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Charles Willard Hayes

GEOLOGICAL SURVEY OF PENNSYLVANIA.

FINAL REPORT ORDERED BY LEGISLATURE, 1891.

A SUMMARY DESCRIPTION

OF THE

GEOLOGY OF PENNSYLVANIA

IN THREE VOLUMES,

WITH

A NEW GEOLOGICAL MAP OF THE STATE,
A MAP AND LIST OF BITUMINOUS MINES,
And many Page Plate Illustrations.

J. P. LESLEY, State Geologist.

VOL. III—PART I.

DESCRIBING THE

CARBONIFEROUS FORMATION,

—BY—

J. P. LESLEY, E. V. d'INVILLIERS AND A. DW. SMITH.

HARRISBURG:
PUBLISHED BY THE BOARD OF COMMISSIONERS
FOR THE GEOLOGICAL SURVEY.
1895.

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LETTERS OF TRANSMITTAL

To his Excellency Governor DANIEL H. HASTINGS, *Ex-Officio Chairman of the Board of Commissioners of the Geological Survey of Pennsylvania:*

Sir: I have the honor to submit for your approval the first part of Volume III of the Final Report, ordered by act of Legislature, approved June 8th, 1891. Volumes I and II have already been published and distributed in accordance with the laws and the rules of the board.

The general geological map of the State, Lyman's Map of the New Red and Halberstadt's detailed Bituminous collieries map, have also been published and distributed. It was expected that the present volume would complete the final report, but the material is so abundant as to render it necessary to issue a second part to volume III.

After the State Geologist, Prof. J. P. Lesley, had completed chapters CXI to CXV (pages 1629 to 1833) of this volume, embracing the Pocono Sandstone formation No. X, and the Mauch Chunk formation No. XI, in the Anthracite region, his health broke down, and the board, with his approval, placed the work of completing the final report in the hands of Mr. E. V. d'Invilliers and Mr. A. DW. Smith, gentlemen who had long been in the employ of the survey, and in whom Prof. Lesley reposed entire confidence.

The undescribed field divided itself naturally into the Anthracite and the Bituminous districts, the former of which was assigned to Mr. Smith and the latter to Mr. d'Invilliers, who was also requested to undertake a description of the Mauch Chunk red shale and Pottsville conglomerate series, outside the Anthracite region. Their labors involved a great deal of original field work and have been long and arduous.

The present volume, in addition to Prof. Lesley's chapters on the sub-conglomerate measures, contains Mr. d'Invilliers' chapter on Nos XI and XII, the Mauch Chunk Red Shale and Pottsville Conglomerate, above referred to, and Mr. Smith's report on the Anthracite Coal Measures.

The next and concluding volume will contain a report on the Bituminous Coal Measures Nos. XIII to XVI, by Mr. d'Invilliers, and a chapter by Mr. B. S. Lyman, on the Mesozoic or New Red Sandstones of South-East Pennsylvania.

A separate Index Volume will contain an ample subject, and geological, reference to all the volumes of the final report, and a concise table of contents of all the publications of the survey, the latter prepared by myself.

WM. A. INGHAM,
Secretary.

320 Walnut street, June 1st, 1895.

VOL. III, PART 1.

TABLE OF CONTENTS.

REPORT ON THE ANTHRACITE REGION.

By A. DW. SMITH.

LIST OF ILLUSTRATIONS.

ANTHRACITE ILLUSTRATIONS.

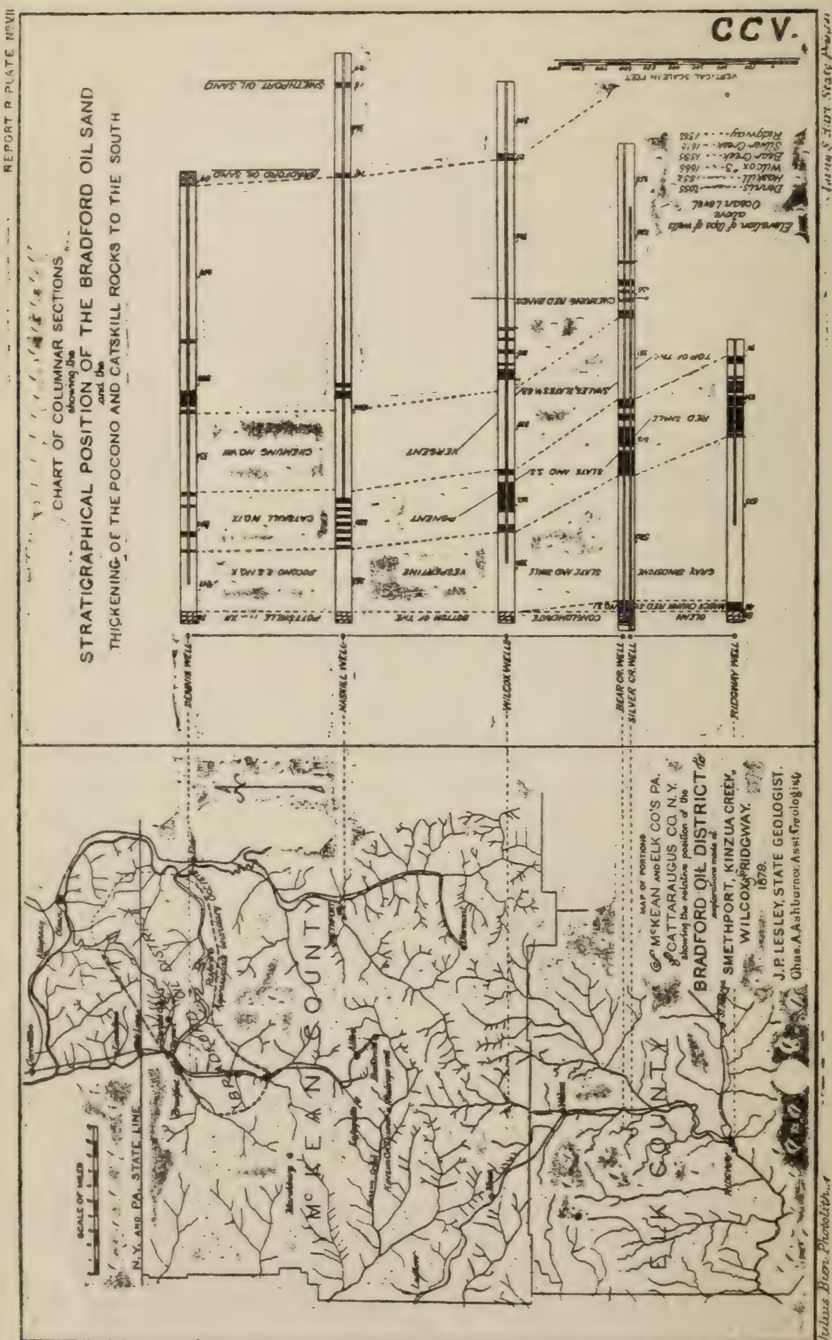
VOL. III.

Chapter CXI.

X. The Pocono Formation.

This is the first, oldest, or lowest sub-division of that great Carboniferous System which has furnished most of the mineral coal to the commerce of mankind in our days; and indeed to the manufacturing ingenuity of the monks of the middle ages who mined the earth fuel in times as far back as the ninth century in Belgium and in Provence; an interesting and instructive history into which it is not necessary to go in this book.

It is also the *salt-brine-bearing formation* of that range of country which stretches from Western Pennsylvania and Eastern Ohio through West Virginia and Eastern Kentucky into Alabama. The old salt wells of Saltzburg on the Kiskaminitas, of the Salines on the Kanawha, and of Pomeroy on the Ohio, are only conspicuous examples of the curious fact that this formation has furnished more salt brine and over a wider territory than any other sandstone formation in the Palæozoic column. Other deposits of sand in the ancient seas have preserved the salts which soaked them in those times, but none in such an eminent degree as this; and we may well believe that its mode of deposit resembled that which prevails along the shores of the Black Sea at the present day. To this supposition its remarkable feature of oblique or current bedding lends additional probability. Sand banks, in front of a long and low-lying shore of a wide-spread continent without mountains, and traversed by great and sluggish rivers, shutting in behind them long wide shallow lagoons exposed to a hot sunshine, must always give occasion for abnormal

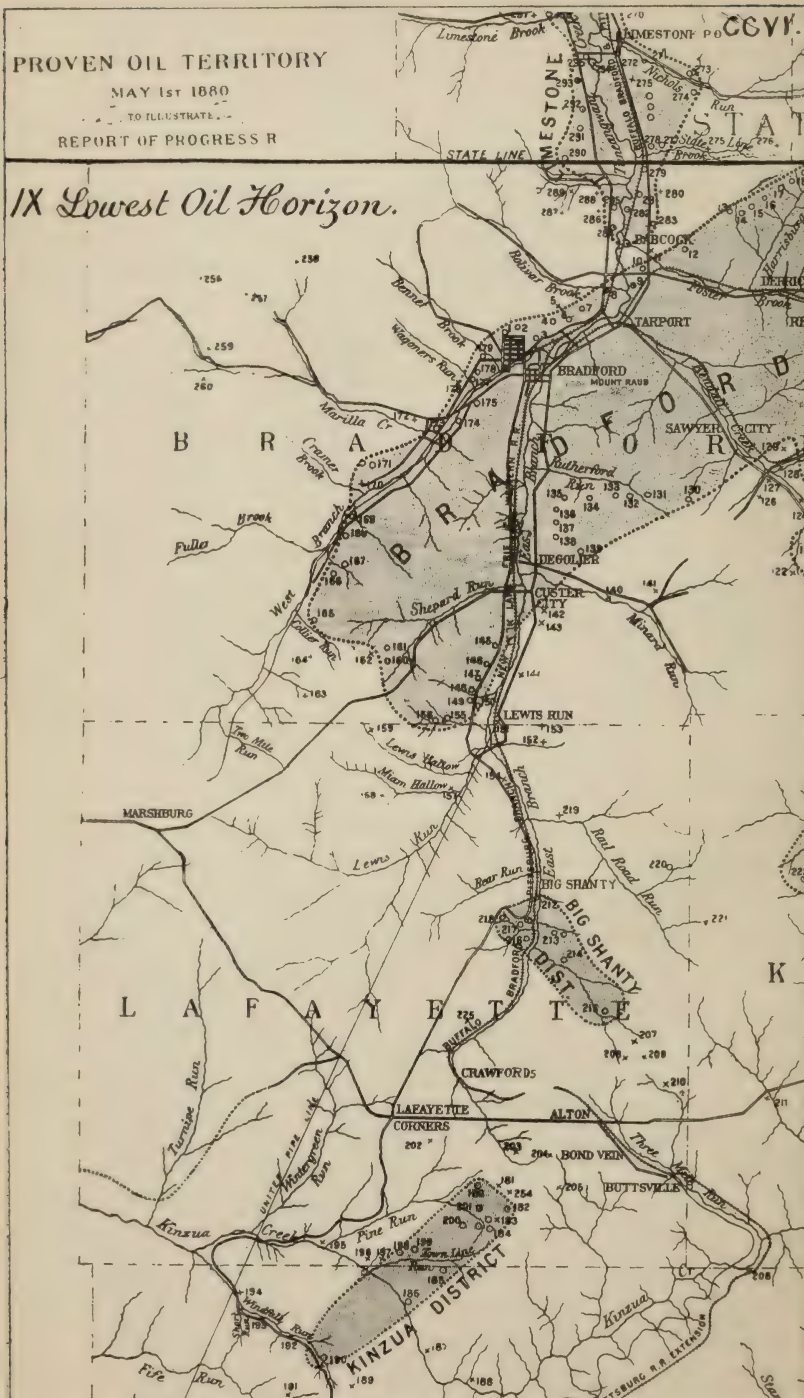

REPORT R PLATE No VII
CCV.
CHART OF COLUMNAR SECTIONS
showing the
STRATIGRAPHICAL POSITION OF THE BRADFORD OIL SAND
and the
THICKENING OF THE POCONO AND CATSKILL ROCKS TO THE SOUTH
SMETHPORT OIL SAND
BRADFORD OIL SAND
CHEMUNG RED BANDS
VERTICAL SCALE IN FEET
Elevation of tops of wells above Ocean Level
Dennis
Haskill
Wilcox
Bear Creek
Silver Creek
Ridgway
DENNIS WELL
HASKILL WELL
WILCOX WELL
BEAR CR. WELL
SILVER CR. WELL
RIDGWAY WELL
RED SHALE
SLATE AND SS.
GRAY SANDSTONE
SLATE AND SHALE
CONGLOMERATE
OLEAN
POTTSVILLE
BOTTOM OF THE
VESPERTINE
PONENT
VERGENT
CATSKILL
CHEMUNG
POCONO
N.Y. AND PA. STATE LINE
SCALE OF MILES
McKEAN COUNTY
ELK COUNTY
MAP OF PORTIONS
OF McKEAN AND ELK CO'S PA.
& CATTARAUGUS CO. N.Y.
showing the relative position of the
BRADFORD OIL DISTRICT to
explorations made at
SMETHPORT, KINZUA CREEK,
WILCOX & RIDGWAY.
1879.
J.P. LESLEY, STATE GEOLOGIST.
Chas. A. Ashburner, Asst Geologist
Julius Bien Photolith.

evaporation, and the deposition of unusual quantities of seasalts. The percolation of fresh rain water through subsequent geological ages has not exhausted the supply.

The earliest coal beds are found in this same Pocono formation; an additional indication of the shallowing of the Appalachian sea, preparatory to the appearance of those continuous marshes, or peat bogs, jungles of reeds and ferns, and standing forests of cone-bearing trees, which occupied immense stretches of the surface of the earth in the Carboniferous age, and became in course of time our anthracite and bituminous coal beds. But the process of preparation was both regular and slow. The scattered plants of the Catskill rocks were floated from distant lands. The coal beds of the Pocono formation are thin and local; some of them mere collections of leaves and twigs floated into small lakes or ponds; a few were genuine peat bogs, of limited extent, and soon buried under inflowing sand. Even the earlier beds of the Productive Coal Measures were irregular in size and area, by which it can be easily inferred that the great vegetation of the true coal age had not yet spread itself far and wide over the earth's surface.

Pocono coal has been found within the limits of Pennsylvania in Cove and Buffalo mountains on the Susquehanna, in Sideling Hill in Huntingdon county, on Tipton Run in Blair county, and in many other ravines descending the escarpment of the Allegheny mountain; but every attempt to work it profitably has been a failure except at the Tipton mines, which will be described in another part of this report.

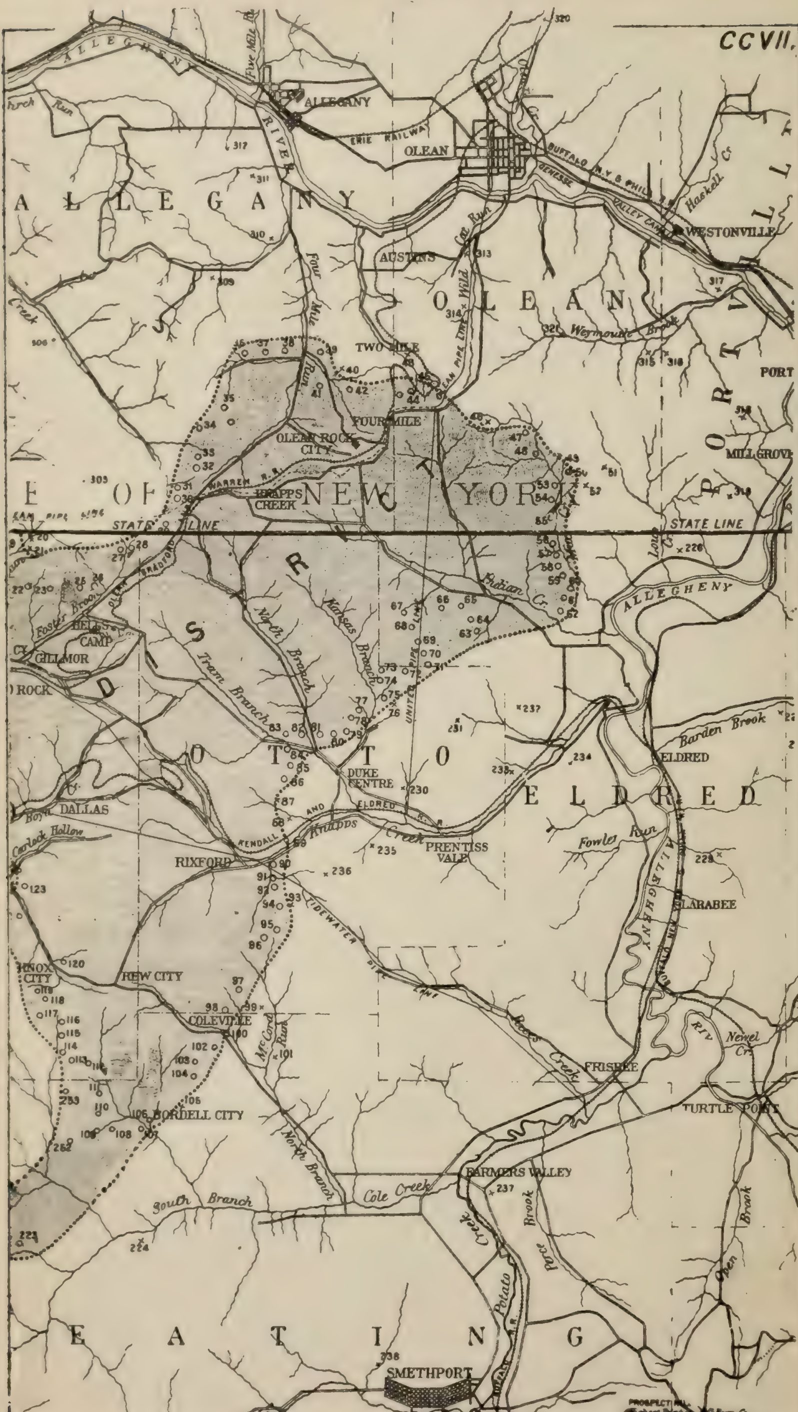
In Virginia, at Augusta Springs and other places, equally fruitless mining adventures have been undertaken. But in Wythe county two beds, one 4 feet thick, the other 8, have been mined for a length of outcrop of about a mile, beyond which they become too thin to mine, although they can be traced along Brushy mountain and the ridges back of it for many miles northward and into Tennessee. In Eastern Kentucky similar small coalbeds are known, in the "Knobstone formation," as the Pocono is there called, facing the Western edge of the Kentucky coal field.


PROVEN OIL TERRITORY
MAY 1st 1880
TO ILLUSTRATE
REPORT OF PROGRESS R
IX Lowest Oil Horizon.
STATE LINE
LIMESTONE
BABCOCK
TARPORT
BRADFORD
MOUNT RAUB
SAWYER CITY
DEGOLIER
CUSTER CITY
LEWIS RUN
MARSHBURG
BIG SHANTY
BIG SHANTY DIST.
CRAWFORDS
LAFAYETTE CORNERS
ALTON
BOND VEIN
BUTTSVILLE
KINZUA DISTRICT
B R A D F O R D
L A F A Y E T T E
Limestone Brook
Bolivar Brook
Bennet Brook
Waggoners Run
Marilla Cr.
Cramer Brook
Fuller Brook
West Branch
Shepard Run
Rutherford Run
Minard Run
Two Mile Run
Lewis Hallow
Mian Hallow
Lewis Run
Bear Run
Rail Road Run
Turnipe Run
Wintergreen Run
Kinzua Creek
Pine Run
Town Line Run
Windfall Run
Fife Run
Three Mile Run
Kinzua Cr.
PITTSBURG R.R. EXTENSION
UNITED PIPE LINE

The abundance of salt brine and the scarcity of coal are therefore the principal features of the Pocono formation, so far as the treasury of the commonwealth or the business interests of its citizens are concerned in it. But to the geographer, the civil engineer, and especially to the geologist, its character as one of the great sand deposits of the ancient sea bottom has many other attractions. In thickness it varies from a few hundred to several thousand feet; and so rapidly that the change takes place in a distance of less than fifty miles. In constitution it is in one region a single mass of hard and massive grey sandstone and puddingstone strata; in another region a triple mass of current-bedded greenish sandstone beds separated by shales containing seams of coal; and in a third region a many sub-divided mass of soft thin sands and massive limestones.

This contrast can be best illustrated by giving measured sections of the formation at various points on the Lehigh river; at Sideling Hill tunnel in Huntingdon county; at the Allegheny mountain in Blair county; in the gaps of the Conemaugh and Youghiogheny in Westmoreland and Fayette counties; on Oil creek in Venango county; and at the Lake Erie outcrop in Erie and Crawford counties.

The Mountain limestone ("*Siliceous limestone*") at the top of Pocono, which appears in Lycoming county, and in the gaps and oil wells of the Pittsburg region, grows to great proportions in West Virginia, and becomes the predominate deposit in the Mississippi Valley. It will be described in a subsequent chapter. In Pennsylvania it is an intermediate formation between the Pocono and the Mauch Chunk (X and XI) too thin and obscure to arrest much attention when the scheme of numbered formations was first made out, and before its proper relationship to the limestones of the far west was known.


CCVII.
ALLEGHENY
ALLEGANY
OLEAN
ERIE RAILWAY
BUFFALO N.Y. & PHILA R.R.
GENESEE VALLEY CANAL
WESTONVILLE
Haskell Cr.
AUSTINS
TWO MILE
FOUR MILE
OLEAN ROCK CITY
KNAPPS CREEK
WARREN R.R.
STATE LINE
NEW YORK
Weymouth Brook
PORT
MILLGROVE
Indian Cr.
Kansas Branch
North Branch
Tram Branch
Foster Brook
HELLS CAMP
GILLMOR
ROCK
DALLAS
Carlock Hollow
DUKE CENTRE
KENDALL AND ELDRED R.R.
Knapps Creek
PRENTISS VALE
RIXFORD
TIDEWATER PIPE LINE
UNITED PIPE LINE
ELDRED
Barden Brook
Fowler Run
CLARABEE
KNOX CITY
NEW CITY
COLEVILLE
McCord Run
BORDELL CITY
Newel Cr.
FRISBEE
TURTLE POINT
FARMERS VALLEY
South Branch
Cole Creek
Potato Creek
Pearce Brook
Open Brook
SMETHPORT
PORTVILLE
DISTRICT
OF
BRADFORD
KEATING
ELDRED

CHAPTER CXII.

X. The Pocono on the Lehigh.

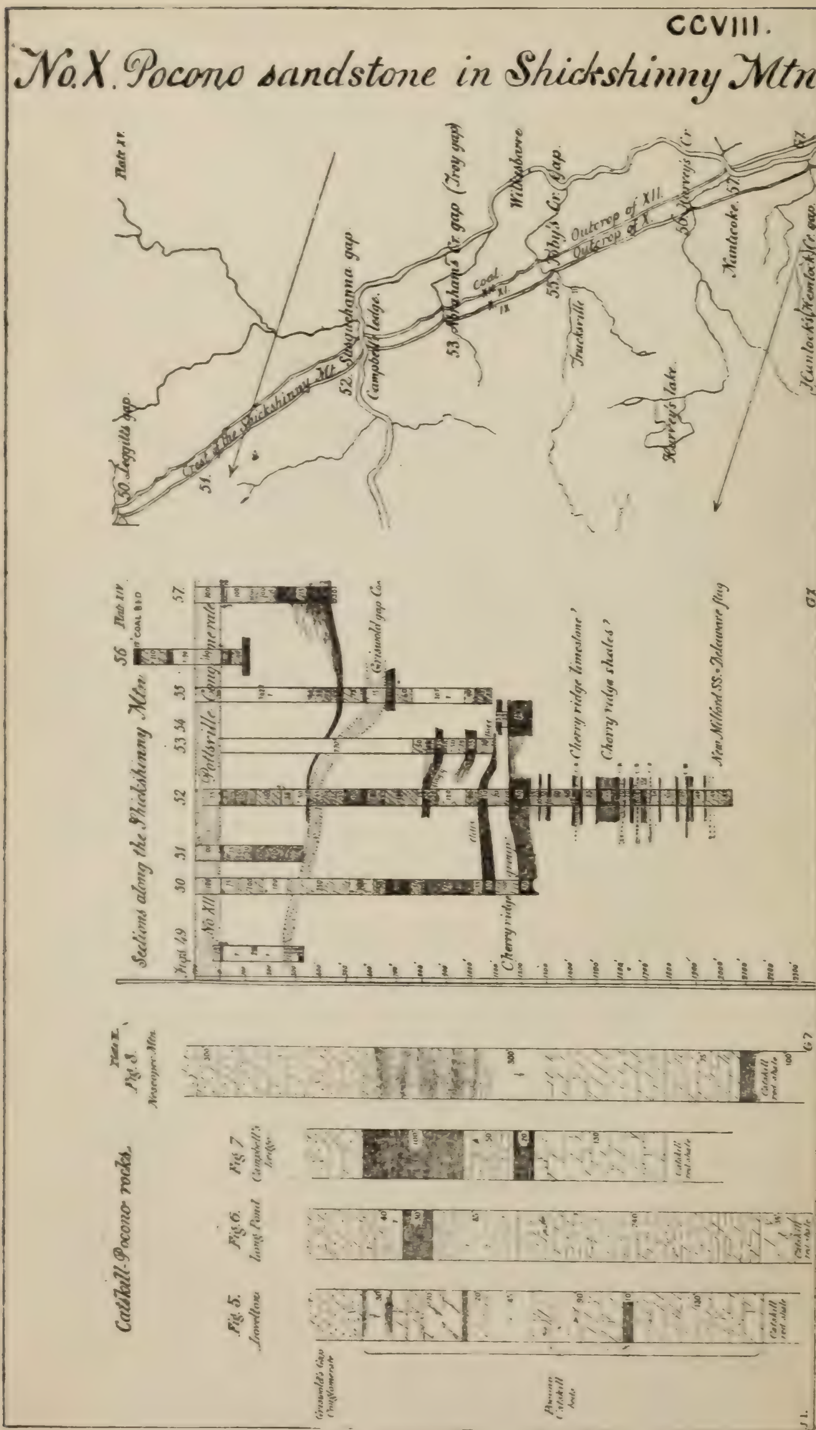
The section of vertical strata in the gap of the second mountain below Mauch Chunk, measured by Mr. Winslow, has been given on page 1595 of Vol. II, and is here repeated:

XII.	POTTSVILLE CONGLOMERATE,		1000′
XI.	MAUCH CHUNK RED SHALE,		2168′
X.	POCONO SANDSTONE, beginning 1000′ S. of the East Mauch Chunk RR. station.		
"	SS., hard, gray; with cong. beds (White's No. 1),	440	
"	Shale and slate, dark,	20	
"	SS., coarse grained, grayish,	26	
"	Slate, dark,	13	
"	Pebbly SS. dark gray, (White's No. 2),	50	
"	Conglomerate, coarse, (White's No. 2),	14	
"	Shale and SS. grayish-green,	28	
"	Yellow ochre,	5	
"	Shale, greenish,	13	
"	Yellow ochre,	5	
"	Shales, olive green, ochrey,	55	
"	SS., dark gray, with shale and slate,	282	
"	SS., white, fine "soapstone" bed at base,	48	
"	Shales, dark, greenish and variegated,	40	
"	SS. dark-gray and reddish, with a few large scattered pebbles (passing the Mauch Chunk RR. station),	214	1253

The next section measured by Mr. Winslow, was along the Lehigh Valley railroad from a point in East Mauch Chunk 1800′ N. of the bridge to a point 3000′ N. of Glen Onoko.

XI.	MAUCH CHUNK RED SHALE,		3342
X.	POCONO SANDSTONE, gray, hard,	160	
"	Sandstone with shale, dark gray,	118	
"	Sandstone, gray, hard, with quartz pebbles,	305	
"	Conglomerate, siliceous,	25	
"	Sandstone, greenish gray, partly concealed,	252	
"	Sandstone, gray,	84	
"	Concealed interval,	279	1223

Still higher up the river, from the ravine N. of Quakake Creek southward to switch house below old Penn Haven railway junction:—


CCVIII.
No. X. Pocono sandstone in Shickshinny Mtn
Crest of the Shickshinny Mt
Campbell's ledge.
Wilkesbarre
Outcrop of XII.
Outcrop of X.
Nanticoke
Harvey's lake.
Trucksville
Sections along the Shickshinny Mtn
Pottsville Conglomerate
No. XII
Griswold gap Con.
Cherry ridge limestone
Cherry ridge shales
New Milford SS. Delaware flag
Catskill-Pocono rocks.
Fig. 5.
Fig. 6.
Fig. 7
Campbell's Ledge
Fig. 8.
Catskill red shale
Griswold's Gap Conglomerate

XI.	Mauch Chunk red shale, visible,		66
X.	POCONO shale, green, hard,	20	
"	Sandstone, gray, siliceous,	15	
"	Shales, green,	20	
"	Sandstone, grayish-red,	10	
"	" greenish gray, hard,	40	
"	" gray, hard, with pebbles,	146	
"	Shales, green,	36	
"	" yellowish, ochrey,	20	
"	Sandstones and shales, greenish,	296	
"	" " " red,	25	
"	" " "	205	833

Still higher up the river, from Stony Creek northward along the L. V. RR. the strata on a south dip of only 5° to 10° read thus:—

X.	POCONO conglomerate, gray,	20	
"	Sandstone and conglomerate, gray, flinty,	100	
"	Shales, greenish,	165	
"	Shales, greenish,	8	
"	Sandstone, greenish gray,	8	
"	" and dark shales,	9	
"	*Shale black and coaly*,	1	
"	Sandstone, dark gray, hard,	20	
"	Shales, dark,	7	
"	Sandstone, shaly, dark,	17	
"	" and shales, greenish gray, flinty,	87	
"	——— concealed,	80	
"	" greenish gray, hard, flinty,	35	557

Still further north, along the L. V. RR. south from Drakes Creek, with north dip:—

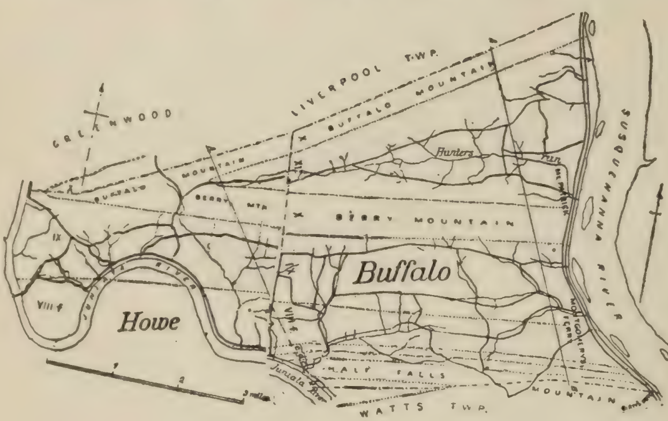
X.	POCONO sandstone and conglomerate, gray,	126	
"	——— concealed,	93	
"	Conglomerate, fine, flinty,	213	
"	Sandstones and shales, dark gray,	51	
"	——— concealed,	27	
"	Shale, yellow ochrey,	13	
"	" hard,	13	
"	Conglomerate and sandstone, dark gray,	13	
"	——— concealed,	76	
"	Sandstone, dark, greenish gray, hard,	77	
"	Conglomerate and sandstone, gray, flinty,	20	
"	Shale, greenish, hard,	27	
"	Sandstone, gray, hard,	49	798

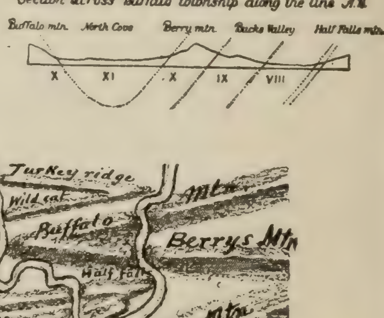
Still further north, on the steep south slope of the Nescopec mountain, the L. V. RR. exposes south dipping rocks up to the Summit rock cut, thus:—

X.	POCONO sandstone, white, hard, flinty, pebbly,	10
"	——— concealed,	422

CCIX.

No. X in Perry county, Buffalo & Cove Mts.





VIIIc. Hamilton terrace in the gap above Harrisburg.

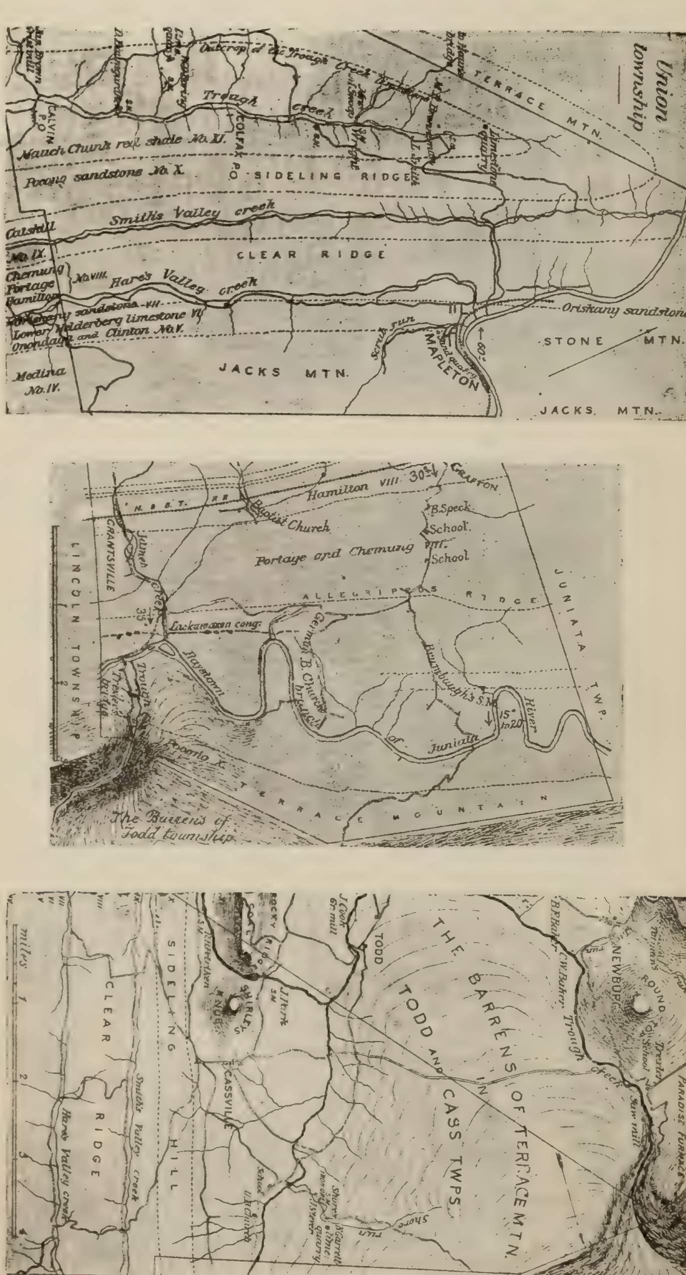
X.	Sandstone, gray, hard broken,	49	
"	—— concealed,	350	
"	Sandstone, gray, coarse,	12	
"	" white, fine, flinty,	24	
"	—— concealed,	77	
"	Sandstone, olive green, fine,	13	
"	" light green, coarse,	13	
"	—— concealed, to first red shale,	140	1110

Still further north, a section of the Wyoming mountain south of Ashley (in the Northern Anthracite coal field) reads thus.—

XII.	POTTSVILLE CONGLOMERATE,		220
XI.	MAUCH CHUNK RED SHALE,		1002
X.	POCONO SANDSTONE, white, coarse, flinty,	283	
"	Conglomerate, with fine quartz pebbles,	3	
"	Sandstone, hard, greenish gray,	3	
"	Conglomerate, small pinkish quartz pebbles,	32	
"	Sandstone, white, coarse, pebbly,	40	
"	" yellowish brown, fissile, friable,	38	
"	" greenish, hard,	44	
"	" gray, hard, fractured, pebbly,	57	
"	" greenish, hard, with conglomerate beds,	256	
"	" shaly, greenish, fractured,	143	
"	" Conglomerate, soft (slate and sandstone pebbles),	3	
"	Sandstone, greenish, hard, much fractured,	112	
"	" greenish-gray,	163	1177
IX.	CATSKILL RED SHALE AND SANDSTONE.		
"	Shale, brick red,	247	
"	Sandstone, green and gray,	84	
"	" and shale, red and reddish,	141	
"	" green, fine, with broken slate,	14	
"	" gray, coarse, flinty,	28	
"	" and shale, red,	15	
"	" gray, hard,	4	
"	" and shale, red,	30	
"	" white, coarse, flinty,	17	
"	" and slate, greenish,	11	
"	Conglomerate, sandy,	3	
"	Sandstone, gray, flinty,	11	
"	" or slate, soft and red,	17	
"	" yellowish, friable,	34	
"	" or slate, soft and red,	34	
"	" green, soft and broken at bottom,	22	
"	" slate, fine, soft, red,	41	
"	Sandstone, chocolate gray, hard,	26	
"	" slaty at top, red,	18	
"	" hard, gray, pebbly,	35	
"	" yellow, friable,	4	
"	" gray hard,	8	

CCX

Nos. X, XI. Terrace Mtn. & Trough Valley

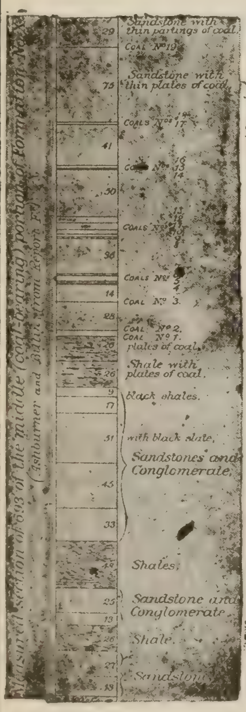


IX.	Sandstone, dark gray, fine, a few pebbles,	82
"	" gray, hard, flinty,	87
"	Conglomerate, fine, dark, with shale,	6
"	Shale, soft, red,	5
"	Sandstone, chocolate red, hard,	13
"	Shale, clayey, red,	24
"	Sandstone, friable greenish,	18
"	Sandstone, friable, yellowish,	15
"	" green, compact,	21
"	Concealed,	20
"	Sandstone and shale, red, soft,	48
"	" yellowish,	11
"	Concealed,	133
"	Sandstone, coarse, greenish, weathers black, with mica scales,	164
"	Concealed,	38
"	Sandstone, gray, fine, shaly,	12
"	" red, hard, shaly,	14
"	" slaty, gray, micaceous,	3
"	Concealed,	14
"	Sandstone, with mica, red,	6
"	Concealed,	9
"	Sandstone, slaty, red,	10
"	Concealed,	6
"	Sandstone, shaly, pebbly, micaceous,	25
"	" brown and grayish, green, mica,	28
"	Concealed from this downward, visible,	1656

The lower part of this last section has been subjoined to the upper to show the important fact that there is no visible break between the Catskill and Pocono formations, and no such nonconformability between the Devonian and the Carboniferous systems, where most largely developed, as has been asserted in various geological books. The same fact is evidently declared by the other sections.*

* It is impossible to fix upon any plane of division between IX and X, anymore than between VIII and IX, as has been shown in Vol. 2 above; nor between X and IX, as will be shown hereafter. The deposits of muds, sands and gravels, with variations of coarseness and color, went on for ages in unbroken sequence upon a wide belt of sea bottom, of considerable depth, scarcely inhabited by any creatures except fishes, and without the slightest mark of disturbance, except that slow and continual subsidence which was needful to maintain a water basin or long sea trough, without which it would have become filled up; as indeed it did become after the inroad of the Pottsville conglomerate No. XII, at the commencement of the age of the workable coal beds. It will be noticed that in the Stony Creek section above 1′ of *black coaly shale* appears almost exactly midway of the section. This corresponds to the much more considerable exhibitions of thin coal seams and black shales in the middle division of the Pocono rocks

No. X Coals. Pocono Sandstone No. X. B. Top. CCXI.



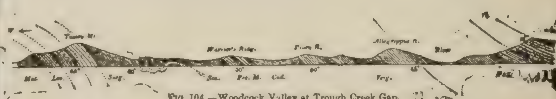
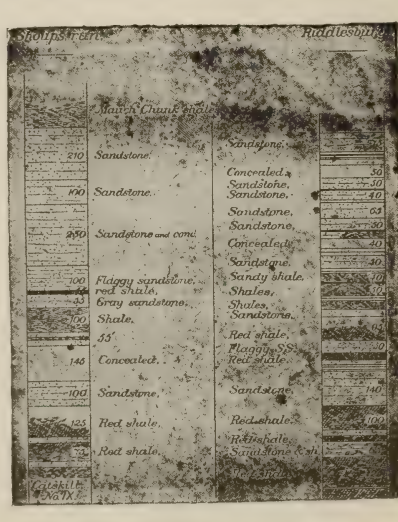
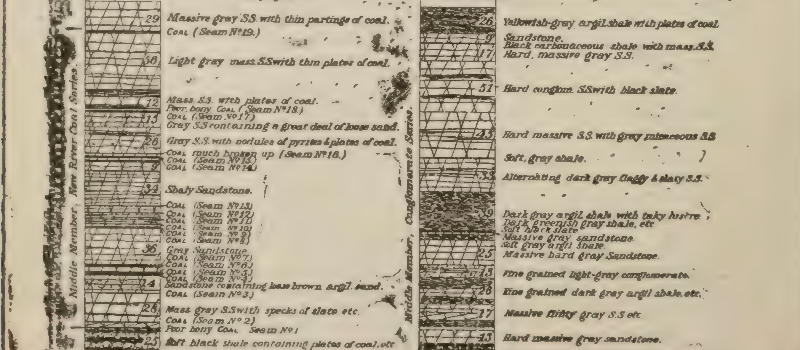


FIG. 104.—Woodcock Valley at Trough Creek Gap.



New River Coal Series & conglomerate of Pocono S.S. No. X in Sideling Hill Tunnel, Huntingdon Co. Pa.

See page 206. Section, continued.



Further north, in the Pittston gap of the Susquehanna river through Shickshinny mountain, White's section has been given already in Vol. 2, on page 1608; but it is here repeated to show the rapid thinning of the formation in a few miles as it passes underneath the Wyoming coal basin.

Coxton Section.

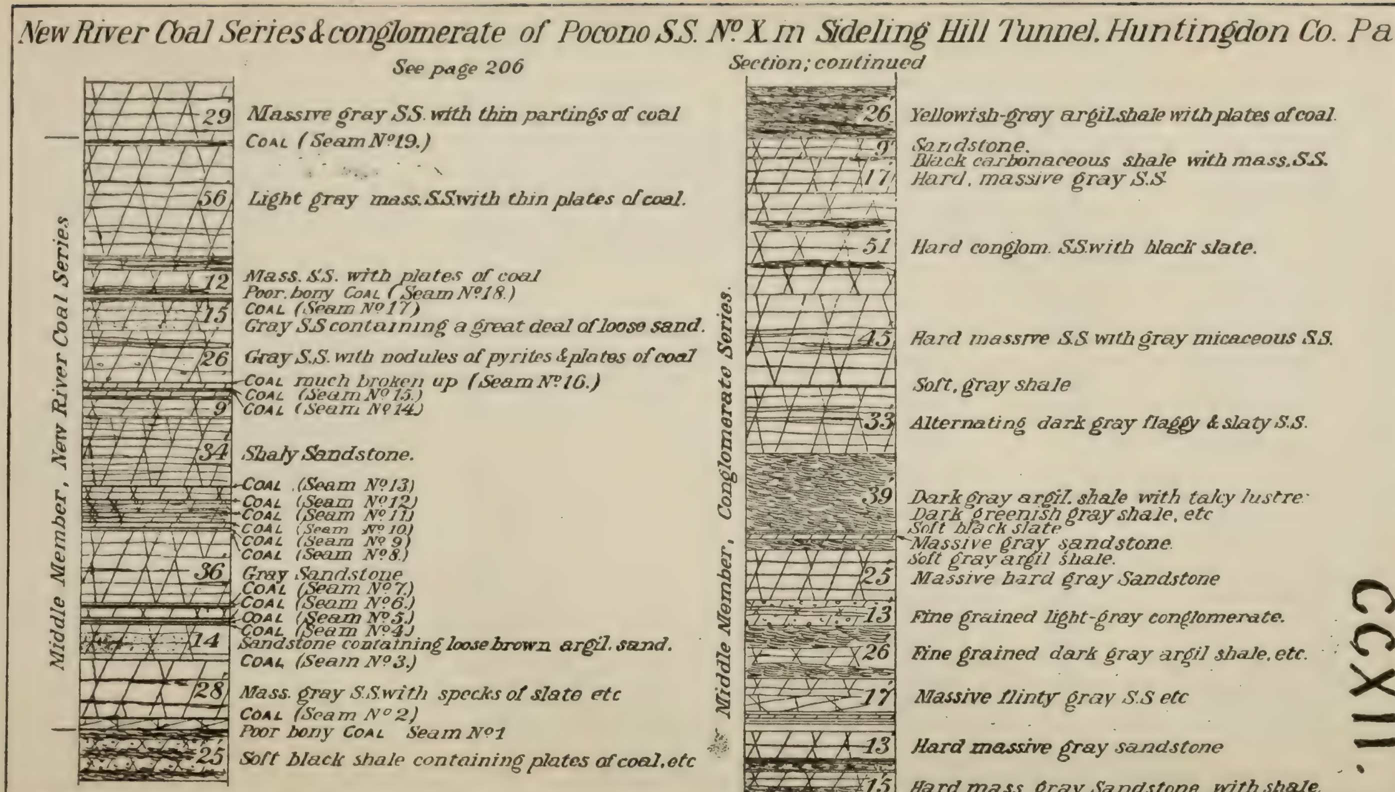
IX.	MAUCH CHUNK RED SHALE,		150
X.	POCONO SANDSTONE, massive gray,	100	
"	Conglomerate with slate and sandstone pebbles,	2	
"	Greenish shale,	1	
"	Sandstone, gray, massive,	55	
"	Concealed,	50	
"	*Red shale*, sandy, seen	10	
"	Concealed,	5	
"	Conglomerate, coarse, whitish,	45	
"	Sandstone, gray, a few pebbles,	30	
"	Sandstone, shaly; and concealed beds,	25	
"	Sandstone; large quartz pebbles at base,	30	353′

Further north in Wyoming county, we have in White's Dutch mountain section (Vol. 2, p. 1582 above, from G 7, p. 141) only what he names Transition beds IX–X, *Catskill-Pocono transition beds*, *IX–X*, because no definite division plane can be fixed on with any satisfaction. The Dutch mountain plateau is made by the *Griswold Gap Conglomerate*, which White assumes as the bottom of the Pocono. It is that which ends the Coxton section just given; and its rise towards the Pottsville Conglomerate XII, and its gradual thinning along its Schickshinny mountain outcrop is graphically exhibited in page plate 14 of his Report G 7, p. 144, (reproduced, reduced on plate 208 of this report). The transition beds, 370′ thick, beneath this Griswold Gap conglomerate down to the top red sandstone of the Catskill series, are thus recorded in G. 7, p. 141:

X.	Griswold gap conglomerate, a very massive greyish white rock filled with large quartz pebbles, at least,		30
X–IX.	Shale, interval, much concealed,	30	
"	Sandstone, massive grayish (Cascade),	70	
"	Shale, sandy, red,	5	
"	Sandstone, gray,	20	

---

of Sideling Hill, in Huntingdon county, to the Tipton coals of Blair county, and to similar deposits elsewhere already mentioned in this chapter. It hints at a momentary local filling of the water basin.



New River Coal Series & conglomerate of Pocono S.S. No. X. in Sideling Hill Tunnel. Huntingdon Co. Pa.

CCXII.

X–IX.	Shale, interval (concealed),	45	
"	Sandstone, greenish (Cascade),	90	
"	Shale, red,	10	
"	Sandstone, greenish, somewhat massive (Cascade),	130	400
IX.	Shale, red, and sandstone, alternate masses, making a superb series of eight Cascades, for 475′ to water level.		

Still further north, on the Tioga river, in Tioga county, White's section (already given on page 1585 above in Vol. 2), in which no transition beds are designated, reads thus:

XII.	*Pottsville Conglomerate,*		60
XI.	*Mauch Chunk red shale,*		245
X.	*Pocono sandstone,* massive,	20	
"	Concealed interval, say	500	
"	Sandstone gray,	25	
"	Calcareous breccia,	3	
"	Sandstone, gray,	25	573
IX.	*Catskill, red shale.*		

Prof. White's general section in Susquehanna, Wayne, Bradford, Wyoming, etc. (already given on page 1576, Vol. 2), is repeated here to make plain what is said above:

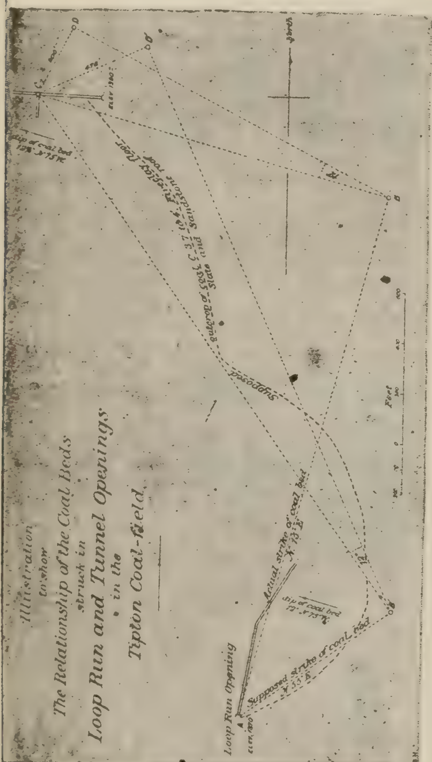
X.	Pocono sandstone, buffish, pebbly,	40′	
"	Shales, buff, sandy and concealed,	200′	
"	Sandstone, buffish white, massive,	125′	
"	Shales with sandstones, gray, current bedded,	265′	
"	*Griswold Gap Conglomerate,* white,	35–	665
"	*Rix's Gap fish bed* at its base.		
IX–X.	*Catskill-Pocono transition beds;* concealed,	50′	
"	Sandstone, gray, current bedded,	15	
"	Concealed strata,	25′	
"	Sandstone, grayish white,	20′	
"	Concealed strata,	25′	
"	Sandstone gray, current bedded,	15′	
"	Sandstone gray, and reddish shales,	200′	
"	*Mount Pleasant Conglomerate,*	25–	375
"	*Mount Pleasant fish bed* at its base.		
IX.	Catskill strata, proper, viz:—		
"	*Mount Pleasant red shale,*	150′	

These Pocono measures are described in White's Report G5, p. 56, thus:—The 40′ rock at the top is very massive and contains very many white quartz pebbles and would certainly be identified with the *Sub-Olean conglomerate* of McKean were the section made in any of the northwestern counties of the state.

The underlying shale mass may be 175′ or 225′ thick; but it is averaged at 200′.

CCXIII (A)

No. X, Pocono sandstone coals at Tipton.



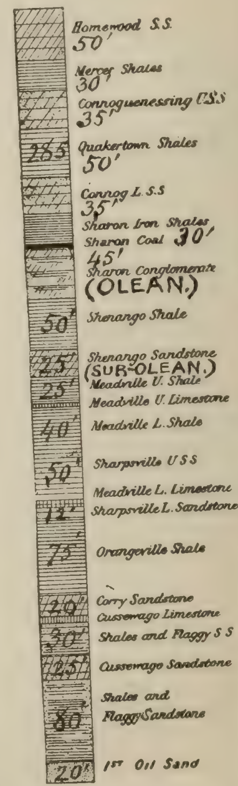


FIG. 113.—Section of Short Mountain synclinal, and anticlinal of Canoe Run, with Vergent iron-ore

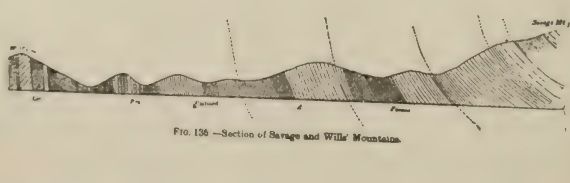


FIG. 136.—Section of Savage and Wills' Mountains.

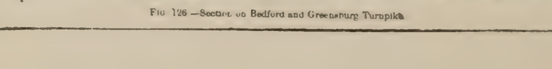


FIG. 126.—Section on Bedford and Greensburg Turnpike.

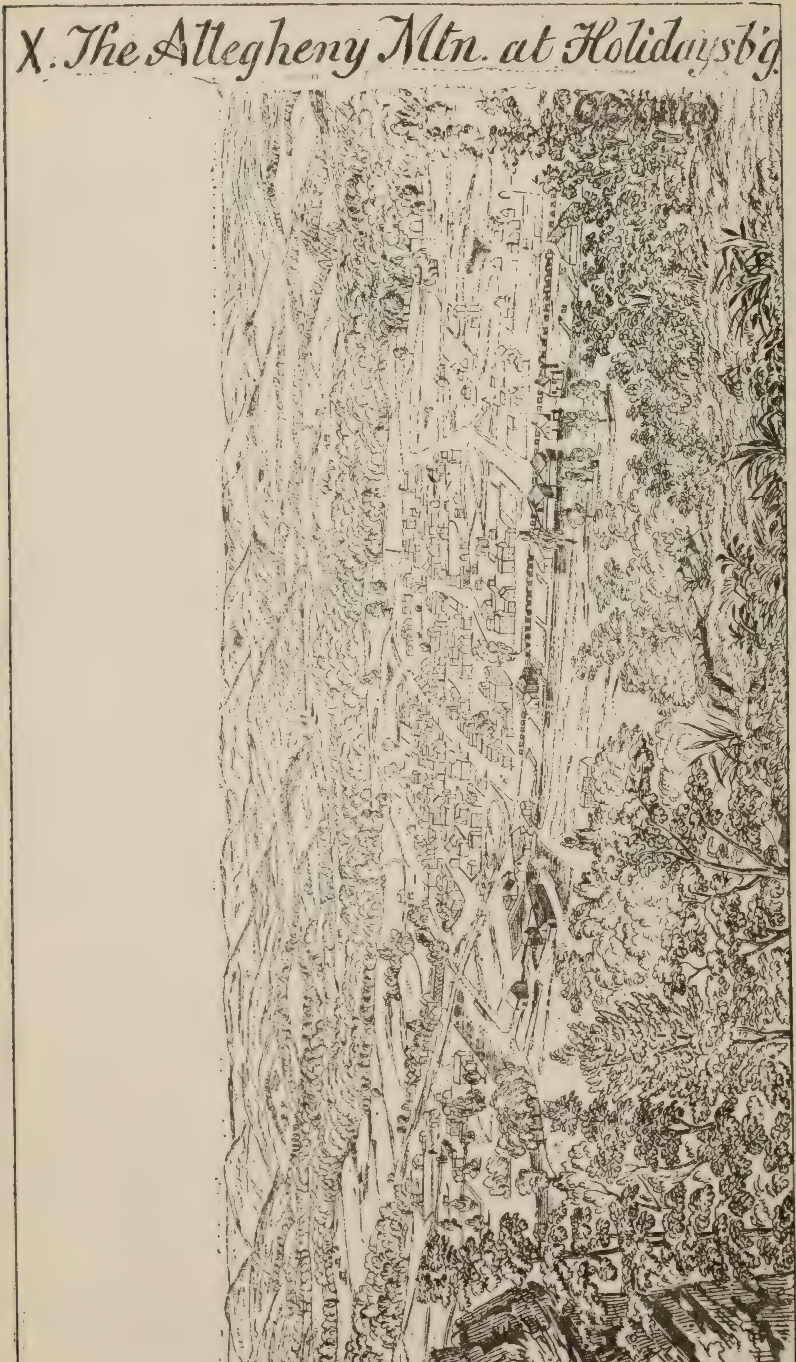
The 125′ sandstone mass has all the Pocono characteristic features, an uninterrupted pile of buff colored layers (1 to 4 feet thick), moderately fine-grained, very hard, and somewhat current-bedded. In a notch of the Lackawanna (Schickshinny) mountain N. W. of Oliphant 100′ of its beds are visible strikingly resembling the *Corry Sandstone* of Erie county.

The 265′ of shales under it include several beds of grayish-white tolerably coarse current-bedded sandstones. On Roaring Run branch 200′ or 250′ of reddish-olive shales overlie shales in which sandstone layers occur.

"*The Griswold Gap Conglomerate* is a remarkable horizon. In the whole 800′ to 850′ interval between it and the *Bottom Conglomerate* of XII, our section of *Mauch Chunk* and *Pocono* rocks has not exhibited a deposit in which the quartz pebbles are numerous, large or persistent enough to warrant the name of a conglomerate But at this horizon lies a *true conglomerate*, so solid and massive as to make the *crest of the Moosic mountain*. In the notches of this crest the rock can be studied all along the western border of Wayne county, and it has two fine sloping outcrops on the opposite site of *Griswold's gap*, just east of Forest City, on the road to White Oak pond. Its outcrop from this gap can be followed, northward, to near Mt. Pleasant, usually on the eastern slope of the mountain crest; and southward, across the Wayne county line into Lackawanna county, about 5 miles south from Waymart. Its pebbles, very white, are somewhat angular and flattish rather than ovoid, vary in size from ½″ to 2″, and rest in a rather coarse, brownish-gray matrix weathering whitish. I would compare this formation with the *Cussewago Sandstone* of my Erie county report, Q^4.

"*The Fish bed of Rix's gap* is a calcareous layer, 2′ to 3′ thick, which outcrops near the base of the *Griswold Conglomerate*, just west of Waymart, in Rix's gap. *Pebbles of red shale* and *greenish shale* and *many fish remains* are mixed with the ordinary quartz pebbles.

"*The Transition layers* (*Sub-Pocono*), a markedly different kind of sediments from the conglomerate just de-


X. The Allegheny Mtn. at Holidaysb'g.

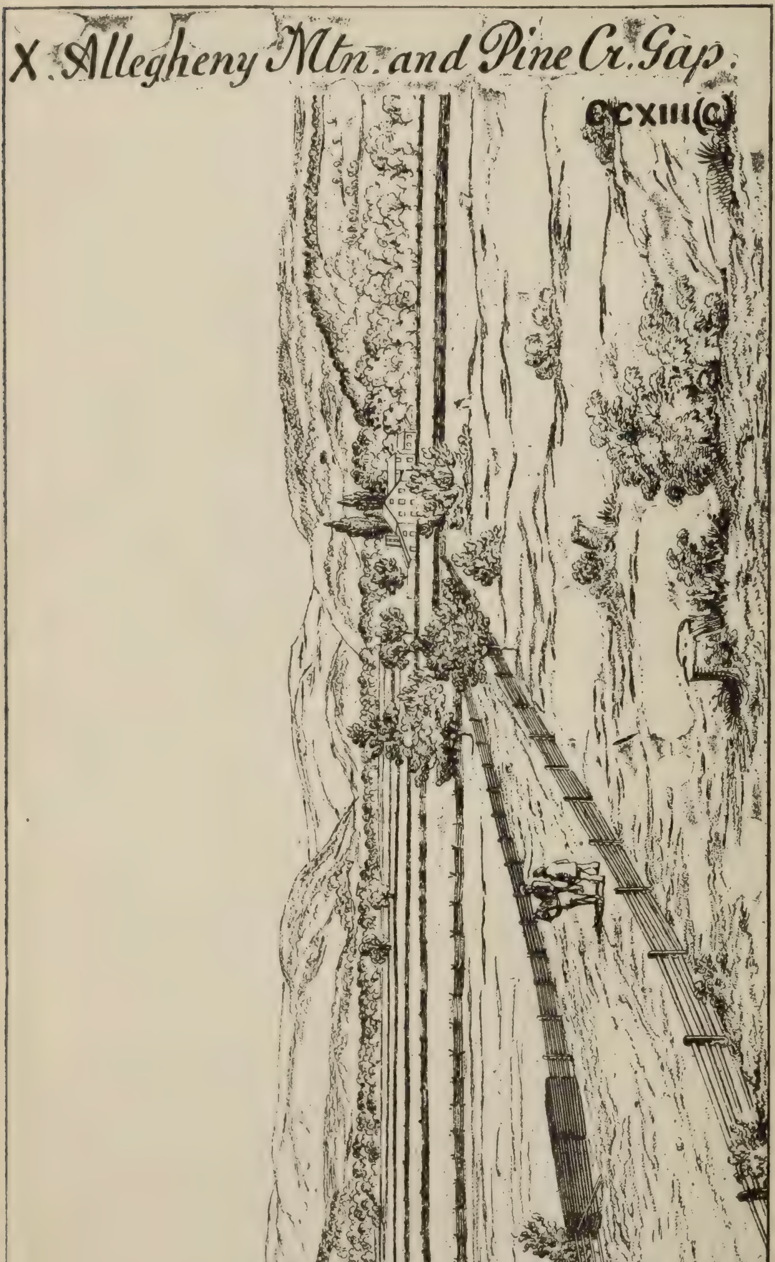
scribed, occupy the next 375; and the North and South Knobs of the Elk mountain range are made by this group. Mount Ararat and the Sugar-loaf of the Moosic mountain range, are similar isolated heights preserved from erosion by outlying patches of this group; 250′ to 300′ of the section being visible on and around their summits;—horizontal plates of coarse, grayish-white, current-bedded sandstone (often streaked with layers of small quartz pebbles), each from 15′ to 25′ thick, and separated by beds of sandy shale (some of them, especially those low in the series, of reddish hue) from 20′ to 50′ thick.

"*The Mount Pleasant Conglomerate*, at the base of the group, is a massive grayish-white sand rock, 20′ to 25′ thick, through which pebbles of quartz are scattered, and sometimes in such abundance as to constitute it a conglomerate. Even where the whole mass is mostly sandstone, there is always a *pebbly portion near the bottom*, 3′ to 6′ thick; and the pebbles in this lower portion are *reddish* or *rose colored*, in striking contrast with the white pebbles of the *Griswold gap conglomerate.**

"*Fish bed:—A calcareous conglomerate*, 2′ to 3′ thick, forms the base of the *Mt. Pleasant rock*, like the *Griswold gap rock:*—quartz pebbles, pieces of shales, and *fragments of fish bones* (to all appearance) so worn as to be undeterminate." (White.)

The Nescopec Gap Section near Catawissa in Columbia county, is the only other one in eastern Pennsylvania which needs be quoted (G7, p. 51). It has been given in full in Vol. 2, p. 1604 above.

* The summit of the hill at the village of Mt. Pleasant is capped by an outlying patch of this formation, about half an acre in extent. Here its pebbles are quite large. Prospect Rock is a broad table of it, and its long lines of cliffs look out from the east and west sides of the South Knob of the Elk mountains. In Ararat Peak it is very conglomeritic, and the people, mistaking it for the *Bottom conglomerate of XII*, believe that coal beds exist in the 300′ to 400′ of measures which form the cone of the mountain over it; which, of course, is a mistake. In Sugar Loaf peak it outcrops again. Along Moosic mountain slope, facing east, in Wayne county, its outcrop can be traced from Mt. Pleasant southward to the Lackawanna county line; and in that direction the rock seems to become a coarser conglomerate. (White.)


X. Allegheny Mtn. and Pine Cr. Gap.
CCXIII(c)

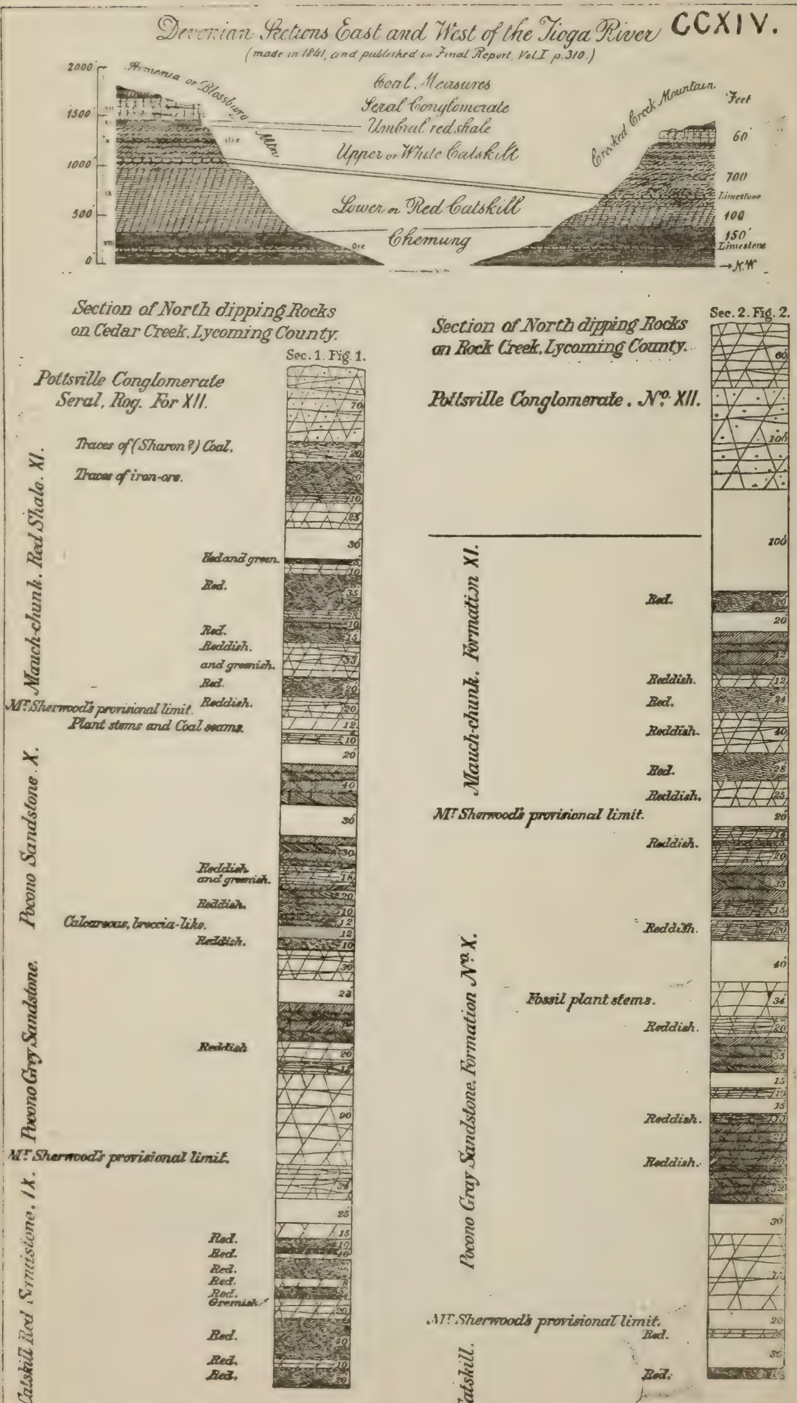
X.	*Pocono* sandstone, coarse, yellowish, ...	30	
"	" concealed; no doubt shaly, ...	250	
"	Sandstones, massive, whitish, some conglomerate, ...	300—	580
IX–X.	*Transition* sandstone and shales, gray, ...	300	
"	Sandstones, gray, becoming reddish downwards, .	75—	375
IX.	*Catskill red shale*, 100′, etc.		

X. Pocono mountains in Pennsylvania.

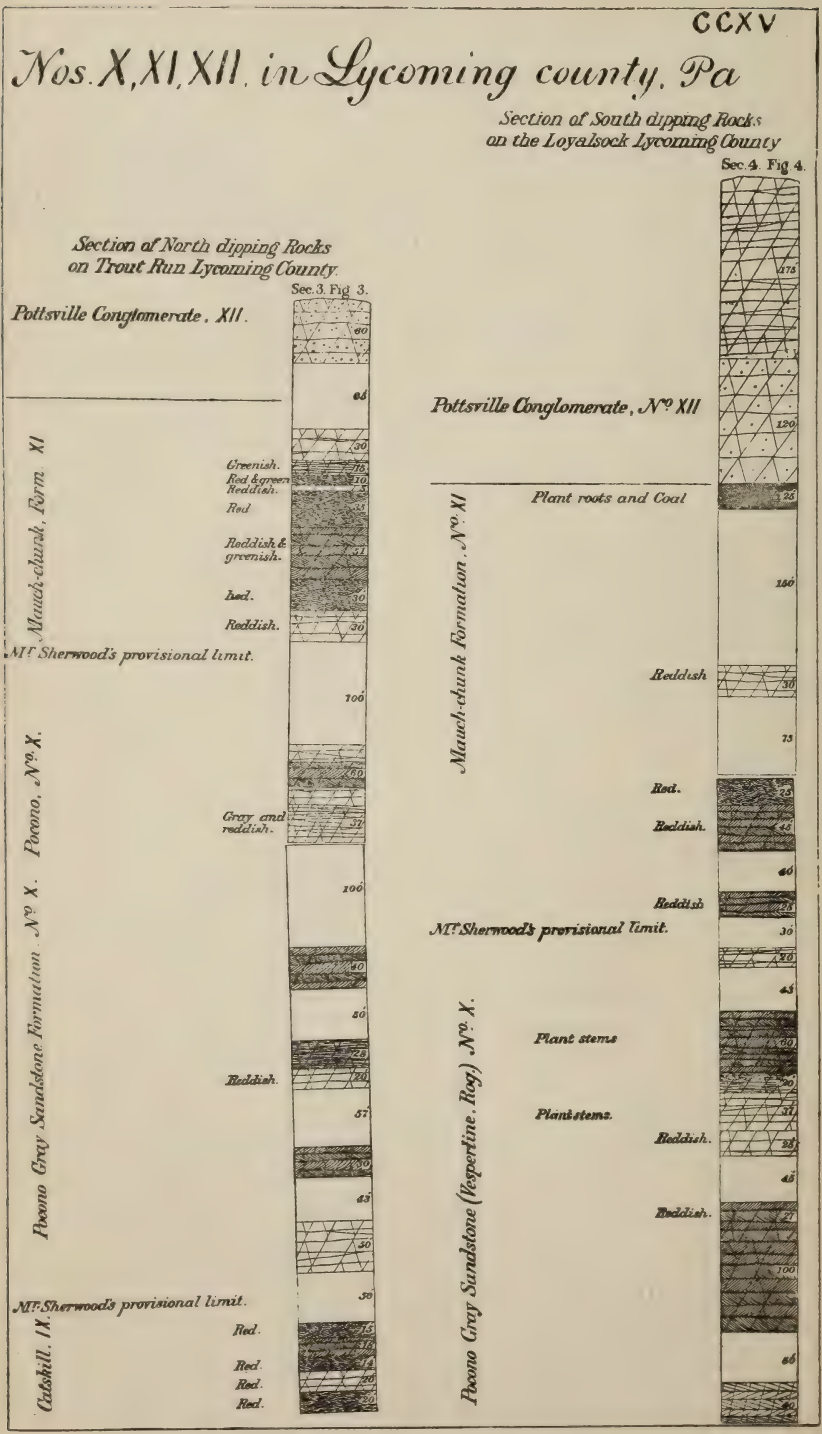
It will be readily inferred from the sections given in this chapter and the notes accompanying them that the Pocono formation plays a predominating rôle in the geography of eastern and northern Pennsylvania. In fact, it makes the sharp crests, or flat tops of most of its mountain ranges, and highest table lands; as well as those isolated peaks which have escaped erosion, and now stand like solitary sentinels here and there on the great Catskill plateau.

To enumerate the mountains the crests of which are made by the long continuous outcrop of the Pocono sandstone would be to repeat the catalogue of Catskill mountains already recited in Chapter CVI of the second volume of this report; for in the case of every one of them, either there are two crests, one Catskill and the other Pocono, or a terrace of Catskill is looked down upon from a higher crest of Pocono. Thus, the Second mountain on the Lehigh, double-crested and almost perfectly straight, runs to the Susquehanna river; makes a loop in Perry county, as Cove mountain; (see Plate CCIX, p. 1638); runs east as Fourth or Peters mountain; returns to the river and makes another cove as Buffalo mountain; again runs east as Mohantongo mountain and returns to the river bank as Mahonoy mountain; runs east again (north of the Western Middle Anthracite field), and becomes the Catawissa and Nescopec mountains; returns west as Wyoming mountain and east again as Schickshinny and Lackawanna mountain, nearly to the New York line; then returns west as Elk mountain, the Great North mountain, and the backbone Allegheny mountain 200 miles in a great curve through middle Pennsylvania to Maryland.

Under all these different names the mountain is one and the same; one outcrop zigzags across the surface of the


Devonian Sections East and West of the Tioga River
CCXIV.
(made in 1841, and published in Final Report, Vol. I p. 310.)
Armenia or Blossburg Mtn.
Coal Measures
Seral Conglomerate
Umbral red shale
Upper or White Catskill
Lower or Red Catskill
Chemung
Crooked Creek Mountain.
Feet
60
700
Limestone
100
150'
Limestone
N.W.
2000
1500
1000
500
0
Section of North dipping Rocks on Cedar Creek, Lycoming County.
Sec. 1. Fig. 1.
Pottsville Conglomerate Seral, Rog. For XII.
Traces of (Sharon?) Coal.
Traces of iron-ore.
Mauch-chunk. Red Shale. XI.
Red and green.
Red.
Red.
Reddish.
and greenish.
Red.
Reddish.
Mr. Sherwood's provisional limit.
Plant stems and Coal seams.
Pocono Sandstone. X.
Reddish and greenish.
Reddish.
Calcareous, breccia-like.
Reddish.
Pocono Grey Sandstone.
Reddish
Mr. Sherwood's provisional limit.
Catskill Red Sandstone. IX.
Red.
Red.
Red.
Red.
Red.
Greenish.
Red.
Red.
Red.
Section of North dipping Rocks on Rock Creek, Lycoming County.
Sec. 2. Fig. 2.
Pottsville Conglomerate. No. XII.
Mauch-chunk. Formation XI.
Red.
Reddish.
Red.
Reddish.
Red.
Reddish.
Mr. Sherwood's provisional limit.
Reddish.
Reddish.
Pocono Gray Sandstone, Formation No. X.
Fossil plant stems.
Reddish.
Reddish.
Reddish.
Mr. Sherwood's provisional limit.
Red.
Catskill.
Red.

State, presenting now vertical, now steeply slanting, now almost horizontal dips; a Catskill terrace beneath a Pocono crest; gapped abruptly by great rivers, or cut by a thousand head branches into a wilderness of ravines, the steep step-like walls of which are of red Catskill sandstone and shale, and the high upland plateaus paved with gray Pocono strata. From the Pocono plateau proper between the Lehigh and the Delaware most of this pavement has been removed. But the Nesquehoning or Broad mountain, west of the Lehigh river, is a triangular flat compound arch of Pocono, covered with sea sand, so like the sand spreads over the Broad mountain of Pottsville conglomerate (No. XII) north of Pottsville, that nothing could induce the owners of the few farms upon its level top to quite resign their hope of mining coal upon it. A similar triangular uplift of Pocono mountain occurs between the two fish-tail ends of the Southern Anthracite Field in Dauphin county. These, however, are but enlargements of the one continuous outcrop, which is altogether nearly a thousand miles long.


CCXV
Nos. X, XI, XII. in Lycoming county, Pa
Section of South dipping Rocks
on the Loyalsock Lycoming County
Sec. 4. Fig. 4.
Section of North dipping Rocks
on Trout Run Lycoming County.
Sec. 3. Fig. 3.
Pottsville Conglomerate. XII.
Mauch-chunk, Form. XI
Greenish.
Red & green
Reddish.
Red
Reddish & greenish.
Red.
Reddish.
Mr. Sherwood's provisional limit.
Pocono Gray Sandstone Formation. No. X. Pocono, No. X.
Gray and reddish.
Reddish.
Mr. Sherwood's provisional limit.
Catskill. IX.
Red.
Red.
Red.
Red.
Pottsville Conglomerate, No. XII
Plant roots and Coal
Mauch-chunk Formation, No. XI
Reddish
Red.
Reddish.
Reddish
Mr. Sherwood's provisional Limit.
Pocono Gray Sandstone (Vespertine, Rog.) No. X.
Plant stems
Plant stems.
Reddish.
Reddish.

CHAPTER CXIII.

X. The Pocono in Perry County.

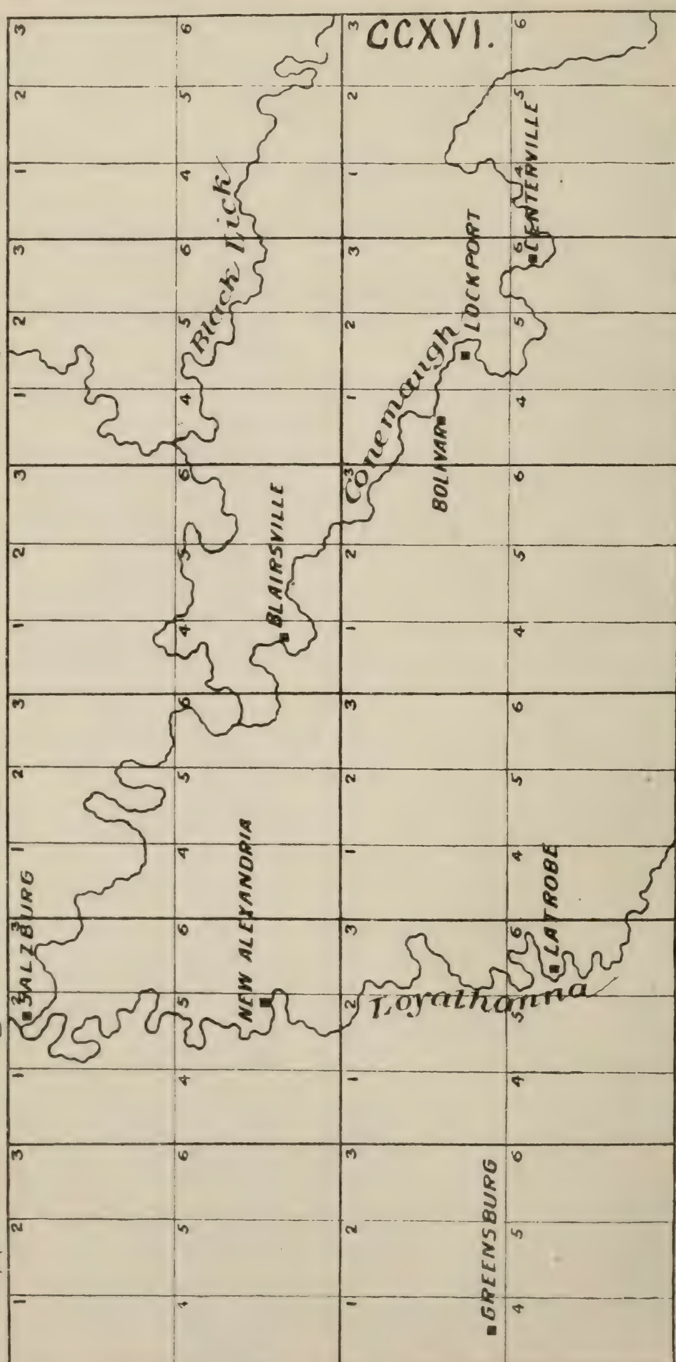
The Cove mountain forms a rampart about 1000′ high, with a level and unbroken crest, sweeping from the river near Duncannon westward 4 miles and returning to the river 8 miles. The rocks dip about 45° (S. 30° E.) at Duncannon; and here in 1877 a tunnel was driven across them, 200′, to a bed of shale 10′ thick, containing two beds of *coal*, two feet apart, the upper one 8 inches thick, the lower one 30 inches; 2′ black slate covered the upper coal. The coal beds are crushed to fragments seldom exceeding a pound in weight. An analysis by McCreath gave:—Carbon, 48.28; volatile matter, 14.38; ash, 36.44; sulphur, 0.32*.

Prof. Claypole speaks of two other coal crops under the one described above; all three traceable along the surface of the mountain by slight but continuous terraces or benches; but there is no reason for expecting the other two to be of any better quality. In fact a line of long since abandoned trial pits may be found in the woods (F2, 292, 293).

X. Pocono Coal of Hunter's Cove, Perry County.

The southern outcrop of Pocono in Berry mountain runs from Mt. Patrick through the middle of Buffalo township into Howe township, ending in a high knob at the Juniata,

*I had some years previously examined an outcrop opening on this worthless deposit 4 feet thick and condemned it. But after the discovery of the Lykens Valley bed of Dauphin county, in the Pottsville conglomerate No. XII, ignorant miners persuaded people that this coal near Duncannon in Pocono sandstone No. X was the same; hence an expensive rock-tunnel to test it in the deep. An analysis of Lykens Valley coal by McCreath gave: Carbon, 78.83; vol. matter, 8.83; ash, 9.39; sulphur, 0. 67.—The relationship of these coals with those mined in Schuylkill county can be seen at a glance by consulting the cross-section, plate XXXI of F,2p. 286 (reproduced on a reduced scale on page plate CLXXXVIII, p. 1548, Vol. 2.



Key to the dissected sheets of J. P. Lesley's unfinish'd map of 1853 in PRR Office.

and returning east as Buffalo mountain, to the river at Liverpool. The two mountains make a triangular cove, watered by Hunter's creek. Their crests rise about 1000′ above the river. The formation is 2000′ thick ; dipping in Berry mountain, 65°, N. 10° E, under the red shale (XI) of the cove. The top sandrocks are about 2000′ beneath the lowest anthracite coal beds of the Lykens Valley basin.

One small coal bed and probably others, exist in these Pocono rocks, but they are absolutely worthless. A drift was carried in at the end of Berry mountain 300 feet on one of these coal beds, which was reported to be 3′ thick at the heading. Prof. Claypole's section at the mouth reads as follows (F2, 154) :—Sandstone ; thin yellow sandstone, 8 inches ; *coal*, 1 inch ; soft green shale, 6 inches ; slaty *coal*, 1 inch ; red and green shales ; *coal*, 1 inch ; green shale, yellow ochre and plant remains. The coal is so soft, both at the mouth and at the end of the drift, that it is not true coal. It has what resembles shale flakes in it. The plant remains are so mashed and broken as to be indescribable, except fragments of *Calamites*. On one wall of the drift two impressions of *Calamites* were noticed, the larger one 3 feet long by 6 inches wide, perhaps *C. transitionis*, Goep. Also strong ribbed casts are common (only one rib in the middle). No roots or underclay are seen ; consequently the beds are not true coal beds, but mere layers of vegetable leaves floated into local pools of water, and matted and mouldered in decomposition ; and apparently all of one species ; as in a boggy pool in a pine forest of the present day.

These coal seams occur about in the middle of the Pocono formation, which agrees with the Sideling Hill section of Huntingdon county, to be next considered (F2, p. 155).

The high synclinal Pocono Sandstone Knob, overlooking Huntingdon, is a fine object. It corresponds to the high synclinal Pottsville Conglomerate Knob, which overlooks the Susquehanna. The Pocono formation was measured on the Susquehanna, 1950′ thick, and its massive sandrocks give the converging, Berry and Buffalo mountains lofty, sharp and nearly dead level crest lines, quite unbroken and impassable by roads, except at one place where a deep

CCXVII.


No. X. Pocono Sandstone.
Anticlinal arch of Chestnut Ridge.
Defile of the Conemaugh river.
Westmoreland Co.
BOLIVAR
No XII. Pottsville Conglom.
Knobs of 80° outcrops on the
east slope of Chesnut Ridge
Knobs of Mahoning
sandstone in the lower
Coal Measures of the
Ligonier Valley,
Westmoreland
County, Pa.
J. P. Lesley 1853

notch or wind gap occurs, traversed by no stream; but a rill starts in the middle of the notch and flows south; and here men have made a fruitless opening on a supposed coal bed, like those above described* (F2, 227).

Buffalo mountain is gapped at Liverpool, on the Susquehanna, and the views obtainable of the two mountains and two gaps are eminently picturesque.

X. Pocono in Huntingdon County.

The crests of Terrace mountain and of Sideling hill come together in the magnificent synclinal knob, rising majestically from the right bank of the Juniata river some miles below the city of Huntingdon, from the summit of which a superb panorama of mountain ranges and fertile valleys well repays the artist and geologist for the fatigues of the ascent. The Catskill terrace adorns the mountain slopes and sweeps around the knob, as described in preceding chapters in Vol. 2.

Coarse, pebbly, greenish-gray, false-bedded, massive sandstone strata, interstratified with thinner gray shales make up the mass. Thin seams of coal, varying from 1 to 6 inches in thickness, are seen at the "Copperas Rocks" in Trough Creek gap through Terrace mountain, half a mile below Paradise furnace, about 200′ beneath the top of the formation (as fixed by Prof. White).

The two sections which follow are recorded in Prof. White's report T3, pp. 79, 81, with a general cross-section on page 80, reproduced on a reduced scale on plate CCXI, page 1642 above.

Shoup's run gap section in Terrace Mtn.

Gray sandstone, massive, coarse, somewhat pebbly (*underlying red shale XI*),	210′
Gray sandstone, dark, with thin dark shales,	100′
Gray sandstones, massive, pebbly beds in a partly concealed interval of	250′
Gray sandstone flags and shales,	100′

* The celebrated Wind Gap of Lehigh county, may be likened to this notch, but is perfectly waterless, much higher and more difficult to explain, but an attempt to explain it will be made in the concluding chapters of the volume devoted to the deposits of the Ice Age.


Outcrop of the Pittsburg bed
CCXVIII.
No. XII Pottsville Cong. Knobs on west slope.
Westmoreland Co. Pa.
No. X. Pocono sandstone crest of Chesnut Ridge,
J. P. Lesley's
Ms. Map of 1853.

Red shale, ...	15′	
Greenish-gray sandstone, ...	55′	
Blue-black shale, with a few thin flags; (At the top, impressions of *Lepidodendron gaspianum*; In the bottom 25′ an abundance of fossil shells.)	100	
Gray sandstone, massive, ...	20	
Sandy shales, ...	10′	
Yellowish-gray sandstone, massive, ...	25′	
(Interval concealed), ...	145′	
GRAY SANDSTONE, MASSIVE, ...	100′	
		1130′
Green sandstone and *red shale* in a partly concealed interval of	125′	
Greenish-gray sandstone, massive, ...	25′	
Red shales visible in an interval of	75′	
Greenish-gray sandstone (making cliffs), ...	25′	
		250
Red shale of IX in great force.		

Riddlesburg gap section in Terrace Mtn.

Gray sandstone, massive (*under XI*), ...	75′	
Shale and sandstone, ...	13	
Shale, dark, ...	3	
Sandstone, ...	10′	
Shale, dark, with broken *plants*, ...	3′	
Gray sandstone, ...	25′	
(Interval concealed), ...	50′	
Gray sandstone, massive, ...	50′	
Black coal shale, ...	½′	
Sandy shales, ...	2½	
Pebbly sandstone, massive, ...	40′	
Shales and shaly sandstone, ...	8′	
Sandstone, massive (lower half *pebbly*), ...	65′	
Gray sandstone, with shale partings, ...	50′	
Calcareous breccia, ...	1½′	
Sandstones and shales interstratified, ...	30′	
Red shale, showing at the bottom of a concealed interval of	40′	
Shales, { yellowish, sandy, 15′; olive and yellow, 15′ }	30′	
Sandstone, massive, ...	50′	
Shales, olive-yellow, ...	15′	
Sandstone, gray, ...	5′	
Shales, yellowish, sandy, ...	40′	
Sandstone, gray, ...	2½′	
Shales, dark, very *fossiliferous* (in the bottom 10′ *Spirifer*, *Rhinchonella*, *etc.*), ...	50′	
Sandstone, massive, ...	10′	
Shales, { sandy, ... 10′; red, yellow, etc., 35 }	45	
Sandstone, *very massive*, ...	30′	
		744′


CCXIX
Loyalhanna
river
Pittsburg coal
outcrop.
Chestnut Ridge
west slope
J. P. Lesley. 1853

Red shale, abundant in a partly-concealed interval of	95	
Shales and flags, ...	50′	
Red and yellowish shales, ...	25′	
Sandstone, gray, ...	8	
Red shale, ...	20′	
Sandstone, gray, ...	5	
Red shale, ...	10′	
Red sandy beds, ...	5′	
GRAY SANDSTONE, MASSIVE; including one *calcareous breccia* (3′ to 4′) 40′ above the bottom; and several other smaller ones, ...	140′	
		358′
Red shale, ...	100′	
Sandstone, greenish gray, ...	25′	
Red shale, ...	20′	
Sandstones, green, with *red shale partings*, ...	65′	
Red shale, ...	125′	
Red sandstone, ...	5′	
		340′

Red shale of No. IX in great force.

The above sections are subdivided into groups, the uppermost of which consists of *Pocono rocks* with little or no red shale; the middle one of *Pocono rocks*, with interstratified red shales, ending below in a massive gray sandstone of great thickness; and the lowest one of *Catskill rocks*.

	Shoup's run.		*Riddlesburg.*	
Upper group, X, ...	730′	1130′	744′	1102′
Middle group, X, ...	400′		358′	
Lower group, IX, ...	250′		340′	

The 100′ massive gray sandstone at Shoup's run gap is undoubtedly the 140′ massive gray sandstone (with calcareous breccias) at Riddlesburg gap, in both cases 1000′ below the bottom red shale of XI, and the lowest well defined gray Pocono sandstone of Terrace mountain (T3, 83).

X. Pocono in Sideling Hill.

In Sideling Hill Ashburner and Billin's section was facilitated by an examination of the East Broad Top Railroad tunnel, and furnished the most interesting and instructive data we have respecting the character of the Pocono formation No. X. This section is exhibited in columnar form in plates CCXI, CCXII, pages 1642, 1644 above. They are taken from Report F, plate 21, p. 206. The description which follows is condensed from Mr. Ashburner's report, pp. 206 to 216.


CCXX (A)
No. XIV. Pittsburg Series, or
Barren Coal Measures,
in the Ligonier Valley of
Westmoreland Co. Pa.
J. P. Lesley. 1853.
LOCKPORT
CENTER

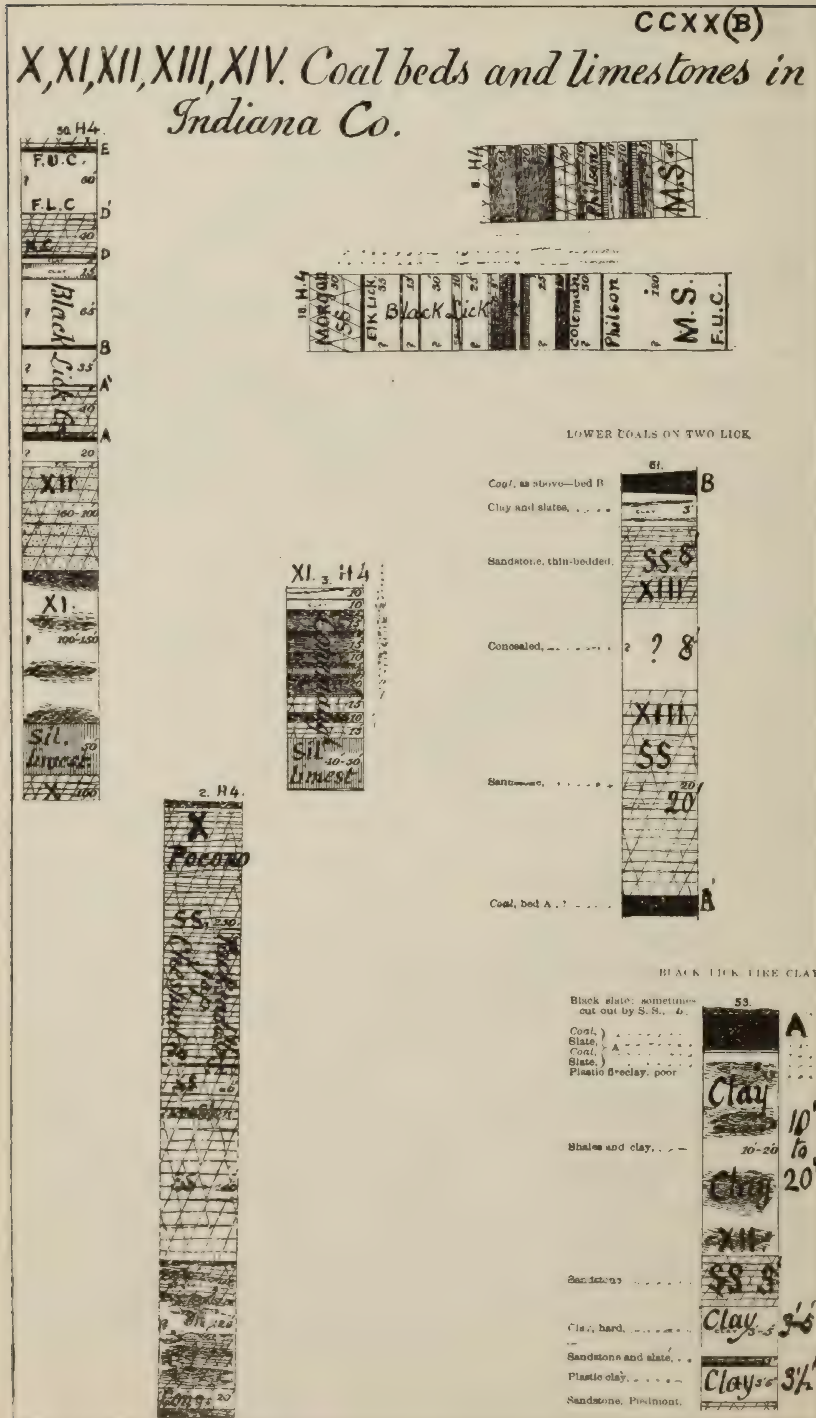
The whole formation was divided by Ashburner into —*Upper Xd* massive and flaggy sandstone beds, 610′;—*Middle*, *Xc*, coal series, 313′, and *Xb*, false-bedded sandstones, with conglomerate beds, 380′;—*Lower*, *Xa*, sandstones and shales, 830′;—total 2133′ thick.

Xd. Upper Gray Sandstone Group.

	Feet.
(Partly concealed.) Composed, for the most part, of hard, coarse-grained, massive, brownish-gray and gray sandstone, alternating with thinly bedded and flaggy sandstone, and shale of the same color. Near the top of the mass are a few beds of red shale and sandstone,	580.
Massive gray sandstone surfaces, coated with ferric oxide, at the west end of Sideling Hill tunnel,	8. 0
Alternating massive gray and greenish-gray sandstone, containing a twelve-inch seam of black slate, showing impressions of minute plants,	22. 0

Xc. New River Coal Series.

Massive gray sandstone, containing thin partings of coal,	29. 0
Gray argillaceous sand,	0. 5
Coal (Seam No. 19),	0. 2½
Soft greenish-gray micaceous shale.	1. 3
Light gray, massive sandstone, containing thin plates of coal and micaceous specks,	56. 0
Sandstone, containing thin partings of coal,	1. 0
Soft, loose sandstone, containing seams of coal, running irregularly through the mass, amounting in all to about 5 inches,	6. 0
Massive sandstone, containing in its lower part plates of coal,	12. 0
Poor bony coal (Seam No. 18),	0. 2
Sandstone,	1. 6
Argillaceous sand,	0. ¼
Coal (Seam No. 17), maximum thickness, 9 inches,	0. 3
Argillaceous sand, containing plates of coal,	0. 4
Gray sandstone, containing between the strata a great deal of loose sand,	15. 0
Gray sandstone, containing nodules of pyrites and plates of coal in the upper portion of the mass,	26. 0
Coal very much broken up (Seam No. 16),	0. 1
Sandstone containing nodules of iron pyrites,	2. 6
Coal (Seam No. 15); brilliant luster, rhombohedral fracture, resembling bituminous coal,	0. 1
Sandy fireclay,	0. 6
Coal (Seam No. 14),	0. 1
Sandstone, with thin partings of coal in the lower portion,	4. 0
Sandstone,	9. 0
Fireclay,	0. 1
Shaly sandstone,	34. 0


CCXX(B)
X, XI, XII, XIII, XIV. Coal beds and limestones in Indiana Co.
LOWER COALS ON TWO LICK
Coal, as above—bed B
Clay and slates,
Sandstone, thin-bedded,
Concealed,
Coal, bed A, ?
BLACK LICK FIRE CLAY
Black slate; sometimes cut out by S. S.,
Coal,
Slate,
Coal,
Slate,
Plastic fireclay, poor
Shales and clay,
Clay, hard,
Sandstone and slate,
Plastic clay,
Sandstone, Piedmont.

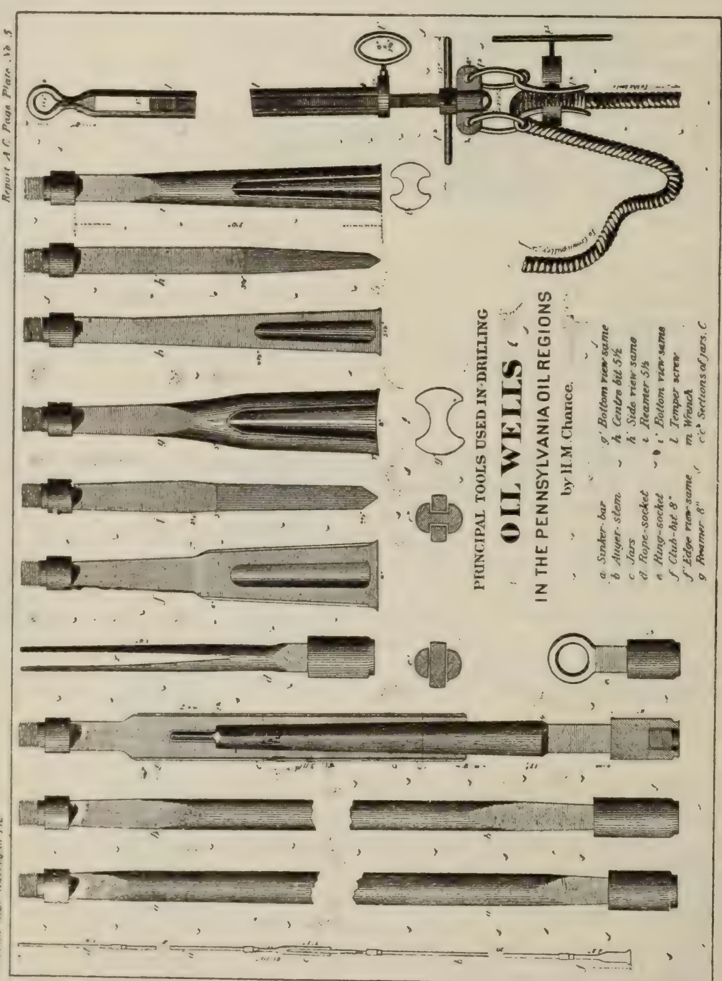
Coal (Seam No. 13),	0. 1
Alternating shaly and massive, gray sandstone,	6. 0
Poor bony coal (Seam No. 12,)	0. 3
Shaly sandstone,	6. 0
Coal (Seam No. 11) ; very much broken up and associated with red sand,	0. 1
Shaly sandstone,	4. 0
Coal (Seam No. 10), maximum thickness 6 inches,	0. 3
Shaly sandstone,	2. 0
Coal (Seam No. 9),	0. 1
Shaly sandstone,	1. 0
Coal, with sandstone above and below (Seam No. 8),	0. 1
Gray sandstone,	36.
Steel-gray shale, of a greasy luster,	0. 8
Coal (Seam No. 7),	0. 1
Fireclay,	0. 1
Sandstone,	5. 0
Coal (Seam No. 6),	0. 1
Sandstone,	0.10
Coal (Seam No. 5), resembling very much specimens from Montgomery county, Virginia,	0. 2
Soft sandstone,	0. 5
Coal (Seam No. 4),	0. 2
Sandstone, containing loose brown, argillaceous sand,	14. 0
Loose sand shale, surfaces coated with acicular crystals of sulphate of alumina, formed by the decomposition of pyrites,	3. 0
Coal ; very much broken up by false bedding, and containing a great deal of iron pyrites (Seam No. 3),	0. 2
Massive, gray sandstone, having a rhombohedral fracture, and containing specks of slate and ferruginous matter,	28. 0
Coal (Seam No. 2) ; very much broken up by false bedding,	0. 1
Soft, gray, shaly sandstone, exhibiting false bedding,	5. 0
Poor bony coal (Seam No. 1),	0. 1

Xb. Middle Conglomerate Group.

Soft, black shale, containing plates of coal and impressions of minute plants, surfaces stained with ferric oxide ; alternating with a fine-grained conglomerate, containing micaceous specks,	25. 0
Yellowish-gray, argillaceous shale, containing thin plates of coal. Surfaces showing "slicken sides."	26. 0
Sandstone,	9. 0
Black, carbonaceous slate, enclosed in hard massive sandstone,	0. 2
Hard, massive, gray sandstone,	17. 0
Hard, conglomeritic, light-gray sandstone, containing a few alternations of black slate,	51. 0
Hard, massive sandstone, alternating with gray slaty micaceous sandstone,	45. 0
Soft, gray shale,	1. 0
Alternating dark gray, flaggy and slaty sandstone, containing micaceous scales,	33. 0
Dark-gray, argillaceous shale, with talcy luster,	39. 0

CCXX(c)

X. Oil well boring tools



Dark greenish-gray shale, with talcy luster, containing acicular crystals of sulphate of alumina, formed by the decomposition of pyrites,	0.10
Soft, black slate,	0. 3
Massive, gray sandstone,	3. 0
Soft, gray, argillaceous shale,	5. 6
Massive, hard, gray sandstone,	25. 0
Fine-grained, light-gray conglomerate, alternating with thin strata of black micaceous sandstone,	13. 0
Fine-grained, dark gray, argillaceous shale, alternating with a hard, gray sandstone, interstratified with a black micaceous sandstone,	26. 0
Massive, flinty, gray sandstone, alternating with yellowish-gray sandstone, showing false bedding,	17. 0
Soft, gray shale,	1. 3
Hard, gray sandstone,	1. 6
Soft, gray shale,	1. 6
Soft, yellowish-gray shale, of a talcy luster,	1. 6
Very hard, massive bluish-gray sandstone, with occasional seams of a lead-colored clay,	4. 0
Hard, massive, gray sandstone,	13. 0
Gray, slaty sandstone,	0.10
Carbonaceous shale,	0. 5
Gray shale,	0. 3
Black coal slate,	0. 2
Gray sand shale,	3. 4
Black slate,	0. 4
Hard, massive, gray sandstone, alternating with yellowish-gray, argillaceous sand shales,	15. 0

Xa. Lower Green Sandstone Group.

Dark bluish-gray, slaty sandstone, alternating with a shale of close texture,	22.
Alternating gray, green, and yellow shale,	25.
Green shale, containing *Cypricardina* and *Orthis*, at the east end of Sideling Hill tunnel,	5.
Partly concealed. Alternating as above, but softer,	25.
Hard, coarse-grained, reddish-gray sandstone, alternating with soft, yellow, sandy shale,	165.
Coarse-grained, yellow sandstone. Surfaces stained with iron, alternating with grayish-brown sandstone,	12.
Alternating yellow, gray and green, shaly sandstone,	44.
Soft, yellow, sandy shale, interstratified with a gray, flaggy sandstone, alternating with a brown sandstone, containing micaceous specks,	50.
Flaggy, olive sandstone, alternating with a greenish-gray sandstone, containing iron concretions. Partly concealed,	42.
Partly concealed. Soft, green and olive sandstone, alternating with soft, yellow, flaggy and hard, massive, gray sandstone, containing ferruginous specks, and having a distinct rhombohedral fracture,	440.

XI, XII. The Kettle and Mauchchunk.

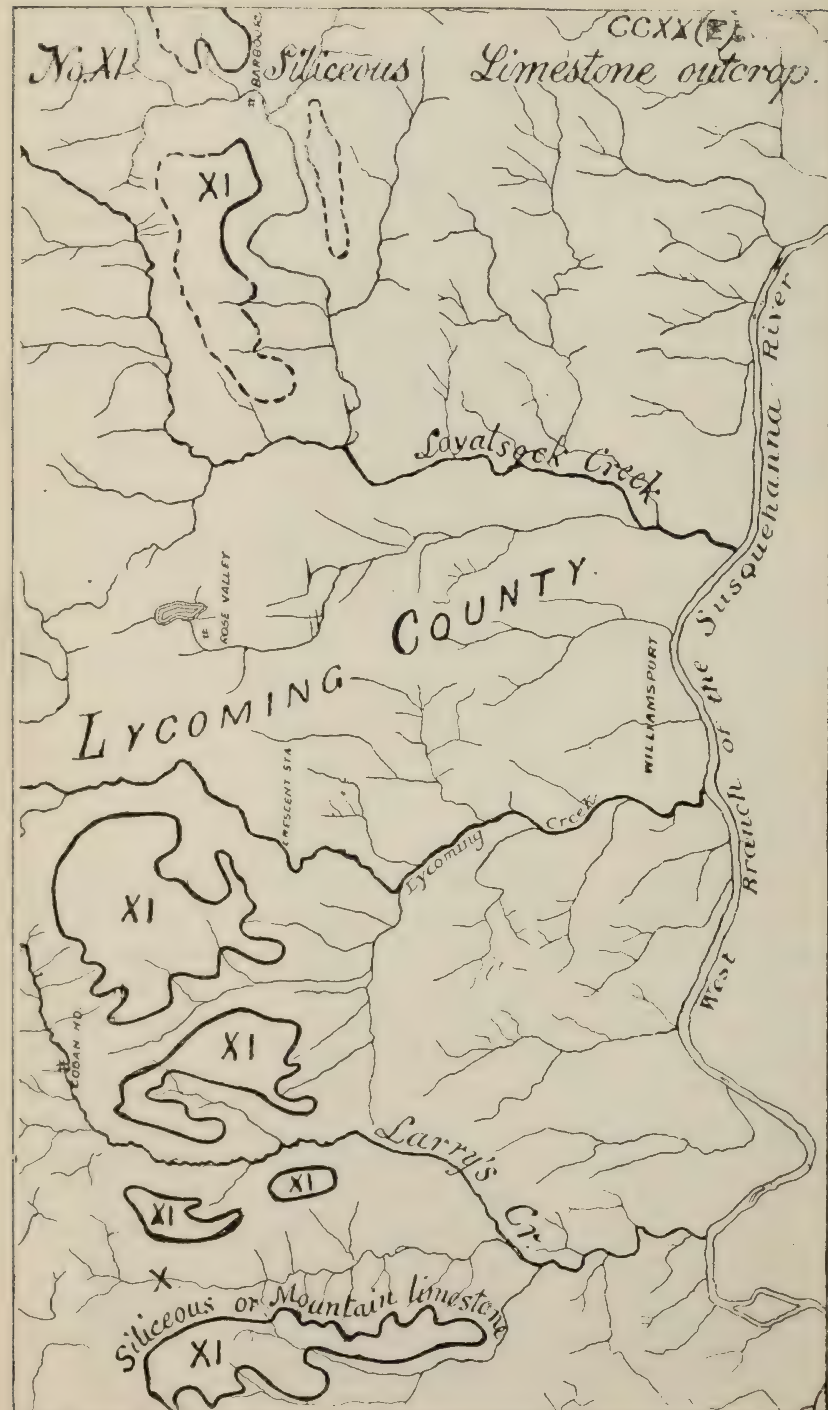
Nineteen (19) seams of coal were cut by tunnel, with an *average* individual thickness of only 1½ inches. All put together, increased by numerous mere streaks of coal not noticed in the section, would not make more than a coal bed four (4) feet thick. The following are their thicknesses (beginning at the top) and their distances apart (in parentheses): 2½″ (76′) 2 (1½) 3 (41) 1 (2½) 1 (½) 1 (47) 1 (6) 3 (6) 1 (4) 3 (2) 1 (1) 1 (37) 1 (5) 1 (1) 2 (½) 2 (17) 2 (28) 1 (5) 1″ (25′ black-slate plant bed). In all instances the intervals (given in parentheses) are of sandstone, except the 5′ of "*fireclay* and sandstone" between beds 6 and 7, and the 6″ of "*sandy fireclay*" between beds 14 and 15 from the bottom.

Grouping the coal beds which lie close together, we have the following series:

Sandstone, top of the series,	29′ 5″
One coal bed, 2½ inches thick.	
Sandstone, mass of,	76′ 3″
Two coal beds, in 24 inches of space.	
Sandstone, mass of,	41′ 4′
Two coal beds in 3′ 3″ of distance,	
Sandstone mass of,	47 1′
Six coal beds in 19′ 10″ of distance,	
Sandstone mass of,	36′ 8
Four coal beds in 6′ 10″ of distance,	
Sandstone mass of,	17′ 0′
One coal bed 2 inches thick,	
Sandstone mass of,	28′ 0′
Two coal beds in 5′ 2″ of distance.	

The sandstone between the several seams has a great sameness of character, and is very much broken up by false bedding and fractures; in many cases it contains thin seams or partings of coal. The numbered seams and partings generally lie parallel with the true bedding of the strata, although in many instances *they are found along the planes of false bedding.* The thicknesses are very variable, in places increasing from 1 and 2 inches up to 10 inches and 1 foot; and sometimes a seam will be very much broken up and separated by a mass of sandstone, which splits the bed for some distance, but afterwards disappears, permitting the several portions to unite again.

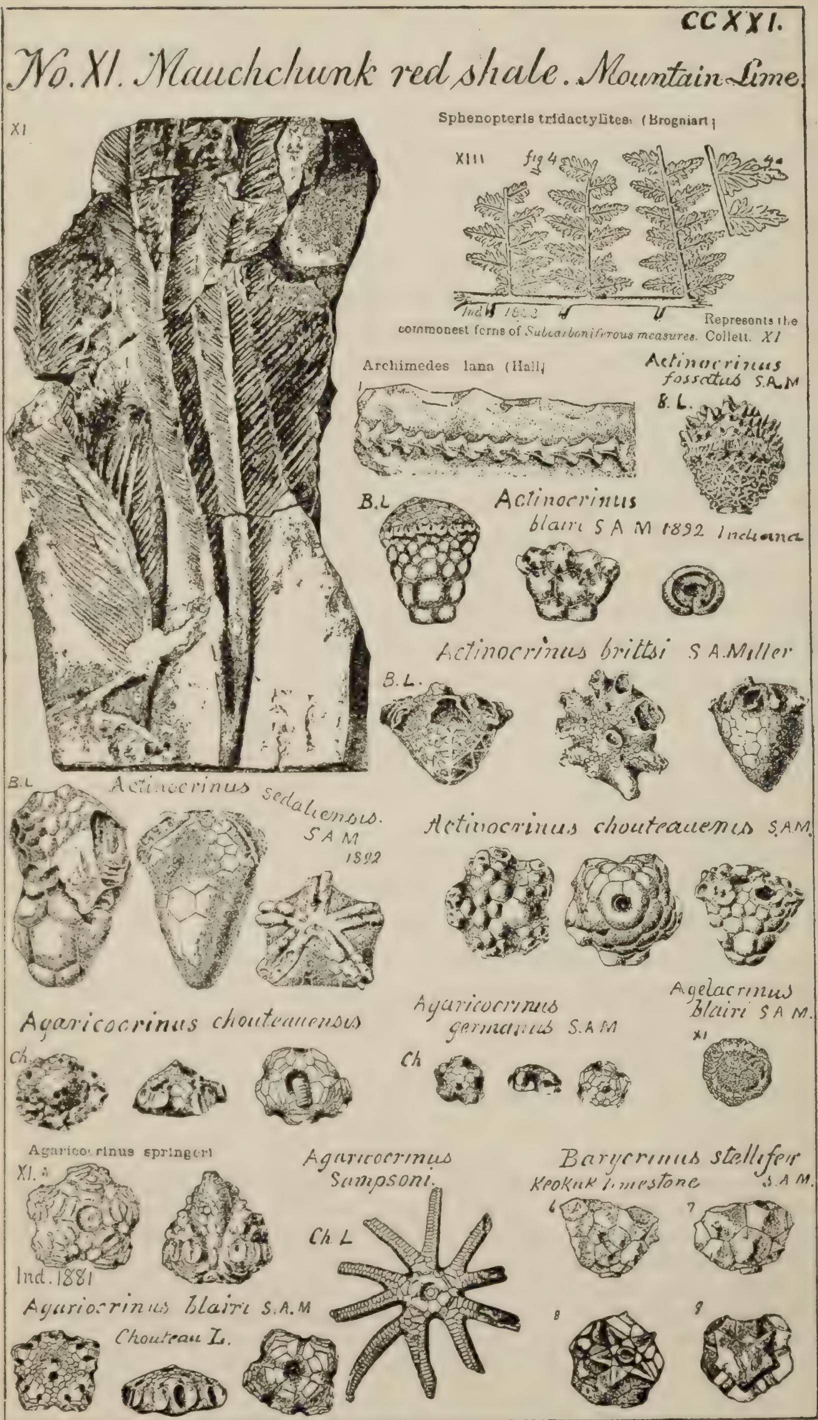
The almost total absence of fireclays under the coal seams, and the occurrence of coarse sandstone in many places di-


CCXX(E).
No. XI Siliceous Limestone outcrop.
BARBOURS
XI
Loyalsock Creek
ROSE VALLEY
LYCOMING COUNTY
CRESCENT STA
WILLIAMSPORT
West Branch of the Susquehanna River
Lycoming Creek
XI
COGAN HO.
XI
Larry's Cr.
XI
XI
Siliceous or Mountain limestone
XI

rectly above them seems to show that the coal has been derived from plants which may have grown at some distance from the locality and been afterwards floated and caught in the falling sediment, forming "drift beds." The period was undoubtedly one of continuous local current agitation as indicated by the coarseness and false bedding of many of the strata.

Xb. The lower part of the middle member is characterized more particularly by its beds of conglomerate and conglomeritic sandstone, both of which exhibit false bedding in a marked degree. At the top of it, directly under the coal seam, comes a bed 25 feet thick, composed of soft black shale containing plates of coal and impressions of minute plants, alternating with a fine-grained conglomerate which contains micaceous specks. The surfaces of the shale are very much stained with iron. Directly below these alternating beds occur (No. 156) 26 feet of a yellowish-gray argillaceous shale also containing plates of coal and showing slickensides, giving evidence of some contortion and slipping of the strata. A massive sandstone 9 feet thick, is separated by 2 inches of black carbonaceous slate from 113 feet of hard, massive and conglomeritic sandstone *showing a greater amount of false bedding than any other part of the section.* One bed contains a few alternating beds of black slate, but is as a whole the hardest and most massive part of the Pocono series, and forms the crest of Sideling Hill, apparently throughout its whole extent. Below these harder and more massive strata are 82′ of shale, with a few beds of sandstone; the whole underlaid again by 25 feet of hard, massive sandstone and 13 feet of fine-grained conglomerate containing thin beds of black micaceous sandstone. Then succeed in descending order, more shales and sandstones.*

* The sandstones have a general sameness, and are falsebedded and fractured, often containing thin seams of coal, which usually lie parallel to and between the sandstone beds, *but in many instances follow the planes of false bedding, showing them to be seams of drifted coal stuff and not true coal beds.* They vary from 1 to 2 inches, but sometimes swell to 10″ or a foot; and sometimes a seam is broken up and separated by a wedge of sandstone for some distance, and then becomes solid again. In the tunnel of


CCXXI.
No. XI. Mauchchunk red shale. Mountain Lime.
XI
Sphenopteris tridactylites. (Brogniart)
XIII
fig 4
Represents the commonest ferns of Subcarboniferous measures. Collett. XI
Archimedes lana (Hall)
Actinocrinus fossatus S.A.M
B. L.
B.L
Actinocrinus blairi S A M 1892 Indiana
Actinocrinus brittsi S A Miller
B. L.
B.L
Actinocrinus sedaliensis. S A M 1892
Actinocrinus chouteauensis S.A.M.
Agaricocrinus chouteauensis
Ch.
Agaricocrinus germanus S.A.M
Ch
Agelacrinus blairi S A M.
XI
Agaricocrinus springeri
XI.
Ind. 1881
Agaricocrinus Sampsoni.
Ch. L
Barycrinus stellifer S.A.M.
Keokuk Limestone
6
7
8
9
Agariocrinus blairi S.A.M
Chouteau L.

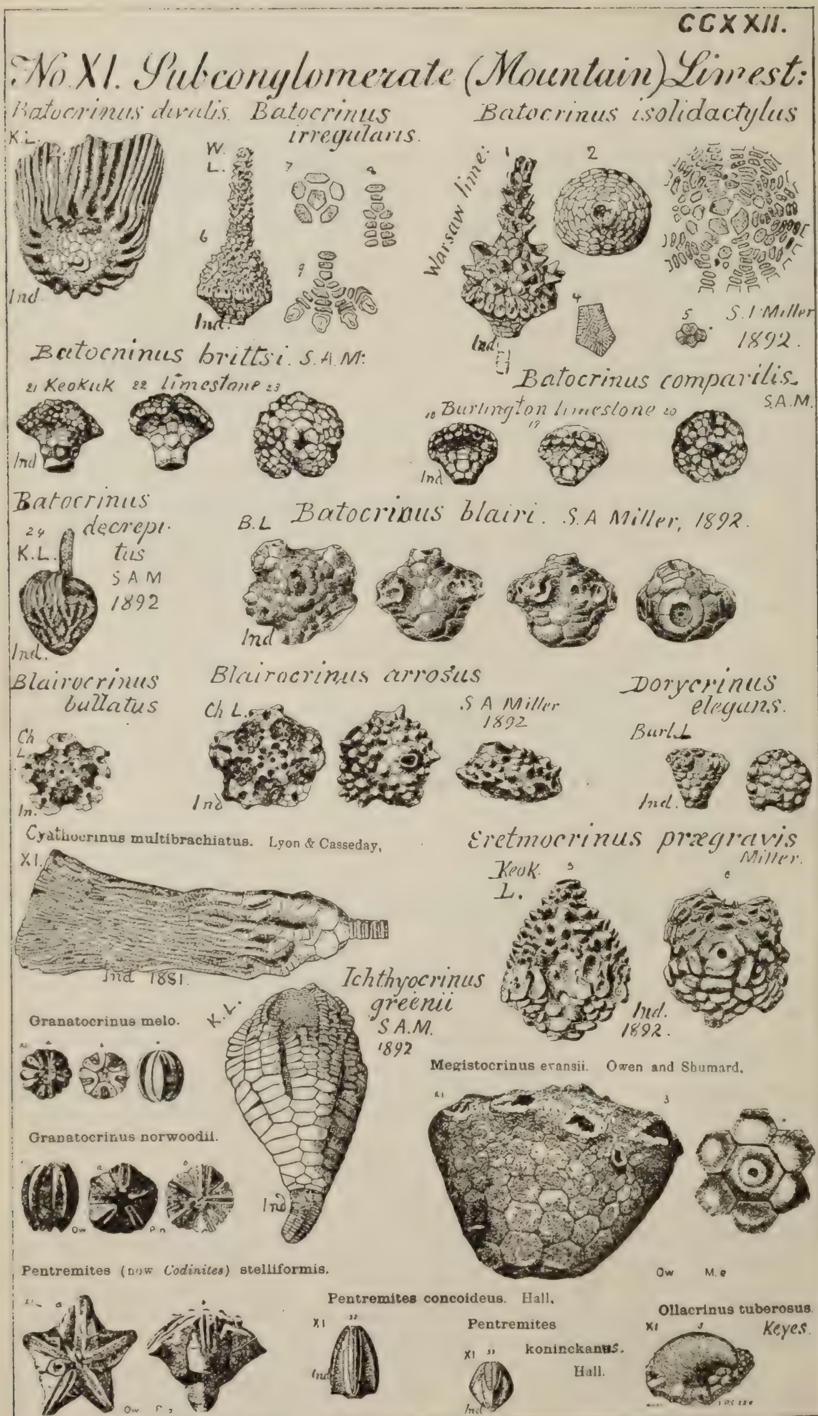
The alternations of shales and sandstones in this subdivision of the formation may be thus grouped as measured feet, the shale groups being in parentheses (31) 122 (83) 38 (26) 40 (5) 15, 380′.*

Fossil plants, the broken remains of a land vegetation, are scattered more or less abundantly throughout the sandstones and slates and shales of the top subdivision *Xd*, and the Coal series *Xc* under it. Lesquereux examined specimens collected from the *dèbris* at the west end of the tunnel, and determined among them :—*Sphenopteris flaccida*, of the Upper Catskill of Belgium, not before found in America.—*Ulodendron* (near to *U. majus*), found in Sub-Cong. coal of Alabama, and also in and above the Conglomerate.—*Knorria acicularis*, Gœppert, new to America.—*Stigmaria minuta*, found in X at Mauch Chunk.—*Stigmatocanna Volkmanniana*, bark destroyed.—A *Lepidodendron*, so distorted as to prevent the outlines of the scars from telling the species.

Dark shales ; olive and reddish marlites, ...	30′	135
Firm, thick-bedded dark shale, *Local coal bed*, 12 inches thick, ...	10′	
Firm, siliceous, rather coarse, bluish-gray sandstone, holding bits of lower rock, drifted stems and coal beds.		
White, pebbly, silicious sandstone, very persistent, concealing the underlying rocks, and having themselves a thickness of at least, ...		60′
Interval of flaggy sandstones and inter-stratified shales, dingy yellow when freshly fractured, and weathering brown ; down to the red marls and sands of the Catskill formation No. IX, ...		500

the South Pennsylvania Railroad through Sidding Hill, Mr. F. H. Lewis, Asst. Eng., reports cutting (at the west end) several coal beds, each about 1′ thick. These are the enlargements of the E. Broadtop Railroad tunnel coals of Ashburner's section, going south. In Carbon and Luzerne counties such "coal smuts" in the Nesquehoning and in the North mountains, in formation No. X, at numerous places have in past years led to much fruitless digging.

*In studying the Wythe county mines of southern Virginia I found a dozen small unworkable coal beds in the Pocono rocks on the northwestern slope of Peak mountain. See my paper in the Proceedings of the American Philosophical Society of Philadelphia.—See also a much later and very interesting section of Pocono coal beds cut by the Lewis tunnel of the Chesapeake and Ohio RR. through the Allegheny mountain, published by Prof. Fontaine in Silliman's Journal for 1877 :—

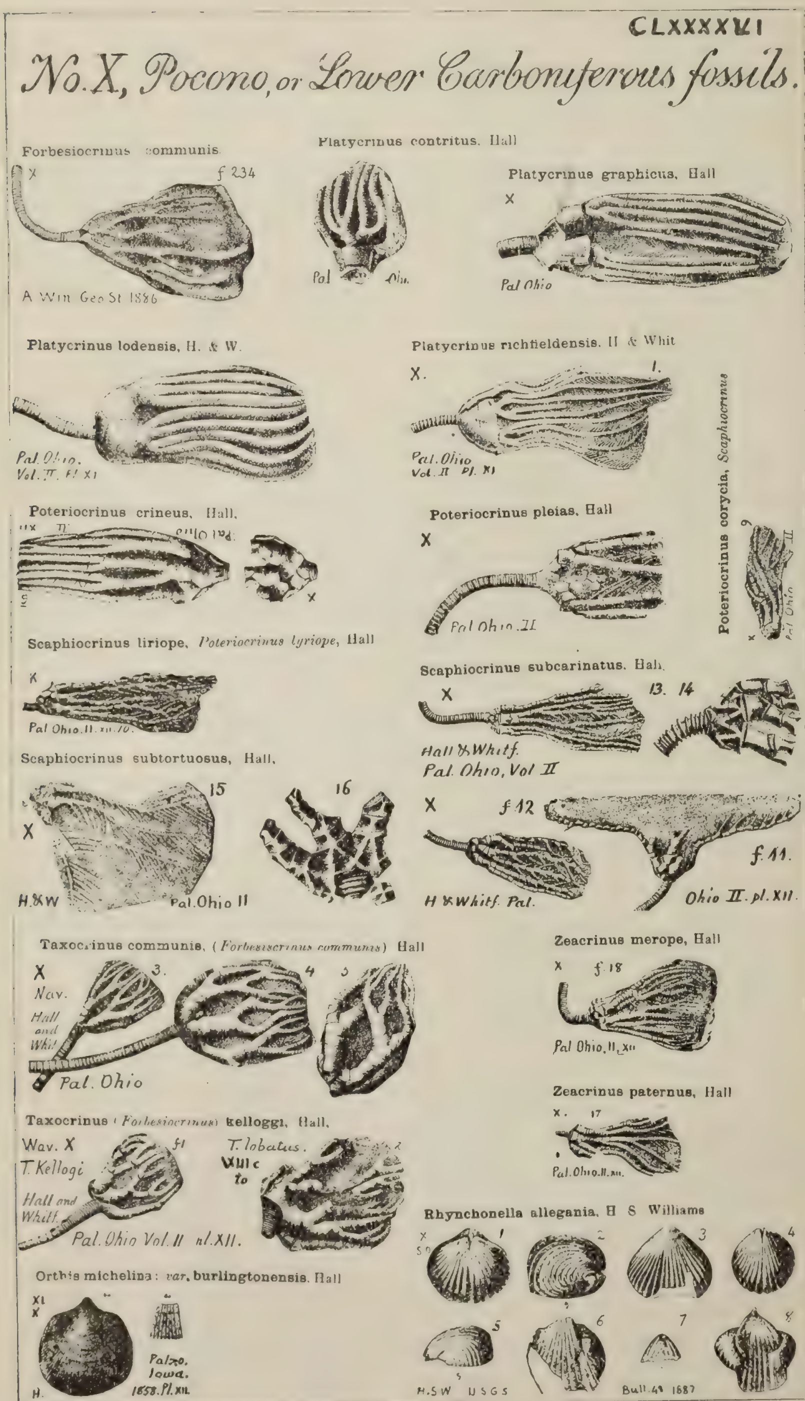

CCXXII.
No. XI. Subconglomerate (Mountain) Limest:
Batocrinus dividis.
K.L.
Ind.
Batocrinus irregularis.
W. L.
Ind.
Batocrinus isolidactylus
Warsaw lime:
Ind.
S. A. Miller 1892.
Batocrinus brittsi. S.A.M.
Keokuk limestone
Ind
Batocrinus comparilis.
S.A.M.
Burlington limestone
Ind
Batocrinus decreptus
K.L.
SAM 1892
Ind.
B.L
Batocrinus blairi. S.A Miller, 1892.
Ind
Blairocrinus bullatus
Ch L.
In.
Blairocrinus arrosus
Ch L.
S A Miller 1892
Ind
Dorycrinus elegans.
Burl. L.
Ind.
Cyathocrinus multibrachiatus. Lyon & Casseday,
XI.
Ind 1881.
Eretmocrinus prægravis Miller.
Keok. L.
Ind. 1892.
Ichthyocrinus greenii S.A.M. 1892
K.L.
Ind
Granatocrinus melo.
Granatocrinus norwoodii.
Megistocrinus evansii. Owen and Shumard.
Pentremites (now Codinites) stelliformis.
Pentremites concoideus. Hall.
Pentremites koninckanus. Hall.
Ollacrinus tuberosus. Keyes.
XI
Ind

Black sandy slates, ...	15	
Sandstone, ...	3	
Coal, slaty, 6 inches thick.		
Fireclay containing rootlets, ...	5′	
Coal, 2 inches thick.		
Fireclay, 1 inch thick.		
Gray sandstone, with films and streaks of coal (floated),	30′	
Black slate and coal, 12 inches thick.		
Brown flaggy sandstone, ...	3′	215′
Coal, 8 inches thick.		
Fireclay, 5 inches thick.		
Bluish-black sandy shales, ...	5′	
Gray flags, ...	50′	
Interval (?) feet thick.		
Olive sandstone, ...	20′	
Argillaceous thickly bedded sandstone, with thin films of coal and black shale, ...	40′	

All the fragments were twisted and coated with coal as hard graphite. *S. flaccida* and *S. minuta* predominate and are abundant. Two years afterwards (1877) another larger collection submitted to Lesquereux mostly represented one species, *S. phenopteris* (*Hymenophyllites*) *furcata*, Brongt. found by him (1851) in No. X at Mauch Chunk, and not rare in the Lower Carboniferous. The tunnel however furnished better specimens than he had ever seen, "large stems, branches and even roots."

Analyses of these coals yielded to Mr. McCreath:—Water, 34, 35, 47;—Volatile matter, 13.66, 16.29, 21.34;—Fixed carbon, 53.29, 61.78, 51.97;—Sulphur, 46, 7.18, 1.03;—Ash, 32.24, 14.39, 25.18. The *red* ash of the second specimen gave:—Iron 6.25;—Sulphur taken up by the iron, 7.145.—It is evident that such ashy beds, with no fireclay floors, must have been drift deposits, and not marsh or peat-bog coal beds, like those of the true Coal Measures which lie far above them geologically, and are mined by the Rockhill I. & C. Co. at the terminus of the line.

The lower sub-division *Xa* resembles the upper *Xd*; but the sandstone beds are not as massive, nor as siliceous; they are softer, coarser in grain, stained with iron, and specked with red and yellow spots. The shales of both kinds, argillaceous and silicious, alternate more frequently with the sandstone beds. Both sandstones and shales are gray, yellow, olive and green. Iron concretions are fre-


CLXXXXVI
No. X, Pocono, or Lower Carboniferous fossils.
Forbesiocrinus communis.
f 234
A Win Geo St 1886
Platycrinus contritus. Hall
Pal Ohio
Platycrinus graphicus. Hall
Pal Ohio
Platycrinus lodensis, H. & W.
Pal. Ohio. Vol. II. Pl. XI
Platycrinus richfieldensis. H & Whit
Pal. Ohio Vol. II Pl. XI
Poteriocrinus corycia, Scaphiocrinus
Poteriocrinus crineus, Hall.
Poteriocrinus pleias, Hall
Pal Ohio. II
Scaphiocrinus liriope, Poteriocrinus lyriope, Hall
Scaphiocrinus subcarinatus. Hall.
13. 14
Hall & Whitf.
Pal. Ohio, Vol II
Scaphiocrinus subtortuosus, Hall,
15
16
H. & W
Pal. Ohio II
f 12
f. 11.
H & Whitf. Pal.
Ohio II. pl. XII.
Taxocrinus communis, (Forbesiocrinus communis) Hall
Wav.
Hall and Whitf
Pal. Ohio
Zeacrinus merope, Hall
f 18
Pal Ohio. II. XII
Zeacrinus paternus, Hall
17
Taxocrinus (Forbesiocrinus) kelloggi, Hall.
Wav.
T. Kellogi
Hall and Whitf.
Pal. Ohio Vol. II pl. XII.
T. lobatus.
Rhynchonella allegania, H S Williams
1
2
3
4
5
6
7
8
H.S.W U.S.G.S
Bull. 41 1887
Orthis michelina: var. burlingtonensis. Hall
Palæo. Iowa. 1858. Pl. XII.

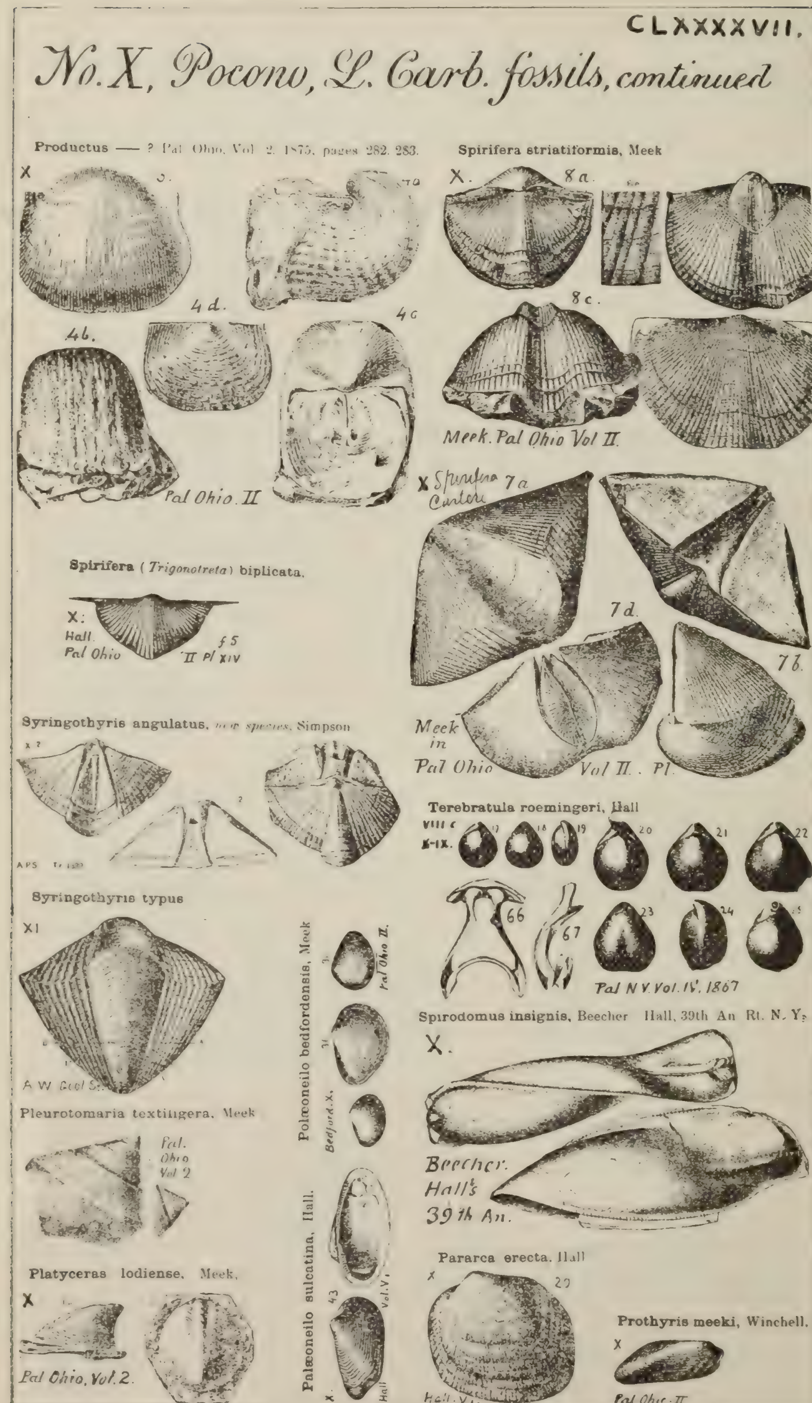
quently found in them. The horizon between the Catskill IX and Pocono X is not distinctly marked, but in a general way the first is more red and the second more gray; while the upper beds of IX are more argillaceous than the lower beds of X.

Pocono coals on Tipton run.

The upper escarpment of the Allegheny mountain, its whole length, is a bold outcrop of the Pocono formation, dipping gently northwest beneath the great Bituminous coal fields of western Pennsylvania. This outcrop is cut through by the numerous ravines that descend from the general upland. Between each ravine projects a lofty spur of Pocono sandstone; as shown by Lehmann's noble pictures for the First Survey, two of which are reproduced on a reduced scale in plates CCXIII (B) and CCXVII (C) on pages 1648, 1650, above; one taken from the hills at Hollidaysburg in Blair county; the other from Jersey Shore at the mouth of Pine creek in Lycoming county. A hundred other striking views of the same character might be made from points high and low along the line of a hundred miles from the Maryland line to Muncy.

In many of these ravines traces of the outcrops of thin seams of Pocono coal have, from time to time in the last fifty years, been discovered, many of which have been dug into in the vain expectation of opening workable coal mines. In one of them only has a measure of success rewarded the explorers. This is the ravine of Tipton run, a few miles northeast of Altoona. Here actual mining operations have been carried on, a branch road laid from the Pennsylvania Railroad at Tipton station, and thousands of tons of good coal put out and sent to market. It is the only case with a history similar to that of the Tom's Run mines in Wythe county, Va.*

* Although the geology of the place was made out by a careful survey nearly forty years ago, at the first unsuccessful opening of two small coal beds, the knowledge was lost; so that when operations of a more serious character were undertaken a few years ago, the wild idea was entertained that the coal beds were those of the true coal measures of Cambria and Clearfield counties thrown down nearly a thousand feet by an assumed fault


CLXXXXVII.
No. X, Pocono, L. Carb. fossils, continued
Productus —— ? Pal. Ohio, Vol. 2. 1875, pages 282. 283.
4 d.
4b.
4c
Pal Ohio. II
Spirifera striatiformis, Meek
8 a.
8 c.
Meek. Pal Ohio Vol II.
Spirifera Carteri
7 a
7 d.
7 b.
Meek in Pal Ohio Vol II. Pl.
Spirifera (Trigonotreta) biplicata.
Hall. Pal Ohio
II Pl XIV
Syringothyris angulatus, new species, Simpson
Terebratula roemingeri, Hall
66
67
Pal N Y Vol. IV. 1867
Syringothyris typus
Pleurotomaria textiligera, Meek
Pal. Ohio Vol 2
Platyceras lodiense. Meek.
Pal Ohio, Vol. 2.
Polæoneilo bedfordensis, Meek
Pal Ohio II.
Palæoneilo sulcatina, Hall.
Spirodomus insignis, Beecher Hall, 39th An Rt. N. Y.
Beecher. Hall's 39th An.
Pararca erecta. Hall
Prothyris meeki, Winchell.
Pal Ohio II

The Tipton mines are in coal beds lying about 700 feet beneath the Conglomerate No. XII which crops out in the spurs at the top of the mountain, with a dip of only one or two degrees (*i. e.* nearly horizontal) towards the west; and immediately under it lies the Mauch Chunk Red Shale formation No. XI, 250′ thick. Under this lie the current bedded Pocono sandstones, No. X, down to the coal beds; which therefore occupy precisely the position of the Sideling Hill Tunnel coal series (*Xc*) as above described; only, that in Huntingdon county the interval from the bottom of XI down to the coal series (*Xc*) is 610′, while in Blair county it is somewhat less; which agrees with the general thinning of all the formations westward.*

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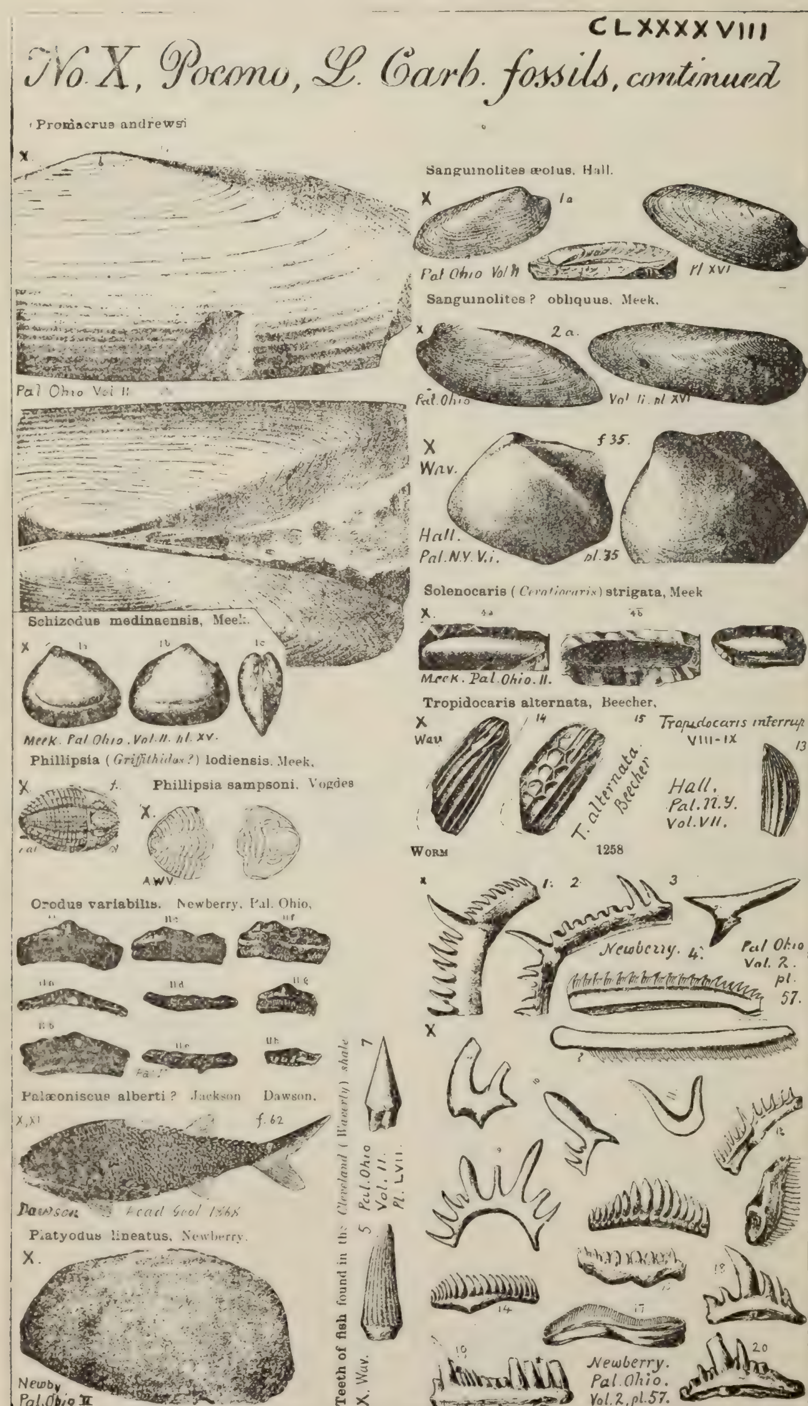
running along the face of the mountain. As some of the layers of the Pocono formation are coarse and even conglomeratic, like those of the lower coal measures, and as some of the plant remains are of species which subsisted into a later age, and are found in beds of the true Coal Measures, the notion of a fault was supported by even one good geologist, and has been dispelled only by experience. It was not considered that had such a downthrow fault really existed it would unmistakably have manifested its presence, by not only doubling the coal beds, but doubling the mountain and all its spurs, besides producing a flagrant deflection of the valley at its foot; making such a bold topographical mark upon the State Map as would have arrested the attention of the Assistants on the First Survey, and been studied until its explanation had been made sure.—In 1885, Mr. Ashburner, who had reported in such detail on the Pocono coals of Sideling Hill in Huntingdon county, at the E. Broad Top RR. Tunnel, as above described, was ordered to make a careful special study of the Tipton coals, and his elaborate report will be found in the Annual Report of Survey for 1885 (1886), pages 250 to 268, from which the condensed statement is made in the text above.

* Mr. Sanders' section along the Pa. RR. from the Tunnel down to Altoona, reads: XIII, Allegheny Coal Series, 345′; XII, Pottsville Conglomerate, 223′; XI, Mauch Chunk, 283′; X, Pocono, 1241′; IX, Catskill 2560′; VIII, Chemung, etc 6519′. The dip (westward) is at the Tunnel, the top of the section, only 1°; gradually increasing to 18° at the Kittanning Point horseshoe curve, and to 32° at the base of the mountain. Bear Pen Point, the top of the mountain at the head of Tipton Run, is 2382′ above tide, and the Loop Run (Tipton) coal mine, a mile further east, is 1370′ A. T. At Bear Pen Point the westward dip is about 1°; at the coal mine it has gradually risen to 12° (with a local variation at one point of 31°) and in the remaining nine miles down Tipton Run to the railway station gradually to 60°.—On the west side of Loop Run above the Saw Mill dam, the first opening (1335′ A. T.) shows thin coal seams scattered through six feet of sandstone, the largest coal bench measuring 2 feet. At the next opening up the run two seams of coal are separated by sandstone, the lower bench 2′ thick.


CLXXXXVIII
No. X, Pocono, L. Carb. fossils, continued
Promacrus andrewsi
Pal Ohio Vol II
Sanguinolites æolus, Hall.
Pal Ohio Vol II
Pl XVI
Sanguinolites? obliquus, Meek.
Pal. Ohio
Vol II. pl XVI
Wav.
f 35.
Hall.
Pal. N.Y. V.i.
pl. 35
Solenocaris (Ceratiocaris) strigata, Meek
Meek. Pal. Ohio. II.
Schizodus medinaensis, Meek.
Meek. Pal Ohio. Vol. II. pl. XV.
Tropidocaris alternata, Beecher.
Wav
Tropidocaris interrup
VIII-IX
T. alternata Beecher
Hall.
Pal. N.Y.
Vol. VII.
Phillipsia (Griffithides?) lodiensis. Meek.
Phillipsia sampsoni. Vogdes
AWV.
Worm
1258
Orodus variabilis. Newberry. Pal. Ohio.
Newberry.
Pal Ohio
Vol. 2.
pl.
57.
Palæoniscus alberti? Jackson Dawson.
f. 62
Dawson Acad Geol 1868
Teeth of fish found in the Cleveland (Waverly) shale
Pal. Ohio
Vol. II.
Pl. LVII.
X. Wav.
Platyodus lineatus, Newberry.
Newby
Pal. Ohio II
Newberry.
Pal. Ohio.
Vol. 2, pl. 57.

Five coal beds are reported by Mr. C. S. d' Invilliers at the Tipton mines: Bed C (Loop Run opening) 3′ 6″; interval 25′; B, 2′ 4″; interval 25′; A, 3′; interval 30′; No. 2, 1′ 6″; interval 20′; No. 1 (largest bench of it), 1′ 6″.*

The Tipton coals are semi-bituminous, or rather low bituminous. Two analyses by McCreath, give:—Water at 212°, 0.700, 0.584; Volatile matter, 26.79, 29.43; Fixed carbon, 66.88, 58.04; Sulphur, 0.80, 3.16; Ash, 4.83, 8.79. "The sulphur exists principally in thin partings throughout the coal."' These beds are certainly persistent regular coal beds and bear no resemblance to the *drift-coals* of formation X. Like the South Virginia Tom's Run coal beds they are true coal beds produced by genuine local coal swamps at the beginning of the great Coal Age.

Their minable qualities have been actually tested by the building of a branch railway for their use, the shipping of the coal to market, and its use on locomotives burning freely, being fine and light, not coking well, making it difficult to rebuild a bad fire, but keeping steam pressure up above 118 lbs. (Report of trial by S. Porcher; page 266.)

At the third opening, "3′ solid coal with a regular underclay." All three openings about the same elevation. At the fourth opening (1350′ A. T.) "coal 2′ 4″, with heavy fire clay floor."

*Mr. Ashburner's survey of the Loop Run drift (see his map on p. 260, An. Rt. 1886, reproduced half size on page plate CCXIII (A) on page 1646 above) 700′, and cross heading 250′, in Bed C, found a top bench 2′ 7″; slate 2″; bottom bench 1′ 11′. Bed B, 30′ underneath, showed a top bench 2′, slate 1″, bottom bench 1′ 1″. A tunnel on the west bank of the run, 350′ long (Aug., 1885), cut a coal bed, 300′ higher in the series than the Loop Run opening bed, so much like the latter as to be confounded with it. This upper bed is probably the one mined by the Gates drift on the east bank of the run; a section reading: top bench 2′ 6″; bony slate 1″; bottom bench 1′ 3″. North of the Gates and 25′ over it, is a 2′ coal; 40′ over this a 2′ 8″ coal; 45 over this a 3′ coal.

Mr. Platt in 1879 examined two old openings ¼ mile north of the Gates drift, and found in one 3′ of coal (6″ bony) with a crumbly roof of shale and floor of fire clay (6″) on sandstone. The other bed is about 15′ beneath the former, if there be no fault in the intermediate 500. This was abandoned because pinched out. In fact one of the larger beds, 4′ thick, pinched out to nothing in a gangway 1000′ long. Pocono coals seem to be subject to this form of irregularity.


CCXXIII.
No. XI. Subconglomerate (Mountain) limestone.
Onychocrinus exsculptus (Lyon & Casseday.
Pentremites (obliquatus?) laterniformis, Owen
2a
2d
6(13
Safford Geol Tenn. Pl.
Pentremites
XI.
R
689
Platycrinus hemisphericus. Meek & Worthen. 1865.
XI
1
Ind 1881
A. N. S. Phila. Collett's Indiana Report
plate 41 fig 1. Keyes Amer Philos Soc.
Platycrinus caducus
K L
S A M 1892
Ind 188
Pl 39
Pl 40
Platycrinus corrugatus Owen and Shu
Platycrinus colletti.
Plat. chouteauensis
Ch L
Ind
Platycrinus burlingtonensis
Platycrinus yandelli
Platycrinus discoideus
Steganocrinus benedicti
Keokuk Lime
S A M 1892
Poteriocrinus rhombiferus Owen.
Pterotocrinus acutus. Keyes
Scaphocrinus lyoni
Scaphocrinus maniformis
12
25
Rhodocrinus benedicti
Keok
20
Keok lime.
Keok l

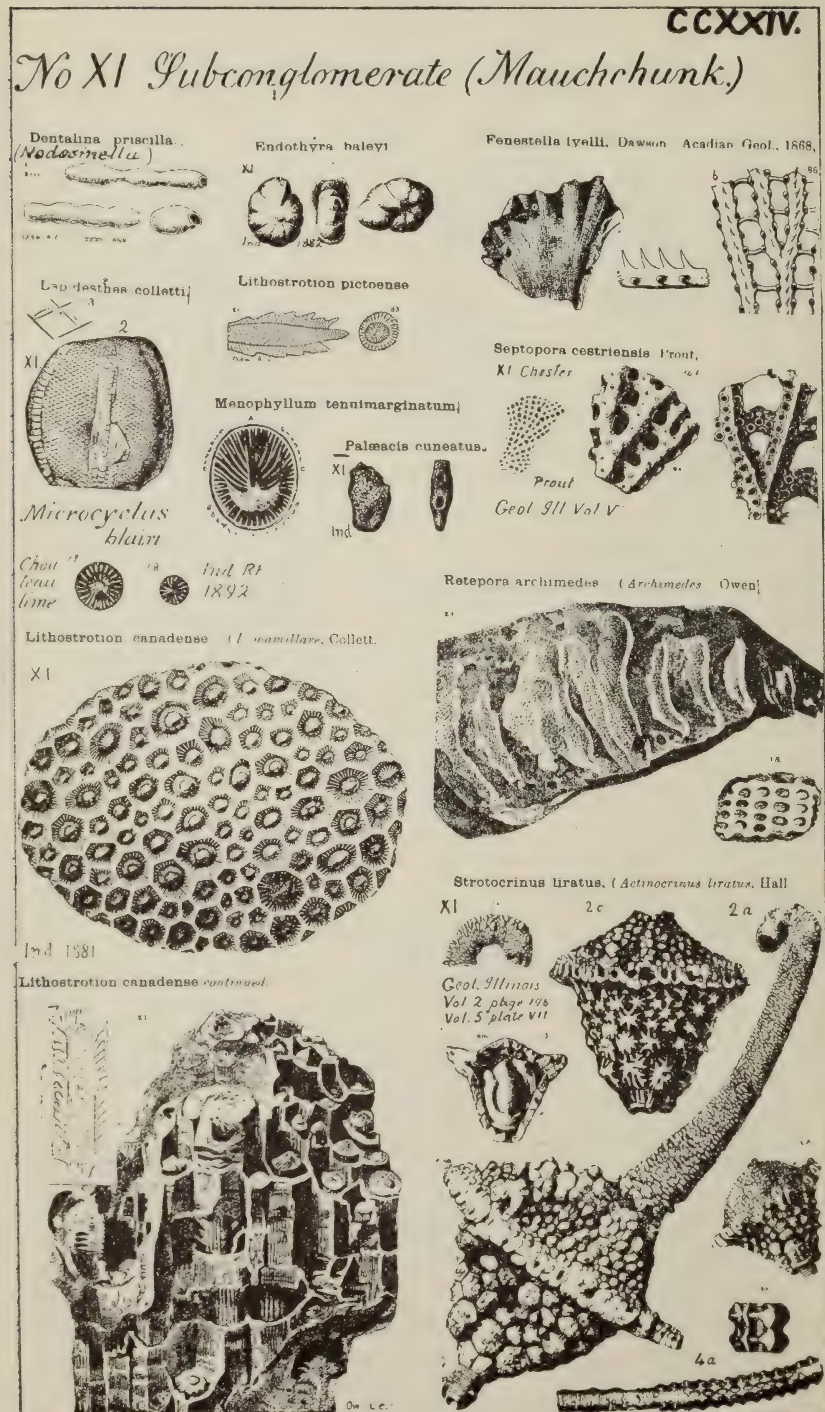
Product of Tipton mines.

The output of the mines (Tipton) in 1886, 1887 was 20,105 net tons. The following years 51,402; 19,921; 28,176; 29,582; 34,760; and from July 1, 1892, to December 31, 19,074. This large quantity of coal sent to market continuously is a sufficient proof of the workability of the beds and the value of the fuel.*

The Fault at the Tipton mines.

It has been said above that the notion of a northeast-southwest fault or down-throw of 1000 feet, throwing down one of the Kittanning coal beds of the Clearfield-Cambria coal measures to the Tipton Run Mines was an inadmissible supposition, contradicted by all we know of the escarpment of the Allegheny Mountains, by the topography of the locality and by the stratigraphy. It is now to be shown that a fault really exists, but of a wholly different character, being of comparatively small size and running in an exactly transverse direction, viz: northwest and southeast. This fault has unusual interest because its character is to a large extent made out by the underground workings; and especially because it falls into the series of faults in middle Pennsylvania which have this northwest-southeast direction; viz: the faults at Three Springs and Orbisonia in southern Huntingdon; the two faults cutting the Bald Eagle Mountain in northern Huntingdon, and the two faults throwing the Osceola and Houtzville coals in Clearfield county. There are no doubt thousands of such down-throws of smaller extent scattered about Central Pennsylvania, produced by the side strains set up when the anti-

*This is the company's statement taken from the books.—In the report on the mineral resources of the United States by Commissioner Day, Washington, 1892, page 259, there is given a table of the coal product of Blair county, Pa., from 1884 to 1890:—208,541; 205,075; 305,695; 287,307; 314,013; 215,410; 298,196 short tons. This can be understood only as including the output of the Bennington, Bell's Gap and other mines at the top of the mountain on the border of Cambria county. The annual reports of the mine inspector for the district gives the following figures of Tipton output for 1886 to 1891: 12,450; 30,000; 49,346; 10,948; 33,205; 25,174. The discrepencies between reports of this kind are always difficult to explain.

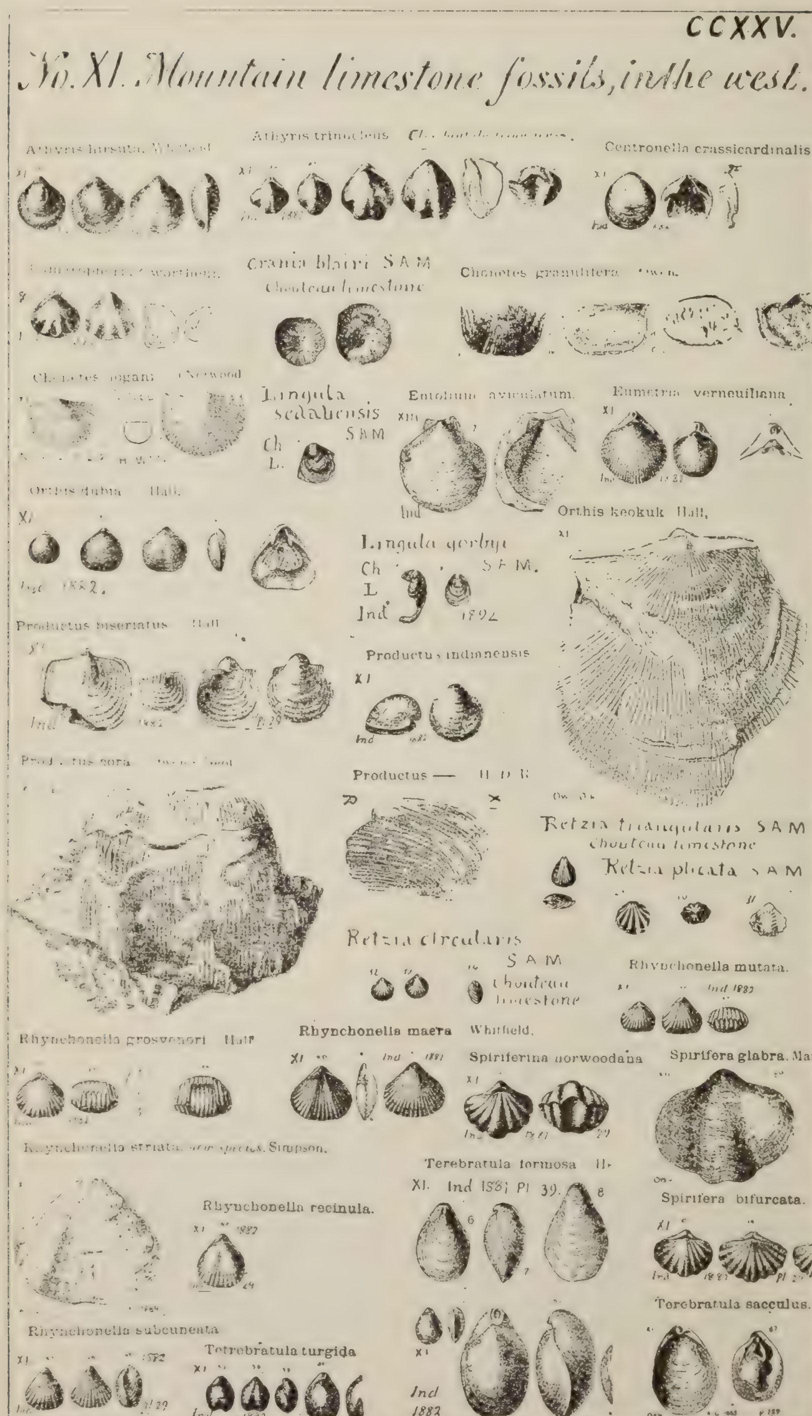

CCXXIV.
No XI Subconglomerate (Mauchchunk.)
Dentalina priscilla.
(Nodosinella)
Endothyra baleyi
XI
Ind 1882
Fenestella lyelli. Dawson Acadian Geol., 1868,
Lepidesthes colletti
2
XI
Lithostrotion pictoense
Septopora cestriensis Prout,
XI Chester
Prout
Geol Ill Vol V
Menophyllum tenuimarginatum
Palæacis cuneatus.
XI
Ind
Microcyclus
blairi
Ind Rt
1892
Retepora archimedes (Archimedes Owen)
Lithostrotion canadense (L. mamillare, Collett.
XI
Ind 1881
Strotocrinus liratus. (Actinocrinus liratus, Hall
XI
2c
2a
Geol. Illinois
Vol 2 page 196
Vol. 5 plate VII
Lithostrotion canadense continued.
4a

clinal and synclinal waves were made. The demonstration of the correctness of such a supposition is to be found in the numerous small down-throws encountered in the gangways and headings of the Rock Hill Iron Mines in Black Log Mountain.

The fault at Tipton, so far as it has been made out under ground, resembles the north end of the Three Springs fault in Huntingdon, its two lips gradually coming together at its northwest end. A description of the Tipton workings as they are at date of writing (March, 1893) will be found in the subjoined foot note.* There are three principal

* "The Loop Run Country Bank Drift was driven in a general course of N. 15° E. about 750 feet to a fault running about N. 49° W. The Loop Run Slope was opened at a point 460 feet S. 67° W. from the mouth of the county bank and driven N. 37° 14 feet W. At the depth of about 700 feet from the mouth of the slope struck a small fault running a little west of north. At about 800 feet struck a larger fault, which has never been explored, and its extent is unknown. As the dip of the coal in the Loop Run Slope was only 12 feet in 100 feet, and the dip in the *Tipton Run Slope* was 22 feet in 100 feet, it was concluded that the fault between the two slopes would soon die out, and the whole field could be worked to the best advantage from the Tipton Run Slope, from the Rock tunnel; hence further exploration in the Loop Run Slope was abandoned. In driving the Rock tunnel to Tipton Run Slope, at the distance of 63 feet from the first timbers we cut one seam of coal about 3 feet thick. At the distance of 281 feet from the first set of timbers we cut a second seam of coal which proved to be "Lenticular" running from a few inches in thickness to more than six feet. At the distance of 506 feet from the first timbers we cut the slope seam which runs of nearly uniform thickness of about 3 feet 8 inches, and sometimes up to 4 feet thick, with good slate roof and fire clay bottom. This slope has been driven some 850 feet from the tunnel and more than that distance back to the easterly crop.

We reached a small fault some 750 feet down the slope. Some of the right headings have been driven about 1500 feet in good coal, which is now full thickness at all the faces of the workings. The headings to the left have not been driven far enough to reach the main fault between the two slopes, nor do we intend to extend them that far until we have passed the workings in the Loop Run Slope, nor until we pass the point where that fault should die out by the difference in dip of the coal on the two sides of the main fault. The extent of the fault at the country bank on Loop Run is a little more than 200 feet, hence dying out at the rate of 10 feet in 100 feet, it would die out about 2000 feet down the slope along the line of the fault. The largest proportion of the coal mined from the two sides of the main fault has been from the Tipton Run Slope and from the tunnel level, back to the crop at the point of the hill between the two slopes—the exact proportion cannot now be ascertained without referring to our mine maps and the engineer's calculations. For the present, we propose to confine our main operations to


CCXXV.
No. XI. Mountain limestone fossils, in the west.
Athyris trinucleus
Centronella crassicardinalis
Crania blairi SAM
Chouteau limestone
Chonetes granulifera
Lingula scalabensis SAM
Entolium aviculatum.
Eumetria verneuiliana
Orthis dubia Hall.
Orthis keokuk Hall.
Lingula gorbyi SAM.
Productus biseriatus Hall
Productus indianensis
Productus
Retzia triangularis SAM
Chouteau limestone
Retzia plicata SAM
Retzia circularis SAM
Chouteau limestone
Rhynchonella mutata.
Rhynchonella grosvenori Hall
Rhynchonella macra Whitfield.
Spiriferina norwoodana
Spirifera glabra.
Rhynchonella striata. new species. Simpson.
Terebratula formosa
Ind 1881 Pl 39.
Spirifera bifurcata.
Rhynchonella recinula.
Terebratula sacculus.
Rhynchonella subcuneata
Tetrebratula turgida
Ind 1882

openings ; two on Loop Run and one on Tipton Run. Loop Run comes into Tipton Run from the northwest. Tipton Run descends from the mountain top to the mouth of Loop Run in a direction about S. 10° E. The old Loop Run drift was driven on the level about N. 10° E. 750 feet to the fault. The new slope, Loop Run Slope, 450 feet S. 67° W. of the mouth of the Loop Run Drift was put down N. 37° W. 700 feet to a slight fault at 650, and 60 feet further a somewhat larger fault. Five breasts on the coal were headed off to the right northward 1500 feet. The fifth of these was driven 750 feet nearly due north, and then stopped, the regular northwest dip being slightly reversed. All these headings were in the direction of the great fault, which stopped the old Loop Run Drift, but did not reach it. The Fifth Drift was heading for the Tipton Slope to the north of it at a distance of about 1500 feet, and it is probable that if continued it would pass the northwest end of the large fault and join the workings of the Tipton Run Slope. It is evident that there is a large amount of unexplored country between the two mines, and that there is no reason to doubt that the Tipton output will go on from year to year.

Tipton Fossil Plants.

Two collections of fossil plants have been made at the Tipton Mines ; the first, a small one, made by Prof. I. C.

Tipton Run Slope and its headings, right and left, which are still being pushed forward with energy by the lessee of that mine.

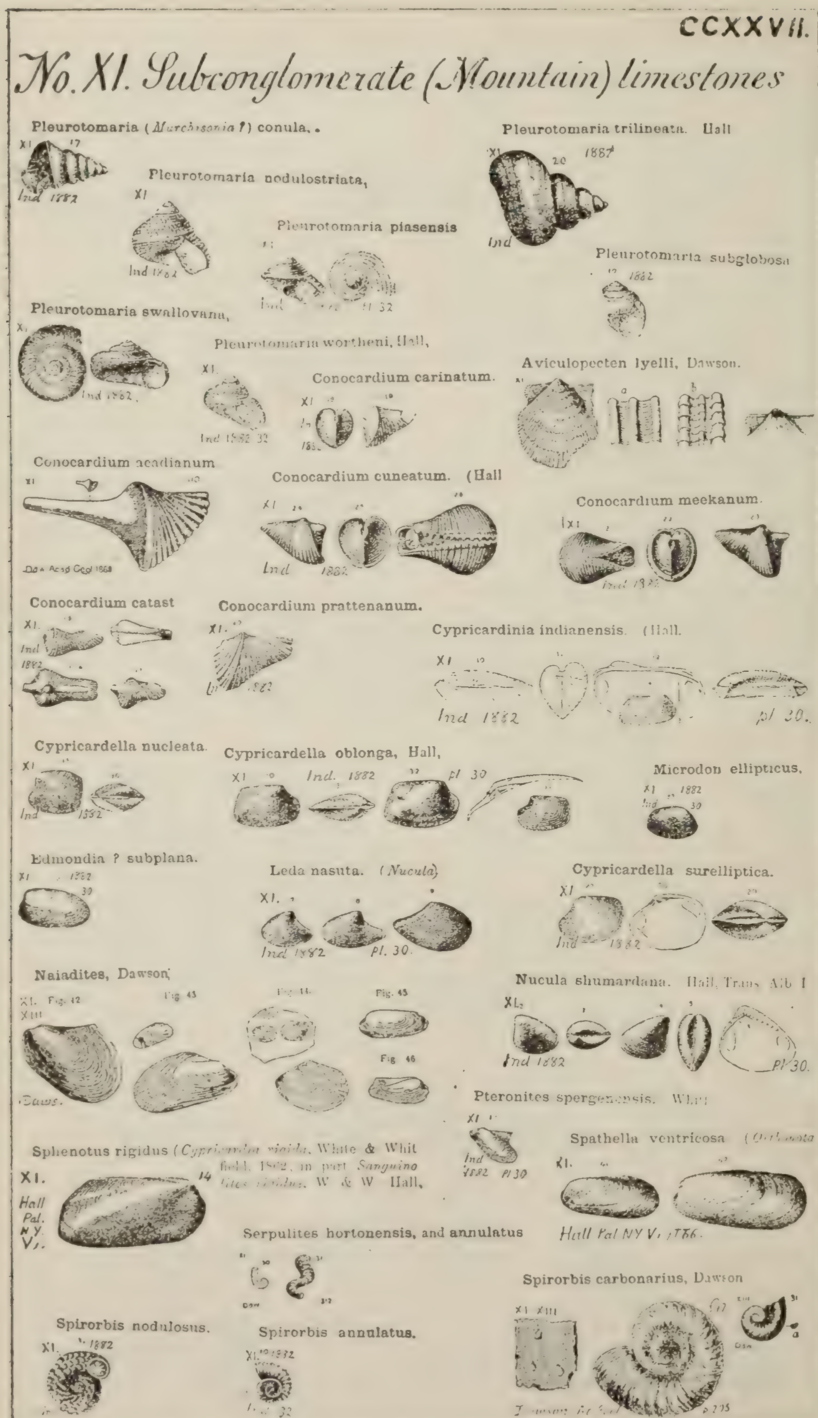
"In the foregoing memoranda it was estimated from the difference in the dip of the coal seams on the two sides of the main fault running N. 49° W. that the fault would die out and the two workings run into each other at the distance of 2000 feet down the fault from the country bank face on Loop Run. This estimate was afterwards modified by the fact that in driving the fifth right heading from Loop Run Slope a great change in the dip occurred, requiring a change in the general course of that heading from the four previous headings. This fifth heading was started some 650 feet down the slope, nearly due north, the coal rising to the left. In driving this heading 750 feet it swung to the west some two degrees and still on the rise, so that it was estimated that the two workings would run into each other some 1400 feet down the fault from the country bank heading. This fifth right heading was pulled in by the lessee contrary to the instructions of the company, and defeated further exploration in that direction."—Mr. Shillingford, March, 1893.


CCXXVI.
No XI Subconglomerate (Mountain, Keokuk, &c.) L.
Conularia intertexta.
S.A.M
Keokuk L.
Ind
1892
Conularia planicostata
Conularia subulata
Ind 1882
Bulimorpha bulimiformis
Bellerophon textilis
Bellerophon sublævis. (Hall.
Bulimorpha canaliculata.
Bulimorpha elongata
Cyclonema leavenworth
Cyclonema sub-angulatum.
Eotrochus concavus. (Pleuroto
Holopea proutana.
Lepetopsis levettei (Patella levettei White,—Whitfiel
Loxonema yandellanum.
Macrocheilus (Soleniscus ?) ponderosus. (Swallow
Macrocheilus ? littonanus.
Murchisonia attenuata
Murchisonia insculpta
Murchisonia terebriformis.
Murchisonia turritella.
Murchisonia vermicula
Naticopsis carleyana, (Natica
Murchisonia vincta
Platyceras capax, Keys.
Platyceras formosum
Platyceras latum, Keyes Amer Philos. Soc Phila
Pleurotomaria elegantula (Murchisonia
Pleurotomaria humilis
Platyceras obliquum Keyes
Pleurotomaria meekana

White of Morgantown, West Va., was referred to Prof. Lesquereux, who determined the following genera and species: Cordaites gracilis, Lx., Stigmaria ficoides Bx. Lepidophyllum lanceolatum Bt., Neuropteris tenuefolia, Bt., Neuropteris loschii Bt. Alethopteris ambigua Lx., Calamites allied to suckovii Bt. A species of Pecopteris. Alethopteris allied to Pennsylvanica Lx. The plants are not abundant but although the collection was so small and fragmentary, Prof. White concluded that the beds belonged to the Allegheny series, viz: Those mined on the Moshannon in Clearfield county, and along the Conemaugh in Cambria county. He even specified the bed from which the specimens came as identical with the lower Kittanning. Prof. Fontaine agreed with him in considering the specimens of tree coal measure age; although he allows that Neuropteris tenuifolia and Sigilaria mamillaris have been reported from the Pocono formation, being long-lived forms, occurring at various intervals from the very bottom to nearly the top of the carboniferous system. (The age of the Tipton Run coal printed in the American Geologist for June 1889.)

Another and much larger collection of these plants was subsequently made (1889), by Mr. Koch, one of the aids on the Survey, and submitted to the inspection of Mr. R. D. Lacoe, of Pittston, the learned collaborator of Leo Lesquereux; and the list of his determinations of genera and species (May 10, 1890) was as follows:—

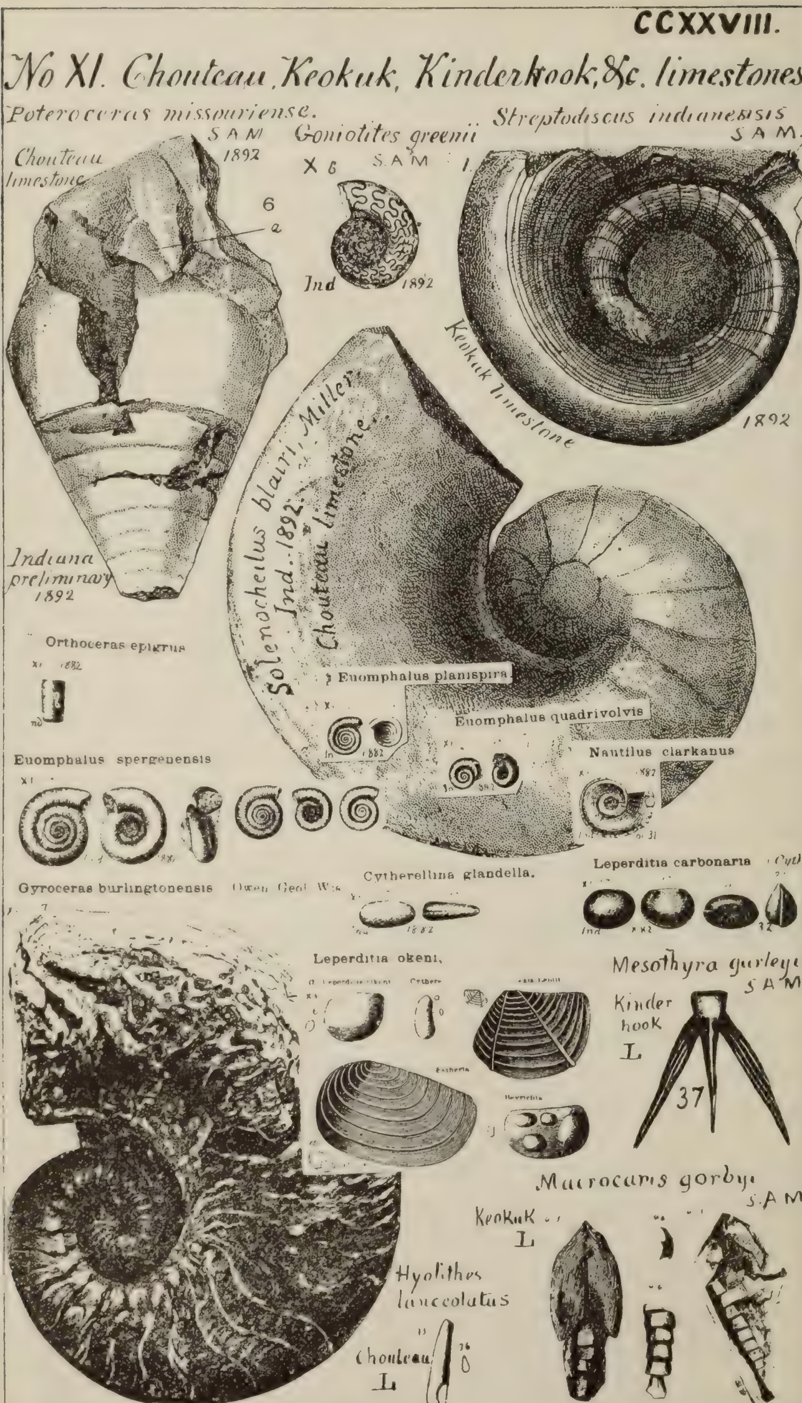
Calamites suckovii, Brongt.; Asterophyllites longifolius, Brongt.; Annularia sphenophylloides, Zenck.; Sphenophyllum oblongifolium, Germ.; Sphenophyllum schlotheimi, Brongt.; Equisetites, sp? Callipteridium, sp.? Neuropteris tenuifolia, Brongt.; N. loschi, Brongt.; N. plicata, Sternb.; N. desori; Lesqx.; N. clarksoni, Lesqx.; N. vermicularis, Lesqx.; Dictyopteris obliqua, Bunby; Alethopteris, sp.? Pseudopecopteris anceps, Lesqx.; P. nervosa, Brongt.; P. cordatoovata, Weiss; P. speciosa, Lesqx. (?); P. sp?. (fructified); Pecopteris villosa, Brongt.; Sphenopteris affinis, Ll. and Hutt.; Lepidodendron rimosum, Sternb.; Sigillaria leveretti, Lesqx., S. sp.? Stigmaria ficoides,


CCXXVII.
No. XI. Subconglomerate (Mountain) limestones
Pleurotomaria (Murchisonia ?) conula.
Pleurotomaria trilineata. Hall
Pleurotomaria nodulostriata,
Pleurotomaria piasensis
Pleurotomaria subglobosa
Pleurotomaria swallovana,
Pleurotomaria wortheni, Hall,
Aviculopecten lyelli, Dawson.
Conocardium carinatum.
Conocardium acadianum
Conocardium cuneatum. (Hall
Conocardium meekanum.
Conocardium catast
Conocardium prattenanum.
Cypricardinia indianensis. (Hall.
Cypricardella nucleata.
Cypricardella oblonga, Hall,
Microdon ellipticus,
Edmondia ? subplana.
Leda nasuta. (Nucula)
Cypricardella surelliptica.
Naiadites, Dawson;
Nucula shumardana.
Pteronites spergenensis.
Sphenotus rigidus
Spathella ventricosa
Serpulites hortonensis, and annulatus
Spirorbis carbonarius, Dawson
Spirorbis nodulosus.
Spirorbis annulatus.

Brongt.; Carpolithes minimus, Sternb.; Cardieocarpus bicuspidatus, Sternb.; C. orbicularis, Newby; C. (Samaropsis) fluitans, Weiss; Trigonocarpus trilocularis, Hild., Xylomides Zomitæ, Goepp. (?); Knorria Sp.?; Lepidostrobus Sp.? Lepidophyllum Sp. ? Cordaites Sp. ? Carpolithes minutissimus (new species); Artisia Sp. ?

This list is arranged by Mr. Lacoe in a table, which I cannot here republish, to show the relationship of the genera and species to those in other American and European localities. His general conclusions are as follows:

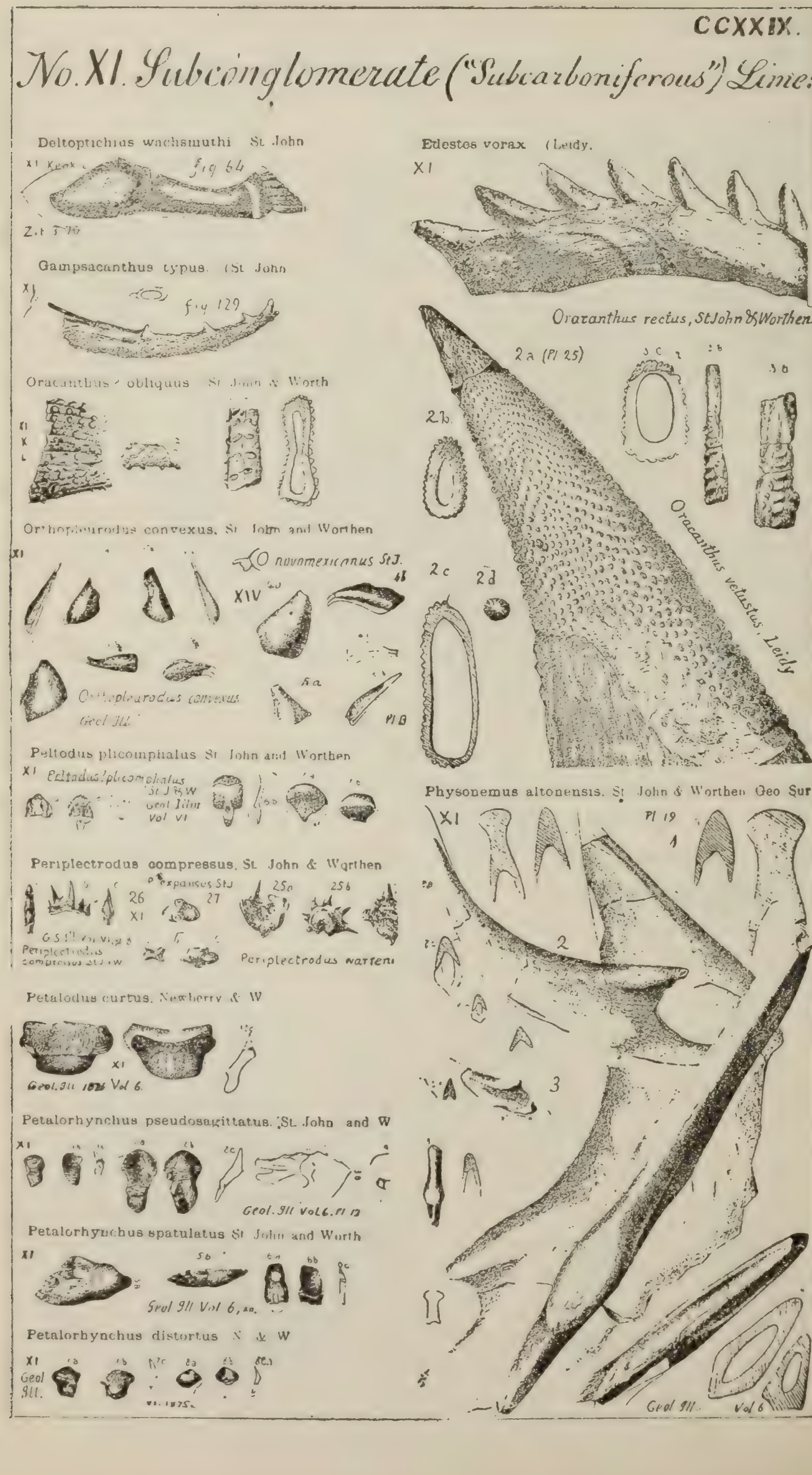
First. The collection of Mr. Koch contains 25 determinable species, and 13 fragmentary or obscure of doubtful identity. *Second.* Of the 25 species determined, 18 have been found on both sides of the Atlantic, 13 of them both in the United States and Canada. The remaining 7 have been described as American species, but some of them may hereafter prove to be European. Sphenopteris affinis has not until this collection at Tipton been seen in America. *Third.* So far as known 13 of them made their first appearance in America at the horizon of the low coals of Arkansas, Alabama, Georgia, Tennessee, etc., which Lesquereaux in his Coal Flora "sub-conglomerate," adding in a footnote to page 636 that "the relation of Pennsylvania No. XI to this southern sub-conglomerate is not definite." Later, in Vol. III, he groups the conglomerate series of West Virginia with the above mentioned low coals; but, later on, and with much additional and better materials from those States, for comparison with the flora of No. XII of Ohio and Pennsylvania, he expressed the conviction that the whole belonged to the conglomerate series No. XII. *Fourth.* Of these 13 species, 5 have been found in the "inter-conglomerate shale" at Campbell's ledge, Pittston Gap, Luzerne county, Pa., with 3 others, making 16 in all, of species under consideration which left their earliest remains in the shales of XI–XII. Of the remaining 9 species, 7 have been found in the lower coal measures near the top of XII. One species, before confined to the "Calciferous sandstone" of Scotland, is now for the first time recorded from an American locality, and the last probably came up from the Devonian, but, be-


CCXXVIII.
No XI. Chouteau, Keokuk, Kinderhook, &c. limestones
Poteroceras missouriense.
S A M
1892
Chouteau limestone
6
a
Indiana preliminary
1892
Goniotites greenii
X 6
S.A.M
Ind
1892
Streptodiscus indianensis
S A M.
Keokuk limestone
1892
Solenocheilus blairi, Miller
Ind. 1892.
Chouteau limestone.
Orthoceras epigrus
Euomphalus planispira
Euomphalus quadrivolvis
Nautilus clarkanus
Euomphalus spergenensis
Gyroceras burlingtonensis
Cytherellina glandella.
Leperditia carbonaria
Leperditia okeni,
Mesothyra gurleyi
S A M
Kinder hook
L
37
Macrocaris gorbyi
S.A.M
Keokuk
L
Hyolithes lanceolatus
Chouteau
L

ing of uncertain relation, it has little or no value here. *Fifth.* Of the 16 species which originated in XII or XI, 12 of them passed up into the coal measures proper; all but one continuing to above the mammoth vein ; and 2 of them reaching the horizon of the Waynesburg coal in the upper productive coal measures. Of the 7 coal measure species, 6 continued to live up to the base of the upper productive coal measures, and the remaining one as far as up to the Waynesburg coal *Sixth.* Of the 25 species from Tipton, all but 4 are common in the coal measures of North America. This gives a distinctly coal measure position to the collection ; or at most in the low coal which I consider belongs to XII according to the Palæontological evidence as it now stands. *Seventh.* The wide geographical distribution of so many of the species in the coal period, with their specific characters so fixed and to be retained without variation throughout the vast period of their after existence, points to a much earlier origin than shown by the records where their remains have until now been found. Further research in the shales of the pre-carboniferous and sub-carboniferous coals may show that many of what are now considered strictly carboniferous or late sub-carboniferous had reached maturity in earlier time, and were passing their declining years in the mild, moist climate of the carboniferous, while awaiting extinction. The Devonian type of the few Pocono plants described from Tipton gives them a much older aspect than those of any other sub-carboniferous series, either in the United States or in Europe, so far as I know. I am informed that Professor Fontaine made additional collections from Montgomery county, Virginia, last summer (1889) and will soon publish the result. (Letter of R. D. Lacoe, Pittston, May 10, 1890.)

Pocono Formation in Cambria County.

In southwestern Pennsylvania the Pocono formation sinks slowly from its outcrop along the Allegheny Mountains westward beneath the first bituminous coal basin and rises to the surface again at the viaduct anticlinal axis, which crosses the Conemaugh river a few miles above Johns-



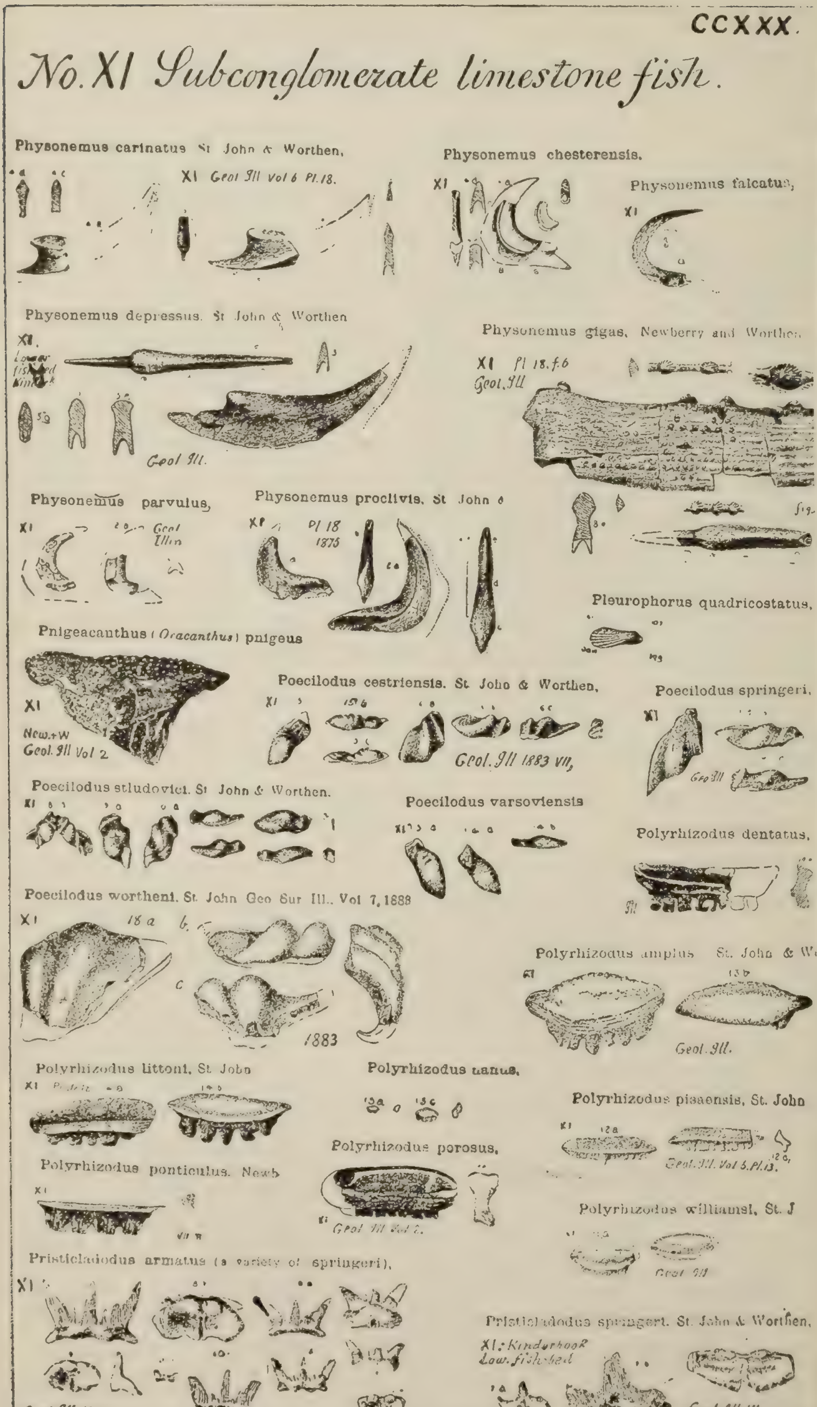
CCXXIX.
No. XI. Subconglomerate ("Subcarboniferous") Lime:
Deltoptichius wachsmuthi St. John
Edestes vorax (Leidy.
Gampsacanthus typus. (St. John
Oracanthus rectus, St John & Worthen
Oracanthus obliquus St. John & Worth
Oracanthus vetustus, Leidy
Orthopleurodus convexus. St. John and Worthen
O. novomexicanus St J.
Peltodus plicomphalus St. John and Worthen
Physonemus altonensis. St. John & Worthen Geo Sur
Periplectrodus compressus. St. John & Worthen
Periplectrodus warreni
Petalodus curtus. Newberry & W
Petalorhynchus pseudosagittatus. St. John and W
Petalorhynchus spatulatus St. John and Worth
Petalorhynchus distortus N. & W

town. Its appearance here is interesting on account of the topographical aspect of the locality. The Conemaugh river descends obliquely through Cambria county, keeping its bed nearly level with the coal beds of the tunnel and Bennington. When these begin to rise gently on the west side of the basin, the conglomerate gets above the railroad and as the road approaches the viaduct it is graded in the underlying Mauch Chunk red shale through a narrow neck of which the road bed has been cut and immediately spans the river on the viaduct. Approaching the cut, the river is about thirty feet below grade, passing through the cut the river is eighty feet below grade. The difference of water level is not produced by any cascade, but by the long course of the stream around a loop or horse-shoe bend to the south four miles in circuit. Consequently, in the course of one hundred yards the valley changes its character totally in the most picturesque manner. Above the viaduct, that is up stream to the east, nothing but coal measures are to be seen. At the viaduct the river is walled by continuous cliffs of horizontal Pocono false-bedded green sandstone. The traveler is transported in a few seconds from a gentle sided valley into a deep gorge; and this continues westward until the lower coal beds of the Johnstown basin make their appearance. *

In Somerset county the Pocono formation rises in a broad, gentle, high arch at the Maryland line, called Negro Mountain. But as this anticlinal arch rises southward into Virginia, and sinks rapidly northward toward Somerset, the top of the Pocono is several hundred feet under the bed of the Castleman's river at Mineral Point; and there is no other exhibition of the formation, except at the above described viaduct, all the way to Clearfield county.

The first long anticlinal mountain of western Pennsylvania is called Laurel Hill. It comes north from Virginia; is

* The false-bedded, or current-bedded, character of the Pocono formation is perhaps nowhere so flagrantly exhibited as in this gorge at the two ends of the viaduct. Great rocks of many tons weight lie beneath the bridge with their layers an inch or two thick, weathered out in diagonal sets, forming the most curious and sometimes beautiful objects.

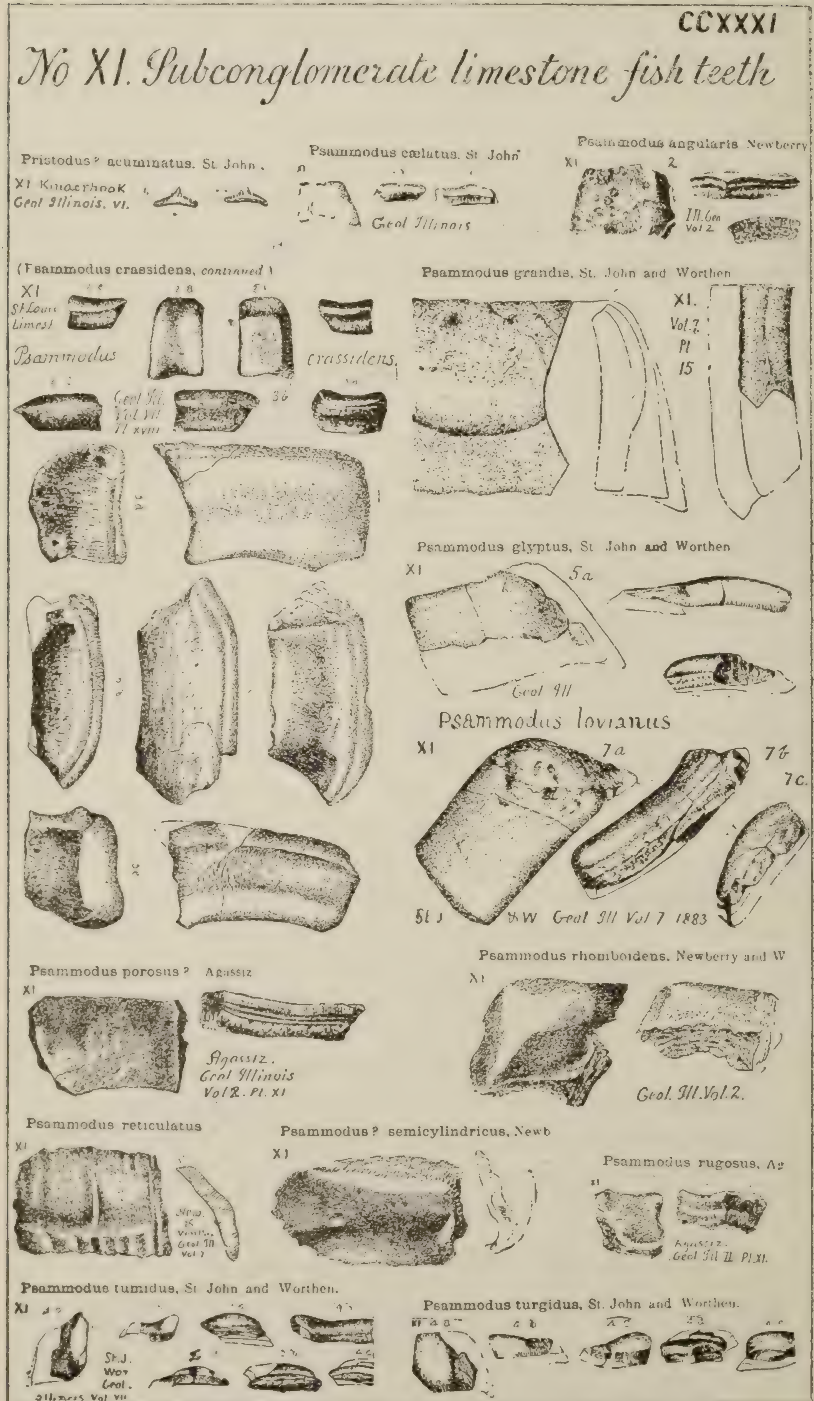

CCXXX.
No. XI Subconglomerate limestone fish.
Physonemus carinatus St John & Worthen,
XI Geol Ill Vol 6 Pl. 18.
Physonemus chesterensis.
XI
Physonemus falcatus,
XI
Physonemus depressus. St John & Worthen
XI
Geol Ill.
Physonemus gigas, Newberry and Worthen
XI Pl 18. f. 6
Geol. Ill
Physonemus parvulus,
XI
Physonemus proclivis, St John &
Pl 18
1875
Pleurophorus quadricostatus,
Pnigeacanthus (Oracanthus) pnigeus
XI
New.+W
Geol. Ill Vol 2
Poecilodus cestriensis. St. John & Worthen,
Geol. Ill 1883 VII,
Poecilodus springeri,
XI
Poecilodus sludovici. St John & Worthen.
XI
Poecilodus varsoviensis
Polyrhizodus dentatus,
Poecilodus wortheni. St. John Geo Sur Ill.. Vol 7, 1888
XI
18 a
1883
Polyrhizodus amplus St. John & W
Geol. Ill.
Polyrhizodus littoni, St. John
XI
Polyrhizodus nanus.
Polyrhizodus pisaensis, St. John
XI
Geol. Ill. Vol 6. Pl. 13.
Polyrhizodus porosus,
Polyrhizodus ponticulus. Newb
XI
Polyrhizodus williamsi, St. J
Pristicladodus armatus (a variety of springeri),
XI
Geol Ill VI
Pristicladodus springeri. St. John & Worthen,
XI; Kinderhook
Low. fish-bed
Geol. Ill. VI,

gapped by the Youghiogheny river near Ursina, and by the Conemaugh near Johnstown; and continues north-northeastward to the Susquehanna river in Clinton county. Its summit is that of a broad flat arch, with long gentle east and west slopes. Its structure is perfectly exposed in the two gaps before mentioned. In the center and at the bottom of the arch are seen the upper layers of VIII–IX (Chemung-Catskill). Over this is a grand arch of Pocono rocks. Near the top of the mountain is a broken thin arch of XI, Mauch Chunk red shale, with limestones and iron ore beds. Flanking the mountain on each side descend the lower coal beds, eastward toward Johnstown and westward into the Ligonier Valley. The conglomerate under the coal beds is eroded on both flanks of the mountain into ranges of spur knobs, between which descend the headwaters of Sandy Creek and Indian Creek on the east, and of the Loyalhanna River on the west. The red shale with its plate of iron ore rises in places nearly to the top of the mountain. But along most of its course the mountain crest is a broad and level plain of Pocono rocks.

Chestnut Ridge on the west side of the Ligonier Valley runs parallel with Laurel Hill, is of almost exactly the same shape, height, breadth and structure, and needs no different description except in two essential particulars; first, in that the axis of the arch is not so completely a straight line, but has what Prof. Stevenson calls off-sets, but which I consider merely slight local warps, as there is no fair evidence of any transverse faulting; and true off-sets would argue a series of anticlinal rolls arranged *en echelon*, their ends passing each other; and of this also there is no clear proof; it is therefore better to consider the irregular course of the axis of the anticlinal as due to warping; and no serious warping is necessary to produce the effect; besides which the steep dips of the east flank of the mountain are in testimony.

The Pocono in Westmoreland and Fayette.

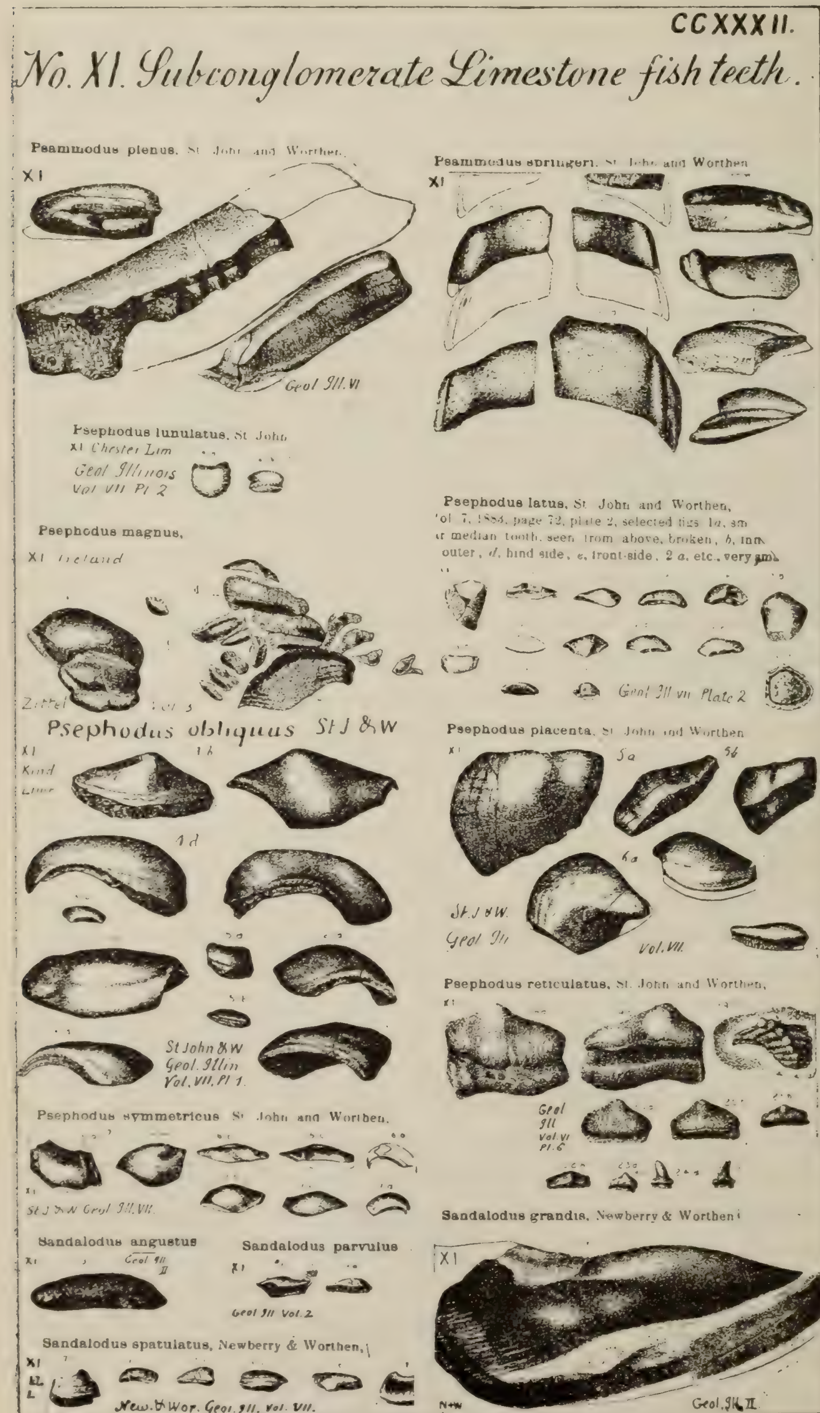
The second point of difference between the two mountains is this abnormally steep dip to the east into the Ligo-


CCXXXI
No XI. Subconglomerate limestone fish teeth
Pristodus? acuminatus. St. John.
XI Kinderhook
Geol Illinois. VI.
Psammodus cœlatus. St John
Geol Illinois
Psammodus angularis Newberry
XI
2
Ill. Geo Vol 2
(Psammodus crassidens, continued)
XI
St Louis Limes
Psammodus
crassidens
Geol Ill. Vol VII Pl XVIII
3b
Psammodus grandis, St. John and Worthen
XI.
Vol 7
Pl
15
Psammodus glyptus, St. John and Worthen
XI
5a
Geol Ill
Psammodus lovianus
XI
7a
7b
7c
St J & W Geol Ill Vol 7 1883
Psammodus porosus? Agassiz
XI
Agassiz.
Geol Illinois
Vol 2. Pl. XI
Psammodus rhomboidens, Newberry and W
XI
Geol. Ill. Vol. 2.
Psammodus reticulatus
XI
Geol Ill Vol 7
Psammodus? semicylindricus, Newb
XI
Psammodus rugosus, Ag
Agassiz.
Geol Ill II Pl. XI.
Psammodus tumidus, St John and Worthen.
XI
St. J.
Wor
Geol.
Illinois Vol VII
Psammodus turgidus, St. John and Worthen.
a
b

nier Valley south from the Conemaugh river for a number of miles; the conglomerate spur knobs showing dips as high as 80°; which is a remarkable phenomenon, unique in southwestern Pennsylvania; and abnormal in its direction; because the universal rule is that dips toward the west from all the anticlinals that traverse that region are steeper than the dips towards the east. What has produced this local exception has not been made out, and perhaps never will be.

The general character of both mountains is plainly exhibited by the contour line topography on page plates CCXVII, &c., which are fac-simile reproductions on one-half lineal scale of certain portions of my large manuscript map of 1853 (never yet published) made from my surveys for the Pennsylvania Railroad Co. Page plate CCXVII shows the Pack Saddle Gap of the Conemaugh through Chestnut Ridge, between Bolivar and Blairsville. The lines of cliff seen on the edges of the gap are the vertical walls of outcrop of the Pottsville conglomerate, under which is a narrow terrace of the soft Mauch Chunk red shale; from which down nearly to the bed of the river appear the arched strata of the Pocono. Page plate CCXIX shows the same descending outcrop cliff wall of the conglomerate at the western end of the great gap gorge of the Loyalhanna. On these page plates are seen the outcrop spur knobs of the conglomerate standing out from the east and west flanks of the mountain; and descending from these spur knobs, the slopes of lower coal measures reaching to the outcrop of the Pittsburg coal beds.

The crest of Chestnut Ridge, like that of Laural Hill, is a nearly flat plain of Pocono, with a thin veneer of the red shale on which are left standing a few masses of the conglomerate which once covered the whole mountain, which have been spared in the general erosion. Page plate CCXXXVII (on page 1712 above) gives my sketches of the most remarkable of these fragments, viz; the Cow Rock on top of the mountain south of the gap of the Youghiogheny looking down upon Connellsville. Of this a description will be given in a succeeding chapter on the Conglomerate.


CCXXXII.
No. XI. Subconglomerate Limestone fish teeth.
Psammodus plenus, St. John and Worthen.
Geol. Ill. VI
Psammodus springeri, St. John and Worthen
Psephodus lunulatus, St. John
XI Chester Lim
Geol. Illinois Vol. VII Pl. 2
Psephodus latus, St. John and Worthen,
Psephodus magnus,
XI Ireland
Zittel
Geol. Ill. VII Plate 2
Psephodus obliquus St J & W
Psephodus placenta, St. John and Worthen
St. J & W. Geol. Ill. Vol. VII.
St John & W Geol. Illin Vol. VII, Pl 1.
Psephodus reticulatus, St. John and Worthen,
Geol Ill Vol. VI Pl. 6
Psephodus symmetricus St. John and Worthen.
Sandalodus grandis, Newberry & Worthen
Sandalodus angustus
Sandalodus parvulus
Geol Ill Vol. 2
Sandalodus spatulatus, Newberry & Worthen,
New. & Wor. Geol. Ill. Vol. VII.
N & W
Geol. Ill. II.

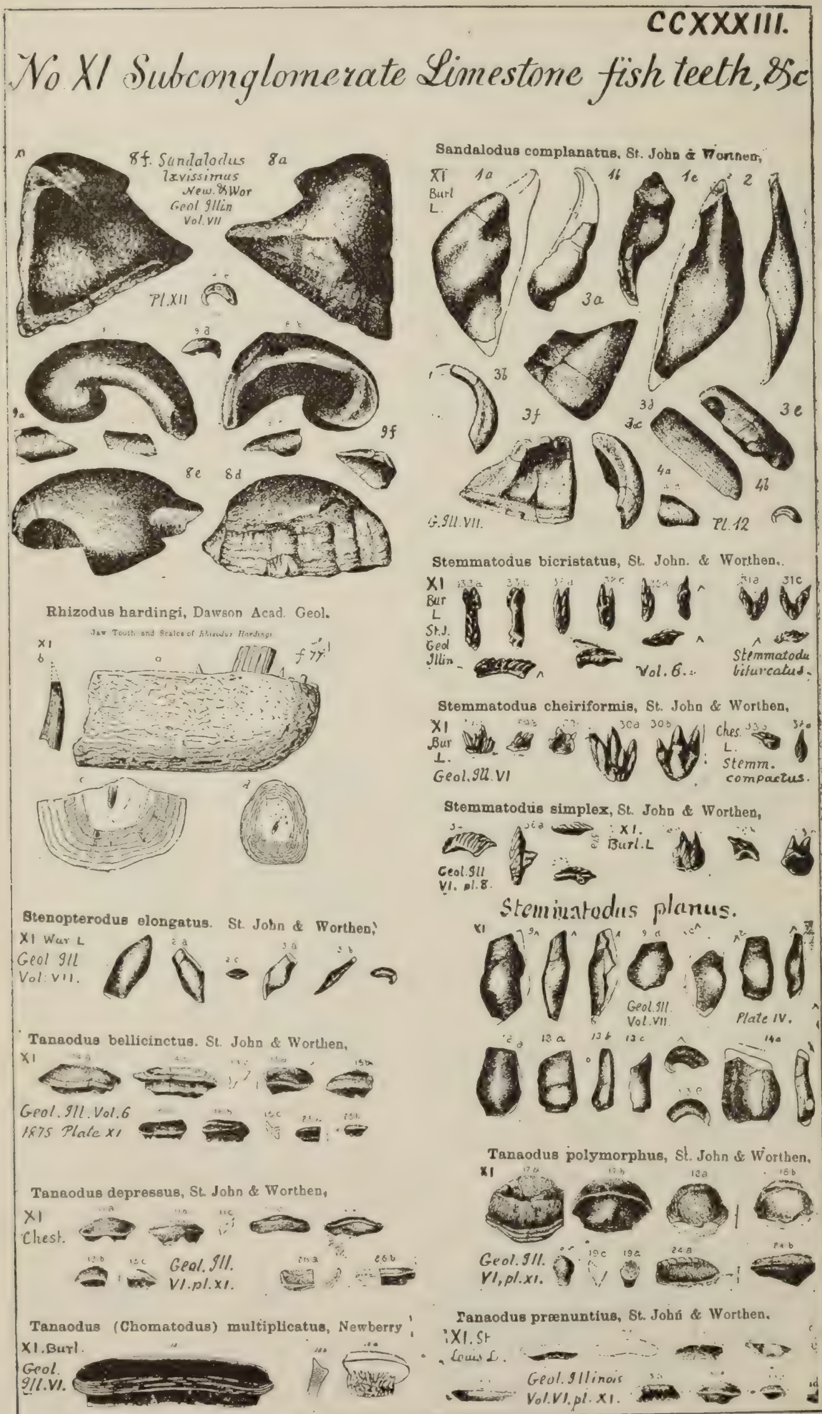
The long line of Chestnut Ridge is gapped at Connellsville, at Latrobe and at Blairsville by the three rivers. The depth of the gorge from the top of the mountain to water level is in two instances about 1300 feet; and the scenery is very impressive. The geology of the three gaps is minutely described in Prof. J. J. Stevenson's Reports K2 and K3, extracts from which will be given directly. The ridge further north is gapped again by Black Lick creek, Two Licks and Yellow creek, and in these gaps the Pocono arch can also be studied. Laural Hill is also gapped by the south and north branches of Black Lick, but these gaps exhibit the Pocono to a less degree. The Chestnut Ridge anticlinal axis dies down in Indiana county sufficiently to allow the coal measures to cover the ridge south of the Yellow Creek Gap. It is then off-set to the west about 3 miles. It then runs on straight and unbroken to the northeast corner of Indiana county into Clearfield county, where it is again covered by patches of coal measures. The rest of its course into Elk county, the arch rises clear of coal measures and becomes what is called the Elk Mountains, covered with conglomerate. In the tortuous gorges of the West Branch Susquehanna waters the Pocono formation, much thinner than along the Allegheny Mountains, outcrops in horizontal ranges of cliffs, capped by the red shale, the conglomerate and sometimes the lowest coal beds.

This is the general condition of things throughout all the northern and northwestern counties of the state; as will be described in Prof. White's discussion of the Pocono or Waverly Rocks in Crawford and Warren counties.

Stevenson's Section in the Conemaugh Gap.

Prof. Stevenson in his first report KK on Westmoreland and Fayette counties gave the following section of the strata exhibited in the arch of Chestnut Ridge for 838 feet, as measured down from the mountain limestone at the top to the bed of the river.

1. Umbral limestone (mountain limestone, silicious limestone); 2. Flaggy sandstone, 250; 3. Shale, 3; 4. Argillaceous sandstone, 40; 5. Shale, 10; 6. Sandstone, conglom-


CCXXXIII.
No XI Subconglomerate Limestone fish teeth, &c
8f. Sandalodus laevissimus New. & Wor Geol Illin Vol. VII
8a
Pl. XII
9f
8e
8d
Sandalodus complanatus, St. John & Worthen,
XI Burl L.
1a
1b
1c
2
3a
3b
3f
3d
3c
3e
4a
4b
G. Ill. VII.
Pl. 12
Stemmatodus bicristatus, St. John. & Worthen.
XI Bur L
St. J. Geol Illin
Vol. 6.
Stemmatodus bifurcatus
Rhizodus hardingi, Dawson Acad. Geol.
Jaw Tooth and Scales of Rhizodus Hardingi
XI
Stemmatodus cheiriformis, St. John & Worthen,
XI Bur L.
Geol. Ill. VI
Ches. L.
Stemm. compactus.
Stemmatodus simplex, St. John & Worthen,
Geol. Ill VI. pl. 8.
XI. Burl. L
Stemmatodus planus.
XI
Geol. Ill. Vol. VII
Plate IV.
Stenopterodus elongatus. St. John & Worthen,
XI War L
Geol Ill Vol: VII.
Tanaodus bellicinctus. St. John & Worthen,
XI
Geol. Ill. Vol. 6
1875 Plate XI
Tanaodus polymorphus, St. John & Worthen,
XI
Geol. Ill. VI, pl. XI.
Tanaodus depressus, St. John & Worthen,
XI Chest.
Geol. Ill. VI. pl. XI.
Tanaodus (Chomatodus) multiplicatus, Newberry
XI. Burl.
Geol. Ill. VI.
Tanaodus praenuntius, St. John & Worthen.
XI. St Louis L.
Geol. Illinois Vol. VI. pl. XI.

erate toward the base, 140; 7. Shale and sandstone, 125; 8. Sandstone with conglomerate layers, 20; 9. Sandy shale, 100; 10. Concealed to the river, 150.

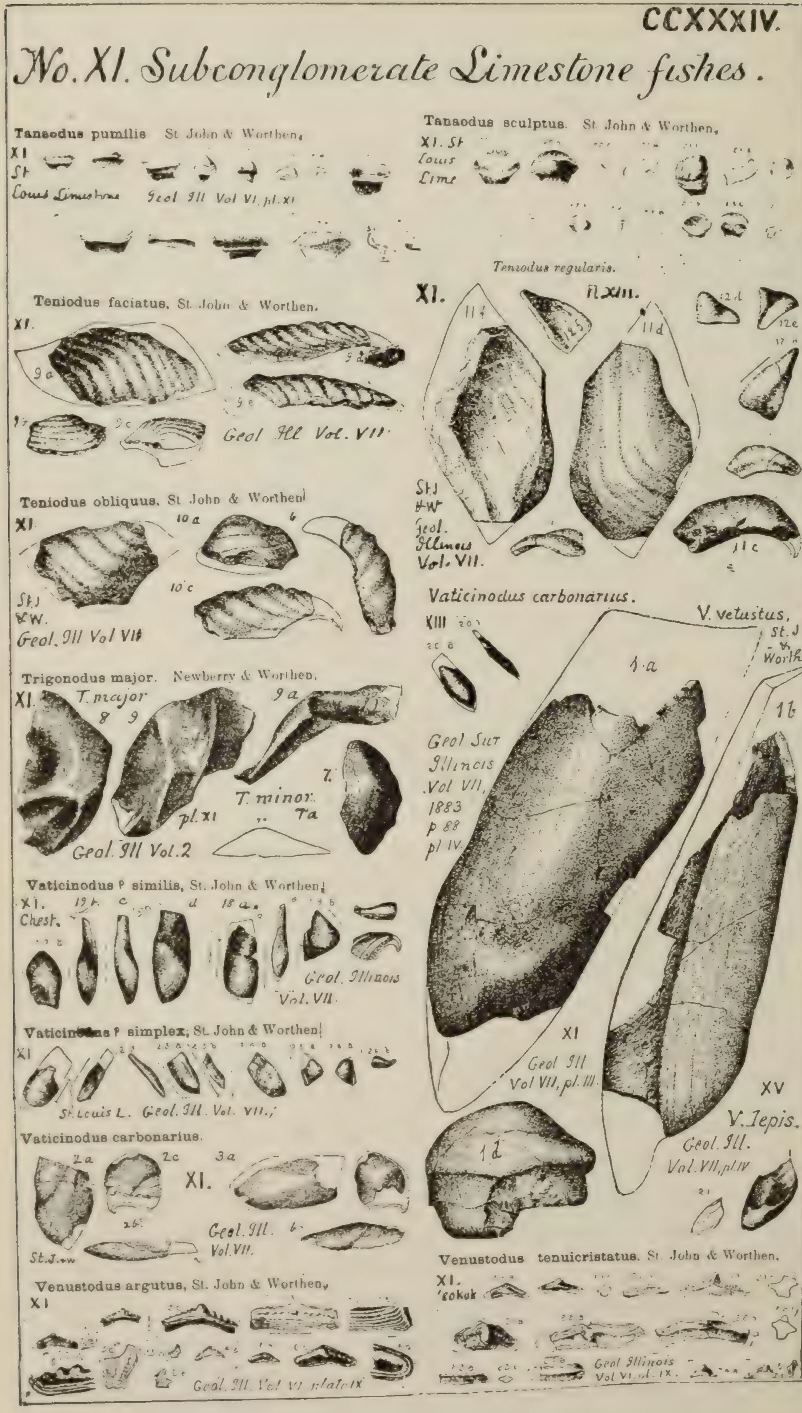
In this section, the portion from No. 2 to No. 6 inclusive may be regarded as a single mass of sandstone, since the two layers of shale are very far from being constant. At other places they are found higher or lower in the section. The upper part of the mass is flaggy and cross-bedded throughout. No. 4 yields readily to the weather. No. 6 is a good compact building stone, showing a shattered weather surface; which has called for strong retaining walls along the railroad. The upper sandstone is fine grained, the lower one conglomeritic with layers containing large pebbles, no such being seen in the upper sandstone.

Below this 450 feet of sandstone are a succession of shales and sandstones without character, and always more or less concealed.

Below this comes a very curious conglomerate sandstone, never to be mistaken where exposed, of peculiar greenish tint, with pebbly layers, one near the middle a foot thick and very persistent. Below this are red shales containing a few layers of reddish sandstone, which have always been considered the top strata of Catskill No. IX; but Prof. Stevenson is inclined to fuse them with the Pocono.

Rocks still lower than any shown in the Conemaugh section were reached in a boring south of the National Road, where the limestone at the base of No. IX was passed through, 50 feet thick. Here on the National Road the great sandstone is seen at the Turkey Nest, thin bedded, light grey, dipping very steeply; under it the shale and sandstone of the Conemaugh; the conglomerate and red shale being also exposed.

A coal bed reported 3 feet thick was bored through on a branch of Red Stone Creek by Mr. I. Hutchinson, near the top of the Pocono formation; that is, 53 feet below the mountain limestone. But this coal bed is not visible at the Turkey Nest, being perhaps concealed by *débris*; nor is any such coal bed visible in the gaps of the Conemaugh, Loyal-


CCXXXIV.
No. XI. Subconglomerate Limestone fishes.
Tanaodus pumilis St. John & Worthen.
XI St Louis Limestone Geol Ill Vol VI, pl. XI
Tanaodus sculptus. St. John & Worthen.
XI. St Louis Lime
Teniodus regularis.
XI. Pl. XIII.
Teniodus faciatus. St. John & Worthen.
XI.
Geol Ill Vol. VII
St. J & W Geol. Illinois Vol. VII.
Teniodus obliquus. St. John & Worthen.
XI
St. J & W. Geol. Ill Vol VII
Vaticinodus carbonarius.
XIII
V. vetustus, St. J & Worth
Geol Sur Illinois Vol VII, 1883 p 88 pl IV.
Trigonodus major. Newberry & Worthen.
XI. T. major
T. minor.
pl. XI
Geol. Ill Vol. 2
Vaticinodus ? similis. St. John & Worthen.
XI. Chest.
Geol. Illinois Vol. VII.
Vaticinodus ? simplex. St. John & Worthen.
XI
St. Louis L. Geol. Ill. Vol. VII.
XI
Geol Ill Vol VII, pl. III.
XV
V. lepis. Geol. Ill. Vol. VII, pl. IV
Vaticinodus carbonarius.
XI.
Geol. Ill. Vol. VII.
St. J. & W
Venustodus tenuicristatus. St. John & Worthen.
XI. Keokuk
Geol Illinois Vol VI, pl. IX.
Venustodus argutus, St. John & Worthen.
XI
Geol. Ill. Vol VI plate IX

hanna and Youghiogheny ; yet the record of the bore hole was kept with scrupulous accuracy.*

* On Cheat river in W. Va. the Pocono section has the same character as in Pennsylvania. Its sandstones are seen in Tygart's Valley. At Lewisburg a coal bed four feet thick occurs in the middle of the group. Further south the group becomes indistinct, merged in the lower member of the great limestone series of Kentucky and Tennessee. In southern Ohio the Pocono is represented by the Waverly under the Maxville limestone. Many fossils fill pockets ; and similar pocketed fossils were found by Fontaine near the Chesapeake and Ohio Railroad in Virginia. The species in both regions being identical or closely allied.

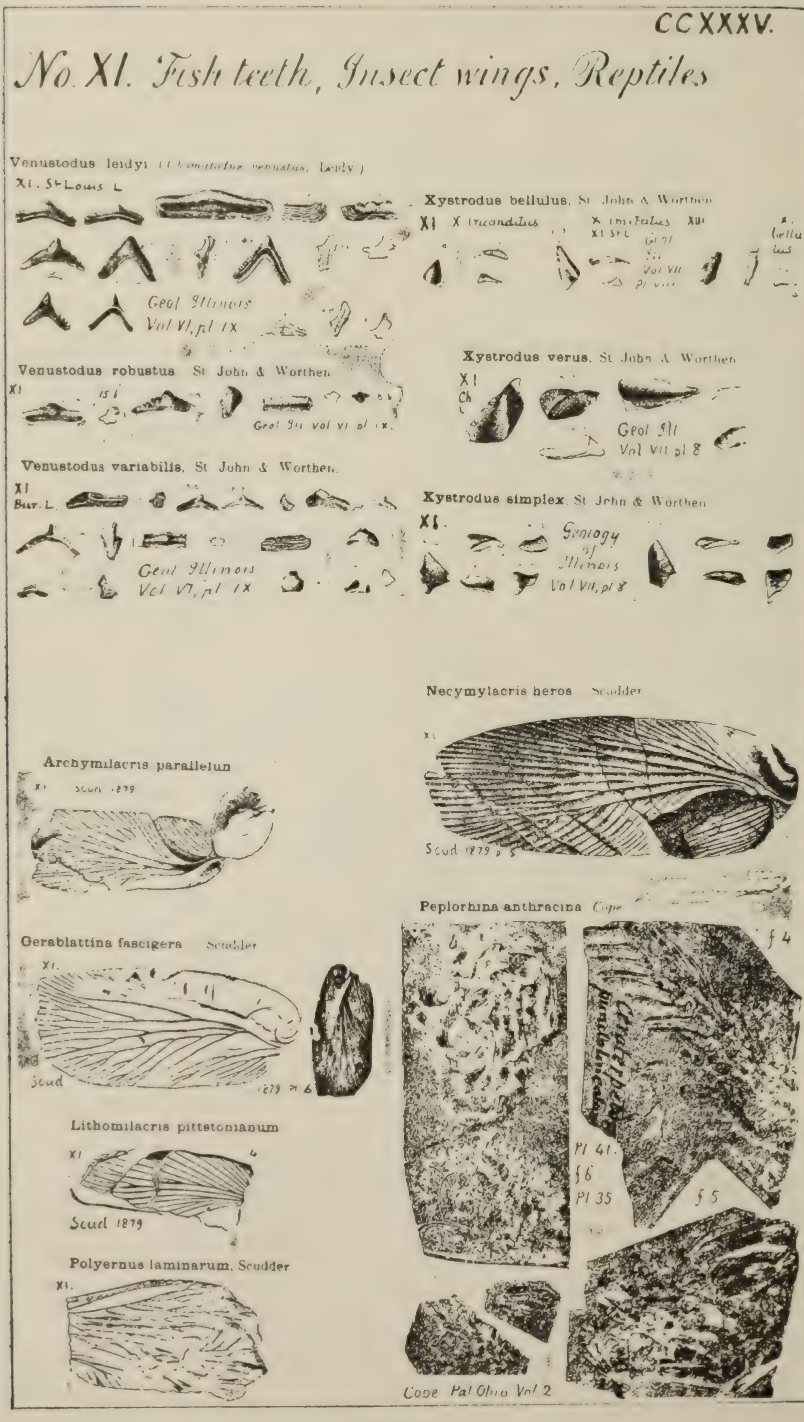
Nothing of economical importance in the Pocono of Fayette and Westmoreland has been certainly found. A lead-zinc vein in a secluded part of the mountain is reported, hand specimens of which were seen by Prof. Stevenson. The ore is said to occur in strings varying from $\frac{1}{16}$ to $\frac{1}{4}$ of an inch. One specimen when analyzed is said to have given a percentage of silver. It is significant that a silver lead ore is reported to have been discovered near Cheat river in West Virginia. All our knowledge of the formation over a wide region teaches that there is no hope of ever obtaining a valuable amount of precious ore anywhere in it.

Prof. Stevenson in his Report K3 on the Ligonier Valley repeats and enlarges his description of the formation. In the interval of 40 feet, between the two beds of shale 250 and 290 feet beneath the mountain limestone, and about midway between the shales, there is a bed of silicious limestone, 4 inches thick, which seems to be the only limestone in the whole formation.

The coal series of Sideling Hill and Tipton Run seem to be represented by occasional slaty layers, containing much vegetable matter, and even thin films of coal. Aside from these the whole series is devoid of both animal and vegitable remains.

The top mass of sandstone is in thin lawyers, bluish-grey, containing much mica ; but the greater portion is exceedingly fine grained, and a good deal like quarzite, being cemented by soluble silica. In this respect it differs from the mountain limestone at the top of the formation in which the cement is carbonate of lime ; hence the name given to the mountain limestone, silicious limestone.

The lower conglomerate sandstone have their pebbles in all cases rounded and polished. There are shale layers in the formation, irregular in shape and containing carbonate of iron balls. On the Yough. river the pebbles of white quartz are numerous and many of them larger than a hen's egg. Both in this and the Conemaugh Gap the layers of smaller pebbles are very definitely bedded. In the lower layers of pebbles they are flattened, and arranged in almost perfect lines according to their longer axis, the layers being from $\frac{1}{2}$ inch to 2 inches apart. This arrangement is characteristic of the horizon and bears no resemblance to the ordinary arrangement of pebbles in any other conglomerate rock, excepting one in the Devonian series underneath the Pocono. On the National road southeast of Connelsville great fragments from the conglomerate outcrops contain both the large pebbles and the flat pebbles in quantity ; and the rock itself reaches the summit of the mountain, where huge masses of the conglomerate layers lie thrown over the ground in the woods north of the Summit House. Just


CCXXXV.
No. XI. Fish teeth, Insect wings, Reptiles
Venustodus leidyi
XI. St Louis L
Geol Illinois
Vol VI, pl IX
Xystrodus bellulus. St John & Worthen
XI
Venustodus robustus St John & Worthen
Geol Ill Vol VI pl IX
Xystrodus verus. St John & Worthen
Geol Ill
Vol VII pl 8
Venustodus variabilis. St John & Worthen
XI
Bur. L.
Geol Illinois
Vol VI, pl IX
Xystrodus simplex. St John & Worthen
Geology of Illinois
Vol VII, pl 8
Necymylacris heros Scudder
Scud 1879
Archymilacris parallelum
Scud 1879
Peplorhina anthracina Cope
Gerablattina fascigera Scudder
Scud
1879
Lithomilacris pittstonianum
Scud 1879
Pl 41
Pl 35
Polyernus laminarum. Scudder
Cope Pal Ohio Vol 2

X. Pocono Formation under Southwestern Pennsylvania.

Sloping westward from Chestnut Ridge at dips of 20° and 30° beneath the third great bituminous coal basin the Pocono formation is seen no more at the surface until it rises in a long line of outcrop extending southwestward from Crawford county, Pa., across the States of Ohio and Kentucky in which it is known under the name of the Knobstone formation, described in the reports of those states,

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beyond the house, the middle flaggy layers have been quarried for furnace lining; also at the Turkey Nest; also handsomely exposed at Old Center Furnace on Dunbar Creek. In West Virginia Prof. White makes the Pocono on Cheat River 480 feet thick, with top and bottom conglomerate subdivisions, separated by shales. It is noticeable that the Pocono of Laurel Hill is less conglomerate, much more flaggy and quite wanting in shales and much whiter than onCnestnut Ridge, being in many places an almost pure white sand.

Fossils are almost entirely unknown in the Pocono rocks of this region as in middle and eastern Pennsylvania; but there are exceptional points of very great interest. For instance, in Victor Hollow, Fayette county, on a branch of George's Creek, there appear the following outcrops near the base of the Pocono formation: Grey sandstone, 1 ft. 6 in.; mottled gray sandstone, 10 in.; grey sandstone, 1 ft. 2 in.; mottled, 1 ft.; dark shale, 8 in.; clay and sandstone, 3 ft. The sandstones are desperately hard like quartzite. The two mottled layers contain many fish spines; the lower one also some indistinct small univalves. With the fish spines traces of zinc-blende and galena; and these ores also appear in the lowest layer.

These univalves are apparently pleurotomaria. It is remarkable that the mountain limestones at the top of the Pocono series should be so very fossiliferous, as shown by Prof. Stevenson's list in Report K3, page 311, and that the rocks near water level in the gaps should also be very fossiliferous, while the intermediate 500 or 600 feet of Pocono rocks should be almost absolutely non-fossfliferous everywhere. These lowest "Devonian" rocks at river level are very rich in Chemung species, with which occur even some Upper Hamilton species. Collections can easily be made alongside of the Pennsylvania Railroad track in the Conemaugh Gap, and the Baltimore and Ohio Railroad in the Connelsville Gap. The first locality is less than 2 miles above the Blairsville Intersection; the other locality is a mile and a quarter below the mouth of Indian creek. Another excellent collection station is in the Laurel Hill Gap, less than 2 miles above Ohiopyle Falls, the first rock cut above the Falls. Excellent collections of the same Devonian species can be made also on the National road on Chestnut Ridge. At all these localities specimens are abundant, and as well preserved as Chemung specimens usually are in New York State. The list given by Stevenson in K3, page 311, is as follows:—Lingula; Discina grandis; Spirifer disjunctus; Rhynchonella stephani; Streptorhynchus chemungensis; Palæoneilo maxima; Sanguinolites rigida; Sanguinolites clavulus; Sanguinolites ventricosa; Mytilarca chemungensis; Pteronites——; Pteronites——; Actinodesma recta; Aetino tesma——; Orthoceras crotalum.

CCXXXVI.

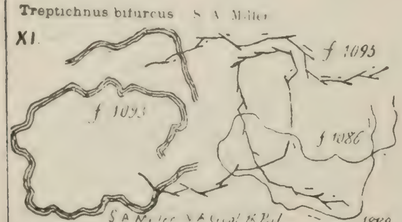
No. XI. Reptile foot prints; — Tracks of worms.

From Mauchchunk red shale, Mount Carbon, Schuylkill Co Pa.

XI.

Treptichnus bifurcus S. A. Miller

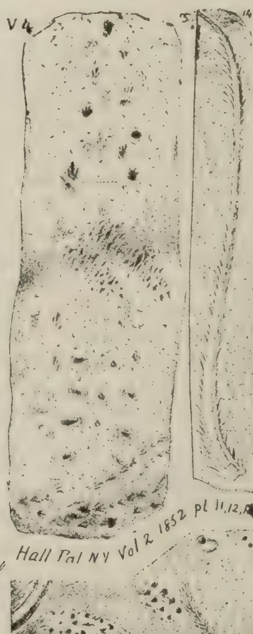
XI.



XI

Tracks of shell fish? Geol. Pa.

V 4



and so-called originally by D. D. Owen on account of its topographical feature, producing, as it does, a belt of almost isolated rounded hills or knobs. In Ohio it has always gone under the name of the Waverly formation, and is so known also in the State of Michigan. In Ohio, one of its sub-divisions is called the Berea grit, sub-divided into upper and lower, a rock recognized in most of the oil wells of Pennsylvania; as it must be passed in reaching the oil sands which lie beneath.

In the gradual and general rise of all the formations northward so plainly visible to the observer ascending the Allegheny river from Pittsburg to the New York state line the Pocono rocks which at Pittsburg lie 1000 feet beneath the surface gradually reach the surface in Venango county, and produce along Oil creek steep slopes or cliffs, the outcrops of what were in early oil times named the first, second and third mountain sand, as distinguished from the first, second and third oil sands beneath them. In the more southern counties all the wells had to go through these mountain sands to reach the oil sands; but different names were applied to them by the well diggers. For example; the third mountain sand was called the first Butler oil sand, because it was originally mistaken for the first Venango oil sand, being the first sand which yielded oil in Butler county, when the oil development was proceeding southward. The most famous of these Pocono rocks has been in recent years called the "Big Injun," a rock which has recently yielded copiously in southern Greene county, on the West Virginia State line. Thousands of wells in western Pennsylvania have passed through the Pocono formation to reach the oil series underneath it; and its character everywhere has been thus made known as will be seen by reference to the well records published by Carll in his seven reports on oil and gas. One volume, his second report, I. 2, a book of 360 pages, being entirely given to such oil well records with explanatory notes. Many other records are given in his other volumes. None of the formations, therefore, are better known than the Pocono, and few of them so well known, and that over an immense region, beneath which, had it not

CCXXXVII.

No. XII. Pottsville Conglomerate outliers which have escaped erosion, on the crest of Chestnut Ridge near Connellsville, Fayette Co

The Elk Rock ([illegible] sandstone) on Chestnut Ridge over Connellsville

been for the oil and gas development, it would have remained concealed from geologists forever. It is impossible to give even a *resumé* of this vast collection of stratigraphical data. It must be collated from a study of these seven remarkable reports, the like of which does not perhaps exist in the history of our science. All that I can do here is to give what we learn from the record of the deep Pittsburg oil well, published in Report L, page 227 to 229.

The Pocono in the Boyd's Hill Well at Pittsburg.

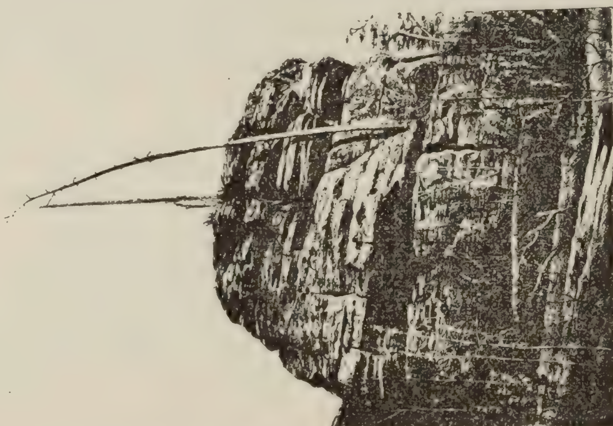
The Boyd's Hill gas well is one of the most interesting and important bore holes ever drilled. It was started on Boyd's Hill at a height of about 100 feet above the main street of Pittsburg, and went down through the barren measures the lower productive coal measures, the Pottsville conglomerate, the Mauch Chunk red shale, the mountain limestone, the Pocono sandstone, and the Catskill red rocks to and through the Venango oil sand group. Its record is tolerably good down to 1700 feet, here the great flow of salt water took place and the remaining 600 feet are not recorded with all the certainty desirable. The derrick platform is 250 feet below the Pittsburg coal bed, at a depth of 350 the Mahoning sandstone was gone through; at 676 the ferriferous limestone; at 729 the top of the Pottsville conglomerate was struck; at 789 one of the conglomerate coal beds; at 889 the mountain limestone 25 feet thick; at 914 the top mass of the Pocono, a white sand rock, 80 feet thick; under which 82 feet of black slate containing gas, under which 110 feet of fine-grained dove-colored mass of sandstone, with no pebbles larger than a pin's head. Under this 154 feet of alternate layers of slate and flaggy sand; then 35 feet of sharp white sandstone, massive and without pebbles; then 30 feet of alternate shales and flag; then 185 feet of "black slate," darker at the top than at the bottom; then 112 feet of white quartzite, probably representing the Berea grit. The greater part of this mass is more or less a conglomerate, having a strong fishy smell, and producing salt water 11° strong from the top to the bottom. Under this was found 110 feet of a sandstone, composed of beauti-

XII.

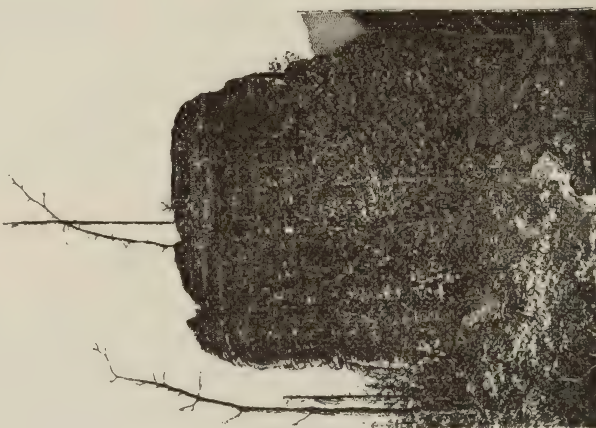
CCXXXVIII.

No. XII. Olean (Lowest Pottsville) Conglomerate in Western New York.

THE OLEAN CONGLOMERATE AT THE ROCK CITY
CATTARAUGUS CO NY



THE OLEAS CONGLOMERATE AT THE ROCK CITY.
CATTARAUGUS CO NY



THE OLEAN CONGLOMERATE AT THE ROCK CITY
CATTARAUGUS CO NY

fully transparent quartz grains all of them angular, and of about the same size, that of a large pin's head. The specimens remind one of the glass sand of the Oriskany outcrops on the Juniata river; much tinted with an orange iron wash. From this remarkable rock issued and still flows a strong brine at the rate of 3000 to 4000 barrels per day; 348 gallons of which make one barrel (280 pounds) of salt and 60 pounds of bittern; bromine, 0.31 per cent. (Dr. Otto). It is from this same layer in the well at Leechburg on the Conemaugh in Armstrong county that the great flow of gas comes which is described in Report L, page 217.

In the page plate, Report L, page 124, may be found the columnar column of the Boyd's Hill well record, a columnar section of the Leechburg well, and a columnar column of Prof. Stevenson's section in the Conemaugh gap through Chestnut Ridge, described above. The Pottsville conglomerate in all three columns being connected horizontally, the diminution in thickness in formation XI Mauch Chunk red shale, that is, of the distance from the bottom of the Pottsville conglomerate No. XII to the bottom of the mountain limestone, going westward from Blairsville to Pittsburg is strikingly exhibited. At the same time the opposite of this in regard to the Pocono formation is equally evident; that is, the Pocono seems to be of almost exactly equal thickness in the Blairsville Gap, in the Leechburg well and in the well at Pittsburg. From 914 feet to 1700 feet, the bottom of the great salt rock, is 786 feet, which may be taken as the minimum thickness of the Pocono formation under Pittsburg.*

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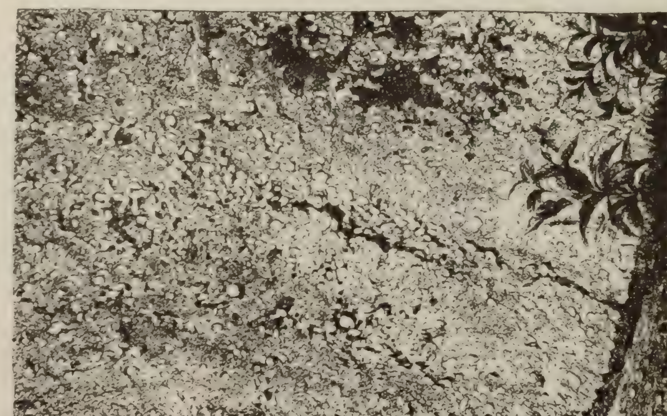
* The new "Big Injun" oil belt of West Virginia extending already 25 miles from Mt. Morris in Greene county, Pa., southwestward past Mannington in Marion county, West Virginia, has been described by I. C. White in the Bulletin of the Geological Society of America, Vol. III, page 187, April. 1892, with important sections of well records at Mt. Morris, Mannington and Fairville Station. The Mt. Morris well, 1905 feet deep, started in the Dunkard creek coal measures, and went down through the mountain limestone 56 feet thick into the "Big Injun" oil sand, 101 feet thick. The Mannington well 1930 feet, found the mountain limestone 92 feet thick; and the "Big Injun" sand thus composed: A, grey sand, with gas 37 feet; B, cream-colored limestone, 17 feet; C, dark sand, 10 feet; D, grey sand with oil at base, 8 feet; E, bluish-grey sand, with more oil and some water. This represents the top of the Pocono formation. The Fairview well, 1999 feet deep, found the

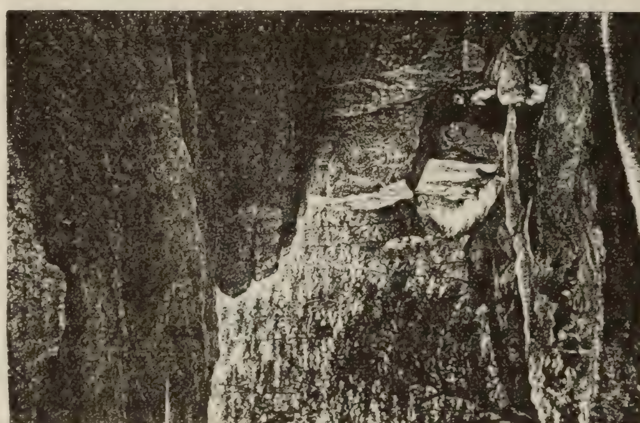
XII

CCXXXIX.

No. XII. Olean (Lowest Pottsville) Conglomerate in McKean Co. Penn^a.



THE OLEAN CONGLOMERATE



DINING HALL PASS OLEAN ROCK CITY

PROFANITY PASS OLEAN ROCK CITY

X. Pocono Formation in the Northern Counties.

Throughout northern Pennsylvania underlying the great upland between the Allegheny Mountains and the New York state line, the Pocono formation has been studied and reported upon by Prof. White in Wayne and Susquehanna; by Mr. Sherwood and Mr. Franklin Platt in Bradford, Tioga and Potter; by Mr. d'Invilliers and Dr. Chance in Clinton, Centre and Clearfield; by Mr. Ashburner in Elk, Cameron, Forest and McKean; by Mr. Carll in Venango and Warren; by Dr. Chance in Clinton and northern Butler, and by Prof. White in Crawford and Erie.

Enough sections have already been published in Vol. II of this summary in connection with the sections of the

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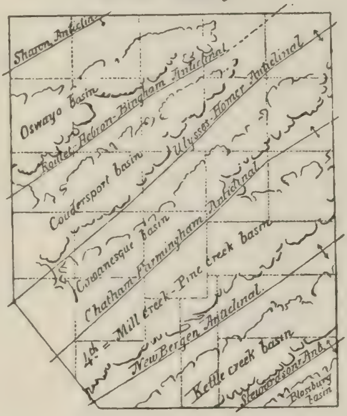
mountain limestone 70 feet thick; and the "Big Injun" thus composed: A, grey sand, 65; B, limestone, 7; C, grey sand, some gas, 20; D, grey sand, heavy gas, 30; E, sandstone, oil show at bottom, 13; F, sand, 7 feet, slate to bottom of well, 5 feet.

Thus we have here the great top sand sub-division of the Pocono 142 feet thick. Since the Mannington test well was drilled 200 others were put down along the belt previous to the reading of Prof. White's paper, opening up one of the largest and most valuable oil fields in the country, located at the top of the Pocono formation, not more than 5 per cent. of the wells drilled within the defined limits proving totally dry. Any oil rock must be variable in porosity and hence in productiveness. Where the oil sand is a coarse gravel like that in the famous McDonald region of Washington county, Pa., or in the great Russian oil field, the oil production is only limited by the size of the bore hole; where the rock is close and compact it can yield little oil. For instance, the famous Mevey well No. 1 at McDonald gushed 15,000 barrels daily; another well, only 300 feet distant from it, drilled through the same fifth sand, was practically dry, the pebble rock having become close grained in that short distance. Thus the richest oil territory is really broken up into oil pools where the pebbles or gravel have been deposited instead of small sand. The top of the Pocono has furnished oil at other localities; the Slippery Rock and manifold oil sands of Pennsylvania, the mica sand of Ohio, and the main sand of Burning Springs and Volcano, W. Va., all belong to this horizon. The Kanawha valley natural gas, used 50 years ago, came from it. The Warfield gas wells of Kentucky are in it. The asphalt deposits of Alabama come from it. The oil and gas are not disseminated uniformly through it, but occur in layers at from 60 to 135 feet below the top, the richest horizon being found at 80 to 110 feet. The texture of the sand is not coarse and pebbly like the Venango oil sands, and therefore the beds do not gush; but produce from 5 to 500 barrels daily after they have been flowing for 30 days, although some have been known to start with 50 barrels per hour. The oil is of a beautiful amber color, and compares favorably with the best of the "white sand" territory; gravity, 48° to 50° (I. C. White.)

CCXL.

No. XII. Inter-conglomerate coals of the northern counties of the state of Pennsylvania.

Potter County.



Whittemore Run No. 1.
Fig. 2.

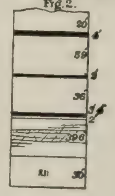


Fig. 1. Skeleton Cross Section in Northern Pennsylvania.

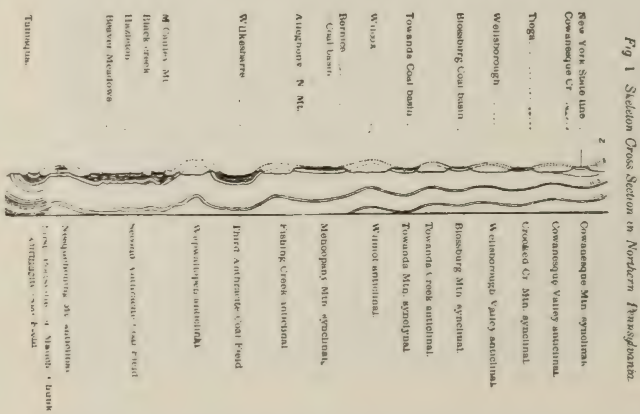
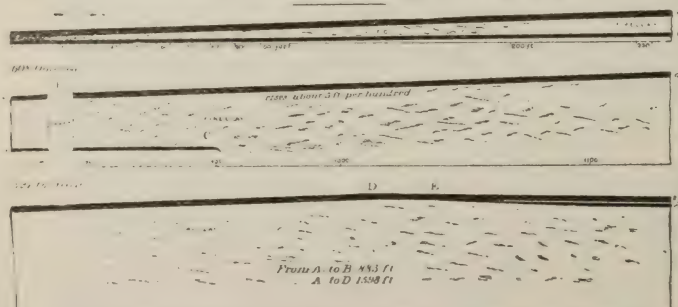


Fig. II.
Isolated lengths of longitudinal Section
to illustrate Variations in Barclay Coal Bed (B) furnished by Mr. F. F. Lyon

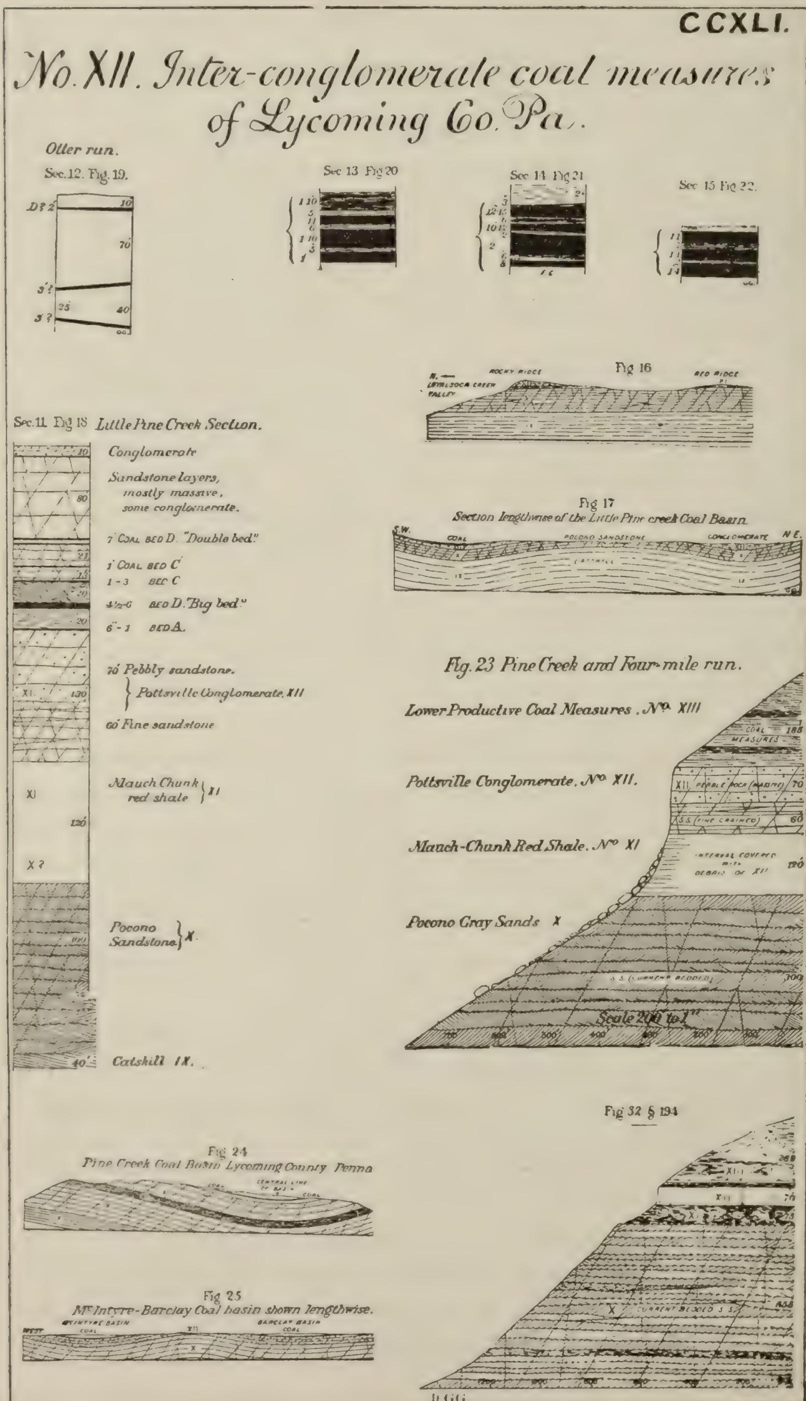


underlying Catskill in the northeastern counties. The Pocono outcrops, nearly horizontal but slightly waving, form lines of cliffs along the waters of the Loyalsock, Lycoming, Pine creek, Kettle creek, the Sinnemahoning, and in fact all the upper waters of the west branch Susquehanna and all the waters of the Genesee and the upper Allegheny, especially as they flow toward and across the New York state line. In McKean county especially the formation has been thoroughly studied, sectioned and described (see Report R).

Everywhere the top of the formation is well defined by an overlying red or red and grey formation No. XI, until the doubtful country is reached in McKean and Warren counties where these shales have been suspected by Ashburner not to be XI, but to be the uppermost uneroded member of X. Against this view I think there are serious objections ; and if it were adopted it would prevent our recognizing the deposit of the Mauch Chunk red shale No. XI in northwest Pennsylvania and Ohio, although if it exists in that great region it is undoubtedly very thin and of a changed character.

In those northwestern counties there are two great conglomerate formations, separated by a shale formation, say 50 feet thick. The upper conglomerate called the Sharon conglomerate by White, the Garland conglomerate by Carll, and the Olean conglomerate by Ashburner, is undoubtedly the lowest subdivision of No. XII, and over it lies the Sharon coal bed well recognized everywhere in northwest Pennsylvania.

The lower conglomerate, called by White the Shenango sandstone, by Carll the sub-Garland, or second mountain sand, and by Ashburner the sub-Olean conglomerate, with its splendid rock cities on the Allegheny river at the state line, is undoubtedly either the great top sandstone division of the Pocono, described by Stevenson in his Conemaugh Gap section, or at least a great sand deposit near the top of the Pocono. I see no reason for not identifying it with the top Pocono sandstone, and thus identifying the intermediate shale formation between the sub-Olean and Olean as Mauch Chunk No. XI.


CCXLI.
No. XII. Inter-conglomerate coal measures of Lycoming Co. Pa.
Otter run.
Sec. 12. Fig. 19.
Sec 13 Fig 20
Sec 14 Fig 21
Sec 15 Fig 22.
Fig 16
Sec. 11. Fig 18 Little Pine Creek Section.
Conglomerate
Sandstone layers, mostly massive, some conglomerate.
7' Coal bed D. "Double bed."
1' Coal bed C
1-3 bed C
4½-6 bed D. "Big bed."
6"-1 bed A.
70' Pebbly sandstone.
Pottsville Conglomerate, XII
60' Fine sandstone
Mauch Chunk red shale XI
Pocono Sandstone X.
Catskill IX.
Fig 17
Section lengthwise of the Little Pine creek Coal Basin.
Fig. 23 Pine Creek and Four-mile run.
Lower Productive Coal Measures. No. XIII
Pottsville Conglomerate. No. XII.
Mauch-Chunk Red Shale. No. XI
Pocono Gray Sands X
Scale 200 to 1"
Fig 32 § 194
Fig 24
Pine Creek Coal Basin Lycoming County Penna
Fig 25
McIntyre-Barclay Coal basin shown lengthwise.
WEST
D GG.

The characteristic distinction between the Olean and sub-Olean deposits was first recognized by Mr. Carll in Venango county (see his earliest reports). He described the Olean as a round pebble conglomerate, and generalized the fact that all the gravel rocks of No. XII above it and of the coal measures still higher contained round pebbles. He described the sub-Olean, on the contrary, as a flat pebble conglomerate, and generalized the fact that from it downward wherever formations X and IX contained pebbles they were not round but flat. This generalization may have been carried somewhat too far, as is shown in Prof. Stevenson's descriptions of the Pocono conglomerates in the Conemaugh Gap near Blairsville; but taken, in a broad sense, the distinction between the older flat pebble rocks and the later round pebble gravels is undoubtedly a true discovery and would be of very considerable importance if its cause were understood in reconstructing the condition of things in sub-carboniferous and carboniferous ages relative to the depth of water, the height of land and the currents of deposition.

Pocono in the Allegheny Mountain Plateau.

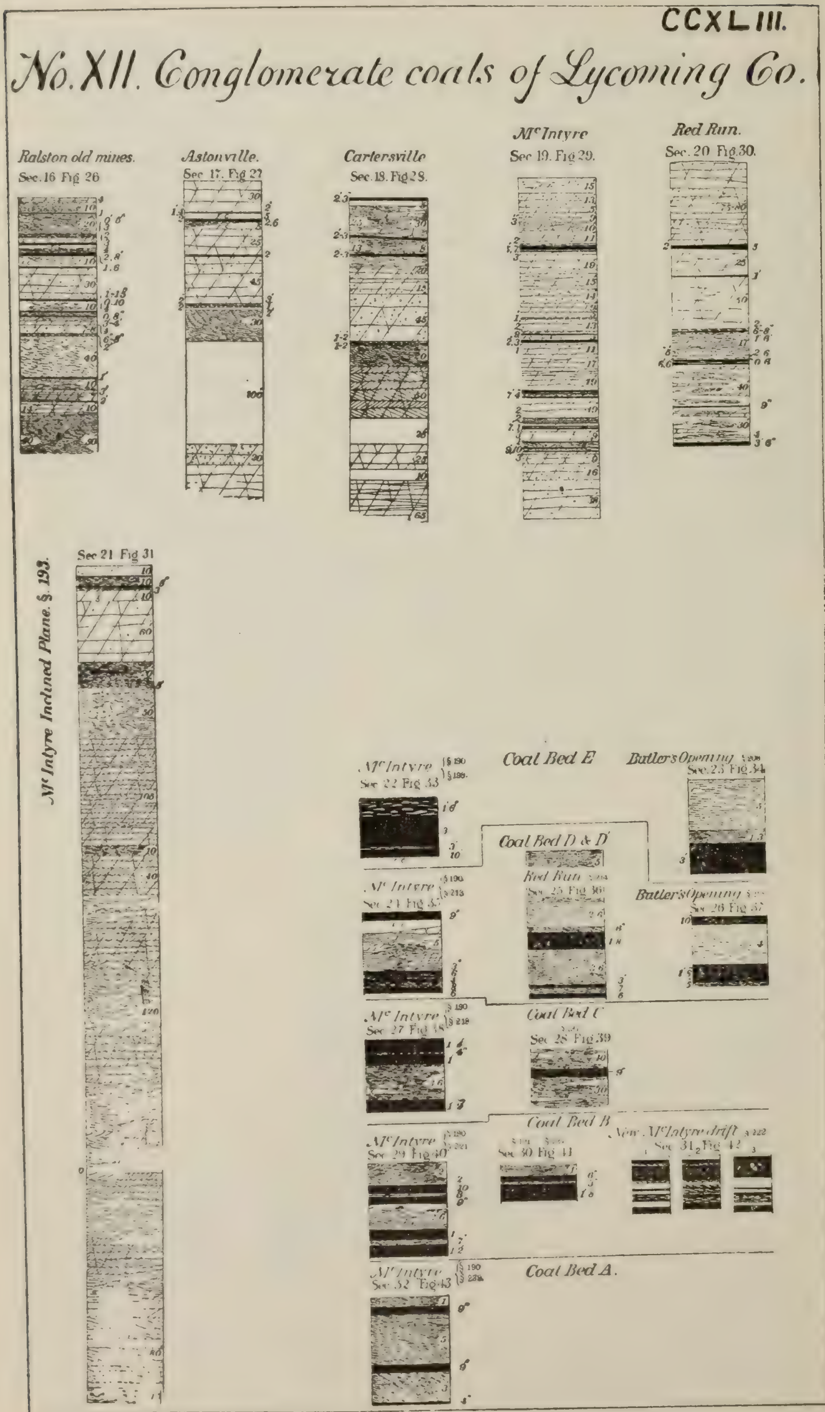
The upland of northern Pennsylvania varying in altitude from 2000 to 2700 feet above tide, may be said to be composed of combined Catskill and Pocono rocks, with shallow parallel basins of XI, XII and occasionally XIII or lower coal measures. This extensive highland of Wyoming, Sullivan, Lycoming, Clinton and Potter counties is traversed by broad and shallow anticlinal waves. which toward the east lift the Chemung formation and thus break up the highland into long, narrow synclinal parallel Pocono mountains, the southermost of which extend the furthest eastward. Thus the first one representing the southern edge or true Allegheny mountain, runs on as the Elk mountain through Wyoming into Susquehanna county. Another is the Towanda mountain, ending at the north branch Susquehanna in Bradford county. Another is the Blossburg mountain. Another is the Tioga mountain, ending a few miles east of the Tioga river at the Bradford county line. Another is

Little Pine Creek Coal Basin.

the Crooked creek mountain, running to the northeast corner of Tioga county, and a few miles into the State of New York. Two others cross Potter county diagonally, and end a few miles in the State of New York.

The first point to be recognized as a distinctive feature of these mountains is their shallow synclinal character, and consequently their very curious internal drainage. In the case of anticlinal mountains innumerable ravines descend their two sides. In the case of these synclical mountains the ravines from their two opposite crests descend inward to a main stream which runs along their middle, and issues by some main gap upon the anticlinal Chemung valley which borders them. Tunkhannock creek is a striking illustration. Shrader's creek, which splits the Towanda Mountain, is another instance.

The next feature to be considered is the decrease in the height of the mountains from south to north. This is owing mainly to the astonishing diminution of the formation itself in that direction. We have seen that in the Mauch Chunk and Pottsville gaps the Pocono formation measures about 3000 feet in thickness. In the gaps of the Allegheny Mountain, at Lock Haven, for example, it measures 1175 feet, and back of Altoona about the same. We have seen that in the Conemaugh gap at Blairsville it is much thinner. So in the northern counties it becomes thinner and thinner until in Potter and McKean it measures little more than 300 feet. At Lock Haven it consists of hard, massive grey sandstones, separated by beds of softer sandstone and shale. In one of its upper bands a thin bed of bituminous slate, a kind of cannel coal, occurs, and just below its junction with the Mauch Chunk overlying red shale XI there is a thin layer of limestone. Dr. Chance remarks that its division into two members is not very plainly shown at Lock Haven; but from Queen's run up the west branch Susquehanna these two subdivisions are always distinguishable by the red color of its lower half contrasted with the overlying grey beds. This makes it an important geological horizon, separating the Venango oil sand group below from the mountain sands above. In


CCXLIII.
No. XII. Conglomerate coals of Lycoming Co.
Ralston old mines. Sec. 16 Fig 26
Astonville. Sec. 17. Fig 27
Cartersville Sec. 18. Fig 28.
McIntyre Sec. 19. Fig 29.
Red Run. Sec. 20 Fig 30.
Sec 21 Fig 31
McIntyre Inclined Plane. §. 193.
McIntyre Sec 22 Fig 33
Coal Bed E
Butlers Opening Sec. 23 Fig 34
Coal Bed D & D'
Red Run Sec. 25 Fig 36
McIntyre Sec 24 Fig 35
Butler's Opening Sec 26 Fig 37
McIntyre Sec 27 Fig 38
Coal Bed C
Sec 28 Fig 39
Coal Bed B
McIntyre Sec 29 Fig 40
Sec 30 Fig 41
New McIntyre drift Sec 31 Fig 42
McIntyre Sec 32 Fig 43
Coal Bed A.

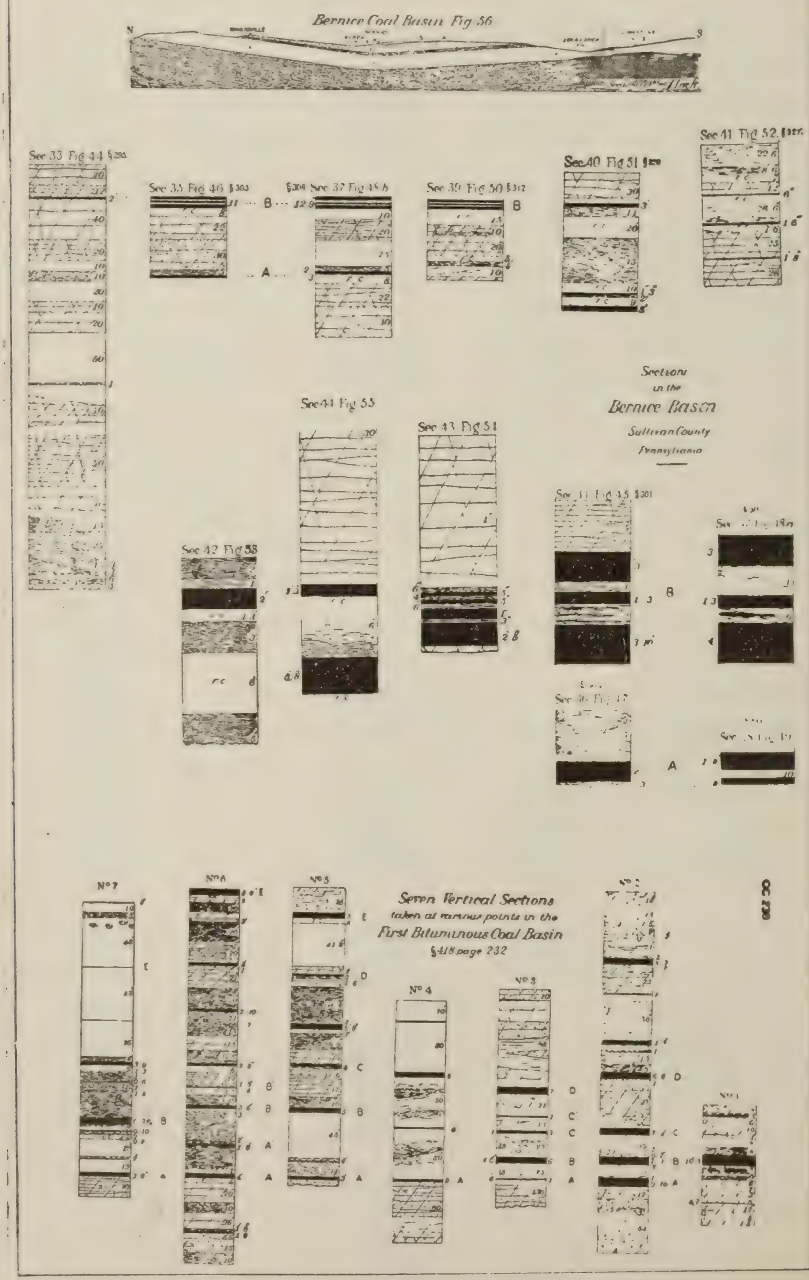
McKean and Elk the lower red subdivision is called red Catskill in Mr. Ashburner's report R2. The characteristic feature of the upper or grey Pocono is its constant sandy character, nearly all hard and massive, but usually fine grained and laminated so as to give the appearance on weathered surfaces of a sandy slate. The grey color is usually greenish, but sometimes approaches a dark steel gray. The sand grains are rounded, rather dark, lustreless, and never sharp. About 60 to 80 per cent. of the mass is sandstone, the remainder sandy shale. From Emporium westward it becomes rapidly less sandy. The shaly bands thickening until in some places more than half the hard sandstone has become olive and grey shale. In the Venango oil region the whole mass is noted for its softness, fast drilling time being always made between the conglomerate or mountain sand and the oil sand ; the only persistent sandy horizon being the third mountain sand or Berea grit.

The thickness of the grey Pocono was measured at many places on the Susquehanna waters ; for instance, at Queen's run, 433 ; Wetham, 400 ; Hyner, 390 ; Renovo, 400 ; Keating, 375 ; Sinnemahoning, 410 ; Sterling, 360 ; Cameron, 425 ; Rathburn, 390 ; Ridgeway, 407 ; Wilcox, 322 ; Kane, 350 ; in Clarion county, about 400 ; in Mercer county, about 400. The parallelism thus shown is very remarkable ; but as Dr. Chance well remarks, no more wonderful than the parallelism exhibited by the coal measures over the great area of western Pennsylvania ; and he might have added no more wonderful than the constant thickness of the Venango oil sand group along a great stretch of the oil bed.

It is the lower sub-division, or red Pocono, then, which makes the principal factor in the decline of the thickness of the whole Pocono formation going northward and westward. As has been said, along the front of the Allegheny Mountain no such distinction is observable. A trace of red shale occurs here and there throughout the formation, but it can hardly be said to be more prominent in the lower than in the upper. But going westward, the red bands rapidly increase in number and in thickness, until at Hy-

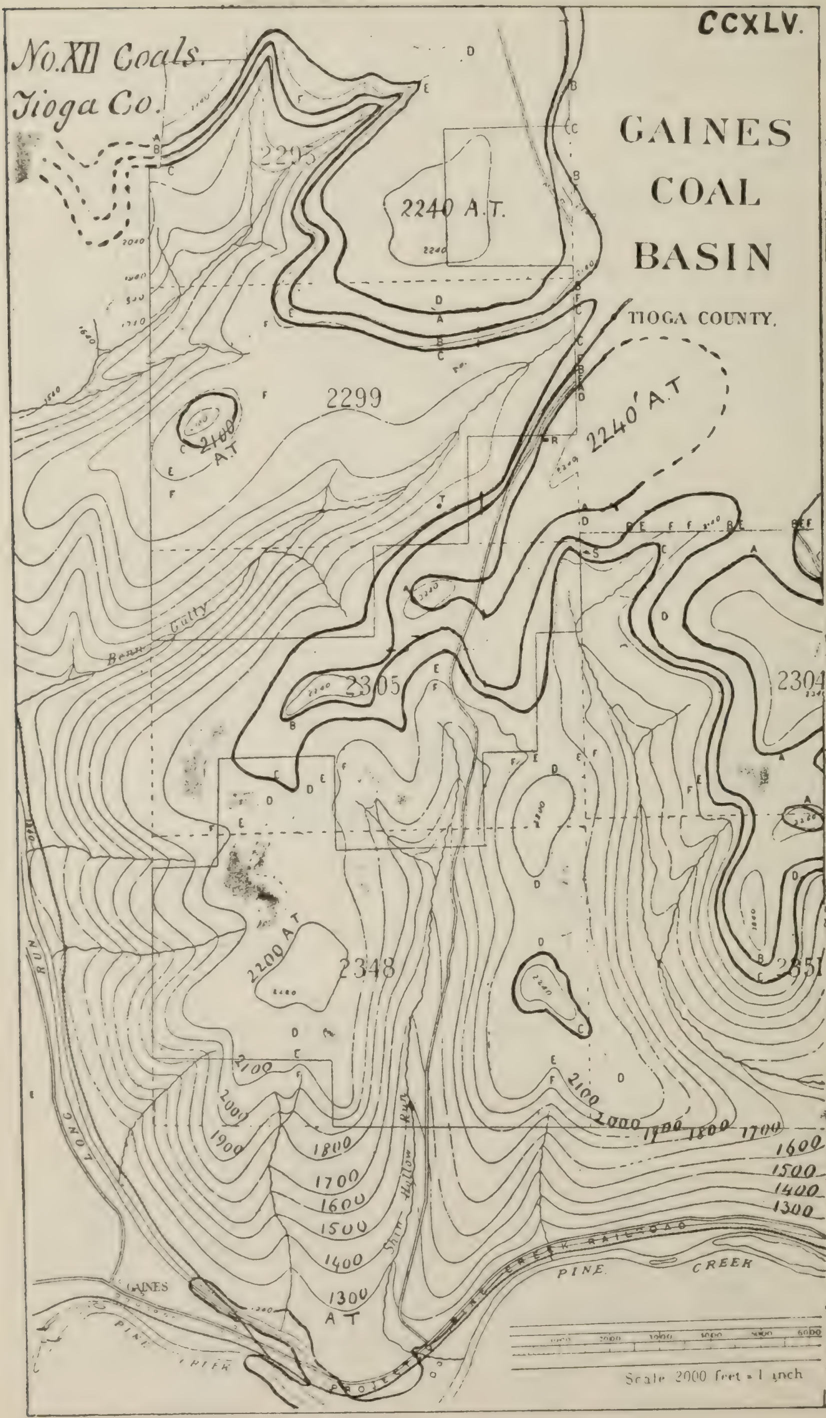
CCXLIV.

No. XII. Conglomerate coals of Wyoming Co.



ner's Station, on the west branch Susquehanna, they aggregate one-tenth of the whole mass. The red color in any one strata is not constant, but repeatedly gives place to grey or olive, and that often abruptly; but as a whole this lower subdivision has a distinct red character in all the country northwest from Wetham or Ritchie. The increase of red from east to west is illustrated by Dr. Chance in the form of a percentage of red, viz: Queen's run, 5; Furney's run, 10 (?); Hyner, 36; Sinnemahoning, 42; Wilcox, 75. This might be continued, he says, westward by tables for the oil region; but in that direction we are approaching a belt of variations along which the greatest irregularity prevails. It is certain, he thinks, that these reds with the exception of the uppermost band, thin out between the oil sands of Venango, Clarion and Butler, and must be considered as geologically synchronous with them. The heavy red band overlying the first oil sand extends far to the west; and this is illustrated by the area of red rocks underground, exhibited in one of Mr. Carll's more recent maps. The reds are also found higher or closer to the conglomerate at Bradford and throughout the northern part of McKean than at points further south; in fact, everything that can be seen throughout that part of the country goes to prove that the horizon at which the red color predominates constantly rises in a north and northwesterly direction. See the theoretical diagram illustrating the deposition of the Catskill and Pocono red beds given by Dr. Chance on page 114, Report G4 on Clinton county, 1880. Mr. Ashburner observing the same facts draws a rather different conclusion, viz: Not a shifting of the horizon of the red color, but a non-conformability between the lower red mass and the overlying grey mass; consequently, speaking not of the Red Pocono but of the Red Catskill.

Dr. Chance gives his measurements of this lower red subdivision of the Pocono, as he considers it to be, thus: "At Queen's run, 742; at Hyner, 600; at Sinnemahoning, more than 450; at Sterling, about 450; at Cameron, 347; at Emporium, about 375; at Ridgeway, about 339; at Wilcox, more than 290; at Kane, about 160; at Bradford, about


CCXLV.
No. XII Coals.
Tioga Co.
GAINES
COAL
BASIN
TIOGA COUNTY.
2240 A.T.
2299
2100 A.T.
2240' A.T.
2305
2304
2200 A.T.
2348
2351
Benn Gully
LONG RUN
Shin Hollow Run
PINE CREEK
PINE CREEK RAILROAD
PROJECTED
GAINES
1300 A T
Scale 2000 feet = 1 inch

250; in Mercer county, about 75." At Kinzua and at Warren the group is almost, if not entirely, wanting. "These places," says Dr. Chance, "lie west of the prolongation of the oil sand shore, which I take it ran a short distance east of them, east also of Stoneham, slightly west of Kane, and not far from Bradford." He adds that in some parts of Venango and Butler the thickness of the group is apparently augmented by bands of red rock coming in beneath the oil sands; or it is possible that these may be the wedge-shaped ends of the Red Catskill (see Dr. Chance's map of the edge of the Catskill basin as he understands it, on page 108, G4).

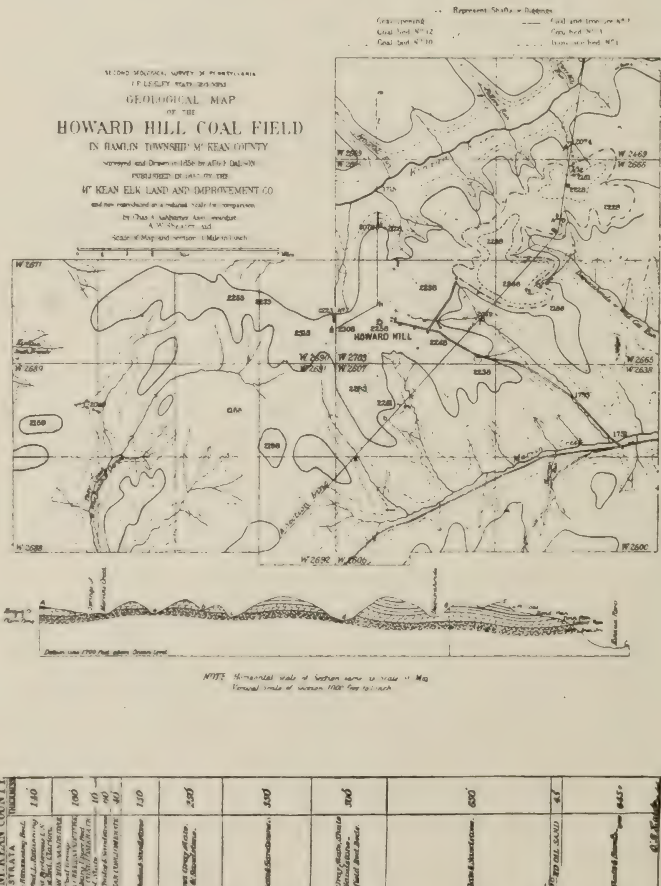
Mr. Ashburner in Report R, page 65, sub divides the Pocono in McKean county where it was studied with great care into three divisions; upper shales and sandstone, middle sub-Olean conglomerate, lower shales and sandstone. It has already been said that the upper shales and sandstones occupy the proper horizon of No. XI, Mauch Chunk red shale, but is entirely different in character from No. XI in other parts of the state; and as No. XI runs out northwestward in a very short distance from Lock Haven to above Queen's run on the west branch, according to Dr. Chance, although it continues westward through Cameron and Elk counties, Mr. Ashburner has some reason for placing these shales in the Pocono, and for considering No. XI as entirely absent. These shales occupy the interval between the Olean conglomerate No. XII and the sub-Olean conglomerate No. X. Their thickness in northern McKean is 50 feet. They increase southward to 230 at Ridgeway in Elk; at Kane they are 90; at the Wilcox wells, 110. Their character is that of grey and yellow flaggy sandstones and clay shales.

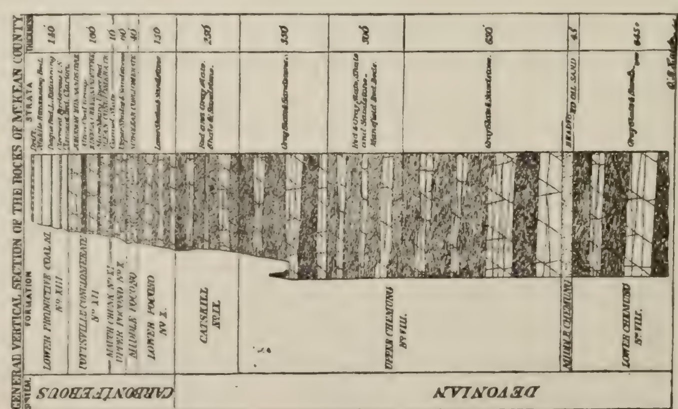
The middle member sub-Olean will be described hereafter.

Ashburner's lower Pocono shales and sandstones throughout McKean are like the upper member, but less massive and more flaggy, with more shales. Their thickness is 150 feet at Bradford and 190 feet at the Wilcox wells. In southeastern McKean they are 300 feet. At the Bear creek and Silver creek wells, Elk county, they are 350. At Ridgeway they measure 413.

CCXLVI.

No. XII. Pottsville Conglomerate coal beds in McKean Co. Penn.





The Marvin creek limestone near the bottom of the Pocono shales is a well-defined bed found in every exposure in the county; as in southern Bradford township along Shepherd run it is seen as a hard, bluish-grey fossiliferous limestone, 2 feet thick, overlaid by grey flaggy sandstone and shale 25 feet and underlaid by 50 feet of greenish-yellow sandy slate. On the west slope of Chappel Hill in northern Sergeant township it outcrops 2080 A. T. as a hard silicious and argillaceous limestone 5 feet thick, containing fragments of Chemung fossils. Above it 20 feet of green and brownish-grey flaggy and shaly sandstone. Below it 60 feet of olive and grey shales and shaly sandstone. At other places fragments of it strew the soil. The weathered stone is a mere silicious skeleton, the lime matrix being dissolved out. This limestone is mentioned in H. D. Rogers' Geology of Pennsylvania, Vol. II, page 548, as not many feet above the Catskill red shale and about 200 feet below the sub-Olean conglomerate near the New York state line, on the road from Potato creek to Bradford, and again 6 miles north of Smethport where a copious lime spring covers the stones and grass with tufa; and similar springs issue along the Warren road 6 miles west. On Bunker Hill on the Bellefonte turnpike a fossiliferous limestone under hard whitish Pocono sandstone dips 7° S. S. E. The same bed under the same sandstone crops out 10 miles south of Smethport, 4 feet thick, exceedingly fossiliferous, very hard and sandy, being in reality a sandstone full of fossil shells. It is seen also on Bennett's Branch further south, and on Tuna creek to the northwest.

Ashburner supposes it to be the same with the lower Meadville limestone in Crawford county, to be described hereafter. In the Benezette dry hole, Elk county, a bed of limestone, probably the same, is reported 7 feet thick at a depth of 123. Nowhere in the region has this limestone been found of economical importance.

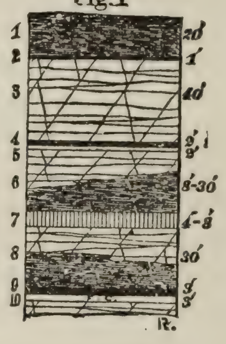
Taking all three of Ashburner's divisions together, he shows the increasing thickness southward from Smethport to Sinnemahoning, Cameron county, thus: At Smethport, 250; Norwich, 300; Keating, 400; Shippen, 450; Empor-

Plate CCXLVII. A..

No. XII. Conglomerate coals in McKean Co. Penn.

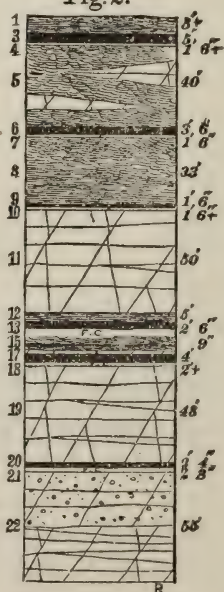
1.	Gray and black slates,	20′
2.	*Coal,*	1′
3.	Gray and brown sandstone,	40′
4.	*Dagus coal,*	2′ 9″
5.	Fireclay,	2′
6.	Sandstone and slate,	8′ to 30′
7.	*Clermont (Ferriferous) limestone,*	4′ to 8′
8.	Sandstone and slate,	30′
9.	*Clermont coal,*	3′
10.	Fireclay,	3′
	JOHNSON RUN SANDSTONE, top member conglomerate series,	—
		140′

Fig. 1



1.	Shales,	15 ±
2.	Gray slate,	3′
3.	*Dagus coal* (Coal-pit opening),	5′
4.	Fireclay,	1′ 6″ ±
5.	Shale and sandstone,	40′
6.	Coal (Rock opening),	3′ 6″
7.	Fireclay,	1′ 6″ ±
8.	Shale and slate,	33′
9.	*Clermont coal* (Charley and Taylor opening),	1′ 6′
10.	Fireclay,	1′ 6″ ±
11.	JOHNSON RUN SANDSTONE,	50′
12.	Black slate,	5′
13.	*Alton Upper coal* (Spring opening),	2′ 6″
14.	Fireclay and shale,	8′
15.	*Alton Middle coal,*	9″
16.	Shale and sandstone,	4′ 3″
17.	*Alton Lower coal* (Hamlin opening),	4′
18.	Fireclay,	2′ ±
19.	KINZUA CREEK SANDSTONE,	48′
20.	*Marshburg Upper coal* (Block opening),	2′ 4″
21.	Fireclay,	2′ 8″ ±
22.	OLEAN CONGLOMERATE AND SANDSTONE,	55′

Fig. 2.



ium, 550; Cameron, 550; Driftwood, 700; Sinnemahoning, 750; and he makes the important practical deduction from these measurements, that the Bradford oil rocks must necessarily sink deeper and deeper going southward to the extent of at least 500 feet; therefore that bore holes to reach the Bradford oil in Cameron county should be put down at least 500 feet deeper than in northern Elk county; and he explains the failure of many test holes in Cameron county to the ignorance of this fact by the oil well borers.

The sub Olean conglomerate in McKean county may be taken as the top of the great Pocono sandstone formation No. X, of eastern and middle Pennsylvania, and consists sometimes of a single solid conglomerate or sandstone, sometimes of a series of alternations of sandstone and conglomerate strata. The conglomerate is composed of a ferruginous, open, angular, loosely cemented sand in which are embedded pebbles of various size, color and composition, invariably water-rolled to a flat or cake-like form. The rock has a tendency to stratification, the layers of which vary from a few inches to 2′ or 3′. The pebbles which separate readily from the matrix, have a hard, smooth surface, much more so than those found in the Olean conglomerate above. The quartzite pebbles are more compact, harder, and more homogeneous than the pebbles of the Olean.

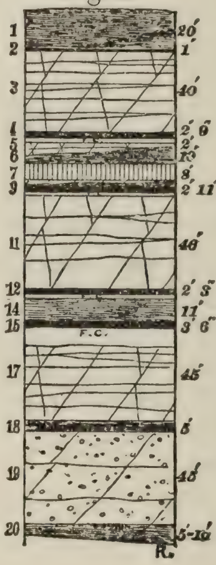
The sandstone strata are hard, massive, fine-grained, ferruginous, often containing clay-iron-stone balls, and with a tendency to fracture like the conglomerate strata parallel to the bed planes; in many places quite shaly; and in many places separated by clay shale partings. The thickness of the sub-Olean is astonishingly persistent, say 40′, not only throughout McKean but also in southern Bradford county.

Fine exhibitions of the rock may be seen along the valley of Kinzua creek, near the Warren county line. A bold cliff overhangs Ludlow station immediately south of the P. & E. railroad. In the Coburn well, it shows a depth of 178′ as a 34′ sandstone, reported to have made a show of oil; the interval between its top and the bottom of the Olean above is here as much as 108′. In the Bear creek

No. XII coal beds, Mc. Kean Co

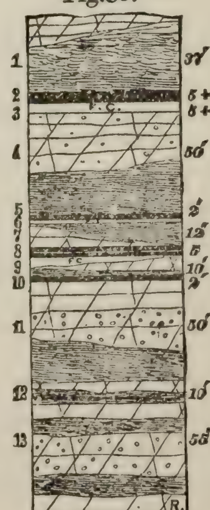
Plate. CCXLVII. B.

Fig. 21.



1. Gray and black slate, ... 20′
2. *Coal,* . . . . . . 1′
3. Hard fine-grained gray and brown sandstone, ... 40′
4. *Dagus coal,* . . . . 2′ 9″
5. Fireclay, ... 2′
6. Sandstone and slate, ... 10
7. *Clermont limestone,* . . . . 8′
8. Sandstone and slate, ... 31′ 6″
9. *Clermont coal,* . . . . 2′ 11″
10. Fireclay, ... 2′
11. JOHNSON RUN SANDSTONE, ... 46′
12. *Alton Upper coal,* . . . . 2′ 3″
13. Fireclay, ... 2′ 6″
14. Blue and black slate, ... 11′
15. *Alton Lower coal,* . . . . 3′ 6′
16. Fireclay, ... — —
17. KINZUA CREEK SANDSTONE, . . 45′
18. *Marshburg Upper coal* and slate, . 5′
19. OLEAN CONGLOMERATE, ... 45′
20. Black slate, (*Marshburg Lower coal,*) . . . . 5′ to 10

Fig. 80.



Clermont (*Ferriferous*) *limestone,* (summits too low to contain it,) . . . —

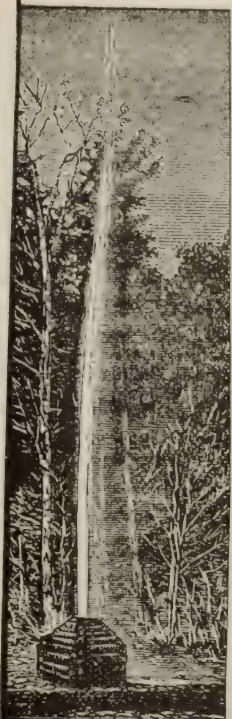
1. Sandstone, shale and slate, ... 37′
2. *Clermont* (*Clarion*) *coal,* . . . . . . 5′±
3. Fireclay, ... 5′∓
4. JOHNSON RUN SANDSTONE (pebbly), and slate, ... 50′
5. *Alton Upper coal,* . . . . 2′
6. Fireclay, (2′) . . . . ?
7. Blue and black slate and sandstone, . 12′
8. *Alton Middle coal,* (2 or more benches,) 5′
9. Fireclay, sandstone and slate, ... 10′
10. *Alton bottom coals,* (sporadic,) . . . . 2′
11. KINZUA CREEK SANDSTONE, conglomerate and slate, ... 50′
12. Slate and sandstone containing *Marshburg Upper coal,* . . . . 10′
13. OLEAN CONGLOMERATE and sandstone with occasional slate beds, ... 55′

well record it appears as Nos. 12, 13 and 14 ; in the Silver creek well record as Nos. 9 and 10. In the Ridgeway section, 20′ above railroad grade, west of the station, it is exposed to the extent of 13′. It has been traced down the valley of the Clarion from Ridgeway southwest as far as Millstone, and to Tionesta, in Forest county (R. 67).

The sub-Olean shales of McKean county, corresponding to White's Shenango shales on the Ohio line, occupy the proper place of the Mauch Chunk red shale formation No. XI, of eastern and middle Pennsylvania ; but doubt has been thrown upon it in McKean county because of the total absence of red shale except in the southeastern part of Norwich township, at the southeast corner of the county ; for which reason Mr. Ashburner concluded that formation No. XI had thinned away to nothing in McKean, and the shales under the Olean conglomerate were properly to be considered the uppermost strata of the Pocono sandstone formation No. X. It is a matter of small importance by which name these shales may be called, but I prefer to consider them No. XI because of the presence in them of the small Mansfield lower coal bed which can be nothing else than the westward prolongation of the Ralston sub-conglomerate coal bed on Pine creek, in Lycoming county.

At the Wilcox wells, one mile north of the Elk–McKean county line, no exposures of red can be seen beneath the Olean ; but at the Bear creek well, eight and one-fourth miles south, the drill, after passing through the lower 25′ of Olean conglomerate, pierced red rock, 15′ ; blue slate, 10′ ; red rock, 20′ ; total, 45′. At the Silver creek well, one mile distant, the same red shale was found directly beneath the Olean. Near Ridgeway, in Elk county, red shale and red soil are seen under the conglomerate. The interval of 50′ has been traced southeast through Cameron and the sections connected with those of Clinton county, where formation No. XI is well determined and exposed. At Marien, in Forest county, some thin red shale beds were found in an interval of 70′ beneath the 70′ sandstone, which is there considered to be the bottom member of the much expanded Olean formation.

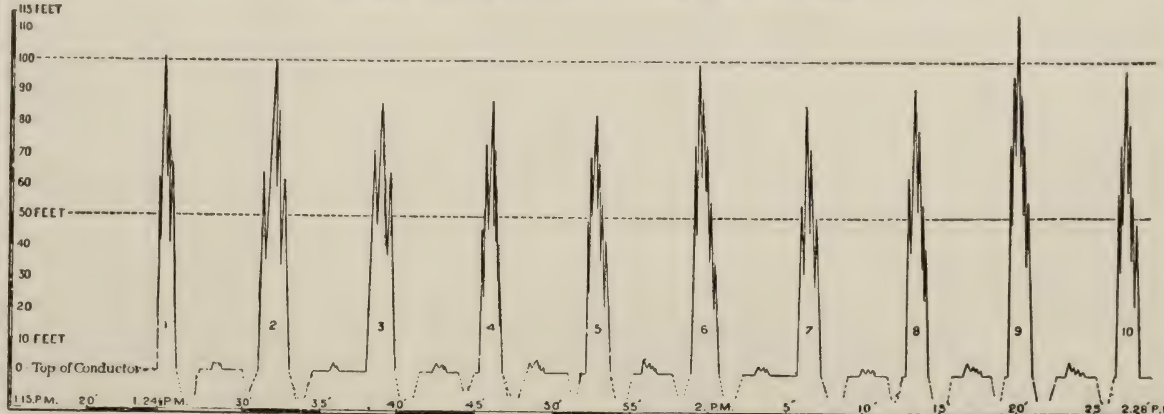
CCXLVII. C.



Kane Geyser Well.

Graphical Representation of the Wilcox Spouting Water-Well, McKean Co. Pa.

The unbroken line on and above the base is the profile of the Water issuing from the Conductor; the Gas rising from the Well at the same time. The broken line below the base indicates the time that no gas is issuing from the Well, and the time that the Water from the Pool around the Conductor is flowing in. The height of the major pulsation in each column was alone determined.

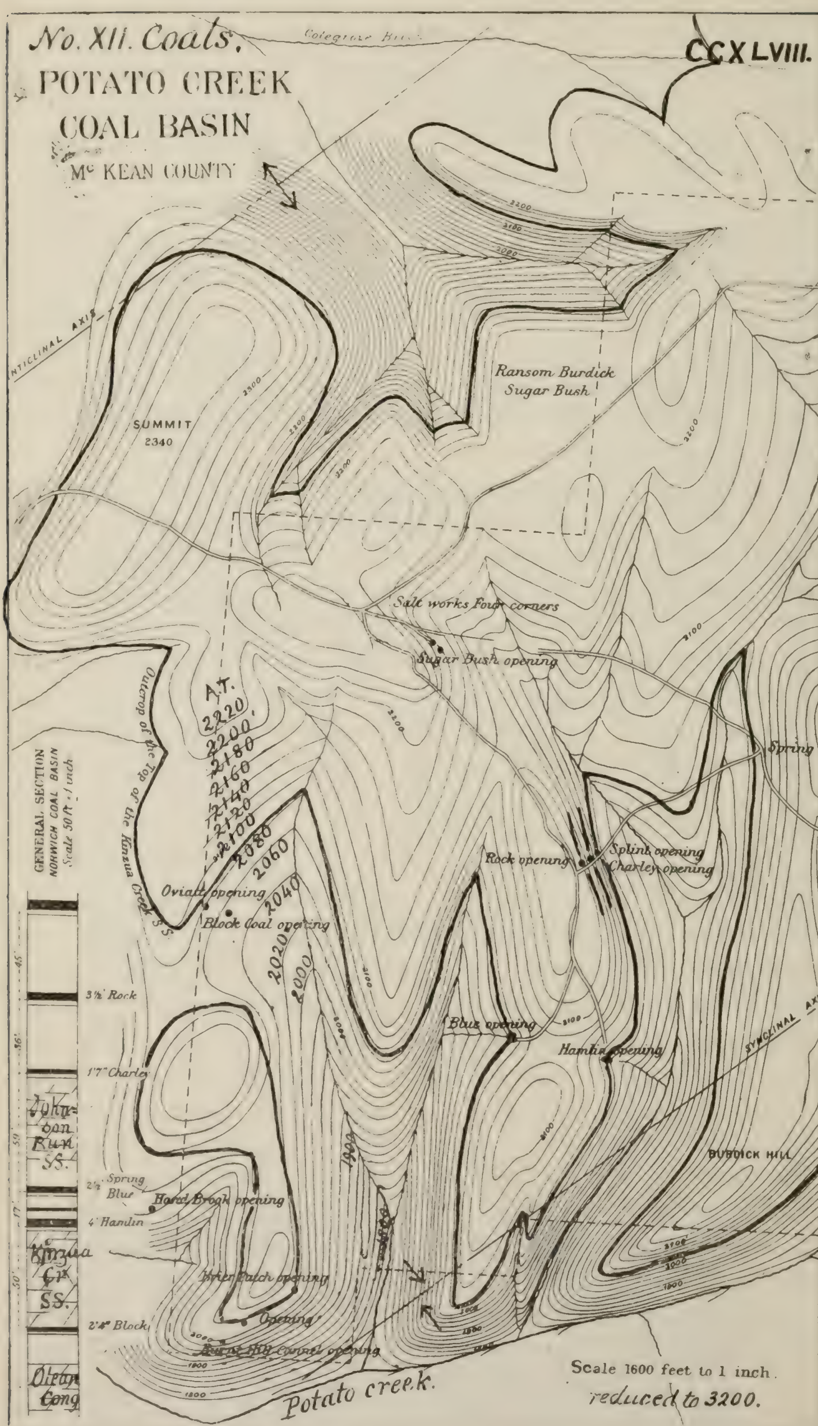


Observations made July 19th 1877, by Chas. A Ashburner, M. S. Asst. Second Geological Survey of Pa.

Through central and northern McKean, the interval is represented by 5′ or 10′ of ferruginous clay shale, or by black slate with occasional layers of cannel coal, or thin slaty coal, called, in Report R, the Marshburg lower coal. At Claremont, very cannelly black slate occurs. On the Boyer farm this slate has been dug into for a coal bed, which received at the time the sensational name of the Mammoth Bed, of course of no value. In the vicinity of Marshburg, Lafayette township, sixteen miles west of Smethport, a poor, slaty coal bed was opened directly under the conglomorate. At Ridgeway, on the Clarion river, the same coal was found on the Gresh hill, north of the railroad station.

The sub-Olean shale formation, say 50′ thick, along the New York state line, in McKean county, increases southward to 230′ at Ridgeway, in Elk county, but not regularly; in fact, the greater part of the increase takes place between the southern line of McKean and Ridgeway; for at Kane the thickness is 90′, and at the Wilcox wells, 100′ or 110′. Drawing an east and west line across the county through Claremont, the average thickness of the formation north of that line may be safely stated at 60′. The general character of the strata is a series of gray and yellow flaggy sandstones and clay shales.

The sub-Olean (Shenango) shales northwest of the Allegheny river, in Warren county, maintain quite a uniform thickness of about 50′ with two or three exceptions; but southeast of the river they thicken quite rapidly; for at Sheffield they measure 100′, and near Brookston, at the southeast corner of Warren county, 120′ or more. At Kane, ten miles east northeast of Brookston, in McKean county; also in Highland township, Elk county, six miles south of Kane; also at the Wilcox wells, six miles east southeast of Kane; also at Ridgeway, fifteen miles south southeast of Kane, and so down the Clarion river, westward, in southern Forest county, at the mouth of Spring creek and at the mouth of Millstone creek. At all of these places the flat pebble sub-Olean is exhibited, and above it, in the same hillsides, the round pebble Olean conglomerate is ex-


No. XII. Coals.
POTATO CREEK
COAL BASIN
Mc KEAN COUNTY
CCXLVIII.
ANTICLINAL AXIS
SUMMIT
2340
Ransom Burdick
Sugar Bush
Salt works Four corners
Sugar Bush opening
Outcrop of the Top of the Kinzua Creek S. S.
A.T.
2220
2200
2180
2160
2140
2120
2100
2080
2060
2040
2020
2000
Oviatt opening
Block Coal opening
Spring
Rock opening
Splint opening
Charley opening
Blue opening
Hamlin opening
SYNCLINAL AXIS
BURDICK HILL
Hard Brook opening
Brier Patch opening
Opening
Potato creek.
Scale 1600 feet to 1 inch.
reduced to 3200.
GENERAL SECTION
NORWICH COAL BASIN
Scale 50 ft. = 1 inch
3½' Rock
1'7" Charley
Johnson Run SS.
2½' Spring
Blue
4' Hamlin
Kinzua Cr SS.
2'4" Block
Olean Cong

posed, with from 100′ to 150′ of intermediate shales separating them ; so that there can be no doubt, whatever, respecting the different characters and fixed relationship of these two formations to each other throughout an extensive region affording innumerable opportunities for examination.

The exceptions northwest of the Allegheny river, mentioned above, are in Elk, Glade and Freehold townships, as follows : In Freehold township under Miller's cliff, no outcrop of it can be seen, nor anything in the soil to indicate its presence, which is one of the arguments in favor of making the Miller's Cliff rock itself sub-Olean as described in the chapter on the Salamanca conglomerate.

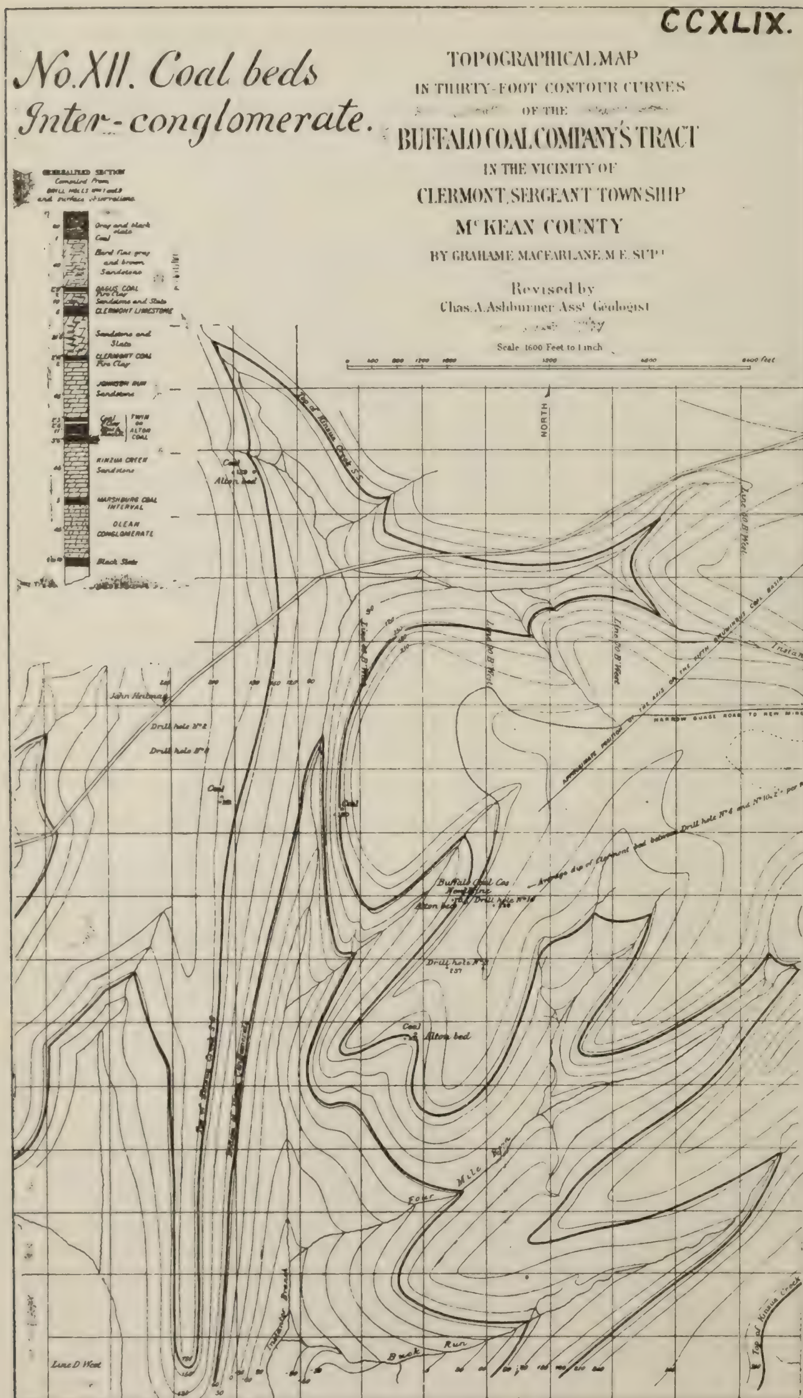
The sub-Olean conglomerate underlies the Pike's Rock Olean, spreading out like a lower terrace southeastward to the township line. It is a yellow, coarse-grained, iron-spotted sandstone separated from the Pike's Rock above by a few feet of sub-Olean shales.

On the eastern side of Matthew's run another patch of sub-Olean remains.

From Farmington and Pine Grove townships the sub-Olean has been removed, except on the Glade and Elk township border.

In Warren county, the sub-Olean conglomerate affords better opportunities for correct identification than most of the other formations in the region ; and yet, in spite of its numberless exposures and well-defined constitutional peculiarities, it is not always easy to keep it in hand from point to point beyond limited areas ; and this is especially true when it is overlaid by other rocks as in the southeastern townships and in McKean, Forest and Venango counties.

Until late in the survey of the oil regions, confidence was felt in the parallelism of the Olean and sub-Olean conglomerates as separated by a pretty constant interval of Shenango shales varying in thickness only between 30′ and 60′, and consequently it was considered a matter of comparative indifference whether at any given locality the one or the other was exposed. But of late Mr. Carll felt the necessity of being more cautious in the use of that formula


CCXLIX.
No. XII. Coal beds
Inter-conglomerate.
TOPOGRAPHICAL MAP
IN THIRTY-FOOT CONTOUR CURVES
OF THE
BUFFALO COAL COMPANY'S TRACT
IN THE VICINITY OF
CLERMONT, SERGEANT TOWNSHIP
Mc KEAN COUNTY
BY GRAHAME MACFARLANE, M. E. SUPT.
Revised by
Chas. A. Ashburner Ass^t Geologist
Scale 1600 Feet to 1 inch
NORTH
GENERALIZED SECTION
Compiled From
and surface observations
Gray and black slate
Coal
Hard fine gray and brown Sandstone
Fire Clay
Sandstone and Slate
CLERMONT LIMESTONE
Sandstone and Slate
CLERMONT COAL
Fire Clay
JOHNSON RUN Sandstone
ALTON COAL
KINZUA CREEK Sandstone
MARSHBURG COAL INTERVAL
OLEAN CONGLOMERATE
Black Slate
Alton bed
John Holtman
Drill hole No. 2
Coal
Buffalo Coal Cos
Alton bed
Drill hole No. 3
Coal
Alton bed
Four Mile Run
Buck Run
Line D West
NARROW GUAGE ROAD TO NEW MINE

of measurement, and even suspected that there were areas over which the sub-Olean, after being deposited, had been removed together with the overlying shales, and then the Olean deposited in its place so as to occupy the geological horizon of the sub-Olean. According to another explanation, the sub-Olean at such points may not have been ever deposited at all, and on that account the Olean may be supposed to occupy a lower horizon in the column than is its due. One thing is certain that the intermediate shales do not maintain a constant thickness between them, so that in the southeast corner of Warren or along the McKean county line, the Olean and sub-Olean are more than 150′ and even 200′ apart. It is, however, possible that this abnormal distance of the sub-Olean beneath the Olean may be otherwise explained, viz., by a lower sand rock being mistaken for the sub-Olean, as will be explained in discussing the exposures in McKean county (I. 4, 190).*

* If the sub-Olean be the top of the Pocono formation No. X and the sub-Olean shale be Mauch Chunk No. XI, the thickening of the shale southeast is to be expected, for along the Allegheny mountain No. XI, is 200′ or 300′ in thickness. The length of time represented by the interval between Olean and Sub-Olean would seem to be short when regarded in northwestern Pennsylvania; but in fact it must have been immensely protracted, judging from the fact that in the anthracite region of eastern Pennsylvania the red shale No. XI is 3000′ thick. There is no satisfactory explanation of the immense thickness of this shale in the east and its comparatively extraordinary thinness in the west; but the suggestion that during part of the time the western shales were out of water and subject to erosion is not supported by any solid evidence; in fact, such a suggestion carries with it a supposition that the sub-Olean shales were originally a thick formation also in the west; but if that were so, erosion would exhibit itself not by planing off the formation to a uniform thinness, but by gouging it in all directions into deep valleys, into which the Olean gravel deposits would necessarily have been banked to an immense depth; and no such phonomenon exhibits itself anywhere in western Pennsylvania. Some great change, however, in the sea currents, must have taken place, and consequently in the geographical relations of land and water in that age. Otherwise there could not have been so essential a change in the character of the pebbles as to put a stop to the deposit of flat sub-Olean pebbles, and to begin an era of exclusive Olean round pebbles. This distinction, held by Mr. Carll first as an hypothesis, was gradually confirmed as year after year of his survey in the oil regions went on, and there seems to be now no doubt that a distinct line of demarcation between the two kinds of gravel has been established. The flat pebble rocks, thinly bedded, current bedded, and weathering down into thin small blocks or plates, always lie below the shales; the round pebble

CCL.

No. XII. Conglomerate coals of Mc.Kean Co.

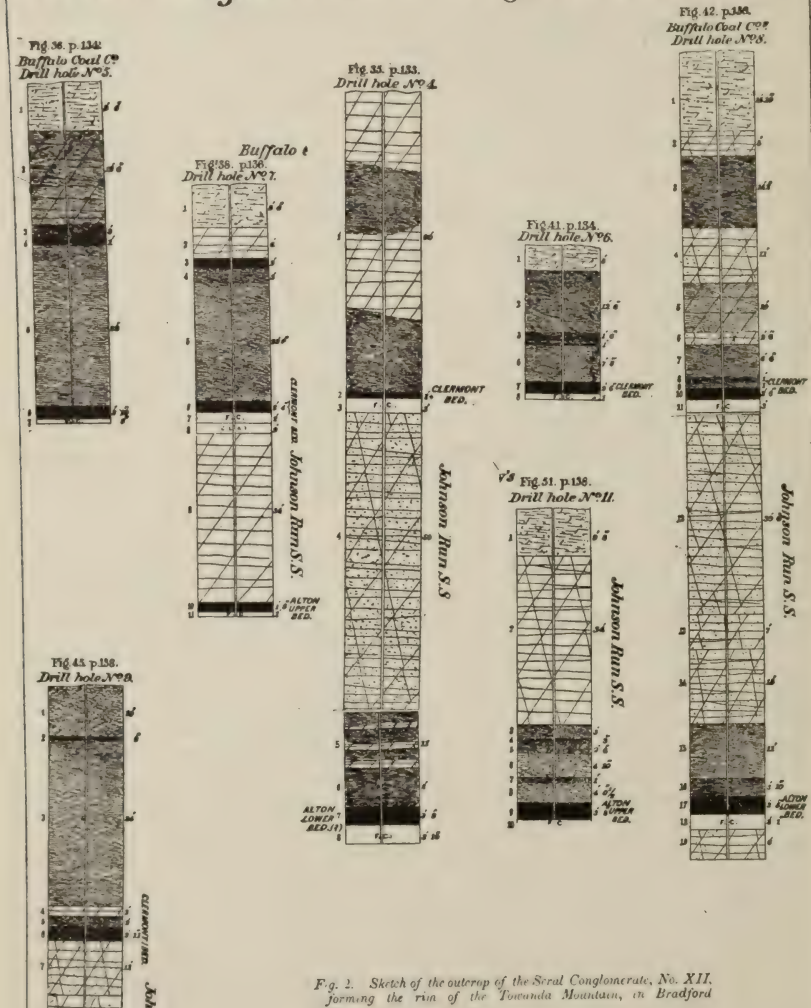
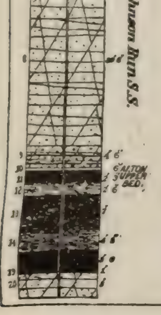
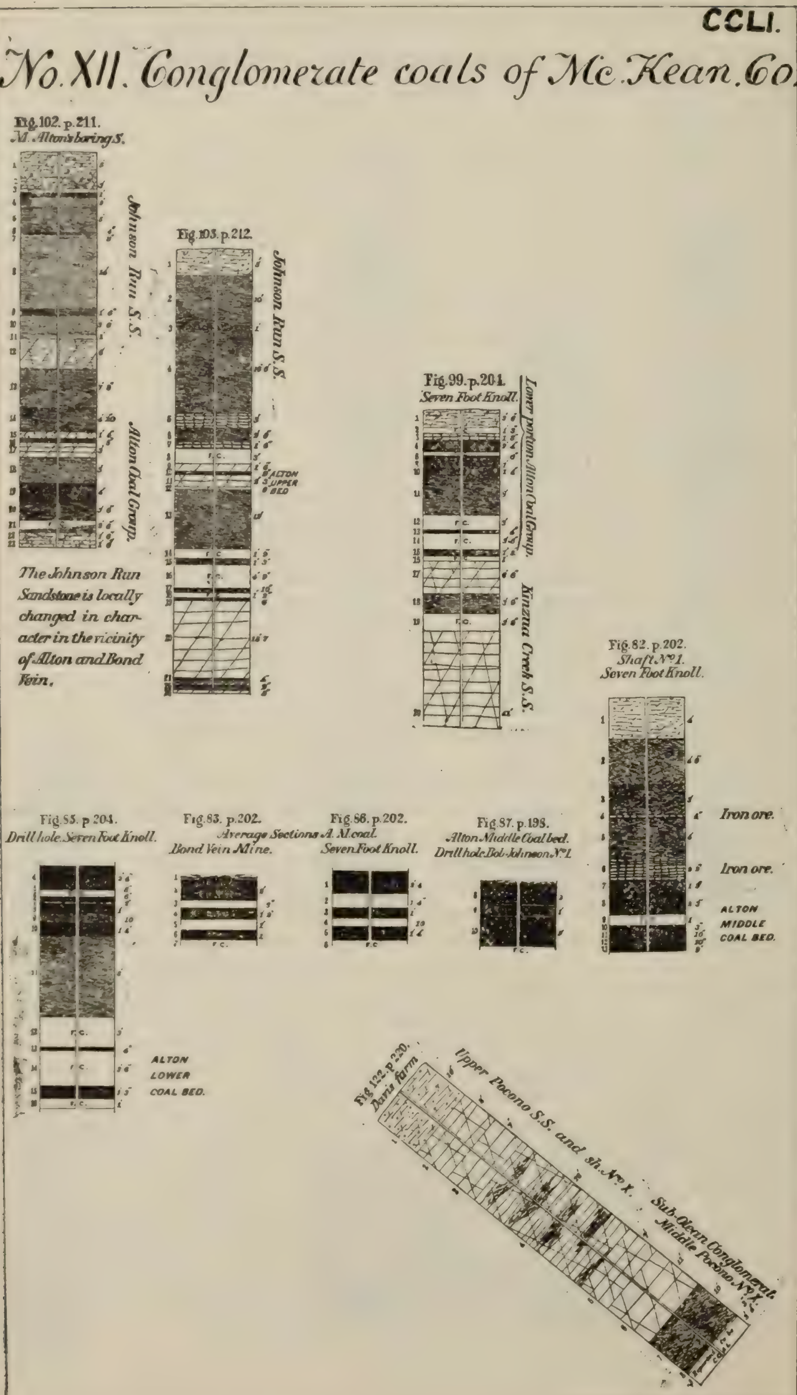



Fig. 2. Sketch of the outcrop of the Seral Conglomerate, No. XII, forming the rim of the Towanda Mountain, in Bradford County.

The sub-Olean is by no means always a conglomerate, although when it is so, its pebbles are always flat. In its range across Warren county, it exhibits great variability in constitution. At Tidioute, on the Allegheny river, to the the south, it is a yellow, ferruginous sandstone, free from pebbles and identical in appearance with the Shenango sandstone of Crawford and Mercer counties. Further up the river, in northern Deerfield, it is much more shaly, but still resembles the Shenango sandstone. Further north, in Conewango, Glade and eastern Elk, it appears in the Allegheny river hills as a conglomerate ; often a mass of finely assorted pebbles no larger than grains of wheat; it is heavily charged with oxide of iron collected in irregular

---

rocks, massive, compact, and breaking up into irregular, cubical blocks, sometimes 40′ thick, and of still greater length and breadth, invariably lie above them. The shape of a pebble depends first on the nature of the fragment from which it has been made, and, secondly, by the kind of friction to which it has been subjected. Pieces of quartz, descending the bed of a river, will be rolled, all of them, round ; if moved forward and backward by gentle waves on a shore they will all of them be worn flat. Mr. Carll cites two specimens from his cabinet in illustration ; one from a gravel bank at Warren, which had lain undisturbed in the drift from the time of the retreat of the ice ; the other from the shore of Lake Erie where it has been exposed to the waves for ages ; the material of both the same ; but the one irregularly oval, and the other flattened and polished. The flat pebble conglomerates may, he thinks, be referred to distant shore deposits of round pebbles subjected for ages to a gentle trituration by waves, polishing and flattening them and carrying them down slowly to the deeper water bed. In the following age, new shore lines with round pebbles might be supposed to overlie the older sea bottom areas. The theory is necessarily vague, and in our ignorance of where the shore lines were, both in the sub-Olean and older times and also in the Olean and later times, it is better to confess our inability to offer a satisfactory explanation of the facts. It must be remembered also that the quartz pebbles, both in the Olean and in the sub-Olean, must have been made out of fragments of quartz veins in some distant azoic country like Canada or New England ; and that thick veins of quartz would furnish large fragments capable of being rounded into an egg shape, while the thinner quartz veins could furnish only plate-like fragments which would necessarily be ground down flat. Therefore, instead of seeking the cause in any correlation of shore to sea in the region itself, we may be obliged to seek an explanation of an entirely different kind, viz., in two different countries, perhaps at a great distance, the rocks of one being traversed by large quartz veins ; the rocks of the other by small ones. But in this case, also, we must remain wholly in the dark respecting the location of such lands, their river systems, and the nature of the sea currents which brought the river detritus to northwestern Pennsylvania.


CCLI.
No. XII. Conglomerate coals of Mc.Kean.Co.
Fig. 102. p. 211.
M. Alton's boring S.
Johnson Run S.S.
Alton Coal Group.
The Johnson Run Sandstone is locally changed in character in the vicinity of Alton and Bond Vein.
Fig. 103. p. 212.
Johnson Run S.S.
ALTON UPPER BED
Fig. 99. p. 204.
Seven Foot Knoll.
Lower portion Alton Coal Group.
Kinzua Creek S.S.
Fig. 82. p. 202.
Shaft No. 1.
Seven Foot Knoll.
Iron ore.
Iron ore.
ALTON MIDDLE COAL BED.
Fig. 85. p. 204.
Drill hole. Seven Foot Knoll.
ALTON LOWER COAL BED.
Fig. 83. p. 202.
Average Sections A. M. coal.
Bond Vein Mine.
Fig. 86. p. 202.
Seven Foot Knoll.
Fig. 87. p. 198.
Alton Middle Coal bed.
Drill hole Bob. Johnson No. 1.
Fig. 122. p. 220.
Davis farm
Upper Pocono S.S. and sh. No. X.
Sub-Olean Conglomerate.
Middle Pocono No. X.

seams or in balls, with a shell of iron filled with ochre. The rock weathers down in rough cubic fragments a few inches in size, covering the steep sides of pyramidal hills with a flat top, so peculiar in outline that a practiced eye can trace the sub-Olean formation from a distance across the country.

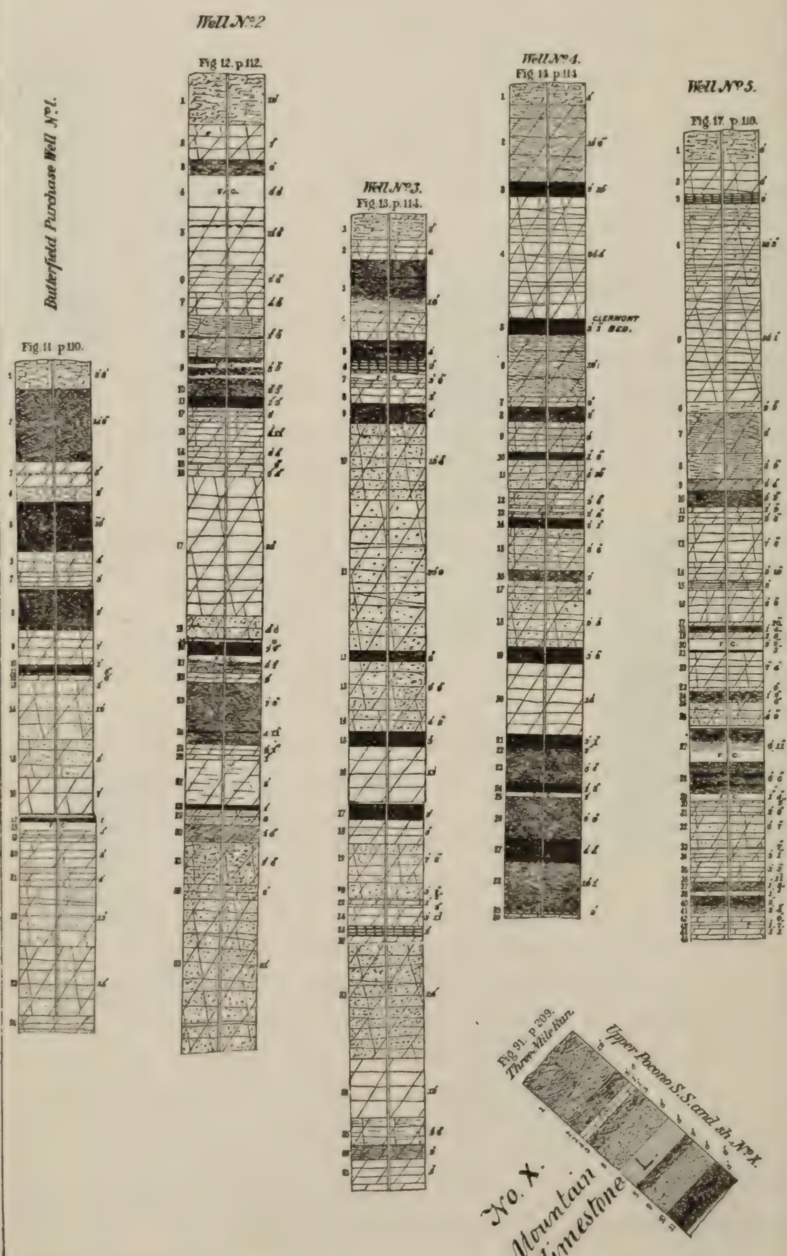
This gradual increase of the conglomeritic character northeastward up the Allegheny river is well shown in Elk township, where the sub-Olean is a massive conglomerate, many of its pebbles being more than an inch in diameter; uneven in structure on account of the irregular accretions of iron in the incoherent sandy matrix facilitating erosion, so that the outcrops crumble down and the cliffs are seldom seen. Near the northwest corner of Elk township there is, however, a good sub-Olean rock city, and there are one or two more half a mile north of the State line, in New York, the rock being less charged with iron; the sand weathered out of it being screened and used for mortar.

The thickness of the sub-Olean wherever it appears along the Allegheny river above Warren is from 30′ to 40′; in one massive stratum, current bedded, pebbly, and heavily seamed with iron, particularly toward its base; perpendicular escarpments from which ponderous blocks slip down into the valley; after the fashion of the Olean conglomerate, for which it has been, therefore, often mistaken, especially before the peculiar flatness of its pebbles was recognized. And this type of the formation extends southeastward into McKean and Forest counties, while its distance below the Olean increases in that direction.

What was the character of the sub-Olean formation in northern Warren and western New York before its removal from the present surface of the region? We can only answer this question by reference to the patch of it left at Miller's Cliff, on the Little Brokenstraw, four miles from the New York State line, eight miles from the Erie county line (if this be, as I suppose, sub-Olean, although Mr. Carll reported upon it as Olean), and by the patches which remain of it in the southeastern corner of Erie county. These fragments present specimens of the formation in its massive conglome-

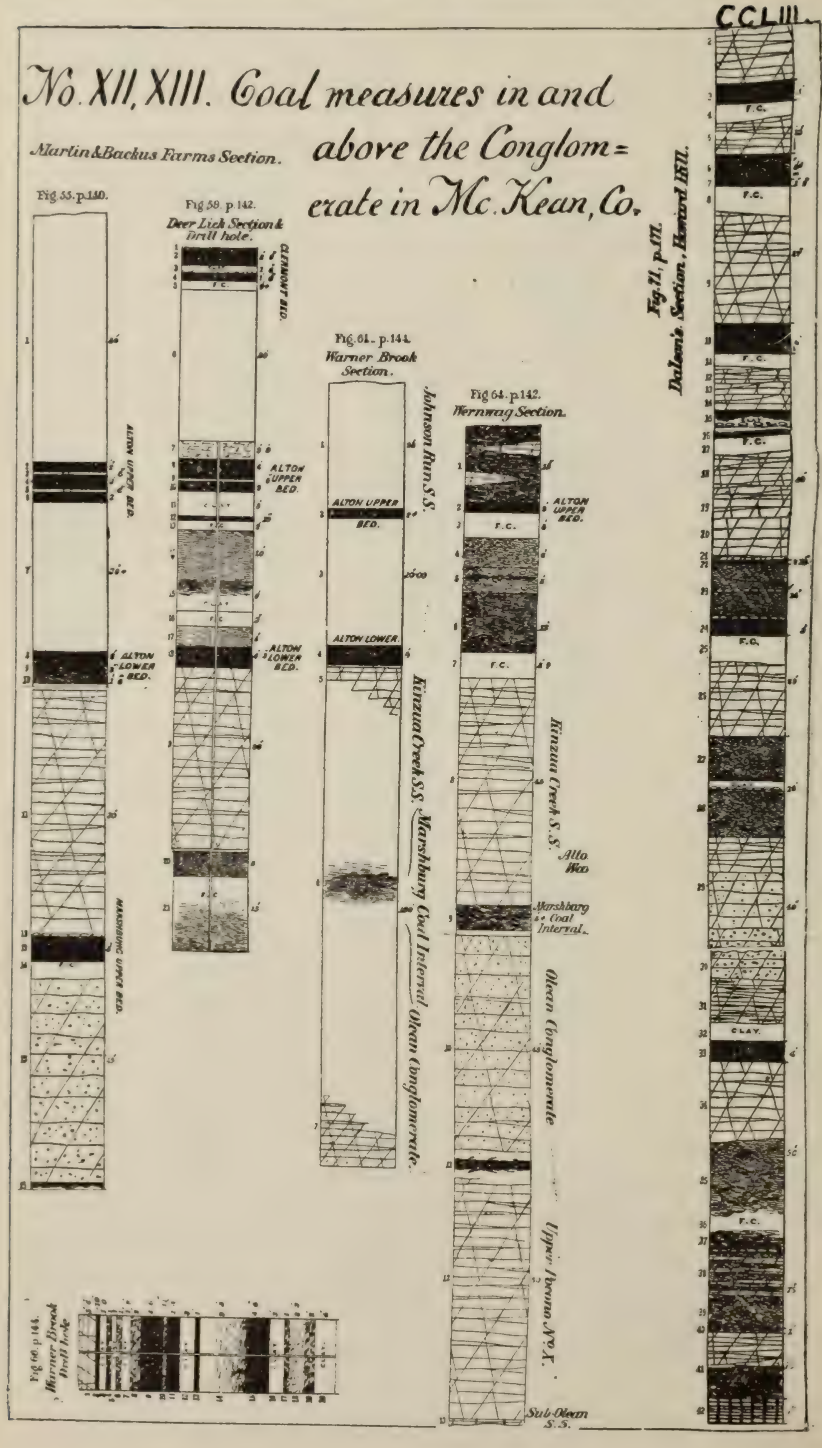
CCLII.

No. XII. Conglomerate coals of McKean. Co.



ritic form from 25′ to 40′ thick and traceable in a narrow belt southwest for about ten miles. Of course the massive pebbly character of the rock partly, and perhaps chiefly, accounts for the preservation of these fragments in Erie county, and it may be said that they represent a streak of pebble rock in the formation running northeast-southwest of no great width, resembling similar pebble streaks in the older Venango oil sand formation, or what are called the oil belts proper; but it is more probable that the formation toward the north was pebbly, as it is now seen to be toward the east, whereas toward the south and west it is universally a sand rock without pebbles and full of iron.

The importance of the sub-Olean as a key rock or guide to well sinkers has never been properly appreciated by them. In the Butler county oil region the ferriferous limestone of the coal measures is universally known and exhibited as a guide; is sought by every Butler county driller with care, and when found measurements are made from it downward to the oil sands. Now what the ferriferous limestone is in the lower Allegheny oil region, the sub-Olean ought to be in the Warren, Forest and McKean oil regions, viz: an accepted guide of measurement to the oil sands in the underground; and yet no driller pays any attention to it, or troubles himself to note it in his record; whether he goes through it in his well or whether it crops out on the hillside above the well. In his drilling, he relies solely upon surface elevations above tide, and the supposed regularity and uniformity of dip over his special region; the consequence is that very important mistakes are continually made in identifying the rocks pierced in one well with those pierced by another. If drillers could be brought to realize the facts that local dips vary in their rate and direction at every point of the region and in all the formations from the top to the bottom, while the distance from the top of the sub-Olean down to the Bradford oil sands, for example, remains a nearly constant quantity, they would certainly take more note of this remakable flat pebble conglomerate, and expend both time and trouble in tracing its outcrop or fixing its underground position everywhere.


CCLIII.
No. XII, XIII. Coal measures in and above the Conglom=erate in Mc. Kean, Co.
Martin & Backus Farms Section.
Fig. 55. p. 140.
ALTON UPPER BED.
ALTON LOWER BED.
MARSHBURG UPPER BED.
Fig 59. p. 142.
Deer Lick Section & Drill hole.
CLERMONT BED.
ALTON UPPER BED.
ALTON LOWER BED.
Fig. 61. p. 144.
Warner Brook Section.
ALTON UPPER BED.
ALTON LOWER.
Johnson Run S.S.
Kinzua Creek S.S.
Marshburg Coal Interval
Olean Conglomerate.
Fig 64. p. 142.
Wernwag Section.
ALTON UPPER BED.
Kinzua Creek S.S.
Marshburg Coal Interval.
Olean Conglomerate
Upper Pocono No. X.
Sub-Olean S.S.
Fig. 71, p. 171.
Dalemis Section, Howard Hill.
F.C.
CLAY.
Fig 60. p 144.
Warner Brook Drill hole.

X. Pocono in Crawford county.

As the Olean conglomerate is the bottom division of the great Pottsville conglomerate formation No. XII, and as No. XII has always been considered the bottom of the carboniferous system, the formations underlying the Olean have been called by many geologists sub-carboniferous, and by others sub-conglomerate, down to the Venango oil sand group, a depth of, say 450′.

These sub-conglomerate formations may be represented in a general and vague manner by the following columnar section given on page 66 of report Q4:

Sharon, Olean Conglomerate.

Shenango shale,	50
Shenango sandstone (sub-Olean), fish bed,	25
Meadville upper shale,	25
Meadville upper limestone, fish bed,	1
Meadville lower shale,	40
Sharpsville upper flags,	50
Meadville lower limestone,	2
Sharpsville lower flag,	12
Orangeville shale,	75
Corry sandstone,	20
Cussewago upper shales,	5
Cussewago limestone,	2
Cussewago middle shales and flag,	30
Cussewago sandstone (first oil sand),	25
Riceville shales,	80
Venango oil sand group,	310

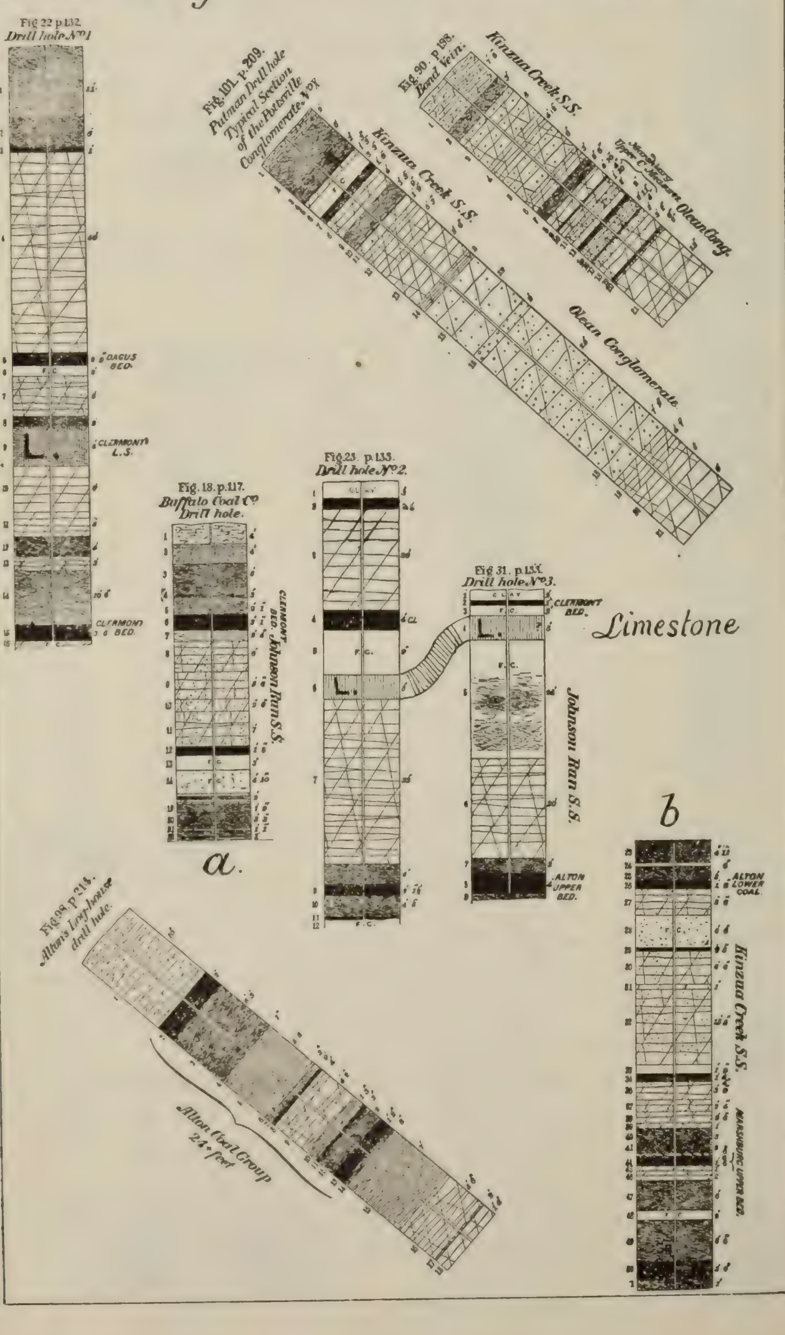
The Shenango shale of Prof. White, lying between the Olean and sub-Olean conglomerates in Crawford and Erie counties, consists entirely of blue, gray and brown clay shales; but here and there appear thin, flaggy sandstone layers; and at one exposure, these merge into 10′ of sandstone. At the bottom is usually found an irregular layer of clay-iron-stone balls.

The Shenango shale in this district was nowhere seen less than 36′, nor more than 60′ (near Sharon 47′; at Tidioute, 60′, etc.).* In Erie county, its bottom layers are left as a

*Toward Jamestown, its thickness runs down from 35′ to 15′, and into Mercer county southward, at Sharon, to 7′; in the Brookfield tunnel, near Sharon, only 3′, and yet keeping its typical character perfectly.

CCLIV.

No XII Conglomera coals in McKean Co.



thin covering to the sub-Olean conglomerate (Shenango sandstone) on the highest hilltops.

Fossils are rare; and all of sub-carboniferous types; badly preserved; Productus, Allorisma, Straparollus, Spirifera.

A carboniferous tree allied to Lepidodendron gaspianum has left its fragments abundantly in the upper layers of Shenango shale at Snodgrass quarry, near Jamestown; and with it Lepidodendron veltheimianum. But this is the only locality at which Prof. White found plants in these shales (Q4, 78).*

The Shenango sandstone (the ferriferous sandstone of Q2; the sub-Garland conglomerate of the earlier oil region reports; the sub-Olean conglomerate of the McKean county reports; and the upper Pocono sandstone No. X, or Vespertine sandstone of H. D. Rogers) is in Crawford county always a tolerably coarse-grained, yellowish-brown, sometimes dull gray sandstone; crowded with iron balls from 1″ to 12″ in diameter, or ever larger; many small round pebbles of shale or fine hard sandstone; not unfrequently small pebbles of ochre; and often scattered through it in great numbers, fish bones, fish teeth, scales and spines; usually badly broken and rubbed; and often reduced to mere blotches of bluish white matter on the weathered sur-

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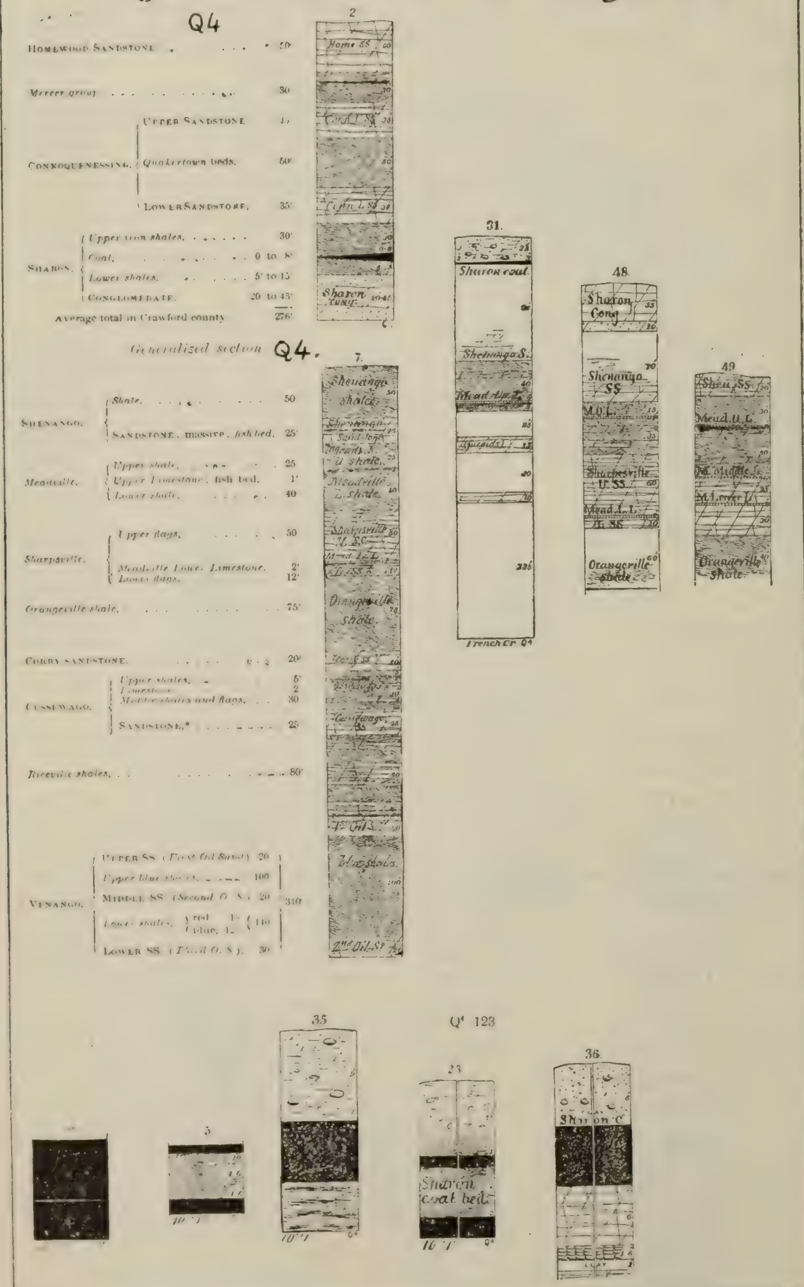
*In the State of Ohio, the strata between the sub-Olean conglomerate and the Berea grit are called Cuyahoga shales. In Pennsylvania, a sandstone makes its appearance among these shales not far from their top, and is traceable from Sharon, in Mercer county, northwards along the Shenango valley to Jamestown, and across Crawford county eastward into Warren and McKean counties, where it becomes the important sub-Olean flat pebble conglomerate. The great mass of shales below it, when followed from the Ohio line eastward, grows into the flaggy sandstones of the Pocono formation No. X. The small amount of shales above it ought to represent, on the Ohio line, the great Mauch Chunk red shale formation No. XI, of eastern and middle Pennsylvania; but it is of course possible that these upper shales may be a part of the Pocono formation, and the Mauch Chunk formation be considered as entirely absent. The upper shale and sandstone form, in Prof. White's reports, the Shenango group; but in view of the doubt thus expressed, the value of such a grouping seems very doubtful; the name Shenango shale, however, may be retained for the shales above the Shenango sandstone; but the name Shenango sandstone has now been lost in the name sub-Olean conglomerate.

CCLV.

XII. Conglomerate coals in Crawford Co.



faces of the rock, so that neither specific nor generic characters can be recognized.

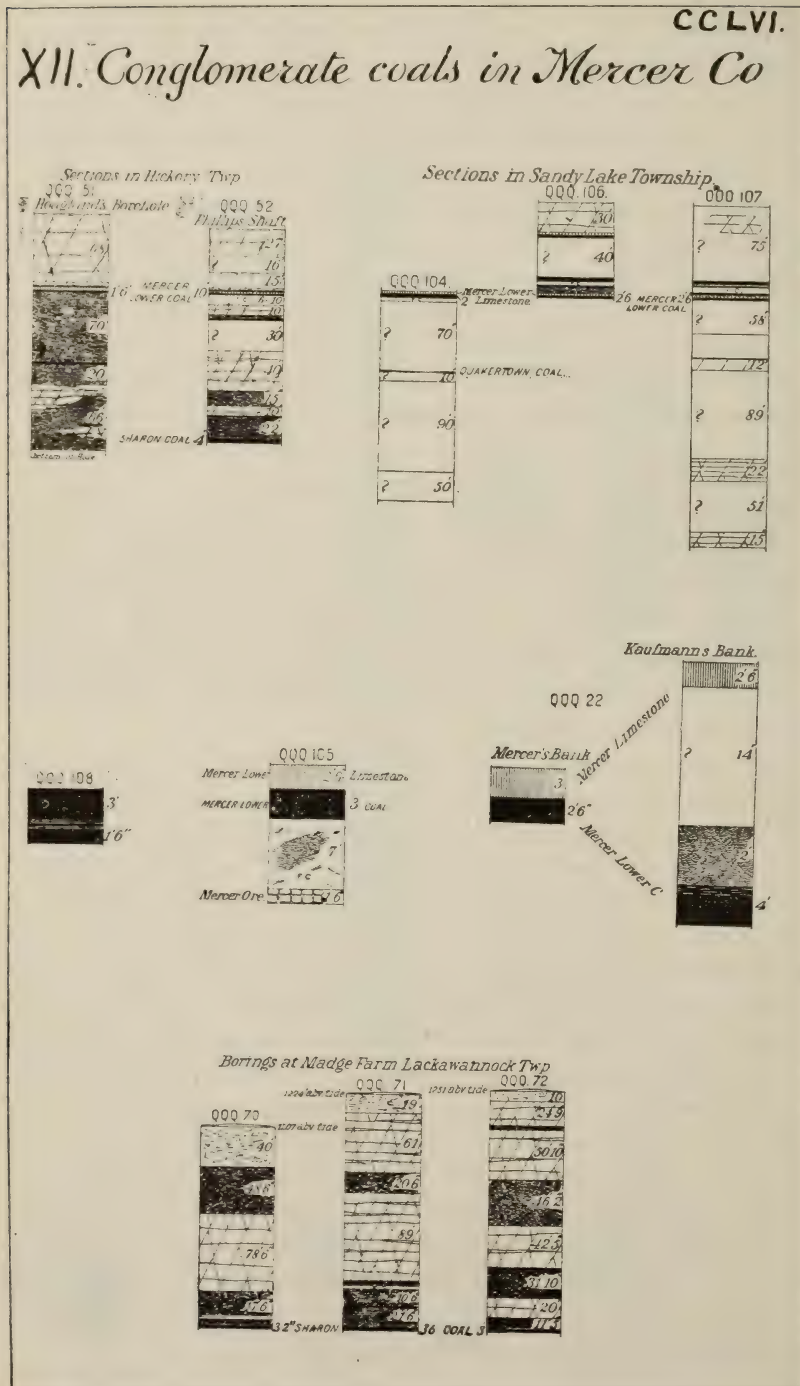
Two plants, Lepidodendron gaspianum,* and, less commonly, Lepidodendron veltheimianum, are present in fragments in almost all the exposed outcrops.

Shells are occasionally found, but generally broken and unrecognizable; species of Orthis, Spirifera, Discina and Productus, apparently different from the species found in the Mauch Chunk or Umbral formation No. XI of eastern Pennsylvania.

As a building stone it is valuable; resisting weather better than the Olean conglomerate; because it is nearly all pure quartz sand cemented by iron; but the innumerable iron ore balls in it make dressing impossible, and it is used, therefore, almost only for bridge abutments and other heavy work; but those of the old Beaver and Erie canal locks are as sound, and the chisel marks as sharp, as when laid sixty years ago. Jackson's quarry, between Atlantic and Evansburg, Sadsbury township, Crawford county, has furnished most of the bridge stone along the Atlantic and Great Western railroad.

Its outcrop (marked by the outside edge of the red color on the Geological Map of Crawford county) encircles the hill on the Mercer county line between the Shenango river and Crooked creek, and the high land between Crooked creek and French creek; the two high lands between French creek and Conneaut Lake creek; the two high lands east and south of Meadville; the long hill range between Little Sugar creek and Sugar Lake, extending from the State road south and southeast into Venango county; the long high land ridge between Woodcock creek and Muddy creek, from New Richmond south into Venango county; the hills around Troy Centre and down the west side of Oil creek into Venango county; a high hill in Athens township, between Little Cooley and Riceville; two high hills in Sparta, southwest and southeast of Spartansburg; one in Rome, east of Centerville, and another between Oil creek and

‡ Dawson. Figured in Pocono (Vespertine) formation No. X of eastern Pennsylvania in Geol. Penn., Vol. II, plate 21, by Lesquereux.


CCLVI.
XII. Conglomerate coals in Mercer Co
Sections in Hickory Twp
QQQ 51
QQQ 52
Phillips Shaft
MERCER LOWER COAL
SHARON COAL
Sections in Sandy Lake Township.
QQQ 106.
QQQ 107
QQQ 104.
Mercer Lower Limestone
MERCER LOWER COAL
QUAKERTOWN COAL
Kaufmanns Bank.
QQQ 22
Mercer's Bank
Mercer Limestone
Mercer Lower C
QQQ 108
QQQ 105
Mercer Lower Limestone
MERCER LOWER COAL
Mercer Ore
Borings at Madge Farm Lackawannock Twp
QQQ 70
QQQ 71
QQQ 72
SHARON COAL

Thompson's run; the hill northeast of Titusville, two or three others on the Warren county line; and similar isolated irregular outcrops around the highest hilltops eastward through Warren county into McKean.

Its outcrop lies 250′ above the level of Conneaut lake, runs at a height of 250′ above water level of Crooked creek and of Conneaut Lake creek; and 375′ above the level of French creek at Meadville.

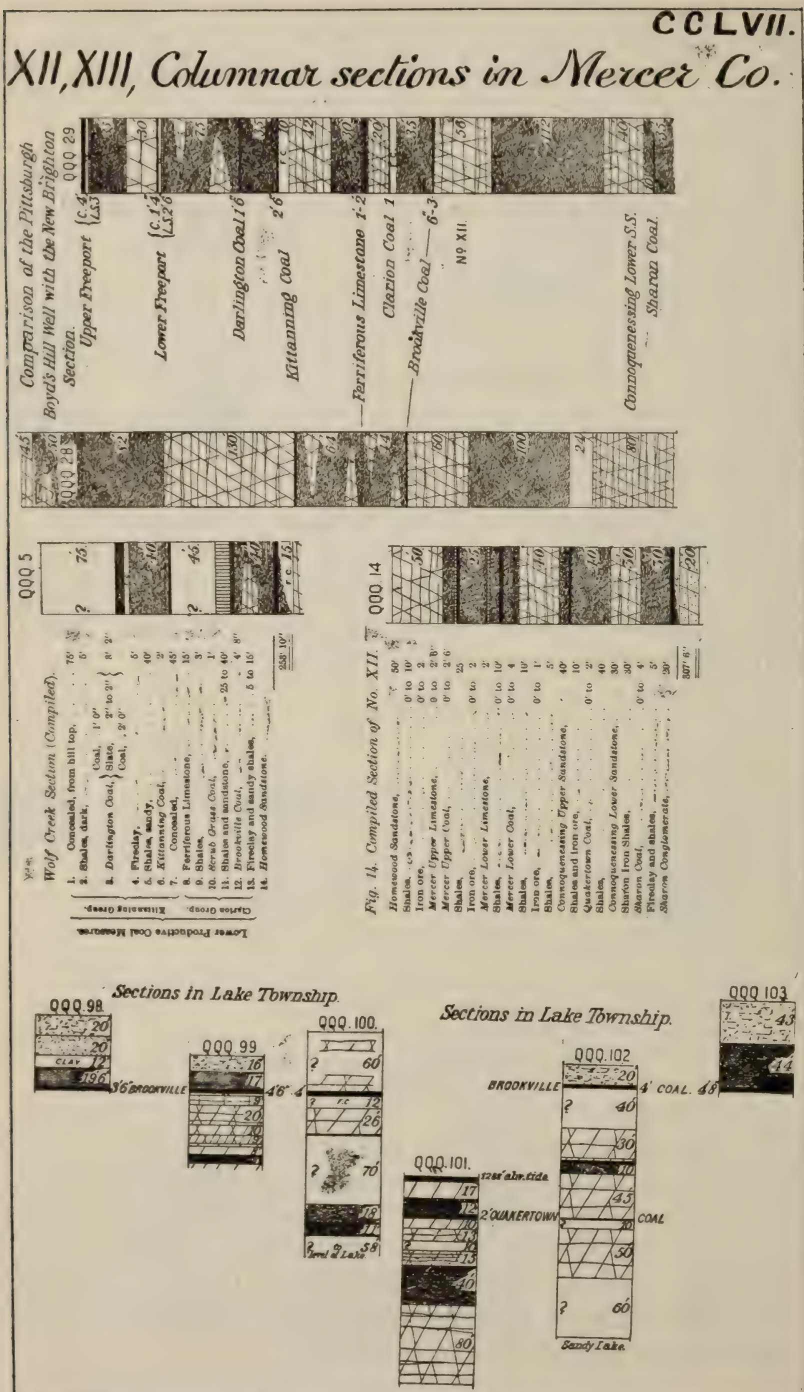
Capping two or three isolated knobs in Concord township, Erie county, near the Warren county line, at 1860′ A. T., it falls southwestward for forty-six miles, 670′ to Snodgrass quarry, near Jamestown, on the Shenango, at the Mercer county line, where it is 1190′ A. T. Consequently the rate of fall is 14½′ per mile.

Its finest exposure is in the cliffs at Greenwood, half a mile south of Glendale, eight miles due south of Meadville; where a brook flowing north from the high lands makes a cascade of 25′ in height, and then cuts a deep and narrow gorge through the underlying Cuyahoga shales.

Glenville Section.

Sandstone, massive, brown, ... visible	10′
Sandstone, flaggy, ...	5′
Shales, blue, ...	5′
Iron ore, calcareous, ...	1′
Shales, blue, ...	5′
Shenango sandstone (sub-Olean, base 1270′), ...	23′
Shales, blue, ...	30′
Meadville upper limestone (a mass of fish and shells,) .	1′ 6″
Sandstone, massive, ...	5′
Sandstone flags in bluish shales, ...	40
Sharpsville upper flaggy sandstone, ...	65′
Meadville lower limestone, no fossils, ...	1′
Sharpsville lower flaggy sandstone, ...	10′
Grangeville shales, etc. (concealed to level of Conneaut Lake creek), ...	65′

Vertical cliffs enclose the deepening gorge for several hundred yards, huge fallen masses lying scattered at the bottom; a coarse reddish-brown sandstone, many of its layers, especially near the bottom, a perfect mass of iron ore balls, as large as an ostrich egg, which have been weathered out from the face of the cliff, leaving it all honeycombed in a striking manner (Q4, 139).


CCLVII.
XII, XIII, Columnar sections in Mercer Co.
Comparison of the Pittsburgh Boyd's Hill Well with the New Brighton Section.
QQQ 29
QQQ 28
Upper Freeport
Lower Freeport
Darlington Coal 1'6
Kittanning Coal 2'6
Ferriferous Limestone 1'-2
Clarion Coal 1
Brookville Coal 6'-3
No XII.
Connoquenessing Lower S.S.
Sharon Coal.
QQQ 5
Wolf Creek Section (Compiled).
Lower Productive Coal Measures.
Kittanning Group.
Clarion Group.
1. Concealed, from hill top, 75'
2. Shales, dark, 5'
3. Darlington Coal, Coal, 1' 0" Slate, 2' to 2" Coal, 2' 0" 8' 2"
4. Fireclay, 5'
5. Shales, sandy, 40'
6. Kittanning Coal, 2'
7. Concealed, 45'
8. Ferriferous Limestone, 15'
9. Shales, 3'
10. Scrub Grass Coal, 1'
11. Shales and sandstone, 25 to 40'
12. Brookville Coal, 4' 8"
13. Fireclay and sandy shales, 5 to 15'
14. Homewood Sandstone.
258' 10"
QQQ 14
Fig. 14. Compiled Section of No. XII.
Homewood Sandstone, 50'
Shales, 0' to 10'
Iron ore, 0' to 2
Mercer Upper Limestone, 0 to 2' 8"
Mercer Upper Coal, 0' to 2' 6"
Shales, 25
Iron ore, 0' to 2
Mercer Lower Limestone, 2'
Shales, 0' to 10'
Mercer Lower Coal, 0' to 4
Shales, 10'
Iron ore, 0' to 1'
Shales, 5'
Connoquenessing Upper Sandstone, 40'
Shales and iron ore, 10'
Quakertown Coal, 0' to 2'
Shales, 40
Connoquenessing Lower Sandstone, 30'
Sharon Iron Shales, 30'
Sharon Coal, 0' to 4'
Fireclay and shales, 5'
Sharon Conglomerate, 20'
307' 6"
Sections in Lake Township.
QQQ.98
CLAY
3'6" BROOKVILLE
QQQ 99
4'6"
QQQ.100.
QQQ.101.
1281' abv. tide
2' QUAKERTOWN
Sections in Lake Township.
QQQ.102
BROOKVILLE
4' COAL.
COAL
QQQ 103

Another fine exposure is at the chasm of Grassy run, a branch of Little Suger creek, in Wayne township, ten miles southeast of Meadville, enclosed between cliffs of Shenango sandstone (over which is a cascade of 35′), very massive, containing immense numbers of iron balls from 1″ to 6″, fish scales and bones (Q4, 126). Hundreds of other less striking natural outcrops might be enumerated.

The Shenango sandstone (sub-Olean conglomerate), followed eastward, becomes coarser and more massive. At Meadville, its bottom layers begin to be pebbly. At Garland, in Warren county, its bottom layers are quite pebbly. At Warren it is a pebble rock throughout, 40′ to 45′ thick. At Franklin, 120′ above French creek water, it is extensively quarried. At Tidioute, 60′ beneath Triumph Hill (Olean) conglomerate, it lies 500′ above the Allegheny river. At Kinzua, 540′.

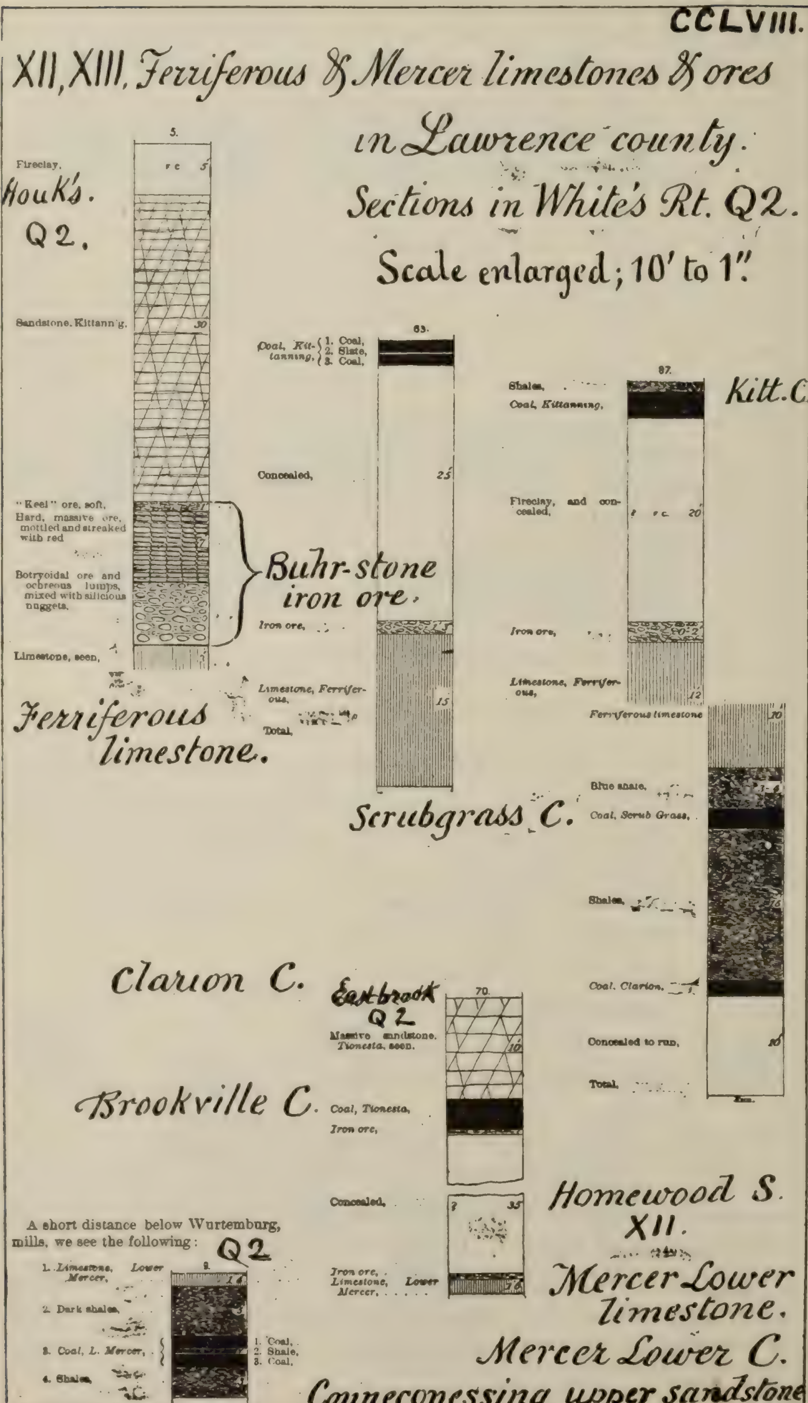
Everywhere all its pebbles have a marked peculiarity, first noticed by Mr. Carll, of being flat or flattish, not round as in the Olean conglomerate higher up.

Meadville Group of Prof. White.

This group, lying between the sub-Olean conglomerate above and the Pithole grit of Venango county (Berea grit of Ohio; Carll's Third Mountain sand) below, is thus subdivided by Prof. White:

Meadville upper shales.
Meadville upper limestone.
Meadville lower shales.
Sharpsville upper sandstone.
Meadville lower limestone.
Sharpsville lower sandstone.
Orangeville shales.

The Meadville upper shales are bluish-gray or ashen-gray, clay shales at the top, sandy shales lower down, sometimes flaggy, never massive; thickness, where well exposed at the head of Cemetery branch of Mill run, near Meadville, 15′; one mile east, 30′; Grassy run, Wayne, 36½′; Glendale, 30′; Jamestown, 25′; Dutch Hill, Union, 40′; Unger's run, East Fallowfield, 15′; Franklin, Venango


CCLVIII.
XII, XIII, Ferriferous & Mercer limestones & ores
in Lawrence county.
Sections in White's Rt. Q2.
Scale enlarged; 10' to 1".
Houk's. Q2.
5.
Fireclay,
Sandstone, Kittann'g,
"Keel" ore, soft,
Hard, massive ore, mottled and streaked with red
Botryoidal ore and ochreous lumps, mixed with silicious nuggets,
Limestone, seen,
Buhr-stone iron ore.
Ferriferous limestone.
63.
Coal, Kittanning, 1. Coal, 2. Slate, 3. Coal,
Concealed,
Iron ore,
Limestone, Ferriferous,
Total,
Scrubgrass C.
87.
Shales,
Coal, Kittanning,
Kitt. C.
Fireclay, and concealed,
Iron ore,
Limestone, Ferriferous,
Ferriferous limestone
Blue shale,
Coal, Scrub Grass,
Shales,
Coal, Clarion,
Concealed to run,
Total,
Clarion C.
Eastbrook Q2
70.
Massive sandstone, Tionesta, seen,
Brookville C.
Coal, Tionesta,
Iron ore,
Concealed,
Iron ore,
Limestone, Lower Mercer,
Homewood S.
XII.
Mercer Lower limestone.
Mercer Lower C.
Connoquenessing upper sandstone
A short distance below Wurtemburg, mills, we see the following:
Q2
1. Limestone, Lower Mercer,
2. Dark shales,
3. Coal, L. Mercer,
4. Shales,
1. Coal,
2. Shale,
3. Coal,

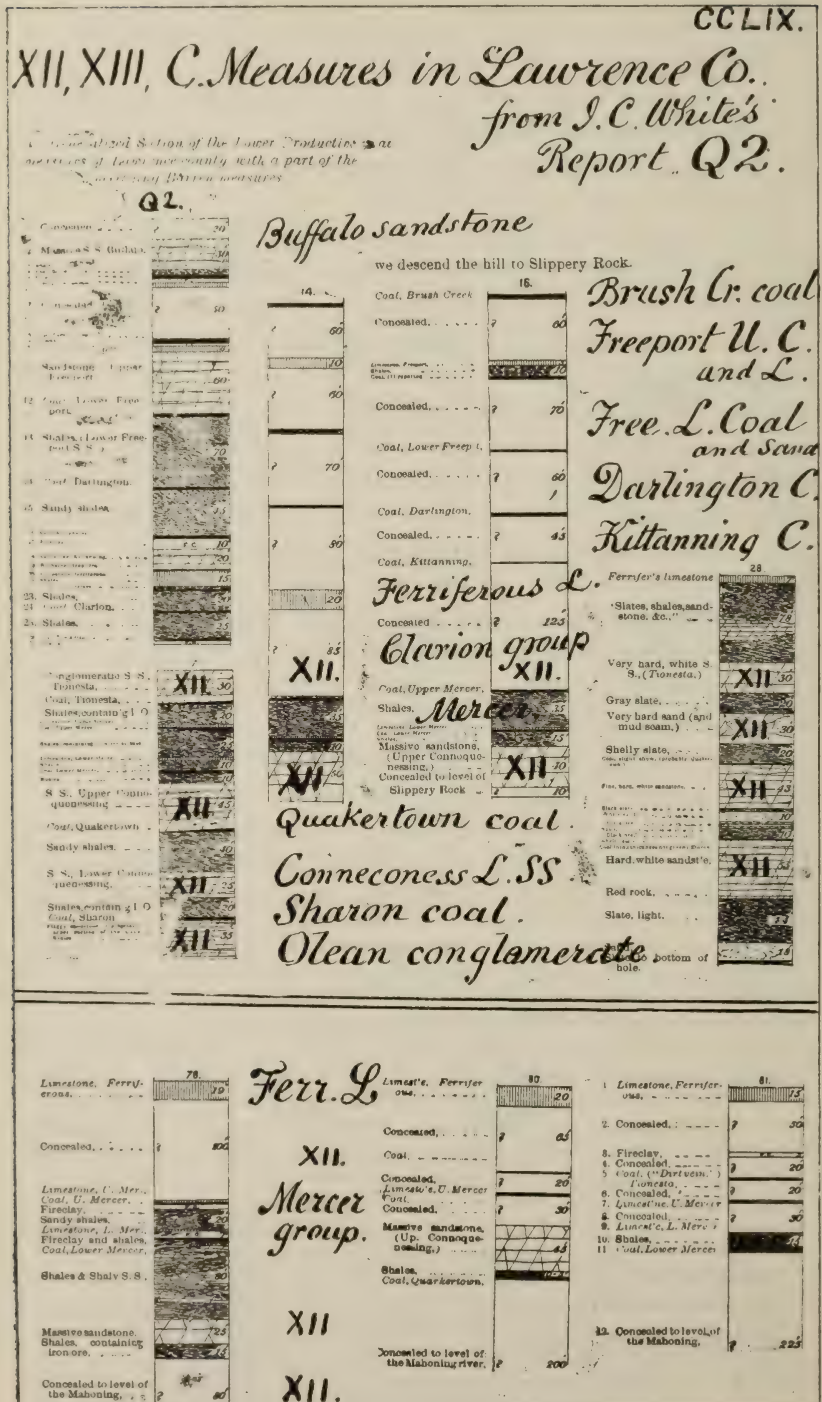
county, 20′, etc.—Seaweed impressions (Fucoids) numerous (Q4, 83).

The Meadville upper limestone is a key to the geology of Crawford county; frequently exposed; seen at Franklin 20′ beneath sub-Olean; thickness never more than 18″; often not 6″.

Fish scales, teeth, bones, plates and spines are so crowded in it that at many places it might be called a fish-bone conglomerate, in which it is difficult to detect any other materials. The most abundant scales are of Palaeoniscus; hundreds covering every slab. Cladodus, Orodus, Lambdodus, Mesodmodus, Stemmatodus, and others, are of frequent occurrence; also the spines named Ctenacanthus, Drepanocanthus, and Batacanthus (one specimen apparently identical with Batacanthus baculiformis of St. J. and W.) Shells abound in it in many places; Spirifera, Streptorhynchus, Orthis, Productus, Discina, Rhynchonella, Conularia and Orthoceras; apparently undescribed species; but the *facies* is most nearly like that of the Kinderhook fauna of the Mississippi valley; some few resemble Keokuk and Burlington types.*

Water-worn pebbles of shale and fine sandstone are nearly always to be found in the formation; usually dark; derived from some older formation; in some places immensely numerous; usually flat, sometimes oval and tapering to a blunt point. The lime matrix is not pure; contains much

*From an inspection of a collection sent to Prof. Worthen, Springfield, Ill., he opposed this opinion; was inclined to regard the fish as rather of Chester limestone aspect. Prof. St. John, of Topeka, to whom Prof. Worthen submitted at first a small collection, also recognized a Chester *facies*, but noticed some Kinderhook affinities; but on receiving a larger and better collection, expressed an opinion in favor of the lower horizon. Prof. White is inclined to identify it with the lower Keokuk, or upper Burlington, fish beds in preference to the Kinderhook. There are certainly many novelties in this Meadville upper limestone; the materials for its study being abundant and accessible. The best places to study and collect are: The gorge south of Glendale; the ravines east of Meadville, up Mill run; ravines of Woodcock creek, two and a half miles east of Meadville; a very fine locality on Grassy run, Wayne township; French creek bluffs at Franklin; ravines at Jamestown on the Crawford-Mercer line; and at McElhenny's, two miles north of Jamestown. Good exposures also on small streams descending to Adamsville. Fish remains can be found almost anywhere on all the lines of outcrop.



CCLIX.
XII, XIII, C. Measures in Lawrence Co.
from I. C. White's Report Q2.
Q2.
Buffalo sandstone
we descend the hill to Slippery Rock.
14.
16.
Coal, Brush Creek
Concealed
Concealed
Coal, Lower Freep't.
Concealed
Coal, Darlington.
Concealed
Coal, Kittanning.
Concealed
Coal, Upper Mercer.
Shales.
Massive sandstone, (Upper Connoquenessing.)
Concealed to level of Slippery Rock
Brush Cr. coal
Freeport U. C. and L.
Free. L. Coal and Sand
Darlington C.
Kittanning C.
Ferriferous L.
Clarion group
Mercer.
XII.
Quakertown coal.
Conneconess L. SS
Sharon coal.
Olean conglomerate
28.
Ferrifer's limestone
"Slates, shales, sandstone, &c."
Very hard, white S. S., (Tionesta.)
Gray slate,
Very hard sand (and mud seam,)
Shelly slate,
Hard, white sandst'e,
Red rock,
Slate, light.
bottom of hole.
23. Shales.
24. Coal, Clarion.
25. Shales.
Conglomeratic S. S., Tionesta.
Coal, Tionesta.
Shales, contain'g I. O.
S. S., Upper Connoquenessing
Coal, Quakertown
Sandy shales.
S. S., Lower Connoquenessing.
Shales, contain'g I. O.
Coal, Sharon
78.
Limestone, Ferriferous.
Concealed.
Limestone, U. Mer.
Coal, U. Mercer.
Fireclay.
Sandy shales.
Limestone, L. Mer.
Fireclay and shales.
Coal, Lower Mercer.
Shales & Shaly S. S.
Massive sandstone.
Shales, containing iron ore.
Concealed to level of the Mahoning.
Ferr. L.
XII.
Mercer group.
XII
XII.
80.
Limest'e, Ferriferous.
Concealed.
Coal.
Concealed.
Limest'e, U. Mercer
Coal.
Concealed.
Massive sandstone, (Up. Connoquenessing,)
Shales.
Coal, Quarkertown.
Concealed to level of the Mahoning river.
81.
1. Limestone, Ferriferous.
2. Concealed.
3. Fireclay.
4. Concealed.
5. Coal. ("Dirt vein.") Tionesta.
6. Concealed.
7. Limest'ne, U. Mercer
8. Concealed.
9. Limest'e, L. Merc.
10. Shales.
11. Coal, Lower Mercer
12. Concealed to level of the Mahoning.

silica ; often resembles a weathered sandstone ; broken surface covered with small, elliptical, sparkling spots due to semi-crystallization and not to minute shells (Q4, 83).

The Meadville lower shales, under the fish-bone conglomerate, resemble the shales above it ; alternating with sandy flags increasing toward the bottom. Thickness in some places as much as 60′, but usually less.

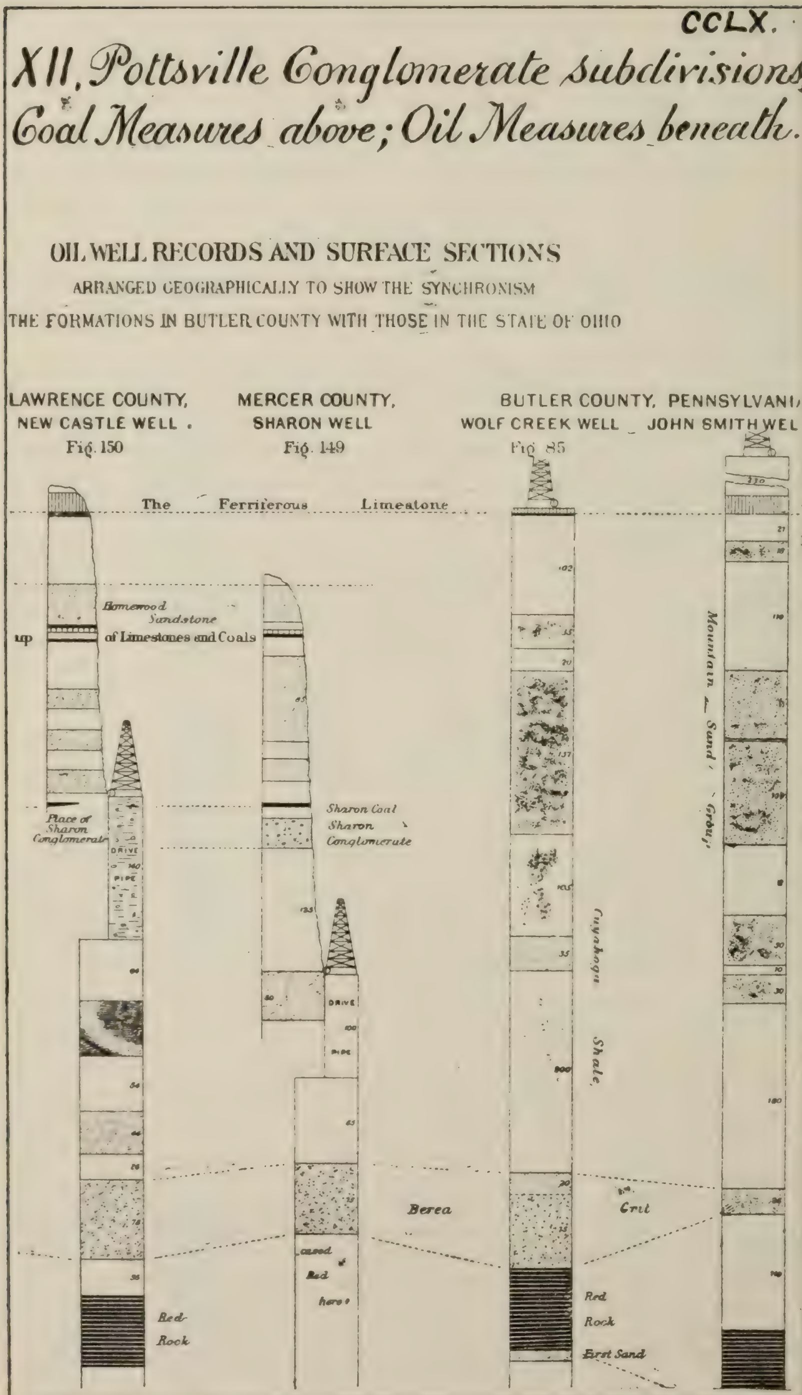
Seaweeds numerous as in the upper shale. Shells badly preserved ; evidently Spirifera, Productus, Allorisma, etc. (Q4, 85).

The Sharpsville sandstone is divided into an upper and a lower series of flags, varying in thickness from six inches to 24″; the division between the two being merely the Meadville lower limestone ; which, when absent, allows the two subdivisions of the Sharpsville sandstone to come together and form a single mass ; its relation to the rocks above it being shown by Prof. White's section, three miles north of Orangeville, Vernon township, Ohio, thus : *

Olean (Sharon) conglomerate, very pebbly,		25
Shenango,	Shale,	50′
	Sandstone (Read's upper Berea),	15′
Meadville shales,		80′
Sharpsville sandstone (Read's lower Berea),		60′
Down to Pymatuning creek,		110

The Sharpsville upper sandstone in Crawford county is a 50′ mass of fine bluish-gray or grayish-brown flagstone layers (1′ to 2′ thick) parted by grayish shales ; the shale rarely making one-third of the mass ; often so little of it that the flags are an almost solid series ; quarried for cellar walls and rough work where better stone cannot be got ; but yielding good building stone from a 36′ layer just south of Atlantic station ; also near Jamestown at the Mercer county line ; also at Miller's, two miles northwest. Only a few isolated knobs in the southeast corner of Erie county hold

* Prof. White, after proving the persistency of the Meadville lower limestone in the body of the Sharpsville sandstone, subdividing it into upper and lower, traced the whole sandstone into Trumbull county, Ohio, and identified it with Mr. Read's lower Berea grit. This is not, however, the original Berea grit of the counties in Ohio further south, Medina, Lorraine, Ashland, Richland ; this lies 270′ to 300′ beneath the Olean conglomerate and is therefore the equivalent of the Corry (Cussewago) sandstone, Pithole grit or Third Mountain Sand of Carll's reports.


CCLX.
XII. Pottsville Conglomerate subdivisions
Coal Measures above; Oil Measures beneath.
OIL WELL RECORDS AND SURFACE SECTIONS
ARRANGED GEOGRAPHICALLY TO SHOW THE SYNCHRONISM
THE FORMATIONS IN BUTLER COUNTY WITH THOSE IN THE STATE OF OHIO
LAWRENCE COUNTY,
NEW CASTLE WELL.
Fig. 150
MERCER COUNTY,
SHARON WELL
Fig. 149
BUTLER COUNTY, PENNSYLVANI
WOLF CREEK WELL
Fig. 85
JOHN SMITH WEL
The Ferriferous Limestone
Homewood Sandstone
of Limestones and Coals
Place of Sharon Conglomerate
Sharon Coal
Sharon Conglomerate
DRIVE PIPE
Mountain Sand Group
Cuyahoga Shale
Berea Grit
cased Red here
Red Rock
First Sand

it. Fossil shells, Rhynchonella, Allorisma, Spirifera and Productus, poorly preserved, are generally found in its exposures. One large fish spine, Ctenacanthus, was found in it in Mercer county.

The Meadville lower limestone, lying between the Sharpsville upper and lower sandstone subdivisions, crops out 235′ above the level of the canal at Meadville (as described by Hodge in 1837, third annual report, page 111); outcrop followed with difficulty because weathering like the sandstones above and concealed by the fallen fragments; persistent through the district; seldom more than 2′, often only 1′ thick; very hard and flinty, breaking in nearly square masses; angles more or less rounded, showing the ready solution of its lime; iron-stained; quarrying a brown siliceous crust; running, when burned for lime, into a slag.* But in exceptional localities in Crawford county a very good and nearly pure white lime has been made from it; for example, on Deckard's run, at Shuey's old quarry, it made plastering lime; but as flux for Liberty furnaces it was a failure.†

Non-fossiliferous as a rule in Crawford county, and thus differing strikingly from the Meadville upper limestone as a general thing, a few fish scales and linguloid shells were found in it at one or two places. But at Garland, in Warren county, and at Tidioute, in Venango county, it resembles the upper limestone in being a perfect mass of broken shells, misshapen Spirifers and unrecognizable other forms; Spirifera disjuncta (or some allied species) is most common.

This remarkable limestone may be traced in outcrop in Mercer county, along the Shenango valley, twenty-one miles to where it passes beneath water level (dipping southward) near Sharon. On the Allegheny river it rises from water level between Franklin and Oil City; crops out all

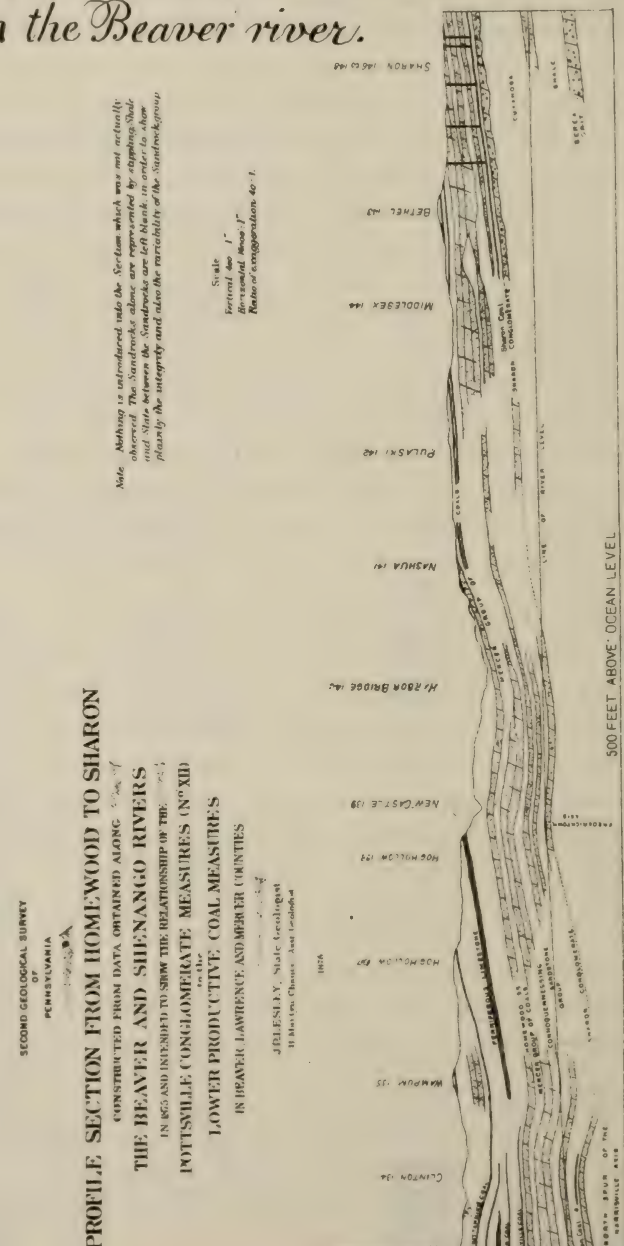
---

*So described by Hodge.

†The silica looks usually to be not more than twenty per cent. of the whole; but an analysis by Dr. Genth for Mr. Carll yielded carbonate of iron, 3.62; carbonate of manganese, 0.31; carbonate of magnesium, 1.70; carbonate of calcium, 27.61; alumina, 4.24; silica, 60.43; water, 1.74 (99.65). At Tidioute, the rock is bleached white, and the people of the neighborhood have mistaken it for quartz.

CCLXI.

XII. Pottsville Conglomerate Subdivisions on the Beaver river.



along the west bank of Oil creek; at Tidioute, lies 375′ above the Allegheny river bed; seems to furnish fragments at Garland on the Brokenstraw, Warren county, 135′ beneath the sub-Olean. In Crawford county it underlies the Olean conglomerate never less than 190′; at Tidioute, 210′; at Warren, Dr. Randall places a corresponding limestone at 200′; at Smithport, in Potter county, I made, in 1840, a limestone lie 200′ below the base of the conglomerate (Geol. Penn. 1858, vol. II, page 548–9).

Its outcrop is marked in many places by little cascades in the beds of the brooks descending the hill slopes; and occasionally a brook will flow for a considerable distance above such a cascade over the top of the limestone stratum, on account of its hardness compared with the enclosing strata of shale. Excellent outcrops for study and collection may be found in Crawford county, near Jamestown, in the hollow down from the bridge below Snodgrass quarry; near Meadville, in the cemetery grounds at the hydraulic ram on Mill run; at Geneva, Greenwood, bed of run just west of railroad station; in Hayfield, west branch of Cussewago creek, heads of ravines. Good outcrops in Mercer county are those opposite Sharpsville, in the banks of the Shenango. A good outcrop in Venango county is in the bluffs opposite Oil City. A good outcrop in Warren county is along the north slopes of the Allegheny river at and below Tidioute (Q4, 89).

The Sharpsville lower sandstone is a series of flags 6″ to 24″ thick, exactly like those above the limestone; amounting usually to only 10′ or 12′; but in one place 30′.

The Orangeville shales are the bottom deposits of the Cuyahoga formation of Ohio; 120′ thick on the Shenango at Sharon; 120′ on Cussewago creek in Crawford county, but usually 100′ throughout Crawford county; in a few places less than 60′; generally dark bluish shales with a few thin sand layers; often holding small lenticular nodules of clay-iron-stone; more commonly weathering brown because the iron is disturbed.

These shales may be observed in the ravines of Hayfield township, Crawford county, right bank of Cussewago creek;


CCLXII.
XII, XIII, Coals in Butler and Beaver.
Clinton Section No. 2.
V 135
Homewood Furnace Section.
V.128
F.L
K.U.
K.M
Wampum Section
V 134
K.M.
K.L
K.M
Freeport Group
Kittanning Group.
Ferriferous limestone
Clarion coal
Brookville coal.
Mercer coals & limes.
Conneconessing Sand.
Sharon coal bed
Sharon (Olean) conglom.
XII
XII
River level
XII.
A Sketch Map intended to show how the Brady's Bend Axes, anticlinal and synclinal, cut off all connection, as to levels, between the Butler Co. oil wells and Wells at Pittsburgh
Butler Co.
Kittanning
Freeport
Pittsburgh
Ohio
The Mercer coal bed with variable roof rock and abnormal floor shale.
H.M. Chance.
Beattie's Bank Coal 6" to 2 6"
V 133
Homewood SS.
"The thickening of this rock cuts off the coal, which rests on a bed of slate that is also pinched out by it. Though it is a very irregular and uncertain bed, it yields very good coal at this bank. The sketch shown by Fig. 133 is intended to illustrate peculiar irregularities of the base, and is a conclusive proof that it had its origin in drifted carbonaceous matter, for how else could the peculiar "shoe" of coal be formed that is seen projecting from the bed downwards into the underlying slates." H.M.C.

in the ravines of Mead and East Fairfield townships, left bank of French creek ; and in the banks of the Shenango at Jamestown, where the Gibson well starts at the top of these shales. It is frequently well exposed in the common road cuttings of Richmond, Randolph, Woodcock, Vernon, Sadsbury, Summit and Summit Hill townships. At Warren, in Trumbull county, Ohio, these shales are darker and have even some thin bituminous layers ; a fact which supports Prof. Orton's identification of them with Andrews' Waverley black slate of southeast Ohio.

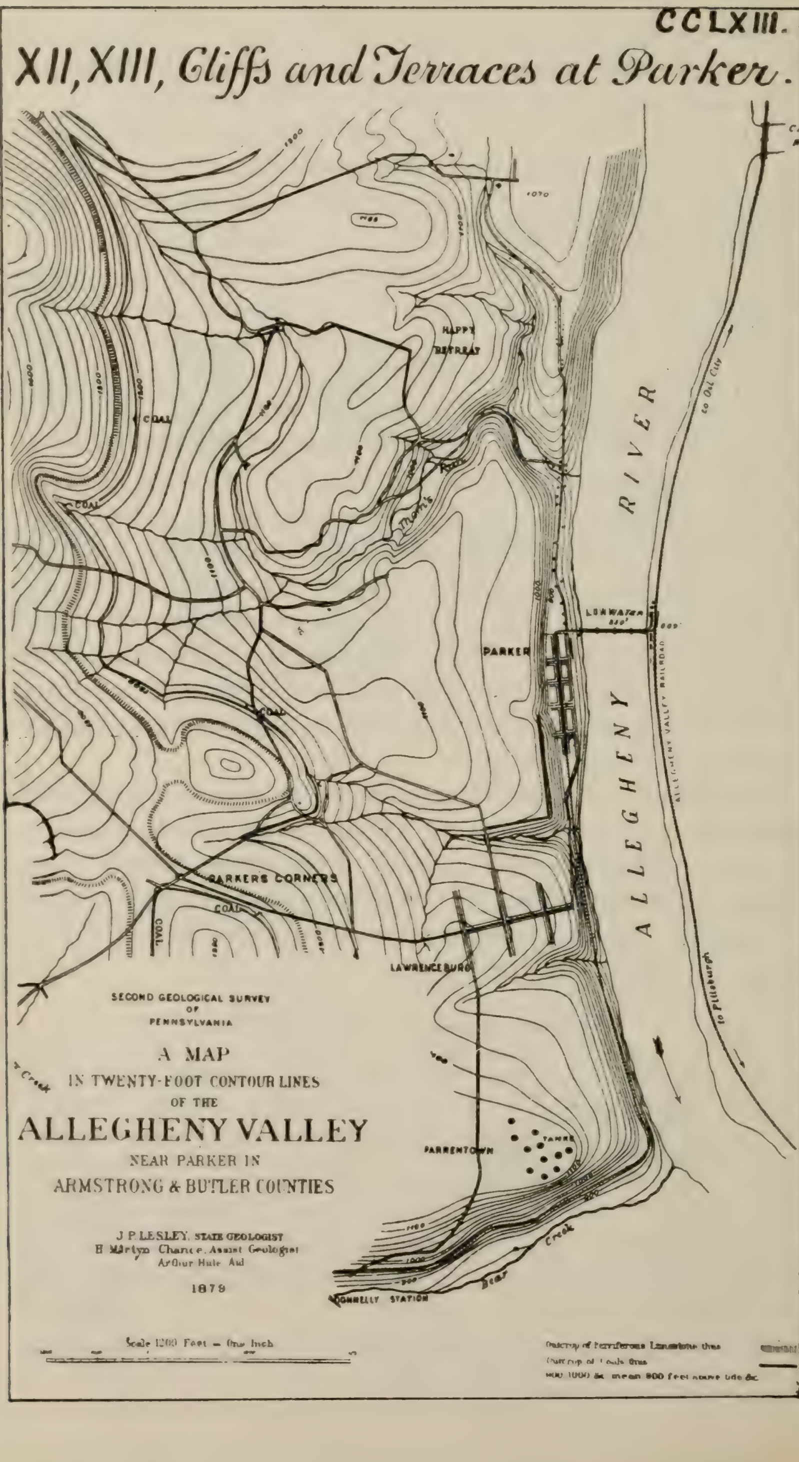
The fossils collected by Prof. White in his district were none of them ever noticed by him in any of the underlying formations. There are great numbers of Lingula melia (Hall), Lingula membranacea (Winchell), Discina pleurites (Meek), Discina newberryi (Hall); species of the Cuyahoga formation in Ohio. These shells are distributed from the top to the bottom of the formation, but more abundantly toward the bottom. With the shells are occasionally found a few fish fragments. These are the only fossils seen in the formation. The Lingula common in the underlying Corry sandstone is another very different species from the two found in these shales.

At Tidioute, on the Allegheny, in Warren county, these shells are very rare ; the formation being chiefly made up of sandy flagstones with only 22′ of the characteristic shales in the whole interval. At Warren, in Trumbull county, Ohio, these fossils are even more numerous than at the best collecting points in Crawford county.

Oil Creek Lake Group (*White*).

This group may be considered the lowest part of the Pocono sandstone No. X, of eastern and middle Pennsylvania ; and corresponds to the Berea group of the State of Ohio. It consists of the Corry sandstone (Berea grit ; Pithole grit ; Third Mountain Sand of Venango county ; Carll) at the top ; under which Cussewago limestone ; under which Cussewago shales ; under which Cussewago sandstone.

This group is at Oil Creek Lake fourteen miles north-


CCLXIII.
XII, XIII, Cliffs and Terraces at Parker.
HAPPY RETREAT
COAL
COAL
RIVER
LOWWATER
PARKER
ALLEGHENY
ALLEGHENY VALLEY RAILROAD
to Oil City
COAL
PARKERS CORNERS
COAL
COAL
LAWRENCEBURG
to Pittsburgh
TANKS
FARRENTOWN
Bear Creek
CONNELLY STATION
SECOND GEOLOGICAL SURVEY
OF
PENNSYLVANIA
A MAP
IN TWENTY-FOOT CONTOUR LINES
OF THE
ALLEGHENY VALLEY
NEAR PARKER IN
ARMSTRONG & BUTLER COUNTIES
J. P. LESLEY, STATE GEOLOGIST
H. Martyn Chance, Assist. Geologist
1879
Scale 1200 Feet = One Inch

west of Titusville, 130′ thick (see Q4, 75, columnar sections 10–11). The limestone and shales in the middle of it are not persistent throughout western Pennsylvania. Going southwest to Jamestown, on the Mercer-Crawford county line, we find, in the Gibson well, sandstone, fine, blue, 30′; concealed, blue, 65′; sandstone, coarse, light-colored at the bottom, making up 100′ and more.* In Mercer county, eighteen miles further south, the Sharon well records sandstone, white, sharp, 75′ † In Lawrence county, thirty miles further south, a well boring records sandstone, pebbly throughout, 120′.‡ In Beaver county, three miles further south, the Beaver Falls well records one solid sandstone, pebbly, 124′ thick. § In Ohio, at Cleveland, sixty-five miles due west of Jamestown, Dr. Newberry's section gives what is supposed to be the same sandstone, 103′+ thick. ¶ In Ashland county, Ohio, fifty miles southwest of Cleveland, Mr. Read's section gives Waverley conglomerate, 130′ thick (under 270′ of Cuyahoga shales);** and in the adjoining county Richland, Waverly conglomerate from 100′ to 190′ thick.††

In Warren county, at Tidioute, twenty-two miles east southeast of Oil Creek Lake, sandstone at this horizon, according to White, predominates through 75′; but the character of the formation and its identity under other names given by other geologists will be discussed in coneection with the Mountain Sand group of Carll.

The Corry sandstone is quarried extensively in Crawford county and at the east end of Erie county, and every-

* Q3, 201.

† Q2, 73.

‡ Q2, 257.

§ Q4, 70.

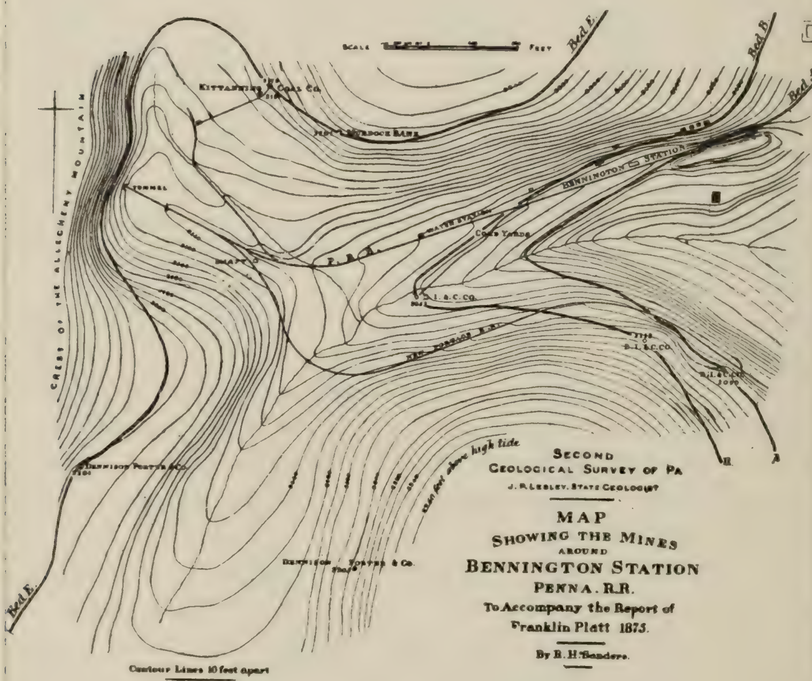
¶ Geol. Ohio, vol. 1, 197, Q4, 82, fig. 11; 92. Dr. Newberry's section reads:—Berea grit, exposed for 30′; *Red* shale 38½; blue shale 15′; blue (*Cussewago?*) sandstone 20′; *Cleveland black shale* 55′; *Erie shale* to level of lake Erie 132′.

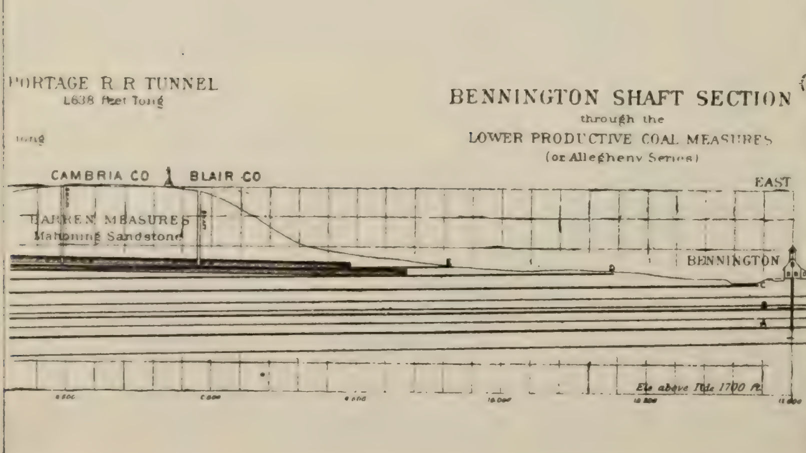
** Geol. Ohio, vol. 3, 523.

†† Geol. Ohio, vol. 3, 316. Beneath come argillaceous and sandy shales, sometimes bituminous, 65′; then shales with bands of flaggy sandstone, 235′; then Berea sandstone (White). See also general section of Knox county, just south of Richland. Geol. Ohio, vol. 3, 335.

CCLXIV.

XIII. Allegheny Coal Series in Blair Co.





where presents similar features. The two quarries on the hilltop one mile south of Corry and 300′ above the town (1740′ A. T.); Colegrove's on the east and Heath's on the west side of the road, are the most extensive in this region. The formation has been swept away from the country leaving on this hilltop only 8′ of its lower layers, 4′ too much shattered for use; lowest 4′ only quarried; hard, yellowish-brown sandstone, in layers from 2″ to 12″ thick; containing a few ill-preserved fossils.

The Corry sandstone is usually in this district 10′ or 15′ thick, and nowhere more than 30′; fine-grained, compact, yellowish-white or buff-gray, it is easily distinguished from the higher sandstones of the country. Pebbles are seen in it at only one or two places. Pebbles of *jasper*, with other pebbles dark and green, and small fragments of white quartz are noticeable at Concord, Erie county.

Large springs of water issue from the base of the outcrop generally, and it is the fountain horizon of the whole region, its place being thus recognizable even where the rock is concealed beneath the soil.

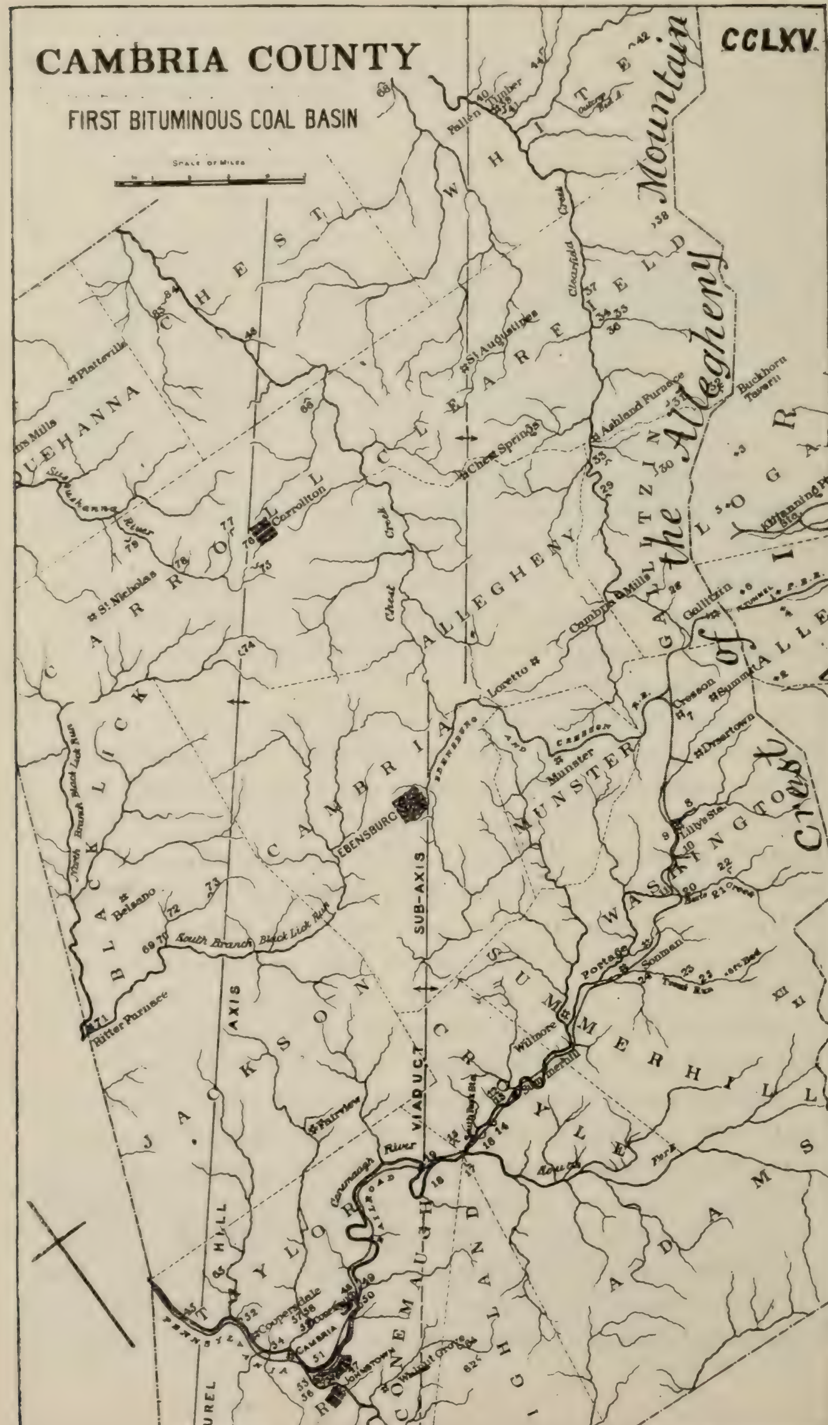
It rises, near Titusville, from the bed of Oil creek; is finely exposed along Pine creek; and has been identified by Mr. Carll along Thompson's run with the Third Mountain sand of the Venango county oil wells. In Warren, east of the county line, on the road to Enterprise, it is finely exposed, 20′ thick, massive, very fossiliferous near its base.

North of Titusville, two and one-half miles, just below Kerr's mill-dam, on Thompson's run, is a massive ledge of it. From here, northwestward up both sides of Oil creek, it can be followed and studied at Hydetown, Centerville, Riceville and Dobbin's quarry on Oil Creek Lake.

Along French creek, it shows itself in many ravines and was once quarried in the bluff opposite Meadville.

On Cussewago creek considerable quarries have been worked at Little's Corners and on the next run a mile above. On the Conneaut creek, at Montgomery's extensive quarries, two and one-half miles east of Conneautville, it is 10′ thick.

On the Shenango river in Pine township, just north of Linesville railroad station, and also in the hills one mile


CAMBRIA COUNTY
FIRST BITUMINOUS COAL BASIN
CCLXV.
Allegheny Mountain
Crest of the Allegheny
WHITE
CHEST
CLEARFIELD
SUSQUEHANNA
CARROLL
ALLEGHENY
GALLITZIN
LOGAN
BLACK LICK
CAMBRIA
MUNSTER
WASHINGTON
JACKSON
CROYLE
SUMMERHILL
ADAMS
TAYLOR
CONEMAUGH
RICHLAND
SUB-AXIS
AXIS
VIADUCT
LAUREL HILL
Carrollton
Ebensburg
St. Augustine
Chest Springs
Ashland Furnace
Buckhorn Tavern
St. Nicholas
Loretto
Cambria Mills
Gallitzin
Summit
Cresson
Munster
Lilly's Sta.
Belsano
Ritter Furnace
Wilmore
Portage
Sonman
Summerhill
Fairview
Coopersdale
Johnstown
Walnut Grove
Platteville
Fallen Timber
Clearfield Creek
Chest Creek
Susquehanna River
North Branch Black Lick Run
South Branch Black Lick Run
Conemaugh River
Little Conemaugh River
Pennsylvania Railroad
Ebensburg and Cresson R.R.

east, are quarries from which much thin stone has been taken for wall work. Near the northwest corner of North Shenango township, the outcrop passes into Ohio towards Newberry's Berea grit outcrop.

In Erie county it is caught only in a few of the highest hilltops in southern Concord, Union and LeBoeuf townships.

Fossil shells are abundant at the fine exposure east of the Warren county line, on the road to Enterprise mentioned above; and here Mr. Hatch discovered and collected many fine specimens of Syringothyris typa, Spirifera alta, Straparollus, Platyceras (all very numerous), and other shells.

The Cussewago limestone greatly resembles the Meadville upper and lower limestones, with the same glassy fracture, but a better limestone. It underlies the Meadville lower limestone 120′ or 130′. It is exposed in several ravines opening on the Cussewago valley; is finely exposed at Line's, one and one-half miles below Little's Corners, Hayfield township; and at Bartholomew's quarry above Little's Corners; also in Kleckner's ravine, Venango township, one mile west of Venango village on French creek. Here it is 2′ thick; blocks of it strewn along the run; 20′ below the top of the Corry sandstone; makes tolerably good lime.

In Erie county, the only observed exposure of it is in Matterson's ravine at the center of Concord township; 1′ thick; pure; 25′ beneath the top of the Corry sandstone; elevation, 1675′ A. T.

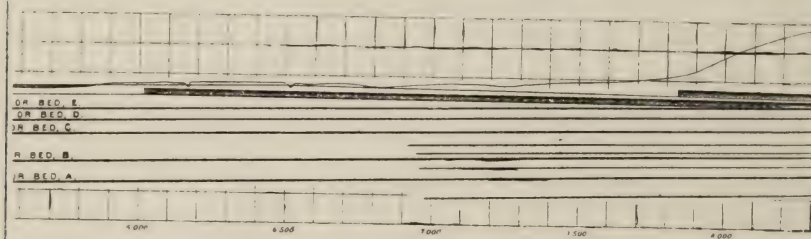
No fossils have been seen in this limestone in Crawford or Erie counties; but it may be represented by the Garland Spirifer bed in Warren county, exposed in the railroad cut 1′ thick, a mass of shells, 350′ beneath the Olean conglomerate. It was not described by Hodge in 1837 in connection with the calcareous shales at this horizon of his Meadville section.

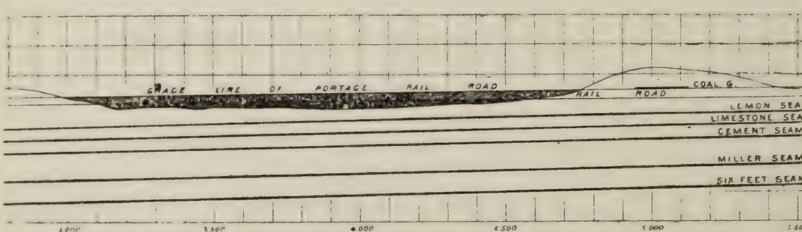
The Cussewago shales, 35′ thick, more or less; bluish or ashen-gray, correspond to Hodge's Meadville calcareous shales of 1837; but it is a very variable deposit; for the interval between the Corry sandstone above and the Cusse-

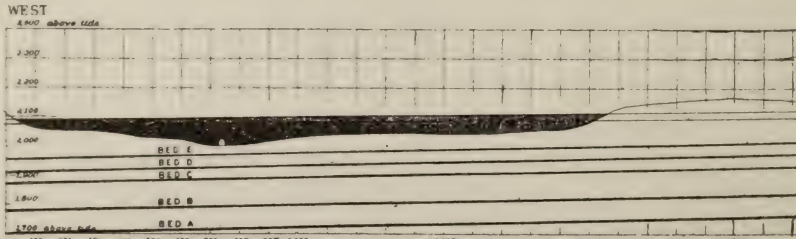
CCLXVI.

XIII. Allegheny Series in Cambria Co.
Sections along the P.R.R.

PENNSYLVANIA R R TUNNEL
through the Allegheny Mountain 3.675 feet







wago sandstone below is frequently filled with sandy flags without limestone or lime shales; and this accounts for the great thickness of the sandstone mass recorded by oil wells in Mercer, Lawrence and Beaver counties.

Red and gray shale 4′ thick is reported by Hodge in his Meadville section of 1837; but Prof. White could find no red shales in his survey of the district, yet he considered these shales as representing the Bedford red shale formation of Ohio. A discussion of the Big Red (Bedford?) formation over the first oil sand and the belt of country to which it is confined is given in Mr. Carll's report, I.3, 1880.

The Cussewago sandstone is a very peculiar, quite coarse, in many places pebbly, commonly buffish-brown sandstone, exposed along the Cussewago valley in Crawford county. Seemingly massive, its grains cohere so loosely that they weather down into beds of loose sand. Near Summit station, on the Pittsburg and Erie railroad, it can be shoveled like beach sand, and might easily be mistaken for part of the northern drift were it not for shale and sandstone layers overlying it in place.*

From French creek to the Ohio line, the Cussewago sandstone can be traced by the decomposed sand along its various outcrops. At Meadville it lies in the hillsides 140′ above French creek. From French creek eastward, the rock becomes harder and more compact. On Oil creek it is a very hard sandstone 30′ thick. Its color is not always a buffish-brown, but occasionally dark green and greenish-blue.

Flat quartz pebbles are seen in it at many localities.

Fragments of wood are embedded in it at Bartholomew's in Hayfield township, and elsewhere.

Oxide of manganese (wad) fills the crevices of the rock

*The rapid and complete weathering of this apparently massive and solid sand rock is illustrated by a story told of a Mr. W., who had a quarry of flinty Sharpsville lower sandstone at the top of his hill; but wishing to find stone less costly for the cellar walls of his new house, he opened in the ravine below on the outcrop of the Cussewago sandstone. The fresh stone seemed sound enough, and the house was built; but the frosts of the first winter following sufficed to crumble the foundation and the dwelling fell down.

CCLXVII.

XIII. Allegheny Series (L.C.M.) Cambria Co

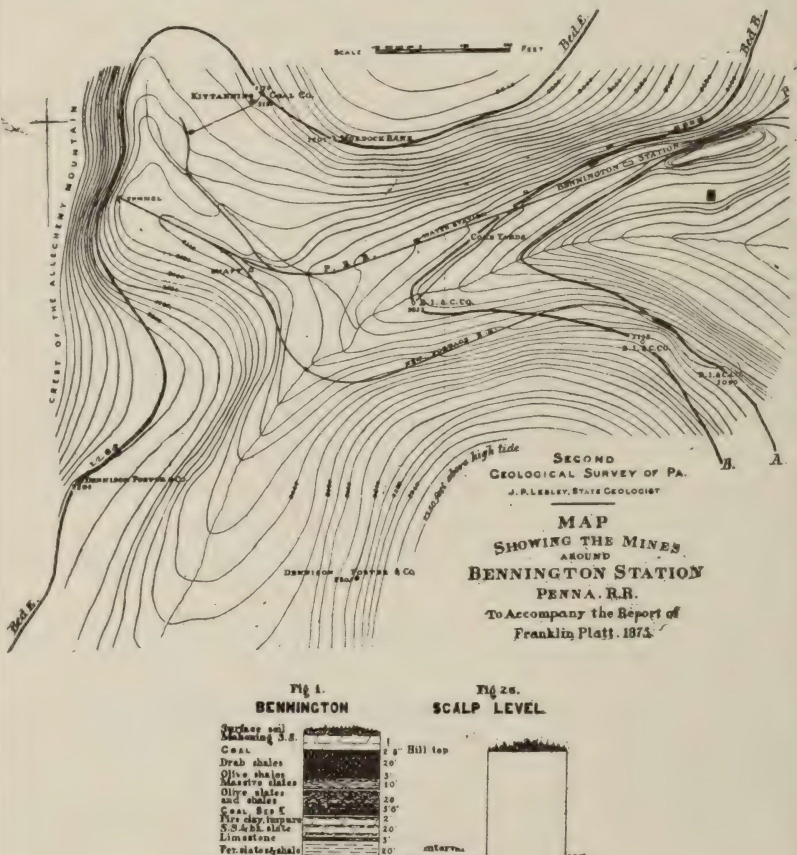


Fig 1.
BENNINGTON

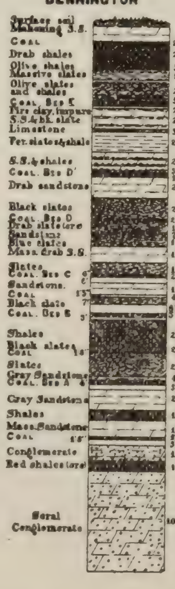
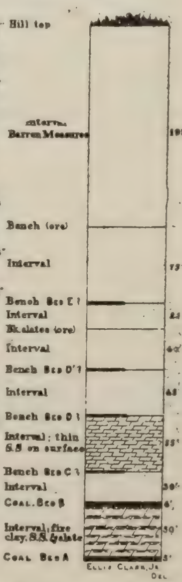


Fig 2a.
SCALP LEVEL.



where exposed just west of Little's Corners; and is probably what blackens the top of the formation elsewhere.*

The Riceville shale of Prof. White, 80′ thick, overlies the Venango first oil sand in a good exposure in the bluff on Oil creek, just west of Riceville, twelve miles northwest of Titusville; a mass of very fossiliferous, drab, bluish and gray sandy shales, turning in places into shaly sandstone.

On French creek, two miles below Meadville, these shales present the following section:

Cussewago sandstone.		
Flaggy sandstone,	12	75′
Fossil bed, blue, sandy, with many Productella boydii, Spirifera disjuncta, a small Orthoceras, etc.,	1′	
Concealed,	5′	
Shales, blue, sandy,	5′	
Concealed,	5′	
Sandstone, hard, flaggy, dark-bluish,	5′	
Concealed,	12′	
Sandstone flags, interstratified with bluish shales,	25′	
Shales, pale-blue,	5′	
Venango first oil sand.		

The fossil shells of Chemung type mentioned in the section are abundant at many places in Crawford county about 15′ beneath the outcrop of the Cussewago sandstone.†

No black shales have been seen in Crawford county here except at one place on Cussewago creek in a ravine just south of Little's Corners, Hayfield township, where a few thin layers of bituminous slate lie scattered through 2′ or 3′ of shale, 25′ beneath the bottom (50′ beneath the top) of the Cussewago sandstone. They were supposed to be cannel coal and were opened for mining. They would flame, but remained as solid ash; and the layers never came together to form a bed. This is the only indication we have that this Riceville shale deposit can represent the black Cleveland shale of the Ohio geology.

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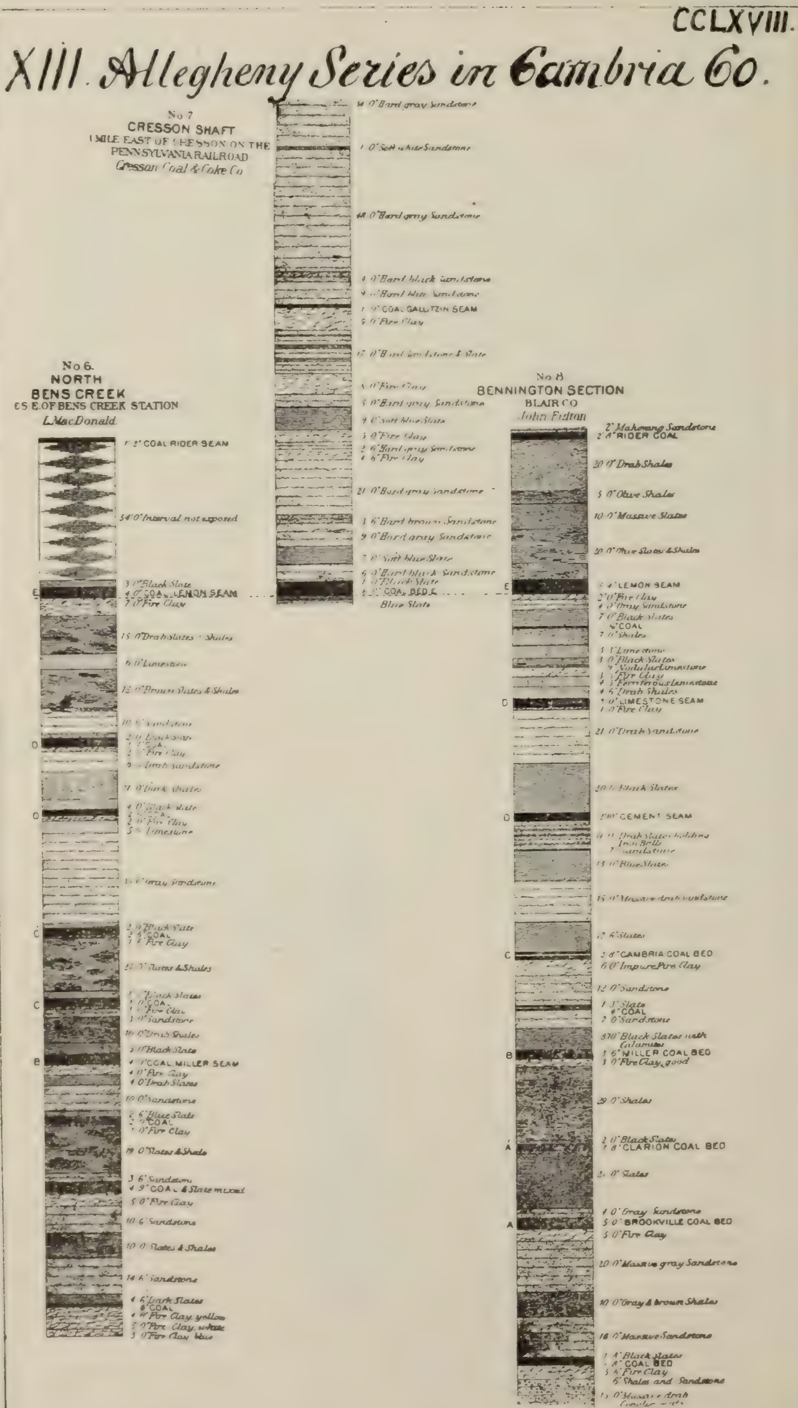
*Tunnels have been foolishly driven into this exposure in search of coal.

† Prof. White's identification of them as Chemung fossils was confirmed by Mr. Whitfield of the Museum of Natural History in New York. They carry the Chemung age through and above the Venango oil sand deposits into what should be Catskill, if the Catskill formation No. IX extended this far westward, and in case it does not, as is most probable, into the succeeding and overlying Pocono formation No. X.


CCLXVIII.
XIII. Allegheny Series in Cambria Co.
No 7
CRESSON SHAFT
1 MILE EAST OF CRESSON ON THE
PENNSYLVANIA RAILROAD
Cresson Coal & Coke Co
1 0' Soft white Sandstone
48 0' Hard gray Sandstone
COAL GALLITZIN SEAM
0' Fire Clay
Blue Slate
No 6.
NORTH
BENS CREEK
E.S. E. OF BENS CREEK STATION
I. MacDonald.
COAL RIDER SEAM
54 0' Interval not exposed
3 0' Black Slate
LEMON SEAM
7 0' Fire Clay
15 0' Drab slates & Shales
6 0' Limestone
COAL MILLER SEAM
19 0' Slates & Shale
COAL & Slate mixed
5 0' Fire Clay
10 0' Slates & Shales
Fire Clay, yellow
Fire Clay, white
Fire Clay, blue
No 8
BENNINGTON SECTION
BLAIR CO
John Fulton
2' Mahoning Sandstone
RIDER COAL
20 0' Drab Shales
5 0' Olive Shales
10 0' Massive Slates
LEMON SEAM
LIMESTONE SEAM
CEMENT SEAM
CAMBRIA COAL BED
6 0' Impure Fire Clay
12 0' Sandstone
Black Slates with Calamites
MILLER COAL BED
Fire Clay, good
29 0' Shales
2 0' Black Slates
CLARION COAL BED
4 0' Gray Sandstone
5 0' BROOKVILLE COAL BED
5 0' Fire Clay
20 0' Massive gray Sandstone
10 0' Gray & brown Shales
16 0' Massive Sandstone
COAL BED
6' Shales and Sandstone

No red layers are seen in the Riceville shale of Crawford county; but an abundance of red beds occupy the same position over the Venango first oil sand in Venango county, as described by Mr. Carll in 1880. (I. 3.) The identification, therefore, of the Riceville shale with any part of the Bedford red shale of the State of Ohio (overlying the Cleveland shale) cannot be made in that way.

Waverly Rocks and Fossils.

The difficulty encountered in the early years of the survey in identifying the flat-lying formations in western Pennsylvania and in Ohio, made it so hazardous to use the Ohio nomenclature that a new one was invented, which was not intended to take the place of the Ohio names, but merely to serve as a provisional convenience. But this plan being necessarily pursued by each assistant geologist on the Pennsylvania Survey in reporting the rocks of his own district, gave rise to a number of synonyms, some of which have been already rejected in the later reports, and all of them will be in course of time, when the questions of identity which still remain open shall be settled.

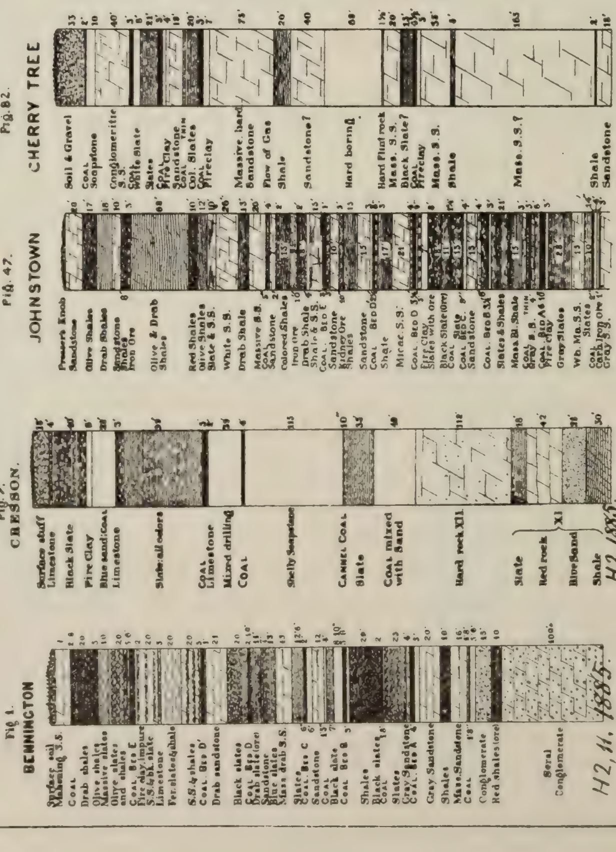
The Waverly formation of southern Ohio occupies the same general horizon as the sub-conglomerate formations of western Pennsylvania; and that is all that can be said of it. Its use by the geologists of the United States has produced considerable confusion, and the name Waverly has been systematically, on that account, kept out of the reports of the Pennsylvania Survey. Several readjustments of the divisions of the Waverley have been made; and one readjustment by Prof. Edward Orton, State Geologist of Ohio, will be found in the *American Journal of Science* for August, 1879, page 139. The disputes between the Waverley of Ohio and the Chemung of New York are well known. They became far more complicated than they were at first by the impossibility of certainly tracing the Catskill and Pocono and Mauch Chunk formations of eastern Pennsylvania to Lake Erie, since these formations wedge in that direction to sharp edges between the well-recognized Chemung of New York below and the perfectly fixed Olean

CCLXIX.

XIII. Allegheny Series in Cambria Co.

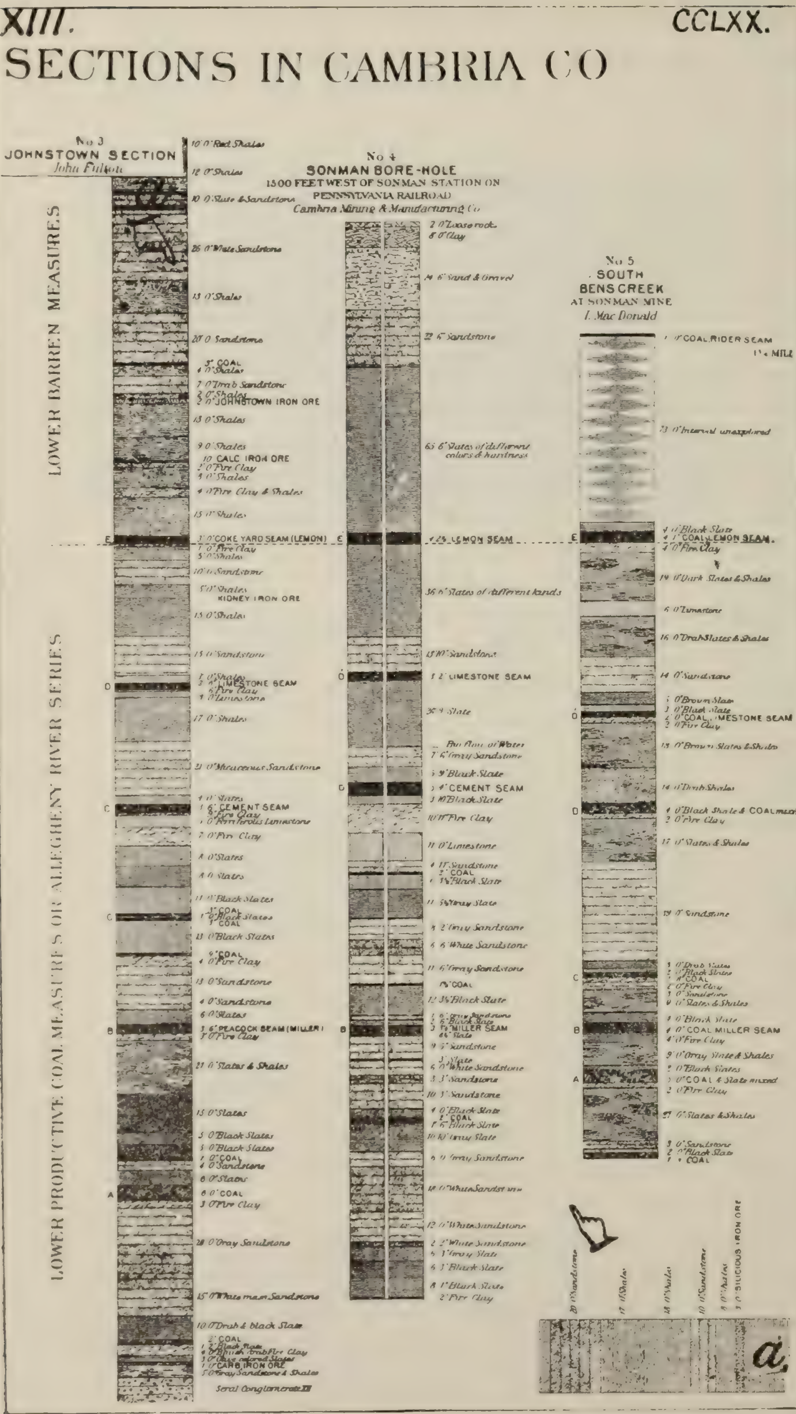
…ohnstown the valley of the Conemaugh River and part of Cambria County.

Electrotyped from an old photograph of a model made by J. P. Lesley in 1856.

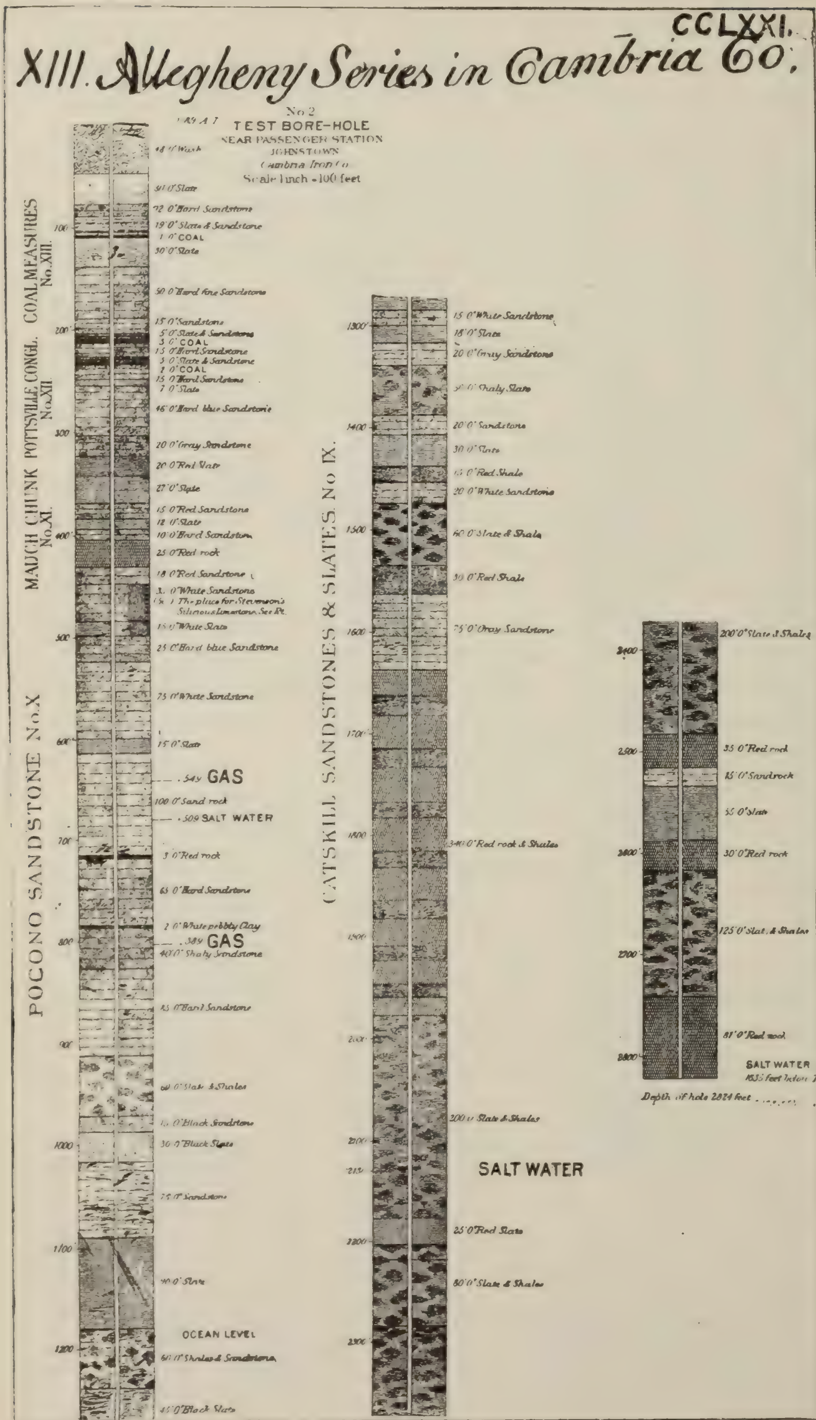


conglomerate above. The chief difficulty arose from two facts, first, that the Chemung fossils going west seemed to live on past the true Chemung age into subsequent ages, leaving their remains in the overlying formations; and, secondly, the peculiar character of the Waverley fossils which appear in northwestern Pennsylvania in the sub-Olean strata, but apparently mixed with Chemung fossils at a lower horizon. It is, however, impossible to exclude from such discussions the great law of the local distribution of fossils in the same age; and it is quite possible for the Waverley, with its special fauna, to be contemporaneous with any of the sub-conglomerate formations elsewhere which do not hold Waverley fossils, the animals that lived in one area of the water basin not living in an adjoining area; and where the two areas met, the fossil fauna of both being intermingled. It must be remembered, however, that a general statement of this sort is not exact science; and, while it relieves the mind of the present weight of a difficult identification, lends little or no aid to its final resolution. The phenomenon also is always on so grand a scale that no imagination, however sharp or expert, is capable of seizing all its features, and of regarding it as a whole with a vision sufficiently clear to produce anything that deserves the name of definite, useful knowledge. We have been drilled by thousands of detailed observations in the painful experience that even a single, persistent deposit, although traceable beyond the possibility of doubt from area to area over a large extent of country, is so infinitely variable in its constitution, in its thickness, color, topographical power, and in the quality and quantity of its fossilized forms, that the greatest modesty must be observed in describing it. How much more difficult must be in all cases the description of a series of such deposits, the tracing of such a large formation from region to region, and its certain identification with other similar and more or less apparently contemporaneous series of deposits or formations at a distance.

The Catskill formation, No. IX, which is so thick in eastern New York and eastern and middle Pennsylvania, thins


XIII.
CCLXX.
SECTIONS IN CAMBRIA CO
No 3
JOHNSTOWN SECTION
John Fulton
No 4
SONMAN BORE-HOLE
1500 FEET WEST OF SONMAN STATION ON
PENNSYLVANIA RAILROAD
Cambria Mining & Manufacturing Co
No 5
SOUTH
BENS CREEK
AT SONMAN MINE
I. Mac Donald
LOWER BARREN MEASURES
LOWER PRODUCTIVE COAL MEASURES OR ALLEGHENY RIVER SERIES
JOHNSTOWN IRON ORE
CALC IRON ORE
COKE YARD SEAM (LEMON)
KIDNEY IRON ORE
LIMESTONE SEAM
CEMENT SEAM
PEACOCK SEAM (MILLER)
CAMB IRON ORE
Seral Conglomerate XII
LEMON SEAM
LIMESTONE SEAM
CEMENT SEAM
MILLER SEAM
COAL RIDER SEAM
COAL LEMON SEAM
COAL LIMESTONE SEAM
COAL MILLER SEAM
SILICIOUS IRON ORE
a.

away westward toward Lake Erie with such a change of aspect that its presence between the Waverly and Chemung cannot be asserted. In like manner, the Mauch Chunk red shale, No. XI, 3,000′ thick in eastern Pennsylvania, thins away toward Lake Erie so completely that its presence immediately under the Olean conglomerate on the Ohio line cannot be asserted, and, therefore, no identification of it with any part of the Waverly is possible. The intermediate great Pocono sandstone formation, several thousand feet thick between the Hudson and Delaware, also thins toward Lake Erie, but can be distinctly recognized through western Pennsylvania, passing into Ohio between the Conglomerate and the Chemung, and is consequently identifiable with very considerable certainty with the Waverly. If, then, the term Waverly were to be used in Pennsylvania it could only be used as a synonym for the whole or some part of the Pocono; but the Pocono formation is developed in Pennsylvania in so superior a manner that it would be vain to expect any advantage from the substitution of the term Waverly for Pocono. The term Pocono was adopted in place of the term Vespertine, used by Prof. Henry D. Rogers in the early Pennsylvania survey and by Prof. William B. Rogers in the early Virginia survey, because the peculiar nomenclature of which it was a single term, applied to the whole palæozoic column by those geologists, based on the fanciful resemblance of the palæozoic ages to the dawn, the morning, noon, afternoon, and evening of a common solar day, was never accepted by American geologists, and only appears in the final report of H. D. Rogers on the geology of Pennsylvania, published in 1858, and in the collected annual reports of William B. Rogers on the geology of Virginia. In spite, however, of this general repudiation by American geologists of the poetic nomenclature, three of the names have curiously enough become fixed in the popular phraseology of the bituminous coal regions. Local geologists, prospectors, and miners along the whole range of the Allegheny mountain use habitually the terms Vespertine sandstone, Umbral red shale, and Seral conglomerate; and it is doubtful whether the correspond-



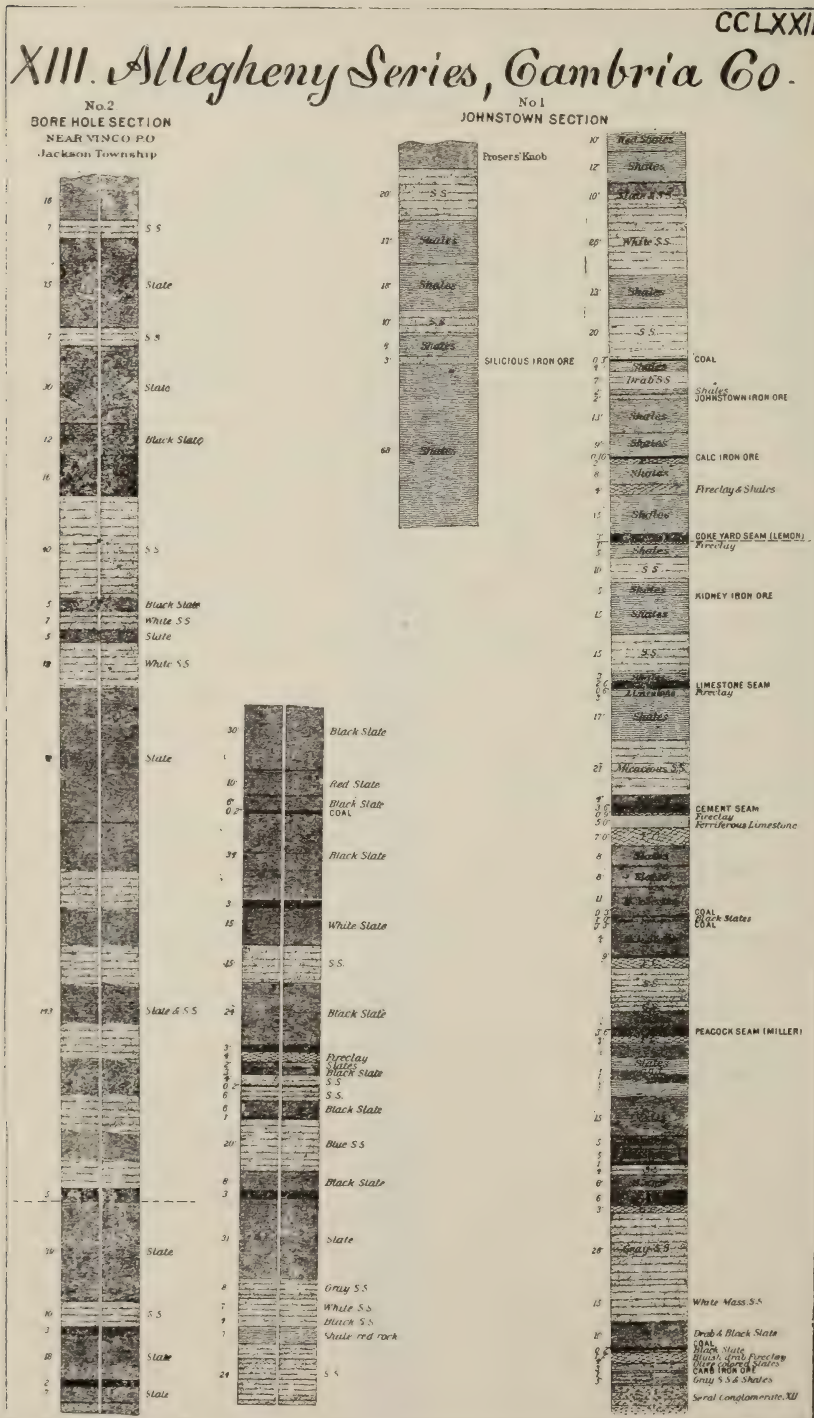
CCLXXI.
XIII. Allegheny Series in Cambria Co.
No 2
TEST BORE-HOLE
NEAR PASSENGER STATION
JOHNSTOWN
Cambria Iron Co
Scale 1 inch = 100 feet
COAL MEASURES No. XIII.
POTTSVILLE CONGL. No. XII.
MAUCH CHUNK No. XI.
POCONO SANDSTONE No. X
CATSKILL SANDSTONES & SLATES No. IX.
91 0' Slate
72 0' Hard Sandstone
19 0' Slate & Sandstone
1 0' COAL
30 0' Slate
50 0' Hard fine Sandstone
15 0' Sandstone
5 0' Slate & Sandstone
3 0' COAL
15 0' Hard Sandstone
5 0' Slate & Sandstone
2 0' COAL
15 0' Hard Sandstone
7 0' Slate
46 0' Hard blue Sandstone
20 0' Gray Sandstone
20 0' Red Slate
27 0' Slate
15 0' Red Sandstone
12 0' Slate
10 0' Hard Sandstone
25 0' Red rock
18 0' Red Sandstone
The place for Stevenson's Siliceous Limestone. See Rt.
White Slate
25 0' Hard blue Sandstone
75 0' White Sandstone
15 0' Slate
GAS
100 0' Sand rock
SALT WATER
3 0' Red rock
65 0' Hard Sandstone
2 0' White pebbly Clay
GAS
40 0' Shaly Sandstone
Hard Sandstone
Slate & Shales
Black Sandstone
30 0' Black Slate
75 0' Sandstone
40 0' Slate
OCEAN LEVEL
60 0' Shales & Sandstone
45 0' Black Slate
15 0' White Sandstone
18 0' Slate
20 0' Gray Sandstone
Shaly Slate
20 0' Sandstone
30 0' Slate
Red Shale
20 0' White Sandstone
60 0' Slate & Shale
30 0' Red Shale
75 0' Gray Sandstone
340 0' Red rock & Shales
200 0' Slate & Shales
SALT WATER
25 0' Red Slate
80 0' Slate & Shales
200 0' Slate & Shales
35 0' Red rock
15 0' Sandrock
55 0' Slate
30 0' Red rock
125 0' Slate & Shales
81 0' Red rock
SALT WATER
Depth of hole 2824 feet

ing terms Pocono sandstone, Mauch Chunk red shale, and Pottsville conglomerate will ever supplant those earlier and more poetical names from popular use in that mining region.

It is equally probable that the geological phraseology of the northwestern counties of Pennsylvania will never be used along the Allegheny mountain or the east and south of it. The names Homewood sandstone, Connoconnessing sandstone, Sharon (Garland-Olean) conglomerate, given along the Ohio line counties to the great or Pottsville conglomerate, are quite inapplicable to the outcrops along and east of the Allegheny mountain. In like manner such names as Shenango shales and conglomerate, sub-Olean, Meadville, Cussewago, Corry, will always be confined to the special district in which they were at first applied ; because the sub-divisions of the sub-conglomerate formations cannot be very nicely recognized along the Allegheny mountain. In a word, the geological nomenclature of Erie, Crawford, Warren, and the State line counties to the south and to the east of them, must remain isolated and peculiar, as the deposits which they represent are in that district different in kind and arrangement and contents from deposits of the same age elsewhere.*

The Waverly group was so named in 1838 by Mr. Briggs, of the Ohio survey from the town of Waverly, in Ohio, where it consists of fine grained sandstone 300 feet thick, overlying black clay slate 200 or 300 feet thick, and under-

* The same thing must be said of the northeastern corner of Pennsylvania, where an equally peculiar geological nomenclature had to be adopted for isolated deposits and series of deposits or formations which could not be certainly recognized in the west. But the subsequent history of this northeastern geological nomenclature has been different; inasmuch as it was found possible to carry these names from the upper Delaware river westward or, rather, southwestward from Susquehanna, Wayne and Pike counties, through Lackawanna and Luzerne into Columbia, Montour and Northumberland and through Carbon. It was found, in fact, possible to apply several of the names of the northeast to outcrops west of the Susquehanna in the Juniata river country. But while these identifications in northeastern Pennsylvania were being made, the survey of Perry county, on the lower Juniata, produced again a different and isolated geological nomenclature, only parts of which can be applied to the geology of the upper Juniata country.

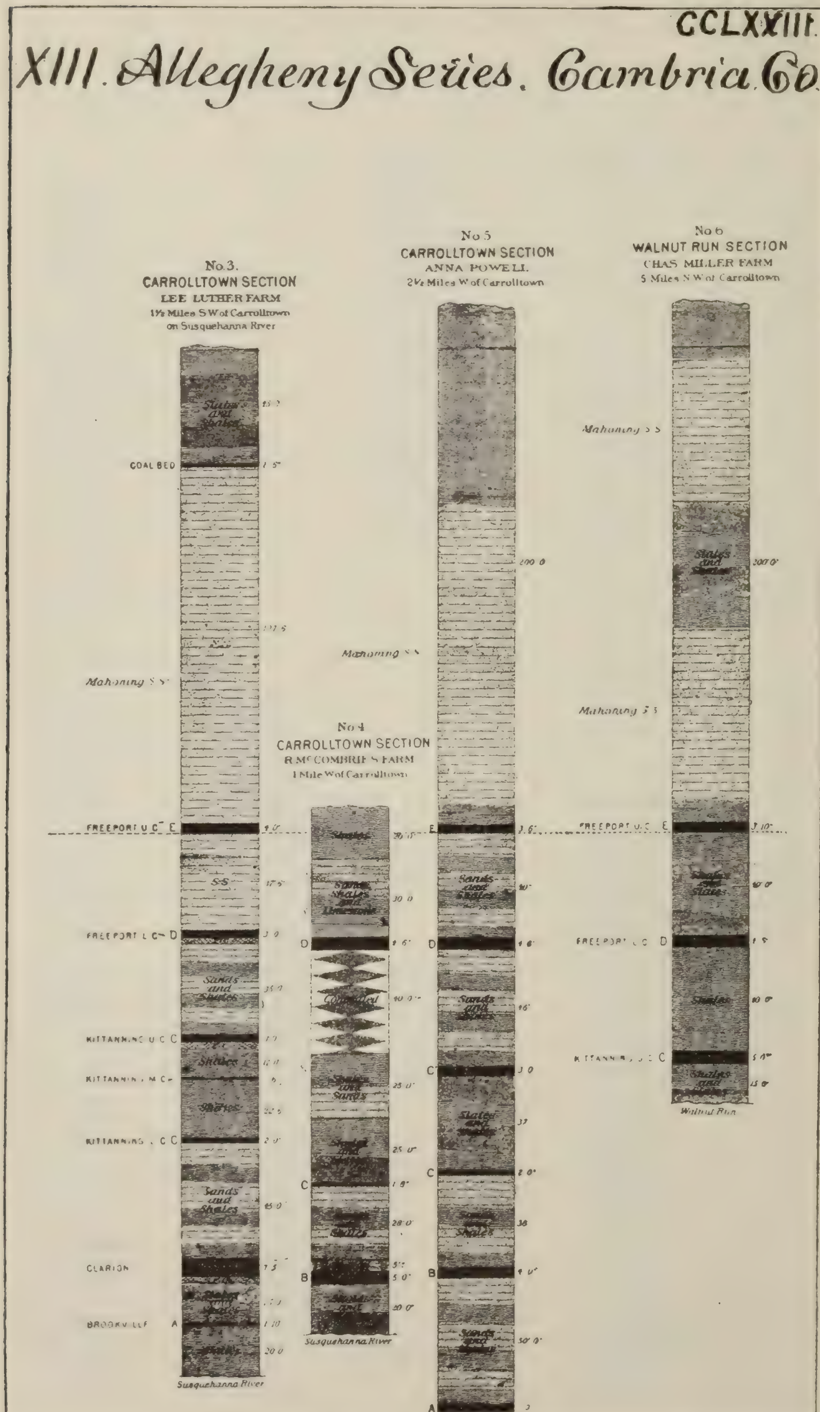

CCLXXII
XIII. Allegheny Series, Cambria Co.
No. 2
BORE HOLE SECTION
NEAR VINCO P.O
Jackson Township
No 1
JOHNSTOWN SECTION
S S
Slate
S S
Slate
Black Slate
S S
Black Slate
White S S
Slate
White S S
Slate
Slate & S S
Slate
S S
Slate
Slate
Black Slate
Red Slate
Black Slate
COAL
Black Slate
White Slate
S.S.
Black Slate
Fireclay
Slates
Black Slate
S S
S.S.
Black Slate
Blue S S
Black Slate
Slate
Gray S S
White S S
Bluish S S
Shale red rock
S S
Prosers' Knob
S S
Shales
Shales
S S
Shales
SILICIOUS IRON ORE
Shales
Red Shales
Shales
Slate & S S
White S S
Shales
S S
COAL
Shales
Drab S S
Shales
JOHNSTOWN IRON ORE
Shales
Shales
CALC IRON ORE
Shales
Fireclay & Shales
Shales
COKE YARD SEAM (LEMON)
Fireclay
Shales
S S
Shales
KIDNEY IRON ORE
Shales
S S
LIMESTONE SEAM
Fireclay
Shales
Micaceous S S
CEMENT SEAM
Fireclay
Ferriferous Limestone
COAL
Black Slates
COAL
PEACOCK SEAM (MILLER)
Slates
Gray S S
White Mass S S
Drab & Black Slate
COAL
Black Slate
Bluish drab Fireclay
Olive colored Slates
CARB IRON ORE
Gray S S & Shales
Seral Conglomerate XII

lying from 40 to 80 feet of what was known as the Ohio conglomerate, which seems to be the equivalent of the Olean conglomerate or Sharon conglomerate of Bradford county, Pa. It is broadly exposed at Portsmouth, Piketown and Chillecope and in Licking and Fairfield counties. Soon afterward Dr. Owen identified the formation in Kentucky (as the Knobstone formation) and in Indiana and Illinois, at New Albany, referring its rocks to the base of the so-called sub-carboniferous system. Other western geologists accepted the name, and in 1841 Hubbard recognized it in the Michigan survey. The eastern geologists considered it Devonian. On the Mississippi river, where it consists of five great limestones, it received the general name of Kinderhook. Prof. Alexander Winchell, describing the Marshall group of Michigan, proved its identity with the Waverly, the Kinderhook, the Yellow sandstone of Iowa, the Choteau limestone, Vermicular sandstone and shale, and the Lithographic limestone of Missouri.

In Ohio the Waverly forms a belt 10 or 20 miles wide from the mouth of the Scioto northeast toward Cleveland, where on Lake Erie it is more than 40 miles wide. In Indiana it crosses the Ohio at New Albany. Its Rockford mottled limestone at the bottom of the group is famous for its Goniotites. In Indiana the group is 500, in Kentucky 200 and in Michigan 160 feet thick, consisting of reddish, yellowish and greenish sandstone ; the Napoleon sandstone being 123 feet thick.

The Waverly, like the Pocono in Pennsylvania, furnishes large quantities of brine ; contains also gypsum ; and furnishes in many places celebrated building stone. The Lithographic limestone of Missouri, 55 feet thick, is characterized by the crinoid Pentremites rœmeri. The vermicular sandstone, 75 feet thick, is full of worm burrows. The Choteau limestone is 100 feet thick. The Burlington shales and sandstones, 75 feet thick, are capped by a 4-foot bed of oolite.

The Waverly fossils are on the whole of carboniferous aspect. Many of the shells passing upward. Its genera of fish-remains are also carboniferous. Some of its most


CCLXXIII.
XIII. Allegheny Series. Cambria Co.
No. 3.
CARROLLTOWN SECTION
LEE LUTHER FARM
1½ Miles S W of Carrolltown
on Susquehanna River
No. 4
CARROLLTOWN SECTION
R. McCOMBRIE'S FARM
1 Mile W of Carrolltown
No. 5
CARROLLTOWN SECTION
ANNA POWELL.
2½ Miles W of Carrolltown
No. 6
WALNUT RUN SECTION
CHAS MILLER FARM
5 Miles N W of Carrolltown
COAL BED
Mahoning S S
FREEPORT U C E
FREEPORT L C D
KITTANNING U C C
KITTANNING M C
KITTANNING L C C
CLARION
BROOKVILLE A
Shales and Shales
Sands and Shales
Shales
Sands Shales and Limestone
Concealed
Shales and Sands
Susquehanna River
Walnut Run

widely distributed characteristic species are *Productella concentrica*, *Productus cooperensis*, *Spirifera carteri*, *S. extenuata*, *S. peculiaris*, *Syringothyris halli*, *Athyris hannibalensis*, *Rhynchonella hubbardi*, *R. missouriensis*, *Centronella allii*, *Bellerophon cyrtolites*, *Grammysia hannibalensis*, *Orthoceras indianense*, *Goniatites oweni*, *G. marshallensis* and *Phillipsia doris* (N. A. Geol. and Pal. by S. A. Miller, 1889, page 68).

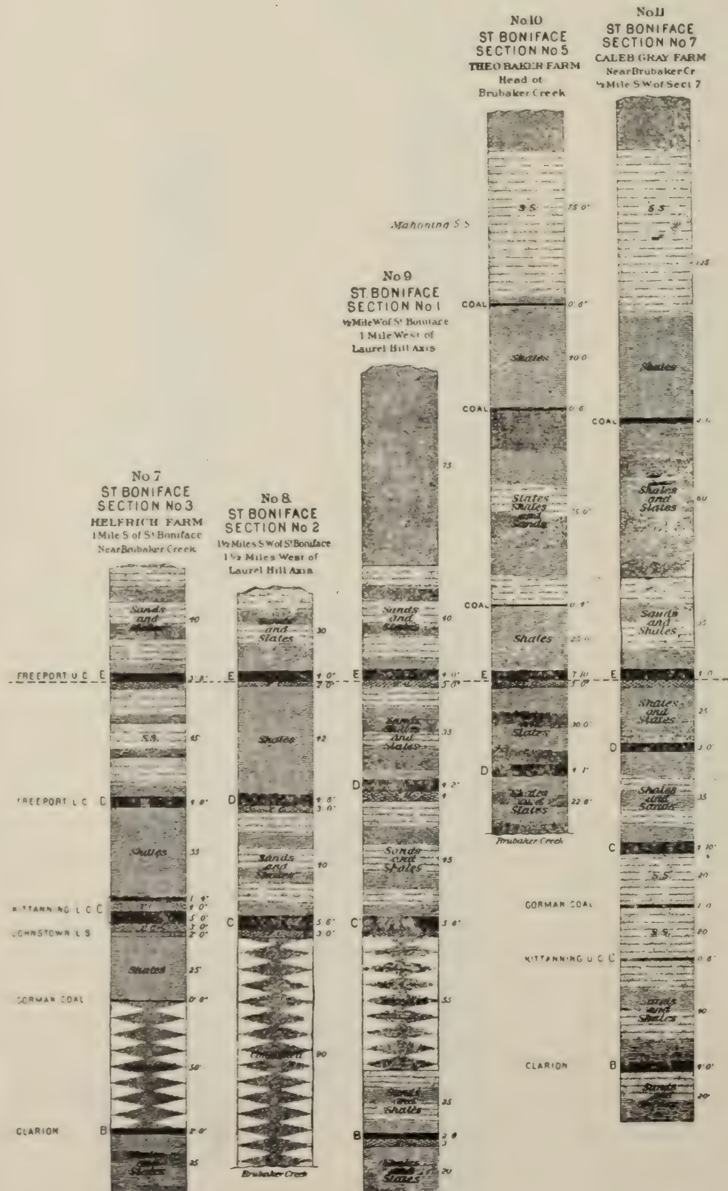
Chapter CXIV.

X–XI. Mountain Limestones.

This insignificant deposit in Pennsylvania would hardly deserve to receive a name, were it not for the fact of grave geological importance that it is the representative not only of the great Mountain limestone, or Scaur limestone formation of Great Britain and Belgium, but also of the large and important limestone formations of the southern and western states in America. In Pennsylvania it appears as a few thin layers at or near the top of the Pocono formation in Trough valley, Huntingdon county; at one or two places along the upper escarpment of the Allegheny mountain in Blair county; at the top of the Pocono in the gaps of Chestnut Ridge, Westmoreland and Fayette counties, and in the oil wells at Pittsburgh and elsewhere in southwestern Pennsylvania, where it is bored through and shows from 40 to 80 feet of solid rock. Its existence in northern Pennsylvania was only conjectural until the extensive private explorations of a geologist of Cogan House, in Lycoming county, Mr. Abram Meyer, who proved its extensive outspread as isolated plates underneath the patches of Mauch Chunk red shale No. XI preserved, from the general erosion of the highlands between the waters of Larry's creek, Pine creek, Lycoming creek and the Loyalsock. Plate

CCLXXIV.

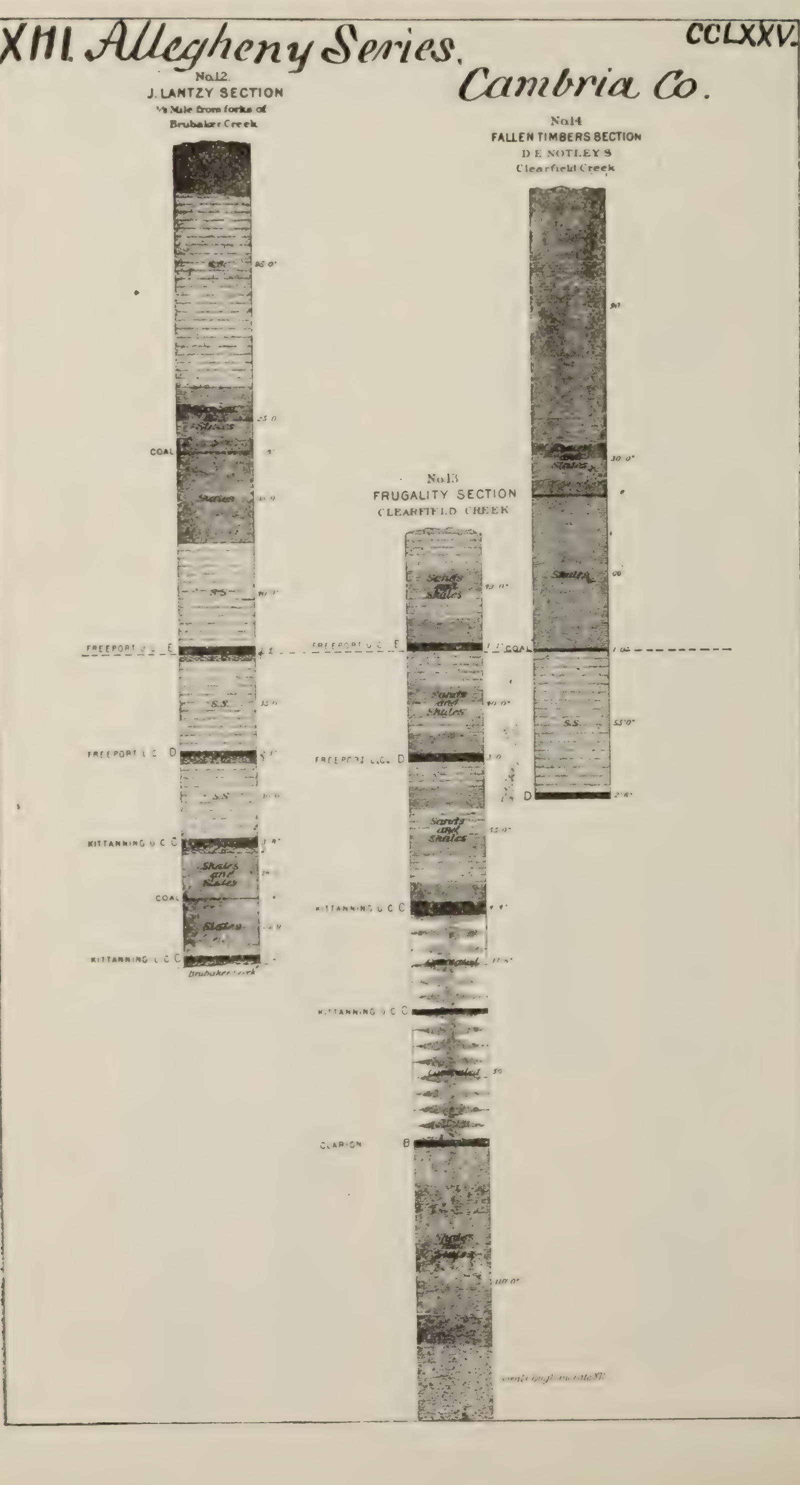
XIII. Allegheny Series, Cambria Co.



CCXX(E) is a reduced copy of a part of Mr. Meyers' map of Lycoming county, showing by black lines the circular outcrops of this mountain limestone around the patches of red shale. Here the formation is much subdivided, exhibiting good and bad layers, but promising an important contribution to the agricultural resources of that region, the only one in the state where it is of practical importance.

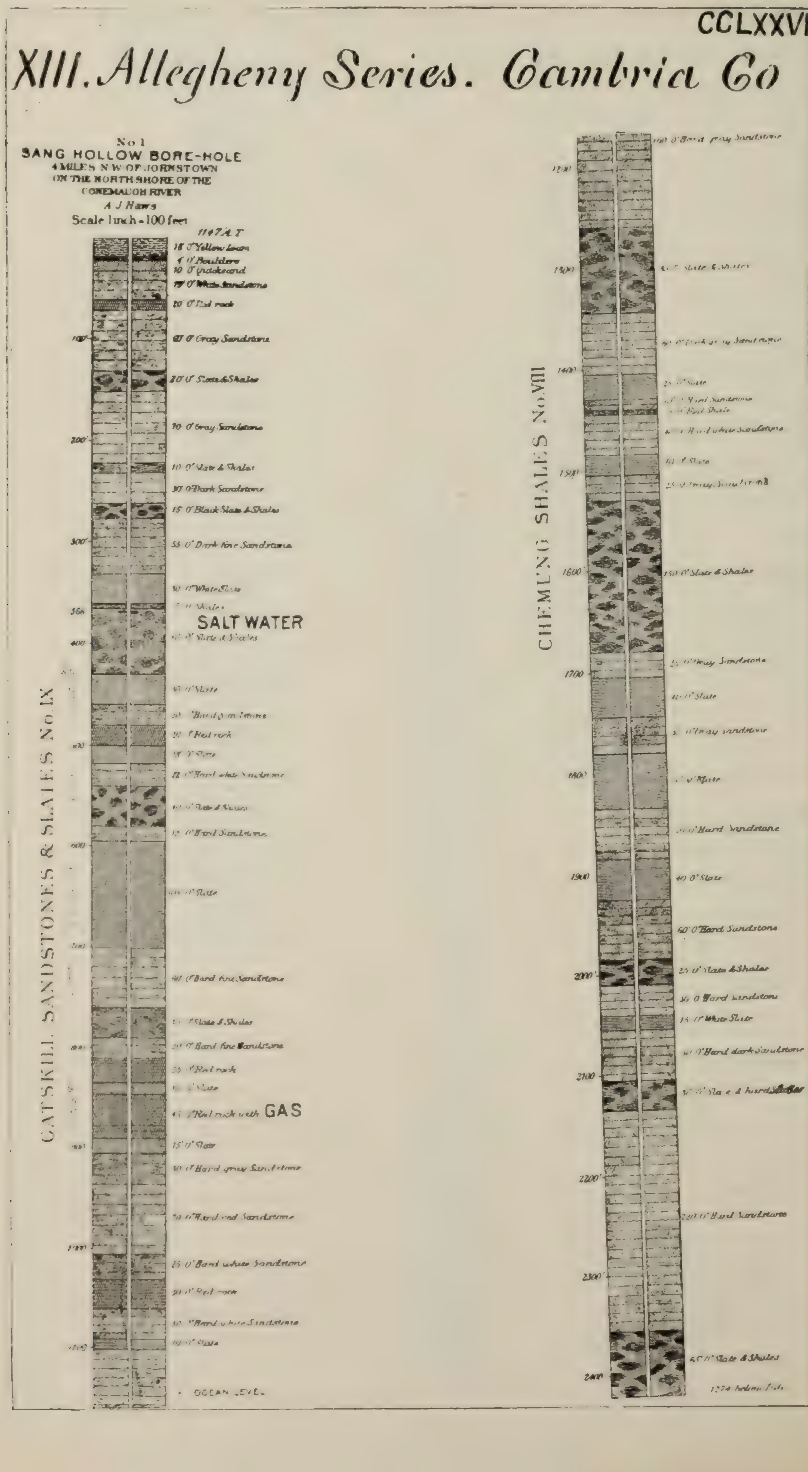
In the northeastern counties it is represented by one or more calcareous beds in the upper Pocono, described by Prof. White in his reports on Susquehanna, Wayne, Pike and other counties in that region. It is not known to exist in the State of New York. Followed south across the West Virginia State line it increases rapidly in magnitude, and appears on Cheat river waters and the Kanawha waters as a large limestone formation 500 and even 700 feet thick; and from this southward to the end of the Cumberland mountain range in Alabama it plays a principal role in the surface geology. On the Mississippi above the mouth of the Ohio it is subdivided into five groups, the lowest of which, the Burlington limestone, varies from 100 to 500 feet. Over this the Keokuk group has a thickness in southern Kentucky of 200 feet. Over this the Warsaw group in St. Genevieve county, Missouri, is 100 feet thick. Over this the St. Louis limestone has a maximum thickness of 250 feet, making bluffs between St. Louis and Carondelet 175 feet high. Over this the Kaskaskia limestone (called also Chester) is on the Mississippi 200 feet thick; at Huntsville, Ala., 635 feet: on the southern line of Tennessee 720 feet; at the northern line 400, and in Indiana 300, making a complete circular outcrop belt around the whole of the Illinois and Indiana coal basin (A. S. Miller).

It will be seen in the next chapter, describing the Mauch Chunk red shale formation No. XI, that these five great southern and western limestone groups cannot properly be considered as representing the insignificant Silicious or mountain limestone of Pennsylvania alone; but that they are as a whole the co-temporary representatives of No. XI red shale as a whole. For, as the red shale here is capped by the great conglomerate No. XII, so the Kaskaskia or


XIII. Allegheny Series.
CCLXXV.
Cambria Co.
No.12.
J. LANTZY SECTION
½ Mile from forks of
Brubaker Creek
No.14
FALLEN TIMBERS SECTION
D E NOTLEY'S
Clearfield Creek
No.13
FRUGALITY SECTION
CLEARFIELD CREEK
COAL
Shales
S.S.
FREEPORT U. C. E
FREEPORT L. C. D
KITTANNING U. C. C
Shales and Slates
KITTANNING L. C. C
Brubaker Creek
Sands and Shales
Concealed
CLARION B
Shales and Slates
110.0"
Sands and Shales
30.0"
Slates
55.0"
D

Chester limestone is capped by the basal coal measure conglomerate on the Mississippi. In different parts of the Appalachian sea different deposits were being made during the same age, large deposits of red shale in middle Pennsylvania, and large deposits of calcareous shales and solid limestones in the southern and western regions. This is but another representation and repetition of what has occurred in all ages, setting at defiance all the attempts of geologists to formulate a general section of the Paleozoic column of formations which shall be applicable to the numerous separate regions of the sea, and making it impossible to carry successfully the rock names of one State over into the geological areas of even neighboring States. Even along the face of the Allegheny or Cumberland mountain, extending in an unbroken line from Pennsylvania to Alabama, the essential change of sediments is sufficiently to give the most opposite aspects to the mountain. In middle Pennsylvania we have the mountain walls built up of horizontal outcrops which are so exclusively sandstone and shale that only this single stratum of the Silicious limestone at the top of the Pocono can be observed. In eastern Tennessee and Alabama, on the contrary, the same mountain wall, differing very little in general appearance, is made up, as to its upper half at least, of outcrops which are almost exclusively horizontal layers of solid limestone, separated by lime shales ; and it is only by a continuous sectioning of the pile of outcrops from north to south that the continuity and contemporaneousness of the formations become evident.

It is useless to inquire very strictly whether a deposit of limestone which separates two perfectly distinct formations should be considered as part of the one or of the other. This is especially the case with the Mountain limestone. It has been called the Umbral limestone, as if it was either the bottom or near the bottom of the red shale No. XI, and is so classified in the sections by Ashburner, Stevenson and White. But on the other hand it is called very justly the Silicious limestone, being in fact a deposit of grains of sand cemented by lime, and as it caps the Pocono section of Stev-


CCLXXVI
XIII. Allegheny Series. Cambria Co
No 1
SANG HOLLOW BORE-HOLE
4 MILES N W OF JOHNSTOWN
ON THE NORTH SHORE OF THE
CONEMAUGH RIVER
A J Haws
Scale 1 inch = 100 feet
1147 A.T.
18 0' Yellow loam
4 0' Boulders
10 0' Quicksand
17 0' White Sandstone
20 0' Red rock
67 0' Gray Sandstone
20 0' Slate & Shales
70 0' Gray Sandstone
10 0' Slate & Shales
30 0' Dark Sandstone
15 0' Black Slate & Shales
55 0' Dark fine Sandstone
SALT WATER
GAS
15 0' Slate
OCEAN LEVEL
CATSKILL SANDSTONES & SLATES No. IX
CHEMUNG SHALES No. VIII
130 0' Slate & Shales
40 0' Slate
60 0' Hard Sandstone
25 0' Slate & Shales
65 0' Slate & Shales

evenson in the gaps of Westmoreland it belongs more to the Pocono than to the Mauch Chunk. Its typical locality is in the Conemaugh Gap, where it is 30 feet thick, subdivided into a variable upper conglomerate sandstone in which are great numbers of more or less angular fragments of Silicious limestone, passing down imperceptibly into a lower division, the Silicious limestone proper, which in its turn passes down without break into the upper Pocono sand stone. The fragments of limestone in the conglomerate upper portion are so free in most cases from traces of water action that one is inclined to imagine them to have been broken from some surface that was above water and deposited in neighboring soundings. The limestone itself is exceedingly fine grained, of a delicate blue and showing no lines of bedding on the fresh surface. It has a flint-like fracture and no definite cleavage ; but on a long exposed surface the color is a dull brown, and the rock a loose sandstone, exhibiting a curious cross-bedding, the characteristic feature of the Pocono sandstones. At first glance the rock would not be taken for a limestone, and silica predominates at all localities. Yet the percentage of lime is considerable, and the rock when burned becomes snow white, slakes readily, and makes mortar without the addition of sand. As a formation, it increases in thickness northward and thins away southward. On the Conemaugh it is 40 and 50 feet in both gaps, as well as in the gaps of the Loyalhanna and Youghiogheny, but dwindles to about 18 feet on the National road, and to barely 4 feet at the State line. On the Cheat river it has disappeared. (K.3, page 52).*

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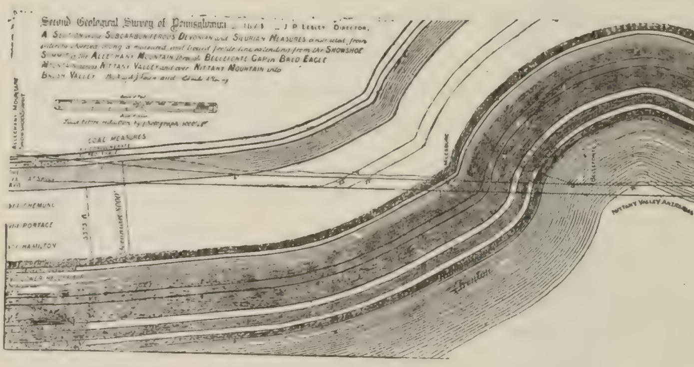
* The Silicious limestone is used in Pittsburg to some extent as a paving stone. On weathered blocks before being laid much of the lime cement is already separated so as to give a distinct scale to the surface. The upper conglomerate is 3 feet thick, and contains large fragments of the lower limestone imbedded in fine limestone as a matrix. This top conglomerate is absent from all exposures south of the Youghiogheny river. On the Conemaugh its presence or absence is unknown because the place is concealed. On the Loyalhanna there are two layers of this conglomerate, one 25 feet above the Silicious limestone and the other 35 feet still higher; both of them quite thin and almost as silicious as the great mass below, but much stained with iron, weathering down into reddish sand; containing some fossils of the more common species ; associated with deep red shales and hematite iron

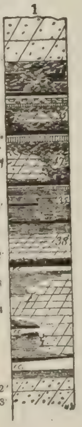
CCLXXVII.

XIII. Allegheny coal series, Clearfield Co.



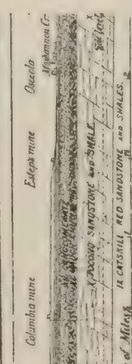
General Section, Fig. 1.

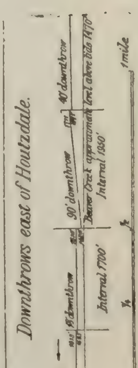
		Observed limits.	Average.
Mahoning sandstone—the top rock.			
Shales and slates, sometimes ferruginous,		20' to 40'	30
Freeport Upper Coal—E,		2' to 4'	3
Fireclay,	2' to 6'	25' to 40'	35'
Shales with ore,			
Freeport Upper Limestone,	1		
Shales and slates, sometimes sandstone,			
Freeport Lower Coal—D,		3' to 7	3½
Fireclay,	1' 6" to 4'	42' to 50	47'
Freeport Lower Limestone,	0' to 4'		
Shale—place of Freeport Sandstone,			
Kittanning Upper Coal—C',		1' 6" to 5'	2½
Fireclay,	2' to 4'	30' to 40	35'
Johnstown Cement bed,	0' to 4'		
Shales and slate, (thin,)			
Coal—Unnamed,	0' to 2'		
Fireclay,	0' to 2'		
Shales and slate,			
Kittanning Middle Coal—C,		1' 6" to 3'	2'
Fireclay,		35' to 40'	38
Shales and slates,			
Sandstone, fine grained, tough,			
Kittanning Lower Coal—B,		3' to 7'	4
Fireclay, 4 to 8'	Sometimes occupied by Clarion Sandstone	70' to 80'	
Shales, sandy, 55'			
Clarion Coal—A', 1 to 2'			
Fireclay, 2 to 10'			
Shales, 20' to 30'			
Brookville Coal—A,		0' to 4'	2'
Fire-clay—brick-clay,		0' to 10'	3'
Pottsville Conglomerate, No. XII.			



Map of Clearfield County Coal Measure Outcrops

The areas left white are No XII those dotted, Mahoning Sandstone.





The limestone struck in the Thayer and other Washington county gas wells at a depth of 1480 feet, and 80 feet thick, strikingly resembles the Silicious limestone described by Prof. Stevenson in K2 p. 98 and K3, p. 52, where it crops out at the base of the Mauch Chunk *red shale* formation No. XI in the gaps of Laurel hill and Chestnut ridge, between Johnstown and Blairsville, and between Ursina and Connellsville.*

The upper part of the mass at Washington is a purer limestone and the lower part more pebbly than specimens obtained from Bolivar and Connellsville, but the resemblance of color, composition and structure is complete. Microscopic sections of the drillings show much of the lime in the form of little round grains, the largest of the size of a mustard seed. Mingled with these are quartz grains, equal in number, more or less rounded. Viewed through a magnifying glass the mass looks oolitic or micro-conglomerate. The Bolivar slices show this structure less plainly, the lime grains appearing elongated, many of them apparently fragments of crinoids. Sections of the chippings from the top of the limestone in the Washington wells show numerous fossil fragments resembling crinoids.

No enlargements by secondary crystalization of the quartz grains was noticed ; although slices made from the Piedmont (No. XII) sandstone, lying higher up in the wells, and charged with brine, look under the microscope very porous, and the heads of crystals of quartz can be seen jutting into the pores from their side walls.

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ore. On Jacob's creek 40 feet of Silicious limestone is exposed under the arch ; fossiliferous throughout ; top layers very pure, yielding the best white lime ; middle layers thin clay beds extremely rich in fossils of many species ; visible bottom 2 feet ; main mass of Silicious limestone probably underground. The above described exposed rocks on Jacob's creek are what Stevenson calls the fossiliferous layers of the Umbral, separated from and lying above the true Silicious limestone. They are no doubt the limestone layers of Trough creek in Huntingdon county, next to be described in the text, where the Silicious limestone itself is apparently absent. They lie only from 10 to 25 feet above the Silicious limestone and, therefore, can hardly be considered as a separate formation. (K. K. page 100).

*Letter of Prof. Alonzo Linn, Wash. & Jeff. Coll., Washington, Pa., Jan. 28, 1885. He pursued the investigation with Rev. Linton, Prof. Geol., in the same college. See Annual Report for 1886, pp. 656, 765.


OUTCROP MAP
OF THE
FREEPORT LOWER COAL BED
IN THE
HOUTZDALE-PHILIPSBURG
BITUMINOUS COAL BASIN
OF
CLEARFIELD CO
By H M CHANCE
Showing two downthrow Faults.
CCLXXVIII
PHILIPSBURG
CENTRE CO.
OSCEOLA
Oseola
Moshannon Creek
Coal Run
Little Beaver Creek
Fault
Fault
Beaver Run
HOUTZDALE
Houtzdale
ANTICLINAL AXIS

The Silicious limestone is struck by all the wells, and its character is so well marked that the tiniest fragment of it under a lens can be identified. It is quite unlike any other limestone in the series of well borings.

It was struck in 1877, in the Boyd's Hill well at Pittsburg at a depth of 889 to 914 feet, and seems to be there 25 feet thick (See Report L p. 227.)

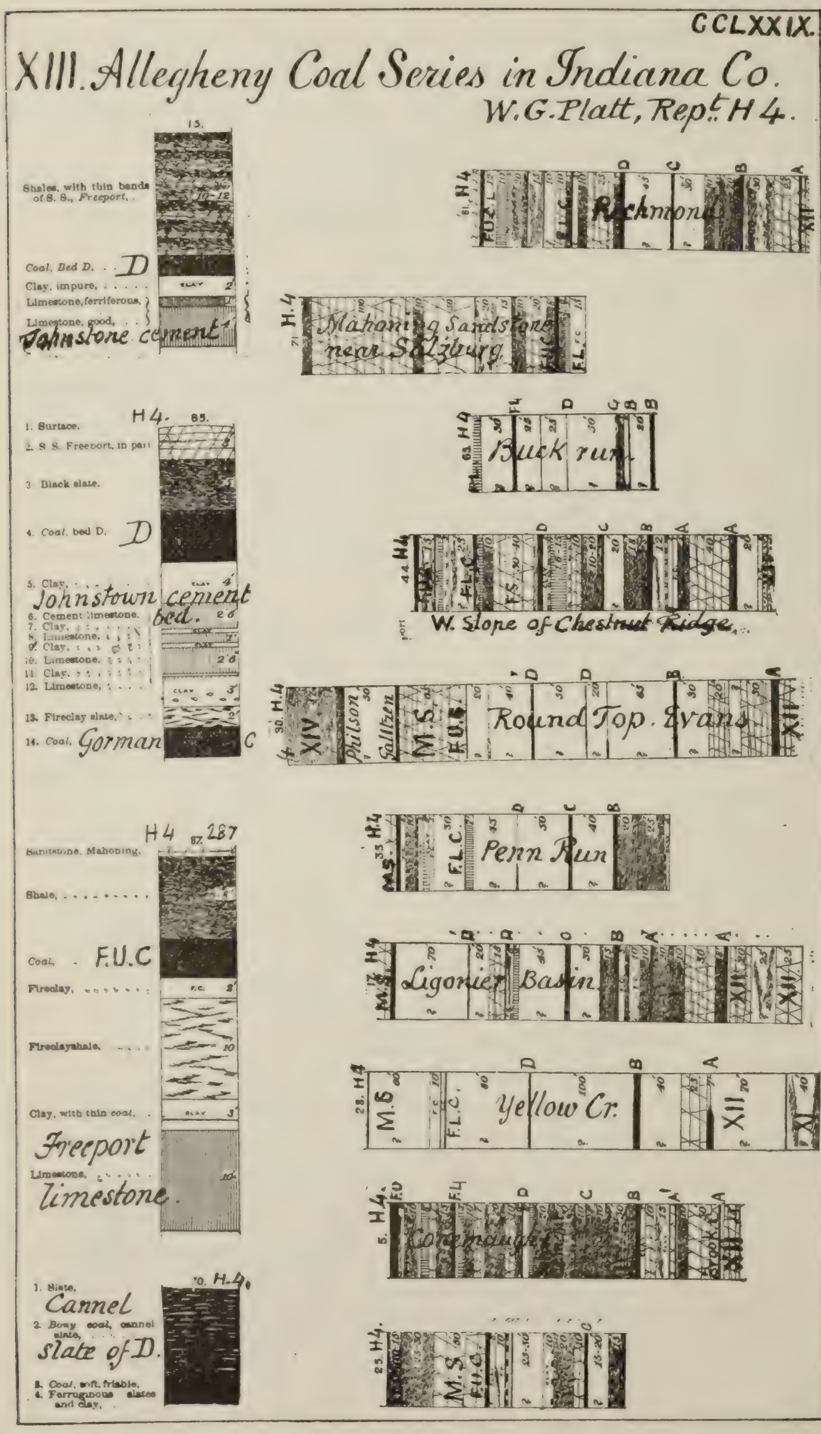
Mountain Limestone on Trough Creek.

At the top of the Pocono, at the inside base of the Terrace mountain slope both White in his Report T3, page 73, and Ashburner in his Report F, page 200, describe limestone beds quarried and of considerable value to the farmers on the red shale soil of Trough Creek Valley. They must not be confounded with the brecciated limestone beds in the upper part of the red shale formation. These will be described later on.

The following sections will show the character of the group. Taylor's quarry :—red lime shales, 10 ft. ; red limestone, 4 ft.; red lime shales, 16 ft.; grey limestone, 2½ ft.; red slate, 3 ft.; grey-green limestone, 4 ft ; total 39½. Pocono sandstone beds immediately underlie the grey-green limestones.

Another section just below Trough Creek Church reads :—red lime shales, 25 ; reddish grey limestone, 1 ; red lime shales, 5 ; grey limestone, 3 ; red lime shales, 4 ; greenish sandy limestone, 3 ; total, 41, overlying sandstone. This lowest stratum may without much forced conjecture represent the siliceous limestone of the Conemaugh gaps.

There are many other exposures of these beds along Trough creek ; as at the quarries of Mrs. Swope, and in both which quarries a greenish-grey limestone 3 or 4 feet thick overlies the Pocono limestone. Mrs. Garrett has a large quarry. Where these limestones rise on the slope of Sideling Hill they are too sandy to burn ; and this is another evidence that we are dealing with the silicious limestone of the Conemaugh gaps. The change of character however is often striking and rapid ; as at Paradise Furnace, where the upper red limestone makes a cliff, thus :


CCLXXIX.
XIII. Allegheny Coal Series in Indiana Co.
W. G. Platt, Rep^t. H 4.
Shales, with thin bands of S. S., Freeport,
Coal, Bed D,
Clay, impure,
Limestone, ferriferous,
Limestone, good,
Johnstone cement
Richmond
Mahoning Sandstone near Salzburg
1. Surface.
2. S. S. Freeport, in part
3. Black slate.
4. Coal, bed D.
5. Clay,
Johnstown cement bed.
6. Cement limestone.
7. Clay,
8. Limestone,
9. Clay,
10. Limestone,
11. Clay,
12. Limestone,
13. Fireclay slate,
14. Coal, Gorman
Buck run
W. Slope of Chestnut Ridge
Round Top. Evans
Sandstone, Mahoning.
Shale,
Coal, F.U.C
Fireclay,
Fireclayshale,
Clay, with thin coal,
Freeport
Limestone,
limestone.
Penn Run
Ligonier Basin
Yellow Cr.
Conemaugh
1. Slate,
Cannel
2. Bony coal, cannel slate,
slate of D.
3. Coal, soft, friable,
4. Ferruginous slates and clay,

Red shale; red variagated massive limestone, 25 feet; red shaly limestone, 4 feet; grey limestone, 3 feet; red lime shales, 7 feet. The lower grey bed is here wanting and immediately underneath comes the Pocono sandstone. Thus we have here 39 feet of continuous lime rocks, but without the silicious limestone.

On analysis the lowest red limestone gave 52 carbonate of lime and 43 silica. The grey limestone gave 91 carbonate of lime, 6 silica; and looks exactly like the silicious limestone of the Conemaugh gaps.

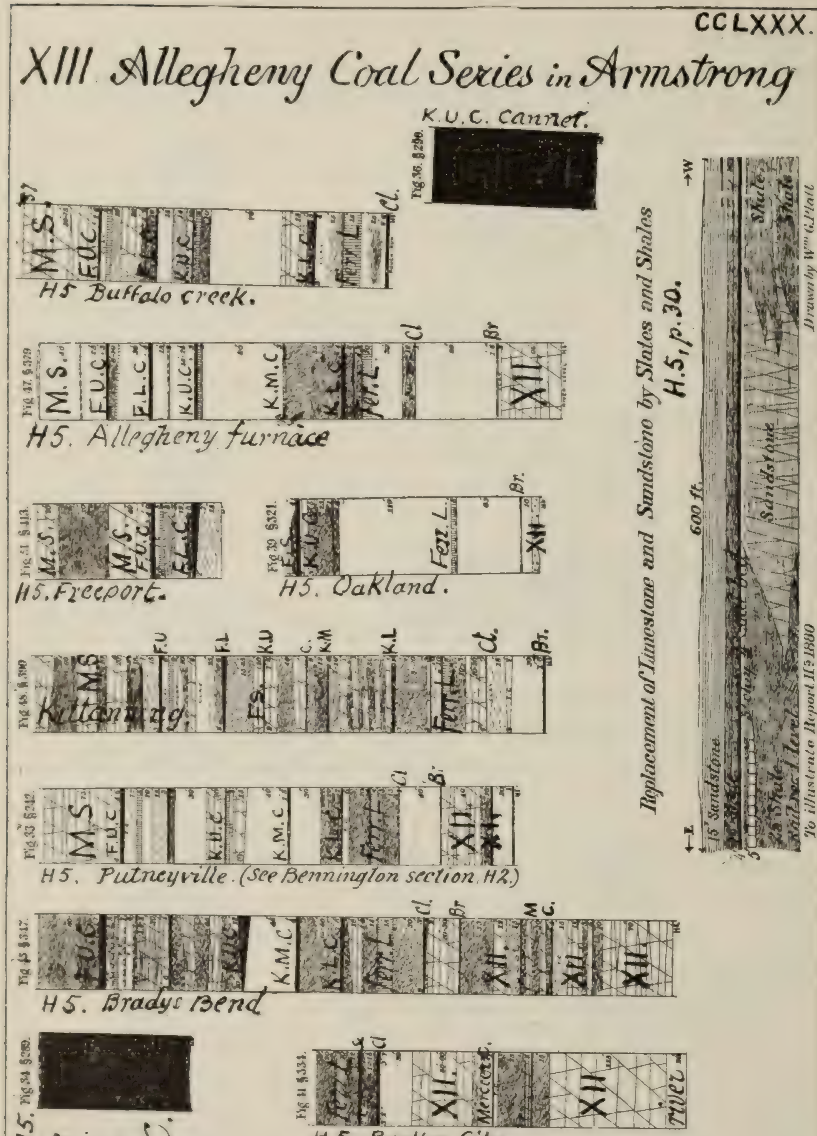
Fossils are rare, except in the form of ground up shells; but at Baker's quarry a species of *Straparollus* was recognized in a red brecciated limestone 30 feet up in the group. The general redness of these limestones show their affinity to the iron ore bearing lime beds over the silicious limestone of the Conemaugh gaps.

Manganese-iron ore deposits derived apparently from the dissolution of the limestone group occur at several places in Trough Creek Valley; nodules and nuggets of various sizes being scattered through a considerable mass of clay and trash. But the limestone beds themselves are not visible at any place where the ore clays have been opened, as at the large mines of Paradise Furnace, making good castings. McCreath's analysis of a sample of 110 pieces showed metallic iron 23.65 and metallic manganese 19.68; phosphorus 0.458. In all cases the ore clays lie directly on the Pocono sandstones at the foot of the mountain, (T3, page 76).*

Silicious Limestone in Lycoming county.

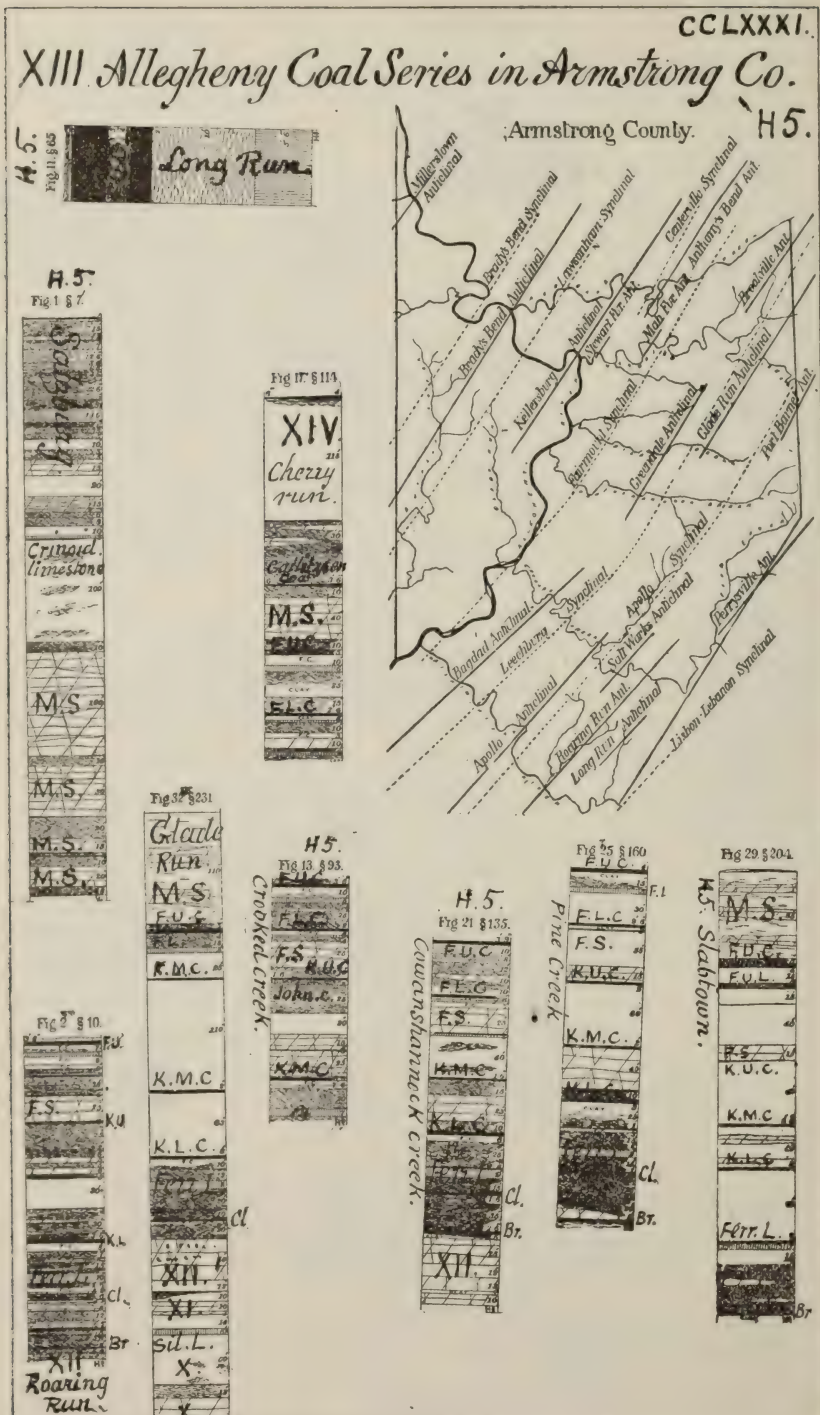
In Lycoming county the silicious limestone at the base of the Red Shale XI and top of the Pocono X has been

*Mr. John Fulton reports two layers of *oxide of manganese* (60 %) 18″ and 6″ thick under a yellow swash clay, 2′, under surface clay, 5′, in Ground Hog valley, Huntingdon county, at Lowry and Eschelberger's quarry. The east side of the quarry is a slope of upper layers of Pocono sandstone No. X. The west side is a face of 6′ brown hematite iron ore mixed with manganic oxide; over which lies a 3′ red shale (Mauch Chunk No. XI), and over this swash clay with a streak of manganese ore, 18″ thick (see sketch). The whole ore bed is mixed with manganese. Analysis showed iron, 39.22, manganese 10.56; phosphorus 0.6; (personal letter, Feb. 7, 1876).


CCLXXX.
XIII Allegheny Coal Series in Armstrong
K.U.C. Cannel.
H5 Buffalo creek.
H5. Allegheny furnace
H5. Freeport.
H5. Oakland.
Kittanning.
H5. Putneyville. (See Bennington section, H2.)
H5. Bradys Bend
H5. Parker City.
H5. Mahoning creek.
H5. New Bethlehem. Red Bank creek
Replacement of Limestone and Sandstone by Slates and Shales
H.5, p. 30.
600 ft.
Sandstone
Shale
To illustrate Report H5 1880
Drawn by Wm G. Platt
Bostonia, H5.
New Salem, or Little Mud lick, cannel
Kittanning Upper C.

traced by Mr. Abram Meyer, as already mentioned, for many miles over the highland, occupying isolated circular or elongated tracts of country, as shown by page map CCXX (E). The whole Mauch Chunk red shale formation he makes 353 feet thick in three divisions. The upper shales from 10 to 150 feet, the middle limestones from 50 to 75 and the lower shales from 80 to 120. His complete section on Hogeland run in 1885 will be given in the Chapter on No. XI. Here I will only describe the silicious limestone which does not lie in this region directly upon well characterized Pocono rocks, but about 80 feet above them, or even more. The limestone is divided into an upper oolitic mass of layers from 3 to 12 inches thick, aggregating 10 feet. The middle division is a single massive silicious limestone in one solid layer 15 or 20 feet thick. The lower division is made up of many flaggy layers of oolitic calcareous limestone, 1 to 3 inches thick, aggregating 12 feet.

On the main Hogeland run, about 6 miles N. W. from Cogan's Station, N. C. R R., 1600 feet A. T., and 500 feet above the stream, runs a bold ledge of rocks called Coogler's Point, formerly considered an outlier of the Monkey Ledge of the Blossburg coal basin by explorers for coal in this locality. Mr. Meyer finding nodules of very pure pearl-grey limestone was led to the discovery that the entire ledge was of limestone, and noticed 17 changes of rock in a thickness of 60 feet. He traced the horizontal outcrop 3 miles, finding the top member made up of two solid layers, each one foot thick, and a third massive 10 foot bed of grey lime paste, containing concretions of fine or crystallized pearl-grey limestones, the nodules varying from one inch in diameter to masses 6 inches in diameter, and even 12 inches long. In some places the structure is oolitic, a proof that it contains minute fragments of bryozoa. Under this is a series of calcareous and sometimes quite siliceous thin layers, one of them reddish and full of crystals of calcite, suggesting encrinal discs. Under this a more massive layer. Then a yellow ferruginous bed 15 inches to 2 feet, taking a very fine finish as a marble, being in places full of calcite encrinal discs. Below this the beds are greenish,

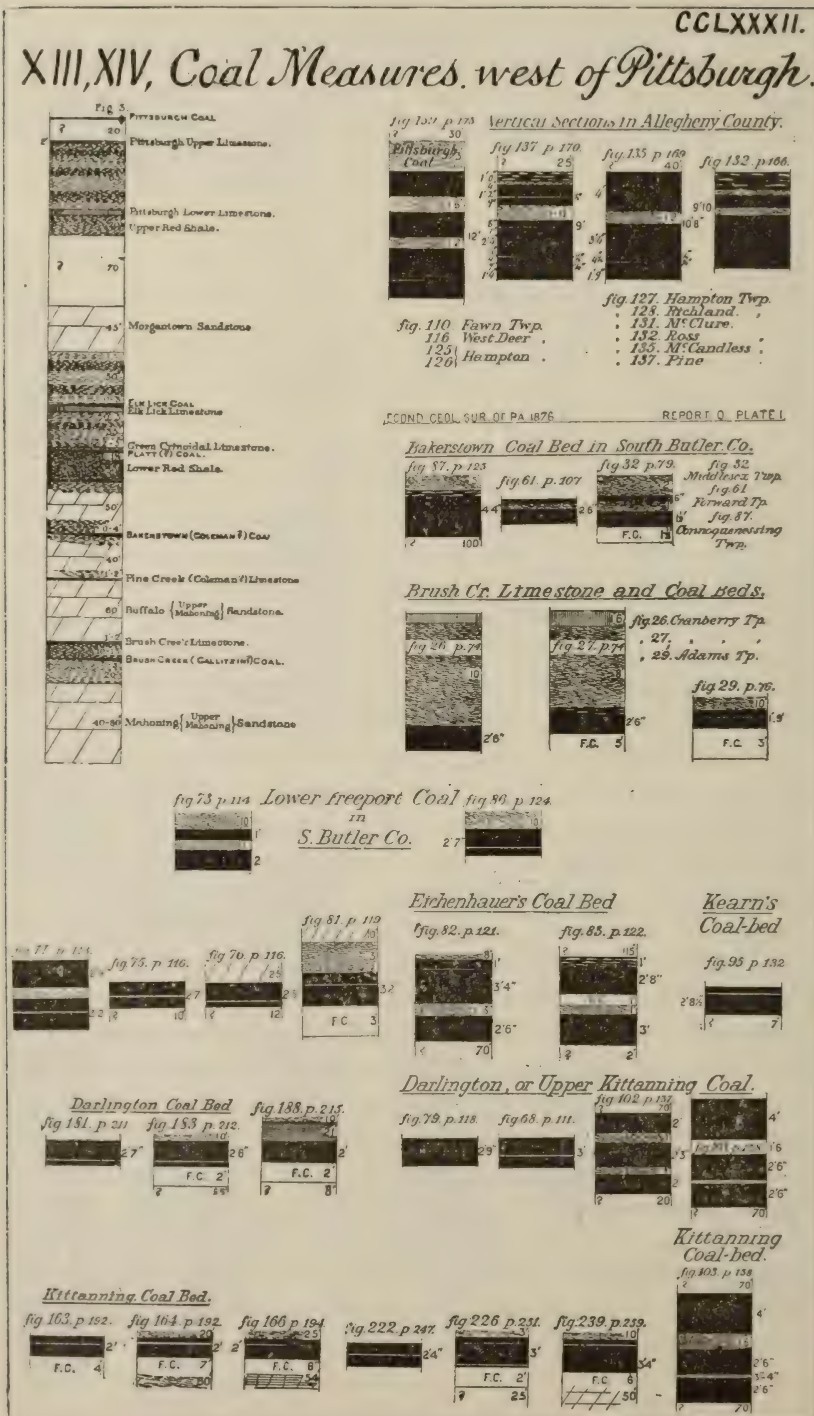

CCLXXXI.
XIII Allegheny Coal Series in Armstrong Co.
H5.
Armstrong County.
Long Run
Fig 11 § 65
Fig 1 § 7
Crinoid limestone
M.S.
Fig 17 § 114
XIV
Cherry run.
M.S.
F.L.C.
Fig 32 § 231
Glade Run
K.M.C.
K.L.C.
Cl
XII
XI
Sil. L.
X.
Fig 13 § 93
Crooked creek.
F.L.C.
F.S.
John.c.
K.M.C.
Fig 21 § 135
Cowanshannock creek.
F.U.C
F.L.C
F.S.
Cl.
Br.
XII
Fig 25 § 160
Pine Creek
F.U.C.
F.L.C.
F.S.
K.U.C.
K.M.C.
Cl.
Br.
Fig 29 § 204
Slabtown.
M.S.
F.U.L.
F.S.
K.U.C.
K.M.C
Ferr. L.
Br
Fig 2 § 10
F.S.
Cl.
Br
XII
Roaring Run.
Millerstown Anticlinal
Brady's Bend Synclinal
Brady's Bend Anticlinal
Lawsonham Synclinal
Kellersburg Anticlinal
Stewart Pt. Ant.
Centerville Synclinal
Anthony's Bend Ant.
Mah. Fur. Ant.
Brookville Ant.
Glade Run Anticlinal
Fort Barnet Ant.
Greendale Anticlinal
Fairmount Synclinal
Bagdad Anticlinal
Leechburg Synclinal
Apollo Synclinal
Salt Works Anticlinal
Perrysville Ant.
Apollo Anticlinal
Roaring Run Ant.
Long Run Anticlinal
Lisbon-Lebanon Synclinal

massive and oolitic. One in 6 to 12 inch layers; one of 15 to 20 feet underlaid with oolitic flags 1½ to 3 inches thick, some of them quite silicious. This whole limestone formation lies upon red shale, dipping 5° S. W. on Coal Run.

Chapter CXV.

XI. Mauch Chunk Red Shale.

The Umbral of H. D. Rogers' Geology of Pennsylvania 1858, and formation No. XI of the various reports of the Second Geological Survey is certainly one of the most remarkable formations of Pennsylvania or, indeed, of any part of the world. Its color, its immense thickness to the southeast and its fading out to the northwest and west, the scarcity of remains of animal or vegetable life characterizing it, the presence of beds of limestone and iron ore, and even coal in districts of the State where it has but little thickness, and its apparent change into the great sub-carboniferous or rather lower carboniferous limestones of the Southern and western States with a complete loss of its characteristic red color, are all features in its history claiming the admiring interest of the geologist. It is astonishing to see the great green and grey cross bedded sandstone of the Pocono age immediately followed by an equally great thickness of fine red and reddish muds deposited in layers sometimes as thin as paper, sometimes mixed with fine red sand, and showing so extreme a shallowness of the water that the foot tracks of lizards, raindrops and shrinkage tracks produced by the heat of the sun have been retained between the layers. This shallowing of the sea along what was undoubtedly a broad and low-lying shore receives additional


CCLXXXII.
XIII, XIV, Coal Measures. west of Pittsburgh.
Fig 3.
Pittsburgh Coal
Pittsburgh Upper Limestone.
Pittsburgh Lower Limestone.
Upper Red Shale.
Morgantown Sandstone
Elk Lick Coal
Elk Lick Limestone
Green Crinoidal Limestone.
Platt (?) Coal.
Lower Red Shale.
Bakerstown (Coleman ?) Coal
Pine Creek (Coleman ?) Limestone
Buffalo {Upper Mahoning} Sandstone.
Brush Creek Limestone.
Brush Creek (Gallitzin?) Coal.
Mahoning {Upper Mahoning} Sandstone
Vertical Sections in Allegheny County.
Pittsburgh Coal
fig 137 p 170.
fig 135 p 169
fig 132 p 166.
fig. 110 Fawn Twp.
116 West Deer
125, 126 Hampton
fig. 127. Hampton Twp.
128. Richland
131. McClure.
132. Ross
135. McCandless
137. Pine
SECOND GEOL. SUR. OF PA 1876 REPORT Q PLATE I.
Bakerstown Coal Bed in South Butler Co.
fig 87. p 123
fig. 61. p. 107
fig 32 p. 79.
fig 32 Middlesex Twp.
fig 61 Forward Tp.
fig 87. Connoquenessing Twp.
F.C.
Brush Cr. Limestone and Coal Beds.
fig 26 p. 74
fig 27 p. 74
fig. 26. Cranberry Tp.
27.
29. Adams Tp.
fig 29. p. 76.
F.C.
fig 73 p 114
Lower Freeport Coal in S. Butler Co.
fig 86 p 124.
Eichenhauer's Coal Bed
Kearn's Coal-bed
fig 75. p. 116.
fig 70. p. 116.
fig 81. p 119
fig. 82. p. 121.
fig. 83. p. 122.
fig. 95 p 132
F C
Darlington, or Upper Kittanning Coal.
Darlington Coal Bed
fig 181. p 211
fig 183 p. 212.
fig 188. p. 215.
fig. 79. p. 118.
fig 68. p. 111.
fig 102 p 137
F.C.
Kittanning Coal-bed.
fig 103. p 138
Kittanning Coal Bed.
fig 163. p 192.
fig 164. p 192.
fig 166 p 194
fig 222. p 247.
fig 226 p. 251.
fig 239. p. 259.
F.C.

evidence from the occurrence of several small coal beds, and several small layers of iron ore at the top of the formation; the coal layers sometimes being consolidated into a thin workable coal bed; and the series of thin solid or nodular iron ore layers turning in places into solid beds of carbonate of iron, 4 feet thick, as at Ralston, Queen's Run, etc., or multiplied and made economically valuable for furnace use as on the west side of Chestnut Ridge in Fayette county.

The surprise of the field geologists is renewed by observing this great red shale formation immediately succeeded by the great basal conglomerate (Pottsville No. XII) of the lower productive coal measures. The transition from the finest red mud to the coarsest pudding stone, or gravel rock, is in all eastern Pennsylvania immediate and universal; and yet there are none of the usual marks of non-conformability; the sequence is perfectly parallel; no disturbance from folding or uplifting of the red shale before the laying down or coming in of the conglomerate is anywhere visible; and I can suggest, after many years of study, no explanation of the phenomenon. Others may be more successful; but up to the present moment I look upon this as one of the many unsolved problems in our geology, waiting not so much for more facts as for a shrewder and more fortunate suggestion. I think no one can doubt that the red shale was deposited on a broad shore-bordered lowland near the sea level, and in regions of its wide extent occupied by marshes, pools and lagoons on which the first true coal vegetation began to grow; and that in connection with this vegetation considerable deposits of carbonate of iron, or of limonite afterwards carbonized, were formed. Of course the water under such circumstances must have been still water, without cutting currents, and fed by rivers eroding low countries at a great distance; a state of things contrasting strongly with that prevalent in the preceding Pocono age, where large quantities of sand were widely distributed in apparently deep water by powerful currents; and still more flagrantly contrasted with the succeeding age in which vast quantities of rounded rocks, gravel and pebbles rolled


CCLXXXIII.
XIII, XIV, Allegheny Co. columnar sections
Vertical Sections in Allegheny County
XV. Monongahela series.
XIV. Pittsburgh series
XIV.
XIV.
Allegheny series. XIII.
XIII. Allegheny series.
Butler County.
Three Sections of the Lower Productive Coal Measures in Western Pennsylvania.
Fig. 7. Kittanning.
Fig. 8 N. Brighton
Fig. 9 Smith's Ferry
XIII.
Kittanning coal
Ferrifer. limestone
Pittsburgh C.
Morgantown massive Sandstone
Elk Lick C
Crinoidal L.
Bakerstown C
Pine Creek Lime:
Buffalo massive Sandstone
Brush Creek
Gallitzin C
Brush Cr. C
U. Freeport C
L. F. C. and L.
L. Freeport C
Lower Freeport C.
Darlington C.
Kittanning C
Ferriferous Limestone
Kittanning
Ferrif. Lime
Clarion Coal
fig. 137. p. 170
fig. 135. p. 169.
fig. 133. p. 167.
fig. 130 p. 164.
fig. 136 p. 169.
fig. 134 p. 168.
fig. 128 p. 163.
fig. 131. p. 165.
fig. 84 p. 123
fig. 85 p. 124
fig. 125 p. 158
fig. 110 p. 141.
fig. 72 p. 113
fig. 78. p. 117.
fig. 103 p. 138
fig. 102 p. 137.
fig. 104 p. 139
fig. 105 p. 139
fig. 50. p. 92

in water, were spread over an area almost equal to that of the northern and southern States.

The only case of non-conformability of XII upon XI which I ever saw was that of a notch about 2 feet wide with one vertical and the other sloping wall exposed on the bluff at the head of the second incline plane descending Solomon's Run, Luzerne county. Into the notch in the soft smooth red shale upper layer had collected a quantity of the first pebbles at the base of the conglomerate. It was a case of true but extremely local erosion. The complete cleanness of the exposed strata left no room to misinterpret the facts, but it stands alone in my experience of many years of field work along the outcrops of No. XI in the anthracite region.

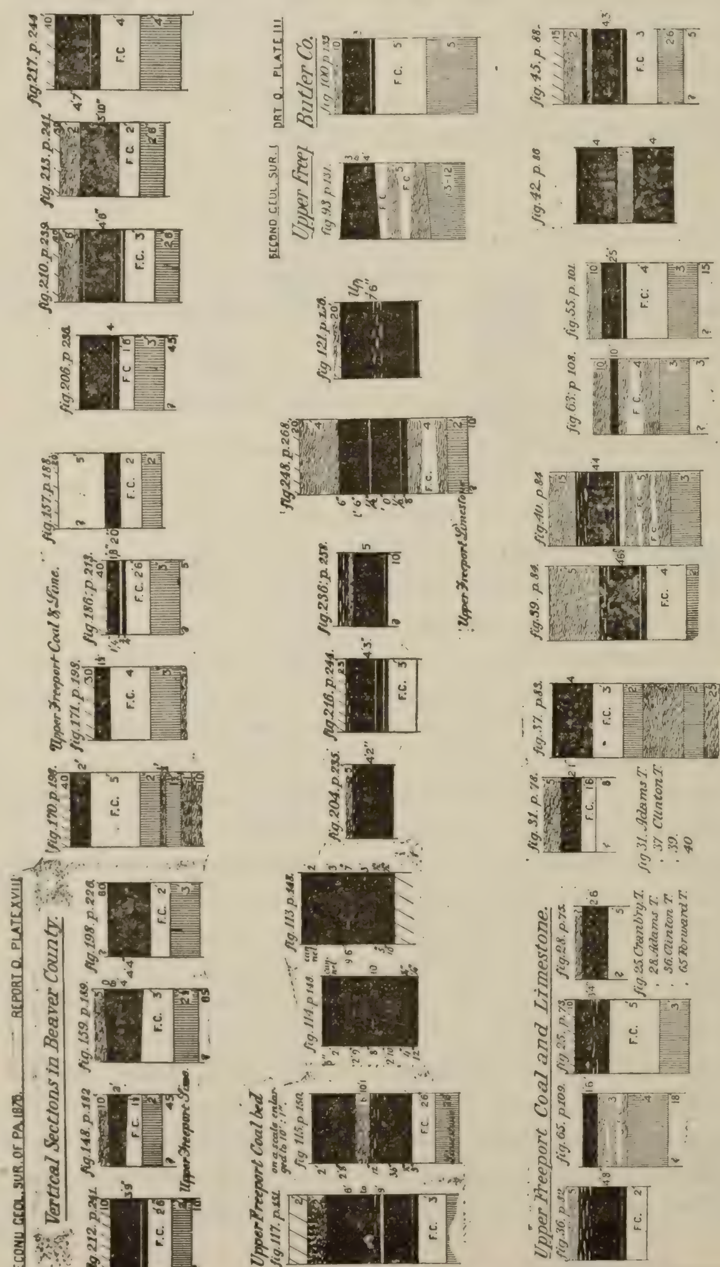
Outcrop geography of the Mauch Chunk.

The outcrops of the red shale surround the three anthracite coal fields. The southern field is not quite separated from the middle field by red shale, but nearly so. The eastern middle is entirely separated from the northern field; and the northern field from the first bituminous coal basin on the north or Allegheny Mountain.

The separate basins of the southern and middle fields have prongs of red shale running up between them to a greater or less distance both from the east and from the west. As the red shale formation is 2000 or 3000 feet thick on the south side of the southern field, and only 200 or 300 feet thick on the north side of the northern field,—and as the grand anticlinal throws the red shale into a vertical altitude on the south side of the southern field whereas the great anticlinal only elevates the red shale on a dip of 30° or 40° along the north edge of the northern field,—it is easily seen that the geographical shape and topographical form of the circle of outcrops change gradually from south to north. Beginning at Mauch Chunk the red shale valley walled in between the straight Pocono second mountain and Pottsville sharp mountain, runs with a depth of about 800 feet and a width of three-quarters of a mile perfectly smooth and straight from the Lehigh to the Little Schuylkill. Two

CCLXXXIV.

XIII. Freeport U. Coal. Variations in Butler, Beaver, and Allegheny.



small anticlinals here throw it to the south ; and then from the Devil's Hole it runs in a similar manner with vertical strata, smooth and straight, to the Schuylkill at Mount Carbon. It keeps on straight across the West Branch to the Swatara where it is deflected a little toward the south, and still runs straight to the Susquehanna above Harrisburg. On the west side of the Susquehanna it fills the cove. Turning the sharp western prong of the Sharp Mountain, it runs straight east northeast back to Tremont, and then bends sharply west again as the Wiconisco Valley to the Susquehanna ; on the west side of which in Perry county it makes the Buffalo cove. Here it turns the west end of the Wiconisco coal basin (or Bear Creek prong of the Pottsville fish tail) and runs E. N. E. to and up between the synclinal prongs of the Broad mountain coal basins. The north edge of which it borders for a good many miles east of Ashland, separating thus the southern from the western middle fields.

From Ashland it forms westward the valley of Mahanoy creek, and at the Susquehanna again turns around the western end of the Shamokin basin and runs east as a narrow deep red valley between the Big and Little mountains to the Catawissa. Here it enlarges into the Catawissa valley, and sends up small prongs between the coal basins of the eastern middle field. This wide expanse of the formation stretches east and west between the conglomerate and the Pocono Mountains on the west. The enlargement continues northward and eastward between the Nescopec mountain and the conglomerate mountains on the north edge of the eastern middle field. Isolated mountains of the conglomerate stand up from the surface of this Conyngham red shale valley, as it is called. The red shale keeps on eastward up the Lehigh headwaters and finally dies away on the upland.

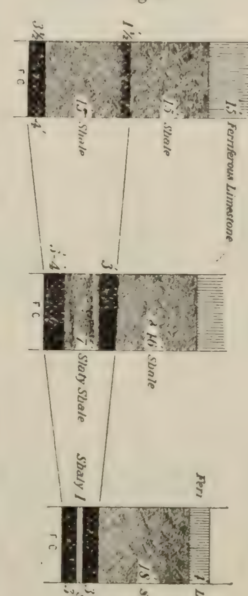
We have thus described three-quarters of the circuit of the red shale outcrop around the southern and middle fields. The eastern part remains to be described. At Mauch Chunk the red shale fills a cove east of the Lehigh similar to the cove in Perry county, known as the Ket-

CCLXXXV.

XIII. Allegheny Coal Series in N. Butler.

Diagram showing the Clarion Coal split into two Beds.

Fig 3

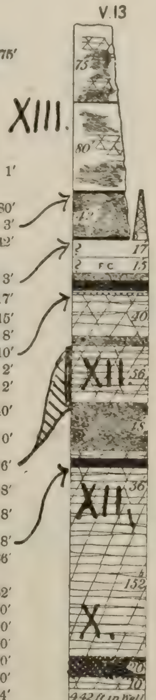


Lawrenceburg ← 2 miles → Bear Creek ← 1½ miles → Martinsburg.

Robert Allen Well Section.

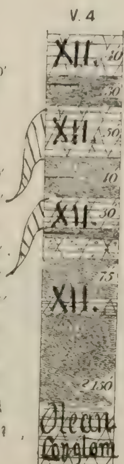
Sandstone and shale to summit,		75'
[The Freeport Upper Coal and Limestone should appear near the top of this interval, but no trace of them was seen on the road.]		
Freeport Lower Coal blossom,		1'
Shale and Slate with S. S. near middle,		80'
Kittanning Upper Coal,		3'
Sandy Shale,		12'
Kittanning Middle Coal, [Well mouth,]		3'
Well Record,	Conductor,	17'
	Fireclay?	15'
	Shale,	8'
[Kitt., Lower,]	Coal,	10'
	Fireclay,	2'
	Loadstone,	2'
[Ferr. Limeat base,]	White Sandstone,	40'
	Shale,	10'
[Homewood S. S.]	Black soft SS.	56'
[Mercer Group.]	Shale,	48'
	White soft S.S.	8'
[Mercer?] [?]	Coal,	8'
	Black S.S.,	36'
	Mountain Sand,	152'
	Shale,	20'
	Black S.S.	10'
Gas and oil,		660'
S.S. heavy flow of salt water,		1040' to 1090'
Depth of well,		1094'

V.13



Homewood Sandstone, [the Tionesta SS. and No. XII of the First Survey,] 10 to 70',	40'
Mercer Group, shales and slates carrying two coal beds and two beds of limestone, with fireclays, iron ores, etc., 10' to 60',	30'
Connoquenessing Upper SS.,	50'
Shale with a thin coal bed and iron ore, (Quakertown coal),	40'
Connoquenessing Lower SS.,	30'
Sharon Group—Sharon shales and coal bed,	10'
Sharon ("Ohio") Conglomerate and "Ferriferous" SS.,*	75'
Shale and Sandstone—Sharon lower sandstone* at base,	150'?
Cuyahoga Shale?	

V. 4



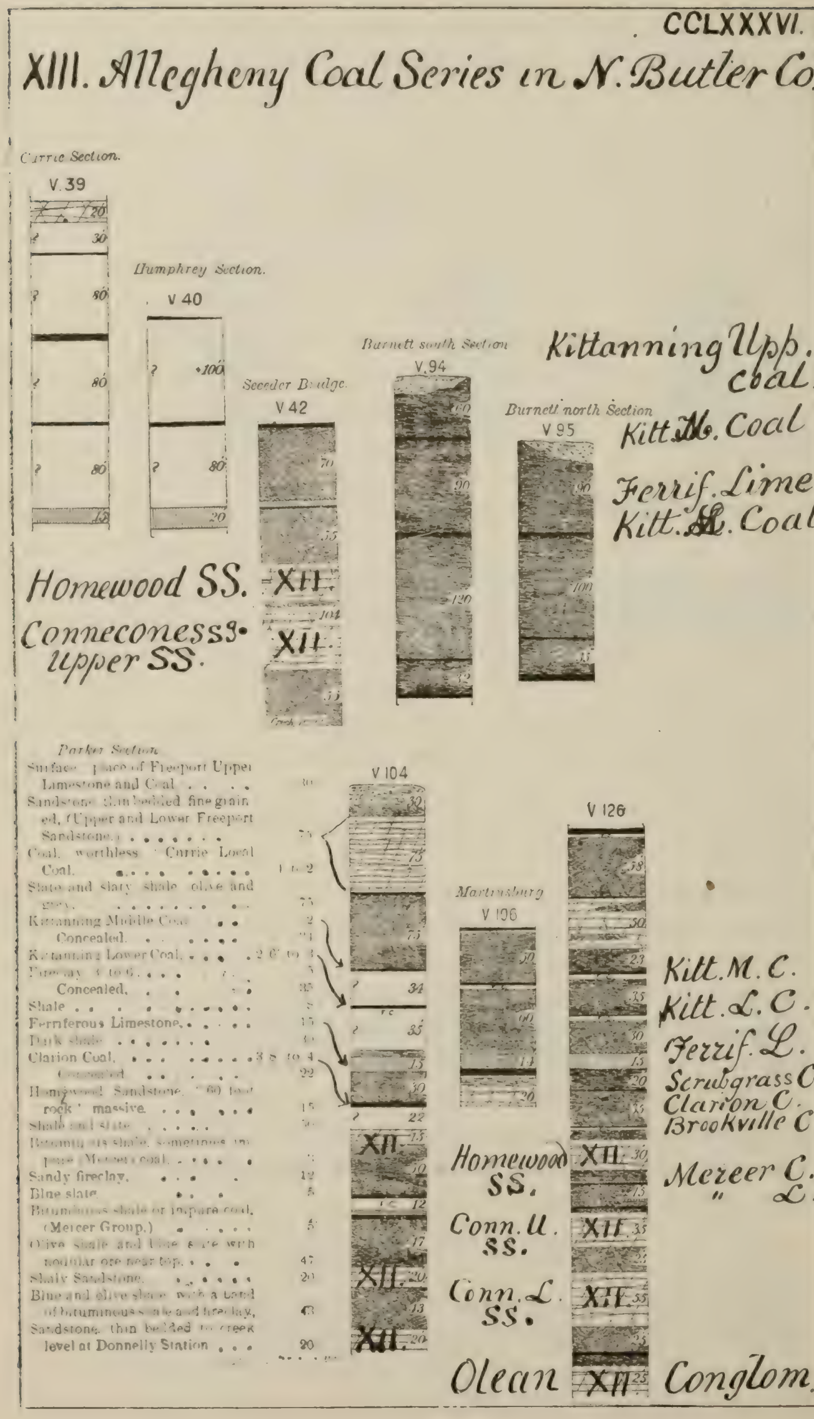
Beaver River series, No. XII.

tle. The red shale turns the eastern end of the southern field, the sharp pointed cliff known as Mt. Pisgah, and runs west between the Locust mountain and the Nesquehoning mountain to the Little Schuylkill. Here it broadens out and occupies the whole soil of Locust valley, sweeping around the west end of the Nesquehoning mountain and returning down the valley of Quakake creek to the Lehigh river. Here it spreads out and occupies the low hill country sending prongs up westward between the basins of the eastern middle field until it joins the east end of the Conyngham valley, and thus completes the circle of the two fields. Keeping in mind the boldly pronounced anticlinal and synclinal structure of the region and the great thickness of the formation it will not be surprising that on the crests of the larger and sharper anticlinal rolls No. XI should appear at the surface on the highlands between the several coal basins. The most striking case of this kind appears on the upland of the Broad mountain northeast of Pottsville, where a curious oval hole of great extent has been excavated through the conglomerate on one of the larger anticlinals, exposing in the flat bottom of the depression the upper beds of the red shale ; a stream drains this hole into Mill creek, and advantage has been taken of the situation to make a high reservoir dam of considerable size.

Having followed the outcrop of No. XI around the southern and middle anthracite fields where the formation is so thick as to make strong marks on the topography, I will now, before describing its outcrop around the northern field, give the measurements and descriptions of the formation along the Lehigh River where it can best be studied, and in order to show its relation to the overlying Pottsville conglomerate No. XII and to the underlying Pocono sandstone No. X, these will be added to the section at least in part.

XI at Mauch Chunk.

The following section was compiled by Mr. Winslow from measurements made from the summit of Mt. Pisgah along


CCLXXXVI.
XIII. Allegheny Coal Series in N. Butler Co.
Currie Section.
V. 39
Humphrey Section.
V 40
Seceder Bridge.
V 42
Burnett south Section
V. 94
Burnett north Section
V 95
Kittanning Upp. Coal.
Kitt. M. Coal
Ferrif. Lime
Kitt. L. Coal
Homewood SS.
Conneconess. Upper SS.
XII.
Parker Section
Limestone and Coal
Sandstone, thin bedded, fine grained, (Upper and Lower Freeport Sandstone.)
Coal, worthless (Currie Local Coal.)
Slate and slaty shale, olive and grey
Kittanning Middle Coal
Concealed.
Kittanning Lower Coal
Concealed.
Shale
Ferriferous Limestone.
Clarion Coal.
Homewood Sandstone, rock, massive
Sandy fireclay.
Blue slate
Bituminous shale or impure coal, (Mercer Group.)
nodular ore near top.
Shaly Sandstone.
Blue and olive slate with a band of bituminous shale and fireclay,
Sandstone, thin bedded to creek level at Donnelly Station
V 104
Martinsburg
V 106
V 126
Kitt. M. C.
Kitt. L. C.
Ferrif. L.
Scrubgrass C.
Clarion C.
Brookville C.
Mercer C.
" L.
Homewood SS.
Conn. U. SS.
Conn. L. SS.
Olean Conglom.

the Lehigh Valley Railroad, and along the Lehigh and Susquehanna Railroad to the Lehigh Canal :

Mt. Pisgah, Pottsville conglomerate and sandstone with shaly bands,	320
Red shale in the body of the conglomerate,	500
Lower conglomerate, with a green matrix, large quartz pebbles, the base of the cliffs of Mt. Pisgah,	120
No. XI red shale and sandstone,	1662
Sandstone, yellow and friable,	83
Red shale,	28
Chocolate colored and grey hard sandstone,	28
Shales, mostly concealed, 1000 ft. south of the Mauch Chunk Railroad Station,	367
Total thickness of No. XI, 2168 feet,	
Pocono No. X sandstone, hard and grey,	25
Grey sandstone and conglomerate, partly concealed,	309
Gray sandstone, hard,	46
Conglomerate with sandstone,	60
Dark shale and slate,	20
The rest of this section has already been given. The whole thickness of No. X being, according to Mr. Winslow,	1253 feet.

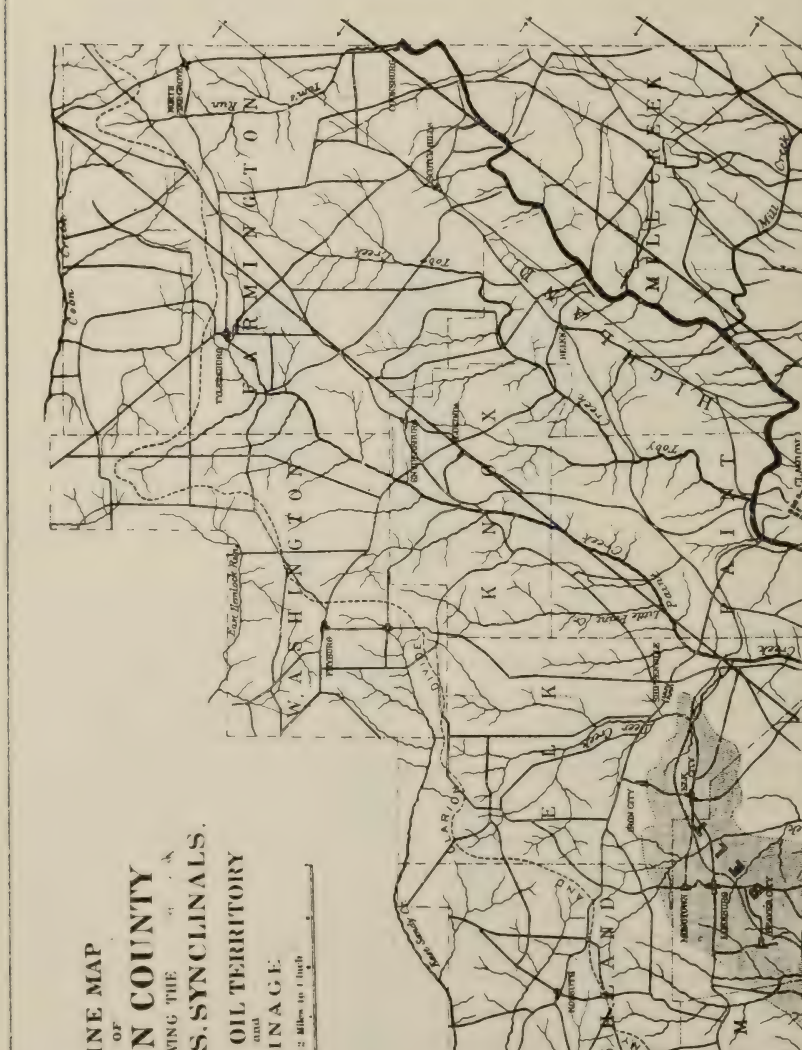
General Description.

On the opposite or eastern bank of the river along the Lehigh Valley Railroad, and on south dipping rocks, are seen the following section : Alternations hard and soft of red sandstone and shale along the river banks, measuring in all 1367 feet, under which partially concealed are red and green sandstones and shales as far as the Onoko tunnel, measuring 608 feet ; the total of No. XI here seen seems to be 1975 feet ; but the upper part of the formation has been eroded from that side of the river. The Pocono sandstone rises at the tunnel, grey, hard and silicious, 160 feet; then ith shale dark grey 118 feet ; then hard grey sandstone with quartz pebbles 305 feet ; and so on up the river with a total thickness of 1273 feet.

Where the Quakake creek comes to the river the red shale dipping 30° north reappears, but only the bottom red shale 66 feet thick, containing a mottled green calcareous layer. This rests on the Pocono, green, hard shale, 20 feet ; then grey silicious sandstone, 15 feet ; then green shales, 20 feet ; then greyish red sandstone, 10 feet ; then hard green-

CCLXXXVII.

XIII. Clarion Co. Coal Field. North part.



ish-grey sandstone, 40 feet; then hard gray silicious sandstone with pebbles, 146 feet, which is probably the Pocono conglomerate strata mentioned in the last section.

From Stony Creek along the Lehigh Valley Railroad northward No. XI is not seen, the uppermost stratum of the next section being a grey silicious Pocono conglomerate and sandstone 120 feet thick.

The same Pocono conglomerate, 126 feet, caps the next section from Drake's creek southward along the railroad.

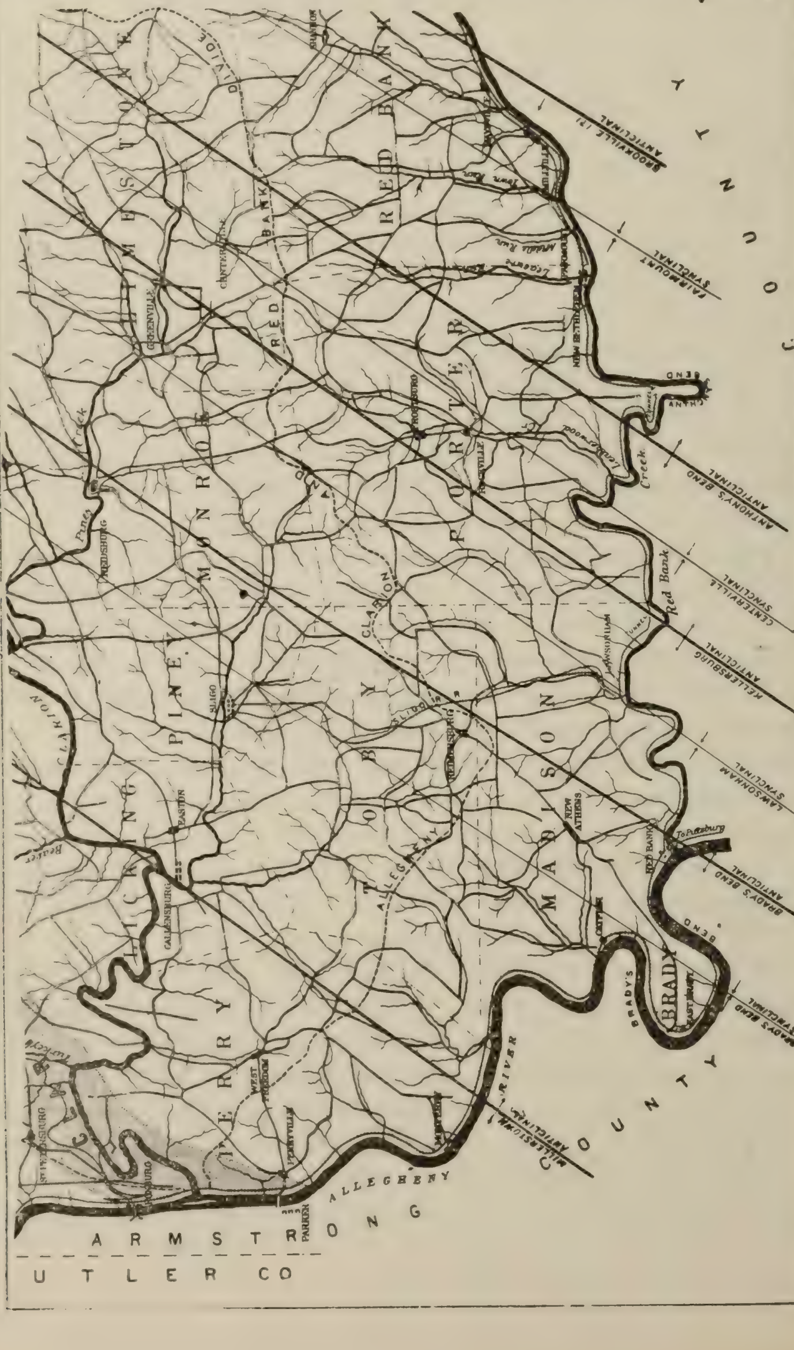
The lower part of XI appears below Leslie's run near the old canal lock, and the section reads: Red shale, 20; green fissile shale, 18; greenish-grey hard silicious sandstone, 10; green shale, 3; hard red shale, 10; bluish-red shale, 2; red fissile shale, 27; greenish-grey shaly sandstone, 25; yellowish-green shale, 10; red fissile shale, 15; green shale, 12½; red and green variagated shale, 12, underlaid by purplish-yellow shale and so forth. This is an example of the way the formation is built up.

From White Haven southward to the Lehigh Tannery a large thickness of No. XI dipping 10° to 15° northward is well exposed, thus: Red shale and sandstone, 173; red shale, partly concealed, 107; red shale and sandstone, 630; grey-green sandstone and conglomerate layers charged with pebbles of red shale, 50; red shale, 78; coarse red sandstone, with partings of green shale, 38; yellow ochery shale, 18; red shale, 19; red shale, much concealed, 70; lying on Pocono sandstone and conglomerate, grey and silicious, 100. To these 1183 feet of No. XI must be added 400 feet of unexposed measures at the top to carry the section up to the base of the conglomerate.

North of White Haven in Neleigh's cut are exhibited 619 feet of No. XI, thus: Chocolate red hard sandstone with shale, 465; concealed, 119; greenish-grey hard sandstone, 30; fine silicious rock containing red shale pebbles, under which appear hard white sandstone, at the middle of the big bend. The place of this section in the formation can only be suspected by the peculiar red shale pebble conglomerate which may be the same as that mentioned in the last section.

CCLXXXVIII.

XIII. Clarion Co. Coal Field. South part.

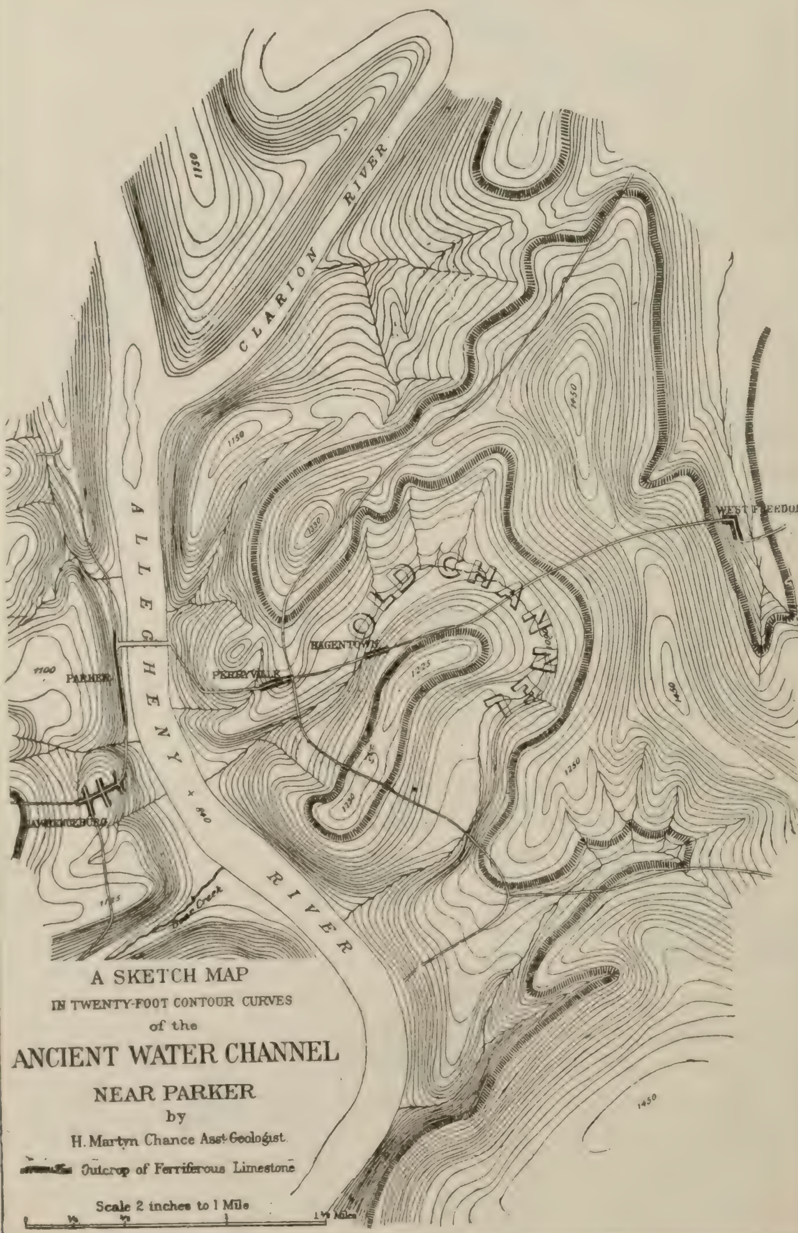


At Moose Head, Luzerne county, a section along the Lehigh Valley Railroad contains a similar rock, thus:—Grey silecious conglomerate, 20; grey sandstone, 4; conglomerate, 6; sandstone, 3; conglomerate, 3; sandstone, 7; grey sandstone with quartz pebbles and also red shale pebbles, 15; conglomerate containing slate pebbles and also large red shale fragments, 5; hard grey sandstone, 5; red shale with red ochre, 28; yellowish-green shale, 10; yellow ochre, 16; white ochre, 2. These two strata are mined at the anticlinal. The dip of all these rocks varies from 5° to 10° north. The total of the rocks here exposed is only 124 feet, and the place in formation can be suspected from the red shale pebble conglomerate. The red shale large fragments are a remarkable phenomenon, lending additional support to the hypothesis that the water was shallow, and that part of the formation had already been elevated and become subject to erosion. But this must have been at a considerable distance; might have been an island; must have been swept by currents; must have remained out of water long enough to have become consolidated and dried. At the same time there is no direct evidence of local erosion; and it is no more necessary that such red shale fragments when imbedded had acquired the consistency of rock than in the case of rough chunks of clay or coal which are known to have been in some cases torn from swamps, transported and redeposited at a greater or less distance in deposits of sand.

The sections given above are not available for even estimating the decline of thickness of the formation from its outcrop at Mauch Chunk northward. But after it rises northward on the slope of the Nescopec mountain and rides high in the air above the great Wapwallopen anticlinal (Montour's Ridge anticlinal), it descends northward over the Wyoming mountain and plunges nearly vertical down beneath the south bed of the northern field in Solomon's Gap, and in fact along the whole range of the mountain, separating its crest from the bold terrace of conglomerate half way down the slope; and here Winslow made his first section from Ashley colliery southward across the

CCLXXXIX.

XIII. Allegheny River Ancient channel. abandoned since the Ice Age.



mountain, getting the whole thickness of conglomerate No. XII 220 feet; Mauch Chunk No. XI, 1002 feet; Pocono No. X, 1177 feet, and 1656 feet of the underlying Catskill No. IX. I will give the upper part of this very satisfactory section, which commences at the top with the Red Ash coal bed, thus:

Red Ash coal bed of the northern field,	10 feet.
Broken slate,	14 "
No. XII sandstone hard, dark, compact,	14 "
Conglomerate, fine, silicious,	19 "
Slate, fissile,	2 "
Conglomerate,	24 "
Slate in separate seams,	1 "
Oonglomerate pretty silicious,	41 "
Conglomerate, coarsely silicious,	119 "
No. XI, red and green shale, with calcareous layers,	246 "
Brick red shale,	120 "
Sandstone, reddish-grey, with quartz pebbles and also red shale pebbles,	27 "
Shale and sandstone, red and massive,	335 "
Sandstone, reddish and greenish-grey, with fine quartz pebbles,	31 "
Brick red shale,	60 "
Sandstone, fine, greenish-grey, which might be just as well made the top layer of the Pocono as the bottom layer of the Mauch Chunk,	183 "
No. XI sandstone, white, coarse, silicious,	283 "
Conglomerate, fine quartz pebbles,	3 "
Sandstone, greenish-grey, hard,	3 "
Conglomerate, pinkish-white, small quartz pebbles,	32 "
Sandstone, white made coarse with pebbles,	40 "
Sandstone, yellowish-brown, fissile and friable,	38 "
Sandstone, greenish, hard,	44 "
Sandstone, grey, hard, with pebbles,	57 "
Sandstone, greenish-grey, hard, with conglomerate layers,	256 "
Sandstone, greenish, fractured and shaly,	143 "
Conglomerate, soft and slate with sandstone pebbles,	3 "
Sandstone, hard, greenish, much fractured, containing occasionally slate pebbles,	112 "
Sandstone, greenish-grey	163 "

Under this section come the bright red, green and grey shales and sandstones considered as the top of the Catskill series No. IX. One value of such a section is the proof it gives of the perfect conformability and essential homogeneity of all these sub-carboniferous and Devonian formations. Not a trace of non-conformability or evidence of

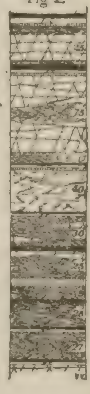
CCLXXXX.

XIII. Allegheny Coal Series in Clarion Co.

Generalized Section of the Productive Coal Measures in Clarion county. VV.

Freeport Upper coal,	4
Fireclay,	5'
Freeport Upper limestone,	3
Shale with ore,	8'
Freeport Upper sandstone,	23'
Shale,	5'
Freeport Lower coal,	6'
Fireclay,	2'
Freeport Lower limestone,	3'
Freeport Lower sandstone, with shale,	75'
Shale,	10'
Kittanning Upper coal,	2'
Fireclay or shale,	3'
Johnstown cement bed (limestone,)	2'
Shaly measures,	40'
Kittanning Middle coal,	2'
Fireclay	2'
Shale with some sandstone,	30'
Kittanning Lower coal,	4'
Sandstone and shale with ore balls,	25'
Ore.—carbonate of iron,	1
Ferriferous limestone,	8'
Shale,	7'
Clarion Upper coal,	2'
Slaty shale,	23'
Clarion Lower coal,	3'
Fireclay,	2'
Shale, sometimes sandstone,	27
Brookville coal,	2'
Fireclay,	5'
Homewood sandstone	

Fig 2.



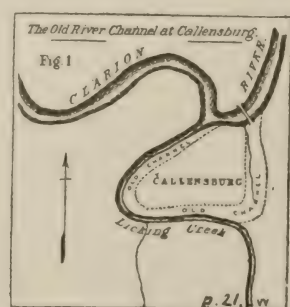
Freeport Group.

Fig 3. enlarged.

Fig. 7. enlarged.

The Old River Channel at Callensburg.

Fig. 1



Clarion Group. VV 31

Fig. 12. enlarged

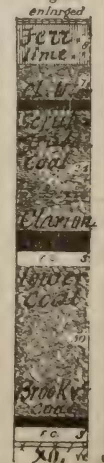
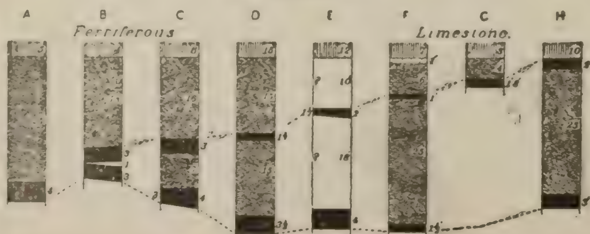


Diagram showing the Clarion Coal split into two Beds by H. Martyn Chance



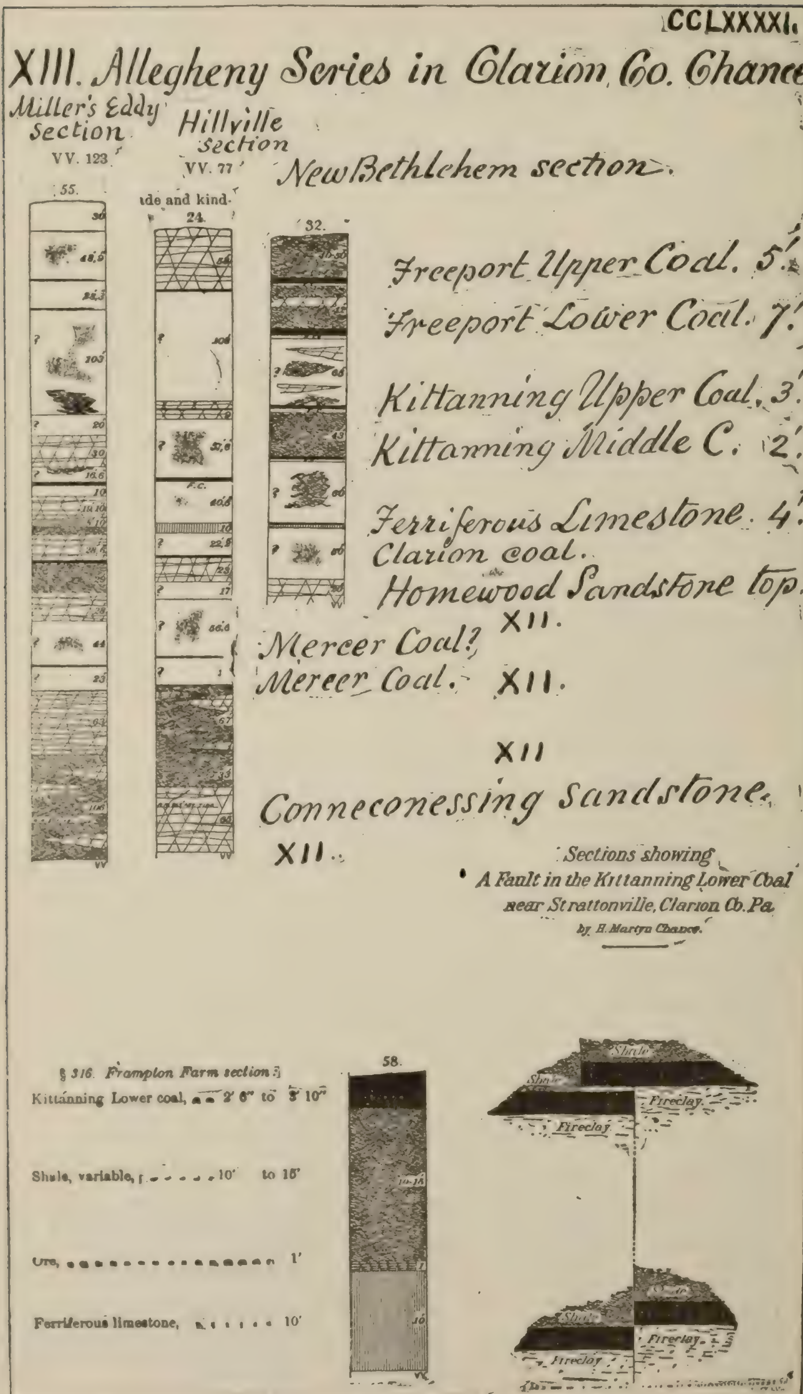
elevation and erosion anywhere in the immediate region of the section can be detected. All the dips are conformable, and the alternations of argillaceous and silicious layers, large and small, are really of the same order ; the principal feature of difference being the color ; and the principal division planes being the coarser sandstone and conglomerate layers.

The feature of most interest in this section is the appearance of limestone at the top of the Mauch Chunk in the shape of calcareous bands in the 246 feet of red and green shales just under the conglomerate. Of this more will be said hereafter.

Comparing this section with the one at Mauch Chunk, it is evident that No. XI has diminished in thickness northward more than one-half ; that is, from 2168 feet at Mauch Chunk to 1002 feet in the Wyoming mountain. We will see that this decrease goes on northward with accelerated speed, and that when the formation after passing beneath the northern coal field rises in the Shickshinny monntain it has diminished to 150′. See G 7, page 44.

Mauch Chunk Red Shale around the Northern Field.

Around the western half of the Wyoming Basin No. XI, retaining a considerable thickness, makes a topography somewhat similar to that of its outcrop around the middle and southern fields, but around the eastern half of the basin it has become so thin that it makes no distinct valley between the Pocono under it against which it leans, and the conglomerate over it, but merely a terrace by which its presence is marked, the outcrop of the conglomerate projecting from the mountain in a low ridge cut through by the small affluents of the Lackawanna, the head waters of which affluents form small double ravines in the red shale before they break through the conglomerate down into the open valley, very much in the style of the double headed ravine of the Kishacoquillas Valley already described in the chapters on No. IV. In this case the conglomerate plays the part of the lower Medina sandstone with the important distinction that in this case the dip is towards the valley,

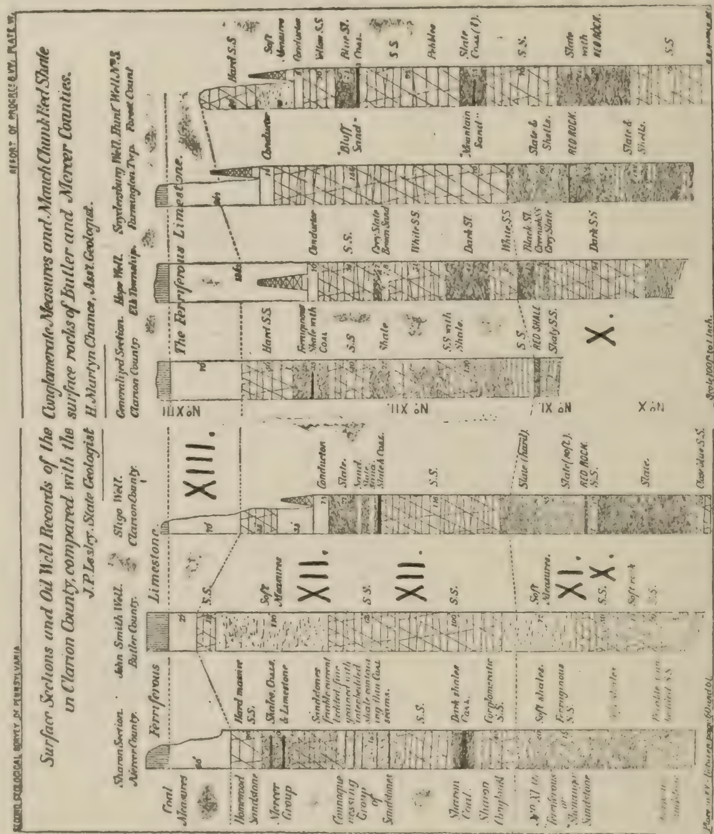

CCLXXXXI.
XIII. Allegheny Series in Clarion Co. Chance
Miller's Eddy Section
VV. 123
Hillville section
VV. 77
New Bethlehem section.
55.
ide and kind
24.
32.
Freeport Upper Coal. 5'.
Freeport Lower Coal. 7'.
Kittanning Upper Coal. 3'.
Kittanning Middle C. 2'.
Ferriferous Limestone. 4'.
Clarion coal.
Homewood Sandstone top.
XII.
Mercer Coal?
Mercer Coal.
XII.
XII
Conneconessing Sandstone.
XII.
Sections showing
A Fault in the Kittanning Lower Coal
near Strattonville, Clarion Co. Pa.
by H. Martyn Chance.
§ 316. Frampton Farm section.
Kittanning Lower coal, 2' 6" to 3' 10"
Shale, variable, 10' to 15'
Ore, 1'
Ferriferous limestone, 10'
58.
Shale
Fireclay

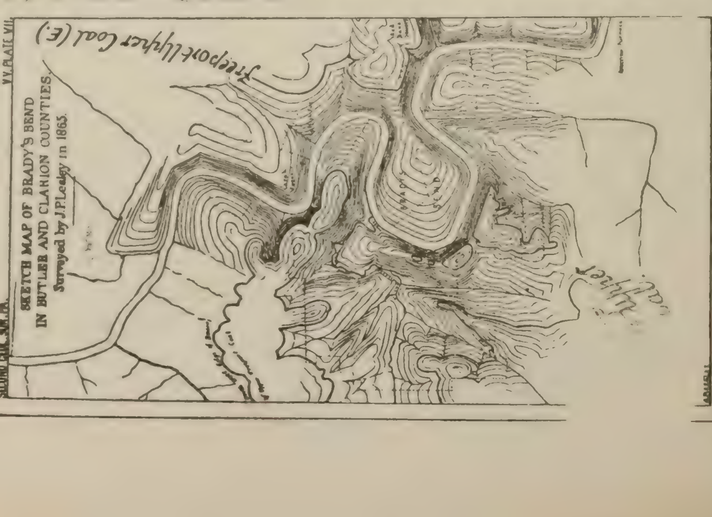
and in the other case the dip is away from the valley into the mountain, the Wyoming basin being a synclinal and the Kishacoquillas valley being an anticlinal.

From Solomon's gap where No. XI is said by Rogers to be 569 feet thick westward to the Susquehanna Gap below Shickshinny the terrace of XI gradually widens and deepens until it becomes a curious picturesque ravine, with vertical walls of red shale, gradually descending to the level of the river; a place well worth the visit of the landscape artist. On the opposite or northern side of the basin, the Susquehanna, which enters the valley through the gap at Pittston and then flows west through it past Wilks-Barre and Plymouth to Nanticoke, turns again, cuts through the conglomerate and then flows on west in the red shale which is at Nanticoke said by Rogers to be about 400 feet thick, so far as its middle and upper portions are visible, all soft, calcareous red shale and red sandstone with an upper division of thin-bedded grey sandstone, alternating with olive colored shales, capped by a sort of honestone beds. The lower division being concealed by the river, and the total thickness of the formation estimated at only about 400 feet. This long straight, solitary, picturesque valley has for its south wall extremely steep cliffs of red shale, capped by the conglomerate, all dipping gently southward beneath the basin. From the other or northern bank of the river rises the long rather gentle slope of the Shickshinny mountain, containing the Pocono rocks, which pass down southward beneath the red shale in the bed of the river. When the river reaches Shickshinny gap through which the Shickshinny creek enters it, and where the whole structure of all three formations and their relation to each other is plainly visible, the river makes a right angle bend southward across the west end of the basin, leaving on its western side a high outlying hill of the conglomerate, around which the red shale outcrops sweep, and ascend the narrow cove, long and sharp, but in all other respects exactly similar to the shorter and more rounded red shale coves in Perry county. In these two gaps, that of Shickshinny mountain and that of Wyoming mountain, the red shale makes good

CCLXXXXII.

XIII. Allegheny Coal Series in Clarion Co.





exposures, and has been measured with some degree of accuracy. But from this point onward the river across the Wapwallopen valley and down past Berwick, Bloomsburg, Danville, Sunbury and Selinsgrove, does not touch or cut the formation until it reaches the western end of the western field in southern Northumberland county. Prof. White in his report on this region G.7, page 44, says the red shales which characterize the Mauch Chunk thin out northeastward and disappear entirely along the northern rim of the Lackawanna basin before reaching Pittston, leaving only 150 feet of greenish shales and flaggy sandstone, which might with lithological propriety be considered the top of the Pocono, for not a trace of red shale can be found in these 150 feet. He places them at the bottom of XI because where the red shales make their first appearance 3 or 4 miles southwest of Campbell's ledge in the Pittston gap they do not come in as a mass on the top of the green-grey beds, but interleave with them as knife edges, and many of the green layers change gradually into red layers as we observe them in the ravines and river cliffs on the way west to Shickshinny. Another reason is that the massive yellowish sandstone which underlies the green beds at Campbell's ledge appears as the top of the Pocono in the more eastern parts of the district.

The green beds going east gradually diminish without a single red layer in them to a thickness of 75 feet only at Leggett's gap above Scranton. The same eastward thinning away of the formation is seen in the Wyoming mountain on the south side of the Lackawana basin, as he describes in his Report G5.

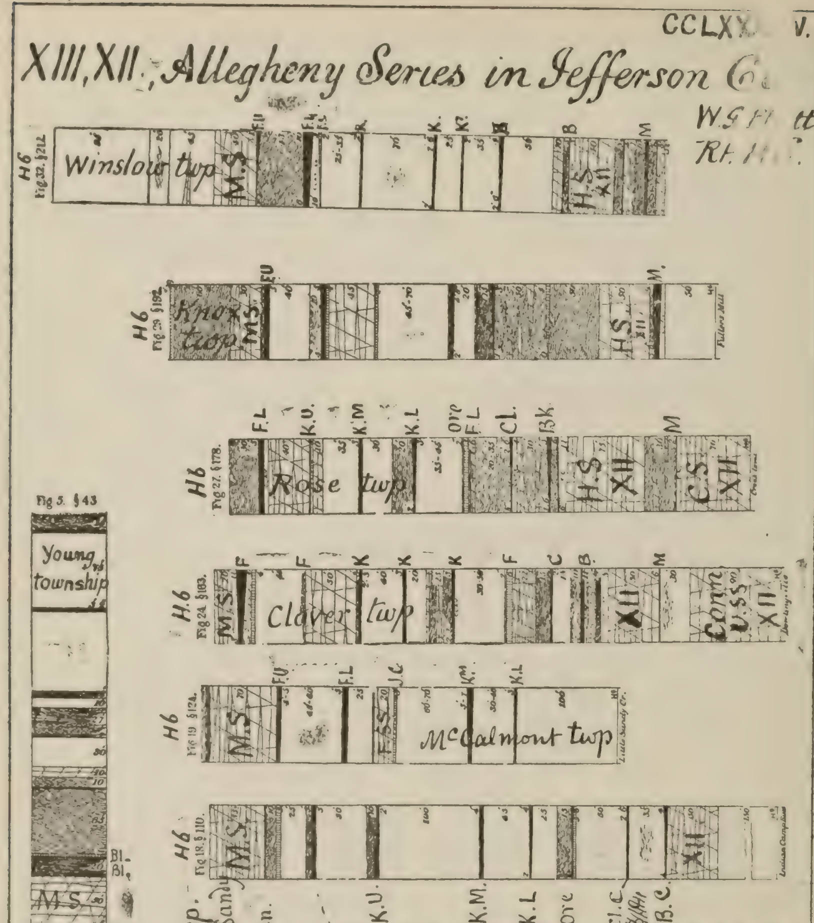
Going west from Campbell's ledge in the Pittston gap the red beds are seen coming in at the gaps of Abraham and Toby creeks in Kingston township. At the Nanticoke gap, 14 miles west from the Pittston gap, he gives the following section: Pottsville conglomerate, massive; shales, drab, sandy, 4 feet; black slate and coaly shales, the fossiliferous formation under the rocks of Campbell's ledge, 10 feet; whitish sandstone, the base of No. XII, 3 feet;—No. XI, green shale, 10; sandstone, green, flaggy, 100; green shales,


CCLXXXIII.
XIII. Allegheny Series in Jefferson Co H6.
Brookwayville.
H6.
H6.
F.L.C
K.U.C
F.S
F.L
H.S.
XII.
Freeport coal
Lagoon channel
Conn. U. SS. XII
Fire clay
Freeport Upper Coal.
Sections of beds
at various mines
in Jefferson Co.
F.U.C.
Freeport Lower Coal.
F.L.C.
Freeport Lower Coal
Kittanning Middle Coal.
Kittanning Lower C.
K.M.C.
K.L.C.
Brookville Coal.
Mercer Upper C. in XII.
B.C.
M.U.C.

sandy, interleaved with red, 100 ; red shale, sandy, 216 ; total, 425 ; No. X Pocono sandstone.

The thickening of No. XI from Nanticoke to Shickshinny Gap, only 8 miles west of Nanticoke, is extraordinarily rapid, at a rate of nearly 100 feet to the mile. For on the south side of the basin in the gap of the Wyoming mountain the measured thickness is about 1200 feet ; thus :— No. XII, base visible, 50 ; concealed, 50 ; sandstone, green, pebbly, 40 ; sandstone, shaly ; green, reddish, 100 ; sandstone, greenish-gray, pebbly, 40 ; red shale, 700 ; concealed, 500 ; massive conglomerate, Pocono No. X, visible in the railroad cut 1 mile below Shickshinny, 150 ; The total of the strata considered as belonging to No. XI, beginning at the top somewhere in the concealed interval of 50 feet and ending somewhere in the middle of the concealed interval of 500 feet must be somewhere between 1000 and 1200 feet thick.

The Pocono conglomerate visible in the railroad cut here 1 mile below Shickshinny dips 65° N. 10 W., and the section is therefore easily measureable, but its thickness strikes one with surprise from the fact that on the north side of the basin not 2 miles distant in the Shickshinny Mountain No. XI is scarcely half so thick. The formation therefore not only thins away eastward but northward, with singular rapidity, and when it comes down again on the northern side of the great anticlinal into the North or Allegheny mountain in Wyoming county near its summit, it has dwindled to only 100 or 200 feet, and so continues exceedingly thin to the New York State line. It is no wonder, therefore, that from all northeastern Pennsylvania ; that is, Susquehanna and Wayne, its erosion has been so easy as to be quite complete. But when we consider the great thickness at Mauch Chunk and in the Kettle it requires a strong imagination to picture the removal of so great a mass from the uplands of Monroe and Pike counties ; although it is next to certain that the formation originally was also much thinner in the direction of the Catskill mountains of New York, from which it has entirely disappeared. The increase in thickness westward from the Lehigh at Mauch Chunk to

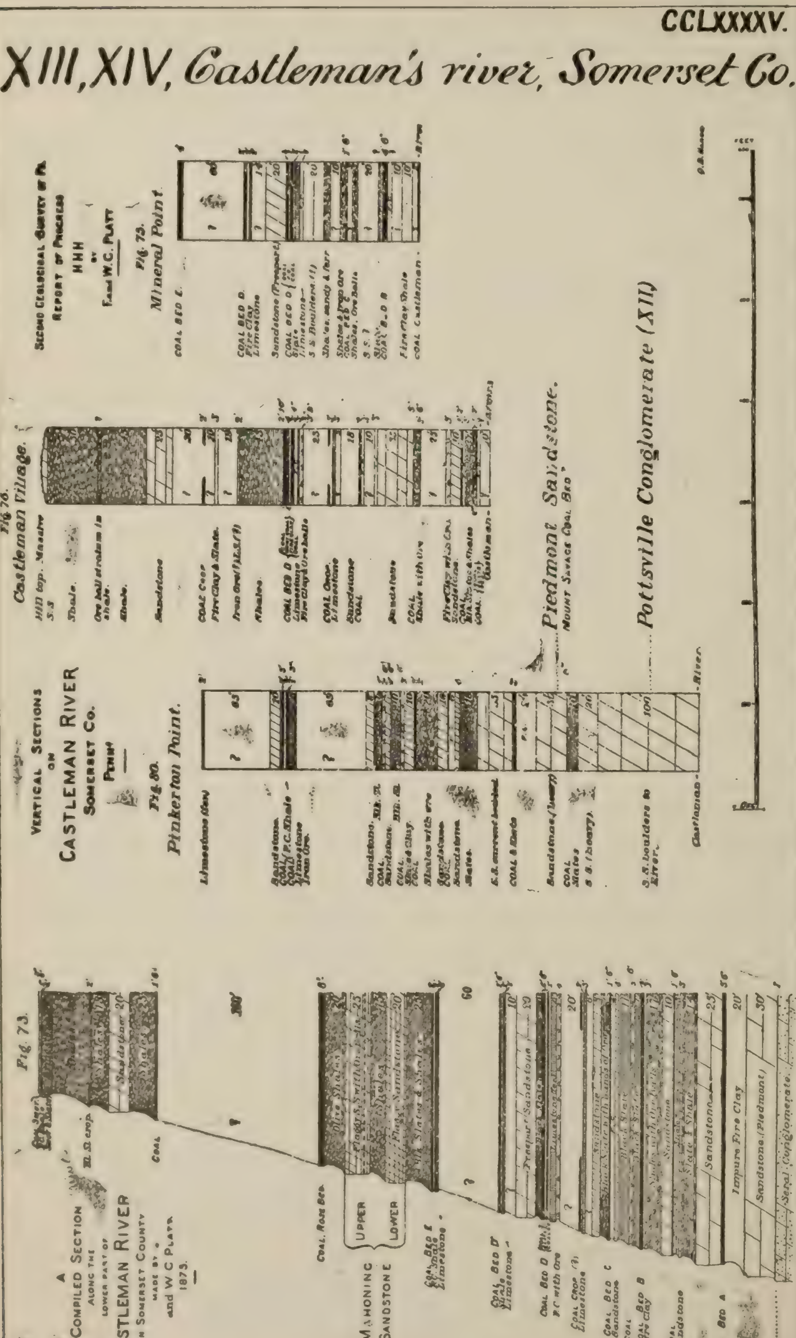


CCLXX V.
XIII, XII; Allegheny Series in Jefferson Co.
Winslow twp
Knox twp
Rose twp
Clover twp
McCalmont twp
Ringold twp.
Little Sandy
Big Run.
Young township
Perrysville.

the Schuylkill at Pottsville is established by the careful measurements made by the first Survey in 1838, published in Rogers' Final Report 1858, Vol. I, page 144, and Vol. II, page 10, where its total thickness is given as 2950 feet, and where it reaches the Susquehanna as rather less.*

*It is a little surprising that the First Survey should almost exactly agree with Winslow's recent measurements of the Pocono No. X at Mauch Chunk the one assigned the round number 1300 feet and the other the exactly measured number 1253 feet; and yet that there should be such a discrepancy between them respecting the Mauch Chunk formation No. XI. Rogers assigning a general thickness to it at Mauch Chunk of 3000 feet, more or less, while Winslow measures for it only 2168. But the fact is that there were nothing like the facilities for measuring XI at that time at Mauch Chunk, and the thickness assigned to it was an exceedingly rough estimate from the size of the valley; whereas on the Schuylkill the vertical attitude of the beds and the abundance of exposures of No. XI at Mount Carbon has always made its measurement comparatively easy.

Rogers' description of the Umbral red shale, as he calls it, around the anthracite basin in Vol. I, page 9, is worth extracting, as the formation was carefully studied by the First Survey. He says throughout the anthracite district the whole red shale formation is remarkable for great sameness of character, bearing a very close general resemblance to the main body of the Ponent (Catskill No. IX) red shales and sandstone; both are characterized by the presence of only a very few organic remains, but with this difference that the fossils of No. IX are mostly bivalve shells and encrini; whereas the few forms found in XI belong exclusively to plants but not to species or even genera identical with those of the coal measures. At the Schuylkill outcrop of XI the formation consists of very argillaceous red sandstones, alternating with red shales in nearly equal proportions; but as we advance towards the Lehigh the sandstones predominate more and more. Everywhere the lower part of the formation contains more tough grey micaceous sandstone, and the middle and upper parts more soft red shale beds, with occasional partings of grey sandy shales. In all three there are alternations of red and grey soft sandstone. The red sandstones are of three varieties; first a florid, red rock, rather soft; second, a brownish-red rock, more common, and, third, a dull greyish-red rock, the hardest of the three. Many sandstone strata are delicately sub-divided by alternate bands of different shades of color, imparting to the dressed surface a pleasing aspect, and may come to use in architecture. Some of the grey silicious sandstone layers of the middle and lower parts of the formation, although less pretty, would make a more durable building stone. The softer varieties of red shale frequently contain a small proportion of carbonate of lime, and in a few localities are seen one or two thin bands of a very argillaceous limestone, not pure enough to use. The greater part of the carbonate of lime appears as oval concretions, seldom half an inch long, looking like yellowish-white pebbles, which weather out and give the rock face a worm-eaten aspect. Several such layers may be seen just south of the Mt. Carbon Hotel in the upper part of the formation; but such layers are more frequent and usually thicker in the middle and lower divisions.


CCLXXXXV.
XIII, XIV, Castleman's river, Somerset Co.
A Compiled Section along the lower part of Castleman River in Somerset County made by F. and W. C. Platt 1875.
Fig. 73.
Vertical Sections on Castleman River Somerset Co. Penn.
Fig. 80. Pinkerton Point.
Fig. 76. Castleman Village.
Fig. 75. Mineral Point.
Second Geological Survey of Pa. Report of Progress HHH by F. and W. C. Platt
Mahoning Sandstone
Upper
Lower
Piedmont Sandstone.
Mount Savage Coal Bed
Pottsville Conglomerate (XII)
Impure Fire Clay
Sandstone (Piedmont)
Seral Conglomerate

*No. XI in the Broad Top Coal Field.**

In the Huntingdon and Bedford district this formation is found encircling the *Broad Top Coal Field*, and occupies the whole of the wedged shaped valley of Trough creek, rising on the inside slope of Terrace mountain. In Sideling Hill tunnel Messrs. Ashburner and Billin measured it 1,100′ thick, divided in three divisions:

1. Upper shales and sandstones 910′; 2. Mountain limestone 49′; 3. Lower shales and sandstones 141′.

Two bands of the Mountain Limestone division are quite fossiliferous. A layer of 4′ of gray mottled carbonate of iron forms the top of the whole group, occurring immediately under the bottom of No. XII as at Ralston, Centreville, Astonville and McIntyre in the Lycoming district; at the Barclay mines in Bradford Co., and at Queen's run and the Tangascootac in Clinton Co. The limestone† or middle member, thins away north and east and can scarcely be recognized anywhere in the Anthracite Field. But it is exposed in Westmoreland and Fayette and has been struck in many of the oil wells in the western part of the State.

No. XI in North-western Pennsylvania.

In Lycoming Co., the four vertical sections constructed in Mr. Sherwood all show the presence of this group of rocks. No. 1, on Cedar creek defines the series to be 271′ thick, and at once indicates the remarkable shrinkage of this great formation going westward. No limestone beds are mentioned, the series being entirely shales, slates and sandstones, red and green predominating. No. 2, on

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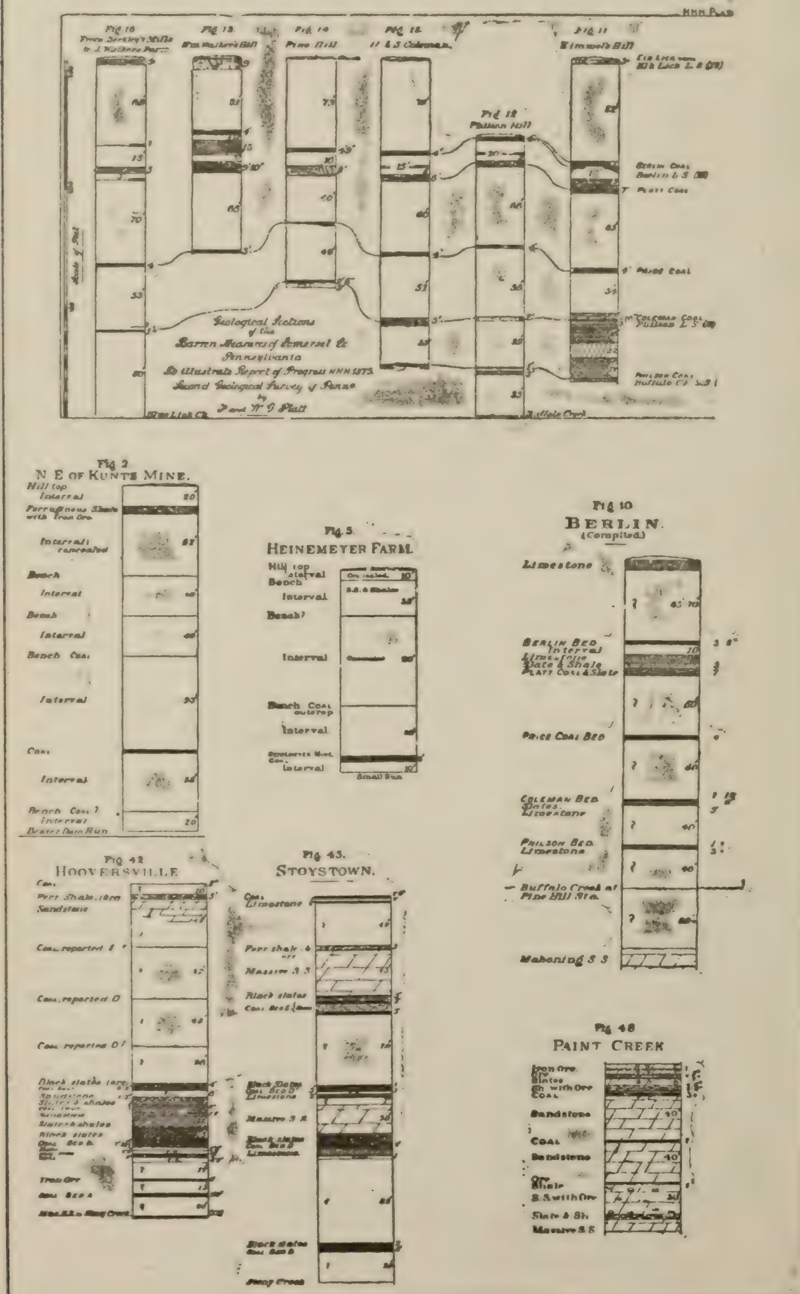
Near Tamaqua on the Little Schuylkill, 12 distinct beds appear, one 6 feet thick, but in it the nodules are rather thinly scattered; in another, 3 feet thick, they are abundant. Around the Wyoming Basin there are greenish silicious shale beds and grey calcareous sandstones. All that is here said serves to illustrate the description of the calcareous shales and limestones to be described next in Huntingdon and Westmoreland counties.

*This and succeeding pages on the Mauch Chunk formation of the western portion of the State have been compiled by Mr. E. V. d'Invilliers.

† At Round Top, near Paradise Furnace, Huntingdon Co., the whole formation is nearly horizontal and the entire group is 1,050′ thick. Brecciated limestone 2′ thick, crops out on Shoup's run 175′ below No. XII, and another bed occurs on Round Top 500′ below XII.

CCLXXXXVI.

XIV. Barren measures in Somerset Co.



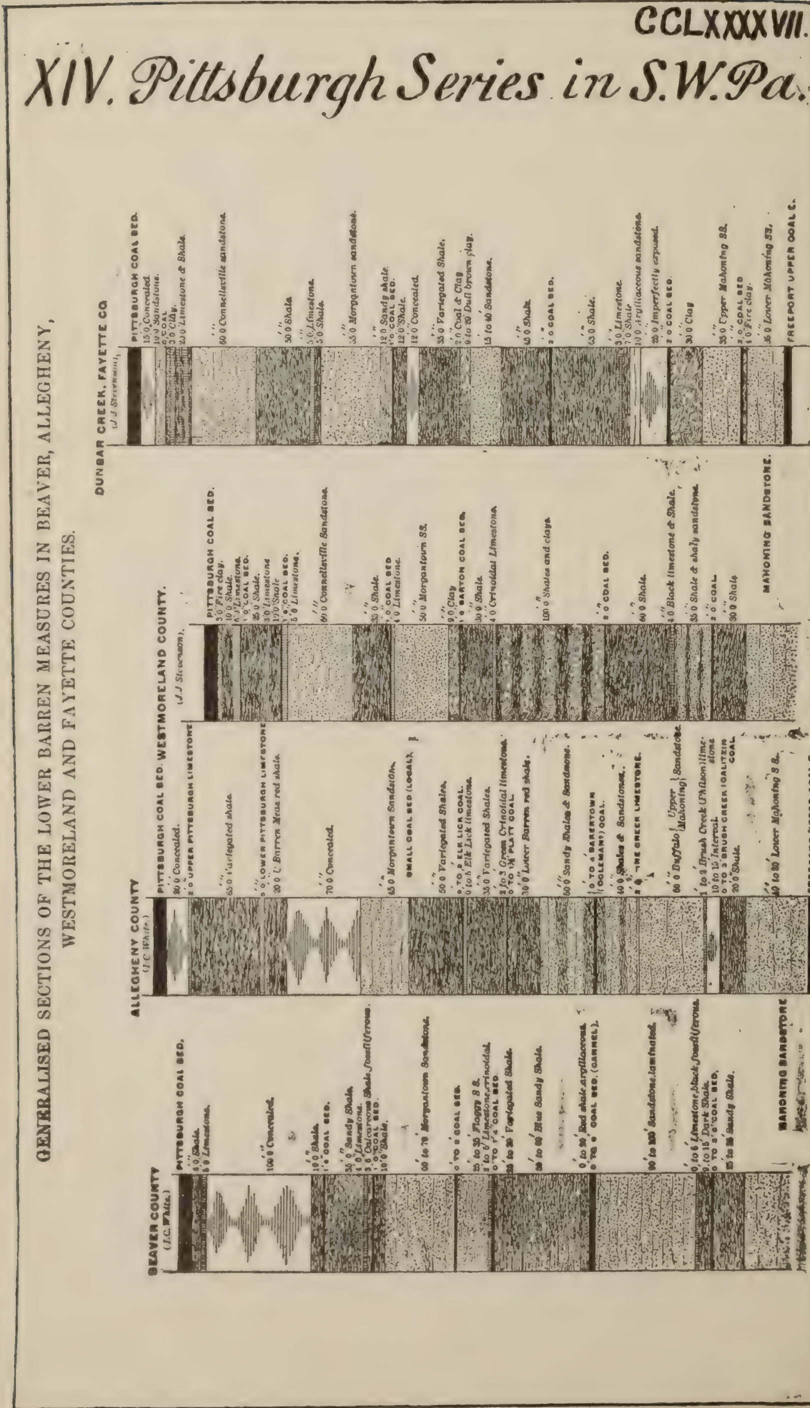
Rock creek, gives the group 331′; but the upper part (100′ thick) is concealed and may include part of XII. They show the same characteristics, but more largely red and gray sandstone. No. 3, on Trout run shows the group dwindled to 206′, but still maintaining its sequence of thin bedded sandstone and shale without economic contents, while No. 4 shows a decided variation as follows: Top member black slate, traces of coal, roots of *Sigilaria* and other plants 25′; interval 150′; reddish sandstone 30′; interval 75′; red, marly shale 25′; reddish false bedded sandstone 45′; interval 40′; sandstone, reddish and false bedded, at bottom 25′; total 415′. The formation is confined entirely to the northern half of Lycoming Co., forming the rims of the several detached coal basins at Rocky Ridge east of the Loyalsock; the Ralston-McIntyre basin on both sides of Lycoming creek; the Pine creek basin between the two forks of Pine creek and skirting the old turnpike along the Clinton Co. line.

The above sections are disputed as being too general. Thus at McIntyre the combined thickness of XII and XI is only 150′. At Ralston an important bed of iron ore was once mined beneath the Conglomerate, occurring in shale in irregular knotty lumps, and consisting of "nearly a white crystalline protocarbonate of iron, somewhat resembling a fine grained sandstone."*

The Mauch Chunk series is stated by the same authority to here show: Pottsville Conglomerate on top, then slaty clay 6″ to 8″; iron ore, in places 3′ to 4′; clay shale 40′; balls of ore 1′0″; clay shale and black slate 10′; sandstone 3′; sandstone measures 7′; red ore balls (cold short) 2′; greenish sandstone 10′ to 14′; red shale or marl 40′ to 50′; total exhibited 122′.

At Astonville the same ore was mined and again at Cartersville, where it was more argillaceous, 1′ to 2′6″. On Red run the same ore group is found underlying the Conglomerate, but of greater thickness. At McIntyre No. XI is divided into three groups of 20′, 5′ and 50′, each contain-

* Geology of Penna., Vol. II, page 513.


CCLXXXVII.
XIV. Pittsburgh Series in S.W.Pa.
GENERALISED SECTIONS OF THE LOWER BARREN MEASURES IN BEAVER, ALLEGHENY, WESTMORELAND AND FAYETTE COUNTIES.
BEAVER COUNTY (I.C. White.)
ALLEGHENY COUNTY (I.C. White.)
PITTSBURGH COAL BED. WESTMORELAND COUNTY. (J.J. Stevenson).
DUNBAR CREEK, FAYETTE CO. (J.J. Stevenson).

ing thin layers of carbonate iron ore, the rocks being reddish and the principal deposit of iron ore being through the middle 5′ thick.

Prof. Rogers expanded his Mauch Chunk formation to 534′ by including 450′ of the Pocono Sandstone; but by confining the group to the narrow limits on Penn and Lycoming creeks, the sections harmonize better with the reports on the whole West Branch of the Susquehanna, as well as to the south and west. It is evident that Nos. XI and X increase alternately, locally, at each other's expense in this district, making it difficult to limit exactly either formation. In the Bernice basin of Sullivan Co. No. XI is not believed to be over 25′ thick.

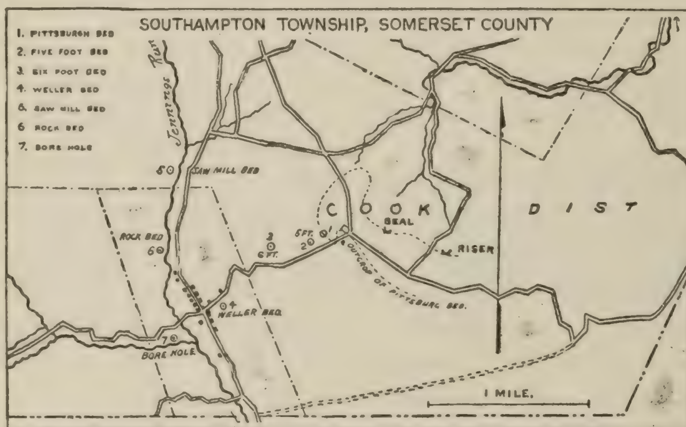
In Clinton Co. No. XI is shown merely by a red line on the geological map running around all the mountain summits north of the Allegheny escarpment; but sometimes no trace of this red band can be found on the ground. At Lock Haven the group is 100′ thick, and is locally exhibited in a number of other places in the county, though but imperfectly. It thins away to nothing 2 miles west of Lock Haven. On the Tangascootac no red shale has ever been found, but on the eastern face of the mountain near Revilletown it is 50′ to 100′ thick. At Glen Union and Wetham it could not be detected; nor at Keating, Sterling or Cameron.

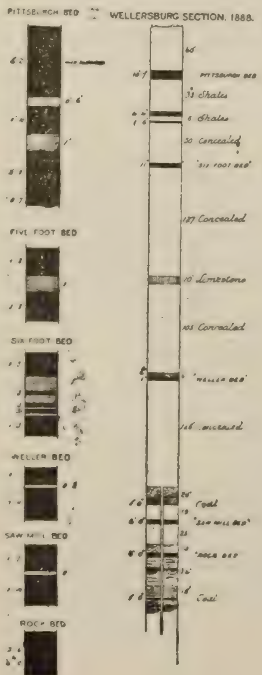
At Sinnemahoning and Emporium, further up the river, a thin layer of red shale or clay occurs; and sporadically at St. Mary's and Johnsonburg. West of the Johnsonburg (Elk Co.) Coal Basin it is not often seen and its western limit as a red shale may therefor be placed at the *Sixth Bituminous Coal Basin.* In other words this great formation of the Anthracite and Broad Top coal regions gradually fades away to nothing in the north-west corner of the State and totally loses its red color.

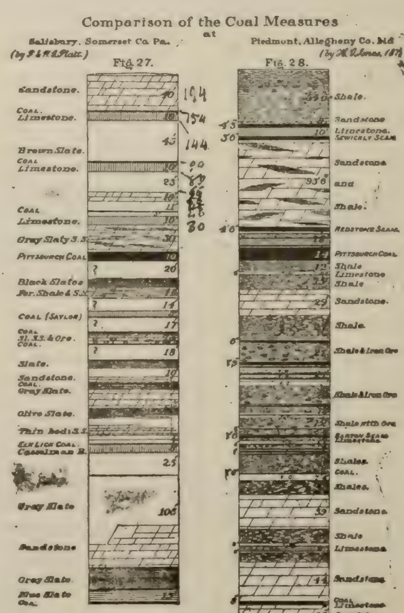
The structure of the Bituminous coal area of the State, and the nearly constant tendency of all the basins to shoal upwards towards the north-east, have served to expose an enormous length of outcrop of the *Mauch Chunk formation* throughout all north-western Pennsylvania; but a

CCLXXXXVIII.

XIV, XV. Pittsburgh bed in Somerset Co. Wellersburg basin.







glance at the State map coloring will show that these rocks do not exist above drainage south of an east and west line through Clearfield and Newcastle, except along the Allegheny escarpment and to a limited extent in Laurel Hill and Chestnut Ridge south of the Conemaugh and isolated spots in that region. But in the north the reported section of these rocks is so thin that they become of slight importance and cease to have any significance in the geology and economy of the great belt of country they overspread.

In the Cameron and Elk Cos. district they are represented by 40′ to 60′ of red and gray shales and thin bedded sandstones coming in immediately underneath the Olean conglomerate base of No. XII; in some localities red colored shales, in others without red shale at all. At Scahonda streaks of coal have been found in the measures beneath the Conglomerate which, north of Ridgway, become a bed of impure coal, opened in the Gresh mine. In the basin west of St. Marys and in the northern part of Benzinger Twp. the formation may be 50′ thick, sometimes containing a thin and sporadic coal bed, and rarely red shales.

A number of outcrops are exposed in the Clarion valley in Jones Twp., Elk Co; but the formation is indistinct and would not exceed 40′. It contains some little lean ore in Grove Twp., Cameron Co., and the same lithological characteristics prevail in many other parts of the district. But very little limestone is reported in the north-west sections and what remains of the great formation of eastern Pennsylvania is confined to an interval of 30′ to 50′ between the base of the Olean-Garland Conglomerate No. XII and the sub-Olean Conglomerate of No. X, largely known as the "Shenango Shales." In many parts of the region, where the map coloring shows its presence, it is merely placed there by inference and can not be measured.

Around the Barclay basin in Bradford Co. the upper red shale band of No. XI is reported 45′ thick, the red color still predominating through this district.

In McKean no red shale is found beneath No. XII, except in the southeast part of Norwich Twp.; but the

Bear Creek well passed through a group of rocks 45′ thick, representing No. XI, consisting of an upper band of red rock 15′, blue slate 10′ and red rock 20′. Generally throughout central and northern McKean this formation is represented by 5′ to 10′ of ferriferous shale or black slate sometimes containing cannelly layers or a thin slaty coal (Marshburg lower coal ?). No limestone has ever been found in connection with it.

In Jefferson Co. the map shows a double outcrop of red shale along the Clarion river and extending down almost to Clarion, and a small patch along the Red Bank east of Fairmount; but there is an almost total lack of exposures. The same statement covers our knowledge of No. XI in all the counties west to the Ohio line. Its horizon is no doubt largely represented by some material lithologically different from rocks above and below it; but the interval they occupy is everywhere small and largely concealed, and rarely filled with red colored rocks.

No. XI along the Allegheny Mountain.

Returning again to the Allegheny escarpment, where the formation is several times thicker, the same uncertainties exist by reason of the concealment of these rocks through this wilderness.

In Clearfield Co. the Mauch Chunk formation is above water level only along the Susquehanna river and the Moshannon and to some extent on some of the streams in the mountainous area north of Clearfield; but there is no good opportunity presented for studying the character of these rocks, as they are largely covered by *débris* from the Conglomerate. Their thickness is considered to range from 50′ to 125′. Through all the southern half of this county these measures are entirely below water level.

In Centre Co. the map shows two separate and narrow belts of these red rocks, one passing up Beech creek from Clinton Co. into Snow Shoe and returning under the escarpment of the Allegheny Mt. to Blair Co.; the other swinging up the Susquehanna river in the *Second Basin* to near Karthaus and for several miles along the Moshannon creek, partially in Clearfield Co. The group will not exceed 150′ in thickness anywhere, generally capped by a plate of carbonate iron ore, of variable thickness, but never exceeding 4′, the sole representative of the Ralston ore and the upper Umbral ore group of Westmoreland and Fayette Cos. Red colors predominate.

In Blair Co. the formation is continuous along the Allegheny Mt. nearly to the Bedford line and being well displayed through the cuts of the Penna. R. R. east of the Gallitzin tunnel, the carefully measured section made there by Mr. R. H. Sanders, may be taken as a standard for the characteristics of this group all along the Allegheny Mt. plateau. (See section page 13, Report T as follows):

XI. Mauch Chunk red shale.

Shale, red,	110′
Slate, gray,	40′
Shale, red,	5′
Slate, gray,	12′
Slate, red,	2
Sandstone, fine grained,	4
Slate, red,	6′
Slate, greenish gray,	4′
Shale, red,	6
Slate, gray,	2
Sandstone, white and grayish white, coarse grained,	52′
Slate, gray,	10
Slate, red,	5
Slate, gray,	5
Sandstone, gray,	10′
Shale, red,	10
	283′

It will be noticed that the entire group is a mass of red and gray slate and sandstone, without coal or iron ore and 283′ thick, of which 144′ are red shale; 68′ gray and greenish gray slate and 66′ are sandstone layers, fine grained, gray and white.

In Cambria Co. the strip of red shale just described forms the supporting belt for the Conglomerate Series marking the crest of the mountain. Three other small areas and partial exposures of these rocks are shown on the map, one under the Viaduct axis on the Conemaugh and tw under the arch of the Laurel Hill axis on Black Lick and in the Conemaugh gap west of Johnstown. The *Siliceous limestone* at the base of the group appears in the latter section 50′ thick, and in spite of its flinty appearance, burns and slakes well, and makes a snow white mortar, needing little sand. The Viaduct arch is barely strong enough to elevate these rocks, the upper part of the group (100′ thick) alone showing there, exposing thin layers of sandstone and red and olive shales, with a layer of siliceous limestone 10′ at water level.

In Somerset Co., owing to the increased strength of the several anticlinal axes going south-west from the Conemaugh, there is a much wider exposure of the *Mauch Chunk rocks No. XI.* Thus, beginning on the east, one band encircles the oblong Salisbury coal basin in the extreme south-east corner of the county, to the east of the Allegheny Plateau proper; a second strip extends out along the mountain crest, from Cambria Co. to the Maryland line; two more areas show under the Negro Mt. axis, one on Shade creek above Roaring Fork and the other, several miles in length, from the Castleman river southward, while along the great Laurel Hill mountain, marking the Westmoreland and Fayette line, various detached areas of these measures appear at the heads of the small branches of Laurel run, and in the gap of the Youghiogheny river. The last area can be better studied in Westmoreland and Fayette Cos., where it is described in subsequent pages of this report.

The eastern flank of the Allegheny mountain has not yet yielded any evidence of the Umbral ores or coal, and there is no good exposure of these rocks anywhere in this part of the county. The same may be said of the limited exposures on Shade and Stony creeks, although the *Siliceous limestone* occurs in the vicinity of Ashtola and has been quarried there, yielding a white lime, intermixed with sand.

Above Listonville on White's creek, west of Negro mountain, the red shales are brought to daylight by the Viaduct axis, and at Waas' saw mill the *Siliceous limestone* near the base of the group is lifted high above water level and has been quarried on McCartney's land. That part of this deposit known as the "fossiliferous band" is quite pure, calcining readily and yielding a white lime, much used for plastering. The siliceous band, averaging 5′ thick, is streaked with numerous seams of calcite, and is overlaid by reddish siliceous limestone. In the Youghiogheny gap through Laurel Hill, the same limestone crops in a bold cliff and is quarried by Mr. Hugus. As on White's creek, the fossiliferous band is burned for lime, while the siliceous bands (much more numerous) have been used for paving purposes. Thin streaks of marble occur here also near the base, polishing well, and the same thin bands have been noted as occurring at Keystone junction, near the summit of the Allegheny mountain east of Meyersdale. With these few exceptions, nothing is known of the constitution of the *Mauch Chunk formation* in this district; but the same measures are greatly expanded and advantageously exposed in this southern part of the State, west of Laurel Hill, as will be next described.

*No. XI in Westmoreland and Fayette Cos.**

Along Chestnut Ridge these rocks are exposed in the

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* This formation was extensively reported upon by Dr. J. J. Stevenson in Rep. K 3, where many exceedingly interesting facts may be found, accompanied by a number of valuable sections of the measures and included ore beds, now entirely abandoned by reason of the demand for the purer and richer Lake ores. In this report the Mauch Chunk formation is described as the "Umbral Series," in explanation of which Dr. Stevenson writes: "For the present it is best to retain the term *Umbral* to designate the rocks immediately below the Pottsville conglomerate, as the series is large and no locality within the State of Pennsylvania so fully shows the characteristics as to justify the application of its name to the whole group. To the various portions of the series the names *Upper Mauch Chunk shales*, *Mountain limestone*, *Lower Mauch Chunk shales* and *Siliceous limestone* are applied in this report.

If it be thought best to replace *Umbral* by a geographical term, the series might be called the *Greenbrier series*, from the Greenbrier river of West Virginia. The name *Mauch Chunk* is objectionable, because at that locality only shales occur, a condition characterizing the series only in central and eastern Penna., while in all the rest of the enormous area in which this series is exposed there is a large proportion of limestone. In Pocahontas Co. of West Virginia along the Greenbrier river, as shown by the section given in the Virginia report, the conditions are a mean between the extremes of limestone and shale, so that the locality would be a fitting one from which to name the series.

gap of the Conemaugh and in all the deeper hollows thence southward to the gap of the Youghiogheny river. In Westmoreland the exposures are not complete; but owing to the hoist in the axis southward the entire group is displayed towards the West Newton pike crossing.

Along Laurel Hill the red shales and limestones of this series occupy rounded knobs on the crest of the mountain. Along the Youghiogheny the upper part of the group is certainly above water level, except at Ohiopyle Falls. The variations in No. XI are extreme; but in the Conemaugh gaps through Chestnut Ridge and Laurel Hill the group shows:

Shales,	82′
Fossiliferous limestone,	6′
Shale,	30′
Sandstone,	20′
Blood red shale,	10′
Calcareous shale,	3′
Sandstone,	17′
Concealed,	20′
Silicious limestone,	30
Total,	218′

The thickness is similar in the gap made by the same river through Laurel ridge, and in the Loyalhanna gap through Chestnut ridge the thickness is less.

In the Youghiogheny gap on the west side of Chestnut ridge the thickness is not far from 325′ and on the east side of the same ridge it is fully 360′. No direct measurement of the group could be obtained in the gap made through Laurel ridge by the Youghiogheny, but a partial section obtained at a little way south from the river shows it to be 360′ and another just north from the National road makes it 390′. Southward from the National road the base of the group is not exposed at any point along Laurel ridge.

Along Chestnut ridge, south from the Youghiogheny, the series was found 350′ thick on the Dunbar furnace property and on the eastern side of the arch near old Center furnace the interval between the base of the Siliceous limestone and that of the Pottsville conglomerate is 350′ measured up a very sharp dip, so that the true thickness is probably nearer 400′. Thence southward the thickness seems to be quite uniform, for in the gap of Cheat river a few miles south from the State line, Prof. I. C. White has found the thickness to be 345′.

The Umbral rocks may be regarded as quadruple,* 1st. A mass of shales and sandstones, including thin coal beds and some iron ores ; 2d. Shale and limestone ; 3d. Shale ; and 4th. The Siliceous limestone.

Along the Chestnut ridge this first division (Mauch Chunk shales) shows great variation. On the Conemaugh it consists mostly of shales, there being but a very small proportion of sandstone. And the same conditions prevail on the Loyalhanna; but on Jacob's creek, flaggy sandstone forms a very great part of the mass. On the Connellsville and Springfield pike only red shale occupies this interval. On the Youghiogheny, under the arch, the shale preponderates. On the National road, the sandstones are thick ; but in the Cheat river gap there is little aside from shale. This upper division frequently contains a series of iron ore beds.

Along the west slope of Laurel ridge the exposures are all incomplete, and few of them are fully satisfactory ; but the variations are quite as marked there as on Chestnut

* Dr. Stevenson describes the first division as consisting of shales and sandstones and includes the *Sharon group* of coal beds, and gives the following section of them on the Youghiogheny :

Shales and sandstone,	30′
Coal bed,	2′
Shale,	3′
Sandstone,	40′
Shale,	15
Sandstone,	45′
Shale,	8′
Coal bed,	1
Shale,	25
Sandstone,	25′
Shale,	12′
Sandstone,	25′
Total,	231

The coal bed No. 2 is thoroughly persistent and becomes workable at Ohiopyle Falls. No trace of limestone was noticed in the section and some of the sandstones are quite conglomeratic.

ridge. A thin coal bed occurs at but a few feet below the conglomerate on the Laurel Hill furnace property, southeast from New Florence; on the Fayette furnace property, in Springfield Twp. of Fayette Co., and on Laurel run, in Stewart Twp., of the same county. In Henry Clay Twp., of this county, a double coal bed was seen on the waters of Big Sandy belonging near the top of these shales.

The second division (Mountain limestone) is more variable than any other except the Siliceous limestone. On the Conemaugh it shows a few feet of impure limestone; in Loyalhanna gap through Chestnut ridge, two thin layers of sandy limestone, separated by 35′ of red shale; on Jacob's creek nearly 40′ of limestone, fossiliferous throughout, the middle part argillaceous. On the Youghiogheny not well exposed, but showing three bands of limestone, separated by red shale, as also on Dunbar creek. Fairly good exposures in southern Fayette show the top limestone to be very pure; the middle earthy and lower of good quality. On Wharton furnace property the middle one is nearly 20′ thick and yields a superior lime; on Cheat 90′ thick.

The third division (Lower Mauch Chunk shales) contain little of interest. On the Conemaugh it shows much sandstone, while on the Loyalhanna only red shale. On the Youghiogheny largely shale, and sandstone again on the National road. In Cheat river gap the group measures 90′.

The fourth division (Siliceous limestone) is a compound group, at the base of the Umbral formation. The upper portion is a conglomerate sandstone with variable thickness, containing angular fragments of the Siliceous limestone, passing down gradually into the Siliceous limestone proper. The limestone itself is an exceedingly fine grained rock, with a delicate blue color and on the fresh surface it shows no lines of bedding. It has a flint-like fracture and no definite cleveage. On the long exposed surface, the color is dull brown and the rock resembles a loose sandstone. Under such circumstances the structure of the rock is perfectly distinct and it shows curious cross-bedding.

At first glance this rock is hardly to be taken for a limestone and the silica evidently predominates at all localities. At the same time lime is present in considerable quantity, for when the rock is burned it becomes snow-white, slakes readily and forms a mortar without the addition of sand.

The Siliceous limestone is of greatest importance northward and dwindles southward. On the Conemaugh it is between 40′ and 50′ thick in both gaps. A similar thickness prevails in the gaps made by the Loyalhanna and the Youghiogheny ; but southward from the last the rock becomes thinner, being only about 18′ on the National road and barely 4′ where last seen within the State. On Cheat river it has wholly disappeared.

In the Ligonier Valley there is an extensive area of the Umbral rocks in Henry Clay Twp. on the main fork of Beaver creek. The group is nearly 400′ thick ; the siliceous limestone well exposed, but the mountain limestones are imperfect. The Upper Mauch Chunk interval is mostly sandstone without traces of the iron ores germane to this horizon.

On the Wharton furnace property however, these ores were once energetically mined, the section being as follows :

Pottsville conglomerate,	.
Interval,	10′
Little Flag ore bed,	.
Interval,	20′
Little Honeycomb ore bed,	.
Interval,	25′
Big Flag ore bed,	.
Interval,	50′
Big Honeycomb ore bed,	.
Interval,	20′
Huston ore bed,	.

A still lower bed known as the "Big Bottom" was once opened on this hill ; but the pit is now concealed.

The Mountain limestone was quarried on this run. Only the middle and lower beds are now exposed, and they are separated by about 40′ of shale : the upper 20′ thick, compact and loaded with fossils. The ore bed is 8′ thick, blue, free from clays, contains many fossils, and yields a beautiful white lime. Between this and the Silicious limestone there is an alternation of shales and sandstones not shown in detail. One layer of sandstone is locally celebrated as the "Grindstone Rock," and it is much used for that purpose.

Along the pike and Big Sandy another section shows:

Pottsville conglomerate,	.
Interval,	30′
Little Honeycomb ore bed,	.
Interval,	22′
Big Flag ore bed,	.
Interval,	11
Rock ore bed,	.
Interval,	35′
Big Honeycomb ore bed,	.
Interval,	27
Huston ore bed,	.
Interval,	15
Big Bottom ore bed,	.

The intervals are largely dull red shales; the ore beds vary from 3″ to 10″ thick and the percentage of metallic iron from 22 per cent. to 35 per cent. Naturally these ores have no longer any economical value. They are all carbonate ore beds, oxidized at the outcrop. The same ore beds were once worked for the Coolspring furnace near the summit of the mountain.

At Centre furnace the Umbral group is 350′ thick, wholly concealed except its Siliceous limestone member. The *Little Honeycomb bed* here on Laurel run is a fine grained, bluish-gray, somewhat micaceous bed, made up of flattened nodules, 4″ to 8″ thick. The *Big Honeycomb bed* is double; ore 4″; clay 10″; ore 6″ to 8″. The other ores belonging to this group are not exposed along the run. Nearer the furnace one of the layers of the Mountain limestone is exposed and from it the limestone was obtained for use at the furnace.

At the Laurel furnace in Dunbar Twp. the same rocks occur, and still contain ore beds, formerly largely worked. A general section of the Umbral rocks in Springfield and Salt Lick Twps. is given in report K 3 page 100 as follows:

Pottsville conglomerate,	——
Shale, with coal bed,	40
Sandstone,	40
Shale,	15
Sandstone,	45'
Shale,	8
Coal bed,	1 7
Shale,	25
Sandstone,	25
Shale,	12′
Sandstone,	25′
Concealed,	50′
Shale and limestone,	35
Concealed,	20 (?)
Silicious limestone, seen,	15′
Total,	356′7″

On Bucks run the upper Mauch Chunk shales occur near Fayette furnace with a coal bed 20″ thick, associated with them ; but no iron ores of the Umbral group occur here.

In Westmoreland Co. some little iron ore has been found along Jacobs' creek, in Mt. Pleasant Twp., and the *Big Bottom bed* was reported 3′ (?) thick as exposed by Mr. T. B. Mays ; but the ore was very lean. The coal above this bed also shows. The Mountain limestone shows in three benches 18′, 20′ and 2′ thick, the middle argillaceous. The whole mass is fossiliferous, and the upper bench a first class limestone.

In Cook Twp. on Powder Mill run the Mountain limestone has been exposed ; at one quarry a layer 7′ thick has been worked, but at Shawley's quarry the limestone is in thin layers spread through 40′ of shale. Also on Linn's run at Robbins mill, where the Rector quarry shows thin layers of pure stone, in all 16′ thick, interstratified with calcareous shale.

In the Conemaugh gap west of Bolivar a complete section shows:

Mauch Chunk shales :		
Variegated shale,	60′	82′
Compact gray shale,	12′	
Red shale,	10′	
Fossiliferous limestone,		6
Drab shale,		30′
Sandstone,		20′

Deep red shale,	10
Calcareous shale,	3′
Sandstone,	17′
Concealed, estimated,	20′
Siliceous limestone, seen,	30′

No iron ore seems to be associated with the Mauch Chunk upper shales in this section. The Fossiliferous limestone is impure, but well shown along the Penna. canal. The Siliceous limestone has been quarried to some extent, and shows its usual characteristics in color and structure. Beyond Nineveh, under the Pottsville conglomerate 160′, the following succession shows: Concealed, 100′; Mauch Chunk shales and sandstones, 93′; Conglomerate sandstone, 3′; Siliceous limestone, 50′.

West of Chestnut ridge, on the east flank of the Connellsville (Blairsville) basin, these same rocks are sparingly exposed in Westmoreland Co., but very satisfactory in Fayette Co., owing to their elevation by the increased strength of the axis. Towards the north the Mauch Chunk red shale division on top is 80′ thick, below which is 20′ of blood red shale, but without iron ore. Then the Fossiliferous limestone, 2′; blood red shale, 35′; Fossiliferous limestone, 1′ 6″; dark red shale, 15′; calcareous sandstone and clay, 4′; red shale, 3′; conglomerate, 3′, and Siliceous limestone, 40′. Towards the south the upper division contains iron ores, lying within the first 75′ below the Conglomerate No. XII; and some thin coal beds, persistent as far north as Jacobs creek in Westmoreland Co. The interval between No. XII and the *Big Honeycomb ore bed* is 60′ to 80′ in central Fayette Co.; but in Springhill Twp. only 30′. Again in Bullskin Twp. the *Big Bottom ore bed* lies directly beneath the Conglomerate No. XII while on Jacobs creek the interval is 70′, and further up the creek 40′, with both Honeycomb beds missing and the first coal bed under No. XII resting on the Kidney ore, which is 25′ above the Big Bottom bed. Below the Big Bottom ore bed the section is also variable. Along the Loyalhanna it is mostly red shale; on the National Road flaggy sandstone.

The Siliceous limestone member is everywhere compact, blue, conchoidal fracture and resembles quartzite, with a large proportion of sand, indeed essentially a sandstone whose cementing material is calcium carbonate. The little conglomerate bed above it contains large fragments of this limestone. It is absent south of the Youghiogheny; but on the Loyalhanna there are two layers 35′ apart, the lower one 25′ above the limestone; both quite thin and siliceous and stained with iron.

On Jacobs creek the exposed limestone is 40′ thick and yields a lime of superior whiteness and quality, the middle layer however being argillaceous; but the Siliceous limestone is beneath the surface. This upper or Fossiliferous limestone is 10′ thick on the Youghiogheny and contains many fossils, increasing in thickness southward, and separated by 10′ to 25′ of clayey sandstone from the bottom or Siliceous limestone, which diminishes in that direction. In this southern district there are often 4 or 5 small coal beds especially well seen in Dunbar Twp., coming in the upper division. These coals are largely associated with the ore beds,* affording a bearing-in for the miners, and formerly used for calcining the ore.

Towards the south the interval between the Conglomerate No. XII and the Big Bottom ore bed near the base is 27′; on Shutes run, near Coolspring furnace 80′; at Lemont mines 70′; Dunbar 94′; Vernon Mines 3′ and on Jacobs creek 36′ to 80′. At the Vernon mines the entire upper portion of the section has disappeared and the Conglomerate rests on the Kidney (?) ore bed.

The highest, known as the *Little Honeycomb*, occurs about 20′ below the Pottsville conglomerate and is seldom more than 4″ thick, so that it is available only when the cover is thin enough to admit of stripping.

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*The Umbral ores have been extensively described in reports K 2 and K 3; but they are no longer regarded as of much economical value. They are found mainly in Fayette Co., disappearing northward in Westmoreland about the middle of Mt. Pleasant Twp., and not seen on the Loyalhanna or Conemaugh. There are 4 persistent beds all less than 1′ thick, except the Big Bottom bed, which varies from 1′ to 3′.

The *Big Honeycomb* is usually a compact flag, 10″ to 12″ thick, and at most localities shows little tendency to variation. It is persistent to a considerable distance north from the Youghiogheny river, but seems to disappear before reaching the northern limit of Fayette Co. The ore is fine grained, smooth and has always been regarded as of excellent quality. Analyses by Mr. A. S. McCreath, as well as by other chemists, show that the percentage of metallic iron varies from 35 to 41 ; that of phosphorus from 0.03 to 0.22 ; and that of sulphur varies little from 0.15 per cent.

The Kidney ore is persistent from Jacobs creek to the State line. It is usually a plate ore from 4″ to 8″ thick and is easily mined, as a small coal bed below it affords a good bearing-in for the digger. Analyses of this ore by Mr. McCreath and others show that the iron varies from 31% to 41%, the phosphorus 0.10% to 0.20%, and the sulphur from 0.08% to 0.40%. The bed is regular in most localities.

The Big Bottom is constantly present at all localities from Jacobs creek to the State line, and occurs in flags, with a total thickness varying from 10″ to 3′. The percentage of iron varies from 32 to 37 ; of phosphorus from a mere trace to 0.25. Selected specimens have shown 41 per cent. of metallic iron.

The *Umbral Ore Group* has by no means the same importance within the Ligonier valley that it possesses on the west slope of Chestnut ridge within Fayette county. In Westmoreland it is absent from Chestnut ridge and is poorly represented by but a single bed on Laurel ridge near the Conemaugh river. Possibly other beds may be present on Laurel ridge, for the explorations made at Laurel Hill furnace were too limited to set the matter beyond doubt.

Southward from Tub mill run along the eastern side of the valley there are no traces of the group, and where the Youghiogheny crosses the synclinal no ore occurs at this horizon aside from a few scattered lumps ; a similar condition seems to prevail on the western side of the valley and north from the Youghiogheny river in Fayette county, for along that river the exposures are perfect for several miles and there are no regular ore beds within 100′ below the Pottsville conglomerate. It may therefore be taken for granted, that to all intents and purposes the Umbral Series of ore-beds is absent from the Ligonier valley *north* from the Youghiogheny river. Whether or not the group is fairly represented along Laurel ridge south from the Youghiogheny river cannot be determined from the exposures with any degree of certainty. But on the east slope of Chestnut ridge *south* from the Youghiogheny it has already been shown that the group maintains the integrity shown on the west slope, as at Wharton furnace there are not less than 9 beds, varying from 4″ to 1′, all yielding a good carbonate ore.

The palaeontology of this formation, especially its limestone members, is illustrated by numerous diagrams on Plates CCXXIII to CCXXXVI.

CHAPTER CXVI.

Formation No. XII, Pottsville Conglomerate.

*In the Anthracite Region.**

Although the description in detail of No. XII in the anthracite coal fields will be given in the "Report on the Anthracite Region" to follow, a brief statement as to its general characteristics and thickness is now in order.

No. XII in the anthracite region is a coarse, mainly quartzose mass, made up of gray conglomerates, white, gray and brownish sandstones, a few thin beds of dark, carbonaceous slate, and generally one or more usually thin beds of coal, which in the southwestern part of the region are large and valuable coal beds. The conglomerates form the largest and most characteristic portion of the mass.

* By A. D. W. Smith. The Pottsville conglomerate contains workable coals in parts of the region. It is often the principal key to the identification of the coal beds. The Anthracite Survey includes No. XII throughout the district; a local knowledge of it is frequently essential to successful mining operations; for these and other reasons the closely connected description of the conglomerate with that of the coal measures, which will be given later in the anthracite chapters, seems highly desirable.

The formation makes a solid base upon which the softer coal measures rest, and its outcrops form mountainous and protecting rims to the coal basins.

The limits of XII are fixed at the top by the easily recognized Buck Mountain or Red Ash coal bed; but at the bottom the limit is not so readily defined, as the transition from the red shales of No. XI to the conglomerates of XII, although occasionally abrupt, is more often gradual, consisting of alternations of beds of reddish shales and sandstones with beds of greenish and grayish sandstones, shales and conglomerates.

One of the most noticeable features of XII in the district is its comparatively great thickness along its southeastern outcrop in Carbon, Schuylkill, Lebanon and Dauphin counties; and its rapid diminution towards its final N. N. E. outcrop in Luzerne and Lackawanna counties. This reduction in thickness is accompanied by a decrease in the coarseness of the materials of the formation.

In the *Southern field* the Pottsville conglomerate has an average thickness of about 1200′; its conglomerate beds are massive and coarse; the pebbles mainly range from hickory nut to egg size, and often much larger. The middle beds of the formation are as a rule the hardest, and usually form a mountain crest or ridge. The workable coal beds, sometimes six in number, are found in the western half of the field and chiefly in the upper and lower divisions of the formation. In the *Western Middle field* the average thickness is about 850′. Two workable coal beds, near the western end of the field, occur in the formation. In crossing the *Eastern Middle field* from the south towards the northeast, No. XII diminishes in thickness from 500′ to about 200′; it also shows a decrease in the size of materials composing it. The one coal bed found here in the conglomerate has locally a workable thickness. In the *Northern field* No. XII has an average thickness of about 225′, but is thinner at either end than in the central portion of the field. The diminished coarseness of the materials is very marked, and towards the northeast end of the field the pebbles in the conglomerate are much scattered and rarely exceed pea size. No coal beds of workable thickness are found.

Prefatory Letter of E. V. d'Invilliers.

In the preceding pages of this *Summary Report* the Archaen geological base of the State with its superimposed variegated *Palaeozoic System* of rocks has been described up to and including the base of the Carboniferous System by a master hand and mind in the person of the widely respected and able State Geologist, Prof. J. P. Lesley; and while it will be my welcome task to present now a summary of the labors of my fellow geologists in the *Bituminous Coal Fields* of the Commonwealth, I cannot refrain from expressing here my deep sorrow and regret that a serious indisposition has prevented Prof. Lesley from completing his life work, and my own sense of unfitness to take up the pen he so reluctantly cast aside some months ago. No man living has the intimate knowledge of the geology of the State that he has, after practically devoting a long lifetime to its study and delineation. He alone remains of the band of devoted enthusiasts, who under the leadership of the learned Henry D. Rogers, penetrated all corners of the great State of Pennsylvania during the progress of the *First Survey*, and laid that wonderfully accurate foundation of knowledge upon which the assistants of the *Second Survey* (1874 to 1891) confidently built their superstructure without finding scarcely a flaw in the masonry of the building. Hence the absence of his poetic descriptions and lucid explanations; of his terse and forcible arguments; his characteristic and striking illustrations; and above all his scholarly comparisons will be keenly noticeable throughout the remaining pages of this work. The indulgent reader must therefore overlook the feeble attempts to take up the thread of this exhilarating geological story whose completion, in part, has been left to willing but inexperienced hands.

There are no less than 30 large volumes of the Second Survey devoted in whole or in part to a description of the *Conglomerate* and the *Bituminous Coal* and *Barren Measures*, prepared by a number of assistants and containing in the aggregate a wealth of valuable information to the student, expert or investor—the work of nearly 20 years of patient toil and study on their part. The work of merely summarizing all this data into a portion of one volume, and eliminating, as far as possible, the natural errors and misconceptions* made in describing portions of the large area covered where wholly or partially undeveloped, requires such an intimate knowledge of the *Bituminous Coal Field* as is possessed by few, if any, of the old assistants of the survey; and realizing my own deficiencies in this respect to a very great degree, I have endeavored within the limits of my time and means, to visit during the past year many of the more recently developed fields, and availed myself freely of the courteous assistance and information offered me by a large number of corporations, mining engineers and geologists, too many to warrant my extending to them individual credit. But to them generally, and to the large corps of assistants whose printed reports already testify to their ability and devotion, I wish here to make the heartiest acknowledgment, in submitting a report which may be considered their work jointly with my own; for I have made the fullest use of their material, as well as of Prof. Lesley's prefatory notices.

Respectfully yours,

E. V. D'INVILLIERS.

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*Unfortunately all the illustrations up to and including plate CCLXXXVIII were printed and paged prior to the preparation of the Bituminous Coal report without regard to the order of description, and still retaining many errors of nomenclature of coal beds. The reader must carefully bear this fact in mind in using them as references in the subsequent pages of the report. In this way, all the illustrations referring to No. XII will be found in pages prior to this chapter.

CHAPTER CXVII.

XII. Pottsville Conglomerate.

The *Pottsville Conglomerate No. XII* (Rogers' Seral Conglomerate)* was, with very good reason, regarded for many

*This, the twelfth distinct formation of the Palaeozoic age, everywhere in Pennsylvania marks the basal member of the true *Carboniferous Series*, and amongst the mining population is therefor most frequently referred to as the "Farewell Rock"—because usually within it no true workable coal beds are found. But while, with rare exceptions, this is eminently true in Pennsylvania, the same formation, greatly amplified in thickness, becomes a very important repository of high grade steam and coking coals when followed southward into the Virginias, Tennessee and Alabama, nowhere more strikingly illustrated than in the Flat Top Field of Virginia and West Virginia, from whose one great inter-conglomerate seam—the Pocahontas coal bed—there was mined and marketed during 1893 no less than three million tons of coal, to say nothing of the very large additional tonnage extracted from this and other beds included in the same *Conglomerate Formation* in other parts of the Appalachian Coal Field of the Southern States.

In Pennsylvania it has many local names. It is the "*Conglomerate*" of the Allegheny escarpment in Sullivan, Lycoming, Clinton, Centre, Cambria and Somerset Cos.; the *Sharon-Olean-Garland Conglomerate* of the north-western counties of the State; the *Mountain Sandstone* of Fayette and Westmoreland Cos., and the *Seral Conglomerate* of the First Survey.

But its distinctive name of "*Pottsville Conglomerate*" No. XII, is now very generally adopted in this State, so called from its magnificent and characteristic development near the county seat of Schuylkill Co., where it exhibits a massive structure of conglomerate and sandstone, 1200′ thick, making a distinct break in the lithology of that locality between the underlying Mauch Chunk red shales and the overlying coal beds, sandstones and shales of the Anthracite Basins.

Much thicker in the eastern portion of the State than in the western, it is also more distinctly conglomerate in its character, exhibiting through a large portion of the Allegheny Mountain Coal Field, a close grained sandstone scarcely more conglomerate than the Mahoning sandstone, which forms the cap rock of the lowest productive (Allegheny) coal series, just as the Conglomerate forms the base of the same series.

Along the western border of the State, south of the Ohio river, this formation is deeply buried under the coal measures; but many gas and oil wells that have penetrated its layers prove it to be still merely a coarse grained sandstone with streaks of pebbly rock; while northward, along the New York State line, where the last vestiges of this formation are exhibited in isolated knobs and remnants, it again partakes of a distinct conglomerate character, generally referred to as the *Olean* (Garland) *Conglomerate.*

Like the underlying Pocono (Vespertine) Sandstone No. X, already described in this volume, it varies in thickness within surprisingly short (geological) distances, with extremes of 50′ and 1200′, the latter however solely in the Anthracite district. Absent from the mountains through all years as the base of the Coal Measures in Pennsylvania, especially as the study of it began in the eastern part of the State, where it is most grandly developed.

The transition from the finest red mud deposits of the *Mauch Chunk red shales No. XI* to the coarsest pudding stone, or gravel rock of the *Pottsville Conglomerate No. XII*, is in all eastern Pennsylvania immediate and universal; without evidence of non-conformability, ; with perfectly regular sequence. In western Pennsylvania No. XII is quite as often a series of sandstone deposits as a conglomerate; contains beds of shale and groups of coal beds, several beds yielding an important supply of fuel, and yet the whole mass is reduced to one-fourth the thickness it shows in the east.

But after 20 years of study we are gradually approaching a clearer understanding of the characteristics of this great pebble formation, so unmistakable in the eastern counties and so baffling and capricious in the western and northern counties, and a flood of light has been shed upon its commercial possibilities by the development of the great *New River—Flat Top coal series* of West Virginia, within the limits of this formation.

In the east it rests upon nearly 3000′ of red shales; along the Allegheny mountain on only about 100′ of red shale; in Elk Co. on 40′ of red shale; in McKean Co. on only grey shales, as it does also in counties to the northwest. But nearly everywhere a bed of coal or a bed of carbonaceous black shale, accompanied by deposits of lean iron ore of XI, marks the junction plane of the Mauch Chunk red shale formation and the Pottsville Conglomerate.

The result of the independent surveys and conclusions of a score of geologists at work through the extensive area bounded by the New York and Ohio State lines and the Allegheny Mountain has been two-fold:

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the central tier of counties, by reason of the enormous amount of erosion that highly plicated region has suffered, it first appears marking the terraced crest of the Allegheny Mountain plateau with a thickness averaging about 250′, scarcely if ever exceeding 300′ in thickness.

First: The sub-division of the *round pebble* Pottsville Conglomerate No. XII into three members; *Upper*, *Middle* and *Lower*.

Second: The identification of the *flat pebble* conglomerate with the coarse beds at or near the top of the Pocono Sandstone No. X. As an effect of these conclusions, three sets of names were applied to the sub-divisions of No. XII, which were finally found to be synonyms, thus:

No. XII.	Upper=Homewood Sandstone=Johnson Run Sandstone.
	Middle=Connoquenessing (Upper and Lower) Sandstone=Kinzua Sandstone.
	Lower=Sharon=Olean=Garland Conglomerate.
No. X.	Pocono Sandstone=Shenango Sandstone=Sub-Olean=Sub-Garland Conglomerate.
	Other lower sub-divisions of the Pocono.

And as a direct result of this harmony the character and confusing nomenclature hitherto applied to the included coal groups within the Conglomerate formation likewise became straightened out and adjusted as follows:

No. XII.	Homewood=Johnson Run sandstone.	
	Mercer coals=Alton coals of McKean.	
	Upper Connoquenessing sandstone.	Kinzua S. S.
	Lower Connoquenessing sandstone.	
	Quakertown coals=sporadic beds in McKean.	
	Sharon coal group=Marshburg coals of Mc Kean.	
	Sharon=Garland=Olean Conglomerate.	
No. XI.	Shenango shales=black slates of McKean county.	
No. X.	Shenango sandstone=Sub-Olean Conglomerate.	

A vast amount of detailed information concerning the characteristics of these several rock and coal groups is given in the various county reports of the survey; but for the general reader it is sufficient to say of the *Pottsville Conglomerate formation* as a whole, that through all of the Allegheny Mountain district, and to the east (with the exception of the Anthracite coal district) there are no coal beds in it of economical importance. In many places however there are excellent beds of fire clay found associated with this group, especially at the horizon of the top of the *Homewood Sandstone;* whereas in several of the western counties, one or more coal groups, within formation No.

XII. furnish excellent coal to which special value is attached by reason of the geographical isolation of these districts from the other productive coal fields of the State. But even in the western counties each district seems to have its individual characteristics.

In this part of the State, according to the many reports of the present survey, the *Conglomerate Series* is divisible into the following groups:

Tionesta Sandstone (name generally now abandoned)	Clarion sandstone of Indiana Co. Johnson Run sandstone of McKean

Mercer Coal Group.

Connoquenessing Upper sandstone Quakertown Coal group Connoquenessing Lower sandstone	Massillon sandstone of Ohio. Kinzua Creek S. S. of McKean Co.

Sharon Coal Group.

Ohio Conglomerate	Second Mountain Sand of Venango. Garland Conglomerate of Warren. Olean Conglomerate of McKean.

These four sandstone members are now well identified and traced over that extensive area of the State drained by Beaver and Shenango rivers, French creek and the Brockenstraw, the upper Allegheny and Clarion rivers, and also in the anticlinal mountain gaps of Indiana, Westmoreland and Fayette counties.

It is doubtful if all four of these members may be recognized separately along the Allegheny Mountain counties and in the valley beds of the upper Susquehanna. What has been called No. XII there does not actually exceed 200' in thickness; but to this must be added the thickness of the sandstone measures intervening up to the first coal bed of the *Lower Productive* (Allegheny Mountain) *Series*, increasing this measurement to an average of about 275' and thus bringing about a harmony with sections along the Allegheny and Beaver rivers, 100 miles further west.*

* Along the northern New York border the vertical interval from the top of the Johnson Run sand-rock to the bottom of the Olean Conglomerate is but 160', and the two middle members seem to have united in one; but in individual localities the upper member attains a thickness of 70' or 80; the

Its outspread in Pennsylvania is very great, for in addition to forming a high buttress wall around all the Anthracite basins, and protecting the semi-bituminous Broad Top field, it forms the Allegheny Mountain plateau and escarpment from New York to Maryland, cut up whilst encircling the several detached bituminous basins of Sullivan, Lycoming, Tioga and Potter counties, where its flat dips cause it to spread over hundreds of square miles of uplands, creating a wild and uncultivated area.

The great anticlinals of *Laurel Hill* and *Chestnut Ridge* hoist it above the surface from the Maryland–West Virginia line north to the Pennsylvania railroad, while beyond it is exposed along these axes by Black Lick, Two Lick, Yellow creek and many branches of the Susquehanna. Deeply buried in all the south-west corner of the State, the steady rise of all the measures north eastward cause it to be exposed again above water level through a wide belt of country north of Lawrence, Butler and Armstrong counties, whilst thousands of oil and gas wells have served to familiarize us with its section and character to the south of this latitude.

The *Olean Conglomerate*,* or base rock of No. XII, received

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middle 50′, and the lower 80′, which with shale and coal beds between, would make the whole Conglomerate Series about 250′.

In this condition and with this total thickness it is reported to exhibit itself in Armstrong Co. along the Allegheny river. The expansion of this group to 1000′ in thickness in Dauphin Co., with numerous coal beds, only tends to prove the propriety of regarding the sandstone Conglomerates of Western Pennsylvania as one series of which the "Conglomerate" of the Ohio Survey is the bottom (Olean Conglomerate) member.

*In Mercer and Crawford counties, this deposit of sand and quartz pebbles was reported upon by Prof. White under the name of Sharon conglomerate. (Q 3, and Q 4). In Warren and Venango counties, by Mr. Carll under the name of Garland conglomerate. (I 1, I 2, I 3, and I 4). In McKean, Forest, Elk, Cameron, Clinton and Potter counties, by Mr. Ashburner and Dr. Chance under the name of the Olean conglomerate. (R 1, R 2, G 3 and G 4). In Clarion, Butler, Lawrence and Beaver counties, the name Sharon conglomerate is frequently used by White and Chance. In the first development of the Oil Creek region, the drillers named it the "Second Mountain Sand," as its outcrop runs high above the valley bed from which their oil borings were sunk to the *First*, *Second* and *Third Oil Sands*. In middle and eastern Pennsylvania it is represented by the lowest coarse beds of the Pottsville conglomerate, No. XII. For its relationships in Armstrong, Indiana, Westmoreland and Fayette, see preface to report H 5 on Armstrong Co.

its name during the survey of McKean Co. from the magnificent fragment of it at the "Rock City" north of the State Line and west of the town of Olean. It is the most important formation for the local geologist to recognize there, as it furnishes a key or horizontal plane for measurement downwards to the older deposits below it, and especially to the valuable Oil Sands of the Bradford Oil Field, lying about 1800′ beneath it.

Prior to 1876 it was continually confused with the Sub-Olean (Pocono) beneath it and the Johnson Run and Kinzua sandstones above it, with the inevitable result of false identification of the Clermont, Alton and Marshburg coal beds of that region.

At Kane this rock is 60′ thick; at Marien in Forest Co. 98′ thick, whilst at Sharon, on the Ohio line, it is but 20′ thick. Still, with all its local variations, this member of No. XII has been traced with patience and skill all through western Pennsylvania north of the Conemaugh, and eastward even to its final outcrop along the crest of the Allegheny mountain.

A brief review of the several reports of the Survey covering the coal areas of the State permits the following statements:—

*No. XII in the Broad Top Basin: Huntingdon and Bedford Co.'s.**

This formation, forming the rim of the Broad Top plateau and the crest of the spurs which project from it northward into Trough valley:— Ray's hill, Rocky ridge, Shirley's knob, Round knob, Chilcoat's knob, Houck's knob, Boker's knob and Crum's knob—consists of three massive sand rocks, separated by two intervals of shale. A general compiled section would average as follows:—

XII.	Homewood sandstone, slightly pebbly, . .	50′	160′
	Mercer shale and coal bed, ...	20′ to 30′	
	Connoquenessing white pebbly sandstone,	50′	
	Sharon shales and coal bed, ...	5′ to 15′	
	Sharon pebbly sandstone, (Olean Congl.) .	25′	

*See plates CCXI, CCXII, CCXIII.

The *Homewood sandstone* (Piedmont or Johnson Run sandstone of western Pennsylvania) Mr. White assigns a thickness of 50′ along Shoup's run; but Mr. Ashburner's survey of East Broad Top gives it 160′ (see plate), and hence increases the entire thickness of No. XII to 280′*.

The *Mercer coal bed* (Alton coal of McKean Co.) can seldom be seen on account of the débris of its enclosing rocks. It crops on Miller's run above Powell coke works, overlying 10′ to 15′ of impure fire clay. At Robertsdale it proved to be only 1′ to 2′ thick though reported 3′ thick east from Broad Top city.

The *Connoquenessing sandstone* is harder and more massive than the one above it and carries white quartz pebbles through it. It is finely exposed between Dudley and Powell stations and for a long distance up Miller's run, making bold cliffs.

The *Sharon* (Marshburg) *coal bed*, with its fire clay floor, shows under the arch of conglomerate on the Dudley road above Powell station, 1½′ to 2′ thick and a 125′ to 140′ below No. XII.

The *Sharon Conglomerate* is a hard grayish-white sandstone capping Round Top knob near Paradise furnace, 1000′ above Trough creek, and makes conspicuous cliffs on both sides of Shoup's run at Coalmont. In above mentioned plate will be found Mr. Ashburner's measurement and description of the Conglomerate series in the long synclinal ridge of Ray's Hill and Rocky Ridge, in which he recognizes the same division but sub-divides the Homewood sandstone, 160′ thick, into three separate members.

Beneath this he notes the Mt. Savage group, or middle member of the series 40′ thick, with its sub-divisions, and finally the Conglomerate proper, a lower member 80′ thick, consisting of two massive gray sandstone strata, the top one 10′ thick and the bottom 70′, consisting largely of Conglomerate.

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*Whether there really is in fact such a great variation in the thickness of this member in the two basins or some misidentification of the members, it is impossible to say. It is well exposed where Miller's run enters Shoup's run with layers 1′ to 3′ thick.

In *Bedford and Fulton Co.'s* Dr. Stevenson gives the group a thickness of 250′ on Six Mile run.* He notes the presence of the Mt. Savage coal bed about 120′ below the top of the Conglomerate, and from 2″ to 10″ thick. Imperfect exposures of the lower division occur at many places along the southern edge of the coal area in these two counties; and though they afford few details their whole thickness appears to be not far from 125′.

No. XII in Sullivan and Lycoming Counties.

In *Sullivan County* the entire formation is from 100′ to 150′ thick, although a section by Mr. Platt (plate CCXLI) would seem to indicate that this formation is only 70′ thick on the north side of the western end of the Bernice basin, whilst elsewhere in that region being plainly divisible into three members: an upper† conglomerate 30′ thick; a middle sandstone, sometimes massive and sometimes thin, about 100′ thick; and a lower conglomerate, carrying pebbles, known as the "*Shinersville Conglomerate*," about 50′ thick, a total of 180′.

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* Prof. Lesley, in a foot note to this report T 2, page 66, tersely sums up the testimony which had been gathered during the first eight years of the Second Survey concerning the character and thickness of this great sandstone formation in Pennsylvania. He says:

"The geology of the Pottsville Conglomerate No. XII, is now accurately known over all northwestern and northern Pennsylvania. Its thickness is generally about 300′, and its triple division seems to be constant. In the northwest it consists of Homewood sandstone at the top, Connoquenessing sandstone in the middle, and Sharon conglomerate at the bottom. Coal shales, coal beds and sometimes limestones, intervene between these subdivisions (See Reports Q 1, Q 2, Q 3, H 4, V 1, V 2, R 1 and G 4). The three divisions of No. XII are known in the counties east of Warren as Johnson's Run, Kinzua sandstone, and Olean conglomerate, and the Coal Measure intervals continue eastward to the Anthracite region, where No. XII becomes 600′ and 1000′ thick, and holds numerous coal beds, some of them important. At Shamokin the triple division is strongly pronounced.

Adding 170′, the thickness of the upper division to 125′, the presumed thickness in Fulton county of the lower division, we have 295 .

Mr. Ashburner in Report F, page 191, divides No. XII into an upper member 100′, a middle member 40′, and a lower member 80′; total 280′." J. P. L.

† In several places the upper member has been found to enclose a small coal bed averaging 20″ thick; sometimes running as high as 2′, but always worthless.

In *Lycoming Co.* the formation was carefully sectioned at four widely separated places by Mr. Andrew Sherwood (plates CCXIV and CCXV). Usually marking the caps of the hills except in the *McIntyre* and *Little Pine Creek coal basins* in the northern end of the county, its exact thickness cannot be inferred from these sections; and whilst it varies from 70′ to 160′, it may be stated that the whole formation, allowing for erosion, fully equals the latter figure in thickness. It is a coarse white sandstone rather than a distinct conglomerate, although in places containing rounded quartz pebbles as in Sullivan county* to the east.

In the counties bordering on the Allegheny Mountain plateau, the Conglomerate Series is much thinner than it is to the east in the Anthracite district; but still the same distinction prevails between its round pebble rocks, whether fine or coarse, and the flat pebble grains of the underlying Pocono No. X, as in the western counties of the State.

Being of little economic importance along the Allegheny escarpment and through the First and Second Bituminous Coal Basins, it has never been given the careful study and detailed investigation its members have received through the western counties.†

In *Clinton*, *Centre*, *Clearfield*, *Cambria* and *Somerset Counties*, along the western slope of the Allegheny Mountain, it is nearly everywhere a deposit of coarse sandstone and fine grained pebble conglomerate, with intercalated beds of shale, aggregating 250′ to 350′ in thickness.

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* For illustrations concerning the conglomerate and its included coal beds in this district see plates CCXIV, CCXV, CCXLI, II, and III.

†Throughout north-western Pennsylvania the Conglomerate is represented by a group of sandstones, sometimes consisting of two or three beds but more often of four, five or six separate rocks, to which the name "*Conglomerate Series*" has been given. Its sandstones are not even usually conglomerate; but each member of the group becomes *locally* a Conglomerate over some area of the north-western counties. They are generally hard coarse grained, white, yellowish white or grayish white sandstones, rather loose grained, and are often much stained with ferric oxide. The grains of sand, when coarse, are always sharp, bright and clean, giving to the fractured surface of the stone a distinct and easily recognized appearance. Between these individual beds of the Conglomerate sporadic beds of coal, iron ore, fire clay and even limestone are of frequent occurrence. In the western counties these become quite persistent, and in Ohio are so regular and reliable that they have been mistaken for a part of the coal measures proper.

In *Cameron*, *Elk* and *McKean Counties* the series is much more variable in thickness than in the western counties; apparently thicker throughout the oil district, especially in Venango Co., than in Elk and McKean Co.'s, and is thinner along the face of the Allegheny escarpment than at Renovo or Keating, although from Renovo along the Philadelphia & Erie R. R. to Kane its thickness is apparently quite uniform. (McKean plates CCXLVI to CCLIV.)

No. XII in Clinton County.

In *Clinton Co.*, on Queen's run, there is a local replacement of the lower part of No. XII by the Mauch Chunk red shales No. XI, as its total thickness measures but 129′. In less than a mile the shale totally disappears and at its horizon are hard massive sandstones evidently belonging to the Conglomerate measures.

At Farrandsville No. XII shows about 220′ of sandstone, the lowermost 70′ of which has a transitional character, being lithologically neither Pocono nor Conglomerate; but no sign of the Mauch Chunk red shale can be detected on this side of the river. At Glen Union the Conglomerate has a thickness of about 220′.

From Hyner to Renovo and for some distance west, the lower member of the group is a hard massive sandstone from 30′ to 40′ thick, above which there are three massive beds of hard whitish sandstone, parted by bands of soft shale, in all 245′ thick.

At Keating the detailed section is imperfect; but enough was seen to fix the total measurement of the group, consisting of five or six sandstones, at 250′ thick; and a thin coal bed here underlies the top rock of the group, and a bed of bituminous shale or impure coal is found beneath the second stratum. The *Conglomerate Series* may be subdivided in this county as it is in Cameron, Elk and McKean Cos. The following table will indicate the relationship:—

Clinton Co. No. XII.		*Cameron, Elk and McKean Cos.*
Fireclay, containing kidney ore,	10′ 0″	=Johnson Run sandstone.
Shale and shaly sandstone, . .	15′ 0″	
Interval, concealed, ...	4 0″	
Coal No. 3, ...	4′ 0″	=Alton Upper coal.
Interval concealed, ...	26′ 0″	=Alton shales and sandstones.
Gray sandstone, ...	10′ 0″	
Coal No. 2, ...	3′ 2″	=Alton Lower coal.
Hard gray sandstone and shale,	33′ 0″	=Kinzua Creek sandstone.
Coal No. 1, ...	1′ 0″	=Upper Marshburg coal.
Conglomerate, ...	25′ 0″	=Olean Conglomerate.

The 25′ rock at the base of the section is the bottom of the *Pottsville Conglomerate No. XII.* Coal No. 3 has two benches 2′ 8″ thick divided by 1′ foot of slate, and the upper 2′ bench was regarded as the best coal ever found on the Karthaus Coal and Lumber Co. property.*

Coal No. 2 was drifted upon at four points and found to yield three benches 1′ 9″, 0′ 9″ and 0′ 3″ separated by slate and bony partings of 3″ and 2″. Coal No. 1 was found only 1′ thick.

No. XII in Centre County.

In Centre county the Pottsville Conglomerate series, 250′ to 300′ thick, do not call for any extended notice. The measures are but poorly exposed along the Allegheny escarpment, owing to the flat dip of the rocks and the consequent concealment by détritus, there being also no large streams, except Beech creek, cutting through these measures along their eastern outcrop.

Along the Susquehanna and Moshannon creek north of Peale their thickness and character can be better studied, although no detailed section of them can be made here at any individual points.

An intra-conglomerate bed, 8″ thick, is exposed in a cut of the Beech Creek R. R. to the east of Briartown summit, occurring about 60′ below bed A. This is the same bed seen over the east entrance to Moshannon tunnel; but it nowhere seems to reach mining thickness or importance. The top member of the Conglomerate exposed in the tun-

*The Company drilled a bore hole on this property 207′ deep, a record of which will be found in detail in G 4, page 78.

nel is rather soft and shaly, but mostly of a fine grained gray sandstone with coal specks, and bearing many good fossil imprints. Along Beech creek the hills are largely capped with the Conglomerate rocks ; but they are nowhere well exposed here for measurement. A coarse conglomerate occurs between Cato and Snow Shoe, geologically associated with the lower portion of the formation, which makes a rugged terrace about 300′ above the creek further east along Counsel run.

On the Susquehanna along Yost's run the group is composed almost entirely of sandstone and shales, with very little conglomerate near the bottom. The general character of this series in Centre Co. therefore is largely sandstone, intercalated with beds of shale with a conglomerate layer, 25′ thick, (Olean conglomerate) near the base.

*No. XII in Clearfield County.**

In Clearfield county conglomerates rarely predominate in the *Conglomerate Series* which is for the most part composed of false-bedded sandstones and shales. The top rock of the series, immediately beneath the Blue Ball fire-clay, is often a coarse conglomerate. This is its character in many parts of Bradford, Graham and Morris townships. It is doubtless the Homewood sandstone.

A coarse conglomerate, with pebbles sometimes as large as a walnut, sometimes occurs at the base of the series. It is seen along the lower part of the Susquehanna river. It may be considered as the representative of the *Olean conglomerate.*

However, neither of these rocks exist *as a conglomerate* over a large area. They are both frequently replaced by sandstone, which may be massive and white, false-bedded, fine-grained and yellow, or even a shaly gray rock, while in many localities they are almost entirely replaced by shale.

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*The Conglomerate No. XII series occupy the bed and sides of the whole length of the Susquehanna river except for a short distance in Bell twp.; Clearfield creek from Knox twp. north ; the Moshannon from Morrisdale north ; all the valleys on the north side of the river ; a belt of high land 3 or 4 miles wide along the Second axis from the north-east corner of Boon twp. north-eastward into Elk Co.; and most of northern Girard, northern Covington and Karthaus twps.

A group of current-bedded sandstones and shales occurs between these two rocks. It may be recognized as the representative of the *Connoquenessing sandstones*. Sporadic beds of coal, sometimes locally of workable thickness, are found in this group. Between the Homewood sandstone, or upper member of the Conglomerate, and the Connoquenessing sandstone group, we find the attenuated eastern representative of one of the Mercer group of coals.*

At many localities along Clearfield creek, and along the Susquehanna river and its main branches above Clearfield, this coal has been found at or near water level. It is commonly not more than 1′ 6″ to 2′ 6″ thick. The Sharon coal has not been recognized in this county. It is probably quite thin or entirely absent.

The thickness of the *Conglomerate Series*, from the fire-clay under bed A down to the red shale of No. XI, may be considered to range from 275′ to 325′.

No. XII in Cambria and Somerset Counties.

In Cambria and Somerset counties, completing the tier of counties lying immediately west of the Allegheny Mountain escarpment, the *Conglomerate Series* creates an important topographical feature; but as this district was among the first reported upon (1874) there was little effort made to classify the series or to distinguish the special characteristics of its members.

In addition to forming the crest of the Allegheny mountain from Gallitzin to the Maryland line, it surrounds the Salisbury basin in the extreme south-east corner of Somerset Co; is exposed along Clearfield creek and its mountain tributaries in Cambria Co. for a dozen miles; is hoisted to daylight by the Viaduct axis along the Conemaugh and Stony creeks; forms both sides and frequently the back bone of Laurel Hill from Black Lick

*At a few localities along the Susquehanna and Moshannon creek a coal of workable size has been found at this horizon. It was worked many years ago, and the coal was shipped in arks to the markets in central Pennsylvania. These openings have long since fallen shut and the coal cannot be measured. It is reported as a three or four foot bed.

creek in Cambria Co. to the Castleman river and is similarly exposed along Negro mountain in Somerset Co. south of the Baltimore & Ohio R. R.

At Bennington, along the Blair Co. line, it is 200′ thick. At South Fork village in Cambria it is a compact fine grained sandstone, not exceeding 250′ in thickness. It forms cliffs along Paint creek in Somerset Co. from Stony creek to Scalp Level and outcrops along Shade creek from its mouth to its source. Along Laurel Hill, forming the dividing line between these two counties on the east and Indiana, Westmoreland and Fayette counties on the west, it forms the cap rock all the way from the Maryland line to the Conemaugh gap west of Johnstown. It is largely a massive siliceous sandstone, but not uniform throughout; it ranges from a fine grained, compact, massive greenish sandstone to a coarse conglomerate, made up wholly of smooth, rounded, quartz pebbles, held loosely together by a siliceous bond.

Three quarters of a mile west of Mineral Point in Cambria Co. a thin seam of coal, separated into two benches by $1\frac{1}{2}'$ of fire clay shale, occurs in the conglomerate; but it is commercially worthless. At Cherry Tree, in the northwestern corner of Cambria Co., an old gas well was bored into the Conglomerate Series, which appears to have a triple character here, as follows:

Well Record at Cherry Tree.

No. XII.	Massive hard sandstone, ...	75′ 0″
	Shale, ...	20′ 0″
	Sandstone, ...	40′ 0″
	Sandstone ? (hard boring), . . .	68′ 0″
	Very hard flint rock, ...	1′ 6″
	Massive sandstone, ...	20′ 0″

In *Somerset Co.*, along the Allegheny mountain, No. XII occasionally appears as a coarse conglomerate, made up of rounded quartz pebbles, with a loose siliceous cement; elsewhere the formation is a massive sandstone, with minute, distinct and separate grains of sand; and sometimes the rock passes by insensible gradations from fine grained to coarse grained, and from coarse grained to pebbly character and *vicê versâ.*

In the Wellersburg basin the Conglomerate Series are represented in Gladen Run gap by about 300′ of measures from the Piedmont or Homewood sandstone on top to the red shale members of No. XI in the gap. In the first 75′ there are three sand rocks, 3′, 22′ and 22½′ thick, with shales and fire clays between them. The next 90′ consists of slate with sporadic thin coal beds and a large 10′ bed of fire clay. The bottom member of the conglomerate is estimated at 35′, largely a massive sandstone.

No. XII in Bradford and Tioga Counties.

The outcrop of the Pottsville Conglomerate, as delineated on the recent State map in these districts, extends beyond and encloses the patches of workable coal, and as elsewhere in the State, gives a very erroneous idea of the *workable coal areas* of this region. The edge of the conglomerate is often a vertical cliff, forming the cornice of a mountain wall descending abruptly into a valley or ravine. At Falls creek the Pottsville Conglomerate is about 160′ thick, quite coarse and seen in precipices along Falls creek and along the valley of Schroeder's creek.

It shows along the south rim of the Blossburg basin as a massive grey sandstone, filled with pebbles of rounded quartz, mostly pea size, and occupies a wide area in the uplands, on both sides of the Babb's Creek valley and along the several important branches thereof.

The *Conglomerate* possesses a very marked character of its own in the Gaines Coal Basin* in Tioga Co. and on Pine creek in Potter Co. to distinguish it from other rocks in this basin. At some points it contains pebbles of quartz; at others it is a hard, white, quartzose sandstone with a very uniform thickness of about 30′. At Long run, instead of capping the hills, the basin has deepened sufficiently to cap this rock with over 190′ of coal measures.

In the McIntyre basin the Pottsville Conglomerate seems to consist of a top member of fine grained massive sand-

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*See plate CCXLV, page 1728.

stone 10′ thick, and a lower member of pea conglomerate, very massive, with pebbles of white quartz, 60′ thick. It occupies a great area and so far as seen, holds both the above character and thickness over a wide section.

*No. XII in Potter County.**

Mr. Platt summarizes the conditions in Potter county as follows: "The *Pottsville Conglomerate No. XII*, is found in parts of Pike, Jackson and West Branch twps., (in the western continuation of the Gaines coal basin of Tioga Co.); in a small area in the southeastern part of Sweden twp.; occupies part of Eulalia twp. in the Coudersport basin; and may possibly come into the highest hill tops in Abbott and Sylvania twps., but only along the center line of the synclinals." The surveys of Cameron and Clinton Co's. show that Nos. XI and XII pass over into Potter Co. along the south and south-west border, especially prominent along the north side of Kettle creek. (See plate CCXL.)

No. XII in McKean County.†

The *Pottsville Conglomerate* here contains the Alton coals, and is therefore represented by the Johnson Run sandstone, Alton coal group, Kinzua Creek sandstone, Marshburg upper coal rocks and the Olean conglomerate,

* In 1876 the special geology of the conglomerate formation of No. XII in Potter and other northwestern counties was very little known. Its division into Homewood sandstone, Connoquenessing sandstone and Sharon conglomerate west of the Allegheny river, or into Johnson Run rock, Kinzua Creek rock, and Olean conglomerate in McKean Co., was not proved until 1879. Neither was the strong distinction drawn between the Olean conglomerate as the base of No. XII and the sub-Olean as the top of No. X, suspected. Consequently the map accompanying the Potter Co. report greatly exaggerates the horizontal spread of both the Mauch Chunk red shales and the Conglomerate, as well of course as the overlying coal measures, all of which has been largely corrected in the final State map accompanying this report.

†The McKean County report was among the earliest prepared and issued by the Survey and was accompanied by an atlas containing a general geological map of the whole county and by detailed topographical maps of its three most important local coal basins; first, the *Potato Creek coal basin* in Norwich twp.; the *Clermont basin* in Sergeant twp.; and the *Alton coal basin* in Lafayette, Bradford and Hamilton twps. All these maps delineate the outcrop of the top of the Kinzua sandstone; and the distinguishing success of the investigations made for this report was the breaking up of the old indefinite "Formation No. XII" into a group of well defined sand

in descending order, having an aggregate thickness of 190′ to 210′. (See plate CCXLVIII et seq.)

Mr. Ashburner, regarding the Alton coal group as an integral part of the Conglomerate, suggested the following comparison of the measures with those reported by Carll in Venango; Chance in Clarion and northern Butler and White in Mercer and Lawrence Cos.

	McKean Co. group.	*Venango, Clarion, Mercer Co. group.*
No. XIII	Clermont limestone.	Ferriferous limestone.
	Clermont coal.	Clarion coal.
	Absent.	Clarion sandstone.
	"	Brookville coal.
No. XII	Johnson Run sandstone.	Homewood sandstone.
	Alton Coal group.	Mercer Coal group.
	Kinzua Creek sandstone.	Connoquenessing sandstone.
	Marshburg Upper coal.	Sharon coal.
	Marshburg Lower coal.	Absent.
	Olean Conglomerate.	

The work of these observers seems to prove that the Homewood sandstone of the south-west, or top member of No. XII, is the extension of the Johnson Run sandstone of the north-west. In McKean the Alton coal group directly underlies this Johnson Run rock; in Mercer Co. the Mercer coals occupy the same relative position to the Homewood sandstone, indicating the identity of the Alton and Mercer coal groups. Of the bottom (Olean) member Prof. Lesley states:

"The Olean conglomerate received its name during the survey of McKean Co. from the magnificent fragment of it at the rock city north of the State line, west of the town of Olean. (Plate CCXXXVIII.)

It is the most important formation for the local geologist in that district. It occupies the highest hilltops and tablelands of the county, and crops out so boldly at a multitude of places, and is so characteristic in its appearance, that it can be identified from township to township. The pro-

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rocks and coal intervals and the determination that only the lowest of the Lower Productive Coal Measure beds existed, and these always variable. Inasmuch as this latter group has no commercial value attached to its coal in this county, the bituminous deposits might, for all practical purposes, be treated in connection with the Pottsville Conglomerate Series No. XII. See plates CCXLVI to CCLIV.

tracted topographical survey of the county furnished the altitude above tide of almost every point of its exposure, and these altitudes, when compared together, furnish the best possible instruction respecting the underground structure, the dip and strike of all the formations, the size and direction of waves and basins. It has, therefore, for many years, indeed since the first reconnoissance survey in 1841,* played an important role in the geology of McKean. But until the more recent thorough topographical survey of the county, the outcrops of the Olean were continually confused with and mistaken for the outcrops of the sub-Olean beneath it and of the Kinzua Creek sandstone and Johnson Run sandstone above it, with which it formed the Great Pottsville Conglomerate No. XII, and on this account the Clermont coal over the Johnson Run sandstone was confused with the Alton coal over the Kinzua Creek sandstone, the Marshburg upper coal over the Olean conglomerate, and the Sharon (Marshburg lower) coal over the sub-Olean conglomerate.

The Olean rock generally consists of a loosely cemented, white or gray pudding stone, its round pebbles ranging in size from a pea to a goose egg, lying in a matrix of coarse sand grains, not as sharp or angular as those which make the matrix of the Kinzua Creek sandstone next above it in the series; and this feature may help to distinguish them.† Its thickness as a formation is pretty uniform over

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* Prof. J. P. Lesley's survey of 1841 was merely a reconnoissance through an unbroken wilderness in which no distinction could be made between the Conglomerate outcrops; and his notes were used, in the final report of 1858, by Prof. Henry D. Rogers. At that time the Pottsville conglomerate, No. XII, was supposed to be to all intents and purposes a solid mass underlying all the coal beds, but having here and there the Ralston coal bed underneath it. Prof. James Hall's report of 1853, Dr. Salisbury's in 1854, Mr. Allen Putnam's in 1854, Mr. Peter W. Sheafer's in 1855 and 1856, Mr. A. F. Dalson's in 1856 and 1857, Dr. David Dale Owen's in 1856, the McKean Co. Railroad's in 1857, Mr. Putnam's in 1864, Mr. Joseph Lesley's in 1868, Mr. Ira Winan's in 1875 and 1877, did much to bring order out of the old confusion, and were all used in the survey of their respective localities in the surveys of '76, '77 and '78 by Mr. Ashburner. See preface to report R, page VIII, IX.

† The pebbles are invariably, so far as the results of surveys show, round or egg-shaped, in marked contrast to the flat or cake-shaped pebbles of the

special areas, but varies when traced across the region. The layers of which it is composed are thick and massive, but vary greatly in individual thickness and in character, changing from pudding-stone to thin and current bedded sandstones, wedging out to nothing in various directions. The sand layers lying between the pebbly layers are frequently steeply current bedded.

The picturesque rock cities, into which the patches of Olean conglomerate left by erosion on so many hilltops break up, consist of immense pavements of isolated, cubical blocks of rock with vertical faces 30′ to 40′ high, separated by fissures from top to bottom, varying from a few inches to 4′ or 5′ in width, and usually distant 20′ to 40′ from each other."* (See plate CCXXXIX.)

There is a difference of elevation above tide of 682′ between the exposure of Olean conglomerate on Prospect Hill in Keating twp., and at the Hukill Dry Hole, in Wetmore twp., and the formation continues to sink southward into Elk, Forest, Venango, and so on down the Clarion and Allegheny rivers to the bottom of the great depression under Greene Co., in the south-western corner of the state.

The thickness of the Olean conglomerate at Kane is about 60′. At Marien, in Forest Co., twenty-two miles south-west of Kane, the record of the Towler & Hunt well, No. 3, shows pebbly sandstone, 98′; blue slate, 25′; sandstone, 70′; total, 193′. Even if the pebbly sandstone alone is regarded as the representative of the Olean, the increase of the formation in that direction to 98′ is remarkable, and shows what variations it is subjected to locally underneath all western Pennsylvania.

The *Third Bituminous basin*, enclosing the Norwich or Potato Creek basin, is identical with the Coudersport syn-

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sub-Olean; and there is no tendency in the Olean mass (as in the sub-Olean) to sub-divide into flagstone; nor does the Olean contain clay-iron balls or show red and ferruginous; nor are there any coal streaks in it. (See plate CCXXXIX.)

* In various parts of Pennsylvania, the great blocks of Mahoning sandstone may be seen slid down gentle slopes in the direction of the dip to a distance of many yards from the places which they originally occupied.

clinal in Potter Co., and the St. Mary's, Toby creek or Dagus Coal basin in Elk Co.

The *Fourth Bituminous basin*, containing the local Clermont basin, is the Oswayo synclinal of Potter and the Johnson Run basin of Elk Co. The Norwich anticlinal divides these two basins, while the Smethport axis separates the latter from the Alton basin, which under the name of the *Fifth Bituminous basin* has been considered to include all that portion of western Pennsylvania west of the Brady's Bend anticlinal.

The *Lower Productive Measures* have only a thickness of 140′ and contain but two commercial coal beds, only one of which has ever been mined; the *Clermont coal bed*. (See plate CCXLVII A.) The *Dagus bed*, the upper of the two, has been referred to the horizon of the Kittanning Lower bed B, underlying about 50 acres in the Clermont basin and ranging from 2½′ to 3′. In the Alton basin the hills are not sufficiently high to include this bed; but at Clermont, where the section is exceptionally small, the Dagus coal occurs only 12′ above the Clermont (Ferriferous) limestone.

The Clermont bed is found from 60′ to 70′ beneath the Dagus bed, separated from it by an interval of sandstone and slate and has usually been regarded as the representative of the Clarion coal.

The *Alton Coal Group* is the most extensive and probably the most important in the county; for with the exception of very small areas of the Clermont and Dagus beds, it includes all the coals which are of commercial value. The group consists principally of shale, slate and fire clay, containing generally three distinct beds of coal; the *Alton upper bed*, the *Alton middle bed* (Alton coal) and the *Alton lower bed*. Rarely more than one bed is sufficiently thick in one locality to be workable, and nowhere in the county have any two beds been worked, one above the other. In the Alton basin the whole group is from 30′ to 35′ thick; at Clermont it is only 20′ thick. (See plates CCXLVII et. seq.)

The *Alton upper coal** has been worked in the old mine at Buttsville and by the Buffalo Coal Co. near Clermont, consisting generally of one solid bench. In the Potato Creek basin, east of Norwich, the bed has been opened at the Blue, Spring and Rochester Cannel mines. Its thickness ranges from 2′ to 3½′.

The *Middle coal*, or Alton bed proper, is generally separated from the top coal by 5′ to 12′ of fire clay, slate or shale; but unlike the upper coal it is invariably made up of two to four distinct benches of coal. It is only mined in the vicinity of Alton, in Lafayette twp.; hence its name. It is from 4′ to 8′ thick including its slate parting, and seems to be generally absent in the Clermont basin, though represented in the Potato Creek basin by the Hamlin bed. The *Lower coal* lies immediately on top of the Kinzua sandstone and has its maximum development in the eastern part of the county, rapidly deteriorating both in thickness and quality to the west. In the Norwich basin it has been opened at the Hamlin, Splint and Lyman Camp mines, with an average section 4′ thick; but in the western basins it is represented by very thin and sporadic coal beds. All of the beds of this group are characterized by irregularities in thickness and quality, and are frequently entirely removed by erosion, the stream bed being subsequently filled in by material which has formed a fire clay or rotten shale, sometimes a sandstone in the upper part of the coal bed.

The *Marshburg upper coal*† (Sharon) is always sporadic in its occurrence and is found at an average distance below the top of the Conglomerate of 125′ or about 170′ below the top of the Clermont (Ferriferous) limestone‡. This coal has been opened in a number of places in the Alton and

*It is the representative of the "Tionesta coal" of Rogers' final report and of report Q 2 page 55.

†Occupies a position beneath the Kinzua Creek sandstone or Middle member of the Pottsville Conglomerate, and may possibly represent the Quakertown coal of reports Q 2 and Q 3.

‡In Lawrence Co. it lies from 250′ to 300′ below the same horizon, a portion of this excess of thickness being absorbed by the Brookville coal and shales between this bed and the Clarion coal and to a general thickening of the Conglomerate series, No. XII being 125′ thick in the vicinity of Marien, Forest Co.

Clermont basins, but never worked to any extent. It is too thin and too poor to be profitably mined and has many features which characterize its representative, the Sharon bed in Mercer Co.

The *Potato creek basin** in Norwich twp. shows a total vertical section from the bottom of the Olean Conglomerate to the highest stratum overlying the limited area of the Dagus coal of about 290′.

The Dagus coal, while known as a 5′ bed, is generally dirty and without area. The Clermont coal is thin and worthless.

The Alton group, 20′ thick, shows a minimum development of the *middle coal* in this basin, while this bed has its maximum development in the Alton basin. Only two coals therefore show in this section; the *Alton upper bed*, perhaps 2′ 6″ to 2′ 10″ thick, sometimes showing a cannel structure, and the *Alton lower bed*, with an average thickness of 4′ in two benches, split by a foot of black slate.

In the Clermont basin the total vertical section of the Coal Measures (including the Conglomerate No. XII) is 285′, a general section of which is given in plate CCXLVII B, page 1734. The Dagus coal is assigned a thickness of 2′ 9″ and the Clermont coal 2′ 11″. In the Conglomerate series the Alton upper coal is found 2′ 3″ thick and the Alton lower coal 3′ 6″. The Dagus coal however has been found only in the high knoll between the head waters of Red Mill creek, Beaver run and Instanton creek. The

*See plate CCXLVIII. McKean Co. contains the most northern outcrop of the Appalachian coal basin of the United States, and the nearness of its coal fields to the northern markets of New York and Canada has led to much investment in coal mining there. But the area colored on the map as being underlaid by the *Lower Productive Coal Measures* very far exceeds the area of the country underlaid by workable commercial coal beds. The *commercial area* is confined to Lafayette, Hamlin, Sergeant, Norwich and Wetmore twps., but only in Lafayette and Sergeant twps. has coal ever been mined for shipment outside of the county. A table of analyses of the McKean Co. coals is given in report R page 83 which clearly shows their variable character and their generally high percentages of sulphur and ash. They almost all show a volatile matter constituent of over 30%, showing them to be coals with a coking tendency, with high volatile matter; but only three samples show a percentage of sulphur under 1%, while ash averages about 10%.

Clermont coal, in this township, has proven to be one of the most important beds in the county. It varies from 2′ 4″ to 3′ 6″ with a possible average of 3′; but it carries usually high sulphur and ash. The Alton upper coal is generally in one bench 3′ 0″ to 3′ 6″ thick and has been so opened and mined by the Buffalo Coal Co. on the east side of Instanton creek, where it carries an inch of bone coal 0′ 8″ from the top. The Alton lower coal has usually two benches separated by from 2″ to 8″ of slate, with an entire thickness ranging from 2′ 6″ to 4′ 0″; but it has never been mined for shipment.

In the *Alton basin* in Hamlin twp. the section extends from a little above the horizon of the Dagus coal and is about 275′ in thickness (See Dalson's section plate CCLIII). The number of coal beds in this township may be reduced to three; the Dagus bed (No. 12 of the section); the Clermont bed (No. 10) and the Alton Middle bed (No. 7). The area covered by the Dagus bed is very limited and outside of the Howard Hill region* there are but few detached areas which are underlaid even by the Clermont coal bed.

In Lafayette twp. the section is somewhat less than 250′, including the Conglomerate measures (see Fig. 80, plate CCXLVII B). The Clermont coal bed shows a variation from 3′ 6″ to 4′ 0″ in thickness, generally in one solid bench with occasionally a small slate binder towards the top. This bed has been mined on the Davis, Newell, Bullock, Root and Whitman farms at elevations of over 2100′ A. T. but it is subject to many variations which affect its value as a commercial coal producing bed.

The *Alton* (Mercer) *coal group* contains the principal coal beds in the township. The upper bed has an average thickness of 2′; the middle or Alton coal, 12′ below, a thickness of from 4′ to 7′, composed of two or more benches; and the lower coal has two or three thin layers, varying in total thickness from 1′ to 3′, but extremely sporadic. The upper coal has been worked in the old Buttsville mine, but it is subject to more local variations and is more treach-

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* Illustrated in plate CCXLVI, page 1730.

erous to mine than the Alton bed. However the partings in this latter coal reduce its workable size to about 3′ and as such it has been mined extensively at Alton and Bond Vein. The Marshburg coal beds, although only locally deposited, seem to be well defined over a considerable area south and south-east of Marshburg.

The *Longwood Coal Co.'s* mine on the Alton coal at Bond Vein has been longer and more continuously worked than any mine in the township; but the variations in the bed in the same mine will be clearly shown by the two following sections:

Rush Entry.		*Maloney Entry.*	
Slate roof, ...	good.	Rock roof, ...	good.
Coal, ...	1′ 9″	Coal, bony, . .	0′ 6″–0′ 8″
Slate (2″ to 11″), . .	0′ 2′	*Coal*, ...	1′ 9″
Coal, ...	1′ 0″	Fire clay, ...	0′ 9″
Slate and coal, ...	0′ 8″	*Soft coal*, ...	1′ 5″
Sandstone, ...	1′ 4″	Black slate, ...	0′ 6″
Coal, ...	1′ 6″	*Coal*, ...	1′ 2′
Fireclay.		Hard fire clay, . .	1′ 0″–1′ 6″

The average section would show about 4′ 0″ of coal which it is possible to mine, out of a total thickness of about 6′ 0″.

Both the middle and upper benches show over 1% of sulphur and the lower bench nearly 3% while the ash percentage is respectively 13.79, 8.55 and 16.50%. In the Seven Foot Knoll, in the extreme south-eastern portion of the Alton basin, the Alton coal bed shows an average thickness with slate partings of 7′, in three benches 2′ 4″, 1′ 0″ and 1′ 4″, with partings of 1′ 4″ and 0′ 10.″

Various drill holes have pierced this coal bed in this and other parts of Lafayette twp. and generally found the bed in three benches and without any improvement in character. (See plates CCL. and CCLI.)

In *Wetmore twp.* the Clermont coal has been opened in a number of places in the Kane locality and along Big Level road, toward Howard hill; on the Coon lot, opposite Oberg's house and in several places in Wilkin's field; but in no place is this bed of sufficient thickness and purity to prove a commercial coal. This latter statement in fact can be applied equally well to all other coal beds of the Series in this township.*

No. XII in Cameron, Elk and Forest Counties.†

In Cameron Co., the Alton coals of No. XII have been opened in the vicinity of the Cameron Coal Co.'s property on Canal run. In the Sherman mine one bed of this group, opened 35′ to 40′ below the Clermont coal of the Lower Productive Series, shows 3′ thick, generally in two benches; but this bed, as well as other coals of the Alton group in this part of the State, contain much ash; are generally sulphurous and much inferior to the overlying beds.

On Sterling run and its branches the Alton beds have likewise been opened, the upper reported 3′ 8″ thick but containing considerable sulphur and burning with a great deal of clinker. It is the equivalent of the Star vein at Mt. Hope. The middle coal is only 1′ 8″ thick. The Marshburg bed has a section of 3′ on the Cochran branch and was also opened in Tannery Hill 30″ thick.

At Sinnemahoning there are three bands of coarse grained sandstone included in an interval of 200′, capping the highest hills and containing no coal beds, which represent the Conglomerate Series. At Cameron there is a thickness of sandy measures nearly 200′ underlying the lowest coal bed, and as this bed probably belongs to the group, this measurement may be increased to 250′.

The *Pottsville Conglomerate formation No. XII* is 161′ thick at St. Mary's and is composed of the following strata:

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* Other portions of the county, as indicated by the colored geological map in report R, record the occurrence of detached areas of the Lower Productive Coal Measures; but none such have hitherto proved to contain deposits of commercial coals and are of more importance geologically, as indicating the former extent of the ancient coal bearing swamp than as being areas of merchantable coal.

† In the report on these counties, the Pottsville Conglomerate Series No. XII is described and illustrated in connection with the next higher Lower Productive Series No. XIII, the principal coal beds of the several geological basins being confined largely to the latter group.

1. Johnson Run sandstone and shale,	32′ 0″
2. Alton upper coal bed,	2′ 7″
3. Shale,	18′ 0″
4. Alton lower coal,	3′ 0′
5. Kinzua creek sandstone,	45′ 0″
6. Shale and coal,	10 0″
7. Olean conglomerate,	50′ 0″

The Johnson Run sandstone is thinner here than at any point in the county except on the Field tract in Jones twp.

The Alton coal beds have never been found of sufficient purity to prove workable, though the upper was opened on the Keystone tract, but abandoned on account of slate.

The Johnson Run sandstone forms one of the most striking geological and topographical features in this basin and has therefore given its name to the top member of the Pottsville Conglomerate No. XII throughout these northwestern counties of Pennsylvania. The Clarion coal frequently immediately overlies it, and the Alton upper coal immediately underlies it, which may largely account for the variation of bed section in this latter coal bed. The strata between the coals are composed of a rather massive fine grained ferruginous sandstone, alternating with shale and slate; frequently conglomeratic, but the pebbles are small and scattered. The boldest outcrops of the rock are found along the slopes of the east Clarion creek valley, most particularly near the headwaters of Swamp and Burlingame runs where "Rock Cities" are formed of great beauty and prominence. The sandstone formation averages 80′ thick.

North of Benezette on the waters of Spring run, the three coals of the Alton group have been opened. The Alton upper bed varies from 2′ 8″ to 2′ 10″; but the same bed at the head of Autens run is stated to be 4′ thick and on Spring run 3′ 9″, with an average of not far from 3′. The Alton middle coal likewise varies from 2′ to 4′ and is locally known as the "Split bed."

The Alton beds, where they have been opened, have been found of sufficient thickness to be economically mined, and in places contain coal of sufficient purity to produce a good fuel; yet the character of these beds is such that little dependence can be placed on them either as to thickness or character of coal for extensive mining operations.

In the Caledonia basin in Jay twp., the Alton beds attain importance also, especially the Middle bed, which shows 3′ 10″ thick on Spring run, where it contains an exceptionally low percentage of ash (4.670%) though its sulphur runs over 2%. It also shows in good condition at the Turkey mine, ½ mile above Weedville, where it contains 3′ 6″ of good clean coal, with 6″ of poor sulphurous coal on top, not mined.

Both the upper and lower Alton beds have been opened on the Monastery lands north-west of St. Mary's, but nowhere showed over 2′ thick. The Scahonda tract contains a limited area of the Alton beds in four prongs of elevated table land north of Scahonda Station ; but these coals are here worthless.

In Fox twp., the Conglomerate and Alton coals foot up about 166′ of measures. The only place in the township where the Alton beds have been practically worked is on the Conner tract on Mill run, where both the upper and lower beds were mined for some time by Mr. D. Eldridge. The coal produced a slaty and poor fuel ; the beds were subject to many local variations in thickness and character, rendering mining very uncertain. The lower coal consisted of two benches 1′ 8″ and 1′ 3″ thick separated by a slate parting 2″ to 3″, the upper bench producing the better coal.

The upper Alton bed showed three benches, 1′ 2″, 1′ 6″ and 1′ 6″ thick with partings of 0′ 3″ between the benches, but always variable. Along Laurel run the same two coals were found 12′ apart, the upper, 2½′ thick and the lower 3′ thick ; and in the Connor mine the sections were respectively 2′ 10″ and 3′ 8″ thick, the lower coal holding a parting in the middle 4″ to 6″ thick. This bed also occurs on the Kersey Coal Co's. land.

In Jones, Ridgeway and Spring Creek twps., enclosing the *Fifth Bituminous Basin*, the Alton group is represented by two beds, separated by 18′ of rock. The upper Alton coal, called locally the "Lower Cannel coal" has been measured 3′ thick and the lower Alton seam or "Shaft bed" has been opened on the east side of the road leading from the Bucktail mine to St. Mary's with a section 3′ 6″ thick.

In the Silver Creek portion of the Fifth Basin, the Conglomerate measures are 280′ thick.

The Alton beds are represented in the section with assigned thicknesses of 3′ and 4′ respectively ; but neither of these beds is pure or persistent in character and they are doubtful commercial assets at the present time, always variable in thickness.

Around Montmorency, in the Johnson Run basin of Ridgway twp., the Johnson Run sandstone is given as 40′ thick, beneath which come the two Alton coals, 3′ and 4′ thick, separated by 15′ of rock. With the exception of several small areas in the northern part of this township, none of the coal strata above the Johnson Run sandstone are found to exist ; and as no dependence can be placed on the coals of the Alton group and Marshburg beds for practical mining, the township has but little commercial value.

The *Wilmarth coal tract*,* on the ridge between Clarion river and Little Mill creek, has furnished a considerable amount of coal for market from a mine known as the Glen Mayo colliery. There has been considerable diversion in the views of local geologists as to the identity of this bed and the value of the tract for mining purposes. Mr. Ashburner's investigations led him to identify it as the Alton lower coal bed, occurring immediately on top of the Kinzua Creek sandstone.

It is a seam of coal largely divided by numerous bands of slate. In the main area the total thickness varies from 4′ to 5½′; but it carries so many slate partings as to render its commercial value problematical. Below the coal bed which is mined occurs a second coal bed about 4′ thick, which has a cannel structure and contains numerous layers of black slate. The interval between these beds is about 40′ making

* A map of this tract, showing two small areas underlaid by the Glen Mayo coal bed, and constructed by Mr. J. H. Mayo, is given in Rep. R 2 page 136, as well as various vertical sections of the bed.

the latter the representative of the Marshburg upper coal.

In the smaller area along the old Montmorency road the Alton lower coal is 3′ 11″ thick, the top 0′ 9″ being very slaty; but whether this is the characteristic section throughout this area it is not possible to say as the coal was seen at but one point.

In Spring Creek twp., around Irwin Mills, the Alton upper coal is 4′ 5″ thick and the Alton lower coal 3′ 2″, with an interval of 28′ between them. As opened by Mr. Irwin the upper bed shows two coal benches 1′ 6″ and 0′ 8″ thick, separated by 0′ 4″ of slate, and on top 1′ 6″ of bony coal. The Alton lower coal shows 2′ of fair coal capped with 2′ of black slate and bony coal. Both beds have however very much the same inferior character here as observed elsewhere in the district. Their coal is generally poor and cannot be mined or sold at a profit in an open market.

*No. XII in Forest County.**

A general vertical section of the coal measures found in the county, and more particularly in Jenks twp., shows a thickness of 334′ 3″, all but 52′ 3″ of which on top of the section, containing the Clarion coal bed 2′ 3″ thick, is referred to the Conglomerate series, containing the Alton upper and lower beds and the Marshburg coal. Nowhere is the surface of the county believed to be high enough

*The most striking feature at first glance, affecting the study of the coal measures is the fact that most of the high summits in this county were immediately underlaid by a sandstone or conglomerate. The geologists of the First Survey and those who followed them in private examinations, noted the fact that there was more than one sandstone and conglomerate bed in the county; and in endeavoring to present a satisfactory differentiation of the group, the most prominent sandstone found in the Tionesta valley was given the name of the "Tionesta Sandstone." This name has not been recognized by the Second Survey as designating any special strata; it had produced great confusion in the stratigraphy of the coal measures and should be expunged from all the sections. It was formerly applied indifferently to one or the other of the three distinct members of the Pottsville Conglomerate Formation No. XII; but since the records of a number of oil wells sunk in this region have definitely proven the triple character of this formation, having now distinct and separate names, there is no longer any good reason to maintain the name "Tionesta sandstone" for any part of the group.

geologically to contain the horizon of the Ferriferous limestone. Stratification is everywhere quite level; but although this fact produces a wide outspread of the Conglomerate Series over the whole county, except where they have been eroded along the Clarion river and the valleys of Tionesta creek and the Allegheny river, the commercial area is exceedingly small, if existing at all. The beds are thin and variable* and their occurrence sporadic.

No. XII in Jefferson County.

Of the whole series, the most persistent and readily recognized members are the *Homewood sandstone*, the *Mercer shales* and the *Connoquenessing upper sandstone*. The former is especially prominent in northern Jefferson, averaging 50′ thick, massive coarse-grained and sometimes pebbly as it is in north Indiana, Clarion and Armstrong Cos.†

Although in Elk and Cameron Cos. there are generally two or three of the Alton beds found, in Forest Co. the same horizon furnishes but one coal which has been designated the Alton upper bed. The facts obtained from the various developments have seemed sufficient to enable it to be asserted, that the coals of Forest Co. have no practical value.

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*Frequent references to the varying characteristics of these coals will be found in report R. R. page 300 et. seq.; but it will suffice, in the presence of their persistent inferiority, to state that the only beds found are the Clarion, which occurs on top of the Johnson Run sandstone, underlying the higher summits throughout the central portions of Jenks twp.; one of the Alton beds, occurring between the Johnson Run and Kinzua Creek sandstone, underlying the higher summits throughout the county east of the Allegheny river; and the upper Marshburg bed, occurring between the Kinzua sandstone and Olean conglomerate through the same area.

†The Homewood sandstone shows through many of the northern townships. Not massive along the Red Bank nor at Brookville; to the north more prominent. In Rose twp. two good beds of fire clay each 3′ thick have been mined on Red Bank from beneath Bed A and on top Homewood S. S. by Messrs. Newsome, Porter & Co., the whole clay deposit measuring 15′ thick in places. Composition not uniform; more or less silicious in places. In Knox thicker and more prominent, often displacing the Clarion strata and Ferriferous limestone. Partly above water level on Falls creek at Osborne's mill, extending east to Wolf run and west up Beaver Dam to Rockdale. Creates prominent "rock cities" in Eldred and a perfect wilder-

The Mercer shales 30′ to 50′ thick, contain usually two seams of coal; the upper important, in one place 9′ thick; both are generally thin.* At Port Barnet these shales contain good fire clay.

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ness to the north in Heath; massive, coarse grained and 50′ thick, and so continues in Warsaw, making a continuous line of outcrop along North Fork valley; still massive at Richardsville. In Snyder a coarse pebble rock along Little Toby, with smooth rounded milk-white quartz fragments, of local occurrence; along North Fork massive and thick but without pebbles. In Barnet and Polk universally massive and 40′ thick.

* *Mercer coal group* is absent in Oliver along Big run and Little Sandy; shows thin coals in the Fairmount basin along Red Bank; indistinct at Brookville, but one of the beds 4′ thick and well exposed on the Vasbinder place north of Brookville, the equivalent of the coal at Port Barnet and Fuller's mills. The Mercer upper (Tionesta) coal directly underlies Homewood SS. at latter place, and was mined by Buffalo Coal Co. Also at mouth of Camp run 5′ 0″ thick; top 3′ 10″; parting 0′ 7″; bottom 0′ 7″ slaty throughout and yields inferior coal, with irregular bed section. On Anderson run only 3′ thick.

In Winslow the Mercer group of slates holds three coals east of Carrier's Sta; the lowest 2′ 6″ in places: two upper beds, variable and obscure. In Union on Big Mill creek, coal 3′, one-half slate or bone. At J. Aaron's upper bench is cannel slate; lower bench 3′ and impure. The Mercer upper coal is mined south-east of Port Barnet (thickest at Fuller's mills) by the Jefferson Coal Co. and Mr. Fuller. The coal has been irregularly formed and much disturbed, even faulted in the latter mine, where a down-throw of 6′ brings the roof to the level of the floor. There are similar developments in the Jefferson mine. The sections are:

Jefferson Mine.		*Mercer Coal.*	*Fuller Mine.*		
Slate, ...			Slate, ...		
Coal, ...	1′ 5″		Coal, ...	0′ 10″	
Slate, ...	0′ 3″		Slate, ...	0′ 2″	
Coal, ...	2′ 7″	9′ 0½″	Coal, ...	2′ 1″	6′ 0″
Cannel slate, . .	0′ 3½″		Slate, ...	1′ 3″	
Slate, . . .	0′ 6″—1′ 6″		Coal, ...	1′ 8″	
Coal, . . .	2′ 3″—3′ 0″				

The upper part, above main parting, is more persistent and yields best coal. In Eldred the Mercer group contains two coals, 4′ apart, which traverse the county with tolerable regularity; well seen at Siegel and west of Kahle. Along Brookville road the upper shows coal 0′ 4″; slate 0′ 3″; coal 2′ 10″. Coal pyritous and slaty; sulphur 1.238, ash 9.265; but answers well for local use, free burning, with 40% volatile matter. Also opened at Singer's. At Siegel the upper coal is 2′ and lower 3′, sometimes variable, showing same character on Shippen run and at W. Rensel's in north-east corner of township, and at various other points, with same section. The lower seam is less explored; best at James Fiscus; larger than the upper bed but inferior, with top coal 2′ 4″, slate 0′ 4″; bottom 1′ 0″. West of Kahle, bed is smaller but better. In Barnet the three Mercer coals occur on Owen Butterfield's farm; but only the middle bed has been mined, 2′ 1″ thick and half slate.

The Connoquenessing sandstone* is well opened along Red Bank and in the north-west; usually about 75′ thick.

The Conglomerate Strata† occupy both sides of the Little Sandy valley below the mouth of Cherry run, showing boulders of massive coarse-grained sandrock, but rarely *in sitû*. The Homewood sandstone is especially conspicuous here in Ringgold twp., and so far as can be judged, is about 50′ thick.

Inasmuch as the whole floor of Jefferson Co. is lifted towards the north and sinks towards the south, there is a far greater outspread of the *Conglomerate Series* along the Elk-Forest Co. line than towards Indiana Co. Although the Conglomerate coal beds are frequently exposed, especially the Mercer group, and have been mined at local points for domestic use, none of them have any commercial value in the open market, especially in competition with the large tonnage annually extracted from much superior beds of the Lower Productive group from the southern and eastern sides of the county.

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*The *Connoquenessing upper sandstone* is the lowest rock exposed along Red Bank in Beaver twp., conspicuous in Rose twp. in the tunnel east of Brookville, and makes the base of the hills at Port Barnet in Pine Creek; magnificently exposed in Garrison's cut 70′ thick and a fine grained grayish white massive sandstone; below Brown & Erskine's clay pits at Bellport mills, and on Sandy Lick up to Iowa mills, beyond which point it goes under water level.

Two deposits of fire clay occur at Port Barnet in connection with this sandstone, both very irregular. The lower is interleaved into sandstone; it may be seen in the cut at Garrison's, 20′ below the top of the sandstone. Maximum thickness about 5′; too impure to mine. The upper almost directly overlies the rock and is mined near Baughman's; varies from a mere streak up to 10′. Its best development is at Bellport mills. It lies in pot-like cavities in the sandstone, fluctuating in the Brown and Erskine pits from nothing to 11′. The deposit is not all of the same quality or of the same character. The top part of it is usually sandy and worthless; some of the clay is hard and compact, whilst elsewhere quite soft. (For other details see H 6 page 157 and 158.) The Connoquenessing sandstone is not exposed in Warsaw twp., though certainly above water level in the valley of the North Fork.

† In Oliver twp., along Big run, 150′ of these measures are exposed. At several places in the Toby valley, and notably in the region at Galush mill a stratum of red shale was noticed about 100′ below the top of the Homewood sandstone coming in at the horizon of the Mercer group, the whole Pottsville Conglomerate series being judged to be about 300′ thick.

No. XII in Indiana County.

This formation is not a dominant feature of Indiana Co., being for the most part concealed beneath water level.

In the Ligonier basin it is not strictly a conglomerate deposit; it is chiefly a fine grained sandstone and but rarely shows belts of coarse sand and small pebbles. Mr. Platt assigns but 65′ to the entire section on the Connemaugh below Bolivar; but it still shows its three divisions.

On Black Lick creek No. XII is assigned 60′-100′ in thickness and still triple. The Homewood sandstone is fine grained, greenish and current bedded.

It is hoisted to daylight on this stream by both the Nolo and Chestnut Ridge axes, the former again exposing these measures to the north on Little Yellow creek, and the latter on Yellow creek and Two Lick. The Indiana axis next west, increasing in strength north of the Conemaugh, does not however succeed in exposing the entire group until reaching the Little Mahoning creek within six miles of the Jefferson Co. line; to the west of this axis the measures are everywhere buried beneath the overlying Lower Productive and Barren Measure groups, which form the surface rocks.

The Indiana Co. map shows but five small outcrops of the Mauch Chunk red shales No. XI, in every case under the crown of one or the other of these anticlinal axes; and at these points only are the overlying Conglomerate Series No. XII fully exposed. Thus it is seen 100′–150′ thick on the Conemaugh under the Laurel Hill axis; 70′ thick at Evans' on Yellow creek under Chestnut ridge, and as cliffs of unknown thickness at Enterprise under the Indiana axis. It rarely shows a conglomerate member, however, and it would appear as if this loss accompanies the reduction of total thickness, the formation growing thinner and less coarse towards the west.*

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*In the gap in Chestnut and Laurel ridges in Westmoreland and Indiana Cos. (Reports K 2 and H 4) Stevenson and Platt have shown that the Conglomerate consists mainly of but one coarse, massive sandstone, which is apparently the Homewood or Piedmont rock; whereas in Lawrence, Butler, Mercer, Crawford and Venango Cos. the bottom bed A of the Lower Productive

No. XII in Armstrong County.

The top of this group is represented by numerous boulders of heavy sandstone, massive and coarse-grained, over the Roaring Run axis on the Kiskiminetas. The Conglomerate is magnificently exposed in a series of cliffs on the Cowanshannock, extending from the grist mill to the mouth of the creek. It is upwards of 60′ thick, massive and heavy.

On Pine creek its top beds are also exposed over the principal anticlinals, but less massive here than on either the Cowanshannock or Mahoning. On the Mahoning the top of the Conglomerate is a compact massive sandstone, rather coarse-grained but rarely pebbly; usually in two layers of nearly equal size, in all 60′. The lower members are also sandstone, divided from the upper by shales of the Alton-Mercer coal group.

At McCrea furnace there is a classic exposure of the entire Lower Productive group and though Mr. Platt assigns only 52′ to the Conglomerate, immediately below the Brookville coal A, the recent stratigraphy of the survey would probably include all the lower part of his section (the so-called Mauch Chunk No. XI and Upper Pocono No. X) in the Conglomerate group, making No. XII here exposed 200′. Along Red Bank creek No. XII shows in the same manner, and Mr. Platt asserts that in his Pocono formation he recognizes an upper sandstone 150′ thick and a lower sandstone 50′ thick, and that slates and shales, holding sporadic coal beds occur between these two formations, which are "without doubt analogous to the small seams described by Messrs. Chance and White as occurring in Butler and Lawrence Cos. in the Quakertown and Sharon groups," that is to say within the Conglomerate Series.

Coal Measures is always at least 250′ and usually fully 300′ above the subcarboniferous (Pocono) shale. Around the Cumberland basin in Maryland this thickness has increased to 500′ and in West Virginia to 1000′, so that if the exhibition in Laurel Hill and Chestnut Ridge gaps be significant of the character of the whole central region, it indicates that the lower members of the Conglomerate group were deposited only around the margin of the Bituminous coal field and that only the upper member was deposited universally over the whole coal field.

The Conglomerate shows massive structure in the hills overlooking the Allegheny river at Parker City and in a ravine opposite Monterey (plate CCLXIII.)

No. XII in Westmoreland and Fayette Counties.

The Ligonier valley, as in Indiana Co., is flanked east and west by Chestnut Ridge and Laurel Hill, both of which mountains hold the Pottsville Conglomerate Series from the Conemaugh south to the State Line.

Dr. J. J. Stevenson in Report K 3 on this district, subdivides the series* in the following general section :—

1. Piedmont sandstone.
2. Shale.
3. Mount Savage coal bed.
4. Shale.
5. Conglomerate.

South of the Youghiogheny, the Piedmont (Homewood or Johnson Run) sandstone is much coarser and sufficiently distinct, with pebbles as large as a pea at Ohiopyle Falls, but a fine grained white sandstone along the National Road on the summit of Chestnut Ridge.

The Mount Savage coal bed exists as such only in Stewart and Wharton twps. of Fayette Co., at Wharton furnace, reported 4′ thick. It was evidently an inferior coal here, with a high sulphur and ash. At the falls of the Youghiogheny it varies greatly and occurs in pots; on Cucumber run badly broken up, but single, and on Bear run, north from the river, 1′ thick but good.

The Conglomerate member No. 5 of the group, is not coarse throughout any locality in the Ligonier basin. It contains many layers and pots of conglomerate, but is more often a fine grained sandstone. It shows its maximum development just south of the State line, 325′ thick in the

*The distinction between the top and lower member of the group he states is only clear in the southern portion of the valley along the Youghiogheny river. To the north the coal bed and its associated shales disappear, permitting Nos. 1 and 5 to coalesce. The same conditions exist west, so that it is manifestly impossible to here recognize and co-ordinate the several members of this series so plainly observed in the north-west counties of the State.

gap of Cheat river; but it rapidly diminishes northward along Chestnut Ridge, until reaching the Conemaugh it is little better than a sandstone occurring in pots of shale. The bed thickens east and southeast from the west slope of Chestnut Ridge, showing much thicker and more imposing in the Conemaugh gap on the east slope and becomes very thick on Laurel Ridge in the gap made by the same river. This mass affords some coarse layers which have economical importance in the manufacture of mill stones.

Returning now to a further consideration of the northwest counties, it becomes at once apparent how radically different are the characteristics of this same group.

No. XII in Warren County.

This formation, 300′ thick through western and northern Pennsylvania, is largely represented in Warren Co. by the lowest sub-division, the *Olean Conglomerate*, the middle and upper sub-divisions having been entirely swept away, with all the overlying coal measures. From Mr. Carll's excellent report on this county, which deals mainly with the geology of the petroleum deposits, Prof. Lesley has extracted the following interesting details bearing upon the Olean conglomerate:

"The Olean conglomerate has been swept away from nearly the whole northern half, north of the river and Brokenstraw creek, and from the western side of the county between the Brokenstraw and Caldwell creek; but small fragments have been left on the highest summits, as, for example, on the ridge three miles west of Garland overlooking the Brokenstraw, a narrow patch two miles long; between the Brokenstraw and Blue Eye run, two little patches east of Spring creek; between Blue Eye run and the little Brokenstraw, three patches in Pittsfield twp.; and a small patch at the Garland quarries. East of Wrightsville, on the little Brokenstraw, nothing remains but Pike's Rocks and Nuttall's Rocks. With these exceptions, the whole of Sugar Grove, Farmington, Pine Grove, Conewango and northern Brokenstraw twp., have been entirely denuded of the Olean, not a trace to be found of it on even the high hills between Warren and Irvineton, north of the river. Between the Conewango and the McKean Co. line, the Olean remains only in isolated patches along Quaker Hill, at the North Rocks, etc., and on the highest land east of Hemlock run, west of Kinzua.

South of the river, the area of the Olean is extensive and continuous through Pleasant, Watson, Limestone and Cherry Grove into western Sheffield and southward into Forest Co. Between the river at Great Bend, below Kinzua and Hook's river, an extensive patch of it runs eastward into McKean Co. Four other patches lie on the highest lands between Mile run, Four Mile run, Deer run and Two Mile run; and three other patches lie further south along the McKean Co. line.

The whole slope of the Olean and other formations is south and southwest at an exceedingly gentle rate of fall, the highest outcrop being around what is called the Pass, six miles northeast of Warren. Its base at the Pass is 1996′ A. T.; but two and one-half miles southwest from the Pass, at the North Rocks (Gardner's) it is only 1978′ (a solid ledge 51′ thick).

The Pass is what may be called a street in the Olean Rock City of the Quaker Hill range, where the high-road from Warren to Corydon passes between perpendicular walls of conglomerate more than 20′ high, separated from each other about 50′, attracting the attention of every traveller, and popularly known as the "Singular Rocks."

In Spring twp., the Olean is only left on the Summit of the ridge between Hosiner run and the Brokenstraw at two or three points; and on the ridge in the northeast corner.

In Pittsfield twp., Drake's Rocks, on the Freehold twp. line, is the furthest patch of Olean to the northwest. Two others are left further south; but south of Garland some of the knobs rise high enough above it to take in the Kinzua Creek sandstone.

In Sugar Grove, Pike's Rocks, two miles east of Wrightsville, are the furthest outlier (top 1980′ A. T.) Nuttall's Rocks are another small patch in the southwest corner of the township.

Pike's Rocks, on the Freehold-Sugar Grove twp. line, is the highest peak in Warren Co. west of the Conewango, and the most northern remnant of the Olean toward Lake Erie. It is a fragment of conglomerate not more than two acres in extent, standing in utter loneliness, completely isolated; making one of the most impressive and awe-inspiring rock cities that can be visited. Perched upon the highest summit within the range of vision and surrounded by well-cultivated, gently-sloping fields, its weather-worn walls, studded with pebbles which glisten in the sunlight, rise bold and sharp on every side; no talûs of broken rock at its base, not a block in sight on all the slopes around; a huge, naked pike of rock, the last fragment left of a great formation which once spread northward toward Canada. Standing on this pinnacle and surveying the panorama of lower country, the student of geology will be impressed with one of the finest lessons of erosion, and understand the method by which frost, rain and sunshine have sculptured the surface of the earth.

Gardner's Rock, the most westerly outlier of the Quaker Hill range, is an almost solid sandstone, with comparatively few pebbles, and these seldom larger than hazel nuts. Gardner's Rock stands by itself on the summit of the divide, between Hatch run and Akely run, overlooking the deep valley of the Conewago below Russellburg. Here an area of about five acres is all that is left of the formation which once spread far and wide over northern Warren Co. and western New York; a bare platform on which sufficient mould has accumulated in the inequalities of the surface to support vegetation, and many trees with their roots in the fissures have grown to large size. Its sides towards the north, west and south are almost vertical. Few loose rocks lie around its base except on the south, where solid rocks 70′ long, 40′ wide and 30′ high are sliding slowly down into the valley of Hatch run; this southern face being a remarkably straight wall of rock 50′ high, nearly due east and west.

The bottom layer is 30′ thick, often presenting a front without crack or seam; current bedded in irregular lines, and streaked with layers of pebbles always egg-shaped, generally small, and rather sparsely scattered through the sand matrix. The upper 20' feet consists of less massive layers, very irregularly bedded, with thin clay shale partings, and weathering into small blocks or even quite thin plates.

In Pleasant twp., south of Warren, the Olean conglomerate crops out in the spurs and ridges of the river hills, but nowhere except on the point west of Sill's run does it approach near the river; the first ranges of hills being too low to hold it. This Olean escarpment has a frontage towards the north of five or six miles. No other such clean-cut escarpment as this abruptly facing the river, without a single outlier to the north of it, is to be found either in Warren or adjoining counties. The rock is here about 30 thick, very massive, and remarkable for the size of its pebbles, some of them larger than goose eggs. It crowns the points and hog-backs with cliffs and rock cities: dips gently south-ward until it holds 125' of upper measures on its back at the summit between the Allegheny river and Tionesta; the highest strata being the Kinzua Creek sandstone, between which and the Olean lies a coal bed.

In Kinzua twp., the Olean is extraordinarily thick, as shown by the Tuttle Creek section, thus:—

Olean	Conglomerate pebbles from pea to hazel nut,	10'	77'
	Sandstone, coarse, with some conglomerate,	15'	
	Conglomerate pebbles from pea to hazel nut,	15'	
	Conglomerate and pebbly sandstone thin layers,	33'	
	Conglomerate from hazel nut to egg size,	4'	
Soft measures, shales, etc., concealed,			24
Sub-Olean sandstone, massive, coarse grained,			32
Concealed to Allegheny River level,			579'

Above it rises 240' of carboniferous measures; the highest point, a mile south-east of Great Bend, holding the top of the Johnson Run sandstone; and three coal beds lying in the interval.

In Limestone twp., on the river, opposite Tidioute, the Olean conglomerate occupies the highest summits with little rock on top of it; but in Watson twp., back of Carbon and Thompson's station, the Olean spreads out and is covered by 80' of upper measures. The Snavely water well stopped, after passing through 34' of white pebble sandstone, without reaching the bottom or obtaining the desired quantity of water.

Where the road from Cobham to Baxter's Mills crosses the high land between east and west Hickory creek, an escarpment of Olean conglomerate 30' high may be studied, lying 40' above a cliff of sub-Olean. Here the Olean is very solid, composed principally of coarse sand containing a few small pebbles, the layers in parts of the exposure as much as 25' thick, solid, without seam or flaw.

In Cherry Grove twp., the Olean makes many conspicuous outcrops and its loose blocks obstruct the upper parts of the valleys of most of the streams, particularly those flowing into Forest Co. Copious springs issue from it and also from the sandstones overlying it, feeding streams which wander over pebbly bottoms and afford some of the best trout fishing. The high divides rise 200' or more above its base so as to includ^ the whole of the Great Conglomerate series; but no good sections can be obtained and the well records are poor.

In Sheffield twp., the Olean of the high lands is covered sometimes with 100' of higher rocks with traces of coal; but toward the Forest Co. line it becomes less massive, and contains fewer pebbles than toward the north; the underlying shales becoming also more sandy; and the interval between the Olean and sub-Olean increasing to about 150′."

The Garland Conglomerate of Warren, Venago, Clarion and Butler is the Sharon Conglomerate of Crawford and Mercer Cos.; the Ohio Conglomerate west of the State line; the Olean Conglomerate of McKean and the bottom subdivision of the great Pottsville Conglomerate No. XII of Northern, Middle and Eastern Pennsylvania, and is the Second Mountain sand of the oil producers on Oil creek and elsewhere.

No. XII in Venango County.

In Venango Co. Mr. Carll makes his Mountain sandstone (No. XII Series) about 400′ thick by lowering its base so as to include the Shenango sandstone (sub-Olean Conglomerate.)

The following table shows the relation of these rocks to the overlying coal measures of the western counties:

Freeport coal group, ...	Allegheny River Series of No. XIII.
Kittanning coal group, ...	
Clarion coal group, ...	
Homewood sandstone, ...	Conglomerate Series No. XII.
Mercer coal group, ...	
Connoquenessing sandstones, ...	
Sharon coal group, ...	
Sharon, Garland, Olean Conglomerate,	

On Ennis Hill the same authority mentions the occurrence of coal in the Conglomerate Series but finds it of no great extent or economic value. The Olean Conglomerate was given the name of "Garland Conglomerate" from its exposures on the hill tops at Garland, and he identifies it as belonging to the same plane as the conglomerates of Colorado, Church run, etc., and the Second mountain sand of Pleasantville.

No. XII in Clarion County.

The Conglomerate Series No. XII* vary in the individual number and thickness of their members although their

*An interesting set of sections is given in plate CCLXXXII which clearly show the variable character of the different members of this group.

total thickness is very nearly constant, 280′-340′. The most striking difference in this group in Clarion as compared with the same measures in the Elk, Cameron and northeastern fields, and the Mercer and Beaver fields to the south-west, is the almost total absence of the Alton, Sharon and Marshburg coals which characterize this group in these fields.

Coal seams of the Mercer horizon, i. e., beneath the Homewood sandstone, have been worked on Catfish run in Madison twp., in Paint twp., and at North Pine Grove in Farmington twp., yielding a very fair non-pyritous coal, but very irregular and of insignificant thickness.

Economically considered, the entire series in this county presents little of interest or value. Its coals are thin, impure and subject to many and sudden local variations, and are few in number.

No. XII in North Butler County.

The Conglomerate Series No. XII shows a transition character in this county between the types of the Elk, ameron, Potter, etc., district and the "Beaver River Series" of Prof. White in Mercer and Lawrence Cos. A general conpiled vertical section is given by Mr. Chance in plate CCLXXXV which indicates the relationship and correlation of the series with the work of the First Survey and Ohio geologists. Taking the records of many oil wells in Butler Co. he concludes that the Conglomerate series must be about 400′ thick, beginning with the Homewood sandstone on top (the Tionesta sandstone and No. XII of the First Survey), 10′ to 70′, with an average of 40′ and ending below with the Sharon Lower sandstone* 150′ thick, a lower member than the Sharon (Ohio) Conglomerate and Ferriferous sandstone, and being largely responsible for the increased thickness of the whole series.

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*But this Sharon Sandstone is no longer considered as a part of the Pottsville Conglomerate Series No. XII; and hence this latter series must be reduced in thickness by just the measurement of that formation. Details concerning the Conglomerate Measures must be sought for in both reports V and Q, treating of Northern and Southern Butler Co.

The Homewood sandstone is exposed as a prominent stratum on Slippery Rock creek, rather coarse-grained and always more or less stained with iron; near Martinsburg in the valley of Bear creek, in perpendicular escarpments 10′ to 30′ high.

The Mercer group, next below, is poorly represented. Both the upper and lower Mercer coal beds are present in some localities, but only as impure beds of bituminous shale; the two Mercer limestones have never been noticed. The group is much more important in Mercer and Lawrence Cos. The Connoquenessing sandstone is a double member, the upper 50′ thick and the lower 30′, enclosing the thin Quakertown coal.

The Sharon group follows next; but though pierced by many oil wells, no coals have been found at the depth corresponding to the horizon of the Sharon coal of Mercer Co. and the Shenango valley.

In Franklin twp., in the R. Allen well section (plate CCLXXXV), the group shows:

Homewood sandstone, black and soft,		56′
Mercer group,	Shale,	48′
	Soft white sandstone,	8′
Mercer? coal?		8′
	Black sandstone,	36′
	Mountain sandstone,	152′
	Shale,	20′
	Black sandstone,	10′
	Total,	338

In Parker twp., an incomplete section of the series was compiled, between Columbia Hill in Allegheny twp. and Donnelly station, which shows the following character: (Plate CCLXXXVI.)

Homewood Sandstone	Massive sandstone,	15′
	Shale and slate,	50′
Bituminous shale (Mercer coal),		3′
Sandy fire clay,		12′
Blue slate,		5′
Bituminous shale (Mercer group),		5′
Olive shale and blue slate, nodular ore at top,		47′
Shaly sandstone,		20′
Blue and olive shale,		43′
Sandstone; thin bedded to creek level,		20′
		220′

The two impure bands of bituminous shale, 17′ apart, are sometimes true beds of impure coal, representing the Mercer group. The iron ore of this group is also present and has been mined in the past for the Bear Creek furnace. Beneath this ore band the measures alternate widely in character, sometimes carrying slate, shale and fire clay, with a band of bituminous shale and sometimes a massive sandstone 120′ thick, which corresponds in position to the Lower Connoquenessing sandstone horizon, the middle member of the Conglomerate series in Beaver and Lawrence Counties.

In Southern Butler Co. the Conglomerate series is very nearly everywhere beneath water level, as well as to the south in Allegheny, Washington and Greene Cos.

No. XII in Crawford County.

This county, together with Mercer, Lawrence and Beaver to the southwest comprises the western limit of the coal bearing rocks in western Pennsylvania. The last remnants of the lowest workable coal bed along the Lake Erie outcrop of the carboniferous system are seen in the southern townships of this county, along the low flat summits of somewhat higher lands between French creek and the branches of Sugar creek on the one side, draining into the Allegheny river, and Crooked and Shenango creeks further west, flowing into the Beaver river. But it must be distinctly remembered that geologically these coal beds are all referable to the *Pottsville Conglomerate series*, and do not form any portion of the Lower Productive Coal Measure series which are entirely absent from this as well as the greater part of Mercer Co. The Conglomerate series however, in all these western counties, contain certain rather sporadic coal beds, within a vertical interval of about 250′ between the Homewood sandstone on top and the Garland (Olean) conglomerate at the bottom. It is between the middle and lowest sub-division of the series that the important "block coal bed" of Sharon in Mercer Co. occurs, so extensively mined in the State of Ohio; but in Crawford Co. this bed is almost everywhere too poor to work, except in east Fallowfield twp. where some of its areas have been exhausted. The map coloring therefor gives a very poor and erroneous idea of the commercial areas of this county which is almost entirely destitute of good coal. (Sections on plate CCLV.)

The lowest member of No. XII is here called the "Sharon Conglomerate." This rock increases in thickness eastward and becomes the Garland conglomerate of Warren Co. and the Olean conglomerate of McKean, Forest and Elk Cos. One patch of this rock caps the hill overlooking Meadville, the upper 35′ comprising good building stone layers; the lower 10′ a conglomerate mass of round quartz pebbles. Beneath this rock here and elsewhere occur in descending order the Shenango shales 50′ thick; the Shenango sandstone, 25′; and other rocks of the sub-carboniferous formation, divisible into another group of 435′ of lower Carboniferous; a still lower group of 310′ comprises Mr. Carll's "Oil Sand Group."

The coal beds of this and Mercer Co. appear to be similar in physical character wherever they are found. They lie in "swamps," irregular in outline and uncertain in extent and are often liable to pinch out and terminate suddenly. They may be locally traced with considerable uniformity as to level and position; but can seldom be relied upon as persistent over wide areas. (Plate CCLV.)

Coal was mined from premature pits or shafts on the McEntire property as early as 1837 to supply the surrounding country before the introduction of railroads, and as nearly as possible the average section of the coal taken from a number of these pits showed a top bench of micaceous coal slate covering a coal seam of good quality 3′ thick. Near McEntire's house a hole 8′ square showed on one side a coal seam measuring 11′ and on the other side only 6′, the lower 6′ being good block coal.

On the Hazen farm, two miles east of Atlantic station, a good but uncertain seam of coal was developed, although several attempts to mine it all resulted disastrously. In thickness it varied from 2′ 6″ to 3′ 0″; but the deposit seemed to be very variable and to thin out abruptly everywhere. While therefore it is entirely possible to find a few productive acres of coal within the limits of this county, it may be safely taken for granted that, for commercial purposes, no mining on a large scale will ever prove profitable in this district.*

The Olean Conglomerate is exhibited in a satisfactory and complete manner by the Meadville quarries in College Hill, where it is plainly divisible into an upper and a lower member.

The upper member† consists of layers of building stone with a few pebbles scattered through them, 35′ thick. The lower member is a conglomerated mass of quartz pebbles 10′ thick. But such a sub-division is by no means possible everywhere; yet it recurs in so many exposures that its significance must be recognized; and at Sharon, in Mercer Co., it is a marked feature; white sandstone, 8′ thick, covering a pebble rock, 9′ thick; and the same thing recurs at the fine cliffs on the Cuyahoya river in Ohio. It characterizes also exposures in Warren, Venango, and Forest Cos. In fact it may be said that wherever the pebbles are abundant, they are vastly more numerous at and for a few feet above the base; and are also larger there.

The lower division seen in the by-road passing up to the Meadville quarries, is a perfect mass of quartz pebbles varying in size from a pea to a hen's egg; never flattened, but always egg-shaped;‡ in a matrix of coarse, greenish-

* The Conglomerate Rock Series however, are well developed in this county, and numerous sections and well records in Report Q 4 gives a clear insight into their character and variation.

† At Meadville, the upper beds are a rather hard, coarse, dull gray (when first quarried often reddish) sandstone showing an occasional pebble of quartz; but building stone free from pebbles can usually be got by neglecting the lowest layers; stone durable, if homogeneous; lower layers with scattered pebbles in a sand grain matrix, quite coarse, and so incoherent that weathering produces a rapid decay of the flags, as shown in parts of the walls of the Methodist Episcopol church in Meadville, the copings, door and window fixtures showing signs of disintegration. Great care should be taken in exposed walls to avoid stone containing pebbles. Thickness of the quarried part of this upper division in some of the quarries at Meadville, 30

‡ This egg shape or roundish shape of the pebbles of the Olean conglomerate was first used by Mr. Carll in distinguishing it from all the flat pebble rocks of an earlier date; and throughout the Erie region, a geologist who

gray sand, disintegrating readily, and letting the pebbles drop in loose heaps around the outcrop. The size of the pebbles seems to increase going east from Crawford Co., where the largest in Crawford Co. are like hen's eggs, whereas along the Allegheny river, above Tidioute, they are often as large as goose eggs.

The Olean in Crawford Co. is not always a conglomerate, however, but varies in its constitution as much as any other rock of the palaeozoic system.* Instead of being everywhere thick and massive, as at Meadville, it changes in many places to a series of thin bedded, fine-grained sandstones, making almost as little mark on the topography of the country as the shaly formation underneath it. Not infrequently it is considerably current bedded, as for example, at Henry's quarry in East Fallowfield.

Its fossils are Fucoids and fish without shells. The top layer, at Henry's quarry, is honeycombed as if from the decomposition of vertical stems of seaweed (Fucoids); and it contains there also pieces of fish scales and bones. Obscure impressions of land plants are seen occasionally. At Snodgrass's quarry, near Jamestown, the Olean conglomerate passes insensibly downward into the sub-Olean shales, and there, in the transition layers, multitudes of *Lepidodendron gaspianum* occur.

Between Oil Creek district and Warren Co., small isolated fragments of the formation cap the highest hills. A glance at the red color on the map will show more plainly than the most minute topographical or geological investigation with so extremely gentle a dip, could show, not only the flat outspread of the formation, but the direction of the

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has rendered himself familiar with genuine outcrops of it, finds no difficulty in recognizing its presence elsewhere when only marked by scattered fragments.

* The Olean conglomerate has been swept away from two-thirds of the area of Crawford Co. The patches of it which have been left in the highest lands are limited on the geological map of the county by the inside border of the red color. The patches are isolated from each other by the valleys; but by the gentle southeast dip, carrying the formation down to water level of the Shenanago river, Crooked creek, French creek and its branches, and Oil creek, they all become united in the great outspread of the formation in Butler, Venango and tne counties further south.

slope which it takes in sinking southward under ground; the normal strike across the county being N 63° E.*

No. XII in Mercer County.

The compiled section of this series given in Plate CCLVII is typical of the condition of this group all through the Beaver River district. It will be noted that the limits of this series are the Homewood sandstone on top and the Sharon conglomerate at the base, so that excluding the underlying Sharon sandstone, the whole group as represented, has an average thickness in Mercer Co. of 250′. The Homewood sandstone is a sharply defined horizon through a large part of Mercer Co., preserving a remarkable constancy of about 50′ in thickness, increasing somewhat northwards.

In Lawrence Co. it is very variable and often turns to sandy shales; but in Mercer this rock is always a massive and often conglomeratic sandstone, from 30′ to 70′ thick. It is well exposed at the county seat, 100′ above the railroad; on Wolf creek at Courtney's mill; on Quill's run at the saw mill west from Pardoe, and on Sandy Lake near Stoneboro, encircling a ravine south of the lake, capped with the Brookville coal 4′ 6″ thick.

The *Mercer upper limestone* and *upper coal* are the two next conspicuous features of the section, separated from the base of the Homewood sandstone by from 10′ to 16′ of shales. The former is the "Mahoning Limestone" of the First Survey, which name has very wisely been abandoned for the more distinctive one above, although it

* This N 63° E direction is not the true horizontal strike line of the formation in Crawford Co., but the theoretical outcrop line, to the northwest of which there are no traces of the formation left on the present surface of the country. The dip is not at right angles to this line, i. e., S 27° E, but considerably west of south; for the S 63° W outcrop line falls from the northeast corner of the county to the southwest corner several hundred feet. A true strike line would be more nearly east and west, as shown by the following levels: Base of Olean at Garland, in Warren Co. (Carll's spirit levels), 1529′ A. T.; top of Olean at Meadville (barometer), 468 above railroad grade, 1548′ A. T., at McIntire's 11 miles S 40° W from Meadville, top of Olean, 1330′ A. T. At Franklin, where French creek joins the Allegheny river, 23 miles southeast of Meadville, it lies 170′ above water, about 1140′ A. T.

can be seen at few localities in this county *. It was once quarried at Cozard's on the Sharon and Mercer road and at Stranahan's showing 2′ thick, with a foot of iron ore on top and the Mercer upper coal underneath 1′ 6″ thick.

This coal, though rarely of merchantable thickness, has been mined at some few places. In Wilmington twp. at Lyle's mine it shows two benches 2′ and 1′ thick separated by 10″ of fire clay, and here only 21′ above the Mercer lower limestone. The coal is quite sulphurous and slaty, and is not highly valued. It was once opened near the southern edge of this township and reported 3′ thick, upper half cannel; also in Devil's Hollow, along the Sharon road just west of Mercer, where it is 2′ thick. (Plate CCLVI.)

The *Mercer shales*, usually 25′ to 30′ thick, underlie this coal; but at Maple Grove, in the north-east part of Sandy Lake twp. and near the Venango Co. line, this interval increases to 58′ and contains near the bottom a local coal deposit known as the "Maple Grove Coal" showing two benches 4′ 0″ and 1′ 6″ thick, separated by 4′ of fire clay. The coal however is extremely local and while the upper bench of 4′ has been extensively mined by the Maple Grove Coal Co., it is found in no other part of the county. At this point the coal is of very fair quality, mining out in large rectagular blocks, tolerably free from pyritous slate

The *Mercer lower iron ore* is a thin seam from 2″ to 6′ thick, usually seen resting directly on the Mercer lower limestone, or entirely replacing it. In early times it furnished the chief ore supply for many local charcoal furnaces. In western Jefferson twp. it occurs as a solid plate of ore 1½′ to 2′ thick and has been extensively mined and shipped to the Sharpsville and Clay furnaces. A small bed is reported to underlie it, the limestone being absent. South of Hadley station the same ore bed was extensively

*Some confusion has arisen in different parts of the county in identifying this Upper limestone bed, inasmuch as there is a lower limestone some 25′ lower in the measures and the two beds are rarely seen exposed in the same section; at Painter's mill both limestones however are visible and careful levels there show them to be 31′ apart and both underlaid by small coal beds.

mined for Mineral Ridge furnace and on Otto creek along the New Vernon twp. line lie the extensive ore mines of the old Harry of the West furnace, where the bed varies from 1′ to 3′ thick. West of Milledgeville, where the coal is mined, the ore, 8″ thick and rich is seen in the roof 4′ above the coal. In Sandy Lake twp. on Wallace's farm the ore was also mined from the roof of the coal for the Mineral Ridge furnace. In Shenango twp., on the Byer's and other farms the ore bed is 6″ to 1′ thick, and was mined for the Middlesex furnace.

The *Mercer lower limestone* occurs throughout the county, sometimes as a limestone bed, sometimes as an iron bed or both combined. It is always a dark gray or bluish rock; sometimes slaty, splitting off in thin plates or slab-like pieces; always richly fossilferous, and especially rich in mollusks and crinoids. At Lyle Mercer's, in South Wilmington, this limestone is 3′ thick underlaid by the Mercer lower coal 2′ 6″ thick. It is quarried to some extent from a bed 4′ thick on Dick's land near the north-west corner of Wilmington and roofs the Carbon Coal Co's. mines in South Lackawannock twp. North of Bethel, near the Snyder Coal Co's. shaft it is quarried in two layers, 20″ of limestone, and lies exactly 160′ above the Sharon coal. In Keel ridge, Hickory twp., it underlies about 100 acres of the Hoagland and other farms, reported 4′ thick and sufficiently pure at this point to be used as flux at the Sharpsville and Clay furnaces. It is a mere mass of fossils at this point. West of Mercer 1½ miles, it shows 2′ thick 25′ above the Mercer upper coal; and the same thickness at Mercer on McDowell's land. Among many other places it can be seen at Stoneboro, at the Maple Grove Coal works and in Mill creek and French Creek twps. (Plate CCLVI.)

The *Mercer lower coal* sometimes immediately underlies this limestone; sometimes it is 20′ beneath it, the variation of interval being often sudden. At Mercer's coal bank it is 2′ 6″ thick while at Kaufman's bank 1 mile south it shows 4′ thick, the top 1′ being slaty while the bottom is divided near the center by 8″ of cannel. At Lusk's bank, near the southeast corner of Wilmington the bed shows upper and lower benches of 2′ and 6″, with a parting shale of 3″. Occasionally the coal resembles that of the Block coal from the Sharon bed which is 160′ lower in the series, and much money has been expended under the misapprehension of this identity. At Rose's in Lake twp. the bed is mined for domestic use and is 3′ to 4′ thick ; but the top bench is slaty and all of it friable and impure. At Thompson's on the north shore of Sandy lake it shows 2½′ thick slaty and sulphury. Here it has the local name of the "Second Vein," the Brookville bed being the "First Vein." It is workable over an extensive area in eastern Sandy Lake twp. (See plate CCLVI.)*

The *Mercer Lower shales*, 15′ to 25′ thick, underlie the last described coal, sometimes carrying a little iron ore.

The *Connoquenessing upper sandstone* is assigned a thickness of 40′ in this district and is regarded as the upper part of the Masillon sandstone of Ohio. In many parts of the county no exposure of sand rock appears at this horizon, shales taking its place; but at Drake's quarries it shows an excellent building stone, light gray in color and pebbly near the top. Near Springfield the different layers of this rock make a cascade in Dennison's run 60′ thick, with massive beds. It is well exposed at Mercer and forms the cliffs which line the Neshannock, and extends along the north and south sides of Sandy Lake.

The *Quakertown coal bed*, first recognized in Lawrence Co., has proved to be quite persistent in Mercer and has been mined at various places; but like all these lower coal

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* At the Oak Hill Coal Co's. colliery south of Sandy creek it varies from 2′ to 4′ and is of good quality. At Keho's, Reagle's and at the Maple Grove works the bed is also of workable thickness, though not of very good quality. In Perry twp. at John Smith's mine it varies from 1½′ to 3′ thick and yields a block coal, holding a considerable amount of sulphur and making plenty of ash. In Mill Creek twp. it is mined at several points, though rarely over 2′ thick. So also in French Creek twp., where it shows a rather impure coal bed 1½′ to 2′ thick. This coal bed therefore may be said to have a wide occurrence in Mercer Co., though of generally low economic value on account of its impurity. Its great importance arises from the fact of its availability in many places where no other and better coal bed is at hand, furnishing an abundant supply of fair domestic fuel.

beds it shows a tendency to run into block coal, though never indicating the purity of the Sharon bed. It occurs between the two (upper and lower) sandstone members of the Connoquenessing formation, separated from the upper by about 10′ of shales and iron ore and from the lower by about 40′ of shales. It is found in East Lackawannock twp. 2′thick; in Springfield twp., as a bed of bituminous shale with streaks of coal, 3′ thick; at Springfield Falls 1½′ thick and somewhat slaty and in Jackson twp., where as the "Comstock vein" it was mined on the Comstock farm. Around Sandy Lake and Stoneboro it also has a local name —the "Third Vein"–and seems to have been mistaken for the Sharon coal by the First Survey. On the road descending from the Mercer Iron & Coal Co., works its outcrop shows about 135′ beneath the Brookville (Clarion lower?) coal. The Sharon coal should be found 80′ to 100′ beneath it.

The *Connoquenessing lower sandstone* is a somewhat indefinite and variable member of the series, although there is a distinctly marked massive lower sandstone horizon, 30′ to 50′ beneath the upper. At McClary's quarry 1 mile east of Sharon, good building stone is got from it and it is 50′ feet thick and quite massive on the north shore of Sandy lake. Its position and relationship are well shown by three vertical sections plate CCLVI from borings on the Madge farm, put down for the purpose of developing the underlying Sharon coal bed. The variation in thickness and character within very short distances is well shown by these sections.

The *Sharon upper shales and iron ore* occupy the interval between this sandstone and the Sharon coal bed, generally about 30′, but varying from 0′ to 70′. The Sharon plant shales are merely the lower layers of this member and of course form the roof shales of the Sharon coal bed. They are filled with well preserved fossil plants, two localities especially noted being the Snyder Coal Co.'s shaft in Lackawannock twp. and the Morris Coal Co.'s shaft in Pymatuning twp. and at Oakland mines in Hickory twp.

The *Sharon coal bed* is the principal economic seam of this entire district. The irregularities of its geographical distribution have been carefully described in the Ohio reports; and in western Pennsylvania it is only in Mercer Co. that it has been found to be a workable coal bed. The main body of it is confined to Hickory twp.; but it occurs to more or less extent in the other townships bordering the State of Ohio and extends into the edges of the tier of townships bordering them on the east. It is absolutely essential to exploit each individual area by itself, as the patches or basins of this bed seem to have little or no connection with one another. Mr. White regards this "irregularity as being due partly to the uneven floor on which its vegetation grew, and partly to an erosion of the bed previous to the deposit of its over rocks." It is characterized by a splint or block structure, and has long been used in its natural raw state in the iron furnace. This feature arises from its low percentage of bituminous matter and to the distribution of its bitumen in thin layers, between bands of mineral charcoal, so that the mass is prevented from caking. It is also quite clean, with a low percentage of sulphur and ash. In Mercer Co. this Sharon coal bed runs about 4′ thick, when fully developed, occasionally swelling to 5′, but frequently shrinking to 2′ below which thickness it is seldom mined.*

Along the Ohio State line the Mt. Morris coal shaft worked this coal averaging 3′ thick from a small area 75′

* At Orr's, below Mercer, it was once mined 3′ thick, coal and shale. In western Wilmington it is also 3′ thick and 180′ beneath the surface. In Lackawannock twp., a little south of Greenfield, a considerable area of it has been found on the Madge and Buchanan farms 275′ beneath the surface, 3′ to 3½′ thick. The northernmost area of it is in West Salem twp., just west of Greenville, where it was once extensively mined by the Greenville Coal Co. It has also been largely mined by the Morris Coal Co. along the Pymatuning—West Salem twp. line, but most of the mining is now confined to Hickory twp., that formerly existing in Shenango twp. near Middlesex having been pretty well exhausted. The Bethel Coal Co's shaft, in the northeast corner of Shenango twp. reached this coal in 54′, and though considerable mining was done in the vicinity of Bethel village, the coal was found very irregular, varying 1½′ to 4′ and frequently cut out entirely by "horse backs." No. 1 shaft is 89′ deep, 1 mile further west, the coal lying practically level, and just west the Neihossel slope found the bed to be very pure and rich but only from 1′ 6″ to 2′ 6″ in thickness. Around Middlesex the coal lies in the hills at 1000′ above tide, mined by drift on land of Mr. Risher, varying in thickness from 0′ to 3′. North from here the coal is dractically exhausted.

beneath the surface. The Crawford coal works, three-fourths of a mile southeast, reached the coal at 120′ though pretty well mined out now.

In the Williams mine along the edge of Lawrence Co. the coal varies from a few inches up to 2′ 6″, and the Sharon coal has not been found in workable condition south of this point. An analysis of the coal here showed volatile matter 35.30; fixed carbon 53.87; sulphur 0.67 and ash 6.36, with 3.790 of water.

In Hickory twp. there are a number of operations on this coal bed; and nearly all of the known workable areas east of the Ohio State line are to be found in this one township, from which already millions of tons of this most excellent but sporadic coal have been mined. In the south-east corner not far north of Bethel the Hickory Coal Co. found the bed about 3½′ thick at 107′ beneath the surface, carrying two thin but worthless riders in the Sharon shales above. The coal bed is as usual extremely variable, the floor of the mine rising and falling in hills and swamps with the coal thinning to 0′ 6″ and thickening to 3′ 6″ in the swamps. The quality of the coal is excellent.*

The Oakland Coal Co.† have mined an excellent quality of coal from two shafts about 135′ deep. In No. 1 the bed was 4′ 6″ thick, now exhausted. In No. 2 the bed is 4′ thick but running from 1′ to 5′. The coal is very black and shining but in some parts of the mine carries a sandstone

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* The Neshannock Coal Co. has several shafts sunk further north, now pretty well worked out. The eastern end of the Sharon coal basin is near the Neshannock shaft No. 2 from which point the coal 3′ 6″ thick, thins away eastward and disappears entirely. In the northeast corner of the township on Rapp's land the coal was extensively mined, 2′ 6″ to 4′ 0″ thick but with many variations from these figures. One mile west the same bed has been mined on the land of Mr. Haan where the same features are repeated from a nearly exhausted area. Another area lies a short distance east from Hickory Corners, known as the Ormsby Estate, but this is nearly worked out also. The largest continuous area of the Sharon coal was found on property south, known as the Pierce Estate. Many hundred thousand tons of coal have been won from this property, over a large portion of which the bed was found to be from 3′ to 4′ thick and only 25′ beneath the surface.

† A plate of sections is given in Q 3 page 113 of six borings in the vicinity of the Oakland shafts which show the marked changes which occur within short distances in the rocks overlying the Sharon coal.

roof and contains too much sulphur for furnace use. At the Home shaft No. 2, a quarter of a mile west, the coal is again found to contain a considerable quantity of sulphur; but it is otherwise good and attractive and shows about the usual thickness. The Pacific slope is 1 mile east from Sharon and the coal mined at this point, 4′ thick of excellent quality, was used in the mills and furnaces at Sharon. In Ohio, just across the line and opposite the Western Iron works the bed has been very largely mined and about 2½ miles south-west from Sharon the Brookfield Company of Ohio has developed extensively. Their works are among the most extensive in the Shenango valley and the pecularities of this unique coal seam can be well observed in the extensive underground workings at this plant.* Below the coal comes 1′ to 2′ of fire clay which rests immediately upon a massive pebble or conglomerate rock. The floor of the coal is most uneven, being constantly elevated and depressed by the hills and swamps of the miners. Coal 1′ to 5′ thick.

No. XII in Lawrence County.

The Conglomerate Series are also coal bearing in this county. Between the upper and middle divisions occur the two Mercer upper and lower coals, with a limestone over each except where the two beds come together on Slippery Rock creek. The upper bed is a block coal, 5′ thick a few miles west of Edenburg, and iron ore usually accompanies the upper limestone, which is very fossiliferous. Between the middle and lower divisions of the conglomerate lies a block coal bed, 2′ thick at the falls of Quakertown run, which has given the name to this bed.

The Sharon coal bed is found under the lower division of the Conglomerate; but it is no where found of workable thickness in this county.

The Conglomerate Measures are so variable within the limits of this county as to make it impossible to represent

*Mr. White in Q 3 page 123 states that "the roof is a black shale perfectly frescoed with plant remains; graceful ferns, the long ribbon like cordaites and the elegantly cicatriced *Lepidodendra Sigillariae* being equally abundant.

them in a typical section; yet a general section plate CCLIX serves to show the relationship of the coal beds and different rock members, and emphasizes the importance to be attached to the two Mercer limestones which unlike all similar beds in the coal series, *overlie* their coals instead of *underlying* them. Many of the coal beds of this series are not universally present in Lawrence Co., and are all cut out by the rapid changes in the Conglomerate series.

The Homewood sandstone is interchangeably spoken of in this report as the Piedmont or Tionesta sandstone. It is a most variable member; for only three miles south of the Lawrence Co. line, at Homewood, it is found 155′ thick whereas at Wampum, four miles above the county line it is reduced to 50′ in thickness and beyond that point northward along the Beaver it disappears entirely as a massive rock, being reduced to a few feet of flaggy sandstone and shale. On passing up the Connoquenessing, the same marked change takes place, and continues on up Slippery Rock to Harris' fording, when a great sand and pebble rock begins to make its appearance, which at Eckert's bridge attains a thickness of 110′ in a solid mass, its top being only 30′ below the Ferriferous limestone. This is the only portion of the Conglomerate that in Lawrence Co. ever contains any considerable quantity of pebbles. Its usual thickness is about 30′ to 35′, and when not pebbly, it makes an excellent building stone.

All the coals of the Conglomerate series are pretty well developed except the Sharon bed; but all thin away and disappear southward into Beaver Co. except the upper coal,* immediately under the Homewood sandstone.

The upper Mercer coal is also very persistent; for even when the overlying limestone is absent the coal is still found unless both have been cut out by the massive sand-

* There is still more or less confusion concerning the identity of this bed, and though it has been mined at several localities and sometimes attains a thickness of 3′ to 4′, it is usually slaty and sulphurous. It has various local names, such as the "Shield's coal in Taylor twp.": the "Four Foot Vein" in the vicinity of East Brook, and "Dirt Vein" in the territory north from the Mahoning and west from the Shenango, where it often contains a layer of slate 2′ to 6″ thick near its center. (For coal bed sections see plate CCLIX.)

stone above. The coal, however, is always very impure and worthless, being in many localities one-half dirt. It is therefore of no economical importance.

The lower Mercer coal, occurring from 0′ to 18′ below its limestone, is also a persistent but slaty and impure bed. It is the "Lower Porter coal" of the First Survey and has been found at numerous localities along the Slippery Rock; in the vicinity of Wampum and as far south as the mouth of the Connoquenessing. Along the Big Beaver it is known as the "Blue Limestone coal" and on the upper Mahoning it becomes a very fair block coal as mined on the land of Mr. Erskine. One mile west of New Wilmington it is found from 2½′ to 3′ thick, often with a few inches of cannel as its base. It is also found along the Neshannock.

The Connoquenessing sandstone, the equivalent of the Massillon sandstone of Ohio, includes all the massive rock between the Mercer lower limestone and Sharon coal. Instead of the rock material in this interval forming a homogeneous mass of sandstone, as it does in some portions of Ohio, it splits up in Lawrence Co. into an upper and lower massive portion with a coal horizon in the center and is therefore given the double name of the *Upper and Lower Connoquenessing sandstones.* The Quakertown coal bed, between these two members, creates a persistent horizon in the county though it is a workable bed at only two or three places. At the "Falls" on Quakertown run it is 2′ thick and at Wright's bank, one mile northeast from Quakertown station it shows a tendency to run into the block variety and is about 3′ thick. It carries a high sulphur however and considerable slate. Along Slippery Rock creek this bed is filled with bituminous matter, but entirely worthless commercially. Its occurrence as a coal bed is very sporadic.

The Sharon coal bed, which attains such importance in Mercer Co. to the north, has scarcely workable dimensions in Lawrence Co., although future shafting for it may reveal a merchantable thickness over parts of the county where its outcrop is now concealed.

No. XII or "Beaver River Group" in Beaver Co.*

This group of rocks is exposed in Beaver Co. only along the Big Beaver and Connoquenessing creek, where limited by the Homewood and Piedmont sandstone above and the Sharon (Garland-Olean) conglomerate below. It shows a mean thickness of about 225′.

The Homewood sandstone, massive and conglomeratic, occurs from 75′ to 155′ thick, and is supposed to be the representative in this district of not only the Piedmont sandstone of West Virginia, Maryland and Central Pennsylvania, but also of the great sand-rock which extends unbroken through McKean and Forest Cos., to which was given, 70 years ago the name of "Tionesta sandstone," which it (locally) still retains though better known now as the Johnson Run sandrock. It reaches its maximum thickness at Homewood station, where it is a massive yellowish-white sandstone, somewhat coarse grained, many of its layers filled with quartz pebbles, the whole making a solid ledge 155′ thick. At Beaver Falls and New Brighton it diminishes to 75′ in thickness. (See plate CCLXI.)

One of the Mercer limestones, with sometimes a thin coal below it, has been identified in the vicinity of the old Homewood furnace, separated from the Ferriferous limestone above by an interval of 135′. It has a dark bluish color; is filled with fossils; varies from 8″ to 12″ in thickness and is quite persistent from this point up the Beaver and Connoquenessing to Wurtemburg, where it is the Lower

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*The latter name was assigned to this series in a prefatory notice by the State Geologist in 1876, inasmuch as at that time there was considerable doubt as to the propriety of separating this series of sandstone and conglomerate, frequently carrying commercial coal beds, from the true Lower Productive Coal Measures.

The work of the field assistants during the succeeding years, however, effectually justified this separation as it also brought about a satisfactory harmony between the Beaver River group along the Ohio line and the Conglomerate series of Lycoming, Potter, Cameron, McKean, Warren and Venango Cos. There is still such marked differences in character and thicknesses of the rocks of this group in Western Pennsylvania, as compared with the Allegheny Mountain district and the Anthracite district that it is doubtful whether there will ever be a perfect correlation of this series which will be uniformly applicable throughout the State.

Wurtemburg limestone of the Slippery Rock section. It occurs in shales 20′ to 80′ thick, containing carbonate ore.

The Connoquenessing sandstone has been divided in this county into three members: *an upper member*, very massive hard white sandstone, 40′ to 50′; *a middle member*, dark sandy shales, containing iron ore at the top and sometimes a thin coal below, 35′ to 40′; and *a lower member*, hard, massive, grayish-brown sandstone, 20′ to 25′ thick; the three members representing the Massillon sandstone of Ohio. The Sharon coal beneath this sandstone seems to be generally absent, and Sharon conglomerate not exposed.

The most noticeable feature of the Conglomerate series in this county is the total absence of all workable coal beds which characterize and render commercially important this group of rocks in Butler, Lawrence and Mercer Cos. to the north and east.

South of the Ohio river to the West Virginia line the Conglomerate Series is everywhere buried beneath a constantly increasing cover of overlying coal measures, and the constitution of this group in the counties of southwestern Pennsylvania can only be gleamed from the imperfect records of the oil well drill holes in that region, very few of which suggest the commercial integrity of this group south of the Beaver river in Pennsylvania.

Beneath the Sharon coal on the Connoquenessing, 1 mile above Jones' bridge, a sharp roll exposes the following lower measures:

1. Bluish shales containing fossil plants,	2′
2. Stratum of iron ore,	1′
3. Dark shales containing fossil plants and streaks of coal near their base,	4′

Shales 1 and 3 of this section are crowded with plant remains which are identical with those seen in the roof shales of the Sharon coal, on the Shenango and Mahoning. Here appear immense quantities of *Cardiocarpa*, *Trigonocarpa*, and *Cordaites;* also *Odontopteris neuropteroides*, *Alethopteris grandifolia*, *A. lonchitica*, *Sphenopteris macilenta*, and numerous others. The shales themselves have the same lithological character as those over the Sharon coal, and if both were thrown on the dump together they could not be distinguished in any manner.

The streaks of coal at the base of No. 3 represent the Sharon coal, or at least its roof, though there is doubtless no workable bed at this locality. (Sections on plate CCLXII).

No. XII in Beaver, Lawrence and Mercer Counties along the Beaver and Shenango Valleys.

As a result of the special survey of the Beaver and Shenango Valleys,* a clearer conception of the Conglomerate Series was obtained and a general vertical section compiled of the entire group together with the overlying Lower Productive Coal Measures (see plate CCLXXXVI). The Conglomerate or "Beaver River Series" here shows:—

No. XII General Section.

Extreme Measurement.			Average.
0′ to 60′	Homewood sandstone	Mercer Group 41 0″	30′
5′ to 15′	Slate		11′
0′ to 3′	Mercer Upper Limestone		2′
0′ to 2′	" " Coal		1′
5′ to 20′	Ferriferous shales		15′
0′ to 2′	Mercer Lower Limestone		1′
0′ to 10′	Shale		5′
0′ to 2′	Mercer Lower Coal		1′
0′ to 10′	Shale		5′
10′ to 60′	Connoquessing Upper Sandstone,		35
0′ to 50′	Shale, with iron ore and "Srawbridge Coal,"		25
20′ to 60′	Connoquessing Lower Sandstone sometimes double, with small coal near the middle,		55′
0′ to 40′	Slate and shale,		25′
0′ to 4′ 6′	Sharon Coal bed,		3′
0′ to 25′	Dark Shale and Slate,		11′
10′ to 40′	Sandstone; upper part Ohio Conglomerate,		25′
	Total average thickness,		250′

The Sharon coal underlies the upper Mercer limestone from 160′ to 175′, and between them occur the two Connoquenessing sandstones. The two Mercer limestones seldom occur in the same section, but the group is readily recog-

* H. M. Chance 1875 Report V part II.

nized, coming in beneath the Homewood sandstone. At Wurtemburg this group consists of the following strata:

Shale,	
Limestone, hard and black,	3′
Fireclay,	2′
Sandstone,	5′
Soft greyish shales,	15′
Limestone (fucoidae)	1′
Coal,	0′ 5″—1′
Shale, black, soft with iron ore,	5′ 8″

The Homewood sandstone here shows to a knife edge, appearing again further up the stream ; but at Homewood furnace it is a massive and 20′ thick, constantly thickening going up the Connoquenessing until it becomes 60′ at Slippery Rock creek. This will give an idea of the extreme variability in thickness and character of the Conglomerate members and will indicate the reason for doubt and error in identifying them in the early years of the Survey.

CHAPTER CXVIII.

Report on the Anthracite Region,

By A. DW. Smith.

Commercial Importance of

The phenomenal growth of the anthracite industry is so well known as to require but little comment; commencing about 1820, in 20 years the product had increased to one million of tons anually, to 8 million tons in 1860, 25 million tons in 1880, and in 1893 the region produced the magnificent total of 48,185,306* tons.

It will perhaps come with some surprise, even to those well conversant with the magnitude of the anthracite trade, when we consider that the value of the product from the 484 square miles underlaid by anthracite beds, at the mines, in 1893 was $85,687,078† or more than the value, that year of the total product from the whole United States of any one mineral excepting bitumious coal, which with an area of more than 200,000 square miles produced only some 50 per cent. more value or $122,751,618. It is interesting to note in this connection that in 1893, with bituminous coal *first*, anthracite *second*, pig iron is a close *third* with a product valued at $84,810,426, silver *fourth* with $77,575,757, lime *fifth* with $35,960,000 and gold *sixth* producing a trifle less than lime or $35,950,000.

The magnitude and value of the anthracite tonnage explains fully why the surface of the region is covered by a net work of railroads which becomes more complex with each succeeding year.

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* Includes the coal consumed at the mines.

† According to "Mineral Products of the United States" U. S. Geological Survey

PL. 299.
GENERAL MAP OF THE ANTHRACITE COAL FIELDS OF PENNSYLVANIA AND ADJOINING COUNTIES.
A. DW. SMITH, GEOLOGIST IN CHARGE
1895.
NORTHERN COAL FIELD
EASTERN MIDDLE COAL FIELD
WESTERN MIDDLE COAL FIELD
SOUTHERN COAL FIELD
BERNICE BASIN
AREA OF ANTHRACITE FIELDS
Northern 176 Sq. Miles
Eastern Middle 33 "
Western Middle 94 "
Southern 181 "
Total Area 484 "
Scale of Miles
Scale of Kilometers
HARRISBURG
Washington Meridian

Location and General Description.

The anthracite coal fields of Pennsylvania* occupy a central position in the eastern half of the State, and may be said to lie between the Susquehanna and Delaware rivers ; none of its basins extend west of the main Susquehanna and but a comparatively small area is found on the west bank of the North Branch tributary, while to the east the Delaware river water shed is reached but not crossed. The drainage of the region is through the Susquehanna, Schuylkill and Lehigh rivers and their tributaries.

Wayne, Susquehanna, Wyoming, Sullivan, Lackawanna, Luzerne, Columbia, Northumberland, Carbon, Schuylkill, Lebanon and Dauphin counties all contain areas of anthracite coal, but the great bulk of the region is found in Lackawanna, Luzerne, Carbon, Northumberland and Schuylkill; in these counties the business of coal mining overbalances all other interests and gives a distinctive characteristic to the population and politics.

The anthracite coal basins are near the north-eastern end of the Appalachian Belt or Province,† which extends southwest across Pennsylvania into Maryland, Virginia, West Virginia, Tennessee, Georgia and Alabama. Their preservation from erosion is due to a northeast sinking and broadening of the great troughs characteristic of the belt, bringing in successively higher measures, until east of the Susquehanna Formation No. XII is seen making mountainous rims to basins which contain many hundred feet of sandstones and shales interspersed with valuable beds of coal. A northeast rise in the measures, however, soon sets in and finally lifts even the lowest coal beds into the air

* Plate 299 shows general shape and location.

Plate 300 is reproduced from a very valuable and beautiful Relief Map of the Anthracite Coal Fields and vicinity, (geologically colored), by Mr. Edward B. Harden. While the illustration is on quite too small a scale to do justice to the original, a general idea of the topography of the region is conveyed.

† A valuable paper on "The Mechanics of Appalachian Structure," by Bailey Willis, is published in the 13th Annual Report U. S. Geological Survey.

and encloses the eastern ends of the basins with the high conglomerate rim.

The general trend of the measures is N 60° to 70° E or S 60° to 70° W, with a decided curve toward the north at the northeastern end of the region. The enechelon arrangement of the basins has also a northerly tendency so that the greatest length of the region, 120 miles, is not along the strike, but in a diagonal line N 45° E from Dauphin to Forest City; the maximum width is between Mauch Chunk and Shickshinny, some 30 miles, or 55 miles including very properly the small outlying anthracite basin to the north at Bernice.

Although a figure embracing all the anthracite basins contains about 3300 square miles, only about one-fifth of this is underlaid by Formation XII and the area occupied by workable coal beds, about 484 square miles, is of course still less.

The anthracite region is divided into the following prominent divisions: (1) Northern or Wyoming–Lackawanna field, lies in the two valleys from which it derives its geographical name; it is the most northeastern of all, a magnificent basin 55 miles long and six miles wide at the most; of canoe shape pointed at the ends, with a slightly crescent curve toward the north. The product from the small coal areas in Wyoming and Sullivan counties twenty-five miles to the northwest is now included with that from the Northern field. This field constitutes what is known to the trade as the Wyoming region.

(2) The Eastern Middle field lies some 10 to 20 miles to the southwest of the Northern field, and is separated from it by the broad high arch of the Wapwollopen anticlinal, from which the coal measures have long since been denuded*. The field comprises a number of small coal basins (resting chiefly along the southern flank of the great Wapwollopen arch) preserved from erosion on the high plateau between the Lehigh and the Susquehanna rivers. The Eastern Middle is the smallest of the divisions although

* For shape of this arch see the "Lehigh river section" by Arthur Winslow. Atlas Annual Report 1886 Pt. IV

PL.300

the area in which its coal basins are found is about 25 miles long and 10 miles wide. It is contained chiefly in Luzerne, Carbon and Schuylkill counties and forms the greater part of what is known as the Lehigh region.

(3) The Western Middle or the Mahanoy and Shamokin field joins the Eastern Middle on the southwest, the measures after making the comparatively shallow basins of the Eastern Middle dip deeply to the south and west to form the important double basin of the Western Middle field. This field is about 37 miles long and 3 to 4 miles wide, lying between the headwaters of the Little Schuylkill and the Susquehanna rivers and within Schuylkill, Columbia and Northumberland counties.

(4) The Southern field; the important arch which lifts to the surface measures as low as Formation No. V at the Susquehanna, sinking toward the east splits but does not wholly divide the Western Middle from the Southern field. No. XII rides, between Frackville and New Boston, the narrowed arch, forming the shallow basins of the Broad mountain before sinking under the great deep basins of the Southern field to re-appear as its southern barrier the Sharp mountain. This field is the largest of the four, some 70 miles in length from the Lehigh at Mauch Chunk to the Susquehanna at Dauphin; its maximun width 8 miles is in the neighborhood of Pottsville. Four miles west of Tremont the eastward extension of the Perry county anticlinal separates the field into two long narrow basins branching westward, the northern (Wiconisco) basin spooning out when about half way to the river. The field lies chiefly in Schuylkill county with smaller areas in Carbon, Lebanon and Dauphin counties. The comparatively small area of the Southern field which lies east of the Little Schuylkill together with the Eastern Middle field constitute what is known as the Lehigh region. While the balance of the field together with the Western Middle comprise the Schuylkill region.

The anthracite coal beds are undoubtedly identical in time of deposit with the bituminous beds of the western part of the State, and it is the accepted theory that they were originally bituminous beds which in some way have been changed into anthracite.

There are but two divisions recognized in the anthracite coal measures:—*First*, the Pottsville conglomerate or Formation No. XII. *Second*, the "Coal Measures," consisting of all the overlying beds of sandstone, shale, coal, and fireclay comprising probably Formations No's. XIII, XIV, XV and XVI of the bituminous fields. The lower part of the Coal Measures are often referred to as Formation XIII.

Formation No. XII.

The Pottsville conglomerate at the base of the coal measures by its resistance to erosion has been an important factor in preserving the small part of the original anthracite field which now remains. It is the floor upon which the coal measures rest and its outcrops from a protecting and enclosing mountainous rim to the softer coal measures.

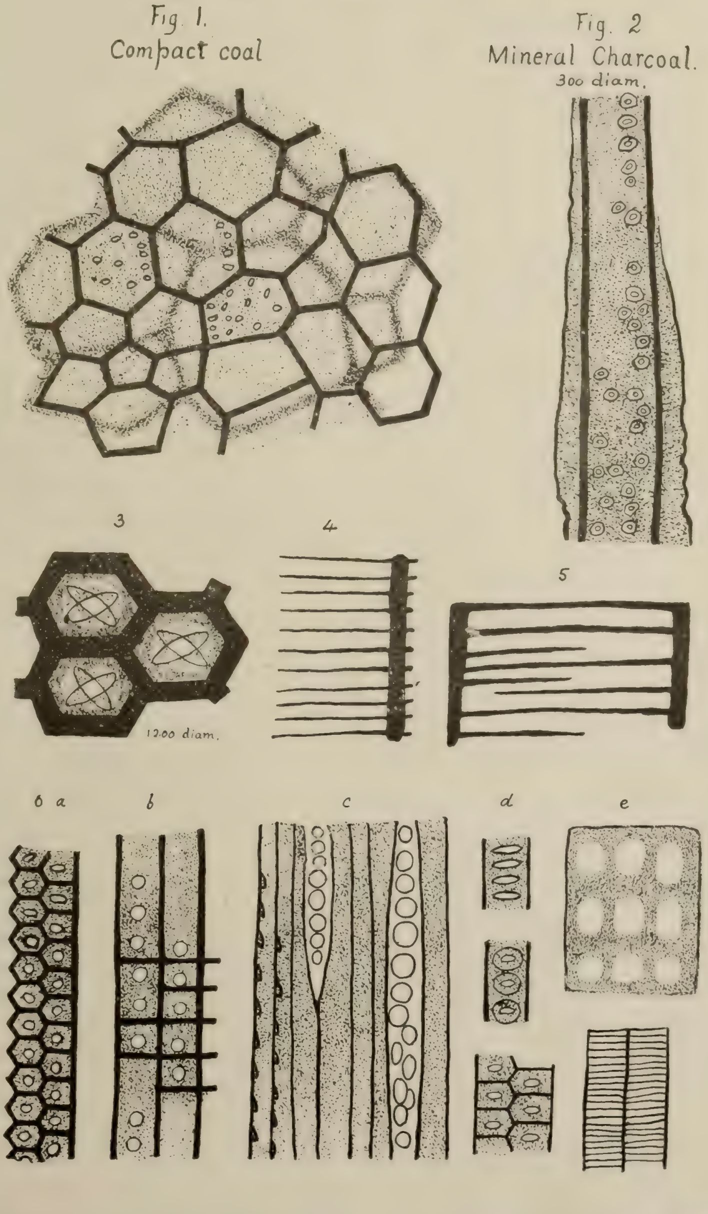
No. XII is composed of beds of grayish conglomerates; white, gray and brownish sandstone usually course and hard; some thin beds of carbonaceous slates; and generally one or more thin seams of coal, which in the southwestern part of the region are large and valuable coal beds. The beds of the *lower part* of the formation generally have a greenish color, which shades into the red of No. XI; the *central part* shows an increased coarseness and hardness of the materials comprising it and usually forms the mountain crest or ridge; the *upper part* as a rule contains more coarse sandstone beds with fewer and finer conglomerates. The *coals of No. XII* are found at different horizons, the valuable Lykens Valley beds are chiefly in the upper and the lower part of the formation.

Limits of No. XII.

The bottom of the Buck Mountain or Red Ash bed, the first coal bed overlying the conglomerate, has been taken as the upper limit of XII; it is as a rule a well defined horizon and but rarely is there any difficulty in fixing its position in the section. The placing of the bottom of XII

PL. 301.

The internal vegetable structure of Coal
as seen by the microscope.
(after J.W. Dawson)



H.V.L.

1885

is a much more difficult affair, as the transition from the red shales of XI to the conglomerates of XII, is not often abrupt but gradual; it is seen in a decreased thickness of the red shale beds, in the appearance of coarse sandstones and conglomerates mixed with the shales which slowly disappear; and in the greenish color of many of the beds with here and there a grayish one. In the Southern field these transition beds have, in places, a thickness of 500 to 600 feet.*

The *transition beds* and the lower beds of XII also exhibit decided variations in the materials composing them, at times heavy conglomerates predominate with but few sandstones and shales or again the whole series may be composed of coarse sandstones and of shales, with the green and reddish tinge running high in the formation; making it difficult, even when a complete section is at hand, to decide where the line between the two formations should be drawn. It is not safe to always take the highest red shale bed as a limit, as beds of red shale, usually thin, but in appearance like the mass of No. XI are not infrequently seen high up in the conglomerates of XII, and occasionally among the overlying coal measures; nor will it suffice to take the lowest conglomerate as beds of conglomerate are often found well down in the red shales of XI. The fixing of a precise limit between the two formations becomes in many instances a matter of individual preference and judgment.

That there are local variations in the thickness of XII is unquestionable, but it would appear not improbable that some of the seeming great differences,† within comparative narrow limits, in the thickness of the conglomerate has been due to the selection of different horizons between XI and XII by the different assistants of the Survey, or even by the same assistant at the various points of exposure.

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* These beds, and those of XI and XII also, are well exposed along the Pennsylvania Railroad in the gap below Pottsville.

† Noted by Mr. Ashburner in the Panther creek basin. See Letter of Transmittal First Report Anthracite Region and cross section, sheet III Southern coal field.

Thickness of No. XII.

The formation shows a marked decrease in thickness and in the coarseness of the material composing it from the southwest to the northeast.*

The greatest thickness of No. XII, not only for the anthracite region but for the State, is found in the Southern coal field; and the maximum is apparently reached in the southwestern part of this field. Measurements of XII at Lincoln and Kalmia collieries, where there are extensive tunnels to tap the Lykens Valley coal beds, furnish a complete section 1475′ thick (Page plate 391). Its thickness on the Broad mountain is about 1200′. This is about the average thickness throughout the field. (For sections of XII see page plates 366, 370 and 391).

In the Western Middle field the conglomerate has an average thickness of about 850′. The section exposed in the East Mahanoy tunnel P. & R. R. R. is one of the best. (Page plate 346.)

In the Eastern Middle field the average thickness is about 300′, but there is a marked decrease from the Silver Brook basins on the south, where the formation is 400 to 500′ thick, northeast across the field to the Upper Lehigh basin where but 200′ of measures are assigned to XII (Section given on page plate 334).

No. XII in the Northern field will average about 225′ in thickness, at the northeastern end it has a general thickness of about 200′ only a little below the average; the forma-

*The conclusion seemed to me irresistible that an explanation of the thickness of the Conglomerate southeastward must be sought for in a supposition of some shore line backed by extensive lands in that direction, far enough away to be beyond the Middle or Lower Palæozoic outcrops, and yet near enough to account for the suddenness of the increase of thickness within the belt of observation. But the present typography of the Atlantic border furnishes nothing for this purpose except the South Mountain range from Reading eastward and its continuation on a larger scale as the Highlands of New Jersey. But the now completed typographical map of the South Mountains between Reading and Easton seems to prove very plainly, what I have long believed, that the Azoic core of this range was entirely covered by the Palæozoic sediments at the time of the deposit of the Pottsville Conglomerate." (Prof. J. P. Lesley in First Report Anthracite Region.

PL.302

Anthracite Region – Mining Methods

METHOD of WORKING two SPLITS of the BALTIMORE BED at the MINERAL SPRING COLLIERY

Near Wilkes-Barre, Pa.

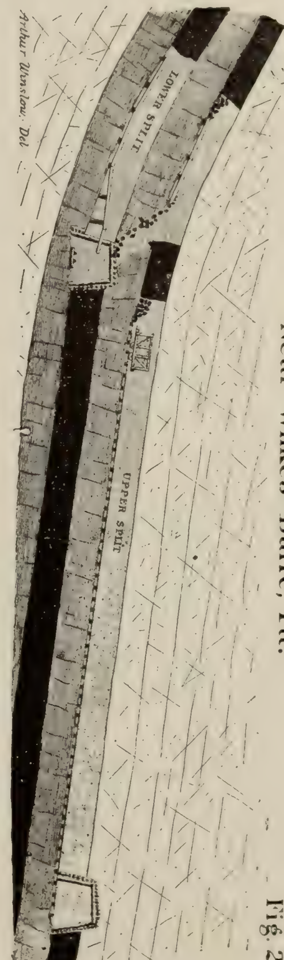


Fig. 2.

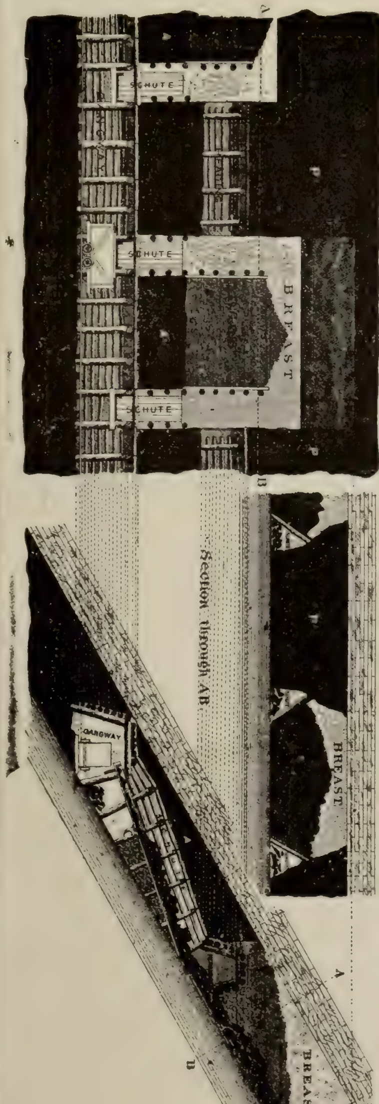


Fig. 3.

DOUBLE SHUTE – Juggler, thick seam, moderate pitch.

tion is thickest apparently in the central part of the field; at the southwest end as little as 90′–150′ has been locally assigned to it. (Page plate 312 gives sections.)

In the Loyalsock-Mehoopany region the limits of XII are not conclusively determined, but enough is known to assure for it a thickness of at least 120 feet. The materials composing No. XII in the Northern field are much finer than in the more southern basins; the pebbles even in the coarsest layers do not as a rule exceed hickory nut size, and northeast of Scranton XII is mainly a coarse sandstone with some thin layers of fine conglomerate. A detail account of this formation in the various sub-divisions of the fields is given later in the report.

The Coal Measures.

The coal measures consist of beds of sandstone, some coarse and hard grading down to fine, soft and shaly; of shale; of fireclay; of black carbonaceous slate or shale and of beds of coal from a few inches in thickness up to the great Mammoth bed with its thickness over large areas of 50′ to 60′. The prevailing color of the sandstones and shales is brown or grayish. Beds of fine conglomerate are not an unusual occurrence within the coal measures and in some instances they are so coarse and massive as to have been mistaken for No. XII.* Fireclay beds usually but not always underlie the coal beds, they are also often seen in the intervals between.

The coal beds are pretty well distributed through the whole thickness of the measures, the intervals separating them vary from a few feet to a couple of hundred; but it is seldom that a barren interval of more than 200′ is seen. The distances between the same coal beds vary somewhat, and at times decidedly, in the different basins and in different parts of the same basin. The lower 300′ to 500′ of measures, from XII to the top of the Mammoth bed, con-

* Mr. Benj. Smith Lyman gives an example of this in a paper called "An Occurence of Coarse Conglomerate above the Mammoth Anthracite Bed" published in Transactions American Institute of Mining Engineers, Vol. XXI.

tain the thickest coals, and are more productive than the measures higher in the series.

The Eastern Middle, Western Middle and Southern fields are closely associated and have common names for their principal coal beds. The Northern field further removed has not only a different set of names for its coal beds, but different names for the same bed within the limits of the field. No attempt has been made to correlate all the beds of the Northern with those of the other fields, but the identity of the Red Ash with the Buck Mountain bed and of the Baltimore with the Mammoth bed is generally accepted.

Thickness of the Coal Measures.

The greatest thickness is found in the deep basins of the Southern field,' where the total aggregates more than 2500′; workable coal beds extend to the very top of the column, and perhaps still others may have been originally deposited, of which every trace has been removed by erosion. In the Western Middle field we find a total of about 1500′ of measures, the upper coal beds of which are thought to correspond with the Southern beds of the same names and at about the same height in the column. All the high coal measures have been denuded from the Eastern Middle field, the deepest basin (Hazleton basin) containing only about 700′ of measures above the conglomerate. In the Northern field at its deepest point there is a thickness of about 1800′; the upper part of these measures seem rather barren of workable beds; the identity of these beds with the high beds of the Southern field is quite uncertain. It is possible that the deposition of the 1800′ of coal measures of the Northern field may represent a period of time equal to that required to deposit the 2500′+ of the Southern field.

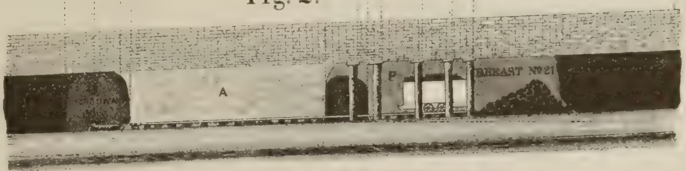
The Structure.

The great waves into which the originally horizontal measures of the anthracite region have been thrown reach their maximum height along the southern edge of the Southern field. Here the north dipping strata have been

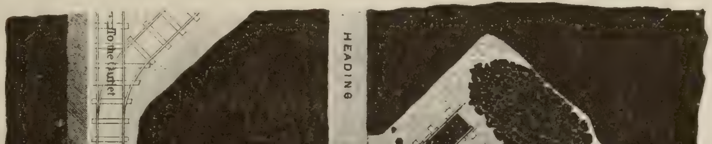
Anthracite Region_ Mining Methods.

WAGON BREAST.

Fig. 2.



Projected Section through C D.



tilted up to a perpendicular and overturned position. Commenting upon this feature in the Panther creek basin of the Southern field, but applicable to the whole field Prof. Lesley says:*

"The most striking feature of the plication of the coal beds of this basin is its sharpness, the rarity of those soft and gentle curvatures which characterize the bituminous coal basins, a rigid plainness of the up and down slopes, suggestive of (1) a severe lateral compression in the jaws of a vice, and (2) a humid plasticity of the coal measures at the time of compression."

Following this, Prof. Lesley also adds:

"It would advance structural geology a long step if we could get at the data for portraying equally well the shape of the whole *bottom* of the Conglomerate (No. XII). Hitherto whenever transverse sections of the Palæozoic system were made deep enough beneath the surface to include the underlying red shale (XI), the plane of contact has been conceived as a series of simple and compound waves of such a shape that the curves of the synclinals were struck with a larger and those of the anticlinals with a smaller radius. But we have always been and still are ignorant for the most part of the true character of this contact plane.

"If, when we know it better, it should turn out to be plicated as sharply as we know the contact planes at the top and above the top of the Conglomerate are, the fact would go far to prove that the Conglomerate itself was as humid and plastic as the coal measures when first compressed. It would also reinforce the opinion that no Palæozoic plication occurred until the close of the coal age; and, that it took place then at once, and for all.

"Although our ignorance of the shape of the bottom plane of the Conglomerate is great, what little we do know about it is significant. It can be studied, more or less unsatisfactorily, at the summits of the spur mountains in which terminate the numerous coal basins of the region."

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* First Report Anthracite Region A A, page xviii.

Since 1883, when Prof. Lesley wrote the above, the completion of the mapping of the anthracite region and the extension of the mine workings and explorations, have furnished the Survey with information for correctly portraying, in special localities, the shape of the contact planes of XII. These results as a whole show the Conglomerate to be less sharply plicated than the overlying and softer coal measures, and tends to strengthen confidence in the theoretically lessening curves of the underlying beds, as usually drawn on the cross sections;* although these same developments have disclosed some plications which do not appear in the overlying beds.

The plication of the measures lessons toward to the north and east; the basins of the Western Middle fields are mostly deep with steeply dipping sides, but less so than those of the Southern; in the Eastern Middle field although the basins are shallow the sides dip rather sharply, say 30° to 50°; while in the Northern field the ruling dips are much more gentle; even at the southwest end where steepest, and at the northeast end the broad basin with its gentle curves is scarcely more inclined than some of the bituminous basins of the western part of the State.

The numerous page plates of cross sections which illustrate this report show clearly the prevailing structure in the different parts of the region. Care was taken in selecting the sections to eliminate as far as practicable the purely theoretical and to choose those on which the position of the coal beds had been determined by actual mine workings.

Composition of Pennsylvania Anthracite.

In the prefatory letter to the First Report Anthracite Region 1883, Mr. Chas. A. Ashburner tabulates the results of the analysis by Mr. A. S. McCreath of some 30 samples of anthracite coal, especially collected for that purpose from the market cars as loaded for shipment; samples were had from each of the fields, and the coal came from

* Page Plates 387, 389 and 390 show shape of XII according to the mining developments at those points.

PL.304.

Anthracite Region – Mining Methods.

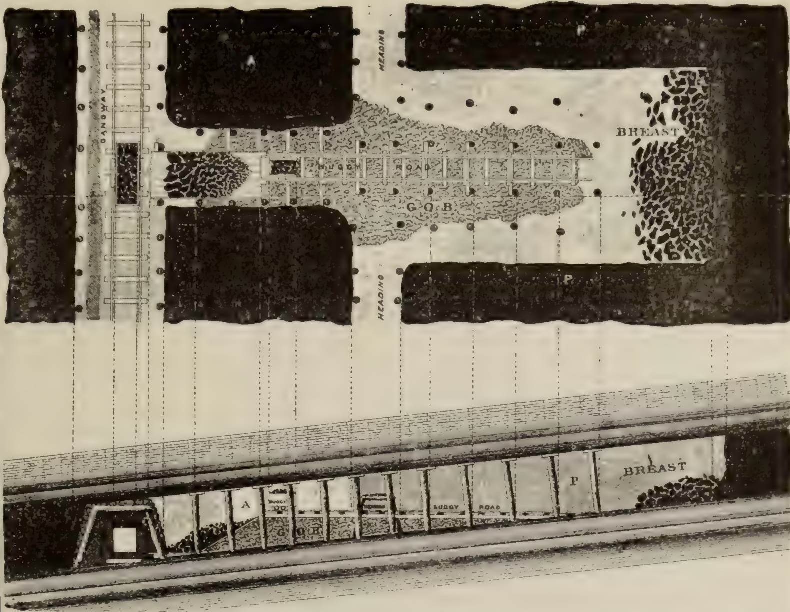
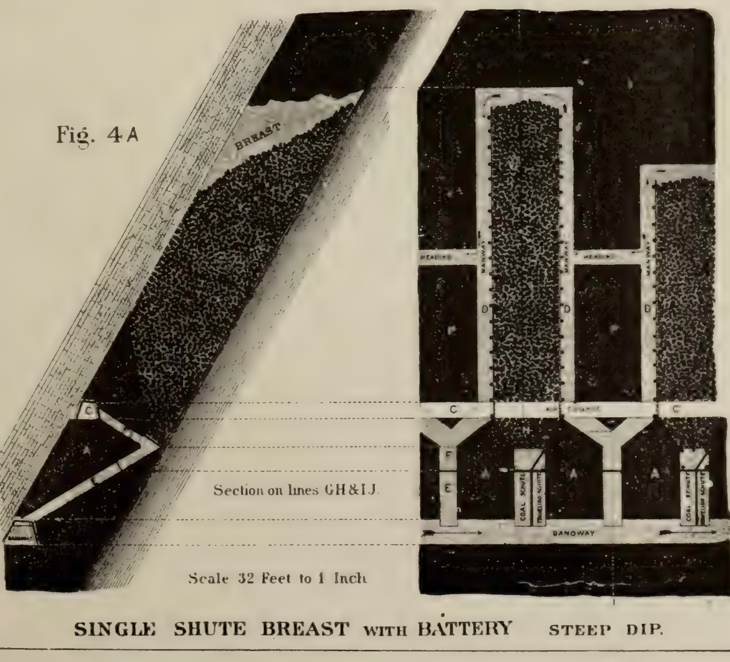


Fig. 4. SINGLE SHUTE BREAST. Flat workings with Buggy

Fig. 4A



SINGLE SHUTE BREAST WITH BATTERY STEEP DIP.

beds between the Primrose and Buck Mountain inclusive. A general average of the results shows the constitution of *commercial* anthracite to be about as follows:

Water,	3.30
Volatile matter,	3.80
Fixed carbon,	84.00
Sulphur,	.50
Ash,	8.40
	100.000
Fuel ratio,	1 : 22.33
Specific gravity,	1.628

"The high amount of ash is undoubtedly due to an imperfect separation of the slate and poor coal from the better coal, in the preparation of the market product." Improvements in the cleaning and preparing have unquestionable been made since 1883 ; but the precentage of impurity (ash) sent to market, is naturally somewhat regulated rather by what the market will stand, than by the best result attainable with the improved machinery.

It is a well known fact that the precentage of ash increases with the decrease in the market size of the prepared coal, this is illustrated in the following table from the same Report, page 182.

Analyses of the Market Sizes of Coal shipped by the Lehigh Coal and Navigation Company, 1882.

Kind of Coal.	Water.	Volatile matter.	Fixed carbon.	Sulphur.	Ash.	Total.	Color of ash.
Egg,	1.722	3.518	88.489	.609	5.662	100	Light cream white specks.
Stove,	1.426	4.156	83.672	.572	10.174	100	Cream.
Chestnut,	1.732	4.046	80.715	.841	12.666	100	Cream.
Pea,	1.700	3.894	79.045	.697	14.644	100	Cream, white specks.
Buckwheat	1.690	4.058	76.918	.714	16.620	100	Cream, white specks.

Specimens of three grades of *bony coal*, mined at Colliery No. 10,—Lehigh Navagation Co.—which from its bad appearance had been thrown on the dirt bank as worthless, were carefully selected and analyzed by Mr. A. S. McCreath (See First Report page 181); the result showed the bony coal to be a much better fuel than much of the coal then shipped. Much less bony coal is now thrown away than formerly; it is mostly broken down to pea and buckwheat sizes where its lustreless appearance is not so noticable.

A later paper by Mr. Ashburner with additional analyses contributed by Dr. Chas. M. Cresson of the Philadelphia and Reading Coal and Iron Co. is published in Annual Report 1885 Chapter II.

Specific Gravity of Anthracite.

An inspection of the analysis, published by the Survey, shows that in specimens where the ash is above the average the specific gravity is as a rule also above the average. The weight of pure anthracite is invariably less than that of the commercial product. Messrs. Coxe Bros. & Co. of Drifton utilize this fact to determine, by a simple specific gravity test, each day the proportion of refuse contained in the product shipped by them to market.*

*The method they employ is fully described in a paper contributed by Mr. Eckley B. Coxe to the American Society of Mechanical Engineers, 1893 under the title of "The use of small sizes of anthracite coal for generation of steam." Mr. Coxe comments on the value of the results as follows: "There seems to be no doubt that there is a close relation between the specific gravity of coal and its percentage of ash. Mr. Walter. R. Johnson, in his celebrated report upon American coals, suggests that there might be such a relation, but gives no figures to establish the fact. A careful study of a great number of analyses of coal and determinations of specific gravity has led us to believe that, although our experiments are not as yet absolutely conclusive, there is a strong probability that, for a given size of coal from the same colliery under ordinary circumstances, the determination of the specific gravity of an average sample will give very nearly the same percentage of ash as will be determined by analysis, although the relation may not be exactly the same for different mines or for different sizes of coal.

If the specific gravity and percentage of ash, in any sample of coal below egg size, is known, the percentage of ash in any other sample of the same size coal, and from the same colliery, can be satisfactorily determined (we are inclined to think) from the specific gravity of that sample, by the following formula:

Anthracite Region — Mining Methods

METHOD OF WORKING BREASTS ON THE MAMMOTH BED
at Hazleton № 6 Colliery of
A. Pardee & Sons.,

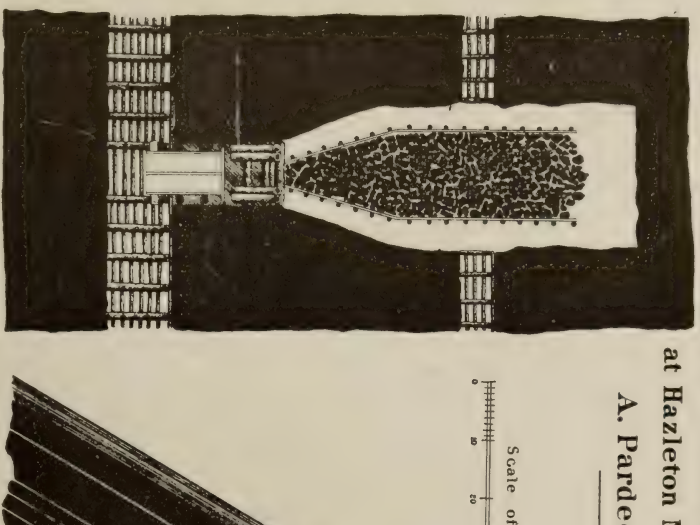


Fig. 1.

Their experiments indicate a specific gravity of about 1.55 for *pure* anthracite from the Drifton colliery. In the thirty analyses of *commercial* anthracite by Mr. McCreath the three specimens from the Northern field average 1.575, the eight from the Eastern Middle field 1.614; the ten from the Western Middle field 1.658; and the nine from the Panther creek basin of the Southern field 1.6307. A number of specific gravity determination of the Lykens Valley coal from the western part of the Southern field, by Mr. John R. Hoffman of the P. & R. C. & I. Co., give a variation of 1.42 to 1.50 with an average of 1.44.

"*Vegetable origin of coal*"

Is the title to a paper by Prof. Leo Lesquereux with "Notes by Prof. J. P. Lesley" published in Annual for 1885, pages 95 to 124. Prof. Lesquereux states: 1. The proofs of the vegetable origin of coal. 2. Objections to the same. 3. Bischof hypothesis. 4. Grand Eury hypothesis. 5. Vail hypothesis. 6. Kuntze hypothesis. 7. The peat bog theory with his own observations and sums up with the following remarks: "It must be kept in mind that all the agencies which contributed to the formation of coal beds

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$$(y'=y+(x'-x)\times a;$$

in which

$x =$ the standard specific gravity,
$y =$ the standard percentage of ash,
$x'=$ the specific gravity of coal determined by our apparatus,
$y'=$ the percentage of ash to be determined,
$a =$ a constant for coal from same mine.

It is possible, however, that for the very smallest size from mines where the percentage of iron pyrites is large or very variable, the formula may require some modification. It might also fail if the character of the coal, slate, or other impurities varied very materially in the different veins or in the different parts of a mine, so that the product of the mine could not be considered a uniform one. There is no question, however, that the determination of the specific gravity in this rough way, which can be done by any careful person, is of great value, and would be a very good check on the shipments of coal received, provided it was accompanied from time to time by a slate determination by means of chloride of zinc, and occasionally by an ash determination by analysis.

I do not wish to speak too positively on this subject, because we have not concluded our experiments, and hope later to give more information upon this point."

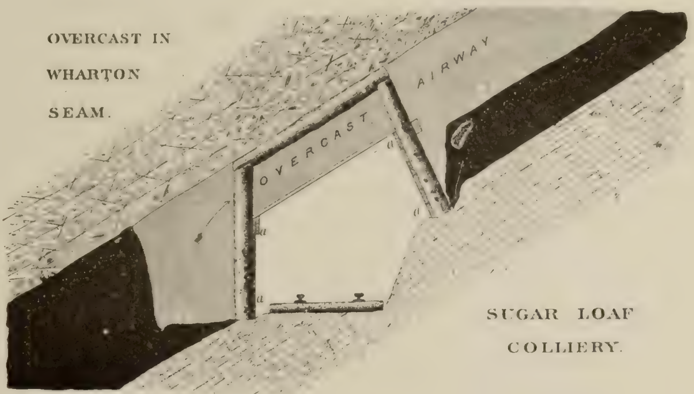
worked on a prodigiously larger scale than those which are now in activity for the formation of peat. Then, the deposits of vegetable remains were from an exceptionally exuberant vegetation, favored by the greatest possible humidity of the air, and a superabundance of carbonic acid in the atmosphere. It was a vegetation from which we can scarcely get an idea from anything now visible. Acrogenous plants, Ferns, Lycopods and Equisita (Horsetail) composed nearly the whole flora of the coal period. All the plants of those orders, represented by numerous genera, were then large trees, their trunks measuring from one to three feet in diameter, forty to 100 feet tall, or even more; growing close together, and forming an impenetrable thicket of stems, branches and leaves; whereas, at the present day, the same kinds of plants are represented by mere herbage of small size, with stems and branches scarcely as thick as a goose quill, and only one or two feet high. Most of the land surface was then a vastness of swamps, in which the first growth, generally floating or creeping plants, was essentially composed of a peculiar species, the *Stigmaria*, whose immensely long stems aud branches, from 4 to 6 inches thick, were woven together, like the thin, matted, floating stems of the *Sphagnum* of the present age, into an immense woven mat, or thick carpet, over which the luxuriant land vegetation of the coal soon spread itself. And, of course, we must suppose that such an accumulation of ponderous material, such a mass of vegetation, sank of its own weight at times and places into the water beneath and became wholly submerged. This supposition becomes a certainty in view of the superposition of thick beds of sandstone, shale, clay, ironstone and limestone upon the old beds of coal.

"To account for the succession of coal beds separated from each other by many feet or yards of rock strata, and constituting a mass of coal measures several thousand feet in total thickness, it is necessary to take into consideration those very slow downward movements of large areas of the earth's surface which have taken place in all geological ages, and were nearly continuous on a grand scale during

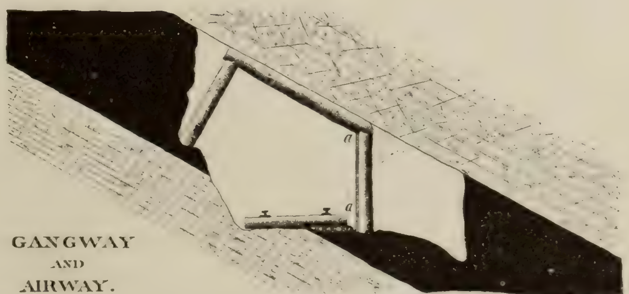
PL. 306

Anthracite Region – Mining Methods

OVERCAST IN WHARTON SEAM.



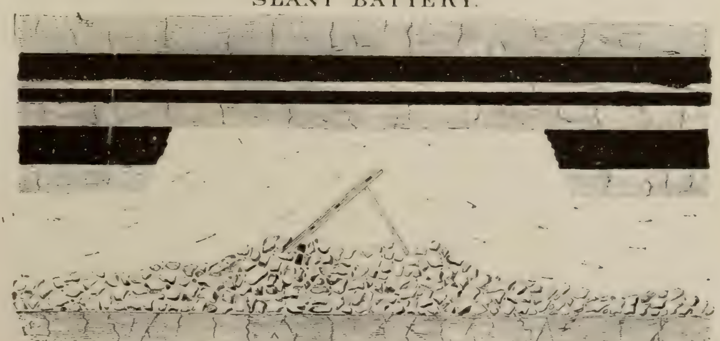
SUGAR LOAF COLLIERY.



GANGWAY AND AIRWAY.

WHARTON SEAM, HAZLETON.

SLANT BATTERY.



the whole time in which the numerous formations of Middle and Western Pennsylvania were being deposited; ending with the rise of the whole region to its present height at the end of the Coal Measure age. During all the last part of the downward movement the coal vegetation flourished magnificently, but was interrupted by inroads, of the sea on an equal grand scale; and these inroads which explan the intermediate sandstone, shale, limestone and iron ore beds, were precisely similar—but vastly greater and perhaps lasting for a much longer lime—to those which have been described as happening in the history of the formation of the peat-bogs of our own day.*

"From all that has been said then it plainly appears that in the growth of peat we have have a microcosmic but true representation of the formation of the ancient coal."

Prof. Lesley's brief notes are accompanied by a page plate (reproduced as Plate 301) showing the vegetable structure of coal as seen by the microscope. His notes conclude as follows:

"For the purpose of the present paper these few exhibitions of the vegetable origin of our coal beds will suffice; and I have chosen those made nearly thirty years ago, first for the purpose of showing how long investigations into the origin of coal were successfully pursued, and secondly, because the conclusions arrived at then have been since verified and confirmed by the work of later investigators, especially by those who have discovered many coals crowded with the preserved pollen of the plants of the coal age. These will be given in my Summary Report.

"Not often is Nature caught in the act of performance; she behaves like a loving house-mother on Christmas eve, moving noislessly about, that the children be not awakened while she fills their stockings with toys and sugar plums. Sometimes a plank in the floor will creak, or a piece of match-wood snap; that cannot always be helped. Volcanic action is impossible without periodical eruptions, nor a restoration of the elevation of worn-down highlands without

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* See also a recent Memoir on this part of the subject by E. Hull, Director of the Geological Survey of Ireland.

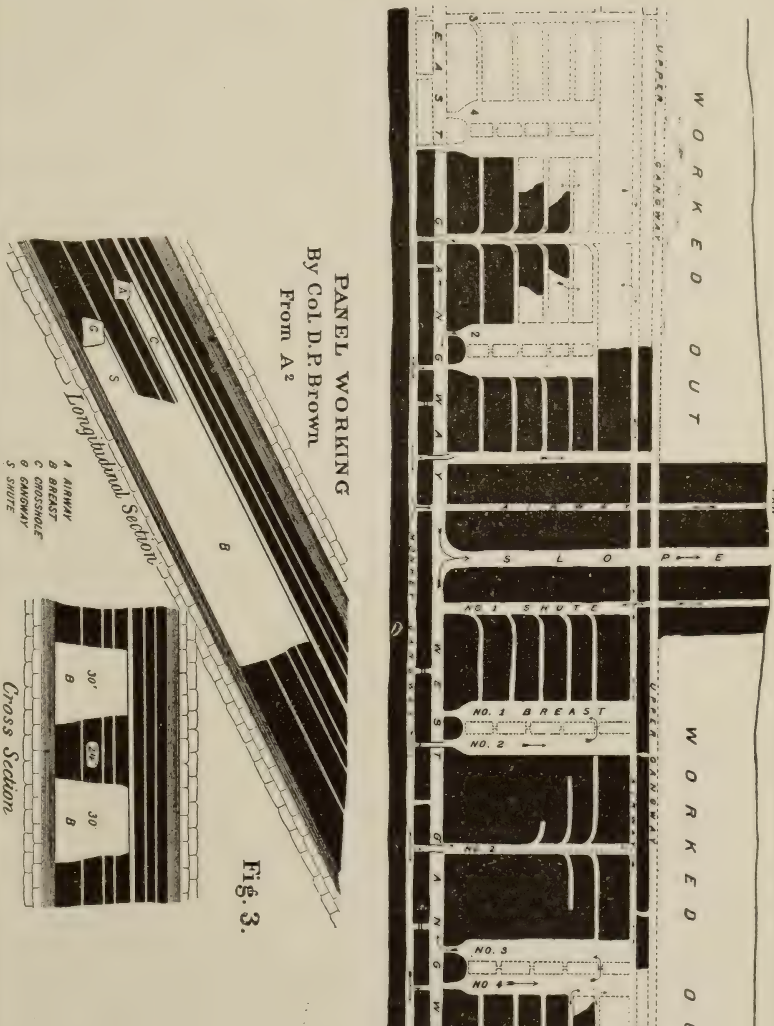
occasional earthquakes. But most of Nature's operations are so noiseless, and so hooded from human eyesight, that Geology plays with her a perpetual game of blindman's buff, and is only now and then successful at a catch, as in the case of the Lac d'Etailleres, narrated by Mr. Lesquereux in the foregoing paper."

Mining Methods and Appliances in the Anthracite Region.

Report AC, "Coal Mining," with an atlas, by Dr. H. M. Chance, published in 1883, was intended, the State Geologist in his letter of transmittal says, "to serve as a manual for the working of anthracite collieries in Pennsylvania, by supplying to superintendents and mining engineers such precise practical information concerning the opening of outcrops; the sinking of shafts and slopes; the construction, erection, and use of machinery; the cutting, handling, and transporting of the coal; the ventilation of the mines; and whatever else of importance is incidental to the exploration and exploitation of our anthracite beds—as the history of anthracite mining in Pennsylvania can furnish."

The abundant success of this report is fully attested in the continued demand for the work and the difficulty with which copies are now to be procured. Its comprehensive scope is seen from the subject headings of the twenty-eight chapters into which the book is divided, they are as follows:—1. Introduction, 2. Prospecting for coal, 3. Methods of opening coal, 4. Shaft sinking and timbering, 5. Slope sinking and timbering, 6 Gangway and tunnel driving, 7. The Mining plant as the surface, 8. Mining systems, 9. Methods of opening and working breasts, 10. Coal mining tools and methods, 11. Underground railways and slopes, 12. Slopes, planes, and inside slopes, 13. Rolling stock and motive power, 14. Winding engines and drums, 15. Winding machinery and appliances, 16. Safety attachments, signaling apparatus and indicators, 17. Access to and from mine workings, 18. Drainage and pumping machinery, 19. Ventilation and ventilators, 20. Colliery management, 21. Mine surveying and mapping, 22. Mine

Anthracite Region - Mining Methods.



gases and explosions, 23. Roof-falls and other accidents, 24. Mine fires, 25. Hygiene of mines, 26. Preparation of coal for markets, 27. The anthracite coal breaker, 28. Waste in mining and preparing anthracite. Appendix A.—Mine laws, B.—Glossany of mining terms, C.—Tables showing produ tion of anthracite.

Page plates 2 to 310 are reduced from illustrations accompanying th report and show some of the different methods of mining anthracite.

In the eleven years which have elapsed since the publication of Dr. hances' report a number of improvements both in mining nethods and appliances have been made, but mainly al g the old lines with little or no radical change in any irection.

One of the most important perhaps is a better and more general *utilization of the small sizes of coal.* Buckwheat No. 2 is saved at nearly every colliery in the region and No. 3 or Rice at many of them, formerly these small coals were thrown on the dirt banks, the rapid improvements in appliances for b rning fine coal would seem to indicate that the time is perhap t far distant when even the smallest particles of carbon ll be utilized.*

A number of " heries" have been established at different points in th egion to re-claim the coal which had been thrown a ay in the great piles of culm that form so prominent a feature of the anthracite landscape. The culm is first thorougly washed to remove the fine dirt clinging to the coal and slate, it is then cleaned (slate removed), sized and prepared for market in the usual way. In some of the old culm banks 50 to 75 per cent. of the contents. is found to be a marketable product.† The cost of erecting the "washeries" has been from $10,000 to

* A paper titled "A Furnace with Automatic Stoker, Traveling Grate, and Variable Blast; intended especially for Burning Small Anthracite Coal" by Mr. Eckley B. Coxe, Drifton, Pa. Transactions American Institute of Mining Engineers Vol. XXII, 1893, gives much valuable information on this subject.

† A paper by Mr. Arthur W. Sheafer, of Pottsville, Pa., "The Re-working of Anthracite Culm-banks" Trans. Am. Ins. Mining Engineers gives statistic. See also Report Pennsylvania Coal Waste Commission.

$20,000 each and it is of course necessary to have a large culm bank, free from fire, containing a good percentage of marketable coal, to make the operation a profitable one.

Culm is also used at a number of the collieries to fill worked out breasts, in order to support the roof while the pillar coal which has been left standing can be safely mined. The culm is mixed with water and conveyed by pipes or bore holes to the desired localities underground, the water is afterwards pumped out of the mine, and in the course of time the weight of the overlying strata compresses the culm until it becomes hard and firm and it then affords the necessary support. In some instances it is found more profitable to utilize the culm in this way than to wash and prepare the coal it contains for market, of course the refuse from a "washery" can be used for filling in if conveniently situated.

An increase in the individual capacity of the collieries is one of the tendencies of the times, in many cases this is made desirable because of the greater cost of opening and operating the mines owing to the constant increase in the depth of working. In 1882 the maximum product from any one colliery was about 300,000 tons per annum, but in 1893 six collieries produced between 400,000 and 500,000 tons each and a number of others over 300,000 tons. There are probably now, at least, a half a dozen breakers which if operated to their full capacity could each prepare during the year some 700,000 tons of coal.

Two breakers built entirely of iron have been erected during the past few years, among other advantages is their compactness and perfect freedom from any danger by fire.*

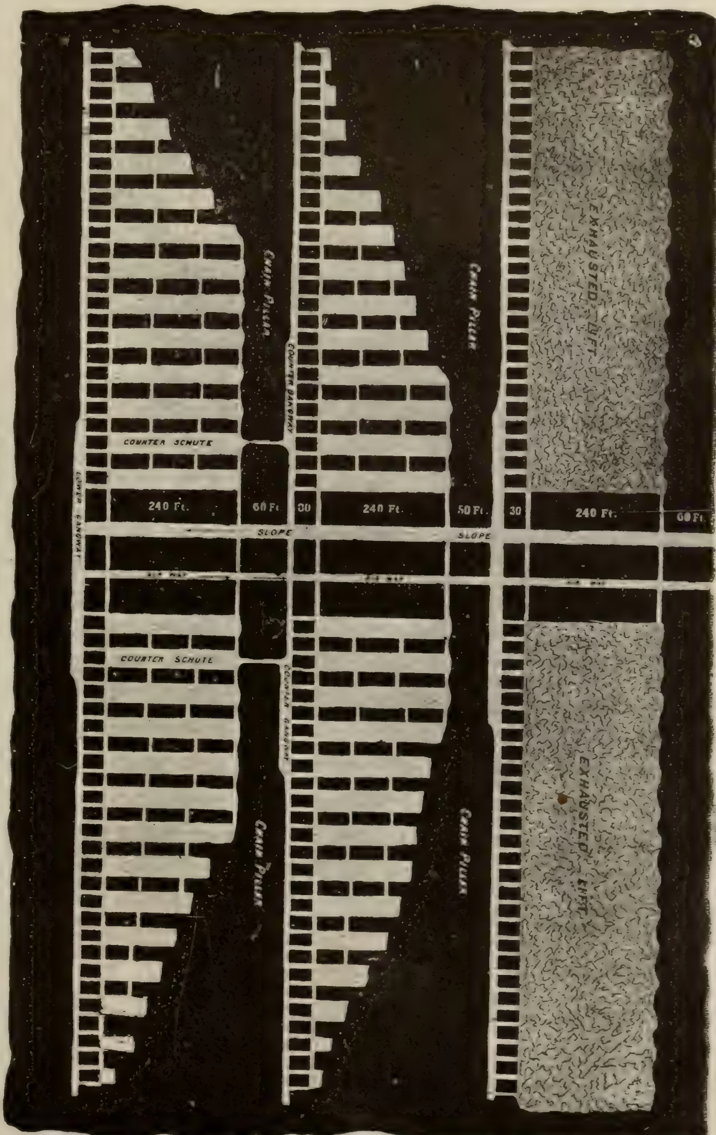
The "stripping" of the coal beds, where they lie flat and sufficiently near the surface, continues to grow in favor and is carried to a greater depth than before, but it is only the shallower basins that can be worked in this way.

Coal Waste (*A 2*) is the subject of a report made in 1882 by Mr. Franklin Platt, it is also made the subject of inquiry by a Special Commission appointed by the Gover-

*For a description see. "Iron breaker at Drifton, &c." by Mr. Eckley B. Coxe, Trans. Am. Ins Mining Engineers Vol XIX. 1890-1.

PL. 308.

Anthracite Region - Mining Methods



MINING BY LIFTS

Scale 200 Feet to 1 inch.

nor in 1889. Some notes from the report by the Commission together with "Estimate of Contents of the Anthracite Coal Fields," will be given at the close of the anthracite chapters.

The Anthracite Survey.

It seems pertinent before entering into the detailed discription of the region, in which constant reference will be made to maps, sections and reports of the Anthracite Survey, to give a brief review of the work of the Survey, its original plans, and of the extent to which it was enabled to carry them out.

The survey of the anthracite region was commenced in 1881, under the direction of the late Charles A. Ashburner, Geologist in Charge. The plan of the survey as outlined by Mr. Ashburner proposed :*—

1. Mine sheets.

The publication of a set of maps, covering all the anthracite basins, drawn to a scale of $800' = 1''$, of uniform size $28\frac{3}{4}''$ x $23\frac{3}{4}''$, and designated as mine sheets. These mine sheets to represent surface features, viz :—railroads, wagon roads, streams, county, township and property lines; outcrops of the principal coal beds; limits of the coal measures; towns, coal breakers &c.; also underground features viz : —all shafts, tunnels, slopes, drifts and airways, together with the mine workings on each bed to be represented by a conventional color, the shape of the floor of the most extensively developed coal beds in the individual distrects, mammoth bed principally to be shown by contour lines $50'$ vertically apart.

With some modifications the plan of publication of the mine sheets has been carried to a successful completion. After the publication of the first sixteen sheets, owing to the demand for a rapid extension of the work and the limited appropriations, it was thought best to abandon the underground contouring, which although adding materially to the value of the sheets, increased decidedly the time

* First Report Progress Anthracite Region.

and cost of their preparation. Other than this but few changes in the plan were found necessary.

2. Cross section sheets.

"The mine maps are to be supplemented by sections across the coal basins, to show the same structure on a vertical plane that the mine maps show by their contours on a horizontal plane. These sections are to be drawn on a scale of 400 feet = 1 inch, ($\frac{1}{4800}$ nature). No special plan, either in the distances of the cross sections apart, or the method of representing the structure which they will illustrate, can be adopted for the entire region. The frequency of the sections in any basin must be governed entirely by the difficulties in the structure to be solved, and the number of facts which it is possible to obtain."

Cross sections of every important basin have now been constructed and published. Care is taken to distinguish on the sections between the theoretical structure and the structure as actually developed by the mine workings.

3. Columnar section sheets.

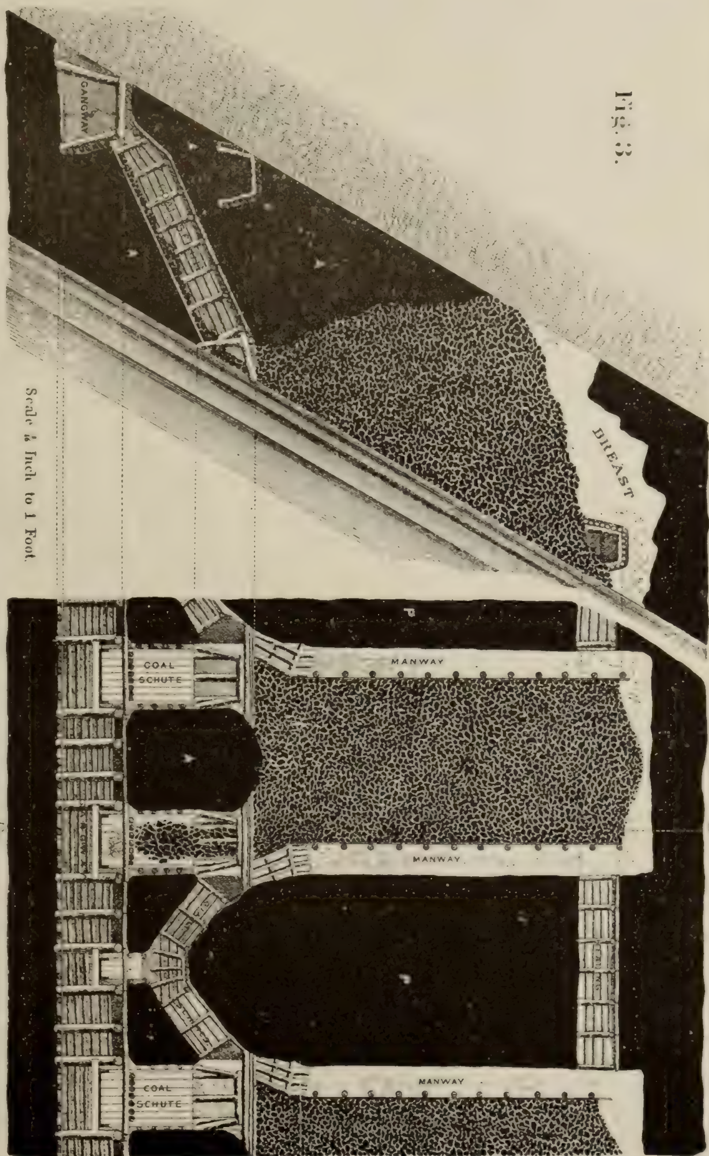
"These sheets are to contain columnar sections of the coal measures and coal beds, to show graphically the character and vertical thickness of the strata included between the coal beds and the divisions and character of the individual beds with the intercalated slate and sandstone. They will be divided into two sets: First, those containing the rock sections, which are within the limits of the productive coal measures, to be drawn to a scale of $40' = 1''$; in these sections, the entire series of strata popularly known as a coal bed, whether coal or refuse, will be printed solid black and designated as coal. The second class of sheets will contain coal bed sections to be drawn to a scale of $10' = 1''$. In these sections the alternation of good coal and poor coal, of sandstone, slate, bone and dirt, will be shown with as much minuteness as is actually found in the bed, in the mine."

Some forty-one columnar section sheets of the first class are published by the survey and they give detailed meas-

PL. 309

Anthracite Region _ Mining Methods

Fig. 3.



Scale ½ Inch to 1 Foot.

DOUBLE SHUTE BREAST WITH BATTERIES
STEEP DIP

Original designed by J. Price Wetherill

urements of the strata cut in nearly every shaft, tunnel, rock slope or bore hole in the region. Of the second variety of sheets—containing only bed sections—but one has been published although the materials for many others were collected.

4. Topographical sheets.

"Surface contour curve maps will be published of most of the coal basin areas. These maps will be on a scale of 1600′= 1″, or one-half the scale of the mine sheets."

Owing to the restricted means of the survey this very important part of the general plan has been but imperfectly carried out. The largest area contoured by the Survey is the northeastern half of the Northern field, here it was found practicable to place the contours on the mine sheets, without overcrowding, and so publish them on a scale of 800′= 1″. It is greatly to be regretted that the Legislature did not authorize the contouring to be carried over the whole region, had this been done in connection with the mine sheets the increased cost would have very small compared with the added value of the work.

5. Miscellaneous sheets.

Under this head general maps of the region showing the location of the collieries and digrams showing graphically the shipments of anthracite have been published.

6. Reports

"After the survey of the entire region is completed, the geological report of all the basins will be published in two volumes; one on *Descriptive Geology*, and the other on *Systematic Geology*. The preliminary reports published with the sheets will only contain facts relating directly to them, with such brief explanations as may be thought necessary to make the illustrations perfectly understood."

The report proposed above has not been published or even prepared although much of the material necessary for it is at hand. The Legislature when providing for the completion of the mapping of the anthracite region made no provision for this report Special reports, which accompanied the earliest of the mine sheets issued, cover about one third of the region. *

Mr. Ashburner remained in charge of the Survey until 1887 when he resigned to accept a more lucrative position with the Westinghouse Company of Pittsburg. Mr. Frank A. Hill, the principal Assistant Geologist was then appointed Geologist in Charge. The progress of the Survey had been dependent upon the varying amounts appropriated to it, but in 1887 the Legislature passed an act calling for the completion of the Anthracite Survey within the following two years—prior to June, 1889—and made the necessary appropriation. At that time there still remained nearly two-thirds of the region to map and the usual cross and columnar section to construct. The successful completion of this large amount of work within the time specified reflects much credit upon Mr. Hills ability and industry.

It had been found impossible to get all the numerous mine, columnar and cross section sheets through the press before the disbandment of the anthracite corps and the writer was retained to complete and supervise this portionof the work.

The *mine sheets* constitute the most important part of the publications of the Anthracite Survey. No rigid system, for their construction, applicable to all parts of the region could be adopted. In practice the Survey first obtained from the mining companies and individuals copies of all the maps, when practicable, but especially of all the mine maps, within the area under consideration; these maps were reduced to a common scale 800′, 600′ or 400′ = 1″ as the case might be, and join together on a common base.† Then one or more parties were placed in the field to locate outcrops, axes of anticlinals and basins, correct apparent or real discrepencies in the connecting maps, and to

* See Anthracite Region, First Report A A.—Anthracite Region, Second Report in Annual for 1885.—Anthracite Region, Third Report in Annual for 1886, Part III.

† The excellent connected maps (300′ = 1″) of the Philadelphia and Reading Coal and Iron Company furnished a very accurate base for most of the Southern and Western Middle fields. In the Northern and Eastern Middle fields extensive field work by the Survey was necessary to establish a reliable base.

Anthracite Region – Mining Methods.

BREAKER IN PROCESS OF CONSTRUCTION

BREAKER AND HEAD HOUSE
AS BUILT BY THE
DELAWARE AND HUDSON COAL CO

COAL BREAKER NEAR SCRANTON

fill out the various features necessary for the completion of the sheets. Sometimes the work original with the Survey is but a small part of the information on a sheet and at other times it comprises nearly or quite all of it. Credit is given on the sheets to the mining companies and individuals who have furnished information, but in most cases it was impracticable.to specify of what that information consists.

The value of the mine, cross and columnar section sheets depends very largely upon the maps and information freely furnished the Survey, by the operating companies and individuals, the mining engineers and the citizens throughout the region. The results attained would have been impossible without their hearty co-operation and it is desired on behalf of the Survey to make a full acknowledge of the credit due to them.

Scope of present report.

The greatest deficiency in the Anthracite publications is undoubtedly the *lack of* more definite information as to the *thickness in detail* and comparative value of *the coal beds.* The publication, which was proposed, of bed sections on sheets and a general report to accompany the mapping, would have supplied this want. Although the numerous columnar sections give a great many total thicknesses of the coal beds at the points cut by the sections, there is—owing to the scale—little or no attempt made to show what portion of the bed is valuable coal and what worthless refuse. An honest and correct columnar section giving only the total thicknesses of the coal beds may easily give a very erroneous idea of their value. It seems advisable to devote the greater portion of this report in an endeavor to supply in part at least this deficiency. Comparatively little space will be given to the description of surface features. the anticlinals and the basins, the extent of the coal beds and similar subjects; not because of any lack of appreciation of their importance but because these points are shown graphically and very clearly by the published mine, cross and columnar section sheets.

In the detailed account of the region which follows. it was found convenient to divide each field into a number of smaller divisions, the boundries as a rule being determined by those of the mine sheets, a set of four sheets usually constituting a division, the limits of each division are, however, stated before described, and they are also shown by the small page plate maps. The divisions are numbered 1, 2, 3, &c., the first division is at the northeastern end of the Northern field and the last is at the southwestern end of the Southern field.

The report was prepared with the mine, cross and columnar sections before the writer and it will no doubt add much to its clearness if read in the same way.

The anthracite sheets, which were issued in sets as fast as prepared, are published in nineteen atlases; and for the convenience of the reader a complete list of the sheets, giving the location of each, date of publication, and the number of the atlas in which it is found, is now inserted.

List of the publications of the Pennsylvania Geological Survey pertaining to the Anthracite Region.

Northern Coal Field.

Mine sheets, scale 800′= 1″.

Sheet number.	Locating name.	Geologist.	Asst. Geol.	Date.	N. C. F. Atlas.
I	Shickshinny, .	Ashburner	Hill, . . .	1887	Part II
II	Newport, . . .	"	" . . .	"	"
III	Nanticoke, . .	"	" . . .	1884	Part I
IV	Warrior Run, .	"	" . . .	"	"
V	Plymouth, . .	"	" . .	"	"
VI	Ashley, ...	"	" . . .	"	"
VII	Kingston, . . .	"	" . . .	"	"
VIII	Wilkes-Barre, .	"	" . . .	"	"
IX	Pittston, ...	Hill, . . .	Griffith, .	1887	Part II
X	Yatesville, . .	" . . .	" .	"	"
XI	Lackawanna,	" . . .	" .	"	"
XII	Pleasant Valley,	" . . .	" .	"	"
XIII	Scranton, . .	" . . .	" .	1888	Part III
XIV	South Scranton,	" . . .	" .	"	"
XV	Providence, . .	" . . .	" .	"	"
XVI	Dunmore, . . .	" . . .	" .	"	"
XVII	Olyphant, . . .	" . . .	" .	"	Part IV
XVIII	Jessup, ...	" . . .	" .	"	"
XIX	Jermyn, ...	" . . .	" .	"	"
XX	Archbald, .	" . . .	" .	"	"
XXI	Carbondale,	" . . .	" .	"	"
XXII	Shepherds Crook	" . .	" .	"	"
XXIII	Forest City, . .	" . . .	" .	"	"
XXIV	Wayne county,	" . . .	" .	"	"

N. C. F. Cross section sheets—scale 400′=1″.

Sheet number.	Section numbers.	In the vicinity of	On Mine Sheets.	Date.	N. C. F. Atlas.
I	1—9,	Shickshinny to Sugar Notch.	I—IV	1889	Part V
II A	A, B, C & D	Nanticoke to Pittston.	III, V, VII & IX	"	" "
II B	" "	" " "	IV, VI, VIII & X	"	" "
II C	" "	" " "	" " " " "	"	Part VI
III	10—19	Ashley and Plymouth.	V & VI	1884	Part I
IV	20—35	Wilkes-Barre and Kingston.	VII & VIII	"	" "
V	20—35	" " "	" " "	"	" "
VI	E, F, G & H	Lackawanna to Olyphant.	XI, XIII, XV & XVII	1889	Part VI
VII	" "	" " "	XII, XIV, XVI & XVIII	"	" "
VIII	I, J & K	Jermyn to Forest City.	XIX—XXIII	"	" "
IX	" "	" " " "	" "	"	" "

N. C. F. Columnar section sheets—scale 40′=1″.

Sheet number.	Sections in the vicinity of	On Mine Sheets.	Date.	N. C. F. Atlas.
I	Wilkes-Barre and Plains	VII & VIII . . .	1884	Part I.
II	W.-Barre, Ashley and Sugar Notch	VI & VIII. . . .	"	"
III	Wyoming, Kingston and Plymouth .	V & VII.	"	"
IV	Plymouth, Nanticoke and Hanover. .	III, IV & V . . .	"	"
V	Shickshinny, Nanticoke & W.-Barre.	I—VIII	1888	Part II.
VI	Wyoming and Pittston	IX & X	"	"
VII	Pittston and Lackawanna	IX—XII.	"	"
VIII	Pleasant Valley	XI & XII	"	"
IX	Scranton and Dunmore	XIII & XIV. . .	"	Part III.
X	Taylorville and Hyde Park	XIII.	"	
XI	Hyde Park and Providence	XIII & XV . . .	"	
XII	Scranton and Dunmore	XV & XVI . . .	"	
XIII	Dunmore, Olyphant and Peckville. .	XV & XVIII . .	1889	Part V.
XIV	Peckville, Jessup and Winton	XVII & XVIII .	"	
XV	Archbald to Carbondale.	XVI—XXII . . .	"	
XVI	Carbondale and Forest City.	XXI & XXIII . .	"	

N. C. F. Miscellaneous sheets and reports.

1. Topographical map—Shickshinny to Scranton by R. P. Rothwell. Scale 3200′=1″, in Atlas to Annual Report, 1885.
2. Topographical map—Scranton to Forest City. Scale 800′=1″. See mine sheets XVI to XXIV.
3. Topographical map—Preliminary part of Lackawanna Valley. Scale 1600′=1″. Annual, 1886, Part III Atlas.
4. Report covering Mine Sheets I & II, Hill, Annual, 1886, Part III.
5. " covering Mine Sheets III to VIII, Ashburner, Annual, 1885.
6. " on Wyoming Valley Limestone Bed, Ashburner, Annual, 1885, chapter X.
7. Description of the Archbald Pot Holes; also of the Buried Valley of Newport Creek, Ashburner, Annual, 1885, Page 615.
8. Description of the Buried Wyoming Valley, Hill, Annnal, 1885, Page 637.
9. " a new substance resembling Dopplerite, Lewis, Annual 1885, Page 647.
10. Columnar Sections (written), Annual, 1886, Part III, Ch. V.
11. Report on the Bernice Coal Basin, Ashburner, Annual, 1885, Ch. XI.
12. Map of the Bernice Coal Basin, Harden, Atlas to Annual, 1885.

Eastern Middle Coal Field.

Mine sheets, scale 800′ = 1″

Sheet number.	Locating name.	Geologist.	Asst. Geologist.	Date.	E. M. C. F. Atlas.
I	Drifton,	Ashburner,	Berlin & Winslow,	1884	Part I.
II	Hazleton,	"	" "	"	"
II*a*	do.	Hill,	Moister,	1889	Part III.
III	Upper Lehigh,	"	"	1888	Part II.
IV	Pond Creek,	"	"	"	"
V	Eckley,	"	"	"	"
VI	Weatherly,	"	"	"	"
VII	Beaver Meadow,	"	"	"	"
VIII	Jeansville,	"	"	"	"
VIII*a*	Silver Brook,	"	"	1889	Part III.
IX	Lofty,	"	"	"	"
X	Honey Brook,	"	"	"	"
XI	Tomhicken,	"	"	"	"
XI*a*	do.	"	"	"	"
XII	Green Mountain,	"	"	"	"
XII*a*	do.	"	"	"	"
XIII	Derringer,	"	"	"	"
XIII*a*	do.	"	"	"	"
XIV	McCauley Mountain,	"	"	"	"

E. M. C. F. Cross section sheets, scale 400′ = 1″

Sheet number.	Section numbers.	In the vicinity of	On Mine Sheets.	Date.	E. N. C. F. Atlas.
I	1-5	Drifton and Hazelton.	I & II,	1884	Part I
II	6-21	Drifton and Harleigh,	"	"	"
III	22-29	Hazelton,	"	"	"
IV	30-38	Upper Lehigh and Eckley,	III-VII,	1889	Part III
V	39-42 & 45	Jeansville,	VIII-X,	"	"
VI	43-44 & 46-49	Oneida & Tomhicken,	X-XIV,	"	"

E. M. C. F.—Columnar section sheets, scale 40′=1′

Sheet number.	Section in the Vicinity of	On Mine Sheets.	Date.	E. M. C. F. Atlas.
I	Drifton and Milnesville,	I & II,	1884	Part I
II	Eckley, Jeddo & Hazleton,	"	"	"
III	Hazle Brook & Hazleton,	"	"	"
IV	Upper Lehigh, Sandy Run & Beaver M.,	III-VII,	1888	Part II
V	Audenried & Jeansville,	VII-VIII,	"	"
VI	Beaver Meadow, Audenried & Tomhicken,	XII-XII,	1889	Part III
VII	Derringer & Gowen,	XI, XIII & XIV,	"	"

E. M. C. F. Miscellaneous.

1. Columnar sections written. Annual, 1886, Pt. III, Chapter VI.

Western Middle Coal Field.

Mine Sheets, scale 800′ = 1″.

Sheet number.	Locating name.	Geologist	Asst. Geol.	Date.	W. M. C. F. Atlas.
I	Delano, ...	Ashburner,	Sheafer & Wells	1882, .	Part I.
II	Shenandoah, ...	"	" "	" .	"
III	Girardville, ...	"	" "	" .	"
IV	Ashland, ...	"	" "	" .	"
V	Mt. Carmel, ...	"	Wells, ...	1886, .	Part II.
VI	Shamokin, ...	"	"	" .	"
VII	Bear Valley, ...	"	"	" .	"
VIII	Trevorton, ...	"	"	" .	"
	Half sheets joining on the north.				
Ia	Delano (north) . . .	Hill, . . .	Moister, ...	1889, .	Part III.
IIa	Shenandoah (north)	" . . .	"	" .	"
IIIa	Girardville (north)	" . . .	Smith, ...	" .	"
IVa	Midvalley, ...	" . . .	"	" .	"
Va	Natalie, ...	" . . .	"	" .	"
VIa	Hickory Swamp. . .	" . . .	"	" .	"
VIIa	Bear Valley (north).	" . . .	"	" .	"

W. M. C. F.—Cross section sheets, scale 400′ = 1″.

Sheet number.	Section number.	In the vicinity of	On Mine Sheets	Date.	W.M.C.F. Atlas.
I	1—3, ...	Mahanoy City, ...	I & II, ...	1884	Part I
II	4—6, ...	Shenandoah, ...	II & III, ...	"	"
III	7—9 & 11, . .	Ashland, ...	III & IV, ...	"	"
IV	10 & 11, . . .	Mt. Carmel, ...	IV, ...	"	"
V	12—15, ...	Mt. Carmel to Shamokin,	V—VII, ...	1889	Part III
VI	"	" "	"	"	"
VII	12—15 & 16—17	Shamokin to Trevorton, .	V—VIII, ...	"	"
VIII	16—18, ...	" "	VII—VIII, ...	"	"

W. M. C. F—Columnar section sheets, scale 40′ = 1″.

Sheet number.	Sections in the vicinity of	On Mine Sheets	Date.	W.M.C.F. Atlas.
I	Trevorton and Shamokin, ...	VI & VII, ...	1887	Part II
II	Shamokin and Mt. Carmel, ...	V & VI, ...	"	"
III	Ashland and Centralia, ...	IV, ...	"	"
IV	Ashland and Girardville, ...	III & IV, ...	"	"
V	Girardville and Shenandoah, . . .	II & III, ...	'	"
VI	Shenandoah and Gilberton, ...	II, ...	"	"
VII	Mahanoy City, ...	I & II, ...	"	"

W. M. C. F.—Miscellaneous.

1. Topographical map Delano to Mt. Carmel by Lehigh Valley Railroad Co. and others scale 1600′ = 1″ (3 sheets) Atlas Pt. I.

2. Report "Survey of Western Middle Field" Hill, Annual, 1886, Pt. III, Ch. III.

3. Columnar sections written, Annual, 1886, Pt. III, Ch. VII.

Southern Coal Field.

Mine sheets, scale 800′ = 1″.

Sheet Number.	Locating name.	Geologist.	Asst Geol.	Date.	S. C. F. Atlas.
I	Mauch Chunk, . .	Ashburner	Sheafer & Hill,	1882	Part I
II	Lansford, ...	"	"	"	"
III	Tamaqua, . . .	"	"	"	"
IV	Tamaqua (west),	Hill, . . .	Smith, . .	1888	Part II
V	Patterson, ...	" . . .	"	1889	"
VI	Morea, ...	" . . .	" . .	"	"
VII	Fackville, ...	" . . .	" . .	"	"
VIII	Gordon, ...	" . . .	" . .	"	"
VIII*a*	Gordon (west), . .	" . . .	" . .	"	"
IX	Middleport, . . .	" . . .	" . .	"	"
X	Pottsville (east),	" . . .	" . .	"	"
XI	Pottsville (west),	" . . .	" . .	"	"
XII	Forestville, . . .	" . . .	" . .	"	"
XIII	Swatara Falls, . .	" . . .	" . .	"	"
XIII*a*	Hegins, ...	" . . .	" . .	"	"
XIV	Westwood, . . .	" . . .	" . .	"	"
XIV*a*	Pottsville Gap, . .	" . . .	" .	"	"
XV	Blackwood, . . .	" . . .	" . .	"	"
XVI	Tremont, ...	" . . .	" . .	"	Part III
XVII	Good Spring, . .	" . . .	" . .	"	"
XVIII	Brookside, ...	" . . .	" . .	"	"
XIX	Williamstown,	" . . .	" . .	"	"
XX	Lykens, ...	" . . .	" . .	"	"
XXI	Lorberry, ...	" . . .	" . .	"	"
XXII	Kalmia, ...	" . . .	" . .	"	"
XXIII	Rausch Gap, . .	" . . .	" . .	"	"
XXIV	Yellow Spring, . .	" . . .	" . .	"	"
XXV	Rattling Run, . .	" . . .	" . .	"	"
XXVI	Big Flats, . .	" . .	" . .	"	"
XXVII	Dauphin, ...	" . . .	" . .	"	"

S. C. F.—Cross section sheets, scale 400′ = 1″.

Sheet number.	Section number.	In the vicinity of	On mine sheets	Date.	S. C. F. Atlas.
I	1–6.	Nesquehoning, ...	I & II, ...	1882	Part I.
II	7–10.	Lansford, ...	II & III, ...	"	"
III	11–12. . . .	Tamaqua, ...	III, ...	"	"
IV	13–14, . . .	Reevesdale & Tuscarora, . .	IV & V, ...	1891	Part V.
V	15–17. . . .	Broad Mountain, ...	V–VII, ...	"	"
VI	" " . . .	Mine Hill, ...	V–VII, ...	"	"
VII	" " . . .	St. Clair, ...	IX & X, ...	"	"
VIII	15a " . . .	Sharp Mountain, ...	IX & X, ...	"	"
IX	18–20, . . .	Broad Mountain, ...	VII & VIII, ...	"	"
X	" " . . .	Mine Hill, ...	XI & XII, ...	"	"
XI	" " . . .	Minersville, ...	XI & XII, ...	"	"
XII	" " . . .	Sharp Mountain, ...	XIV & XV	"	"
XIII	21–22, . . .	Sharp Mountain, ...	XV & XVI, ...	"	Part VI.
XIV	" " . . .	Otto & Middle Creek, ...	XII, XV & XVI, . .	"	"
XV	" " . . .	Broad Mountain, ...	XII & XIII, ...	"	"
XVI	22–24, . . .	Sharp Mountain, ...	XVI & XVII, ...	"	"
XVII	23–24. . . .	Tremont & Smoky Hollow, .	XVI & XVII, ...	"	"
XVIII	" " . . .	Thick Mountain.	XIII & XVII, ...	"	"
XIX	25–26, . . .	Good Spring and Brookside,	XVII & XVIII, . . .	"	"
XX	27–28. . . .	Williamstown & Lykens, . .	XIX & XX, ...	"	"
XXI	29–31, . . .	Schuylkill & Dauphin basin,	XXII–XXVI. . . .	"	"

S. C. F.—Columnar section sheets, scale 40″=1′.

Sheet number.	Sections in the vicinity of	On mine sheets.	Date.	S. C. F. Atlas.
I	Hacklebarney to No 10.	I-III.	1882	Part I
II	Mauch Chunk to Tamaqua	I-III.	"	"
III	" Bed sections P. C. basin. . . .	I-III.	"	"
IV	Tamaqua to New Phila., ...	IV. V & IX.	1889	Part I IV
V	New Philadelphiato Pottsville, .	X & XI.	"	"
VI	Heckschersville & Minersville,	XI & XII.	"	"
VII	Minersville to Lykens, ...	XI. XII. XVII-XI, ...	"	"
VIII	Sharp Mountain,.	IX, X. XIV, XV, XXII-XYIV,	"	"
IX	Branchdale & Broad Mtn., . . .	VI-VIII & XII.	"	"
X	Tremont,.	XII & XVI-XIX.	1891	Part IV *b*
XI	Middleport to Kalmia.	IX. XI, XII, XV, XXI & XXII,	"	"

S. C. F.—Miscellaneous maps and reports.

1. Topographical map of the Panther Creek basin, Mauch Chunk to Tamaqua by R. P. Rothwell, Scale 1600=1″ in S C F Atlas Part 1.

2. Report on the Panther Creek basin--Ashburner--1883--in A A First Report Anthracite Region.

3. Report on the New Boston basin with map, B. S. Lyman. Annual Report 1887.

Anthracite Region—General Miscellaneous.

1. General Map of the Anthracite Coal Fields=Scale 5 miles=1″ 1882, S. C F. Atlas Pt 1.

2. General Map of the Anthracite Coal Fields showing position of collieries. Scale 2 miles=1″ 1886. Atlas to Part III Annual 1886.

3. General map of the Anthracite Coal Field showing position of collieries, Scale 2 miles=1″ revised 1890. Under separate cover.

4. Statistics—Shipment and Production for 1881 & 1882. First Report Anthracite Region Chapter VIII.

.5 Statistics--Shipment and Production 1883 & 1884, pamphlet.

6. Statistics--Shipment and Production 1885 & 1886. Annual 1886 Pt III Ch. IV.

7. Chart showing Shipments, 1820-1882. S. C. F. Atlas Pt 1.

8. Chart showing Shipments, 1825-1886. Annual 1886 Pt III Atlas.

9. Columnar sections Anthracite Region. Annual 1885-Atlas.

CHAPTER CXIX.

Northern Coal Field.

The Northern coal field or Wyoming-Lackawanna basin lies almost wholly in Luzerne and Lackawanna counties, only a small area extending into Wayne and Susquehanna counties. The field is about 55 miles long from the northeastern end near the junction of Wayne, Susquehanna and Lackawanna counties to the southwestern end near Shickshinny; it has a general width of 4 to 6 miles. In shape the basin is very like that of a canoe; it has pointed ends, but its northern side is concave instead of convex.

Formations Nos. XII and X form a high mountainous rim—in general about 1000′ above the valley—around the basin; this is a double rim around the southwest edge, where the erosion of the red shales of XI makes a rather deep trough between the two hard formations, but the thinning of XI toward the northeast, elevates and decreases the size of this trough until all three formations practically unite to form a single mountain ridge.

The Lackawanna river, seldom more than 100′ to 150′ wide, breaks through this rim at a high gap, 1500′ A. T., at the extreme northeast end of the field, and flows southwesterly, within the basin, for 30 miles to join the North Branch of the Susquehanna river, just after it enters the field through the deep gap—550′ A. T.—its waters have cut in the northern mountain rim at Pittston. The Susquehanna flows southwest through a broad fertile plain within the coal measures, for 14 miles; then at Nanticoke turns west, leaves the basin by another gap—415′ A. T.—in the northern rim; resumes and continues its southwest course, in the red shale valley just north of the field, until Shickshinny is reached, where turning abruptly to the south, the river has cut off and separates a high narrow trough of coal measures—the Salem basin—some two miles long, from the main body of the field.

PL. 311

Anthracite Region _ Northern Coal Field

KINGSTON FLATS, LOOKING SOUTH.

WYOMING VALLEY FROM THE WILKES BARRE MOUNTAIN.

Nature has furnished comparatively easy outlets from the field toward the west and north by way of the Susquehanna river, but to the south and east where the chief markets for the coal lie there is no escape, except by crossing the high Pocano plateau—2000′ ± A. T.—which forms the watershed between the Susquehanna and the Lehigh and Delaware rivers. Six important railroad lines now cross this plateau to reach the seaboard markets.

The Susquehanna river has a width of 800′ to 1200′ with a broad flood plain one to two miles wide; the valley of the Lackawanna is much narrower, but in both cases the hills within the basin rise slowly with gentle slopes and to seldom more than half the heigth of the bounding mountains.

The beautiful Wyoming and Lackawanna valleys were classed among the most fertile of the State long before the far greater value of their coal deposits were understood.*

Structure.

The comparatively gentle slopes of the surface find an echo in the gentle dips of the coal beds underlying them not that it necessarily follows that a hill or ridge on the surface means a hill or ridge—an anticlinal—in measures, in fact, in this basin, it is more often the reverse, many of the ridges especially in the southwestern part of the field are formed by synclinal measures.†

The steepest dips and the most numerous and important anticlinals are found in the southwestern part of the field, say from Pittston to Shickshinney and south of the river; within this area dips of 30° to 40° are quite common and occasionally steeper dips of 60° to 70° are met with. Between Nanticoke and Pitstton north of the river, and from Pittston all the way to Forest City at the northeastern end of the field, the dips seldom exceed 10° to 20° and the few anticlinals disturb but little the gentle curves of

* For Historical Notes see Annual, 1885, pg. 277, also History of Wyoming Valley. by George B. Kulp, Esq , of Wilkes-Barre.

† The shape of the floor of the basin under the Kingston and Plymouth flats was for a long time the subject of many conjectures, but developments made since the publication of the mine sheets give for the most part gentle and regular dips ranging from 1° to 10°.

the basin floor. Comparatively but few faults or slips are encountered in this field although the measures are not wholly free from them; they are more often found among upturned beds than were the measures lie so nearly horizontal.

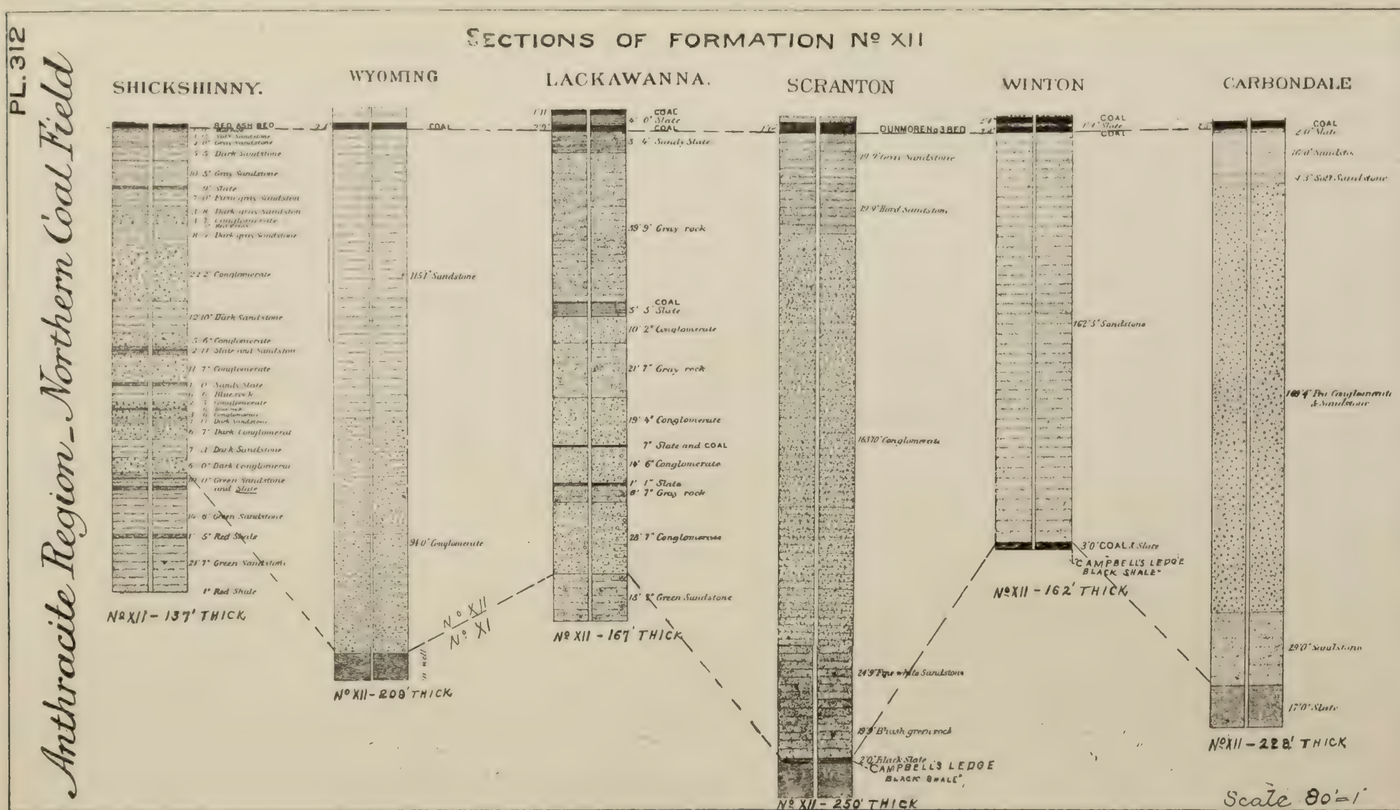
The position of the various anticlinals and synclinals, as indicated by surface exposures and developed by the mine workings, are shown on the mine sheets. The cross section sheets* also show the position and shape of the different axes where intersected by the section lines and they will be discussed individually briefly, in the report of the locality in which each occurs.

The *anticlinals* have a general parallelism throughout the field even to the far northeast end. The usual course is about N 70° E or S 70° W. Between Shickshinny and Nanticoke this course is about parallel to the sides of the basin, but the gentle curving of the field towards the north, soon causes the course of the anticlinals to become more and more oblique to the general trend of the measures, so that towards the northeast end of the field the few scattered axes cross the basin at an angle of about 45°.

In common with the general structure of the whole anthracite region it is usual in this field to find the steepest dips towards the north and more gentle ones towards the south.

Nearly all the anticlinals of the Northern field originate within the coal measures and die out eastward before crossing the conglomerate rim. Two important exceptions to this are seen south-east of Pittston, and the unusually wide area there covered by No. XII and the scattered patches of coal measures is due to the extension of these axes across the Conglomerate and out of the field. Some of the most important of the anticlinals are continuous for a number of miles; but it is quite common for an axis to flatten down and be replaced by another which springs up a little to one side, this new axis is sometimes regarded as simply

* See also the cross section page plates.


PL. 312
Anthracite Region_Northern Coal Field
SECTIONS OF FORMATION Nº XII
SHICKSHINNY.
WYOMING
LACKAWANNA.
SCRANTON
WINTON
CARBONDALE
RED ASH BED
COAL
DUNMORE No 3 BED
22'2" Conglomerate
12'10" Dark Sandstone
1' Red Shale
NºXII - 137' THICK
115'1" Sandstone
94'0" Conglomerate
NºXII - 209' THICK
Nº XII
Nº XI
39'9" Gray rock
10' 2" Conglomerate
21' 7" Gray rock
19' 4" Conglomerate
7" Slate and COAL
14' 6" Conglomerate
28' 7" Conglomerate
Nº XII - 167' THICK
163'10" Conglomerate
CAMPBELL'S LEDGE
BLACK SHALE"
Nº XII - 250' THICK
162'5" Sandstone
3'0" COAL & Slate
NºXII - 162' THICK
29'0" Sandstone
17'0" Slate
NºXII - 228' THICK
Scale 80'=1'

a continuation of the first and sometimes as a district flexture.

The *deepest part* of the Wyoming-Lackawanna basin, (about 2200′ feet), lies about half-way between Nanticoke and Wilkes-Barre, from here northeast the measures have a general rise reaching their highest point in the neighborhood of Lackawanna station, some four miles above Pittston, where only 100′ to 150′ of coal measures are left. From Lackawanna northeast the measures once more sink along the basin, bringing in successively the higher beds, attaining a depth of about 700′ below the river a mile or or two beyond Scranton; then rising again slowly but surely as we follow up the valley of the Lackawanna until the lowest coal bed finally disappears into the air beyond Forest City at the northeastern end of the field.

Formation No. XII.

The northern outcrop of No. XII occupies a narrow strip of country, seldom more than 1000′ to 1500′ wide for the whole length of the field; between Shickshinny and Nanticoke this outcrop forms a mountain ridge, but from Nanticoke northeast the rocks of No. X more commonly make the main crest with those of XII forming a subordinate ridge a little lower along the southern slope. The southern outcrop of XII from Wilkes-Barre northeast covers a broader strip of country ranging from one-half to one and one-half miles in width; the mountain slope and the dip of the conglomerate beds often so nearly correspond as to throw their final outcrop far back and high up on the ridge or even a little beyond its crest. This broad southern rim of XII is seamed here and there with deep ravines, which the streams after cutting through XII have eroded in the softer underlying measures. Here, as on the north, the conglomerate beds sometimes form a separate ridge but more often only a terrace a little below the highèr mountain summits formed by the rocks of No. X. Between Wilkes-Barre and Shickshinny the southern outcrop of XII is only a few hundred feet wide, but forms a high ridge with a red shale valley between it and the No. X mountain, making an excellent exhibition of the "double rim" which in many points of the field exists only in a much modified form.

The average thickness of Formation No. XII in the Northern field is about 220′; its usual variations are between 150′ and 300′, although a minimum thickness of 90′ is reported at one place near Moconaqua and again at another point south of Wilkes-Barre, and a maximum thickness of 450′ is reported to have been cut by a hole bored for water south of Scranton; but it may perhaps be reasonably questioned whether the line between XII and XI has been correctly placed in the instances just mentioned.

In the southwestern half of the field the conglomerate beds of No. XII* are made up of rather coarse materials, the pebbles often reach egg size, although a hickory nut conglomerate is usually the coarsest layer; the materials composing XII grow finer toward the northeast but in rather an irregular way, as now and then a coarse massive outcrop of conglomerate is seen. In the neighborhood of Carbondale the heaviest beds of XII are a coarse-grained, massive, whitish gray sandstone, containing a few scattered pea-sized pebbles.

Lines were run by the anthracite corps locating the outcrop of the bottom of XII all the way around the field; for the most part but little difficulty was found in accurately fixing its position, as the lower members of the formation generally make an outcropping ledge below which the shales of XI can usually be seen in the wash and at times in place.

The "*Campbells Ledge*" *black carboniferous shale* bed—one to ten feet thick—of which mention is made by Mr. I. C. White, Report G 7, and placed by him at the bottom of No. XII, is apparently persistent under a considerable portion of the field, its outcrop has been dug into at a number of points and it is also recognized in some of the diamond drillings, further mention of this will be made in the detailed reports. At some of the places opened thin streaks of coal are found among the shales. Mr. R. D. Lacoe, of

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* For sections of XII see plate 312.

Pittston, obtained a large number of fossils from the outcrop at Campbell's Ledge. For list of these see G 7 page 39.

A thin bed of coal, at the most 1′ to 2′ thick, is sometimes found among the conglomerate beds of No. XII. At no point where opened is the bed of workable thickness; further mention of it will be made when describing the localities in which it has been found.

Coal Measures.

The 1800 feet of coal measures found in the deep basin between Wilkes-Barre and Nanticoke comprises the maximum thickness of the Northern field measures. They consist of the usual beds of sandstones, shales and fire-clays, alternating in varying order and interval with beds of coal. The lower 500 feet are by far the most productive, mining operations are largely confined to these, and our knowledge of the higher beds of the series is still rather meagre and not wholly conclusive.

The eleven workable coal beds in the vicinity of Wilkes-Barre, in the "Wyoming basin," have a set of names wholly different from those in use in the Eastern Middle, Western Middle or Southern fields; and the eleven workable beds found in the vicinity of Scranton in the "Lackawanna basin," have still another set of names different from those in use in the vicinity of Wilkes-Barre or in the other fields. The Survey has used the recognized local names on its maps and in the reports, indicating the probable identity of some of the beds from point to point. The frequent splitting of the large coal beds into two or even more smaller beds, which sometimes become separated by as great an interval as 200 feet, (many instances of which the mine working prove beyond question); illustrates the uselessness of insisting upon a positive correlation of all the beds in one field with those of another field or even between the beds at widely separated points in the same field, except where the bed is continuous and can be traced by mine workings and its outcroppings.

Proportion of Refuse in the Coal Beds.

The coal beds of the Northern field contain proportionately less refuse—chiefly slate and bony coal—than do the beds of the other fields; this is due perhaps partly to a smaller amount of foreign material having been originally deposited in the beds with the coal; and chiefly to the fact that the beds of this field have suffered but very little from the close folding which has made unmarketable, by crushing or intimately mixing with the slate, a considerable amount of coal in the Southern, Western Middle and to a less extent in the Eastern Middle fields.

The average of 891 bed sections well distributed throughout this field eliminating all refuse and including all bony coal as refuse, gives 81.8 per cent. marketable coal and 18.2 per cent. refuse. From this it would appear that, where special information as to the purity of a bed is lacking, the assumption of say 80 per cent. of the total thickness of a bed to be marketable coal is a wholly reasonable one.

For convenience in description the Northern field is divided into six divisions, and a seventh, the Loyalsock-Mehoopany field of Sullivan and Wyoming counties, is also included under this head, they are as follows :*

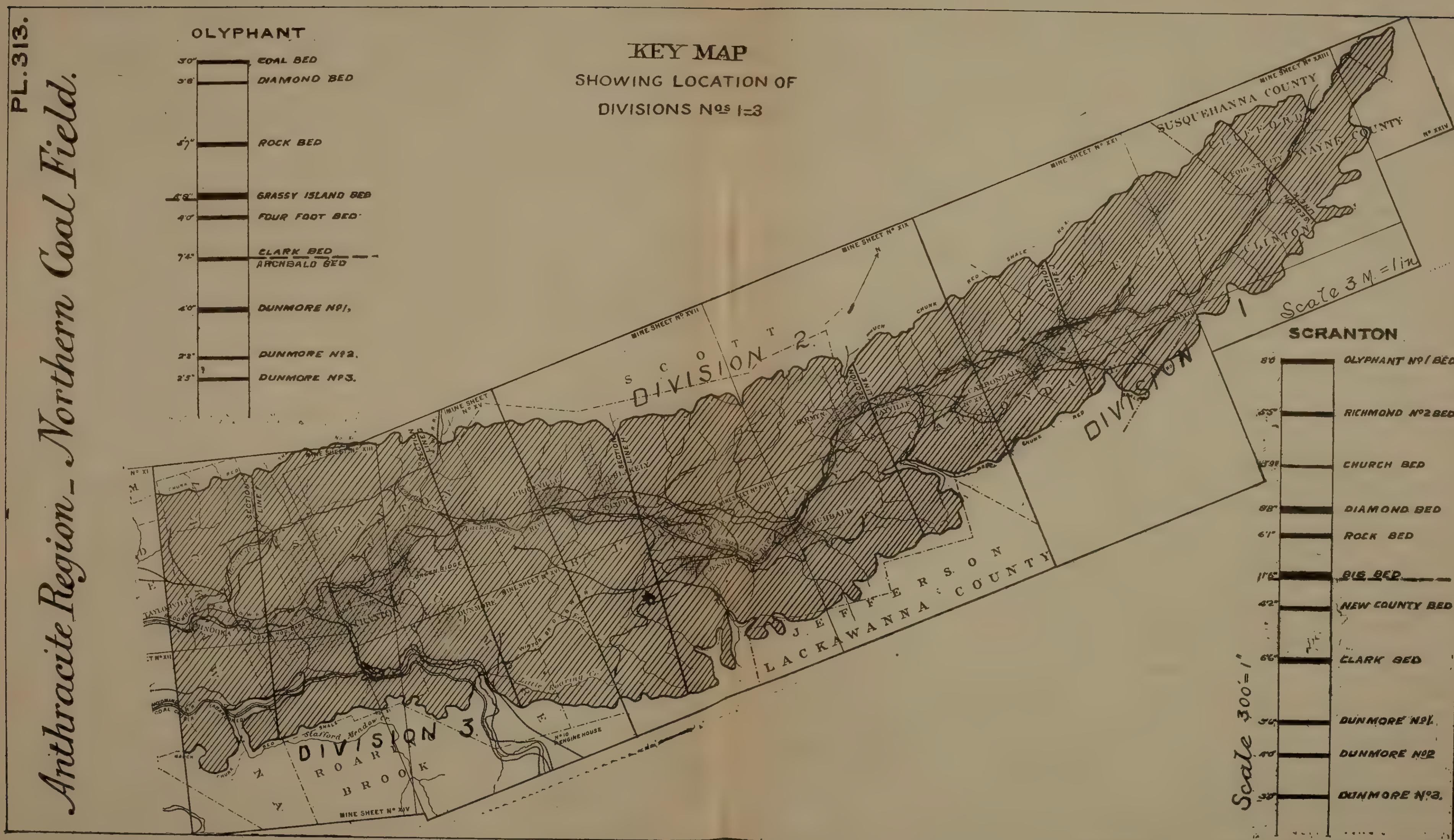
1. Forest City-Carbondale Division.
2. Jermyn-Priceville "
3. Scranton "
4. Pittston "
5. Wilkes-Barre, "
6. Nanticoke-Mocanaqua "
7. Loyalsock-Mehoopany "

1. *Forest City-Carbondale Division.*

This division comprises all of the area mapped on mine sheets XXI to XXIV,† these mine sheets also show the topography of the division by contour lines 10′ vertically apart. The general structure is exhibited by cross section K at Forest City and J at Carbondale, published on cross

* Page plates 313 and 321 show location.

† Page plate 313 also gives relative location of this division.


PL. 313.
Anthracite Region_ Northern Coal Field.
KEY MAP
SHOWING LOCATION OF
DIVISIONS Nos 1=3
OLYPHANT
COAL BED
DIAMOND BED
ROCK BED
GRASSY ISLAND BED
FOUR FOOT BED
CLARK BED
ARCHBALD BED
DUNMORE No1.
DUNMORE No2.
DUNMORE No3.
SCRANTON
OLYPHANT No1 BED
RICHMOND No2 BED
CHURCH BED
DIAMOND BED
ROCK BED
BIG BED
NEW COUNTY BED
CLARK BED
DUNMORE No1.
DUNMORE No2
DUNMORE No3.
Scale 300'=1"
Scale 3 M.=1 in.
DIVISION 1
DIVISION 2
DIVISION 3
SCOTT
JEFFERSON
LACKAWANNA COUNTY
SUSQUEHANNA COUNTY
WAYNE COUNTY
ROARING BROOK
CARBONDALE
ARCHBALD
MINE SHEET No XIV
MINE SHEET No XXI
MINE SHEET No XXIV

section sheets VIII and IX.* A number of columnar sections giving the detailed thicknesses and character of the strata at various points within the division are given on columnar section sheets XV and XVI.

This area includes the extreme northeastern end of the field. The Lackawanna river enters the basin, through a gap in the northern rim of No. XII, just above Forest City, it crosses the coal measures and occupies a narrow valley along the southern edge until Carbondale is reached, where the valley broadens out and the coal beds underlie both the valley and the hills on either side. South of the river the ground rises in one steep slope, with little or no terracing, to the outcrop of No. XII near the top of the mountain. North of the river where most of the coal lies the ground rises abruptly from the waters edge, then flattens off and goes rolling back to the mountain nearly two miles away. Elk creek, Coal brook and Fall brook flowing diagonally to the river drain this area.

Two railroads—the N. Y., L. E. & W. and N. Y., O. & W.—find a northern outlet by following up the Lackawanna river; an eastern outlet is gained by the Delaware and Hudson Coal Co's R. R. by a series of inclined planes over the Pocono mountain to the south of Carbondale.

The general level of the valley is about 1000′ A. T. at Carbondale, rising to 1500′ A. T. at the Forest City gap seven miles above. No. XII outcrops on the mountain side 1800′ to 2000′ A. T.

Formation No. XII: The place of outcrop of the bottom of the formation is here sometimes rather difficult fix upon the ground, owing to the thinness of No. XI, a greenish shale only 15′ to 20′ thick, and the close resemblance of the beds of No. X with those of No. XII. Much care was taken in the determination of this outcrop and it is thought to be very closely shown upon the mine sheets. The crest of the mountain surrounding the field in this division is usually composed to beds of No. X, with the rocks of No. XII making an outcropping ledge or ridge a

*Page plate 316 gives parts of these sections.

little lower on the mountain side. At the eastern end of the field beyoud Forest City where No. XII rises into the air, its outcrops form steep cliffs 100′ or more in height at nearly 2200′ A. T.

The general thickness of No XII seems to be about 200′ although it varies from 125′ to 220′. It is composed of course grained hard sandstones and pea conglomerates. A diamond drill hole on Lot 32 about one and one-half miles west of Forest City, put down by the Hillside Coal & Iron Company cut through No XII with a thickness of 125′ as follows:

CLIFFORD BED,	2′ 3″	No. XII=125′ 1″
Slate,	7′ 6″	
Pea Conglomerate,	18′ 9″	
Conglomerate,	5′ 10″	
Hard sandstone,	2′ 2″	
Conglomerate,	4′ 3″	
Hard sandstone,	27′ 3″	
Conglomerate,	6′ 9″	
Sandstone,	3′ 3″	
Conglomerate,	7′ 3″	
Sandstone,	3′ 4″	
Conglomerate,	39′ 9′	
Green shale,	17′ 7′	No. XI=17 7″
White rock,	15′ 4″	Top of No. X.

A bore hole near the mouth of Kendrick's drift, south of Carbondale has also cut through the formation which is there 220′ 7″ thick. This section is given on columnar section sheet XV and also on page plate 312.

The structure is that of a broad shallow basin with gentle dip of 10° more or less on either side. The trend of the basin is about N. 25° E. The two rather mild anticlinal flexures—the Coal Brook and Northwest axes—developed by the mine workings run about N. 70° E., or cross the basin at an angle of about 45°. Along Brace brook above Forest City a gentle dipping axis is exposed, it appears to be only local importance. The general dip of the basin, although not uniform, is toward, the southwest and it has a fall in that direction of about 1100′ in this division.

The *coal measures* of this division attain their greatest thickness under the high ground, near the axis of the basin, north of the river and between Carbondale and

Forest City; this thickness probably does not exceed 400′ and includes four coal beds workable for part if not for all of the area underlaid by them.

The *identily of the coal beds* worked at Forest City with those lower down the valley in the vicinity of Carbondale, has been, owing to the scanty developments intervening, a matter of much uncertainty; although it was supposed to be correctly expressed on the mine sheets. Later developments and particularly a series of eight diamond drill holes, recently bored for the Hillside Coal and Iron Co., seem to conclusively prove the former conjectures to be partly incorrect. The first of these borings is near the Forest City No. 2 shaft and they extend southwest at brief intervals to the site of the new Richmondale colliery on Lot No. 31. The record of these holes and their relative position is given on page plates 314 and 315. Bore hole No. 1 shows the "Shaft" bed of Forest City No. 2 colliery to be in two splits, each about 3′ thick and 14′ apart; Nos. 2 and 3 show the interval to widen to 26′ and the beds to thicken to 4′; No. 4 shows the beds still thicker. No. 5 thinner; No. 6 thicker; No. 7 still thicker; No. 8 or Richmondale No. 1 shows the splits each about 8′ thick and 20′ apart: from here it is easy to trace and identify these splits of the "Shaft" bed as the "Top coal" bed and "Bottom coal" bed* of the Northwest colliery and of the Coal Brook colliery at Carbondale, (see columnar sections on sheet XVI).

The uniform position of the "Slope" bed at about 100′ above the "Top coal" and the variation in the number and thickness of the thin Dunmore beds below the "Bottom coal" are important facts disclosed by the bore hole records.

The identity of the beds at Forest City with those at Carbondale may now be expressed as follows: (See also page plate 319.)

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*Southwest of Carbondale the "Top" and "Bottom" coals again unite and are called the Archbald bed.

Carbondale.		*Forest City.*
Grassy Island bed (not worked)	=	"Slope" bed.
"Top Coal" bed "Bottom Coal" bed	=	"Shaft" bed.
Third bed	=	Thin beds not worked.
Dunmore Co. 3 bed, bottom bed of Watkins bore hole	=	Clifford bed.

On the mine sheets the "Slope" bed is erroneously called the "Top Coal;" and the Clifford bed is printed in the same color as the Third bed suggesting an identity between them which does not exist.

The changes noted in themselves do not call for any revision of the outcrop of the bottom Dunmore or Clifford bed, or of the outcrop of the "Bottom coal" or "Shaft" bed as given upon the mine sheets: but the fact that the wash even on the hillsides is often 50′ or 60′ deep and that a heavy growth of timber covers the surface makes it quite probable that these outcrop lines are more or less in error except when fixed by mining developments or explorations.

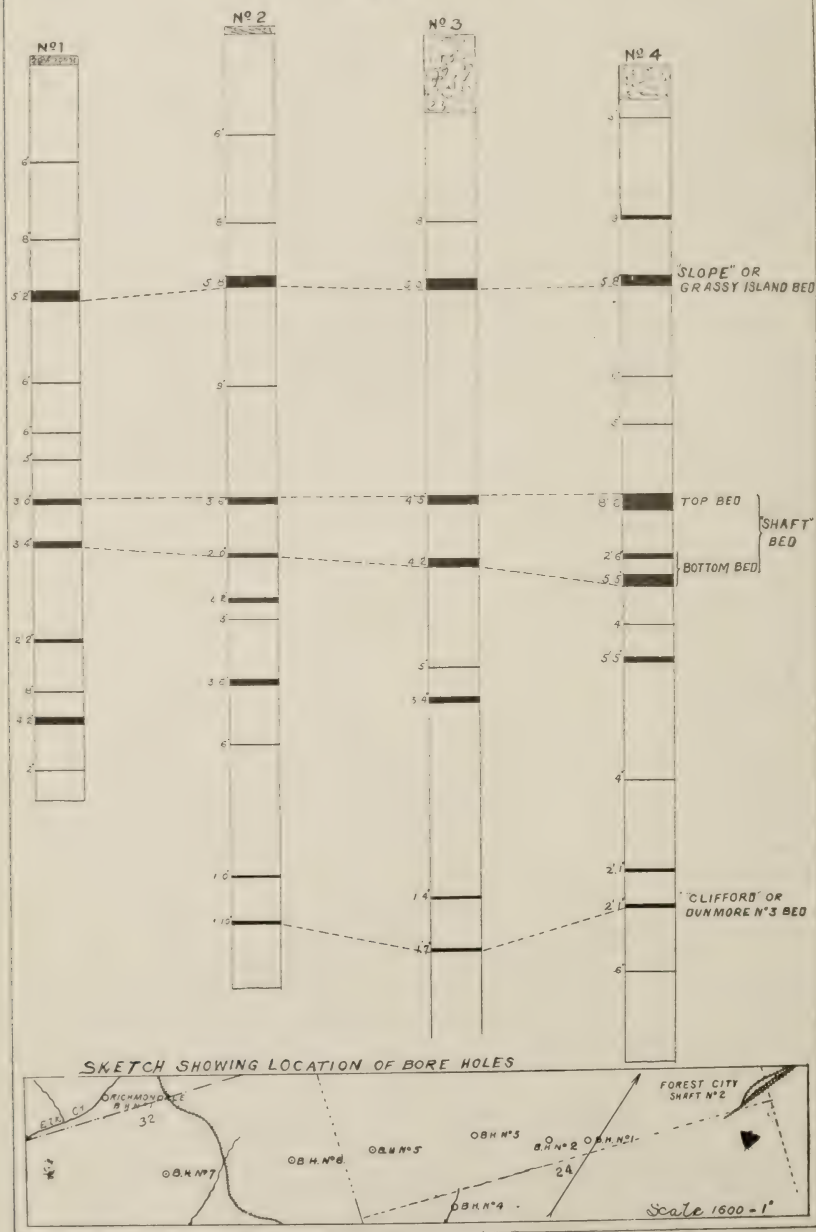
Clifford or Dunmore No. 3 bed, is the lowest of the Dunmore coals it lies at the base of the coal measures and marks the dividing line between them and formation No. XII. The Clifford although only workable for a portion of its extent is apparently the most important of the Dunmore beds in this division ; it reaches its best thickness about the northeastern end of the division and is worked at the Clifford collery just above Forest City where it has an average thickness of about 5′ ; the bed however grows thinner to the southwest as in the bore hole at Forest City shaft No. 2 and in the new borings southwest of the shaft, it varies from 1′ 7″ to 3′ 4″ in thickness with an average of about 2′ 6″. At the Hendricks drift bore hole south of Carbondale this bed was cut 2′ 5″ thick ; an examination of the records on columnar section sheets XV and XVI show no other borings near Carbondale of sufficient depth to have cut the Clifford bed ; the bed is so variable in its thickness that it is possible however that future developments may prove limited areas of it to be workable in this vicinity

PL. 314.

Anthracite Region_Northern Coal Field.

DIAMOND DRILL BORE HOLES SOUTHWEST OF FOREST SHAFT Nº 2 H. C. & I. CO.

Scale 100 = 1'

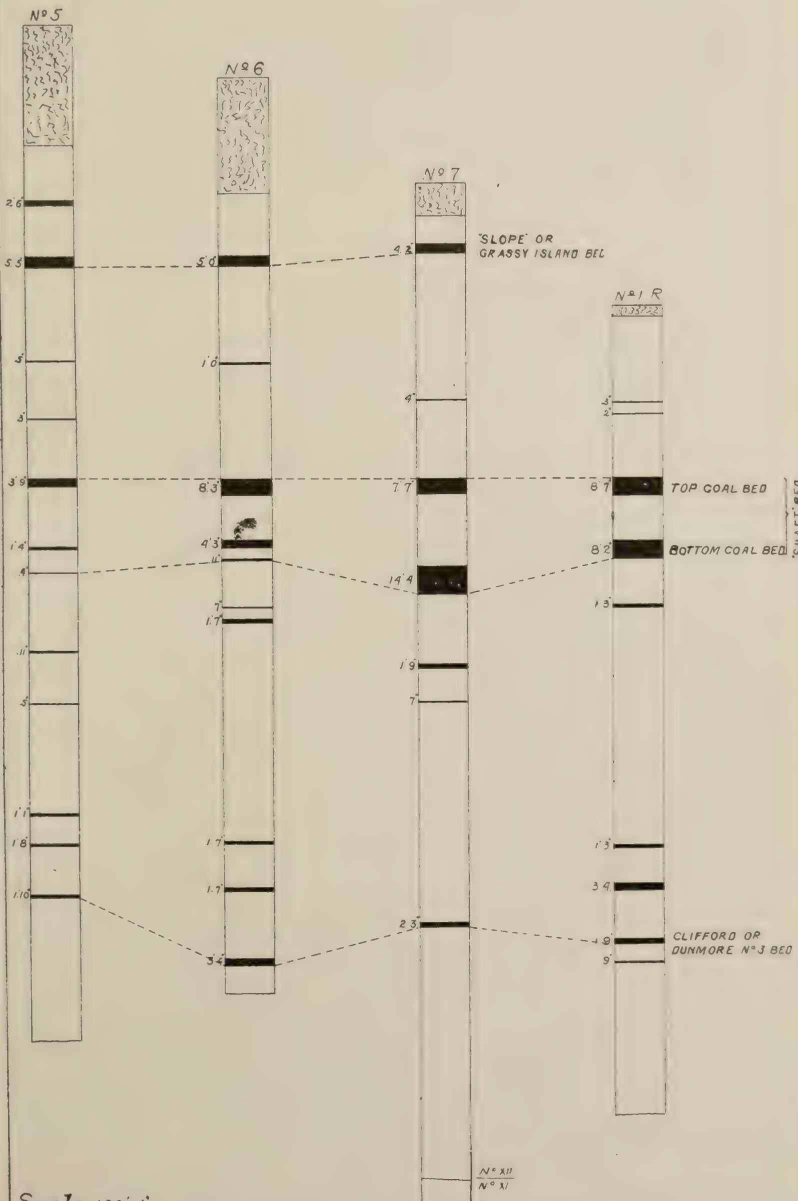


PL. 315.

Anthracite Region – Northern Coal Field

DIAMOND DRILL BORE HOLES SOUTHWEST OF FOREST CITY SHAFT Nº 2 H.C.&.I.CO

Continued.



Scale 100'–1'

Third Bed is the only other of the Dunmore coals–which are represented in this division by four or five small beds of varying thickness—that is worked. It is opened in the hill south of Carbondale and to a small extent in the Coal Brook* colliery north of the town, where worked the bed is 4′ to 5′ thick but in general it is rather irregular and variable. Some of the bore hole records indicate that possibly limited areas of this coal between Carbondale and Forest City may prove workable. The Third bed is usually found 100′ to 120′ above the Clifford bed and 10′ to 50′ below the "Bottom coal" bed.

Shaft or "Top coal" and "Bottom coal" bed is the most important bed in this division and extensively mined, especially about Carbondale where the workings on this bed include some of the oldest operations in the field. As we have already seen the bed is a double one and apparently continues so nearly all the way to the Forest City No. 2 shaft, where the splits reduced in size unite to form the Shaft bed. The interval between the splits varies from a few inches to 30′ or 40′, making it necessary in places to work them separately. In the vicinity of Carbondale the bed runs from 12′ to 14′ thick, about equally divided between the two splits—Top coal and Bottom coal—; at the Northwest and Richmondale collieries the bed will average 10′ to 12′ thick still in two splits; and at the Forest City and Clifford† collieries where it is a single bed it has a thickness of 5′ to 7′. The coal has a good reputation, the bed is fairly clean and certainly does not fall below the average of the field or 80 per cent. of its thickness in clean coal. At Forest City the interval between it and the Clifford is about 180′; at Carbondale this interval is about 125′ or possibly less.

Slope or Grassy Island bed, the highest of this division, is worked only at the Forest City colliery where it is found

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* A cross-section through Coal Brook is given on plate 316.

Note—On mine sheet XXIII the bed mined from the Clifford shaft called on the sheet the "Top" coal and printed in blue is the "Shaft" bed and should be in red; this correction is made on the cross and columnar section sheets.

† A cross-section through the Clifford shaft is given on plate 316.

about 80′ above the Shaft bed, this interval increases to 100′ or 120′ toward the southwest. It has apparently quite a uniform thickness of about 5′ not only in the mine workings but where cut in the new bore holes. The extent of this bed is not shown on the mine sheets; it underlies the high land close to the axis of the basin and has at the most only 100′ to 120′ of cover.

2. *Jermyn-Priceville Division.*

This division comprises all that part of the field mapped on mine sheets XVII to XX,* these mine sheets give also the topography of the area shown by contour lines 10′ vertically apart. The general structure is exhibited by two sections across the basin, J at Jermyn and H at Olyphant published on cross section sheets VII to IX.† Columnar sections giving the detailed thicknesses and character of strata at various points within the division are given on columnar section sheets XII to XV.‡

The area embraced by this division includes the full width of the field, some 4 to 5 miles, and it is some 9 miles in length from the sheet line a little below Carbondale to the sheet line at Priceville. It has within its limits the towns of Mayville, Jermyn, Archbald, Winton, Jessup, Peckville, Olyphant and Priceville.

The Lackawanna river, from Carbondale to Jermyn, occupies a central place in the basin, with the mountains on either side sloping down quite uniformly to the river flat which is about half a mile wide; at Jermyn the river bends and flows south, in a narrow valley, to Winton close to the southern rim of the field, leaving a hilly area to fill the central part of the basin; at Winton the river turning sharply to the right flows west, then to the southwest, and at the division line at Priceville it is once more in a wide valley and near the trough of the basin; the structure and more gentle dips here throw a much larger coal area to the southeast than to the northwest of the river. The river falls

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* Page plate 313 shows general location.

† See also reduced sections page plate 316.

‡ See also sections on page plate 317.

about 240′ from 1000′ A. T. to 760′ A. T. in crossing this division. Both mountain rims of the field are notched, but not very deeply by streams tributary to the Lackawanna. The waters of Rush brook north of Jermyn have cut the deepest; No. XII crosses the brook at 1050′ A. T.

Formation No. XII.—The southeastern outcrop of No. XII is from one-fourth of a mile to a mile wide; its irregular shape is caused largely by the erosion of the streams which cross its boundaries. Owing to the many exposures its outcrop is for the most part easily traced. The dips are gentle, often less than the slope of the ground, throwing the bottom beds of conglomerate far back on the mountain side where they outcrop at 1700′ to 1900′ A. T. Along the northwestern rim the dips are steeper 15° to 25° making a narrower outcrop of No. XII in general about 2000′ wide; the beds are not so well exposed as along the southeast but yet frequently enough to prevent the likelihood of any important error in the location of its outcrop.

The character of the materials composing No. XII is much the same as in the Forest City–Carbondale division, mostly fine conglomerate and sandstone, shading from one to the other, with occasional layers of coarse pebbly conglomerate.

The full thickness of the formation seems to have been cut in the bore hole 2000′ south of the Peirce breaker at Winton, (section 16 col. sec. sheet XIV)*, which gives "162′.5″ of Sandstone" from the Dunmore No. 3 bed to "3′.0″ of coal and slate," probably the "Campbells Ledge black shale bed" found in a number of places further south at the base of No. XII. If this be the Campbells Ledge shale, and it seems most probable, it is the most northeastern proving of it recorded. A new bore hole—No. 8—put down by Mr. John Jermyn, northwest of Jermyn No. 5 colliery, on the Sandy McLean warrant, cut No. XII 247′ thick, composed of hard sandstones and conglomerates, largely the latter, with 6″ of slate—Campbells Ledge shale?—at the base.

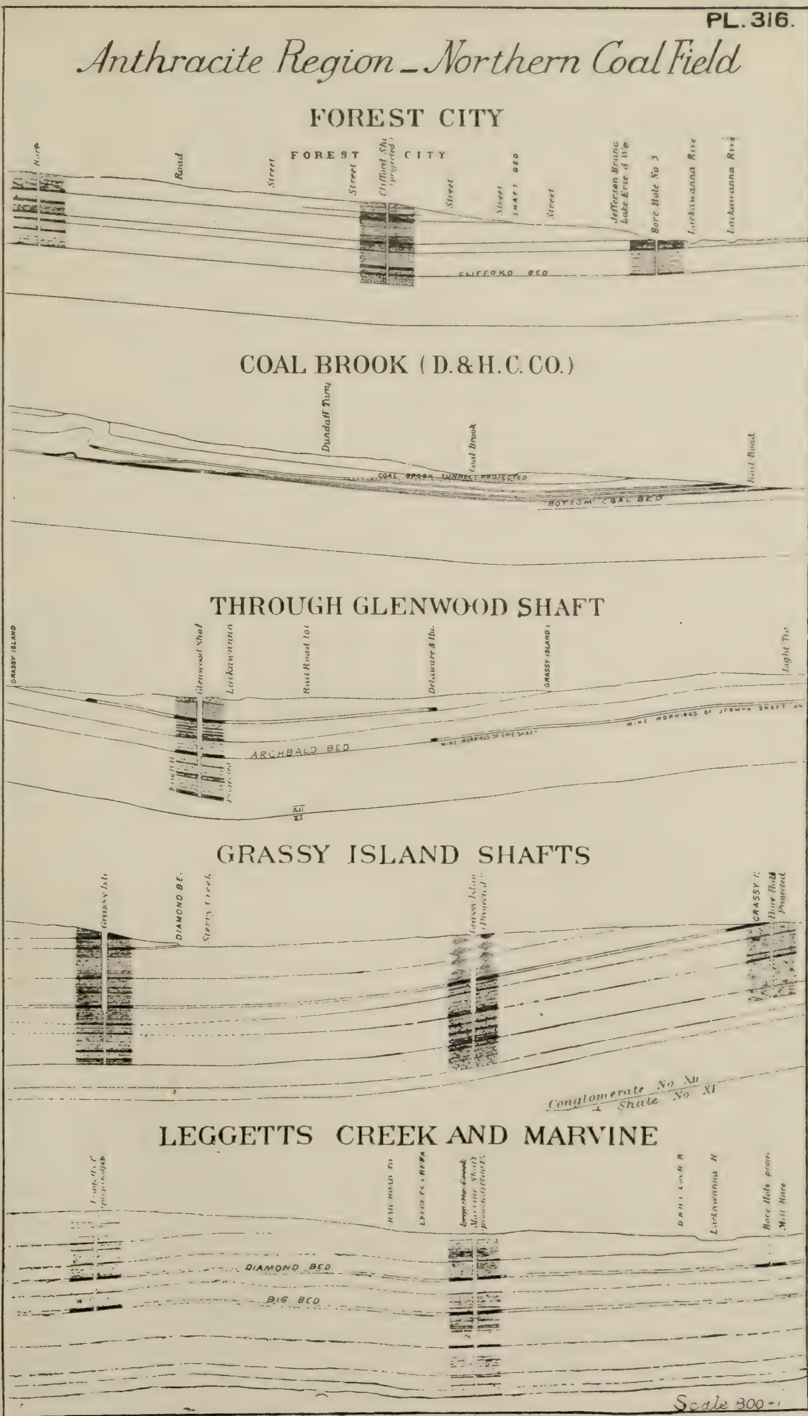
* Reproduced on plate 312.

Structure.—From Carbondale to Jermyn the basin continues to dip gently to the southwest along its axis, but from Jermyn for the next two miles or so, say to a little beyond the Ridge shaft, the basin rises at least 300′ and retains only the Archbald and Dunmore beds within its cover. This lifting of the lower measures along the axis may in some way have determined the deflection of the river toward the southern rim of the field at Winton. From near the Ridge shaft the basin once more sinks toward the southwest, under Peckville and Olyphant, rapidly bring in higher coal beds. The deepest point in the measures of this division is near the southwestern line at Priceville.

The northeastern half of the division is practically free of rolls, but the southwestern half shows several anticlinal axes, two of which are quite important; the most northern of these is the *Archbald axis* which is developed in the mines of Jones, Simpson & Co., and of the Delaware and Hudson Canal Co., at Archbald. The course of the axis is about N. 65° E., its southwestward extent and shape is not yet fully determined. The presence of this axis is undoubtedly influential in the uplift of the measures between Jermyn and Peckville, but it is hardly of sufficient importance to be the sole cause of it. A little oval patch of No. XI is brought to-day along the Lackawanna on the north flank of the axis. The *Peckville-Winton* anticlinal effects chiefly the outcrop of the Grassy Island coal bed above Peckville, although not connected on the mine sheets it seems possible that this axis is identical with one shown in the mine workings at Peckville. Several small rolls are seen to the south of the Peckville-Winton anticlinal; their position is shown on the mine sheets.

Coal measures—The highest coal beds of this division are found in the hill south of Olyphant and Priceville, the maximum thickness of the measures is 700′ to 800′ and they contain nine coal beds some of which are workable for part and others for all of their extent. The Archbald or Clark bed from its size and extent is the chief bed of the division, its outcrop is given upon the mine sheets as is also that of the lowest or Dunmore (No. 3) bed.

PL. 316.


Anthracite Region – Northern Coal Field
FOREST CITY
FOREST CITY
Road
Street
Street
Street
Street
SHAFT BED
Street
Bore Hole No 3
CLIFFORD BED
COAL BROOK (D.&H.C.CO.)
Dundaff Turn
Coal Brook
Rail Road
COAL BROOK TUNNEL PROJECTED
BOTTOM COAL BED
THROUGH GLENWOOD SHAFT
GRASSY ISLAND
Glenwood Shaf
Lackawanna
Delaware & Hu
ARCHBALD BED
GRASSY ISLAND SHAFTS
DIAMOND BE.
Conglomerate No XII
Shale No XI
LEGGETTS CREEK AND MARVINE
Lackawanna
DIAMOND BED
BIG BED
Scale 300

The *Dunmore beds* of the Jermyn-Priceville area are so variable in number, and thickness* that it is here impossible to conclusively identify the three well define coals extensively worked in the vicinity of Dunmore and Scranton. On sheet XIX—Jermyn sheet—a note says: "the existance of any workable bed under the Archbald is regarded as doubtful." A bore hole (see Sec. 13, Col. Sec. sheet 15) from the bottom of the Erie shaft to 160′ below the Archbald bed cut but two thin seams of coal 9″ and 6″ respectively; another bore hole (see sec. 14, col. sec. sheet 15) on the hill north of Mayville to 215′ below the Archbald bed cut four thin coals, the largest but 10″ thick. Developments on the adjoining sheet No. XVII made since its publication, to be referred to, make it seem possible that the thinness of the beds in the Erie and Mayville bore holes may be only local, and that a Dunmore bed of workable thickness may underlie some portion of this sheet. On sheet XX a Dunmore bed reported to be 3′ to 4′ thick has been opened at several points by trial shaftings along the southern outcrop.

The greatest development of the Dunmore coals in this division is within the area covered by sheet XVI; the Marshwood rock slope (near the southeast corner) opens three beds all of which are worked; bed No. 1 is 4′.3″ thick, No. 2 is 4′.2″ and No. 3 (the bottom bed) is 4′.2″ thick; these beds correspond fairly well and are probably identical with beds Nos. 1, 2 and 3 of Dunmore, the workings on which are only two miles southwest of the slope; at the Dolph colliery south of Jessup one of the Dunmore beds—No. 2 probably—is extensively mined, its thickness varies from 5′ to 12′, with an average of about 8′; an inside bore hole from near the Grassy Island shaft (see sec. 10 col. sec. sheet XIII) cut three Dunmore beds, workable so far as mere thickness; a bore hole (see sec. 18 col. sec. sheet XIV) on the Theodore Woodbridge warrant in Peckville to 338′ below the Archbald or Clark bed cut seven small coal beds the largest of which is but 2′ 2″ thick; at the Mt. Vernon colliery just south of Winton (marked Peckville

*For example see "Winton" and "Glenwood" columar sections plate 317.

Coal Co. on the mine sheet) a Dunmore bed, No. 1 probably, has been worked to a small extent, the bed is 5′ thick but rough and dirty with but 2′ 6″ of coal; at Mr. Thos. Waddell' s new colliery just across the river, the Dunmore No. 1 bed is opened by a slope, several bore holes (see sec. 22, 24 and 25 col. sec. sheet XIV) put down before the colliery was established, cut the bed 5′ to 8′ 6″ thick.

On sheet XVII, in the central part of the basin underlying Priceville, Olyphant and Blakely, the diamond drill borings including a number of recent holes put down by Mr. John Jermyn, the Lackawanna Coal Co. and the Hillside Coal and Iron Co., show all the Dunmore beds to be thin and apparently here unworkable. The bottom bed, 2′ to 5′ thick at some 260′ below the Clark bed, makes the best showing but the coal is dirty and of inferior quality.

Along the northern side of the basin and close to the northern outcrop these beds shown a decided improvement, which has largely been demonstrated by developments made since the publication of this sheet; on the Sandy McLean warrant, on the mountain northwest of Priceville, the bottom Dunmore bed—perhaps here Nos. 2 and 3 combined—has been shafted along its outcrop and found to have an unusual thickness of 15′ 2″, 14′ of this being coal; a series of bore holes test the bed for half a mile southeast of the outcrop. These borings demonstrate that the bed splits near the outcrop, that the lower split—Dunmore No. 3 bed—has where bored 5′ to 7′ of good coal and the upper split 2′ to 4′ thick contains perhaps too much bone and slate to be valuable; additional borings are now being made further to the southeast to determine the extent in that direction of the workable thickness of the bed.

At the Ontario colliery on the James Dodd tract—establishedsince the publication of the mine sheet—a Dunmore bed, called by the operators No. 2, is extensively worked; the shaft is 300′ deep, a bore hole (see sec. 10, col. sec. sheet XIV) just west gives a section of the measures cut. The bed is about 6′ thick with 4′ 6″ to 5′ of coal; a new tunnel 900′ long, on a level with the top of the shaft, opens up a large area of this coal above water level. The northeastward extent of this bed with a workable thickness is not yet determined.

To sum briefly the Dunmore beds of this division three of which at one point at least are workable, show such diversity of thickness and quality, that, in nearly every case it requires a thorough proving* to determine their value, which may be considerable or very little.

Archbald or Clark bed, or *the "Top coal" and "Bottom coal"* of Carbondale is in this division, except near Carbondale, a single bed. The mine workings in this bed are now so extensive that its identity throughout the division seems unquestionably established. The outcrop of the bed between Peckville and Carbondale is shown on the mine sheets ; southwest of Peckville the outcrop of the Grassy Island bed is given instead. At the Powderly mines, near Carbondale the bed is 13′ to 15′ thick, in two benches—Top coal and Bottom coal—of about equal thickness, in some parts of the mine the benches are so far apart as to be worked separately; at the Keystone colliery the bed averages 7′ 6″ thick with but 5″ of refuse; at the Edgerton colliery the bed is about 12′ thick; at the Erie, Glenwood,† Jermyn shaft, White Oak and Eaton collieries the bed has an average thickness of about 10′. Practically everywhere on mine sheets XIX and XX the bed seems to be of good regular thickness, containing but a small proportion of refuse and the coal is of excellent quality. A section of the bed at Archbald is as follows : *Coal 2′ 6″*, *slate 2″*, *coal 6″*, *slate 2″*, *coal 1′ 6″*. *slate 2″*, *coal 5′ 0″*. *Total 10′*, *coal 9′ 6″*. West of Archbald the bed is thinner and more broken by slate partings and bony benches; at the Mt. Jessup colliery the bed is 8′ to 9′ thick with 1′ 6″ to 2′ 0″ of refuse; at the new Riverside colliery, on the Howells Estate, west of Winton, the bed is about 6′ thick with 4′ 6″ to 5′ 0″ of coal; at the new shaft of the Blue Ridge Coal Co., on the Ann Dilly warrant, the bed is about

*It is highly important that borings should reach a sufficient depth to make sure of cutting the lowest bed, 300′ below the Clark bed, if that horizon is known, is not too much.

† For cross section through Glenwood see plate 316.

5′ thick; at the Sturges shaft near by 6′ thick with 3′ of coal; the bed is now worked at the Jermyn collieries at Priceville with a thickness of 3′ to 5′; along the north side of the basin between Priceville and Peckville the Clark bed, as it is here called, is thin or so split by slate or bone partings sometimes of considerable thickness, as to make it difficult to identify the bed in the borings and probably renders it unworkable for much of the area.

Four foot bed:—In the interval between the Archbald or Clark bed and the Grassy Island bed two small coal beds usually occur, one of which at times reaches a workable thickness and is called the Four Foot bed. The only work ings on this bed thus far are at the Grassy Island shaft, of the Stony Creek Coal Co., near Jessup, where its thickness is about 4′; shaft and bore hole records–see col. sec. sheets—show it to vary from 2′ to 6′ thick at other points in this division.

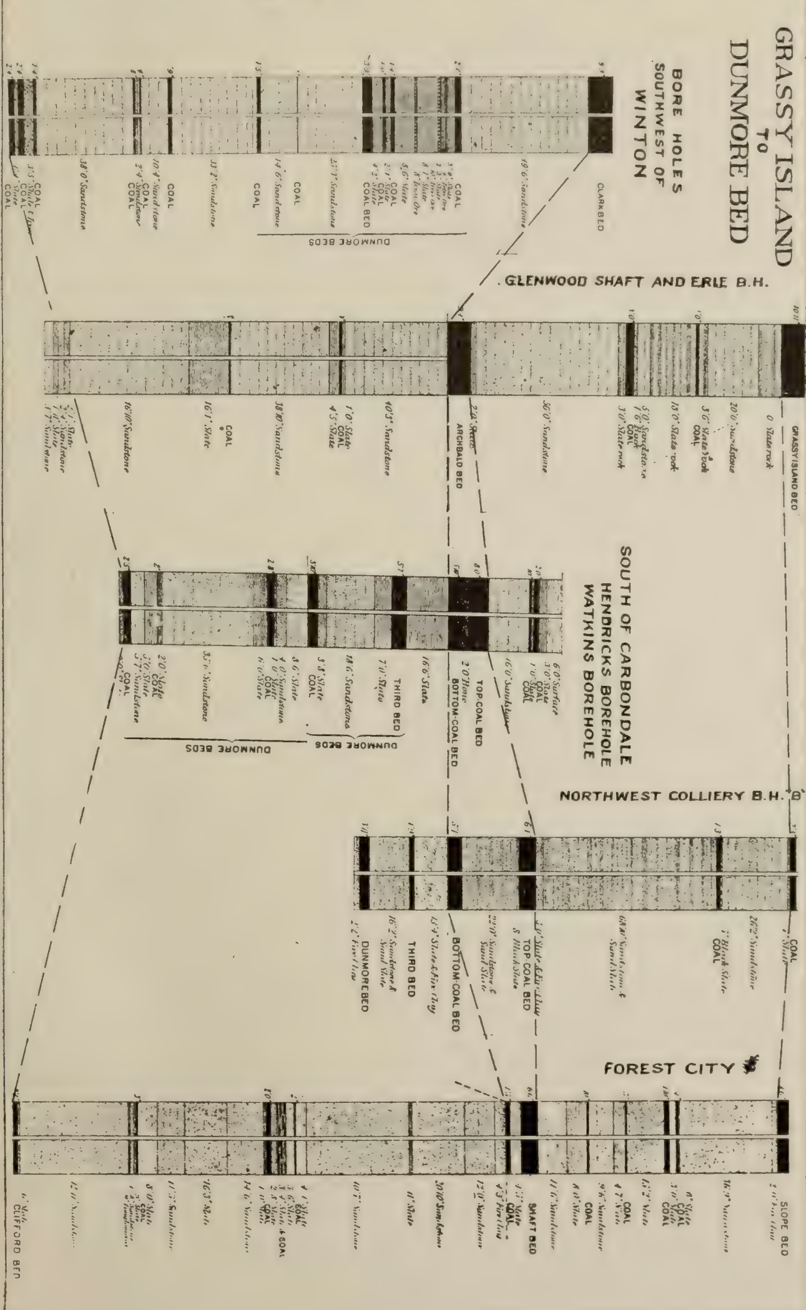
Grassy Island bed is separated from the Archbald or Clark bed by an interval of 130′ to 140′, throughout the northeastern part of the division, along the southwest at Priceville this interval is 200′.

The approximate outcrop of the bed is given on mine sheets XVII and XVIII; the extension of the Lackawanna colliery workings, since the publication of the mine sheets, has shown that the bed spoons just west of the branch railroad up Tinklepaugh creek, although the bed may be caught again in the hill to the northeast near the approximate outcrop given on the sheet. In the basin about Jermyn, sheet XIX, the Grassy Island bed is also found, it underlies here an area about 4 miles in length with a maximum width in the hill southwest of the town of about 4,000′; its outcrop is not indicated. North of Priceville on the Jermyn property the outcrop has been found about 1,000′ higher up the mountain side than the mine sheet shows.

The Grassy Island is the principal bed of the southwestern half of the division and indeed of the whole field, in other parts of which it is called the Big bed, Pittston bed,

PL.317.

Anthracite Region – Northern Coal Field.



Baltimore bed, etc. It is worked at the Glenwood colliery in the Jermyn basin, where it has a thickness of about 10′; borings to the south and west of the town give a thickness for it of 5′ to 12′ with an average of about 8′, the cover over the bed in this neighborhood is light, seldom more than 100′. In the main basin, sheet XVII and XVIII, the bed is extensively worked, at the Grassy Island colliery* of D. & H. C. Co. and the Grassy Island colliery* of the Sterry Creek Coal Co., the bed is 10′ to 12′ thick; at the Olyphant, the Eddy Creek, the Lackawanna and the Jermyn No. 4 and 5 collieries the bed averages from 7′ to 9′ thick, though occasionally thickening to 14′ or thinning to 4′ or 5′. The coal is of good quality, the bed contains about the average amount of refuse, say 18 to 20 per cent.

Rock bed is next above the Grassy Island with an interval of about 80′ between, in which a small leader or two are usually found. The bed is not worked in this division, where cut by shafts and bore holes it is generally about 6′ thick in two benches with 1′ to 2′ of slate between. The coal is rather rough and inclined to be bony.

Diamond bed is found in the high measures south of Olyphant and Priceville; where cut by the Olyphant No. 2 and the Eddy Creek shafts it has a thickness of 3′ 6″ to 4′ 6″. Its place is about 100′ above the Rock bed. It is not worked in this neighborhood.

Olyphant No. 2 bed is 70′ to 100′ above the Diamond. It is mined in the hill south of Olyphant, at the Olyphant and the Eddy Creek collieries, where the bed is about 7′ thick, coal of excellent quality. The sections show three leaders between the Diamond and Olyphant No. 2 bed but none of workable thickness.

Olyphant No. 1 bed is found 16′ to 50′ above the Olyphant No. 2 bed and is also worked at the Olyphant and Eddy Creek collieries, where it has a thickness of about 7′. This is the highest bed of the division and the cover over it does not much exceed 50′.

*A cross section through the Grassy Island shafts is given on plate 316.

Owing to their high position in the measures the two Olyphant beds have a rather limited extent much of which owing to its favorable situation and excellent quality of the coal has now been worked over.

3. Scranton Division.

The Scranton division comprises all that part of the field mapped on mine sheets XIII to XVI* ; these sheets do not give the topography, but it is given on a small scale map (-3200′=1″) contained in Annual, 1885, Atlas.† The general structure is exhibited by two sections across the basin, G at Providence and F at South Scranton, published on cross section sheets VI to VIII.‡ Columnar sections giving the detailed thicknesses and character of the strata at various points within the division are given on columnar section sheets X to XIII.‖

The area covered by the four mine sheets is that between Priceville and Taylorsville some nine miles in length with a width of about five miles between the outcrops of No. XII. The City of Scranton occupies the central portion of the division ; the business portion of the city is built upon a bluff, the sides of which rise steeply a 100′ or more above the river, at just above the junction of the Lackawanna and Roaring brook. Leggetts creek on the north, Roaring brook and Staffords Meadow brook on the south, have each cut rather deep gaps in the mountain rim of the basin. Keyser's Valley run is an important tributary rising within the coal measures, draining the valley north and west of Hyde Park and emptying into the Lackawanna at Taylorsville. The Lackawanna falls about 120′, 760′ A. T. to 640′ A. T. in crossing this division.

Formation No. XII in this area becomes a more prominent feature of the topography ; the materials composing it are coarser, the beds are more massive and the under-

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* Page plate 313 also gives the general location of this division.

† The original of this map by R. P. Rothwell M. E. is drawn on a scale of 800′=1″

‡ Parts of these sections are reproduced on page plates 316 and 320.

‖ Some columnar sections reproduced on page plates 318 and 319.

lying shales of XI are softer and thicker throwing No. XII more in relief. Its thickness along the north rim of the basin is about 200′, along the southern rim 250′* with perhaps a thickness of 448′ at one point. Several bore holes, mostly for water, have cut the full thickness of No. XII and underlying measures, see colunmar section sheets. One No. 18, sheet IX, near the corner of Prescott and Mulberry streets, Scranton gives:

4′.	6″	DUNMORE NO. 3 BED,	
19′.	9″	Gray sandstone,	No. XII 230′ 1″.
163′.	10″	Conglomerate,	
24′.	9″	Fine white sandstone,	
19′.	9″	Bluish green rock,	
2′.	0″	Black slate (Campbells Ledge Shale,)	
99′.	1″	Soft red shale,	No. XI.

Another bore hole also for water near the corner of Sanders and Stone streets, Scranton gives :—

4′.	0″	DUNMORE NO. 3 BED,	
18′.	0″	Sandstone,	No. XII=448′?
35′.	0″	Shelly rock,	
395′.	0″	Conglomerate,	
20′.	0″	Red shale,	

If the 20′ of red shale represents the top of No. XI then No. XII has here a decidedly abnormal thickness of 448′. It seems however not unlikely that the correct parting is higher up somewhere in the "395′ Conglomerate."

The north outcrop of No. XII is only 1,000′ to 2,000′ wide and high up on the mountain side. On the south the gentle north dipping rocks of XII make a barren area, much of it a mile and a half wide, from which all the coal beds have been denuded, leaving many bare exposures of conglomerate beds. The waters of Stafford Meadow brook cut deeply into this southern rim and expose the shales of No. XI along the valley of the stream.

The Campbells Ledge black shale, at the base of No. XII, has been exposed at the Roaring brook gap on the south; here coal is found mixed with the shale, and it is also found at the Leggetts creek gap on the north and at several other points along the outcrop on both sides of the basin.

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* See Colunmar section on plate 312.

The *structure* is clearly exhibited by the cross sections and mine sheets. The gentle curve of the broad flat basin is but slightly rippled by some four or five small rolls; the more important of these, commencing at the north, are the Green Ridge, Hyde Park, Dunmore and Meadow Brook anticlinals. The Dunmore axis for part of its length shows an overlap or down throw of 50′ more or less; this overlap is developed by the mine workings. The Lackawanna basin, which has been slowly sinking, reaches about its maximum depth under the river valley in the neighborhood of Providence, where the lowest coal bed—Dunmore No. 3—is 600′ to 700′ below the surface or about Tide Level, from here the measures have a very gradual rise to the southwest.

Coal Measures:—Probably the greatest thickness of coal measures in this division and in the Lackawanna basin is under the Hyde Park hill where the total reaches about 950′ with 11 coal beds workable for part or all of their area.

The Dunmore or the Red Ash coal beds * as they are called further to the southwest, three of which are of workable thickness, in this division, are very extensively mined south of the Lackawanna, and especially so about Dunmore ; to which fact is no doubt due the name—Dunmore beds. Along the north side of the basin, and north of the river, these beds are undoubtedly thinner and less regular, although the provings have not been extensive. The rapid exhaustion of the thicker upper beds will no doubt lead before long to a more thorough exploration of the Dunmore beds in this neighborhood.

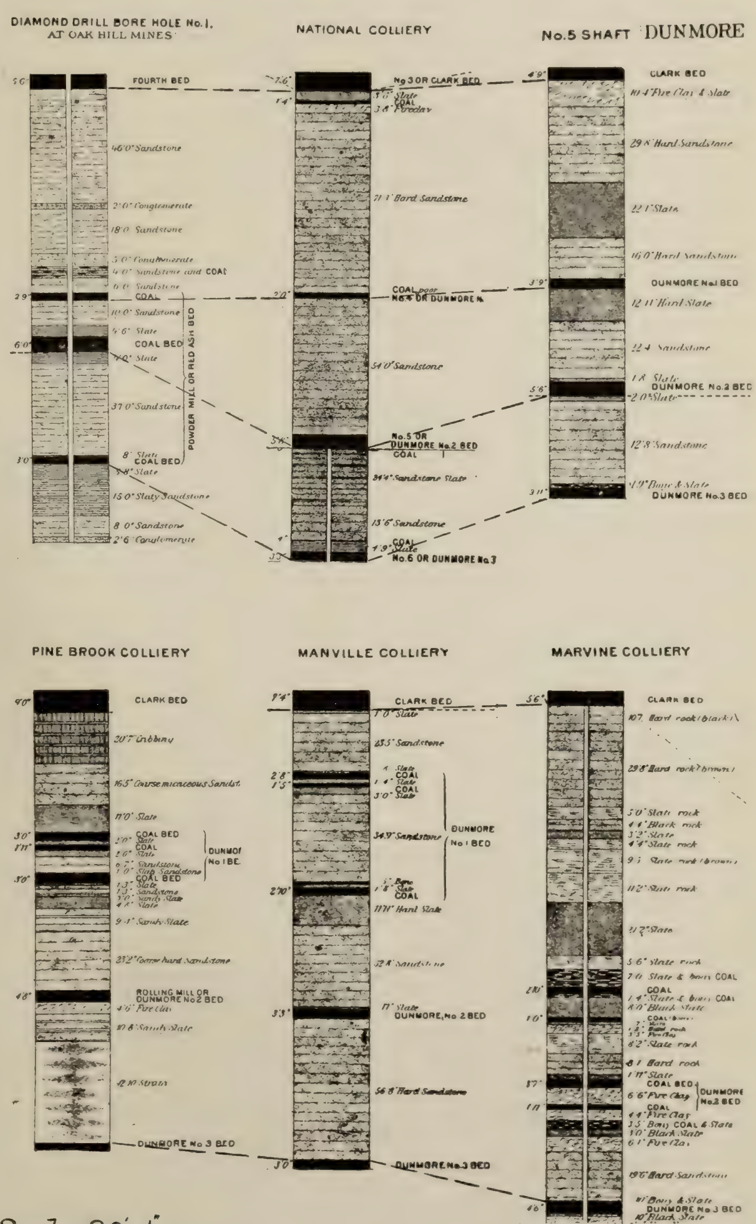
Dunmore No. 3 bed, the lowest of the series lying on top of No. XII, reaches its maximum development in the neighborhood of Dunnmore where it is extensively worked with an average thickness of about 5′. A mile and one half north of Dunmore at the Pancoast colliery a recent bore hole shows the three Dunmore beds to be of workable thickness and

* See columnar sections on plate 318.

PL. 318.

Anthracite Region – Northern Coal Field.

CLARK BED TO REDASH OR DUNMORE BEDS



Scale 80' = 1"

unusually close together; the record of the hole from the Clark bed down is as follows:*

3′ 9″	*Clark bed.*
64′ 0″	Strata.
4″	*Coal.*
77′ 0″	Strata.
8″	*Coal.*
8′ 0″	Strata.
2″	*Coal.*
20′ 0″	Strata.
5′ 11′	*Dunmore No. 1 bed.*
5′ 0″	Strata.
5′ 3″	*Dunmore No. 2 bed.*
10′ 0″	Strata.
1″	*Coal.*
1′ 0″	Strata.
4′ 11″	*Dunmore No. 3 bed.*
40′ 0″	Strata.

The detailed section of No. 1 bed is: *Coal 2″, Slate 1′ 1″, Coal 8,″ Bone 2″, Coal 3′ 10″; Total 5′ 11″, Coal 4′ 8.″* Of No. 2 bed: *Coal 2′ 9″, Slate 2″, Coal 7″. Bone 3″, Coal 2″, Bone 2″, Coal 8″, Bone 6″; Total 5′ 3″, Coal 4′ 2″.* Of No. 3 bed: *Coal 1″, Slate 9″, Coal 3′ 11″, Bone 2″; Total 4″ 11″, Coal 4′ 0″.*

To the west and south in this division No. 3 bed is thiner and often split by slate partings.

Dunmore No. 2 bed is extensively mined by the Pennsylvania Coal Co. at Dunmore† and at the Green Ridge, the Pine Brook, the Fairlawn, the Stafford, the National‡ and the Meadow Brook§ collieries; it has a variable thickness from 3′ to 6′, with an average of perhaps 5′, yielding 3′ 6″ to 4′ of coal; the interval between it and bed No. 3 is ordinarily about 50′ composed chiefly of a fine hard sandstone.

Dunmore No. 1 bed is usually 30′ to 40′ above bed No. 2; in the neighborhood of Dunmore it is a good bed of coal 4′ to 8′ thick, but going northwest under Scranton the bed

*On section 20 Col. Sec. sheet XII the bed called Dunmore No. 1 is now identified as the Clark bed, the section commences with that bed.

† Cross sections at No. 1 shaft P. C. Co., given on plate 320.

‡ Columner section on plate 318.

§ Cross sections at Meadow Brook shaft given on plate 320.

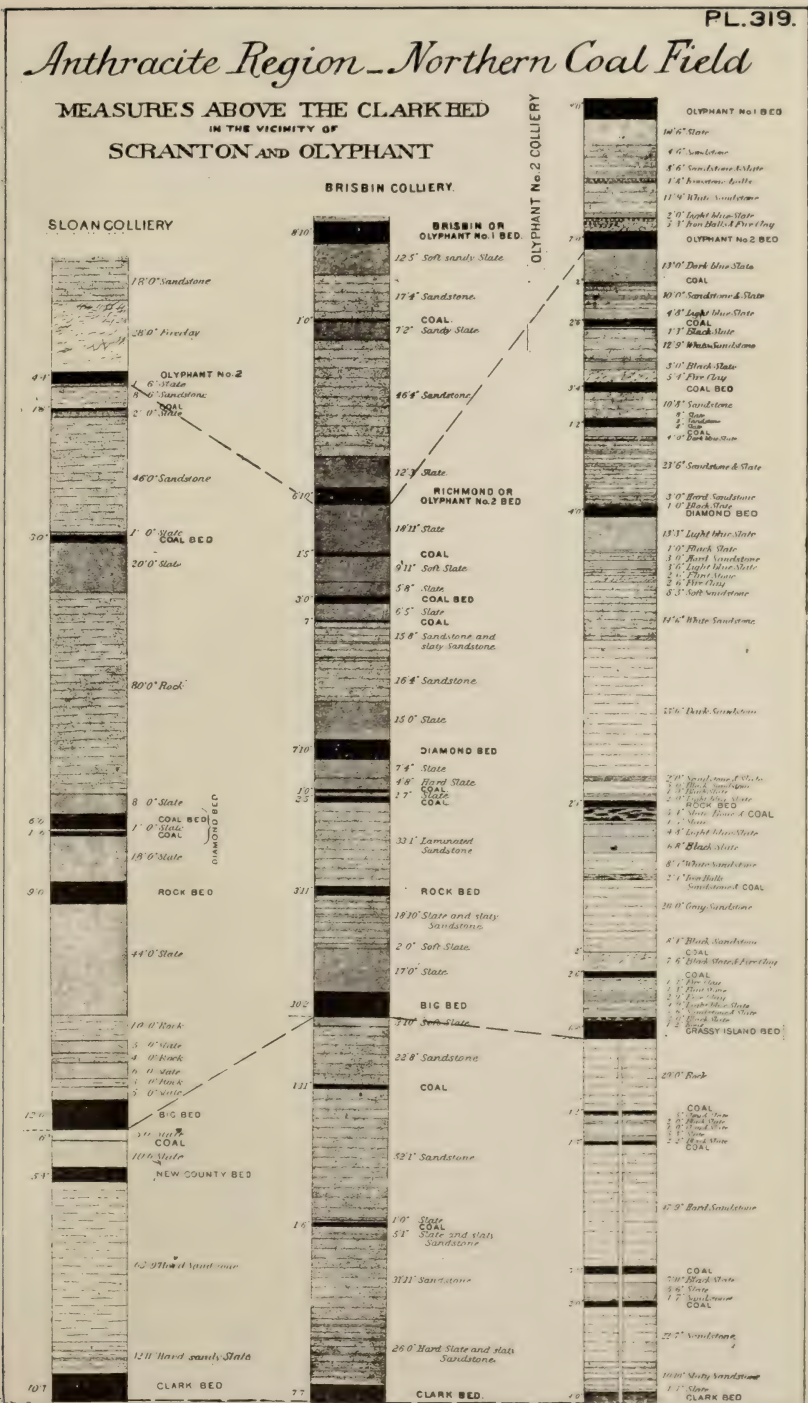
splits into two or even three parts, separated by 6′ to 10′ of slate and it has up to the present time been but little worked; the bed is mined at the Greenwood colliery, below Scranton, in fairly good condition about 5′ thick; between the Greenwood and the Dunmore workings the borings show it to be thin and dirty.

Clark bed is probably the most extensively wrought bed of the division although all the larger beds are pretty thoroughly worked, its position low in the coal measures gives it a large area and the bed is of good thickness and quality for nearly or quite its whole extent. The interval between it and the Dunmore No. 1 bed varies from 35′ to 170′ being thickest at the northeast and thinning toward the southwest. The bed is sometimes a double one with 1′ to 3′ of slate separating the two benches each 4′ to 5′ thick. In the collieries about Hyde Park the bed is at its best and is there 10′ to 12′ thick; in the northeastern part of the division about Providence and Green Ridge the bed is less thick, running from 4′ to 8′; at the Manville* colliery Green Ridge, where the bed is extensively mined it averages about 7′ thick; at the old Clark mines at Leggett's creek gap the bed is reported by the First Survey to be 5′ to 8′ thick. The bed carries about the average proportion of refuse. A section at the Manville shaft gives: *Bone 4″, Bony coal 9″, Coal 4′ 0″ Slate and bone 11″, Coal 1′ 4″. Total 7′ 4″, Coal 6′ 1″.*

New County bed, or the Four Foot bed of the preceding division becomes a thick and important bed in this division and is extensively mined, especially so towards the southwest. The bed first begins to show an improved thickness in the vicinity of Providence; at the Tripp, Mt. Pleasant, Diamond and Bridge collieries the bed is divided by 2′ to 8′ of slate, the upper bench having a thickness of about 5′ and the lower bench 3′; further southwest at the Holden, Taylor, Pyne, Archbald, Continental,† Stafford and other collieries in this vicinity the bed runs from 7′ to 9′ thick yielding 5′ to 7′ of coal. A section of the bed at

* Columnar section on plate 318.

† Cross section through Continental shaft on plate 320.



PL. 319.
Anthracite Region – Northern Coal Field
MEASURES ABOVE THE CLARK BED
IN THE VICINITY OF
SCRANTON AND OLYPHANT
SLOAN COLLIERY
BRISBIN COLLIERY
OLYPHANT No. 2 COLLIERY
18' 0" Sandstone
28' 0" Fireclay
OLYPHANT No. 2
46' 0" Sandstone
COAL BED
20' 0" Slate
80' 0" Rock
8' 0" Slate
DIAMOND BED
18' 0" Slate
ROCK BED
44' 0" Slate
BIG BED
NEW COUNTY BED
12' 11" Hard sandy Slate
CLARK BED
BRISBIN OR OLYPHANT No. 1 BED
12' 5" Soft sandy Slate
17' 4" Sandstone.
COAL.
7' 2" Sandy Slate
46' 4" Sandstone
RICHMOND OR OLYPHANT No. 2 BED
18' 11" Slate
COAL
9' 11" Soft Slate
5' 8" Slate
COAL BED
6' 5" Slate
COAL
15' 8" Sandstone and slaty Sandstone.
16' 4" Sandstone
15' 0" Slate
DIAMOND BED
7' 4" Slate
4' 8" Hard Slate
33' 1" Laminated Sandstone
ROCK BED
18' 10" Slate and slaty Sandstone.
2' 0" Soft Slate
17' 0" Slate.
BIG BED
22' 8" Sandstone
COAL
52' 1" Sandstone
31' 11" Sandstone
26' 0" Hard Slate and slaty Sandstone.
CLARK BED.
OLYPHANT No. 1 BED
OLYPHANT No. 2 BED
13' 0" Dark blue Slate
COAL
10' 0" Sandstone & Slate
12' 9" White Sandstone
COAL BED
23' 6" Sandstone & Slate
3' 0" Hard Sandstone
DIAMOND BED
13' 3" Light blue Slate
14' 6" White Sandstone
ROCK BED
6' 8" Black slate
GRASSY ISLAND BED
29' 0" Rock
47' 9" Hard Sandstone
22' 7" Sandstone
CLARK BED

the Archbald colliery is as follows:—*Coal, 3′. 3″, Slate, 8″. Coal, 1′. 0′, Bony Coal,* 11″, *Coal,* 1′ *4″, Bony Coal,* 4″, *Coal, 1′. 6″; Total 9′. 0″ Coal, 7′. 1″.* The interval between it and the underlying Clark bed or the overlying Big bed—a 100′ to 150′ above the Clark—is very variable, the columnar sections show the relative position of these beds at a number of points.

Big bed, or the Grassy Island bed of the Jermyn–Priceville division, is supposed to be the equivalent of the Baltimore or Mammoth bed of the vicinity of Wilkes-Barre. It is not only the chief bed of this division but of the field and of the whole anthracite region. The bed is the thickest of the series, varying from 10′ to 18′ thick, fairly free from refuses and yielding a coal of excellent quality; its outcrop is shown upon the mine sheets and in this division the greater part of its territory has been worked over.

The following sections will serve to show the character of the bed:

1. At Mt. Pleasant shaft a section gives: *Coal, 1′. 3″, Slate, 6″, Coal, 10″, Bony coal, 2″, Coal, 4′.10″, Bony coal, 6″, Coal 1′.7″, Bony coal, 3″, Coal, 3′.10″; Total, 13′.9″, Coal, 12′.4″.*

2. At Diamond No. 2 shaft a section gives: *Coal, 1′.4″, Slate, 6″, Coal, 5′.0″, Slate 6″, Bony coal, 6″, Coal, 5′.0″; Total, 12′.10″; Coal, 11′.4″.*

3. At the Belleview colliery a section gives: *Slate, 2″, Coal, 1′.1″, Slate, 6″, Bone 1′.1″, Coal, 5′.0″, Bone, 4″, Slate, 1′.0″, Coal, 2′ 0″, Slate, 6″, Coal, 7″, Slate, 2″, Coal, 2′.4″, Slate, 9″, Coal, 2′.9″; Total, 18′.3″; Coal, 13′.9″.*

4. At the Capouse colliery a section gives: *Coal, 1′.0″, Coal, 4′.0″, Slate, 2′.3″, Coal, 1′.6″, Slate, 3″, Coal, 3′.9″; Total, 12′.9″; Coal, 10′.3″.*

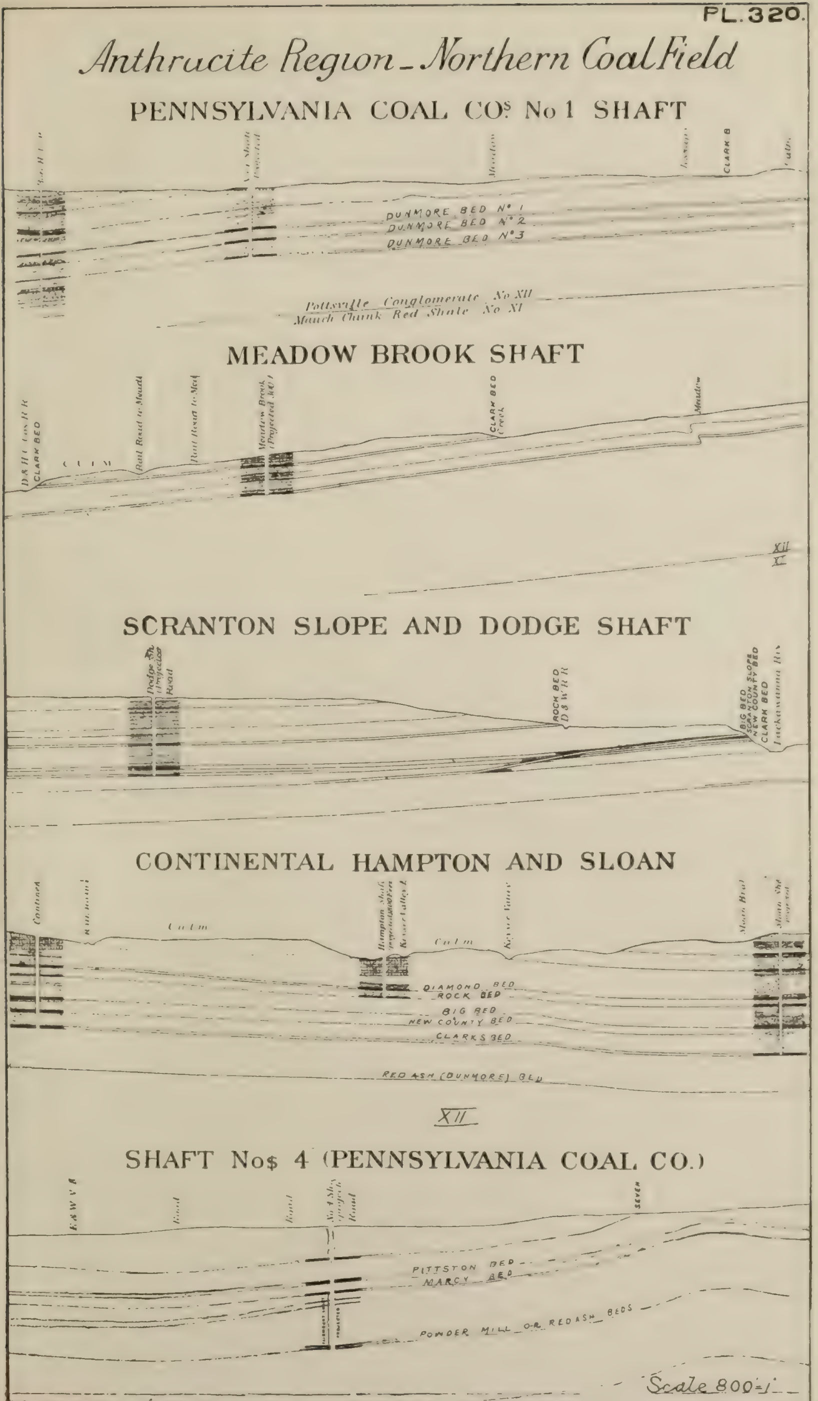
5. At the Archbald shaft a section gives: *Coal, 1′.1″, Slate, 2″, Coal, 4′.5″, Slate, 11″, Coal, 1′.1″, Bone and slate, .11″, Coal. 1′.3″, Bone and slate .4″, Coal, .10″; Total, 11′.0″; Coal, 8′.8″.*

The average thickness of the Big bed in this area may be safely taken to be at least 12′ with 10′ of coal. The interval between the Clark and the Big bed varies from 100′ to 150′; in the neighborhood of Providence and Green Ridge it is about 150′, while at Scranton and Hyde Park it is about 100′ and in the vicinity of Taylorsville it is rather more than 150′.

Rock bed is next above the Big bed with an interval of 50′ to 100′ between them, about Hyde Park the interval is some 80′ and quite regular. Between Priceville and Providence the provings show the bed to be but 2′ to 3′ thick, but it improves in thickness to the southwest and between Providence and Taylorsville it is an important bed largely worked. The coal is usually in two benches; at the Tripp Cayuga and Von Storch collieries these benches each 3′ to 4′ thick are 2′ to 10′ apart; in the collieries further southwest about Hyde Park and Taylorsville the benches are close together with only a few inches of slate between, with a total thickness for the bed of 7′ to 10′ carrying about the average proportion of refuse, 18 or 20 %. Only a comparatively small area of this bed is found south of the river and the mine workings are all on the north side.

Diamond bed is regarded as one of the best of the Scranton division, it has throughout a good workable thickness of 8′ to 12′, coal is of excellent quality, the benches of coal are usually of good size 3′ to 6′ thick and the slate and bone partings not very numerous. The position of the bed rather high in the measures confine it to the deeper parts of the basin and to the high ground about Hyde Park, it spoons out before reaching the southwest line of the division; it is all on the north side of the river excepting in the neighborhood of Throop, where it is mined at the Pancoast colliery. Its thickness will average about 10′.

NOTE.—The identity of the Big bed at the Pyne colliery, as given on the columnar sections of the shaft and rock slope—(Nos. 2 and 3 Col. Sec. sheet X)—may be questioned. According to these sections the Big bed is represented by 19′ 5″ of slate in the slope and 1′ 3″ of bone and coal in the shaft; it seems however more reasonable to suppose that the interval between the Big and New County beds has increased and that the so-called "Rock" bed is really the Big bed, than that the Big bed has grown thin and worthless in the short distance between the Pyne and Archbald collieries. The rapidly advancing mine workings will soon settle this question.


PL. 320.
Anthracite Region - Northern Coal Field
PENNSYLVANIA COAL COS No 1 SHAFT
CLARK B
DUNMORE BED No 1
DUNMORE BED No 2
DUNMORE BED No 3
Pottsville Conglomerate No XII
Mauch Chunk Red Shale No XI
MEADOW BROOK SHAFT
CLARK BED
CULM
Rail Road to Maud
Meadow Brook (Projected 300')
CLARK BED Creek
Meadow
XII
XI
SCRANTON SLOPE AND DODGE SHAFT
Dodge Sh. (Projected) Road
ROCK BED D S W R R
BIG BED
SCRANTON SLOPE
NEW COUNTY BED
CLARK BED
Lackawanna Riv
CONTINENTAL HAMPTON AND SLOAN
Continental
Culm
Hampton Shaft
Keyser Valley
DIAMOND BED
ROCK BED
BIG BED
NEW COUNTY BED
CLARKS BED
RED ASH (DUNMORE) BED
XII
SHAFT Nos 4 (PENNSYLVANIA COAL CO.)
Road
No 4 Sh. projected Road
SEVEN
PITTSTON BED
MARCY BED
POWDER MILL OR RED ASH BEDS
Scale 800=1

The interval between it and the Rock bed is only 20′ to 30′.

Church Slope bed, between the Diamond and the Olyphant No. 2 or Richmond bed two small coal beds are usually found, the lower and thicker of these coal beds is known as the Church Slope bed. The interval between it and the Diamond in the vicinity of Providence is from 50′ to 60′, this increases to 100′ at the Diamond No. 2 shaft, Hyde Park, where the bed has an unusual thickness of 7′. The bed becomes thinner towards the southwest. The only working of it is at the Church colliery on sheet XVI, where the bed has the following sections: *Slate 1′ 10″, Bone 2″, Coal 2′ 6″, Clay 6″. Total 5′ 0″. Coal 2′ 6″.*

Olpyhant No. 2 or Richmond bed is, by its high position in the measures, limited to the high ground near the central part of the basin; it is found south of the Lackawanna at the Eddy Creek mines; and under the hill north of Providence where it is extensively worked from the Richmond drifts; also under the Hyde Park hill where it is worked to a small extent from the Richmond shaft. The bed varies from 3′ to 7′ in thickness and its coal is of good quality. The interval between it and the well known Diamond bed averages about 150′, while between it and the somewhat irregular Church bed the distant varies from 50′ to 100′.

Olyphant No. 1 bed, called the Brisbin bed at the Brisbin* colliery, is the highest workable bed of the division and comparatively underlies but a small area. The workings on this bed from the Eddy Creek colliery extends into this division, the bed is about 7′ thick and in good condition; the bed is also caught in the hill north of Providence and in the high ground at Hyde Park, but the coal lies very close to the surface. At Eddy creek the Olyphant beds are about 50′ apart but at the Brisbin shaft, Hyde Park, this interval has widened to 120′.

4. Pittston Division.

The Pittston division comprises all that part of the field mapped on mine sheets IX to XII.† The topograpy of the

*See columnar section on plate 319.

† Page plate 321 also gives the general location of this division.

division is shown on the Rothwell map Scale 3200′=1″ contained in Annual, 1885, Atlas. The general structure is exhibited by two sections across the basin. E above Moosic published on cross section sheets VI to VIII and D at Pittston on sheets II*a* II*b* and II*c*.† Columnar sections giving the detailed thickness and character of the strata at various points within the division are given on columnar section sheets VI to VII.‡

The area covered by this division extends from Taylorsville to a little below Wyoming, about nine miles in length, and the field has here a maximum width of about six miles. Pittston is the chief town, centrally situated along the banks of the Susquehanna. Moosic, Pleasant Valley, Avoca, Lackawanna and Wyoming are also towns of more or less importance within this area.

The Susquehanna river enters the field from the north, through the gap above Pittston; at the town the river sweeps around to a southwest course, flowing along the southern edge of its flood plain—here about a mile wide—and near the axis of the basin. The Lackawanna river swinging over toward the northern rim of the field joins the Susquehanna only half a mile below the Pittston gap. North of the rivers the mountain rises back from the river flat with few or no preliminary foot hills, with the exception of a little corner at the northeast of the division where a hill and a valley drained by St. John's creek intervene between the Lackawanna and the north mountain. Abrahams creek enters the field at Wyoming through quite a deep gap. South of the rivers the ground rolls back in a succession of high hills or ridges and rather shallow valleys to the outcrop of No. XII well up on the mountain side, and at Pittston some four miles southeast of the river. Spring brook is the largest tributary of the Lackawanna from this side of the field; Little Mill creek, Tompkins creek, Gardners creek and Mill creek with their branches also drain the back country.

† Parts of these sections are reproduced on page plate 320.

‡ Some of the columnar sections are given on page plate 322.

The Lackawanna and Susquehanna have a combined fall in this division of about 120′, from the Lackawanna at about 640′ A. T. near Taylorsville to the Susquehanna at about 520′ A. T. near Port Blanchard.

Formation No. XII is somewhat thinner here than in the Scranton division although its general characteristics are practically the same. The flat dipping rocks of its southern outcrop continue to occupy a wide belt of barren territory on the mountain's slope, the basal beds of the formation climbing up close to the summit; and on sheet X the increased thickness of the red shale gives the basin a double mountain rim.

South of Pleasant Valley and one-half mile east of the Boston colliery we find a prominent red shale cove, formed by the erosion of No. XII where elevated by the Slope No. 4, Fernwood and Mill Creek Slope anticlinals. This and the Ontario anticlinal at Spring Brook are the only instances in the field, where the shape of the outcrop of No. XII has been particularly affected by anticlinal axes crossing its outcrop; the axes usually expire within the field. The conglomerate beds at the base of XII are exposed almost continuously along the southern outcrop.

Along the northern edge of the basin the dips are steeper, No. XII occupies a narrow belt, its precise outcrop is more difficult to fix as it is in many places covered by glacial drift, and No. XI which is mostly a greenish flag or shale is still too thin and hard to make a prominent and unmistakable terrace on the mountain slope.

A number of bore holes have cut the full thickness of No. XII in this division; one on lot No. 41 south of Pleasant Valley gives a thickness of 167′ 8″, see col. sec. 6, sheet VIII, for details; another at the Halstead colliery above Pittston gives a thickness of 235′, see col. sec. 18, sheet VII; and a third south of the Sibley colliery, north of Lackawanna, gives a thickness of 163′ 3″, see col. sec. 23, sheet VII.

The Campbell's Ledge black shale at the base of XII received its name from being opened on its outcrop near Campbell Ledge. On the south side of the basin the outcrop of this shale has been dug into along Spring Brook, along Lidey's creek, southeast of the Boston colliery, and along Gardner's creek.

General Structure: The basin which has been rising southwest from Scranton, reaches its shallowest point soon after crossing the line between sheets XIII and XI, in the vicinity of St. Johns creek, a half mile or so north of Lackawanna station, where only the lowest or Red Ash bed retains cover with a minimum elevation of about 550′ A. T. From here the basin sinks once more toward the southwest, bringing in successively the overlying coal beds, and at the division line near Port Blanchard the Red Ash bed has a depth of about 100′ below tide. The rise of the ground south of Port Blanchard has preserved a small area of the Hillman bed, the highest coal of the division.

The structure of the basin as we proceed southwest grows less simple and the undulations of the strata are more numerous and powerful, the anticlinals and synclinals, especially along the southwestern side of the field, effect materially the plan of mining operations. The principal anticlinals of this division are all south of the Lackawanna river, some three or four with gentle dips cross the Susquehanna to soon die out on the opposite side. The dips vary from 0° to 40°. A description of each axis seems unnecessary as their position, influence, importance and the observed dips can be best understood from an examination of the mine sheets and cross sections.

The *Coal Measures** of the Pittston division have a maximum thickness of about 600 feet (found under the hill just south of Port Blanchard) containing some six workable coal beds. Practically all the central part of the basin between the northeastern limits of Pittston and Wyoming and Port Blanchard, contains all these coal beds except the uppermost or Hillman bed. As already noted the measures underlying the northeastern halves of sheet XI and XII are much thinner and embrace but one or two of the bottom coal beds.

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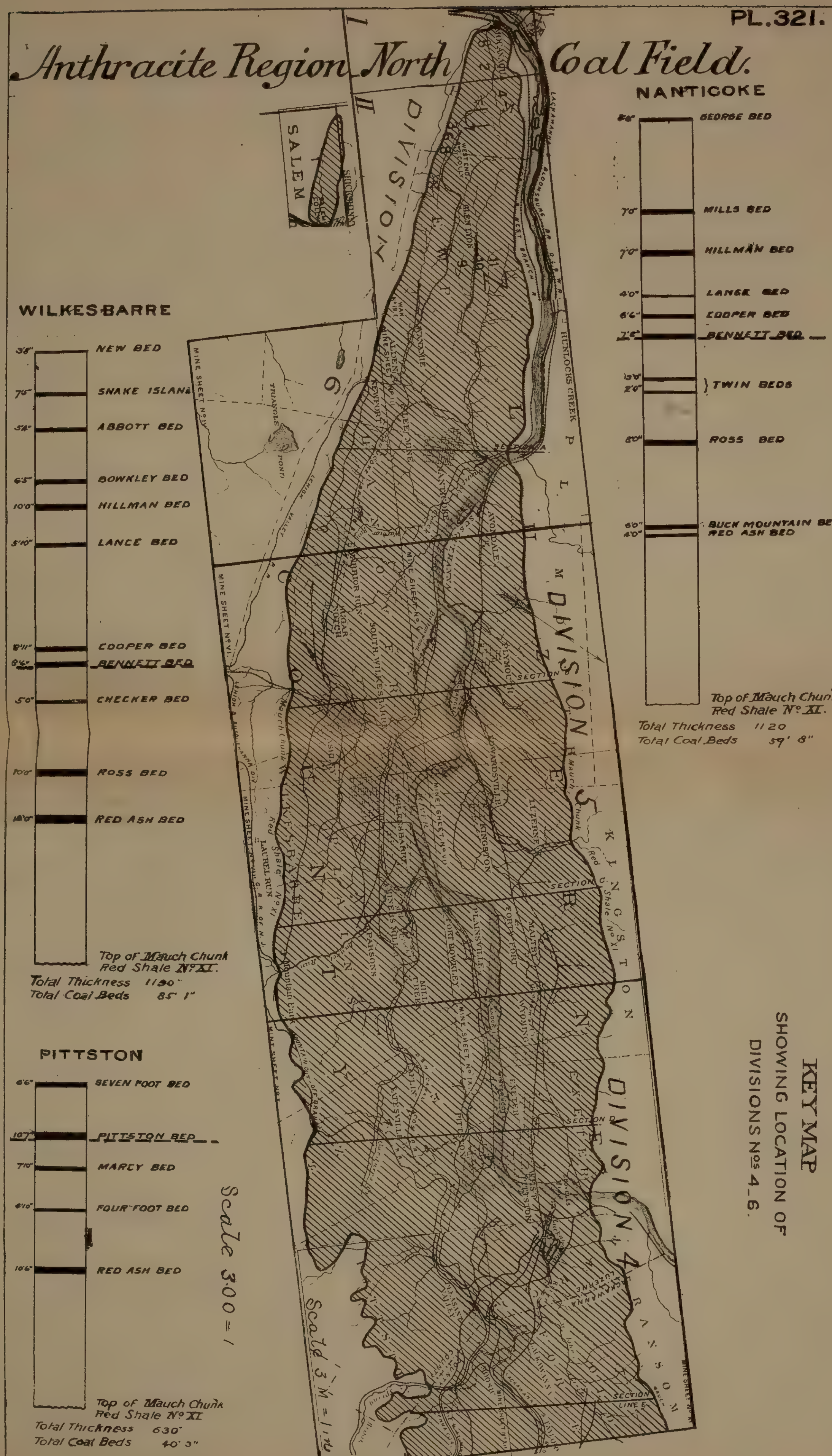
* See columnar sections on plate 322.


PL.321.
Anthracite Region North Coal Field.
NANTICOKE
GEORGE BED
MILLS BED
HILLMAN BED
LANCE BED
COOPER BED
BENNETT BED
TWIN BEDS
ROSS BED
BUCK MOUNTAIN BED
RED ASH BED
Top of Mauch Chunk Red Shale No XI.
Total Thickness 1120
Total Coal Beds 59' 8"
WILKES-BARRE
NEW BED
SNAKE ISLAND
ABBOTT BED
BOWKLEY BED
HILLMAN BED
LANCE BED
COOPER BED
BENNETT BED
CHECKER BED
ROSS BED
RED ASH BED
Top of Mauch Chunk Red Shale No XI.
Total Thickness 1130'
Total Coal Beds 85' 1"
PITTSTON
SEVEN FOOT BED
PITTSTON BED
MARCY BED
FOUR FOOT BED
RED ASH BED
Top of Mauch Chunk Red Shale No XI
Total Thickness 630'
Total Coal Beds 40' 3"
KEY MAP
SHOWING LOCATION OF
DIVISIONS Nos 4_6.
Scale 3.00 = 1
Scale 3 M = 1 in
DIVISION 4
DIVISION 5
DIVISION 6
SALEM
HUNLOCKS CREEK
KINGSTON
PLYMOUTH
LUZERNE
KINGSTON
PLAINSVILLE
PARSONS
LAUREL RUN
MINE SHEET No VI.
MINE SHEET No IV

Red Ash or Powder Mill bed: * The Dunmore beds of the Scranton division are, on these sheets, known as the Red Ash or Powder Mill bed. On the northeastern halves of sheets XI and XII the bed is usually a tripple one, but as we proceed southwest seldom more than two splits are recognized and in some areas but one. The intervals separating the splits are quite variable and often change considerably within a short distance; when a tripple bed the top and bottom splits may be 60′ to 70′ apart or the three splits may be separated one from the other by only a few feet or inches of slate or sandstone; when a double bed the splits are not often more than 10′ to 20′ apart.†

On sheet No. XI, particularly in the neighborhood of Lackawanna the Red Ash is an excellant bed ; since the publication of the mine sheet three additional large collieries—Jermyn No. 1, William A. and Babylon—have been established, working this bed and a considerable territory has not been mined over. As a rule the bed is in three splits, the mine workings are mostly in the middle split some 7′ to 8′ thick, exceptionally clean and good ; when practicable the coal of the top and bottom splits are worked in connection with the middle split. The following section at the Babylon colliery represents fairly well the condition of the bed in the vicinity of Lackawanna:—Top split—*Coal, 2′ 0″ ; Slate, 1″. ; Coal, 6″ ; Slate, 3″ ; Coal, 8″ ; Slate, 1″ ; Coal, 7″.—Total 4′ 2″ ; Coal, 3′ 9″ ;* Middle Split.—*Coal, 5′ 4″ ; Slate, 2″ ; Coal, 1′ 4″—Total 6′ 10″ Coal, 6′ 8″ ;*—Bottom Split:—*Coal, 1′ 0″ ; Slate, 3″ ; Coal, 4″ ; Slate, 6″ ; Coal, 1′ 4″ ; Slate 3″ ; Coal, 2′ 6″—Total 6′ 2″ Coal 5′ 2″*.

Jermyn No. 1 and Old Forge collieries work all three splits in some places. On the east side of the Lackawanna a new colliery, Greenwood No. 2, formerly Oak Hill, works

* Page plate 318 illustrates the identity between the Dunmore beds of Scranton and the Red Ash bed.

† See sections on columnar section sheets VI, VII and VIII.

NOTE.—At the Sibley colliery mine sheet XI the mine workings printed in brown—the Red Ash conventional color—are now known to be in the Fourth or Clark bed.

the bed the varying thickness of the splits and intervals here are shown by columnar sections 20 to 26 sheet VIII.

At the Halstead shaft, south of the William A. and Babylon collieries, three splits are seen, but along the southwest line of the Halstead tract only two splits are found, each about 7′ thick with 5′ to 6′ of sandstone between Farther southwest at the Phoenix and Twin shafts the bed is a single one about 7′ thick, a section at the Twin colliery gives:—*Coal 1′ 7″*, *Bone 5″*, *Coal 3′ 5″*, *Bone 2″*, *Coal 1′ 3″*—*Total 6′ 10″*, *Coal 6′ 3″*. At the Barnum* shaft about halfway between the Phoenix and Twin the bed appears to be in two splits, with 55′ of "rock" between, the top split 2′ 9″ and the bottom split 4′ 4″ thick.

On mine sheet XII the mine workings are chiefly in the Red Ash bed; the split worked at Spring Brook, Stark, Central, Consolidated, Ontario and Elmwood collieries will average about 8′ in thickness with 6′ to 7′ of coal. In some few places two splits of the bed are worked. The variability of the Red Ash bed is well shown by columnar sections 1 to 13 on sheet VIII. With rare exception at least one member of this bed is of workable thickness and quality, but the identity of the workable member from place to place is often a matter of much uncertainty unless there are connected mine workings between.

On mine sheet No. X only a very small area of the Red Ash has been worked, but owing to the near exhaustion of the superior Pittston bed the attention of the operators is being turned toward it. The Fairmount shaft cuts the bed in two splits, top 4′ 3″ and the bottom 6′ thick, with 3′ 6″ between; the new Chapman shaft of the Butler Coal Mining Company, on Lot 25, works the bed in two splits 25′ apart, the upper split about 5′ thick and the lower split 4′; their Fernwood shaft, also new, some 2000′ north of the Boston breaker (now abandoned), works the Red Ash bed which was 14′ on the saddle of the Fernwood anticlinal, but split on the north side with the upper split soft and dirty, in the shaft; and the lower split yielding 3′ to 5′ of coal. In

* See columnar section, plate 322.

the old workings at the Boston colliery the splits are together making a bed 10′ to 12′ thick with 8′ to 9′ of coal; the slate partings are rather numerous.

The little patch of Red Ash coal preserved on the mountain side between Lamp Black and Gardner's creeks has been tested by diamond drill and by trial shafts ; two bore holes show but one bed with about 3′ of coal, this same bed is exposed by a shafting along the outcrop with the following section : *Slate and bone 9″*, *Coal 7″*, *Slate 5″*, *Coal 7″*, *Slate 2″*, *Coal 2′ 4″*,—*Total 4′ 10″*, *Coal 3′ 6″*. Near the middle of this small coal area a 5′ bed has recently been opened; it is probably an upper split of the Red Ash bed, but its extent is exceedingly limited.

At the Keystone colliery a shaft now cuts the Red Ash bed in two splits, the upper 2′ 8″ thick and 35′ above the bottom split, some 6′ 6″ thick with 5′ of coal. This bed with 4′ to 5′ of coal is also worked by a rock slope at the Annora colliery close to Laflin station.

On mine sheet IX at the time of its publication (1887) there were practically no workings on the Red Ash bed, but it is now being mined at several of the colleries, it is usually identified as a single bed or in two splits very close together, some of the columnar sections show small coal beds above and below the main bed. The Stevens colliery (new) on the James Slocum tract north of West Pittston mines the bed with the following section: *Bone 4″*, *Coal 1 1″*, *Bone 4″*, *Coal 1′ 2″*, *Bone 3″*, *Coal 1′ 3″*, *Slate 2″*, *Coal′ 5″*, *Slate 5″*, *Coal 7″*. *Total 6′ 0″*, *Coal 4′ 6″*; at the Schooley colliery* the bed is about 8′ thick with 7′ of coal; in the Tompkins shaft bore hole 7′ 11″; at No. 1 Jr. shaft 7′ 0″; and in the bore hole near No. 14 shaft 8′ 7″ thick.

The approximate outcrop of the Red Ash bed is given upon the mine sheets.

Fourth or Clark bed of the Scranton division is on mine sheets XI and XII, found at a fairly uniform distance of about 80′ above the top member of the Red Ash bed ; going southwest this interval widens and on sheets XI and XII, where the Red Ash is a single bed, it is

* Columnar section of air shaft on plate 322.

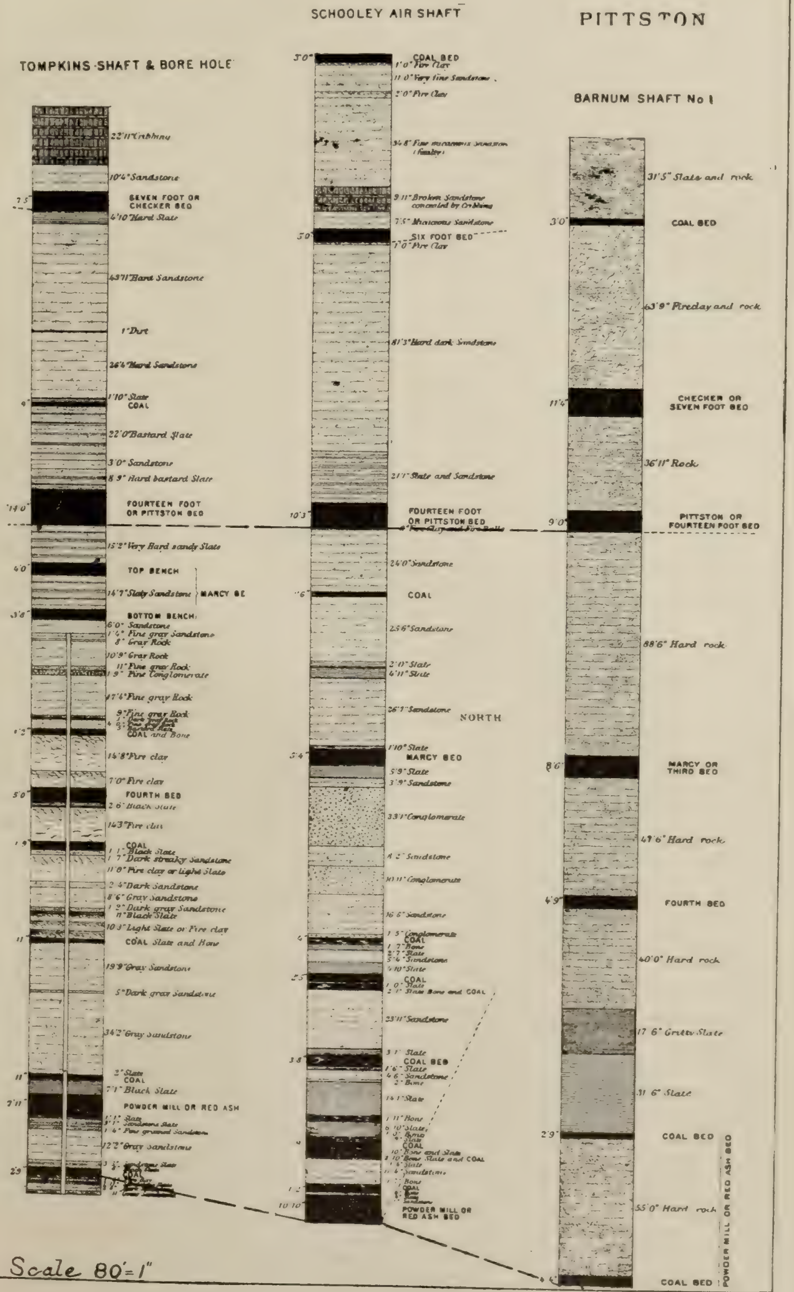
about 140′. The bed, although a persistent one, and usually of workable thickness, is apt to be rough and bony and high in refuse. Its thickness varies from 2′ to 7′ or 8′ with an average of perhaps 5′; and it is mined to a limited extent at the Phœnix, Hillsdale, Consolidated and Katy Did collieries.

Marcy, Third or New County bed of the Scranton division is mined extensively at the Sibley, Dunn and Oak Hill collieries north of Lackawanna. The bed lies there close to the surface and the southwest rise of the measure soon lifts it to outcrop; it has a quite regular thickness of 7′ to 8′; a section of the bed at the Dunn slope shows its general character in this vicinity: *Coal 1′ 3″*, *Bone 1″*, *Coal 7″*, *Bone 6″*, *Coal 11″*, *Bone 2″*, *Coal 1′ 10″*, *Slate 7″*, *Coal 10″*, *Coal 1′ 3″*, *Total 8′ 0″*, *Coal 6′ 8″*. The fall of the measures southwest of Lackawanna soon brings the bed in again and in the vicinity of Pittston it is an important bed 5′ to 8′ thick, fairly clean and regular, yielding coal of excellent quality. It is mined at nearly all the collieries in this neighborhood. Southwest of Pittston the bed deteriorates somewhat both in quality and thickness, at No. 6 shaft of the Pennsylvania Coal Co. the bed is about 5′ thick; at No. 11 shaft 1′ 6″ to 4′ 0″ thick, at the Annora colliery the bed is 7′ to 8′ thick with 2′ to 3′ of refuse, at the Keystone colliery the bulk of the product has come from the Marcy bed, there about 6′ 6″ thick with 1′ to 3′ of refuse. The bed is thin on the north side of the Susquehanna; it is now worked at the Schooley colliery with a thickness of 3′ 6″; where cut by borings at a few other points on this side of the river the bed has a thickness of 4′ 0″ to 5′ 0″. The interval between the Marcy and the underlying Fourth bed is seen to vary from 20′ to 80′, but 50′ is about the usual distance.

Pittston or Fourteen Foot bed,—the Big bed of Scranton or Baltimore bed of Wilkes-Barre ; the area underlain by the bed is nearly all in the southwestern half of the division on mine sheet IX and X although a small portion extends over on sheet XI and XII. The fall of the measures towards the southwest first brings the bed under-

PL. 322.

Anthracite Region—Northern Coal Field.



Scale 80'=1"

cover in the hill south of the Halstead colliery. The outcrop of the bed is shown upon the mine sheets, except along the north in the neighborhood of West Pittston and Wyoming where the depth of the wash, 150′ at times, makes its position uncertain. South and east of the Susquehanna much the greater part of its area has been mined over. The Pennsylvania Coal Co.* own nearly all of this territory and the high reputation in the market of their "Pittston Coal" is due to the excellent quality of the coal of this bed and the care which was taken to exclude any bony or inferior coal from the product. North of the river the bed is also extensively worked about West Pittston, at the Clear Spring, Exeter and Schooley collieries, but in the neighborhood of Wyoming a considerable area is still untouched.

The bed is quite regular and shows a fairly uniform thickness throughout this division, the coal is usually in benches of good thickness and easily separated from the intervening refuse; the thickness of the bed is seldom less than 7′. 0″ or more than 14.′ 0″, and its average thicknes is about 10′. 6″ with 8′ to 9′ of coal. The two sections following show the general structure of the bed :—*1.* At shaft No. 10 Jr.; *Coal, 1′. 0″ ; Coal, 5′. 1″ ; Bone, 6″ Slate, 6″; Coal, 7″; Bone, 6″; Coal, 2′. 9″; Total, 10′ 11″; Coal, 9′ 5″. 2.* At Exeter colliery; *Coal, 8″; Coal, 4′. 0″; Slate 4″; Coal, 2′. 0″; Slate, 8.″; Coal, 2.′ 0″; Total, 9.″ 8″; Coal, 8′, 8″.*

The distance of the Pittston above the Marcy bed is usually about 75′, although in some instances this interval is as little as 30′—see columnar sections.

Checker or Seven Foot bed is the next workable coal above the Pittston bed; north and east of Pittston it is about 40′ above, but this increases toward the southwest and at the Tompkins shaft † below Pittston it is 121′, at the Schooley shaft across the river it is 100′, the latter interval seems to be maintained to the division line. The principal working of this bed is at the Pennsylvania Coal Co.'s collieries north and east of Pittston, at their Tompkins shaft below the

* A cross section at their No. 4 shaft is given on plate 320.

† Columner section of shaft given on plate 322.

town, at the Seneca, Ravine, Twin and Phoenix collieries, and about West Pittston at the Clear Spring, Exeter and Schooley * collieries. In the workings the bed varies from 4′ to 8′ thick but it is rather apt to carry a high proportion of refuse or inferior coal. Below the Schooley colliery about Wyoming a slight rise in the measures combined with the depth of the wash, often 100′ or more has cut out the bed or brought it with dangerous nearness to the wash. On the opposite side of the river below Tonkins colliery the shaft and bore hole records give a thickness of 4′ to 6′ for this bed.

A Coal bed some 3′ to 4′ thick is usually encountered between the Checker and the overlying Hillman bed.

Hillman bed 175′ or so above the Checker bed is the highest of this division; it underlies a small area south of the river in the neighborhood of Port Blanchard and is opened by a drift at No. 14 Shaft colliery where it has a thickness of about 8′; it is probably the top bed cut in No. 6 shaft, there some 6′.0″ thick. Owing to its limited extent it is comparatively of but little importance.

A deposit of *wash* 50′ to 130′ deep, and 30′ to 110′ below the present level of the river, underlies nearly all the low ground between the river and the foot of the north or Kingston mountain (mine sheet IX). This deposit of wash, with an increase in depth, extends all the way from West Pittston to the Nanticoke gap and fills what is known as the *Wyoming Burried Valley*, described by Hill in Annual Rept., 1885, also discussed near the close of this chapter.

5. *Wilkes-Barre Division.*

This division comprises all that part of the Northern field mapped on mine sheets V—VIII.† Its topography is given on the Rothwell map Scale 3200′=1″ contained in Annual Rept., 1885, Atlas. The general structure is exhibited by two sections across the basin, C at Port Bowkley

* At the Exeter and Schooley collieries this bed was formerly called the Six Foot Bed.

† Page plate 321 also gives the general location of this division.

and Forty Fort and B at Ashley and Plymouth, published on cross section sheets II*a* II*b* & II*c*; and by 26 short cross sections published on sheets III to V.† Columnar sections giving the detailed thicknesses and character of the strata at various points within the division are published on columnar section sheets I to V.‡ A Preliminary Report covering this division, by Mr. Chas. A. Ashburner, will be found in Annual Report, 1885, Chapter VI.

The Wilkes-Barre division is easily the most important of all the areas into which we have divided the Northern field; it is the largest, the basin reaches its maximum depth, it has the greatest thickness of coal measures, the largest number of coal beds, and the thickest coal beds; hence its original coal contents was in excess of any of the other divisions and the large proportion which still remains to be mined is still more in excess. A number of the largest colliery operations in the anthracite region are located in this division and each year shows an increase in its producing capacity. Mine sheets V, VI, VII and VIII define the limits of the division, which extend from the sheet line near Plainsville and Wyoming to the sheet line near Warrior run and Avondale some nine miles, and its width is that of the field, about 6½ miles at the northeast contracting to 4 miles at the southwest. Wilkes-Barre on the south bank of the Susquehanna and near the centre of the division, is the county seat of Luzerne and the chief city of the Wyoming basin. Plainsville, Parsons, Ashley, Sugar Notch, Forty Fort, Luzerne, Dorranceton, Kingston, Edwardsville and Plymouth are all towns of more or importance within this division.

The broad fertile plain of the Susquehanna river, one to two miles wide, occupies a place a little to the north of the central part of the basin, and has a general elevation of 520′ to 550′ above tide. The river crosses this plain twice in its southwest course across the division, at Wilkes-Barre it skirts the southeastern edge of the river flat, at

† Parts of these sections are reproduced on page plates 323, 324 & 328.

‡ Some of the columnar sections are reproduced on page plates 325 and 326.

Plymouth the northwestern edge and opposite Avondale it is again seen at the southeastern edge. At time of high water the river overflows much of the river flats. Toby's creek breaks through the northwestern rim and makes the only low gap on that side of the field. Laurel run and Solomon's creek have cut rather deep notches in the southeastern rim of XII, these streams and their tributaries together with the lower part of Mill creek and Buttonwood creek drain the area southeast of the river.

Northwest of the river the mountain rises back from the river plain without preliminary foot hills excepting those between Kingston and Plymouth. Southeast of the river there are a series of low hills or ridges filling the central part of the field and rising slowly back to the No. XII outcrop; (see Rothwell's topographical map).

The outcrops of *Formation No. XII*, owing to steeper dips, occupy a narrow strip of territory but 1000′ to 2000′ wide on either side of the basin. On the southeastern side there is a beautiful example of a double mountain rim to the field, the inner one of No. XII and the outer of No. XI; but on the opposite side of the field it is only occasionally that No. XII rocks make a separate mountain ridge. The materials composing XII are perhaps a little coarser than before. Its thickness in this division will average about 200′, although a bore hole at the Red Ash colliery (columnar section sheet I sec. 6) gives a thickness of but 113′ between the Red Ash bed and a "green shale" supposed to be at the top of No. XI. A section of No. XII* taken at Solomon's gap by Arthur Winslow is as follows: (Annual Report 1886, Part IV, page 1337).

14′	Sandstone, hard, dark and compact.
19′	Conglomerate, fine and silicious.
2′	Slate, fissile.
24′	Conglomerate.
1′	Slate, in separate seams.
41′	Conglomerate, medium silicious.
119′	Conglomerate, coarse silicious.
220′	Total thickness No. XII.

* Page plate 312 gives a section at Wyoming.

The Structure.—The basin continues to deepen toward the southwest and the maximum depth for the field is to be found somewhere in the wide, undeveloped territory lying between Warrior Run and the river (Sheet VI); it may be a few hundred feet north of Askam where a diamond drill bore hole,* in the basin north of the "Hog Back" anticlinal, is reported to have cut the Red Ash bed at a depth of about 2200′ or about 1600′ below tide. As the Red Ash bed at the northeast line of the division is about 100′ below tide, the fall of the measures towards the southwest amounts to about 1500′, this fall is of course not uniform, owing to the rise and the fall of the measures on the sides of the anticlinal waves which traverse the basin obliquely.†

All the more important anticlinals are found south of the river, although some three or four axis do cross above Wilkes-Barre to expire southwest under the Kingston flats. All along the northern rim of the basin there is a gentle south dip, usually from 3° to 10°, which continues quite uniformly for a mile or a mile and a half before the expiring effects of the anticlinals, which traverse the central and southern side of the basin, are encountered. South of the river the anticlinals are both numerous and important, dips of 20° to 30° are those commonly encountered by the mine workings, while steeper pitches of 40° to 50° are not unusual, and here and there vertical and overturned measures are encountered. The position of the

* This record could not be obtained by the Survey.

† NOTE.—Some of the deepest mine workings in this division are as follows: The Red Ash bed at the Pettebone shaft has an elevation of 560′ below tide; the bottom of the Red Ash slope, Kingston colliery, near middle of the "Mary B. Reynolds" tract, has an elevation of 556′ below tide; at the Woodward colliery the slope on the Bennett bed driven southeast under the Kingston flats, has reached the bottom of a basin, near centre of lot No. 9, with an elevation of 359 below tide; a slope on the Red Ash bed, which is driving in the same direction, should reach this basin at about 660′ below tide. At the Lance colliery a slope southeast on the Bennett bed has crossed under the river and reached an elevation of 322′ below tide, 2000′ beyond. At the South Wilkes-Barre shaft the Baltimore bed has an elevation of 440′ below tide. At a number of other colliery the workings are nearly or quite as deep as some of those just mentioned.

anticlinal and synclinal axes are shown on the mine sheets by blue lines and also often by the shape of the mine workings; the numerous cross sections help to show their shape and relative importance, and they are also described by Ashburner in Annual Report, 1885, Chapter 8.*

The *Coal Measures*† in this division have a total thickness of about 1800′, the highest are found in the deep basins in the neighborhood of Askam (mine sheet VI), but few developments of the high measures have been made and the records of these are not in the possession of the Survey; the little information which the writer has would indicate that the coal beds in the upper half of the series are both thin and few in number. It is really only the lower half of the formation which is well developed and in it, in the vicinity of Wilkes-Barre, some eleven workable coal beds are found; the lower 500′ of measures contain the thickest and most valuable of the coal bed.

The mine sheets show two large groups of mine workings, one about a mile and one half wide along the northern rim of the basin, and the other about two miles wide along the southern rim, but swinging out into the centre

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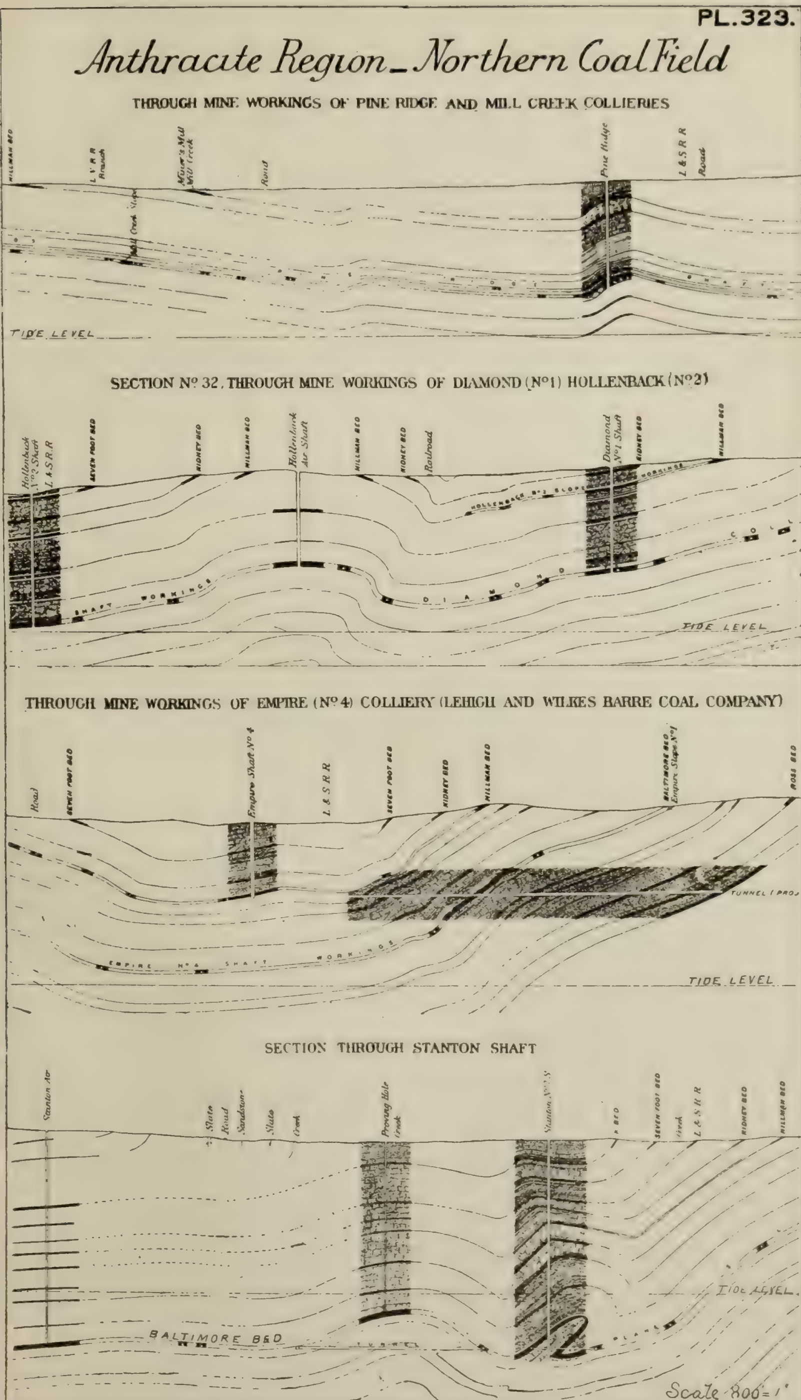
* Since the publication of the mine sheets the extension of the mine workings has added some important facts to our knowledge of the anticlinal axes, which does not appear on the sheets, notably:

The extension of the mine workings from the Wyoming and Midvale collieries developed the Wyoming Shaft anticlinal (overturned) southwest to the east line of the D., L. & W. Pettibone property; it apparently continues still further to the southwest and is probable identical with the overturn encountered by the Kingston Coal Co. in the neighborhood of Wyoming avenue.

The Baltimore bed workings from the Dorrance shaft develope a sharp axis, broadening to the southwest, under the Kingston flats, about on a line with the first pond holes beyond the river bridge. The natural gas which bubbles up at the pond holes and again in the river near the jail was formerly, and as it appears correctly, supposed by many to indicate the existence of such an axis. This axis is thought to be a continuation of either the Prospect shaft or the Cemetery anticlinal, but which of these it is has not yet been determined.

The Buttonwood anticlinal is now known to extend northeast, at least so far as South Wilkes-Barre, and is probably a few hundred feet north of the Vulcan Iron Works, its course is about in line with the Conyngham anticlinal and they may be identical.

† Some sections are given on plates 325 and 326.


PL.323.
Anthracite Region _ Northern Coal Field
THROUGH MINE WORKINGS OF PINE RIDGE AND MILL CREEK COLLIERIES
HILLMAN BED
L V R R Branch
Mill Creek Slope
Road
Pine Ridge
L & S R R
Road
TIDE LEVEL
SECTION Nº 32. THROUGH MINE WORKINGS OF DIAMOND (Nº1) HOLLENBACK (Nº2)
Hollenback Nº2 Shaft
L & S R R
SEVEN FOOT BED
KIDNEY BED
HILLMAN BED
Hollenback Air Shaft
HILLMAN BED
KIDNEY BED
Railroad
Diamond Nº1 Shaft
KIDNEY BED
HILLMAN BED
HOLLENBACK Nº2 SLOPE WORKINGS
SHAFT WORKINGS
DIAMOND
TIDE LEVEL
THROUGH MINE WORKINGS OF EMPIRE (Nº4) COLLIERY (LEHIGH AND WILKES BARRE COAL COMPANY)
Road
SEVEN FOOT BED
Empire Shaft Nº4
L & S R R
SEVEN FOOT BED
KIDNEY BED
HILLMAN BED
BALTIMORE BED
Empire Slope Nº1
ROSS BED
TUNNEL (PROJ.)
EMPIRE Nº4 SHAFT WORKINGS
TIDE LEVEL
SECTION THROUGH STANTON SHAFT
Slate
Road
Slate
Creek
Proving Hole
Creek
SEVEN FOOT BED
Creek
L & S R R
KIDNEY BED
HILLMAN BED
TIDE LEVEL
BALTIMORE BED
Scale 800' = 1"

of the basin above Wilkes-Barre, with an undeveloped territory, in the central part of the field, one to three miles wide between them. The extension of the mine workings since the publication of the sheets (1884) has filled in much of this gap southwest as far as Plymouth and South Wilkes-Barre; beyond this the condition of affairs remain as before.

The lowest coal bed and the first to describe is the Red Ash bed.

Red Ash bed in this division ranks second only to the celebrated Baltimore bed; it reaches its maximum thickness and quality in the neighborhood of Plymouth. The two or more splits in which this bed is seen in the divisions to the northwest, combine for the most part in this to form one large bed, or if in two members the separating interval is small.

On mine sheet VIII—Wilkes-Barre sheet—southeast of Mill Creek, near the division line, the bed still seems to be in several small splits rather widely separated—see Bennett colliery bore hole, Section 22, Sheet V—but the bed rapidly improves going southwest. The Red Ash is opened by the Coal Brook slope, L. V. C. Co., some 800′ north of the L. and S. R. R., at Mountain Park; the bed is here 10′ thick but is much divided by seams of slate and bone; at the Oakwood colliery this bed has recently been opened with a thickness of 16′ in fairly good condition; the Conyngham colliery now works Red Ash bed 11′ thick; at the Baltimore colliery it has a thickness of 14′; at the Red Ash colliery 22′ including 5′ to 7′ of slate in the middle; at the Hollenback colliery the bed is in two splits, the top split 6′ and the bottom split 12′ thick; at the Empire,* Stanton* and Franklin collieries there are also two splits some 5′ to 30′ apart, the top split is about 7′ and the bottom split about 10′ thick.

On mine sheet VI—Ashley sheet—the Red Ash bed is worked along its outcrop between Ashley and Sugar Notch with a general thickness of 11′ to 12′.

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*Cross sections through Empire and Stanton on plate 323. Columnar sections (below the Baltimore bed) at the Empire on plate 325.

On mine sheet VII—Kingston sheet—at the Woodward and Pettebone collieries the Red Ash bed is about 10′ thick; at the collieries along the mountain, the East Boston, Black Diamond, Mill Hollow* and Harry E. the bed is 8′ to 10′ thick; at Kingston Shaft No. 2 the bed is about 9′ thick, but from there to the southwest it thickens very rapidly.

On mine sheet V—Plymouth sheet—; at the No. 4 shaft D. & H. C. Co. above Plymouth the bed will average 16′; from here southwest to Nanticoke it easily maintains an average thickness of 20′, occasionally swelling up to 30′ or even 40′ in thickness and but rarely dropping below 15′. The bed is extensively worked and supplies some of the largest producing collieries in the region.

As a rule the bed is in fairly good condition containing a good percentage of marketable coal; this is especially true in the neighborhood of Plymouth where the coal is mostly in thick benches easily separated from the slate and bone. In the northeastern part of this division the bed is sometimes divided by numerous slate and bone partings and the coal is in smaller benches.

The following sections give some idea of the general composition of the bed:

1. At the Nottingham † colliery below Plymouth: *Coal 2′ 10″, Coal 2′ 8″, Bony 8″, Coal 1′ 2″, Coal 2′ 6″, Coal 4′ 0″, Big slate 1′ 2″, Coal 3′ 0″, Slate and bone 2′ 0″, Coal 1′ 10″; Total 21′ 10″; Coal 18′ 0″.*

2. At the Mill Hollow colliery: *Coal good 1′ 9″, Bone and slate 9″, Coal hard 1′ 2″, Bone and slate 4″, Coal rough 1′ 0″. Coal good 3′ 9″, Total 8′ 9″, Coal 7′ 8″.*

3. At the Baltimore colliery near Wilkes-Barre: *Bone 4″, Coal 3′ 2″, Slate 1″, Coal 6′ 0″, Slate 6″, Coal 10″, Bone 1′ 8″, Coal 10″, Total 13′ 5″, Coal 10′ 10″.*

4. At No. 9 colliery Sugar Notch. *Coal 2′ 10″, Bone 2′ 6″, Coal 5′ 9″, Slate and bone 2′ 6″; Total 13′ 7″, Coal 8′ 7″.*

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*Cross section through Black Diamond and Mill Hollow on plate 324.

† Cross section at Nottingham on plate 324.

The probable extent of the Red Ash bed is shown by its outcrop as given on the mine sheets *.

Six Foot bed, a bed some 30′ to 50′ above the Red Ash bed is seen along the south side of the basin between Wilkes-Barre and Sugar Notch, where it is called locally the Six Foot bed; its thickness varies from 4′ to 9′; it had not been worked at the time of publication of the mine sheets. In other parts of the division it is either missing or probably not of a workable thickness. It is, perhaps, a split of the Red Ash bed.

Ross bed is the chief bed between the Red Ash and Baltimore beds, although some 4 or 5 small coals are usually seen in this interval. It is supposed to be identical with the Marcy bed of the Pittston division. In this division it is for the most part a quite variable bed both as to its thickness and composition; its greatest draw back is its liability to be divided by numerous partings of slate or bony coal.

In the territory about Mill creek and Laurel run on mine sheet VIII the provings indicate that the Ross does not reach a workable thickness and quality; at the Red Ash and Empire collieries the bed is 8′ to 9′ thick; at the Franklin colliery (sheet VI) the bed has an abnormal thickness of 30′ to 40′ in the upper tunnels, but in the new rock slope further north its thickness is but 6′ to 7′; at Ashley No. 6† the bed has a total thickness of 20′ and is extensively mined; at the Sugar Notch‡ and Maffett collieries the Ross is the principal bed and averages 8′ to 9′ thick. Along this side of the basin the interval between it and the Red Ash bed is ordinarily 150′ to 200′.

North of the river, on sheet VII, the Ross where cut in the Pettibone shaft is about 4′ 0″ thick; at the Forty Fort and Harry E. collieries the bed is worked, above water

*At the Mill Hollow upper drifts, now worked by the Raub Coal Co., the bed is found to outcrop about 1000′ further back on the mountain side, than shown on the sheet. Its dip corresponds very closely to that of the surface.

† Cross section through this colliery on plate 328.

‡ Cross section through these collieries on plate 328.

level, in two splits each 4′ to 5′ thick with 5′ to 10′ of rock between ; at the Mill Hollow drifts the two splits unite to form one bed 8′ to 10′ thick ; at the East Boston colliery the bed is about 15′ thick ; at the Kingston collieries about 9′ 0″, and at the Woodward about 7′ 0″. Its usual distance above the Red Ash on this sheet is 50′, increasing toward the southwest.

In the neighborhood of Plymouth, on mine sheet V, the bed is for the most part quite regular in its thickness, and in good condition. In the collieries about the town its thickness varies from 7′ to 9′, below the town the bed becomes thinner with a thickness of 5′ to 6′ at the Avondale colliery and 4′ at the Chauncey. The interval between the Ross and the Red Ash on sheet V varies from 100′ to 150′

At the Parrish colliery, Plymouth, an average section of the Ross gives : *Coal 1′ 6″*, *Bone 6″*, *Coal 9″*, *Sulphur 3″ Coal 8″*, *Bone 8″ Coal 2′ 8″; Total 7′ 0″*, *Coal 5′ 7″*.

Eleven foot bed of the Harry E., Forty Fort. Maltby* and Hunt collieries, mine sheet VII, was, at the time of publication of the sheet (1884), identified as the Bennett bed or Bottom split of the Baltimore bed. The near approach of the mine workings from the Forty Fort colliery in the Six Foot bed, to the workings in the Bottom split of the Baltimore from the Henry colliery, proves, these beds to be identical ; and that the Eleven Foot next below the Six Foot is a coal, between the Baltimore and the Ross bed, which reaches an unusual thickness in this locality. Its thickness at the above collieries varies from 8′ to 12,′ it carries a high proportion of refuse, distributed in numerous partings throughout the bed.

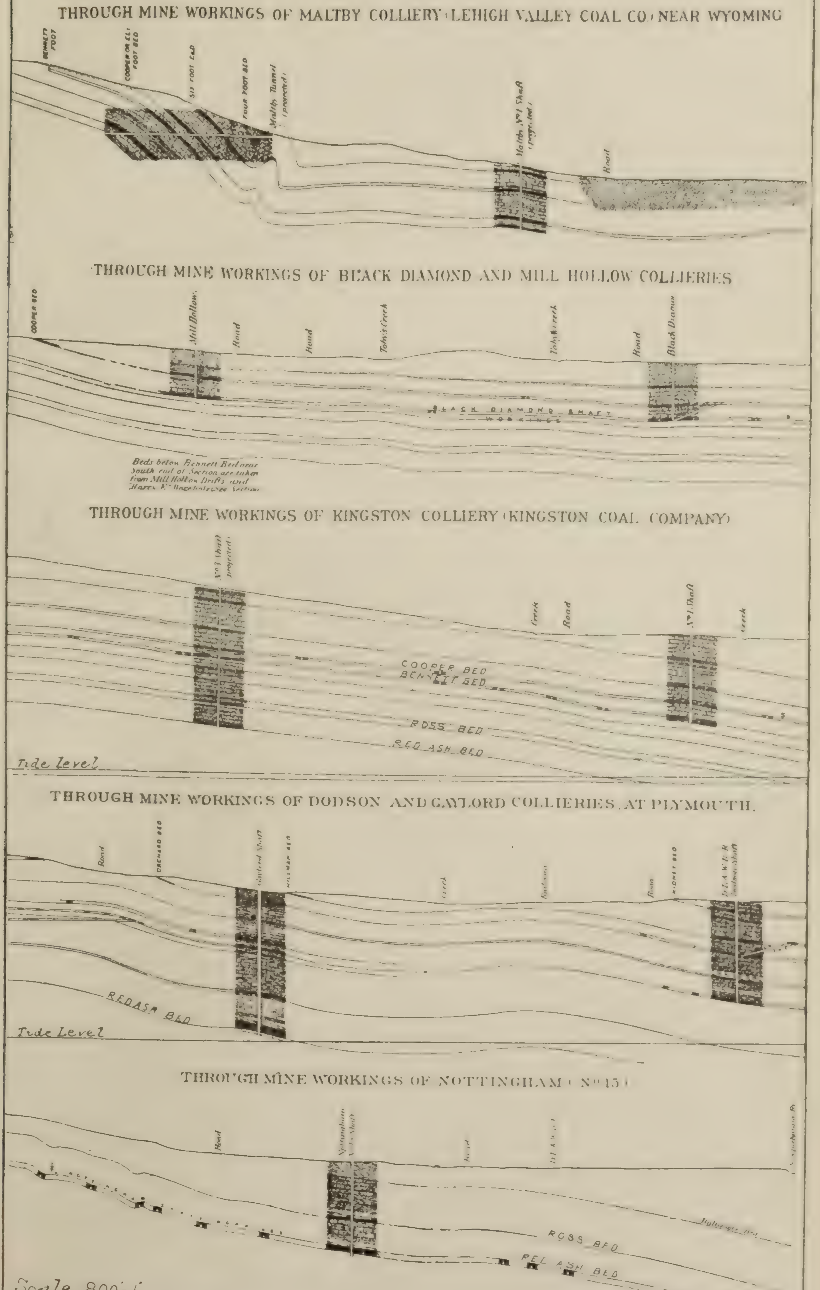
A section at the Maltby colliery is as follows :—*Coal 6″ Slate 2″*, *Coal 2′ 3″*, *Slate 9″*, *Coal 5″*, *Bony 2′ 2″ Coal 1′ 0″*, *Bone 8″*, *Coal 2′ 5″*, *Total 10′ 4″*, *Coal 6′ 7″*.

South of the river the "Four Foot" bed of the Enterprise and Wyoming collieries (see sections 1 and 4 col. sec. sheet I) would seem to be identical with the Eleven Foot bed. The so-called "Ross" bed of Mineral Spring colliery, only

* Cross section through on plate 324.

PL. 324.

Anthracite Region – Northern Coal Field.



some 40′ to 50′ below the Bennett, is perhaps also identical with the Eleven Foot bed of the northwest side of the river.

Baltimore bed, or Bennett and Cooper beds is identical with the Pittston or Fourteen foot bed of the preceeding division and is the principal bed of this division and of the field. The bed for the most part is a double one, the two splits being usually so far apart as to be worked separately ; north of the river the top split is called the Cooper bed and the bottom split the Bennett bed ; these names are also in use south of the river but not to the same extent. The importance of this bed is determined by its large thickness ; the excellence of its coal ; its favorable composition, usually in good sized benches of clean coal, easily separated from the refuse which forms a moderate percentage of the total ; and its considerable extent. Its outcrop given upon the mine sheets shows the area underlaid by it.

The Baltimore was one of the first beds to be opened and it is now mined at a majority of the collieries of the division. The first extensive working of the bed was at the old Baltimore colliery, just east of Wilkes-Bare, on mine sheet VIII, here the various benches are closely united forming one big bed, in places 30′ thick, but with an average thickness throughout the colliery of about 20′ with 16′ to 17′ of clean coal.

A section of the bed at the Back slope, Baltimore colliery, gives : *Bone 2″, Coal 8′ 4″, Sulphur 2″, Coal 1′ 4″, Slate 8″, Coal 3′ 3″, Checkered Coal and Sulphur 1′ 0″, Slate 6″, Coal 4′ 6″, Total 19′ 11″, Coal 17′ 5″.*

The bed commences to divide along the northeast line of the Baltimore workings, but to the south and west it continues as one large bed so far as Ashley and near to the city line just southwest of the South Wilkes-Barre shaft* (sheet VI), where the new workings from the shaft find the bed divided into two members.

The thickness of the bed seems to diminish slightly to the southwest; at the Conyngham colliery its average thickness

* Columnar section on plate 325.

is about 17′; at the Hollenback* colliery 18′; and at the Empire, Stanton, Franklin, South Wilkes-Barre, Ashley and the new Maxwell collieries it will average about 15′. In the territory south and east of Wilkes-Barre its area is nearly all mined over and many of the workings are abandoned. Southwest of Ashley on sheet VI a comparatively small extent of the bed is as yet mined; it is there in two or possibly three splits † somewhat thinner and in not so good a condition.

To the north and northeast of Wilkes-Barre in the vicinity of Parsons, Mill Creek‡ and Plainsville the Baltimore bed is invariably in two splits, some 20′ to 40′ apart, the upper split or Cooper bed is here usually the larger with an average thickness of perhaps 9′, while the lower split or Bennett bed will average about 7′ thick.

On mine sheet VI the Baltimore bed is probably everywhere in two splits, known as the Cooper and Bennett beds. At the Hunt, Maltby, Forty Fort and Harry E colleries the so-called "Six Foot" bed is now proven to be the Bottom split or Bennett bed, and the "Four Foot" bed the Top split or Cooper bed; at these colleries the "Six Foot" is a good, clean bed, averaging about 6′ in thickness, and it is now the chief source of supply. A section of the "Six Foot" bed at the Maltby colliery is as follows:—*Coal 6″*, *Bone 3″*, *Coal 5′ 5″*,—*Total 6′ 2″*, *Coal 5′ 11″*. The "Four Foot" bed, some 4′ to 5′ thick, where cut in the shafts and tunnels, has been but little worked owing, no doubt, to its closeness to the bottom of the deep "buried valley," which crosses these properties. The interval between the "Six Foot" and "Four Foot" is about 50′.

In the colleries to the southwest the splits are thicker; at the Mill Hollow and Black Diamond colleries the Cooper bed is 6′ to 7′ thick and the Bennett bed about 9′ thick; at the East Boston § collery the Cooper bed is about

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* Cross section on plate 323.

† See columnar sections on sheet II.

‡ Cross section at Mill Creek colliery on plate 323.

§ Cross section on plate 324, Columar section on plate 326.

PL. 325.

Anthracite Region - Northern Coal Field.

WILKES BARRE

6′ and the Bennett bed 11′ to 12′ thick, with an interval of 60′ to 70′ between; this interval is much less at the Kingston colleries * where at times the beds are but a few feet apart, the Cooper is here about 8′ and Bennett 10′ to 11′ thick.

Just across the sheet line, on mine sheet V, at the Boston shaft, the Cooper and Bennett are together making a bed about 24′ thick, but they soon separate with the Cooper about 11′, and the Bennett about 14′ thick; at the Deleware and Hudson Canal Co's, collieries north of Plymouth Junction, the splits are near together, the Cooper having a thickness of about 8′ and the Bennett 13′; at the Lance colliery* the Cooper is 7′ and the Bennett 8′ thick; at the Dodson† colliery where they are united the bed is 14′ thick; at the Gaylord colliery† when divided the Cooper has a thickness of 7′ and the Bennett of 9.′ The most southwesterly working of the Baltimore upon this sheet is at the Parrish colliery‡ where the bed is about 15′ thick with the two splits close together. The outcrop of the bed which has been well back on the hill side swings to the south and crosses the L & B R. R. about 1500′ below the Plymouth station to be lost beneath the deep wash covering of the Plymouth flats.

The Survey has collected a large number of sections of the Baltimore bed which were used in arriving at the aver-

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* Columar section on plate 326.

Underground slopes, from the Woodward shaft, on the Bennett and Cooper beds now extend far under the Kingston flats; the mine workings on the Baltimore bed from the Dorrance shaft are now on the Kingston side of the river; the near approach of these workings at no very distant day will furnish an addittional verification of the idenity of the beds between the Kingston and Wilkes Barre sides of the river.

†Cross section on plate 324. Columnar section on plate 326.

‡ A new slope on the Baltimore at this colliery is now nearly a mile in length and extends under the river to near the middle of the flats on the Wilkes Barre side. The course of the slope is southeast with an average pitch of 6°. A slope from the Lance shaft on the Bennett bed also crosses under the river to a point near the Pennsylvania R. R.

It is expected that development in progressat the Lance colliery and at the South Wilkes Barre colliery will in the near future bring the mine workings of these collieries very near or quite together.

age thickness given, the amount of coal in the bed can very safely be estimated by deducting 18 % or 20 % from the total for refuse.

The interval between the Baltimore and the Red Ash—the two principal beds—varies from 250′ to 350′ but it is generally about 300′ thick.

Five Foot bed of sheet V, *Lance bed* of sheet VII or *First bed* above the Baltimore on sheets VI and VIII: Two coal beds usually of workable thickness are generally found between the Baltimore and the well-known Hillman bed; it is the lower of these which is called the Five Foot, &c.

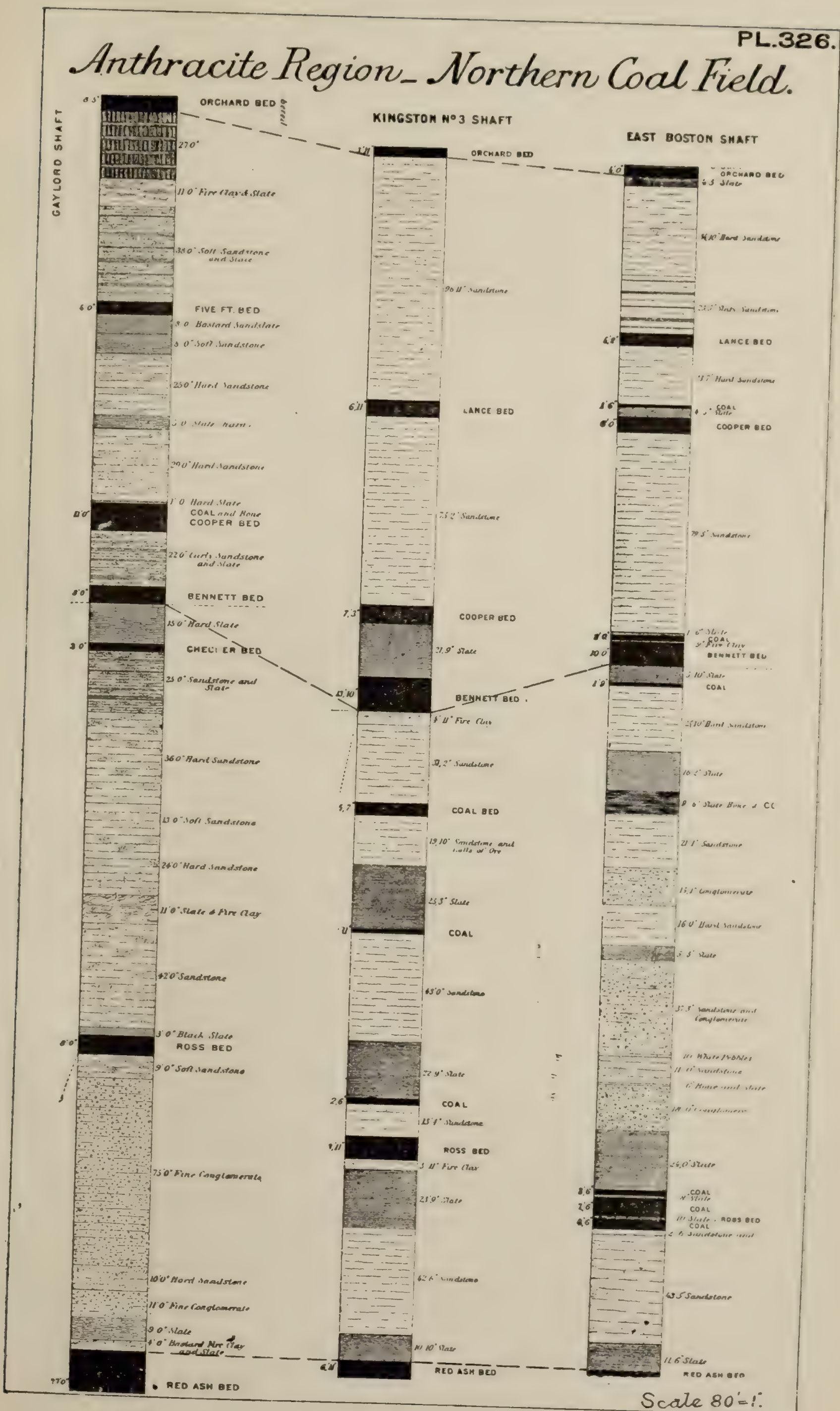
In the neighborhood of Plymouth the most extensive workings on the Five Foot bed, as it is there called, are at the Dodson, Plymouth No. 2 and Boston collieries, where the bed has a thickness of 5′ to 6′. Its make up is shown by the following section at Plymouth No. 2: *Coal 3′ 0″, Slate and bone 1′ 3″, Coal 1′ 3″,—Total 5′ 6″, Coal 4′ 3″.* Its distance above the Cooper bed varies from 15′ to 70′ but is usually about 60′.

This coal is called the "Lance" bed at the Kingston collieries where it is worked with an average thickness of about 6′. Where cut in the Woodward, East Boston, Black Diamond and Pettebone shafts the bed has about the same thickness—6′—and is at an average distance of 70′ above the Cooper bed. A section at Kingston gives: *Coal 2′ 6″, Parting 2″, Coal 1′ 2″, Slate 10″, Coal 1′ 4″, Bone 5″,—Total 6′ 5″, Coal 5′.*

Below Wilkes-Barre this bed is seen at the Stanton, Empire and South Wilkes-Barre shafts and at the Sugar Notch collieries; it is the "first bed above the Baltimore and is usually designated in that way, it has a thickness of about 5′ and occurs 60′ above the Baltimore; at the Franklin colliery where it is called the "Sump" bed it gave the following section: *Coal 3′ 4″, Bone 7″, Coal 1′ 2″, Bone 8″,—Total 5′ 9″, Coal 4′ 6″.*

At the collieries above Wilkes-Barre this coal is not recognized as workable.

Old Bennett or *Orchard* bed of the west side of the river


PL.326.
Anthracite Region – Northern Coal Field.
GAYLORD SHAFT
KINGSTON No 3 SHAFT
EAST BOSTON SHAFT
ORCHARD BED
27.0'
11.0' Fire Clay & Slate
38.0' Soft Sandstone and Slate
FIVE FT. BED
Bastard Sandslate
Soft Sandstone
25.0' Hard Sandstone
Slate
20.0' Hard Sandstone
Hard Slate
COAL and Bone
COOPER BED
22.0' Curly Sandstone and Slate
BENNETT BED
15.0' Hard Slate
CHECKER BED
25.0' Sandstone and Slate
36.0' Hard Sandstone
13.0' Soft Sandstone
24.0' Hard Sandstone
11.0' Slate & Fire Clay
42.0' Sandstone
3.0' Black Slate
ROSS BED
9.0' Soft Sandstone
75.0' Fine Conglomerate
10.0' Hard Sandstone
11.0' Fine Conglomerate
9.0' Slate
4.0' Bastard Fire Clay and Slate
RED ASH BED
ORCHARD BED
96.11' Sandstone
LANCE BED
75.2' Sandstone
COOPER BED
21.9' Slate
BENNETT BED
Fire Clay
Sandstone
COAL BED
19.10' Sandstone and balls of Ore
25.3' Slate
COAL
45.0' Sandstone
22.9' Slate
COAL
13.4' Sandstone
ROSS BED
3.11' Fire Clay
21.9' Slate
62.6' Sandstone
10.10' Slate
RED ASH BED
ORCHARD BED
Slate
Hard Sandstone
Slate Sandstone
LANCE BED
Hard Sandstone
COAL
Slate
COOPER BED
Sandstone
Slate
COAL
Fire Clay
BENNETT BED
Slate
COAL
Hard Sandstone
Slate
Slate Bone & Coal
Sandstone
Conglomerate
16.0' Hard Sandstone
Slate
Sandstone and Conglomerate
White Pebbles
Sandstone
Bone and Slate
Conglomerate
24.0' Slate
COAL
Slate
COAL
Slate
ROSS BED
COAL
Sandstone
43.5' Sandstone
11.6' Slate
RED ASH BED
Scale 80'=1".

and The *Stanton* or *Five Foot bed* of the east side, is the second of the two workable beds between the Baltimore and Hillman beds, although some of the shafts on the east side have cut still a third bed of workable thickness in this interval; see columnar sections.

On sheet V this bed is worked at the Dodson, Lance and Plymouth No. 2 collieries where it is called the "Old Bennett" bed; it has a thickness of 10′ to 15′ but contains a great deal of refuse, especially in the upper part of the bed. At the Gaylord colliery the coal is known as the Orchard bed and is about 8′ thick. On sheet VII at the Kingston and East Boston collieries the bed is also known as the Orchard; it is but 4′ to 5′ thick and is as yet unworked. The distance between it and the Five Foot, Lance, &c., varies from 70′ to 115′.

On the Wilkes Barre side at the collieries of the Lehigh and Wilkes Barre Coal Co., south and south-west of the city this coal is called the "Stanton" bed; it has a thickness of 5′ to 6′ and is mined to a small extent. At the Lehigh Valley Coal Co.'s collieries above Wilkes Barre and at their Franklin colliery below, the bed is known as the "Five Foot." A section at the Franklin Colliery gives: *Coal 1′ 6″*, *Slate 3″*, *Coal 1′ 5″ Slate 1″*, *Coal 1′ 1″*, *Slate 2″; Total 4′ 4″*, *Coal 3′ 10″*. The interval between it and the Lance bed is about 130′. Above the city the bed is worked at Enterprise, Henry and Wyoming collieries; a section of it at the Henry is as follows: *Bony Coal 1′ 2″*, *Coal 4′ 2″*, *Totat 5′ 4″*, *Coal 4′ 2″*. Its distance above the Baltimore bed in this vicinity is 170′ to 200′.

Although the bed appears to be presistent throughout this division it seems probable that for a considerable portion of its extent it is too thin or too dirty to be workable. The territory just east of Wilkes Barre seems to come under this head as 3′ 11″ of rough coal at the Hollenback shaft is the thickest coal shown in the interval between the Baltimore and Hillman beds.

Hillman bed is the principal coal above the Baltimore bed, and occurs 200′ to 300′—ordinarily about 270′—above the Top split; its good thickness, which it maintains throughout, and its position in the measures, make it a prominent bed and it seems to have been easily and correctly identified throughout the division. Although rather high in the measures it underlies a very considerable area the greater part of which is on the southeast side of the river. On the west side at Plymouth the Hillman is worked at the Dodson, Lance and the D. & H.'s Plymouth collieries; it is there a good clean bed 8′ to 10′ thick. A section at the Lance is as follows:—*Coal 1′ 6″*, *Bone* 3″, *Coal 2′ 7″*, *Bone 2″*, *Coal 4′. 0″—Total 8′ 6″*, *Coal 8′. 1″*. To the southwest the outcrop is lost in the deep wash covering the Plymouth flats. The bed is cut in the Butzbach Landing bore hole, across the river, 13′ thick at 250′ below the surface. To the northeast the outcrop is back of Ross hill between Plymouth and Kingston, passes to the south of the Kingston shafts, is concealed by the deep wash of the Kingston flats and reappears on the east side of the river above Plainsville.* At the Woodward shaft, below Kingston, the bed is 9′ thick; and at the Pettebone, on the flats above, it is cut at a depth of 400′ with a thickness of 13′.

On the east side of the river the Hillman is extensively worked at the Enterprise, Henry, Wyoming, Prospect, Dorrance, Hillman, Conyngham, Hollenback and Hillman Vein collieries; in thickness it varies from 8′ to 16′, where the latter the upper is apt to carry a high per cent. of bony coal and slate; this is sometimes left up to form the roof. South of the city the bed is largely mined at the Empire where it averages about 9′ in thickness; it is also worked at the Stanton, South Wilkes-Barre, Franklin and Sugar Notch collieries with an average thickness of 7′ to 8′. A section at Empire No. 5 slope gives:—*Coal 5′ 3″*, *Bone 3′*, *Coal 1′ 6″* *Bone 4″*, *Coal 2′ 0″ Total 9′ 4″*, *Coal 8′ 9″*. In the central part of the basin between Sugar Notch and the river the bed lies deep and its thickness is as yet undetermined.

Kidney, *Bowkley or* Plymouth *Lance bed* is found at a fairly regular interval of about 60′ above the Hillman bed. It has a general thickness of 5′ to 6′, seems to be persistent and regular, and has an excellent reputation as

* See cross section 27, 29 and 30, sheet IV.

it carries rather less than the usual proportion of refuse and the coal is of good quality. As the mine workings thus far have been largely confined to the lower and thicker coals a comparative small area of this bed is developed.

At the colleries of the Lehigh Valley Coal Co., it is known as the "Bowkley" bed and is worked at Prospect and Dorrance with a thickness of 6′ to 7′; at their Franklin colliery below Wilkes-Barre this bed is also mined showing:—*Coal 4′ 3″, Bone 6″, Coal 1′ 0″, Total 5′ 9″, Coal 5′ 3″.*

The Lehigh and Wilkes-Barre Coal Co. call it the "Kidney" bed; at the Empire and Stanton collieries it is 4′ to 6′ thick; at the South Wilkes-Barre shaft it is but 3′ thick; it is the principal bed of Sugar Notch No. 10 colliery where about an average section gives:—*Coal 5′ 5″, Slate 1″, Coal 1′ 3″, Total 6′ 9″ Coal 6′ 8″.*

The bottom bed of the Buttonwood shaft, at 512′ from the top, is thought to be the Kidney bed ; it is reported to show 6′ of clean coal. About Plymouth the bed was formerly called the "Lance" but the name Kidney is gradually taking its place; the bed is mined at the Dodson, Lance and Plymouth No. 2 collieries; the coal is clean and good, some 5′ to 6′ thick. This is the highest bed mined on the west side of the river.

Abbott, Seven Foot or Hutchinson bed.—The Abbott bed of the Prospect and Dorrance colleries of North Wilkes-Barre is some 70′ above the Bowkley bed and has a thickness of 5′ to 6′, yielding about 5′ of clean coal. A section at the Dorrance gives :—*Coal 4′ 4″, Slate 2″, Coal 9″—Total 5′ 3″ Coal 5′ 1″.* The bed is also mined at the Franklin collery of the L. V. C. Co., where it has about the same thickness.

At the colleries of the Lehigh and Wilkes-Barre Coal Co. this bed is known as the "Seven Foot;" it is cut in the Conyngham, Hollenback, Stanton and South Wilkes-Barre shafts—(see columnar sections)—with a usual thickness of 5′ to 6′, although at South Wilkes-Barre shaft it is but 3′ 11″ thick. The distance between it and the underlying Bowkley or Kidney bed increases towards the southwest as it is 100′ at the Stanton and 150′ at the South Wilkes-Barre shaft. At Stanton a small leader is cut between these beds.

The Hutchinson bed of the Lance shaft at Plymouth, 5 8″ thick, and 110′ above the Kidney or "Lance" bed would seem to be identical with the Abbott or Seven Foot bed.

Snake Island or Rock bed is opened at the Island slope some 2,000′ south of the Hillman breaker; it is 60′ above the Abbott bed and seems to be identical with the Rock bed of the Dorrance shaft. The bed is 5′ to 7′ thick but at the Dorrance contains 40% of refuse. The South Wilkes Barre is the only other shaft cutting these high measures and it is there difficult to identify this coal in the thin unworkable beds above the Seven Foot.

New bed is some 80′ above the Snake Island and 145′ above the Abbott bed; it is opened above Wilkes Barre by a little drift along the railroad just north of the junction of Mill creek and Laurel run; it is apparently the 1′ 10″ coal bed cut in the Dorrance shaft 80′ above the Snake Island or Rock bed; it is there of course unworkable and there is no indication of a workable bed at this horizon in the South Wilkes Barre shaft.

Auble bed cut 4′ 5″ thick in the South Wilkes Barre shaft at 335′ above the Seven Foot or about 190′ above the horizon of the New bed. The bed lies close to the surface only 65′ below the top of the shaft and is not worked

Higher coal beds—The Auble bed some 1300′ geologically above the Red Ash bed is the highest bed of the Northern field identified and named. The deep undeveloped basins south-west of Wilkes Barre between Sugar Notch and the river contain measures much higher than this. A diamond drill bore hole at Askam is reported to have cut the Red Ash bed at a depth of 2,200′ and the total thickness of the measures in this neighborhood is supposed to be 1800′ or possibly 2000′, leaving an interval of between 500′ and 700′ above the Auble bed of which we know very little. The development of this territory will be looked forward to with considerable interest from both a commercial and a geological standpoint; should these higher measures contain one or more coal beds of good workable thickness and quality, the area underlaid would probably be quite sufficient to be an important addition to what is now very valuable property; it is also possible that the beds of these high measures may show some points of resemblance which will suggest an identity between them and the high beds of the Southern field

A heavy deposit of *wash* with a maximum depth of more than 200′, underlies apparently all of the *flats* on both sides of the river and fills the old *Wyoming buried valley*, described by Hill in Annual Rept 1885, with additional notes given near the close of this chapter.

6. *Nanticoke—Shickshinny Division*

Comprises all that part of the Northern field mapped on mine sheets I to IV,* The topography for the area covered by mine sheets III and IV is given on the Rothwell Map (Scale 3200′=1″,) Annual Report, 1885, Atlas; that for sheets I and II is published on the mine sheets. The general structure is shown by four sections across the basin—A at Nanticoke, published on cross section sheets II*A* and II*B*; No. 4 at Glen Lyon, No. 3 at West End, No. 2 (Lee), No. 2 at Macanaqua, and No. 1 at Salem basins, cross section Sheet I; also five short sections at Wanamie, Alden, Warrior Run and Nanticoke on sheet I†. Columnar sections giving the detailed thicknesses and character of the strata at various points within the division are published on columnar section sheets I and V.‡ A Preliminary Report covering mine sheets I and II by Frank A. Hill is published in Annual, 1886, Part III Ch II, and Chas. A. Ashburner's Report, Annual, 1885, Chapters VII and VIII covers mine sheets III and IV.

The Nanticoke–Shickshinny division comprises the

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* Page plate 321 also gives the general location of this division.

† Portions of these sections are reproduced on page plates 328 and 329.

‡ Several Columnar sections are reproduced on page plates 330.

southwest end of the Northern field, extending from Avondale and Warrior Run, where the basin is about four miles wide, some twelve and a half miles southwest to the spoon of the basin two and one-half miles beyond Shickshinny on the west side of the Susquehanna. Nanticoke is the largest town but the division also includes Warrior Run, Alden, Wanamie, Glen Lyon, Mocanaqua and Shickshinny.

The Susquehanna river crosses the north corner of the division, leaving the field at the Nanticoke gap to flow in the red shale valley just north for some nine miles to Shickshinny, where, bending abruptly south, the river cuts crosses the coal measures leaving a narrow basin about two and a half miles long to cap the mountain ridge on the west bank of the river, which separates it from the main body of the field. A low divide crosses the field near the middle of sheet II; the northeast drainage is through Newport and Nanticoke creeks which empty into the Susquehanna above the Nanticoke gap, and the southwest drainage through Black creek which reaches the river at Mocanaqua. As the field narrows the surface rises and the central part of the basin is filled by narrow valleys and ridges all of which are lower than the bounding conglomerate rims *.

Formation No. XII forms the crest of the ridge along both sides of the basin, with No. XI outcropping a little below the crest. Along the southeastern rim, owing to the generally steep north dips of 60° to 70°, the conglomerate occupies but a narrow strip of territory, sometimes not more than 200′ wide with a general elevation of 1000′ to 1200′ above tide. The south dips of the basin are more gentle so that the northwestern outcrop of XII is usually 600′ to 800′ wide and at 1100′ to 1300′ above tide. The mountain has a precipitious slope toward the river and the shales of No. XI are well exposed. On mine sheet I and the western half of sheet II erosion has removed all the coal beds from the shallower parts of the field, uncovering No.

* Page plate 327 is from a photograph of a Relief Map of the southwestern end of the field by Mr. E. B. Harden and shows very clearly the topography of the district.

PL.327.


MODEL OF THE SOUTH-WESTERN END OF THE NORTHERN COAL FIELD IN LUZERNE COUNTY PENNSYLVANIA
BY EDWARD B. HARDEN
TOPOGRAPHER, PENNA GEOLOGICAL SURVEY
SCALE OF FEET
MARCH 1887.
GLEN LYON
WEST END COAL CO.
SALEM COAL CO.
LEHIGH & WILKESBARRE COAL CO.
SUSQUEHANNA

XII along the anticlinal axes within the central part of the basin. At Shickshinny the rivei has cut 50′ to 100′ below the basin of the conglomerate and the formation outcrops in cliffs on both sides of the river.

The upper part of the formation is more sandy with smaller pebbles than the lower part which is a hard coarse pebbly rock exposed in numerous cliffs and ledges, under which the shales of XI can often be seen, making in this division the accurate location of the bottom of XII a comparatively easy affair. The Conglomerate grows thinner toward the southwest; on sheets III and IV it has a thickness of 200′ to 250′, while on sheets I and II its usual thickness is about 150′*.

Coal in XII. The sections of XII scattered throughout the field sometimes show one or two beds, but a few inches thick, of coal or coal and slate, occurring in the formation. One of these coals called "Bed A" is prevalent over a portion of this division. The greatest thickness with which it has been cut is at the Mountain tunnel of the Salem Coal Co. where its section is: *Coal 1′ 0″, Slate and bone 1′ 10″; Total 2′ 10″; Coal 1′ 0″.*

The Campbell's Ledge black shale at the base of No. XII is reported by I. C. White (G7) as exposed at the Nanticoke gap. Susquehanna Coal Co.'s diamond drill bore hole No. 7 (new) at Glen Lyon cuts "slate" and "8″ of shelly coal" at this horizon.

The Structure.—As noted, the deepest point in the Wyoming basin is probably close to Askam and near the line between mine sheet IV and VI, where the Red Ash bed is reported to have a depth of at least 1600′ below tide; from here toward the southwest the basin has a general and at times quite rapid rise, falling for a brief interval at the eastern end of the Black Creek basin (sheet I), but rising again to the final spoon of the basin beyond Shickshinny where the Red Ash bed rounds the trough at about 1250′ above tide.

The anticlinals are both numerous and important. The

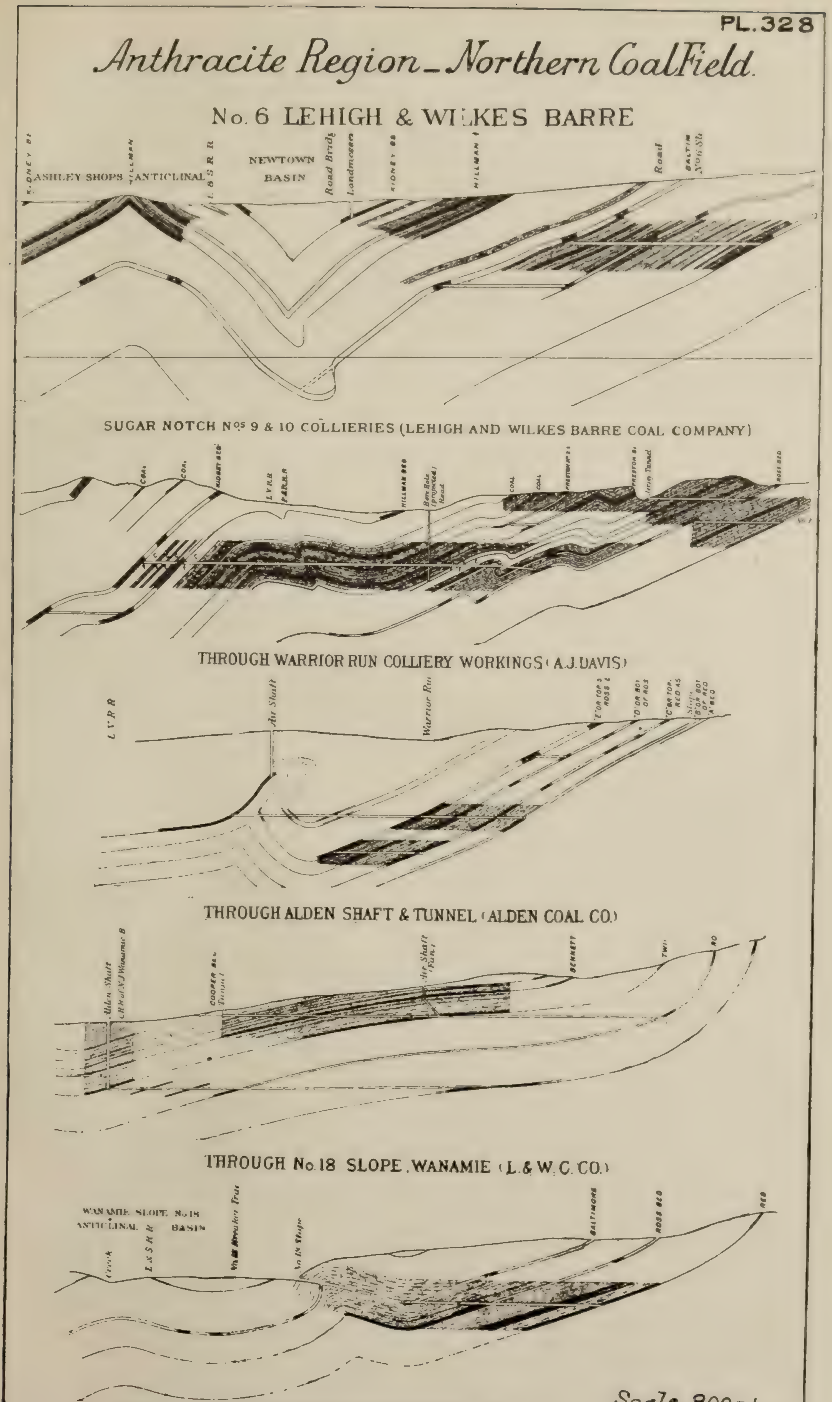
* See columnar sections Nos. 1, 4, 5 and 7, sheet V; also Shickshinny section on plate 312.

crescent shape of the field brings in this division the general course of the axes (N 65° E) about parallel with that of the southern rim of the field. Dips of 20° to 40° are quite common and along some of the larger axes, of which the Hanover Hogback is one, the north dips are often nearly or quite perpendicular. The probable position of the principal anticlinals is shown upon the mine sheets; the cross sections show their shape on the plane of intersection and they are described by Messrs. Ashburner and Hill in Annual Reports for 1885 and 1886.

The *Coal Measures* * it seems probable have a maximum thickness of about 1800′ in the basin first north of the Hanover Hogback and close to the line between sheets IV and VI. Of the upper half of the series we have but little information; the highest measures cut in this division are at the old Dundee shaft, south-east corner of sheet III, near the river road; this shaft is reported to be 812′ deep, with a bore hole from the bottom of the shaft, cutting the Red Ash bed 868′ below or 1680′ from the surface, and 1130′ below tide. The coal beds in the shaft, with the exception of the one at the bottom, are said to be thin, or so dirty, as perhaps to be unworkable. A bore hole on the Nanticoke hill (No. 2, new, Susquehanna Coal Co.), cut 1260′ of measures above the Red Ash bed; its highest workable bed, the George, is 900′ above the Red Ash. All of the beds now worked are found in the lower half of the formation, and apparently those of the upper half are less numerous and thin or dirty. The principal mine workings are in the vicinity of Nanticoke, Alden and Wanamie, Glen Lyon, and Mocanaqua; with a considerable area of undeveloped territory to the east and south of Nanticoke; and to the north of Wanamie, between Nanticoke and Glen Lyon. The coal beds known to be workable for part or all of their extent are nine in number.

Red Ash or Buck Mountain bed as it is called at some of the collieries in this division is an important bed of good thickness and quality. At the Susquehanna Coal Co.'s

* Partial columnar section on plate 330.


PL. 328
Anthracite Region – Northern Coal Field.
No. 6 LEHIGH & WILKES BARRE
ASHLEY SHOPS
ANTICLINAL
NEWTOWN
BASIN
Road
SUGAR NOTCH Nos 9 & 10 COLLIERIES (LEHIGH AND WILKES BARRE COAL COMPANY)
THROUGH WARRIOR RUN COLLIERY WORKINGS (A.J. DAVIS)
L.V.R.R.
Air Shaft
Warrior Run
THROUGH ALDEN SHAFT & TUNNEL (ALDEN COAL CO.)
Alden Shaft
COOPER BED
Air Shaft
BENNETT
THROUGH No. 18 SLOPE, WANAMIE (L. & W. C. CO.)
WANAMIE SLOPE No 18
ANTICLINAL
BASIN
BALTIMORE
ROSS BED
RED
Scale 800 = 1

No. 3 colliery, West Nanticoke, the bed is 15′ to 20′ thick with an average of 14′ to 15′ of coal; at their Nanticoke collieries* the Buck Mountain bed as it is there called although an excellent bed and very extensively worked is not so thick, it sometimes reaches 10′ to 12′ but its average thickness is not more than 7′ or 8′. At the Warrior Run† colliery on the south side of the basin the Red Ash is worked in two splits about 50′ apart,† the top split about 7′ and the bottom split 8′ thick‡; west of Warrior Run the bed becomes thinner, at the Hanover tunnel the identity is somewhat uncertain, but where mined at Alden† and Wanamie No. 18 the bed has a thickness of about 7′, at No. 19 water level tunnel the bed, where cut, was both thin and poor. At the Glen Lyon West End No. 2 (now Lee) Dupont drift and West End No 1§ workings the bed will average about 9′ thick, although local variation occasionally swell its thickness to 14′ or 15′ or reduce it to only 5′ or 6′. A section of the bed at the Glen Lyon shaft§ is as follows:—*Coal 7″, Bone 6″, Coal 5″, Bone 3″, Coal 4′, 1′, Bone 2′ 0′, Coal 2′0″, Total 9′10″, Coal 7′1′.* In the Salem basins§ on the west side of the river (sheet 1) the name Buck Mountain is used; the basins are comparatively small and shallow and contain only a small area of the Ross bed in addition to the Buck Mountain which is thoroughly mined and robbed over nearly all of its extent; its thickness will average about 8′ with 6′ of coal.

The outcrop of the Red Ash bed is shown upon the mine sheets.

Ross bed.—At the Chauncey colliery, mine sheet III, above West Nanticoke the the Ross bed has been worked to a small extent and is now being reopened; the bed has a

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* See cross section, plate 329. Columar section, plate 330.

† Cross section on plate 328.

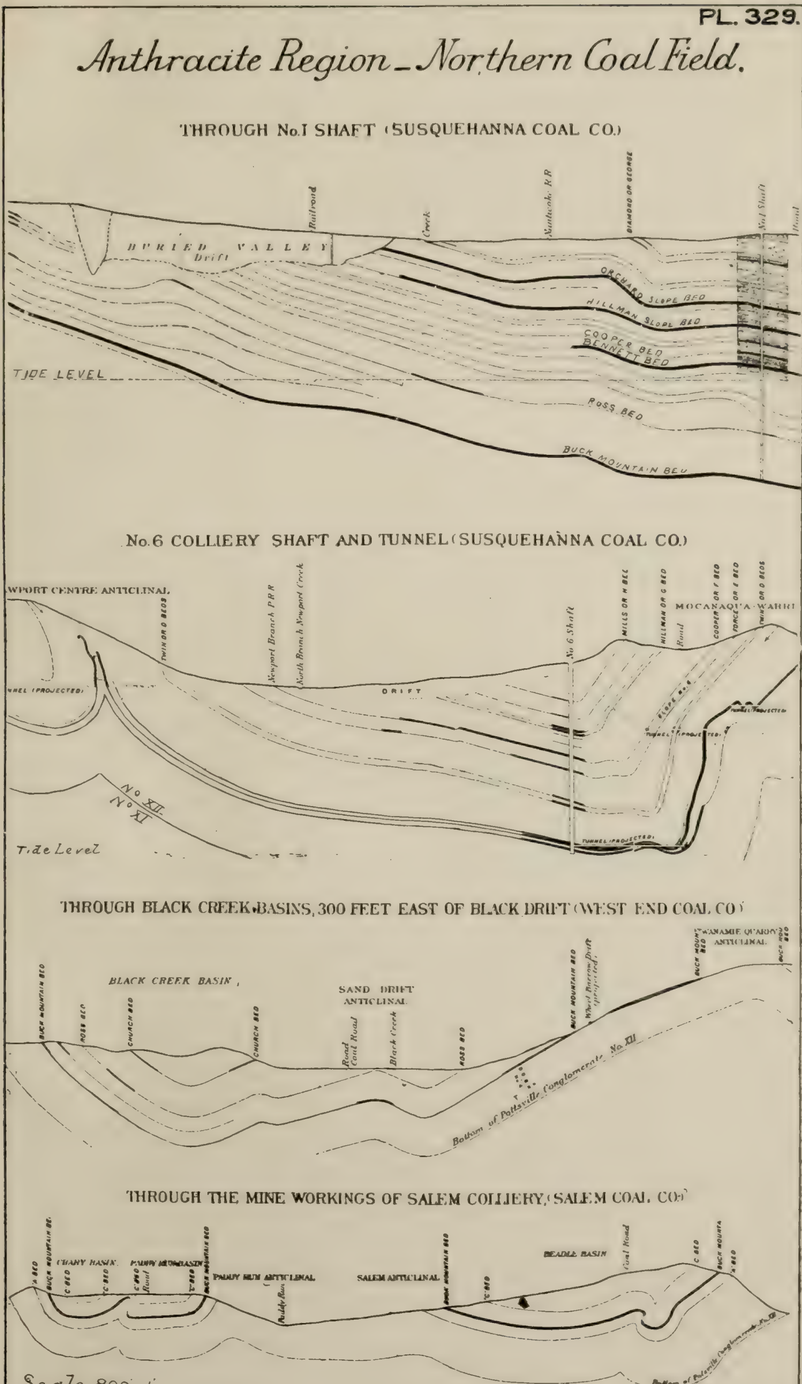
‡ Since the publication of mine sheet IV the views as to the identity of the beds at the Warrior Run colliery have changed somewhat; the Ross bed of the mine sheet is now called the top split of the Red Ash bed; the Bennett the bottom split of the Ross and the Cooper the top split of the Ross; these changes are shown on section 9 cross section sheet No. 1.

§ Cross section on plate 329

thickness of about 4′ with 3′ 6″ of coal; its distance above the Red Ash bed is here 200′ with a leader 1′ 6″ thick at 15′ below the bed. At the Susquehanna Coal Co.'s Nanticoke collieries the Ross is worked with an average thickness of about 4′ 6″; a section at No. 2 shaft is a follows: *Bone 6″, Coal 1′ 2″, Bone 10″, Coal 2′ 3″,—Total 4′ 9″, Coal 3′ 5″*. The bed is here about 170′ above the Red Ash and three small coals 2′ to 3′ thick each are cut between. At the Warrior Run colliery, sheet IV, beds "E and D" are now regarded as the Ross in two splits 50′ apart; the top split is about 15′ thick and the bottom split 9′; at the Alden and Wanamie No. 18 collieries the Ross bed is about 7′ thick at 140′ above the Red Ash. At Wanamie No. 19 slope, sheet II, the bed has thickened to 20′ or 25′ in places and has an average of at least 15′ in thickness. The Ross is now worked in this same basin, on the adjoining property, of the Susquehanna Coal Co., by means of a long tunnel south from Glen Lyon No. 6 shaft level; the tunnel cuts the bed in two splits so close as to be worked together at times, but the distance between them widens towards the southern outcrop; the thickness of both splits is rather variable but will average perhaps 8′ of coal each. The interval between the lower split and the Red Ash is only 40′ to 50′.

At the Glen Lyon shaft and water level tunnel the Ross bed has an average thickness of about 10′ and is only 15′ to 25′ above the Red Ash. An upper split of the Ross 3′ 10″ thick some 3′ to 4′ above the main bed is seen at both the shaft and tunnel (see columnar sections 8 and 11 sheet V); on these sections the bed now identified as the Ross is called the Buck Mountain bed. Further to the west on the West End Coal Co.'s property the Ross is opened at the "Upper drift" where it is 7′ thick and at the "Golden drift" 5′ 6″ thick with an interval of 100′ between it and the Red Ash bed.

Twin or Wanamie "*Baltimore*" *bed* is the next workable bed above the Ross; the name Twin is local to this division and the idenity of the bed is still a matter of


PL. 329.
Anthracite Region - Northern Coal Field.
THROUGH No. I SHAFT (SUSQUEHANNA COAL CO.)
BURIED VALLEY
Drift
Railroad
Creek
Nanticoke RR
DIAMOND OR GEORGE
No. I Shaft
ORCHARD SLOPE BED
HILLMAN SLOPE BED
COOPER BED
BENNETT BED
TIDE LEVEL
ROSS BED
BUCK MOUNTAIN BED
No. 6 COLLIERY SHAFT AND TUNNEL (SUSQUEHANNA COAL CO.)
NEWPORT CENTRE ANTICLINAL
TUNNEL (PROJECTED)
TWIN OR D BEDS
Newport Branch PRR
North Branch Newport Creek
DRIFT
No 6 Shaft
MILLS OR H BED
HILLMAN OR G BED
Road
COOPER OR F BED
FORCE OR E BED
TWIN OR D BEDS
MOCANAQUA-WARRI
No XII
No IX
Tide Level
THROUGH BLACK CREEK BASINS, 300 FEET EAST OF BLACK DRIFT (WEST END COAL CO.)
BLACK CREEK BASIN
SAND DRIFT ANTICLINAL
BUCK MOUNTAIN BED
ROSS BED
CHURCH BED
Road
Coal Road
Black Creek
Wheel Barrow Drift (projected)
WANAMIE QUARRY ANTICLINAL
Bottom of Pottsville Conglomerate No. XII
THROUGH THE MINE WORKINGS OF SALEM COLLIERY, (SALEM COAL CO.)
CRANY BASIN
PADDY RUN BASIN
PADDY RUN ANTICLINAL
SALEM ANTICLINAL
BEADLE BASIN
Coal Road
Paddy Run
BUCK MOUNTAIN BED
C BED
Bottom of Pottsville Conglomerate No. XII
Scale 800' = 1"

some uncertainty; in its position above the Red Ash bed it corresponds very well with Baltimore bed of the Wilkes Barre division, but its general thinness, variability and unreliability are in direct contrast with the Baltimore bed characteristics, and it is commonly supposed to belong below the Wilkes-Barre Baltimore although this is not yet certain. At No. 2 Shaft Nanticoke the Twin is seen 140′ above the Ross in two splits, 6′ apart the upper one 6′ 3″ thick and the lower 7′ 1″ thick; the "Upper Twin" is worked to a small extent and has an average thickness of about 4′ 9″; at No. 1 shaft and in the bore holes near the southern line of the Susquenanna Coal Co's. property some four or five thin coals are cut between the Ross and the Forge bed, one or two of these coals no doubt represent the Twin bed but all of them are too thin to be workable; the workable area of the Twin at the Nanticoke collieries is apparently quite limited.

The Twin bed of Alden seems to be identical with the Twin bed of Nanticoke; here it is a fairly good single bed 6′ to 7′ feet thick, at 130′ above the Ross, and has been mined rather extensively. The "Baltimore" bed of the Wanamie collieries at 90′ above the Ross is shown by the mine workings—the properties adjoin—to be identical with the Twin bed of Alden; it is a good bed averaging about 7′ thick and is worked to a considerable extent; it was supposed to be identical with the Baltimore bed of Wilkes-Barre and it is still possible that this identity is correct. At Glen Lyon No. 6 shaft the bed identified as the Twin, the first above the Ross and 130′ higher in the measures, is about 6′ thick with 3′ 6″ of coal; in the next basin south, that of slope No. 19 Wanamie, the Twin is 3′ 7″ thick and only 40′ above the Ross.* The Church drift bed of the Black Creek basin, mine sheet I, has a thickness of about 5′ 6″; it is 110 above the Ross bed and would appear to be identical with the Twin. The Salem basins west of the Susquehannna are too shallow to contain this coal.

* On cross section No. 4, sheet I, the upper split of the Ross in this basin is incorrectly called Twin bed.

Bennett, Forge or E, although not a thick bed is fairly regular and persistent throughout this division. As the name indicates it is supposed to be the Bennett or Bottom split of the Baltimore bed; it is found 50′ to 100′ above the Twin and 350′ to 400′ above the Red Ash bed. At the Nanticoke collieries the bed is extensively worked and has an average thickness of about 6′, a section at No. 12 slope is as follows: *Bone 3′, Coal 3′ 1″, Bone 9″, Coal 2′ 3″, Total 6′ 4″, Coal 5′ 4″;* at Alden colliery it is also extensively worked with a thickness of about 4′ 6″ with 4′ of coal; at Glen Lyon No. 6 colliery the Bennett 5′ thick is worked; at the Lee colliery (formerly West End No. 2,) new shaft, in the Priscilla Lee No. 1 basin, this bed is reported to contain 7′ of coal.

Cooper bed, found 30′ to 40′ above the Bennett or Forge bed, in the vicinity of Nanticoke is 8′ to 10′ thick but is not worked on account of the large amount of refuse which it contains; at Alden shaft, if the identity be correct, the Cooper bed is only 9″ thick; At Glen Lyon No. 6 colliery the bed is about 6′ thick, improved in quality and is worked; it is also mined at the new shaft Lee colliery, where it is reported to have 7′ of coal. Beds above the Cooper are worked only at the Nanticoke and Glen Lyon collieries.

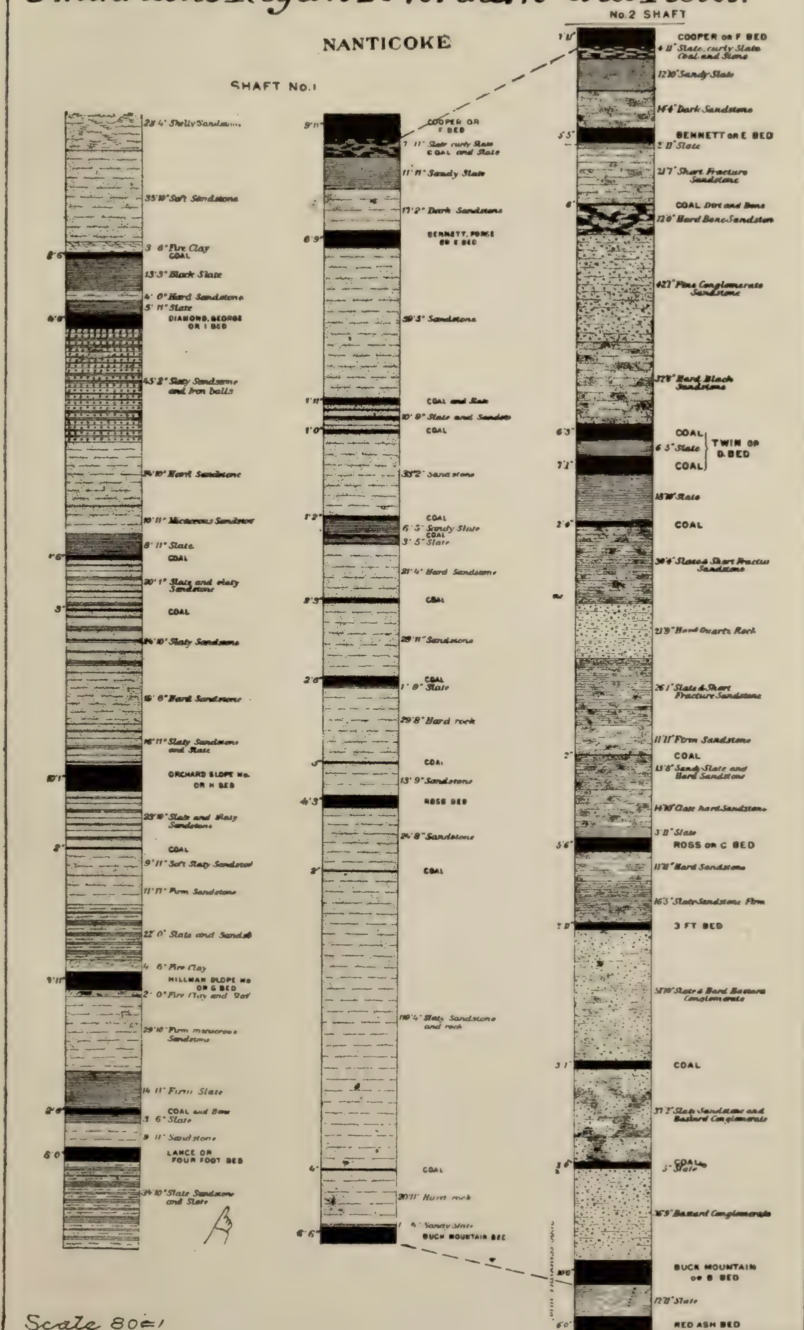
Lance or Four Foot bed, as the coal some 40′ above the Cooper at Nanticoke is called, is 4′ to 5′ feet thick, high in refuse and not mined; at the Alden and the Glen Lyon shafts this bed is less than 3′ thick and unworkable.

Hillman Slope or G bed, some 60′ above the Lance bed, is one of the chief beds of the Nanticoke collieries, where it will average 7′ to 8′ thick; it has about the same general thickness at the Glen Lyon colliery, where it is also a good bed, the southwestward rise of the measures causes it to finally outcrop about half a mile west of the Glen Lyon shaft.

Mills, Orchard, Slope No. 4 or H bed, some 70′ higher in the measures, is also an important bed at Nanticoke, worked even more widely than the Hillman; the bed is quite regular, coal of good quality and has an average thickness of about 7′ 6″; a section at No. 4 slope is as fol-

PL.330.

Anthracite Region – Northern Coal Field.



lows: *Rock 7″, Coal 1′ 5″, Bone 2″, Coal 4′ 2″, Bone 3″, Coal 1′ 5″,—Total 8′; Coal 7′.* The first bed cut in the Glen Lyon shaft, 6′ 6″ thick, is identified as the Mills bed.

George, Diamond or I bed is the highest bed mined in this division; it is worked at No. 1 shaft, Nanticoke, with an average thickness of about 7′, but it is a rather dirty bed. In the interval between it and the Mills bed, some 175′ to 200′, two small "leaders" are usually found. Owing to the rapid westward rise of the measures, it is probable that the George bed makes its final outcrop before mine sheet I is reached.

Coal above the George bed.—The George, some 900′ above the Red Ash, is the highest bed explored in this division. Of the 900′ or more, of mostly undeveloped measures, above the George, found in the deep basins east of Nanticoke, there is little or nothing to add to the notes given a few pages back.

A brief description of the *Wyoming buried valley*, a small area of which is seen above Nanticoke in this division, also of the *buried valley* of Newport creek, on mine sheet II and III, follows within the next page or two.

Division 7. The Loyalsock and Mehoopany Coal Field in Sullivan and Wyoming Counties.

On the North Mountain plateau some 25 miles to the north and west of the Northern coal field, several small areas of anthracite coal have been preserved from erosion in the high table land and along the troughs of the shallow basins. These coal areas lie about the headwaters of the Loyalsock and Mehoopany creeks in Sullivan and Wyoming counties and are known to the Survey as the Loyal sock and Mehoopany coal field.* The tonnage from the only colliery in this division, that at Bernice, is now included with the tonnage of the Wyoming region (Northern field).

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*The name Western Northern coal field is also sometimes applied to these areas.

Bernice basin.

The Bernice basin, in Sullivan county, about the headwaters of the Loyalsock creek, is the largest and most important of the coal areas of this division. It has a general elevation of about 2000′ A. T.

In 1884 Mr. Charles A. Ashburner made an examination of the Bernice basin and his report is published in Annual Report 1885, Ch. XI; the report is accompanied by a Topographical and Geological map of the basin (see Atlas to 1885 Annnal) from surveys by Mr. E. B. Harden in conjunction with those of the State Line and Sullivan R. R. Co., also by a page plate illustration (reproduced as plate 333) showing in a general way the location of all the areas comprising the Loyalsock and Mehoopany field. The description following is chiefly from Mr. Ashburner's report and the quotations wholly so.*

The North mountain may be considered the eastern extension of the Allegheny mountains; back and to the north of the mountain frontier the strata are comparatively horizontal, possessing the low dips which are universally found all through the State back of the Allegheny crest; the coal measures are found only existing on the higher summits. "The dip of the coal measures in some of the areas covered by the map coincide so nearly with the slope of the surface of the ground that it has been impossible with any degree of accuracy to geometrically construct the approximate outcrops of the coal beds or conglomerate, where but few exposures were found and almost no explorations had been made."

There are two coal beds found in the Bernice basin, called A and B. Bed A, the lower of the two, at no point opened, has a thickness of more than 1′ to 1′ 10″ of coal and of course

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*Report G2 published 1880 contains an earlier report on the Bernice basin by Mr. Franklin Platt. "Notes on the Bernice basin" by Clarence R. Claghorn are published in Transactions American Institute Mining Engineers Vol. XVII p. 606.

PL. 333.

Map of the
Loyalsock and Mehoopany Coal Field
Scale 4 miles = 1 inch
4 3 2 1 0 4
Coal Measures No. XIII
Pottsville Cong. No. XII
Dushore
Colley
Well
Lovelton
Forkston
W Y O M I N G
S U L L I V A N
Big
Loyalsock Creek
Birch Creek
Bernice
Bella Sylvia
Mehoopany Creek
Bowman's Creek
Harvey's Lake
Long Pond
Lewis Lake
Eaglesmere
Laporte
Thorndale
Davidson
E.B.H.

is commercially unworkable. Bed B is an important coal with an average thickness of about 9′ and occurs 60′ higher in the measures.

Formation No. XII.—There are but few exposures of the strata and it is difficult to obtain a complete section. Mr. C. R. Claghorn states that the interval between bed B and the top of the Mauch Chunk red shale No. XI does not exceed 180 feet; Mr. Franklin Platt G² makes this interval about 250′.

Messrs. Ashburner and Claghorn regard both beds A and B as occurring in No. XII, and identical with the Lykens Valley coals of the Southern and Western Middle fields: the chief reason advanced by them for this identity is a resemblance in the composition of these coals. It seems to the writer that bed B is much more likely to be identical with the Red Ash or Buck Mountain bed at the top of No. XII instead of a coal within the conglomerate formation. The nearest workable coal beds in No. XII are found at Shamokin 50 miles away, while in the Northern field but 25 miles distance, one thin coal with a maximum thickness of 2′ 10″ at Shickshinny is found. This coal corresponds very well in its position and size with bed A of the Bernice basin and there are a number of points of resemblance between bed B and the Red Ash bed. As to the change in the composition of the coal it is not exceptional; the coals of the Southern field from Tremont westward to Dauphin show a similar and quite as decided a change.*

If bed B as seems to me wholly probable is at the top of No. XII, the formation then has a thickness of about 180′, or practically the same thickness as in the Northern field. It is composed of the usual sandstones and conglomerates. Mr. Ashburner gives a section of the upper part of the No. XII, as exposed in the Jackson air-shaft, as follows:

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*The courtesy of Mr. David White, of the United States Geological Survey, permits me to state, in advance of publication by him, that the evidence from his recent collection and study of fossils from the Bernice is wholly in favor of the coal measure age of Bed B and of the Conglomerate age of Bed A and that the three foot bed of the Mehoopany region would seem also to be in the Conglomerate (Apr. 11, 1895).

1. Soil,		6′	0
2. Gray, micaceous, shaly sandstone,		6′	3″
3. Gray slaty shale,		2	0″
4–11. *Coal-bed B,*	3. *Coal*, top bench,	4′	0″
	5. Slate and bony coal,	0′	9″
	6. *Coal*, middle bench,	1′	2″
	7. Slate and bony coal,	1′	3″
	8. *Coal*,	0′	4″
	9. Sandy slate,	0′	3″
	10. *Coal*, bottom bench,	3′	10′
	11. Fire-clay,	4′+	
12. Interval,		5′	0′
13. Sandstone and conglomerate,		45′	0″
14. Black slate,		6′	0″
15. *Coal-bed A*,		1′	11′
16. Slate,		0′	3″
17. Fire-clay,		7–8′	0″
18. Hard sandstone,		22′	0″
19. Conglomerate and sandstone,		30′	0″
Total,		148	0″

Bed A has been drifted upon at three points in the Bernice basin, Mylert, Jackson and Hess openings. At the Mylert drift Mr. Claghorn reports the bed 2′ 4″ to 2′ 5″ thick with 1′ to 1′ 2″ of coal; at the Hess drift the bed "varies from 10″ to 2′ in thickness, is very much faulted and the rocks are false-bedded."

"The principal points of interest in bed A are (1,) its variable composition, at the Jackson opening according to the usual classification the coal is bituminous and at the Mylert drift but a mile and a half distance the coal is a semi-anthracite, showing a change in the carbon ratio from 4.4 to 8.4; (2,) "in proving the existence of a bitumnious coal bed underlying the bed which is mined, which is a semi-anthracite; and (3,) in showing a remarkable peculiarity which the coal possesses of re-absorbing water after it has been once driven off."

Bed B:—"The principal economic interest which is attached to this portion of the Loyalsock field is the existence here of a valuable workable semi-anthracite coal-bed. The bed occurs under geological conditions similar to those which generally obtain throughout the bituminous regions of the State, but the coal has a composition which of itself would entitle it to rank higher in the trade than some of the softer coals mined from the anthracite region proper; yet the Bernice coal has the physical properties and structure of many of the Pennsylvania bituminous beds, and is itself underlaid by a bituminous bed. This anthracite bed has been explored and extensively mined in the vicinity of Bernice. The area under which this coal bed is supposed to lay is shown by the darkest shade on the accompanying map (see Atlas of Annual Report,) and the area of the bed which is worked is shown by a map of the mine placed in its proper position relative to the surrounding topographical features."

Bed B has an average thickness of 8′ or 9′ of coal in three benches, the top bench usually about 3′ 0″ thick, the middle bench 1′ to 2′ thick, and the bottom bench 3′ to 5′ thick; at the ends of the basin the benches are separated from each other by only a few inches of slate or fireclay, but towards the centre of the basin these partings thicken very materially until there are 40′ of strata separating the top from the middle bench and 20′ separating the middle from the bottom bench* the bed has 60′ to 90′ of cover. The area underlaid by bed B is about 4 miles long, east and west, with a maximum width of about one mile; practically all this area is owned or controlled by the State Line and Sullivan R. R. Co.

Composition of bed B:—"The coal from the Bernice basin is probably more marked than any other coal mined in Pennsylvania, having the structure and physical appearance of a bituminous coal and the composition of an anthracite coal.

"The high percentage of fixed carbon in this coal, the small amount of gas which is evolved upon heating, and the non-coking properties of the coal render it an unsatisfactory fuel to bituminous consumers.

"Not until the Geological Survey had made numerous analyses of the Bernice coal, and had shown that it possessed

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*This splitting of the bed is characteristic of the Red Ash bed of the Northern field.

a composition which would entitle it to be called an anthracite more than some of the softer anthracites mined from the western part of the anthracite region, and until the operators had designed a mechanical method of preparing the coal, and had succeeded in removing the prejudice of the coal trade and consumers against the coal, which they had always been disposed to regard as bituminous and not anthracite, was the coal rated by the trade either as a competing fuel of the soft anthracite or as a specialty.

"The free-burning character of this coal, the property it possesses of continuing to burn under conditions in which fires made of other coals would go out, the easy, complete combustion of the carbon in the coal, and the open like tendency of the ash, which results from combustion, and which seldom has a tendency to clinker, renders the coal a desirable fuel."

"Specimens of the three benches of coal in bed B, as mined at Bernice, were forwarded to the Laboratory of the Survey for analysis. They yielded as follows (A. S. McCreath), taking the general average of all the benches together as they are shipped to market.

"The coal is bright, shining, compact, and shows considerable charcoal and iron pyrites."

Water,	1.295
Volatile matter,	8.100
Fixed carbon,	83.344
Sulphur,	1.031
Ash,	6.230
	100.000
Color of ash,	gray.
Carbon ratio,	1: 10. 3

Of course it makes no coke, but it is a *true anthracite*, and the above analysis represents fairly the character of the coal as furnished in quantities from the Bernice mines."

"But while the Bernice coal from bed B is thus clearly an anthracite, according to the trade classification, and a semi-anthracite, according to the classification suggested in this report, and is used for exactly the same purposes and in the same way as the other Pennsylvania anthracite coals, yet in its appearance and structure it differs much from them."

"It has a dull luster, instead of the well-known shining luster of the other anthracites, and it entirely lacks the conchoidal fracture which is possessed by every other Pennsylvania anthracite."

"So different is it in physical structure that it cannot be passed through an ordinary anthracite breaker. (See Report GG, page 183.) Such a breaker would so crush it as to leave little beside slack and pea coal."

Mehoopany coal basins.

East of the Bernice basin and in Wyoming county the rocks of No. XII cap the high summits lying between the main Mehoopany creek and its North branch, and between the Mehoopany and Bowman's creeks; within the former area a three-foot coal bed is opened and worked to a small extent to supply the few settlers along Mehoopany creek.

"While Mr. E. B. Harden was surveying the Sullivan county part of this area, Mr. Frank A. Hill made a reconnoisance of its eastern end with a view to the extension of the Survey eastward into Wyoming county. This reconnoisance was commenced at Mehoopany, August 27, 1883."

Mr. Hill's notes are appended to Mr. Ashburner's report on the Bernice basin and in part are as follows:

"Up the South branch, about a mile above Forkston, is Squire Spaulding's house.

"The easternmost coal opening (No. 1) is about half a mile from Squire Spaulding's house, on the crest of the mountain west of the South branch.

"Another coal opening (No. 2) (F. Chrisman) is on the mountain crest between Stony brook and Spring brook. Here a gangway has been driven 390 feet, and a number of breasts have been turned. The operators report 1000 tons mined.

"The bed is quite regular, thus:

At mouth:

Top, massive conglomerate.	
Coal,	2′ 10″
Bone,	0· 7″
Fire-clay,	4′ 4′

260 feet in the gangway:

Top, massive conglomerate.	
Fire-clay,	0 5″
Coal,	3′ 2′
Bone,	0′ 6″
Bottom, fire-clay.	

Section of the bed at face, 390 feet from the mouth:

Top, massive conglomerate.	
Coal,	2′ 6′
Bone,	0′ 4″
Bottom, fire clay.	

"This (No. 2) Chrisman opening is about 2100 feet above tide, or more than 200 feet higher than the lowest coal-bed at Bernice, a good argument for the Chrisman coal-bed being above the Mauch Chunk Red Shale No. XI, and very probably in the body of the Pottsville Conglomerate, No. XII.

"The rise of the measures eastward justifies Professor White in assigning the whole of Wyoming county east of the Susquehanna river to the Catskill formation, No. IX.

"Daddow's opening, (No. 3), mentioned by Mr. Platt in Report of Progress GG, page 205, is at the west end of this same coal area (between Stony and Spring brooks), where the decent is westward to the head springs of the Loyalsock, near the county line. This is in fact the highest land of this part of the region.

"Daddow's opening is more than a mile west of Chrisman's opening, and the outcrop is continuous between them, there being another opening (No. 4) on the coal half way between them."

There are certainly several hundred acres underlaid by this three foot coal bed and perhaps considerable more. Its identity with the beds of the Bernice basin is uncertain, the

40′ of conglomerate which overlie it rather suggests bed A; but it is not at all improbable that it is identical with bed B or perhaps with only the bottom bench of the bed which may be here widely separated from the upper benches. Mr. Platt calls the coal a semi anthracite.

"There are two conglomerates in these areas, both specially well defined on Stony brook; one above the coal-bed coarse and heavy; the other under the coal bed, less coarse and interleaved with sandstone beds.

"The upper or roof conglomerate has a thickness of 40 feet where best exposed. The lower conglomerate and sandstone mass seems to be from 250 to 300 feet thick.

"In the midst of this lower mass is seen a *little coal* a few inches thick."

It was reported to Mr. Hill that coal or coal smut was found on the South Mountain between Mehoopany and Bowman's creeks; the writer paid a brief visit to this locality during the summer of 1894 and ascertained that a "coal bed" opened near the wagon road crossing the mountain was but one or two inches thick, irregular and disappearing altogether, probably identical with the few inches of coal seen in the lower conglomerate mass. The high summit near the wagon road is apparently a little too low to catch the "Chrisman" coal.

A topographical map of the whole North mountain region, with detailed measured sections would throw much needed light on the geology of this region, the extent of the coal areas, the identity of the coal beds and of the conglomerates, the place of the top of No. XI and other questions on which opinions have differed for many years.

Special Features of the Northern Field.

Glaciation.

The great ice sheet of the Quarternary period covered deeply the whole Northern field, its markings are plainly seen on the highest summits; the terminal moraine crosses the Susquehanna river some six miles south of the southwest end of the field. The glacier has left an undesirable legacy in the shape of great deposits of drift, which partly fill many of the valleys and often cover the gentle sloping hillside to a depth of 75 to 100 feet.

"The depth of this drift and the location of pot-holes in areas underlaid by workable coal-beds, is a matter of great practical importance to coal operators. The depth and character of the drift have a direct practical bearing upon the sinking of shafts, from which to work the coal beds. The thickness of the rock roof over the mine workings between the top of the workable coal-beds and the bottom of the drift, is no less important as affecting the possibilities and safety of mining enterprises.

"The location of points where the outcrops of worked coal-beds will be covered by a considerable depth of drift, and the location of pot-holes is of value to the miners of coal, since the running of gangways and breasts into the drift may not only involve unanticipated cost, but may involve the loss of lives.

"The position and depth of the glacial drift at any one point in the valley, and the location of pot-holes, can only be determined by boring holes, sinking shafts, or by the more undesirable and hazardous plan of driving the mine workings into the drift." (C. A. A.)

The Archbald Pot-holes, described by Mr. Charles A. Ashburner, Annual Report, 1885, page 615, are two oval holes 40 to 50 feet deep and 20 to 30 feet in diameter, cut down through the rock to the bottom of the Archbald coal-bed, which were encountered by the mine workings of Jones, Simpson & Co.'s Eaton colliery near Archbald. Rounded pebbles and gravel filled the bottom of the holes. With reference to the formation of holes Mr. Ashburner says:

"In only two ways is it possible for me to conceive of these holes being formed:

First. By the water which always flows underneath a glacier, particularly near its terminus.

Second. By water flowing over the edge of the retreating ice, at the terminus of a glacier."

Buried Valley of Newport Creek.

The valley of Newport creek (mine sheets II and III) is filled with drift to the depth of about 100 feet, the valley having been originally that much deeper than now; the drift also covers deeply the sides of the valley and at some points a vertical depth of more than 200 feet of wash or drift is encountered.

It was the unexpected tapping by the mine workings of a depression in this drift-filled valley which occasioned the Nanticoke mine disaster of December 18th, 1885, by which twenty-six men lost their lives, described by Mr. Ashburner in Annual Report, 1885, page 627.

This buried valley where it exists on the Susquehanna Coal Co.'s property not only at Nanticoke* but at Glen Lyon, near the head of Newport creek, has been thoroughly explored by the drill and its exact depth at several hundred points is now known. Mr. J. H. Bowden, the chief engineer for the company, has had constructed a very interesting and valuable map showing the shape of the rock floor of the buried valley by contour lines 10 feet vertically apart.†

This map shows a northeast fall in the buried valley of about 170 feet (600′ A. T. to 430′ A. T.), in the four miles between Glen Lyon and Nanticoke, taking the lowest point developed at each place. It also confirms Mr. Ashburner's opinion that the depression in the buried valley, which caused the Nanticoke disaster, was in the nature of a whirl pool rather than a pot-hole as was supposed by many at the time.

Wyoming Buried Valley.

Mr. Frank A. Hill in Annual Report, 1885, pages 637 to 647, tells what was then known of this very important feature of the Wyoming basin. Mr. Hill says:—"The Lackawannock mountain forms the northern border of the Wyom-

*See cross section through No. 1 and No. 6 shaft plate 329.

† Mr. Bowden has kindly furnished the Survey with a blue print copy of this map, and it is hoped that its publication can be made in the near future.

ing coal-basin, so that the river enters this basin at Pittston, leaves it at Nanticoke, and crosses it again at Shickshinny. Along its course lies the Wyoming Buried Valley. Its history is one of the greatest interest, its present condition one worthy of study, while its future record will be largely dependent upon the influence of engineering foresight and skill.

"The buried valley is the work of ages of erosion, an erosion which has obliterated at least three workable coal-beds from an unknown area, and cut a channel through the Wyoming basin greater in depth than the highest artificial point within its boundaries.

"The study of this valley is one of the greatest economic importance, as its presence is a constant menace to life and property. The determination of its boundaries is a matter of vital importance to land owners, operators, and miners."

Following this Mr. Hill describes the boundaries of the buried valley and gives detailed information as to the depth of the wash as determined by shafts and bore holes. The paper concludes as follows:—

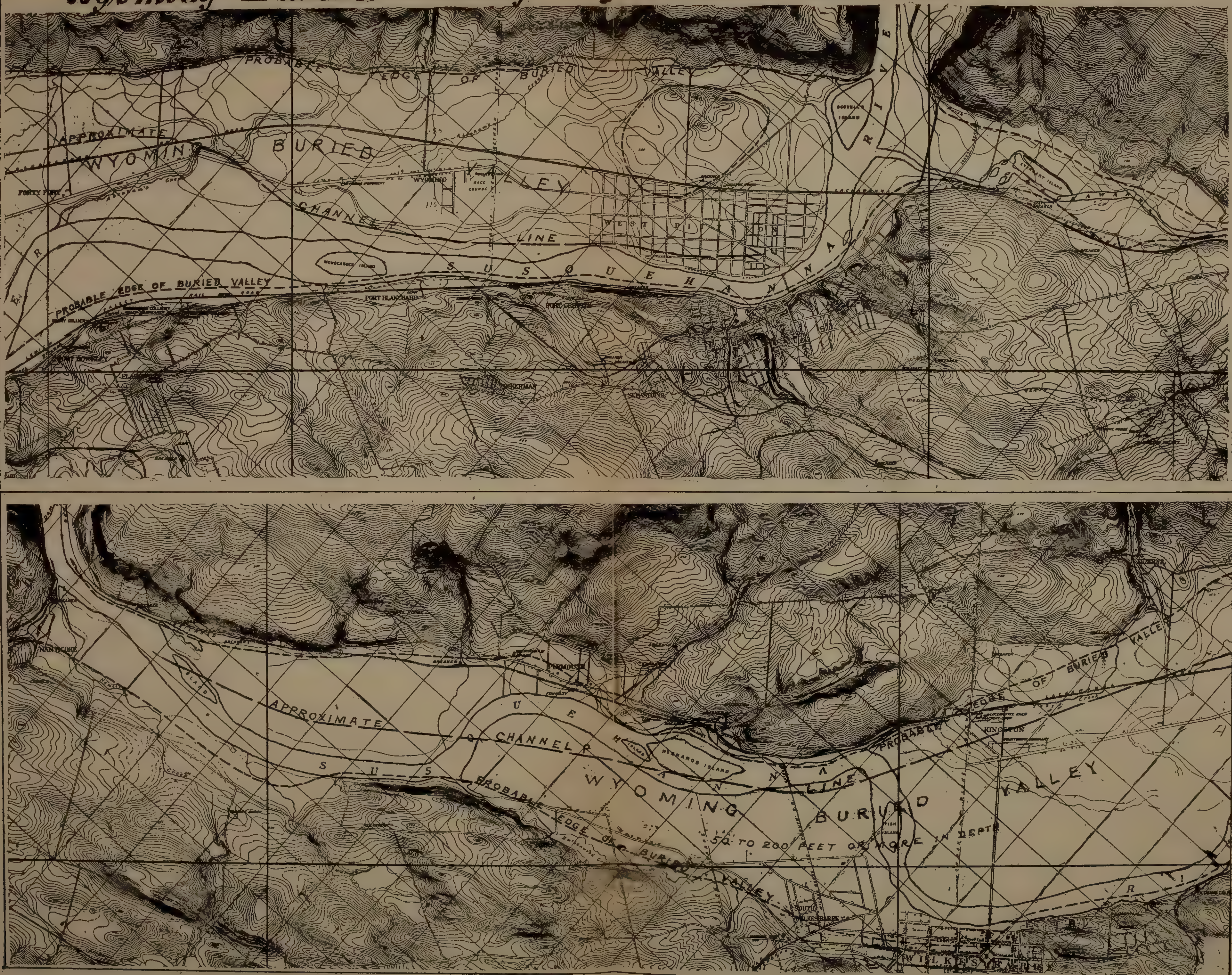
"There have already been several accidents from the contract of the mine workings with this hidden channel, all either fatal to life or destructive to property. The workings from a number of collieries are now approaching the Buried Valley areas. Whatever of risk there has been before will be multiplied proportionally by the number of new breasts and gangways that enter this comparatively unknown territory, while the possible shifting of the present river will add to the element of danger.

To guard against a hidden danger is always most difficult. Such a danger is here, and its avoidance is a question to be solved by the engineers and superintendents of the region."

Since 1885 many new borings, a large number of which were made simply to determine the depth of the wash, have added materially to our knowledge of the buried valley. From this information the following additional statements can be made. 1. The limits of the buried valley—the area within which the rock floor has an elevation lower than that of the present river bed—are practically the limits

Wyoming Buried Valley — Northern Coal Field.

PL. 331 AND 332.



of the broad river flats, which extend from West Pittston to the Nanticoke gap, with a narrow and comparatively shallow area extending a couple of miles up the Lackawanna valley (see page plates 331 and 332.) 2. The slope of the sides of the buried valley is as might be supposed, quite variable and very similar to a modern valley. 3. The channel* or line of greatest depth of wash, although not fully determined, appears to be close to the north side of the river under the flats between West Nanticoke and Plymouth, just south of the river between Plymouth and Toby's Eddy, under the borough of Kingston, north of the D. L. and W. R. R., at Forty Fort, then perhaps swings southeast to follow close to the north bank of the river to West Pittston or possibly continues close to the foot of the mountain to the gap above West Pittston. 4. The maximum depth of the wash thus far encountered in the vicinity of West Pittston is about 130′ or 400′ A. T., near Forty Fort 215′ (Tripp B. H. No. 1) or 335′ A. T., near Kingston (Woodward farm B. H. No. 2) 2[illegible]2′ or 318′ A. T., opposite Plymouth a depth of 300′ of wash was recently reported † which would make the rock floor there about 230′ A. T., at Avondale near the river 189′ if wash was found or rock at 337′ A. T.

The facts cited above in connection with those given by Mr. Hill show very clearly the important bearing which this buried valley has upon present and future mining operations beneath it. The compilation, by the Survey, upon a map of working scale, of all the information obtainable bearing upon this subject would undoubtedly be of much service to the mine operators and help to solve some of the questions of economic and geologic value connected with it.

The origin of this buried valley is difficult to account for;

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* At least one prominent mining engineer, who has studied the buried valley in special localities, is inclined to think that it has no connected channel but that the deep places along its bottom are formed by a series of pot holes.

† The writer is unable to make an authorative statement of this although he has no reason to question the correctness of the information.

its known great depth—certainly 192′ and probably nearly 300′—below the present level of the river makes it hard to conceive of an outlet for it, and Prof. Lesley now regards his theory of sub-glacial erosion as wholly inadequate; his discussion of this subject in preface to Report G 7 is as follows:

"*Buried river channels* appear in this as in preceding reports by Mr. White; and he gives interesting details of the old channel of the Susquehanna river underneath the Kingston flats, opposite Wilkes-Barre. Bore-holes through 210′ and 212′ of drift, struck the old river bed at 185′ and 180′ below the present river level; *i. e.*, at 340′ A. T., whereas the river level at Wilkes-Barre is now 525′ A. T. (See pages 24, 25 G 7.)

"What renders the depth of this ancient channel of the river embarrassing, is the fact that a rock-dam lower down the river, at Bloomsburg, crosses its bed 450′ A. T. (pages 26, 303, 307, 350, 352 G 7), and another near Sunbury, at 430′ A. T., apparently to the exclusion of any possible side channel. Even at the Dauphin county line the rocky bed of the Susquehanna is 385′ A. T.; *i. e.*, 45′ higher than the bed of the ancient channel at Wilkes-Barre. Did the ancient river flow northward then into New York state? That were hardly possible, in view of the character of the Tunkhannock canon, which would require for this purpose to be deepened at Tunkhannock about (580± — 340′ — 40′=) 280 feet; and at the New York State line about (780± — 340′ — 200′ =) 640 feet, which is utterly incredible.

I think we are shut up to the explanation of subglacial erosion—rivers beneath the ice-sheet, charged with angular drift materials, ploughing deep valley-grooves in the softer Coal Measures as far as Nanticoke, and in the soft red shale from Nanticoke to Shickshinny."

Limestone Beds.

The occurrence of limestone beds interstratified with the shales, sandstones and coal beds of the coal measures, although characteristic of all the bituminous measures of the

State, are quite rare in the anthracite region. The only localities where clearly defined and persistent limestone beds have been located by the Anthracite Survey are in the Wyoming Valley.

A "Report on the Wyoming Valley Limestone Beds," by Charles A. Ashburner, is published in Annual Report, 1885, Chapter X. Some four thin beds of limestone, 1′ to 3′ thick, are exposed at different points in the valley, but chiefly in the vicinity of Wilkes-Barre. They occur near the middle of the 1800′± of coal measures contained in the Wyoming basin and at about 10′, 169′, 305′ and 332′ respectively above the Hillman coal bed.

"These beds are of special interest to geologists and palæontologists, on account of the number of fossil remains of water shells found in one of the most persistent of the beds, and which I have named the Mill Creek limestone-bed."

A "Description of the Fossils Contained" in these limestone beds by Professor Angelo Heilprin accompanies Mr. Ashburner's report.

Peat Bog Mineral.

The "Description of a new substance resembling Dopplerite from Post-Glacial Peat Bog at Scranton," by Professor H. C. Lewis, is published in Annual Report, 1885, pages 647 to 657.

CHAPTER CXX.

Eastern Middle Coal Field.

The Eastern Middle* lies ten miles to the south of the Northern field and is separated from it by the great Wapwollopen arch, which elevates Formation X to outcrop and form the high plateau lands between the fields. This field is the smallest of all and is contained mostly in southern Luzerne, with smaller areas in Carbon, Schuylkill and Columbia counties. It consists of a number of small coal areas lying about the high watersheds between the Susquehanna, Lehigh and Schuylkill rivers; preserved from erosion in the comparatively shallow troughs between seven or eight nearly parallel anticlinals which cross this divide. These anticlinals are in the eastward range of the great Shade Mountain axis of Northumberland, Snyder and Mifflin counties, and apparently represent that axis separated into a number of minor folds before it flattens east under the Pocono highlands of Monroe county.

The maximum length of the Eastern Middle field, some 26 miles, is along the course of the anticlinals or about N. 70° E., and its greatest width some 10 miles is near the centre of the field. There are large areas from which all the coal measures have been eroded, leaving only Formation No. XII; so that the total area underlaid by workable coal beds is only about 33 square miles.

The surface of the principal coal basins has a general elevation of 1400′ to 1700′ A. T., with the ridges which lie between them 100′ to 300′ higher. The greatest range of elevation is from about 950′ A. T., along Black creek near Gowen to 1932′ A. T. at Buck Knob some 4 miles west of Gowen.

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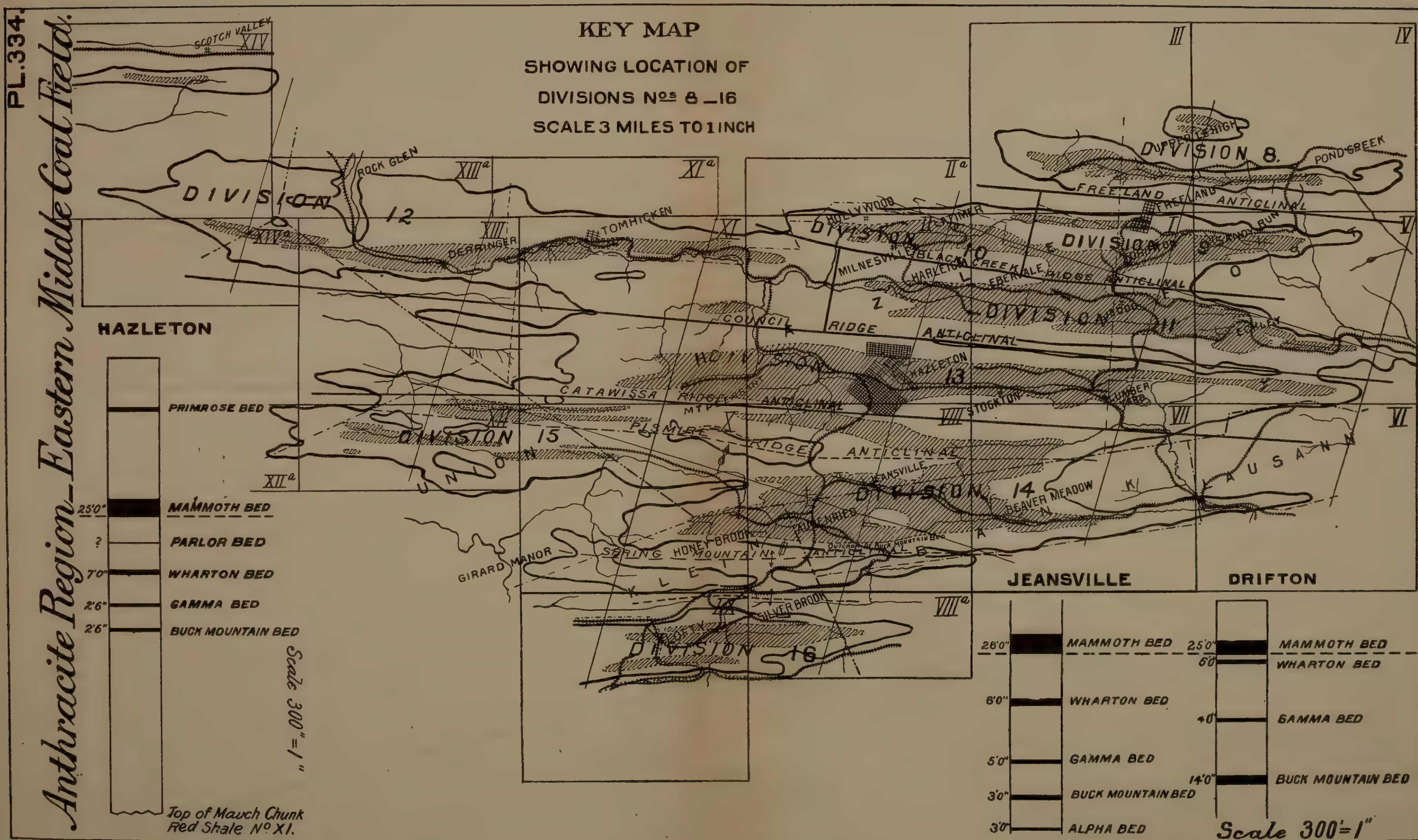
*Small map of the field on plate 334.



PL. 334. Anthracite Region_Eastern Middle Coal Field.

The largest drainage basin is to the Susquehanna by way of Black and Catawissa creeks; the next is to the Lehigh via Pond, Sandy, Hazle and Beaver Meadow creeks; with but a small area draining south through the Little Schuylkill. The position of the coal basins high on the divide gives favorable grades for railroad outlets in practically all directions.

The *structure* of the field is for the most part quite simple, and consists of a succession of anticlinals, with usually broad flat crests; and rather shallow basins between, the dip of whose sides range from 10° to 40°. The basins are not all perfectly regular and the larger ones are often more or less corrugated by shorter anticlinal flexures, some of which sharply upturn the coal beds or even exhibit in few cases the breaking off and "thrusting" of the broken ends of a bed one beyond the other forming an "overlap." The favorable situation of the beds for mining because of the large extent of outcrop exposed and the comparative shallowness of the basins (the deepest is 400′ or 500′ A. T. at the lowest point), has led to a very extensive development of the field and its structure is practically fully determined. The numerous cross sections published by the Survey, some of which are reproduced on page plates 340 to 345 are especially valuable as there is but little of the theoretical in the structure shown by them.

Erosion has denuded the crests of some of the anticlinals sufficiently to exposes, here and there patches of red shale, mostly long and narrow, within the conglomerate country. The principal anticlinals, all but the last of which form prominent ridges, are:—from the north, Freeland, Black Creek Ridge, Council Ridge, Catawissa Ridge, Pismire Ridge, Spring Mountain and Messrs Run; a detail account of each is rendered unnecessary as the mine and cross section sheets show clearly their extent, shape and relative importance.

*Formation No. XII** outcrops in the ridges separating the coal basins and covers a considerable area of highlands

* Section of No. XII on page plate 336.

from which all the coal measures have been eroded. The spoon of its basins make long, high, and often narrow, conglomerate capped ridges, which project out into the red shale country, both, to the east and to the west.

The formation is made up of coarser materials here than in the Northern field; some of the conglomerate beds are composed of pebbles nearly or quite all of which are of egg size. The thickness of the formation is given at but 200′ along the northern rim of the field, but it shows a decided increase towards the southwest and along the southern limits in the Silver Brook basins its thickness is about 500′. The field corps while locating the outcrop of the top of No. XI encountered at a number of places in the northern half of the field, and north of the Catawissa Ridge axis, a "lower conglomerate" below the first beds of red and yellow shale, which were taken by them as the top of No. XI. Several points where this "lower conglomerate" was found is noted upon the mine sheets. The rapid increased thickness of No. XII towards the southwest might be explained by the disappearance of these upper shales and the coming together of the "upper" and "lower" conglomerates.

A *thin bed of coal*, the Alpha bed, 60′ to 100′ below the top of XII is nearly always present and at the west end of the Beaver Meadow basin it is locally of workable thickness.

*Coal Measures.**—But little coal above the Mammoth bed is found in any of the basins; the Hazleton basin contains the greatest thickness of measures, about 700′ with one workable coal (the Primrose bed), above the Mammoth. The Mammoth although of less extent than the underlying beds, by reason of its excellence and large thickness, 20′ to 30′, is easily the most important; the Buck Mountain at the base of the coal measures, while quite variable in different parts of the field, sometimes 14′ to 15′ thick and again thin and worthless, ranks next; and the Parlor, Wharton and Gamma beds are of varying size and moment in different localities. The outcrops of the Mammoth and

* Sections of measures below the Mammoth bed are given on page plate 337.

PL. 335.

Anthracite Region_Eastern Middle Coal Field.

AT HOLLYWOOD COLLIERY NO. 2 — LOOKING EAST (PICTURE REVERSED.)

STRIPPING AT HOLLYWOOD COLLIERY NO. 1 — LOOKING EAST (PICTURE REVERSED.)

[illegible]

Buck Mountain beds are given upon the mine sheets and details as to the local thicknesses and value of all the beds are soon to follow.

The proportion of *refuse in the coal beds* of this field is somewhat greater than in the Northern field. An average of the bed sections collected by the Survey give 77% of the thickness of the beds as merchantable coal; 75% will be a little more convenient for use as well as safer.

For convenience in description the field is divided into a number of smaller areas, whose limits are chiefly determined by the natural divisions. They are as follows.

Division 8—Upper Lehigh-Pond Creek basins.
" 9—Woodside and Cross Creek basins.
" 10—Little Black Creek basin.
" 11—Big Black Creek basin.
" 12—Black Creek, Roberts Run and McCauley basins.
" 13—Hazleton basin.
" 14—Dreck Creek and Beaver Meadow basins.
" 15—Green Mountain basins, Nos. 1–5.
" 16—Spring Mountain and Silver Brook basins.

Division 8. Upper Lehigh–Pond Creek basins.

This is the most northeastern of the divisions and it is mapped on mine sheets Nos. III and IV,* the structure is shown by cross sections Nos. 30, 31, 32 on cross section sheet IV † and sections Nos. 1 to 12 on columnar section sheet IV ‡ give the strata cut at different points in the division

There are three separate coal areas or basins in this division, all north of the Freeland anticlinal; the principal one, the Upper Lehigh–Pond Creek basin lies in the valley of Pond creek, which drains east to the Lehigh; it is some 6 miles long and 500′ to 3000′ wide, narrow along the eastern half and widening out at the west end. High on the mountain a mile northeast of the Upper Lehigh end of the large basin two small basins of Buck Mountain coal are caught.

Formation No. XII outcropping about the Upper Lehigh-Pond Creek basins, makes a rim 1000′ to 2000′ wide.

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* Page plate 334 gives the relative location of the division.
† Page plate 338 gives two reduced cross sections.
‡ Page plate 337 gives reduced columnar sections at Upper Lehigh.

Its eastern outcrop spoons about a mile and one-half east of Pond Creek village and caps the high ridge on the east bank of the creek; repeated explorations have failed to find any Buck Mountain coal on this ridge, a short anticlinal which lifts the red shale to the surface along its axis probably explains the absence of the coal beds. The nothern outcrop of XII overlooking Butler Valley is plainly marked by prominent cliffs and ledges of coarse conglomerate, Prospect Rock and Cloud Point on either side of Hell Kitchen run are notable examples; along the southern outcrop, on the north flank of the Freeland anticlinal, the exposures are less numerous and the outcrop is often obscured by a rather deep covering of wash.

The thickness of No. XII is cut by two bore holes; bore hole No. 1 (sec. 1 col. sec. sheet IV) is close to the Upper Lehigh breaker and gives a thickness of 180′ for the formation, from the bottom of the Buck Mountain bed to "15′ green shale" overlying red shale. The upper 50′ is mainly sandstone with the lower 130′ nearly all conglomerate. Two coal beds are cut, one 1′ 3″ thick at 35′ below the Buck Mountain bed and the other the Alpha bed 4′ 11″ thick at 62′ below.

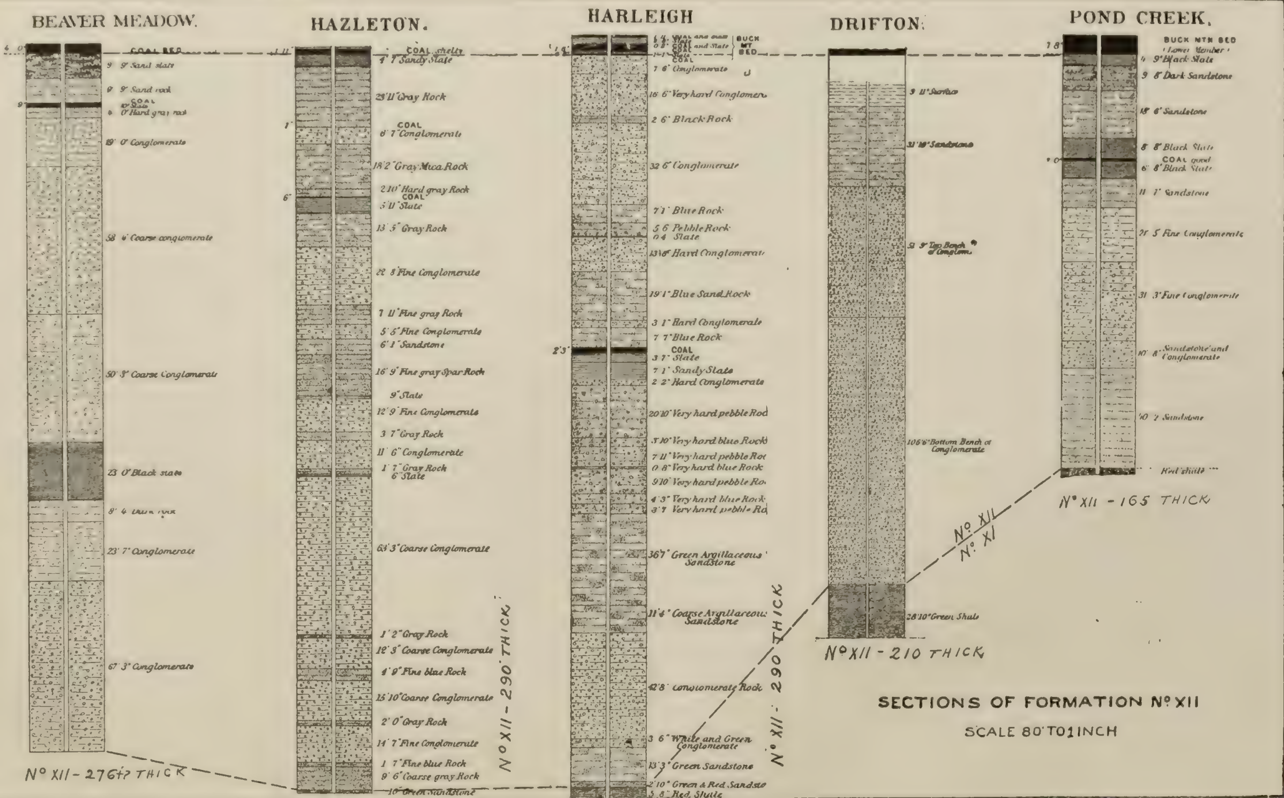
Bore hole No. 1* Pond Creek (sec. 11 sheet IV) gives a thickness of only 165′ to red shale, but one coal bed is cut, and that 1′ 0″ thick at 40′ below the Buck Mountain bed.

Basin No. 5, as the larger of the two coal areas northeast of Upper Lehigh is called, is about a mile long and 1000′ wide near the middle; its greatest depth is perhaps not more than 150′; the north dips are quite gentle, 10° or less, but the measures turn up rather sharply to make the northern outcrop and the south dips are 35° to 40° (see cross section 31, sheet IV). The *Buck Mountain* is apparently the only workable coal, certainly the only one developed, the mine workings cover nearly the whole extent of the bed, but additional coal is now had by stripping. The thickness of the bed is exceptionally large as it will average perhaps 20′ with 15′ or 16′ of coal, bore hole No. 14, sec. 9, col. sec. sheet IV, cuts 22′ 7″ of coal in a thickness of 31′.

* Reproduced on page plate 339.

PL. 336.

Anthracite Region_Eastern Middle Coal Field.



SECTIONS OF FORMATION N° XII

SCALE 80' TO 1 INCH

The *little basin* just south of basin No. 5, and on the south side of a gentle axis which separates them, was only partly developed at the time of publication of the mine sheet (1888). The basin was thought to be 300′ or 400′ wide and perhaps half a mile long, the cover over the Buck Mountain bed is very light.

Upper Lehigh—Pond Creek basin is about 6 miles long, 600 to 800′ wide at its eastern half and expanding to 3000′ wide in the western half. Seven short anticlinal axes, slightly oblique to the general course of the basin, have been developed by the mine workings. The dips as a rule are gentle, although some overturned dips have been encountered. Nearly two miles in length, of the narrow part of the basin, between Pond Creek and the Upper Lehigh collieries, belonging to the Highland Coal Co., is wholly undeveloped ; a heavy deposit of wash make the precise location of the outcrop here uncertain.

Alpha bed in formation No. XII, is quite variable in its thickness, its best showing is 4′ 11″ in bore hole No. I, at Upper Lehigh, the bed however cannot be regarded as workable except possibly for a very limited extent.

Buck Mountain bed has been extensively mined at the two collieries (Upper Lehigh and Pond Creek) in this basin ; at Pond Creek colliery the bed is in two splits about 18′ apart, the upper split 5′ thick and the lower split 7′ to 8′. The Buck Mountain is the only bed here and the basin is only about 120′ deep at the most.* The Upper Lehigh Coal Co., have practically mined over all their Buck Mountain area and are now getting additional coal by stripping. The average thickness of the bed here is about 12′ with 9′ to 10′ of coal.

The maximum depth of the basin some 250 feet with 200 feet of coal measures is found at Upper Lehigh and it contains three coal beds above the Buck Mountain ;†—a *three foot bed* at 60′ above, another *three foot* bed 25′ higher and 35′ above this the *Wharton bed* some 6′ thick. A shaft

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* See Pond Creek cross section on plate 338.

† See Upper Lehigh columnar section on page plate 337.

has recently been sunk and gangways started on all three of the beds, the largest, the Wharton, has but little cover and is not extensive.

Division 9—Woodside and Cross Creek basins.

The area embraced in this division covers part of mine sheets I, III and V;* sections showing the structure of the basins are published on cross section sheets I, II, and IV sections 1—8 and 33 & 34;† columnar sections are given on columnar section sheets I & IV‡.

The Woodside and Cross Creek basins lie between the Freeland and Black Creek Ridge anticlinals.

The *Woodside* is a long narrow *basin*§ of Buck Mountain coal along the southern flank of the Freeland axis. Originally it was no doubt part of the more important Cross Creek basin on the south, but erosion has long since removed the coal bed from the saddle of the small axis between. The basin is about 2 miles long and not over 800′ wide, its eastern end is near the borough of Freeland; it has a depth of about 150′, the north dips are about 30°, but the south dips are much steeper, 60° to 70° or more. The mine workings are confined chiefly to the eastern half of the basin; toward the west end the bed thins and goes below a workable thickness. Where worked the *Buck Mountain* bed is 10′ to 14′ thick. *No. XII*, 260′ thick, mostly conglomerate and barren of coal beds, is cut by a bore hole (sec. 2, Col. Sec. sheet I.)

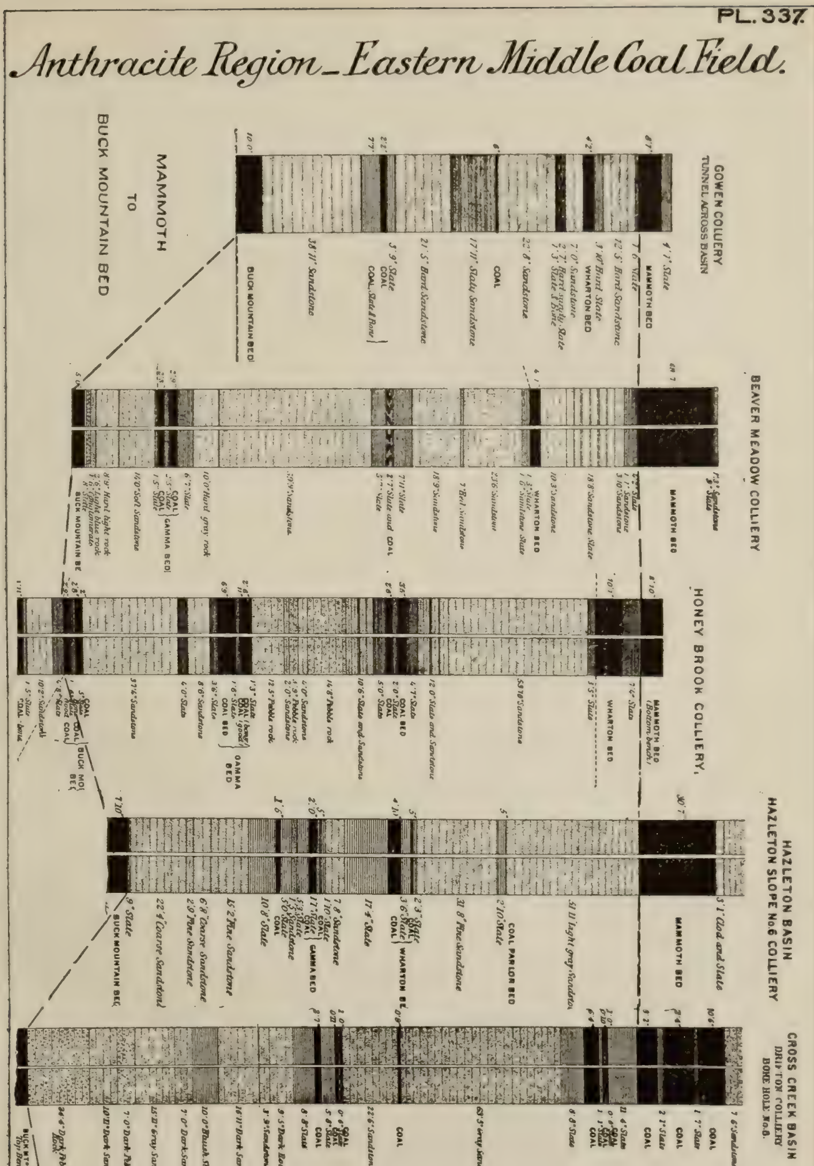
Cross Creek basin, in the synclinal between the Freeland and Black Creek ridges is really the eastern continuation of the Little Black Creek basin or *vice versa*, and the north and south township line between Hazle and Butler is in this instance used to separate them. The eastern limit of the Cross Creek basin 4 miles away is determined by the spoon of the measures a mile and one-half beyond Sandy Run; the width of the basin is 3000′ to 4000′

*Page plate 334 also shows relative location of the division.

†Page plate 338 gives reduced cross section of the basin.

‡Page plate 337 gives a reduced columnar section of the measures.

§ See cross section of Woodside basin on page plate 338.


PL. 337.
Anthracite Region_Eastern Middle Coal Field.
GOWEN COLLIERY
TUNNEL ACROSS BASIN
MAMMOTH
TO
BUCK MOUNTAIN BED
BEAVER MEADOW COLLIERY
HONEY BROOK COLLIERY,
HAZLETON BASIN
HAZLETON SLOPE No.6 COLLIERY
CROSS CREEK BASIN
DRIFTON COLLIERY
BORE HOLE No.8.
UPPER LEHIGH

but narrows to the spoon and towards the division line. Southwest of Drifton the Buck Mountain bed saddles the Black Creek Ridge axis and dips down into the Hazleton basin.

The Lehigh-Susquehanna divide crosses the basin, Sandy run drains to the Lehigh, and Cross creek cuts south across the Black Creek Ridge axis to join Big Black creek. Drifton and Sandy Run are mining towns within the basin.

The structure in general is that of a broad rather shallow basin, but it is broken here and there by short sharp anticlinals which turn the strata up at abrupt angles and sometimes overturn; the axes are seldom extensive, quickly dying down as a rule (see cross sections on page plate 338). At Drifton and to the west the dips steepen and the basin is considerably deeper, the maximum reached is about 800′. The total thickness of the coal measures is about 400′, the Mammoth is the highest and the Buck Mountain the lowest workable bed.

No. XII has been drilled through at several points and has a thickness of 200′ to 260′ made up mostly of coarse conglomerate.

Alpha bed is cut in two or three of the bore holes and is absent in the others. In bore hole No. 1 near No. 2 slope Drifton it has a thickness of 3′ 10″ at 75′ below the Buck Mountain bed; this is the only point in the basin where it shows a workable thickness.

*Buck Mountain** is an excellent bed of large thickness and good quality and practically its whole area in this basin is under development. Its thickness ranges from 10′ to 20′ with an average of about 14′ with nearly 11′ of merchantable coal; the partings of slate and bony coal as a rule are not large, but they are scattered through the whole thickness of the bed.

Gamma bed is worked at the Sandy Run colliery, near the eastern end of the basin, it is there 45′ above the Buck Mountain bed and has a thickness of about 6′ much parted by slates; further west, at the Highland and Drifton col-

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*Bed sections on page plate 339.

lieries the bed apparently does not reach a workable thickness and in some places is entirely absent.

Wharton bed, about 200′ above the Buck Mountain bed, ranges from 4′ to 14′ thick, but for the most part is high in refuse and probably does not average more than 5′ of good coal; it is now worked at the Drifton aad Highland collieries; at Drifton the Mammoth and the Wharton are separated by only 10′ to 15′ of slate, but at Highland this interval is 90′ with three small coals between.

*Mammoth bed** is found in the deeper part of the basin about Drifton, it also underlies a small area of the Highland property where it is now mined by "stripping." The bed is 20′ to 35′ thick, slate partings 1′ to 2′ thick divide the bed into two or three large benches; its average thickness is perhaps 25′.

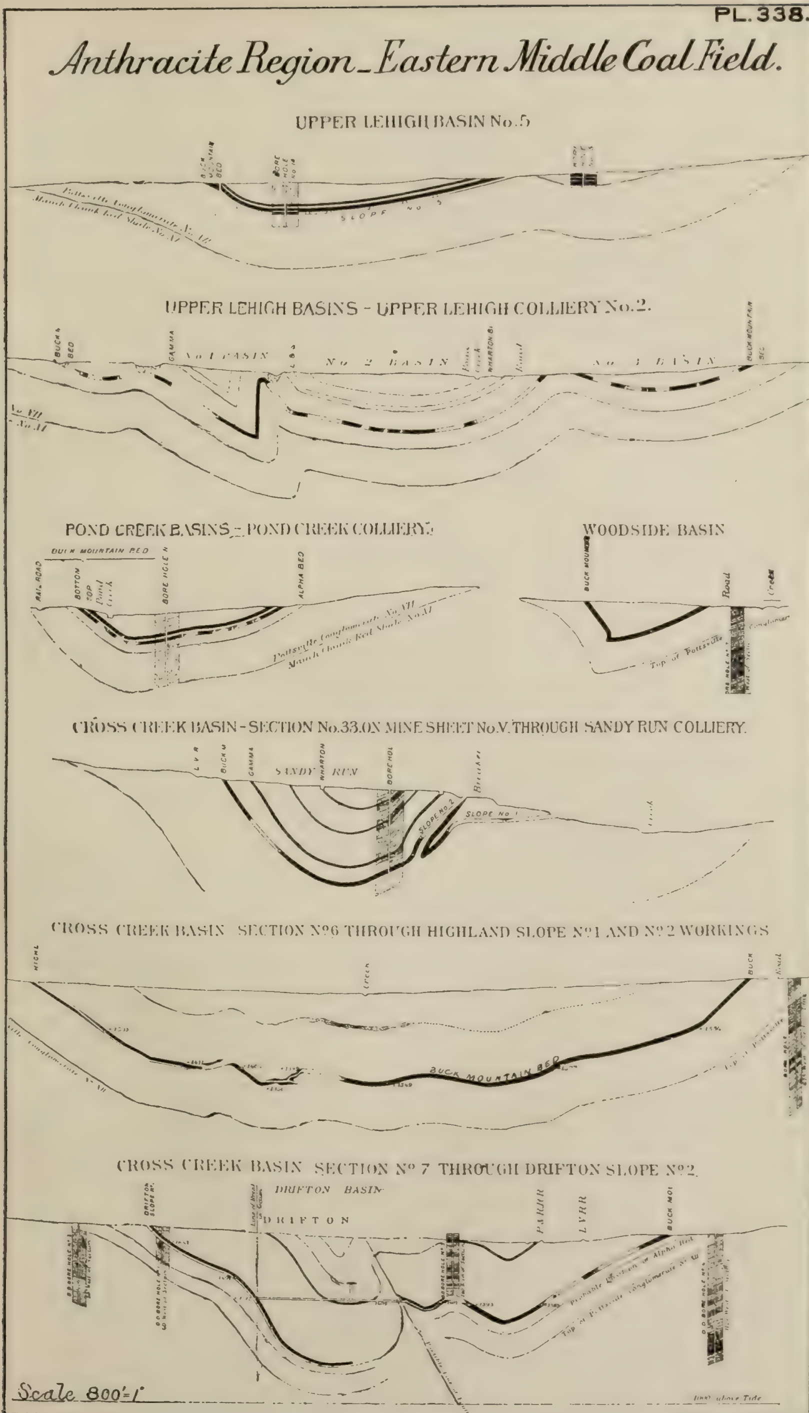
Primrose bed;—Bore hole No. 8 at Drifton cuts just under 30′ of wash a coal bed 8′ thick, but as this boring is probably very near the deepest part of the basin the extent of this bed must be quite limited.

Division 10—Little Black Creek basin.

The area covered by this basin is mapped on the northern part of mine sheets I and II;† its structure is shown by sections 9 to 14 on cross section sheet II;‡and columnar sections of the measures are published on columnar section sheet I.

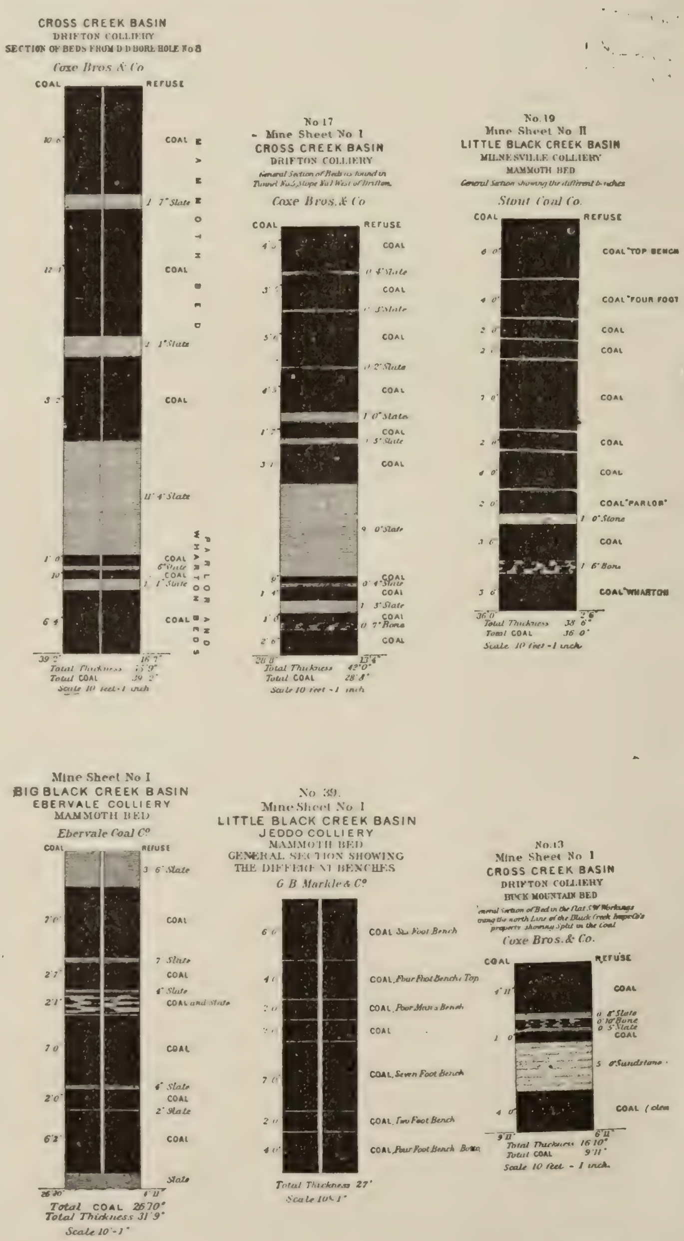
The Little Black Creek basin lies in the valley north of Black Creek ridge and is the western extension of the Cross Creek basin, it has a length of 3 miles with a width of one half a mile. Little Black creek flows west in the basin then turns and cuts south through Black Creek ridge, Lattimer, Milnesville and Hollywood are mining towns within its borders. The deepest part of the basin is at Lattimer where the Mammoth bed is about 400′ below the surface at the syncline; the basin widens as it raises towards the west and is divided into three or four sub-basins by

* Bed sections on page plate 339.
† Page plate 334 also shows relative location of the division.
‡ Page plate 340 gives reduced cross sections of the basin.


PL. 338.
Anthracite Region _ Eastern Middle Coal Field.
UPPER LEHIGH BASIN No.5
SLOPE No 5
UPPER LEHIGH BASINS - UPPER LEHIGH COLLIERY No.2.
No 1 BASIN
No 2 BASIN
No 3 BASIN
POND CREEK BASINS - POND CREEK COLLIERY
BUCK MOUNTAIN BED
ALPHA BED
Pottsville Conglomerate No VII
Mauch Chunk Red Shale No XI
WOODSIDE BASIN
Road
CROSS CREEK BASIN - SECTION No.33.ON MINE SHEET No.V. THROUGH SANDY RUN COLLIERY.
SANDY RUN
SLOPE No 2
SLOPE No 1
CROSS CREEK BASIN SECTION No 6 THROUGH HIGHLAND SLOPE No 1 AND No 2 WORKINGS
BUCK MOUNTAIN BED
CROSS CREEK BASIN SECTION No 7 THROUGH DRIFTON SLOPE No 2.
DRIFTON BASIN
DRIFTON
Scale 800'=1"

Anthracite Region_Eastern Middle Coal Field.

BED SECTIONS



SCALE 20'- 1"

the introduction of the same number of anticlinals, one of which is overturned, the cross sections illustrate this quite fully, the basin terminates in two prongs.

No. XII has been drilled through at the Lattimer colliery (see sec. 12 col. sec. sheet I) with a thickness of 240′ to "green sand rock and red shale," it is composed mostly of conglomerates with but little sandstone; *two* small *coals* 5″ and 12″ thick are cut at 80′ and 110′ below the Buck Mountain bed.

The workable coal of this basin is confined almost exclusively to the Mammoth bed.

Buck Mountain bed, which, by reason of its large extent and good thickness, is the principal bed of the Cross Creek basin, grows rapidly thinner towards the west and here, for the most part at least, is unworkable. Bore hole records give it a thickness of from 7″ to 3′ 2″.

Between the Buck Mountain and the Mammoth some three or four thin coal beds up to 3′ 10″ thick are seen, but not one of them maintain a persistent workable thickness.

Mammoth bed.—The coal deposits of this basin have centred in the Mammoth bed, which ranges from 35′ to 60′ thick, contains a rather small proportion of refuse and will average about 30′ to 35′ of good coal.* The coal is mostly in large benches, the bottom bench is called the "Wharton" and it seems highly probable that this is the Wharton bed of the Cross Creek basin which at Drifton is but 10′ below the Mammoth (see bed sections 15, 17 and 19 columnar sheet I).

The nearness of much of the bed to the surface permits a great deal of the coal to be won from "strippings," and they are now very extensive. Near the spoon of the basin in some places a perpendicular thickness of 100′ or even more has been exposed; this is due to the doubling together of the bed at the synclinal axis and is of course not its true thickness. The many reports which have been in circulation of a coal bed 100′ thick in this basin were founded on these local thickenings.

* See bed sections on page plate 339.

Above the Mammoth the cross sections indicate a thickness of about 150′ of measures where the basin is deepest, but the Survey has no record of what they consist.

Division 11—Big Black Creek basin.

Mine sheets I, II and V map this basin;* its structure is shown by sections 15 to 21, and 35 and 36 on cross section sheets II and IV;† sections of the measures are published on columnar section sheet II.

This one of the largest and most important of the basins of the field, it lies in the synclinal valley between Black Creek and Council ridges. Eckley, Foundryville, Jeddo, Oakdale, Ebervale and Harleigh are mining towns within its limits. Nearly all the drainage goes west through Big Black creek; Sandy run a tributary of the Lehigh is seen at the extreme eastern end of the division.

The Big Black Creek basin is about 7 miles long and for much of its length 3000′ to 4000′ wide; it terminates at the west in two prongs, caused by the introduction of a small anticlinal, which brings in a little basin of Buck Mountain coal just south of the main basin; at the east it ends in a long, narrow trough. The floor of the eastern half of the basin is traversed by some 3 or 4 small anticlinals; the Eckley overturn is the chief one of these. At one point along its course the Buck Mountain bed has been broken off and the ends shoved by each other forming an overlap; the mine workings have fully demonstrated this. The western half consists of a simple basin with its sides dipping from 10° to 40°. The maximum depth, some 600′ to 700′ to the Buck Mountain trough, is found in this half. The cross sections and mine sheets illustrate very clearly the structure.

Formation No. XII has been drilled through in at least two places, one at Jeddo and the other at Harleigh (see sections 26 and 34 col. sheet II); both holes give nearly the same thickness, 290′ and 295′, made up largely of conglomerate with a few layers of sandstone. These and other

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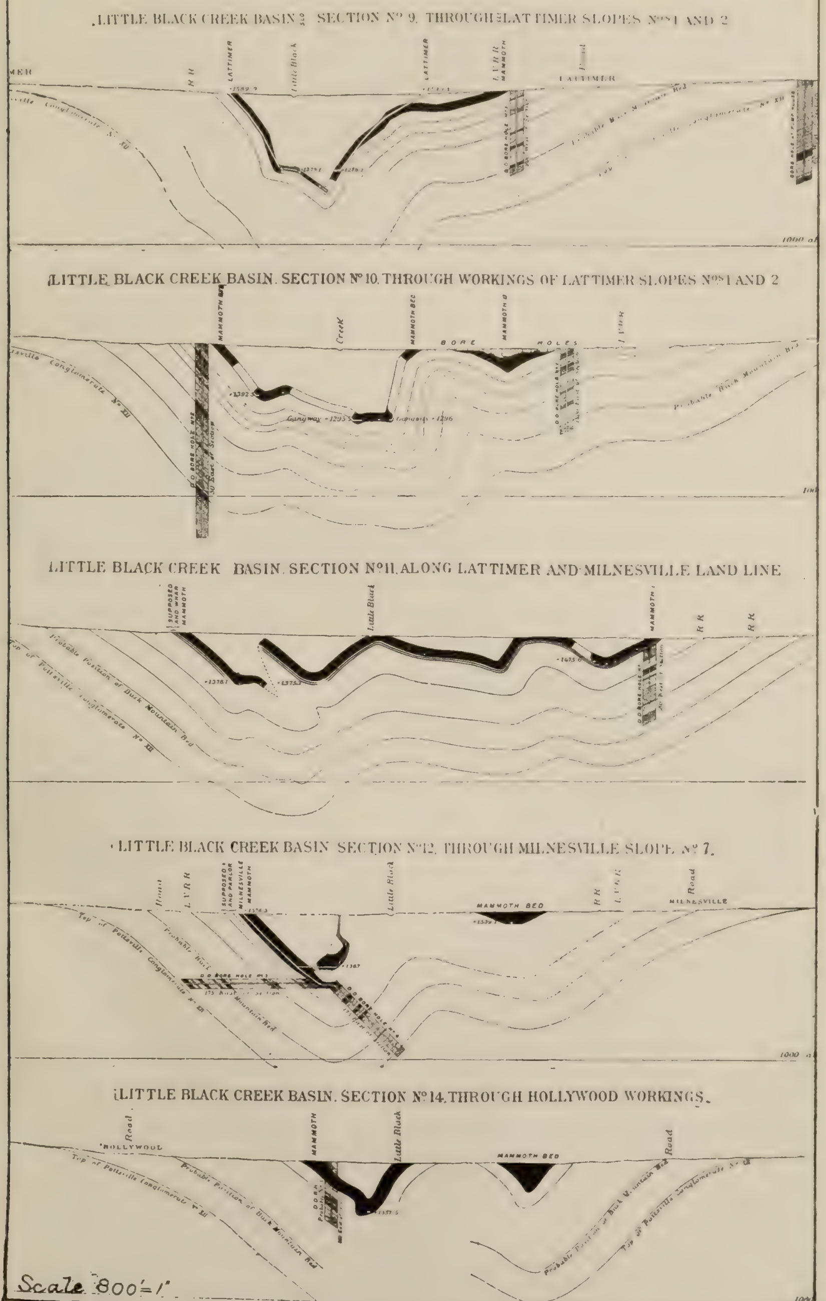
* Page plate 334 also gives relative location of the division.

† Page plate 341 gives reduced cross sections of the basin.

PL. 340.

Anthracite Region_Eastern Middle Coal Field.



borings which have cut below the Buck Mountain bed show one thin coal, *Alpha bed*, 9″ to 2′ 3″ thick at a distance ranging from 50′ to 115′ below the Buck Mountain bed.

Buck Mountain bed, in the eastern half of this division, is a large and valuable coal; but in the western half, particularly beyond Jeddo, No. 3 slope is thin, unreliable and perhaps nowhere of workable thickness and extent. It so happens that the thinning of the Buck Mountain bed takes effect near the first appearance of the Mammoth bed, and as the intervening beds are of but little value, the basin practically contains but one workable coal, the Buck Mountain in the eastern half and the Mammoth in the western.

The Buck Mountain bed at Jeddo, Nos. 2 and 5, at Eckley and at Buck Mountain No. 4 slope, has a thickness of 10′ to 25′, the increase being towards the east. At the No. 4 slope the bed is worked in two splits which are separated by 2′ to 10′ of slate. The average thickness for the workable area is perhaps 15′ with 12′ of coal.

Gamma and Wharton beds are mostly thin, or unreliable and apparently only a small portion of the area underlaid by them is workable. No effort has been made to work the *Gamma* bed. The *Wharton* is opened, at the Harleigh colliery, 5′ to 7′ thick at 20′ to 30′ below the Mammoth; it seems to be workable as far east as slope No. 3 Ebervale, but nothing very encouraging has been developed beyond that.

Mammoth bed basin* has a length of some 3½ miles with an outcrop width of about 2000′. The bed here, as elsewhere in the field, has a large thickness and the coal is of excellent quality; its thickness varies from 20′ to 35′ divided mostly into large 6′ and 7′ benches of solid coal, and carries in all a fairly small percentage of refuse. The bed in this basin probably averages 20′ in thickness of good coal.

Above the Mammoth there are 200′ to 300′ of measure at the most, with the exception of the first 100′ the Survey has no record of them.

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* Bed section on plate 339.

West of the spoon of the Black Creek basin and between Black Creek and Council ridges, *three or four small patches of Coal Measures* are found. These measures have been tested at a number of points by trial shafting and diamond drillings which have found some 2 or 3 coal beds, but all thin and worthless (see records on columnar sheet II). The most southern and western of these areas is shown on mine sheet XI as perhaps containing along Stony creek the Buck Mountain coal bed (and named the Stony Creek basin), but as no coal has been opened here, its value and extent, if it exist, is of course unknown.

A drainage tunnel 15,100′ long, commencing in Butler valley at the north, taps the Little Black Creek and the Big Black Creek basins between the 1040′ and 1060 A. T. level, and will furnish an outlet for a large body of water imprisoned in the old workings and continuous drainage for the new work. Mr. John Markle, President of the Jeddo Improvement Company, which constructed the tunnel, is preparing a paper descriptive of the tunnel for publication in the Transactions of the Am. Inst. Mining Engineer and the full details will probably then be given.

Division 12—Black Creek—Roberts Run basins and McCauley basin.

The coal areas covered by this division are mapped on mine sheets XI, XIII, XIII*a*, XIV and XIV*a**; the structure of the basins is shown by sections 46—50 on cross section sheet VI†; sections of the measures are published on columnar section sheets VI and VII‡.

Some two miles west of the Big Black Creek basin, in the same general synclinal and underlying the valley of Black creek, three long narrow coal areas, briefly separated by short sharp anticlinal axes, are found. These areas are known as the (East) Black Creek, (West) Black Creek and Roberts Run basins; their combined length is 11 miles with a maximum width of half a mile.

McCauley basin is a wholly separate coal area, caught near the top of the McCauley synclinal mountain, some four miles northwest of the Roberts Run basin.

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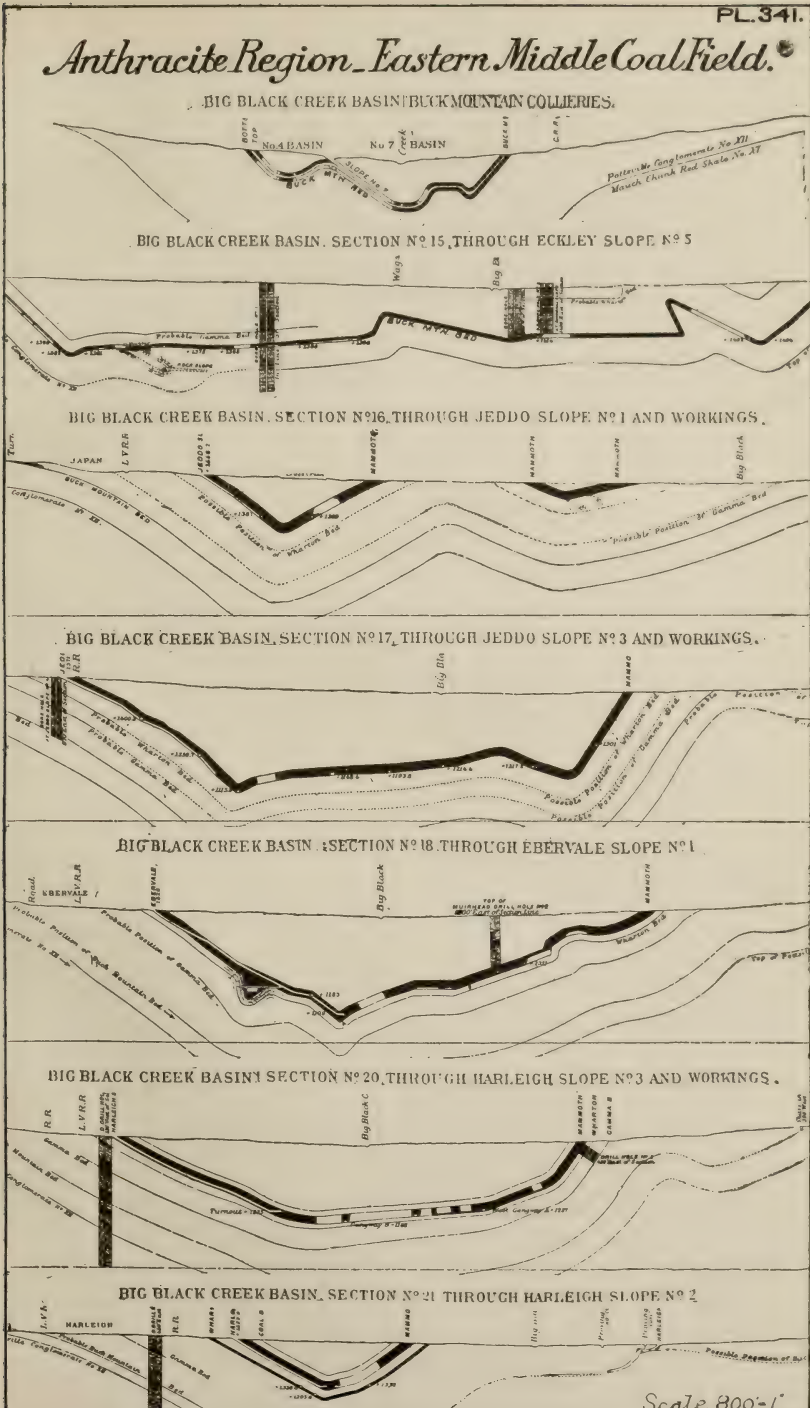
* Page plate 334 also gives relative location of this division.
† Page plate 342 gives reduced sections showing structure.
‡ Page plate 337 gives a reduced section showing measures.


PL. 341.
Anthracite Region_Eastern Middle Coal Field.
BIG BLACK CREEK BASIN BUCK MOUNTAIN COLLIERIES.
No.4 BASIN
No 7 BASIN
BUCK MTN BED
Pottsville Conglomerate No XII
Mauch Chunk Red Shale No XI
BIG BLACK CREEK BASIN. SECTION No 15, THROUGH ECKLEY SLOPE No 5
Probable Gamma Bed
BUCK MTN. BED
BIG BLACK CREEK BASIN. SECTION No 16, THROUGH JEDDO SLOPE No 1 AND WORKINGS.
JAPAN
L.V.R.R.
MAMMOTH
Big Black
BUCK MOUNTAIN BED
Possible Position of Wharton Bed
Possible Position of Gamma Bed
BIG BLACK CREEK BASIN. SECTION No 17, THROUGH JEDDO SLOPE No 3 AND WORKINGS.
Probable Wharton Bed
Probable Gamma Bed
Possible Position of Wharton Bed
Possible Position of Gamma Bed
BIG BLACK CREEK BASIN. SECTION No 18 THROUGH EBERVALE SLOPE No 1
Road
EBERVALE
L.V.R.R.
Big Black
MAMMOTH
Probable Position of Gamma Bed
Probable Position of Buck Mountain Bed
Wharton Bed
BIG BLACK CREEK BASIN. SECTION No 20, THROUGH HARLEIGH SLOPE No 3 AND WORKINGS.
R.R.
L.V.R.R.
Big Black C
MAMMOTH
WHARTON
GAMMA B
Gamma Bed
Mountain Bed
Conglomerate No XII
BIG BLACK CREEK BASIN. SECTION No 21 THROUGH HARLEIGH SLOPE No 2
L.V.R.
HARLEIGH
R.R.
Probable Buck Mountain
Conglomerate No XII
Gamma Bed
Possible Position of
Scale 800'-1"

Black creek turning north at Gowen has cut a deep gorge through West Buck mountain and flows out of the coal measures on towards the Susquehanna. Roberts run drains the short, rather steep valley of coal measures as they rise west of Gowen. Black Ridge, Tomhicken, Derringer and Gowen are small mining towns in the Black creek valley.

The rim of *No. XII*, surrounding the Black Creek basins is a broad one, especially so on the north, where it is a mile wide to the saddle of the West Buck Mountain anticlinal, and another mile to the outcrop of XII on the north side of the shallow basin, beyond. This basin west of the Black creek gorge, along Falls run, is perhaps deep enough to contain a small area of the Buck Mountain bed, although it has not been demonstrated. No. XII where cut through at Gowen has a thickness of 200′ of coarse conglomerate and sandstone to a green sandstone taken to be the top of No. XI.

(*East*) *Black Creek basin** has at its eastern end an overturned axis which causes the basin to terminate in two prongs, the southern one being the longer; westward this axis soon dies down. The basin is about 3 miles long and 1200′ wide, with south dips ranging from 20° to 40° and northerly dips of 10° to 20°.

The same thin and mostly worthless state of the *Buck Mountain bed*, which was noted in the Little Black Creek and in the western half of the Big Black Creek basin, prevails throughout the eastern part of this basin; but near the west end at the Tomhicken colliery the bed once more reaches a workable condition and has a thickness of 4′ to 8′, but is still inclined to be irregular.

Gamma bed is not recognized in this basin.

Wharton bed is unusually near the Buck Mountain and interval of only 20′ to 40′ separating them, it is worked at the Tomhicken and Black Ridge collieries with an average thickness of about 8′, but at times it is high in refuse.

Mammoth bed only some 30′ above the Wharton is at the Black Ridge colliery in two splits, 40′ apart, the upper

* See cross sections at Black Ridge colliery page plate 342.

split is about 6′ thick and the lower one 8′; at Tomhicken* The splits are together making a bed about 12′ thick. The Mammoth is the highest bed of this basin and there are only about 60′ of measures above it.

The greatly reduced interval between the Mammoth and Buck Mountain beds and the total absence of the Gamma bed makes the identification of the beds of the (East) Black Creek basin, as assumed, a matter of some uncertainty, although it appears to be the most probable one.

(*West*) *Black Creek basin* is just west of the (East) Black Creek basin and separated from it by a short anticlinal axis along whose side the Buck Mountain bed outcrops. It is the largest of the three basins and is some 5 miles long and about 2000′ wide. Two anticlinal axes range along its central and western part, the northern and large of these exhibits a very pronounced overturn (see section 48 and 49 cross section sheet VI). It is this overturned axis which divides the long narrow western prong of the (West) Black Creek basin from the Roberts Run basin lying to the north and west.

Alpha bed of No. XII is represented by a few inches of coal but suggests no probability of a workable thickness.

Buck Mountain is the chief bed of the basin owing to an improved condition and its greater extent, its thickness varies from 4′ to 10′ and it will probably average 6′ of coal for the area.

Gamma bed at 30′ to 50′ above the Buck Mountain is but 2′ to 3′ thick and not worked.

Wharton bed here 100′ to 150′ above the Buck Mountain is a good bed averaging about 7′ 6″ in thickness and extensively mined at both the Derringer and Gowen collieries.

Mammoth bed has a small basin narrow and long north of Derringer colliery, and another little area south of Gowen ; its thickness varies from 10′ to 14′, at places in two splits with a thin slate between, the upper split is rarely worked, the average yield of the bed is perhaps 8′ of clean coal. The Mammoth is the highest coal of the basin and is found 30′ to 50′ above the Wharton bed.

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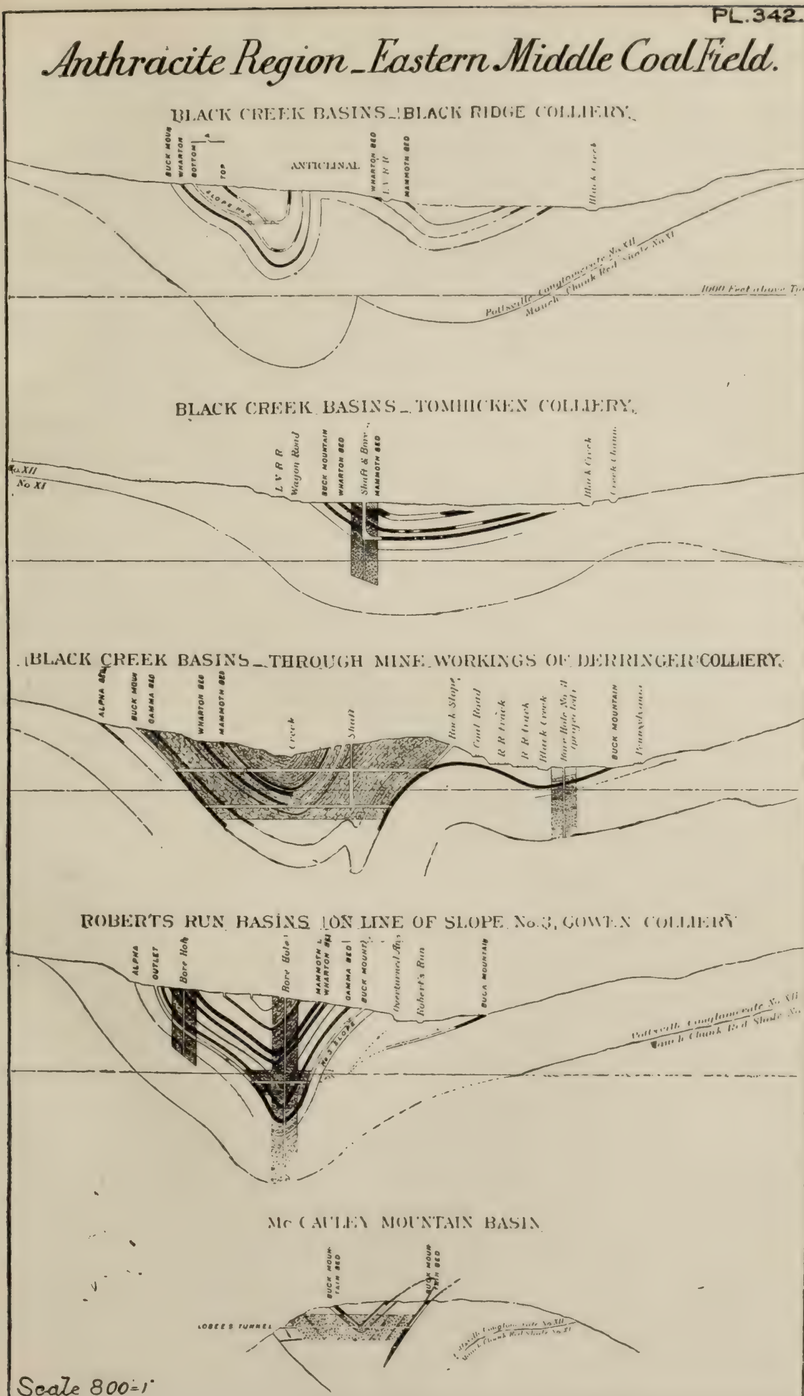
* See cross section page plate 342.


PL. 342.
Anthracite Region _ Eastern Middle Coal Field.
BLACK CREEK BASINS _ BLACK RIDGE COLLIERY.
ANTICLINAL
BLACK CREEK BASINS _ TOMHICKEN COLLIERY.
BLACK CREEK BASINS _ THROUGH MINE WORKINGS OF DERRINGER COLLIERY.
ROBERTS RUN BASINS ON LINE OF SLOPE No. 3, GOWEN COLLIERY
Mc CAULEY MOUNTAIN BASIN.
LOBEES TUNNEL
Scale 800=1"

*Roberts Run basin** extends from Gowen up the valley west for at least two miles (the precise spoon of the basin is not yet determined) with a general width of about 800′. The north dips of the basin are from 50° to 60° and the south dips 30° to 40°; the structure is simple; one small roll near the trough of the basin has been developed. The coal beds have much the same section as in the preceding basin.

Buck Mountain bed is still further improved in size and is 11′ to 12′ thick.

Gamma bed thin and unworkable.

Wharton bed diminished to about 5′ in thickness.

Mammoth bed has an average thickness of about 11′.

The Mammoth, Wharton and Buck Mountain beds are worked by the Gowen colliery. The surface and the measures rise rapidly towards the west.

† *McCauley basin:*—Four miles northwest of the Roberts Run basin the McCauley synclinal mountain, surrounded on all sides by the red shale country, looms up prominently. Formation No. XII which caps this mountain has preserved in its trough a deep narrow basin of *Buck Mountain coal* more than a mile long and about 400′ wide.

Buck Mountain bed has here an average thickness of about 14′; its area has been almost wholly mined over; the workings develop a curious overturn or overlap of the bed (see section 50 cross section sheet VI).

A thin coal (Alpha bed) *below* the Buck Mountain has been opened, at several places on the mountain, east of the Buck Mountain outcrop, in what have thus far been unsuccessful efforts to find additional areas of Buck Mountain coal; it is quite possible that an undiscovered area of the bed may exist but its extent certainly cannot be very great or some of the numerous trial shaftings would have found it.

*See cross section on page plate 342.

†See cross section on page plate 342.

Division 13—Hazleton basin.

This division is mapped on mine sheets I, II, V and IX*; the structure of the basin is shown by sections Nos. 22-29 cross section sheet III, No. 36 sheet IV and No. 45 sheet V†; sections of the measures are published on columnar sheet II and VI‡.

The Hazleton is the largest of the Eastern Middle basins, both in surface area and estimated coal contents. It lies in the synclinal valley between Black Creek and Council ridges; its length is 14 miles extending from within 4 miles of the Lehigh to 4 miles beyond Hazleton; the greatest width, one mile, is at Hazleton; the basin narrows slowly in both directions; from Lumber Yard east it is a long narrow trough which widens out somewhat before spooning. The Lehigh-Susquehanna divide 1600 A. T. crosses the basin at Hazleton, the principal town of the field. Hazle creek drains east and Cranberry creek and Long run drain west into Black creek. Stockton, Crystal Ridge and Humboldt are small mining towns in this division.

The basin reaches its maximum depth under Hazleton, where the Mammoth in the trough is 1000′ below the surface; the total thickness of the coal measures is about 700′. The mine workings in this neighborhood have developed an unusually confused and distorted condition of the strata at the bottom of the basin (see cross sections 25§ and 26 sheet III). West of Hazleton the measures rise rapidly, the dips lessen, two or three well developed anticlinals appear and the basin terminates in a double prong. Regular dips up to 50° or 60° are common; the south dips are generally the steeper; the numerous cross sections show clearly the general structure.

Formation No. XII is pierced by three bore holes (49, 50 and 61, col. sheet III) in the neighborhood of Hazleton; it has a thickness of 260′ to 290′ to the first "green sandstone,"

* Page plate 334 gives relative location of this division.
† Page plate 343 gives reduced sections showing structure.
‡ Page plate 337 contains a reduced section of the measures.
§ Section 25 is given on page plate 343.

which is probably, but not certainly, at the top of No. XI. The *Alpha bed*, thin and unworkable, is cut at a number of points; it is not always persistent.

Buck Mountain bed, as is usual in this field, has its greatest thickness at the east near the Lehigh; here the old Buck Mountain colliery* worked the bed in two splits each 10′ to 15′ thick with 10′ to 20′ of slate between; the Lumber Yard-Buck Mountain axis is developed in these workings; it is here overturned, and at one point there is an important "overlap," so that south dip workings are under north dip workings, and the two parts of the bed nearly parallel for several hundred feet. At the next colliery west, the Hazle Brook, the Buck Mountain bed is extensively worked; on the north side of the basin the bed is in two splits, each 6′ to 8′ thick, dipping 35° to 70°, on the south side of the basin the splits unite and make one bed 6′ to 10′, dipping 30° to 40°. West of the Hazle Brook colliery—which is near Lumber Yard—the bed is generally conceded to be thin and poor, and much of its area is certainly unworkable. Since the publication of the mine sheets a tunnel has been driven to it at the Hazleton colliery, also one at the Humboldt colliery (recently abandoned). The bed runs up at times to 6′ and 8′ in thickness.

Gamma bed, some 30′ to 60′ above the Buck Mountain, is throughout the basin a thin, dirty bed, 2′ to 7′ thick, and although now worked to a small extent at a number of the collieries is as a rule poor, and quite variable as to its thickness and yield of coal.

Wharton bed is in fairly good condition for its whole extent and will probably average 6′ in thickness; it is particularly good at the west end of the basin, and at the Mt. Pleasant and Humboldt collieries it is 7′ to 9′ thick. Nearly all the collieries mine this bed; the interval between it and the Buck Mountain varies from 100′ to 150′.

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* Messrs. Coxe Bros. & Co. are re-opening this colliery and expect to win a great deal of coal, chiefly by stripping. Their explorations have developed an error in the location of the east gangways so that the basin is really a couple of hundred feet wider near the east end, and it is now known to extend 1000′ ± further east, than is shown on the mine sheet.

Parlor bed some 10′ to 30′ above the Wharton is generally supposed to be a split of that bed. West of Hazelton it appears to be persistent as a separate bed throughout this basin ; but east of Hazleton it is rarely seen and is of little or no consequence. Thus far it has been worked only to a small extent, its thickness varies from 3′ to 8′, and it is apt to carry considerable refuse.

Mammoth bed easily maintains in the Hazleton basin its well merited reputation for thickness and excellence of quality, the bed is 20′ to 40′ thick and will average 20′ of marketable coal. Mine workings now practically develop its entire extent,* the shape of its basin is accurately shown on the mine sheets by underground contouring. The large thickness of the Mammoth offers special inducements for the "stripping" of the bed and where ever practicable this is done.

The changes in thickness of the interval, consisting mostly of sandstone, between the Mammoth and Wharton bed are worthly of special note ; at the east end of the basin this distance is about 80′, near the middle of the basin about Hazleton the interval is only 40′, but from here to the west spoon, only one and a half miles beyond, the interval shows a rapid and regular increase and at the west end of the basin the beds are separated by a distance of 200′†. The mine working prove conclusively that variations in this interval is due to a difference in the quantity of material deposited and not to local rolls or bulging of the strata.

Primrose bed is found in the deeper parts of the basin about Hazleton at 140′ to 160′ above the Mammoth, it has a thickness of 4′ to 8′, rather variable in its composition ; the bed is worked to a small extent.

Another coal bed is found about 100′ above the Primrose, not always of workable thickness, at the best it is but 4′ to 5′ thick, and has been opened at but two or three places.

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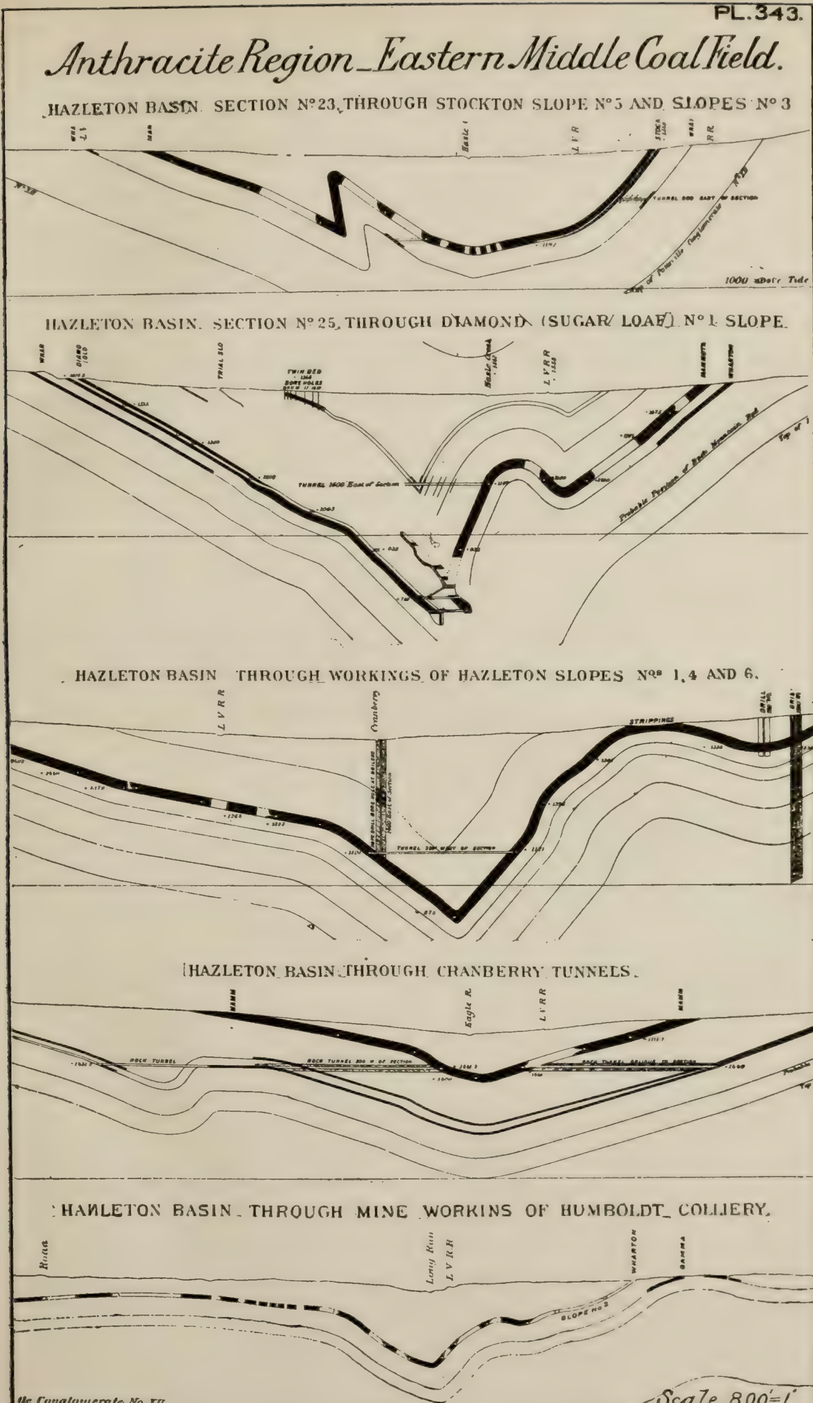
*Since the publication of mine sheet I a shallow basin of Mammoth coal was discovered between the Hazle Brook colliery and the eastern spoon of the main Mammoth basin, the coal lay just under the wash and was mined by stripping, this basin is about 2000′ long and 200′ wide at the most.

† Cross section on page plate 343 illustrate this.


PL. 343.
Anthracite Region_Eastern Middle Coal Field.
HAZLETON BASIN. SECTION N° 23, THROUGH STOCKTON SLOPE N° 5 AND SLOPES N° 3
1000 above Tide
HAZLETON BASIN. SECTION N° 25, THROUGH DIAMOND (SUGAR LOAF) N° 1 SLOPE.
TUNNEL 1600 East of Section
HAZLETON BASIN THROUGH WORKINGS OF HAZLETON SLOPES N°s 1, 4 AND 6.
STRIPPINGS
HAZLETON BASIN THROUGH CRANBERRY TUNNELS.
ROCK TUNNEL
HAZLETON BASIN THROUGH MINE WORKINS OF HUMBOLDT COLLIERY.
SLOPE No 3
Scale 800'=1"

Above this there are at the deepest part of the basin perhaps *200′ of measures*, apparently without workable coal beds.

Division 14—Dreck Creek and Beaver Meadow basins.

Mine sheet VII, VIII and X map the area covered by these basins ;* the structure is shown by sections 37 to 42 on cross section sheets IV and V;† sections of the measures are published on columnar sheets IV, V and VI.‡

Dreck Creek basin is next south of the Hazleton basin and high up in a shallow synclinal valley between the Catawissa and Pismire ridges. The Buck Mountain bed is supposed to throw a narrow saddle over both these anticlinal ridges and thus form a connecting link between the important Hazleton and Beaver Meadow basins. Dreck creek flows east through the eastern half of the basin and four small branches of Cranberry creek either cross or originate in the western half. The basin is supposed to be about 5 miles long and about 2000′ wide, with gentle dips of 10° to 20° on both sides, its depth at the most is 300′ to 400′ and it probably contains the *Buck Mountain*, *Gamma* and *Wharton* beds. There are no mine workings in this basin and the developments are confined to some three or four bore holes and about the same number of trial shaftings on coal. Three bore holes along Dreck creek (see sec. 17 sheet V, sec. 5 and 7 sheet VI) cut three or four thin coal beds, none of which however are workable. Some explorations have also been made in the western part of the basin but apparently without better results.

Beaver Meadow basin is used to designate *all* of the large coal area south of Pismire ridge, between it and Spring Mountain. Several anticlinal axes divide this area into a number of sub-basins and the name Beaver Meadow basin is often used in a more restricted sense.

Beaver Meadow, Coleraine, Tresckow, Jeansville, Audenried and Beaver Brook are mining towns within this area.

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* Page plate 334 also gives relative location of the division.

† Page plates 344 and 345 give reduced sections showing structure.

‡ Page plate 337 gives sections of the measures.

The Lehigh-Susquehanna divide crosses the basin between Jeansville and Audenried; Beaver creek drains east, Beaver brook and Hunkidori creek flow west.

The total length of the coal basin is about six miles and for much of its length it has a width of one mile. It is broken up into a number of smaller basins by numerous anticlinals of varying length and importance, some of these axes are sharply overturned and a number of "overlaps" occur.* What, at first glance at mine sheet VIII, appears to be an impossible state of affairs is seen north of Tresckow, where the overturning of the Yorktown axis makes it appear as if the mine workings of the Wharton bed passed from the Coal Measures into Formation No. XII, when really the coal bed is for a short distance vertically below part of XII although of course in geological order still above. The shape and extent of the sub-basins are best understood by referring to the mine and cross section sheets.

No. XII sends eastward a long narrow basin, some 4 miles beyond the coal measures, which terminates east of Hazle creek; its southern rim varies from a few hundred feet to half a mile in width, depending chiefly on the degree of dip; the broad western spoon lifts out about the headwaters of Spies run a mile beyond the Buck Mountain outcrop. Outcrops of No. XI surround the basin on all sides except the north. No. XII has a thickness of about 300′; section 13 columnar sheet V gives a complete section; the lower 200′ is almost wholly conglomerate; "black slate" followed by "green sandstone" seems to indicate the bottom of the formation, while the "green sandstones" and thin "conglomerate beds" which follow might properly be classed as transition measures.

Alpha bed in No. XII reaches a workable thickness at the northwestern spur of the basin beyond Beaver Brook; the full extent of the workable thickness is not yet developed; where cut by bore holes Nos. 1 and 2 it is 4′ to 6′ thick; it seems to be presistent over the whole basin but generally not more than a foot or two thick.

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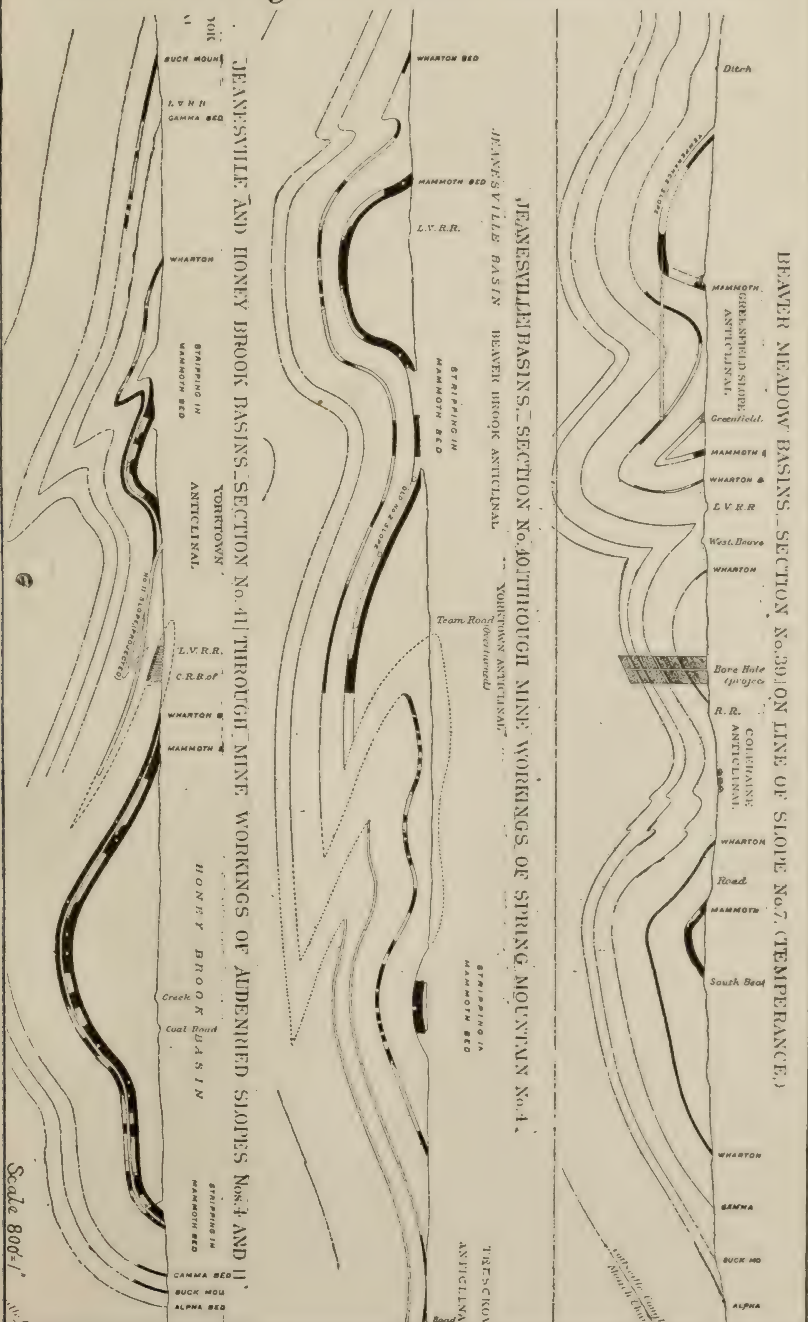
* See cross sections on page plate 334.

PL. 344.

Anthracite Region_Eastern Middle Coal Field.



Buck Mountain bed can hardly be regarded as first class over any considerable area in this basin. The most extensive working of it is at the Beaver Brook collieries at the west end of the basin, and at the new Evans colliery northeast of Beaver Meadow on the Robert Clark tract. The bed has been proved by borings at a number of points scattered over the basin (see columnar sections); about Audenried it frequently reaches a thickness of 6′ to 8′ or even 10′ but much of this thickness is composed of slate and bony coal; near Beaver Meadow the borings show from 3′ to 7′ of coal in the bed. The eastern limit of the bed along Beaver creek is only approximately known and is supposed by some to extend further east than is shown on the mine sheet.

Gamma bed is found 50′ to 100′ above the Buck Mountain; it is generally a double bed; the two benches 2′ to 6′ thick each are sometimes 20′ apart; its thickness and composition are quite variable and it seldom yields more than 3′ or 4′ of good coal. At the time of publication of the mine sheets (1889) the bed was practically untouched; since then it has been opened at several points; where now worked at the Beaver Meadow colliery the bed is 5′ to 10′ thick with about 3′ of slate separating the two benches.

Wharton is a good, reliable bed throughout the basin and is extensively worked at all of the operating collieries. Its thickness varies from 6′ to 12′ with probably an average of 8′ with 6′ of coal. In general the bed contains but 2 or 3 partings of slate or bone and the benches of coal are of good size. At Beaver Meadow the Wharton bed is about 100′ above the Gamma and 100′ below the Mammoth; going west the total distance between the Gamma and the Mammoth beds (200′) remains about the same but the interval between the Wharton and Mammoth gradually decreases and at Jeansville and to the west they are but 10′ or so apart.

Mammoth bed is extensively mined for its whole extent, and wherever practicable it is worked by stripping. The bed is in good condition and has a large thickness probably averaging for its entire area 30′ or 35′ and occasionally is found 60′ thick; much of the coal is in large benches sometimes 10′ or 12′ thick.

Above the Mammoth in the deeper parts of the basin there are perhaps at most 200′ of measures, which however are not known to contain any workable coal beds.

15. Green Mountain basins, Nos. 1 to 5.

The area covered by this division is mapped on mine sheets X, XI and XII;* its structure is shown by sections 43 and 44 on cross section sheet VI.† Three sections of the measures are published on columnar sheet VI.

Formation No. XII occupies the high ground of the Green mountain which extends out into the red shale country, west of the Beaver Meadow basin, for some 8 miles with a general width of 2 miles. Several anticlinals, the most prominent of which is the Pismire Ridge axis, traversing the measures parallel to the general strike, have thrown them into a series of waves, along whose crests No. XI sometimes appears and in whose hollows the Buck Mountain and some of the overlying coal beds have been preserved. These coal areas are known as the Green Mountain basins; the principal areas are numbered 1 to 5; their probable shape and extent is shown on the mine sheets.

The drainage is all towards the west through Tomhicken creek and its branches. The new settlements of Oneida and and Nelson City are the only towns of the division.

No. XII outcropping forms high cliffs and ledges along the brow of the mountain. Only the upper 200′ of the formation has been drilled through, this is composed largely of hard conglomerate with some thin layers of sandstone; the cross sections give the full thickness of No. XII at about 300′.

Alpha bed has been shafted at several points but is thin and unworkable.

Basins Nos. 1, 2 and 3 are south of the Pismire Ridge axis.

Basin No. 1 is a little outlying patch of the Buck Moun-

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* Page plate 334 also gives relative location of this division.

† Page plate 345 gives two sections showing structure.

tain bed, near the south brow of the mountain, whose existence is proved by a couple of trial shaftings. The basin is suppose to have an extent of perhaps 1200′ or 1500′ in length and 200′ wide in the middle.

*Basin No. 2**, incorrectly marked No. 3 on mine sheet X, is about a mile northeast of No. 1, its length is abont 2 miles and width 1000′ with a sharply overturned anticlinal throwing a narrow strip of coal just to the north of the main basin. The Buck Mountain bed has a maximum depth of about 500′, the dips towards the north are 60° to 70°, while those towards the south are 40° to 45°. The Green Mountain slope of the Lehigh and Wilkes-Barre Coal Co., is the only operation in the basin. The *Buck Mountain* about 10′ thick is the principal bed, on account of its size as well as its much greater extent; above the Buck Mountain three coal beds 5′ to 10′ thick are found, the middle one of these 6′ to 7′ thick is worked.

Basin No. 3 lies west and in the next trough north of No. 2, it is 2½ miles long and at most 1200′ to 1500′ wide and also has a narrow overturned basin along its northern rim. The basin has a maximum depth of about 600′ with dips of 40° to 45° on both sides. The basin is opened by the Oneida No. 2 slope on the Buck Mountain bed and a new slope Oneida No. 3, near the line between the James Smith and the Christian Troxel tracts, on the south dip of the Gamma bed; tunnels from the slope open the Wharton bed.

Buck Mountain is a good bed with an average thickness of about 10′, but as a rule the coal is in rather small benches separated by slate partings 3′ to 4′ thick.

Gamma bed is quite variable, its average thickness is perhaps 5′, on the south side of the basin it is in two splits with 3′ to 10′ of slate between; the interval between it and the Buck Mountain is about 120′.

Wharton bed some 80′ above is a thin but quite regular bed with a thickness of 4′ to 5′ in the workings.

In the 250′ of measures above the Wharton bed; found

*Cross section on page plate 345.

where the basin is deepest, four rather thin but probably workable beds have been cut, it is supposed that some or all of these coals represent the Mammoth, split into several small beds; owing to their high position in the measures of this basin the extent of the beds is comparatively small.

In the basin next south of No. 3, on the Christian Troxel warrant, a little area of Buck Mountain bed exists, which has been opened by a small trial slope. This basin is not numbered.

*Basin No. 4** is an important area of coal lying along the Big Tomhicken creek in the first basin north of the Pismire Ridge axis. The coal area is about 3 miles long with a width of 1200′ near the west end and narrowing to 400′ or 500′ towards the east. Both sides of the basin dip about 40°. Oneida No. 1 slope (mine sheet XII) opens the coal beds. The *Buck Mountain* is a good regular bed 10′ to 15′ thick with an average thickness of about 12′. The *Gamma bed* 130′ above is 3′ to 6′ thick. The *Wharton*, 40′ to 50′ higher, is a a small bed about 3′ thick; neither the Gamma nor Wharton beds are worked. The *Mammoth bed*, formerly identified as the Wharton, is 20′ to 25′ thick in two splits with about 10′ of slate between. A tunnel north from No. 1 slope opens the Mammoth.

Basin No. 5 is a long, narrow trough of Buck Mountain coal lying along the northern side of Basin No. 4 and only a couple of hundred feet away. It is formed by a sharply overturned axis with the north dips bent over until they incline 45° south. The coal in the south dip is found in good condition and it is mined by a tunnel from Oneida No. 1 slope.

Division 16—Spring Mountain and Silver Brook basins.

The Spring Mountain basin is mapped on the southern part of mine sheets VIII and X; the Silver Brook basins are mapped on mine sheet VIII*a* and IX;† no cross sections of these basins are published.

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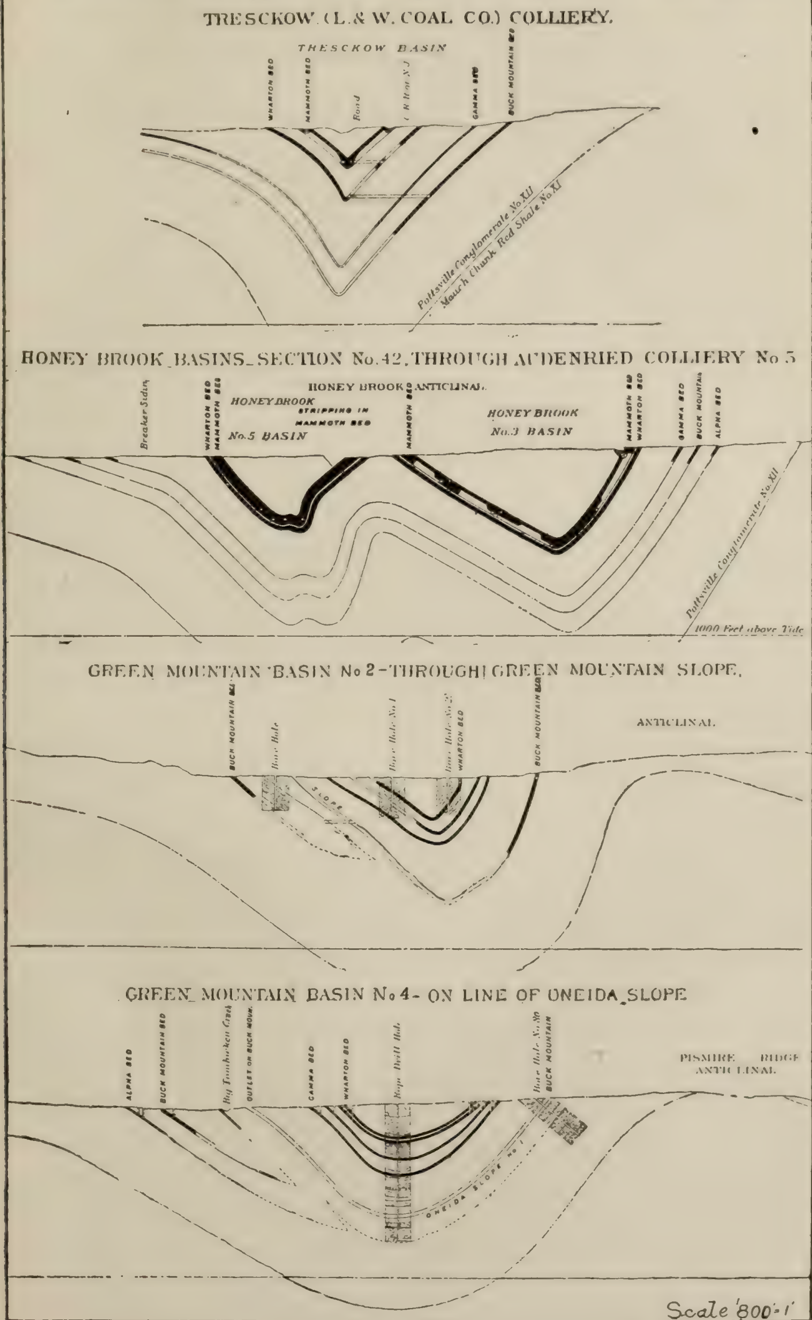
*Cross section of page plate 345.

†Page plate 334 also gives relative location.

PL.345.

Anthracite Region_Eastern Middle Coal Field.



Capping the high lands between the Beaver Meadow and Silver Brook basins there is a long narrow basin of No. XII, apparently with all the coal measures which it once contained carried away by erosion; it is called the *Spring Mountain basin.* Three diamond drill (sections 8, 9 and 10 on columnar sheet VI) located on the headwaters of Spies and probably at or very near the deepest part of the basin cut only No. XII measures with the *Alpha bed* of that formation having a thickness of 2′ at the most.

*Silver Brook basins**, three in number, are found on Head Mountain two miles south of the Beaver Meadow basin. The drainage is mostly south through the Little Schuylkill river. Silver Brook, Old Silver Brook and Lofty are small towns within the division.

No. XII is estimated to be between 300′ and 400′ thick, but no complete section of its measures is available.

Silver Brook basins Nos. 1 and 2 form a coal area about 4 miles long and 2000′ wide, split at the west by an overturned anticlinal which flattens and dies out eastward. The basin north of the overturn is called No. 1 and the one to the south No. 2.

Buck Mountain 6′ to 8′ thick is the principal bed, occasionally it is quite irregular. It is worked extensively from No. 1 colliery and is now also opened by a new slope, on the south dip of No. 1 basin, and 1000′ west of the site of the Old Silver Brook breaker.

A bed supposed to be the *Skidmore* (or Wharton) is also opened by a new slope, at Silver Brook No. 2 colliery, 1000′ southwest of the old breaker; this bed is 6′ to 7′ thick but rather dirty.

Mammoth bed of this basin lies for the most part just below the wash and is extensively mined by "stripping;" its normal thickness is probably 30′ to 40′ but where double together along the axis of the little basins or pots it

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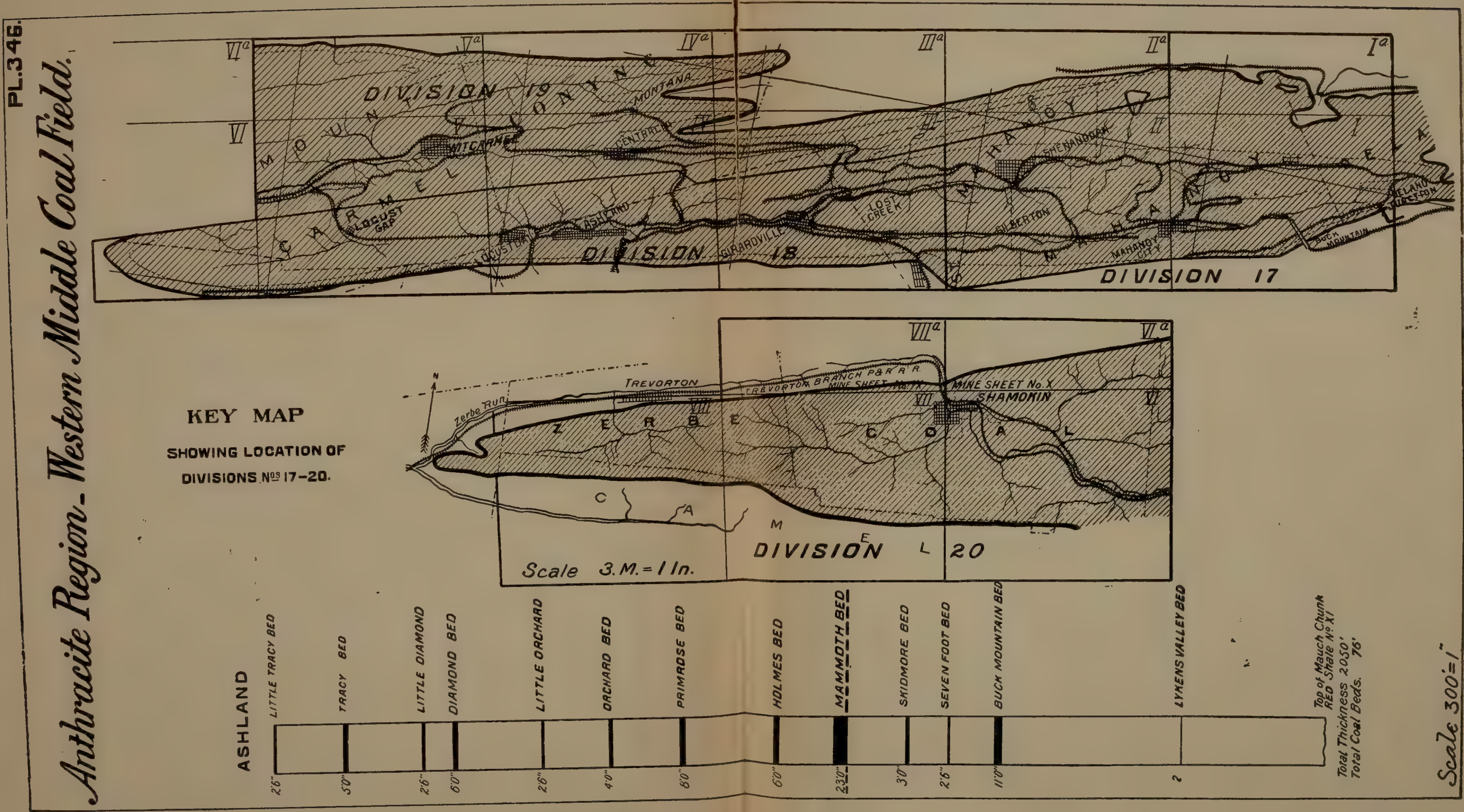
*Although included in the Eastern Middle these basins belong more properly to the Western Middle field, as they are within the outcrops of No. XII surrounding that field, and are separated from the other basins of the Eastern Middle by two anticlinal axes which expose the Mauch Chunk red shale for their whole length.

sometimes has a *vertical* thickness of 100′. In addition to the Mammoth area given upon the mine sheet the bed has been found and worked by stripping in basin No. 2, west to near the little village of Old Silver Brook.

Basin No. 3 is a long narrow coal area, about half a mile south and west of basin No. 2, and south of the Lofty anticlinal axis. The limits of this basin are only approximately known, but it is supposed to be about 600′ wide and 2 miles long. There are no mining operations, the two or three provings of the Buck Mountain bed cut it with a thickness of 5′ to 6′.


PL. 346.
Anthracite Region_ Western Middle Coal Field.
DIVISION 19
MOUNT CARMEL
MAHANOY
MONTANA
CENTRALIA
LOCUST GAP
ASHLAND
LOCUST RUN
DIVISION 18
GIRARDVILLE
LOST CREEK
SHENANDOAH
GILBERTON
MAHANOY CITY
BUCK MOUNTAIN
DIVISION 17
KEY MAP
SHOWING LOCATION OF
DIVISIONS Nos 17–20.
TREVORTON
Zerbe Run
TREVORTON BRANCH P.& R. R.R.
MINE SHEET No. X
SHAMOKIN
ZERBE
COAL
CAMEL
DIVISION 20
Scale 3.M. = 1 In.
ASHLAND
LITTLE TRACY BED 2'6"
TRACY BED 5'0"
LITTLE DIAMOND 2'6"
DIAMOND BED 6'0"
LITTLE ORCHARD 2'6"
ORCHARD BED 4'0"
PRIMROSE BED 8'0"
HOLMES BED 6'0"
MAMMOTH BED 23'0"
SKIDMORE BED 3'0"
SEVEN FOOT BED 2'6"
BUCK MOUNTAIN BED 11'0"
LYKENS VALLEY BED 2
Top of Mauch Chunk
Red Shale No XI
Total Thickness 2050'
Total Coal Beds. 76'
Scale 300' = 1"

CHAPTER CXXI.

Western Middle Coal Field.

The Western Middle field * is about evenly divided between Schuylkill at the east and Northumberland at the west, with Columbia county cutting out a central block four or five miles in length. The field is south and almost wholly west of the Eastern Middle basins with which it is closely associated at the east. It is one large coal area 36 miles long and 4 to 5 miles in width, narrowing at the ends, with two prongs or fingers jutting out a couple of miles eastward from the central portion of its northern rim. The eastern end of the field outcrops on the high divided between the Schuylkill and the Susquehanna, while the western end rounds out in a beautiful high prow 10 miles west of Shamokin and within 5 miles of the Susquehanna. Geologically the Western Middle basins are in the great Shamokin synclinal between the Shade Mountains and Tuscarora anticlinals both of which flatten and divided as they come east from the Susquehanna.

The eastern half of the field is drained by Mahanoy creek which breaks through the Mahanoy mountains south of Ashland and continues its westward course in the red shale valley on the south. Shamokin creek drains the western half of the field and escapes north through the deep gap at Shamokin.

The mountain rim of conglomerate inclosing the basin has a general elevation of 1500′ to 1700′ A. T. with a maximum elevation of 2100′ A. T. at Bears Head north of Delano; the lowest points in the field are at the Ashland gap 850′ A. T. and at the Shamokin gap 700′ A. T. Locust mountain, with an elevation equal to that of the outer rims, crosses the field diagonally and forms the divide between

* A small map of the field is given on plate 346.

Mahoney and Shamokin creeks; the Phila. and Reading R. R. crosses at Locust Summit, the lowest point in this divide 1246′ A. T. Several ridges, only a couple of hundred feet lower, are found in the interior of the field, the surface of which is in general hilly and broken with rather narrow valleys which have steeply sloping sides. The field is third in size and contains about 94 square miles underlaid by the lowest or Lykens Valley coal bed.

Structure—The Western Middle field is comprised in two principal basins, divided by the great Locust Mountain anticlinal, along whose arch No. XII is exposed for nearly its whole length. This axis which forms the Locust Mountain enters from the southwest, making a red shale cove in the southern rim, crosses the field diagonally at an angle of 10° to 20° with the sides, and with lessened dips passes out of the field into the red shale on the north.

The two basins into which this axis divides the field are of nearly equal size depth and importance. The Mahanoy basin at the east is about 25 miles long from Delano to the spoon some 4 miles west of Locust Gap and some 2½ miles wide near Shenandoah, with a maximum depth of about 2000′ to the basin of the Buck Mountain bed. The Shamokin basin is about 30 miles long from the east end of the Centralia sub-basin to the west end of the field three miles beyond Trevorton, and some three miles wide near Shamokin; the greatest depth of the Buck Mountain bed is perhaps 1800′. Each of these large basins is divided by anticlinals of more or less importance into a number of smaller or sub-basins, (for position and shape of these see mine sheets and cross sections).

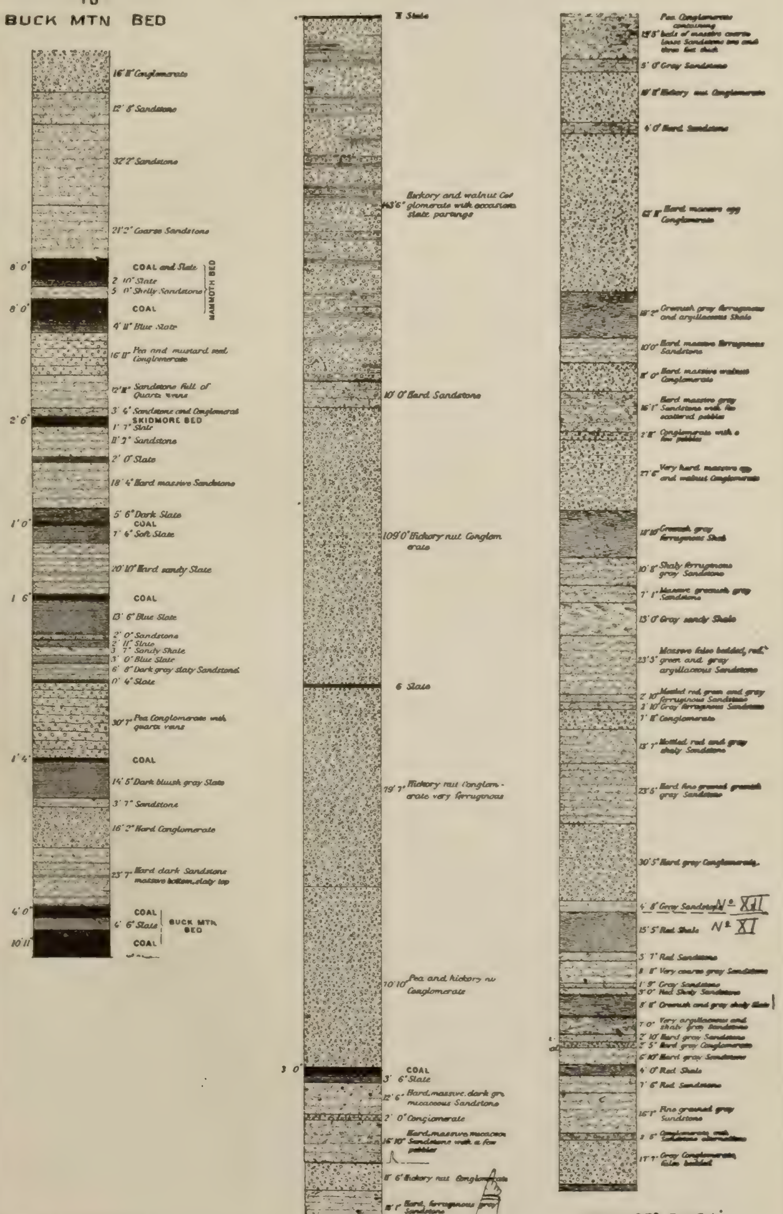
Formation No. XII, as we have said, surrounds the field with a high mountain rim, made more prominent by the deep red shale valleys which frame the basins, save for the brief spaces at the east where No. XII connects with the Eastern Middle and with the Southern fields. The average thickness of the formation is about 850′; the upper half is composed almost entirely of beds of coarse conglomerates, hickory nut and egg size; in the lower half some beds of gray and greenish sandstones and shales appear. One of

Anthracite Region _ Western Middle Coal Field.

EAST MAHANOY RAILROAD TUNNEL

MAMMOTH BED TO BUCK MTN BED

FORMATION Nº XII



Scale 80' = 1"

the best and a complete section is exposed by the East Mahanoy R. R. tunnel through the Mahanoy mountain at the east end of the field; the formation here has a thickness of 830′.* The published cross sections show No. XII to vary from 600′ to 1200′ in thickness, but it seems probable that this wide difference is largely due to insufficient information or to individual preferences in fixing the limit between No. XII and XI, where the transition beds permit of considerable latitude.

Coals of No. XII or the Lykens Valley Nos. I and II beds both of which occur near the central part of the formation and 300′ to 500′ below the Buck Mountain bed. They reach their best development near the west end of the field; at the east they are generally thin aud often but one of them is present. Sometimes one or two additional thin ibeds of coal, but nowhere of workable thickness, are seen n the formation. The place and thickness of the Lykens Valley beds at various points is given in the detail report following.

The *Coal Measures* have a total thickness of 1200′ to 1500′ and contain 10 or 12 workable coal beds. The lower 300′ to 500′ of measures are the most productive and the mining operations have been chiefly confined to them. Nature has been very lavish in this field and especially so in the Mahanoy basin, the beds are nearly all of large size and the intervals between them comparatively small; the Mammoth bed† alone frequently contains 30′ to 50′ of coal.

Condition of the coal beds: The beds are more steeply inclined in this than in the preceeding fields, perpendicular and overturned dips occur along many of the axes; the average dip for the field is perhaps not less than 35° or 40°. The sharp and close folding of the strata exhibited in many of the basins has not been without its effect upon the condition of the coal beds. As the coal is softer than the neighboring slate, sandstone and conglomerate beds, the sliding and shifting of the strata caused by the uplifting

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* This section is given on page plate 347.

† Plate 348 gives two photographs of the Mammoth bed along its outcrop. Plate 349 gives mine interior views.

and folding has had a tendency to crush the coal, to reduce it to a soft dirt, to mix it with the partings of slate and bony coal and to occasion pinched and swollen places in the bed. The steep dipping beds of a close fold may be counted upon to contain a greater proportion of small sized coal, than the same beds on the gentle dips of an open fold. Some of the collieries working the steep dipping beds send half of the coal hoisted into the breaker to the dirt bank.

An average of 1144 bed sections well distributed throughout the field, eliminating all refuse, including bony coal in the refuse, gave an average of 77% of coal and 23% of refuse; but as the best beds are the ones selected to be worked first, it is quite possible that this average is too high and that to estimate 75% or even less as the average proportion of coal, in the beds of this field, is sufficient.

For comparsion with the Northern field where the coal beds are but little disturbed, it should be remembered that in this field the benches of coal of a steep dipping bed are often so much shattered as to make a large proportion of waste in preparation, although their appearance in the mine may properly justify their classification as good coal; this still more increases the difference in favor of the Northern field.

For convenience in description we have divided each of the principal basins into two divisions, making for divisions of the field as follows:—

17. Mahanoy basin, Delano-Shenandoah Division.
18. Mahanoy basin, Lost Creek-Locust Gap Division.
19. Shamokin basin, Centralia-Mt. Carmel, Division.
20. Shamokin basin, Shamokin-Trevorton, Division.

17. Mahanoy Basin, Delano-Shenandoah Division.

This division comprises all the Mahanoy basin from the east end of the field near Delano to the west line of sheet II a mile beyond Shenandoah; it is mapped on mine sheet I, I*a* and II*. The structure is shown by sections 1 to 5 on

* Page plate 346 gives the relative location of the division.

PL. 348.

Anthracite Region_ Western Middle Coal Field.

STRIPPING OF MAMMOTH BED NEAR SHENANDOAH - FROM PHOTOGRAPH BY MR. F. B. HARLAN

THE MAMMOTH BED SHOWING [illegible] - FROM PHOTOGRAPH BY MR. [illegible]

PL. 349.

Anthracite Region – Western Middle Coal Field.

INTERIOR OF AN ANTHRACITE MINE – FROM PHOTOGRAPH BY MR. E. B. HARDEN

INTERIOR OF AN ANTHRACITE MINE. – FROM PHOTOGRAPH BY MR. E. B. HARDEN cross section sheets I and II* and by the contouring of the floor of the Mammoth bed on the mine sheets. Sections of the measures are published on columnar sheets V, VI and VII†. Topographical sheets I and II give the surface elevations in 10 foot contour lines. A Preliminary Report by Hill is found in Annual, 1886, Part III, Ch. III.

Mahanoy City and Shenandoah, both large and prosperous mining towns, are the principal places of the division. The drainage is all towards the west through Mahanoy creek and its branches. Mahanoy creek proper is in the valley close to the southern rim of the field. Shenandoah creek the principal tributary drains a shorter and nearly parallel valley a mile to the north. The surface of the basin is hilly and the valleys are rather narrow with steep sides.

Structure.—The field is closed at the east by a high rim of No. XII, the dip of the measures toward the west is quite rapid. The Mahanoy basin (general) is in this division composed of three principal sub basins; the Shenandoah basin on the north and the Mahanoy sub-basin on the south extend the full length of the two sheets while between the Middle Mahanoy basin on sheet I gives place in a measure to the Ellengowan basin on sheet II.‡ Overturned measures are quite common. The Bear Ridge overturn or the Mahanoy axis is the most important; it commences at the east with regular north and south dips, but going westward the north dips grow gradually steeper becoming perpendicular, and then overturned, until the regular south dip and the inverted north dip are parallel, both inclining about 60° south. The general rise of the measures is towards the east or falling towards the west, the deepest point reached in this area is supposed to be in the Mahanoy sub-basin near Gilberton (sheet II), where the Buck Mountain bed at the axis is about 1600′ below the surface and 400′ below tide; the other basins have a depth of perhaps 300′ or

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* Page plates 351, 352 and 354 contain selected portions of the cross sections.

† Page plates 353, 355 and 356 contain selected columnar sections.

‡ Shape of the basin is perfectly shown by cross sections on plates 351, 352 and 354, also by plate 350.

400′ less. The published cross sections and the contouring of the floor of the Mammoth bed on the mine sheets show very clearly the structure of the division.

Formation No. XII shows a marked increase in its thickness since leaving the Eastern Middle field. The East Mahanoy Railroad tunnel on (sheet 1) furnishes a complete section of No. XII,* also of 300′ of measures at the top of No. XI and of the Coal Measures to above the Mammoth bed. The section measured by the Survey makes No. XII 830′ thick; the upper 600′ is composed almost wholly of beds of coarse conglomerate with pebbles of pea, hickory nut and walnut size, the lower 230′ has less conglomerate and beds of green and grayish sandstone some of them shaly. One coal bed 3′ thick is seen at 415′ from the top.

The outcrop of No. XII on the south side of the field is about one-fourth of a mile wide. The Buck Mountain coal bed outcrops about half way up the mountain side, the conglomerate makes the crest and extends about half way down the southern slope to meet the shales of No. XI. The dips towards the north are 30° to 50°. South of Mahanoy City the Western Middle and Southern fields are connected by a broad band of conglomerate, which saddles over the axis to dip under the New Boston basin of the Southern field.

On the north side of the field a broad outcrop of conglomerate, a mile in width with gentle dips, caps the mountain; the Buck Mountain outcrop is low down on the south side, and the Mauch Chunk red shale about half way down the northern slope overlooking the Catawissa valley. This broad sheet of conglomerate extends seven or eight miles northeast of Delano and beyond the limits of the Western Middle field and holds the coal basins at Silver Brook which are included in the Eastern Middle field. Bears Head, a knob of No. XII, a mile north of Delano, has an elevation of 2100′ A T and is one of the highest points in the anthracite region.

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* Given on page plate 347, original on col. section sheet VIII section II.

PL. 350.

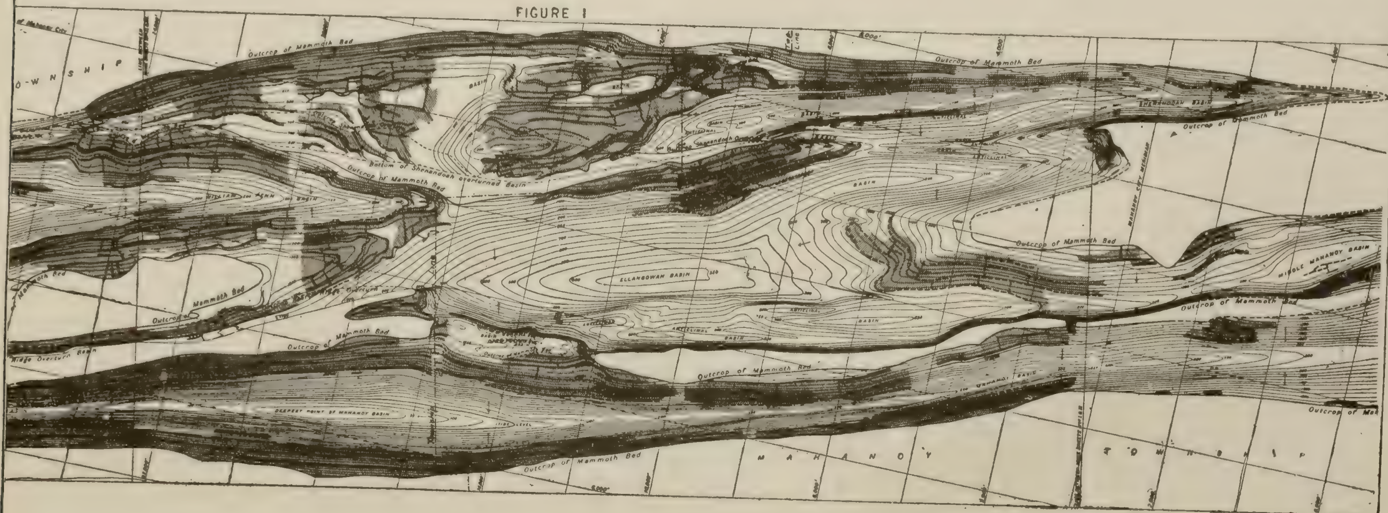
MAP SHOWING

THE SHAPE OF THE FLOOR OF THE MAMMOTH BED

IN THE

EASTERN END OF THE WESTERN MIDDLE COAL FIELD

FIGURE 1



Coal Measures of this division have a maximum thickness of about 1000′ and contain ten or eleven coal beds of workable thickness. That part of the field covered by mine sheet II is probably richer in coal than any similar area in the anthracite region. Twelve workable beds, all over 5′ thick, counting three splits for the Mammoth, have an aggregate average thickness of 113′, containing about 87′ merchantable coal; and the greatest depth of the lowest coal bed is but 1500′.

Coals of No. XII:—The Lykens Valley beds, usually two in number, reach their best development near the west end of the field. In this division they are represented by a single bed found 400′ to 500′ below the Buck Mountain; the bed although thin appears to be persistent, the coal as a rule is soft or shelly. At the East Mahanoy R. R. tunnel its thickness is 3′; a bore hole for water, drilled horizontally, south from the face of Pott Run tunnel, cut "3′ 8″ of shelly coal" at 500′ below the Buck Mountain. This coal is also shafted along its northern outcrop and has there a thickness of 2′ 6″ to 3′ 6″, but at no place opened does it give good solid coal for its full thickness and, of course, at present cannot be regarded as a workable bed.

Buck Mountain bed, lying on top of No. XII, is a large and valuable coal, worked at nearly every colliery in this division. Its outcrop—given approximately upon the mine sheets*—usually makes a well defined terrace below the first prominent exposure of conglomerate around the inner rim of the field. On mine sheet I the bed is usually 10′ to 18′ thick, with an average of about 13′, with say 10′ of merchantable coal; at the east end of the Mahanoy sub-basin the bed is in two splits, both of them worked, with at times 20′ of slate between. Towards the west the thickness of the bed diminishes; on the east half of mine sheet II it is 10′ to 14′ thick, on the west half 6′ to 10′ thick, with an average for the sheet of about 10′ with 8′ of coal.

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* Recent mine workings from Park No. 2 colliery (mine sheet I) show that between the breaker and Delano, the bed saddles the anticlinal on the south and makes a small basin of Buck Mountain coal not indicated on the mine sheet.

Seven Foot bed, or the Gamma bed of the Eastern Middle field, is at the eastern end of the division a thin coal but 2′ to 3′ thick; it improves however towards the west and at the collieries about Mahanoy City it is worked quite largely with a thickness of 4′ to 8′. On mine sheet II the bed is as yet but little worked, owing chiefly to the abundance of coal in thicker and more reliable beds. It varies from 3′ to 10′ in thickness, with an average of perhaps 5′ to 6′, but occasionally the bed is missing altogether. The interval between it and the Buck Mountain bed shows considerable variation, but in general it is about 80′.

Skidmore bed, or Wharton bed of the Eastern Middle field, is perhaps less variable in its thickness than the Seven Foot, but the workings in it as yet are not extensive; it runs from 3′ to 10′ thick, having an average of about 6′ with 4′ of coal. On sheet II in the Mahanoy sub-basin, this bed is as a rule but 2′ to 4′ thick. Its distance above the Seven Foot is about 60′.

Mammoth bed easily stands first among the coal beds of this field, as well as of the region, and the greater part of the total product of the Western Middle field has been furnished by this bed.

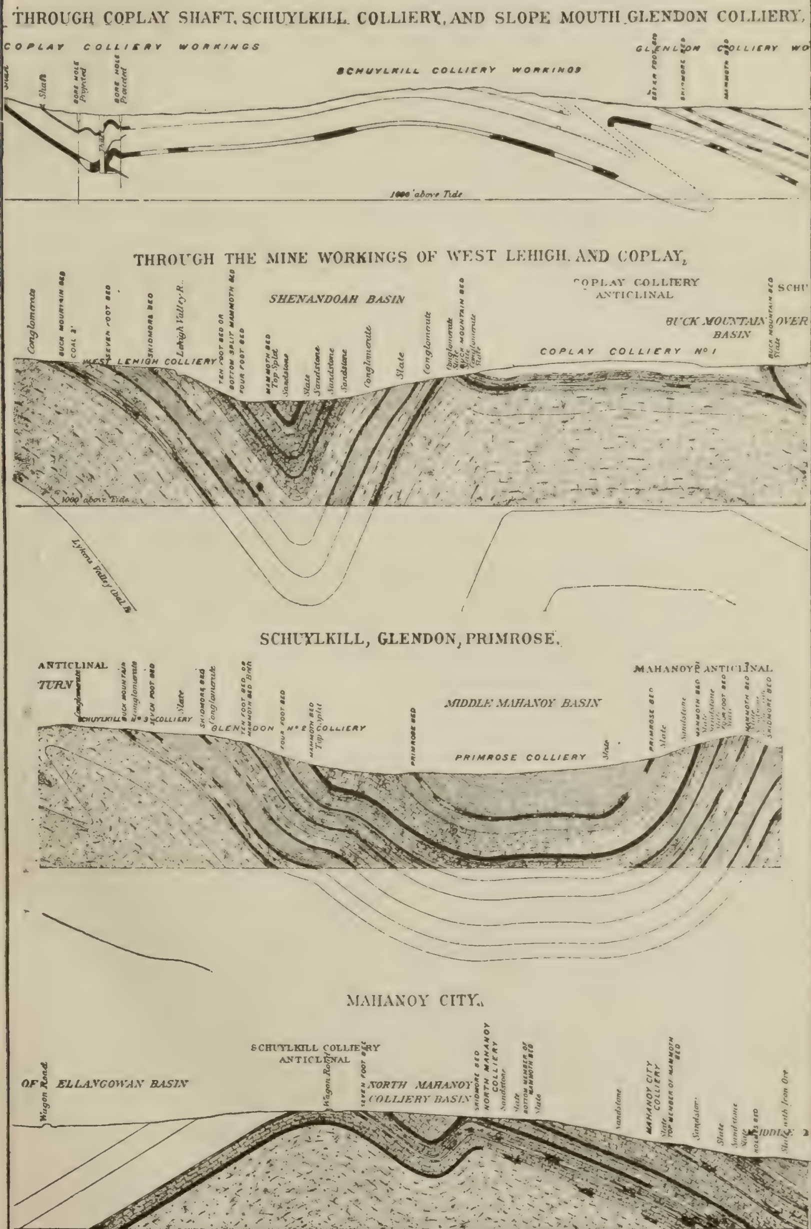
On mine sheet I the Mammoth is usually in three splits, with an interval of 150′ to 200′ between the top and bottom splits. The Bottom split is locally known as the "Ten Foot" bed, the Middle as the "Four Foot" bed, and the Top as the "Mammoth" bed. The Middle and Bottom splits are not in good condition about the eastern end of the Mahanoy sub basin, and the Buck Mountain bed is there worked in preference to them; towards the west the condition and thickness of the bed improves,* and at the collieries north of Mahanoy City the Mammoth is extensivly wrought. The Top and Bottom splits have here a combined thickness of about 30′, sometimes one being the thicker and again the other; the Middle split is as a rule but 3′ to 4′ thick and only occasionally worked.

On mine sheet II the bed maintains a large thickness throughout, the intervals separating the splits grow less and

* Just the reverse of the Buck Mountain bed.

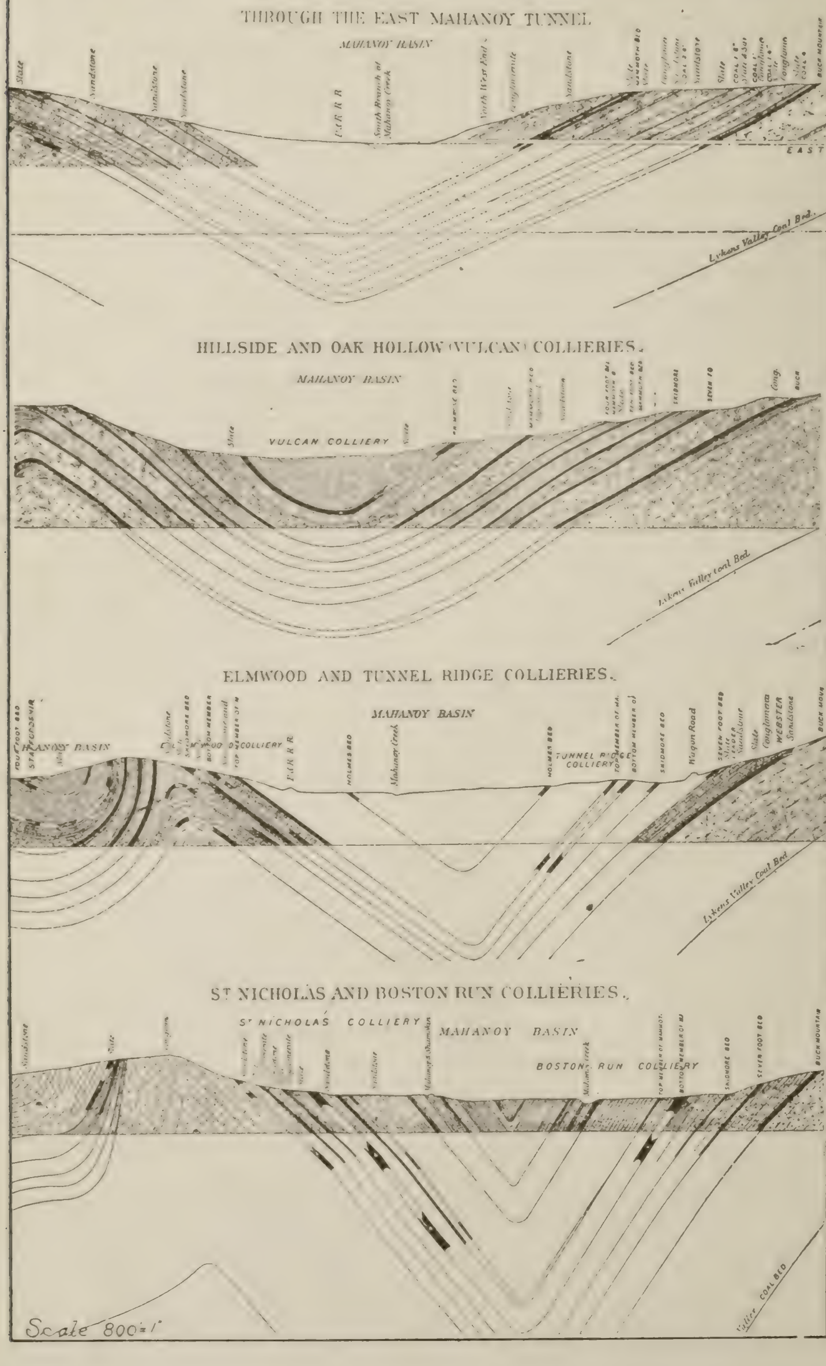
PL. 351.

Anthracite Region_Western Middle Coal Field.



PL.352.

Anthracite Region_Western Middle Coal Field.



the distance between the top and the bottom of the bed is seldom over 100′. The middle split is often absent or united with one of the others; along the western edge of the sheet the splits practically unite and form one great bed 40′ to 60′ thick. For the sheet the bed has an average thickness of about 40′ with say 30′ of good coal. The sections of the bed show many variations but as a rule the benches of coal are large with small slate partings between; the well known excellence of the bed is fully attested by the very extensive mine workings. The bottom of the Mammoth bed is usually 60′ to 80′ above the Skidmore and about 250′ above the Buck Mountain bed.*

A small coal bed between the Mammoth and the Holmes bed sometimes reaches a workable thickness of 3′ or 4′; it is worked at the Bear Run colliery and called there the "Four Foot" bed.

Holmes bed, about 150′ above the top of the Mammoth bed, has but a limited extent on mine sheet I, most of which has been mined over; the bed is 12′ to 14′ thick and yields a good clean coal.† The deepening of the basin towards the west gives on mine sheet II a considerable area of the Holmes bed. It has a thickness of 8′ to 14′ with an average of 11′ yielding 8′ to 9′ of clean coal; on the eastern part of this sheet the bed is cleaner, a little thicker and mined to a greater extent than at the west.

Primrose bed about 100′ above the Holmes is practically confined to mine sheet II; it is worked at a number of places scattered over the sheet and is as a rule a fairly good bed, although occasionally split by a 2′ to 3′ parting of slate; its average thickness is perhaps 8′ to 9′ with 6′ to 7′ of merchantable coal.

Orchard bed about 10′ thick, *Diamond bed* about 8′ thick and *Tracy bed* about 7′ thick are preserved in the high measures along the trough of the Ellengowan basin and are mined to a small extent between Mahanoy City and

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* See sections of the measures between the Mammoth and Buck Mountain beds on plate 355.

† The mine workings on this bed, shown on the mine sheet by a full green line, are locally marked "Primrose" bed.

Shenandoah. The Orchard bed is about 140′ above the Primrose, the Diamond bed some 85′ higher and the Tracy bed about 75′ still higher. The Little Orchard bed 2′ 10″ thick is cut at the Ellengowan colliery some 20′ above the Orchard.

Little Tracy bed about 1000′ above the Buck Mountain bed is caught for a very limited area, in the highest measures of this division, south of Ellengowan colliery.

18. Mahanoy Basin, Lost Creek—Locust Gap Division.

The area covered by this division is mapped on the lower halves of mine sheets III, IV, V and VI, and it comprises the west half of the Mahony basin extending from the west line of sheet II near Shenandoah to the spoon of the basin beyond Locust Gap. The structure is shown by cross sections 6 to 14 on sheets III to VI and by the contouring of the Mammoth bed on the mine sheets. Columnar sections of the measures are published on sheets II to V. Topographical sheets II and III cover the eastern part of the division. A Preliminary Report by Hill is published in Annual Report 1886 Pt. III Ch. III.

Mahanoy Plane, Girardville, Ashland, Locust Dale and Locust Gap are the principal towns. Drainage is west through Mahony creek and its principal branches, Shenandoah creek and Big run. The Mahanoy creek leaves the coal field by a deep gap in the Mahanoy mountain at Ashland; a mile and a half west Big run cuts a second gap not so deep, in the southern rim and joins the Mahony creek in the red shale valley below. The extreme western end of the basin is drained by the headwaters of Locust creek which find a northern outlet through a shallow gap in the Locust mountain.

Locust Mountain jutting out from the southern mountain rim makes a long diagonal ridge across the field and joins the mountain on the north just north of Shenandoah. The Mahanoy basin in the preceeding division embraced the

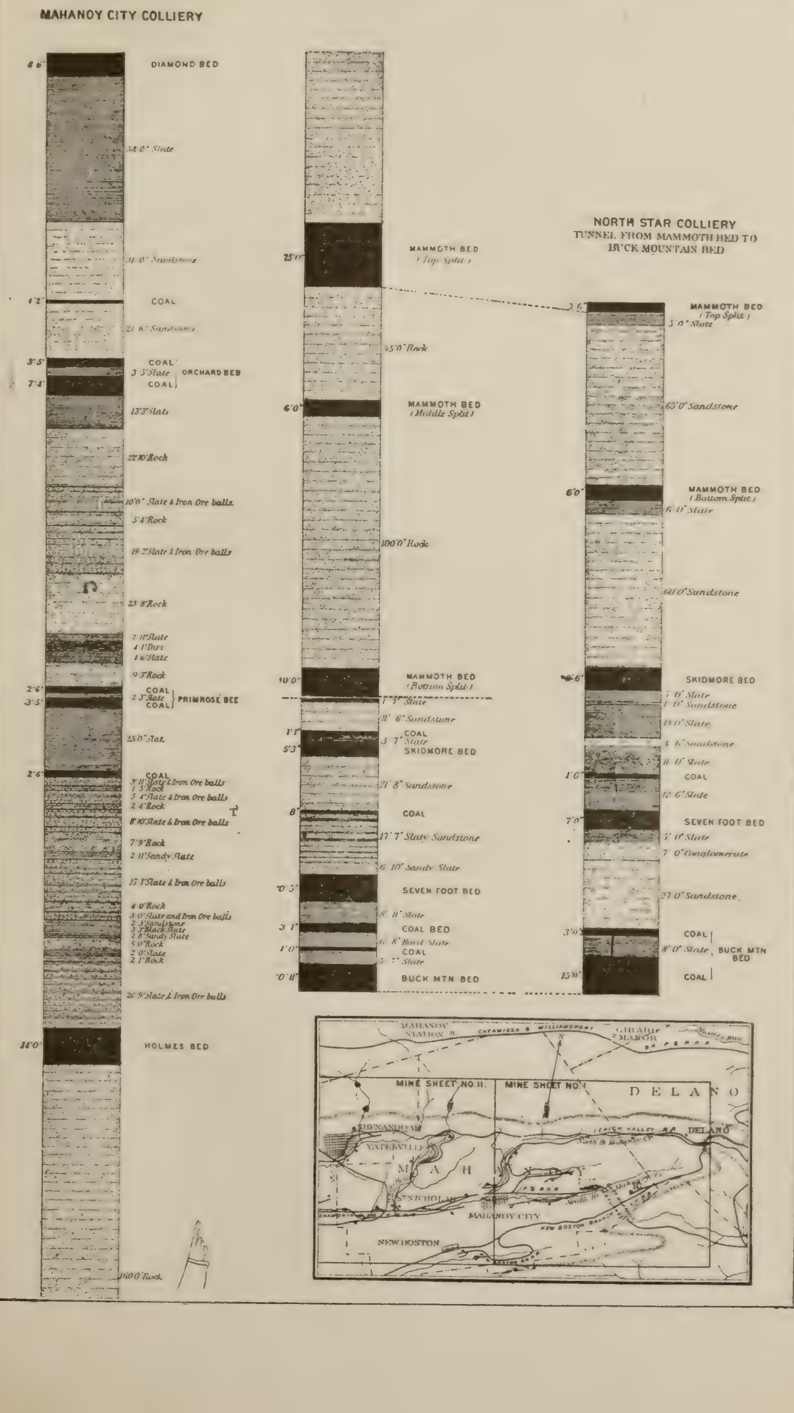
* Page plate 346 gives the relative location of the division.

† Page plate 357 and 358 gives selected portions of the cross sections.

‡ Page plate 359 contains a selected columnar section.

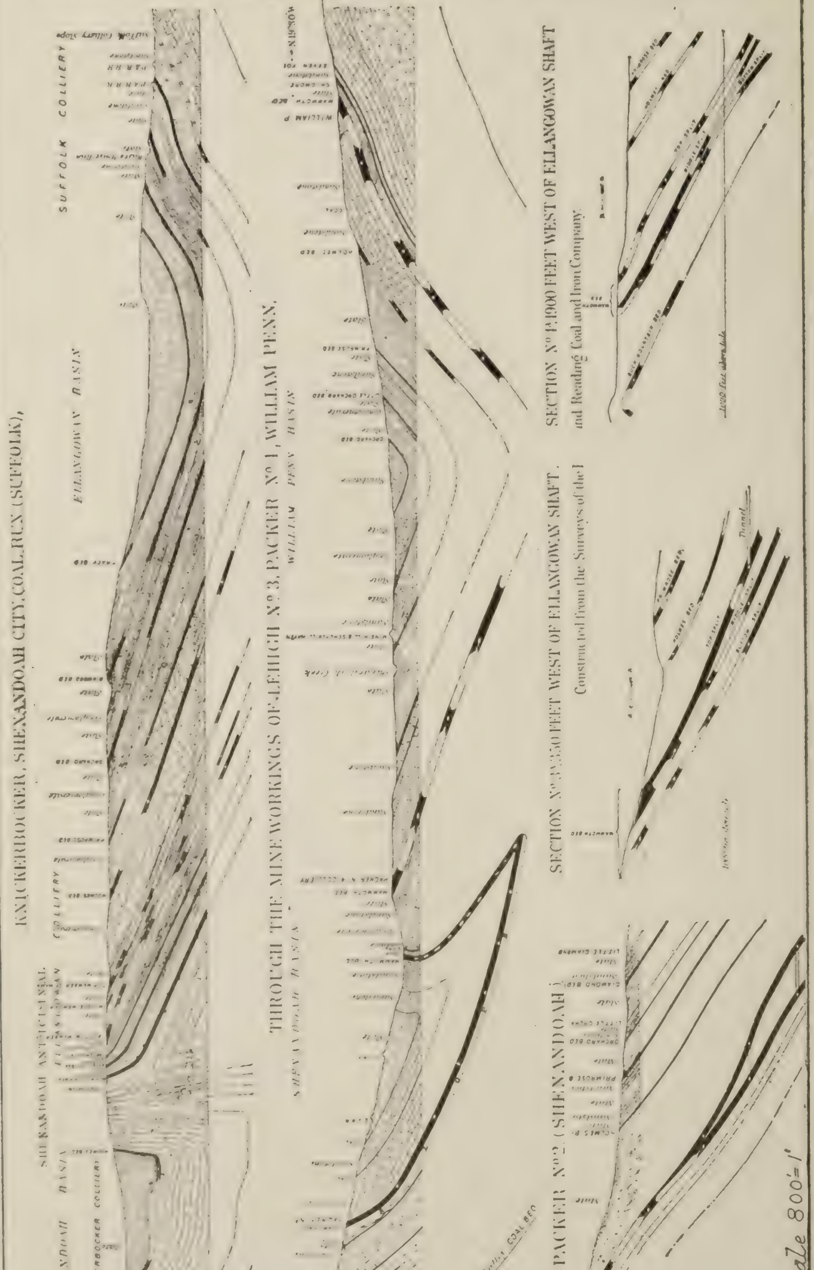
PL.353.

Anthracite Region_Western Middle Coal Field.



PL. 354.

Anthracite Region_Western Middle Coal Field.



full width of the field, but in this it gradually narrows and rises until it lifts into the air where Locust Mountain branches off from the Mahanoy Mountian.

Structure:—The surface of the basin is for the most part a single longitudinal valley, although the structure of the basin itself continues to be compound. The Mahanoy sub-basin with steep dipping sides extends the whole length with one or more shallower basin, sometimes with over-turned dips, along the north.* The length of the basin in this division is 12 miles and the maximum width 2 miles is at the east end. The deepest place in the Mahonoy basin is probably at Ashland close to the P. & R. R. R. station, the Mammoth bed, at the basin, is here estimated to be 1450′ below tide or 2250′ below the surface, with of course the Buck Mountain and Lykens Valley beds at a still greater depth. The Buck Mountain bed saddles the Locust Mountain axis in two or three places connecting the Shamokin and Mahanoy basins by broad bands of workable coal. The Lykens Valley beds are below the surface along this axis for most of its length.

Formation No. XII does not expose a complete section at any one point within the division. The cross sections indicate about the same thickness here as at the east Mahanoy tunnel or about 830′. Its hard conglomerate beds make the Mahanoy mountain on the south and arch the crest of the Locust mountain on the north. At some places two Lykens Valley coal beds have been exposed; one of these has been worked to a small extent.

The *Coal Measures* are at most about 1500′ thick and contain 12 coal beds of workable size; the mine workings thus far are confined almost wholly to some 5 or 6 of these beds in the lower part of the formation.

Lykens Valley beds:—Two coals are cut by a bore hole in No. XII at the Locust Run colliery (col. sec. 15 sheet III). The upper 2′ 10″ thick at 240′ below the Buck Mountain bed, and the lower 1′ 6″ thick 85′ lower. Two Lykens Valley coals were also cut in the new Centralia

* See cross sections on plates 257 and 358.

drainage tunnel but both are thin, poor and worthless, on the south dip, in this basin. From the Centralia tunnel to the west end of the Mahanoy basin, two coal beds in No. XII are usually found; one of these at times is of a workable thickness.

The Lower Lykens Valley bed has been worked in the Mahanoy mountain, west of Big run gap at the Gordon, Helfenstein and Ben Franklin collieries; all now abandoned. The thickness of the bed varies from a few inches up to 10′ or 12′ but the bed is faulty and much of the coal is soft or shelly.

Buck Mountain bed is large and in good condition, along the south dip of the Locust Mountain anticlinal, and is worked extensively as far west as Ashland; its thickness will average 14′ or 15′, fairly clean, yielding 11′ to 12′ of coal. It is also of good thickness on the opposite dip and to the south in the Mahanoy sub-basin where the bed averages about 10′ in thickness, but at times carries considerable refuse. West of Ashland, in this division, the bed grows thinner and there is little or no working of it, although the provings are quite too few to determine fully its value; at the gap south of Ashland it is but 4′ to 5′ 6″ thick.

Seven Foot bed is not yet worked in this division and is for the most part thin and dirty; its best development is on sheet III in the vicinity of Packer No. 5 and Bear Ridge collieries where the bed has a thickness of about 6′ with 4′ of coal; west of this the bed is much thinner, only 2′ to 3′ thick. The provings of the bed are not very numerous.

Skidmore bed is mostly thin and not much worked; the so-called Skidmore bed of Merriam, Monitor, Locust Springs and Locust Gap collieries (mine sheet V), some 40′ to 50′ below the Mammoth bed, has been proven by the extension of the mine workings to unite with it and it is now regarded by the mine operators as the Bottom split of the Mammoth bed. The Skidmore bed proper where cut in the tunnels and bore holes varies from 2′ to 5′ thick; the best developments of it are at the Merriam colliery where the bed is worked 8′ thick with 6′ of coal and at the Lawrence colliery where the bed is 6′ to 8′ thick.

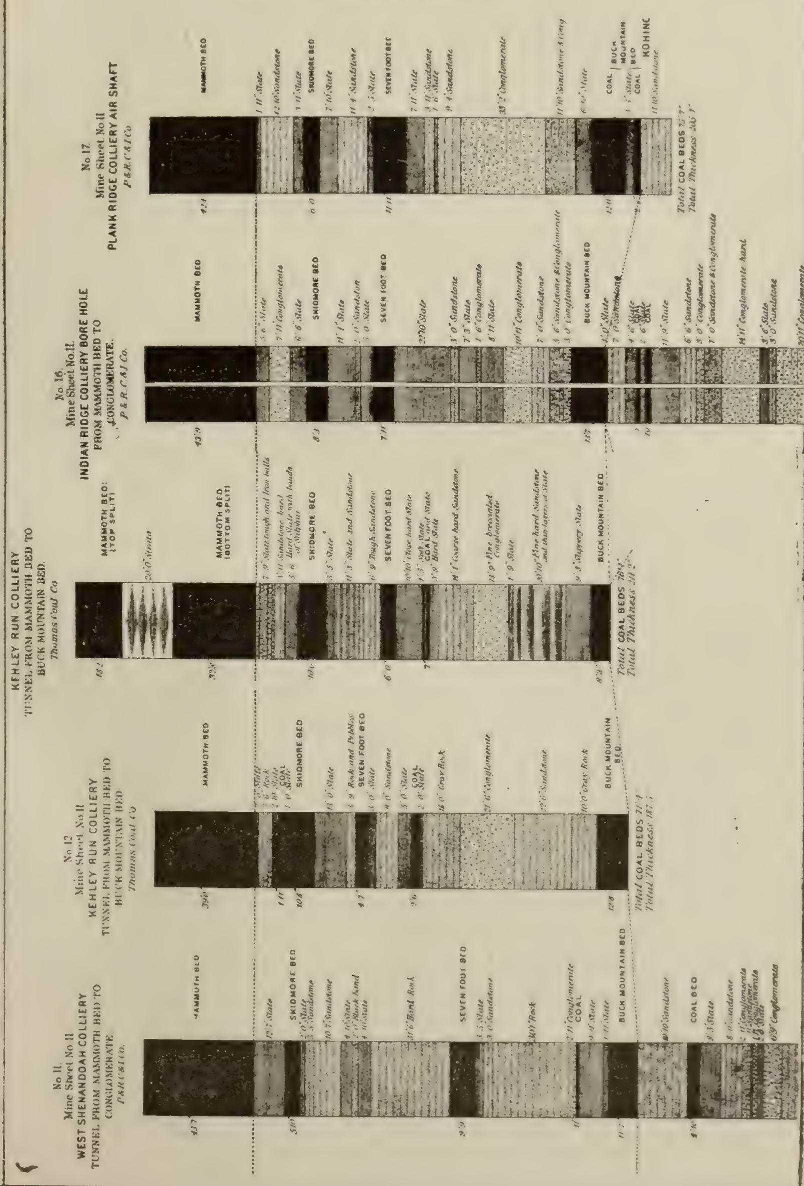
PL.355

Anthracite Region_Western Middle Coal Field

MAMMOTH TO BUCK MOUNTAIN BED

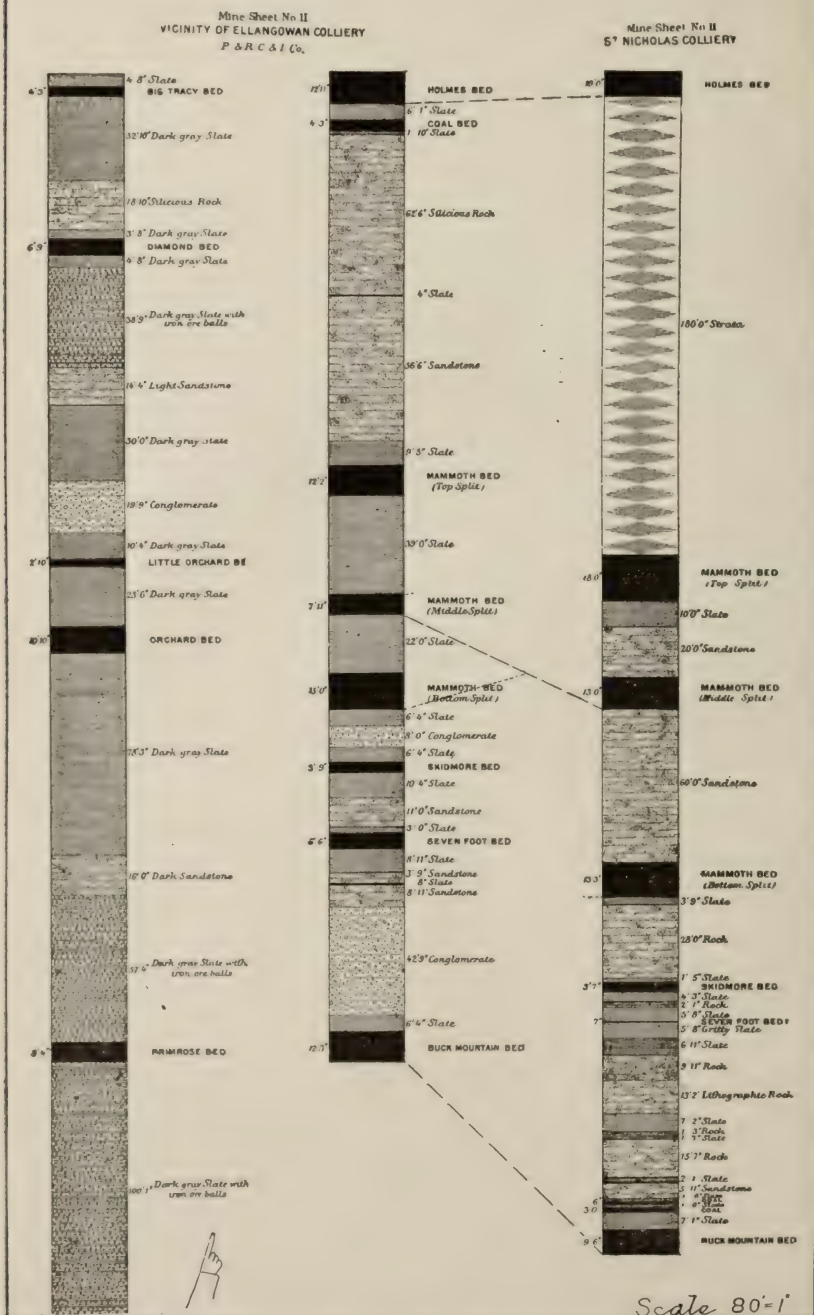
IN THE VICINITY OF

SHENANDOAH



PL 356

Anthracite Region – Western Middle Coal Field



Mammoth bed :—It is easy to see from a very brief inspection of the mine sheets that thus far the Mammoth and some portions of the Buck Mountain bed have received nearly the exclusive attention of the mine operators. On mine sheet III in the Mahanoy sub-basin, which is especially narrow and steep at the Girard colliery, the Mammoth is a single bed 20′ to 40′ thick ; to the north in the William Penn basin the bed in places separates into two splits sometimes 100′ apart ; the average thickness of the bed for this sheet is about 30′, with 25′ of coal. On mine sheet IV the Mammoth is mostly a single bed 20′ to 30′ thick, swelling locally now and then to 40′ or more; its average for the sheet is perhaps 25′. On mine sheet V and VI, the Mammoth is usually in two splits ; at Locust Spring and Locust Gap collieries three splits are found, the average total thickness of the bed is perhaps 20′. The interval between the Mammoth and the Buck Mountain beds, in this division, is about 200′. The Mammoth is usually a clean and good bed with much of its coal in large size benches.

Holmes bed is 120′ to 150′ above the Mammoth bed ; it is worked to a small extent at a number of the collieries, but perhaps most on mine sheet III, where although the bed has a general thickness of about 10′ it seldom yields more than 5′ or 6′ of coal and that is pretty well scattered through the bed. West of sheet III the bed has a thickness of but 3′ to 5′ and is not much worked.

Primrose bed, 50′ above the Holmes at the east and 150′ above towards the west end of the division, is opened at a dozen or so scattered places with a usual thickness of 4′ to 5′, high in refuse. At the Merriam colliery (sheet V) the Primrose is worked on both dips of the Mahanoy sub-basin, from a new tunnel ; it has here a thickness of about 7′ and is in fairly good condition.

Orchard bed where cut in the long tunnel at Packer No. 5 colliery is 8′ thick with about 4′ of good coal, at Preston No. 2 the bed was worked with a thickness of about 6′ and it was also worked a little at the Diamond colliery (abandoned); the new tunnel south across the basin, at the Locust Spring colliery, cut the south dip of the Orchard in "fair condition."

Little Orchard, *Diamond*, *Little Diamond*, *Tracy* and *Little Tracy* beds range from 3′ to 7′ thick where proved by the three or four tunnels which cut the high measures; but as none of the beds are now worked no very definite conclusion as to their value has been reached.

Shamokin basin.

The Shamokin basin is larger than the Mahanoy basin, lies to north and west and they are separated by the Locust Mountain anticlinal. Its length is 30 miles, between Mt. Carmel and Shamokin the basin is 3 miles wide; west of Shamokin it slowly narrows, terminating in two short prongs, near the junction of Zerbe run and Mahanoy creek; to the east the basin narrows but little ending in three long prongs or fingers the two northern ones making ridges which project out into the red shale; the southern one a long narrow trough raises out on the flat crest of North Mahanoy mountain seven miles further east.

19. Shamokin Basin, Centralia—Mt. Carmel Division.

The area comprised in this division is the east half of the Shamokin basin and is mapped on mine sheets II, II*a*, III, III*a*, IV, IV*a*, V and V*a*.* Cross sections 9 to 13 on sheets IV to VII† and the contouring of the Mammoth bed on the mine sheets show the structure of the basin. Sections of the coal measures are published on columnar section sheets II and III. The shape of the surface at the eastern part of the division is shown by Topographical sheets II and III. A Preliminary Report by Hill is published in Annual Report, 1886, Pt. III, Ch. III.

The drainage with the exception of the Centralia basin is to the west through Coal run and the North and South branches of Shamokin creek; the Centralia basin is drained by Big Mine and Ravens runs which flow south through gaps in the Locust mountain to Mahanoy creek.

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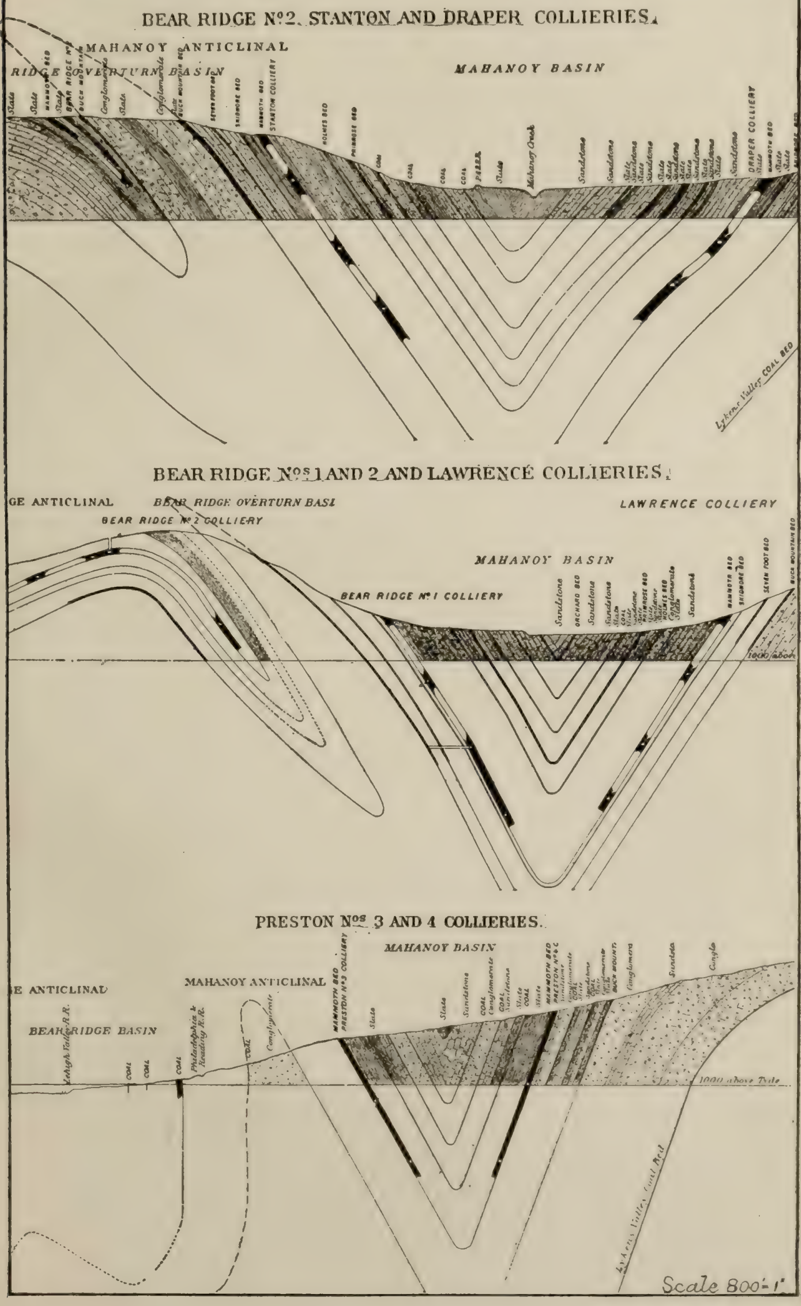
* Page plate 346 gives the relative location of the division.

† Page plates 360 and 361 gives selected portions of these cross sections.

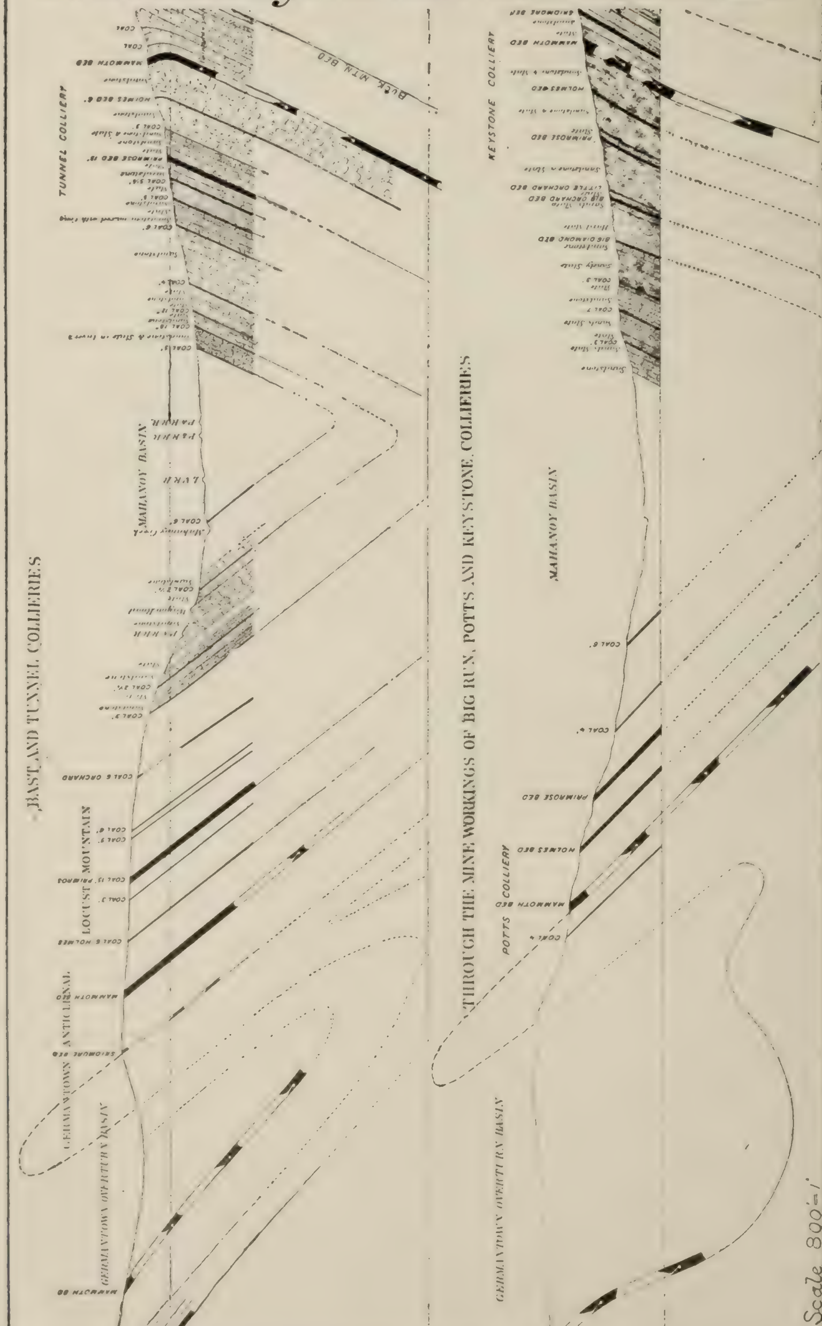
PL. 357.

Anthracite Region—Western Middle Coal Field.



PL. 358.

Anthracite Region_Western Middle Coal Field.



Centralia and Mt. Carmel are the principal towns; Ravens Run, Montana, Alaska and Green Ridge are smaller towns within the division.

Structure.—The Shamokin like the Mahanoy basin is a compound one and owing to its greater width has still more sub-divisions; in general the sides of the basins are not quite so steep and this is especially true in this division which includes the eastern spoon of the sub-basins; dips up to 40° and 50° are quite common but no important or extensive overturns have been developed. The measures are deepest along the western edge of the division; they have a general and at times a rapid rise to the east; this eastward rise brings up No. XII along the crests of the principal axes to form ridges which rise to join the mountain rim. Still further east the removal of all of No. XII from the Red Ridge and Coal Ridge axes leaves two synclinal conglomerate spurs holding the lower coal measures and projecting out from the rim of the field for a couple of miles into the red shale country.

The most southern and eastern of the sub-basins is the Centralia,* a long narrow trough of coal measures 6 or 8 miles in length and half a mile wide.† A narrow strip of coal measures connects it with the Mt. Carmel basin at the west. Other basins to the north are the the Pennsylvania or Coal Ridge or Montana, the Black Diamond, the Coal Run and the Natalie basins. The mine and cross section sheets show the shape and extent of each.

Formation No. XII surrounds the division on the northeast and south. Its thicknes is probably 600′ or 800′, but it is difficult to fix it exactly even when the measures are exposed, as thin beds of red and greenish shale are scattered through the lower part of the formation. A diamond drill bore hole on the Wm. Elliot

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* A tunnel about a mile long, has recently been completed, to drain the collieries in this basin. The tunnel commences along Big Mine colliery and extends northwest through Locust mountain to the Hazel Dell and Centralia collieries, tapping them at about the 1000′ A. T. level; this is low enough to drain nearly all the Mammoth coal in the basin. Drainage connections have been made with other collieries.

† See cross sections on plate 360.

tract near the Natalie colliery went 815′ below the Buck Mountain bed or about 740′ across the measures; the last 250′ cut a number of thin beds of green sandstone, greenish shale and red shale, with the bottom of the hole in sandstone with some thick beds of conglomerate close above.

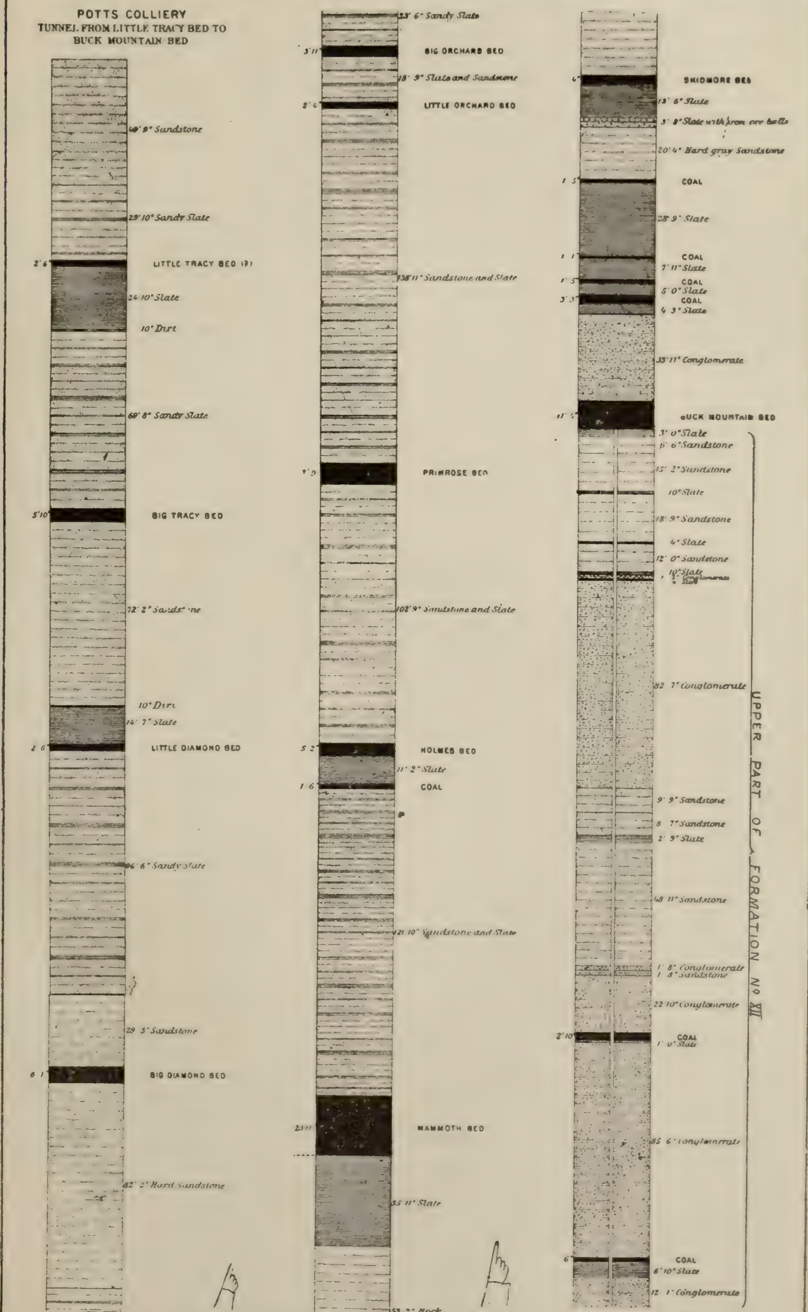
The *Coal Measures* proper have in this division a maximum thickness of 800′ to a 1000′ and contain 8 or 10 workable coal beds. The mining developments have been confined almost exclusively to the Mammoth and underlying beds.

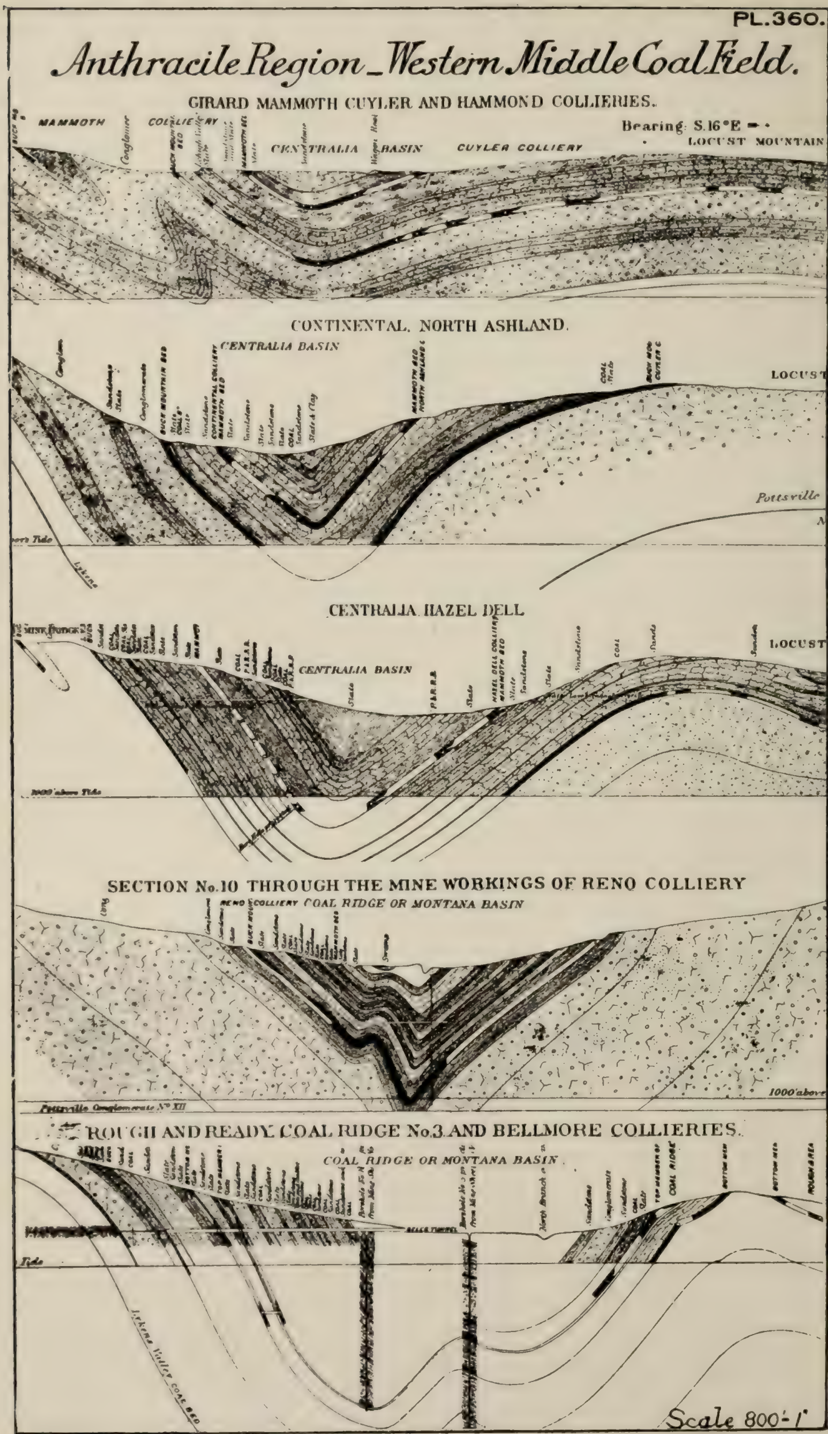
Lykens Valley coal beds two in number show some improvement, but owing to the abundance of coal in the thicker and more reliable beds above cut little attention has been given to them. The beds are 30′ to 100′ apart and sometimes one of them is missing. The Centralia drainage tunnel cut No. II or the upper bed on the north dip of the Centralia basin with a thickness of "3′ to 4′ of good coal." A tunnel at Belmore colliery cuts 2′ of dirty coal at 150′ and a 3′ 2″ coal bed at 230′ below the Buck Mountain. bed. The No. II bed has been worked in a couple of water level drifts on the Wm. Elliot tract near Natalie, the bed in places was 8′ or 9′ thick but contained very little firm hard coal, dip is 30° to 40° degrees to the south; the deep bore hole 2000′ south cut at 260′ below the Buck Mountain a 7′ 9″ bed with 4′ 5″ of coal; this is identified as No. II bed although no coal was found below and a thin worthless bed is cut 40′ above. A mile and one half east of the Leisinring drifts on the Wm. Elliott, recent shafts (summer of 1894) have opened two Lykens Valley beds 100′ apart the upper with "9′ of coal and the lower 7′ 6″ of coal," looking fairly firm for the outcrop, dip 60° south; the shafts are on the north side of Big Mountain a couple of hundred feet below the summit. These recent explorations prove the Lykens Valley outcrop to be continuous along the northern slope of the mountain and that it does not curve in to saddle the Hickory Swamp and Hickory Ridge anticlinals nearly so much as represented upon mine sheet V*a*.

One of the chief obstacles to a successful working of the Lykens Valley beds is the usual crushed and unsound con-

PL. 359

Anthracite Region _ Western Middle Coal Field




PL.360.
Anthracite Region _ Western Middle Coal Field.
GIRARD MAMMOTH CUYLER AND HAMMOND COLLIERIES.
Bearing: S.16°E
MAMMOTH COLLIERY
CENTRALIA BASIN
CUYLER COLLIERY
LOCUST MOUNTAIN
CONTINENTAL. NORTH ASHLAND.
CENTRALIA BASIN
LOCUST
Pottsville
CENTRALIA. HAZEL DELL
CENTRALIA BASIN
LOCUST
SECTION No.10 THROUGH THE MINE WORKINGS OF RENO COLLIERY
COAL RIDGE OR MONTANA BASIN
1000'above
ROUGH AND READY. COAL RIDGE No.3. AND BELLMORE COLLIERIES.
COAL RIDGE OR MONTANA BASIN
Tide
Lykens Valley COAL BED
Scale 800'-1"

dition of their coal. It seems likely that where the beds are but little disturbed and are still in nearly a horizontal position that the coal will be found in a more satisfactory state

Buck Mountain bed ranks next to the Mammoth in size and productiveness. The most extensive working of it is in the Centralia basin where the bed varies from 10′ to 20′ in thickness with an average of about 15′, with 11′ or 12′ of coal; in the Montana and Black Diamond basins* to the north at the Morris Ridge, Reno, Monroe and Midvalley No. 2 the bed has practically this same thickness†. Approaching the western edge of sheet IV and on sheet V the bed seems to be much thiner, at Midvalley No. 1; on sheet IV*a* the bed is about 6′ thick, further west on sheet V*a* the Natalie colliery mines the bed about 9′ thick with an average of 7′ of good coal. South on sheet V about the only exploration of the bed is by an inside bore hole at the Black Diamond, now Ferndale, colliery where a thickness of 5′ was cut.

Seven foot bed is not worked in this division and would seem rarely to contain more than 2′ or 3′ of coal; the tunnel at the Logan colliery and rock slope at the Hazel Dell show an exceptionally thickness of about 8′ for this bed.

Skidmore bed is worked along the north flank of the Locust mountain at the Alaska and Reliance collieries and is there about 9′ thick with 7′ of coal. Elsewhere in the division where proved by bore holes or tunnels in the Centralia basin and at the Belmore, Mt. Carmel, Midvalley No. 1, Black Diamond and Natalie collieries the bed is thin and poor varying from 2′ to 6′ thick and containing considerable refuse.

Mammoth is in one large bed in the Centralia basin and is about 200′ above the Buck Mountain; its area here is nearly all mined over; the bed is quite uniform in thickness and the coal in good sized benches; it will average about 23′ in thickness with 19′ of coal. To the west on sheets V and

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* Cross sections on plate 360.

†On the Rea tract at the extreme eastern end of the Black Diamond basin there is a comparatively small area of the Buck Mountain bed10′ to 15′ thick which is not indicated on mine sheet IIa.

Va the Mammoth is usually in two splits, worked separately, with an interval up to 100′ between. At the Mt. Carmel colliery* a third split is found and worked; the relative thickness of the splits varies, sometimes the Top split and at other times the Bottom split will be the thicker; the combined thickness will average about 18′ with 14′ of coal.

Holmes bed is found at about 150′ above the Mammoth bed; it is opened at only a few places in this division and appears to be a rather variable bed. It is worked at Mid-valley No. 1 with 6′ of clean coal; also worked to a small extent at the Pennsylvania colliery† with a thickness of 4′ or 5′; where cut in the Alaska shaft it is 3′ 9″ thick with 3′ of coal.

Primrose bed is not opened in this division; it is cut at the Belmore colliery 6′ thick and at the Alaska shaft 5′ thick.

Orchard bed is the highest coal tested; it was cut in a drill hole at the Belmore colliery (sec. 12 col. sec. sheet II) with a thickness of 6′.

Still *higher coal beds*, the Little Orchard, Tracy, and Little Tracy are probably contained along the axes of the deep basins, but they are as yet wholly undeveloped.

20. *Shamokin Basin, Shamokin—Trevorton Division.*

Mine sheets VI, VI*a*, VII, VII*a* and VIII map the area covered by the division.‡ The structure is shown by cross sections 14 to 18 on sheets V to VIII and by the Mammoth bed contours on mine sheet VI. § Sections of the measures are given on columnar sheets I and II. ‖

This division includes the western half of the Shamokin basin. Shamokin mountain bounds it on the north and Locust mountain on the south; it has a length of about 15 miles with a width of 3 at the eastern end, slowly tapering to a point some four miles beyond Trevorton where No. XII lifts into the air.

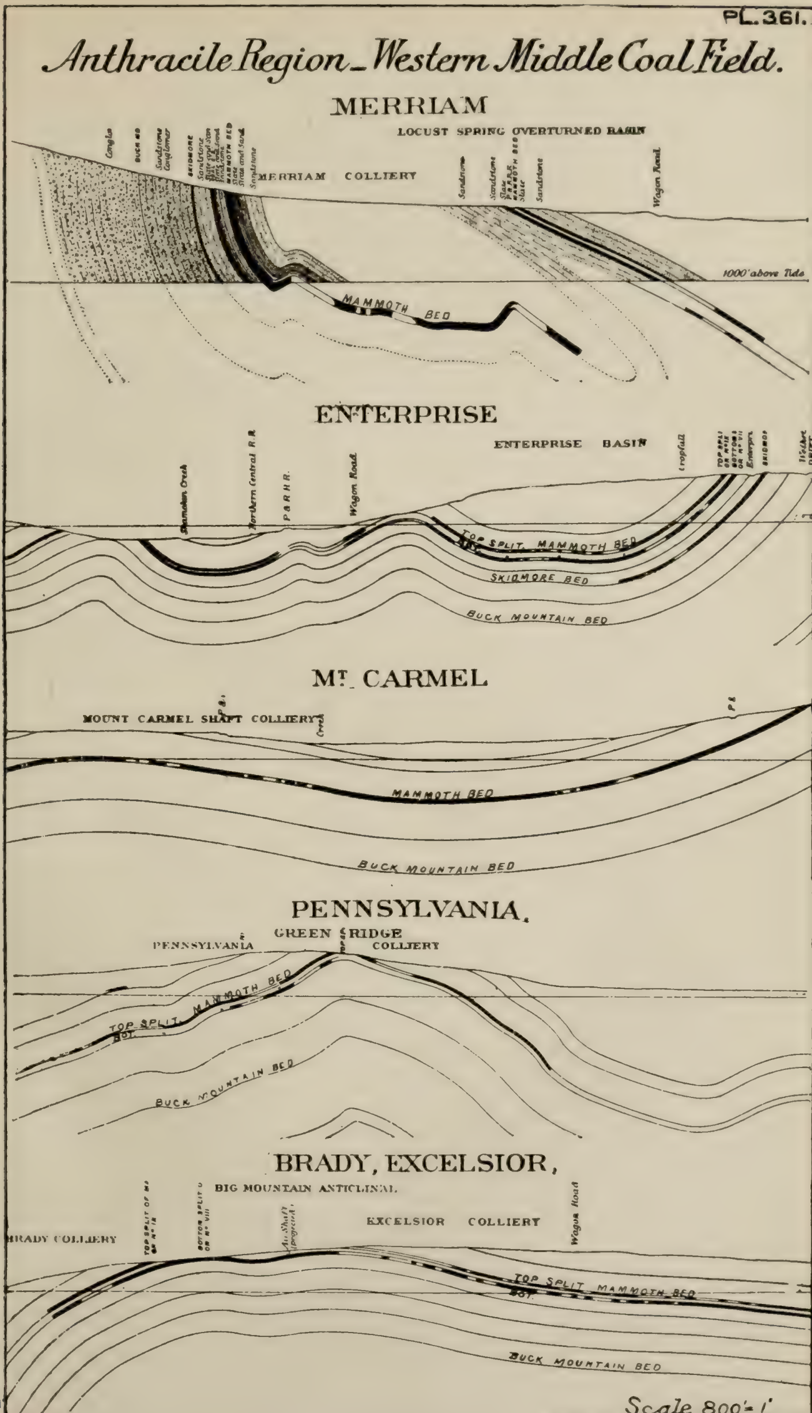
* Cross section on plate 361.

† Cross sections through this colliery on plate 361.

‡ Page plate 346 gives the relative location of the division.

§ Page plate 362 contains selections from these cross sections.

‖ Page plate 362 contains a selected columnar section.


PL. 361.
Anthracite Region _ Western Middle Coal Field.
MERRIAM
LOCUST SPRING OVERTURNED BASIN
MERRIAM COLLIERY
Wagon Road
1000' above Tide
MAMMOTH BED
ENTERPRISE
ENTERPRISE BASIN
Shamokin Creek
Northern Central R.R.
P. & R. R.R.
Wagon Road
TOP SPLIT, MAMMOTH BED
SKIDMORE BED
BUCK MOUNTAIN BED
MT. CARMEL
MOUNT CARMEL SHAFT COLLIERY
MAMMOTH BED
BUCK MOUNTAIN BED
PENNSYLVANIA.
GREEN RIDGE
PENNSYLVANIA
COLLIERY
MAMMOTH BED
TOP SPLIT
BOT.
BUCK MOUNTAIN BED
BRADY, EXCELSIOR,
BIG MOUNTAIN ANTICLINAL
BRADY COLLIERY
EXCELSIOR COLLIERY
Wagon Road
TOP SPLIT MAMMOTH BED
BOT.
BUCK MOUNTAIN BED
Scale 800' = 1'

Shamokin, with about 15,000 inhabitants, is the town of chief importance. Trevorton, a small mining village in the red shale, near the western end of the field; is frequently referred to.

Most of the area is drained by Shamokin creek and its western lateral Carbon run which find a northern outlet through the deep gap 700 A. T. at Shamokin. Six miles west, near Treverton, Zerbe run has also cut through the Shamokin mountain and furnishes a drainage outlet for the west end of the field. The southern barrier, Locust mountain, carries an unbroken crest line 1600′ to 1700′ A. T. across the division. The surface of the interior of the basin is rather broken and hilly, but the highest of the ridges are a couple of hundred feet lower than the conglomerate rim. No. XII at the west end rounds out very beautifully, and seen from the east resembles the bow of a gigantic canoe.

Structure:—The deepest part of the basin is under the southern part of the town of Shamokin where the Mammoth bed is estimated to be about 600′ below tide or some 1300 or more below the surface. The Mammoth over much of the central portion of the basin is undoubtedly more than 1000′ deep. Although dips of 50° to 70° are not uncommon, few perpendicular or overturned measures have been encountered.

The mine workings on sheet VI, VI*a* and the eastern part of VII are very extensive and the structure of the subbasins is here pretty well understood. Between Shamokin and the North Franklin colliery near Trevorton there is a gap of about 4 miles practiaally undeveloped save for a few trial shafts; the surface is covered with brush and timber and there are few exposures. At the west end of the field (sheet VIII) the North Franklin mine workings show clearly the simplified structure* of the narrowed basin.

About Shamokin the most extensive developments are in the shallower basins along the southern rim were considerable coal is found on gentle dips of 10° to 20°, although of

* See cross section on page plate 362.

course, the beds are often much steeper. On the north side of the basin the workings are also numerous, a portion of them are on beds dipping 50° to 60° south. The steep dipping beds contain more refuse than those which have been less disturbed.* See the mine and cross section sheets for the details of structure.

The area covered by *Formation No. XII* has a width of only 1000′ to 2000′ owing to the steep dips along its outcrop ; as usual the central or upper part of the formation makes the mountain crest ; the Lykens Valley beds usually make benches a little below the crest on the outer slope and the red shale outcrops about half way down ; the Buck Mountain terrace is usually pretty well defined high up on the inner slope. The thickness of No. XII as measured at the Shamokin gap is 750′ composed chiefly of beds of coarse conglomerate containing two recognized beds of coal (see section 16, cross section, sheet VII or page plate 363.)

The *Coal Measures* have a maximum thickness of 1200′ or 1300′ in the deep basins about Shamokin and contain eleven coal beds, all of which have been worked to a greater or less extent within the division. The beds of this basin were originally numbered and they are usually designated by these numbers, although the equivalent names are now in use.

Lykens Valley coal beds, although considerably improved, as to thickness, are but little worked on account of the high proportion of soft or unsound coal that they usually contain. At Cameron colliery† in the Shamokin gap the Lower or No I bed, 300′ above the red shale, is opened by a short drift, it is 2′ to 3′ thick, in poor condition ; on the No. II bed, some 50′ higher, a slope 800′ deep was sunk and the bed worked for half a mile or more, both to the east and the west ; the thickness of the bed varies from 2′ to 7′, and in places it yields good, sound coal ; the working

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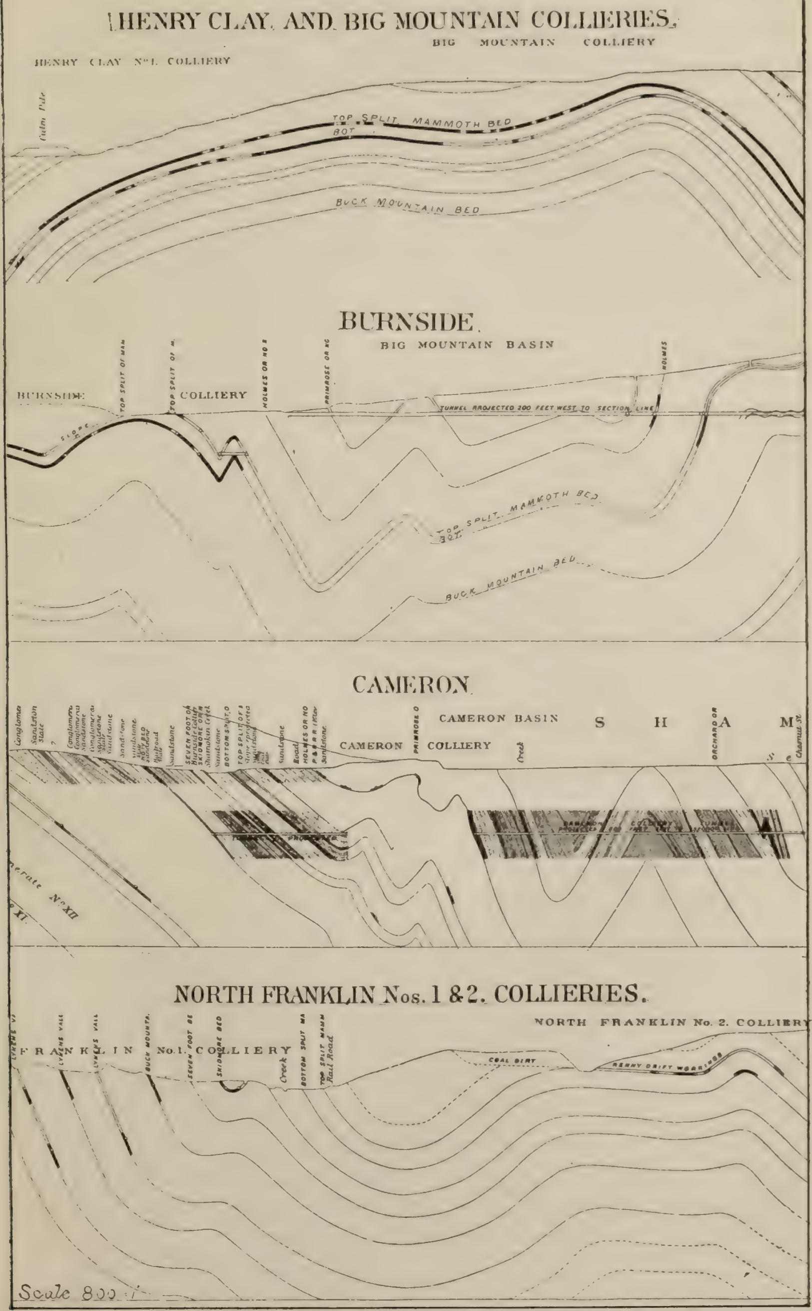
* A carefully kept record at a colliery operating on a steep dip shows that 50 per cent. of the material hoisted out of the mine as coal goes to the dirt bank.

† Cross section through Cameron workings on plate 362.

PL. 362.

Anthracite Region_Western Middle Coal Field.



of this bed is now abandoned; slope pitches 40° to 50° south. At the Luke Fidler colliery a bore hole (record given on mine sheet VI*a*), cut the No. II bed 6′ 5″ thick in good condition; the dips here are quite gentle and it is thought that the coal will continue to be good over the undisturbed area; the No. I bed is absent in this bore hole: two thin coals are cut between No. II and the Buck Mountain bed, 400′ above. On the south side of the basin the Enterprise Coal Co. have reopened the Margie Franklin colliery workings on the No. II bed, which is there reported to have a thickness of 6′ to 10′ good coal. Four miles west a small slope on the Wilson and Dewart tract opens a Lykens Valley bed 10′ thick; its outcrop is a couple of hundred feet below the crest of the Locust Mountain on the south side.

At the Zerbe run gap (mine sheet VIII) the North Franklin No. 1 colliery (now abandoned) was established to prepare exclusively the Lykens Valley coal; four beds are opened, three of which were mined. The lowest, *No. O*, is reported 5′ 6″? thick with 1′ 6″ of slate in the middle; this bed was not worked. *Bed No. I*, about 100′ higher, was worked above water level and by a slope below for half a mile or so on either side of the gap. The bed when sound contained 10′ of coal. The gangways stopped in "fault." *Bed No. II*, about 150′ above No. I, is worked above water level for half a mile east of the gap; the coal is considerably crushed and pinched; at its best the bed is 6′ to 8′ thick. *Bed No. III*, 120′ still higher and about 200′ below the Buck Mountain bed, was worked ½ mile east and ¾ mile to the west; its thickness varies from 5′ to 10′ and in common with the others contains a large proportion of soft and crushed coal. There is a little colliery mining a Lykens Valley bed for local use at the extreme western end of the basin.

Buck Mountain or No. V bed is known as No. IV bed on mine sheet VI*a* and VII*a*. The bed when opened on gentle dips is usually a good one yielding 6′ or 7′ of coal; in the steep dipping measures it is much less reliable and is often thin or worthless. It is now the chief source of supply at the Hickory Ridge and Hickory Swamp collieries and yields 5′ to 7′ of coal. The Corbin, a new colliery, works the Buck Mountain were it saddles over the Big Mountain anticlinal on the east side of Shamokin creek; here the bed is in two splits each about 5′thick with a 10′ interval between. At Enterprise colliery the bed is about 6′, at Burnside* and Bear Valley collieries. it runs from 2′ to 10′ thick and will average about 5′ to 6′ of coal. At the Cameron in the Shamokin gap the bed is not so good and is but 3′ to 4′ thick. At Zerbe run gap (sheet VIII) the bed is opened by two or three short drifts and although reported to be a thick bed is apparently esteemed of little value.

At the Hickory Ridge, Hickory Swamp and Cameron collieries a three foot bed about 80′ above the Buck Mountain bed is worked to a very small extent and called on mine sheets VI*a* and VII*a*. Bed No. V; it is perhaps a split of the Buck Mountain bed.

Seven Foot or No. VI bed is worked only at the Cameron colliery where it has a thickness of 3′ to 6′ but is not in good condition. The bed seems to be thin throughout the division; it is not recognized as a workable bed on the south side of the basin.

Skidmore or No. VII bed is worked quite extensively at the Cameron and at the Enterprise collieries; at each it is about 5′ thick and in pretty good condition. Some provings not altogether conclusive at the Luke Fidler, Hickory Swamp, Hickory Ridge, Burnside and Bear Valley collieries indicate that it is generally thin and unworkable.

Mammoth, or Nos. VIII and IX beds as its two splits are called, is extensively mined on both sides of the basin about Shamokin although it is not yet touched in the deep troughs in the middle of the valley or in the long blank space between Shamokin and North Franklin. The splits are usually about 25′ apart but this interval varies from 10′ to 50′; both beds are usually in good condition yielding a clean coal with only a moderate proportion of refuse. On mine sheets VI and VIa bed No. VIII will easily average

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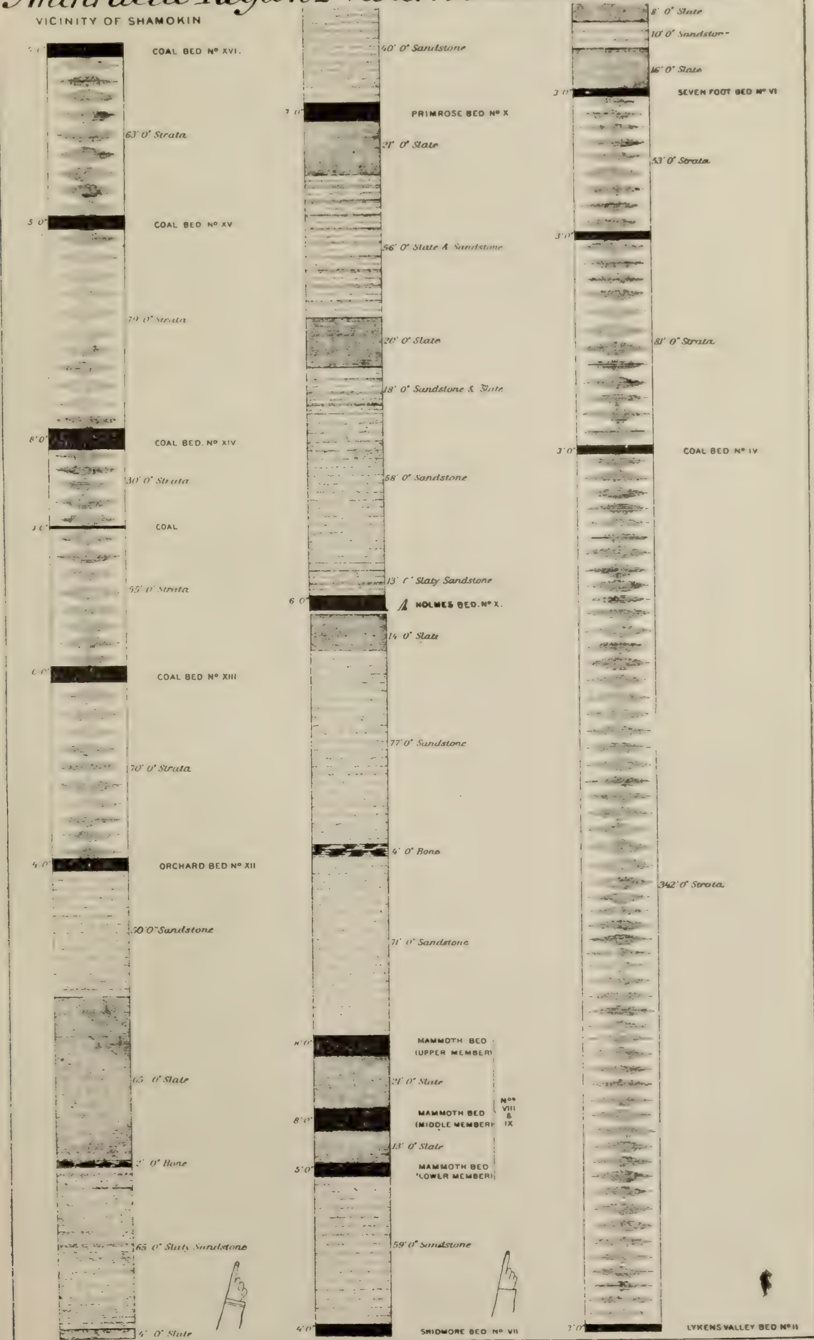
* Cross section on plate 362.

PL.363.

Anthracite Region_Western Middle Coal Field.



8′ and No. IX 7′ in thickness; further west the bed is of larger size, at Bear Valley colliery the combined thickness of the two splits is about 20′. On sheet VIII in the extensive working of the Mammoth at the North Franklin No. 2 colliery each split has an average thickness of about 12′. The Mammoth is the highest bed worked at the Trevorton end of the field. At Cameron colliery a third split sometimes encountered below No. VIII is called No. VII½ bed. The distance from the Buck Mountain bed up to the bottom of the Mammoth is from 250′ to 300′.

A *coal bed* 1′ to 6′ thick is usually found between No. IX and No. X; the bed is not mined although it may prove to have a workable thickness and quality in some localities.

Holmes or No. X bed is wrought quite largely at the Cameron, Luke Fidler and Neilson collieries; it is a fairly good bed 5′ to 8′ thick with 4′ to 6′ of coal. It is also worked at Henry Clay*, Burnside and Bear Valley collieries on the south side with a general thickness of about 9′ with 7′ of coal.

Primrose or No XI bed is opened at Cameron, Neilson and Dan'l Webster (abandoned) collieries with a thickness varing from 5′ to 10′ though in general about 7′; where cut in the Burnside tunnel it is 4′ 3″ thick. Its distance above the Holmes is about 150′.

Orchard No. XII with a thickness of about 5′ is mined only at the Neilson colliery.

Little Orchard or *No. XIII* bed 5′ thick; *Diamond* or *No. XIV* bed about 6′ thick; and the *Little Diamond* or *No. XV* bed 5′ thick, have all been drifted upon at one or more points along Shamokin creek south of the town.

Tracy No. XVI bed probably the highest of the division is worked in the hill southwest of Shamokin at the Eureka colliery. The bed has an average thickness of about 5′ and a considerable quantity has been mined from it.

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* Cross section on plate 362.

CHAPTER CXXII.

Southern Coal Field.

The Southern is the largest of the four great divisions of the anthracite region. Its lowest workable coal bed underlies an area of about 181 square miles or 5 square miles more than that of the Northern field. Its length is 70 miles from Mauch Chunk on the Lehigh to Dauphin on the Susquehanna, and its maximum width is 8 miles in the neighborhood of Pottsville.

The wide central portion of the field which includes the Broad Mountain coal basins is about 20 miles long; at Tuscarora the field is but 2 miles wide and it continues about the same for the remaining 20 miles east to the Lehigh; at the west beyond Tremont the rapid western rise of the great Selins Grove anticlinal from beneath the Coal Measures, wedges the field into two long narrow basins or prongs, often called the North and South Fishtails; the former is 15 miles long and the latter 30 miles long. The great body of the Southern field lies in Schuylkill county; about half of the eastern prong or head in Carbon county; the western ends of the Fishtails in Dauphin and a central portion of the southern tail in Lebanon.

The Schuylkill river may be said to have its rise in the Southern field and it drains rather more than the eastern half; tributaries of the Susquehanna, of which Swatara creek is the most important, drain the western part.

Sharp mountain, the southern boundary of the field, runs in long, straight stretches from the Lehigh to the Susquehanna, with but one turn or loop, that east of Middleport. Its sharp and narrow crest has a general elevation of 1200′ to 1500′ A. T. On the north, Locust mountain at the east has mostly a narrow summit, then comes the high table land of the Broad mountain with a

PL.364.

Anthracite Region – Southern Coal Field.

SHARP MTN. AT POTTSVILLE GAP, LOOKING WEST.

FROM PHOTOGRAPH BY MR. E. B. HARDEN

NO. XII AT MINE HILL GAP, LOOKING EAST.

FROM PHOTOGRAPH BY MR. E. B. HARDEN

general elevation of 1600′ to 1700′ A. T., 3 and 4 miles wide with projecting ridges into the red shale at the east and west; and last the Thick, a single but rather wide crested mountain which bounds the Wisconisco basin. Both the North and the South Fishtail are elevated longitudinal valleys with higher mountain rims on either side.

The central part of the basin is hilly and broken; the principal valley is along the foot of the Sharp mountain; to the north the surface is seamed by numerous valleys made by the streams, rising upon the southern slope of the Broad mountain, cutting down across the measures to find an outlet through one of the gaps in the southern barrier. The Gate ridge or Red mountain, a couple of hundred feet lower than Sharp mountain, parallels it from Tremont to Port Carbon. The Mine hill, an important conglomerate ridge, about 15 miles long from the West Branch to Big Creek, is next south of the southern slope of the Broad mountain and at times is nearly as high.

The lowest elevations are found at the gaps in the Sharp mountain; the Little Schuylkill below Tamaqua is 780′ A. T., the Schuylkill below Pottsville* 600′ A. T., the West Branch below Westwood 660′ and the Swatara below Tremont 700′ A. T.

The Southern field is most advantageously situated as to tide water markets; it is only some 93 miles from Pottsville to Philadelphia with gentle and favorable grades all the way. This was one of the first basins to be developed and for a number of years between 1830 and 1850 its product exceeded that of any of the other divisions; but as it became known that the coal beds of the other fields, generally, contained less refuse and were more reliable, its relative production grew less and it now stands at the foot of the column.

The exhaustion of the cheaper mined coals in the other basins will no doubt in time place the Southern field, by reason of its great extent and enormous coal content, once more in the front rank. A tendency in that direction is

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* Page plate 364 gives view looking west from the gap.

already seen. The better utilization of the small sizes of coal is also of material assistance to the Southern operators.

Structure.

The field consists of a number of connected basins, which, commencing on the north with the comparatively shallow basins of the Broad mountain and its southern flank, grow successively deeper with more steeply inclined sides to culminate at the south in the exceeding deep, sharply compressed and at times overturned basins along the foot of Sharp mountain.

The general strike of the measures in the central part of the field is about N. 65° E. to N. 70° E. and that of the anticlinals is much the same, although there is a tendency to approach the basin's southern rim.

The shape and importance of *all* the many waves into which the strata of the Southern field have been thrown is not fully known. The position and probable extent of the principal anticlinal axes, with the observed dips, are indicated upon the mine sheets, and the probable shape of each and of the basins as well is shown by the cross sections.

With but few exceptions the north dips are much steeper than the south ones.

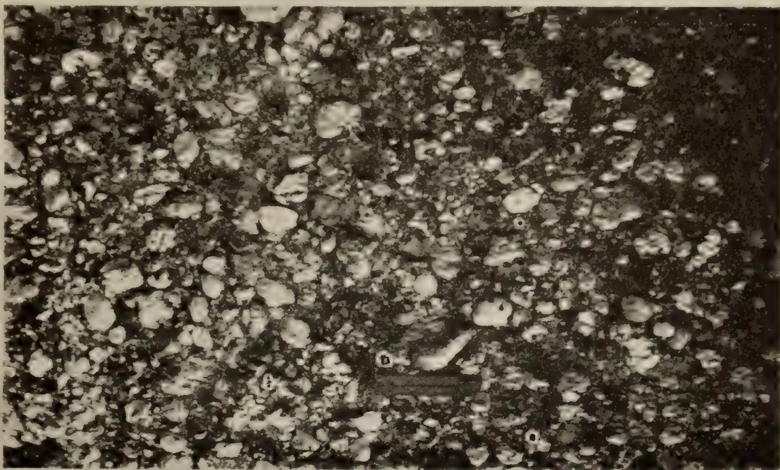
Among the many important flexures of the field, probably none are more important than the Mine Hill and the Gate Ridge anticlinals; each in the past has had a decided influence in fixing the shape and extent of the field, and each in the present is an important factor in the mining operations.

The *Mine Hill Axis*, or an equivalent, appears first spanning a red shale cove in the Broad mountain west of Mt. Pleasant and disappears as a gentle flexure in the side of Sharp mountain at Summit Hill. Centrally it forms a broad high conglomerate arch, which steepens as in dips into the valuable Heckschersville coal basin on its north flank; but on the south often carries a moderate pitch for some distance, before turning down into the deep basins between it and the Sharp mountain.

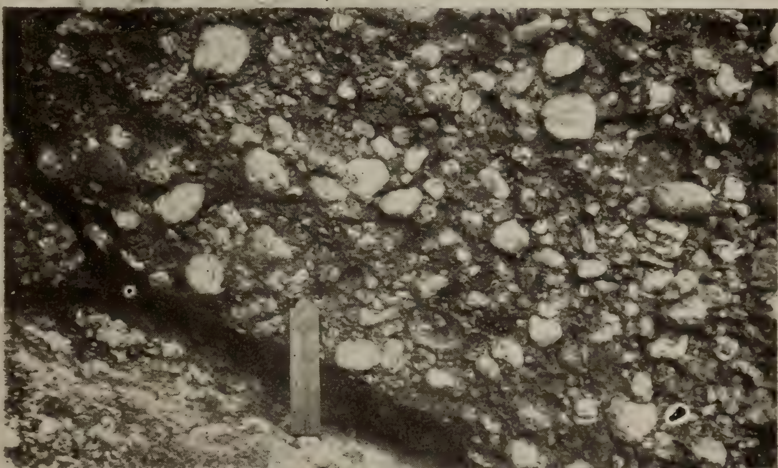
The *Gate Ridge Axis*, the eastern representative of the

PL.365.

Anthracite Region _ Southern Coal Field.



POTTSVILLE CONGLOMERATE, RATHER COARSE – FROM PHOTOGRAPH BY MR. E. B. HARDEN.



POTTSVILLE CONGLOMERATE, RATHER COARSE – FROM PHOTOGRAPH BY MR. E. B. HARDEN

Selins Grove anticlinal, is first seen in the Smoky Hollow cove at the junction of the fish tails. It parallels the southern boundary for more than twenty miles to pass out through Sharp mountain, east of Middleport, forming the Devils Kettle or Cove as it goes. The strata all along its crest, save where it enters and leaves the field, is sharply compressed ; with perpendicular, overturned, or confused dips towards the north. The south dips usually range from 20° to 50°. A double crest to this axis, seen at a number of places, with a narrow deep basin between, adds to the difficulty of identifying the beds on its north and south flanks. The great thickness of the coal measures along its course through the field seems to preclude the elevation of other than the higher coal beds along its crest.

Formation No. XII.

The Pottsville Conglomerate* in the Southern field is noted for its great thickness (1,100′ to 1,475′), the coarseness of its materials and the number and the size of the coal beds which it contains. These beds are especially large and valuable near the junction of the fishtail and throughout the Wiconisco basin. Six Lykens Valley † beds 3′ to 10′ thick are sometimes worked. Sections of No. XII are given on page plates 367, 371, 379 and 392 and need not be repeated. Special reference to it and its coal beds will be made in each division.

Coal Measures.

The thickness of the Coal Measures in this field appears to be certainiy 2500′ and possibly two or three hundred feet more. They consist throughout of the usual alternations of sandstones, shales, slates and fires clay and contain 20 different coal beds, well distributed, all of which have been worked at one or more points within the basin. The Mammoth, with a good thickness and its usual characteristics, is the principal bed and supplies the bulk of the product.

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* See plate 365 for photographs of conglomerate blocks, with coarse pebbles.

† This coal is especially liked for use in open grates and for domestic purposes and it commands a high price in the market.

The Buck Mountain, at the base of the measures, is an important but rather variable member of the group. The position of both these beds, low in the column, place them below the level of present mining operations, except in the shallower basins and along the rims of the deeper ones. The Diamond bed, about 900′ above, and the Peach Mountain bed, about 1500′ above the Buck Mountain, may be mentioned as usually of more than ordinary value. The highest workable bed, the Brewery, 5′ thick, is about 2200′ above the conglomerate; above this there are one or two thin coal beds.

Condition of the Coal Beds.

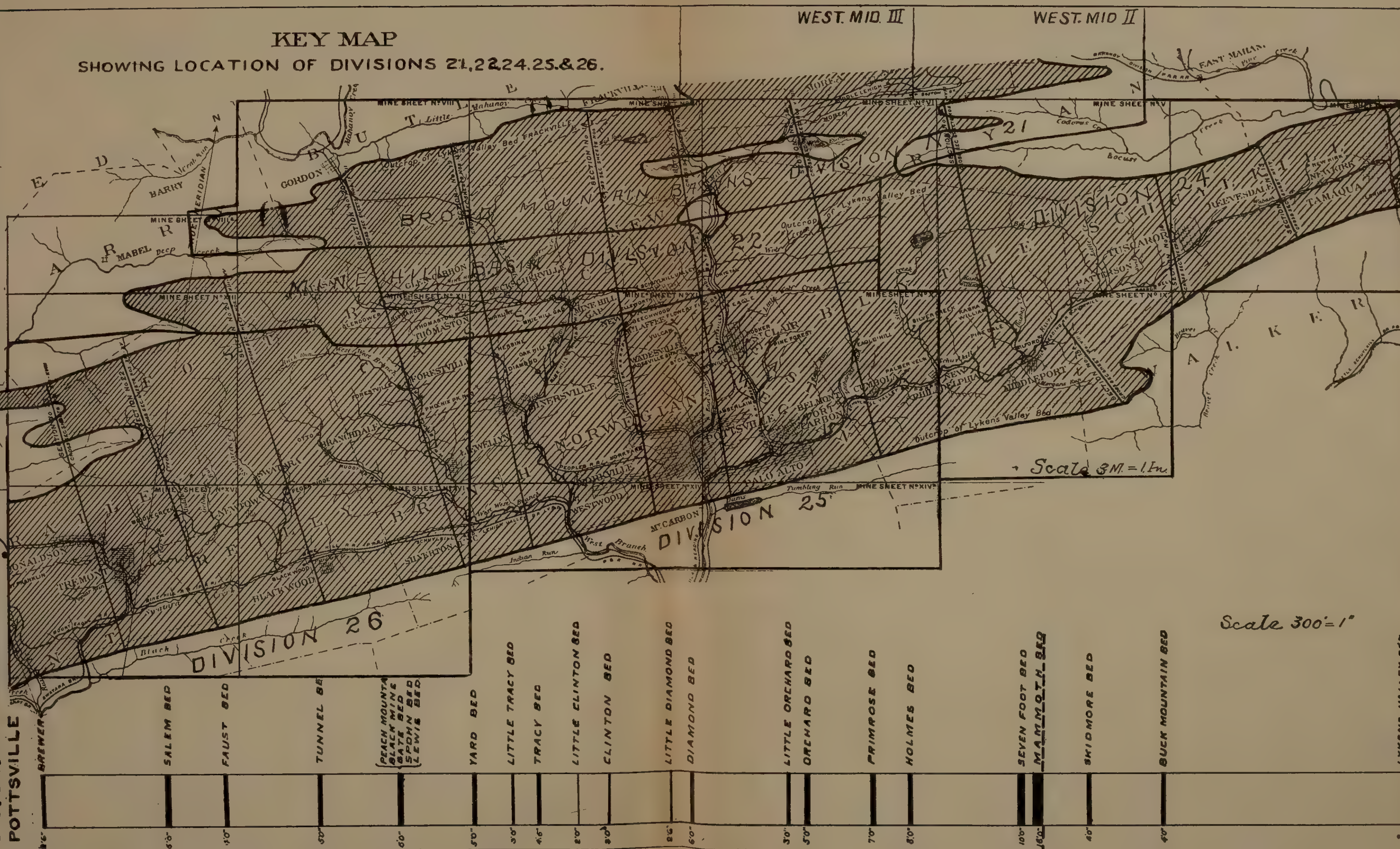
With little or no exception the coal beds throughout the whole Southern field show in some degree the bad effects of the excessive pressure exerted at the time they were lifted into the highly inclined position they now occupy. Where the strata is nearly perpendicular or overturned as in the Sharp mountain and along the north dip of many of the axes, especially that of the Gate Ridge, the coal beds and the softer strata bear marks of their having suffered a movement parallel to the plane of stratification, "analogous to the sliding which takes place between the leaves of a ream of paper when one side is lifted." The coal is more or less crushed and the fragments polished by mutual rubbing, "sometimes converted into lenticular flakes with a lustre and color somewhat resembling black lead," and sometimes reduced to a soft mushy condition as at the outcrop. "Another effect of this slipping of the coal upon itself is a warped or twisted folding of the coal beds, and their alternate contraction or enlargement by undulations in their confining strata. Thus the levels in some of the gangways have a decidedly serpentine course, and similar undulations of roof and floor are visible in the direction of the dip."*

Although the above applies especially to coal beds having a dip of more than 70° or probably less than 15 per cent. of the entire field. Still the great bulk of the coal even

* See cross section through Blackwood colliery on plate 387.

PL. 366.

Anthracite Region_Southern Coal Field.



when found on gentle dips has been to some extent injured, and shows to a less degree the effects of a sliding and crushing movement of the strata which here and there renders the coal soft, unsound or mixes it with slate, and squeezes or bulges the coal beds.

The colliery operations have naturally been located to mine the coal beds which were thought mostly likely to prove sound and regular. Two hundred and seventy-five bed sections, reported to the Survey and measured chiefly at operating collieries, give an average of *72 % of coal and 28% of refuse.* This perhaps fairly represents the condition of the coal beds where there is no unusual disturbance of the strata and where the dips are not excessive. The perpendicular and overturned beds, and in some localities even those on gentle dips, undoubtedly contain a much higher proportion of refuse

The increased value and demand for the small sizes of coal is of especial importance to operators of this field as it enables them to save a large proportion of the product which would formerly have gone to the dirt bank.

For convenience in description the field is divided into the following divisions:—

Division 21. Broad Mountain.
" 22. Heckscherville Valley.
" 23. Panther Creek.
" 24. Tamaqua—Middleport.
" 25. Pottsville.
" 26. Llewellyn—Tremont.
" 27. East Franklin—Brookside.
" 28. Williamstown—Lykens.
" 28. Schuylkill—Dauphin.

Division 21. Broad Mountain Basins.

The area covered by this division is mapped on the upper parts of mine sheets VI, VII, VIII and VIII*a* and on the southern edge of Western Middle mine sheets II and III.* The northern ends of cross sections 16 to 20, on sheets VI

* Page plate 366 shows the relative location of the division.

to XII, show the general structure of the basins. Columnar section sheet IX gives sections of the coal measures and conglomerate. The New Boston, the most important of the Broad mountain basins, is mapped, cross sectioned, contoured and fully described in a private report by Mr. Benjamin Smith Lyman, published by permission of Mr. Warren Delano in Annual Report, 1887. The reader is referred to that report for more detailed information than will be here given.

The high table land of the Broad mountain is formed by a great broad undulating arch of No. XII, which connects the Western Middle field with the deep basins of the Southern. This arch is a compound one and is depressed by two or three comparatively shallow synclinals, holding the beds of the lower Coal Measures along the troughs. These basins send projecting ridges into the red shale both to the east and west.

Formation No. XII covers the surface for much the larger part of the division, and exposures of its massive conglomerate beds are quite numerous. Its thickness is about 1200′, and detailed sections of it are found in the records of bore holes 1 to 4, published* on columnar section sheet IX; two of these records probably comprise the whole formation.

The Broad mountain coal basins are separated by the Eisenhuth Run and Powder Mill anticlinals, both imported flexures with dips of 10° to 40° on either side, and continuous for the whole length of the division. Each also elevate to surface, along the axis, patches of Mauch Chunk Red Shale No. XI, to outcrop along Mill creek and Rattling run. Other shorter and less important anticlinals are seen at different points within the division.

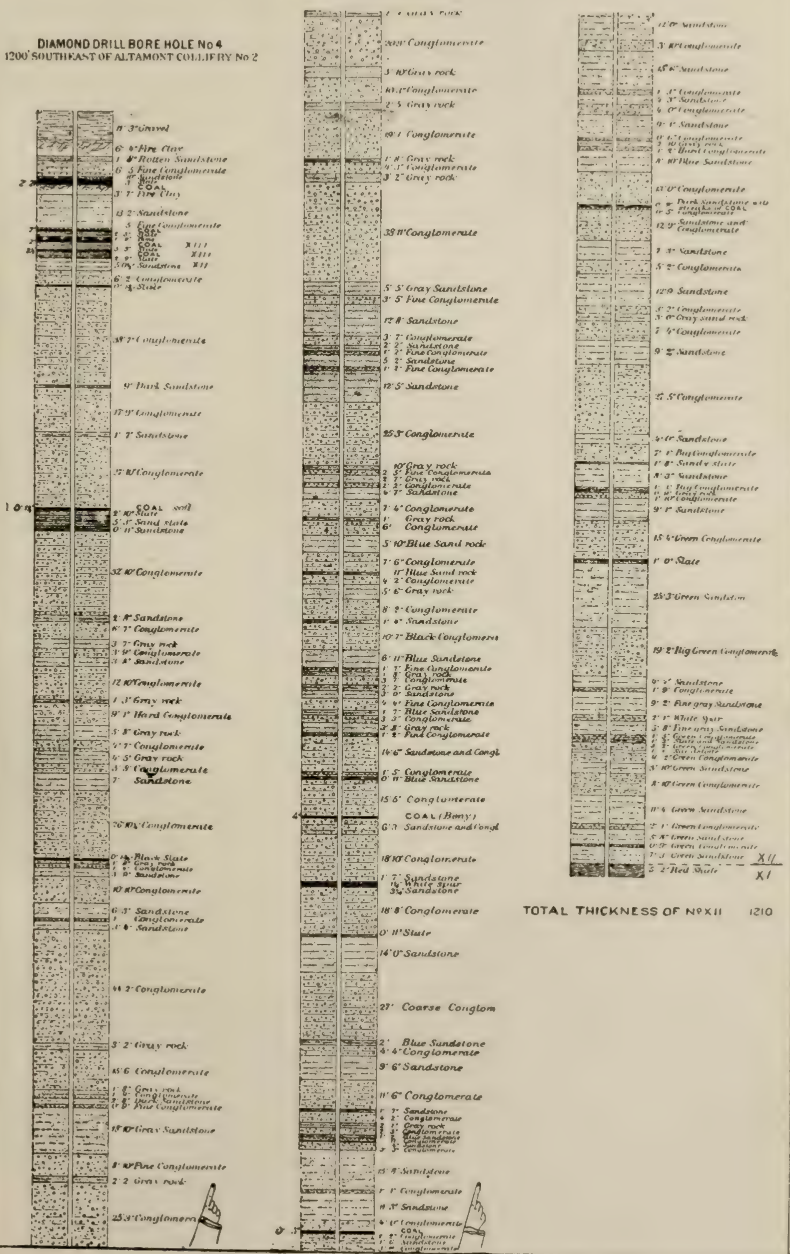
The principal coal area on the Broad mountain, and the only one containing the Mammoth bed, is that in the trough north of the Eisenhuth run anticlinal. The eastern limit of this basin is found in the mountain spur some four miles east of New Boston and its western limit in the high knob

* See also page plate 367.

PL.367.

Anthracite Region — Southern Coal Field.

NºXII ON THE BROAD MOUNTAIN



south of Gordon. It has a total length of about 14 miles and a general width between the Lykens Valley outcrops of three fourths of a mile. One or two short anticlinals not well developed would seem to cross the basin obliquely. The eastern half is known as the New Boston basin, and the whole might be called the New Boston–Gordon basin.

The basin is deepest, some 500′ or 600′ to the Buck Mountain, towards the ends; and so shallow near the Centre Turnpike as to lift that bed to outcrop. The Mammoth is the highest coal bed and its area at the Gordon end is quite imited.

In the New Boston basin the coal beds, particularly the Mammoth and Buck Mounuain beds, are of large thickness and good quality. The New Boston colliery was in operation for a number of years, and when the breaker burned in 1893 it was not rebuilt as most of the coal had been taken out. The Morea, a comparative new colliery on the west end of the same property, also found the beds thick and in good condition; this colliery has commenced to work the Ely and Riehle tracts adjoining on the west.

Mr. Lyman makes the following estimate of the average thickness of the beds and coal on the New Boston and Morea leases.

	New Boston.		*Morea.*	
	Coal.	*Total.*	*Coal.*	*Total.*
Mammoth top split, ...	10′ 6″	13′ 3″	10′ 6″	13 3′
Mammoth middle split, ...	3 0′	3′ 0″	4′ 6″	5 5″
Mammoth bottom split, ...	9′ 4″	10′ 7″	20′ 0′	25′ 0″
Skidmore bed, ...	5′ 4″	6′ 4″	3′ 8″	4′ 9″
Seven-foot bed, ...	2′ 7″	2′ 8″	5′ 1″	6′ 0″
Buck Mountain, ...	13′ 10″	15′ 4″	9′ 7″	11′ 0″
	44′ 7″	51′ 2″	53′ 4″	65′ 5″

"As regards quality, the coal of the bottom split of the Mammoth bed is, at New Boston, considered the best of all they have worked there; but the Buck Mountain coal is called about equally good. The Skidmore coal is found somewhat inferior, and the Seven-foot there is the least satisfactory of all. The Seven-foot coal at Morea appears to be quite another bench, and seems to be of good quality.

Nothing definite is known of the quality of the two upper splits of the Mammoth on the tract. No assays have been made of any of the coals."

The explorations of the Broad Mountain Coal Company, consisting of deep trial slopes, tunnels, trial shafts, and diamond drillings, pretty thoroughly test the basin from the west line of the Ely and Reihle to its west end near Gordon a distance of seven or eight miles. These explorations show that there is a marked decrease in the thickness of the coal beds and an increase in the proportion of refuse of unsound coal which they contain. This change, without apparent cause, would seem to commence with the Ely and Reihle tracts and continue all the way to the west end of the basin. The dips developed are no greater than those at New Boston and Morea and why the condition of the beds should be so different it is hard to understand; but the thoroughness of the explorations does not seem to leave any doubt as to the correctness of the general conclusion. The chief difficulty is said to be not so much the thickness of the beds as their variable composition, sometimes containing good sound coal which suddenly becomes soft, shelly, mixed with slate, or otherwise damaged.

The Altamont colliery No. 2 consists of trial slopes on the Buck Mountain and Mammoth beds; the former bed has an average thickness of about 9′ 6″ with 5′ 6″ of coal, and the latter contains 10′ of coal when found in good condition.

The slope on the Buck Mountain bed near Gordon plane cut but little sound coal; the bed is there 5′ or 6′ thick.

The mine sheets show the probable extent of the Buck Mountain and Mammoth beds in the New Boston-Gordon basin.

The *Lykens Valley coal beds* of Formation No. XII, in this division sometimes have four or five representatives; one of these, the Lower Lykens Valley bed, is persistent throughout and at times reaches a thickness and condition bordering upon the workable. Altamont No. 1 colliery, abandoned, is located upon this bed, which is there about 3′ thick; the coal pinched and the gangways stopped in fault. Openings on this bed at a number of places along its outcrop and the diamond drill borings, show it to vary from 1′ to 4′ in thickness.

The *other basins* of the Broad mountain lie between the Eisenhuth Run and Powder Mill anticlinals, and consists of three separate areas of the Lykens Valley coal beds; the middle one of which may contain a small area of the Buck Mountain bed although it is not yet developed. A Lykens Valley bed has been shafted at a number of places along the outcrop of the little basin on the hill southwest of the Eisenhuth run dam. Probaly it is the same bed, or Lower Lykens Valley, shafted on both dips of the middle basin where it crosses Dyers run. The results of these openings now quite old are not known to the writer.

Division 22, Heckscherville Valley or Mine Hill Basin.

A long narrow trough of coal measures lying between the Mine Hill ridge and the foot of Broad Mountain. It is mapped on the southern parts of mine sheets VI, VII, VIII and VIII*a* and on the northern edge of mine sheets XI, XII and XIII.* The basin is crossed by sections 17 to 22 published on cross section sheets V to XII.† Columnar sections of the measures are given on columnar section sheet VI.‡ This division embraces the valley of Wolf creek and the valley of the West Branch between the Mine hill and Broad mountain, extending west to the spoon of the basin beyond Mt. Pleasant, a distance of 12 miles with a maximum width of about one mile between the Buck Mountain bed outcrops.

Mill creek cuts across the basin at the east. The West branch of the Schuylkill has its source along the slope of Broad mountain facing the valley, flows eastward in the basin and finds a southern outlet through the gap in Mine hill above Minersville; and the West West branch has its rise on the high ground at the west end of the basin. This valley has been the scene of mining operations for many

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* Page plate 366 gives the general location of the division.

† Page plate 367 gives some sections showing shape of basin.

‡ Page plate 369 gives columnar sections of coal measures.

years. New Castle, Heckscherville, Glen Carbon and Mount Pleasant are small towns within its limits. The collieries now in operation are Richardson, Thomaston, Taylorsville and Glendower.

The gentle dips seen near the axis of the Mine Hill anticlinal become steeper as they approach the basin, having along the south side of the valley a general north dip of 40°–50° which meeting still greater dips of 50°–70°, from the opposite side making a rather deep though narrow trough. The westward droop of the Mine Hill axis causes it apparently to die out at the West West branch, to be replaced by the Peaked Mountain anticlinal which springs into prominence along the north flank, and forms a deep red shale cove southwest of Mount Pleasant as it passes west out of the field.

Ranging along the northern edge of the valley for nearly its whole length is an overturned basin (Jugular basin) of Mammoth coal, the north dips outcrop before turning down into the main basin. It is seldom more than a few hundred feet wide. The south dip of the bed ranges from 30° to 50° and the north dip from perpendicular to, at the Anchor colliery (see page plate 368) it is bent over, nearly parallel with the south dip or inverted to 40° south. For a long time owing to the inverted parallel dips this coal was supposed to underlie the Mammoth of the main basin, but the mine workings have now so thoroughly developed the structure as to remove all doubts as to its identity. The coal of this overturned basin although sometimes of great thickness is apt to be soft and shelly or much mixed with slate and dirt.

The main basin has a general depth of about 1200′ to the Buck Mountain bed between New Castle and Mount Pleasant then rises out rapidly to the east and to the west.

No complete section of *No. XII* is had in this division; the best exposures are at Mill Creek and Mine Hill gaps* where the upper beds are seen, its thickness as shown on the cross sections is about 1200′.

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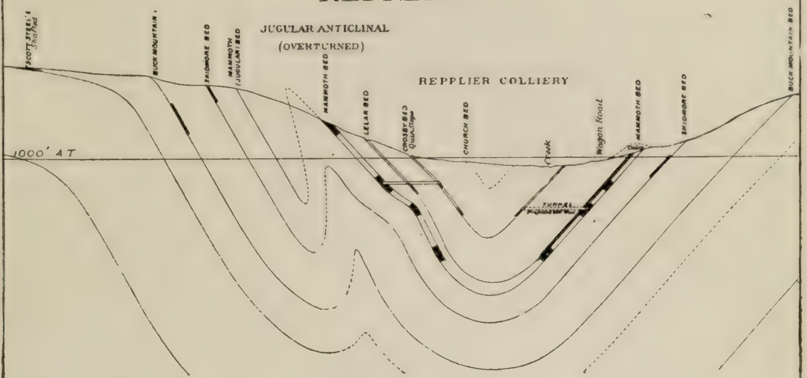
*See photograph showing the conglomerate in Mine Hill gap on page plate 364.

PL.368.

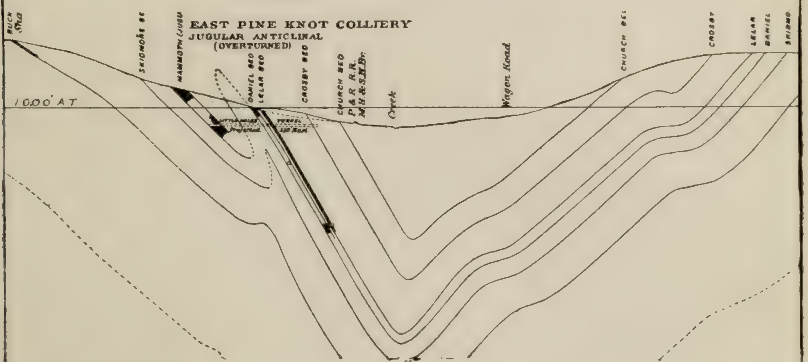
Anthracite Region_Southern Coal Field.

HECKSCHERVILLE VALLEY BASIN

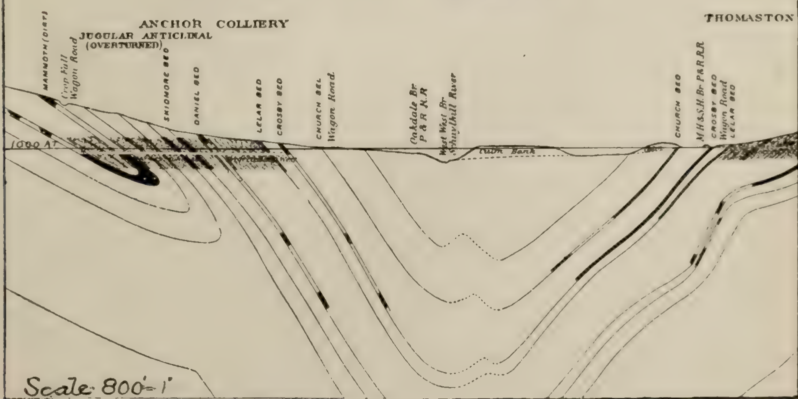
REPPLIER.



EAST PINE KNOT



ANCHOR AND THOMASTON



Scale 800'=1"

Lykens Valley Coal beds.—Two thin beds of this series are found to the east on the south dip at Mill Creek; on one of these there was formerly a small drift, though both beds so far as known are here thin, slaty and unworkable. At the west end of the basin beyond Mt. Pleasant four Lykens Valley beds have been opened. No record was obtained of the thickness of the upper three; the bottom bed however, No. 5,? is opened by two small drifts, Mosiers on the north dip and Bolicks on the south; at Mosiers drift the bed is 4′ to 5′ thick with 3′ to 4′ of coal.

"*Scott Steel*" *bed.*—On the north side of the basin, in the Mill creek gap, a small bed of coal about 100′ below the Buck Mountain is found. It is perhaps a split of the Buck Mountain, but is locally called the "Scott Steel" bed; where, opened at the Ebony colliery, the bed is 2′ to 4′ 6″ thick, quite variable, at the best yielding 2′ 6″ of good coal.

Buck Mountain bed is practically untouched throughout the whole division; the bed has not been thoroughly tested but the general evidence is that it is both small and dirty. The only working of the bed was about Mill creek gap and along Wolf creek, here there are some water level drifts and a slope down one lift on the bed. On the west side of Mill creek the bed is 3′ 6″ to 5′ thick with 3′ to 4′ of coal, on the east side its thickness is given in Report of First Survey as 7′ 6″. At the Thomaston colliery a tunnel recently driven south towards the Mine Hill axis cut the Buck Mountain 3′ 5″ thick, 1′ 11″ of coal, still further west; near the spoon of the basin the bed is opened in two or three trial shaftings, but no definite information concerning them was obtained.

Skidmore or Billy Best bed reaches its best development at the Thomaston* and Richardson* collieries where the bed is extensively mined on both sides of the Heckscherville Valley basin and in its Peaked Mountain basin branch; its average thickness in this neighborhood is 6′ with 4′ to 5′ of coal. At the eastern end of the basin in the small drifts about Mill creek the bed is much thinner being 2′ 6″

* Cross section through Thomaston colliery on page plate 368.

to 3′ 6″ in thickness. The interval between it and the Buck Mountain decreases from 150′ about Mill creek to 40′ at Thomaston colliery.

Back bed is the name given to a thin bed of coal 3′ to 4′ thick which is found at Thomaston and neighboring collieries between the Skidmore and the Mammoth beds; it is seemingly a split of the Skidmore bed; it is not worked.

The *Mammoth** *bed* is worked extensively the whole length of the basin, it is usually found in three splits, to which the local names of Daniel, Lelar aud Crosby are given to the Bottom, Middle and Top splits respectively. The south dipping Mammoth of the overturned or Jugular basin has also been worked to a greater or less extent for nearly its whole length; the thickness of the bed in this basin varies from 10′–60′, including slate partings; as has been said, much of the coal is unsound, and usually only the better portions of the bed have been taken out. The distance between the Daniel and Crosby beds or Top and Bottom splits is quite uniformly 200′, and the interval is noticeable for the beds of coarse, hard conglomerate which make up a large part of it (see columnar sections). Towards the Mill creek end of the basin the Lelar or Middle split is found near the Daniel, but toward the west it is higher up and nearer the Crosby bed. The Crosby and Daniel, as a rule, are the more important portions of the bed.

Speaking of the Mammoth, east of Mill creek at the Neville shaft in the Jugular basin, Report of First Survey, page 442, says:

"A perpendicular shaft is sunk in the centre of a synclinal basin, through sand and debris 75′ to the Jugular bed. The upper portions of this great bed seem to have been swept away leaving a band of coal divided by slate variable in thickness, the average yield of which is 12′ of coal."

Between Mill creek and the Mill Hill gap and for a mile

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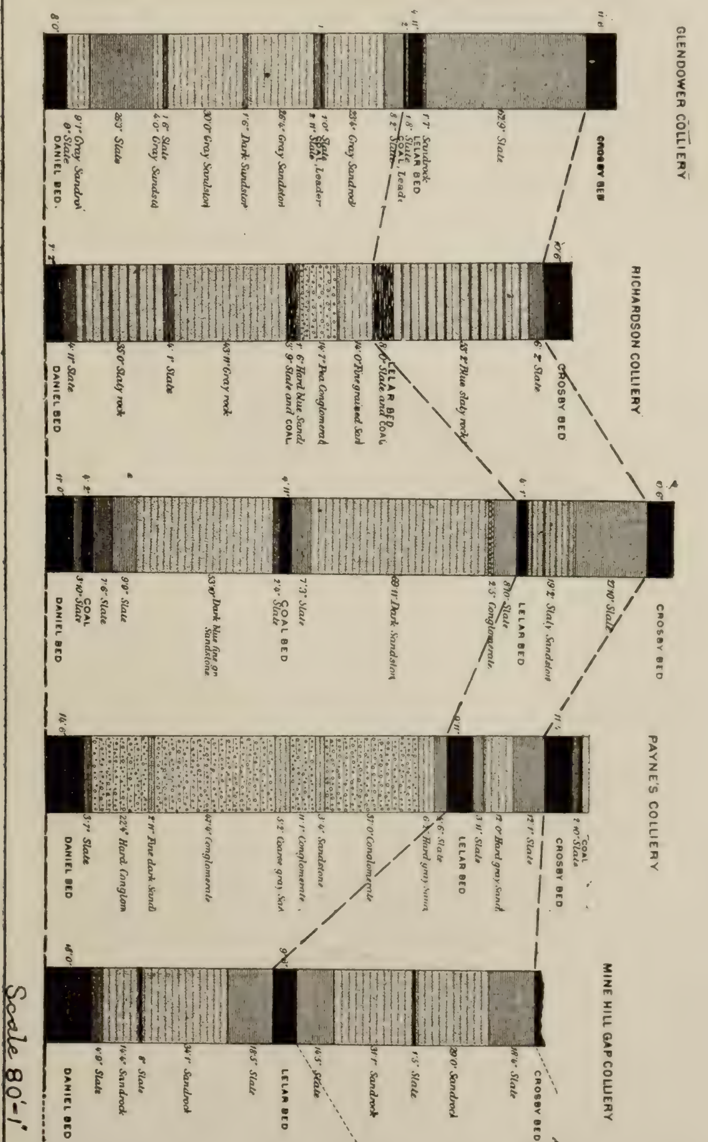
* Page plate 369 shows the relative position and thickness of the Mammoth splits at different points in the basin.

PL. 369.

Anthracite Region – Southern Coal Field.

SECTIONS TO SHOW THE DIVISIONS OF THE MAMMOTH BED IN THE HECKSCHERVILLE BASIN



or more further west the average thickness of the Daniel bed according to Report of First Survey is 15′ to 20′. The Lelar bed is thin at the east end of the basin but at the Mine Hill gap is 6′ to 8′ thick in good condition. The Crosby also thickens towards the west, being 3′ to 4′ thick at Repplier colliery* but increasing to 10′ or 12′ in thickness at Mine Hill.

Beyond Mine Hill gap the active operations at Thomaston, Richardson, Glendower and Taylorsville furnish us with recent information as to the thickness of the beds. The westward thinning of the Daniel continues; at Thomaston the bed varies from 8′ to 15′ thick ; at Richardson 6′ to 8′; and at Taylorsville and Glendower 4′ to 6′ thick. The bed yields about 75 % of coal. Across the Peak Mountain axis at the old Rohrsville slope the First Survey reports the Daniel bed to be 19′ thick. The Lelar bed is 4′ to 6′ thick where cut by the several tunnels, but is presumably of poor quality as it remains unworked. The thinning of the Daniel bed is compensated for to some extent by an increased thickness of the Crosby, which throughout the western part of the basin has an average thickness of about 12′ with 10′ of coal.

Holmes or *Church bed* overlies the Crosby by 100′; the development of the bed is confined to the operating collieries in the western half of the basin ; the general thick- of the bed is 8′ to 10′ with 6′ to 8′ of coal.

Primrose bed is probably the highest workable bed of the basin; it is cut in tunnels crossing the basin; at Oakdale it is 11′ thick and at Paynes 15′ thick; as the bed is unworked its condition is apparently not first class.

Above this the basin where deepest contains 100–200 of measures which remain unexplored.

The general condition of the beds worked in the Heckscherville Valley is fairly good, comparatively little faulty ground has been encountered and the beds are perhaps less variable in thickness and quality than in general throughout this field.

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*For cross section through this colliery see page plate 368.

Division 23. Panther Creek Basin.

This division is mapped on mine sheets I, II and III,* which show the structure of the basin by a contouring of the floor of the Mammoth bed. Twelve vertical sections published on cross section sheets I, II and III † also delineate the structure and the relation of the coal beds. Columnar section sheets I, II and III ‡ give numerous sections of the measures and also detailed sections of the principal coal beds.§ Topographical sheet I gives the shape of the surface by contour lines 10′ apart. All of the above are contained in Atlas Part I, Southern Field.

The "First Report of Progress" (1883) by Mr. Charles A. Ashburner treats almost wholly of the Panther Creek basin, which was the first area to be mapped and reported upon. The work here was done in greater detail than was found practicable to continue over the whole field.

The name Panther Creek basin is applied to that part of the Southern field lying between the Little Schuylkill and the Lehigh or between Tamaqua and Mauch Chunk. The basin is about 12 miles long and 2 miles wide narrowing to a sharp point at the spoon of the field high on the mountain a mile east of Mauch Chunk. The name is derived from the Panther creek which flows west within the basin and joins the Little Schuylkill at Tamaqua.

Nearly all of this basin is the property of the Lehigh Coal and Navigation Company, and as the coal is shipped to the eastern markets by way of a railroad or the canal along the Lehigh river, it is included with the Eastern Middle field in forming what is known to the trade as the Lehigh region.

Referring to the *structure* Prof. Lesley says (AA Report I): "The most striking feature of the plication of this basin is its sharpness, the rarity of those soft and gentle curvatures which characterize the bituminous coal basins, a rigid plainness of the up and down slopes, suggestive of (1) a severe lateral compression in the jaws of a vice, and (2) a humid plasticity of the coal measures at the time of compression."

* Small scale map on page plate 370.

† Selected cross sections showing structure on page plates 372 and 373.

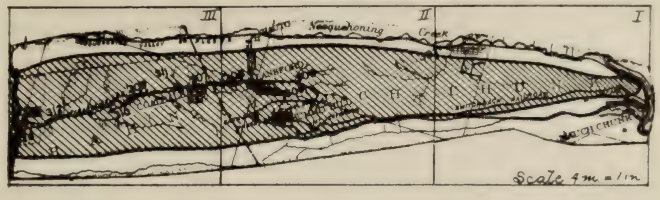
‡ Relative position of the coal beds shown on page plate 370.

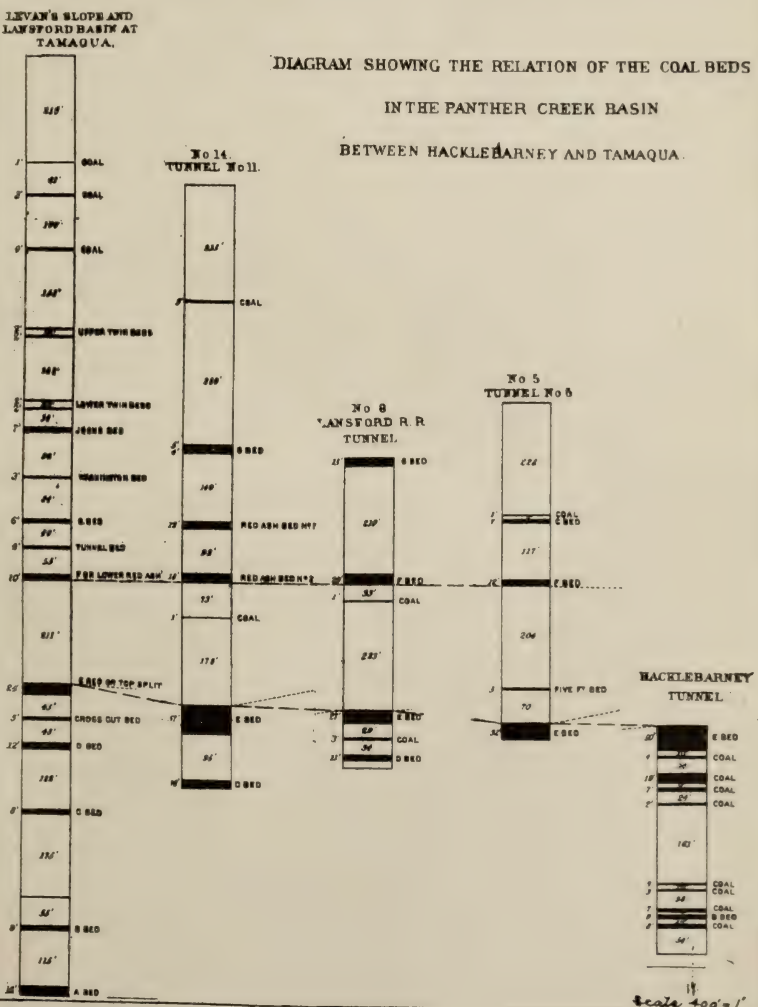
§ Some of these are given upon page plate 374.

PL. 370.

Anthracite Region – Southern Coal Field.

PANTHER CREEK BASIN, DIVISION No. 23





The fall of the measures towards the west is at times quite rapid, and at the Little Schuylkill, cross section 12, shows Bed A to attain a probable depth of 2500′ below the river.

Formation No. XII, according to Mr. Ashburner, has a thickness varying from 878′ to 1296′, a number of detail sections are given on columnar section sheet II; three of these are reproduced on page plates 371.

At the little Schuykill the *coal measures* have a thickness of about 1900′ (see sec. 17 col. sheet II) containing 13 coal bed with a thickness of 3′ or more; the total thickness of the coal beds is given as 120′. The Mammoth is the principal bed, always thick and sometimes exceedingly so; one section at Tunnel No. 9 gave a thickness of 114′ 2″ (see page plate 374). Mr. Ashburner reports that 88 per cent. of the total coal removed from the Panther creek basin has been from the Mammoth bed. A description of the coal beds as condensed from his report is as follows:—

"*Lykens Valley Beds.* The question of the occurrence of these coal beds in the Panther Creek basin, with workable dimensions, is one of great uncertainty. Too few facts have been obtained upon which to base any conclusions. That the beds, which have been opened in the Locust Mountain gap and which are shown in the Tamaqua section are the true representatives of the Lykens Valley beds, there seems to be no doubt, but that they extend under the entire basin or are as thick or thicker than in the gap it is impossible to say."

"*A Bed.*—Geologically this is the lowest coal bed that has been worked in the Panther Creek basin. It has been mined on both the east and west sides of the river in the Locust Mountain gap. The horizontal distance between this bed and the B bed, on the west side, is 202 feet, and on the east 260 feet. This interval is filled mostly by conglomerate; the coal bed is also underlaid by conglomerate. The Locust Mountain drifts are closed, and it was impossible to examine the bed. It is reported, however, in the east drift to have measured as much as 16′ thick. The average for the entire workings would probably not exceed 10′ with 8′ of coal.

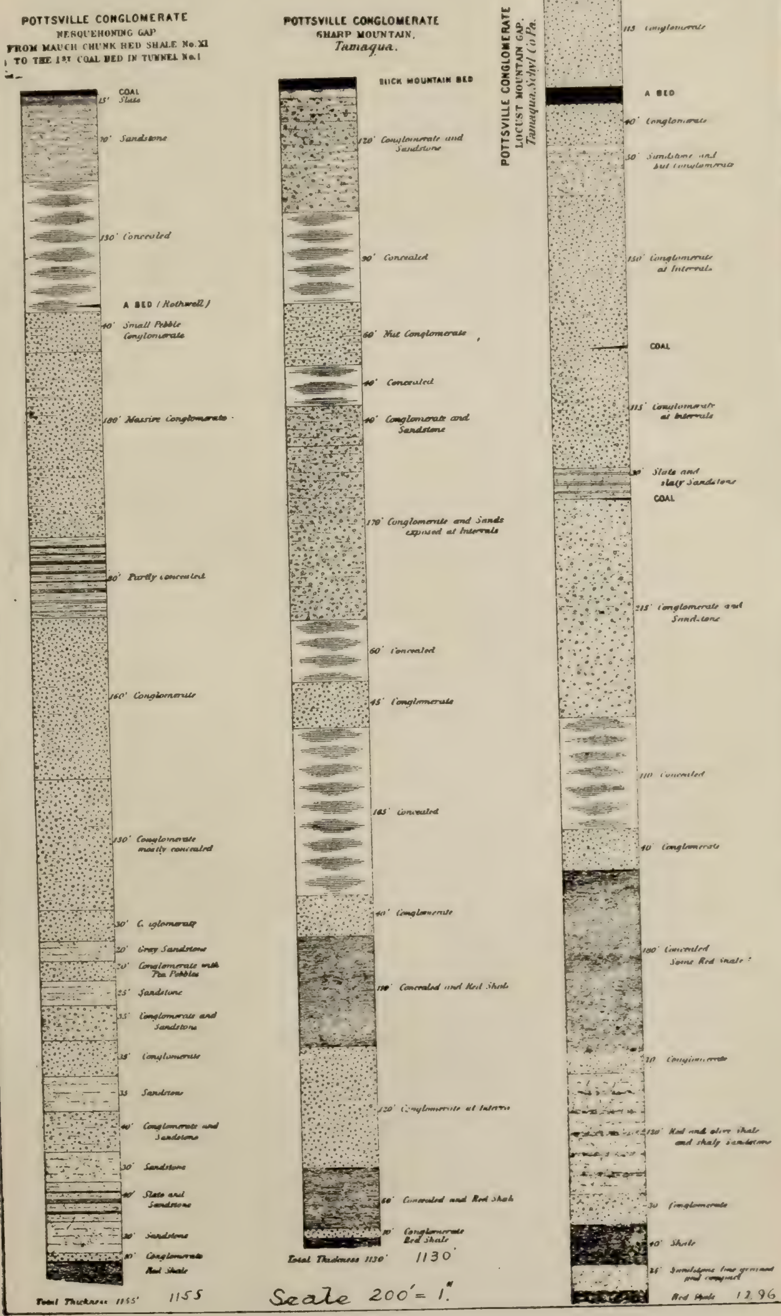
The A bed has been opened on the outcrop at Nesquehoning tunnel No. 1 and is reported to contain but 1′ of coal. It was also cut in the Nesquehoning R. R. tunnel, but was found to be worthless. The average thickness of the bed for Mine sheet No. I has been taken as 3′ with 1′ of coal, for sheet II, 5′ thick with 2′ of coal, and for sheet III, 7′ thick with 4′ of coal. On this basis the estimated original contents for the basin is 62,011,362 tons."

"*B Bed.*—The B bed has been mined in but two localities in the Panther Creek basin: in the Hacklebarney tunnel, where it had an average thickness of 12′, with 9′ of coal, and in Levan's drift, which is in the Locust Mountain gap, and is included in the Greenwood colliery, where its average thickness has been reported as 6′, with 3′ of coal. On the south dip of the Hell Kitchen basin the bed seems to be badly faulted. The bed was cut in the Nesquehoning R. R. tunnel, where it is 14′ thick, but only contains 2′ of coal. The bed was shafted on south of Tunnel No. 11, where it was found to contain 5′ of coal; also on Sharp Mountain near the river, where it contained only 2′ of coal. The average thickness assigned to the bed on Mine sheet No. I is 15′, with 10′ of coal; on sheet No. II, 8′, with 2′ of coal, and on sheet No. III, 6′, with 2′ of coal. This is probably an underestimate of the actual thickness of coal to be found in the bed in the areas covered by sheets Nos. II and III. With these thicknesses it has been estimated that the total original contents of the bed was 71,954,700 tons, of which but 115,347 tons have been taken out."

"*C Bed.*—This bed has been mined to a very limited extent in the Panther Creek basin. The only place where it has been cut on sheet No. I is in Tunnel No. 1 at Nesquehoning. The average thickness of the bed for the entire sheet has been taken as 4′ 6″, with 3′ of coal. On sheet No. II it has been opened in Tunnels No. 6, 7 and 9. The average thickness on this sheet has been taken as 5′, with 3′ of coal. On sheet No. III the bed has been opened at Tunnels Nos. 8, 10 and 11, and at Greenwood tunnel and Levan's drift. More is known of this bed in the area covered by sheet No. III than elsewhere. In Tunnel No 11,

PL. 371.

Anthracite Region - Southern Coal Field.



the bed has been named in the records of the Lehigh Coal and Navigation Company the D bed. At this point it has its maximam thickness of 17′, with a thickness of coal ranging from 11′ to 14′.

At Tunnel No. 8 the bed has been locally called the "Crack" and is 4′ thick; at the Greenwood tunnel it is 8′ thick. The average thickness for the sheet has been taken to be 11′, with 8′ of coal. It has been estimated that it underlies 638 acres on sheet No. I, 3,070 acres on No. II and 3,729 acres on sheet No. III, with a total original content of 128,256,560 tons; 136,890 tons have been taken out of the bed at Greenwood and Sharp Mountain collieries."

"*Mammoth bed.* The most important of all the anthracite coal beds is what has been generally named, the Mammoth bed. Although it is found to undergo many changes in its thickness, and the alternation of its numerous coal benches with bony coal, slate and sandstone, and as to the character of the coal which it will produce, which sometimes make it difficult to recognize it, yet it possesses many features and characteristics which are peculiar to it in almost every locality where it has been opened, and which make it the most easily recognized geological horizon of any in the Carboniferous formation of the anthracite region.

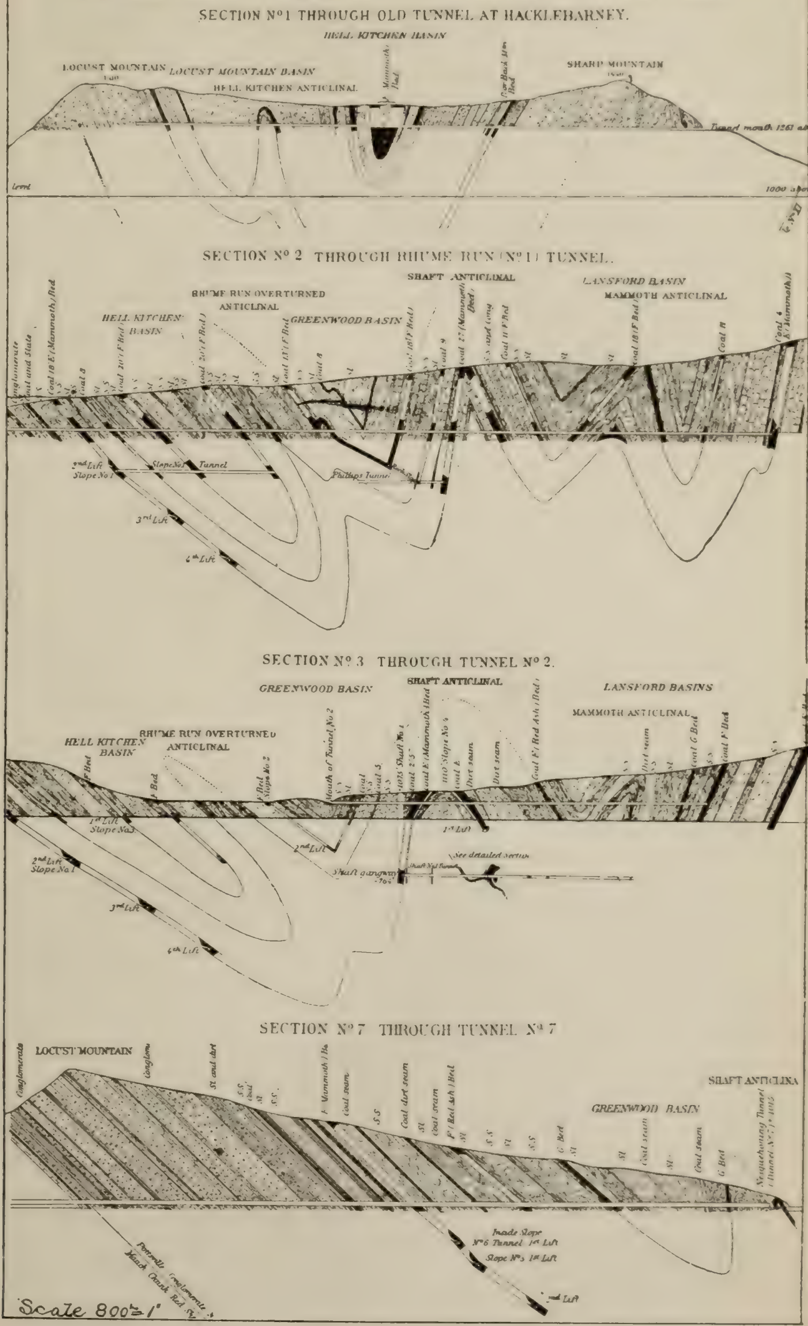
This bed is sometimes found to exist as one bed of coal, the benches of which are not separated by more than two or three feet of slate or bony coal. These separating layers are more frequently only a few inches thick and vary very much as to number. This feature can be observed by glancing at the sections of the Mammoth bed on Columnar section sheet No. III. At one place in the old quarry workings at Summit Hill, where the bed measures 53′ 1″ thick, as many as 20 separate layers of slate and bony coal were contained in the bed, having an aggregate thickness of 12′ 10″. Some of these slate layers are continuous over wide areas, and are oftentimes easily identified from point to point by the experienced miner. When studied in connection with the immediately associated coal benches, they form valuable clews, in determining in what part of the bed mining is being carried on. This is very important in some cases, where the separating slate becomes locally thickened and it becomes important to know whether the whole face of the coal bed is being mined, or whether there might not be another bench of good coal above or below those which are being worked. As a rule these widely separated coal benches or splits rarely number more than four, usually three, sometimes only two. In most parts of the region they are best known as the top, middle and bottom splits of the Mammoth bed. In the Panther Creek basin, where the Mammoth bed undergoes this change, the different members are called E or Top Split, Cross-Cut or Middle Split, and D, or Bottom Split. In this basin, the name Mammoth is generally assigned only to what in reality is its top split.

The Mammoth has been more extensively mined than any other of the Panther Creek coals. Eighty-eight (88) per cent. of the total coal removed has been from the Mammoth bed. The number of tons of coal mined from the several splits in the different parts of the basin may be ascertained by reference to the tables. The Mammoth bed underlies 495 acres on Mine sheet No. I; 2,817 acres on sheet No. II; and 3,532 acres on sheet No. III. It is estimated that this bed in the Panther Creek basin originally contained 572,370,108 tons of coal, and that 47,826,441 tons have been removed up to January 1, 1883, so that there still remains to be mined about 91.5 per cent. of the total original contents. This is a low estimate, in view of the fact that the Mammoth bed is supposed to contain only 23′ of coal on Mine sheet No. I, and 27′ on Mine sheets Nos. II and III. The thickest section of the Mammoth bed which has been measured in this district, or in fact as yet in the Anthracite Region, is 114′ 2″ at a point 4,017′ west of the inside slope of Tunnel No. 9 (Section No. 20, Sheet No. III). This is an abnormal thickness and cannot be taken to represent what the bed can be expected to maintain over any area.

Seventeen sections of the Mammoth bed have been carefully measured in the different mines of the Lehigh Coal and Navigation Co. to show the alternation of coal and slate

PL. 372.

Anthracite Region – Southern Coal Field.



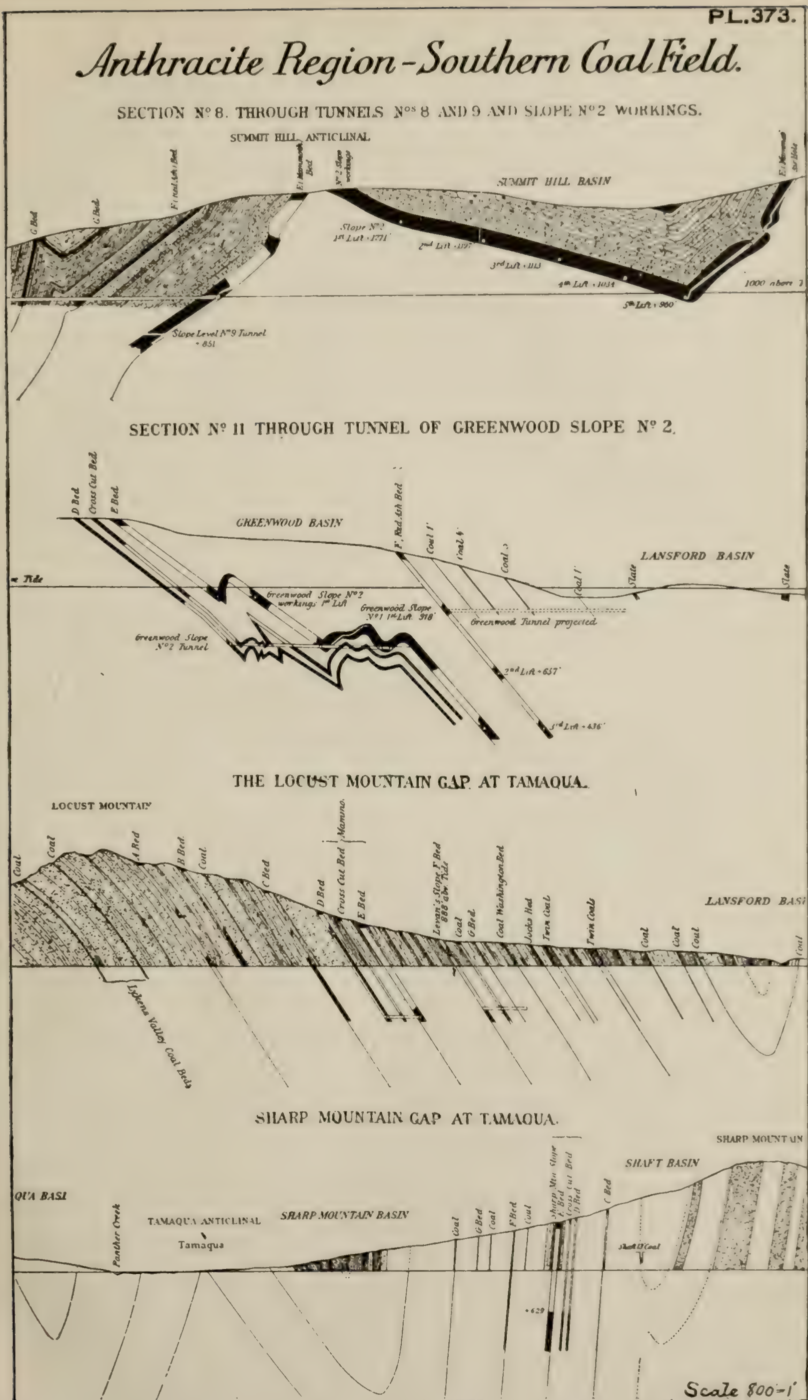
in the bed. These sections have been constructed in verticle columns on a scale of 10′ = 1″, and may be found on Columnar section sheet No. III."

"*F or Lower Red Ash Bed.* Next to the Mammoth, this has proved to be the most important bed which has been opened in the Panther Creek basin. It has been most extensively mined at Nesquehoning and Greenwood. It varies very much in thickness. The greatest *which has been recorded* is 17′ 7″, in the gangway driven west from Tunnel No. 11. On mine sheet Nos. I & II this bed has been mined from Tunnels Nos. 1 & 2, slopes Nos. 2 & 3, and shaft No. 1. All of these workings are embraced within what is known as Nesquehoning colliery No. 3. The average thickness of the bed for this sheet has been taken as 13′, with 9′ of coal. So many measurements of the bed were obtained over a wide area, and on different sides of the basins, several on sheet No. I, that 9′ is believed to be the medium thickness which could justly be assigned to the bed. It is probable that the estimate made of the coal contained on sheet No. II is too low, as the bed there has been assumed to contain on an average 5′ of coal. On this sheet the F bed has been mined from Tunnels Nos. 6, 7 and 9. Although the sections of the bed measured show as high 9′ feet of coal, areas have been developed where the bed is either unworkable, from containing to much slate, or is pitched out. At Tunnel No. 6, where the bed has been extensively worked, a gangway was driven 3200′ in the bed, where the coal was faulted. What coal was found here was too poor to mine. In view of the possibility of the bed being faulted over other areas on this sheet, the average thickness of coal for the sheet has been taken to be 5′. On mine sheet No. III, the F bed has been opened at Tunnels Nos. 8, 10 and 11 and at Greenwood. It has been found to be very regular throughout the Greenwood and No. 10 workings. An average of 9′ of coal has been assigned to the bed on sheet No. III. The estimated total original contents of the F bed for the entire basin is 130,379,486 tons, underlying 314 acres on mine sheet No. I, 2,288 acres on sheet No. II, and 3,039 acres on sheet No. III. Up to the 1st of January, 1893, there had been mined from this bed 5,675,141 tons, so that at that time there remained 124,704,345 tons to be mined."

"*G or Upper Red Ash Bed.* This bed is geologically the highest coal bed which has been mined to any extent in the Panther Creek basin. It has been worked in a drift at Nesquehoning, on the north dip of the Greenwood basin; from Tunnel No. 1 on the south dip of the same basin; from Tunnel No. 9 on the north dip of the Bull Run basin; and from the old Levan's slope at Tamaqua, where a tunnel was driven from the foot of the slope in the F bed to the G bed. In the drift workings, above referred to, the bed measured 7′ thick, with 5′ of coal; and on the south dip of Greenwood basin, in Tunnel No. 1, 5′, with 3′ of coal. The bed seems to be badly rolled and pinched at other points on Mine sheet No. II, where it has been cut by Tunnels Nos. 1 and 2; so that, in computing the total original contents of the area contained on Mine sheet No. I, an average thickness was assigned to the bed of 5′, with only 2½′ of coal. On Mine sheet No. 11 the bed has been cut in Tunnels Nos. 5, 6, and 7. Its thickness at these points varies from 6′ in Tunnel No. 6 to 15′ in Tunnel No. 7, on the south dip of the Greenwood basin. The average thickness of the bed on this sheet has been taken to be 6′, with 3′ of coal. On Mine sheet No. III the bed has been cut in Tunnels Nos. 8, 10, and 11; in Greenwood tunnel, and in front of Levan's slope, as already stated. On this sheet the bed varies in thickness from 4′ at Greenwood tunnel to 10′ in Tunnel No. 8. The average for the sheet has been taken to be 5′, with 3′ of coal. The total original contents of this bed in the entire basin are estimated at 36, 748, 163 tons."

"*Washington Bed.* This bed has been located immediately under the Jock in Greenwood tunnel No. 1, at Tamaqua. It measures 3′ in thickness, and may be considered to contain at a minimum 1′ of clean coal. It underlies 1,083 acres on Mine sheet No. II and 1,796 acres on Mine sheet No. III, containing in the aggregate, 8,940,331 tons."

"*Jock Bed.* This bed was cut in Greenwood tunnel No. 1 on the south side of the Lansford basin, and was at one


PL. 373.
Anthracite Region - Southern Coal Field.
SECTION Nº 8. THROUGH TUNNELS Nºs 8 AND 9 AND SLOPE Nº 2 WORKINGS.
SUMMIT HILL ANTICLINAL
SUMMIT HILL BASIN
SECTION Nº 11 THROUGH TUNNEL OF GREENWOOD SLOPE Nº 2.
GREENWOOD BASIN
LANSFORD BASIN
Greenwood Tunnel projected
THE LOCUST MOUNTAIN GAP AT TAMAQUA.
LOCUST MOUNTAIN
Lykens Valley Coal Beds
SHARP MOUNTAIN GAP AT TAMAQUA.
SHAFT BASIN
TAMAQUA ANTICLINAL
Tamaqua
SHARP MOUNTAIN BASIN
Panther Creek
Scale 800-1'

time opened on its outcrop on the same side of the basin near Tamaqua. The bed has been considered to range between 6′ and 7′ thick. It is estimated that it contains 3′ of coal. It underlies 700+acres on Mine sheet No. II, and 1245+acres on Mine sheet No. III. If the bed can be depended upon containing 3′ feet of coal under these areas, its contents would amount in the aggregate to 18,153,490 tons of coal."

"*First Twin Beds.* The section of these beds is similiar to those of the Second Twin beds, 128′ of strata lying between the two. Nothing is certainly known as to either the permanent thickness of the beds, or the character of the coal.

The information which can be had, relative to all these coal beds, is very meager, and nothing is positively known as to whether the beds could be mined, or what they could be expected to produce".

"*Second Twin Beds.* These beds are said to have been opened near water level at Tamaqua, and to have shown a thickness of 2′ each, with an interval of 13′ between ; 158′ of strata intervene between them and the First Upper Red Ash bed."

"*First Upper Red Ash Bed.* This bed is separated from the second by 106′ of rock. It is reported to be 4′ thick, although not proved sufficiently to suppose that this may be taken as its average thickness.

The coal beds from the Second Twin to the F or Lower Red Ash inclusive, comprise the Lower Red Ash group."

"*Second Upper Red Ash Bed.* This bed has been prospected on in the same basin, and is separated from the above bed by 63′ of rock. It is reported to be 3′ thick ; nothing, however, is known as to whether it will prove workable."

"*Third Upper Red Ash Bed.* The highest coal bed, known to exist, is what has been named the *Third Upper Red Ash* bed, being the highest of the three beds composing the Upper Red Ash group.

This coal is reported to have been found on the northern side of the Lansford basin immediately east of Tamaqua. It is but one foot thick, and dips at an angle of 80° S. It will probably never prove workable."

24. *Tamaqua—Middleport Division.*

The area embraced in this division is all of that mapped by mine sheets IV, V and IX.* The general structure is shown by sections 12, 13, 14, 15 and 15*a*, published on cross section sheets III to VII.† Columnar section sheets II to IV give the measures cut by most of the shafts and tunnels.‡ No topographical sheets have been published.

Locust mountain, an eastern spur of Broad mountain, makes the northern, and Sharp mountain the southern boundary of the division which covers the full width of the field.

From Tamaqua to Tuscarora the basin is only about a mile and one-half wide. East of Middleport the Sharp mountain turns south to round the Gate Ridge anticlinal and then resumes its usual course, of about S 70° W., towards the Susquehanna. This bend in the southern boundary and a slight turn towards the north of the Locust mountain, increase the width of the field about Middleport to nearly 5 miles; this is maintained with some increase for a considerable distance to the west.

Tamaqua, a town of 4,000 to 5,000 inhabitants, is at the eastern edge of the division with the villages of Tuscarora, Patterson and Middleport in order to the west.

Wabash creek, some 3 miles long, drains east to Tamaqua. The Schuylkill river, heading just beyond Tuscarora, flows in a southwesterly course along the foot of the Sharp mountain. Swift, Big and Kaska William creeks cut across the measures to join it from the north. Morgan's and Yellow Spring runs are small streams rising on the slope of Sharp mountain.

Mining developments are confined almost wholly to the rims of the basins and are along the foot of Locust moun-

* Page plate 366 gives the relative location of the division.

† Page plates 375, 377 and 378 illustrate the structure.

‡ Page plates 376 and 382 give partial sections of the coal measures.

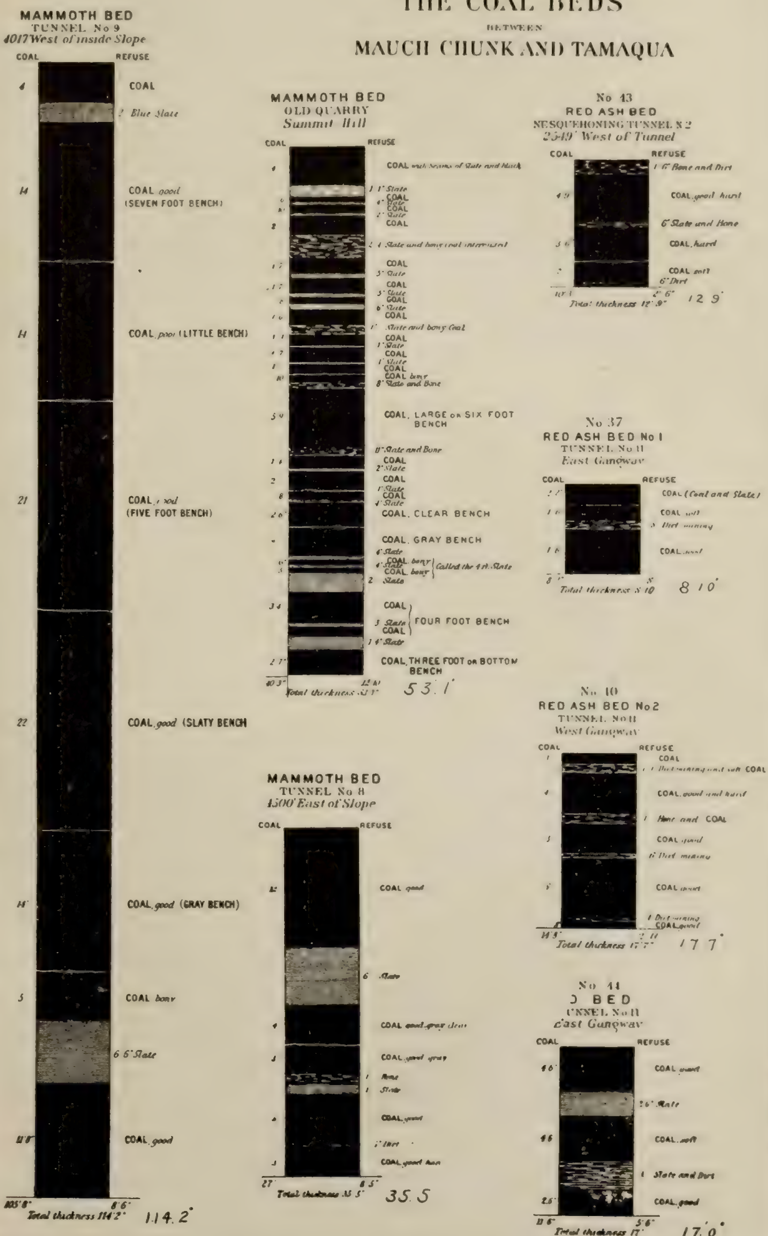
Anthracite Region – Southern Coal Field.

SECTIONS OF

THE COAL BEDS

BETWEEN

MAUCH CHUNK AND TAMAQUA



tain, the Mine hill, and the foot of Sharp mountain. With the exception of some local sale mines, there are now but two operating collieries in the division, the West Lehigh below Tamaqua and the Kaska William above Middleport. Forty to fifty years ago mining operations were much more active, as the number of abandoned collieries and mine workings testify. The Report of the First Survey is the best authority concerning these early operations and we are indebted to it for much of our information regarding them.

There has been in a small way some mining along the outcrops of the upper beds in the deeper parts of the basin, which in connection with exposed dips and coal outcrops, indicate the probable structure of the central part of the basin as drawn on the cross sections.

Structure.—The Mine Hill is the principal anticlinal; west of Tuscarora No. XII outcrops along its axis and makes a ridge which rises west to nearly the height of the Locust mountain, with a narrow basin (the Big Creek) of Coal Measures between them. The eastward droop of the axis brings up higher and softer measures along the crest and although easily traced from Tuscarora to Tamaqua by surface dips, it has but little effect upon the topography. The Gate Ridge anticlinal crosses sheet IX and passes out of the field east of Middleport. A number of additional anticlinals, all having an important bearing on the economic working of the coal beds, have been developed by the scant mine workings or are seen in the rock exposures. The position, extent and shape of these axes so far as known are shown upon the mine sheets and by the cross sections.

Formation No. XII is well exposed in both the gaps at Tamaqua; a measured section gives it a thickness of 1296′ at the Locust Mountain gap and 1130′ at the Sharp Mountain gap. (See sec. 49 and 50 col. sheet II, also page plate 371.)

Lykens Valley Beds.—Above Tamaqua on the west side of the gap, a drift now fallen shut was driven some 400′ on a Lykens Valley bed. The same bed was opened by trial shafting on its outcrop for half a mile further west. No record of the thickness of the bed or quality of the coal could be obtained.

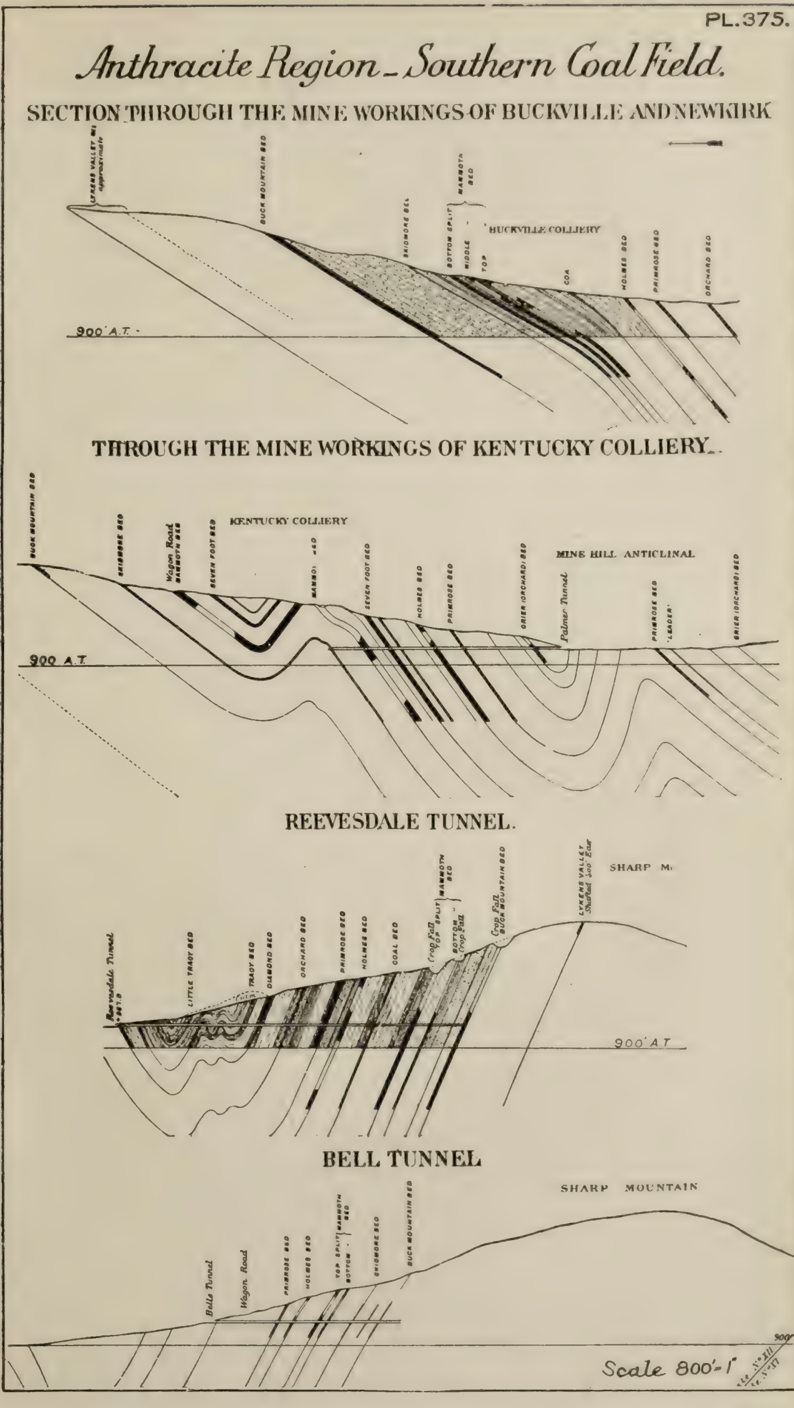
At 145′ above this bed and 240′ below the top of XII, traces of another, the Upper Lykens Valley, bed are said to be found. It does not seem likely that either of these beds are workable in this division, except possibly in some small well favored areas.

At the Sharp mountain gap no coal beds are seen below the Buck Mountain, but it is apparently a Lykens Valley bed which is shafted on top of the mountain south of Reevesdale tunnel. The localities mentioned comprise all the known openings on the beds within the division and the outcrop of the Lowest Lykens Valley bed as drawn on the mine sheets is necesarilly largely conjectural.

Buck Mountain bed:—At the gap above Tamaqua three coal beds, below the bottom split of the Mammoth are worked (see mine sheet IV, cross section 12, and col. section sheet II), and were called by the First Survey beds A, B & C; on mine sheet IV beds A and B are known as Bottom and Top splits of the Buck Mountain bed. Coal A or the Bottom split lies on top of a coarse massive conglomerate, the bed is "16′ thick but rubbed and fissured." Coal B or the Top split is 100′ higher in the measures, with conglomerate just below the bed, and is 9′ thick. At Newkirk colliery there are but two beds below the Mammoth, beds D and B. A tunnel is driven 400′ beyond B in an attempt to find the "A" bed of Tamaqua which apparently has disappeared or has joined the "B" bed by the thinning of the intervening rock. The B or Buck Mountain bed at Newkirk "averages 17′ thick, is faulty to the east but good to the west;" the bed was extensively worked.

At Buckville the water level tunnel was driven to and beyond the Buck Mountain bed which is there double, "the two coals are each 6′ thick with 20′ of rock intervening in the tunnel, but 35 to 40 west they come together and the coal becomes dirt and is valueless."

At the Kentucky colliery the bed has been shafted but not worked. On the Shippen & Wetherill tract a mile to the west recent openings show the bed to range from 4′ to 9′ thick. The Buck Mountain bed is opened high



PL.375.
Anthracite Region - Southern Coal Field.
SECTION THROUGH THE MINE WORKINGS OF BUCKVILLE AND NEWKIRK
BUCK MOUNTAIN BED
SKIDMORE BED
BOTTOM SPLIT
MIDDLE
TOP
MAMMOTH BED
BUCKVILLE COLLIERY
COAL
HOLMES BED
PRIMROSE BED
ORCHARD BED
900' A.T.
THROUGH THE MINE WORKINGS OF KENTUCKY COLLIERY.
BUCK MOUNTAIN BED
SKIDMORE BED
Wagon Road
MAMMOTH BED
SEVEN FOOT BED
KENTUCKY COLLIERY
SEVEN FOOT BED
HOLMES BED
PRIMROSE BED
GRIER (ORCHARD) BED
MINE HILL ANTICLINAL
Palmer Tunnel
PRIMROSE BED
'LEADER'
GRIER (ORCHARD) BED
900 A.T.
REEVESDALE TUNNEL.
Reevesdale Tunnel
LITTLE TRACY BED
TRACY BED
DIAMOND BED
ORCHARD BED
PRIMROSE BED
HOLMES BED
COAL BED
Crop Fall
TOP SPLIT
MAMMOTH BED
BOTTOM
Crop Fall
BUCK MOUNTAIN BED
LYKENS VALLEY
SHARP M
900' A.T.
BELL TUNNEL
SHARP MOUNTAIN
Bells Tunnel
Wagon Road
PRIMROSE BED
HOLMES BED
TOP SPLIT
BOTTOM
MAMMOTH BED
SKIDMORE BED
BUCK MOUNTAIN BED
Scale 800'=1"

up on Mine Hill northwest of Silliman Slope; its thickness there is "3′ 6″"? Near the north end of Whitfields upper tunnel two beds (Buck Mountain ?) 5′ 6″ and 2′ 6″ thick, somewhat crushed and broken are cut with about 40′ of rock between. At the Northdale tunnel the Buck Mountain is worked for 1000′ east and west; the bed is 6′ thick with a 3′ bed of shelly coal at 21′ above and a 6′ bed of coal dirt and slate 12′ still higher.*

In the Sharp mountain below Tamaqua the Buck Mountain bed is worked in the overturned basin on both sides of the gap; it is about 10′ thick. At Reevesdale tunnel the bed has also been worked; its thickness is about the same, but at both places it is, in common with all Sharp mountain beds, irregular and dirty. At the two Sharp mountain tunnels south of Tuscarora the bed is cut but not worked; at Bells the bed is in two splits, at least, 3′ and 2′ 6″ thick with 37′ interval between; at Gormans but half a mile away the section shows one bed 10′ thick, soft and dirty. To the west on mine sheet IX the bed is not worked and although there is apparently an old shaft or two on its outcrop little or nothing is definitely known of its thickness.

The bed "A" of the Locust Mountain gap is nowhere recognized on the South side and apparently does not exist unless combined with the Buck Mountain or bed B.

Skidmore, *or Bed C* of the First Survey is worked on both sides of the river above Tamaqua, "on the east side it is 6′ to 7′ feet thick but faulty, on the west side is 8′ to 9′ thick," the bed is here 120′ below the Mammoth. At the Newkirk water level tunnel it is said by Rogers to have been cut at 40′ below the bottom split of the Mammoth with a thickness of only 1′ 8″ although it is not seen in the sections of the tunnel obtained from the P. & R. C. & I. Co., published on columnar section sheet IV. At the Kaska William colliery the bed is 3′ to 6′ thick and as it is not worked perhaps is not good. In the Sharp mountain south of Tamaqua there are a couple of water level drifts upon it. At the Coal Hill colliery east of Middleport a bed identified as the Skidmore was formerly

*Columnar section of tunnel given on page plate 382 and cross section on plate 377.

worked quite extensively and is said to be about 6′ thick and in the main clean and good. At Buckville, Reevesdale, Bell and Gorman tunnels the Skidmore seems to be entirely absent or represented by merely a thin leader of coal.

The *Mammoth bed* has been worked more extensively than any of the others. The bed is in two well defined members called Top and Bottom splits or beds E & D of the First Survey, with often a third member the Middle split or Cross-cut bed which is usually thinner than either the Top or Bottom splits, but is worked at several places. Three splits are found at the gap above Tamaqua; the Bottom split is here 14′ thick; the Middle split 50′ above is 4′ to 5′; and the Top split 50′ above that has an "average thickness of 22′, but much of the coal is soft and shattered." The Bottom split has been mined through and connects with the workings on the same bed at the Newkirk colliery,* the bed dimishes in thickness and at the lower tunnel it is but 4′ to 5′ thick The Middle split at Newkirk is 3′ to 4′ thick and has been worked to a small extent, the coal is reported to be excellent. The Top split is the principal bed in the workings on the west side of the tunnel it is 12′ to 15′ thick and at one point 30′ thick.

At Buckville† colliery the interval between the beds has so dimished that the Top and Middle splits are together and but 16′ of slate separate them from the Bottom split which is only about 3′ thick, while the combined Top and Middle splits are 18′ to 25′ thick.

At Kentucky colliery‡ the bed worked is probably the Top and Middle splits of the Mammoth, it is 20′ thick at the tunnel, in the water level gangway to the west the bed is thought to have split and the upper split 6′ to 12′ thick worked forward. The so called Skidmore bed 4′ thick of the published columnar and cross sections, cut at the north end of Palmer tunnel, would seem to be identical with the Bottom split of the Mammoth at Buckville and Newkirk collieries. This bed has been recently shafted

* See cross sections on page plate 375.

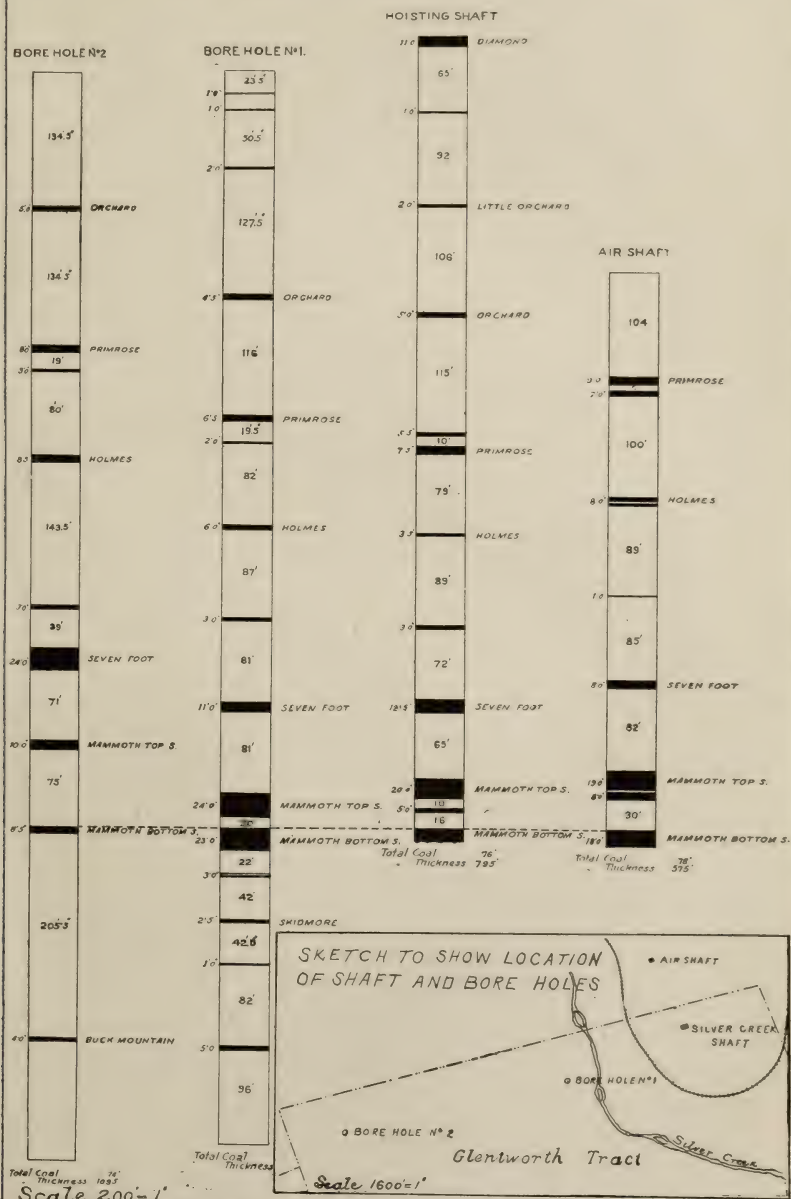
† Section through tunnel on page plate 375.

‡ Section through tunnel on page plate 375.

PL.376.

Anthracite Region-Southern Coal Field.

COLUMNAR SECTIONS OF MEASURES CUT AT SILVER CREEK COLLIERY P. & .R. C. & .I. CO.



on the Shippen and Wetherill tract a mile west of the tunnel where it has a thickness of 10′ of coal. The Middle split, with 2′ 6″ of coal and the Top split with 4′ to 16′ of coal are opened by trial slopes and shaftings at several places on this tract.

About 1000′ east of Silver Creek dam a large coal bed probably the Bottom split of the Mammoth was shafted many years ago on both dips of the Big creek basin; the record of these trial shaftings preserved by Mr. P. W. Sheafer give a thickness of 12′ with 11′ 6″ coal for the bed on the south dip and 9′ 3″ thickness and 8′ 8″ of coal on the north dip.

South of the Shippen and Wetherill openings, on the opposite side of the Mine Hill axis, are the old workings (about 1853) of the Pott and Silliman slopes on the Mammoth; the bed is reported to average 8′ but to be somewhat faulty and dirty at times. Back of Silliman's slope and about 40′ lower in the measures another bed has been drifted upon (printed in purple on the mine sheet), but which seems now to be the Bottom split of the Mammoth; a section of this bed measured 8′ 6″ in thickness with 5′ 4″ of coal, part of which was "shelly."

The workings from Whitfield's upper tunnel on the Mammoth connect with those from Silliman's old slope; the bed at Whitfield's is "6′ to 11′ thick with an average of 8′; in the west gangway the bed is 10′ to 20′ but faulty."

At Northdale tunnel the Mammoth bed is about 20′ thick but sometimes swells to 30′ or 40′.

At the Kaska William shaft* in the next basin south of the tunnel and only 1500′ away, three splits of the bed are recognized. It seeems not unlikely but that the 3′ bed in the tunnel at 60′ below the "Big bed" is identical with the Bottom split of the shaft. The Bottom split 15′ thick and the Middle split, called there the "Upper split," 8′ to 12′ thick are worked quite extensively; the distance between them varies from 75′ to 125′; the Top split or Seven Foot 30′ above has been mined a little with a thickness of 4′.

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* Cross section on page plate 377.

In the Sharp mountain at the West Lehigh shaft below Tamaqua three splits of the Mammoth were worked, the Bottom split being the principal bed; along the gangway to the west the parting slates grow thinner making practically one bed 30′ to 40′ thick at times. The workings from West Lehigh connect with those from the Reevesdale tunnel,* here but two splits are recognized; in the working from the tunnel west the Top split, 10′ to 15′ thick is the larger; the Bottom split is 5′ and 8 thick with an interval of 50′ between at the tunnel.

At Bells tunnel† the Top split shows 4′ of rough coal and the Bottom split 5′ of fairly good coal. At Gormans tunnel the Top split is 6′ to 8′ thick, and the Bottom split 6 thick of dirty coal not worked.

At the Coal Hill colliery and at the Rocktown tunnel east of Middleport the Mammoth bed if correctly identified is both thin and poor, being only 4′ to 5′ thick of dirty coal.

There have been no borings to test the bed in the deep central basins, the nearest approach to it is a D. D. hole on the Adam Stahl tract about 600′ northwest of the Pinedale breaker, ‡ the Mammoth is cut about 1000′ below the surface, but is only some 1500′ south of the Kaska William workings, (see cross sect. 15 and col. sect. 1 sheet XI). At the bore hole the Seven Foot bed is 3′ thick, Upper split 11′, the Lower split 5′ 6″, with a leader 3′ 4″ thick between the splits.

Between the Mammoth and the Holmes bed *two small coal beds* 3′ to 5′ thick are found at Buckville and Palmer tunnels and are often seen at other points in the field, but the coal is usually poor or thin.

A deposit of coarse conglomerate overlies the Mammoth at bed Palmer tunnel and at the Pott and Silliman slopes; these same conglomerate beds make a bold cliff, on the Shippen and Wetherill tract, which has given rise to considerable discussion as to the identity of the coal beds there.

Holmes or F bed is found at quite a uniform distance of

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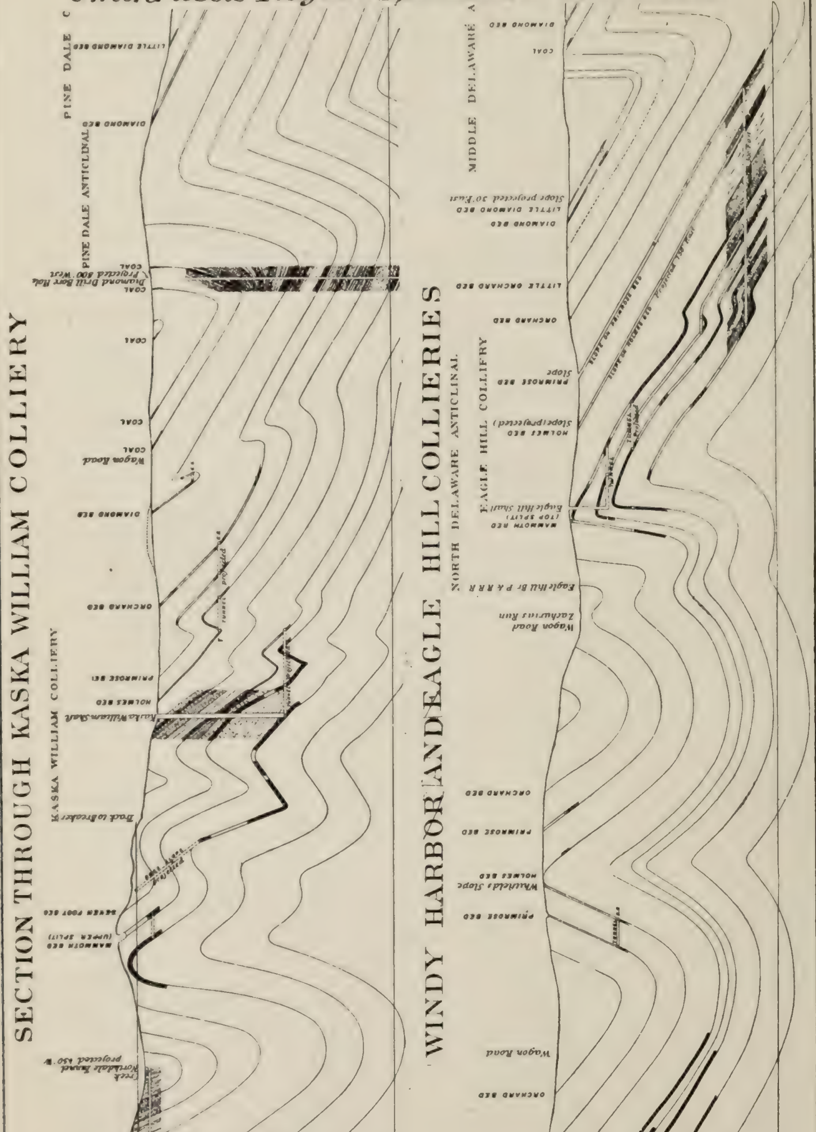
* Cross section on page plate 375.

† Cross section on page plate 375.

‡ Columnar section on page plate 382.

Anthracite Region _ Southern Coal Field.



about 200′ above the top of the Mammoth and has been worked for a lift and sometimes two along the foot of Locust mountain all the way from Tamaqua to Tuscarora. The bed has a comparatively regular thickness of 10′ to 12′ and will probably average 11′ for the whole distance; its condition is only fairly good, at times the coal is firm and sound and at others crushed and broken. The Newkirk anticlinal with overturned dips at the Newkirk breaker lifts the bed to a double outcrop at that point.

This bed where shafted on the Shippen and Wetherill tract at its western spoon in the Big Creek basin, is but 18″ thick. South of Silliman's slope a gangway has been driven west on a bed identified as the Holmes which has a thickness of 9′. At Kaska William there is an old slope on this bed with a reported thickness of 6′.

The south dips along the Locust mountain and the Mine hill carry the bed down not to reappear until the southern edge of the field is reached in the Sharp mountain; at West Lehigh the bed about 5′ thick was opened though but little worked; at the Wabash slope, Reevesdale, the bed was worked half a mile to the east; it is 10′ to 20′ thick. At Bell's tunnel it has 5′ to 12′ of dirty coal; at Gorman's 4′ to 6′ thick, pretty good. At the Coal Hill and Rocktown tunnels the bed is 6′ to 8′ thick but crushed and dirty.

Primrose bed in this division is nowhere particularly good; it was worked to a small extent above Tamaqua, where the bed is about "6′ thick but the coal is bony." At Newkirk there is about 3000′ of gangway on this bed which is there "4′ thick." It is the "Rough bed" of Palmer tunnel 8′–16′ thick of coarse rough coal. The Mine Hill anticlinal lifts the bed to outcrop along the saddle; east of Tuscarora the north dip is steep or overturned and is not opened; the south dip pitching about 40° was worked by the old Tioga colliery, at the northeast corner of the village; the gangway is more than a mile in length, the bed is 5′ to 6′ 6″ thick when regular. At the Swift creek colliery the bed is said to contain 7′ of good coal; a leader 2′ to 3′ thick lying close above it, was reached by a tunnel. At Kaska William a tunnel south from the old Holmes slope cut and worked a little of the Primrose but the bed is small, only 3′ to 4′ thick and quality not first class. On the north dip in the Sharp mountain this coal is not worked; where cut at Reevesdale tunnel the bed is a confused mass 18′ thick. At Rocktown tunnel it is apparently but 7″ thick. The interval between the Holmes and the Primrose varies from 60′ to 80′.

Orchard or Grier bed was mined along the Locust mountain above Tamaqua by a water level drift; its thickness is given as 6′ to 7′ but the coal was somewhat faulty.

At Newkirk about 3000′ of gangway is driven on this bed which has there a thickness of 7′ to 8′. The bed is also tunnelled to at Buckville and Tuckers collieries; at the latter the bed is "5′ thick good hard coal somewhat streaky." At the Palmer tunnel the bed is 9′ thick where first cut but at the face of the short gangway driven west it is but 2′ 6″ thick. Although the identity is uncertain it is thought to be the Orchard bed which is worked at the Peach Mountain slope, about a mile southwest of Tuscarora; the bed is reported as 4′ 4″ thick in a drift just to the east, but the large falls along the outcrop suggest a thicker bed. At Kaska William an old gangway on the bed extends nearly the length of the tract and is said to have yielded 5′ of good coal. The Orchard where cut in the Reevesdale tunnel is but 2′ thick; there are no workings in the bed on this side of the basin. The distance from the Primrose to the Orchard is 100′ to 150′.

Little Orchard bed.—A bed about 3′ thick at 60′ above the Orchard is tunnelled to at Newkirk; apparently the coal is not first class as only a few hundred feet of gangway was driven. The Little Orchard elsewhere in this division is not recognized as a workable bed.

Diamond bed is not worked between Tamaqua and Tuscarora unless it be the unidentified bed of Randall's slope at Tuscarora, the bed is 5′ to 7′ thick, but considerably crushed. At Reevesdale tunnel the supposed Diamond bed is but 3′ 3″ thick. Slattery's little drift at the western edge of Tuscarora is on a steep dipping bed 5′ to 7′ thick called by some the Diamond. Near the wagon bridge over the Schuylkill, just west of the Bell colliery, a 16′ bed of coal dipping 70° northward thought to be the Diamond has been drifted upon. At Kaska William there is a shallow slope on the bed which is there 6′ thick. It is also the bed of the Pinedale colliery, ½ mile southeast of the Kaska William, the coal has there a gentle dip 20° to 40° and is 4′ to 7′ thick but the bed was not good for the whole length of the gangways. It is thought to be the Diamond bed with 2′ 6″ of coal which was worked at the far end of the Milford tunnel above Middleport. Although the Diamond outcrops several times between the north and south rims of the field there has been but little working of the bed in this division and what there is, is not altogether satisfactory.

Clarkson or Tracy the next workable bed occurs about 200′ above the Diamond bed ; the workings on this bed are confined to the rim of the deep basin about Middleport; although the bed is undoubtedly occurs in the high measures between Tamaqua and Tuscarora, there are no developments upon it. The Clarkson was the principal bed of the old Milford colliery* above Middleport, the bed is there "2′ to 6′ thick with an average of 5′ of good coal, the east gangway stopped in a rock squeeze." "About 25 yards below water level in the slope there is a rock fault, with a sudden upcast of 25 yards ; it entirely cuts off the coal without even a leader ; this is an unusual thing in this coal basin." The Clarkson is also worked from the Milford tunnel for half a mile to the east, on the opposite side of the basin, and to a small extent on the same dip in the hill south of the Brockville Station where the bed is 3′ to 4′ thick. Half a mile west of the slope a tunnel driven north from Docker and Bowmans slope gangway cut the Clarkson with a thickness but 1′ 10″. With the exception of some shallow shaftings along the outcrop farther to the west there has been no other working of the bed in this division.

Charles Pott or Little Tracy bed, 100 feet above the

* Section through this colliery on page plate 378.

Clarkson was also worked at the Milford colliery; the bed is there 2′ to 3′ thick of good coal; in the Milford tunnel the north dip of the bed is represented by a thin leader; at Dockers and Bowmans tunnel the bed is 8′ 4″ thick all slate and dirt and appropriately called the "Poor House bed," These and a water level gangway driven through the hill east of Middleport comprise the workings on the bed in this division.

Palmer bed 2′ to 3′ thick is the coal of Kestenbaugh tunnel and Docker and Bowmans slope; it has been also worked on the north dip in the Middleport hill and at the Milford tunnel, with about the same thickness. Its distance above the Charles Pott bed is about 125′.

Lewis or Peach Mountain bed is the principal member of the Upper Red Ash coals; it is this bed which is worked on both dips to the spoon of the basin, east from the Milford tunnel, "the bed yielded 2′ of solid coal." It is thought to be the Lewis bed which was mined at the Hine and Glasmine slope a mile below Middleport; the bed here is reported to be 10′ to 12′ thick. This same bed? was mined from the old "deep shaft" along Yellow Spring creek southeast of New Philadelpha; the sharp compression of the measures here along the double Gate Ridge anticlinal axis and the distance from positively determined points makes the identity of the bed very uncertain.

The highest measures in this division are found between Middleport and New Philadelpha, and probably include several small coals above the Peach Mountain bed.

25. *Pottsville Division.*

Mine sheets X, XI, XIV and XIV*a* and the southeastern part of VI map this division.* The general structure is shown by sections 16 to 19 on cross section sheets V to XII.† Columnar sections of the strata are published on columnar section sheets V, VI, VII, VIII and XI.‡

The Pottsville division is one of the most important of the

* Plate 366 gives the general location of the division.

† Plates 377, 378, 380 and 381 give selected cross sections.

‡ Plates 376, 382 and 382 give selected columnar sections.

field and embraces all of the Southern basin south of the Mine Hill anticlinal and between New Philadelphia and Llewellyn; having a general width of four miles and a length of nine. It includes a number of extensive mining operations within its limits.

The natural boundaries of this division, Mine hill on the north 1200′ to 1600′ A. T.; and the Sharp mountain on the south 1200′ to 1400′ A. T., are about parallel. The Schuylkill river flows along the foot of Sharp mountain west to Pottsville where it turns south and leaves the field through a deep gap (600′ A. T.) in the mountain. Mill creek has cut through the Mine hill and across the measures to join the Schuylkill a couple of miles above Pottsville. The West branch of the Schuylkill not only makes a second gap in Mine hill but also a second gap in Sharp mountain two miles west of Pottsville; in crossing the basin it curves slightly to the west at Minersville. A number of smaller streams most of which flow south across the measures drain the intermediate country. The interior of the basin is hilly and broken but none of the hills approach in height that of the bounding rims.

Pottsville, the seat of Schuylkill county, is centrally located at the foot of Sharp Mountain. New Philadelphia, St. Clair, Port Carbon and Minersville are all important mining towns within this area.

The Silver Creek (new), Eagle Hill, Pine Forest, Eagle, Beechwood, Oak Hill and York Farm are the principal operating collieries in this division, but there are numerous other workings of more or less importance which at this time are temporarily or permanently abandoned.*

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* The chief of these is the widely known Pottsville colliery (cross section on plate 380, columnar on plate 383) of the East Norwegian valley a mile and one half north of the town. Two shafts each about 1470′ deep (the deepest in the anthracite region) were sunk; and two tunnels one 1400′ long from the bottom level, and the other 1800′ long at 440′ above, were driven north to cut the Mammoth bed. Two anticlinals with confused and faulted measures were encountered in the tunnels and when the Mammoth bed was finally reached it was (contrary to well grounded expectation) found to be thin and in poor condition. An attempt was made however to mine the Top split and also the Diamond and Primrose beds, the most promising of the coal cut in the shaft. All of the beds proved to be rather variable in thick-

The whole Southern field but especially this part of it contains many old mine workings, driven before the law required a survey, and of which there is no more reliable record than that of the recollections of the old miners. These old workings, especially when full of water, are a source of considerable danger and several serious accidents have occurred. A careful investigation and inquiry is not always successful in establishing even their approximate extent and each year makes it more difficult.

Structure.—Along the south side of Mine hill the dips are comparatively gentle and the the basins shallow; going south the dips become steeper and the basins of greater depth, culminating in the deep basin between the Gate Ridge axis and the Sharp mountain, where the Buck mountain bed has an estimated depth of more than 3000′. The axes of the basins all incline toward the north and approaching the southern rim of the field the north dips are almost invariably perpendicularly or overturned. The coal beds on these dips are found much crushed and broken.

The principal anticlinals are the South Gate Ridge, North Gate Ridge, the South Delaware which recent developments have shown to extend west beyond the West branch, the Middle Delaware, North Delaware and South Mine Hill; the mine and cross section sheets show the probable position and extent of each and of other subordinate axes as well.

Pottsville Conglomerate No. XII is finely exposed in the gap below Pottsville where it measures about 1350′ in thickness with 400′ or 500′ of transition measures composed of greenish sandstones and conglomerates, and olive and reddish shales separarating it from the main body of No. XI. (See plate 379 for section of XII.) On the opposite side of the division at the Mill creek and West branch gaps in the Mine hill only some 300′ or 400′ at the top of the formation is exposed.

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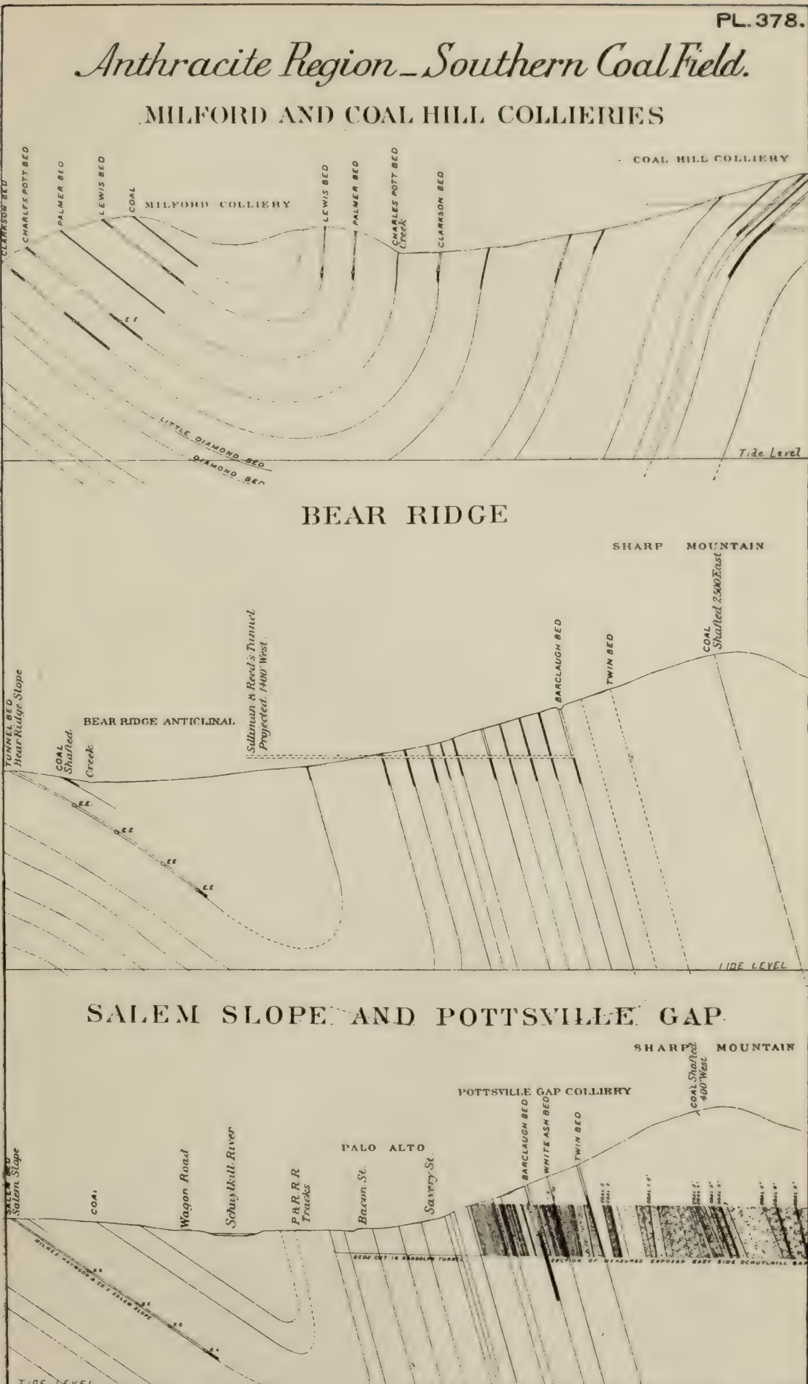
ness and in quality and the gangways encountered drooping saddles cutting off the coal above them. Owing to the unexpected combination of difficulties which were met with, operations at this colliery were suspended about 1884 and have not been resumed. The exhaustion of the cheaper coals near the surface will no doubt in time make it desirable to extend and operate this colliery.


PL. 378.
Anthracite Region _ Southern Coal Field.
MILFORD AND COAL HILL COLLIERIES
CLARKSON BED
CHARLES POTT BED
PALMER BED
LEWIS BED
COAL
MILFORD COLLIERY
LEWIS BED
PALMER BED
CHARLES POTT BED
Creek
CLARKSON BED
COAL HILL COLLIERY
LITTLE DIAMOND BED
DIAMOND BED
Tide Level
BEAR RIDGE
SHARP MOUNTAIN
COAL Shafted 2500'East
TWIN BED
BARCLAUGH BED
Silliman & Reed's Tunnel Projected 1400' West.
BEAR RIDGE ANTICLINAL
TUNNEL BED Bear Ridge Slope
COAL Shafted.
Creek
TIDE LEVEL
SALEM SLOPE AND POTTSVILLE GAP
SHARP MOUNTAIN
Coal Shafted 400'West
POTTSVILLE GAP COLLIERY
BARCLAUGH BED
WHITE ASH BED
TWIN BED
PALO ALTO
Salem Slope
COAL
Wagon Road
Schuylkill River
P.& R.R.R. Tracks
Bacon St.
Savery St.
TIDE LEVEL
Scale 800'- 1"

The total thickness of the *Coal Measures* above the Buck Mountain bed is 2500′ or more, containing some 20 coal beds which reach a workable thickness. The highest beds of the series are worked at the York Farm colliery* of the Lehigh Valley Coal Co. in the Pottsville basin.

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* Messrs. A. B. Cochran & Sons, the mining engineers for the Company, have kindly furnished the Survey with the record of a new tunnel driven south across the basin to the Sharp mountain coal beds.

The section as reported reads as follows:

York Farm Colliery—First Lift Tunnel.

Measurements to Veins, Etc.

Top Slate Black Mine Vein equals 0.

304.4	Bot. Slate, ...	Tunnel Vein $7\frac{1}{2}$ feet thick ; dip, 28° S.
339.0	Top "	
492.2	Rabbit Hole Vein, $2\frac{1}{2}$ feet thick.	
625.6	Bot. Slate, ...	Faust Vein, 8 feet thick, all dirt; dip, 38° S.
636.7	Top "	
937.0	Bot. Slate, ...	Salem Vein, 10 feet thick ; dip, 39° S.
945.0	Top "	
1038.0	Leader, 2 feet 10 inches thick.	Dip, 37° S.
1297.0	" 2 " 4 " "	" 30° S.
1411.0	" 0 " 2 " "	" 22° S.
1432.0	" 0 " 2 " "	" 22° S.
1442.0	Vein,. . 4 " 7 " "	" 22° S.
2056.0	Leader, 0 " 10 " "	" 34° S.
2131.0	. . . .	" 30° S.
2143.0	. . . .	" 10° S.
2318.0	. . . .	" 10° S.
2328.0	. . . .	" Flat.
2451.0	. . . .	" 85° North.
2498.0	. . . .	" 84° North.
2513.0	Leader, Perp. on Top.	" 66° S. on Bottom.
2552.0	Seam of Dirt.	" Perpendicular.
2562.0	. . . .	" 66° S.
2628.0	Leader, 1 foot 9 inches thick.	" 64° S.
2679.0	Bot. Slate.	
2685.0	Top "	
2750.0	Leader, 1 foot of Dirt.	" 65° S.
2864.0	Vein,. . 3 feet 0 inches thick.	
2907.0	Bot. Slate, ...	. . . . " 75° S.
2912.0	Top "	
3037.4	Face of Tunnel and Top of Tunnel Vein.	

North Tunnel to Selkirk Vein—Second Lift.

Bot. Slate Black Mine equals 0.

170.57	Little Tracy Vein, 2 feet 4 inches thick. . . .	Dip, 25° S.
285.00	Bot. Slate, Selkirk Vein.	" 27° S.
306.00	Face of Tunnel.	

The principal mining operations are in the Mammoth, Skidmore, Buck Mountain, Holmes, Primrose and Diamond beds, on the gentle dips and in the comparatively shallow basin between the Mine hill and the North Delaware axis. South of this axis the collieries (now mostly abandoned) were chiefly upon the Peach Mountain coal bed, although all the beds were opened and worked to some extent along their outcrops.

In the upturned coal measures of Sharp mountain, although the whole series is exposed, the coal beds are so crushed and irregular as to make their identification uncertain, and mining operations in them have hitherto been unsuccessful.

Lykens Valley beds:—The only exposure of these coals in the division is found in the Pottsville gap where 11 small coal beds are seen scattered through the upper and central parts of No. XII; the thickest of these is but 1′ 6″ and they are certainly here without commerical importance.

Buck Mountain bed outcrops along the south side of the Mine Hill anticlinal, except north of Beechwood colliery where for a mile or more perhaps the bed saddles over the axis and into the Heckscherville basin; the developments on the bed are not extensive and are in the neighborhood of this outcrop. The bore holes* at the new Silver Creek colliery cut the bed with a thickness of 4′ and 5′ respectively. At the Pine Forest colliery the bed is now worked quite extensively; on the gentle 10° to 20° south dips of the South Mine Hill axis, the bed is here in excellent condition and averages about 7′ of coal. The bed was worked by a water level drift on the west side of Mill creek opposite the Eagle colliery; thickness not ascertained.

At Beachwood colliery a water level tunnel driven north cut the Buck Mountain and a plane was driven up the pitch; the bed was 4′ to 6′ thick but irregular and dirty and the attempt to work it was abandoned. A bore hole starting from the Seven Foot bed near the foot of the slope shows a total thickness of 13′ 6″ for the bed. At the Her-

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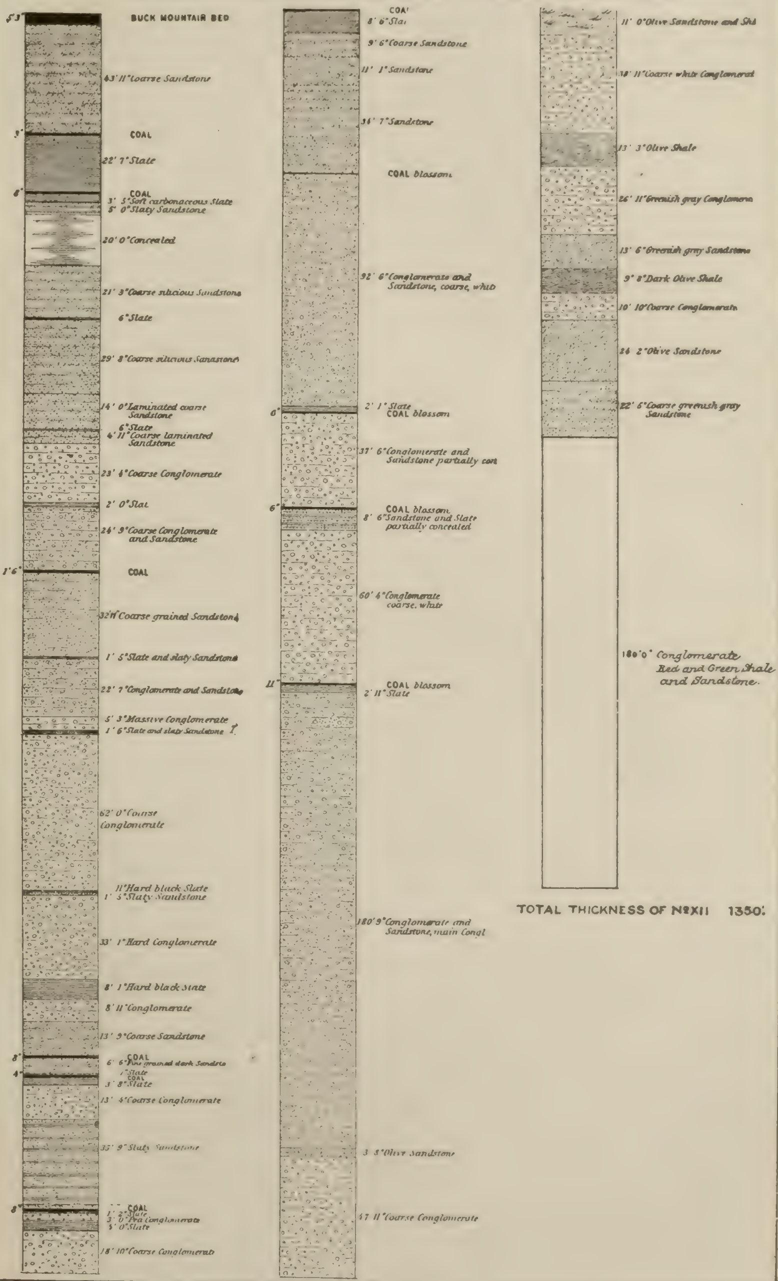
* See section on page plate 376.

PL.379.

Anthracite Region_Southern Coal Field.

NºXII AT THE POTTSVILLE GAP IN SHARP MOUNTAIN



bine colliery the Buck Mountain was worked above water level by a gangway half a mile in length; at the tunnel opening this gangway the thickness of the bed is 7′ but presumably it does not continue in first class condition or the workings would be more extensive; close below the Buck Mountain some 3 or 4 thin coals are cut, splits perhaps of the main bed.

The bed varies from 3′ to 15′ thick, where in an undisturbed condition with gentle dips yields a first-class coal; on steep dips, and on some of gentle ones too, it is apt to be irregular and dirty.

In the Sharp mountain the bed is known as the Twin and is worked. At the Fitzpatrick colliery on the east side of the Westwood gap the bed has two members each about 3 thick with 10′ of sandstone between.

Skidmore bed is 100′ to 150′ above the Buck Mountain; the principal workings on the bed are along the South Mine hill axis between Silver and Mill creeks; it was mined at the Ledger Vein, Butler, Windy Harbor, Pine Forest and Eagle collieries; the bed has a thickness of 5′ to 8′. At the new Silver Creek colliery, less than a mile south of the old Butler workings, two drill holes have cut the Skidmore horizon; in one it is but 2′ 6″ thick and at the other it is missing or was drilled through without being seen. At Eagle Hill colliery the bed is about 7′ thick when regular, but in places thins to 2′ or 3′ of dirt. At the Pottsville colliery both of the long tunnels were driven to the Skidmore; the bed is there 3′ to 4′ thick but for the most part soft and dirty. The Skidmore is practically not worked between Mill creek and the West branch, and at the few points in this area where the bed is cut, it is thin and dirty; just beyond the West branch the Skidmore has been worked to a moderate extent along the outcrop on both sides of Wolf creek; and is reported to have a thickness of 6′ to 7′. The "White Ash" bed of the Sharp mountain is thought to be the Skidmore; it is worked for a depth of a hundred feet or so below its outcrop from Pottsville gap to Westwood gap, and is one of the best beds of this locality; its thickness varies from 5′ to 10′.

Mammoth bed in this division is probably at its best for the Southern field. It is separated into two or three splits having an aggregate thickness of 25′ to 30′, yielding 15′ to 20′ of good coal. The Top split is called the Seven Foot bed, and the Bottom split is called the Mammoth and if divided is called the Top and Bottom splits. The workings on the Mammoth are much more extensive than those on any of the other beds, and in this division it has probably yielded more coal than all others combined.

Along the eastern edge of the division the bed is in three splits. The new Silver Creek colliery develops an unusually large thickness of the bed; the three members have at the shaft a total bed thickness of 56′ 6″ with 42′ 6″ of good coal, (see page plate No. 376) the Seven Foot is 12′ 6″ thick, Top Split 20′ 0″ and Bottom Split 24′ 0″. At Butler colliery just north, and Windy Harbor colliery* a mile to the west, according to Report of First Survey, the Bottom Split is about 10′, Top Split 12′ to 15′, and Seven Foot 5′ to 10′ thick. At Eagle Hill colliery† the Seven Foot bed is 8′ to 10′ thick, the Top Split 3′ to 13′ and the Bottom Split 5′ to 10′. West of the slope the Top and Bottom splits unite forming a bed about 25′ thick; the character of the bed varies, yielding at times nearly the full thickness of good coal, and at others it is pinched, or the coal is soft and shelly. At Pine Forest colliery the Seven Foot 5′ to 10′ thick yields the best coal; the Mammoth although thicker carries considerable dirt and refuse.

The extensive workings on the Mammoth about St. Clair which continue west to Beechwood‡ open the bed on a long gentle south dip, vary from 10° to 20° and with a developed length of half a mile or more from the outcrop. The Mt. Hope slope, Pine Forest slope, Kirk and Baum slope, Hickory slopes, St. Clair shaft, Wadesville shaft and Beechwood colliery are all in this territory. The bed is in two splits, the top split or Seven Foot varies from 7′ to 15′ in thickness and the bottom split

*Cross section through Windy Harbor and Eagle Hill on plate 377.

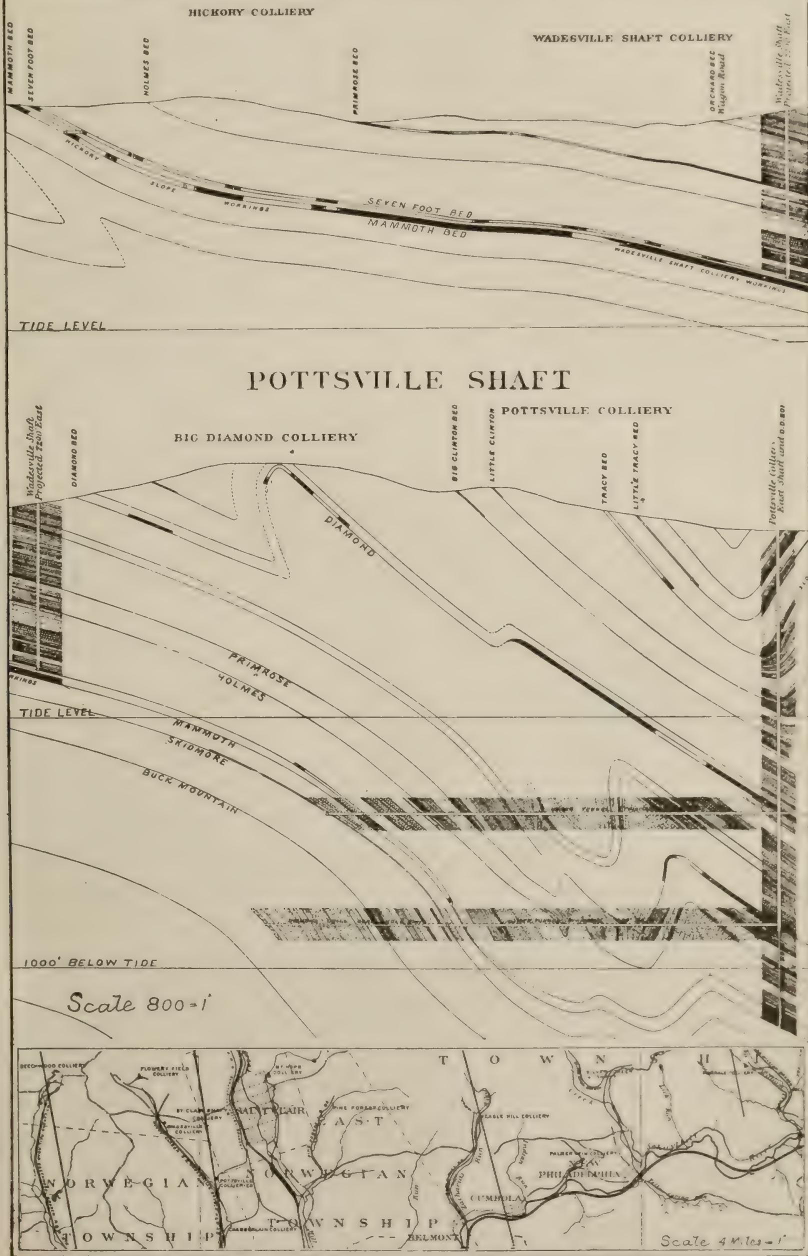
†Cross section through Windy Harbor and Eagle Hill on plate 377.

‡ See cross section on plate 381.

PL. 380

Anthracite Region—Southern Coal Field

HICKORY AND WADESVILLE SHAFT COLLIERIES



or Mammoth, 10′ to 50′ below is 10′ to 30′ thick ; the combined thickness of the two splits easily averaging 30′. The bed is favorably situated and the coal in fairly good condition.

The Pottsville shafts were sunk with the expectation of reaching the Mammoth on a little increased dip and at a half mile still farther south of the outcrop, the unexpected importance underground, of two small anticlinal axes developed at the surface in the upper beds, affected material the position, thickness and quality of the Mammoth and adjacent coal beds. In the upper tunnel the Seven Foot is 6′ to 7′ in good condition, but the Mammoth is only 4 thick soft and dirty ; at the lower tunnel the two splits would seem to be together in an irregular and dirty bed but 3′ to 4′ thick. A diamond drill hole from the bottom of the east shaft cut the Seven foot 11′ 10″ thick and the Mammoth 18 8″; the rods became fast and were broken off in the hole without definitely determining whether all the bed had been bored through.*

The Eagle colliery above St. Clair, located in the Johns basin on the south side of Mine hill between the Mine Hill and South Mine Hill anticlinals, works the Mammoth bed, formerly at least, with much success. The dips are moderate except along the southern outcrop where the bed stands perpendicular or over-turned. The Seven foot is but 6′ to 7′ thick while the Mammoth is 20′ to 30′ thick.

West of the West branch at the Oak Hill colliery, and at the workings about Wolf creek† the bed is in three recognized splits, the Bottom split 10′ to 14′ thick, fifty feet above is the Middle split 3′ to 5′ thick, and at 100′ still higher the Top split with a thickness of about 10′. None of the workings extend for more than 2000′ south of the outcrop; the dips are mostly 30° to 40°.

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*There is an error in the columnar section of the bore hole published on sheet V. It show a thickness 27′ 1″ for the Mammoth, the section was copied from an incorrect record which gave the actual thickness cut as 31′ instead of 21′. The estimate dip is 26° making the corrected thickness of 18′ 8″.

† See cross section through Herbine colliery on plate 381.

In the Sharp mountain the "Barclaugh" bed is identified as the Mammoth, several small operations on it have been opened at various times on both sides of the Pottsville gap and on the mountain side south of the town; in common with other Sharp mountain coals it varies much in thickness and in quality; in general it is 5′ to 10′ thick.

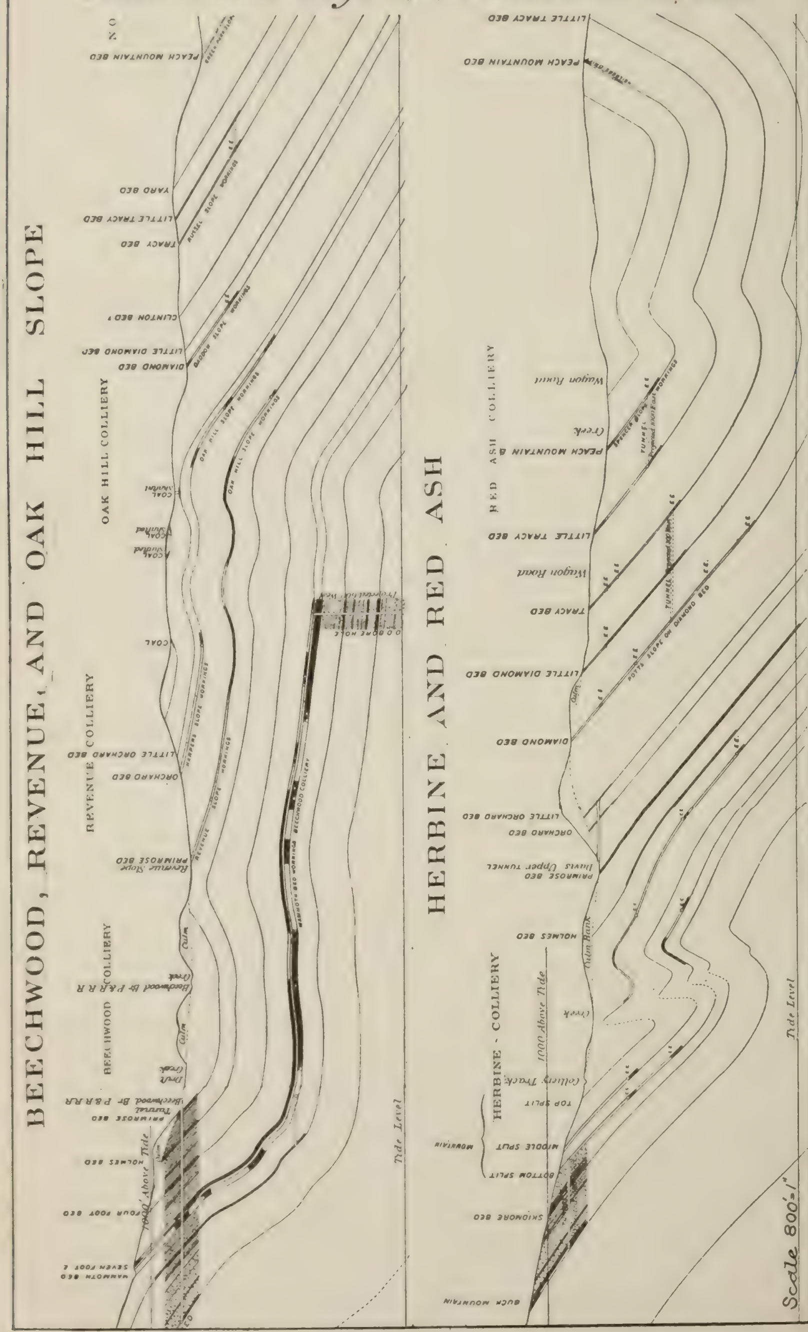
Four Foot bed at a distance varying from 20′ to 80′ above the Seven Foot a small bed of coal called the Four Foot is often found, it varies from 0′ to 7′ thick. The bed is not worked.

Holmes bed is usually 150′ to 200′ above the Mammoth. In this division it is not regarded as an especially good bed, its thickness varies from 3′ to 8′, but even when of good thickness the coal is often poor and dirty. The bed has been worked at Cedar Hill, Eagle Hill, Pine Forest and Oak Hill collieries and at a number of small openings between St. Clair and Beechwood. North of Minersville, along Wolf creek, the Holmes bed is also called the Church bed.

Primrose bed, 80′ to 100′ above the Holmes, is as a rule of good size and quality, and in regard to the quantity of coal mined it probably here ranks next to the Mammoth. At the Silver Creek shaft the bed is in two members 6′ and 7′ thick, 10′ feet apart; at the old Cedar Hill colliery just south the Primrose was the principal bed. At Eagle Hill it is 8′ to 10′ thick and furnishes a considerable part of the product; it is the bed of the Peach Mountain colliery a mile to the west and now connected with the Eagle Hill from a lower level. At Pine Forest it is 7′ to 8′ thick, but in poor condition. At the Pottsville shafts the bed is 10′ to 15′ thick, but along the gangways at times runs much below this. A number of small drifts worked the bed along the outcrop in the neighborhood of St. Clair. The Monitor, Revenue, Browns, Harpers and Oak Hill Slopes collieries now abandoned and all in the neighborhood of Mt. Laffee worked the Primrose bed with a thickness of 5′ to 8′ fairly clean and good. West of the West branch the Primrose is an important bed 10′ to 14′ thick and is now worked extensively at the Oak Hill colliery and formerly at Kears slope. In

PL. 38i.

Anthracite Region_Southern Coal Field.



the Sharp mountain at the Westwood tunnel the Primrose? is cut 12′ 5″ thick.

Orchard bed, at about 125′ above the Primrose bed, ranges from 3′ to 8′ in thickness, the workings upon the bed are comparatively few. The Orchard with 4′ to 6′ of coal was worked at Neil's old colliery on Silver creek; where cut in the Silver Creek shaft it is 5′ thick. At Pine Forest colliery this bed was recently opened, its thickness is 6′ to 8′, yielding a fair quality of coal. Where cut in Pottsville shaft the bed is 4′ thick, of poor quality. Between St. Clair and Mt. Laffee, there are scattered openings along its outcrop, and at Mt. Laffee at the old Harper and Oak Hill slopes it was worked to some extent; in this neighborhood the bed averages about 5′ thick usually in fair condition. About the Wolf creek there are a few unimportant openings on the bed, its thickness there is given as 4′ to 5′.

The *Little Orchard* is a thin bed found 30′ to 50′ above the Orchard, it has been dug into at a number of places along its outcrop and is also cut in some of the shafts and tunnels; in thickness it varies of 1′ to 4′, and is practically unworked.

The *Diamond* is one of the most prominent of the upper coal beds and is worked at several important collieries. It is the principal bed of the Palmer Vein colliery near New Philadelphia, its average thickness is there about 6′, rather high in refuse. Heron's drift, Feeder Dam colliery and Griffith Jones slopes are also on the Diamond. It was one of the beds worked at the Pottsville colliery; at the shafts the total thickness of the bed is 10′ to 12′, along the gangways it yields 4′ to 5′ of good coal. Between St. Clair and the West branch, several small slopes open the bed along its outcrop. At Daddows old slope along the West Norwegian creek the bed is reported 9′ thick when in good condition. From the West branch westward the Diamond is continuously worked to the division line, at the Starr slope its thickness is reported as 4′ to 5′, improving to the west as at the Red Ash colliery adjoining it is said to yield 6′ to 7′ of good coal.

Little Diamond bed, east of the West branch, is usually about 30′ above the Diamond and generally 1′ to 3′ thick, an effort was made to work the bed at Palmer Vein colliery, it was 5′ where cut by the tunnels, but it was soon abandoned. Gangways were opened south of the Eagle Hill colliery on the bed but the yield of good coal was small. The most satisfactory proving of the bed is perhaps at Wolf creek where at the Davis Lower drift the bed is said to yield 3′ of good coal, at this point the interval between it and the Diamond has increased to about 130′.

Clinton and Little Clinton two small *beds* lying between the Little Diamond and the Tracy have been worked along the outcrops to a limited extent at several points in the neighborhood of the Pottsville colliery. They are not recognized in other parts of the field; the Clinton is 4′ to 6′ and the Little Clinton 2′ to 3′, but the yield of good coal is much less.

Tracy bed, called the *Clarkson* in the vicinity of New Philadelphia, a widely persistent coal bed of good sizes 4′ to 8′ thick but often shelly and dirty in quality. There are scattered openings along its outcrops all the way across this division, but the amount of coal mined from the bed is quite insignificant. The largest operation is the Lewis colliery at Minersville, where the bed is 5′ thick yielding a good coal until a faulty or pinched condition was encountered along the gangways; north of Minersville about Wolf creek the bed is known locally as the "Cockle" and is there especially prized for domestic use, its thickness is also about 5′.

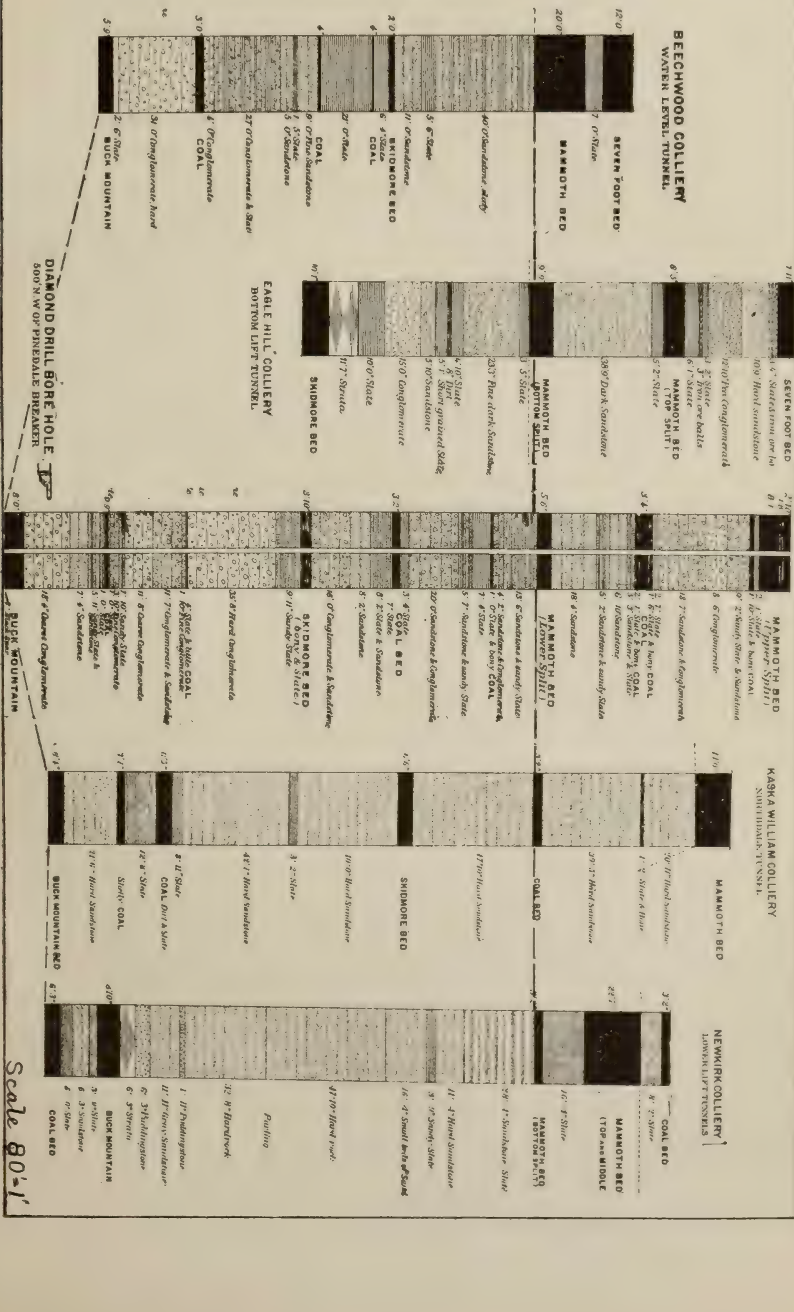
Little Tracy, "*Spohn*" of Mill creek, *or Charles Pott bed* of New Philadelphia is found about 80′ above the Tracy bed, it is worked quite extensively at the Palmer Vein colliery; its thickness there is from 3′ to 8′. It is also opened on both sides of Mill creek, in the old gangway on the east it is reported to be 6′ thick, at the Chamberlin colliery on the west side it is 3′ to 4′ thick and was the principal bed; from the Chamberlain to the West branch there are only a few openings close to the outcrop upon this bed. Along the Wolf creek it was mined at Taylors

PL. 382.

Anthracite Region – Southern Coal Field.

MEASURES BETWEEN MAMMOTH AND BUCK MOUNTAIN BEDS

EAST OF POTTSVILLE



slope, and by a tunnel from Spencers slope where the bed is reported 3′ 6″ thick; where opened at the Lewis colliery it is said to be 3′ to 4′ thick.

Palmer or *Yard bed*, although thin, is worked extensively at the Palmer Vein colliery, and old workings down a lift or two extend almost continously from there to Mill creek, approaching Mill creek the bed thins a little, and becomes faulty, west of Mill creek it has not been recognized as a workable bed, where worked it was 3′ to 4′ thick and yields about 3′ of good coal.

Peach Mountain, Spohn, Lewis, Gate or Black Mine is the most celebrated of the upper red ash beds; its coal has an excellent reputation, the bed is extensive and of good workable thickness; its long lines of nearly parallel outcrops along the sides of the successive basins offer numerous favorable locations for opening. It was one of the first beds to be opened and was given a different name in nearly all the basins in which it is found; that the Peach Mountain, Spohn and Lewis are one and the same bed is now thoroughly established; that the Gate and Black Mine are only different names for the same bed, in the basins between and south of the Gate Ridge axes, is regarded as most probable, although owing to the sharp uplift and confused overturned dips along the Gate Ridge axes it can hardly be regarded as established, until there is some additional development of the lower coal beds south of these axes.

In the old Novelty slope near New Philadelphia, where the bed was worked extensively 50 years ago, it is reported to have averaged 4′ 6″ in thickness; the bed is opened at several points and worked nearly continuously to Mill creek, its thickness remaining about the same.

On the west side of Mill creek, at Wallace and Rothermels old slope, the bed is reported to average 7′ thick, in three benches. This is probably a fair average thickness for the bed on the south dips in the numerous workings between Pottsville and Minersville. The north dips, with but little exception, are perpendicular or overturned, and although the bed may maintain its thickness, the coal is without exception soft, shelly or dirty. The range in the thickness of the bed on the south dips is between 5′ and 10′ with an average yield of 4′ 6″ to 5′ of good coal.

Tunnel or *Sandrock bed* of Cumbola, 100′ to 200′ above the Peach Mountain, is also an important member of the upper beds, and usually of a fair workable thickness. The workings on the bed are not very extensive; the bed known locally as the "Sandrock" was worked by two small slopes, one just north of Cumbola and the other just north of Belmont, at the eastern slope the bed is recorded by First Survey as 4′ thick and at the western slope 5′ 6″. The Tunnel bed was worked by the Bear Ridge* slope, half a mile south of Cumbola, with a thickness of 5′. At York Farm colliery it is a good bed, averaging 6′ to 7′ in thickness, sometimes swelling to 8′ or 10′. At the old Fogarty and Salem workings, west of the West Branch, the thickness of the bed is given as 5′.

Rabbit Hole bed is about 100′ above the Salem and is usually a thin unworkable seam, 2′ to 3′ thick.

Faust bed; 75′ above the Rabbit Hole bed at York Farm colliery is 4′ to 5′ thick, but poor and dirty.

Salem bed; the workings on this bed are all in the Pottsville basin, but the bed is also found north of the Gate Ridge axis ; formerly the bed was extensively mined on the south dip between Pottsville and Port Carbon, where it is reported to average 3′ in thickness. West of Pottsville at York Farm colliery the bed is 6′ to 7′ and even much thicker, but is frequently shelly and dirty ; the bed was drifted upon south of the Salem colliery; thickness not known.

Brewery is the highest workable *bed* and is about 2200′ above the Buck Mountain and 240′ above the Salem bed ; its outcrop was exposed at Yuengling's brewery, on Mahantongo street, Pottsville, and it has since been cut by the long tunnel at York Farm colliery. It has a thickness of about 5′, with 2′ to 3′ of good coal. Between the Salem and Brewery beds at York Farm are found two small coal beds or leaders, the lower of which is 2′ thick and is known as the South Salem bed.

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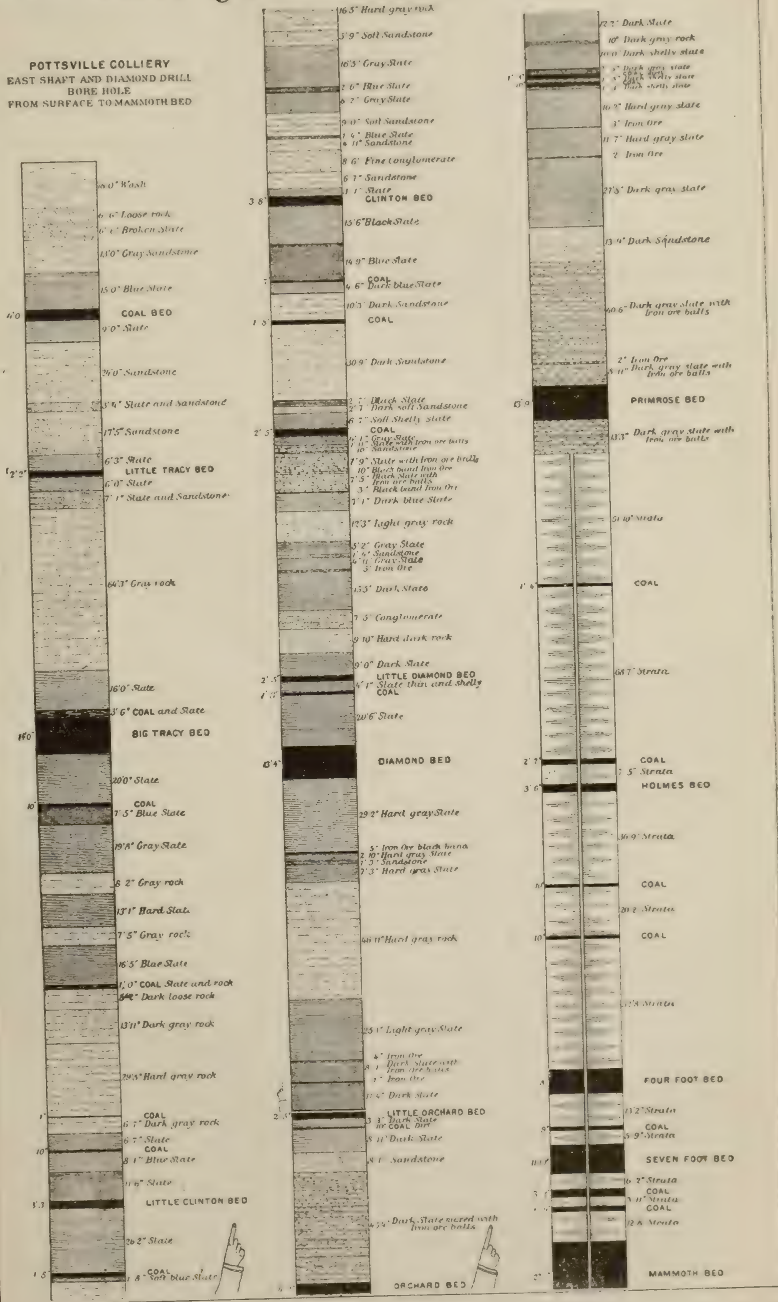
* See cross section plate 378.

Anthracite Region - Southern Coal Field.

POTTSVILLE COLLIERY
EAST SHAFT AND DIAMOND DRILL
BORE HOLE
FROM SURFACE TO MAMMOTH BED



A small bed about 185′ above the Brewery bed is cut in the York Farm tunnel and its outcrop is seen at two or three points on the surface ; the bed is 1′ to 3′ thick, containing little or no good coal. It is interesting, chiefly because it is probably the highest coal bed in the anthracite region.

26 Llewellyn—Tremont Division.

Mine sheets XII, XIII, XV and XVI map this division.* Its structure is shown by sections 21 to 23 on cross section sheets IX to XVI.† Columnar section sheets VI to IX record the measures cut by the tunnels and bore holes within the area.‡

This division embraces all of the Southern basin between the Mine hill and Peaked mountain on the north, and the Sharp mountain on the south ; extending from the sheet line just east of the town of Llewellyn to the sheet line two miles west of Tremont, a distance of about nine miles ; the width of the division is about five miles.

The water shed between the Schuylkill and Susquehanna crosses mine sheets XII and XIII. Sheafers creek, Muddy branch and the West West branch are the principal tributaries of the Schuylkill ; Swatara creek and its branches, Gebharts run, Middle creek, Good Springs creek and Rausch creek drains the western side of the watershed.

Sharp mountain runs in nearly a straight line across the division, it is gapped, south of Tremont by Swatara and Rausch creeks. The Mine hill and its anticlinal both die down coming westward, and disappear on the east side of the West West branch, the Peaked Mountain axis, which springs up on the north, carries through, and makes a deep red shale cove two miles west of Mt. Pleasant. South of Peaked Mountain the Buck Ridge and the West West Falls anticlinals, both make prominent ridges as they rise west and bring No. XII to outcrop along the axis, and

*Page plate 366 gives relative location of the division.

†Page plate 384 and 387 contain selected portions of the cross sections.

‡Page plate 385 and 386 contain selected columnar sections.

each makes a deep red shale cove as it passes out of the field (see mine sheet XIII). Red mountain, a high ridge made by the Gate Ridge anticlinal, ranges across the division about parallel to Sharp mountain and a mile to the north.

The *Structure*, so far as known, is pretty well shown by the mine workings as mapped on the mine sheets and by the cross sections. The coal measures of the northern half of the division have a general westward rise, all the way across, and spoon out in the high land beyond Forestville on sheet XIII. The deep basins of the southern half also rise west but not so rapidly, this rise lifts the Mammoth bed to outcrop around the North and South Gate Ridge anticlinals, near the west edge of the division, two miles beyond Tremont.

The mine workings are mainly in the thick lower coal beds, where they lie near the surface along the northern outcrop. The beds of the high measures are opened along their outcrops here and there in the central part of the field; but the developments on these beds are very much less than in the Pottsville division, in consequence of which their thickness and the details of the structure of the deep central basins are much more uncertain here than there.

The operating collieries are Albright, Phœnix Park, Forestville, Otto, Middle Creek and Blackwood, in addition to which, the area contains, about twice as many more operations which are temporarily or permanently abandoned.

Formation No. XII does not expose any but incomplete sections. The two breaks in Sharp mountain made by Swatara and Rausch creeks give a total thickness of the formation of about 1100′ or 1200′, with apparently the absence of most of the several hundred feet of "transition" measures seen at the Schuylkill gap. The Broad and Thick mountains give but partly exposed sections, the cross sections would indicate that the conglomerate is perhaps a couple of hundred feet thicker here than along the southern rim. The character of the strata composing the series remains about as before, but the increased thickness of its coal beds is a matter of much importance.

The *Lykens Valley coal beds* are here found in the upper 800′ or 900′ of No. XII; west of Tremont there are six workable beds in the series, numbered 1 to 6 from top downward; all six of these beds are supposed to be recognized at one or more points in the western half of this division, and are so indicated on the cross sections; but it is very doubtful whether more than one or two of the beds maintain an extensive workable thickness. The openings on these beds are comparatively few, and the results have not seemed to warrant at present a more thorough development of them, the chief obstacle to their successful working is not so much the thinness of the beds as their unreliability.

The most eastern opening in this division on what, perhaps, may be considered a workable Lykens Valley bed, has been made by a trial shafting near where the West Falls axis crosses the West Branch (on sheet XII); here a bed 4′ thick estimated to be about 450′ below the Buck Mountain was opened. On the west side of Swatara creek at the crossing of Swatara Falls axis some 3 or 4 Lykens Valley beds were once opened by trial drifts and shaftings, now fallen shut; no record of their thickness could be obtained; although the openings commanded an extensive area above water level the beds were not worked.

Lykens Valley No. 5 bed, often called the "Lykens Valley" bed is apparently the coal opened by a short drift on the west side of Middle creek, a mile north of the Middle Creek colliery; the bed is reported as 2′ to 3′ thick. The Kemble drift near the western spoon of the Peaked Mountain basin, on the first prong north of the Donaldson mountain, develops the same? Lykens Valley bed with a thickness of 4′ to 5′, said to be in good condition on the gentle south dip of the north side of the basin; an air hole on the north dip develops a curious inversion of the bed, see cross section No. 23.* This outcrop and that of No. 4 bed which closely overlies it have been shafted three-quarters of a mile to the east of the drift; at the first openings No. 4 is said to show 4′ of coal and No. 5 8′ of

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* Also page plate 384.

coal, dipping 50° north ; at the second openings, along the township line, the upper bed 4′ and the lower 3′ 6″ of coal. At the Eureka tunnels,* on the mountain north of Donaldson, Lykens Valley beds No. 2 and 3 were opened ; both are thin and irregular, No. 3 especially so. In the Sharp mountain at the Swatara and Rausch gaps the lowest of the Lykens Valley beds lying just north of a coarse heavy conglomerate ledge has been drifted upon and worked to a small extent, these drifts are now fallen shut. Near Blackwood, just below the crest of Sharp mountain, on the southern side, some four beds were opened by trial shafting.

Buck Mountain bed is not extensively worked and what developments there are, are along the northern outcrop. On sheet XII the only working of the bed is on the south dip of the Mine Hill axis, in the neighborhood of the Black Heath tunnel ; its thickness here is 5′ to 7′. Following west along the outcrop, and in the basin to the south, the bed was reached by a tunnel at the Forestville colliery, since the publication of the mine sheets, it is 4′ to 5′ thick, but soft and slaty. Not until we reach Middle Creek colliery, 4 miles southwest of Forestville, do we again find the bed worked, although it is shafted at several places in the interval between, and tunneled too at South Pyne colliery, where its thickness is 5′, apparently very poor or the bed would have been worked. At Middle Creek† the bed is about 10′ thick with 7′ to 8′ of coal when at its best ; the mine map shows a number of pinched or faulty places where the breasts are not worked. Where worked at Colket,‡ two miles further west, the bed is also about 10′ thick, but the gangways driven west show it thinning in that direction, and at no point west of this has it yet been found of a good workable thickness and quality. One or more "leaders" are usually found closely overlying the Buck Mountain bed, see columnar sections. In the Sharp mountain the bed is reached by the Dundas tunnel, and at the tunnel has a

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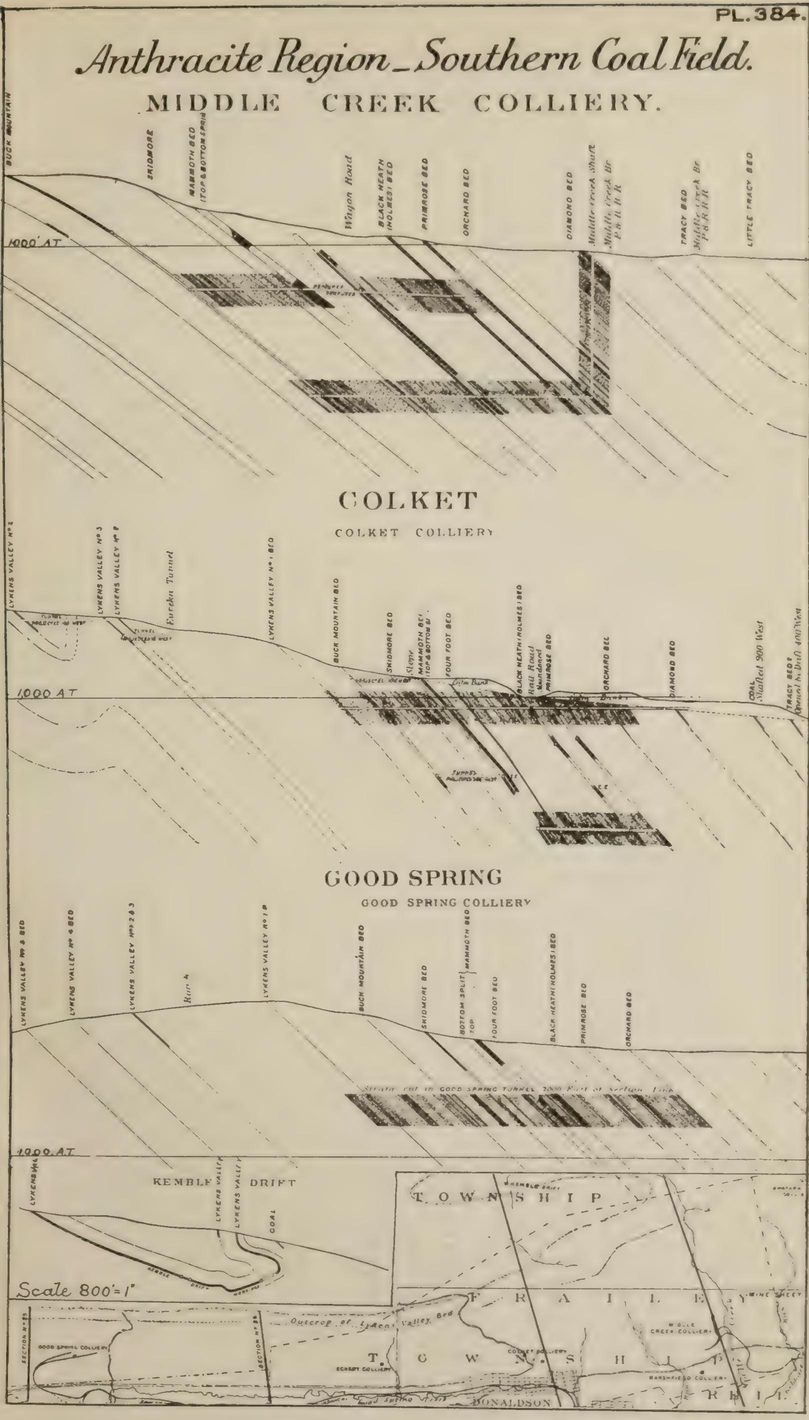
* See Colket cross section on plate 384 ; Columnar section on plate 386.

† Cross section on plate 384.

‡ Cross section on plate 384.


PL. 384.
Anthracite Region _ Southern Coal Field.
MIDDLE CREEK COLLIERY.
COLKET
COLKET COLLIERY
GOOD SPRING
GOOD SPRING COLLIERY
KEMBLE DRIFT
Scale 800'=1"
TOWNSHIP
FRAILEY
DONALDSON

thickness of 3′ 11″; it is also thought to be the bed of Houser's drift at the Swatara gap.

Skidmore bed in this division has not been worked except at the Forestville and Black Heath collieries, where it is a bed of good coal, 6′ to 7′, but west of this, where cut in the Pyne,* Middle Creek† and Colket colliery tunnels, it is a thin dirty bed, at the most but 3′ 10″ thick, at Colket. The Dundas tunnel section in Sharp mountain gives it a thickness of 5′, but the bed is not worked.

Mammoth bed, which will be found thin and reduced further west, is here still the great bed of the region; and although but a very small part of its extent, and that chiefly along the northern rim, has been worked, yet it is mined more extensively than any of the other beds and has probably here produced as much coal as all the rest combined. The bed is here generally in two splits, called Top and Bottom splits, with a varying interval between, which at times disappears and the splits come together to form one big bed. The Forestville colliery worked the Bottom split for nearly a mile on both sides of the slope, the bed there having a general thickness of about 10′; the Top split, 6′ thick, is opened at Dolbin's slope, a 1000′ to the east; the interval between the splits (170′) is exceptionally large. At Otto the top member is the best and is called locally the "White Ash" bed; it is 10′ to 12′ thick with 8′ to 10′ of coal; the interval between it and the Bottom split is but 20′ to 30′; the Bottom split has a general thickness of about 6′. About the same conditions are found at the Swatara Falls colliery, at the Pyne collieries, and in Fisher's basin. West of Swatara creek the Bottom split improves and the Top split deteriorates, and at Middle Creek colliery the Bottom split, 9′ thick, is decidedly the better bed; the Top split, 0′ to 5′ higher, although 10′ to 20′ thick, yields less sound coal. At Colket the two splits unite in one big bed 20′ to 25′ thick, the bottom part of bed yielding the best coal.

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* Columnar section on plate 386.

† Columnar section on plate 385.

At Rausch Creek* and East Franklin† collieries, west of Tremont, the Mammoth is extensively worked on both dips of the Gate Ridge anticlinal; the interval between the splits varies from a few inches to a few feet; it is worked as one bed, the gangways being driven sometimes along the bottom and sometimes along the top of the bed; the whole thickness is 15′ to 20′, the bed yielding a good percentage of clean coal.

The Sharp mountain working of the Mammoth bed is limited to the Blackwood colliery, where a Top split 8′, a Middle split 4′ and a Bottom split 5′ thick are found.‡

Four Foot bed is in this division 80′ to 120′ above the Top split of the Mammoth, and although in general thin and unworkable, at the Otto colliery the bed is 4′ to 7′ thick, fairly good, and at Colket colliery 3′ to 5′ thick.

Holmes, or Black Heath bed as it is called about Tremont, is in this division frequently 10′ or 12′ thick, but is generally a rough dirty bed, variable in thickness and high in refuse. It is opened and worked to a small extent at Otto, Pyne and Middle Creek collieries with a thickness of 4′ to 12′. At Colket colliery it is perhaps better, as the workings on it are extensive, down three lifts with gangways a mile and one-half in length; the First Survey Report says, "the bed is 3′ to 12′ thick." At East Franklin and Rausch Creek two water level gangways on the Holmes were driven around Gate Ridge anticlinal axis; the bed is 5′ to 10′ thick. The interval between the Mammoth and the Holmes is usually about 200′. At Blackwood, in the Sharp mountain, the bed identified as Holmes, has a general thickness of 7′.

Primrose bed in this division and especially so on sheet XII, is undoubtedly one of the best of series and easily ranks next to the Mammoth. Between Forestville and Branchdale the bed was largely worked; at McDonald's Slope, at Phœnix Park No. 2 and the Otto collieries, it is quite regular and has a thickness of 10′ to 12′ yielding 8′ to 10′ of good coal. Further west the bed is somewhat

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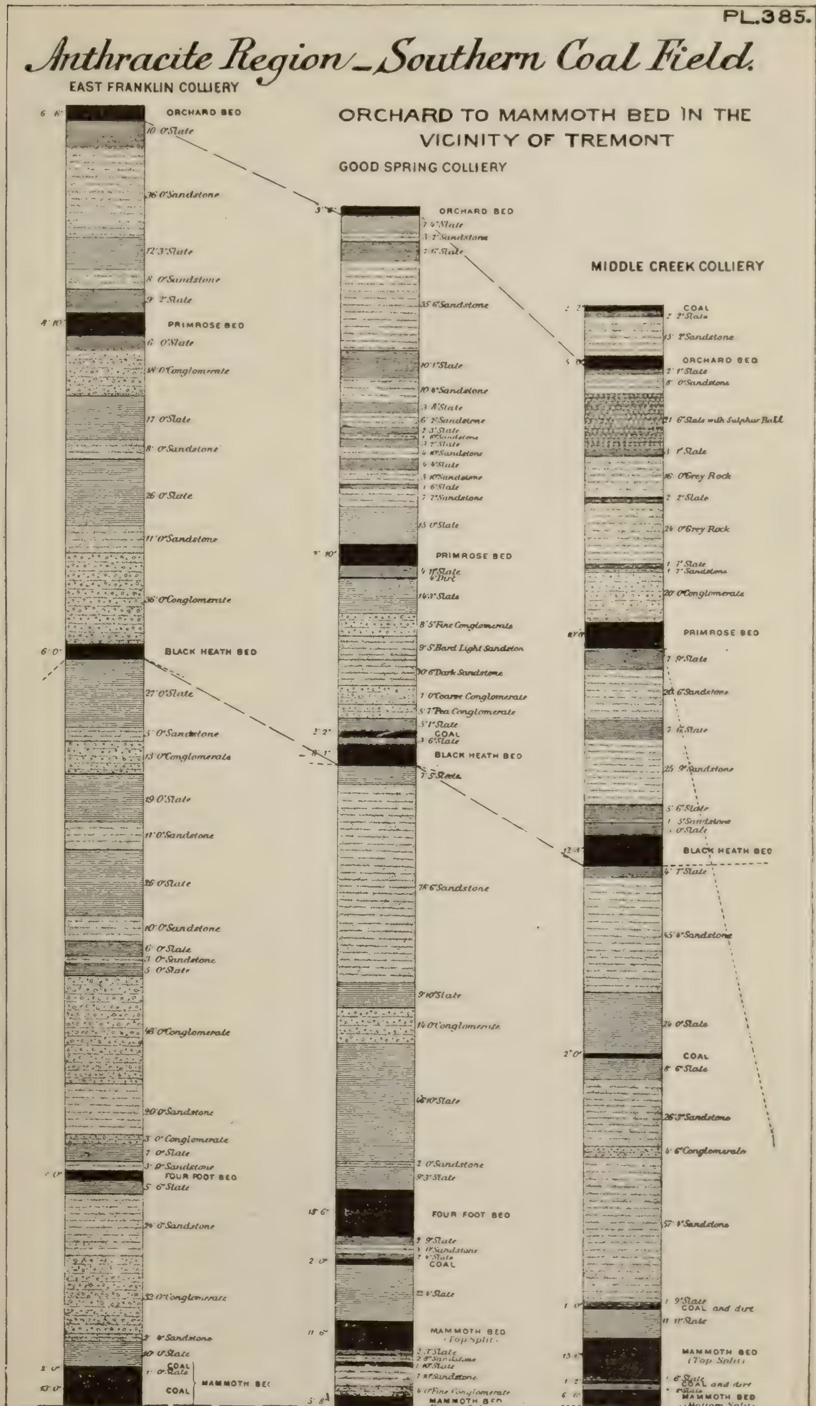
* Cross section on plate 387.

† Columnar sections on plates 385 and 386.

‡ Cross section through Blackwood on plate 387.


PL.385.
Anthracite Region _ Southern Coal Field.
ORCHARD TO MAMMOTH BED IN THE VICINITY OF TREMONT
EAST FRANKLIN COLLIERY
ORCHARD BED
PRIMROSE BED
BLACK HEATH BED
FOUR FOOT BED
COAL
MAMMOTH BED
GOOD SPRING COLLIERY
ORCHARD BED
PRIMROSE BED
COAL
BLACK HEATH BED
FOUR FOOT BED
COAL
MAMMOTH BED (Top Split)
MAMMOTH BED (Bottom Split)
MIDDLE CREEK COLLIERY
COAL
ORCHARD BED
PRIMROSE BED
BLACK HEATH BED
COAL
COAL and dirt
MAMMOTH BED (Top Split)
COAL and dirt
MAMMOTH BED (Bottom Split)

thinner; at the Pyne colliery it was extensively worked with an average thickness of about 9′; and at Middle Creek the thickness is about the same but the gangways encountered a great deal of faulty coal. At Colket the bed has 5′ to 7′ of coal and at East Franklin 6′ to 8′ of coal with a thickness of about 10′. The thickness of the Sharp mountain representative at Blackwood is 5′ to 7′. The interval between the Primrose and the Holmes is 80′ to 100′.

Orchard bed is now operated at the East Franklin colliery and yields 5′ to 7′ of coal in a thickness of 7′ to 12′. The few provings of the bed along the north side of the basin show it to be thin and impure. At the Colket water level tunnel its thickness is 3′ and at Middle Creek shaft 5′. The Sharp Mountain representative at Blackwood is 5′ to 8′ thick.

Little Orchard bed so far as developed is either too thin or impure to be worked; or is absent entirely.

The *Diamond* is a pretty good *bed*, south of Forestville, where worked by the Phœnix Park No. 3 colliery; and also formerly by the old Diamond colliery;the bed is 4′ to 7′thick yielding 4′ to 6′ of coal; this coal is opened by a short drift at the Pyne colliery, also by a drift at the Colket colliery. It is thought to be the Diamond bed which was worked by the Red Mountain colliery south of Tremont; the measures are there dipping 70° to 80°, and the thickness of the bed is quite variable. It now seems probable that the gangway from Evarts Upper tunnel in Red mountain (mine sheet XVI) is on the same bed, although there pinched and unworkable. John D. Felty's drift one-half mile south of the Rausch Creek colliery is on the Diamond. At Blackwood the Diamond is given as 4′ to 6′ thick but dirty.

Little Diamond bed is undeveloped.

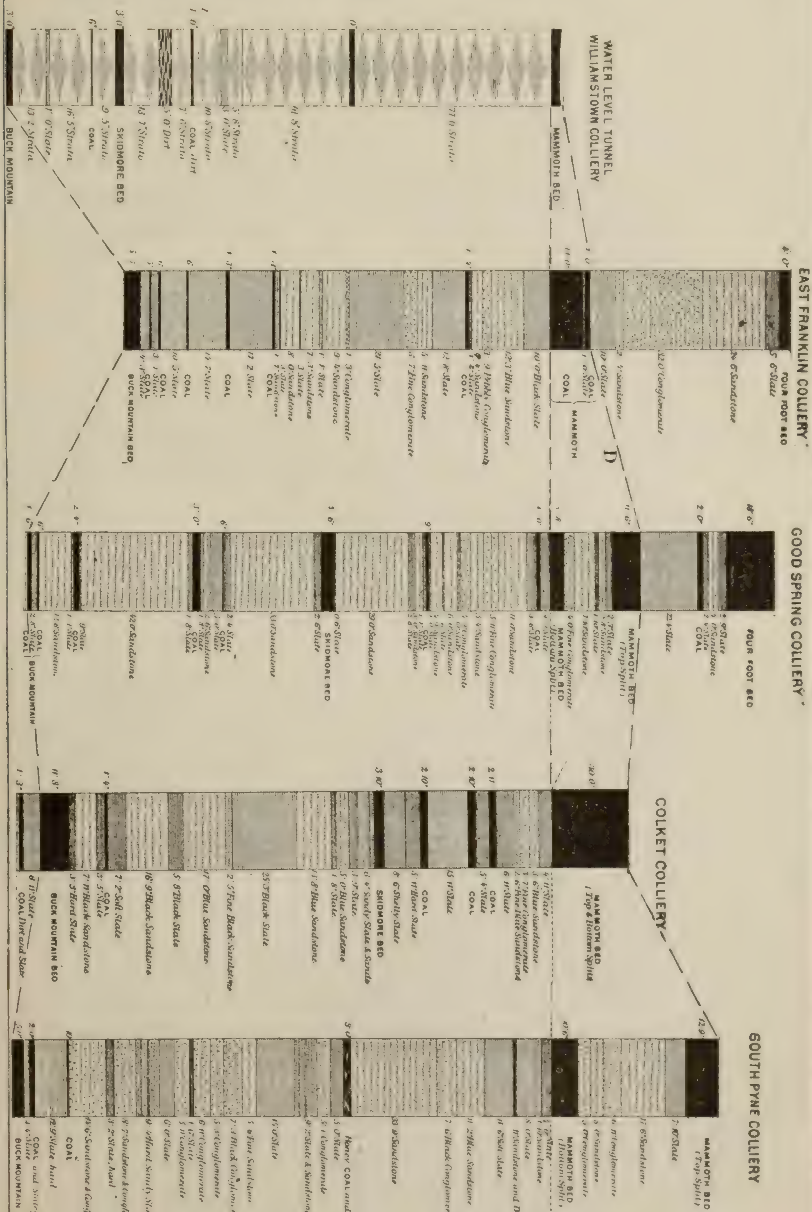
Tracy bed is found about 300′ above the Diamond bed; the most important working of the bed was at Phœnix Park No. 1 colliery (mine sheet XII) now abandoned; the south dip of the bed having been mined to the basin, the bed is here 5′ to 6′ thick averaging about 4′ 6″ of coal; two short tunnels were driven to the north dip but the pitch is steep and the bed in poor condition. The only additional workings on this bed are in the vicinity of Tremont; a half a mile above the town, the bed is drifted upon on both dips of the Big Lick mountain axis; the First Survey reports the bed here 1′ to 10′ thick; the extent of the drifts especially the westward one which is more than a mile in length would indicate a fair yield of good coal. This bed was also opened along the Little Lick mountain axis, at Eckels tunnel, just west of the town; the thickness here is reported at 5′. Evarts tunnel in Red mountain also cuts this bed, but in common with all the beds in the tunnel, it is there thin and unworkable.

Little Tracy bed was mined to a small extent above water level east and south of Phoenix Park, the bed is 3′ to 5′ thick but not first class. The next working of the bed, to the westward, is in the vicinity of Tremont, where bed was worked at the Clarke and McCormick drifts and at Eckels tunnel with a thickness of "4′ to 5′" and apparently yielded a fair proportion of good coal. The distance between the Tracy beds is usually about 150′.

Peach Mountain, or Black Mine bed is, in this as well as in the Pottsville division, the chief member of the upper coal beds; its position high up in the measures brings it to outcrop along the flanks of the principal anticlinals and the westward rise of the measures lifts it completely out a mile or so beyond Tremont. The bed is not nearly so well developed as in the Pottsville division and it has been impracticable to give on the mine sheets more than a small portion of its outcrop. The Branchdale colliery (sheet XII) was one of the largest operators of the bed, which there yielded "4′ to 5′ of coal when sound." The Black Mine bed was worked on both sides of the north Gate Ridge anticlinal a half mile above Silverton Junction, (Sheet XV); the Albright Coal Co. have recently re-opened the east slope and continued it to the basin, with a total length of about 1200′, the bottom of the slope is at tide level; the bed averages about 7′ in thickness and is in good condition. Other workings of the bed are found in the neighborhood of Tremont, at the Marshfield colliery, Clarke and McCor-

Anthracite Region_Southern Coal Field.

MEASURES BETWEEN MAMMOTH AND BUCK MOUNTAIN BEDS WEST OF POTTSVILLE



mick drifts, Eckels tunnel, and Spanglers drift, the bed is 4′ to 10′ thick, and except on the very steep dips is usually in good condition. The Stroh colliery (abandoned) north of Newton (sheet XV) worked a steep 70° north dipping bed, not certainly identified; on the mine sheet the workings are printed in purple, the color assigned to the Rabbit Hole bed, but it seems quite probable that it is a more important bed than this perhaps either the Tunnel or the Black Mine bed?

Tunnel bed occurs about 150′ above the Peach Mountain or Black Mine, the bed was worked many years ago by a slope, with gangways driven west, along the West West branch a half mile above Silverton Junction; the thickness here is reported as 5′ without slate but the bed is inclined to be faulty. At Feger Ridge colliery, a recent operation a mile northeast of Newtown, the bed is opened by water level drifts and by a new slope, sunk since the publication of the mine sheet; it has a variable thickness of 2′ to 8′, some sections showing 7′ of good coal, while at other points the coal is pinched and worthless. This coal is also opened by trial shaftings at several other places along its outcrops, but no additional records of its thickness were obtained.

Salem ? bed:—Recent explorations at the Albright colliery above Silverton Junction, develop the shape of the South Gate Ridge anticlinal, and prove conclusively the relative position of the coal beds on both sides of its axis. The so called "Salem" bed of the First Survey (incorrectly named the Black Mine bed, on the workings from the slope, mine sheet XV) is only 150′ above the Tunnel bed; whereas at the York Farm colliery this distance is about 300′, with the Faust and Rabbit Hole beds in between. The Report of First Survey, page 175, says—that "the Salem bed" as worked from the slope, "has only 3½′ of coal; the benches here are not regular; there is often a bottom bench 1′ thick.

South Salem ? bed:—Some 400′ south of the Salem slopes, and 250′ higher in the measures, "a 4′ bed of coal, soft and faulty" has been drifted upon. This is apparently the highest bed opened in the division.

It seems highly probable that the "Salem" and "South Salem" beds of the Albright tract, are *not* the same as the Salem and South Salem beds of the York Farm colliery and other parts of the field; and it is not certain that the Tunnel and Black Mine beds of this tract are correctly identified.

27. *East Franklin—Brookside Division.*

The area coverd by this division is mapped on mine sheets XVII and XVIII.* The structure is shown by sections 24, 25, and 26 published on cross section sheets XVI to XIX.† Sections of the measures cut in the various tunnels are given on columnar section sheets X and XI.‡

The division extends from the sheet line near the East Franklin breaker, nine miles west, to the sheet line just beyond the Brookside colliery workings. At the east line the full width of the field about three and one-half miles is embraced. The rapid westward rise of the Gate Ridge or Smoky Hollow anticlinal, lifts the coal measures and conglomerate to outcrop in a high, broad arch, a mile or so west of the East Franklin breaker, and separates the field into two long narrow basins diverging westward; the mine sheet of this division cover all of the broad arch and the eastern half of the northern or Wiconisco basin which is two miles wide.

The surface within the basin is rather elevated ranging from 1000′ to 1350′ A. T. along the streams and the conglomerate rims to the basin are 300′ to 400′ higher.

Good Spring and Lower Rausch creeks, flowing east and south, drain sheet XVII; and a second Rausch creek flowing north through the only gap in Thick mountain furnishes drainage for sheet XVIII. Within this coal area there are no towns of importance; but Tower City in the red shale valley just south of Brookside is practically a mining town.

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* Page plate 391 gives the general location of the division.

† Page plates 384 and 387 contain selected cross sections.

‡ Page plate 385, 386, 388 and 392 contains some selected columar sections.

Lincoln and Brookside collieries, both large producers, working exclusively the Lykens Valley beds of No. XII; and the East Franklin and Good Spring, working the Mammoth and adjacent beds, are the operating collieries of the division.

The *structure* is well shown by the cross sections* and mine sheets, the North Gate Ridge or Smoky Hollow and the Big Lick Mountain are the chief anticlinals; the most extensive mine workings are about the arch of the former; while the latter sub-divides the Wiconisco basin, and where it dies out in the southern rim at Brookside makes the flat dips worked by that colliery.

Formation No. XII is assigned a thickness of 1475′ on the south side of the Gate Ridge arch; the lower 350′ contains beds of red shale interspersed with the conglomerate and sandstone beds. The great mass of coarse heavy conglomerates are in the upper half of the formation, the lower half contains more beds of sandstone and slate. Six of the Lykens Valley coal beds are recognized as workable, in addition to which some four or five thin coals 1′ to 1′ 6″ thick are usually seen. The tunnels at Lincoln and at Kalmia collieries combined furnish a complete and reliable section of the whole formation, see page plate 392 or col. sec. sheet XI.

Lykens Valley coal beds are extensively worked at the Lincoln colliery,† on the south flank of the Smoky Hollow or Gate Ridge axis, at New Lincoln colliery‡ on the north flank of the same axis, and at Brookside colliery on the south side of the Wiconisco basin 6 miles to the west; some small openings have been made on these beds at Lorberry and Fishing creek gaps in the Sharp mountain, and at Klinger's gap in Thick mountain.

The lowest *Lykens Valley bed* of the district, bed *No. 6*, lies about 450′ above the Mauch Chunk red shale, this bed is quite thin and apparently not alway persistent; a brief

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*Some portions of these sections are given on plates 384 and 387.

† Cross section on plate 387; columnar section on plate 392.

‡ Cross section on plate 319; columnar section plate 388.

attempt to work the bed was made at Lincoln colliery where the bed is 1′ to 3′ thick.

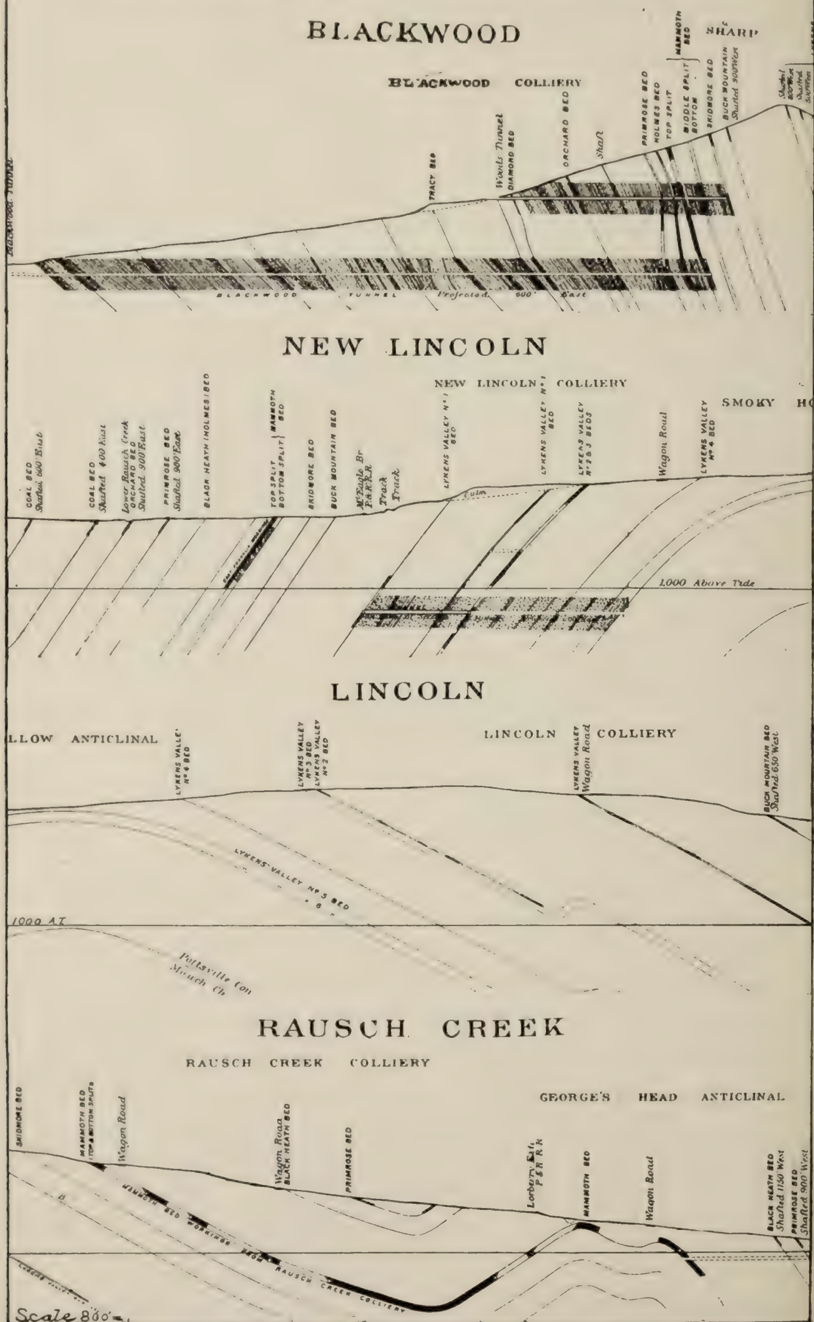
Lykens Valley No. 5 bed, known also as the "Lykens Valley bed," is one of the principal beds of the group; it lies about 50′ above No. 6. At Lincoln colliery this bed, when in good condition, yields about 4′ of coal, but like all the Lykens Valley beds its thickness and quality fluctuates considerably. At New Lincoln a tunnel south to No. 5 bed found 9′ 2″ of slate and dirt, unworkable. Along the south side of the Wiconisco basin, to the west, the bed greatly improves; and it is the only source of supply for the big Brookside colliery, which works the bed on mostly moderate dips found where the Big Lick mountain axis dies out in the north dip of the basin; the bed here averages fully 10′ with about 7′ of good coal, occasionally the thickness increases to 15′ or 20′ or runs down to only 3′ or 4′ in thickness; when the former the coal is often shelly or soft.

Lykens Valley No. 4 bed at Lincoln and New Lincoln collieries is 125′ above bed No. 5, but at Brookside the interval is 80′. Three lifts on this bed are worked at Lincoln colliery, the bed varies from 3′ to 7′ in thickness, with an average of 5½′ or 6′, yielding 3′ 6″ to 4′ of coal. The tunnel at New Lincoln cut this bed 4′ 7″ thick, but all dirt and slate; and a gangway driven upon it found but little improvement. At Brookside colliery the bed has been opened, at several points, by rock slopes from No. 5 bed, and by a short slope from the outcrop; the bed is but 2′ to 4′ thick and so high in refuse as to be unworked for the present.

Lykens Valley Nos. 3 and 2 beds are separated by only a few inches of slate at New Lincoln colliery, and practically form one bed 8′ to 10′ thick, which was operated with considerable success. At Lincoln colliery tunnel the parting slate is about 10′ thick and the beds are mined separately, the workings are mostly in bed No. 2 which is extensively worked; occasionally the coals come together and make one bed about 8′ thick, yielding about 5′ of coal; where separated the lower bed No. 3 is thin, 2′ to 4′ and dirty, and has yielded but little coal; but the upper bed No. 2 will average about 6′ thick with 4′ to 4′ 6″ of good

PL.387.

Anthracite Region – Southern Coal Field.



coal. These coals are not opened at Brookside, but it is perhaps one of them which is cut in a trial shafting near the southern end of section line 25 (see mine sheet XVII) with a reported thickness of but 2′ of coal. The distance between beds Nos. 3 and 4 is about 250′.

Lykens Valley No. 1½ bed, a thin bed or leader lying about 70′ above No. 2 bed was opened with some 600′ of gangway at New Lincoln colliery, it is only about 2′ thick and can hardly be regarded as a workable bed.

Lykens Valley No. 1 bed at Lincoln colliery is an important member of the series, there and at New Lincoln this bed is found about 350′ above bed No. 2 and 300′ below the Buck Mountain bed at the top of formation No. XII; at Good Spring colliery* the interval between it and the Buck Mountain has diminished to 220′. The thickness of the bed at Lincoln colliery varies from 3′ to 10′, but the average thickness is about 6′ with 4′ of good coal. At New Lincoln it was reached by a tunnel from No. 2 bed and about 1000′ of gangway driven; the bed is 4′ to 6′ thick but containd so much refuse that its working was abandoned. A tunnel north from near the foot of the Good Spring slope cuts this bed with a total thickness of 3′ 6″.

North Brookside colliery.—One fourth mile northwest of Good Spring breaker, and just over the flat crest of Thick mountain, a slope, dipping 38° S. and 400′ deep, is sunk on the No. 2 bed and a tunnel nearly 800′ long driven north from the slope level cuts the underlying Lykens Valley coal beds. No. 2 bed although 9′ thick is here nearly all slate and dirt, and the underlying beds are thin and also dirty; the slope has been allowed to fill with water.

At *Kohlers gap*† in Thick mountain 3 miles to the west the Lykens valley beds have been opened at their outcrop;

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* Cross section on plate 384.

† Some confusion exists as to the name of the creek which finds an outlet through the gap in Thick Mountain and indeed of the name of the gap itself; the First Survey calls it Klingers gap but on the mine sheet of the Second Survey it was marked Kohlers gap on authority which seemed conclusive; the stream is called both Rausch creek and Bear creek, the mine sheets giving the preference to Rausch creek; either name is unfortunate, as we have a Rausch creek heading just over the divide to the east and a Bear creek over the first divide to the west.

these openings are mostly fallen shut with the exception of a drift on No. 2 bed operated for the use of the farmers in the Pine Creek valley on the north. Report of First Survey page 190, gives the following thickness for the Lykens Valley beds here and cross section 26 on sheet XIX shows their relative position. "The No. 5 bed, the lowest opened, is 2½′ thick; No. 4 is 7′ thick but squeezed in the gangway; No. 3 is 5′ thick with only 2′ of good coal; No. 2 is a good bed 6′ thick, and No. 1 is a small coal."

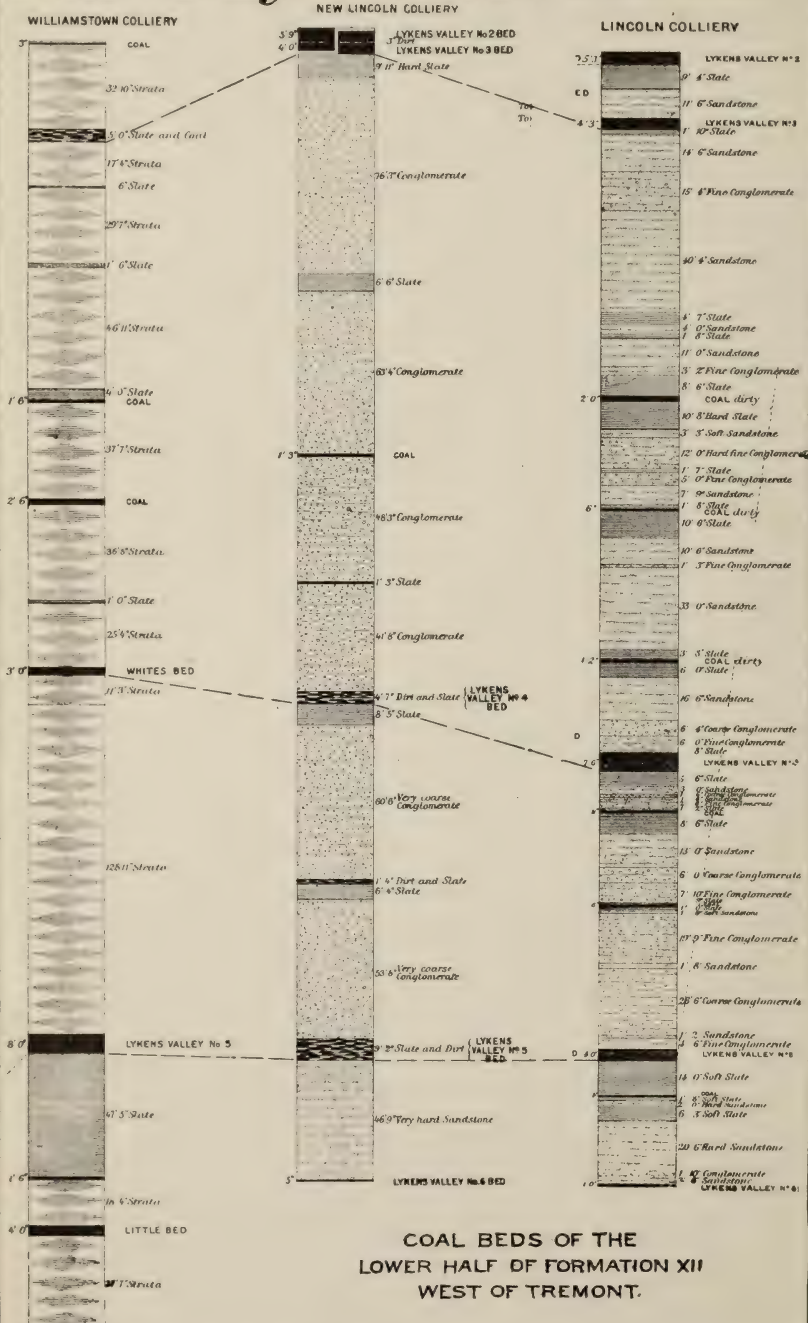
Buck Mountain bed, so far as developed in this division, is thin and irregular, and its outcrop does not make the plainly marked terrace so often seen in the eastern part of the field. At East Franklin colliery a tunnel was driven to this bed and an attempt made to work it; the thickness at the tunnel is 5′ 7″ but the amount of refuse is such that work was stopped after driving a 1000′ of gangway. Near the Lincoln colliery the Buck mountain has been shafted with a thickness of about 3′. At Good Spring the tunnel driven north cuts this bed, and an air hole is driven upon it to the surface; the coal is thin and unworkable. The report of the First Survey, page 190, gives a much better account of the bed at Kohlers gap, where it is called "11′ thick with a 4′ coal at 12′ above." It seems likely that this is a local thickening of the bed.

Skidmore bed, 120′ above the Buck Mountain, is worked along the foot of Thick mountain at the Good Spring colliery and formerly at Eckert colliery 3 miles east; at Good Spring the bed is 6′ to 7′ thick with 4′ to 5′ of good coal. At East Franklin the tunnel from the Mammoth to the Buck Mountain cut several leaders of coal less than 1′ 6″ thick, one of which probably represents the Skidmore; that this is a local thinning of the bed is perhaps indicated by the result of some surface shafting 1500′ west of the New Lincoln breaker where two coal beds 4′ 5″ and 5′ 7″ thick were found 80′ and 100′ south of the Mommoth and a 2′ 9″ bed (the Buck Mountain ?) was opened 50′ beyond. Between Good Spring and Brookside little or nothing is known of the thickness of this bed.

Mammoth bed is in two splits but so near together that

PL.388.

Anthracite Region – Southern Coal Field.



COAL BEDS OF THE
LOWER HALF OF FORMATION XII
WEST OF TREMONT.

both members are often worked from one gangway driven either on the top or the bottom split; this is the condition in the extensive workings at the Rausch Creek colliery* where the total thickness of the bed averages about 20′, for the most part in good condition; the average dip of the bed is about 25° southerly. At East Franklin† on the opposite side of the axis, the bed is about 15′ thick with 4′ or 5′ of slate separating it into two splits; on the moderate dips close to the Smoky Hollow axis the bed was mostly sound and good, but on the steep dips of 60° to 70°, further north it is soft and shelly at times. Schmoele Slope two miles westward is on a 50° north dip, the splits are worked separately, the total thickness is about 15′, but condition of the bed variable. The Good Spring slope on the north side of the Wiconisco basin is sunk 400′ on the Top split of the Mammoth, at the slope the two splits are 20′ apart but this interval varies in the workings; the Top split run about 10′ thick with 8′ to 9′ of coal, and the Bottom split 5′ thick with 4′ of coal. Three miles east, along the outcrop, the two splits of the Mammoth were worked separately at the Eckert colliery, thickness not recorded. To the west of Good Spring at Kohlers gap the bed according to Report of First Survey, page 190 is the Lomason or Big coal 10′ thick in two benches 4′ and 6′ each; west of this the bed is not opened in this division. The interval between the Mammoth and the Skidmore is 90′ at Good Spring.

Four Foot bed is not worked, the Good Spring tunnel cuts it 18′ 6″ thick, but all dirt. Where cut in the East Franklin tunnel its thickness is 4′.

Black Heath or Holmes bed is worked at East Franklin and Good Spring collieries, the only collieries in the divisison operating beds above the Mammoth; the bed has a good general thickness of 8′ to 10′, but is high in refuse yielding not more than 50 to 60 per cent. of good coal. It occurs 200′ to 250′ above the Top split of the Mammoth.

Primrose bed, 80′ to 100′ above the Black Heath, is opened at Good Spring with a thickness of about 7′ but is

* Cross section on plate 387.

† Columnar section on plate 385.

dirty. At East Franklin the Primrose is worked 9′ to 10′ thick, but high in refuse, yielding perhaps 5′ or 6′ of good coal.

Orchard bed 130′ above the Primrose at Good Spring is 4′ to 5′ thick fairly good. At East Franklin the interval is about 80′ and the bed 6′ to 12′ thick with an average yield of 6′ to 7′ of good coal.

Diamond bed.—At 450′ above the Orchard bed, the East Franklin tunnel cuts near the axis of the basin lying between Little and Big Lick mountains a thick bed of coal called there the "Diamond" bed ; that this is the true Diamond bed is a matter of considerable doubt as its distance here above the Orchard is twice that usually found, and the presence of the two large, though soft and dirty and perhaps worthless, coal beds between at 120′ and 350′ above the Orchard is also quite exceptional ; the bed is 10′ to 12′ thick, high in refuse due largely probably to the steep dip of 60° to 70° and its position close to the axis of the basin. In the hill facing Kohlers gap, but still on the north side of the basin, at Nye's drift a coal bed at about the same horizon in the measures and perhaps identical with the "Diamond" of East Franklin is opened ; its thickness is about 10′ with 6′ of coal, the basin of this bed must be here quite narrow although the north dip is not yet developed.

The "Diamond" bed is probably the highest workable bed of this division ; to the south however in the Schuylkill—Dauphin basin still higher beds, the precise idenity of which is doubtful, are found (see cross section 24).

The Old Rowe tunnel cuts about 1100′ of measures above the Mammoth and passes through some 7 coal beds mostly small or dirty at the tunnel. The first or highest bed in the tunnel, known locally as the *Greenwalt* was worked by a water level drift through to Stumps run, the bed is 4′-5 thick, dipping about 70° south, the coal has an excellent reputation. This bed occupies about the same horizon as the "Diamond" bed of East Franklin and is perhaps identical with it.

Higher beds, on Stump run, 300′ above its junction with

Lorberry creek and near the axis of the basin, two coal beds close together the lower "8′ thick" and the upper "6′ thick" are opened along the outcrop; these coals seem to be about 500′ above the "Greenwalt" bed, 1400′ above the Mammoth and are the highest coal known in the division.

28. *Williamstown–Lykens Division.*

This area is mapped on mine sheets XIX and XX.* The structure is shown by cross sections Nos. 27 and 28 on cross section sheet No. 20,† and columnar sections of the measures are given on columnar section sheet No. VII.‡

The division includes the western half of the Wiconisco basin, and extends from a mile east of the Williamstown colliery nine miles west, to the end of the basin.

The mountain ridges of No. XII, bounding the basin, gradually approach going westward to unite and form a short high ridge, called Short mountain, where the formation lifts into the air some three miles west of Lykens. The mountain sides slope steeply down to the deep red shale valleys bounding the field, which are 1000′ lower than the mountain crests. The narrow valley between the ridges, although 600′ to 700′ below the crest, is still high above the surrounding country. This valley is drained chiefly by Bear creek which finds an outlet through a break in the Big Lick mountain north of Lykens; a long branch of the creek extends up the valley eastward and a little short branch drains the cove to the west. The West branch of Rausch creek flowing eastward drains the eastern edge of the division. The northern or Thick mountain is without a break in this division. There are no towns within the measures, but Williamstown, Wiconisco and Lykens are large and prosperous mining towns situated in the red shale valley along the south.

The *structure* is nearly that of a simple basin with both sides dipping steeply, the exception is made by a narrow

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* Page plate 391 gives the general location.

† Page plates 389 and 390 contain selected portions of the cross sections.

‡ Page plates 386 and 388 give columnar sections at Williamstown.

overturned axis, developed in the Short Mountain colliery workings, along the north side of the basin; this axis, with gentler dips probably, extends east and bulges up the center of the basin south of Bear Valley shaft.*

The disappearance of the Lykens Valley No. 1 bed, and the thinness of beds Nos. 2 and 3, has the effect of making two distinct coal bearing groups. (1) The lower or Lykens Valley group consists of 3 or 4 workable beds found within a space of 200′ to 250′ at the top of the lower half of Formation No. XII; all of these beds outcrop well below the mountain rim of the basin and on the outside. Between the upper and lower group there is a space of 600′ to 700′ consisting almost entirely of coarse, massive conglomerate beds with occasional thin beds of sandstone, slate, or a leader of coal but a few inches in thickness; these measures constitute the upper half of Formation XII and make the crest of the mountain. The upper group is comprised of 400′ to 500′ of measures between the Buck Mountain and the Orchard beds, and contains 5 or 6 coals which reach locally, at least, a workable thickness.

The precise identity of the upper beds is a matter of some uncertainty; the coal beds and probably the intervening slate and sandstone have thinned very materially coming west, and the section at the Bear Valley shaft differs from a section of the same measures cut at Good Spring,† the nearest working colliery, 6 miles to the east; the identity of the Mammoth and Skidmore beds is perhaps less questionable than the others. This thinning of the upper group continues across the division, the beds growing still leaner as we approach the western end of this basin.

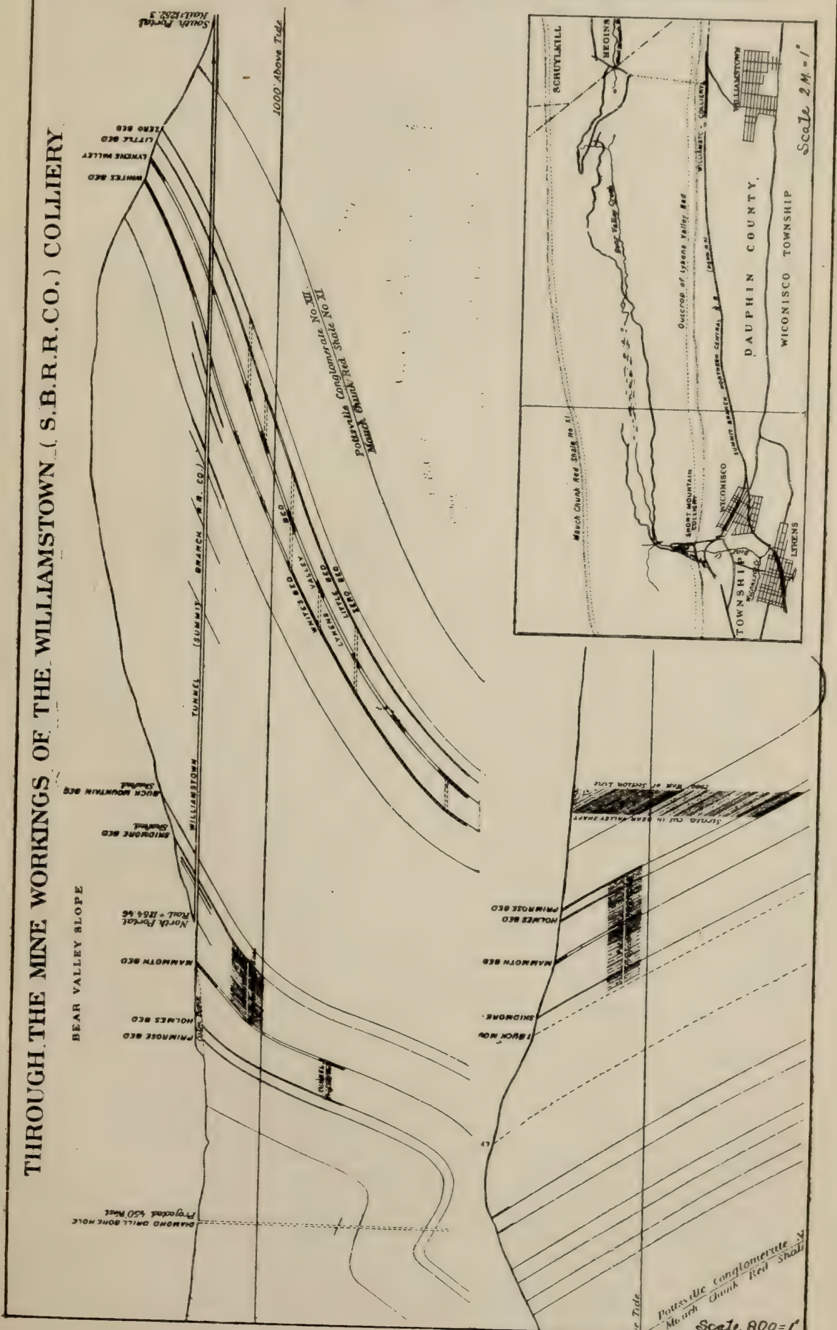
Two large and well equipped collieries operate in this division. The Williamstown, on sheet XIX, works extensively the Lykens Valley beds on the south side of the basin; also the upper group of beds, from the outcrop, on both sides of the basin. The Short Mountain colliery, on sheet XX, mines only the Lykens Valley beds;

* See cross sections on plates 389 and 390.

† See sections on plate 386.

PL.389.

Anthracite Region_Southern Coal Field.



and the workings extend clear to the westward spoon, and around the basin to the opposite side; the beds are opened by two deep slopes, on the north dip, nearly to the basin*, and by a new water level tunnel piercing almost through Thick mountain on the north(see cross section 20).

Formation No. XII at Williamstown is about 1400′ thick, thinning somewhat towards the west, and apparently less than 1200′ thick at Short Mountain; the Williamstown tunnel cuts a complete section of No. XII;† this section is given on columnar section sheet VII, but the detail of all the rock beds could not be obtained. The new water level tunnel at Short Mountain now cuts nearly the whole formation, but the sharp anticlinal axis encountered makes its precise thickness a matter of some uncertainty; a columnar section is published on sheet No. VII. The 500′ or 600′ of *transition measures* seen at Pottsville between Formations XII and XI have mostly disappeared and are represented by only about 100′ of sandstone and red and green shales. A brief general description of the coal beds of XII has already been given and we will now consider them separately; the beds are known by names here; both the name and its supposed equivalent number will be given.

Zero bed, of the Williamstown colliery, is the lowest of the Lykens Valley coals and occurs 230′ above the top of Formation XI and 37′ below the Little or No. 6 bed, it has not, heretofore, been classed as workable; since the publication of the mine sheet it has been opened at the Williamstown colliery by short tunnels from the Little bed; and is found to have a thickness of 2′ to 6′; its workable extent is not yet determined.

Little or Lykens Valley No. 6 bed is a persistent but

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*See cross section on plate 390.

†See columnar section on plate 388.

NOTE. It is interesting to note that, although the Pottsville shaft workings, 1576′ below the surface, are usually quoted as the deepest workings in the anthracite region; the lowest gangway at the Short Mountain slope actually reaches a slightly greater depth, the mouth of the slope is 887′ A. T. and the foot 692′ B. T., making a total vertical depth of 1579′; with reference to tide however, the Pottsville colliery reaches 836′ B. T. or 144′ lower than the Short Mountain slope.

thin coal, with an average thickness of not more than 3′, yielding perhaps 2′ of coal; the bed is worked to a small ex-on the south side of the basin both at Williamstown and Short mountain collieries.

Lykens Valley, or No. 5 bed is the principal bed of this division, it is found 30′ to 50′ above the Little bed, and has probably yielded two-thirds or more, of all the coal produced by this area. Here, as to the east, at Brookside, the bed shows marked fluctuations in its thickness and proportion of refuse, but its average thickness in the large area worked over will reach 9′ to 10′ with a yield of 6′ or 7′, of good coal.

A new tunnel, north in Thick mountain, from the foot of Bear Valley shaft cuts this bed "12′ to 15′ thick, but faulty and badly crushed."

Whites or Lykens Valley No. 4 bed is 75′ above No. 5 bed, and although much smaller, ranks next to it in size and productiveness. The workings thus far are all on the north dip; at Williamstown and the Short mountain collieries the bed will average about 3′ 6″ in thickness with 2′ 6″ of coal.

Lykens Valley Nos. 2 and 3 beds, within 150′ above the Whites bed some 2 or 3 small beds of coal are usually seen, representing probably beds Nos. 2 and 3, but no places in this division are they found of workable thickness and quality.

Lykens Valley No. 1 bed, although an important bed to the east at New Lincoln, is apparently absent here or replaced by a thin leader a few inches in thickness; the whole interval, of about 600′; between the thin beds Nos. 2 and 3 and the Buck mountain is composed almost entirely of coarse heavy conglomerates and sandstones.

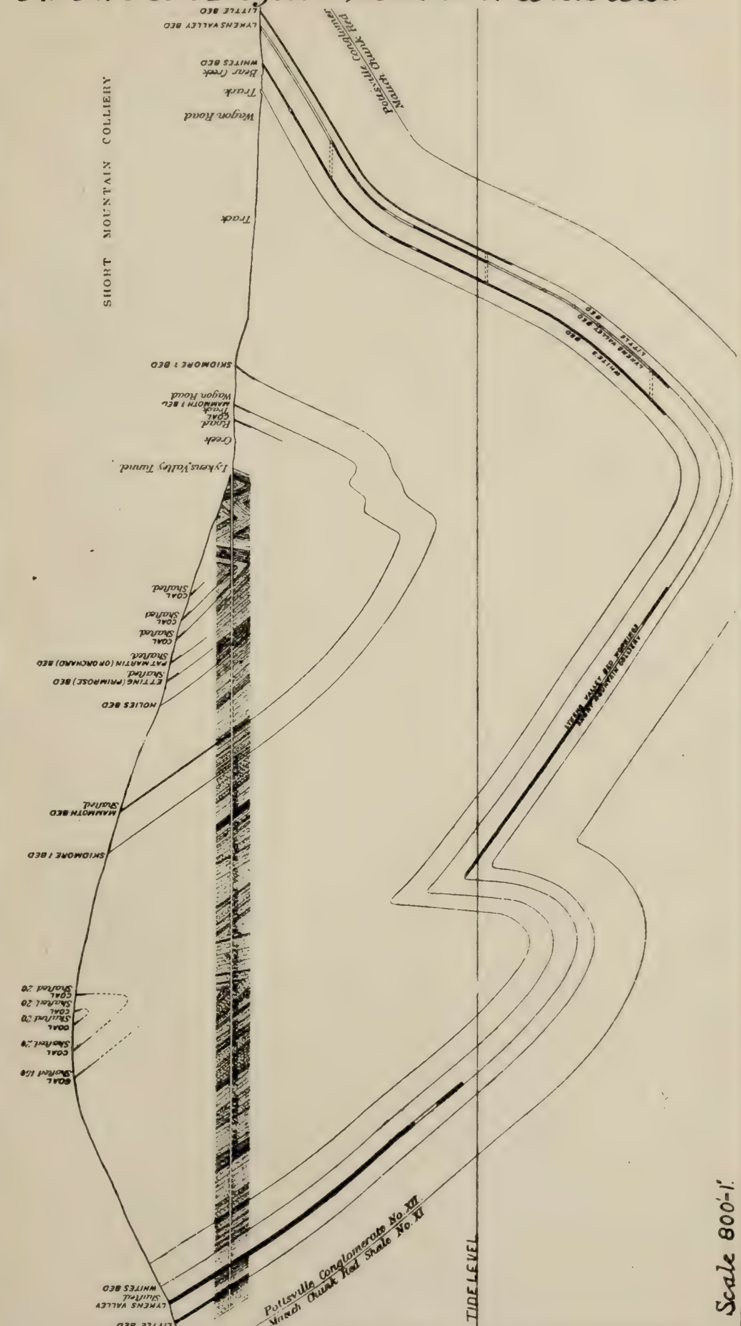
Buck Mountain bed, at the top No. XII, is worked near the northern end of the Williamstown tunnel, the bed is but 2′ to 3′ 6″ thick. On the north side of the basin at the Summit slope apparently a couple of thin unworkable "leaders" is all that remains of this bed; and to the west, at the Lykens Valley tunnel, even these thin leaders seem to have disappeared.

Skidmore bed is opened on both sides of the basin at the

PL.390.

Anthracite Region_Southern Coal Field.

SECTION ACROSS THE WICONISCO BASIN; THROUGH THE MINE WORKINGS OF SHORT MOUNTAIN (L.V.C.CO.) COLLIERY.



Williamstown colliery; on the north dip the bed is about 3′ thick, but on the south dip the bed averages about 7′ with 5′ of coal; the beds thins to the west and at the Lykens Valley tunnel is unworkable.

A "*Leader*" 2′ to 3′ thick, which is now worked at Summit slope, lies between the Skidmore and the Mammoth beds.

Mammoth bed, found about 160′ above the Skidmore, barely retains first place among the upper coal beds; its thickness at Bear Valley and Summit slopes is about 8′ when in good condition; the bed grows thin and faulty proceeding west, and in the old workings from the Lykens Valley tunnel the bed is 2′ to 4′ thick, with a rather uncertain percentage of good coal.

A "*Leader*," 80′ above the Mammoth, yielding 1′ 6″ to 2′ 0″ of good coal, is now being worked from the Summit slope.

Holmes bed, at 110′ above the Mammoth, is not worked in this division; where cut by the tunnel at Summit slope it is 9′ thick but faulty and unworkable; where opened to the west it is mostly thin and unworkable.

Primrose bed is mined quite extensively from Summit slope, the workings on this bed are incorrectly marked on mine sheet XIX as the "Holmes bed;" the bed will average about 5′ with 4′ of coal. In the old workings from the Lykens Valley tunnel (sheet XX) the "Etting" bed is supposed to be indentical with the Primrose; the thickness of this bed where worked on the south dip is very variable, but it probably does not yield, on the average, more than 2′ or 2′ 6″ of coal; on the north dip the bed is not worked.

Pat Martin or Orchard ? bed was formerly worked, on both dips, from the Lykens Valley tunnel; its thickness averages perhaps 4′ but its quality is very variable.

All the coal measure beds at the Lykens Valley tunnel lie close to the axis of the basin and the measures are sharply compressed and folded, with the beds mainly pinched and variable; the identity of the beds, even where cut in the tunnels, on the opposite sides of the basin, is perhaps doubtful and their precise identity with the bed of the same horizon to the east of Williamstown, still more doubtful.

In the basin at Williamstown colliery the 600′ or more of measures found above the Primrose bed is entirely destitute of workable beds, the same interval about Tremont contains at least two beds of good size and quantity.

Division 29. Schuylkill–Dauphin basin.

This division is mapped on mine sheets XXI (south of the overlap of XVII) and XXII to XXVII;* cross sections 29 to 31 on sheet XXI serve to show the general structure,† columnar section given the relative position of most of the coal beds are published on columnar section sheet VIII. The topography of the basin, west of sheet XXII, is shown on the mine sheets by contour line 10′ vertically apart.‡

The Schuylkill-Dauphin basin, or the Southern Fishtail as it is sometimes called, is a long narrow deep trough, some 30 miles long from Lorberry gap, westward, to within one and one-half miles of the Susquehanna river above Dauphin. At the east the basin is a mile and a half wide, but tapers to a very slender point, where the coals of No. XII lift into the air along the high narrow crest of the synclinal mountain, close to the river.

Sharp mountain is the southern rim of the trough, and Fourth mountain the northern rim; as the basin narrows westward the mountains converge, and make the "Big flats," north of Water Tank station and a narrow single crested spur, called Short mountain, reaching out some 6 miles beyond. The narrow interior valley or plateau, high above the exterior red shale valleys, is deeply trenched, at the

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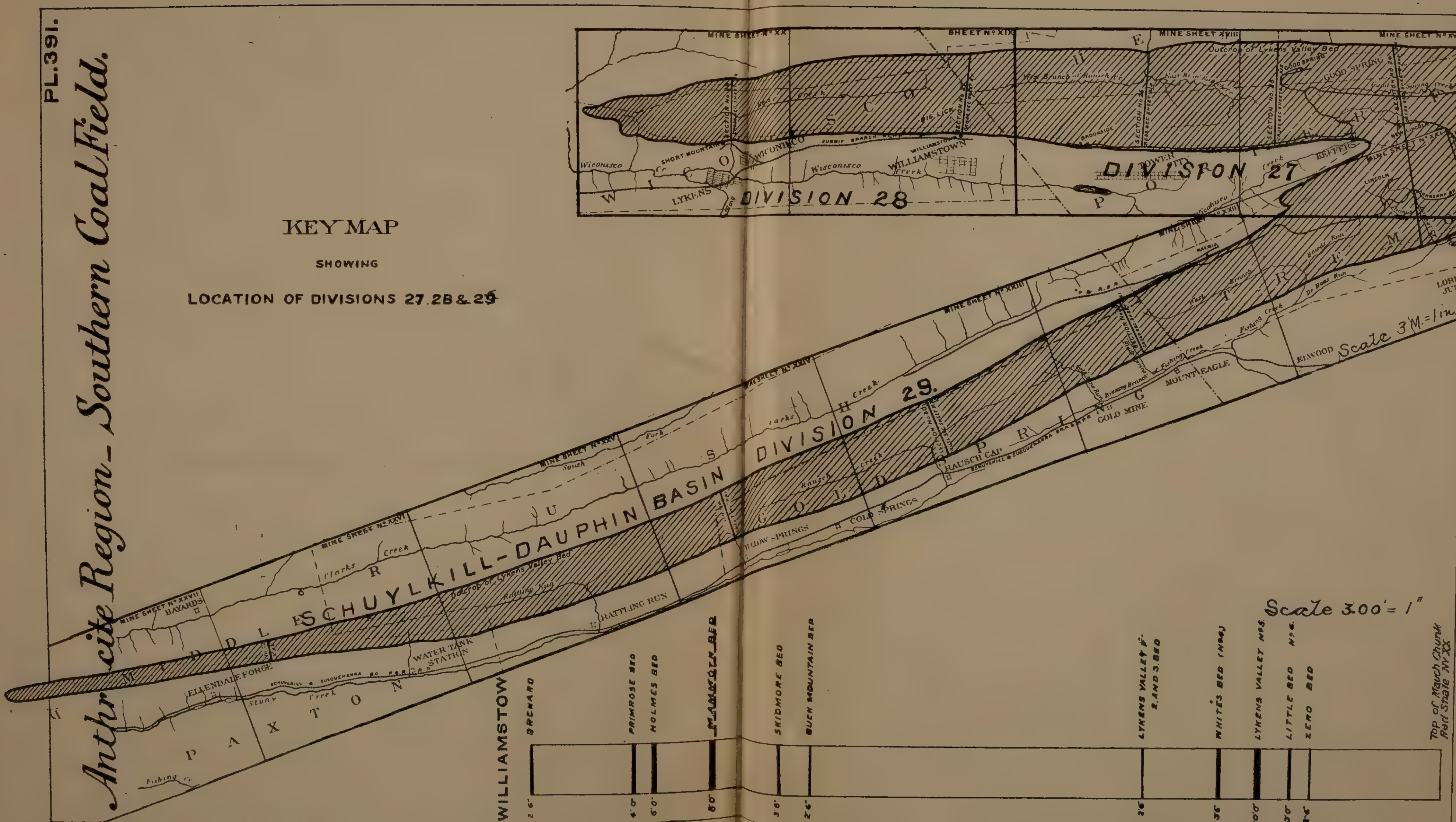
* Page plate 391 gives general location of the division.

† Page plates 393 and 394 contains portions of the cross sections.

‡ A report to which reference will be made, on the "Dauphin and Susquehanna Coal Company's Lands and the Stony Creek Coal Estate," by Richard C. Taylor, published about 1840, contains much information concerning the exploration of the coal beds, then in progress, under his supervision. The report of the First Survey on this portion of the field is comprised mainly of information furnished by Mr. Taylor, which is commented upon as follows :—"While employing his details, I must observe that my own later observations have shown me that the thickness assigned to some of the coal beds is too great."

PL. 391.



Anthracite Region – Southern Coal Field.

six gaps in Sharp mountain, where the streams break through, to drain into the longitudinal valley of Stony creek and its eastward extension, Fishing creek. The Fourth mountain, about 1600′ A. T. along its crest, forms an unbroken barrier for its full length.

The *mining operations* in this division, with the exception of the Kalmia colliery on the north side of Fourth mountain, were all prior to 1858; and the digging of two boat loads of coal, from a bed outcropping near the western extremity of Short mountain, as early as 1802 is mentioned by R. C. Taylor in his report.

Report of First Survey (1858), page 440, says: "The Dauphin coal basin is now entirely deserted by coal miners; for several years little or no coal has been shipped from it. So unreliable do the seams prove, and so great is the outlay required, that, recollecting that former experiments have failed, no disposition at present is manifested to develop its resources.

*Kalmia colliery** at the east end of the division was established about 1870, and continued in operation for ten years or more. A water level tunnel opens the Lykens Valley Nos. 4, 5 and 6 beds, its workings connect on the east with those from the Lincoln colliery; the best coal was obtained from the flat dips about the George's Head axis, just before reaching the Lincoln workings.

Structure.—The basin is apparently, for its full length, a single close fold. The strata on the northern side of the fold, or in *Fourth mountain*, have a general south dip of 40° to 50°, which is increased to 60° or 70° at the east in the Kalmia workings. On the south, in *Sharp mountain*, between Lorberry and Gold Mine gaps, the beds are overturned; and the inverted dips are 70° to 80° south. As the basin raises and narrows westward, it brings the beds of Sharp mountain closer to the trough, the dips become perpendicular, then steeply north, and finally in Short mountain 30° and less toward the north.

Formation No. XII: The outcrop of the top of No. XI

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* Cross section on plate 393.

or the bottom of XII is concealed on both sides of the basin for its full length, by blocks of conglomerate; which cover the mountain slopes all the way to the streams in the bottom of the Clark and Stony creek valleys. The only exposures of the lower beds of XII are at Lorberry gap, Kalmia tunnel and in Short mountain at the west end.

No. XII in Fourth mountain appears to have all of its usual thickness and to be not less than 1400′ or 1500′ thick (see sec. 29 plate 393). The crest of the mountain is made by the hard and massive beds of the *upper half* of the formation; barren, so far as the explorations show, of coal beds, although they include the horizon of one or more of the upper Lykens Valley beds. The *lower half* is less hard and massive and contains three or four coal beds which outcrop on the north slope 100′ to 200′ below the crest.

On the south, in Sharp mountain, No. XII seems to have been more easily eroded and disintegrated (owing no doubt to the greater pressure and disturbance to which it has been subjected); its crest line is lower and narrower, and it is gapped at half a dozen places; and from the mine and cross section sheets it would appear to be much thinner.*

The *Coal Measures* at the east end of the division, north of the Fishing Creek gap, are perhaps 1500′ to 1800′ thick,

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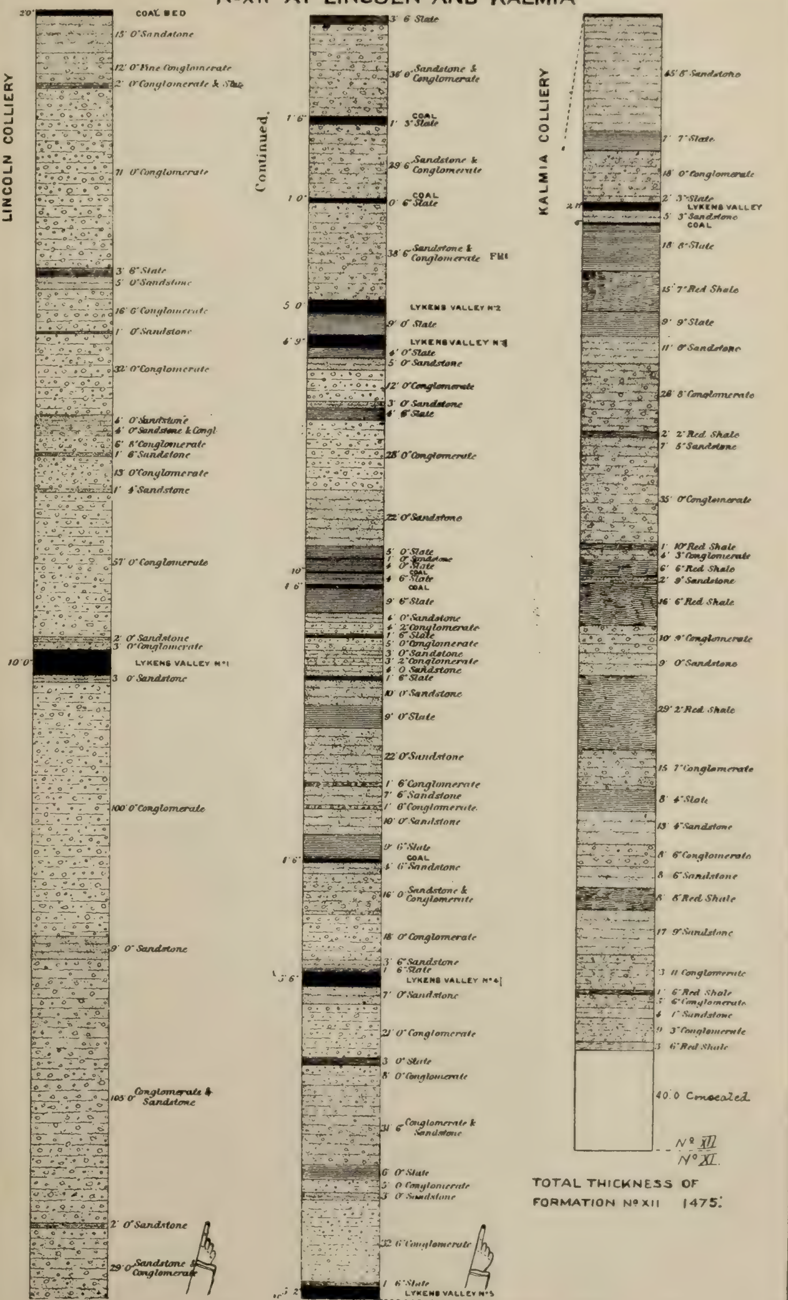
* The writer now thinks that the mine sheets are in error, in the placing of the southern outcrops of the "top of No. XI and of the lowest coal bed," between Lorberry gap and Rattling run (mine sheets XXI to XXV); and that the actual outcrops are some 800′ to 1000 south of the place indicated upon the mine sheets. This would give No. XII its usual thickness (and I see no good reason to suppose it has been reduced one-half as the sheets now indicate); and makes it highly probable that the lower Lykens Valley beds, perhaps thin and worthless?, will be found low down on the southern slope of Sharp mountain and that the beds opened at the Fishing Creek, Black Spring, Gold Mine, Rausch Creek and Yellow Run gaps all belong to the coal measures, or possibly the lowest in the top of XII.

One of the reasons, which led the writer to place the outcrops as they now stand, is the remarkable jump which the crest of Sharp mountain makes, at Lorberry gap, from beds just below the Buck Mountain bed, 1500′ south to conglomerate beds at the base of the formation, and below Lykens Valley No. 6 bed. A recent study of the topography of this gap brings the conclusion: That the crest rapidly makes its way back to the upper beds of XII, and at Fishing Creek gap, three miles west, it is once about in its former position.

PL. 392

Anthracite Region_Southern Coal Field.

No XII AT LINCOLN AND KALMIA



but with the westward rise of the basin they grow rapidly less and the lowest beds probably spoon just east of, or at, the Big Flats. Owing to the scant developments, our knowledge of them is very incomplete and is confined chiefly to the lower 600′ to 800′. Mr. R. C. Taylor, to whose report we are indebted for much of the present information, found it is not only impossible to identify these coal beds with the well-known beds of other parts of the field, but was quite uncertain as to the identity even between the beds in nearby gaps.

Condition of the coal beds: The uplifting and close folding of the strata, in this basin, has so rubbed, crushed and altered the coal beds, as to render them extremely variable and unreliable, both in thickness and quality, and they are all high in refuse and small coal; this is especially true of the south side of the basin. It is possible, that improvements in the method of burning small sizes of coal, will so enhance their value as in time, to make the mining of the beds of this basin, where there is a great quantity of coal above water level, a profitable one.

The *Lykens Valley beds of No. XII* have been partly opened at Lorberry gap, Kalmia colliery, on the Dull and Hoff lands, and at several points along Short mountain.

At *Lorberry gap* there are five coal beds opened below the "Umbehower" bed (1′ 6″ to 3′ 6″ thick) of the Sharp mountain colliery, which the Survey is inclined to regard as the Buck mountain bed (see mine sheet XXI and cross section 24). The two lower beds were mined to a small extent; but no reliable record of the thickness of any one of them could be obtained. The thickness here of No. XII would appear, from the cross section, to be 1500′ or 1600′.

At *Kalmia colliery* (mine sheet XXI and XXII) Lykens Valley Nos. 4, 5 and 6 beds were mined.

The beds are reached by a water level tunnel, from the north side of Fourth mountain, the gangways extend west two miles, and east three miles connecting with Lincoln colliery workings; average dip of the beds is about 65°

south. The thickness of the beds, and the yield of coal, is very variable; the tunnel section (columar section sheet XI) gives a thickness of 2′ 11″ for No. 6 bed, 8′ 8″ for No. 5 bed and 2′ 10″ to 4′ 6″ for No. 4 bed; but the mine map shows in all the beds; here and there, stretches of gangways were the coal was so thin or so dirty that it was not thought worth while to work the breast.

On the *Dull and Hoff lands*, 2 miles northwest of Rattling run and on north slope of Fourth mountain (mine sheet XXV), a number of trial openings, on some four or five of the Lykens Valley beds, were made in the summer of 1888. At 500′ north of the summit and 100′ below, a thin bed of slate and coal is opened. Some 200′ lower in the measures, and about same distance north, another bed was opened which yielded a little clean, bright coal. At 160′ below this, is a bed of 2′ 7″ thick of good coal, the best found; and 100′ still lower a bed 5′ 5″ thick of coal and dirt crushed and broken. Below this 40′ or 50′ a 2′ 6″ bed of slate and dirt was opened.

Some three or four coal beds, of the lower or Lykens Valley group, are opened on both sides of the narrow mountain crest north of the saw mill (mine sheet XXVI).

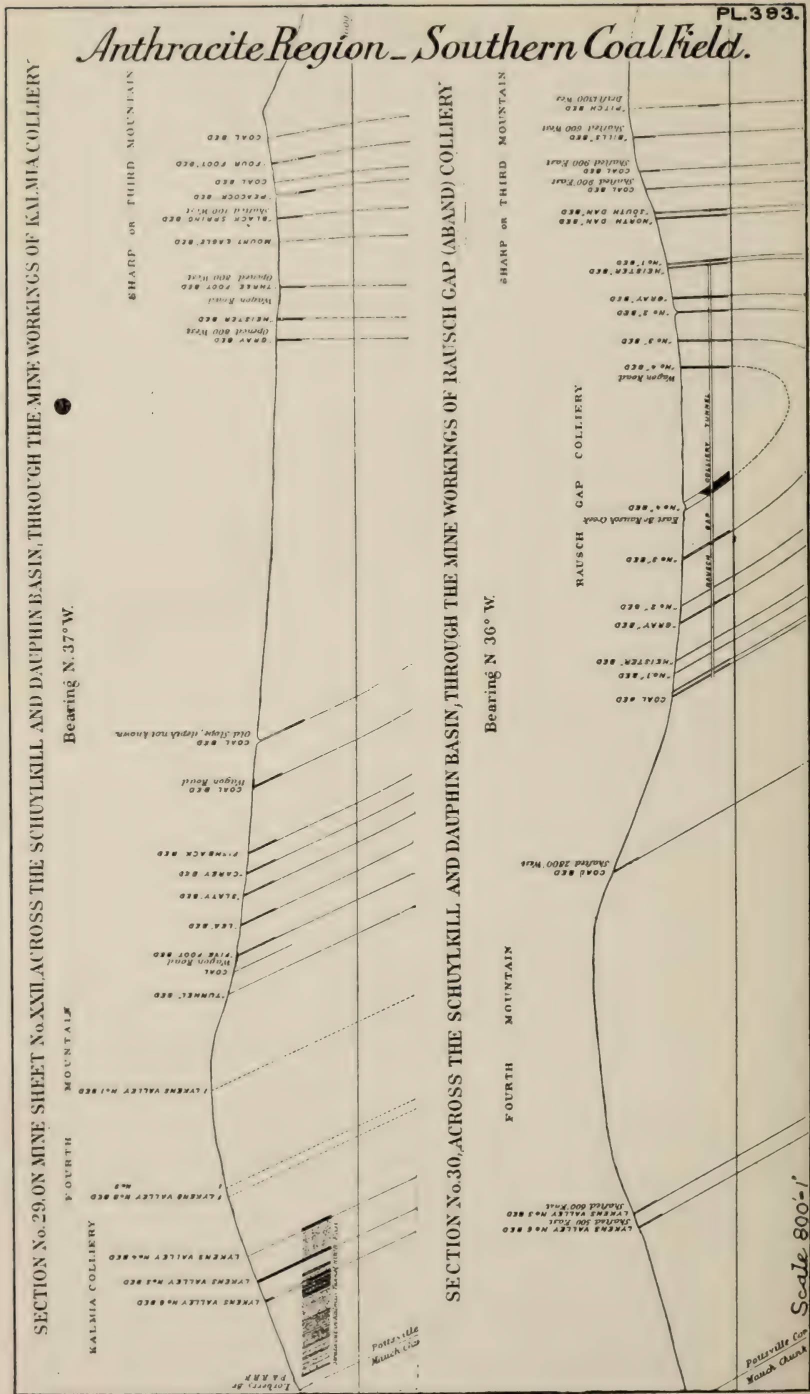
Youngs drift opened in 1824 is on a 25° north dipping bed 17″ to 51″ thick. *Kuglers drift* is on a bed 25′ below Youngs; also on north dip, "in some places the bed consisted of four to five feet of good coal; at others it was greatly reduced in thickness and mixed with slate."

North Vein drift is on south dip of the Kugler bed, thickness in the drift not given. (See cross section 32 on plate 394.)

In the summer of 1888 some trial opens were made on the Bayard land on the south dip of these same beds, about a half a mile east of the North drift; details of the result was not obtained.

A coal bed is opened at the western extremity of Short mountain about a mile north of Dauphin.

The explorations on the coal beds above the conglomerate were mainly at the gaps in the Sharp mountain, although


PL. 393.
Anthracite Region _ Southern Coal Field.
SECTION No. 29, ON MINE SHEET No. XXII, ACROSS THE SCHUYLKILL AND DAUPHIN BASIN, THROUGH THE MINE WORKINGS OF KALMIA COLLIERY
Bearing N. 37° W.
SHARP OR THIRD MOUNTAIN
FOURTH MOUNTAIN
KALMIA COLLIERY
SECTION No. 30, ACROSS THE SCHUYLKILL AND DAUPHIN BASIN, THROUGH THE MINE WORKINGS OF RAUSCH GAP (ABAND) COLLIERY
Bearing N 36° W.
SHARP OR THIRD MOUNTAIN
RAUSCH GAP COLLIERY
FOURTH MOUNTAIN
Scale 800'-1'

some few openings on the beds outcropped at the foot of Fourth mountain have been made. There were formerly two shipping collieries in the basin, one at Gold Mine gap and the other at Rausch gap.

At *Black Springs gap* there are a number of old drifts and a short tunnel, now fallen shut. The following section and notes are from Mr. R. C. Taylor's report of 1842.

	Spaces in feet,	Total of thickness. *Feet.*	Thickness of each vein of coal.	REMARKS.
Commencing at the Vertical Wall of Conglomerate, fifty feet thick, forming the Backbone of the ridge of Sharp Mountain—				The strata nearest the ridge are a little inclining south.
To traces of a Southern vein, said to be 3 feet, . . .	70	70	. . . . .	Course N. 57°E.
1. To Coal Drift on 4 feet vein,	100	170	4.	Length of drift, 275 feet.
2. Vein next the Iron Ore bed, 3½ to 4 feet, supposed to be the Pitch Vein, ...	73	243	3.	East of gap, excellent coal.
Bed of rich iron ore, 2 feet thick adjoining, ...	. . . . .	. . . . .	. . . . .	Do. Cross cut, 38 feet.
3. Peacock vein; very good Coal; 6 to 8 feet elsewhere, with 6 inches of iron ore in the bottom, slate, . . .	30	273	4.4	Do. New drift, 117 feet.
4. Black Spring vein	124	397	6.	Do.
5. Mount Eagle vein, ...	74	471	5.4	Do.
6. Three Feet vein, north of Big House, ...	250	721	3.0	West side the gap.
7. Heister vein vertical . . .	100	821	10.7	Drift 1003 ft. long, N. 57° E.
8. Grey vein vertical, N. 57° E.	100	921	14.1	Drift 590 feet long.
Central space in the valley without coal; no regular strata were reached in any shaft here.	2100	3021	. . . . .	Apparently disturbed.
			50.4	Total proved.

Along the *Mount Eagle road*, at the foot of Fourth mountain, some eight or nine coal beds were opened; a columnar section (No. 7, sheet VIII) was compiled chiefly from Mr. Taylor's notes (see also cross section 29, plate 393).

At *Gold Mine gap* a water level tunnel 1000′ long and several water level drifts were driven, all of which are now shut. The position of the gangways here, as given on mine sheet XXII, was determined by the outcrop, easily traced by the falls, as no survey of the working could be found. Mr. R. C. Taylor's section here is as follows:

Details of Coal Veins.	Spaces in feet.	Total thickness.	Thickness of Coal.	Remarks.
Vertical wall of puddingstone 50 feet thick.				
Crop of coal and smut, ...	129	129	. . . .	Not proved.
Second crop, ...	90	219	. . . .	Not proved.
1. Four feet coal vein, 1197 feet above tide, ...	60	279	4.0	Largely conchoidal.
3. Peacock vein, from 2 to 7 feet thick, ...	160	439	4.6	Course N. 57° E. Drift 112 feet.
6. Three feet vein at Old Shanty, ...	429	868	3.0	
7. Heister vein, ...	109	977	9.0	Good Coal.
8. Grey vein, 10 or 12 feet, . .	120	1091	12.	
Vein not drifted on, ...	111	1208	. . . .	Unproved.

Rausch gap, 3 miles further west, was the scene of the principal mining operations. The workings, shown here on mine sheet XXII, are from a survey made in 1854 and 1855, the original map of which is in possession of the Philadelphia & Reading Coal & Iron Co.; from notes on this map the following information about the thickness of the beds and their condition was obtained. Cross section 30 (see plate 393) gives their relative position.

On the *south side of the basin*, commencing with the highest bed cut in the tunnel, and proceeding downward, we have:

No. 4 bed, 7′ thick, soft.

No. 3 bed, gangways east and west end in rock fault.

No. 2 bed, west gangway ends in rock fault, east gangway has 16″ of coal at face.

Grey bed, soft and soft fault. Taylor calls this bed 10′ thick.

Heister bed, face of west drift, 1′ 6″ soft coal, a large body of coal above gangway but of inferior quality; face of east drift 3′ 6″ of coal, dirt and slate. A thickness of 6′ of coal is assigned it by Taylor.

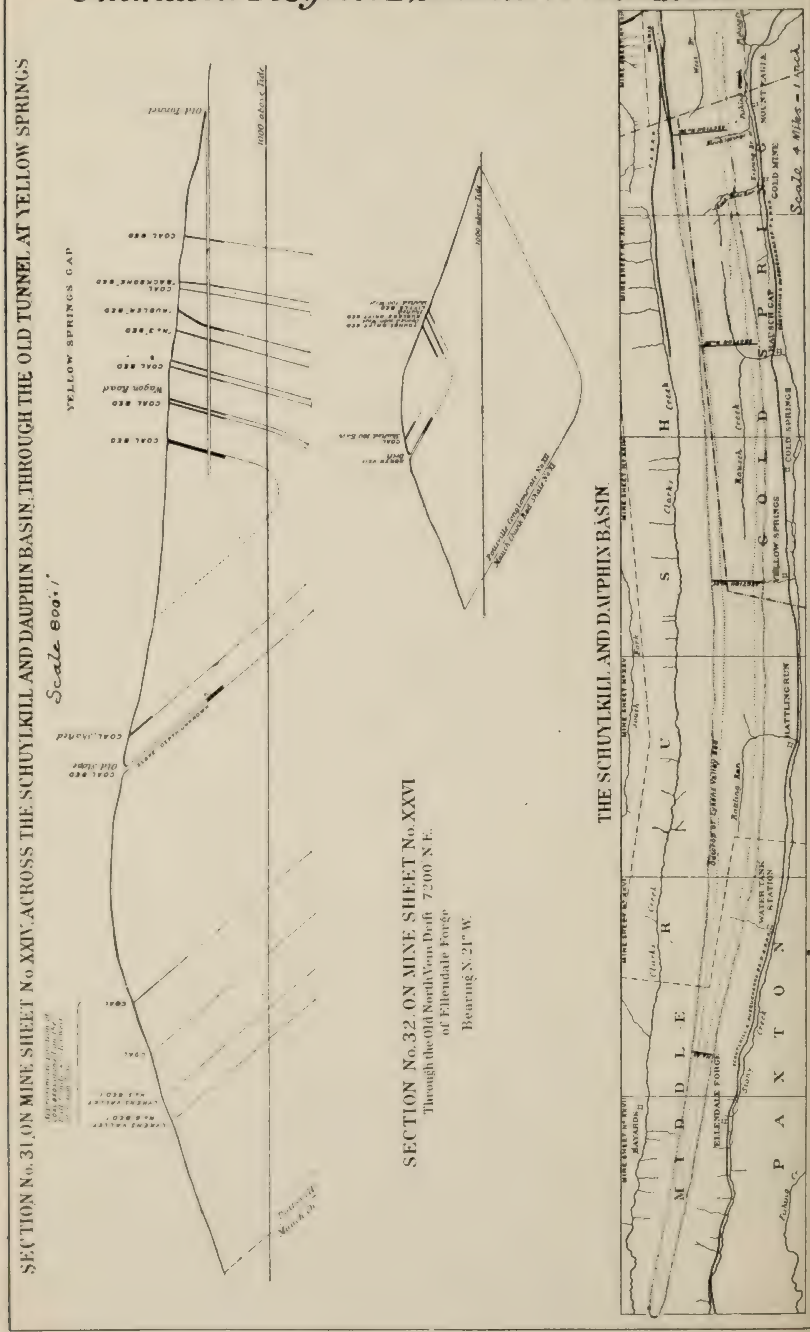
No. 1 bed, average thickness 8′, coal at face, curly, soft, and mixed with slate.

North Dan bed, face of west drift 2′ good coal; face of east drift 1′ 2″ of good coal.

South Dan bed, face of west drift in rock fault.

PL. 394.

Anthacite Region _ Southern Coal Field.



Four small beds are opened below this, all north of the "backbone" of conglomerate.

On the *north side of the basin*, of the beds cut in the tunnel the map gives the following notes:

No. 4 bed, 37′ thick, soft fault.

No. 3 bed, coal good.

"Leader, 1′ thick."=No. 2 bed.

Grey bed, soft fault.

Heister bed, dirt 1′ 3″.

No. 1 bed, coal 1′, dirt 6″.

? Bed, coal 2″, dirt 2′.

Dirt bed, 4′ thick.

Four miles west at *Yellow Springs gap*, 1500′ of tunnel was driven, north, to near the basin; 3 short drifts opened; and a slope commenced on the side of Fourth mountain on a south dipping bed ; the only data we have of the coal beds are those cut in the drifts, Nos. I, II and III, and given in Taylor's report, as follows :

Drift No. I, 3′ of hard coal and 1′ of soft coal.

Drift No. II, 6′ 3″ thick of fine coal, dip 68° N.

Drift No. III, bed 4′ thick including slate, dip 37° N.

All three beds are north of the "backbone" of the mountain.

At *Rattling Run gap*, 3 miles west, 2 beds are drifted upon north of the "backbone;" the Perseverance bed 5′ 6″ thick with 1′ of slate, and a thin bed 37 yards north.

Some distance *south of the crest*, Taylor reports the outcrop of several coal beds the thickest of which are but 2′ to 3′ ; "one of these is opened at the Reliance drift at the head of the inclined plane 572′ above the dam—about 860′ A. T. ; the extension of the drift did not result favorably." None of these openings or outcrops, although they were looked for, were seen in the late Survey due perhaps to the heavy undergrowth covering the mountain slope. It now seems most probable that these are the north dipping Lykens Valley beds, which are concealed between here and Lorberry gap.

Big Flat openings, were made in 1838 ; several trial shaftings were sunk, opening two or three small beds, from one of which several tons of coal were raised and brought down to the landing; this "the bottom bed is 20″ to 36″ thick." The broad mountain summit called "Big Flats" is formed by the heavy massive beds of conglomerate at the top of XII swinging around the end of the basin; and the coals at Big Flats are the spooning out of the lower beds found inside of the conglomerate ridges.

"*Fort Lookout shaft* a mile west was sunk 82′ to find a bed report 4′ thick" apparently without success.

Composition of the coal.

The coals of the Schuylkill-Dauphin basin shows a progressive increase, in the proportion of volatile hydrocarbons which they contain, from east to west. Some of the coals no doubt should be classified as semi-anthracite or even semi-bituminous, "although it is unfortunate that in the analysis cited by Professor Rogers (the only ones available) no attempt has been made to separate the moisture from the volatile hydrocarbons, all being considered alike volatile matter. This fact vitiates any classification which may be based on such analysis."

Report of First Survey, page 970, gives the analyses as follows:—

Location and Bed Name.	Fixed carbon.	Volatile matter.	Ash, water, and impurities.	Total.	Fixed carbon.	Volatile combustible matter.	Carbon ratio. $\frac{c.}{v.h.c.}$
1. Black Spring Gap, Lea Vein,	88.84	8.96	2.20	100	90.83	9.17	9.90
2. Black Spring Gap, Gray Vein,	81.62	9.78	8.60	100	89.30	10.70	8.35
3. Black Spring Gap Gray Vein,	81.40	11.40	7.20	100	87.72	12.28	7.14
4. Gold Mine Gap, Peacock Vein,	82.15	10.95	6.80	100	88.23	11.77	7.49
5. Gold Mine Gap Heister Vein,	81.47	10.43	8.10	100	88.65	11.35	7.81
6. Raush Gap Peacock Vein,	77.23	10.57	12.10	100	87.96	12.04	7.30
7. Yellow Spring Gap,	79.55	10.95	9.50	100	87.90	12.10	7.26
8. Rattling Run,	74.55	13.75	?	100	84.42	15.58	5.41

CHAPTER CXXIII.

Estimate of Contents of the Anthracite Coal Fields.

Report of the Pennsylvania Coal Waste Commission,* published in 1893, contains in full an estimate, made by the writer, of the "Existing Anthracite Coal Field before mining began." The summary tables which follow are taken from this report; for full details of method and bed thickness, reference should be made to that report.

TABLE A.

Estimate of Total Original Contents of Northern Coal Field.

1. Area No.	2. Between cross sections.	3. Probable average thickness of coal at cross sections.	4. Probable average thickness of coal for areas.	5. Surface area lowest workable bed in acres.	6. Probable original contents in tons.†
		Feet.	Feet.		
1	K	. . . . . .	. . . . . .	1,071.4	9,511,766
2	K J	6.38 10.96	8.67	5,927.8	96,620,768
3	J I	10.96 9.32	10.14	5,822.0	110,985,950
4	I H	9.32 20.65	14.98	10,845.5	305,537,256
5	H G	20.65 26.66	23.65	10,180.8	452,658,729
6	G F	26.66 29.83	28.25	9,892.1	525,369,431
7	F E	29.83 15.91	22.87	5,644.8	242,701,562
8	E D	15.91 23.75	19.83	13,483.5	502,670,273
9	D C	23.75 38.03	30.89	13,667.3	793,703,846
10	C B	38.03 55.60	46.82	13,429.8	1,182,112,483
11	B A	55.60 32.97	42.28	11,587.7	964,634,309
12	A 4	32.97 29.18	31.08	6,593.9	385,284,214
13	4 3	29.18 16.29	22.74	1,717.2	73,412,361
14	3	. . . . . .	. . . . . .	1,012.6	21,016,836
15 . . .	Bernice basin.		3.5	1,950.0	31,161,000
Totals, . .	. . . . . .	. . . . . .	. . . . . .	112,826.4	5,697,380,784

* The body of this report, to which the estimates are but an appendix, contains so much that is valuable, regarding especially the utilization of the small sizes of anthracite coal; that did space permit, the writer would be glad to reprint it in full.

† Specific gravity 1.55, or 1,830 tons per foot acre.

TABLE B.

Estimate of Total Original Contents of Eastern Middle Coal Field.

Area No.	NAME OF BASIN.	Surface area lowest workable bed in acres.	Probable original contents in tons.*
16	Upper Lehigh—Pond Creek, ...	939	23,305,987
17	Cross Creek and Woodside, ...	1,600	49,812,655
18	Big Black Creek, ...	3,236	91,944,442
19	Little Black Creek, ...	966	27,660,617
20	(East) Black Creek and Stony Creek,	572	9,957,701
21	(West) Black Creek, ...	1,061	22,303,544
22	Robert's Run and McCauley, . . .	323	12,898,935
23	Hazleton, ...	4,948	165,712,453
24	Beaver Meadow and Dreck Creek, . .	5,470	163,135,463
25	Green Mountain, Nos. 1 to 5, ...	900	19,751,938
26	Silver Brook Basins, ...	930	16,007,712
	Total, ...	20,945	602,491,447

* Specific gravity 1,614, or 1,960 tons per foot acre.

Table C.

Estimate of Total Original Contents Western Middle Coal Field.

1. Area No.	2. Between cross-sections.	3. Probable average thickness of coal at cross-sections.	4. Probable average thickness of coal for areas.	5. Surface area lowest workable beds in acres.	6. Probable original contents in tons.*
		Feet.	Feet.		
27 . .	(M. S. I.)	. . . . . .	. . . . . .	5,591.3	155,487,956
28 . .	(M. S. 2 & 2*a*.)	. . . . . .	. . . . . .	7,115.4	690,012,331
29 . .	(M. S. 3 & 3*a*.)	. . . . . .	. . . . . .	7,414.2	609,577,908
30 . .	(M. S 4 & 4*a*.)	. . . . . .	. . . . . .	8,108.5	673,918,507
31 . .	(12) 13	33.49 24.29	28.89	7.464.0	422,644,522
32 . .	13 14	24.29 21.45	22.87	7,562.0	338,968,162
33 . .	14 15	21.45 37.75	29.60	5,929.0	343,976,864
34 . .	15 16	37.75 37.49	37.62	1,759.0	129,700,217
35 . .	16 17	37.49 39.88	38.69	4,141.0	314,021,968
36 . .	17 18	39.88 33.19	36.54	3,734.0	267,423,106
37 . .	18	. . . . . .	. . . . . .	1,372.0	63,833,290
Totals,	. . . .	. . . . . .	. . . . . .	60,190.4	4,009,564,831

* Specific gravity 1.614, or 1960 tons per foot acre.

TABLE D.

Estimate of Total Original Contents Southern Coal Field.

1. Area No.	2. Between cross-sections.	3. Probable average thickness of coal at cross-sections.	4. Probable average thickness of coal for areas.	5. SURFACE AREA ACRES. Buck Mountain bed.	5. SURFACE AREA ACRES. Lowest workable bed.	6. Probable original contents in tons.
		Feet.	Feet.			
38 . . .	(M. S. I.)	. . . .	. . . . .	. . . . .	781.0	89,830,647
39 . . .	(M. S. II.)	. . . .	. . . . .	. . . . .	3,322.0	353,503,493
40 . . .	(M. S. III.)	. . .	. . . . .	. . . . .	3,926.0	589,662,991*
41 . . .	12 / 13	73.39 / 47.23	60.31	1,773.1	2,115.4	209,593,895
42 . . .	13 / 14	47.23 / 40.43	43.83	1,637.5	2,099.1	140,672,385
43 . . .	14 / 15	40.43 / 48.45	44.44	5,317.3	7,570.7	463,146,591
44 . . .	15 / 16	48.45 / 54.41	51.43	4,864.7	8,755.1	490,375,381
45 . . .	16 / 17	54.41 / 59.01	56.71	6,285.1	8,597.7	698,598,921
46 . . .	17 / 18	59.01 / 65.29	62.15	4,025.7	5,688.7	490,386,619
47 . . .	18 / 19	65.29 / 65.88	65.59	6,901.9	10,467.6	887,283,417
48 . . .	19 / 20	65.88 / 57.54	61.71	5,287.1	6,993.3	639,483,204
49 . . .	20 / 21	46.58 / 47.58	47.08	. . . . .	10,802.7	996,838,587†
50 . . .	21 / 22	47.58 / 48.34	47.96	. . . . .	7,396.9	695,320,435
51 . . .	22 / 23	48.34 / 63.55	55.95	. . . . .	4,420.8	449,670,956
52 . . .	23 / 24	63.55 / 40.90	52.23	. . . . .	6,173.0	586,151,906
53 . . .	24 / 25	40.90 / 40.50	40.70	. . . . .	2,536.0	187,645,234
54 . . .	25 / 26	40.50 / 29.18	34.84	. . . . .	2,996.2	189,776,671
55 . . .	26 / 27	29.18 / 29.59	29.39	. . . . .	3,542.8	189,295,418
56 . . .	27 / 28	29.59 / 21.68	25.64	. . . . .	3,546.4	165,310,187
57 . .	28	. . . . .	. . . . .	. . . . .	1,144.5	32,660,056
58 . . .	24 / 29	40.90 / 35.16	38.03	. . . . .	4,614.3	319,025,965
59 . . .	29	. . .	. . . .	. . . . .	8,170.1	334,199,304‡
Totals,	. . . .	. . . . . .	. . . . .	. . . .	115,946.2	9,198,435,263

* "Specific gravity 1.6307, or 1977 tons per foot acre."

† Specific gravity 1.614, or 1960 tons per foot acre.

‡ Specific gravity 1.500, or 1818 tons per foot acre.

RECAPITULATION.

Estimated total original contents and area of Pennsylvania anthracite coal-fields.

Totals by Fields.

	Area lowest workable coal-bed, square miles.	Probable original contents in tons.
Northern, ...	176.29, say 176	5,697,380,784, say 5,700,000,000
Eastern Middle, .	32.72, " 33	602,491,447, " 600,000,000
Western Middle, .	94.04, " 94	4,009,564,831, " 4,000,000,000
Southern, ...	181.16, " 181	9,198,435,263, " 9,200,000,000
Totals, ...	484.21, say 484	19,507,872,325, say 19,500,000,000

The trade has made the following divisions of the anthracite fields, viz:

1. Wyoming region, ... Northern field and Bernice basin.
2. Lehigh region, ... Eastern Middle field and Southern field east of Tamaqua.
3. Schuylkill region, ... Western Middle field and Southern field west of Tamaqua.

Totals by Regions.

	Area lowest workable coal-bed, square miles.	Probable original contents in tons.
Wyoming, ...	176.29, say 176	5,697,380,384, say 5,700,000,000
Lehigh, ...	45.25, " 45	1,635,488,578, " 1,600,000,000
Schuylkill, ...	262.67, " 263	12,175,002,963, " 12,200,000,000
Totals, ...	484.21, say 484	19,507,872,325, say 19,500,000,000

THE FUTURE SUPPLY.

It is estimated that the production, including coal sold and consumed at the collieries, has exceeded the shipments by about 10 per cent.

The tables compiled by Mr. P. W. Sheafer for the years 1820 to 1868, and since 1868 by Mr. John H. Jones, show the shipments to January 1st, 1893, to have been:

Total Shipments and Production to 1893.

	Shipments. Tons.	Production, adding 10 per cent., say. Tons.
Wyoming region,	382,990,423	421,000,000
Lehigh region,	147,652,656	162,500,000
Schuylkill region,	289,719,916	318,500,000
Total,	820,362,995	902,000,000

Basing our estimate on, that for every ton produced 1½ additional tons are lost, the following table would show the probable amount of coal still contained in the ground:

Coal Consumed and Coal Remaining, 1893.

Region.	Estimated original contents. Tons.	Amount used up 2½ times production. Tons.	Estimated contents remaining. Tons.
Wyoming,	5,700,000,000	1,052,500,000	4,647,500,000
Lehigh,	1,600,000,000	406,250,000	1,193,750,000
Schuylkill,	12,200,000,000	796,250,000	11,403,750,000
Total,	19,500,000,000	2,255,000,000	17,245,000,000

The above table shows 17,245,000,000 tons of marketable coal still in the ground; what per cent. of this will be won the future alone can determine.

It is to be doubted whether the total coal won when the field shall be abandoned will exceed 40 per cent. of the total contents. An estimate on that basis would show the available marketable coal still in the ground to be as follows:

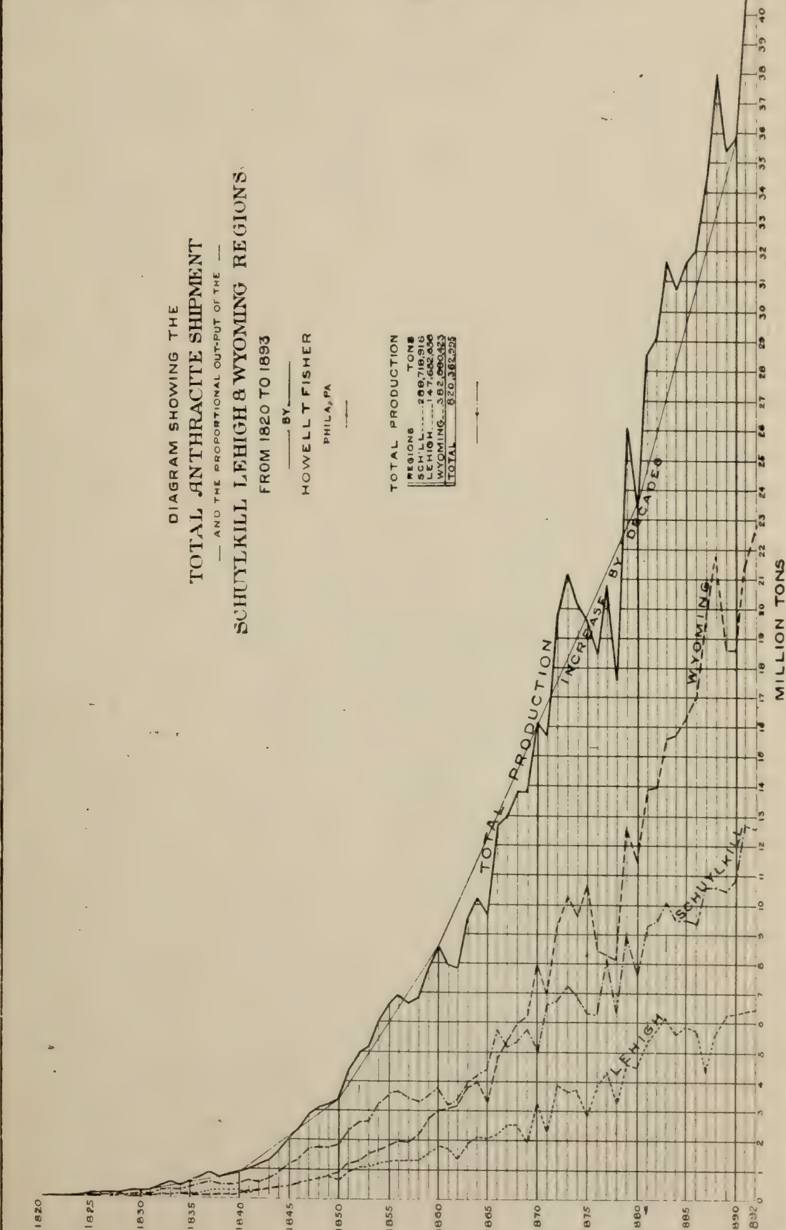
Coal Available in the Ground, 1893.

Wyoming region,	1,859,000,000 tons.
Lehigh region,	477,500,000 tons.
Schuylkill region,	4,561,500,000 tons.
In all,	6,898,000,000 tons.

PL. 395.

Anthracite Shipments from 1820 to 1893.

Diagram Table made by H. T. Fisher.



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