicinity of Kellersburg.

§ 271. *The Buhrstone iron ore* has been quite extensively mined on the Barrett property, between Kellersburg and Centreville, for use at Stewardson furnace. The stratum has an average thickness of about six inches, though often yielding a foot of excellent ore. The ore itself is mainly a brown hematite and not a carbonate. The specimen analyzed by Mr. McCreath is probably slightly above the average in richness. The ore is produced here at a low cost, the friable shale roof greatly assisting the mining operations. An experienced miner can, with tolerable ease, raise a ton of ore in a working day of about eight hours. The system adopted in mining is the same as that employed generally throughout the county—being to wedge down the shale roof after "bearing in" on top of the ore. The ore is then raised by wedges from beneath. Occasionally, where the roof is unusually tough, the ore is blasted. Mr. McCreath's analysis, above referred to, is as follows:

Protoxide of iron,	none.
Sesquioxide of iron,	68.928
Sesquioxide of manganese,	2.048
Sesquioxide of cobalt,	trace.
Alumina,	1.358
Lime,	8.670
Magnesia,	.576
Sulphuric acid,	.012
Phosphoric acid,	.584
Carbonic acid,	6.980
Water,	6.600
Insoluble residue,	4.370
	100.126
Metallic iron,	48.250
Metallic manganese,	1.426
Sulphur,	.005
Phosphorus,	.255

§ 272. *The Ferriferous limestone* is also in good condition. It shows in all the ravines which furrow the uplands on both sides of the creek valley. It can be followed nearly to Kellersburg before passing under the water-level. On the Mrs. Young farm it has been quarried; and along the creek, above Stewardson, its path is distinctly marked by the ore strippings above it.

§ 273. *Stewardson Furnace* is situated in a bend of Mahoning creek, about a mile above where this latter stream meets the Allegheny river. The stack is of stone, 43 feet high, 11 feet across the boshes, and 4 feet square in the hearth. Its capacity is from 75 to 80 tons of metal per week.

With the exception of the ordinary stoppages for repairs, the furnace has been in blast for many years, and is the only one at present operating in Armstrong county.* Being favorably situated with regard to all the material needed for its supply, iron has been produced here from the native ores at a low cost. Exactly what is the cost of production was not ascertained; nor the average net gain of metal from the roasted ore; but presumably in neither respect does Stewardson differ from Pine Creek or Mahoning furnaces. The character of the iron produced is exactly the same as in the other instances, it being both cold short and silicious. Additional flux would reduce the quantity of silicon and greatly improve the pig. Mr. McCreath's analysis of a specimen of the metal resulted as follows:

Silicium,	3.407
Sulphur,	.038
Phosphorus,	.912
Manganese,	2.139

§ 274. *The geology at Stewardson* is substantially the same as that previously described for Mahoning furnace. In brief, it presents the Lower Productive rocks, 300 feet thick, with a thin covering of Barren Measures on the hill summits south of the furnace; while at the base of the slopes Conglomerate and sub-conglomerate measures make an interval of about one hundred feet.

The structure is complicated slightly by a feeble anticlinal axis which rolls the rocks very gently just east of the furnace; but the disturbance is too feeble to exercise much influence over the dips, which towards the north in Madison township are unaffected by it.

The main dip and the prevailing one at Stewardson is

* Since the above was written a stack capable of producing from 250 to 300 tons of metal per week has been erected at Kittanning.

towards the southeast, away from the important anticlinal axis at the mouth of the creek. This uplift, from its great strength, causes quick changes in the geology between the furnace and the river.

The effect of the dip along the southeast flank of the anticlinal may be plainly seen along the right bank of the creek, in the line of "strippings" which follow the Buhrstone ore, nearly continuously from the mouth of the creek, eastward past the furnace, to the mouth of Scrubgrass. In this distance, the ore quickly descends from its elevated position at the hill tops overlooking the Allegheny, nearly to water level at the mouth of Scrubgrass.

This structure necessarily limits the outspread of the Lower Productive coal measures west of Stewardson, and turns their outcrops sharply north and south around the hills, as may be seen by following the course of the Freeport Upper coal bed as laid down on the geological map. In descending the creek from the furnace sub-conglomerate measures slowly rise to daylight, until at the mouth of the stream 300 feet of these rocks are above the water level, driving the Lower Productive rocks to the hill tops and forcing more than one half of that group into the air. An erroneous impression prevails in the region of Stewardson, that the coal bed mined for coking at the furnace near the top of the hill, is identical with that once worked by the Mahoning Coal Co., in a similarly elevated position near the mouth of the creek. The above description of the geology is sufficient to correct this error. The Stewardson coal is the Freeport Upper; that at the creek's mouth is the Kittanning Lower.

§ 275. Aside from the strata mined for use in the furnace, little is exposed at Stewardson. The lower part of the slopes, both above and below the furnace, being occupied by the Conglomerate, the surface, along those levels, is thickly strewn with huge masses and bowlders of sandstone. The exposures will not enable a narrow division to be drawn between the Pottsville Conglomerate and the underlying Mauch Chunk shales, but it is obvious that sandstone largely makes up both formations. The Potts-

ville particularly is massive and heavy bedded, some of it being not only coarse grained, but of a true conglomerate type. It is partially exposed at the mouth of a small ravine above the furnace.

The Brookville coal shows in the same ravine, just above the top of the Conglomerate. The outcrop, which is 60 feet below the Ferriferous limestone, consists mainly of richly carbonated slates, with thin knife-edges of coal interleaved. The bed is valueless. The same also is true of the Clarion seam, the thickness of which does not exceed one foot.

§ 276. *The Ferriferous limestone* supplies the furnace with flux. The deposit is nine feet thick, in one compact bench, all of which is good stone. It is quarried a short distance east of the furnace, at the base of a small knob, whose summit ends with the roof slates of the Kittanning Lower coal. The limestone has further been exposed at the numerous ore strippings in the vicinity of the furnace, showing in much the same condition at all points. A specimen of the rock from the Stewardson quarries was analyzed by Mr. McCreath with the following results:

Carbonate of lime,	96.007
Carbonate of magnesia,	1.498
Oxide of iron and alumina,	1.462
Phosphorus,	.034
Insoluble residue,	.790

The Buhrstone ore is in its usual position on top of the limestone. In the immediate vicinity of the furnace the ore has been taken out underground as far as it can profitably be followed. But in the ravines extending north and south it has scarcely been touched, excepting on the Campbell and Barrett properties; from these ravines enough ore can be taken within a radius of a few miles to supply the Stewardson stack for a long period of years. Moreover much ore yet remains within easy distance from the outcrop, between the furnace and the river.

§ 277. The ore stratum averages about six inches thick, the ore itself being of a dark reddish color, smooth, compact, and frequently coated with incrustations of calcite. As at Campbell and Barrett's, so here at Stewardson, the

ore is mainly a brown hematite. No other ore is used in the furnace. Mr. McCreath's analysis shows it at its richest, and far above the average of that used in the stack:

Protoxide of iron,	none.
Sesquioxide of iron,	73.143
Sesquioxide of manganese,	1.386
Sesquioxide of cobalt,	trace.
Alumina,	1.691
Lime,	4.920
Magnesia,	.800
Sulphuric acid,	.010
Phosphoric acid,	.636
Carbonic acid,	3.980
Water,	8.800
Insoluble residue,	4.800
	100.166
Metallic iron,	51.200
Metallic manganese,	.965
Sulphur,	.004
Phosphorus,	.278

Soft greenish fireclay shales overlie the ore at Stewardson.

At a distance of from three to five feet above the Buhrstone is a second band of ore, called here the "kidney ore," which is persistent at all the exposures. Its average thickness being only about 3 inches, the stratum is too small to be profitably removed considering the amount of dead rock to be handled in the operation.

A small seam of coal runs through the exposures 10 feet above the Buhrstone ore. It is the Ferriferous coal of which frequent mention is made in foregoing pages. At Stewardson it is 6 inches thick.

§ 278. *The Kittanning Lower bed* is not mined at Stewardson, nor is anything known of it there aside from its outcrop. It shows in the road a few hundred yards west of the limestone which it overlies by exactly 35 feet. As before stated, the bed is mined at the mouth of creek where it is 3 feet thick, but vastly inferior in quality to the Freeport Upper seam.

Shales and slates here overlie the Kittanning Lower coal instead of the sandstone stratum which usually appears at

this horizon. Along Scrubgrass creek, however, above the furnace, the sandstone reappears in very prominent form.

§ 279. Thence upwards in the column to the Freeport Upper coal the rocks are concealed at Stewardson. The only objection to the latter seam is the large amount of phosphorus it contains, as otherwise the bed is in fairly good condition, 3½ feet thick, uniform and regular without disturbances of any kind, firm, compact and clean, and with a hard slate roof. Mr. McCreath's analysis of a fair average specimen of the coal is as follows:

Water,	1.470
Volatile matter,	35.520
Fixed carbon,	55.545
Sulphur,	.835
Ash,	6.630
	100.000
Color of ash,	yellowish-gray.
Coke, per cent.,	63.010
Fuel ratio,	1:1.56
Phosphorus in coal,	.0684
Phosphorus in coke,	.1085

The coking is badly done in open air ricks, which require from 8 to 12 days in the operation according to the state of the weather. The coke is very tender.

Mining operations here being necessarily confined to the left bank of the creek, (as the coal is absent from the opposite side, being forced into the air by the rise of the rocks in that direction,) they have to contend against the sharp southeast dip already mentioned. To obviate this difficulty and to afford good drainage to the mine without the aid of pumps, the main gangway has been driven through the hill into the next ravine to the south where the coal is unchanged. The mines are well ventilated, and otherwise in good order.

Below the coal is a stratum of impure fireclay, below which are clay shales for 10 feet. No trace is found of the Freeport Upper limestone which should occur in this latter interval. It reappears, however, in the neighborhood of Templeton and also east of the furnace towards Goheenville.

Above the roof slates of the coal are shales for 25 feet; above these the Mahoning sandstone appears, but thin bedded and shaly. The rock occupies an interval of about 40 feet, near the top of which is a trace of coal. Finally at the top of the hill red shales complete the exposures, the shales corresponding with a similar stratum observed near Mr. Opperman's house, on the ridge above the forks of Pine creek.

§ 280. *The only tributaries of Mahoning creek* deserving of notice are Pine run and Little Mud Lick descending from the north, and Scrubgrass creek descending from the south. All flow through deep ravines, but all are comparatively small streams in which there is never much water at any season of the year.

The valley of the Scrubgrass is a wilderness from the mouth of the stream above Stewardson furnace nearly to Goheenville. The slopes in places are thickly wooded, but chiefly with small timber of secondary growth, the original forest, which consisted mainly of oak and chestnut, having in large part been consumed in the charcoal pits that once supplied Stewardson. The side hills are steep and from 300 to 400 feet in height, with the Conglomerate of XII for their base rock, and the Mahoning sandstone on the uplands.

So few exposures occur in the lower part of the valley that little can be said of the condition of the strata there. A gentle southeast dip slowly buries the lower rocks under the stream bed as the valley is ascended until a synclinal axis is crossed between Laughlin's saw-mill and Goheenville; continuing thence southeast, the rocks rise in that direction towards an anticlinal, whose arch is felt near the head waters of the creek, about one mile above the village last named. This latter axis, which brings the Ferriferous limestone to daylight at the upper end of the Scrubgrass valley, is perhaps identifiable with the Oscar axis of Pine creek; or possibly it may be the extreme southern prolongation of the Dowlingville axis of the Red Bank. The connection, however, in either case is unsatisfactory.

§ 281. The small coal seam exposed near the mouth of Scrubgrass in the left bank of the stream, is the Brook-

ville, here only a few inches thick. Shales overlie it, and over these is the Clarion sandstone 15 feet thick. Higher up the valley the Ferriferous limestone shows in the right bank of the creek. The limestone is very compact and dense; its usual physical aspect is in fact, here wholly changed. Moreover it is devoid of fossils. The Buhrstone iron ore is represented above it, but in greatly reduced thickness. A heavy sandstone 30 feet thick replaces the shales which usually occupy the interval between the ore and the Kittanning Lower coal. The limestone presents the appearance of having been subjected to heavy pressure from the overlying sandstone.

The regularity of the section is however resumed with the Kittanning Lower coal which has been exposed 3 feet thick, on the top of the sandstone and about 50 feet above the water level. The same bed is close to the water's edge near Reedy's house, nearly a mile above the saw-mill. The centre of the basin is close to this latter locality.

§ 282. Of the higher members of the section only the Freeport Upper coal is mined, being on the uplands south from the creek. The outcrop line of the bed passes close to Mr. D. Zimmerman's house, keeping below the Templeton road towards the west; but towards the east it crosses the road just above R. McCall's house, whence it runs out of Boggs township into Wayne, to be there forced into the air on the back of the small anticlinal before mentioned. The seam next passes through the high ridge to the south, reappearing in the slopes overlooking the North fork of Pine creek. Its condition at the latter place as well also as that of its underlying limestone has already been fully described. (See Oliver and Cochran mines.)

§ 283. *At Goheenville* where the two forks of Scrubgrass unite, the Kittanning Lower coal is a few feet underneath the creek bed. Sandstone overlies it, showing in the banks of the stream above and below the village. The southeast rise of the rocks soon brings the coal bed to daylight in that direction, and finally the Ferriferous limestone makes its appearance above the dam. The Buhrstone iron ore is in good condition and of workable thickness. It was mined

here some years ago, at which time the workings extended along the face of the hill from the dam to Kammerdiener's house, the ore proving of persistent thickness. The ore was also mined in a ravine south from Mr. Kammerdiener's; while up the Scrubgrass valley, it can be traced above the water level nearly to the B. Curtis farm, when it disappears under the highlands in which the creek starts. In these highlands the Freeport Upper coal is represented in detached areas, one of which, on the D. Schrecengost farm, marks a high knob standing at the head of the Scrubgrass valley. Another and much larger area of the same coal is that contained in the Rupp and Walker farms; still another is found on the divide between the two forks of Scrubgrass above Goheenville, where the coal bed and its underlying limestone have been exposed on the Calhoon property.

§ 284. *The region of the Mud Lick* and Pine run, embraces nearly all of Red Bank township, in the northeast corner of the county. It is a region of steep and high hills, whose surface rocks are mainly those of the Lower Productive group. How much of these rocks the hills contain, and how much of the surface is given over to non-productive strata is best expressed by the geological map.

The geological structure presents some interesting features. *The Glade run anticlinal*, coming up from the south, runs across the south-east corner of the township, having there well-defined opposite dips towards the north-west and south-east. But fading out gradually north-eastward, it has so much weakened before crossing Pine run, in the neighborhood of Paul's saw-mill, that it is there scarcely felt at all, while on the high knob known as Mt. Tabor, a small area of Barren Measures rides across its flattened arch. Due west of this place about two miles, on the hills between the Mud Lick and the Little Mud Lick, the vanishing end of another anticlinal is felt, entirely distinct and separate from the other, and strengthening rapidly in the same direction in which the other weakens and dies. This second axis is the Dowlingville anticlinal of the Red Bank, and the axis which crosses the Little Sandy about two miles above its mouth, in Jefferson county. In the

mines on the Yount and Felter farms south of Freedom, it has dips along its south-east flank amounting to 4° and 5°. But so rapidly does it vanish southward that it is barely felt at all on the hills west of New Salem, while on the Mahoning, still further south, its arch is imperceptible.

In other words, the rocks have here been so raised that they pitch towards the centre of the township from its north-east and south-east ends, having also, at the same time, gentle dips towards the north-west and south-east. The effect of such structure on the local geology is obvious. It places the Ferriferous limestone nearly at the hill-tops along the Red Bank and Mahoning creeks, while towards the centre of the township a steady accumulation of Lower Productive rocks takes place, extending not only to the top of the group, but including the Mahoning sandstone in the summits overlooking the Charleston grist-mill. Where the ends of the two anticlinals overlap, the rocks are nearly horizontal.

§ 285. *The valley of the Little Mud Lick* has gained considerable local notoriety through the large bed of impure cannel coal which outcrops there. Another part of the same cannel deposit originated the extensive mining developments at Bostonia, near New Bethlehem, on Red Bank creek. The bed in question is the Kittanning Upper seam.

Before describing in detail the cannel deposit along Little Mud Lick, the higher rocks found there may first be briefly noticed. The Mahoning sandstone is on the uplands west of the creek, continuing also still further westward into Mahoning township. East of the creek it can only be looked for in the high knobs which hold the Freeport Upper coal.

§ 286. The Freeport *Upper* coal bed occurs in a few small detached areas west of the head springs of the creek, which are merely outliers of the main body of the bed found further west in Mahoning township. On the eastern side of the valley, the seam first shows going south, on the Doverspike and Kunsleman farms, north-west of the Charleston grist-mill; still further south it is caught in the hill at Mrs. Thompson's, where there is a considerable area of it,

extending in an easterly direction to the Pine run waters. The cannel coal of the Kittanning Upper seam monopolizing attention, the Freeport Upper has been neglected. Where once opened on the Smith property near the top of the hill above Charleston, it measured four feet thick. Its limestone underlies it at a distance of ten feet.

In the imperfect exposures along the Little Mud Lick the Freeport Lower coal nowhere shows. The Freeport sandstone underlying it is well exhibited in the road descending from Mrs. Thompson's to the school-house. The rock has a loose, shaly structure.

§ 287. *The Kittanning Upper coal* which underlies the Freeport sandstone is, as was stated above, the chief feature of interest in the region. In other parts of Red Bank township besides here at Mrs. Thompson's, and in some parts also of Mahoning township, the bed assumes a like cannel structure, but its condition is nowhere so good as along the Little Mud Lick. By barometrical measurement the seam at this locality is exactly one hundred feet below the Freeport Upper.

With regard to the extent of its outspread, either at this place or anywhere in the region under consideration, nothing of a definite nature can be stated, because too few developments have been made upon it to decide that question. But one area of it extends along the left bank of Little Mud Lick from below the school-house, certainly as far as the Wynkoop farm. This area, however, does not extend eastward through the hill to Pine run at Charleston, as otherwise the bed would have revealed itself in the diligent search made for it by the farmers along the latter stream. Nor can the bed be found with its cannel, on the right bank of Little Mud Lick; nor on either bank above the school-house; but it re-appears in the ravine of Cathcart run further west; and another area of it is met with at Bostonia, as already mentioned; still another, and the least important of all, has been found on the Jacob Schieck property south-east of New Salem.

§ 288. Obviously, therefore, the areas are detached. In speaking of the Bostonia cannel in his Report of Progress

for 1874, Mr. Franklin Platt described it as a "pot deposit," which in a word expresses the nature of the conditions, and which applies equally well to the Mud Lick area as to Bostonia.

Usually where the cannel is present it is wedged between two layers of bituminous coal. At each place the deposit consists of a series of lenticular masses which feather in an east and west direction towards the edges, and deepen downwards. The floor therefore is undulating, while the roof and the upper layer of bituminous coal are a more or less regular plane. In this manner a succession of miniature troughs is formed with slightly elevated ridges between. At the centres of these troughs the cannel is thickest and the layers of bituminous coal widest asunder, whereas on the backs of the dividing ridges the layers of bituminous coal unite and the cannel is pinched out.

This feature is prettily shown in the mine at Mrs. Thompson's where the main entry is driven southeast *across* the troughs (and ridges) whose trend is nearly north and south. At the mouth of the pit the cannel bench is only a few feet thick, increasing, however, steadily under the hill until at a distance of about one hundred feet from the pit's mouth, the cannel is eight feet thick. Meanwhile the floor has sunk to a depth exactly corresponding to this thickness of coal. Rooms have been driven off at this point towards the north and south, and as far as they have advanced (from 50 to 100 feet) no diminution in the thickness of the cannel takes place. But continuing southeast along the main entry, the floor slowly rising again in the direction of the advance, the cannel ultimately disappears before the present head of the entry is reached.

§ 289. The main entry of the Thompson mine stops at the disappearance of the cannel, but in other mines close by where like conditions exist, the gangways have been pushed across the ridges into adjoining troughs on the opposite side. The sides or walls of the troughs incline at varying angles. Some are gentle, dipping as at Thompson's at about 5°, while in other cases, as for example in the Brooks mine on Cathcart run, the slope is as much as 22°. The layers

of bituminous coal are unaffected by the undulations whether the slope be steep or gentle. Their thickness is uniform. The following sections of the bed will express the conditions more clearly. Fig. 34 represents the Thompson mine:

Fig. 34. § 289.

Slate roof,		—
Bituminous coal,	4′ 0″	13′ 11″
Cannel,	0′ 0″–8′ 0″	
Bituminous coal,	1′ 11″	
Slate in floor,		—

The Wynkoop mine is shown in Fig. 35:

Fig. 35. § 289.

Slate in roof,		—
Bituminous coal,	2′ 2″	9′ 2″
Cannel,	1′ 0″–6 0′	
Bituminous coal,	0′ 6″–1′ 0″	

§ 290. In the Brooks mine the conditions are somewhat changed. There, in addition to the interleaved mass of cannel, a second bench appears above the upper bituminous layer, thus:

Fig. 36. § 290.

Cannel,	5′ 1″	15′ 1″
Bituminous coal,	1′ 0″	
Cannel,	0′ 10″–7′ 0″	
Bituminous coal,	2′ 0″	
Slate in floor,		—

The second layer of cannel is, however, in this case of no advantage, for it is little more than slate; none of the cannel in fact from this Brooks mine is of value, even the best of it being too slaty for use.

§ 291. Indeed to call any of the deposit, either along Mud Lick or elsewhere, a cannel, is a misnomer, for strictly speaking it is a cannel slate with a conchoidal fracture. In some localities it is vastly better than in others, purer and freer from slate. It has already been stated that the best of it, so far as it has yet been uncovered, is along the Little Mud Lick, but even there it is doubtful whether the run of the mines could be relied upon for a marketable article. The Bostonia mines, in so far as they relate to this bed, were a failure.

The cannel slate carries a less amount of iron pyrites than the associated bituminous coal, which, moreover, is a distinguishing feature of all the cannel slates in western Pennsylvania. It is not likely that the vegetation which produced this cannel slate along Mud Lick grew originally in the locality in which it is now found; for the steep sides of the troughs in which it lies are opposed to any such interpretation. More likely it was washed in along with mud and clay upon the floor of the bed in which, by its weight, it produced the depression and inequalities above described. Or, as has been suggested by Prof. Lesley, the areas may have originally existed as floating masses of vegetation which, at a certain stage of their existence, sank to the bottom of the pool, whose floor was at that time occupied by what is now the lowermost layer of the Kittanning Upper coal bed.

§ 292. The following analyses of the bed were made by Mr. McCreath. No. 1 is the upper bituminous layer at Mrs. Thompson's. No. 2, the middle layer of the cannel deposit, same mine. No. 3, the bottom layer of the cannel, also at Mrs. Thompson's. No. 4 is the cannel slate at the Brooks mine:

	No. 1.	*No. 2.*	*No. 3.*	*No. 4.*
Water,	1.220	1.610	.810	.640
Volatile matter,	37.930	37.830	34.465	32.665
Fixed carbon,	52.757	53.182	54.482	52.306
Sulphur,	1.388	.678	.588	1.044
Ash,	6.705	6.750	9.655	13.345
	100.000	100.000	100.000	100.000
Color of ash,	gray, red tinge.	gray.	gray.	gray.
Coke, per cent.,	60.850	60.560	64.725	66.695
Fuel ratio,	1:1.39	1:1.40	1:1.58	1:1.60

§ 293. The lower rocks of the series are little exposed in the Mud Lick valley. The Kittanning Lower coal is almost entirely neglected here, as it is, indeed, throughout nearly all of the southern end of Red Bank township, the bed itself being small, and the coal inferior for domestic use to the cannel slate.

The Ferriferous limestone shows near the level of the creek below the Thompson mine. It has here been quarried to a small extent for fertilizing purposes. The Buhrstone ore accompanies it, but is both lean and thin. The limestone is 145 feet below the Kittanning Upper coal.

Near the mouth of the creek the Pottsville Conglomerate makes a wilderness of the ravine.

§ 294. *Pine run*, flowing through a deep and narrow valley, comes from Jefferson county, which it leaves below Snyder's mill; flows then a nearly direct west course to Charleston mills, where it receives its main branch, Mud Lick creek, descending from Freedom; beyond which it makes a sharp bend southward to join the Mahoning at Eddyville.

The rocks contained in the sides of the valley embrace the Lower Productive group, and about 200 feet of Conglomerate and sub-conglomerate measures. Ascending the valley from Eddyville, bowlders of heavy sandstone, representing the Pottsville Conglomerate, are abundant along the base of the slopes and in the run bed. The same rock is continuous close to the water-line above the Charleston mill, where there is a fine exposure of it near the bridge

below the mouth of Mud Lick. The rock finally disappears under the run before reaching the point where the stream is crossed by the Milton and Maysville road.

Of the Lower Productive strata neither the Brookville nor Clarion coals have been exposed anywhere in the region. The Ferriferous limestone extends up the Mud Lick to Freedom, and up Pine run to Snyder's saw-mill, before reaching the water-line. It may be seen on the D. Rumbaugh property, below the Charleston mill, and also on the Mrs. Himes farm, near New Salem, on the Mud Lick; also on the Felter farm, still further north, and again at Yount's and Hinterleiter's, near where the creek starts. At New Salem it is just below the road at the centre of the village.

Along Pine run, above Charleston, the limestone is seldom exposed, the valley there being a wilderness. It shows, however, close to the water's edge in Snyder's dam, across the Jefferson line. The rock is from six to eight feet thick, consisting of good stone, of a dark gray color, and crowded with fossils. The Buhrstone iron ore is absent.

§ 295. Thirty feet above the limestone is the Kittanning Lower coal 3 feet thick. It has been opened below the Charleston mill by Messrs. Rumbaugh and Smith, but is not now operated at either place. Above New Salem it is mined on the Felter farm where it is but 2′ 7″ thick and impure. Still higher up the valley it is exposed on the Yount and Hinterleiter properties. It is the only bed of minable thickness in the hills about North Freedom. Along Pine run above Charleston it is not mined, the local supply of coal for that neighborhood being derived from the Butler and Booser mines working the Freeport Upper seam. The Kittanning Lower bed was, however, once exposed in the ravine below Mr. J. Schieck's house where it is said to be 3 feet thick. A direct measurement at this place of the interval between this coal bed and the Freeport Upper gave 193 feet as the result.

The Kittanning Lower coal is here roofed by sandstone.

§ 296. Nothing is known in this region of the Kittanning Middle seam, nor is it probably of value. But the Kittanning Upper coal has been exposed on the Schieck farm,

showing there the cannel feature it possesses on the Little Mud Lick, though on a greatly reduced scale. The section is thus:

Slate,		—
Coal, soft, bituminous,	3′ 0″	6′ 6″
Cannel,	2′ 6″	
Coal, soft, bituminous,	1′ 0″	
Clay slate,		—

The cannel slate here exists in irregular depressions similar to those on Little Mud Lick only shallower. And the slate itself is of much the same quality. Rooms driven off the main entry on both sides have shown the deposit to have an exceedingly limited outspread. It is 81 feet below the Freeport Upper coal.

§ 297. *The Freeport limestone* is scarcely noticeable in this region. Nor is the Freeport Lower coal of importance. The Freeport Upper seam is confined to a few knobs at the hill tops. It is mined by Mr. Butler east of the Charleston mill, where also the Freeport limestone is quite extensively quarried. The coal bed shows thus:

Slate,		—
Coal,	3′ 10″–4′ 0″	
Clay,		—

Although without much cover at this place, the compact roof keeps the coal firm and dry. Small areas of the same bed are found on the Fisher estate to the west, and still larger areas are in the hill tops overlooking New Salem from the east. In one of these latter knobs the bed was opened 4 feet thick by Mr. Copenhaver. It occurs also in the hills at Mt. Tabor, being mined in that locality on the Kiehl farm. It has also been opened on the Booser property south from Mt. Tabor and close to the Jefferson line.

Its limestone here everywhere accompanies it. The Butler quarries have already been mentioned, to which may be added the exposures at Dingle's north from Mt. Tabor, and those at Copenhaver's east from New Salem. The rock is 5 feet thick.

The Mahoning sandstone is little represented, the hills being barely high enough to include its lowest layers. Some fragments of the rock show on the surface above the Butler mine and also in the region of the Mt. Tabor church.

Chapter VII.

The Valley of Red Bank Creek, in Armstrong County.

§ 298. *Red Bank creek* is the northern boundary, as the Kiskiminitas river is the southern boundary of Armstrong county east of the Allegheny river. To the north is Clarion county, whose southern boundary line is the right bank of the creek.

The mouth of the stream is just below the neck of Brady's Bend, about midway between Parker City and Kittanning. Its headwaters are at the eastern border of Jefferson county, where they are interlocked with springs which send their waters eastward into the Susquehanna. Originally the creek was known as the Sandy Lick throughout all its course, appearing under this title in all the old maps and drafts of the region. At present, however, that name is applied only to one of its branches, descending past Reynoldsville, the name Red Bank being first assumed at Brookville, where its three principal branches, the Sandy Lick, Mill Creek and the North Fork unite. At what time the change was made is not known; nor the reason for it. Certainly red rocks nowhere occur along the creek in sufficient quantity to suggest the name the stream now bears.

After crossing the Armstrong line it receives the Little Sandy, also from Jefferson county, beyond which it has no important tributaries either from the north or south. None, indeed, could come into it from the south, inasmuch as its water basin in that direction is restricted very nearly to the hills which overlook it. A glance at the map will show how closely the divide between the Mahoning and Red Bank skirts the latter stream. At one place (in the "Narrows") the distance between the two creeks is less than two miles; and where widest apart in Armstrong county, namely at the Jefferson line, the distance between them is

less than ten miles, from which area also nearly all the surface water goes into the Mahoning.

Excepting, then, in the region of Fairmount, where under the influence of a synclinal the valley broadens somewhat, Red Bank creek flows through a narrow valley—more or less of a cañon, in fact—whose steep side walls are from 300 to 400 feet in height. Few benches or offsets occur to relieve the steepness. Some benches are found on the uplands, where the surface rocks largely consist of slates and shales. The valley itself is in great part a wilderness.

Whatever timber of value the Armstrong slopes may have originally possessed is now gone. Some of it, no doubt, was floated to market at Pittsburg; but more of it was consumed in the charcoal pits that an early period supplied Rock furnace, and at a later date supplied Red Bank furnace at the mouth of the stream. At the present time the forest region of the creek has receded into the interior of Jefferson county, along the Little Sandy, and along Mill creek and the North fork, whence, yearly, a large amount of superb pine and hemlock timber is cut and floated into the Allegheny.

§ 299. *The fall in the creek bed* is expressed by the levels along the Bennett's Branch R. R. ascending the right bank. These levels show an average gradient of about 10 feet to the mile along the Armstrong county border, or 280 feet exactly as the total fall in the railroad between Patton's at the Jefferson line and the mouth of the creek. After making the necessary deductions and allowances for the long bend in the creek below New Bethlehem, which the railroad avoids by a tunnel, the result shows an average fall in the stream bed, between Patton's and the mouth, of between 7 and 8 feet to the mile.

§ 300. *The surface rocks* in large part consist of Conglomerate and sub-conglomerate strata. *The Lower Productive Coal Measures* are on the uplands. At Fairmount, however, these latter measures not only project into the valley, but come down to the creek level. Of the next higher Lower Barren group, scarcely more than the Ma-

honing sandstone is anywhere represented, and then only in detached and isolated areas.

The condition of all the different strata of the valley being elsewhere related in detail in this report the reader must be referred to those pages for particulars. Briefly however it may here be said of the Lower Productive coal measures that no new features are presented in the Red Bank valley. The Pottsville Conglomerate is also similar in every respect to its condition either along the Mahoning creek to the south, or along the Allegheny river to the west. In regard to the underlying shales of the Mauch Chunk formation, these too are uniform and persistent, lacking only the Mountain Limestone, which has evidently thinned out and disappeared from the measures before reaching this latitude. The most careful search for it along the Red Bank failed to discover it; and considering the frequent and favorable exposures of its horizon there, it could not possibly, if present in any recognizable form, have escaped detection.

§ 301. Of the next underlying *Pocono formation* some 200 feet are exposed, for the study of which admirable opportunities are afforded in the side cuttings of the railroad. Their examination resulted in establishing certain facts: *First*, that two sandstone deposits, one 150 feet thick and the other 50 feet thick are persistent and continuous. Of these the larger is the top of the formation. *Second*, that the slates and shales which occupy the interval between the sandstones are subject both to constant and rapid changes; so much so indeed that scarcely any one section of them will apply literally to another locality, perhaps only a few hundred yards distant. *Third*, that small streaks of coal are interleaved among the formation, sometimes wedged between massive sandstone, and at other times resting among the shales. *Fourth*, that all these coals are sporadic. Even with the closest section making it was found impossible to keep hold of them, or to identify the coal of one locality with that of another though the seams are sometimes one foot thick, and the localities often near together. They are emphatically lenticular masses of coal which feather towards their edges and disappear. Their position in the

geological column is without doubt *analogous* to the small seams described by Messrs. Chance and White as occurring in Butler and Lawrence counties in the Quakertown and Sharon groups.

§ 302. *The stratigraphy of the valley* will best be understood if considered in connection with the surface rocks. Proceeding from east to west, the creek is crossed at Dowlingville, a short distance east of the Armstrong county line, by an important anticlinal axis. The same axis crosses the Little Sandy, near Langville. It lifts the Ferriferous limestone to the hilltops, and brings some 300 feet of Conglomerate and sub-conglomerate strata to daylight in the bed of the valley. Its course southwest through Red Bank township has already been described; northeastward through Jefferson county it has not yet been studied.

The dip then at the Jefferson-Clarion county line is at the rate of about 3° northwest, down the stream, towards the synclinal which crosses the creek at Fairmount. The effect of this synclinal upon the topography is to open the valley and give a more gentle slope to the hills. It also brings the Pottsville Conglomerate from the hilltops, and sends it beneath the water level at Millville. The Ferriferous limestone touches the creek bed at Fairmount, while on the hills to the north and south the structure necessitates the presence of all the Lower Productive group in the hills, with an ample cover of Barren rocks in addition. Directly, however, below Fairmount, the Ferriferous limestone comes out of the water again in obedience to the northwest rise of the rocks towards the anticlinal of Anthony's Bend, below New Bethlehem. The presence of the latter axis is responsible for the long *détour* which the creek there makes, besides having caused the valley to contract again into more or less of a gorge.

§ 303. *The Anthony's Bend axis*, though inferior in strength to that at Dowlingville, yet lifts sub-conglomerate rocks to daylight. Thence westward to the river the surface rocks undergo little change, the strata being sustained in their elevated position by a third anticlinal, the *Kellersburg axis*, which crosses the Red Bank near Broken Rock

station. It crosses the Allegheny river near the mouth of the Mahoning, whence southwestward it is lost under the uplands of East Franklin township. Its course northeastward through Clarion county has been traced by Mr. Chance, as also that of the Anthony's Bend arch. Between the two on Red Bank is the *Centreville synclinal*, a shallow basin with such gentle dips as scarcely to affect the levels of the strata. It crosses the creek just below the Bend.

§ 304. In the Geology of Pennsylvania by Prof. H. D. Rogers the structure along the lower waters of Red Bank was described as consisting of a single anticlinal arch, called the Brady's Bend or 5th Axis, which was supposed to cross the Allegheny, *between the mouths of the Mahoning and the Red Bank*, and the latter stream *at Lawsonham*. The same error has frequently been repeated in later publications. The truth is, that instead of an arch in the place described there is a shallow synclinal, with dips nearly as gentle as the Centreville axis, but yet plainly defined; and instead of a single arch on the Allegheny, there is one at each of the mouths of the two creeks above named. Both are of nearly equal strength. The Kellersburg anticlinal, at the *mouth of Mahoning creek*, has been mentioned; that at the mouth of the Red Bank is the *Craigsville axis of the Buffalo*, the true *Brady's Bend axis*, and the one which crosses the Ohio below Pittsburg.

The Lawsonham synclinal is further indicated by the presence of the Freeport Upper coal in a few isolated knobs on the uplands between Rimerton and Lawsonham. At the mouth of the creek the Ferriferous limestone is nearly at the hill summits.

§ 305. The following detailed description of the rock exposures and mining developments of the Red Bank valley relate chiefly to the Armstrong county side. Those which occur in Clarion county on the opposite bank are described by Mr. Chance in Report VV.

Above Maysville the valley is a hopeless wilderness eastward nearly to Troy in Jefferson county. The slopes are untillable, not only by reason of their steepness, but as much on account of the frequent bowlders of sandstone

and conglomerate, with which their surface is strewn. Lower Productive rocks are on the uplands one mile back from the creek. There the surface is smoother and the soil of a much better character.

Along the Bennett's branch railroad so few exposures occur in this region that the Conglomerate and sub-conglomerate rocks are but imperfectly revealed. *A stratum of red shale* shows near the level of the track, a short distance below Patton's station near the county line. It is directly overlaid by massive sandstone 20 feet thick, with which the exposure terminates. The shale is 290 feet below the base of the Ferriferous limestone, and if the measures here possess the same thickness that they do along the Mahoning creek to the south, the shale is below the horizon of the Mountain limestone, and must therefore be among the Pocono rocks. Aside from this fact the shale has no significance, and not having elsewhere been noticed it probably is only of local occurrence.

§ 306. *The Pottsville Conglomerate* is well exposed further down the creek in the neighborhood of Maysville as also near Millville still further west. It goes under the creek at the latter place.*

The Brookville coal is too small and too slaty ever to command much importance at Maysville. It is exposed along the road above the bridge, where in the absence of better seams it is mined in a small way for local supply. It is from 18 to 20 inches thick. Dark shales are its roof, fireclay of a poor quality is its floor, while almost directly under the clay are the sandstones of the Pottsville.

The Clarion coal is unknown here or hereabouts as is also the Ferriferous limestone, the latter stratum being first seen on the Shirry farm to the southeast, whence eastward it is easily followed in its upward course towards the Dowlingville anticlinal. At Freedom it is nearly at the hilltops.

*Since my examination of this region, specimens of gray quartzite, taken from the property of Mr. Mohney, have been forwarded to me by Mr. Smith of Kittanning. The rock occurs among the massive strata of the Conglomerate. Its thickness has not yet been determined by investigation. It seems in early times to have supplied the Indians living along the banks of the creek with arrow heads.

It is exposed in the Coleman fields south of the village. In good condition it slakes readily into smooth white lime.

The Kittanning Lower coal, 30 feet above the limestone, is the only source of fuel supply which the elevated region about Freedom possesses. It is three feet thick, as in the valley of Mud Lick, before described.

§ 307. *The Freeport Upper coal* makes its appearance as the centre of the basin is approached below Millville, being seen for the first time, going west, in a few detached knobs south of the latter village.

The exposures on the Schick and Kunsleman farms consist at the top of the Mahoning sandstone, which is caught only in the summits of a few especially high hills. The Freeport Upper coal bed is between four and five feet thick, roofed by hard slate and resting regularly upon clay. It is mined on the Shick farm, so near the hilltop that its roof-slates are its only protection; but these being tough and compact, the coal is firm and dry. The same bed has also been opened at J. Kunsleman's, where it is 3′ 6″ thick.

Forty feet below it is the Freeport Lower coal—the seam chiefly mined in the neighborhood, being worked on the Horn property, and again at Troupt's. It has further been found at Schick's, and at Kunsleman's, at which latter place it shows as follows:

Slate,		—
Coal,	1′ 4″	
Bony coal,	0′ 3″	3′ 10″
Coal,	2′ 3″	
Slate,		—

Both the upper and lower benches of the bed yield good fuel.

§ 308. *The Kittanning Upper seam*, the next below the Freeport Lower, is, at Schick's, separated from the other by an interval of 35 feet. Black slates alone mark its outcrop, of which no examination has been made to ascertain if the bed here carries its cannel slate bench. The outcrop of the Kittanning Middle bed is from 35 to 50 feet still lower. Between it and the Kittanning Lower seam is an interval of 45 feet, chiefly occupied by sandstone. The outcrop of the

Kittanning Lower bed was sufficiently opened up at one time on the Schick property to show three feet of coal. The section terminates at the level of Sugar run with the Ferriferous limestone, which rock is here five feet thick, with about six inches of good iron ore (the Buhrstone) on top. It is 45 feet below the Kittanning Lower coal.

§ 309. Considering now the exposures at New Bethlehem, these are chiefly found along the small nameless run, descending from the highlands about Oakland to the creek below New Bethlehem. The Lower Productive group is in the hills, with the Mahoning sandstone on top. The Pottsville Conglomerate is at the base of the slopes. The dip is southeast.

The *Pottsville Conglomerate* is beautifully exhibited in the side cuttings of the railroad, opposite the mouth of the small stream above mentioned. It may further be seen near the bridge along the branch railroad leading to the Bostonia mines. Its upper layer is a massive plate, below which is a mass of sandy shales, and slate, and clay. These interchange variously with sandstone. So far as exposed they seem to be simply lenticular masses between walls of massive rock. At one locality, above the grist-mill, some good fireclay is found at this horizon; but the amount of it is small. The thickness of the Conglomerate in this region is not less than 75 feet.

§ 310. *The Brookville coal* is represented by an outcrop of dark slates and impure clay near the bridge on the branch railroad. *The Clarion coal* is concealed, but where once investigated at Fairmount it was found 2½ feet thick. *The Ferriferous limestone*, which is in the creek bed at Fairmount, has at New Bethlehem risen to an elevation of 120 feet on the slopes. It is quarried near the tipple of the Bostonia mines, where it shows six feet of excellent stone, overlaid by soft shales. *The Buhrstone iron ore* was not noticed in the exposure. It is, however, known to occur on the opposite side of the creek, in Clarion county.

The Kittanning Lower coal is not now mined on the left bank of the stream, in the vicinity of New Bethlehem; but a partial exposure of it may be seen at the point of the

hill, on the Doverspike (?) farm, to the southwest of the town. It is this bed also which outcrops at the level of the railroad, 45 feet above the Ferriferous limestone, at Fairmount. It is 2½ feet thick.

Between the Kittanning Lower and the Kittanning Upper seams, the measures are mainly concealed. The interval between the two is here about one hundred feet, of which the lower part above the Kittanning Lower coal consists mainly of sandstone. The Kittanning Middle coal was not observed.

§ 311. Mention has already been made in these pages that the Kittanning Upper seam at Bostonia carries a thick bench of cannel slate. The occurrence was fully described, with sections to illustrate it, by Mr. F. Platt, in his Report of Progress for 1874.* In the present connection it is sufficient to say that the occurrence is in every respect a similar one to that in the Mud Lick valley, already fully noticed. The cannel slate occupies at Bostonia, just as on Mud Lick, narrow and shallow depressions in the floor of the seam.

Mines were opened upon it on an extensive scale by the Red Bank Mining Company with the intention of developing it for shipment. But no sale being found for it in the markets, the mines, if not entirely abandoned, are at least not now operated. Mr. McCreath's analyses of the slate may be here reproduced to show its character:

	No. 1.	*No. 2.*
Water,	0.510	.730
Volatile matter,	30.490	31.680
Fixed carbon,	46.194	49.815
Sulphur,	.576	.455
Ash,	22.230	17.320
	100.000	100.000

§ 312. Thin slates and shales overlie the cannel slate, filling an interval of 25 feet, at the top of which is the Freeport Lower coal, once opened into by the Red Bank Company but not now operated. The seam, in fact, is so overloaded with iron pyrites that marketable coal cannot be obtained from it. This is in striking contrast to the superb

* Report H, pp. 239, 240.

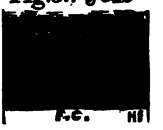
condition of the seam on the opposite side of the creek at Fairmount, where its handsome appearance is fully borne out by the excellent reputation which the coal from that place bears in the western markets. At Fairmount it is 6 and 7 feet thick; at Bostonia it is reduced to 4 feet. Moreover at the latter place both roof and floor are rolling and irregular, while the coal itself is much disturbed. Mr. McCreath's analysis of it is as follows:

Water,	1.690
Volatile matter,	35.940
Fixed carbon,	53.950
Sulphur,	3.380
Ash,	5.040
	100.000
Color of ash,	gray.
Coke, per cent.,	62.370
Fuel ratio,	1:1.50

§ 313. *The Freeport Upper coal*, 50 feet above the Freeport Lower, is the seam worked in the main colliery of the Red Bank Mining Company. Its condition is in every respect similar to that shown by it along Mahoning creek between Putneyville and the Mahoning furnace. It shows the following section in the Red Bank Co's. mine:

Roof, cannel slate,		—
Coal, bony,	0′ 6′	
Slate,	0′ 3½″	4′ 5½″
Coal,	3′ 8″	
Fireclay,		—

Fig. 37. § 313



§ 314. The mine at first experienced considerable trouble from rock faults and horsebacks, which not only seriously affected the quality of the coal, but which made mining both troublesome and expensive. Nor was relief obtained from these troubles until a complete mine map had been constructed by Mr. Jno. F. Blandy, Sup't of the mines, when an ancient stream was revealed with all its various branches and ramifications. The facts thus elicited were stated by Mr. Blandy in a paper read before the American Institute of Mining Engineers, and published in the Transactions of that society, to which source the reader is re-

ferred for particulars.* Mr. McCreath's analysis of a specimen of the coal from the mine is as follows:

Water,	1.840
Volatile matter,	35.940
Fixed carbon,	53.661
Sulphur,	1.739
Ash,	6.820
	100.000
Color of ash,	gray.
Coke, per cent.,	62.220
Fuel ratio,	1 : 1.49

§ 315. The northwest rise of the rocks towards the anticlinal at Anthony's bend, forces the Freeport Upper coal out of the hills in that direction, and shoots it also over the village of Oakland. Its outcrop is seen in the road near Mr. Shoemaker's house, east of the village, whence southwest it makes an irregular and zigzag line towards Mahoning creek. None of the bed is preserved on the "limestone narrows."

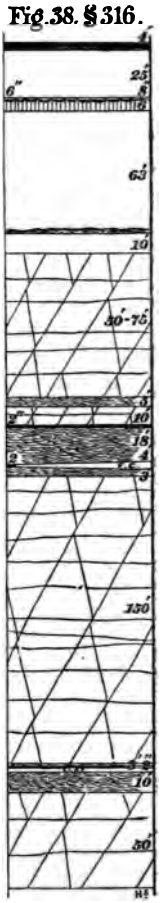
The Mahoning sandstone is massive and coarse grained on the hills overlooking New Bethlehem. It makes an abundant display along the road ascending the hill south of the town; and it is no less a conspicuous feature on the hilltops at the Bostonia mines. In the same condition it reappears in the Mahoning valley, on the slopes at Putneyville, as already described.

§ 316. Descending through the valley below New Bethlehem, the side cuttings of the railroad are chiefly through the sandstones of Conglomerate and sub-conglomerate formations. Occasional thin layers of black slate and clay appear, and sometimes small streaks of coal; but all such layers are too fugitive to be traced. The following vertical section compiled from the exposures along the railroad, and from additional exposures in the ravines to the south, partially shows the succession from the uplands about Kellersburg to the water level at Rock run:

*See Vol. IV, p. 113, *et seq.*

Coal bed, *Kittanning Lower*,		4′ 0″
Interval,		25′ 0″
Buhrstone iron ore,		0′ 6″– 0′ 8′
Ferriferous limestone,		6′ 0″
Interval,		63′ 0″
Coal and black slate, *Brookville bed*,		?
Interval,		10′ 0″
Sandstone massive, *Pottsville Conglomerate*,		50′ 0′ – 75′ 0″
Shales,	Mauch Chunk Shales.	5′ 0″
Sandstone,		10′ 0″
Coal, not persistent,		0′ 2″
Shales, ferriferous,		18′ 0″
Fireclay, good,		2′ 0″– 4′ 0″
Shales,		3′ 0″
Sandstone, massive, *top of Pocono formation*,		150′ 0″
Slate,		1′ 0″
Coal, not persistent,		0′ 2″
Clay,		2′ 0″
Shales,		10′ 0″
Sandstone, massive,		50′ 0″
Total thickness,		437′ 0″

Fig. 38. § 316.



§ 317. Below the Brookville coal the only constant members of the above section are the Pottsville Conglomerate and the massive sandstone layers of the Pocono. And these are unfailing, cliffing out along the slopes, which they convert into a wilderness from below New Bethlehem to the river.

The condition of the Pottsville Conglomerate at New Bethlehem has already been noticed. The slates and shales of the Mauch Chunk Formation are not exposed to advantage along the railroad, but may be seen in the long bend of the creek south of the tunnel, where also the fireclay

deposit near the base of the group is mined. The openings upon the clay, 75 feet above the creek, are on the McCauley property. Some years ago the deposit was operated to a considerable extent by the Messrs. Kier Bros., of Pittsburg, in whose works, close to the railroad at the tunnel, the clay was made into bricks and retorts. But this part of the enterprise proving a failure the works were abandoned, and such clay as is now mined is shipped in its raw state to Pittsburg.

The thickness of the deposit is from 2 to 4 feet and even more in places. Three feet is perhaps a fair average. In character and composition there is apparently little change in it, so far as it has yet been exposed. It is a smooth hard clay, very brittle, and of a dark gray color. Mr. McCreath's analysis of a specimen from the mine on the left bank of the creek resulted as follows:

Silica,	44.610
Alumina,	38.010
Protoxide of iron,	1.251
Titanic acid,	1.020
Lime,	.080
Magnesia,	.407
Alkalies,	1.735
Water and organic matter,	13.630
	100.743

§ 318. The massive sandstone deposit at the top of the Pocono begins a few feet below the clay. It is exposed in the creek bank below the clay mine; and it makes the narrow neck of land through which the tunnel cuts; but the best exhibition of it is at Broken Rock station, at which place its full thickness is handsomely shown in a series of cliffs. The lower part of the deposit is particularly massive and heavy. Underneath it at Broken Rock occur some thin layers of slates and shales with some interleaved masses of coal. The succession in the cut just above the station is as follows:

1. Sandstone,	40′ 0″
2. Coal,	trace.
3. Shales,	2′ 0″
4. Sandstone,	10′ 0″
5. Slates,	1′ 0″
6. Coal,	0′ 2″

7. Clay,	2′ 0″
8. Shales,	10′ 0″
9. Sandstone, at railroad,	?
	65′ 2″

The section represents the east end of the cut. At the west end, a few hundred feet distant, Nos. 2 and 3 have disappeared, while Nos. 1 and 4 have united into a compact mass. No trace either of the lost coal or clay reappears beyond, but the lower seam of coal, No. 6, is continuous to the end of the cut. It could not, however, be again identified satisfactorily in the exposures to the west.

§ 319. From Rock run the measures slowly sink northwestward into the basin, whose central line crosses the creek near Lawsonham. The basin, however, being a shallow one, and the dips exceedingly gentle, the rocks are lowered only about one hundred feet from their elevation on the Kellersburg arch. Yet the change is sufficient to bring the heavy sandrock at the top of the Pocono to water level, and to make the Mauch Chunk shales and slates underlying the Pottsville Conglomerate the prominent feature in the cuts at Lawsonham. West from that place the sharp rise towards the Craigsville or Brady's Bend axis causes the Pocono strata again to take an elevated position in the region of Red Bank furnace at the mouth of the creek.

§. 320. In a thick deposit of ferruginous shales, exposed at the water station on the Sligo Branch R. R., just north of Lawsonham, hollow concretions of carbonate iron ore are found in great abundance. Of no practical value in themselves, they contain inside such beautiful and well formed crystals of *siderite* that the locality is one of interest to mineralogists. A rock cut at this place exhibits the following succession, in which the small coal very likely corresponds with that outcropping between the 2nd and 3rd mile post, west of Lawsonham:

Shales, with ore-balls containing siderite crystals,	20′ 0″
Sandstone,	3′ 0″
Coal,	1′ 0″
Shales and sandstone,	—
	24′ 0″

Rapid changes and replacements take place towards the south. In another cut a few hundred feet distant, displaying exactly the same horizons, the succession is thus:

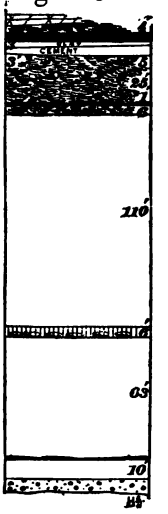
Shales,	30′ 0″
Coal,	0′ 1″
Slate,	0′ 3″
Coal,	0′ 1″
Shales,	1′ 0″
Sandstone,	—
	31′ 5″

§ 321. The uplands of Madison township as well as those of west Mahoning embrace for the most part only the lower strata of the Lower Productive group. In a few detached hills, however, at the western end of Madison township the Freeport Upper coal is represented.

Proceeding west from Oakland along the road skirting the highest land, the Freeport Lower coal everywhere makes the summits, but is not worked. The Kittanning Upper bed is the chief source of the local coal supply. Near the McAuley school-house, in the "limestone narrows," the following rocks are exposed:

Sandstone Freeport,		—
Slates,		—
Coal, *Kittanning Upper*,		4′ 0″
Impure clay,		3′ 0″
Johnstown cement seam,	3′ 0″–	5′ 0″
Shales variegated,		25′ 0″
Coal, *Kittanning Middle*,		1′ 0″
Shales, ferruginous,		6′ 0″
Interval,		110′ 0″
Ferriferous limestone and ore,		6′ 0″
Interval,		63′ 0″
Brookville coal,		?
Interval,		10′ 0″
Pottsville Conglomerate,		—
		233′ 0″

Fig. 39. §321.

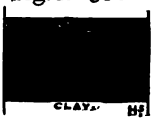


§ 322. *The Kittanning Upper coal* is mined on the An-

thony property east of the "narrows," and also on the J. McAuley farm to the west. At both places it yields fairly good coal. In the Anthony mine it carries a small bench of cannel slate, separated from the underlying bituminous bench by a thin layer of slate and bony coal as follows:

Cannel slate,	0′ 6″	
Soft slate and bony coal,	0′ 4″	4′ 4″
Coal,	3′ 6″	
Hard clay,	—	

Fig. 40. §322.



The Johnstown cement is a very ferruginous rock, too impure for use as a fertilizer. For the latter purpose, however, abundance of excellent stone may be obtained from the Ferriferous limestone, which latter stratum outcrops in the bluff, below the cemetery, where it has been opened 6 feet thick, in good condition and supporting the Buhrstone ore. The above section shows that the distance between the Ferriferous limestone and Johnstown cement is here exactly the same as at Putneyville.

Neither the Brookville, nor the Clarion nor the Kittanning Middle coal is of value in the vicinity of the "narrows."

§ 323. Thence westward the rocks rising towards the Kellersburg anticlinal, the section gradually diminishes until in the neighborhood of the village last named, the sandstone overlying the Kittanning Lower coal is in the hill tops. The rock is abundantly shown on the surface and in the ravines leading towards the creek.

The Kittanning Lower coal is reported 3 feet thick on the H. M. Keller property northwest of the village. Near the hill top at the same place the Kittanning Middle coal has been opened 18 inches thick. West from Kellersburg the Kittanning Lower coal has an unbroken run through the hills southward to the river and the Mahoning creek.

The same also may be said for the Ferriferous limestone and the Buhrstone iron ore, both of which were once worked in the ravine northwest of Kellersburg, to supply the needs of Rock furnace, now long since abandoned. The limestone at this place, on the back of the Kellersburg arch, is 400 feet

above the Red Bank, being 230 feet above the same stream on the back of Anthony's bend anticlinal to the east. It is 285 feet above the water level in the Lawsonham synclinal, and 350 feet at the mouth of the creek. These measurements express the extent of the undulations between basin and basin.

§ 324. *The Ferriferous limestone* undergoes little or no change west from Rock furnace. Its outcrop line passes through the fields of the C. Hawk farm, whence it runs northwest past the cemetery into a small ravine trending parallel to the creek, which causes the line to turn sharply west into another ravine leading towards Duncanville. There it is exposed below Mrs. Morrow's house, and there also the Buhrstone iron ore has been worked. At Duncanville the summits fail to include more than the Kittanning Upper coal bed, but west of the village the Freeport Upper coal appears in a few knobs near the Early school-house and close to the Lawsonham synclinal. The coal has not been explored there, nor the limestone, by which it is probably underlaid.

From Mrs. Morrow's the outcrop line of the Ferriferous limestone, after passing up a branch ravine to the west, crosses the road near Mr. H. Christman's house, after which it runs into the Craig and Early ravine where it is exposed. Finally it rounds the river hill at the mouth of the creek near Mr. Turner's house, at which place both ore and limestone have been worked. Moreover at this place also the Kittanning Lower coal is mined.

Chapter VIII.

The Valley of the Allegheny River in Armstrong County.

§ 325. *The Allegheny river* in its southward course through the western counties of the State divides Armstrong lengthwise into two unequal parts, of which the eastern part contains more than double the area of the other. The river crosses the county border near Foxburg, whence southward to the mouth of the Red Bank it is the dividing line between Armstrong and Clarion; thence to the mouth of the Kiskiminitas it is wholly within Armstrong county, while south from Freeport below the mouth of the Kiskiminitas, it flows between Westmoreland and Allegheny counties to its junction with the Monongahela at Pittsburg, where the combined waters of the two rivers assume the name of Ohio. The name "Allegheny" in Seneca dialect is said to be synonomous with "Ohio" in other Indian dialects, both names signifying "fair water."*

§ 326. Between Foxburg and Freeport the irregular course of the Allegheny carries it over a distance of sixty miles,

* It may here also be incidentally mentioned that as a relic of the early occupation of the region by the aboriginal tribes, Indian utensils and curiosities are found in great abundance along the Allegheny. Of such curiosities many valuable specimens have been found at Kittanning. Kittanning itself, the present county seat of Armstrong, was, indeed, originally an Indian settlement of considerable size and importance. It was, in early times, made the object of a special attack by an expedition of whites under the command of Gen. Armstrong, from whom afterwards the county took its name. Brady's Bend was the scene of a similar but earlier conflict conducted against the Indians by Capt. Brady. The so-called "Purchase Line," extending in a nearly west direction from the Cherry Tree on the Susquehanna river, terminated at Kittanning. Mr. R. W. Smith's forthcoming history of the county will contain full and interesting descriptions of the Indian occupation of the region and the early struggles of Colonial times.

which is nearly one fifth its total length. Its fall in this distance, according to recent measurements is 112 feet, or only about one fifteenth of the total fall between the head-springs of the river in Potter county and its mouth at Pittsburg. Its upper waters descend rapidly as far as Olean, whence to Pittsburg the descent is gentle. The average rate of fall through Armstrong county is less than two feet per mile. Small steam tugs have ascended as high as Olean, 255 miles from Pittsburg, and could have gone still higher on the floods, perhaps to a point within 50 miles of the head-springs. There are few cases on record of where a river has been similarly ascended to within such a short distance of its starting place. The reason for it in the case of the Allegheny is partly found in the gentle slope of the river bed, and partly also in the absence of abrupt waterfalls or cataracts. Briefly, the river bed consists of a succession of pools, separated by shallow rapids, or "riffles" as they are locally called. Between Foxburg and Freeport the pools are often a mile or more in length, being in some cases from 15 to 20 feet deep, and even deeper. The rapids are so many easy steps by which the river descends to lower levels. They are the chief obstacles to navigation, inasmuch as they can only be crossed by boats at high water stage, when the river is flooded. Their removal in part as high as Oil City would neither be difficult nor a a matter of great expense, whereas the opening of such a channel would greatly stimulate the trade of the valley by affording a cheap outlet to market for all its products, including the oil from the lower oil belt. Recently the subject received attention from the United States Government, under whose auspices an examination of the river was made by a corps of engineers, whose report has not yet been made public. Still more recently an interesting and instructive paper, in which this question of the river improvement is ably treated, was read before the Engineers' Society of Western Pennsylvania, by Mr. T. P. Roberts, C. E., of Pittsburg.

§ 327. *The topography of the valley*, if restricted to Armstrong county, presents little variety. Steep hills are

the usual conditions, from 400 to 500 feet in height, rising on both sides almost directly from the water-line, and spreading out on top as a smooth rolling table-land, indented by frequent ravines. Where the valley widens, there fragments of terraces are found, covered with a loose stratified mass of gravel and sand. These terraces, when present, are a prominent feature, stretching, as they sometimes do, for a half mile and more along the slopes, on which they form gently sloping plains inclining from north to south, down the stream. Their discussion and probable origin is reserved for a subsequent chapter of this report.

§ 328. *The surface rocks* embrace some 800 feet of measures, in which are included a portion of the Lower Barren group, all of the Lower Productive coal measures, the Pottsville Conglomerate, the Mauch Chunk shales, and a part of the Pocono sandstone. The map will show their geographical distribution; the numerous vertical sections appearing further on along with the detailed description of the mining developments, will render sufficiently clear their geological succession; for the rest, the following brief description of the stratigraphy will explain the geology in general.

Commencing at the extreme northeast end of the county the river flows over nearly horizontal rocks. Similarly undisturbed strata build up the side hills, at the base of which are Conglomerate and sub-conglomerate strata, while the hill-summits back from the river are occupied by small detached areas of Lower Productive rocks. Such is the geology round about Foxburg and Parker City.

An anticlinal axis, trending northeast, crosses the river near the mouth of Bear creek, below Parker City. The fold is too feeble to exercise much effect on the local geology, nor can it be traced southwestward under the uplands of Perry township. But its influence is nevertheless plainly seen in the gradual accumulation of rocks which takes place between Monterey and Brady's Bend. Lower Productive Measures, with a thin coping of Lower Barrens cover all the uplands of Perry township, while some of the Conglomerate strata found in the hills at Parker City disappear under the river before reaching Brady's Bend. Brady's

Bend is in a well-defined synclinal, whose presence has, in fact, determined the curve in the river, nearly ten miles long. Passing out of the synclinal, an anticlinal, called the Brady's Bend axis, is crossed before the mouth of Red Bank is reached. It is an important fold, continuous both towards the northeast and southwest, in which latter direction it crosses the Buffalo at Craigsville, whence it proceeds in a straight line through Butler county. Its effect geologically in the Allegheny valley is to lift the Ferriferous limestone to the hilltops and to bring again to water-level the sub-conglomerate rocks which in the Brady's Bend synclinal are lowered beneath the river bed, thus in effect repeating, at the mouth of Red Bank, the geology of Foxburg and Parker City.

§ 329. Next a synclinal—and a very shallow one—is crossed at Rimerton, and next the *Kellersburg anticlinal*, just above the mouth of the Mahoning. So much has elsewhere been said of both these axes, that their mention in this connection will alone suffice. Together they sustain the Ferriferous limestone in the same elevated position to which it was lifted on the arch of the Brady's Bend anticlinal; and they free both Washington and Madison townships from Lower Barren rocks.

Below the mouth of the Mahoning the river flows continuously in the same basin. No more anticlinals are crossed; but as the river, in the bends, shifts from side to side of the basin in which it flows, some important changes in the local geology are accordingly produced. Moreover, the structure is complicated somewhat by the gradual extinction of the Kellersburg anticlinal under the highlands of East Franklin township, west of Kittanning. Wherein these changes consist, as regards the surface rocks of the valley, is further elaborated in the detailed description.

§ 330. The same detailed description so fully sets forth the mineral resources of the region that scarcely anything additional is needed in the way of general comment. Iron ore, at present the chief feature of economic interest, is present in great abundance, easily available and in good con-

dition. *The Buhrstone stratum*, averaging from 6 to 8 inches thick, and stretching in continuous lines on both sides of the river from Brady's Bend to Kittanning, will yield a prodigious amount. *The Freeport ore*, underlying the Freeport Upper coal, is apparently restricted to the region of Brady's Bend; but even though thus limited in its outspread, the stratum is nevertheless one of immense importance to the iron interests of the valley. Of coal there is scarcely any limit. The Freeport Upper seam is generally the best and most reliable. Its average thickness along the river is about 3½ feet. Moreover its coking properties are superior to those of the other seams. The Freeport Lower bed is in the highest degree irregular and uncertain. So is the Kittanning Upper; and so also the Kittanning Middle seam; but the Kittanning Lower is generally regular in point of thickness, though pyritous. None of the coals are strictly first class either for steam use, or for gas making or for coking.

§ 331. With respect to limestone the region is most bountifully supplied. The Ferriferous stratum is in admirable condition both for furnace flux and for use in the kiln. In addition, however, to the Ferriferous stratum, the Freeport Lower and the Johnstown cement beds are both present in places, while the Freeport Upper, in the vicinity of Manorville not only attains unusual thickness, but its condition there adapts it for use in furnaces making Bessemer pig.

Fireclay is no less abundant. The strata are not equally good in all localities, but some places are particularly favored, as for example the neighborhood of Kittanning where two seams of excellent clay are mined for shipment.

Good building stone can be obtained in any amount from the various sandstone deposits. Mention may be here made of the quarry near Monticello furnace where the rock, especially massive and compact, is admirably adapted for the foundations of large buildings. Good flagstone is comparatively scarce.

§ 332. *The belt of the so-called "Third oil sand"* crosses the river from Clarion county above Parker City, stretching

thence across Hovey township into Butler county. The "Fourth sand" belt trending nearly east and west is at Brady's Bend. South from this locality and across the Brady's Bend anticlinal no oil has yet been discovered, either at the horizon of the "Third" or "Fourth" sands, or at any other horizon within a distance of 2000 feet below the surface. It would therefore appear that the oil-producing area is confined to the region west of the Brady's Bend anticlinal axis.

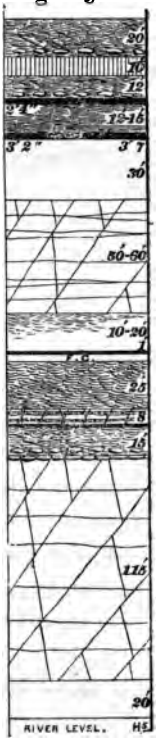
The river slopes in Armstrong county have in great part been stripped of their good timber. Some oak, however, remains, and some chestnut, either of which would supply in abundance the timbers needed in mining operations. Otherwise none of it is marketable.

§ 333. The following detailed description of the valley is arranged in order from north to south. The object has been briefly to discuss the geology at each of the prominent places along the railroad, beginning at Parker City and ending at Freeport; to state what rock-formations are found at such points, where the principal strata outcrop, and what their condition; when possible, to present vertical sections, showing not only the geological succession of the strata, but their distinguishing features at the different localities. Such an arrangement necessarily involves frequent repetition, but besides placing the economic geology of the region in a clear light, it will readily enable the local geologist to find what he is in search for.

§ 334. Round about Parker City, and north of this beyond the Clarion river to the north end of Hovey township, the hills consist mainly of Conglomerate and sub-conglomerate rocks. Along the Butler county line running due north some of the lowermost strata of the Lower Productive group are contained in a few detached summits, the most important of which is on the Milford farm. There the section includes the Ferriferous limestone between which and the river the exposures reveal the following strata:

Fig. 41 §334.

Shales, with ore balls,	20′	0″
Ferriferous limestone,	10′	0″
Shales and slates with ore balls,	12′	0″
Coal bed, *Scrubgrass seam*,	2′	4″
Slates,	12′ 0″–	15′ 0″
Coal bed, *Clarion seam*,	3′ 2″–	3′ 7″
Interval concealed,	30′	0″
Sandstone, *Pottsville Conglomerate*,	50′ 0″–	60′ 0″
Shales and concealed rocks,	10′ 0″–	20′ 0″
Coal bed,	1′	0″
Fireclay, bluish,	?	
Shales, dark,	25′	0″
Sandstone interchanging with shales,	8′	0″
Small coal smut, not persistent,	—	
Dark shales and bituminous slates with ore balls,	15′	0″
Iron ore,	?	
Sandstone massive, Parker bluffs,	115′	0″
Concealed to river,	20′	0″
Total thickness,	356′	11″



§ 335. *The Kittanning Lower coal* overlying the Ferriferous limestone outcrops in the south side of the Anchor ravine about two miles northwest of Parker city. At the same place the hill rises beyond the horizon of the Kittanning Upper coal, but the strata are wholly concealed. Some investigation was at one time made of the Kittanning Lower seam on the Fox property, near the point of the hill. The bed is said to be small and of no value.

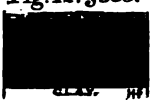
The coal consumed in the engines at the oil wells, as also that used for domestic purposes at Parker, and in the region round about, is partly derived from the Clarion seam, and partly from the Scrubgrass. The Clarion however is the main source of supply. The bed here is thicker than at any other point along the Allegheny river in Armstrong county. It is chiefly mined on the Milford and Fox farms,

where its outcrop line makes a prominent bench. North of the Anchor ravine its outcrop line runs west into Butler county.

The bed yields impure pyritous coal. Moreover the seam is so parted by a small band of slate, that careful picking is required in mining it. The following measurement, made in the J. A. Wangler mine on the Fox property fairly represents the average thickness of the seam in the neighborhood:

Slate,		—	
Coal,	0′ 9″		
Slate,	0′ 0½″–0′ 1′	3′ 6″	
Coal,	2′ 8′		
Clay,		—	

Fig. 42. § 335.



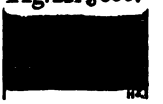
The coal is hard and exceedingly compact, coming out of the mine in blocks of convienient size. A specimen of it from the Wangler mine was submitted to Mr. McCreath for analysis with the following results:

Water at 225°,	1.310
Volatile matter,	45.025
Fixed carbon,	46.916
Sulphur,	2 954
Ash,	3.795
	100.000
Color of ash,	pink.
Coke, per cent.,	53.665
Fuel ratio,	1:1.04

§ 336. *The Scrubgrass coal* is here exactly midway between the Clarion seam and the Ferriferous limestone. Mr. Chance has shown that the Scrubgrass is not an independent bed, but merely a split from the Clarion. At Parker city however, it is regularly developed, 2½ feet thick, and even 3½ feet thick in the Anchor ravine, rivaling there the Clarion in importance. Where exposed on the hill northeast of Wangler's mine, an excellent opportunity is afforded for observing the succession of the strata above it to the limestone, and below it to the Clarion coal. Still further north it is mined on both sides of the Anchor ravine, being 3 feet thick on the Fox property, and 3½ feet thick in the Anchor

mine, from which latter the following measurement was taken:

Fig. 43. § 336.



Slate,		—
Coal,	2′ 3″	3′ 6″
Slate,	0′ 3″	
Coal,	1′ 0″	

The coal is very similar in appearance to that from the Clarion seam, though less slaty and apparently also less pyritous.

§ 337. *The Brookville coal* makes almost no show whatever in this vicinity. A small outcrop of slate marks its geological horizon at an exposure north of Wangler's mine, but no coal appears in connection with it there. In the *Geology of Pennsylvania*, page 574, the bed is said to measure 15 inches thick west of Lawrenceburg (now 2d ward of Parker city.)

§ 338. *The Ferriferous limestone* is well exposed on the Milford farm, where also it has been quarried. It is a bluish rock, tolerably compact and highly fossiliferous. The Buhrstone iron ore is absent.

The outcrop line of the limestone is easily traced around the hill of the Milford farm, facing the river, whence it runs northward, just above the line of pits working the Clarion coal. Next it passes around the head of a small ravine, where it is well exposed, and next into the Anchor ravine where it is exposed again on the Fox property. At the latter place it is 13 feet above the Scrubgrass seam. The Anchor farm contains a small area of limestone, whence northward the outcrop line crosses into Butler county. South from the Milford farm, it keeps west of the Butler line (it is therefore high above the flat at Lawrenceburg) until it passes into the ravine of Bear creek, along the south side of which it extends to the river front. (See map.)

§ 339. *The Pottsville Conglomerate* is in such massive condition on the hills overlooking Parker city that it acquires considerable prominence there. Lawrenceburg (the 2d ward) is built upon it, at the southern edge of which it is finely exhibited at the point of the bluff above Bear creek.

It shows also along the road leading to the Pump station at Donelly's; and it is no less conspicuous to the north of Parker in the Anchor ravine.

From top to base the rock is exceedingly compact. Much of it is coarse grained, and having two independent systems of cleavage planes, it breaks up into huge bowlders along its outcrop edge. Beneath it, but separated from it by a considerable mass of shales is a small coal seam, which was once opened into above Donelly's. Underneath this coal, is a well defined series of shales and soft argillaceous rocks extending to the level of the Butler and Karns city RR. at Donelly. There in a cut, the entire series is well exposed. The main distinguishing feature of the shales is their dark color; near the base of the series is a layer of rich bituminous slate, above which a trace of coal appears, but fails to maintain itself for more than a few yards, disappearing in the shales. At the base of the series is a stratum of carbonate iron ore, the thickness and quality of which could not be ascertained, from lack of sufficient exposures. The ore was once mined at this place for the old Donelly furnace which stood near the present railroad station.

§ 340. The shales are undoubtedly the equivalent of the *Mauch Chunk formation*, from which however the *Mountain limestone* is here absent. Further down the river the same shales are repeated in all the exposures below the Pottsville Conglomerate, and they also reappear in the Red Bank and Mahoning valleys as already fully described.

Below the shales is the great sandstone deposit that makes the vertical cliff behind the town at Parker. It is at the top of the *Pocono formation*, corresponding thus (as it does also in physical appearance) with the massive sandstone, which is so distinguishing a feature along the lower waters of Red Bank. Its color at Parker is from gray to drab.

§ 341. *The oil producing belt* which crosses the river above Parker trends north-east and south-west. Nearly all Hovey township is underlaid by the oil-bearing rock, which in the driller's parlance is known as the "Third sand," underlying the Ferriferous limestone about 1200 feet. The

territory about Parker having long been operated is now nearly exhausted. The wells along the river front north from Parker have yielded abundantly, and the total production of oil from this immediate region has been enormous. Few of the wells, however, are now yielding above two barrels per day, which, at the present price of oil, scarcely repays the cost of pumping. Some oil has also been obtained from the "Second sand," about 1100 feet beneath the Ferriferous limestone.

§ 342. It has been elsewhere stated that at the mouth of Bear creek the river crosses a feeble anticlinal. The dips on either flank of the axis do not exceed ½°. South from the creek some topographical changes are produced along the right bank of the river by the upper Coal Measure-benches advancing to the river front, where steep slopes are presented 400 feet in height. The same topography is continuous past Monterey and around the bend above Hillville into the cove east of Queenstown. At the latter place the ascent to the uplands is easier, but south from it the former topography is repeated in the neck of Brady's Bend where the side walls of the valley are in some cases nearly vertical.

Along the face of these hills the Parker City section is reproduced again and again, almost without change. Accordingly as the strata are lowered by the very gentle southeast dip, just so much the section is lengthened by the additional rocks which come into the highlands, while at the base of the column a proportional amount disappears under the water line.

§ 343. The *Conglomerate rocks* are well exposed in a small ravine opposite Monterey. Some thin seams of coal appear in the shales underneath the Pottsville Conglomerate, which latter, as a massive rock 50 feet thick, forms a prominent cliff along the hill below the school-house. The coal seams are undoubtedly the equivalent of the bed already described as occupying a similar geological position at Donelly, on the Karns City RR.; but at Monterey it is subdivided into a number of layers as shown by the following section:

Coal,	0′ 2″
Shales,	2′ 0″
Coal,	0′ 2″
Sandstone, argillaceous,	1′ 6″
Coal, impure,	0′ 5″
Sandstone, argillaceous,	4′ 6″
Coal,	0′ 6″
Sandstone,	—
Total thickness,	9′ 3″

§ 344. *The Brookville coal* outcrops in the road near the school-house. The Clarion coal, two feet thick, is exposed still higher. Twenty-five feet above the last, the Ferriferous limestone appears, with its ore on top, which latter was at one time worked east of the road. The outcrop line of the limestone extends up the ravine to the A. Evans property, where the stream-bed rises above it. The rock is eight feet thick, and is composed of good stone.

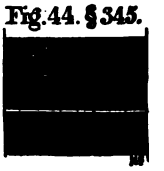
The Kittanning Lower coal is here thirty feet above the limestone. It is mined on the Evans property, and again at Snow's, being four feet thick at both places. In this measurement nearly six inches of bony coal are included, besides a small parting of slate near the centre of the seam.

§ 345. *The Freeport Upper bed* ranges along the summits of the hills more than a mile south from the river at Monterey. Its outcrop line extends up the Evans ravine already mentioned, as far as Schwatz's store, at the county line. Thence it runs northeast, to cross the pike at Mr. Guthrie's, beyond whose farm it skirts the road as far as Mr. J. Knox's house. North of the latter place, after crossing the ravine of Bear creek, it overshoots the hills of Hovey township.

The bed is mined by Mr. Pitman, on the west side of the pike, close to the Butler county line; also by Mr. Shakeley, on the adjoining farm to the south. Although close to the hilltop at both places, it is well protected from surface water by a roof of tough black slate. The following section is exposed at Pitman's:

Slate and bony coal,	2′ 0″	
Coal,	1′ 8″	
Slate,	thin.	5′ 11″
Coal,	1′ 8″	
Coal, hard and slaty,	0′ 7″	
Clay,		—

Fig. 44. § 345.



The dip is here gentle to N. W.

A small area of the same seam is contained in the hilltop on the White farm, about one half mile south from the river at Monterey.

The Mahoning sandstone is shaly and indistinct. Along the pike south from Shakeley's it makes almost no show at all, being replaced by soft shales. The same rocks also make the hilltops south from Schwatz's store, along the Butler line.

§ 346. *Opposite Hillville* the strata are imperfectly exposed. The section begins at the river with the top layers of the Pocono, above which are the dark shales of the Mauch Chunk formation, with some interleaved masses of sandstone, in all 75 feet thick. Above the shales is the Pottsville Conglomerate, 60 feet thick; and above the Conglomerate are the Coal Measures, of which the entire Lower Productive group is here present. The latter strata may be partially seen along the road leading from Hillville to Queenstown, and again along the road which skirts the south side of Armstrong run. The Ferriferous limestone is 280 feet above the river at Hillville. The Kittanning Lower coal, 3½ feet thick, is 30 feet still higher.

Thence to the hilltop the meagre exposures reveal little of interest. *The Freeport Upper coal* crosses the Queenstown and Hillville road near Mr. Hill's house, but it is there unexplored. Towards the west the road rises rapidly into Lower Barren Measures, crossing first the Mahoning sandstone in massive condition, and then ascending to the hilltop at J. Morrison's, north of Queenstown, where a small coal, roofed by shales, outcrops near the barn. This is among the highest strata of the region, being from 75 to 100 feet above the Freeport Upper coal.

The same geology is continuous thence down the river into Brady's Bend. At the mouth of Sugar creek the harder strata stand out in bold cliffs on the hills, affording admirable opportunities for section making. The extensive mining developments made here at a former period by the Brady's Bend Coal and Iron Company further assist in the examination and study of the strata. Some years ago

an elaborate report upon the geology of Brady's Bend and of the Sugar creek valley was prepared for the Brady's Bend Company by Prof. J. P. Lesley, whose vertical section of the Lower Productive Coal Measures is herewith reproduced, appending thereto my own section of the Conglomerate and sub-conglomerate strata, omitted in Prof. Lesley's report. (See page 215.)

§ 348. Brady's Bend, throughout a number of years, was the seat of an active iron industry. At one period it possessed the most extensive iron plant in western Pennsylvania, out of Pittsburg. Four furnaces, each making about 100 tons of metal per week, stood on the right bank of Sugar creek about a mile above its mouth. Of these furnaces two were 50 feet high, 7 feet diameter at the trundle head and 14 and 13 feet bosh respectively; the other two, Nos. 3 and 4, were 43 feet high, 11 and 9 feet bosh, and 6 feet diameter at the trundle head. No. 4 made charcoal forge iron, the others used coke. They went out of blast just previous to the crash which overtook the iron trade in 1873, and all are now dismantled and in ruins.

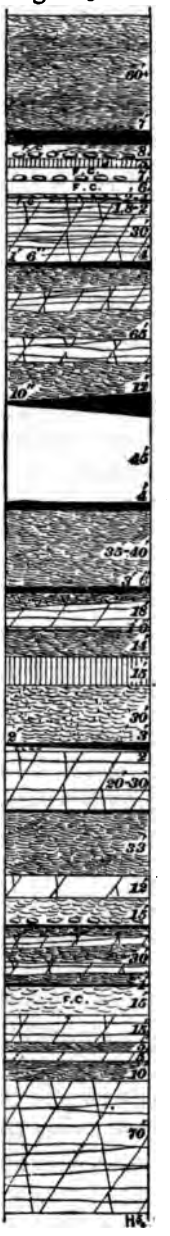
A rolling-mill for making rails stood on the river bank at the mouth of the creek. It had 25 puddling furnaces, 10 heating furnaces and 5 trains of rolls, and in 1856 made nearly 8000 tons of railroad iron. These works, moreover, were distinguished in being among the first in the United States to make rails. Operations in them ceased when the furnaces went out of blast, and like the latter they are now in ruins.

§ 349. The history of iron making at Brady's Bend, its early successes, and its subsequent disastrous failure need not be recited here. The causes which induced that failure were no doubt partly due to the poor quality of iron made, but extravagant management was also in good part responsible for the result. The location is an admirable one. The surrounding hills contain in abundance all the stock needed for smelting, the iron ore, coal and limestone, and the strata lying nearly horizontally, without faults or serious troubles, no better conditions can be conceived for mining. It is stated that the Freeport ore, which, from its great thick-

§ 347. *Section at Brady's Bend.*

Shale and slate,		60′ 0″+
Coal bed, *Freeport Upper*, "*Summit vein*,"		7′ 0″
Fireclay and shale with ball ore,		8′ 0″
Limestone, Freeport Upper,		5′ 0″
Fireclay with ore balls,		7′ 0″
Fireclay without ore balls,		6′ 0″
Iron ore, Freeport Summit) *ore*,	2′ 0″–	4′ 0″
Fireclay with ball ore,	1′ 8″–	2′ 0″
Sandstone, thin bedded,		30′ 0″
Coal bed, *Freeport Lower*,	1′ 6″–	4′ 0″
Shales and *Freeport SS.*,		65′ 0″
Coal bed, *Kittanning Upper*,	0′ 10″–	12′ 0″
Interval,		45′ 0″
Coal bed, *Kittanning Middle seam*,		4′ 0″
Shales, olive and blue,	35′ 0″–	40′ 0″
Coal bed, *Kittanning Lower*, "*Furnace bed*,		3′ 6″
Sandstone and sandy shales,		18′ 0″
Iron ore, "*Buhrstone ore*,"		1′ 6″
Shales,		14′ 0″
Limestone, "*Ferriferous limestone*,"		15′ 0″
Shales, sandy, fossiliferous,		30′ 0″
Coal bed, *Clarion seam*,	2′ 0″–	3′ 0″
Clay,		2′ 0″
Sandstone,	20′ 0″–	30′ 0″
Coal bed, *Brookville seam*,		thin.
Shales,		33′ 0″
Sandstone, massive,		12′ 0″
Clay shales with ore nodules,		15′ 0″
Coal, thin and variable,		—
Shales, dark colored and sandstone layers,		30′ 0″
Coal and slate,		1′ 0″
Fireclay shales, coarse and dark,		15′ 0″
Sandstone,		15′ 0″
Shales,		5′ 0″
Sandstone,		5′ 0″
Slates and shales,		10′ 0″
Sandstone,		70′ 0″
Total thickness,		627′ 0″

Fig. 45 § 347.



ness at this place, was the main dependence of the furnaces, is here so cold short that the metal produced from it must inevitably have been bad; but this statement is not borne out by any of the analyses as yet made. Certainly Mr. McCreath's analysis is no proof of it, nor are the analyses made for the company by other chemists any more so. If the truth were fully known it could, I suspect, be easily proved that inexperience in the management was responsible in large part for the bad iron. The manufacture of iron has undergone so many important changes in the last decade that the plant at Brady's Bend, as it originally existed, would hardly meet the requirements of the present time for making cheap iron. But this in no manner affects the question of the desirability of the location. The furnace plant might easily and at small outlay have been supplied with the necessary modern improvements, which, with prudent and intelligent management, were all that was required to enable the business of iron making to be conducted here with reasonably profitable returns.

§ 350. The accompanying detailed description of the principal strata of the above geological section is mainly that of Prof. Lesley, given in his report to the Brady's Bend company, in 1865, and herewith reproduced by permission. Added thereto are some additional facts which came under the writer's notice during a recent examination of the region. Thus enlarged, the description will be understood to apply equally to the Brady's Bend Company's property, and to all of Brady's Bend township, which latter is crossed from west to east by Sugar creek, flowing through a deep valley, and having small lateral ravines coming into it from either side. In the main valley, as well as in the branch ravines, the mining operations of the company were conducted. The surface rocks are chiefly those of the Lower Productive group, with a covering of Lower Barrens on the uplands. The "Fourth Sand" oil belt, of which more will be said presently, runs under the northern part of the township. Preliminary to the detailed description of the mining developments, Prof. Lesley's remarks upon the geological structure of the region are of interest.

§ 351. "Brady's Bend occupies the exact geological centre, or deepest part of the sixth and last Bituminous Coal Basin, counting from the Allegheny mountain northwestward towards Lake Erie and the State of Ohio. Its rocks, therefore, would be perfectly horizontal, but for three things which happen to prevent: 1. The gentle northwest and southeast dips, from the two sides of the basin, in towards its center line. 2. The extremely gentle settling of the whole basin southwestward towards the Ohio river; and 3, less gentle local variations of dip, produced by a system of almost invisible cross waves, at right angles (approximately) to the basin itself.

The first of these disturbances causes any given bed at Brady's Bend to take a more and more elevated outcrop-level around the hills, when followed *down* the river as far as the old American furnace (ten miles), where the fifth or Kittanning basin begins its southeast dip, and also around the hills when followed *up* the river towards Franklin and the Meadville Highland, so that the Tionesta coals [now called the Pottsville Conglomerate coals], which at Brady's Bend are near the water level of the river, cap the highest hills around the mouth of French creek.

The second disturbing cause produces the same effect in a northeasterly direction, carrying up the Tionesta coals into the highest hills of Elk and McKean counties, and plunging them 500 feet deep beneath the Ohio river at Pittsburg.

The third set of disturbances are purely local, and produce those swamps and rolls in the mines of which the miners complain, and they affect also very much the course of the smaller ravines and vales, determining the sinuosities of Sugar creek, and even the curves of the great valley of the Allegheny river itself. The curious bend in the river, ten miles around and three quarters of a mile across its neck, is due to the river having here found the centre of the VI basin; but the determination of the cliffs below the rolling mill has been made by a local dip from the river front, southwestward (instead of northwestward) into the valley of Snyder's run branch of Sugar creek. The swamp

in the ore mines at the head of the inclined plane is produced by this and a counter local dip meeting it from the southwest.

§ 352. Practically, the high hills between the branches of Sugar creek and the river are built up of horizontal strata, making mining very easy, and exhibiting a country for mining purposes almost entirely undisturbed and in its original condition. The crust of the earth is traversed by numerous nearly vertical cracks, the general direction of which, where I saw them best, is not far from east and west; but these cracks cannot be thought to penetrate more than one rock or one system of rocks at a time, or they would have inevitably thrown one side of the crack up and the other down, producing vertical faults in the coal beds. They must, therefore, be considered as shrinkage cracks on a large scale, confined to the rocks in which they occur, and determined in their direction partly, perhaps, by electricity and magnetism common to all parts of the crust, but chiefly, as I believe, to the local strain of the dip, and the local composition of the stratum.

The law governing the number of these cleavage planes is a simple one; the distance of the clefts from one another is, in the main, proportionate to the massiveness of the strata which they divide; that is, the cleavage planes of the great beds of massive sandrocks lie much further asunder than those of the thin-bedded sandstones; while those subdividing beds of shale are still closer to each other and more numerous. We may state the law in another way: the coarser the materials of the stratum, the larger are the cubes into which it is subdivided where it lies, and the huger the blocks which fall from its outcrop edges down the hill slopes. Hence the vast blocks which encumber the steeps of the Allegheny, wherever the erosive agency has acted forcibly upon the Mahoning, the Freeport, the Tionesta [or Pottsville] Conglomerate sandrock formations.

§ 353. The law governing the size or width, and also the length and depth of the fissures, is an analogous one:—the great sandrocks exhibit clefts sometimes many inches in width, and running many yards or hundreds of feet con-

tinuously. The pressure of these rocks sometimes carries their cracks down (or up) through the softer and thinner beds, and the strain of the dip will even cause these cracks to descend many fathoms below where they originated.

* * * * * * * * * * *

"There are always two systems of cleavage planes, and a third is added where the rocks are much uptilted. One of the two is always better defined than the other. In the neighborhood of Brady's Bend this major or primary system has its planes running S. 80° W., N. 80° E., and dipping 70° towards the south. The minor or secondary system has its planes running nearly at right angles to the other, dipping irregularly 60° towards the east."

§ 354. *The Mahoning sandstone* is heavy-bedded and very prominent on the slopes to the east of Queenstown, but towards the west it rapidly fades out into shale. It is scarcely observable in the exposures round about Criswell City. On the south side of Sugar creek it makes a low cliff at the summit of the hills overlooking the river. It is massive near the village of Greenville, which is built upon it; also on Holder's run, below the Somerville oil well.

§ 355. *The Freeport Upper coal seam*, called locally the "Summit Vein," was mined by the Brady's Bend company, for coking. According to Prof. Lesley, the bed "consists of four benches: 1st, top bench, 12″; fireclay and roof slate, 12″ to 18″. 2d bench, 2′ 4″; undermining slate, 3″. 3d bench, 1′ 10″; floor slate, 6″ to 24″. 4th bench, 4″; underclay. It is a bright, rich coal, with streaks of pyrites, the grain or horizontal crystallization running S. 65° E., N. 65° W., so that it is mined on the face advancing towards the N. 25° E., up the gentle rise towards the river bluff from behind. Only the 2d and 3d benches are mined out, yielding always about 4 feet of coal. The floor rises and falls enough sometimes to exhibit the 4th bench in the gangway floor. The butts of sigillaria, from one to two feet thick, sometimes fall from the roof slate, standing vertical where they grew. Other large trunks, some of them forked, lie prostrate, crushed flat, across the gangway and rooms, in the same

roof slate. The coal makes good light gray coke, which might be mixed with raw coal for the furnace use."

The bed is prettily exposed beneath the Mahoning sandstone cliffs, at the hilltop, south from the rolling mill, where it is contained in two small detached knobs; the main outcrop line of the bed is further south, running past the old mines once worked by the Company for the coke yards. In the ravine of Greenville run it is at the present time being mined near where it touches water level. In Holder's run ravine it is little exposed; but further west, in the Kalor oil district, it supplies the derrick engines with fuel, being there mined on the Butler farm. On the north side of Sugar creek the bed is somewhat obscure, not only on Pine run, but also on Cove run and on Whiskey run. Its geological horizon is contained in a few knobs at the hilltop, in the neck of the bend.

The Freeport Upper fireclay and the *Freeport Upper limestone* are well exposed near the hilltop south from the rolling-mill. Neither stratum has been worked to any extent in this neighborhood; both, however, are in good condition.

§ 356. "*The Freeport (or Summit) ore*, 26 feet below the coal, and running about 2 feet thick, but occasionally 4 feet (as in the Phillip's hill) solid, compact, very argillaceous, almost a clay, mined by stripping; and also in gangways and rooms; mined with the pick, by bearing in on the clay above and lifting the ore in masses from 15 to 20 inches thick; yielding one and a half tons to the yard, and requiring 3 to 3¼ tons to the ton of metal; specked with delicate rose-colored specks throughout, from incipient decomposition; remarkably like the "Big Bottom" ore of the Connellsville and Uniontown region; disposed to make red short iron; requires mixture with siliceous ores; would be greatly improved by mixture of ¼ magnetic or red hematite ores. An incline plane, 210 feet high, lets down the ore from the level of the gangways and stripping grounds to the calcining-yard below, whence it is carried off by a gravity railroad to the furnaces. A vast amount of stripping and mining has been accomplished. In some spots the bed is too thin to strip;

20 feet of stripping is the maximum it will bear. Ball ore occurs under the regular bed."

§ 357. The ore was mainly worked by the Company on the high plateau between Holder's run and Greenville run. It extends also west of Holder's run, and apparently in good condition. Towards the south its horizon is under all the high land of Sugar Creek township. It was once worked in the region west from Buffalo mills. North of Sugar creek its run is obscure, probably by reason of its diminished thickness there. A chemical analysis by Mr. McCreath of a specimen of the ore from Phillip's hill resulted as follows:

Protoxide of iron,	38.378
Sesquioxide of iron,	2.646
Bisulphide of iron,	.090
Protoxide of manganese,	1.153
Protoxide of cobalt,	trace.
Alumina,	1.223
Lime,	10.840
Magnesia,	2.666
Sulphuric acid,	trace.
Phosphoric acid,	.480
Carbonic acid,	32.074
Water,	1.910
Insoluble residue,	8.540
	100.000
Metallic iron,	31.750
Metallic manganese,	.893
Sulphur,	.042
Phosphorus,	.224

§ 358. *The Freeport Lower coal* is a most variable element in the section. Generally in the region round about, the bed is almost unknown to the farmers. It is at water level at Criswell City, and possibly also it is the "Pot vein" mined on the hill northwest of Roger's mill. But the last identification is confessedly doubtful, the "Pot vein" (so called from the extreme irregularity of the deposit) being most likely the equivalent of the Kittanning Upper seam. Either way, however, the matter is of no importance, as the bed is of little or no value in a mining sense. Limestone accompanies the Freeport Lower coal in the ravine of Holder's run; it is 20 feet above the Kittanning Upper seam. A simi-

lar limestone is found on the hill northwest of Rodger's mill, occupying there a similar position with regard to the "Pot vein."

"*Freeport sandstone* thin bedded, but forming well marked cliffs and rough places on the hillsides; the rock that furnishes so many of those great rude contorted masses of sandrock seen lying in profusion upon the river hills between Catfish and Sarah furnaces, and between Brady's Bend and Red Bank. Some of its layers are solid, and 2 feet thick, rough, coarse-grained and false-bedded. The whole formation, including the shale above, about 65 feet."

§ 359. *The Kittanning Upper coal seam* occurs almost directly underneath the Freeport sandstone. Ten inches thick along the river front, it receives a rider of cannel slate in the ravine of Holder's run, becoming upwards of 12 feet thick. The bed generally is obscure. The cannel slate exists only in irregular depressions or concavities, similar to those already described in connection with the same Kittanning Upper seam at Bostonia on the Red Bank, and at Mrs. Thompson's on the Little Mud Lick. Out of the depressions the bed is sometimes scarcely more than a streak in the rocks. A good exhibition of its cannel slate feature may be had at the Ganner mine in the ravine of Holder's run, at which place the bed is 2 feet thick at the outcrop, increasing within a short distance to 5 feet, all bituminous coal of a fairly good quality. The floor of the seam then rapidly descends at an angle of 10° to a depth of 7 feet, the roof meanwhile remaining horizontal; the interval between is gradually occupied by mass of impure cannel slate of a dull lustre, and having a conchoidal fracture. The bed being below the water level of the run, difficulty is encountered in draining the mine, which fact has put a stop to the developments in that direction, leaving the limits of the cannel slate deposit a matter of conjecture. The "cannel," however, is of no value, being much too impure even for domestic purposes. The over- and underlying strata are so well exposed on the Ganner property that the geological horizon of the cannel slate deposit can there be satisfactorily determined.

The Kittanning Middle coal, called the Kittanning upper in Prof. Lesley's report, is indistinct in the region of Brady's Bend. No good exposure of it there came under the writer's notice. Prof. Owen describes it as four feet thick in one place, which, moreover, is accepted by Prof. Lesley. In the Geology of Pennsylvania, (p. 577,) the position of this bed and the coal next below is reversed.

§ 360. *The Kittanning Lower bed*, called "Furnace Bed," "Four Foot Bed," "Middle Bed," &c., was formerly mined for use in the rolling-mill. It is at present mined on the hill north of the rolling-mill, near the oil tanks; also, at the southern edge of Queenstown, where it is much affected by sharp and irregular dips, arising from "swamps." Along the face of one exposure the coal is raised 13 feet out of level in a horizontal distance of 100 feet. A heavy sandstone here underlies the coal, occupying nearly all the interval between it and the Ferriferous limestone.

The Kittanning Lower coal supplies also the lower part of Sugar Creek valley with what fuel is there needed for domestic use. It is opened on both sides of the creek at McLaughlin's hotel, being also opened again a few hundred yards further west. It is both sulphurous and slaty. The roof is sandstone, of which 20 feet are exposed at McLaughlin's. The coal goes under the water level between the latter place and Rodger's mill. Along Greenville run, near James' store, its thickness is greatly increased.

§ 361. "*Siliceous slab ore*, representing the "Buhrstone ore" of Clarion, Venango, Armstrong, and neighboring counties of the State, on which more than 50 charcoal and stone coal blast furnaces have been running for the last two generations. It is here a solid bed somewhat less than 2 feet thick, pretty uniform in size, but variable in quality and position. When it is suspended in the sandy shales above the limestone, it is siliceous, or mixed with chert, "buhrstone," or segregated silex; but when it lies directly upon the limestone it is a soft calcareous brown hematite deposit, passing into ferriferous limestone, back of the furnaces, where there is not more than from 3 to 6 inches of the

ore. In some places the slab ore is highly bituminous and pyritous. In other places a small coal bed or layer of bituminous slate, &c., is seen to occupy about the same position, 6 to 10 feet above the limestone.* It is between this small carboniferous layer and the limestone, that there always appears a shale formation holding balls of ore. In fact the explanation of the wide extent of this buhrstone ore deposit, is simply this: first, a mud consisting largely of carbonate of iron, mixed occasionally with coaly matter, and gradually topping off with sand; afterwards, the percolation of the waters holding carbonic acid, carrying a good deal of the carbonate of iron down in an oxydized and hydrated condition, to lie upon the top of the limestone, and to penetrate the pores of its uppermost layers, partially converting them into ore. Some of the carbonate of lime was arrested in its slow descent and segregated into balls.

§ 362. *The Ferriferous limestone*, called also the great Fossiliferous limestone of the lower [Productive] coal measures, here 15 feet thick; blue, hard, purest towards the bottom; usually crowded with encrinite joints, here showing only a few bivalves; massive, in layers 1 to 2 feet thick, forming a quarry bench all along both sides of Sandy Creek [Sugar Creek?] valley above and below the furnaces, and showing the mouths of innumerable caves, connected together underground, and penetrating the ridges in all directions horizontally. This limestone fluxes the ores used in the furnaces. Some ore occurs also just under the limestone, and it will occasionally measure from 4 to 10 inches."

The limestone is at present quarried near the school-house at the mouth of Pine run, use being there made of it for quarry lime. It goes under Sugar creek a short distance west of the quarry.

§ 363. *The Clarion coal bed* is well exposed in the ravine of Whiskey run, having there been opened close to the water level, near the No. 12 oil well of the Brady's Bend Company. At this exposure it is only one foot thick, all poor coal.

* The small coal bed thus alluded to is the well known Ferriferous seam.

The Brookville seam is likewise exposed on Whiskey run, near by. Like the Clarion above it, it is of no importance or value in the region of Brady's Bend.

Below the Brookville coal Prof. Lesley's section shows a stratum of shales 25 feet thick, below which is the so-called Tionesta coal bed, and below this the Tionesta sandstone. These measures are now understood to belong the Pottsville Conglomerate, which latter formation is admirably exposed at the top of the cut along the incline plane, north of the rolling-mill. Both the Conglomerate and sub-conglomerate strata here differ somewhat from their condition at Parker City, as a comparison of the vertical sections will at once reveal. The Pottsville Conglomerate at Brady's Bend is looser and more shaly. The dark shales of the Mauch Chunk formation are a trifle thicker than at Parker or Monterey; but their physical aspect is much the same. The great sand rock at the top of the Pocono is like the Conglomerate above it, much disposed to shaly structure. In this respect it shows some sudden transitions from rock to shale. The rock occupies the interval between the water line of the river and the base of the cut on the incline plane.

§ 364. The "Fourth sand" oil belt occupies the northeast corner of Brady's Bend township and the southern edge of Perry, being considerably more than a mile wide, and trending in a nearly east and west direction from the river, past Queenstown, past Criswell City and on thence into Butler county. The productive area apparently terminates at the river, no oil having yet been found on the east bank in Clarion county, but towards the west the yield of oil has been abundant. Though developed already to a considerable extent, the region is yet far from exhausted, and much good territory still remains there. As is natural, however, the wells are no longer so productive as they once were, nor are they so long lived. In the earlier stages of the region's development wells yielding from 2,000 to 3,000 barrels per day were not unusual, whereas at the present time a well producing one hundred barrels per day, at the start, is considered a fair return. Moreover, it has been ascertained that in these wells the yield quickly diminishes to 10 or 15

barrels per day, remaining then tolerably constant at that figure for a considerable period. The total production of some of the larger wells has, it is said, been upwards of 50,000 barrels before final exhaustion. According to the driller's records the vertical distance here between the base of the Ferriferous limestone and the top of the "Fourth Sand" varies from 1242 to 1272 feet. The average thickness of the sandrock itself is about 20 feet.

§ 365. A second oil-producing belt, separate and distinct from the other, is that known as the "Kalor district" which occupies the right or south bank of Sugar creek, commencing at the Butler farm about two miles west from the village of West Brady, and extending thence nearly due west across the Butler county line. Although yet only partially developed it has already been sufficiently proved that the belt is both narrow and small. It was first discovered in the early part of the year 1878, at which time a trial well put down on the Butler farm obtained oil at a depth of 1,205 feet below the base of the Ferriferous limestone. The first yield was 125 barrels per day; the present production is 12 barrels per day and the well is still pumping.

Since its first discovery operations have extended the belt a short distance east of the Butler farm, and towards the west as above stated. All efforts to connect it by means of a continuous line of wells with the "Fourth Sand" belt lying north of the Perry township line have proved unavailing; indeed, the efforts to find oil at all on the north slope of Sugar creek at this place, even directly opposite the Butler farm, have so far been unsuccessful. That territory is without doubt unproductive; and the "Kalor" belt is confined to the south side of the stream, its width in a north and south direction being less than one quarter mile. But while it is impossible to establish an unbroken connection between the "Kalor district" and the main "Fourth Sand" belt, and while the vertical distance between the Ferriferous limestone and the productive sandrock is considerably less at Kalor than in the other belt, (the difference is from 50 to 60 feet,) yet, judging from the

character and appearance of the oil produced, there is good reason to believe that the rock in both places is one and the same. Without accurate well records showing each stratum, and extending across from Kalor into the "Fourth Sand" belt, it is impossible to definitely decide this question of identity, and such records are not in existence. It will not do, however, to assume as the drillers in this region have done, that because the vertical distances in the two places do not exactly correspond, that therefore the sand-rocks do not. Such a basis of identification is totally inadmissible. It is true that Mr. Carll has fairly proven that a horizontality exists in the oil sands, no less remarkable than that in the Coal Measures; but that local variations of interval occur underground is just as certain as it is among the Lower Productive Coal rocks, of which evidence at Kalor may be seen in the neighboring hills.

§ 366. Oil has been obtained also in small quantities from the "Second Sand" (?) on the Somerville property, north-west of Greenville. The well has at no time yielded more than from two to five barrels per day, but is remarkable on account of the character of the oil produced, which, having undergone a natural process of refinement, is relieved of its heavier oils, and is adaptable at once for illuminating purposes. The well, therefore, supplies much of the oil needed for home consumption in the country round about. In color and appearance generally it closely resembles artificially refined petroleum, resembling the latter closely also in specific gravity and other properties. The drilling record of the well could not be obtained for inspection.

§ 367. Between Brady's Bend and the mouth of Red Bank creek, the side slopes of the river valley present few rock exposures. The region is in good part an unimproved wilderness; in the same condition also are the steep forbidding hills that closely skirt the river from below the mouth of Red Bank to the mouth of the Mahoning. The uplands, however, being covered with Lower Barren and Lower Productive Coal Measures, are under cultivation. The Lower Barrens are chiefly confined to the western part of Sugar

Creek township, around the heads of Buffalo creek; the Lower Productives, on the other hand, are the surface rocks of nearly all Washington township.

At McKee's mill, (Sherrat P. O.,) the *Ferriferous limestone* is at the water level of Huling's run. Towards the east and south the hills at their summits terminate with the horizon of the *Freeport Lower coal.* One small area of the Freeport Upper seam is contained on the Hankey property, in the long narrow tongue of land between McKee's mill and Watersonville. The same bed goes under the highlands of Sugar Creek township, on its north-west dip conformably to the Kellersburg anticlinal, on the Crawford property, about one mile west from McKee's mill. It there shows the following section:

Slate,		
Coal,	2′ 1″	
Slate,	0′ 2″	3′ 9′
Coal,	1′ 6″	
Clay,		

Both benches of the bed are impure. The Freeport Upper limestone has been found in the well near Mr. Crawford's house; and again in the road near Mr. J. Snyder's house, about one mile N. W. of Crawford's. It is a compact grayish rock without fossils.

The Freeport Lower coal outcrops twenty feet below the limestone at Snyder's, but has not there been explored.

The Freeport iron ore is reported to occur near the top of the hill on the McKee farm, one mile north-west of the mill. A thickness of 20 inches is claimed for it. The stratum not being now exposed, the condition of the ore could not be ascertained.

§ 368. Descending thence eastward towards the mill, the outcrop of the *Kittanning Lower coal* is crossed near Mr. McKee's tenant house. The same bed has been opened 4 feet thick on the McKee property, east of the mill. Most probably also it is the Kittanning Lower seam that shows near the water level on the Titley farm, due south from McKee's. In this vicinity a higher seam, possibly the Kittanning Upper, is mined both on the Titley and Ellenberger farms, showing as follows:

Thin SS. Freeport SS?		
Coal,	3′ 2″	4′ 11″
Slate,	1′ 3′	
Bony coal,	0′ 6″	

The sandstone found in such great abundance on the surface east of the Ellenberger mine was identified as the Freeport sandstone. The same rock continues thence eastward to the river, occupying the highest territory to the exclusion of the Freeport group of coals.

The Ferriferous limestone at McKee's mill is absent from the measures, being there replaced by massive sandstone, which rock also below the mill makes a wilderness of the Huling's run ravine. In places it is a compact conglomerate, upwards of 30 feet thick, and extending from below the Kittanning Lower coal to below the horizon of the Ferriferous limestone. Fading out, however, towards the north the sandstone slowly passes into shale, permitting the reappearance of the limestone in good condition and from 8 to 10 feet thick on the Riddle property where it is quarried. Exactly similar conditions occur at Monticello furnace near Kittanning.

§ 369. Returning now to the river valley in the neighborhood of Rimerton and the mouth of Red Bank creek, Conglomerate and sub-conglomerate strata comprise more than one half of the hills. The railroad cutting at the mouth of Red Bank creek affords good exposures of the massive sandstone at the top of the Pocono. The dark shales of the *Mauch Chunk formation* are mainly concealed. The *Pottsville Conglomerate* is also hidden along the river front, but is finely exhibited in the sides of a small ravine above Fair's saw-mill, west from Rimerton. The rock is massive and coarse grained, presenting in this respect much the same appearance as in the vicinity of Parker City. It is 60 feet thick.

Of the coal-measure strata neither the Clarion nor the Brookville bed was seen; both are probably of little importance hereabouts. The Ferriferous limestone is 10 feet thick, very compact and brittle and in good condition. It is used in Red Bank furnace for fluxing the ores. It may further

be seen on the Early farm N. E. of Rimerton, where it is 350 feet above the river level; again also at Turner's, and on the opposite side of the river at Hankey's and Craig's. Its outcrop line is easily followed around the hills.

§ 370. *The Buhrstone ore* roofed by soft clay shales has an average thickness in this neighborhood of about 8 inches. Such is its condition on the Early farm, where the stratum has been quite extensively mined. The America furnace, a small stone charcoal stack which stood on the river bank at Rimerton, derived a good part of its stock of ore from these Early mines, which are still being operated for the shipment of the ore to market at Pittsburg. The metal made at Red Bank furnace is also from the ore of the Buhrstone stratum.

The Kittanning Lower coal is here a persistent and regular seam, but impure. Where mined for shipment to market on the hills N. E. of Rimerton its total thickness is four feet, including, however, some 6 inches of bony coal directly under the roof, which practically reduces the seam to 3½ feet. Frequently the bony coal is separated from the lower bench by a small band of slate. The same bed is further mined on the Turner property at the point of the hill overlooking the mouth of Red Bank; also on the opposite side of the river in Washington township.

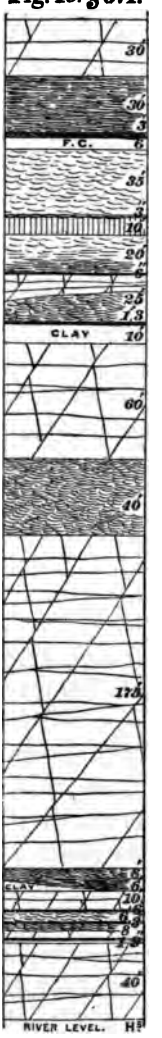
Thence upwards to the Freeport Upper limestone all is concealed. The latter stratum, together with the Freeport Upper coal, is contained only in a few knobs at the extreme hilltops. The small area of this coal on the Hankey farm, and those on the Craig and Early farms in Madison township have already been mentioned. The same bed is used for coking at Red Bank furnace.

§ 371. *At the mouth of the Mahoning* the geology differs only from that above described, in the absence of the Freeport group of coals, which, on the arch of the Kellersburg anticlinal are forced into the air. The anticlinal crosses the river in the bend above the mouth of the creek. The exposures are especially good at this place, exhibiting all the strata from the hilltops to the railroad level, and enabling the following section to be constructed:

Section at mouth of Mahoning creek.

Fig. 46. § 371.

Sandstone, massive,	30′ 0″
Black slates,	30′ 0″
Coal bed, *Kittanning Lower seam*,	3′ 0″
Fireclay,	6′ 0′
Fireclay shales,	35′ 0″
Iron ore, "*Buhrstone*,"	0′ 3′
Ferriferous limestone,	10′ 0″
Fireclay shales and slates,	20′ 0″
Coal bed, *Clarion seam*,	0′ 6″
Sandstone and shales,	25′ 0″
Coal bed, *Brookville seam*,	1′ 3″
Clay,	10 0″
Sandstone massive, *Pottsville Conglomerate*,	60′ 0″
Shales, dark colored, *Mauch Chunk*,	40′ 0″
Sandstone, *Pocono*,	150′ 0″–175′ 0″
Shales ferruginous,	6′ 0′
Black slates and dark clay,	6′ 0′
Sandstone,	10′ 0″
Coal and slate,	0′ 6″
Clay shales,	6′ 0′
Coal and slate,	0′ 3″
Sandstone and shales,	8′ 0″
Slates and bony coal,	0′ 3″
Clay,	1′ 6″
Sandstone,	40′ 0″
River level,	
Total thickness of rock,	524′ 6″



§ 372. *The Kittanning Lower coal* was once operated by the Mahoning Coal Company, on the hill north of the railroad station, but for some years past the mines have been idle. The same bed underlies the ridge of high land stretching northeast from the company's mine, past Fleck's, and on thence towards Duncanville, while on the opposite side of the river its range is no less wide, underlying as it does

all of Washington township. At the Mahoning Coal Company's mines it is a trifle over 3 feet thick, maintaining also the same average thickness in the ravine east of Fleck's; but towards the east it thins away gradually until at Stewardson's Furnace, as has elsewhere been stated, it is scarcely more than 18 inches thick. Like conditions prevail also towards the south.

At the mouth of the Mahoning the bed is both slaty and pyritous. The roof being invariably tough black slate, the coal throughout all the Mahoning Company's mine is dry and firm. The following analysis of a specimen of the coal by Mr. McCreath, fairly represents its condition at this place:

Water,	1.180
Volatile matter,	42.550
Fixed carbon,	49.686
Sulphur,	1.999
Ash,	4.585
	100.000
Color of ash,	pinkish-gray.
Coke, per cent.,	56.270
Fuel ratio,	1:1.17
Phosphorus in coal,	.0061
Phosphorus in coke,	.0108

§ 373. Long lines of "stripping" mark the run of the *Buhrstone ore* on the left bank of the river, both above and below the creek's mouth, and also up the creek valley to the mouth of Scrubgrass. The thickness of the seam, as given in the above section, was taken from an exposure near the head of the incline plane on the Mahoning Coal Company's property, at which place, however, the stratum is somewhat reduced, the average thickness in this neighborhood being nearly 8 inches. The ore is excellent, hard, compact, and rich in iron.

The Ferriferous limestone is here also in good condition. The rock is well exposed at the head of the incline plane.

The Clarion coal undergoes rapid and frequent changes of thickness, ranging from 6 inches, as shown in the section, to two feet and more in places. It yields impure coal.

The Brookville seam outcrops at the point of the hill,

high above the railroad bridge. At the same place the *Pottsville Conglomerate* shows in massive condition. At the head of the incline plane, however, only a few hundred yards further north, it is subdivided by shale into alternate layers. The dark slates and shales of the *Mauch Chunk formation* here contain nothing of interest.

The great sandrock deposit next below the shales is the equivalent of the Parker City bluffs, and the same which makes the base of the slopes at Brady's Bend. Elsewhere in this volume it has been shown with what persistency the same rock extends up Red Bank creek and the Mahoning. Shortly below the mouth of the creek last named the sandstone disappears under the river bed, on its southeast dip, not to reappear again above the water line in that direction.

The exposures at the mouth of the Mahoning exhibit an interesting series of small coal seams and slate layers underneath the top layer of the Pocono sandstone. They are best seen in a railroad cut north of the bridge, where they show their variable and uncertain nature by frequent and sudden transitions from coal into slate and slate into shale. Scarcely a single one of the small coal seams can be traced for any distance beyond the limits of the cut. Like the small seams of carbonaceous matter which occupy similar geological horizons along Red Bank creek, they are essentially sporadic.

§ 374. Below the mouth of the Mahoning, the river in flowing nearly due south follows the dip of the rocks into the basin, and as this dip begins with angles of 4° and even 5°, the strata rapidly assume lower levels down the stream. Quick changes in the surface geology ensue. At Templeton the Pocono rocks have disappeared under the river bed, and all of the Lower Productive Coal Measures are in the hills. Still further south, in the region of old Ore hill furnace, 200 feet of Lower Barren rocks come in on top of the Lower Productives, while the Ferriferous limestone has descended to the river level. At that point, however, the river by shifting its course, first towards the east and next towards the west, approaches the sides of the basin,

where meeting an opposite dip the strata ascend the slopes, and lower rocks gradually reappear above the water line, until below the mouth of Pine creek the horizon of the Pottsville Conglomerate is reached. Such, in brief, is the geology between the mouth of the Mahoning and the mouth of Pine creek.

In the matter of local identifications little difficulty need be experienced, as the exposures are in every case ample for all the purposes required. The dark shales of the Mauch Chunk formation are handsomely shown in the railroad cut north of Templeton. The Pottsville Conglomerate, as a massive, heavy, coarse-grained rock, shows in the little ravine east of the railroad at the same place, where it is at least 60 feet thick, cliffing out along the slopes below the school-house.

§ 375. *The Templeton ravine* affords some good exposures of the lower horizons of the Coal Measures. *The Brookville bed*, 18 inches thick and underlaid by dark clay, outcrops in the right bank of the stream above the grist mill, being there about ten feet above the water line. A short distance higher up, *the Clarion seam* appears, small and of no value. Then at the bridge, at the forks of the road, the *Ferriferous limestone* is at water level. It is eight feet thick, and has its usual iron ore on top. The ore is from 5 inches to 1 foot thick. *The Ferriferous coal seam* appears in the shales, just above the ore, and the *Kittanning Lower seam* is at the top of the exposure, about 30 feet above the limestone. The succession here is as follows:

Slates and shales, dark,	20′ 0″
Coal bed, *Kittaning Lower*,	1′ 8″
Clay,	3′ 0″
Sandstone,	5′ 0″
Shales and slates,	7′ 0″
Coal bed, *Ferriferous seam*,	1′ 0″
Fireclay shales,	15′ 0″
Iron ore,	1′ 0″
Ferriferous limestone,	8′ 0′
Total,	61′ 8″

Besides the small size of the Kittanning Lower bed, the

coal is highly pyritous. The seam has been opened near the run level, a short distance above the bridge.

§ 376. Traced down the river from Templeton both the limestone and the iron ore are persistent in good condition. Messrs. Brown and Mosgrove of Kittanning, have largely operated the ore on the right bank, in Washington township, and operations no less extensive were conducted on the left bank for the supply of Ore Hill furnace. Opposite the Barton House the limestone is at the river level, but rising thence down stream it is at the railroad track at the 51st mile post, where the road-bed is ballasted with it.

§ 377. Both the *Kittanning Middle* and *Kittanning Upper coal seams* are obscure in all this neighborhood. But the Freeport group is well exposed on the left bank of the river, about midway between Templeton and Ore hill furnace. *The Mahoning Sandstone* is beautifully exhibited in a series of cliffs extending past the old furnace. The rock is massive and coarse-grained, of a dark color from the iron it contains, and at least 50 feet thick. In the same condition it spreads out south-eastward into Boggs township, reappearing in the deep valley of the North Fork of Pine creek. Above Ore hill furnace the rock has a covering of smooth Barren shales, which are the county rock over the uplands between the river and the Pine Creek valley. The Freeport group, as exhibited in the exposures round about the old furnace, is as follows, including the Mahoning sandstone:

Sandstone, Mahoning,	50′ 0″
Shales, ferruginous,	
Coal bed, *Freeport Upper*,	3′ 0″
Fire clay, coarse, poor,	3′ 0″
Ferruginous shale,	8′ 0″
Limestone, *Freeport Upper*,	4′ 0″
Fire clay, good,	1′ 6″–4′ 0″
Shales and thin SS. layers,	19′ 0″
Coal bed, *Freeport Lower*,	2′ 0″
Clay, dark, impure,	3′ 0″
Shales,	3′ 0″
Sandstone Freeport,	?
Total thickness,	99′ 0″

The Freeport iron ore, so important at Brady's Bend, is

entirely absent from the neighborhood of Templeton and Ore hill furnace.

The Freeport fire clay was at one time worked by Messrs. Kier and Stewart, along a line of pits extending north from the township road at Mr. Dorsey's house. The mines having long been idle, are now so completely fallen shut that no fair sample of the clay could be obtained for examination. It is described by Mr. Stewart as a hard compact clay, of fairly good quality. Obviously, there is a considerable amount of it at this place, within easy reach of the outcrop, but without proper facilities for lowering it to the railroad, the deposit could not profitably be operated.

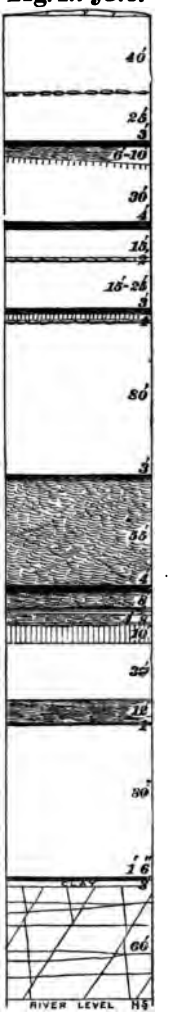
§ 378. *The Freeport Upper coal*, though small, is in excellent condition; bright, hard, and very free from both slate and pyrites. Its outcrop line, going north, passes up the south side of the Templeton ravine, and thence into the Mahoning valley; it overshoots the hill north of Templeton. On Mr. Thompson's land, east of Templeton, it was once quite extensively worked high up above the water level, but the mine has since been abandoned. The bed is also in the hills on the opposite side of the river from Templeton.

§ 379. *Below the mouth of Pine creek* the course of the river continuing towards the W. S. W. approaches the side of the basin, and the section is lowered to include the Pottsville Conglomerate at the mouth of the Cowanshannock. The geology of the region is illustrated by the following section, constructed from the exposures round about the old Allegheny furnace, which stood on the right bank of the river, between the mouth of the Cowanshannock and Kittanning. Many of the measurements are taken from a section made some years ago by Prof. Lesley, and reproduced in the Geology of Pennsylvania:

Section at Allegheny Furnace.

Fig. 47. § 379.

Hill top, Sandstone fragments, Mahoning SS.,		
Interval, concealed rocks,	40′	0″
Iron ore, thickness unknown,		
Interval, concealed rocks,	25′	0″
Coal bed, *Freeport Upper*,	3′	0″
Slates and shales,	6′ 0″–10′	0″
Limestone, Freeport Upper,	?	
Interval,	30′	0″
Coal bed, *Freeport Lower*,	4′	0″
Interval,	15′	0″
Iron ore, siliceous, poor,	2′	0″ ?
Interval,	15′ 0″–25′	0″
Coal bed, *Kittanning Upper*,	3	0″ ?
Limestone, ferruginous, *Johnstown cement*,	3′	0″
Iron ore,	1′	0″ ?
Interval,	80′	0″
Coal bed, *Kittanning Middle*,	3′	0″
Shales,	55′	0″
Coal bed, *Kittanning Lower*,	4′	0″
Slate and shale,	8′	0″
Coal bed, *Ferriferous*,	1′	0″
Slate,	0′	6″
Fire clay, good,	0′ 8″–2′	6″
Slate and clay shale,	4′	0″
Iron ore " *Buhrstone ore*,"	0′	8″
Ferriferous Limestone,	10′	0″
Interval,	30′	0″
Slates,	12′	0″
Coal bed, *Clarion*,	1′	0″
Interval,	80′	0″
Coal bed, *Brookville*,	1′	6″
Clay, impure,	3′	0″
Sandstone, *Pottsville Conglomerate*,	60′	0″
River level, at Allegheny furnace,		
Total thickness of rock,	517′	2″



§ 380. Rock exposures being everywhere abundant in this region, identifications are easily accomplished if the above section be properly applied. Little extended comment is, therefore, necessary. *The Mahoning Sandstone* is contained in all the hills, but makes little display on account of

its shaly structure. *The Freeport Upper coal* was once opened near the hill top above Allegheny furnace; the same bed was also used for coking at Monticello furnace; it is mined on the uplands of Valley township, between the river and Cowanshannock creek; its outcrop line crosses the road at Troy Hill, north-east of Kittanning; and it has been opened on the left bank of the river, near the summit of the slope at the mouth of Pine creek, where, as in all the other localities above mentioned, it is accompanied by its usual underlying stratum of limestone. The coal bed was wrongly called the "Elk Lick seam" in the description given of the Allegheny furnace region in the Geology of Pennsylvania, by Prof. H. D. Rogers.

§ 381. The Freeport Lower coal is of importance along the right bank of the river at Allegheny furnace. An opening there made upon it some years ago, showed 4 feet of coal, corresponding in this respect with the conditions at Miller's, on the Middlesex and Kittanning road, where, in places, the same bed increases to 4½ feet thick. Towards the north and northeast it rapidly thins away, becoming obscure in the region of Pine creek, as well as at the mouth of the Cowanshannock. But towards the south, in the vicinity of Kittanning, its thickness is maintained as will appear from the descriptions given elsewhere of that region. Its outcrop was observed on the Monticello furnace property at the usual distance below the Freeport Upper seam.

The Freeport sandstone here makes almost no show at all. *The Kittanning Upper coal* is likewise obscure. It was not observed at the mouth of Pine creek, nor at the mouth of the Cowanshannock, but an opening once made at its horizon on the hill above the Allegheny furnace revealed, it is said, 3 feet of coal. If so, the bed fails to maintain any such thickness towards the south. Only its outcrop-smut is now showing on the hill above the old furnace, where also the *Johnstown cement* comes out as a ferruginous impure limestone containing also much clay. The limestone and coal above it were mistaken for the Freeport Upper deposit in the Geology of Pennsylvania, which error gave rise to the misidentification of the latter seam with the Elk Lick.

The Kittanning Middle coal bed being nowhere mined at present between the mouth of Pine creek and Allegheny furnace, little is known of it, aside from its outcrop, which in most cases is small. The thickness given to the seam in the above section is taken from the Geology of Pennsylvania.

§ 382. *The Kittanning Lower seam* is irregular in point of thickness. Where opened about 50 feet above the railroad level at the mouth of Pine creek it is 2′ 7″ thick, increasing to 3 feet at Monticello furnace, as also at the mouth of the Cowanshannock. Its outcrop line is just above the old coke yards at Monticello. On the property of Messrs. Brown, Neale, and Orr, near Allegheny furnace the bed is four feet thick, consisting of hard, firm coal, but rather impure from iron pyrites. Almost directly underneath the seam at the latter place, where it sinks below the level of Organ's run, is an impure iron ore, containing so much of the sulphide of iron, that the ore could not be used even to mix with other ores in the stack of an iron furnace. Nor does it, on the other hand, contain enough of the sulphide to make it valuable in the manufacture of sulphuric acid. It is exceedingly hard and tough, fine grained and of a dark bluish gray color, with minute crystals of iron pyrites scattered abundantly through it. A specimen of the ore, analyzed by Mr. J. M. Stinson at the State Laboratory, showed the following composition :

Iron as carbonate,	27.267
Iron as bisulphide,	8.733
Total metallic iron,	36.000
Phosphorus,	.350
Sulphur,	9.981
Insoluble residue,	12.520

§ 383. *The deposit of fireclay* which occurs between the Ferriferous coal bed and the Buhrstone iron ore is of value in the vicinity of Allegheny furnace and also at Kittanning ; but towards the north it is apparently wholly replaced by shale. The deposit, indeed, is essentially an irregular one, consisting rather of abundant "nests" or pockets of clay in shales. The clay itself, however, is of excellent quality. Hard clay and a semi-plastic variety are both obtained from

the deposit, and both are equally pure and good. The two varieties interchange variously, sometimes passing into one another by slow changes, and sometimes suddenly; the semi-plastic clay is more abundant than the other. Mr. McCreath analyzed a specimen of the semi-plastic clay with the following results:

Silica,	50.370
Alumina,	32.890
Protoxide of iron,	1.641
Titanic acid,	1.030
Lime,	.310
Magnesia,	.353
Alkalies,	.290
Water and organic matter,	13.760
	100.644

Low in lime and iron and alkalies, and high in silica and alumina, the analysis is a very favorable one. Titanic acid, now known to be an almost invariable element in our fire-clays, is here also present, but not in sufficient quantity to affect the refractory nature of the clay, one way or the other.

The deposit has been successfully operated for a number of years on the property of Messrs. Brown, Neale and Orr, in the ravine of Organ's run. The mines along the north side of the ravine have exhausted the clay in that direction, the deposit having there proved continuous only for a few hundred feet under the hill, pinching out finally and fading away into shale; but towards the south, from the outcrop on the opposite side of the ravine, there is clearly a large amount of clay contained in the hill. Much has already been removed, but vastly more yet remains untouched. In addition to the frequent changes in the character of the clay, the deposit is also subject to no less frequent changes of thickness. Sometimes the seam is reduced to 6 inches and even less; at other times it expands to four feet. Taking the average of the mines I should judge the yield to be about 15 inches.

§ 384. Attention may here be incidentally directed to the reduction which takes place at Allegheny furnace, in the usual distance between the Kittanning Lower coal and the

Ferriferous limestone. Only thirteen feet intervene; whereas, at the mouth of the Cowanshannock, on the opposite side of the valley, the interval is 30 feet, which is the usual one; at Kittanning it is 50 feet on one side of the river, and about 35 feet on the opposite side. The succession at Allegheny furnace is well shown in one of the clay mines, where a break in the roof enables the strata to be accurately measured.

§ 385. The discovery, some years ago, of a stratum of carbonate iron ore four feet thick, on the left bank of the river, above the mouth of the Cowanshannock, led to the establishment of Monticello furnace, which, since 1873, has been out of blast. The ore was adjudged to be the Buhrstone by those whom it concerned; but subsequent developments revealed that a serious error of identification had been made; and that while close to the geological horizon of the Buhrstone, that the latter was in fact, together also with the Ferriferous limestone, absent along the river front from the mouth of the Cowanshannock to the mouth of Pine creek, as well as up both these lateral valleys to where the horizon of the ore sinks beneath the water level. The ore at Monticello proved only to be a large pocket, which quickly flattened out towards its edges and disappeared. Its geological horizon is *below* the Ferriferous limestone, and near the Clarion coal seam.

§ 386. Nearly all the interval between the Kittanning Lower coal and the Clarion is at Monticello occupied by coarse, massive, compact sandstone. Not only is the limestone thus replaced, but the usual overlying shales are absent too. The sandrock being admirably adapted for building, has been largely quarried for that purpose, by which means it has been well exposed in a small ravine between the furnace and the mouth of the Cowanshannock. The rock is from 40 to 50 feet thick.

The same rock has been shown to exist at the same geological horizon along the Cowanshannock, at the old Bonner furnace, two miles southeast of Monticello, replacing there both limestone and ore; traces of the same sandrock are further seen in the ravine of Hay's run, north of Monti-

cello, and also in the conglomerate cliff, a few feet above the railroad track, north of Pine Creek station. On the south side of the Cowanshannock, at its mouth, the strata are regularly developed, and both ore and limestone are present; so they are at Allegheny furnace; so they are at Kittanning; but under the western part of Valley township, and under a part also of Boggs and East Franklin townships, they present abnormal features, among which is the sandstone above mentioned, cutting out not only the ore and limestone, but other well-known strata in addition.

§ 387. From the conditions at Monticello it is evident that the removal of the limestone and other strata has been effected by ancient erosion, begun just prior to the formation of the Kittanning Lower coal seam, and continued until the horizon of the Clarion had nearly been reached. Subsequently, before the Kittanning Lower coal was laid down, coarse sand was swept in and completely filled the little vale. It is, however, obvious from the conditions, that instead of a single valley, a succession of little vales close to one another, and all trending southeast and northwest, at that time occupied what may now be designated as the disturbed area of the Ferriferous limestone. And this fact is obvious from the gradual tapering which takes place in the sandstone towards the north at Monticello; its subsequent reappearance no less thick further north, in the ravine of Hay's run, there also to taper again; and its reappearance for the third time under precisely similar conditions, north of Pine creek. On the little ridges between the vales, some limestone has been preserved, but only in fragmentary, broken condition, as was shown by the small amount of limestone obtained near the Monticello stack. Whether the little vales united into a single valley at some point towards the east cannot be ascertained, because in that region the geological horizon involved is beneath the present water line. So also it is towards the west under East Franklin township.

§ 388. The remainder of the section, including the Clarion and Brookville coals, contains so little of practical interest, that it may be briefly dismissed. For the benefit of those

persons interested in the matter of identifications it may be stated that the *Clarion coal bed* outcrops near the head of a little ravine, close to the old casting-house at Monticello. It is one foot thick, which also is its thickness in the ravine of Organ's run near the old Allegheny furnace. The *Brookville bed* is exposed in the road above the school-house, near L. Tarr's house; also in the little ravine at Monticello. *The Pottsville Conglomerate*, though massive and heavy, makes little display excepting in the large bowlders of rock that here closely skirt the water's edge.

§ 389. *Advancing now southward a few miles to Kittanning* the only change which takes place in the geology is the disappearance of the Pottsville Conglomerate beneath the river bed. The town of Kittanning is built upon a narrow river terrace, the top of which 30 feet above the river, is at the horizon of the Ferriferous limestone. The terrace is a recent but stratified deposit of sand and clay and gravel, with a layer of rounded crystalline pebbles from the northern drift.

The dip of the rocks at Kittanning is towards the south. Two counter dips in fact here meet each other and produce this southerly incline:—one towards the northwest *across the river* and away from the *Bagdad anticlinal;* the other towards the southwest, caused by the collapse of the *Kellersburg arch* under the highlands of East Franklin township. The effect of the northwest dip across the river is seen in the bold and picturesque cliffs that face the town; the effect of the other is to lower the strata rapidly towards the south, and to deepen the basin in that direction.

The frequent rock exposures in the neighborhood of Kittanning make the locality a favorable one for the study of the Lower Productive strata. The measures are here indeed not entirely normal, certain minor features of the group, as for example the Johnstown cement and the Freeport Lower limestone being absent. Moreover an unusual thickness of sandstone is exhibited at certain horizons, which usually in other localities are occupied by shale. Indeed the section is not exactly the same on the two sides of the river, in hills directly facing each other, and on neither

side is the section the same in every respect as that found at Allegheny furnace to the north, or at Manorville to the south. The difference in the vertical distance between the Kittanning Lower coal and Ferriferous limestone at Mr. Reynold's quarries, and between the same strata on the hill below the late Judge Boggs' residence, has already been mentioned; other differences no less wide will readily appear on close examination. Many of them are pointed out in the sequel; and while in no case is the total aggregate length of the section sensibly increased or diminished by them or outcrop lines obliterated from the map, yet they are of the utmost importance to the student anxious to correctly apply the same general section to other localities in which like strata are found, and where similar irregularities of deposit, less perfectly exposed, are likely to give rise to false interpretations of the geology.

§ 391. In the matter of detail, the strata differing but little from their condition at other places in the valley already fully described, require here only brief notice. Considering the section in ascending order, the *Brookville coal* is near the base of the hill at the clay works of Mr. Ross Reynolds, nearly a mile northeast of Kittanning. It is described as a double bed parted near the centre by a small layer of slate, which is its condition also at Monticello. The rocks intervening between the Brookville and the Clarion coals are mainly shales, near the top of which is an important deposit of fireclay—that mined by Mr. Reynolds for shipment to market at Pittsburg.

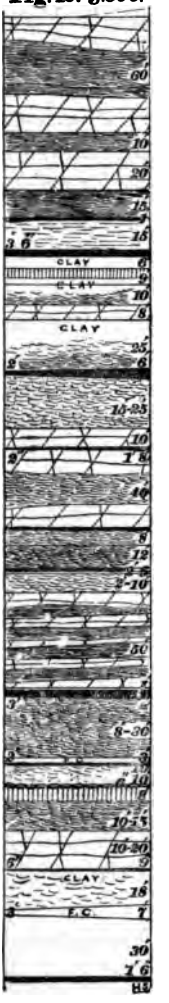
§ 392. *The clay deposit*, though an unusual feature of the section, and one of local development yet apparently underlies all of the Reynolds property. At Kittanning it has been entirely eroded and its place filled with sand and gravel; still further south its geological horizon is below the water line. On the west bank of the river, opposite the town, as well also as opposite Mr. Reynolds' clay works, it is obscure and probably of little value. In the region of Allegheny furnace and at Monticello, it was not observed at all. The main body of the deposit is therefore obviously contained on the Reynolds farm.

§ 390. The section herewith given of the rocks at Kittanning has been compiled from numerous local sections, and is intended to represent as nearly as possible in one column the conditions on both sides of the river. A section made by Mr. White along the right bank of the river facing the town, is shown in Fig. 7, Report Q, page 41.

Section at Kittanning.

Sandstone and slate,	Mahoning sandstone,	60′	0″
Slate,		10′	0″
Sandstone,		20′	0″
Black slates,		15′	0″
Coal bed, nameless,		1′	0″
Clay shales,		15′	0″
Coal bed, *Freeport Upper*,		3′	6″
Clay, impure,		6′	0″
Limestone, Freeport Upper,		6′	0″
Fireclay, dark colored,		3′	0″
Clay and shales, impure,		10′	0″
Sandstone,		8′	0″
Clay and shales,		25′	0″
Coal bed, *Freeport Lower*,	2′ 0″–	6′	0″
Sandy shales, ferruginous,	15′ 0″–	25′	0″
Sandstone, thin bedded, *Freeport SS.*,		10′	0″
Coal bed, *Kittanning Upper*,	0′ 2″–	1′	8″
Sandstone and shales,		40′	0″
Coal bed, nameless, very irregular,			thin.
Shales,		8′	0″
Black slates, massive,		12′	0″
Coal bed, *Kittanning Middle*, parted,		1′	6″
Clay, coarse, impure,		1′	0″
Clay shales,	2′ 0″–	10′	0″
Sandstone, interchanging with black slates,		50′	0″
Fireclay slate, dark gray,		1′	0″
Coal bed, *Kittanning Lower*,	3′ 0″–	4′	0″
Shales, reddish,	8′ 0″–	30′	0″
Fireclay, dark colored,	2′ 0″–	3′	0″
Coal and slate, *Ferriferous coal*,		0′	10″
Shales and sandy clay,		10′	0″
Iron ore, Buhrstone,		0′	6″
Ferriferous limestone,		8′	0″
Shales,	10′ 0″–	15′	0″
Sandstone,	10′ 0″–	20′	0″
Coal bed, *Clarion*,	0′ 6″–	0′	9″
Clay and clay shales,		18′	0″
Fireclay, good,	3′ 0″–	7′	0″
Interval,		30′	0″
Coal bed, *Brookville*,		1′	6″
Total thickness,		497′	3″

Fig. 48. § 390.



The clay is semi-plastic, unctuous, and pearl-gray. Being admirably located for mining, rising gently under the hill, it can be loaded on the cars at a comparatively low cost. The deposit in places attains a thickness of 7 feet, 5½ feet being perhaps the average, so far as yet uncovered. The clay goes in its raw state to Pittsburg for manufacture there into bricks and retorts. According to the chemical analysis made of it by Mr. McCreath, it is inferior in composition to the clay from the overlying Kittanning deposit, worked near Allegheny furnace, by Mr. Tarr, and near the Kittanning court-house, by Mr. D. Stewart. How the average of it will compare with the average of the other in resisting high temperatures is an undecided question; or if decided, the result is at least unknown to the writer. Mr. McCreath's analysis is as follows:

Silica,	58.750
Alumina,	25.170
Protoxide of iron,	2.195
Protoxide of manganese,	trace.
Titanic acid,	1.050
Lime,	.710
Magnesia,	.936
Alkalies,	3.535
Water,	8.110
	100.456

§ 393. *The Clarion coal* shows in the exposures above Mr. Reynolds' clay pits; also at the level of the road, on the west bank of the river, some distance above the bridge at Kittanning; at neither place is it of value.

The measures between the coal last named and the Ferriferous limestone show some curious and rapid changes, comparing the exposures at the clay pits with those on the opposite side of the river.

The Ferriferous limestone is a compact rock, uniform in quality and composition throughout. Though not quite so well adapted for furnace flux as the limestone from the Freeport Upper deposit, so extensively quarried at Manorville, yet the Ferriferous deposit yields excellent stone. Moreover, the Ferriferous stratum is as uniform in thickness as it is in quality. Mr. Reynolds has very success-

fully operated it for the manufacture of quick lime, which shipped to Pittsburg finds a ready market there. At the Reynolds quarries the rock is 90 feet above the railroad; at Kittanning it is just below the court-house, at the level of the railroad track; at the rolling mill, ¼ mile still further south, it is in the bed of the river; whence southward it does not reappear again above the water line. A specimen of the rock from Mr. Reynolds' quarry showed the following composition on a partial analysis by Mr. McCreath:

Carbonate of lime,	95.567
Carbonate of magnesia,	1.422
Oxide of iron and alumina,	.930
Phosphorus,	.035
Insoluble residue,	2.110

§ 394. *The Buhrstone iron ore* has hitherto been only little worked in the neighborhood of Kittanning, but on the completion of the new iron furnace, now in process of building close by the rolling mill below the town, extensive developments may be expected. The average thickness of the stratum, to judge from the few natural exposures of its outcrop, is about 6 inches; the ore is identical with that obtained from the same stratum elsewhere in the county; a compact bluish carbonate, to all appearances of good quality and rich in iron. The conditions for mining are exceptionally favorable; nearly horizontal measures; frequent lateral ravines to open up long lines of outcrop; easy access to the railroad, which the line of the ore closely follows. On the west bank of the river the ore is equally good, but mining there will be somewhat more expensive, because of the gentle westerly dip into the hill, requiring some additional outlay to provide suitable drainage. At the present price of labor, the cost of mining a ton of ore will not exceed $1 75 per ton; transportation and calcination will add from 50 to 75 per cent. to the original cost, so that the roasted ore, ready to charge into the furnace, and yielding 40 per cent. of metallic iron, will rate from $2 75 to $3 00 per ton. In smelting the ore at Kittanning, it is the intention to mix it in the new furnace with magnetic ores from Lake Superior.

§ 395. In this connection mention may be made of the Kittanning Mineral spring, situated at the base of the hill, near the court-house. Issuing from the shales directly above the Buhrstone ore, the water contains such ingredients as would be liberated by chemical reaction, either from the Buhrstone stratum or from the ore masses contained in the shale. Lime is its principal ingredient, both as bicarbonate and sulphate; and containing also some magnesia, the water is said to act in medicine as an alterative. Its iron gives to it a mild tonic effect. The physicians of the town highly indorse the spring, and by some of the residents, who speak from actual experience of its properties, it is rated no less high. Prof. Genth, of the University of Pennsylvania analyzed a sample of the water which had been sent to him for that purpose, by Mr. R. W. Smith, with the following results: One gallon of 231 cubic inches:

Sulphate of alumina,	1.52753
Sulphate of ferrous oxide,	24.49271
Sulphate of magnesia,	26.84937
Sulphate of lime,	65.12190
Sulphate of soda,	8.72585
Sulphate of potash,	0.90762
Phosphate of lime,	0.11036
Bicarbonate of lime,	16.05445
Bicarbonate of manganese,	0.24629
Chloride of sodium,	0.64741
Silicic acid,	1.17201
	145.85550

§ 396. *The Ferriferous coal seam* appears above the roof shales of the Buhrstone ore near the court-house, but besides being small and of no importance practically, the seam is uncertain and irregular. No trace of it is seen at Mr. Reynolds' quarries, nor does it show in the exposures on the opposite side of the river.

§ 397. *The fire clay deposit* next above the Ferriferous coal has been opened by Mr. D. Stewart, near the Mineral Spring. It is most likely the equivalent of that mined by Mr. Tarr in the ravine of Organ's run, with which it has many features in common. The identification however, is not a matter of certainty if the Ferriferous coal seam be taken as a basis of calculation in each case; but as the lat-

ter bed is in the highest degree irregular, it is safer to regard the fire clay deposits as identical. The matter, however, is not one of great practical importance, as both clays are equally good. Mr. McCreath analyzed a specimen of the clay from Mr. Stewart's mine, with the following results:

Silica,	55.960
Alumina,	28.415
Protoxide of iron,	1.641
Titanic acid,	1.010
Lime,	.070
Magnesia,	.396
Alkalies,	.615
Water and organic matter,	12.690
	100.797

If the reader will compare the above analysis with that of the Organ's run clay, he will find how closely the two correspond in chemical composition.

The shales overlying the clay exhibit some interesting changes of thickness at the different exposures. At Mr. Reynolds' quarries they are 5 feet thick, with a stratum of sandstone of equal thickness underlying, which latter rock there cuts out the Stewart fire clay; at the court-house the sandstone has disappeared, and the shales are 8 feet thick, with the fire clay underneath as above mentioned. On the west bank of the river directly opposite, they are 30 feet thick, increasing the interval between the Ferriferous limestone and the Kittanning Lower coal to 43 feet. At the court-house the same interval is 21 feet, and only 18 feet at the limestone quarries.

§ 398. *The Kittanning Lower coal*, called the Kittanning seam in the Geology of Pennsylvania, and in the earlier reports of the present survey, is the bed best known and most worked in the neighborhood of the town. Locally it bears the name of the "Town Vein."

Its importance for the local market is however more to be ascribed to its favorable location for mining at the base of the hills than to any special advantages its coal possesses over that from the other seams; for, in point of fact, the bed is much inferior in quality to either of the Freeports,

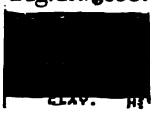
being not only a much parted seam, but a highly pyritous one. Without thorough washing to remove its pyrites, it could not be employed at all for furnace use; and for the same reason it has also been condemned at the gas works.

Where mined near the court-house by Mr. Thompson, it is barely more than three feet thick, parted in such a manner that only about 2½ feet of coal can be profitably taken out. On the opposite side of the river, at the bridge, its thickness is the same, and its quality is somewhat improved.

At Mr. Reynolds' quarries, where it is mined for use in the lime kilns, it yields very indifferent coal, slaty, and overloaded with iron pyrites. The mine section is as follows:

Slate,			
Coal,	0′ 10″		
Bony coal,	0′ 2″		
Coal,	1′ 4″		
Parting, (chiefly iron pyrites,	0′ 1″	4	1″
Coal,	1′ 4″		
Bony coal,	0′ 4″		
Clay,			

Fig. 49. §398.



An analysis by Mr. McCreath of a specimen of coal from this mine showed the following constituents:

Water,	.950
Volatile matter,	40.855
Fixed carbon,	51.694
Sulphur,	1.366
Ash,	5.135
	100.000
Color of ash,	White.
Coke per cent,	58.195
Fuel ratio,	1:1.26

§ 399. At Mr. Taylor's below the rolling-mill, south from the town, the same seam is at water level. It has been opened up there by a slope descending from the railroad. Still further south, at Manorville, Mr. George Reichert had a hole drilled to test the depth of the coal at that point, finding it at about 75 feet below the channel of the river, or 103 feet below the top of the first terrace on which the derrick stood. The dip, therefore, between Kittanning and Manorville is not far from 2° towards the south. Mr. Reichert states that the coal bed in the test hole showed a

thickness of 6 feet Measurements, however, so obtained are not to be depended upon for strict accuracy in the thickness of a coal seam, on account of the difficulty of separating narrowly the coal from the roof slates, and the almost unavoidable risk of including some of the latter in the measurement.

The strata immediately overlying this coal, between it and the Kittanning Middle seam about 60 feet higher, have little uniformity in the vicinity of the town. They comprise, indeed, the most uncertain part of the section.

In the small ravine just south of the Reynolds' quarries, the interval is occupied wholly by ferruginous shales, which are continuous along the left bank of the river to the court-house, where they are finely exhibited, rising from the foundations of the building to a height of about 40 feet on the slopes. Thence southward, past the Mineral Spring, they gradually give place to sandstone, first in thin layers and projecting finger points of rock which, gradually expanding, finally usurp, at the rolling-mill, the entire interval formerly occupied by shales; still further south, under similar conditions, the shales reappear again. On the opposite side of the river, at the same horizon, neither sandstone nor shales appear, the interval being there occupied by black slate.

§ 400. *The Kittanning Middle coal* is not of workable thickness at Kittanning. It is well exposed in the face of the bluffs opposite the town, and also in the railroad cut below the rolling-mill. The heavy sandstone deposit above this coal makes the line of prominent cliffs above the bridge; and the same rock is quarried on Mr. Brown's property near Troy Hill; also in the ravine along which the Dayton road leads. At both quarries the rock is so much cracked and broken by vertical crevices that only small stone is obtainable from it.

In the railroad cut below the rolling-mill, the sandstone gives place to shale, reappearing however again a short distance beyond, to again disappear with a rapidity fairly bewildering. These irregularities, as well as those in the next interval below, are the result of ancient erosive action.

The Johnstown cement bed, which belongs on top of the sandstone last described, is absent from the measures at Kittanning, but only locally so as it is found at Allegheny furnace towards the north, and at Rosston station towards the south, at the mouth of Crooked creek.

The Kittanning Upper coal is without value or importance here, being small and easily overlooked in the exposures. Its greatest development close to Kittanning, is in the region of Troy Hill where it shows in the road above the sandstone quarry. The same seam at Mr. Taylor's house near the rolling-mill is only a thin streak.

The Freeport sandstone being loose and thin bedded, is scarcely noticeable in the exposures.

§ 401. No trace appears of the *Freeport Lower limestone* at Kittanning. But the limestone underlying the Freeport Upper seam is a constant member of the section. It is in the road at Troy Hill, whence southwestward, sinking slowly with the other strata, it occupies lower levels. At Manorville its thickness is much expanded, presenting an abnormal development there, of great importance to the region, and of which a description is given on another page. At Kittanning its thickness is 6 feet on the average. It is little worked excepting on the uplands by the farmers who employ it for fertilizing, and who might advantageously employ it still more for the same purpose. A good exposure of it is on the Worthington road west of Kittanning.

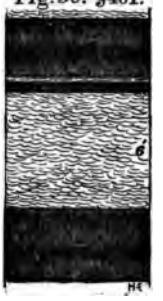
The Freeport fireclay is mined near Manorville on Mr. Reichert's land and also on adjoining properties. It is made into bricks and other articles in works near the Manorville railroad station.

§ 402. *The Freeport Lower coal seam*, called locally the "Rolling vein" from its great variability of thickness, is in some places a valuable adjunct to the section, and at other places, perhaps near by, of no practical value whatever. Along the right bank of the river it maintains a tolerably persistent thickness of four feet, southward from the Allegheny furnace until opposite Kittanning, when its outcrop is not easily followed. On the hills opposite, between Troy Hill and the rolling-mill its changes are so frequent

and of so radical a nature, that no dependence can be placed upon it in mining. Some years ago it was operated on the Buffington property above the rolling-mill, which at that time, it supplied with fuel. In thickness it is said to have there ranged from 8 and even 10 feet to a mere streak. The mines are now closed. An outcrop in the ravine close to the pike, northeast of Kittanning, shows the bed separated into two benches by a thick parting of shale. The upper of the benches is slaty and is itself parted near the base; the lower bench, on the contrary is clean and yields good coal. The section is as follows:

Shale in roof,			—
Coal,	Upper bench,	3′ 0″	13′ 5″
Slate,		0′ 3″	
Coal,		9′ 6″	
Shales,		6′ 0″	
Coal,		3′ 8″	

Fig. 50. §401.



The bed was likewise opened into on Troy Hill below the road, where having thinned away in a short distance to a few inches in thickness, the mine was abandoned. At Manorville it is also a double bed, measuring, however, only 4 feet thick in all. The parting shale is one foot thick.

The shales overlying the coal undergo some change in thickness, by which the interval between the Freeport coals is reduced from 50 feet in places to 35 feet. These figures represent the distance between the beds at Manorville and Troy Hill respectively.

§ 403. The outcrop line of the *Freeport Upper coal* ranges some distance back from the river in the region of Troy Hill, crossing the eastern pike above the picnic grounds, to run thence southward through the hills that closely skirt the river. West of the town its run is so much obscured in consequence of the reduction which there takes place in the thickness of the seam that only with some difficulty can it be traced. At the limestone quarry back of the residence

of the late Judge Boggs, it is entirely absent from the measures; towards the north along the Middlesex road it makes only a feeble show until near the region of Allegheny furnace.

The coal obtained from it along the left bank of the river, at Kittanning, is in some cases of a fairly good quality, but as often very impure. On the whole, so far as we may judge from the few exposures of it, the bed is not promising. At Troy Hill and at the Buffington mines above the rolling-mill it is slaty; but at Mr. Taylor's, a short distance further south, its condition is somewhat improved.

Its average thickness in these mines is 3½ feet; sometimes reduced by a small slate parting as on Troy Hill, but quite as often rising above the average and yielding 4 feet of coal. Generally speaking, it is uniform and regular along the left bank of the river.

Of the remaining 120 feet of rocks represented in the section little need be said, as they contain nothing of practical interest. The Mahoning sandstone being usually much current-bedded and also argillaceous, weathers down into loose shales, with which the uplands east and west from the town are abundantly strewn. A good exhibition of the Mahoning sandrock is presented in the ravine above Mr. Taylor's.

§ 404. *The rolling-mill* so often alluded to in the above description of the strata occupies a place on the left bank of the river, just outside of the town of Kittanning. Of late years the mill has been idle, but quite recently it has been placed in complete working order, preparatory to renewal of operations. An iron furnace with a capacity of about 300 tons of metal weekly is in course of erection close to the mill; the iron made will be from a mixture of magnetic ores from Lake Superior, with the native carbonates, from which muck-bar will be made in the rolling-mill. The experiment of bringing the magnetic ores into this particular region of the carbonates is one that has never before been attempted in the Allegheny valley; but there is no reason to doubt of its ultimate success, pecuniarily, if intelligently and prudently conducted. One of the chief obstacles to

be overcome is the production of good coke for the iron furnace. Possibly the Freeport Lower coal seam may be sufficiently regular on the Buffington lands to enable it to be wrought for that purpose, providing it be found to possess the property of coking. Otherwise the Freeport Upper seam must be looked to for coke. A well is now being drilled at the rolling-mill, in the hopes of finding natural gas at available depths there, with which to supply the heating furnaces of the mill. The well is not yet completed, having only reached a depth of a few hundred feet beneath the surface. The gas, if struck, will come from sandrocks which underlie the surface at Kittanning by from 1200 to 1500 feet.*

§ 405. Little additional description is now required of the sixteen miles of territory which intervene between Kittanning and Freeport, except to point out the localities at which exposures occur, and briefly to note their main features. The structure is so simple, and the surface geology so uniform, that any one at all acquainted with the rocks of the Lower Productive and Lower Barren groups cannot easily go astray. At Manorville about 125 feet of the Lower Productive Coal Measures are above the water level; the uplands contain some 300 feet of the overlying Lower Barren group, in which there is no feature of economic interest.

§ 406. *The Freeport Upper limestone* is the stratum of greatest importance at present, not only at Manorville, but southward from this, as far as Kelley's station, and on both sides of the river. The gradual increase of thickness in the limestone which sets in at Kittanning continues southward, layer coming in upon layer, until in the neighborhood of Manorville the deposit, including its division layers of slate, is 28 feet thick; thence southward its thickness slowly diminishes, the dimensions at Freeport being the same as those at Kittanning.

The business of quarrying the rock for furnace flux at Pittsburg, has of late years developed into an active in-

* Since the above was written the well has been continued to a depth of 1500 feet and abandoned, no gas having been met with.

dustry between Manorville and Kelly's station. High in lime and low in phosphorus, no better stone for furnace use can anywhere be obtained in the Allegheny valley. All of the deposit, however, is not equally good. Certain layers, readily distinguished by their physical aspect, supply the stone for shipment; the other layers contain more alumina and more phosphorus. All of them, however, can be used in the kiln for quarry lime.

The furnace-layers have an extended run. They are worked by Mr. Reichert, near the north end of the belt, where the rock in all is only ten feet thick, a nearly solid mass, however, without the slate divisions which so largely assist further south in expanding the deposit.

The most extensive quarries are those of Messrs. Dull & Co., in the ravine of Fort run, from which place enormous quantities of rock have been taken, and where also the deposit attains its maximum development. The section is as follows:

1.	Limestone,	1′ 3″
2.	Clay,	0′ 8″
3.	Limestone, impure,	1′ 0″
4.	Slate,	2′ 2″
5.	Limestone,	4′ 5″
6.	Clay-slate and impure limestone,	2′ 5″
7.	Limestone, dark-colored,	2′ 2″
8.	Slate and impure limestone,	3′ 2″
9.	Limestone,	2′ 10″
10.	Slate and clay,	1′ 3″
11.	Limestone, called "Glassy layer,"	2′ 7″
12.	Limestone,	4′ 0″
	Total,	27′ 11′

§ 407. The so-called "Glassy layer" (from its tendency to splinter) is of a light pearl gray color, very brittle, smooth, and compact; conchoidal in its fracture; has some small fossil shells (univalves) and also some particles of calcite. It is the best of the layers. Its thickness along Fort run is apparently less than at Reichert's or at Mehaffey's, near Logansport. Mr. McCreath made analyses of specimens from those benches that are quarried for furnace use by Messrs. Dull & Co. The benches are Nos. 5, 9, and 11, of the above section. The analyses are as follows:

	No. 5.	No. 9.	No. 11.
Carbonate of lime,	89.303	82.589	89.857
Carbonate of magnesia,	1.900	5.751	2.898
Oxide of iron and alumina,	2.002	3.367	1.860
Phosphorus,	.021	.063	.017
Insoluble residue,	4.830	7.310	4.520

§ 408. The deposit is worked on both sides of the river at Logansport, where, in all, it is 12 feet thick, and in much the same condition as at Reichert's, the shale layers at Fort run having, with one exception, thinned away and disappeared before reaching Logansport. A section made at Mehaffey's quarry, on the left bank of the river, may here be reproduced to show the conditions more clearly:

1. Limestone,	1′ 7″
2. Limestone, impure,	0′ 8″
3. Limestone,	2′ 4″
4. Limestone, impure,	0′ 10″
5. Clay and slate,	1′ 3″
6. Limestone, impure,	0′ 7″
7. Limestone, "Glassy layer,"	5′ 6″
Total,	12′ 9″

Analyses were made by Mr. McCreath of samples from benches 1, 4, and 7, with the following results:

	No. 1.	No. 4.	No. 7.
Carbonate of lime,	96.453	93.214	93.571
Carbonate of magnesia,	1.445	2.065	1.324
Oxide of iron and alumina,	.964	1.340	1.207
Phosphorus,	.007	.004	.029
Insoluble residue,	.830	2.220	3.170

The rock at Mehaffey's quarry is covered with a deposit of loose gravel and sand, representing a river terrace 220 feet above the present level of the stream.

§ 409. *The Freeport Upper coal* is opened at several places close to Manorville; also in the ravine of Fort run, and on the hill south from the Logansport quarries. Its average thickness is 3½ feet. From Manorville its outcrop line extends up Garrett's run into Kittanning township, nearly to Blanket Hill, near which place it is mined on the D. Shoemaker farm.

The Freeport Lower coal is only 15 feet below the base of the limestone at the Fort run quarries, which interval however increases towards the south as the limestone gradu-

ally diminishes in thickness. The road leading southward from the mouth of Fort run, presents some good exposures of the Freeport group, as does also the road below Mr. Reichert's house, where the Freeport Lower limestone is represented beneath its coal.

At Rosston station, (mouth of Crooked creek,) only about one hundred feet of the Lower Productive Coal Measures are above the water line, the upper levels of the hills consisting of Lower Barrens. *The Freeport Upper limestone* is here partially exposed directly above the railroad. About one half mile south from the station the *Johnstown cement* outcrops at the level of the track. *The Freeport sandstone* massive and heavy bedded forms a line of prominent cliffs at the same place. The succession is as follows:

Sandstone, Freeport,	40′ 0″
Coal, irregular, non-persistent,	trace.
Slates,	12′ 0″
Coal bed, *Kittanning Upper*,	1′ 6″
Clay, impure,	2′ 0″
Limestone, dark, ferruginous, *Johnstown cement*,	2′ 0″
Shales,	4′ 0″
Sandstone,	1′ 0″
Fire clay, impure,	8′ 0″
Thin SS. with iron ore,	6′ 0″
Black slate,	10′ 0″
Railroad track,	
Total,	86′ 6″

§ 410. The westward course of the river from the mouth of Crooked creek removes it from near the centre to the western edge of the basin, causing lower rocks to appear above the water line between Rosston and Logansport. Below the latter place, the river, by a sharp bend towards the south-east, returns again to the centre of the basin at Freeport.

At the head of the bend above Logansport 200 feet of the Lower Productive strata are above the river, which enables the Kittanning Lower coal to appear. It is opened on the Bruner property, below the mouth of Glade run, and also near the water's edge, opposite Logansport station. It yields little good coal at either place, besides being parted near the centre by a persistent layer of slate. The follow-

ing measurement of the seam was obtained in the Bruner mine:

Shale and slate, dark,		
Bony coal,	0′ 3″	
Coal,	1′ 5″	3′ 3″
Slate,	0′ 1″	
Coal,	1′ 6″	

As the bed at Bruner's is 25 feet above the river level, the Ferriferous limestone can here only be concealed by a few feet.

Massive sandstone here roofs the coal instead of black slates as at Kittanning. Twenty feet of the rock are exposed in a bluff opposite Logansport, while bowlders and other fragments from the same stratum are abundant along the river bank, both at Logansport and for some distance lower down.

§ 411. In the neighborhood of *Kelley's station*, the upper half of the Lower Productive group makes the base of the hills. A good exposure of the Freeport group is found at the railroad station as well also as some overlying Lower Barren rocks, including a small seam of iron ore above the Mahoning sandstone. It is as follows:

Iron ore,	?
Sandstone, Mahoning,	35′ 0″
Slates and shales,	25′ 0″
Coal bed *Freeport Upper*,	3′ 6″
Clay shales,	7′ 0″
Limestone, *Freeport Upper*,	8′ 0″
Shales,	35′ 0″
Coal bed, *Freeport Lower*,	5′ 0″–6′ 0″
Total,	119′ 6″

The section ends at the level of the railroad, whence to the river the rocks are concealed.

The iron ore at the top of the section occupies a similar geological position to that of the Johnstown stratum. It was once opened and mined on the hill above the railroad station at Kelley's, for use at Monticello furnace, but the old pits upon it being now closed, neither its thickness nor its quality could be ascertained.

§ 412. *The Freeport Upper coal* is considerably broken by partings. From Kelley's station its outcrop extends up

the ravine of Taylor's run to the little village of Centre Valley, where it is opened and mined. An average section of the bed for this locality, is as follows:

Coal,	2′ 1″	
Slate,	0′ 1½″	
Coal,	0′ 8″	3′ 6¼″
Slate, persistent, but small,	—	
Coal,	0′ 8″	

Extensive quarries on the *Freeport Upper limestone* exist at Kelley's station, but being similar to those at Logansport and elsewhere, require no special description.

The Freeport Lower coal assumes here a semi-cannel feature, which moreover it retains with more or less persistency all the way from Kelly's to Freeport. The coal however has little or no practical value, being too slaty for domestic use. The mine once opened upon it at Kelley's is now closed. The bed is reported as having a thick parting of slate near the centre.

Some years ago, before the discovery of petroleum, the seam was quite extensively operated at Freeport for the distillation of its oil. Its occurrence at the latter place is elsewhere alluded to in connection with the Freeport section of rocks.

Between Kelley's and Freeport the geology is without change. Few or no rock exposures occur, nor has there been any development of the strata. Opposite Aladdin station are some old abandoned salt wells, which derived their supply of salt water from the same rocks that have yielded it so generously in the neighborhood of Saltsburg, the rocks of Formation X or the Pocono sandstone.

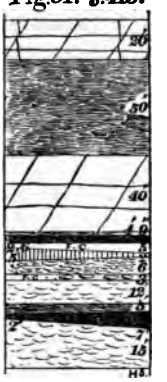
§ 413. *The town of Freeport* is built upon a river terrace, similar to that at Kittanning, only on the opposite side of the valley. High abrupt slopes, along which the Mahoning sandstone makes picturesque cliffs, face the town from the east. The western hills are less steep, showing a succession of well defined river terraces and coal benches along their flanks.

Of the Lower Productive Coal Measures at the base of the hills, about 150 feet are above the river level; they sup-

port some 300 feet of the Lower Barren group. From the top of the Mahoning sandstone to the water level, the succession is as follows:

Sandstone,		20′ 0″
Slates, grayish,		50′ 0″
Sandstone, massive, forming cliffs,		40′ 0″
Black slates,		1′ 3″
Coal bed, *Freeport Upper*,		3′ 6″
Fireclay,	2′ 6″–	5′ 0″
Limestone, Freeport Upper,	2′ 0″–	5′ 0″
Shales, sandy,		6′ 0″
Fireclay, impure, with iron ore nodules,		3′ 0″
Clay shales,		12′ 0″
Black slates,		5′ 0″
Coal bed, *Freeport Lower*, cannel slate,	2′ 0″–	7′ 0″
Clay shales,		15′ 0″
Total,		172′ 9″

Fig. 51. §413.



§ 414. *The Mahoning sandstone* is decidedly the most conspicuous feature of the Freeport geology. Not only along the Allegheny river, but also along the Kiskiminitas it is magnificently exposed, and along the valley of the Buffalo it is no less prominent for many miles above Freeport.

Its massive condition admirably adapts it for building purposes, although to obtain good stone from it, careful selection is required, as many of the layers are unfit for use. Where exposed at Mr. Taylor's quarry on the hill near the cemetery the top of the deposit is valueless, but the lower horizons are exceedingly compact and can be raised in large blocks suitable either for paving or for building. The rock is fine grained, slightly micaceous, and of a somewhat mottled appearance from its brownish specks of iron. It resists well the action of the weather.

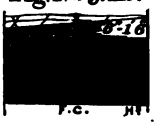
§ 415. *The Freeport Upper coal* is largely mined in the neighborhood, supplying the town with coal for domestic use, and the mills with fuel for steam. Its average thickness is 3½ feet, with good firm roof of slate.

It is needless to enumerate all the different openings on the bed in the vicinity of the town. That of Mr. James McCullough on Buffalo creek, at the west end of Freeport

is characteristic for the neighborhood, while the measurement there made, although in respect of thickness a trifle perhaps under the general average, yet shows the usual subdivisions in the vicinity of Freeport. It is as follows:

Sandstone,			—
Black slate,	0′ 6″–1′ 6″		
Coal,	2′ 5″		
Slate,	0′ 1″	3′ 5″	
Coal,	0′ 9″–0′ 11″		
Fireclay,			—

Fig. 52. § 415.



The coal is everywhere impure, and not only along the river front, but on both sides of Buffalo creek. Its condition along the east side of the Buffalo is rather better than at the other places, which fact has caused the mining to centre more or less in that locality. For domestic purposes the coal from all the mines answers well enough, but in the gas works only that from the east side of the creek is employed. It is said to produce about 9000 cubic feet of gas to the ton of coal. In consequence of the sulphur (from the iron pyrites) the gas requires much scrubbing and washing; its illuminating power, as measured by the candle test, is not known.

The sample of the bed, analyzed by Mr. McCreath, was taken from the Jno. Hagy mine, at the north end of Freeport:

Water,	1.430
Volatile matter,	39.835
Fixed carbon,	50.206
Sulphur,	2.819
Ash,	5.710
	100.000
Color of ash,	cream.
Coke, per cent.,	58.735
Fuel ratio,	1:1.26

The Freeport Upper limestone may be seen at the McCullough mine, and also on the left bank of Allegheny, opposite the town. Its average thickness is 4 feet, none of which is especially good stone.

§ 416. Allusion has elsewhere been made to the semi-cannel condition of the *Freeport Lower coal bed*, between *Kelley*'s station and Freeport. The mines which worked it

many years ago were along the left bank of the river, some at the mouth of the Kiskiminitas, and others below this in a small ravine. All of them being now closed, no good opportunity exists for a measurement or examination of the deposit; but a partial exposure of it is found at the old workings in the ravine above mentioned.

The bed is eminently an irregular deposit, similar in many respects to the deposit of cannel slate at New Bethlehem, on Red Bank creek, and along the Little Mud Lick branch of the Mahoning. According to the statements of miners who worked in the old pits, as much as 7 feet of coal were sometimes obtained, whereas in other places the dimensions of the stream were reduced to a mere thread. Along Buffalo creek it rests upon a layer of bituminous coal, slaty and worthless; on the Kiskiminitas it is separated from this bituminous bench by a stratum of shale from 6 to 8 feet thick. Like conditions to the last are found in the little ravine.

To judge from the specimens of the cannel slate (for such indeed it is and not, strictly speaking, a cannel coal) yet lying about the mouth of the old mines, it is much too impure for use in grates or stoves, without considerable annoyance from ashes. Its yield of oil was, according to a proximate analysis made by Dr. Alter, of Freeport, 33 ounces of crude oil from 22 pounds of coal. One gallon of the crude oil produced one ounce of paraffine, besides coal tar and lighter oils, benzole, etc.*

The *Freeport Lower limestone* is absent in this neighborhood.

The sandstone cliffs extending along the right bank of the river from a point nearly opposite the mouth of the Kiskiminitas to the West Pennsylvania R. R. bridge, are made by the Freeport sandstone, here a massive and important deposit. The same rock is also finely exhibited on the opposite bank of the Allegheny, below the bridge, and again on Buffalo creek, at the grist mill above Freeport.

Along the river front at Freeport the *Kittanning Upper coal* is represented only by black slates and bituminous

* Geology of Pennsylvania, p. 596.

shales. This is its condition at the level of the tow path, near the railroad bridge; and again, just above the railroad track near Garvey's ferry. But at the grist-mill on Buffalo creek it consists of good hard coal, resting directly beneath the Freeport sandstone.

The Johnstown cement is absent from the measures at Freeport.

CHAPTER IX.

The Valleys of Glade run, Limestone run and Buffalo creek.

§ 417. The region described in the present chapter comprises those townships of Armstrong county situated west from the Allegheny river and south from Brady's Bend. That part of it fronting on the river has been fully treated on previous pages of this Report; only the interior, lying away from the river, is here considered.

The geology of the region is unfolded in the valleys of Glade run, Limestone run and Buffalo creek, which in the following pages are treated of separately, succeeding in the order named. All are comparatively small streams, and all are tributary to the Allegheny.

The region in general presents a broad expanse of upland, covered mainly with Lower Barren shales; in the valleys are the Lower Productive rocks. The soil is uniformly the product of the disintegration of the local Carboniferous strata. No transported material is anywhere found; no erratic bowlders; not a single crystalline pebble of the northern drift to indicate that glacial ice ever passed across the uplands or down the valleys.

The stratigraphy consists of two anticlinals and two synclinals, which cross the map from northeast to southwest. These axes, however, are so fully treated of in the detailed description, that little need here be added. One of the anticlinals is the *Kellersburg arch*, coming from the northeast and crossing Limestone run, near Montgomeryville, whence southward it expires, covering all the highlands of North Buffalo and South Buffalo townships with Lower Barren rocks. The other anticlinal is the *Brady's Bend arch*, which crosses Buffalo creek at Craigsville. It is an important fold. The synclinals are shallow. The

village of Worthington is in one of the basins, corresponding to Rimerton, on the Allegheny river; the region of Adams P. O. is in another basin—that of Brady's Bend. At the south end of the region, beyond where the Kellersburg arch disappears, the rocks are nearly horizontal.

§ 418. *Glade run* embraces, with its tributaries, the western portion of East Franklin township, and the eastern portion of North Buffalo township. The general trend of the valley is from west to east, across the incline of the strata; but the incline being exceedingly gentle at all points, the geological changes effected are slight and unimportant.

The Lower Productive Coal Measures make the surface rocks from one end of the valley to the other. In the hill-tops are the *Lower Barren Measures*, making the smooth glade land, from which the run has taken its name.

The upper part of the valley, from Middlesex to Centre Hill, lies within a shallow basin—the Worthington basin, whose sides here incline at low angles, ranging from ½° to 2°, with perhaps 1° as the average dip. Below Centre Hill the run leaves the basin, to flow along the crest of the *Kellersburg anticlinal*, which, though nearly extinct in that region, is yet of sufficient strength to lift the rocks about 200 feet above their level at the centre of the trough. Hence the lowest strata exposed in the valley, are in the vicinity of the Green settlement, near the mouth of the stream.

Descending the run from its head waters near Middlesex, the surface rocks are almost wholly Lower Productives, of which about 150 feet are uncovered. *The Freeport Upper coal* is nowhere operated. The outcrop line of this bed is at this place no less obscure than in the region to the southeast along the Worthington road above Kittanning, of which mention has elsewhere been made. Nor is the *Freeport Upper limestone* present at Middlesex. But the *Freeport Lower coal* occupies its usual position in the measures wherever its horizon is reached. It is however both thin and unimportant, not exceeding at the best two feet in thickness. It is unaccompanied by limestone. A good exposure of the coal bed occurs in the road at the school-house, ½ mile south from Middlesex.

§ 419. *The Kittanning Upper coal* is the main bed of the Middlesex region, and the source from which the local coal supply is derived. It is 35 feet vertically below the Freeport Lower coal, which interval is almost entirely occupied by the *Freeport sandstone*, here both massive and prominent. The rock is finely shown along the Middlesex and Kittanning road, west from Mrs. Cowan's house. Southward it loses its massiveness of bedding, becoming in consequence, less and less conspicuous towards the Worthington pike, and the Reed settlement.

The Kittanning Upper coal is opened on the Crawford farm close to the church, north of Middlesex; again on the Cowan property ¼ mile to the S. E., and again at Campbell's near the school-house. At each of these places it is four feet thick, with small and irregular slate partings. Traced, southward, the bed is split by a persistent layer of slate, first thin and inconsiderable, but increasing gradually in thickness until it finally assumes damaging proportions. Its maximum development is at A. Milliken's, where at an exposure in a small branch ravine the following section was obtained:

Slate,		—
Coal,	2′ 3″–2′ 6′	7′ 3″
Slate,	1′ 0″–1′ 3″	
Coal,	3′ 4″–3′ 6″	
Clay,		—

On the W. Bowser farm, south from Milliken's, the parting slate is much reduced in thickness. At the same place also limestone is reported to have been found underneath the coal. The rock is not now exposed; it represents the *Johnstown cement bed.*

The Kittanning Upper coal is also mined in the ravine of Long run to the west, a description of which will be found in connection with the Buffalo valley developments.

§ 420. Going now southward through the valley few exposures of interest occur until the Reed settlement is reached south from the Kittanning and Worthington road. And while the same rocks as those above described, are there again encountered, the face of the section is materially changed. *The Freeport Upper coal* now appears with a

thickness of from 4 to 5 feet; *the Freeport Lower coal*, greatly expanded is one of the main features of the section; and the *Kittanning Upper seam* with its underlying cement bed, is here, as at Middlesex, a bed of prominence.

The region of the *Reed settlement*, three miles west of Kittanning, having acquired some local notoriety through the thickness of its different coal seams, a careful examination was made of it, with a view of establishing the character of the coal, and of determining the economic importance of the region. Briefly, the result of the survey was unfavorable. The coal seams while large at this particular place, owe their increased thickness to an abnormal growth, which fails to maintain itself in any direction. Besides, the coal from both the Freeport beds is so slaty and pyritous, that the great thickness of the beds, adds nothing to their value. Good evidence of their impurity is shown in the very limited extent to which they have yet been mined for local supply, coal from other localities being preferred by the farmers.

The following section, obtained from exposures in the Reed ravine, between the church and the old abandoned oil derrick, will illustrate what is said below of the mines and openings upon the different strata:

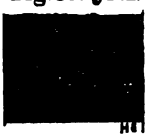
Mahoning sandstone, loose and thin bedded,	—
Coal, *Freeport Upper seam*,	5′ 0″
Interval,	30′ 0″
Coal, *Freeport Lower seam*,	3′ 0″– 6′ 0″
Limestone,	—
Interval,	30′ 0″
Coal, *Kittanning Upper seam*,	4′ 0″?
Limestone, Johnstown cement,	3′ 0″
Water level,	—
Total,	78′ 0″

§ 421. *The Freeport Upper coal* is exposed close to the water line on Mr. Humphrey's property, and again on the opposite side of the ravine near the township road. At both places it is a double bed, whose parting slate divides the seam so unevenly that only the upper bench is of workable dimensions. This upper bench is itself traversed by innumerable knife edges of slate that form more or less of

a net work through the coal. Little value can therefore be attached to the bed as it here exists. Towards the south however its condition improves very materially in this respect, although by the gradual disappearance of the division slate and lower bench, the bed becomes considerably reduced in thickness. The section at Humphrey's is as follows:

Coal in roof, ...	—	
Coal, slaty, ...	3′ 3″	5′ 2″
Slate division, ...	0′ 5″	
Coal, ...	1 6″	

Fig. 53. §421.



Southward from Humphrey's the outcrop line of the bed passes in plain view around the point of the hill into the Bowser ravine, where it is again opened. The parting slate there occupies the same relative position that it does at Humphrey's, but its dimensions are so much diminished that the coal benches are nearly together. The coal is also less slaty and the bed generally is improved. The Freeport Upper limestone is reported to have been found at Bowser's, two feet below the coal.

§ 422. Thence still further south the coal is easily followed to Centre Hill. The township road leading to that place from Bowser's is in the Mahoning sandstone, of which, in places, there is a fine display. At Centre Hill the rock makes a low cliff along the side of the ravine between the village store and the Dunker church, where also the Freeport Upper coal was once opened, showing a thickness of only 3 feet. But failing to maintain even this thickness the attempt to mine it at Centre Hill was abandoned, as was also that made by Mr. Jas. Campbell on the hill above the Green settlement near the mouth of Glade run. The bed is also small and unimportant along the right bank of the run, on the Painter property, as well as south from this, through the Barnett and Cowan farms; but across the hill along the river front it is in workable condition.

At Campbell's the *Mahoning sandstone*, massive and coarse grained, roofs the Freeport Upper coal, and is the country rock.

§ 423. *The Freeport Upper limestone* is absent from the measures north from Reed's, towards Middlesex; towards the south it appears for the first time in the Bowser ravine, there however so attenuated that it is of little practical value; still further south, in the region of Centre Hill, it is little known; on the opposite side of the run, at Painter's, it has been exposed near the road below the school-house, being there several feet thick; whence eastward and south-eastward towards the river and towards the Manorville region an enormous expansion takes place; where exposed at Mr. Jas. Green's, on the hill overlooking the river above the mouth of Glade run, the following section shows:

Shales,	3′ 0″
Coal,	0′ 2″
Clay, impure,	1′ 0″
Limestone and clay,	2′ 0″
Limestone,	5′ 0″
Clay and poor limestone,	1′ 0″
Limestone,	3′ 0″
Fire clay, poor,	3′ 0″
Limestone, ferruginous,	2′ 0″
Clay,	0′ 6″
Limestone, poor,	1′ 0″
Total,	21′ 8″

§ 424. *The Freeport Lower coal* has twice been opened in the Reed settlement—at Doty's and on the Reed farm. It is an extremely variable bed, much disturbed by clay veins and horsebacks. Indeed the section presented changes so constantly in the same mine that no safe estimate could be made of the amount of coal probably to be derived from this bed. Both at Doty's and at Reed's it at times rises to 6 feet in height, without persistent slate partings; but these expansions are usually followed by contractions, which from their nature, and the amount of dead work necessary to overcome them in mining, are especially ruinous to the seam. This feature of variability is well displayed in the Reed mine, where entries have been pushed in all directions to avoid the irregularities, but without success. Moreover the coal is pyritous to a high degree; the amount of slate is also excessive. Mr. McCreath's analysis of a specimen of the Reed coal is as follows:

Water,	1.010
Volatile matter,	40.210
Fixed carbon,	47.366
Sulphur,	3.824
Ash,	7.590
	100.000
Color of ash,	Cream.
Coke per cent.,	58.780
Fuel ratio,	1:1.18

With the same rapidity that the seam thickens southward from Middlesex towards Reed's, so it thins away again southward from Reed's. At Centre Hill its outcrop is small and meagre. So it is along the hills above the Green settlement. In places it is accompanied by its limestone, of which an outcrop occurs in the road north of the Bowser mine. The thickness of the stratum is unknown. The rock, so far as it shows, is compact and good.

§ 425. *The Freeport sandstone* is indistinct through all the valley of Glade run. At Reed's it makes no display at all; nor does it show to any extent in the ravine at Centre Hill; still further south, towards the mouth of the run, it is equally obscure.

§ 426. *The Kittanning Upper coal* is regularly persistent along Glade run, from Middlesex to the river. Its condition at the first named locality has been described. At Reed's it makes a conspicuous outcrop, which, on examination, is reported to have shown four feet of coal. The openings once made to ascertain this thickness are now closed.

The coal is accompanied in the Reed ravine by the *Johnstown cement bed*, which outcrops on the face of the hill, above the oil derrick. The rock is a cement in composition, very compact, contains some few fossil shells, and is of a dark blue color. It is not sufficiently exposed to estimate its thickness exactly, but as much as 3 feet of rock may be depended upon.

The oil well drilled some years ago at this locality reached a depth, it is said, of 1600 feet, having started just below the horizon of the Johnstown cement. Not a trace of oil was found; and no record having been kept of the

drilling operations the thickness of the different strata pierced is known only vaguely.

§ 427. *In the Centre Hill ravine* the Kittanning Upper coal is 20 inches thick. It comes out below the store. The Johnstown cement has disappeared in the interval between Reed's and Centre Hill. Nor is anything known of the rock south from Centre Hill towards the mouth of the run. The coal is likewise obscure in the Green settlement, but its apparent absence there is perhaps attributable to unfavorable exposures.

At the mouth of the run below the Green settlement the section extends downwards to the top of the Ferriferous limestone. *The Kittanning Lower coal* is at the base of the hills, just above the first river terrace. It is mined at Bruner's, in the river valley, some distance below the mouth of Glade run.

The massive sandstone cliffs that make so distinguishing a feature of the Glade run geology in the vicinity of the Green settlement, belong, apparently, to the Kittanning Middle sandstone, the same rock that shows so conspicuously on the slopes opposite Kittanning.

§ 428. *Limestone run* takes its rise in the highlands of Washington township, south of Rimerton; flows a southeast course towards the Allegheny, which it joins opposite the mouth of the Cowanshannock.

The valley is crossed transversely by the *Kellersburg anticlinal*, the centre of which passes close to the village of Montgomeryville. The arch of the axis being quite flat, and the uplift feeble, the dips are gentle; and broadening still more as it weakens southward, the rocks finally sweep across its back in nearly horizontal sheets.

Great uniformity, therefore, prevails in the geology of Limestone run. As the valley deepens in its downward course, so the section lengthens. Feeble, however, as is the anticlinal, it has the effect of preventing the Freeport Upper coal from touching those hills, through which the arch of the axis passes; but losing this strength towards the south, Barren Measures ride across it in East Franklin township. This feature is best expressed by the map.

Along the upper waters of the run, in the vicinity of the Lutheran church, the side hills present a section, of which the Ferriferous limestone is the base, and the Freeport Lower coal the top. Few exposures occur excepting of the *Ferriferous limestone*, the *Buhrstone iron ore*, and the *Kittanning Lower coal*, all of which strata have been quite extensively worked, especially the limestone and ore. The developments at this place date back to the period of the old America furnace, near Rimerton, but more recent developments were made in connection with Monticello furnace.

§ 429. The "ore strippings" begin at A. Wiant's, near the head of the run, where the top of the limestone makes the stream bed. Thence the "strippings" are continuous down the run to Montgomeryville, but are most extensive, perhaps, near the Lutheran church, in the vicinity of which large amounts of ore have been taken out. The exposures in their present condition are unfavorable to examination, shales having obscured the face of the ore. The best opportunity for measurement is at the bridge below Montgomeryville, both limestone and ore being there exposed. The ore is 5 inches thick, hard, compact, and rich in iron. The limestone is likewise good, 10 feet thick, fossiliferous, and of a dark gray color. It has been quarried to some extent further down the run, whence to the river it is continuously above the water-level, the run, in fact, leaving the stratum higher and higher on the hills, as the stream bed slowly deepens. A long outcrop area of the Buhrstone ore is thus presented in the Limestone run valley, favorably situated for mining. The roof rock of the ore is shales.

§ 430. *The Kittanning Lower coal* is repeatedly exposed, as for example at Wiant's, at Fair's and also at Montgomeryville. It outcrops, also, in the road side between Montgomeryville and Christman's mill. It is 3½ feet thick, roofed by black slate, above which is massive sandstone 20 feet thick.

The coal maintains its thickness very evenly in all the mines, preserving also a fairly good condition. Occasionally the coal is in direct contact with the sandstone above,

but no trouble of a serious nature is occasioned by the juxtaposition of the two. Nor is there any apparent change in the coal bed further down the run between Christman's mill and the river. It everywhere yields good dry fuel, hard and clean looking.

The Kittanning Middle coal was nowhere observed along the run. Its obscurity is perhaps due to unfavorable exposures.

The Kittanning Upper seam is present. So also is the *Johnstown cement.* Neither stratum however has been fairly opened up for examination. Both are partially exposed near Mr. Bish's house in a small ravine, about one mile south from Montgomeryville. The cement bed also outcrops in the road a few hundred yards distant from the village, towards the west. It is a compact rock, too impure for the lime kiln.

§ 431. With regard to the *Freeport group* it has already been stated that only its basal portion is preserved in the hills around the head waters of the run. Towards the east however, and northeast as well as towards the south and southwest from Montgomeryville the entire group covers the uplands.

No exposures favorable to the examination of the Freeport coals, are anywhere found northeast of Montgomeryville; but in ascending the hill towards the south, along the Kittanning road, the outcrop line of the Freeport Upper seam is crossed near the hilltop. Thence it curves westward to Long's where it has been opened; and eastward around the hill into the next ravine at Mr. D. Tarr's, where it is opened again, showing 3½ feet of coal, with slate roof and clay floor. The coal has small irregular slate binders through it, as well as minute layers and flakes of iron pyrites. Neither impurity exists to a sufficient extent to seriously damage the bed.

The dip in Mr. Tarr's mine is towards the S. E.; at Montgomeryville it is towards the N. W.; the arch of the Kellersburg anticlinal therefore runs between these two points.

The uplands at Tarr's are covered with Lower Barren

rocks to a depth of about 150 feet, in which the Mahoning sandstone makes little show. The prevailing rock is a loose argillaceous shale.

§ 432. Below the coal at Tarr's is the *Freeport Upper limestone*, below which is the *Freeport Lower coal* in its usual position; the *Kittanning Upper coal* is represented only by a doubtful outcrop, but the *Johnstown cement* appears at the bend of the road near Mr. Bish's house. The section as there leveled may here be reproduced:

Slate,	—
Coal, *Freeport Upper*,	3′ 6″
Shales and poor fireclay,	5′ 0″
Limestone, *Freeport Upper*,	3′ 0″
Interval,	28′ 0″
Slate,	2′ 0″
Coal, *Freeport Lower*,	2′ 6″
Interval,	40′ 0″
Coal? *Kittanning Upper*,	—
Limestone, *Johnstown cement*,	3′ 0″
Interval to *Ferriferous limestone* near Montgomeryville,	100′ 0″+
Total,	187′ 0″

The outcrop face of the Freeport Upper limestone shows the deposit to be here available for the kiln. The Freeport Lower coal, in the vicinity of Montgomeryville, nowhere exceeds the thickness given to it in the section; it is therefore of little importance; but towards the south, approaching Kittanning the same bed increases to 4½ feet thick.

In descending Limestone run below Christman's mill, *the Clarion group* is soon crossed, and finally the outcrop of the Pottsville Conglomerate before the river is reached. These rocks, however, require no extended description here. The *Clarion coal* is reduced a mere thread, and the *Brookville seam* is little better. As regards the Pottsville Conglomerate its condition along the hills at the mouth of the river has already been sufficiently described in former pages.

§ 433. *Buffalo creek* drains a much larger area than either of the streams above described. It starts in the highlands of Sugar Creek township, near Adams' store, on the divide overlooking Sugar creek; flows thence a tolerably direct course southward, through West Franklin,

North Buffalo and South Buffalo townships, uniting finally with the Allegheny river, at the town of Freeport.

Its tributaries are small. Among the largest are the West Fork or Craigsville branch; Rough run and Pine run. The average volume of water is small.

The upper part of the valley has been cleared of its timber growth; along the lower part, below the mouth of Rough run, the slopes are unfavorable to cultivation, being steep and rugged. These districts, therefore, are in great part a wilderness, containing, however, little or no timber of value.

§ 434. *The stratigraphy of the valley* being extremely simple, may be briefly told: An anticlinal uplift of considerable strength crosses the West Branch nearly at the village of Craigsville, and the North Fork below Foster's mills. The arch is entirely regular, with dips of from 3° to 5° on either side. It lifts the Pottsville Conglomerate to daylight.

The same anticlinal prolonged northeastward reaches the Allegheny river near the mouth of Red Bank creek. Towards the southwest it strikes into Butler county, where its run has been described by Prof. White in his Report of Progress for 1876.* He called the axis the Brady's Bend anticlinal.

The upper part of the valley north of this anticlinal has northwest dips, while the lower part from Craigsville to the mouth of Marrowbone run, has southeast dips. Both in ascending and descending, therefore, from the neighborhood of Craigsville, the strata steadily accumulate. One by one they disappear under the creek bed, until Lower Barren rocks are found on the uplands of Sugar Creek township at Adams' store; southward the same thing occurs, with one exception; that before the Freeport group has there reached the water level, the creek, by a long bend, sweeps back again towards the edge of the basin, causing lower rocks to reappear again at the surface, and keeping Lower Productive Measures in the valley all the way to the mouth of the creek.

Report Q, pp. 19 and 20.

For the rest, the geology of the valley will be sufficiently elucidated by a description of the mining developments. Beginning with those in the neighborhood of Adams' store, we find that the efforts thus far made by the farmers to discover a coal seam of workable thickness among the Barren rocks have been unsuccessful. All of west Sugar Creek township along the divide between the Buffalo and Sugar Creek consists of a rolling upland of Lower Barren Measures, underneath which the Freeport Upper coal spreads out in a nearly flat sheet, at depths ranging from 100 to 200 feet below the surface.

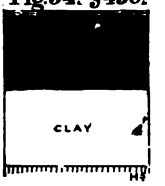
§ 435. *Adams' store* being at the edge of this Lower Barren belt, the Freeport Upper coal quickly makes its appearance in the little ravines leading from thence southward into the Buffalo. But the coal is of such uncertain thickness that the attempts to work it have not been attended with very satisfactory results. Its outcrop line ranges near the school-house at Burford's, running thence past Foster's, and into the McElroy ravine, where it was opened at the roadside, about 30 feet above the water level. Both roof and floor are uneven and irregular, the coal itself also varying in thickness from 18 inches to 4 feet. An oil well recently drilled, near by, found the Ferriferous limestone at a depth of 210 feet below the derrick floor, or 235 feet below the Freeport Upper coal. According to the statement of the drillers the "Third Sand" is absent here from the measures, as is also the "Fourth Sand." The so-called "Bowlder" was found in its regular position, but fine-grained and without either gas or oil.

§436. *The Freeport Upper coal* bed does not improve in condition southwest from McElroy's along the range of hills between the two forks of the Buffalo. In fact scarcely any trace of it at all is found in the neighborhood of the Hindman school-house overlooking the waters of the West fork. But it reappears in the McCue ravine west of the Catholic church. The area of irregularity is therefore confined to the territory between the forks of the creek, and north-eastward towards the Adams store. It will be shown presently that a similar area of irregularity exists along the

east side of the creek above Foster's mills. Where opened on Mr. Cue's land, the bed presents the following section:

Slate,	—	
Coal,	2′ 1″	3′ 9″
Slate,	0′ 1″	
Coal,	1′ 7″	
Clay,	4′ 0″	
Limestone,	?	

Fig. 54. §436.



Both benches of the bed yield coal of indifferent quality. The limestone has not been uncovered.

The Freeport Lower coal outcrops in the road near Mr. McCue's house. Its thickness is not known. An interval of 50 feet separates it from the other bed. The dip is N. W. and very gentle.

§ 437. *At Foster's mills*, in Sugar Creek township, the Kittanning Lower coal roofed by heavy sandstone is near the water level; towards the west a high knob on the Wilson property contains the Freeport Upper seam. The two beds are 180 feet apart.

Neither seam is of much importance. The Freeport Upper is about 3½ feet thick, but slaty and impure. It was opened on the Wilson property close to the township road. Its limestone, likewise impure, accompanies it. After passing out of the Wilson hill these strata strike into the highlands eastward and northward towards Adams' store; and also southward towards Middlesex where, however, both coal and limestone are obscure.

The Kittanning Lower coal has an average thickness of about 3 feet at Foster's. It is much more extensively developed in the region of Buffalo mills, further south. At Foster's the sandstone overlying it is particularly massive, as it is also towards the west, down the stream and in the main valley. Where the Foster's mills branch and the main stream come together, the Ferriferous limestone is at daylight.

§ 438. Descending now to Buffalo mills, the Ferriferous limestone gradually ascends along with the other strata to cross the intermediate anticlinal. *The Pottsville Conglom-*

erate and some of the underlying *Mauch Chunk shales* are raised above the water line before the centre of the axis is reached. The surrounding hills contain all the Lower Productive Coal Measures, of which good exposures are found at different places. In the following description, the strata are considered in ascending order; the area embraced in the observations extends over nearly all of West Franklin township.

The map will best show the outcrop area of the Conglomerate and sub-conglomerate rocks. They may be seen at the mouth of Long run and at Craigsville, at which last named place the exposures are very complete. At the bridge near Mr. Rumberger's woolen factory, sandstone and shales fill an interval of more than 100 feet above the creek. One sandstone layer near the base of the exposures is so highly calcareous that in weathering it assumes a smooth rounded surface which resembles somewhat the usual outcrop appearance of the Mountain limestone. It shows at the roadside near the store. Above it shales occur; and above these is a succession of thin sandstones, which together constitute the Pottsville Conglomerate. Along the north fork of the creek the last named rock is more massive than at Craigsville. In weathering it breaks up into the large blocks so abundantly strewn along the bottom lands of the valley.

§439. *The Brookville coal* is persistent throughout the region wherever its horizon is above the water level, but its thickness is irregular. Where exposed on Mr. J. Nickel's property, on the right bank of the creek nearly opposite the mouth of Long run, it is not only much broken by slate partings, but the coal itself is so slaty that the seam is there practically worthless. The following measurement made in Mr. Nickel's mine will best exhibit the conditions there:

Slate in roof,	—	
Coal,	1′ 9″	3′ 2″
Slate,	0′ 1″	
Coal,	0′ 3″	
Slate,	0′ 7″	
Coal,	0′ 6″	

Fig. 55. § 439.

The seam was again observed in the lane leading to Mr. R. Shields house; again also in the road near Hawk's saw-mill; and again below the bridge at Buffalo mills. At each of these places only the outcrop of the bed is exposed. At the bridge, where the coal bed sinks below the water level, it is underlaid by fire clay of a poor quality. Its roof is shales.

§ 440. *The Clarion coal* is not less persistent than the Brookville, and equally variable in point of thickness. It is repeatedly exposed. At A. Hindman's, on the West Branch above Craigsville, it is 2 feet thick. It outcrops in the spring at Mr. R. Shields' house; and again at the so-called "Big Spring," about one mile below Buffalo mills. At the latter place it is 2′ 6″ thick, roofed by 20 feet of compact black slates, (as also at Hindman's,) which separate it from the Ferriferous limestone. No trace is here seen of the Scrubgrass seam. The Clarion bed goes below the creek a short distance below the outcrop at the "Big Spring."

Mr. P. Graff, proprietor of the Buffalo mills, sank a well 1600 feet deep at this locality without finding either gas or oil. The well started at the horizon of the Clarion coal. Another well will shortly be drilled in the ravine near the woolen factory, with the hope of striking a flow of gas for use under the boilers of the mill.

§ 441. *The Ferriferous limestone* is so well known throughout all this region, and its outcrop line is generally so plainly marked by the "benches" of the old ore workings that no detailed description of its run through the country is required. Up Long run it is above water level to McDowell's saw-mill; up the West Branch it extends to the Butler county line; and down Buffalo creek it remains above the stream to McGerry's.

Its average thickness is about 12 feet. Excellent exposures of it are found on the hill above Mr. Graff's woolen factory, it being there quarried in considerable quantity for the limekiln. It is well exposed again at O'Neill's, west of the mills, and also at W. Hindman's, near the Butler county line. Along the West Branch it may be seen at the road side near Mr. Sweeny's; also at A. Hindman's; also near

Craigsville on the high knob north of the village. At Sweeny's it is close to the water level; at Craigsville it is 218 feet above the creek.

On the left bank of the stream Mr. Henry has opened it; also Mr. R. Shields; also Mr. Ehrenfelt on Long run near the saw-mill. It is the same at all these exposures, being a compact, bluish gray rock, fossiliferous, with a rough fracture somewhat conchoidal. A specimen from Mr. Graff's quarry showed the following composition on analysis by Mr. McCreath:

Carbonate of lime,	93.292
Carbonate of magnesia,	.968
Oxide of iron and alumina,	1.713
Phosphorus,	.047
Insoluble residue,	3.220

§ 442. *The Buhrstone iron ore* here accompanies the limestone. Its average thickness is about six inches. In places, however, it greatly exceeds these dimensions, as for example at Mr. R. Shields, who claims to have once mined it 1 foot thick on his farm. The ore is uniformly of good quality at all the exposures. Many years ago it was mined on nearly all the neighboring hillsides for use at the Buffalo furnace, a small stone stack on the left bank of the creek near the grist mill. The furnace long since went out of blast, and is now in ruins. The Buhrstone stratum only partly supplied the furnace with ore, much having also been obtained from the Freeport stratum, a higher deposit, to be described in order presently.

The amount of ore available from the outcrop of the Buhrstone stratum in the region of Buffalo mills is prodigious, as a glance at the map will readily show. Its extent along the main branch of the creek is more than 6 miles on both sides of the valley, and more than 3 miles along the West Branch, not to speak of the frequent side ravines. But without facilities for cheap transportation iron cannot be profitably made there.

§ 443. *The Kittanning Lower coal* is the principal seam of the region because of its favorable location in the hills. Where mined by Mr. Graff on the bluff directly opposite the woolen factory it is slaty and very pyritous; it is 3½ feet

thick on the average, including a small but persistent binder, consisting chiefly of iron pyrites from ½ to 1 inch thick. The binder is within 1½ feet of the floor. Other and smaller bands of iron pyrites traverse the bed at lower horizons, but they are less persistent than the other, though no less damaging.

The upper part of the seam yields the best coal. The engine at the woolen factory uses this fuel, and the lime kiln also uses it. It is claimed to produce a high heat.

From Mr. Graff's mine this *Kittanning Lower* bed rises rapidly up the creek, along which its outcrop line is marked by a succession of pits, which once worked it. On the west branch it is repeatedly exposed. On Mr. Rodger's land near the Butler county line, the section presented is similar to that measured in Mr Graff's mine, with the exception however, that slate there parts the seam, instead of pyrites as at Graff's.

Continuing up the creek, above the mouth of the West fork, Mr. Henry has opened the coal on the left bank, and Mr. Shields has also exposed it near by. It is further opened on the Hawk property southeast of Shields', and again at Ehrenfelt's on Long run. Below the mills it is mined in the vicinity of the Big spring. West from the woolen factory it rises rapidly towards the Craigsville anticlinal. At the forks of the road, leading to Mr. O. Neill's it is nearly at the hilltop, whence however westward, it slowly sinks again to water level, which it reaches beyond the Butler county line.

A specimen of coal from this bed, obtained from the Roger's property was analyzed by Mr. McCreath with the following results:

Water,	1.160
Volatile matter,	42.720
Fixed carbon,	48.742
Sulphur,	2.313
Ash,	5.065
	100.000
Color of ash,	Reddish gray.
Coke, per cent.,	56.120
Fuel ratio,	1: 1.14

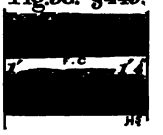
§ 444. In this neighborhood the seam is usually roofed by heavy massive sandstone, of which a good exhibition is afforded in a small ravine between the village of Worthington and Buffalo mills. Shales intervene between the coal and sandstone. The sandstone is 40 feet thick; coarse-grained to pebbly in composition. It extends to the western edge of Worthington, which town is built upon it. Along the western side of the creek it is equally massive and perhaps somewhat thicker, extending indeed above the horizon of the Kittanning Middle coal, and apparently cutting out the latter bed entirely. Much of the sandrock is adaptable for building, particularly for laying heavy foundations. The large bowlders of sandstone distributed along the slopes in the vicinity of Buffalo mills are from this deposit, and not from the Pottsville Conglomerate as might at first be supposed.

In the shales between the sandstone and coal are numerous concretionary masses of iron ore. These exist in such abundance that at one time they were profitably mined for Buffalo furnace.

§ 445. *The Kittanning Upper coal*, accompanied by the *Johnstown cement bed*, appears at several localities. The coal seam undergoes constant changes of thickness, but the cement stratum is the same, or nearly so, at all points. The coal is mined south of Mr. Ehrenfelt's house on Long run, in the vicinity of which it is known as the "summit coal" from its close proximity to the hilltops in that region. The following measurement made in the Tumbaugh mine shows the bed divided by a ruinous slate parting of nearly equal thickness with the coal benches above and below it.

Slate,	—	
Coal,	1′ 10″	
Slate and fireclay,	1′ 0″–1′ 4″	5′ 2″
Coal,	1′ 10″–2′ 0″	

Fig. 56. §445.



The seam is again exposed on the F. Atchison property close to the school-house, north of Worthington. It is here reduced to 20 inches thick, without slate parting. The ce-

ment bed accompanies it at this place, showing in the run near the house. It is a dark blue rock, three feet thick, with some minute fossil shells and in composition strictly a cement. South from Worthington the coal reappears at the road side in a small ravine, below Mr. R. Huston's mine, and again near the level of the creek at Beatty's mill. At the latter place, the succession from the Freeport sandstone downwards to the base of the Johnstown cement, is well shown along the roadside near the mill. It is as follows:

Shales with layers of sandstone, *Freeport SS.*,	25′ 0″
Coal, *Kittanning Upper seam*,	1′ 0″
Black slate and impure clay,	7′ 0″
Limestone, *Johnstown cement*,	2′ 0″
Interval, to creek, concealed,	25′ 0″
Beatty's mill,	—
Total,	60′ 0″

§ 446. The exposure of the Freeport sandstone at Beatty's mill is typical for the rock throughout much of this region. Nearly everywhere it is loose and shaly. Only on the hills west of Buffalo mills does it assume a more compact form, and then only over a limited area. Its thickness generally is expressed in the above section.

The variability of the Freeport coals in West Franklin township has caused a tolerably complete development of them in that region. In some localities the upper of the beds being highly irregular in point of thickness, and hence troublesome and expensive to follow underground, the lower seam of the group, the Freeport Lower bed, has been sought out and found of workable thickness. This statement is applicable more particularly to the eastern part of the township from McDowell's mill on Long run southward past Worthington and on thence into North Buffalo township. Great obscurity there exists with regard to the outcrop of the Freeport Upper coal. At the western edge of the township, however, the seam regains its usual thickness. So it does also in South Buffalo township, along the lower waters of Buffalo creek.

§ 447. *The Freeport Lower coal* is at present mainly worked in the region south from Worthington, along the

hills overlooking Buffalo creek, between Dr. Maxwell's property and Beatty's mill. Its average thickness there is 3½ feet, with occasional expansions to 4 feet and even more in places. It was once opened in the little ravine east of the township road at Dr. Maxwell's, but that opening is now closed. Next it appears on the Wm. Long property, where it was also opened and subsequently abandoned. Continuing still further south it is mined on the R. Huston farm, close to the township road. Its roof is a thin layer of slate, over which is sandstone, which latter rock frequently cuts down into the coal, damaging it sometimes quite seriously. Though slaty in places, the bed has no persistent division at this locality. The seam varies from 3 to 4 feet thick. The following section was obtained in the mine on the W. Meals property, one mile south from Huston's:

Sandstone,	20′ 0″
Slate,	0′ 6″
Coal,	3′ 6″–4′ 0″

The southeast dip prevailing at this locality sends the coal bed and the overlying strata of the Freeport group under the Barren Measure plateau to the east, between the Buffalo and Glade run.

North of Worthington as well as west of it, the Freeport Lower coal has not been explored, other seams being preferred to it.

§ 448. *The Freeport Upper coal*, in the region west of Buffalo Mills is accompanied by its usual underlying limestone, and its iron ore. The most complete exposures are found on the Rogers and Smith properties near the Butler county line. The ore belt extends south from the township road at Rogers', as well as north of it, towards the west branch of the Buffalo. The stratum was once worked for Buffalo furnace, having, indeed, been mined not only on the Rogers property, but on nearly all of the neighboring hills. The deposit here exhibits similar features to those which distinguish it in the Brady's Bend region. Locally it goes by the name of the "summit ore."

Mr. Rogers reports the stratum to have a thickness of

two feet on his farm, which statement also is confirmed at other localities. Mr. Graff describes the ore as inferior to the Buhrstone, being leaner in iron. Its average yield of metal in the furnace was 25 per cent. to the ton of raw ore. Regarding the amount of phosphorus and sulphur it here contains nothing definite is known.

East of the creek, along the hills above Worthington, the ore is missing.

The Freeport limestone is scarcely developed at all. Indeed throughout all the eastern part of the township little evidence can be obtained of its existence; and the conditions are scarcely improved west of the creek, for even when present there, it is highly impure. It occurs as irregular plates and nodules above the ore at Rogers'.

§ 449. *The Freeport Upper coal* is so uncertain an element in the section that in all questions relating to the available mineral resources of West Franklin township, it may be left out of consideration. Sufficient has elsewhere been said of its absence over all the region east from Foster's mills towards Middlesex; and of its absence also in the hills north of the West Branch; also north from Worthington as well as south from it. This is the reason of the dearth of coal along the upland overlooking that village, and along the uplands also on the opposite side of the creek southwest from Buffalo mills. A high knob above Mr. McGerry's extends above the horizon of the bed, but nothing is there known of it. Many knobs of similar height at other localities should also contain it. The bed was cut through, 18 inches thick, in the well at Mr. J. Y. Minteer's, one mile south from Worthington.

The Mahoning sandstone is shaly throughout all the region under discussion. The shales are variegated in color. Partial exposures of them occur along the road leading east from Buffalo creek. They contain no limestones or coal seams of importance.

The same Lower Barren shales overspread all the highlands of North Buffalo and South Buffalo townships, in which there is a continuous but slow accumulation of strata

towards the centre of the basin at Slate Lick village, where some 300 feet of the Lower Barren series are represented.

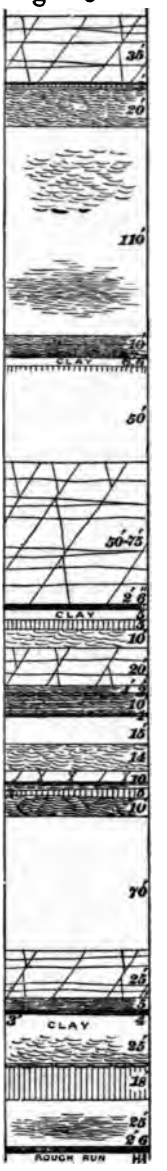
§ 450. *The Green Crinoidal limestone* outcrops near the summit of a prominent "round top" on the farm of Mr. Wm. Rea one mile northwest of Slate Lick. It also occurs in Mr. Sloan's orchard, and on the Reyburn farm; also on the Isaac Steel farm, northeast of the village. It is of a grayish-green color, impure, crowded with fossil stems and shells, and 2 feet thick. Below the limestone is a stratum of bluish fireclay without value, below which is an extensive mass of *red ferruginous shale*, conspicuous from its bright color over all the fields and roads, wherever its horizon touches. A similar band of *red shale* occurs lower in the column. An imperfect section was leveled between the hilltop at Mr. Rea's and the creek at the mouth of Rough run with the following results: (See page 288.)

§ 451. The above section will require little description, excepting to point out where the different strata outcrop under favorable conditions for examination.

The Mahoning sandstone, current-bedded and shaly near the headwaters of Sipe's run, grows more and more massive in descending the creek, until it stands out in bold cliffs along the hillsides at the mouth of Pine run. So also it extends down the creek, prominent on both sides, to the town of Freeport. Fine opportunities for examining it are afforded at Scheurer's, at the point where the Butler and Freeport road crosses Buffalo creek. The cliffs there show the full thickness of the deposit, in one compact mass. Moreover, they are exceedingly picturesque from their pitted and honeycombed condition, resulting from the oxidation of masses of iron pyrites. The various changes which the sandstone undergoes, from its shaly and indistinct condition at Worthington, to its massiveness and pronounced character at Scheurer's, are highly interesting and instructive.

The Freeport Upper coal rests directly under the sandrock, both at Scheurer's and Monroe's, being unaffected by such contact at the last named locality, but much crushed at Scheurer's. In some instances it is cut out entirely by

Fig. 57. § 450.



Sandstone,	35′ 0″
Coal seam,	trace.
Green Crinoidal limestone,	2′ 0″
Clay, bluish,	1′ 0″
Red shale,	20′ 0″
Interval, chiefly slates and shales,	110′ 0″
Red shale,	5′ 0″
Shales, dark,	5′ 0″
Coal seam,	1′ 6″
Clay, impure,	5′ 0″
Limestone,	?
Interval,	50′ 0″?
Sandstone, Mahoning SS.,	50′ 0″– 75′ 0″
Coal seam, *Freeport Upper,*	2′ 6″
Clay,	5′ 0″
Limestone, *Freeport Upper,*	5′ 0″
Clay shales,	10′ 0″
Sandstone,	20′ 0″
Slates and shales, dark,	4′ 0″
Iron ore,	0′ 3″
Shales with SS. layers,	10′ 0″
Coal and slate, *Freeport Lower coal bed,*	1′ 0″
Concealed,	15′ 0″
Shales,	14′ 0″
Sandstone,	6′ 0″
Coal seam, *Kittanning Upper,*	1′ 0″
Clay and shales,	3′ 0″
Limestone, *Johnstown cement,*	3′ 0″– 5′ 0″
Shales, dark,	10′ 0″
Concealed,	70′ 0″
Sandstone,	25′ 0″
Slates,	5′ 0″
Coal seam, *Kittanning Lower,*	3′ 0″– 4′ 0″
Shales and clay,	25′ 0″
Buhrstone iron ore,	?
Ferriferous limestone,	18′ 0″
Interval, slates,	25′ 0″
Coal seam, *Clarion,*	2′ 6″
Mouth of Rough run,	—
Total thickness,	595′ 9″

the sandrock, which then rests upon the limestone. The seam in this vicinity rarely exceeds the thickness given to it in the section, namely, 2½ feet; but at the point where the creek reënters Armstrong county from Butler, near the south end of the township, the coal bed has increased to the dimensions it exhibits at Freeport, of which sufficient has been said elsewhere.

The limestone varies widely in composition At Monroe's it yields excellent stone, compact and brittle, with small threads of calcite running through it. It makes a pure white lime, adaptable as well for plastering as for use as a fertilizer of the soil. An analysis, by Mr. McCreath, of a specimen of the rock from the Monroe property, gave the following results:

Carbonate of lime,	94.642
Carbonate of magnesia,	1.574
Oxide of iron and alumina,	1.182
Phosphorus,	.012
Insoluble residue,	1.850

The conditions at Monroe's are wholly changed at Scheurer's; the limestone there is of a ferruginous nature, and sandy. Lower down the stream, however, near Freeport, it regains, to a large extent, the features it presents at Monroe's.

Some fireclay of a tolerably good quality was noticed at Monroe's, between the coal and the limestone.

The Freeport Lower coal bed is worthless along the lower waters of Buffalo creek. It is well exposed in the bluff at Scheurer's.

The Kittanning Upper coal and the *Johnstown cement bed* outcrop near the head of the dam above Bricker's gristmill; again also in the road leading east up the hill from the mouth of Rough run. The coal is near the water-level at Scheurer's. It is small and unimportant at all points. The limestone is of a cement nature, iron and alumina both entering largely into its composition. Some interesting variations in the strata at this geological horizon, involving sudden changes and replacements of rock, were seen above Bricker's mill.

§ 452. The geology at Bricker's mill corresponds exactly with that at Beatty's mill, before described. At each place the *Johnstown cement* is near the water level; but between the two localities the creek makes a long bend westward towards the outer edge of the basin, and in so doing permits a reappearance of the Ferriferous limestone above the water-line for a short distance. In this bend the lowest rocks of the above section are found.

The Kittanning Middle coal was not observed. The sandstone intervening between that horizon and the Kittannang Lower seam, is prominent in a range of cliffs below the mouth of Rough run, and also at the bridge below Mr. Adams' house.

The Kittanning Lower coal is little worked. It may be seen at the mouth of Rough run, on both sides of the creek. An opening on the right bank supplies a small limekiln with fuel for calcining the Ferriferous limestone. The coal is compact and hard, but pyritous.

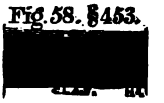
The Buhrstone iron ore was at one period quite extensively worked in this neighborhood, for Winfield furnace, which stood in the ravine of Rough run, about ¾ of a mile above the mouth of the stream. The ore is solid and to all appearances of a good quality.

§ 453. *The Ferriferous limestone* is just above the water-line at the mouth of Rough run. It disappears quickly under the creek bed, both towards the north and south; but rising sharply up the ravine of Rough run towards the Brady's Bend anticlinal, it there presents long lines of outcrop. The limestone is of a brownish color, and of excellent quality. A good exposure of the deposit is found near the old furnace stack.

Near by also, and close to the water-level of Rough run, is the Clarion coal bed, which, though slaty and poor, and much broken by partings, is mined for use in the limekilns. This is one of the few localities in Armstrong county at which the Clarion seam is mined. It shows the following section:

Slate,		—
Coal,	1′ 1″	
Slate,	0′ 1″	
Coal,	0′ 6″	2′ 6″
Slate,	0′ 1″	
Coal,	0′ 9″	
Clay,		-

Fig. 58. § 453.



Herewith is given an analysis of the coal, by Mr. McCreath:

Water,	1.010
Volatile matter,	42.650
Fixed carbon,	48.661
Sulphur,	1.644
Ash,	6.035
	100.000
Color of ash,	pinkish-gray.
Coke, per cent.,	56.340
Fuel ratio,	1:1.14

INDEX TO H[5].

Index A. Names.

NOTE.—*The prefatory pages are not included in these indexes.*

Index B. Beds.

(Arranged in geological order, downwards.)

* Saltzburg Sandstone, name proposed.

POTTSVILLE CONGLOMERATE, No. XII, *divisible into Upper, Middle, and Lower; Homewood sandstone, Connoquenessing sandstone, and Sharon (Garland, Olean or Ohio) Conglomerate.*

Page.

NOTE—*In this report only the upper division or Homewood sandstone is recognized as XII; the middle division is called Pocono sandstone, X, only because so called in the gap at Blairsville, &c. See Reports H³, H⁴. K², K³. See Preface.*

Index C.

List of Analyses made.

List of Anticlinals and Synclinals arranged in their order from southeast to northwest, and described from southwest to northeast.

List of Sections Figured and Unfigured.

SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA.

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The following Reports are issued for the State by the Board of Commissioners, at Harrisburg, and the prices have been fixed as follows, in accordance with the terms of the act:

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B.[2] PRELIMINARY REPORT OF THE MINERALOGY OF PENNSYLVANIA FOR 1875. By Dr. F. A. Genth. Price in paper, $0 05; postage, $0 02.

C. REPORT OF PROGRESS ON YORK AND ADAMS COUNTIES—1874. By Persifor Frazer. 8vo., pp. 198, illustrated by 8 *maps* and *sections* and other illustrations. Price in paper, $0 85; postage, $0 10. Price in cloth, $1 10; postage, $0 12.

CC. REPORT OF PROGRESS IN THE COUNTIES OF YORK, ADAMS, CUMBERLAND, AND FRANKLIN—1875. Illustrated by *maps* and *cross-sections*, showing the Magnetic and Micaceous Ore Belt near the western edge of the Mesozoic Sandstone and the two Azoic systems constituting the mass of the South Mountains, with a preliminary discussion on the DILLSBURG ORE BED and catalogue of specimens collected in 1875. By Persifor Frazer. Price, $1 25; postage, $0 12.

CCC. REPORT OF PROGRESS IN 1877. The Geology of LANCASTER COUNTY, with an atlas containing a colored geological map of the county, local map of the GAP NICKEL MINE, map and sections of the East Bank of Susquehanna River; other geological sections across the county, and geological colored maps of York and Lancaster counties. By Persifor Frazer. 8 vo., pp. 350. Price of Report, $0 89; postage, $0 16. Price of Atlas, $1 32; postage, $0 08.

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DD. THE BROWN HEMATITE DEPOSITS OF THE SILURO-CAMBRIAN LIMESTONES OF LEHIGH COUNTY, lying between Shimersville, Millerstown,