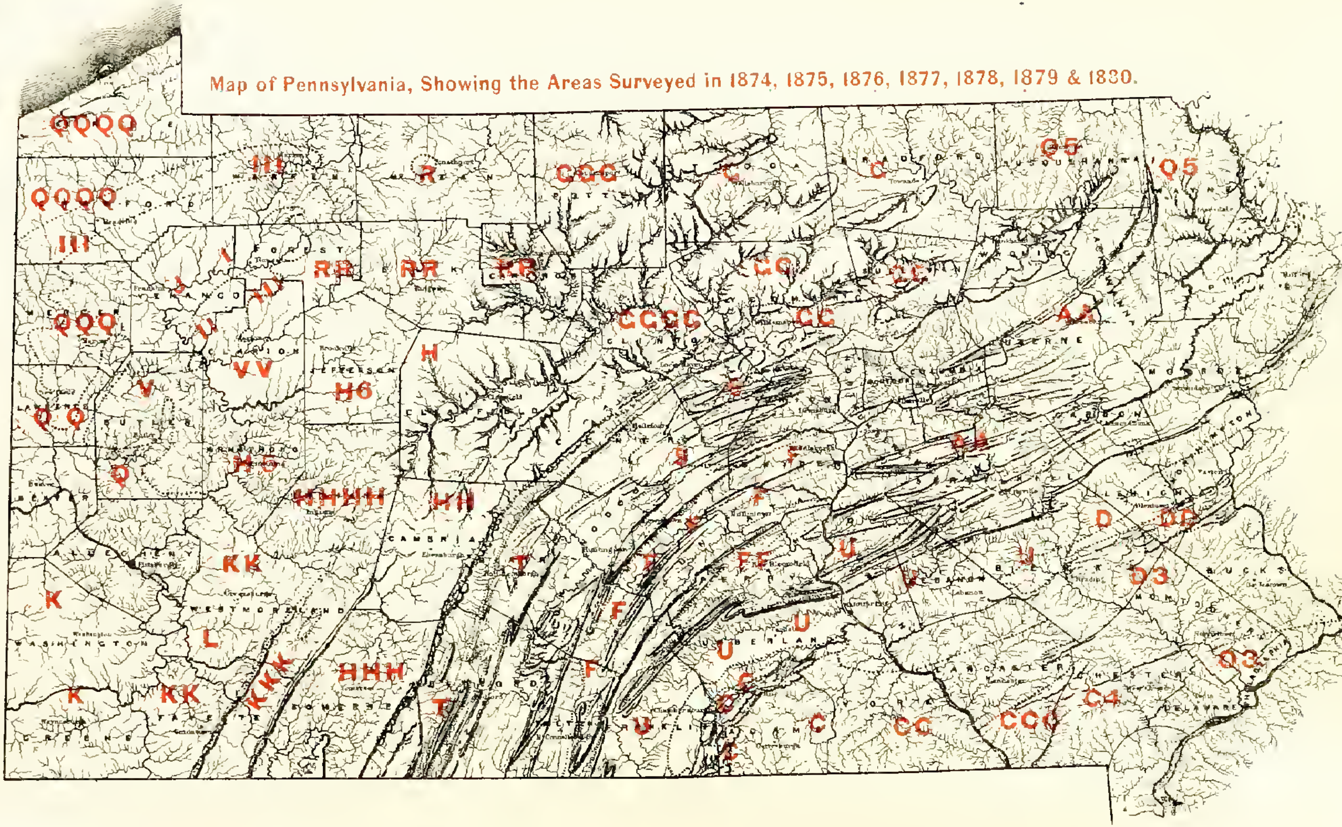

Map of Pennsylvania, Showing the Areas Surveyed in 1874, 1875, 1876, 1877, 1878, 1879 & 1880.

SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA:

REPORT OF PROGRESS

T.

THE GEOLOGY OF

BLAIR COUNTY,

BY

FRANKLIN PLATT.

WITH 35 PAGE ILLUSTRATIONS AND

AN ATLAS

OF 14 SHEETS OF THE COLORED MAP OF MORRISON'S COVE, &C.; 1 INDEX SHEET; AND 2 SHEETS OF COLORED SECTIONS.

HARRISBURG:
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LETTER.

615 WALNUT STREET,
PHILADELPHIA, *May 1, 1880.*

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

DEAR SIR: In accordance with instructions received from you the survey of Blair county was commenced in 1875.

Mr. R. H. Sanders spent the years 1875, 1876, and a part of 1877 in making a complete topographical and geological map of the greater part of Blair and some of Bedford county. This task he accomplished skilfully and quickly. The handsome Morrison's Cove sheets, in the Atlas accompanying this report, are the results of his labor during the years named.

In 1877 I examined the county with a view of writing and printing a report thereupon at an early date. Being detailed from time to time for work in other districts which required immediate attention, Mr. W. G. Platt (who had examined the Blair county coal measures for report HH) was requested to facilitate the preparation of the report by writing the chapters on the Blair county coal measures and also on the Zinc and Lead ores of the Sinking Valley. And these two chapters are presented as prepared by him.

In making the examination of the county I received much aid from the citizens and from the corporations engaged in the iron and coal industries.

I remain,

Your obedient servant,

FRANKLIN PLATT.

TABLE OF CONTENTS.

BLAIR COUNTY.

CHAPTER I.

Geography.

§ 1. Blair county lies next south of Centre county, and therefore nearly in the middle of the State; next north of Bedford, which extends to the Maryland State line; next east of Cambria, which lies on the Allegheny mountain plateau; and next west of Huntingdon, through which flow the two main branches of the Juniata river.

The shape of the county is so irregular, that the reader must be referred for its boundaries to the accompanying map.

Its *west* boundary was run from summit to summit along the top of the Allegheny mountain.

Its *north* boundary is a straight east and west line from the top of the Allegheny mountain diagonally across the Bald Eagle valley to the top of the Bald Eagle mountain.

Its *eastern* boundary follows this mountain southwest to the Little Juniata at Tyrone city, and down the river to opposite the end of the Canoe mountain, along the crest of which it runs nearly half way to Williamsburg; then cuts straight across Canoe valley, past Yellow springs, to the top of Tussey mountain; thence along the same nearly to Henrietta furnace.

Its *southern* line crosses Morrison's cove from the top of Tussey to the top of Dunning's mountain near Bloomfield ore banks; then follows Dunning mountain crest southwest 3½ miles; and finally makes a nearly straight W. N. W. course to the top of the Allegheny mountain.

§ 2. *The townships of Blair* county lie in the following shape and order with reference to each other:

Snyder.

Antis. Tyrone Morris.

Logan. Catharine.

Allegheny. Frankstown. Woodberry.

Blair.

Juniata.

Freedom. Huston.

Taylor.

Greenfield. North Woodberry.

§ 3. *Area and population.*—Blair county is estimated to cover 594 square miles of surface, and its population in 1870 was 38,051, and in 1880 was 52,751.

Although about one half of the county has a rugged, mountainous surface unsusceptible of cultivation, the rest is good valley land; and so great is the variety and scope of its geology that both its agricultural and mineral products are unusually varied and valuable, and its wealth and prosperity exceptionally great. The coal and coke works at Bennington and other places on the Allegheny mountain; the blast furnaces at Bennington, Altoona, Hollidaysburg, McKee's Gap, Rebecca, Springfield and Frankstown; the various forges and rolling-mills and the great railroad shops at Altoona; the brown hematite iron ore mines of Bloomfield, Springfield, and numerous other places (the two first named second in size and value to none other in the State); and the fossil ore of the Clinton formation mined at Frankstown, Hollidaysburg and McKee's gap, are all important industries. Moreover, the valleys show numerous rich farms in Morrison's cove and Canoe valley.

The detailed report which constitutes the greater part of this volume will show where these various industries are located, and point out, it is to be hoped with sufficient clearness, the cause of such location in the geology and topography of the places; and will indicate moreover the grounds upon which some of these industries may reasonably look forward to a healthy growth fully as great as that which they have experienced in the past. Wherever disaster has followed upon premature enterprise, based upon imperfect preliminary examination, the explanation of the failure will be given, and the hopefulness or hopelessness of further attempts briefly indicated.

§ 4. *The maps of Blair county* which accompany this volume are worthy of special mention and examination.

The *county map*, colored to show the geology, is similar in construction to the maps of other counties already published by this Survey. The geology was laid on the county map, and can therefore possess no greater accuracy than the county map itself. A comparison of the map with the Morrison's Cove contoured map shows that the original work in making the county map is more accurate than is usually found on such maps or atlases.

The colored contoured Morrison's cove map is the one to which special attention is called. It is in 14 large sheets, with an index sheet additional; is on a scale of 1600′ to 1 inch, and with contours showing every 20 feet of elevation; and is carefully colored for every geological formation from the Siluro-Cambrian rocks of II up to the Coal measures of XIII. It is a sample of what should ultimately be done in every county in the State. The beauty and completeness of the map are apparent even to a careless observer; but they will be far more strikingly apparent to the student who will follow the careful description of the topography and geology given in this Report and personally examine the beautiful relationships as given by the map. The topography of the map is the work of Mr. R. H. Sanders, and was done skillfully, quickly and accurately. Much of the geology was done by Mr. Sanders, and much also by him in conjunction with the writer.

§ 5. *Levels above tide.*—That large part of the county covered by the sheets of the Morrison Cove Map, extending to and into Cambria county, on top of the Allegheny mountain, was leveled by transit, vertical circle and barometer in several thousand places, as the contour curves show. The barometric levels were all referred to levels above tide fixed at the various railway stations in the county, given in the following tables copied from Report of Progress N:

Pennsylvania railroad.

Stations.	*Distance from Philada*	*Above tide.*
Gallitzin,	249	2161
Tunnel, B. M. at east end,	—	2126
Bennington Furnace,	—	2038
Alligrippus,	—	1920
Murdocks,	—	1626
Kittanning,	242	1594
Altoona, B. M. at ticket office,	237	1178
Blair Furnace,	234	1114
Elizabeth Furnace,	232.5	1079
Bells Mills RR. junction,	230	1060
Fostoria,	228.5	1029
Tipton,	226	990
Tyrone RR. junction,	223	907
Tyrone water station,	222	896
Birmingham,	220	866
Union Furnace,	216	799
Spruce creek,	215	777
Tunnel; west end,	?	761
Barre Forge,	212	724

Bell's Gap railroad.

Fallen timber,	15½	1422
Van Ormer's, Clearfield cr. water,	—	1482
Cree's summit,	—	1857
Vanscoyoc,	—	1995
Figart's,	—	2108
Summit Allegheny mountain, B. M.,	—	2301
Lloyd's station (coal bed,)	8½	2180
Lloyd's RR. junction (to Fallen Timber,)	8	2167
Point Lookout,	6	1915
Collier,	4	1642
Roots',	—	1222
Bell's mills RR. junction with Pennsylvania RR.,	0	1060

Hollidaysburg branch; (continued as Williamsburg branch.)

RR. Stations.	*Miles.*	*Feet above tide.*
Altoona,	0	1178
Allegheny,	1.6	1152
Eldorado,	3.5	1093
Canaan,	4	1066
Duncansville,	7	990
Hollidaysburg,	8	953
Old Terminus,	8+3400′	944
Brush Run, (old canal line,)	—	933
Frankstown, "	—	918
Reese Station, "	—	903
Clapper's Run, "	—	901
Koofer's Run, "	—	893
Juniata River, "	—	893
Pike Ponds, "	—	885
Flowing Spring, "	—	881
Springfield RR. junction, (old canal line,)	—	876
Williamsburg, "	—	847

Morrison's Cove branch.

Stations.	*Miles.*	*Above tide.*
Hollidaysburg,	0	942
Drawbridge,	—	942
Juniata river,	—	937
Reservoir,	3	967
Catfish,	—	968
Riddle's lane,	—	933
Brook's mill,	—	1006
McKee's gap through Dunning Mtn.,	7	1036
Martha furnace,	—	1054
Hammond's,	—	1133
Roaring spring RR. junction,	9	1196
Erb's summit in Morrison's cove,	11	1354
Martinsburg RR. junction,	14	1344
Martinsburg,	—	1366
Henrietta RR. junction,	—	1391
Mathew's summit,	17	1471
Nicodemus's summit,	—	1432
Clover creek,	—	1392
Henrietta ore bank,	20	1409
Terminus in Leathercracker cove,	—	1422

Springfield branch, Canoe valley.

Williamsburg RR. tunnel,	876
Trestle No. 1,	968
Goods,	1006
Davis summit,	1376
Eighth mile post,	1374

Chapter II.

Geological Formations.

§ 6. Blair county, like Bedford, Centre, Clinton, and Lycoming, along the same belt, extending from the top of the Allegheny mountain down to and across the ridges and valleys which front that escarpment, is crossed by outcrops of all the Palæozoic formations from the Productive Coal measures (No. XIII) down to the Lower Silurian, or Siluro-Cambrian limestones (No. II), and even to the top layers of the Potsdam sandstone (No. I), which are recognized by Mr. C. E. Hall, on the crown of the sharp (overturned) anticlinal axis of Sinking Spring valley, which crosses the Little Juniata river east of Tyrone forges. The order of these formations is succinctly as follows:

Carboniferous.	Lower Productive Coal Measures,	XIII.
	Pottsville conglomerate,	XII.
	Mauch Chunk red shale,	XI.
	Pocono gray sandstone,	X.
Devonian.	Catskill red sandstone,	IX.
	Chemung olive shales,	VIII.
	Portage gray grits,	
	Genesee dark slates,	
	Hamilton sandstones,	
	Marcellus dark slates,	
	Upper Helderberg limestones, &c.,	
	Oriskany sandstone,	VII.
Silurian.	Lewistown (Lower Helderberg) limestone,	VI.
	Waterlime, Salina, and Niagara marls,	V.
	Clinton red shales and fossil ore,	
	Medina upper white and lower red sandstones,	IV.
	Oneida white sandstone,	
Siluro-Cambrian.	Hudson river shales,	III.
	Utica black slates,	
	Trenton limestone,	II.
	Calciferous (Magnesian) limestone,	
	Potsdam sandstone,	I.

It is not known what formations of an older date underlie these well-known fossiliferous Palæozoic rocks in any part of middle Pennsylvania, nor how thick, nor of what composition the representative Potsdam No. I may be. Perhaps it consists here as in Virginia and Tennessee, of thousands of feet of shales, sandstones, and conglomerates.

It is a remarkable fact, that even the most important arches into which the whole mass has been raised in our middle counties, although they bring to the present surface (at from 900 to 1300 above tide) the top layers of the Potsdam, yet do not bring up the whole formation, to say nothing of the more ancient Cambrian, Huronian or Laurentian systems, on the eroded surface of which it must certainly rest. The region nearest to Blair county, where these older systems come to daylight and form mountain ranges, is on the borders of Franklin and Adams county, nearly a hundred miles distant towards the east-southeast; and in other directions their nearest appearance at the surface is in northern New York, Canada, around Lake Superior, in Arkansas, and the Rocky Mountains. Nothing can reveal their presence and character under Blair county but future deep borings along the center lines of Canoe and Sinking Creek valleys; and these *might* have to be carried down several thousand feet before striking the metamorphic schists, gneisses, and granites, with crystalline limestones and beds of magnetic iron ore, which our knowledge of the general geology of the United States would prepare us to expect.

The *Palæozoic formations*, however, from XIII down to I, are all finely exposed to view, especially the Juniata and Little Juniata rivers, and in the numerous ravines which descend from the summit to the base of the Allegheny mountain back of Hollidaysburg, Altoona, and Tyrone city.

Along these ravines and river-ways all the formations have been examined and measured in the course of this survey, and the result is now presented in the tabular section, (Chapter 2) prepared by Mr. Sanders, on the basis of his instrumental work, embodied in another form on the map sheets in the Atlas accompanying this volume.

The upper part of the section (from XIII to VIII) was measured along the line of the Pennsylvania railroad from the tunnel near Gallitzin to Altoona. Formations VII and VI were obtained from numerous exposures along the northwest face of the Bald Eagle mountain, and especially around Hollidaysburg. Formations V, IV, III are well exposed with steep dips in the gaps at Tyrone city, and Williamsburg; in McKee's gap in Dunning's mountain; and in Spruce creek gap through Tussey mountain. The 6000 feet of limestones of II were measured along the two rivers, especially along the Little Juniata.

Notwithstanding the numerous good exposures of these upturned strata, and notwithstanding the great advantages derived from an extensive and long continued instrumental survey of the whole region crossed by this generalized section, it is not perfect. There are blank spaces in it which it would cost much more to fill up with the desired details. Much and very expensive quarrying and digging would be needed before every layer and group of layers in the entire column of more than 23,000 feet could be exposed equally well to examination. The softer formations do not stand out in cliffs like the harder ones; and although numerous rock cuts along the railways afford the fairest opportunity for measuring the limestone strata, there are quite as many and longer intervals of embankment where no outcrops are exposed. The shales of the Devonian system are especially hard to see, covered as they are by a slid surface of fragments, soil and vegetation.*

The section must be accepted, then, only as a fair approximation to the truth, and as a useful guide to local geologists, and searchers for mineral beds, to whom must be entrusted the future task of completing its details where they are wanting, and of filling the numerous gaps in its succession.

§ 7. With regard to the *thicknesses* assigned in the section two remarks are needful :—

---

* The record of the artesian boring made under the direction of Mr. T. N. Ely, superintendent of works at Altoona, subsequent to the date of our survey, given in chapter 3, will show how much more complete an artificial exploration of a formation may be than most natural exposures permit.

a. While the slopes of the rocks are usually very decided, generally steep and often vertical (although the dips in ascending the Allegheny mountain fall off to almost nothing) they are not regular and persistent for any great distance. Consequently, measurements which depend, not upon the addition of the thickness of one exposed layer to that of the layers above and below it, but to mathematical calculations based on *dip and distance*, are never exact; since the slightest increase or diminution in the dip will make a difference in the thickness. And this error, whether plus or minus, must increase with the total thickness of the formation measured. Changes of dip, faults, crushes, &c. *in concealed intervals* are especially dangerous to the measurer; and, as there are numerous concealed intervals along the line of this section, it is not impossible that the thickness assigned to such of the formations as are several thousands of feet thick may be wrong by some hundreds of feet, in spite of all the care taken to get them right.

b. As to the several formations, each considered as a unit, another difficulty in estimating their thicknesses arises from the fact that some of them *graduate into each other*, so that it is impossible for a geologist to decide with certainty where to draw the line between them. And this is true even when the strata are well exposed; more true of course, when they are partially concealed. There are *transition beds* between X and IX; between IX and VIII; especially between the sub-divisions of VIII, between Chemung and Portage, Portage and Hamilton, &c. In the absence of breaks in the succession, and of well defined fossiliferous, calcareous, or highly ferriferous beds, the limits assigned to clay shale, shaley sand, and sand deposits must be empirical. The constitution of such rocks is too indefinite, and the color too variable, and the alternations too frequent to furnish fixed and certain horizons.

c. The same formations have been measured in the same careful manner, on the basis of similar instrumental surveys, by Messrs. Billin and Ashburner in Huntingdon county, from the coal measures of South Broad Top mountain across Sideling hill, Aughwick valley and Blacklog mountain; and the section thus constructed has been published in Report of Progress F, Chap. 2, page 184.

But the Huntingdon section is only 18,397± feet long; because, while it commences in the Coal Masures at the Mahoning Sandstone, like the Blair county section, it ends downwards just below the top of the Magnesian limestones of No. II.*

The Blair and Huntingdon sections being fifty miles apart (east and west across the outcrops) differences in the composition, subdivision and thickness of the several formations were to be expected; and being made by different geologists the same empirical limits to some of the formations were not adopted. Nevertheless a comparison between them is very satisfactory, and their combination furnishes the first pretty complete instrumentally-measured section of the Palæozoic system in America.†

§ 8. Vertical section of the measures in Blair County from the Mahoning Sandstone (XIII) down to nearly the base of the Magnesian limestones II.

XIII. Coal measures (HH. pp. 3, 4.)

MAHONING SANDSTONE.		
Coal bed,		2′ 8″
Shales, drab,		20′
Shales, olive,		5′
Slates, massive,		10′
Slates and shales, olive,		20′
Coal bed E,		5′ 6″
Fire clay, impure,		2′
Sandstone and black slate,		20′
Limestone,		3′
Slates and shales, ferruginous,		20′
Sandstone and sandy shales,		20′
Coal bed D,		3′
Fire clay,		1′
Sandstone, drab,		21′
Black slate,	20′	22′ 10″
Coal bed C′,	2′ 10″	
Slates, drab, holding *iron ore balls,*		11′
Sandstone,		0′ 7″

* Colored illustrative sections accompany it.

† For an analytical comparison of the two sections with the deductions to be made for it see the Preface, and also in Chapter 3.

Slates, blue,		13′
Sandstone massive, drab,		15′
Slates,		12′ 6″
Coal, Slate, Coal, } *Coal bed C*,	{ *Coal*, 6″ Slate, 6″ *Coal*, 1′ 8″ }	2′ 8″
Fire clay,		6′
Sandstone,		12′
Slate,		1′ 3″
Coal,		0′ 4″
Sandstone,		7′
Coal bed B, { Black slates, with calamites,	8′ 10″ }	12′ 4″
Coal,	3′ 6″ }	
Fire clay,		3′
Shales,		29′
Coal bed A′, { Black slate,	2′ }	3′ 8″
Coal,	1′ 8″ }	
Slates,		23′
Sandstone, gray,		4′
Coal bed A,		4′
Fire clay,		9′
		345′ 4″

XII. Pottsville Conglomerate.

Sandstone, coarse grained iron stained,	14′
Coal,	0′ 1″
Fire clay,	9′
Sandstone, slaty,	4′
Sandstone, fine grained grayish white,	15′
Sandstone, massive white,	81′
Concealed interval,	100′
	223′ 1″

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 S. S.,	52′
Slate, gray,	10′
Slate, red,	5′
Slate, gray,	5′
Sandstone, gray,	10′
Shale, red,	10′
	283′

X. Pocono sandstone.

Shale, gray,	2′
Sandstone, gray,	150′
Sandstone, gray,	50′
Shale, red,	3′
Sandstone, massive gray,	292′
Sandstone, gray,	42′
Slates, dark gray,	20′
Sandstone, massive gray,	133′
Slates, olive gray,	15′
Shale, red,	20′
Sandstone, gray,	60′
Slate, gray,	40′
Sandstone, gray,	30′
Slate, greenish gray,	5′
Sandstone, gray,	2′
Slate, gray,	10′
Sandstone, massive gray,	15′
Shale, brown,	5′
Shale and slate, red,	20′
Sandstone, brown,	15′
Slate, gray,	5′
Shale and slate, red,	20′
Sandstone, massive, gray,	20′
Shale, red,	10′
Shale, red,	19′
Sandstone, gray,	11′
Sandstone, gray, slaty,	10′
Sandstone, brown, slaty,	17′
Shale, red,	10′
Sandstone, gray, micaceous,	1′
Iron ore, { *Iron ore*, greenish gray, conchoidal,	1′ 0″
Sandstone, gray, micaceous,	0′ 1½″
Iron ore, like the above,	1′ 9″
Sandstone, massive, gray, some false-bedded,	26′
Slate, red,	5′
Iron ore, like the above,	1 6′
Sandstone, gray, micaceous, thin-bedded,	14′
Sandstone, ferruginous,	1′
Sandstone, gray,	38′
Slate, gray,	7′
Slate, red,	3′
Sandstone, brown,	1′
Slate, red,	2′
Slate, gray,	15′
Sandstone, gray,	16′
Shale, red,	5′
Slate, red,	7′
Sandstone, gray,	45′
	1241′ 4″

IX. Catskill Red Sandstone.

Shale, red,	9′
Shale, gray,	3′
Shale, red,	15′
Sandstone, brown,	12′
Shale, red,	25′
Sandstone, gray,	20′
Shale, red,	25′
Concealed interval, }	196′
Sandstone, red, thickness unknown, }	
Concealed interval,	167′
Shale, brown,	30′
Sandstone, brown,	50′
Red shale and }	35′
Olive shale, 3 small layers, }	
Sandstone, brownish-gray,	30′
Sandstone, gray, slaty,	10′
Sandstone, reddish-brown,	30′
Shale, red,	3′
Sandstone, yellowish-gray,	20′+
Concealed interval, containing }	264′
Reddish sandstone and slate, }	
Shale, gray,	6′
Sandstone and red shale,	50′
Sandstone, gray, slaty,	10′
Shale, red, and sandstone,	265′
Sandstone, red,	20′
Shale, red,	10′
Sandstone, red,	15′
Shale, red, and sandstone,	15′
Sandstone, red,	15′
Shale, red,	80′
Concealed interval,	305′
Shale, gray,	15′
Sandstone, red, with some gray shale,	14′
Shale, red,	10′
Shale, red and gray,	10′
Shale, gray,	2′
Sandstone, red,	4′
Slate, red, with some gray sandstone,	15′
Shale, gray,	20′
Shale, red,	70′
Sandstone, gray,	5′
Shale, red,	40′
Sandstone, reddish-brown,	15′
Shale, red, with layers of gray sandstone,	60′
Sandstone, gray, with red shale and some small layers of gray shale,	25′
Sandstone, gray, and slate,	40′
Concealed interval,	480′
	2560′

VIII. Chemung, &c.

Slate, red, with gray sandstone, mostly sandstone,	20′
Slates, gray,*	40′
Sandstone, gray,	20′
Slate, gray,	3′
Sandstone, gray,	20′
Slate, gray,	40′
Sandstone, gray, and pink slate,	90′
Sandstone, gray, and slate,	40′
Concealed interval,	410′
Slate, gray,	192′
Sandstone, gray,	8′
Slate, light gray,	10′
Sandstone, gray,	1′
Slates, dark gray,	8′
Sandstone, gray,	10′
Slates, dark gray, and concealed,	86′
Slates, dark gray,	15′
Sandstone, gray,	1′
Slates, gray,	50′
Sandstone, gray,	2′
Slate, gray,	4′
Sandstone, gray,	10′
Slate, gray,	0′ 2″
Sandstone, gray,	1′
Slate, gray,	70′
Concealed interval,	300′
Slate, gray,	20′
Sandstone, slaty,	260′
Shale, gray,	20′
Sandstone, gray, and slates, thin bedded,	30′
Concealed interval,	505′
Sandstone, gray, thin bedded, with layers of slate,	50′
Slate, gray, with thin layers of gray sandstone,	460′
Slates, gray,	50′
Concealed interval,	50′
Slates, gray, with a few layers of gray sandstone,	35′
Slates, gray, cleavage planes, iron stained,	50′
Concealed, mostly gray slates,	780′
Slates, olive and gray, with 10 feet of red slates,	185′
Slates, red,	5′
Slate, gray, and gray sandstone,	418′
Sandstone, slaty, and gray slate,	75′
Sandstone, gray,	10′
Slates, gray, some of the slate has ripple marks,	100′
Sandstone, gray, slaty, thin bedded,	600′
Slates, gray and black,†	1365′
	6519′ 2″

* Here occurs a downthrow to the west of 8

† The black slates are at the bottom of the interval, representing the Marcellus

VII. *Oriskany Sandstone.*

Sandstone, coarse grained, with some conglomerate. Thickness could not be measured at any one place in the county; probably about,	50′

VI. *Lower Helderberg, &c.*

Lewistown limestone, not all exposed; mostly a dark blue massive limestone; thickness measured at the "Chimney rocks" near Hollidaysburg,	900′

V. *Clinton Red Shale, &c.*

Limestone, gray, slaty,	120′
Concealed interval,	30′
Slate, gray, with some *limestone*,	60′
Slate, dark gray,	5′
Limestone, slaty,	14′
Limestone,	1′
Slate, gray,	3′
Shale, red,	26′
Slate, gray,	1′
Limestone,	0′ 10″
Slate, gray,	5′
Shale, green,	0′ 6″
Shale, red,	1′
Shale, gray,	1′
Shale, red,	14′
Slate, gray,	5′
Limestone, impure,	1′
Slate, dark brown,	5′
Slate, olive gray,	2′
Slate, red,	7′
Slate, gray, with small layers of *limestone*,	45′
Limestone, fossiliferous dark blue,	1′ 9″
Slate, gray,	1′ 6″
Limestone,	0′ 6″
Slate, gray,	4′
Limestone,	0′ 2″
Slate, olive,	30′
Limestone,	3′
Slate, gray,	3′
Limestone,	2′
Slate, gray,	6′
Shale, red,	2′
Shale, olive,	3′
Shale, red,	6
Shale, green,	2′
Shale, red,	3′
Shale, olive,	2′
Shale, red,	6′
Shale, gray,	5′

Slate, gray, and concealed,	30′
Concealed interval, } Fossil ore beds, }	50′
Slate, gray,	20′
Concealed interval,	30′
Slate, brown,	30′
Concealed interval,	640′.
	1328′ 3″

IV. Medina and Oneida.

Sandstone, white Medina,	100′±
Sandstone, red, with layers of red slate from 6″ to 5′ thick,	255′
Concealed interval,	540′
Sandstone, massive red,	84′
Sandstone, green, slaty,	1′ 8″
Sandstone, red, with a few layers of red shale,	87′
Slate, green,	0′ 6″
Sandstone, red,	10′
Shale, red,	5′
Slate, green,	5′
Sandstone, red,	5′
Sandstone, gray,	20′
Shale, red,	1′
Sandstone, gray,	10′
Shale, red,	0′ 6″
Sandstone, red,	10′
Sandstone, grayish red,	15′
Slate, red,	1′
Slate, green,	1′ 6″
Sandstone, gray,	15′
Slate, gray,	1′
Sandstone, brown,	20′
Slate, gray,	1′
Sandstone, brown,	8′
Shale, red,	0′ 6″
Sandstone, reddish brown,	75′
Slate, red,	1′
Sandstone, red and gray,	200′
Sandstone, red,	9′
Shale, red,	4′
Sandstone, red,	2′
Slate, red,	3′
Slate, green,	1′
Slate, red,	4′
Slate, green,	2′
Sandstone, red,	6′
Sandstone, red, some little of it gray,	15′
Sandstone, red,	10′
Slate, gray,	2′
Sandstone, red,	18′
Slate, gray,	0′ 5″

Sandstone, grayish brown,	12′	
Shale, red,	0′	3″
Sandstone, brown,	20′	
Shale, green,	0′	2″
Sandstone, brown,	4′	
Shale, red,	1′	
Sandstone, brown and gray, and concealed,	150′	
Sandstone, gray, and concealed,	409′	
Sandstone, gray,	320′	
Sandstone, gray, and slaty sandstone,	440	
	2906′	6″

III. Hudson River Slates

Slates gray and black, not well exposed in any place in the county,	900′

II. Trenton, Calciferous, &c.

Limestone, dark blue, blue, and gray, also dolomite,	5400′
Sandstone, white, some of it iron stained,	40′±
Limestone, and towards the bottom come in slates and sandstones (*Potsdam?*) which are the lowest rocks in Blair county,	1160′
	6600′
Total,	23316′

CHAPTER III.

Description of the Palæozoic formations.

Coal Measures.

§ 9. The *Coal measures* of Blair county are described in a subsequent chapter; nothing need be said of them here, except that they cap the Allegheny mountain and are mined in the upper reaches of the ravines by which the Old Portage and the new Pennsylvania railroads ascend to their respective summit levels. The lower beds can be entered in all the ravines which descend from the Cambria county highland, along the whole west boundary line of Blair county.

Pottsville Conglomerate.

§ 10. The *Pottsville conglomerate* (XII) is described in detail in the same chapter. It is usually spoken of as forming the crest of the Allegheny mountain along its whole extent. But this is not strictly true, for the knobs into which the crest is subdivided by numerous "gaps" or short ravines, are dome-shaped hills of coal measures, on the outer face of which appear the conglomerate rocks of XII, about 200 feet thick; from the steep outcrops of which innumerable fragments have slid down and roughen the upper front slopes of the mountain, and the much steeper sides of the ravines.

Mauch Chunk red shale.

§ 11. The *Mauch Chunk red shale* (XI,) nearly 300 feet thick, crops out along the higher part of the face of the mountain, and in the steep sides of all the ravines; but these are in great part concealed by a sheet of fragments from the overlying Conglomerate layers. In front of each crest–knob of coal measures, between two ravines, is a gently sloping platform or terrace, leading out to a lower knob composed of *Pocono* (X) upper rocks. The red shale spreads over each of these projecting platforms.

It will be seen by the detailed section in Chapter 2, that the layers of XI are not by any means all *red.* Only 144 feet of the mass of 283 are marked "*red shale*;" 68 feet are marked "gray" and "greenish gray" slate; and 66 feet are sandstone layers, fine grained, gray, and white. At the top are 110 feet of *red shale* in a body; and near the bottom are 52 feet of coarse whitish sandrock also in a body.

There are no useful minerals visible in this formation, as so defined. But it is not known what lies upon the 110 feet of red shales in the 100 foot interval over, up to the 80 foot massive lowermost sandstone of XII. The interval may in fact conceal still higher red shales; or it may conceal black shales and fireclays and perhaps thin coal beds and some iron ore, as in the northern counties. Perhaps the concealed 100 feet ought to be added to XI, increasing the stated thickness from 283′ to 383′; or to XII, increasing it from 200′ to 300′.

The only opportunity for learning the composition of the *Conglomerate* and *Sub-conglomerate* (*Mauch Chunk*) strata in this region was afforded by an artesian boring commenced on the highest ground about Ebensburg in Cambria county.*

The Ebensburg well-record.

Soil, &c.,		10′
Sandrock,	15′	70′
White sand,	15′	
Sandrock, blue,	20′	
Sandrock, coarse, gray,	20′	

* The well was bored in 1874 to supply the town with water. Its record was obtained from the office in Ebensburg by Mr. A. J. Rhey, and transmitted to the office of the Geological Survey, August 18, 1880. It is not included in the Report of Progress HH.

Lower Barren.	Slate,	38′	65′	85′
	Shale,	27′		
	Coal,		2′	
	Black slate,		18′	
Mahoning sandstone.	Sandrock,		24′	80′
	"White slate,"		56′	
Freeport Upper ?	Black slate,		21′	38′
	oal, (E?)		4′	
	Fire clay,		5′	
	Limestone,		8′	
Sandrock,				22′
Coal,			4′	170′
Shale,			26′	
Slate,			140′	
	Flint rock,			25′
Shale,			58′	348′
Fireclay,			10′	
Shale,			115′	
Slate,			45′	
Shale,			120′	
	Sandrock,		27′	86′
	Flint rock,		33′	
	Sandrock,		26′	
Slate rock,			46′	66′
Red slate,			5′	
Slate,			15′	

But this section, even if the record be exact, is of little assistance in deciding questions concerning the limits of the formations, because: 1. None of the coal beds are identified with certainty; 2. Coal was not noticed over the 10′ fireclay; and other thin coals may have been passed through unnoticed; 3. The drillers' terms: slate, shale, slate rock, sandrock, white slate, &c., are indefinite; 4. The record of 8′ of *limestone* is so unusual in this region as to give rise to various questions; and 5. especially because the exact horizon of the mouth of the well is not determined.*

All that this well record shows is a succession of sandstone and shale groups starting in the *Barren-measures*, going down through the *Mahoning Sandstone* and *Lower Productive coal measures*, and passing completely through the *Conglomerate* No. XII, into the *Mauch Chunk* red shale formation No. XI, thus:—

* Probably about 200′ above Freeport Upper Coal, E.

Sandstone,	70′
Shale and *Coal*,	85′
Sandstone,	80′
Shale and *Coal* and *limestone*,	38′
Sandstone,	22′
Shale and *Coal*,	170′
Sandstone,	25′
Shale and *Coal ?*	348
Sandstone,	86′
Shale, partly red,	66′

The record of 5′ of *red shale* at the bottom is of less consequence, in view of the fact that beds of red shale occur frequently, and at various horizons, through the Coal Measures, the Conglomerate series and the Sub-conglomerate measures, for three or four thousand feet; but it is significant that in a well 1000′ deep no *red shale* is reported except near the bottom, not far beneath 86′ of "rocks," sandy and flinty, which must necessarily represent a portion of the *Pottsville Conglomerate* No. XII, probably the lower massive division, which, on Broadtop in Huntingdon county, is 80′ (see Report F, p. 192).

Mr. Saunders has limited No. XI in his section to 283′; but this is discussed in the Preface.

Pocono sandstone.

§ 12. The *Pocono sandstone*, No. X, forms the high platform (in front of the crest of the Allegheny mountain) which is cut by a multitude of ravines into a range of high *spur-knobs*, boldly marked upon the map, and a fine feature of the landscape as seen from the east.

The top layers crown these knobs at 2400′ or 2500′ A. T., and descend to 1800° A. T. in the ravines.

The bottom layers run along the faces of the spurs at 2000′ A. T., and disappear in the beds of the ravines at 1300′ to 1500′ A. T.

The dip which carries them all down towards the west, into the mountain, varies from 30° outside to 10° in the ravines.

In Mr. Sanders' section the thickness of the formation is limited to 1274′.*

* The propriety of this limitation is discussed in the Preface.

The shape of the spurs is determined by the different kinds of layers composing the upper, middle, and lower parts of the formation.

Two grand divisions, an upper and a lower, can be noticed at a glance.

The *upper division of X* consists of about 800′ of nearly continuous strata of more or less massive gray sandstone. The solid uniformity of this huge sand deposit seems only broken by a 3′ bed of *red shale* (200′ from the top), and by a 20′ bed of dark-gray slates (540′ from the top). All the rest seems to consist of sand-rock layers of gray color, and *characteristically current-bedded.* It is to this great homogenous sand deposit that the Allegheny mountain owes its height and length across the State. The sandy and pebbly layers of the Pottsville conglomerate and supporting Coal measures merely furnish the mountain with its crest-knobs; while the terrace knobs or spurs are all made by this 800 feet of *Pocono Upper* massive, gray sandstone.

The *lower division* (about 500′ thick) is, on the contrary, a series of thin layers of alternate gray and olive-gray sandstone (with red and gray shales and slates) so sub-divided up as to offer comparatively little resistance to atmospheric erosion. The amount of *soft red shale* in this mass of 500′ is very considerable (say 120′); to which must be added a large aggregate amount of gray slates, brown sandstones, and isolated thin micaceous gray layers (say 160′); leaving only about 200′ of massive gray sandstones, and these widely separated,—a 60′ mass near the top; a 30′ mass lower down; a 20′ mass about the middle; and three others 26′, 38′, and 45′, near the bottom.*

The consequence of this distinction of upper gray and lower red Pocono, is plainly shown by the topography and on the map. The *upper-terrace* knobs, steep near the top, slope gently forward at the bottom and project as lower-terrace spurs, the outer ends of which form the *lower-terrace* knobs (composed of the underlying Catskill formation

* Mr. Chance is obliged to make a similar distinction and use similar names in describing the Pocono formation in Clinton county. See his report G^4, 1889.

No. IX) which are so remarkable a feature of the landscape when seen from below.

Of course the side ravines, half way back into the mountain land, are walled by cliffs of the Upper Pocono Sandstone series.

§ 13. *Iron ore.*—Three *thin calcareous ferruginous beds* occur in the middle of the lower red division; the upper bed 1′ thick; the middle bed 1′ 9″ thick; and the lower bed 1′ 6″ thick. Between the upper and middle ore beds lies a gray micaceous sandrock 1′ 6″ thick; the middle and lower ore beds are separated by 5′ of red shale.*

A specimen was analyzed by Mr. McCreath, and the rock evidently did not deserve the name of iron ore, for it contains only 7.75 per cent. of *iron;* a considerable quantity of *carbonate of lime;* and 25.00 of insoluble residue.

§ 14. *Coal* beds belonging to the *Pocono* formation have been opened at various times during the last 40 years, in the ravines descending from the mountain. Their place in the formation has not been determined with absolute exactness; but they probably represent Mr. Ashburner's *Pocono coal group* in Sideling Hill, Huntingdon county,† the top bed of which lies there 610′ below the bottom of the *Mauch Chunk red shale* No. XI.

Kramer & Hart's mine.—A workable bed of coal has been opened about five miles north from Tipton Station, and on the road across the mountain, near the boundary line between Antis and Snyder townships; 500 feet (by barometer) above Tipton Station, and, therefore, 1480 feet above the ocean; the crest of the Allegheny mountain is 790 feet above the coal opening or 2273 feet above ocean level.

The red rocks of the Catskill (?) formation are showing in place about 180 feet (by barometer) below the coal; from that point up to the coal are yellowish thin bedded sandstones. If this be taken as the junction point of IX and X, and allowing for the north dip of the measures, the coal is in the Pocono formation, 200 feet above the top of the red rocks.‡

* This exposure occurs on the Pennsylvania railroad track.

† See Report F, p. 209.

‡ See Preface.

The coal opening is known as Kramer & Hart's Laurel Run coal bank. The measures here are dipping north 8°, the coal dipping the same. The coal bed is thirty inches thick, with six inches of bone coal, the entire three feet being mined.

The roof consists of 10 feet of black and gray slates, very loose, rendering extensive timbering necessary in the mine.

The floor is six to twelve inches of fireclay, which probably rests on sandstone, though the latter was not seen.

Five hundred feet south of the coal mine there is a coal outcrop at the water's edge, fully 15 feet below the level of the mine. There formerly was a mine on this second outcrop; but the common report is that the miners struck a wall of rock. There may be a small downthrow in the measures on the mountain face at this point, but it is more probably an irregularity in the coal deposit, and the two outcrops may really belong to one coal bed.

Such irregularities are constantly found in the small and treacherous coals of the Pocono formation. At the Kramer & Hart mine, the opening is about 8 feet above the run; but on tracing the bed along the outcrop the coal shows only a few inches in thickness when it reaches the run level, and this small coal streak is underlaid and overlaid by slates of the same kind as are seen in the roof of the mine. The distance is short, the outcrop visible the entire distance, and yet the coal bed has been almost entirely replaced by slates.

The *character* of the coal is bituminous. A specimen of it from the Kramer & Hart mine was analysed by Mr. McCreath, who reports the results thus:

Bituminous coal, with a bright shining luster, somewhat coated with silt, and containing considerable iron pyrites.

Water at 225°,	.700
Volatile matter,	26.790
Fixed carbon,	66.878
Sulphur,	.802
Ash,	4.830
	100.000
Coke per cent.,	72.510

The coal forms a coherent coke with a silvery luster, and yields a gray ash with a red tinge.

The fuel ratio is—volatile hydrocarbon to fixed carbon as 1 : 2.496.

Pocono (*Vespertine*) *coal* has not been opened at any other place along the mountain face in Blair county. As no coal bed of *workable* size has ever been seen in this formation in any part of Pennsylvania, although (as at Duncannon, on the Susquehanna river) thin coal beds do exist in it, it is not to be expected that the ravines of the Allegheny mountain will ever be valuable in this respect.

Catskill sandstone.

§ 15. The *Catskill red sandstone formation* (*No. IX*) is limited in the section to a thickness of 2560′. Of the measures occupying this interval only 1148′ are visible along the Pennsylvania railroad ; and 1412′ concealed.

Of the 1148′ exposed—*red shales* aggregate 450′ ; red shales and sandstones intermixed, 250′; brownish sandstones and hard shales, 250′; and gray massive sandrock deposits (5′ to 20′ thick) less than 200′.

There are four principal concealed intervals, viz : (196+167=) 363′, near the top ; 264′, above the middle ; 305′, below the middle ; and 480′, at the bottom of the formation. These may be safely counted upon as concealing soft rocks ; more or less red. Alternations of hard and soft layers of moderate thickness pervade the whole formation. Taking all these facts together into consideration it is easy to explain *the long slope of the lower terrace spurs* extending down to the foot-hills in front of the mountain.

No useful minerals are known in these rocks in Blair county.* But the following references to the outcrops in Huntingdon county may assist in a further search.

* In the Huntingdon county section there is an iron ore bed (only from 4″ to 12′ thick) in the transition series of 90′, between the *Catskill* and *Chemung*, and only 13′ above the assigned upper lithological limit of the *Chemung*.

Its horizon is marked by numbers of *Spirifer disjuncta* and a species of *Rhynchonella*.

Coal in the *Catskill No. IX.*—Near the bottom of the formation—that is, in 350′ of "red shale and sandstone, alternating with massive gray shale and gray sandstone" the bottom of which is 60′ above the *assumed* top of No. VIII (*Chemung transition bed,*)—small deposits of *drift coal* occur 1½ miles from Mapleton in Union township, Huntingdon county.*

Iron ore in the *Catskill, No. IX.*—An impure bed of very sandy brown hematite, of variable thickness, lies 400′ beneath the *assumed* top of the formation, and runs along Smith's valley in Huntingdon county.†

Fish beds.—The *Catskill formation, No. IX,* is characterized in the north by layers filled with *fish spines, bones &c.*, but none have been reported in it from the Blair county exposures. A diligent search for them would probably be successful.

Chemung shales.

§ 16. *The Chemung, Portage, Hamilton,* and *Upper Helderburg* groups constitute *formation No. VIII* of the first survey with a total measured thickness of 6520′.

This immense pile of deposits thins away southward through Virginia into an insignificant deposit of (Hamilton) black shale at the Tennessee line, certainly not more than 500′ thick.‡

Westward it thins to about 1000′ in Ohio; and

Northward also it thins to 5764′ in Clinton county and to about 2000′ in New York State.

Eastward it thickens to 7474′ in Perry county, on the lower Juniata. In Schuylkill county, it seems to be more than 8000′ thick.

The Chemung olive shales constitute more than one half of formation No. VIII.

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* Ashburner, Report F, p. 217.

† Idem.

‡ See notes on the geology of Wise, Lee and Scott counties, by J. J. Stevenson, Proc. Amer. Philosophical Society, Philadelphia, September, 1880, and January, 1881. Geology of Tennessee, Safford, 1869, page 331.

In Perry county 4384′ out of the whole 7474′ may be called *Chemung* rocks, and the lower measures beneath them are as follows:

Chemung, olive shales on the Juniata river,			4384′
Newport (*Portage?*) sandy shales and sandstones,			835′
Genesee shale, . . . in the interval of			1120′
Hamilton	sandstones and shales, with ore beds,	610′	1015′
	olive shales,	405′	
Marcellus shale, with its ore bed,			90′
Upper Helderburg	limestone 25′ to 45′, say,	35′	65′
	shale,	30′	

In the Huntingdon county section, however, Mr. Ashburner assigns 90′ to transition layers and 1860′ to the *Chemung shales* proper; 1450′ to the *Portage flags;* 325′ to the *Genesee slates*; 635′ to the *Hamilton* flaggy sandstone and shale group proper; 875′ to the *Marcellus* black slate group; and 80′ to the *Upper Helderburg* group;—Total, 3455′.

Whatever the amount of acknowledged variability, these remarkable deposits can hardly have suffered such *natural* changes in the mere 50 miles between Orbisonia and Millerstown. The difference must be due partly to measurement, and partly to the absence of fixed partition planes. In fact there are no well defined lines of demarkation anywhere in this column of deposits.

The top of the Chemung in our Blair county section is arbitrarily fixed at the lowest visible band of *red shale;* under which lie 250′ of gray slates and slaty sandstones of a well pronounced *Chemung* type. Beneath these are 410′ concealed rocks (no doubt shaley like the others*); and beneath these again lie 192′ more of Chemung shales. Then three 10′ layers of gray sandstone slightly diversify another 260′ of chimney shales; probably continued down through the next interval of 300′ concealed (=1412′).

This mass of gray shales lies on 330′ of visible rocks, mostly slaty sandstone, continued as shales down through a hidden interval of 505′ (=2247′).

The next 50′ is of thin-bedded gray sandstones, lying on 695′ of gray slate, with a few sand layers. These lie on 780′

*There is no question about the rock in these concealed intervals, for they are only concealed along the line of measurement. The topography along the belt shows plainly enough what kind of rock the intervals contain.

of partially concealed strata, mostly of the same gray slate character; under which are plainly seen 185′ of olive and gray slates, ending with 5′ of red slate;—Total, 4007′.

This *Chemung* division of No. VIII, therefore, corresponds in thickness pretty well with the 4384′ of Chemung in Perry county.

The Chemung shales are called by Prof. Rogers *Vergent shales.* The rock is described as grayish, olive-colored, and bluish shales, enclosing gray sandstone layers; and several hundred feet of alternate gray and red sandstones are made to constitute the top of the formation.

Pterinea (*Avicula*) *chemungensis*, *Mytilarca* (*Inoceramus*) *damnoniensis*, &c., are its characteristic fossils.

Its thickness on the Old Portage railroad on the level between Planes No. 9 and No. 10, is not less than 2200′. On the Potomac it is said to measure 2100′.*

§ 17. *Chemung iron ore.*—A bed of brown, sandy, granular iron ore runs through the upper part of the formation, among the alternations of red and gray layers.†

Portage flags.

§ 18. The *Portage group*, in Blair county, forms the lowest terrace at the foot of the Allegheny mountains.

In the section they may be represented by the 418′ of gray slates and sandstones, 75′ slaty sandstones, 10′ gray sandstone, 100′ of gray slates (ripple-marked), and 600′ of gray sandstones of our section;—Total, 1103′.

They correspond to the 1450′ of *Portage flags* in the Huntingdon county section; and to the 835′ of *Newport sands* in the Perry county section.

These are the rocks which make the long line of rounded foot hills in front of the Allegheny mountain; and on the last slope of one of these Altoona is built. They are curi-

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* Geol. of Penn., Vol. I, p. 541.

† Mr. Ashburner describes this "*Larry's creek ore*" as 13′ from the bottom of the *Catskill-Chemung* beds. It is in Clear ridge merely a ferruginous sandstone, analysing 16.00 sesquioxide of iron. Report F, page 235.

ously sculptured by short and gentle ravines, which descend across the basset-edge of the rocks ; the dip being westward into or under the mountain, at angles varying from 20° to 30°. Many of the layers are olive-colored ; and some of them weather to a bright yellow, green, and red. They contain no minerals of any value ; but they abound (locally) in fossil shells.

These rocks, capped by Chemung shales, constitute also the hilly country in the center of the Frankstown cove or Scotch valley, through which the Juniata river flows on its way to the Williamsburg gap in Canoe mountain.

Prof. Rogers called the *Portage group*, *Vergent flags*, and says that where they are finely exposed near Frankstown, they measure a little more than 1200′ ; on the Potomac river, below Cumberland, 1600′ ; and on the Susquehanna river, at Muncy, about 1200.′ He describes them rightly as a series of fine-grained, dark-gray sandstone layers, moderately thin, alternating from top to bottom with thin beds of blue clay-shale. If there be any want of uniformity it consists in a greater preponderance of the sandflags in the middle of the formation.

A few large *fucoids* may be found, and a small species of *Nucula* occasionally occurs.*

§ 19. There runs along the foot hills of the mountain, west of Altoona, a sharp little ridge, made by a massive sandstone, conglomeritic, 20′ thick, dipping 80° towards the N. 70° W. It is reënforced by 40′ of *overlying* fine-grained, but massive, iron-stained and fossiliferous sandstone beds.

Considering the mark which this 60′ of hard rock strata makes upon the surface of the country, it is not surprising that it was mistaken formerly for the *Oriskany sandstone* No. VII. Its place in the series will be seen by reference to the section.

Genesee slates.

§ 20. *The Hamilton formation* is divided in New York

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* Geol. of Penn., 1858, Vol. I, p. 540.

into three groups: Upper (*Genesee*), Middle (*Hamilton*), and Lower (*Marcellus*).

The upper and lower are black or blackish slate deposits.

The middle consists of gray shales and fine and coarse sandstones. In the region of the lower Juniata this middle mass is very thick and forms high and rocky ridges.

In Blair county the whole of the *Hamilton* formation is composed of soft dark slate, with calcareous layers, which become limestone beds in Maryland.

This is the formation out of which the Tuckahoe or Altoona valley (the valley of the Upper Little Juniata and Bald Eagle creek) has been excavated and which the line of the Pennsylvania railroad pursues from Tyrone City to Altoona. Its outcrops also encircle the central hills of Scotch valley or the Frankstown cove.

The slates are so black that attempts have repeatedly been made to find coal beds in them. Near Tipton, for instance, some one has sunk a shaft for coal. Of course all such attempts are fruitless.

§ 21. Professor Rogers divided the *Hamilton formation* as a whole into three parts, upper, middle and lower, naming them as follows:

§ 22. *Genesee* (*Cadent*) *Upper black slates*, a bluish-black fissile slate, sometimes minutely micaceous.

Characteristic fossil, a minute, arrow shaped, leaf like organism.

Thickness 250′ to 300′ at Muncy, in Lycoming county; at Frankstown, Blair county, somewhat thicker; near Cumberland on the Potomac, 700′.*

The *Genesee* formation is not black in this part of Pennsylvania, but olive colored and brownish-gray, sometimes dark olive. Its upper portion is partly flaggy; its lower portion entirely shaly. The color of the lowest layers is deeper (dark olive, and occasionally bright brown,) slightly bituminous and stained with iron. This is its character in Huntingdon county.†

§ 23. *Hamilton* (*Cadent*) *Olive shale* (*Hamilton proper*)

*Rogers' Geol. Penn., 1858, Vol. I, pp. 138, 139 and 540.

† Ashburner, Report F, p. 227.

Hamilton flags.

—a group confined to middle and eastern Pennsylvania (and New York) and wedging out before reaching Maryland.

At Muncy, it is a mass of hard, blue, calcareous, sandy shales; with *Microdon bellistriata*, *Delthyris mucronata*, *Fucoides velum*, &c.

At Lock Haven, it is *more calcareous*, and *less sandy;* but still a dark bluish-gray sandy shale in its upper parts, passing down into impure *calcareous shales* and *impure limestones*, with small balls of *pyrites.*

Thickness, in Blair county, between Frankstown and the foot of Lock mountain, about 400′.

On the Old Portage railroad the rocks above and below it are well exhibited; but none of its fossils are visible. No trace of this middle member could be found on the Potomac; and it must be very thin south of Hollidaysburg.*

The *Hamilton group*, in Huntingdon county is subdivided thus:—

Upper part, gray flags and shales.

Towards the middle, sandstones prevail (either massive, or flaggy, or slaty) to the exclusion of shales; and here we find numerous fossil shells: *Aviculopecten princeps*, *Chonetes mucronatus*, *C. coronata*, *Grammysia*, *Spirifer granulifera*, *S. mucronatus* and *Tentaculites*, with *Spirophyton caudagalli* and other seaweeds.

Lower part, sandstones more flaggy and shaly; the flags being sometimes quite *calcareous*, and iron-stained; shale alternations increase downwards, and predominate at the bottom.

Ripple marks are abundant.†

Marcellus slate.

§ 24. *Marcellus* (*Cadent Lower*) *black slate* is a thinly

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* Rogers Geol. Pa., l. c.

† Ashburner, Report F, pp. 227, 228.

laminated fissile *black slate;* with *Orthis limitaris;* and cakes of blue *limestone.*

Regular beds of limestone appear in it at Selinsgrove (Union county,) and in Franklin and Bedford counties, and in Maryland.

Thickness at Muncy 600′; at Frankstown 350′; on the Potomac, 400′.*

Mr. Rogers, therefore, assigns a total thickness of 300′+400′+350′=1050′ to the *whole Hamilton formation,* at Frankstown, in Blair county.

Mr. Ashburner's measurements in Huntingdon county make it 325′+635′+875′=1835′.†

The *Marcellus black slate* Mr. Ashburner divides into Upper, Middle, and Lower, thus: 571′+20′+284′=875′.

The Middle member of the *Marcellus* (20′ thick) near Orbisonia, in Huntingdon county, may be a very local deposit. It consists of gray, shaly *clay-limestone* layers, alternating with greenish-gray *lime-shales.*

Mr. Sanders' section-record in Blair county for the *whole Hamilton,* is as follows:—"Gray and black slates; the black slates the lowest; thickness not known; 1365′.

The lower part of this mass must include Mr. Ashburner's 60′ of *Upper Helderberg* strata, which (if no change took place in the 40 miles of interval) would leave 1300′ for the *whole Hamilton;* or for the *Hamilton proper* and *Marcellus* and more or less of the *Genesee* (if present).

§ 26. *Iron ore.*—At the very bottom of the *Marcellus black slate* division, in Huntingdon county (and eastward) occurs a 4′ brown hematite ore bed; and the whole mass of slates is more or less stained with iron; so that *local* ore beds may be expected anywhere.

Such a deposit has been mined just west of McKee's gap, in Blair county; near the railroad station, in 1852–3–4, for Martha furnace; but the old openings are now fallen shut. Mr. J. K. McLanahan reports that the ore was locked in between black slates, and contained so much carbon as to lose greatly in roasting; pig-iron fairly good, but rather red-short.

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*Rogers Geol. Pa., l. c.

† Report F, pp. 221, 222, 223.

Two pieces picked from the place by Mr. McLanahan were sent to the Harrisburg laboratory, and Mr. McCreath reported their composition as follows:

No. 1. "Black band," from adit at point of hill near RR. station, under 30′ of cover; dark-brownish-black; brittle; much carbonaceous matter.

No. 2. "Ore from same locality, near the surface, among black slates; cellular; brittle; dark-brown; considerable carbonaceous matter, but less than in No. 1.

	1.	*2.*
Iron,	38.300	40.500
Manganese,	1.395	
Sulphur,	.682	.024
Phosphorus,	.054	.094
Insoluble residue,	16.330	24.060

§ 27. *Bog ore.*—One and a half miles west of Canoe Creek P. O., on the place of S. King, there is a considerable deposit of bog iron ore.

Upper Helderberg.

§ 28. *The Upper Helderberg formation* of New York State is not recognized by Prof. Rogers as existing anywhere in Pennsylvania except on the Delaware river.

On the Juniata river, however, there are deposits which probably deserve that name: dark-blue and gray argillaceous *limestones*, alternating with green, olive and gray *calcareous shales.*

In New York it is subdivided into *Corniferous limestone*, *Schoharie grit*, and *Cauda-galli grit.* These middle and lower grits may be represented by sandy shales lying on our *Oriskany sandstone No. VII*, or may be represented by the upper layers of No. VII. But there seems to be no good reason for not recognizing the *Corniferous limestone* in the group of *limestone* and *lime-shale layers* under the *Marcellus black slate*, which group is in the Huntingdon county section, 60′ thick.* Some of these limestone beds are quarried, but make lean lime; and there are local layers of a poor clay-ore.

* Ashburner's section, Report F, p. 224.

In Blair county the formation is scarcely if at all distinguishable from the overlying *Marcellus.*

Oriskany Sandstone.

§ 29. *The Oriskany Sandstone No. VII* is small in Blair county, varying from 20′ to 50′, and making an insignificant ridge along the foot of the Bald Eagle and Dunning's mountain. The formation is very variable throughout Pennsylvania; sometimes thickening up to 150′, as at Newton Hamilton on the Juniata, (and even to 350′ on the Potomac river in Maryland;) at other places disappearing entirely, as in Clinton county.*

At Orbisonia in Huntingdon county it is more than 150′ thick. And at Three Springs, a few miles distant, only 58′; the upper 12′ coarse, ferruginous, calcareous sandstone; the middle 15′ a friable pea conglomerate; the lower 31′, coarse, friable, irregularly fragile sandstone, coated with iron ore, and full of the following fossil shells:—

Cyrtoceras expansus, *Dalmania micrurus*, *Eatonia peculiaris*, *Megambonia lamellosa*, *Orthis hipparionix*, *Platyceras ventricosa*, *Pterinea texilis*, *Rensselaeria marylandica*, *R. ovalis*, *R. ovoides*, *Spirifer arenosus* and *S. arrectus*. None of these shells are found in the overlying formations. No land plants have been seen.

Iron ore and glass sand are mined along the outcrop in many places in the State. In fact it is the chief source of glass sand in Pennsylvania.†

In Blair county the *Oriskany iron ore* shows only at one place, on the wagon road 1½ miles east of Frankstown. The outcrop ore is red, compact, and looks like a bed 2′ or 3′ thick, lying directly upon the Sandstone.

In Blair county the *Oriskany sandstone* is highly fossiliferous; and in many places flinty; but usually friable, easily decomposing into loose sharp sand at the surface.

At Kimberlin's, 1½ miles north of Cause creek, there is a

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* See other measurements in Geol. Penn., Vol. I, p. 137.

† Ashburner, Report F, p. 239.

quarry affording an excellent, firm, *building stone*, exhibiting 30′ of layers.

There is an exposure, in a cut on the Pennsylvania railroad line, 1 mile southwest of Tyrone, at bridge No. 12.

On the poor-house farm, 1 mile northwest of Hollidaysburg, a fine deposit of *glass sand* overlies the limestone No. VI. The sand is clean and sharp, and used for foundry purposes.

At Baker's limestone quarry (or rather 200 yards north of it) near Allegheny furnace, the *Oriskany* hard massive sandrock layers appear, aggregating 50′. *Under* them are seen 20′ of dark, thin, calcareous slates.

Near Baker's ore mine, 4 miles northeast of Altoona, the Oriskany rocks show, but their thickness cannot be measured.

South of Frankstown they are exposed in several places.

At Tyrone they crop out along the crest of the ridge west of the town.

At Altoona a well has been sunk for water, for the railroad shops, to a depth of 2006′.

The dip adopted by the engineers for their section drawing is about 41° (westward);* but Mr. Sanders took two dips near the place and recorded them as 50° and 52°. The following is the record of the well furnished by Mr. Theo. N. Ely, Sup't Mot. Power, at Altoona. *A* being the *vertical* depths in the well; *B* and *C* the same reduced to *transverse* measurement, supposing the dip to be 41° or 52°:

			A.	*B.*	*C.*
VIII.	Slate,	to 400′	400′	300′	250′
VII.	Sandstone,	to 430′	30′	22′	20′
VI.	Limestone,	to 743′	313′	234′	192′
VI.	Slate,	to 1116′	373′	279′	231′
VI.	Limestone,	to 2006′	890′	670′	557′
			2006′	1505′	1250′

It is very evident that the *Oriskany Sandstone*, at Altoona, is only 20′ thick, and that no slates underlie it, unless they be mistaken for limestone in the drillings.

At Lewistown, in Mifflin county, on the contrary, the

* MS. copy made by J. B. Collin, Mech. Eng., Altoona, Feb. 26, 1880.

Oriskany Sandstone is exposed 110′ thick, and under it lie 205′ of *Oriskany* shales=315′.*

At Mount Union, 26 miles further southwest, the sandstone is 95′ thick and the shales 282′=377′.†

At Orbisonia, 11 miles still further south, the sandstone has dwindled to 58′, and the shales have either disappeared or become so calcareous as to be included in the limestone mass below.‡

It is no wonder then that at Altoona, 40 miles west of Orbisonia, the sandstone is only 20′ thick, and the shales absent, and that through Centre and Lycoming and Union counties the *Oriskany* can scarcely be found.

Lower Helderberg.

§ 30. The *Lower Helderberg* (*Lewistown*) *limestone formation, No. VI*, includes the *Water-lime*, or *cement beds* at its base.

In New York State it lies upon the *Salina* or *Onondaga Salt beds;* and these lie upon the *Niagara limestone* and *shale beds;* and these on the *Clinton red shales.*

In Pennsylvania the salt beds are absent, and the *Niagara* and *Clinton* formations are mixed together; so that the broad outcrop of solid Lower Helderberg limestone beds (represented on the map by the belt of Antwerp blue color) forms a bold feature in the geology of every county in Middle Pennsylvania, and in none more so than in Blair county.

In the Altoona well record § (above mentioned) we see:—

		A.	*B.*	*C.*
Lower Helderburg.	*Limestone*, . .	313′	234′	192′
	Slate, . . .	373′	279′	231′
	Limestone, . . .	890′	670′	557′
		1576′	1183′	980′

But it must be understood that the boring was stopped *in* limestone, and the formation may therefore be any amount thicker.

* Dewees' Report F, p. 49. † Idem, p. 103. ‡ Idem, p. 239.

§ A strong odor "something like that of petroleum" at about 1600′ vertically down the well; or 300′ (at 52°) *geologically* beneath the top layer of the lower limestone mass.

Mr. Sander's measurements of exposed sections in other parts of Blair county read as follows :—*

VI.	*Limestone*, mostly dark-blue, massive, not all exposed,	900′
	Limestone, gray, slaty,	120′
	Concealed,	30′
	Slate, gray, with some *limestone* beds,	60′
	Slate, dark gray,	5′
	Limestone, slaty,	14′
	Limestone,	1′
		1130′

Mr. Ashburner's instrumental measurements in Huntingdon county extend along the column of these Upper Silurian rocks about the same distance, and subdivide the whole limestone group of No. VI into three; thus :—†

VI.	*Lewistown limestone, (Lower Helderburg,)*	162′
	Water-lime (cement) beds,	580′
	Salina (Onondaga Salt) group,	440′
		1182′

Mr. Dewees' instrumental measurements of the outcrops at Lewistown (Logan Gap) and Mt. Union (26 miles apart) in Mifflin county, are as follows :—‡

		Logan gap.	*Mt. Union.*
VI.	*Lewistown lime shales,*	140′	18′
	Lewistown limestone,	185′	35′
	Water-lime,	470′	544′
	Salina shales,	350′	473′
		1145′	1070′

Mr. Chance's measurements at Lock Haven, in Clinton county, are as follows : §

VI.	*Limestone*, massive, impure; shaly at top,	80′
	Lime shale and impure *limestone*,	83′
	Slates, soft, bluish-black; upper part *calcareous*,	177′
	Limestone, shaly and massive,	30′
	(*Limestone?*) concealed by the Susquehanna,	+500′
	Limestone, massive, quarried,	25′
		+895′

Prof. H. D. Rodgers assigns them thicknesses (not instrumentally measured) in various places, from which the ex-

* See p. above.

† Report R, p. 241, in great detail.

‡ Report R, p. 103, summary.

§ Report F, p. 269; Report G4, 1881.

posures at the Capon axis on the Potomac in Maryland are here selected for comparison with the above :*

VI.	*Premeridian limestone,*		24′
	Scalent limestone,	about	350′
	Scalent gray marls,	about	350′
	Scalent variegated marls,	about	300′
		about	1024′

His estimates at Mifflintown in Juniata county, are as follows :

VI.	*Premeridian limestone,*		140′
	Scalent limestone,	perhaps more than	30′
	Scalent gray marls,	about	600′
	Scalent variegated marls,	exceeds	400′
			1170′

And again "near the Tuscarora mountain," further down the Juniata river :

VI.	*Premeridian limestone,*		100′
	Scalent limestone,		200′
	Scalent gray marls,	about	600′
	Scalent variegated marls,	about	100′
	About,		1000′

Mr. Dewees measures these strata south of the Tuscarora mountain, near Millerstown, thus :†

VI.	*Limestone shale,*	40′ to	50′
	Lewistown limestone (partly concealed),	30′ to	40′
	Water-lime (concealed),		180′
	Maximum,		270′
V.	Variegated shales,‡		1180′

Between Muncy, in Lycoming county, and Milton, the Susquehanna West Branch exposes the formation thus :—

VI.	*Premeridian limestone,*	150′
	Scalent limestone,	100′
	Scalent gray marls,	1200′
	Scalent variegated marls,	20′
		1470′

On the other hand, the *Scalent* part of the formation thins

* Geol. of Pa., 1858, pp. 135, 136.

† Report FFF, on Perry county.

‡ It is evident that Mr. Rogers has included some of these in No. VI.

away to nothing southeastward; and it can scarcely be recognized anywhere along the Blue mountain at the Susquehanna, Swatara, Schuylkill, Lehigh, and Delaware water gaps. And the *Lewistown* (*Premeridian*) limestone is absent at the Susquehanna water gap, but comes gradually in (eastward) through Dauphin and Schuylkill counties, until it is 105′ thick at the Delaware water gap, in Monroe county.

It is evident that in Blair county Formation No. VI is nearly at its maximum; and it is a pity that no well-borings can ever be made deep enough to reach this interesting formation in any part of western Pennsylvania or eastern Ohio, to tell us of its condition beneath the bituminous coal fields.*

§ 31. *Outcrop.*—The dips being steep along the valleys at the foot of the Allegheny mountain, the belt of the outcrop of No. VI is not more than half a mile wide, and often much less.

This outcrop runs along the ridge back of Tyrone city, and, crossing the Pennsylvania railroad between Tipton and Astoria, keeps in the bottom of the valley, east of the railroad, past Altoona, under Allegheny furnace, and down the creek to Duncansville, south of which it spreads out into a long triangle. It then curves to the northeast along the top of the little ridge between Hollidaysburg and the reservoir, and so, close to Frankstown, up into the Scotch Valley Cove to the Beaver Dams. Here it returns south along the foot of Canoe mountain to Flowing Spring, where it crosses the Juniata and continues along the foot of Lock mountain to Old Town run, in the Cove. Here it broadens out again and runs north to Frankstown, curves to the west and south around the foot of the mountain, passes under the lower end of the reservoir, and thence for 20 miles follows the foot of Dunning's mountain into Bedford county.

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* When it comes up to the surface in middle Ohio, it is so thin that there seems to be a doubt whether it can be properly recognized in the top layers of the "Cliff Limestone" in Montgomery, Highland, Adams, and other counties (called *Niagara* and *Clinton*). *The Lower Helderberg limestone* is recognized in the northern part of Highland county, Ohio, near Greenfield, but is there only 100′ thick; further south it often disappears entirely. But the limestones assigned to the *Niagara*, beneath it, are 275′; and those still lower, assigned to the *Clinton*, are 50′.—(See Geol. Ohio, 1870, p. 256 and 307.)

For an account of its economical importance the reader is referred to a future chapter; but this is the place for a short list of the fossil shells which characterize it in other parts of the valley of the Juniata.*

§ 32. *The fossils of the Lewistown limestone* are *Acervularia, Alveolites minima, Astylospongia inornata, Merista levis, Orthis oblata, Pentamerus galeatus, Rhynchonella formosa, Atrypa reticularis, Aulopora, Conophyllum, Merista arcuata, Stromatopora, Trematospira formosa, Zaphrentis*, abundant in the lower 50 feet in Huntingdon county.

The rock is often rough and often cherty, always full of fossils, especially crinoids, and was in fact a wide spread coral reef growing in a comparatively shallow sea, one shore of which seems to have been in southeastern Pennsylvania, and the other in southern Ohio.

§ 33. The *water lime* layers 150 feet lower show coaly coatings, and impressions of *sea weeds* and *bivalve shells.*

These are Mr. Rogers' *scalent limestones*, and have for their characteristic fossil the *Cytherina alta* (now called *Leperditia alta.*)

The presence of this little *crustacean*, and the absence of the *corals* so abundant in the more massive beds above, distinguish these lower rocks.

They are also *magnesian*, and make a *cement* or *hydraulic lime*, and become more than 200′ thick in Blair and Bedford counties, although only 40′ or 50′ thick in Lycoming county.

§ 34. The (*Scalent*) gray marls, with thin black clay limestone layers, and fissile slate, contain also some massive *magnesian limestone* beds (cement beds†). Almost the only fossils are the same *Leperditia alta*, and the *Beyrichia seminalis*, another minute crustacean.

§ 35. The (*Scalent*) variegated marls, still lower in the series, are also somewhat fossiliferous.

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* *Celestine* is found in it at Blair furnace.

† These are the rocks quarried for hydraulic lime at Cumberland in Maryland.

Clinton.

§ 36. *The Clinton Formation, No. V* occupies the west slope of Bald Eagle and Dunning mountains, and the whole circle of mountain sides surrounding the Frankstown cove (Scotch Valley &c.) facing inwards.

It is colored red on the map.

In Huntingdon county it has been divided by Mr. Ashburner into four groups, thus :—*

		Saltillo.	*Orbisonia.*
V.	*Clinton red shale,*	270′	233′
	Upper olive shale,	162′	163′
	Fossil ore group,	42′	53′
	Lower olive shale,	—	660′
		—	1109′

In Mifflin county it has been subdivided by Mr. Dewees into ten groups, thus :—†

		Logan gap.	*Mt. Union.*
V.	*Niagara Limestone,*	4′	3′
	Niagara Shales,	70′	232′
	Clinton Variegated Upper Shales,		
	" " gray shales,	1018′	285′
	" red shales,		
	" Upper Fossil ore shale,	251′	141′
	" ore sandstone and ore beds,	38′	42′
	" middle olive shale,	178′	359′
	" iron sandstone, block ore,	7′	2′
	" Lower shales,	571′	307′
		2137′	1371′
	Or, omitting the *Niagara,*	2063′	1136′

This diminution to *nearly one half* in 26 miles (southwestward) is very extraordinary.

In Blair county its thickness is made by Mr. Sanders' detailed section, ... 1328′
Or, *omitting all above the highest red shale,* . . . . 230′

Thickness of the *Clinton proper*, No. V, ... 1098′

* Report F, p. 248.

† Report F, p. 103.

In Clinton county, at Lock Haven, Mr. Chance makes the thickness of the *Clinton shales* (between the lowest quarried limestone of VI, and the topmost white Medina sandstone,)* . . . . 1080′

Prof. Rogers gave the name *Surgent* to this formation,† and subdivided it into—

		A.	B.	C.	D.
V.	*Surgent red shale—marl,*	975′	400′	340′	380′
	Surgent upper shale,	120′	50′	225′	160′
	Surgent ore sandstone,	110′	15′	25′	8′
	Surgent lower shale,	166′ (lower shale and upper slate)	100′?	?	60′
	Surgent upper slate,		100′	250′	50′
	Surgent iron-sandstone,	4′	80′	25′	58′
	Surgent lower slate,	100′	200′	150′	700′
		1475′	945	1215′	1416′

A. Lehigh water gap in Lehigh county.

B. Perry county at the Susquehanna river.‡

C. Mifflintown in Juniata county, Juniata river.‡

D. Danville in Montour county, N. Br. Susquehanna.

In Lycoming county Prof. Rogers gives the following general description of the *Clinton* No. V, probably derived from the notes of Mr. A. McKinley in 1839.§

V.	*Surgent red shale,* usual characters,		350′
	Surgent upper calcareous shale.		
	Grey and greenish shale,	40′	230′
	Limestone, with minute *Beyrichia, Calamopora, Atrypa, Cytherina, Avicula, &c.,*	65′	
	Greenish and buff slates,	65′	
	Alternations of slates and ferruginous limestone beds (4″ to 2′) with four or five beds of impure *ore,* with its usual fossils,	60′	
	Surgent lower calcareous shale (5 miles below Jersey shore), greenish shale with sandy calcareous bands, containing *Agnostis, Hemicrypterus,* and a small branching *fucoid,*		110′
	Surgent upper slate—branching *fucoids,*		700′
	Surgent iron sandstone, with an *ore* bed,		
	Surgent lower slate,		
			1390′

§ 37. The *Clinton* (*Surgent*) *red shales*, which from Muncy

* Report F, Appendix B, p. 265; and Report G4, 1881.

† Geol. Penn., 1858, vol. I, pp. 131, 132, 133.

‡ Probably from measurements by Dr. A. A. Henderson in 1839, 1840.

§ Geol. of Penn., 1858, vol. I, p. 536.

to Lock Haven (350′) is a clayey and sandy marl, of dull brick red color, some layers calcareous, becomes more sandy in Blair and Bedford counties, but thins gradually away to nothing before reaching the Potomac river at Cumberland in Maryland.

§ 38. The *Clinton* (*Surgent*) *fossil ore shales* (upper and lower), which wants its grey calcareous *ore sandstone* from Muncy to Lock Haven, gets it again in the Bald Eagle valley; and in Bedford county the *ore sandstone* not only becomes thick but makes a well marked ridge.

The *upper shale* which at Jersey Shore is 230′ thick and divisible into three parts, dwindles away past Lock Haven and Altoona until it is only a few feet thick at Cumberland. Its divisions at Jersey Shore are given in the section above.

The *lower shale* contains a few beds of limestone, passing sometimes into an impure fossil ore.

§ 39. The *Clinton* (*Surgent*) *slates* (*upper and* lower, which are (with their included *iron sandstone*) 700′ at Jersey Shore, and 600′ at Howard furnace in Centre county, diminish in thickness up the Bald Eagle valley; but the *Iron sandstone* increases in thickness towards Blair county.

The slates form the upper middle slope of the Bald Eagle mountain; and *block ore* is mined high up the mountain, as will appear in a subsequent chapter.*

Medina and Oneida.

§ 40. *Medina and Oneida Sandstones Formation No. IV.*—The mountains made by this mass of sandstone layers make the prominent feature of Blair county, and of its map, on which the formations are represented under one color, yellow.

Mr. Sander's section (in the last chapter) gives a total thickness of 2366′.

Mr. Chance's measurements in Clinton county give a total thickness of 2301′.

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* The *Clinton rocks* exposed at Frankstown are described in Geol. Pa. 1858, Vol. I, Chap. 6, pp. 556, 557.

Mr. Ashburner's measurements at Rock Hill gap, in Black log mountain, Huntingdon county, distinguish four members, thus :—*

IV.	*Medina white sandstone,*	400′	1330′
	Medina red sandstone,	930′	
	Oneida red conglomerate,	158′	568′
	Oneida gray sandstone,	410′	
			1898′

Mr. Dewees' measurements at Logan's gap in Jack's mountain near Lewistown in Mifflin county, give—†

IV.	*Medina.*	*White sandstone,*	820′	2100′
		Red sandstone,	1280′	
	Oneida.	*Red conglomerate,*	309′	622′
		Gray sandstone,	313′	
				2722′

Mr. Rogers makes but three divisions of No. IV, assigning various thicknesses to them in various parts of the State ; thus :—‡

IV.	*Levant white Sandstone,* . . . . about,	400′
	Levant red Sandstone,	800′
	Levant gray Sandstone, . . only,	100′
	Total thickness in Milliken's cove,	1300′

His measurements in Will's mountain and Buffalo ridge, surrounding Milliken's cove in Bedford county, are selected here (from others remeasured instrumentally by the Second Survey) for the purpose of indicating the thinning away of this remarkable deposit *as sandstone* towards the south. In fact on the James river in Virginia the whole *Medina* measures only 300′, the whole *Oneida* only 90′=390′ §; and west of Knoxville in Tennessee, all that can be recognized of the sandrocks of No. IV amounts to but 40′. Towards the north the thinning is equally remarkable; for, on the Niagara river the *Medina* measures but 300′ to 400′, and the *Oneida*, in Oneida county, N.Y., only 100′ to 120′. To-

* Report F, p. 256.

† Report F, p. 54.

‡ Geol. Pa., 1858, Vol. I, p. 127.

§ Prof. J. L. Campbell, on the Geology of the Rich-patch, in Hotchkiss' "The Virginias," Vol. I, No. 12, Dec. 1880, illustrated with sections —J. J. Stevenson calls the Medina in Wallen's ridge Lee county, Va., "evidently more than 300′ feet." Proc. Amer. Philos. Soc., Aug. 1880.

wards the west the thinning out is complete; for nothing is seen of the sand-rock in middle Ohio and Kentucky. Towards the east there is also a thinning; for at the Lehigh and Delaware water-gaps (A. & B.) the following are the rude estimates of thickness:—

		A.	B.
IV.	*Medina sandstone,*	760′	200′+
	Oneida sandstone,	400′	700′
		1160′	900′+

§ 41. As this interesting formation comes to the surface nowhere east of the Susquehanna river between the Blue mountain in Pennsylvania and the Mohawk valley in New York, the theory of its originating in some current setting down from the northeast cannot be tested. But it is noteworthy that the *Mayhill* or *Llandovery sandstone* formation of England exactly corresponds to it.

§ 42. The mountains of No. IV will be described topographically in another chapter; but it is proper to call attention to the geological cause of their peculiar shape.

In the First Geological Survey a distinction was recognized between the "Upper, Middle, and Lower of IV."

The *Upper of IV* (*Medina White*), being a series of hard sandstones, makes the crest of the mountain.

The *Middle of IV* (*Medina Red*) being comparatively soft, and in fact a mass of sandy shales including some thick layers of sandrock, makes a groove on the side of the mountain, the drainage of which delivers through a series of small double-headed ravines.

The *Lower of IV* (*Oneida Gray*) being very massive and hard, makes a terrace more than half way up the side of the mountain; and through this terrace rock the ravines break.

This is the normal relationship of geological constitution to topographical form in Tussey, Canoe, Loop, Lock, and Dunning mountains, in all of which the strata are inclined at various angles.

But in the Bald Eagle mountain, where the strata are vertical, the terrace rises to the height of the crest; and the mountain has in fact two crests, with a shallow groove between, delivering its drainage, however, always through the *Oneida* crest, into the limestone valley.

By referring back to Mr. Sander's section, this distinction into three will be easily recognized:

Upper mass of sandstone (crest),	1068′±
Middle mass of alternations,	520′
Lower mass of sandstone (terrace),	1319′

§ 43. The *Medina white* is made up of massive beds of hard white and greenish-gray flinty sandstone; fine grained, compact and homogeneous, and contains in Blair county few or none of the pebbles which make it so coarse a rock in Franklin, Cumberland, Dauphin, Schuylkill and Monroe counties; showing that we are to look for its origin in that direction.

Its uppermost beds are in thin layers, mottled red and gray, are often covered with a net work of obscure impressions of sea plants (*Arthrophycus Harlani*), and alternate with soft greenish non-fossiliferous slate layers. But the main body is a pile of massive fine grained, hard, white and gray sandstone beds, sometimes yellowed and speckled from the decomposition of disseminated iron-ore particles.*

This description is confined to the upper 400′ or 500′ of the 1068′ above.

§ 44. *The Medina red* must be understood as including the lower 500′ of the above 1068′, and also the 520′ of the middle mass, making its estimated thickness by the First Survey 900′ or 1000′.

In fact it has two well marked sub-divisions: an upper and lower.

The *upper* sub-division is mostly a red clay sandstone, thin bedded, flaggy, containing towards the bottom coarser sand rocks, and even thin layers of small quartz pebbles. *Flattish fragments of red shale occur throughout the pile of sandstone*, and these can hardly be derived from any other source than the underlying red shales. Such is its general character in Mifflin county, where it is 500′ to 600′ thick.

The *lower* sub-division, has a peculiar character in Mifflin

*H. B. Rogers, Geol. Pa., 1858.

county, being a pale red sandstone, imbedding so many pebbles of white quartz and Silurian (No. III) slates, and (No. I) sandstones, as to be in reality a conglomerate. The union of this 400′ pile of hard, massive layers with the *Oneida gray* mass beneath it causes the great height and prominence of the terraces around the Kishicoquillis valley.

In Blair county, however, this lower sub-division of the "Middle of IV" lends no such aid to the Oneida, which has to form its terrace alone the best it may. There is no overlying conglomerate to reënforce it, nothing but alternations of sandstones and shales; the sandstones exhibiting an obscure vertical-stem plant. This lower division, then, represents the 520′ *middle mass* above mentioned.

§ 45. The *Oneida gray* sandstone is characteristically speckled or pitted by reason of the decomposition of minute granules of iron ore distributed through the deposit.

It also is distinguishable into *upper* and *lower.*

The upper sub-division is a somewhat clayey sand, greenish-gray, slightly micaceous, ocher-pitted, and with its rock layers sometimes separated by thin fissile yellow slates; thickness less than 400′.

The lower sub-division, an ocher-pitted hard gray sandstone, is less than 200′ thick.

The whole being say 600′; which leaves 700′ of the 1319′ to satisfy the description of the *lower subdivision of the Middle of IV* as described above.

The fact is, that we cannot properly describe the combined Medina and Oneida formation No. IV, until we obtain at least twenty *instrumently-measured sections* of it in various parts of middle Pennsylvania. The description of it in the Geology of Pennsylvania, 1858, a summary of which has just been quoted, is of very little service for an understanding of the deposit as a whole, and of the variations which it exhibits along its numerous exposures.

Hudson river and Utica.

§ 46. *Hudson River and Utica slate Formation No. III,* outcrop along the front of the terrace of No. IV, and border the *Siluro-Cambrian* limestone region of Morrison's Cove, Canoe Valley, and Sinking Valley.

In the gaps made through the Bald Eagle mountain at Tyrone; through Tussey mountain at Spruce creek, Water-street; and Pattonville; through Canoe mountain, above Williamsburg; and through Dunning's mountain, at McKee's,—the imperfect exposures of this formation have been measured and found to amount to about 900′.

At Orbisonia, in Huntingdon county, in Rockhill gap, through Blacklog mountain, the *Hudson river* brown and bluish-gray sandy slates (with clay-sandstone layers and a reddish-gray shale, holding *mineral stems* in the upper part) measure alone about 800′; and the brown and black fissile *Utica slate* (very carbonaceous, and the bottom layers calcareous) measure about 1070′; total of III = 1870′.

The formation, therefore, seems to double its thickness, eastward, in only 50 miles.*

At Lewistown, in Mifflin county, in Logan gap, through Jack's mountain, careful measurements give: *Hudson river*, 937′ + *Utica*, 695′ = 1632′.

This is a thinning of 240′ in about 40 miles north-northeastward from Orbisonia.†

Here the formation (III) is subdivided into:—

H. R.	Sandstone, gray, hard, flaggy, and blue-black; shale,	425′
	Shale, yellow-gray, compact, conchoidal,	190′
	Sandstone, blue-gray, hard, fine, conchoidal,	140′
	Shales, dark, ferruginous,	182′
U.	Shales, dark, ferruginous, bituminous,	210′
	Shales, black, cleavage perfect,	302′
	Slates, gray, covered up,	855′

In the Great or Cumberland valley, along the south face of the North, Blue, or Kittatinny mountain, the exposed thickness of No. III (*Hudson river and Utica*) is very great,

* Ashburner, Report F, p. 257.—There can be no mistake about these dimensions, for the rocks are very steep and well exposed, and the top of III comes sharply up against the bottom layer of *Oneida gray sandstone.* The lower limit of the *Utica* is not so certain, being assumed at a shaly brown hematite ore bed overlying the *Trenton* blue limestones of II. There is no appearance of non-conformability here between III and IV.

† F, pp. 50, 55.

amounting to and even exceeding 5000′, according to the measurements of Mr. Sander's at the Susquehanna water gap and of Mr. Chance at the Schuylkill, Lehigh and Delaware water gaps.

§ 47. Mr. Rogers describes the *Hudson river* (*Matinal shales*) as bluish and greenish-gray shales, alternating with thin gray, calcareous fossiliferous clay sandstones.

*Some of the fossils characteristic of the limestones of II are found in the upper part of this upper division of III, mixed in with its own characteristic species.**

Mr. Rogers estimates the *Hudson river* at 1200′ in the Kishicoquillis and 700′ in Nittany valley.

§ 48. Mr. Rogers describes the *Utica* (*Matinal*) *black slate* as remarkably uniform in all parts of Middle Pennsylvania; a very dark blue carbonaceous slate and shale; extremely fissile in its lower beds; nowhere abundantly supplied with fossils, extensively pervaded by cross-cleavage planes in Kishicoquillis valley, where fossils are therefore hard to obtain; but in Nittany valley fossils are numerous and easily procured.

Estimated thickness in Kishicoquillis valley 400′ and in Nittany valley 300′.

§ 49. *Beds of passage* from the *Utica* downwards into the *Trenton*. These transition layers are thin, blackish limestones breaking up into small pieces; weathering deep brown; the whole set amounts to about 30′.

At Millerstown, at the south end of Canoe valley, along the west foot of Tussey mountain, the bottom beds of III are gray and black slates, but the contact with the top beds of II is not clear.

At Pattonsville the passage beds are better seen, as above described; also near Martinsburg; also in McKee's gap; also near Franklin Forge on the Juniata; also north of Yellow springs, in Canoe valley.

§ 50. *The Henrietta iron ore* deposit (to be described in a separate chapter) lies between III and II, that is, under

[* This is another warning against the too prevalent practice of trusting more to palæontological than to lithological and structural evidence for the classification of deposits.—J. P. L.]

the *Utica* and over the *Trenton.* In very few other places along the extensive outcrop has any ore been seen, and nothing important enough to exploit. The Henrietta deposit is probably due to the fault described in the next chapter. The iron ore deposits of Path valley in Franklin county lie also at the junction of III and II, along a great fault.

Trenton.

§ 51. *The Trenton, Black river, Bird's-eye, Chazy, and Calciferous limestones* of New York and Canada, are all included in No. II of Pennsylvania, and represent part of the *Lower Silurian* of Murchison and the British Survey; *Upper Cambrian* of Sedgewick; or the *Siluro-Cambrian* of Sterry Hunt.

These beds are finely exposed along the Little Juniata, on both sides of the two anticlinals of Canoe valley and Sinking valley.

They are exposed along the Raystown branch or main Juniata, between Tussey and Canoe mountain, on the two sides of the Canoe valley anticlinal.

Elsewhere in Blair county their numerous exposures are unconnected, and afford no opportunities for instrumental measurement.

The *top* of the series is well defined; but the *bottom* is obscure, because there is only one place where it reaches the present surface plane of erosion, viz: near Birmingham Here Dr. Jackson recognized *Potsdam* sandstone strata in the axis of the Sinking Valley anticlinal, in 1838, and Mr. C. E. Hall collected Potsdam fossils in 1877. The spot is remarkable, for being the solitary point in all Pennsylvania north and west of the Blue-Ridge-South Mountain range, where the Potsdam (No. I) comes up to the surface.

It is also remarkable as the only locality in Pennsylvania where the real thickness of the Siluro-Cambrian limestone series can be instrumentally measured. In the Cumberland valley the strata are so plicated and faulted that no consecutive measurements are possible. In the Kishicoquillis valley of Mifflin county the arch is gentle, the exposures scattered, and only a part of the formation brought to the surface. Here, along the two Juniatas, the dips vary little and vary regularly, and the whole column of rocks exhibits itself, and large portions of it six times.

Mr. Sanders' measurements sub-divide the whole into three parts:—

Upper Limestone series, ...	5400′
Middle white sandstone beds, ...	40′
Lower Limestone series (with the Potsdam), ...	1160′
Total, included some Potsdam layers, ...	6600′

Mr. Sanders has measured about 3000′ of consecutive layers at Harrisburg; and Mr. Prime gets about 2000′ at Allentown and Bethlehem; but very little can be said yet about this great deposit of No. II in other parts of Pennsylvania.

§ 52. Its description will occupy a separate chapter of this report. But the reader is referred for a remarkable discussion of its alternations of nearly pure *limestone* layers and nearly pure *dolomite* (magnesian) layers, to Report MM, McCreath, 1879, pp. 311 to 362, with woodcut sections of the alternations.

The exposures of the limestone rocks are not sufficient to permit of a thorough differentiation; layers of limestone and of dolomite, of varying thickness, succeeding each other continuously.

§ 53. There are siliceous horizons in the limestone mass in Nittany valley, where the rock is either sandstone or calcareous sandrock; and there are occasional layers of flint.

These beds, though in no case thick, make a good show on the surface, covering the region with bowlders and pieces of sandstone and flint, entirely out of proportion to the really small size of the beds themselves, as compared with the enormous thickness of the limestones.

§ 54. *Quarries.*—The limestones are quarried in many places for burning for lime for agricultural purposes; also for building stone and to furnish flux to Rebecca, Rodman, Springfield and Williamsburg furnaces.

Ralston's quarry, at the mouth of Potter creek, near

Waterside, furnishes a stone which burns to a good white lime.

Lyon's quarry, three and a half miles west of Pattonsville, shows very fossiliferous limestone, dipping south 60° west, 23°.

Reighard's quarry, one half mile north of Lafayetteville, also shows a very fossiliferous blue limestone, dipping North 80° East, 50°.

In a quarry one mile north of Lafayetteville the limestone is massive, dark colored, much specked with quartz and calcite, and with some very small spurs of zinc ore.

Hoover's quarry, one mile north of Woodberry shows massive limestone layers, of good quality for burning for lime. The limestone is light colored and has a cleavage plane of North 30° East, 17°; and a dip of North 70° West, 88°.

Breidenthal's quarry, one mile west of Stonerook school house shows limestone layers varying in color from light blue to deep blue black. It burns to a white lime. The rocks dip South 70° East, 37°.

Snowberger's quarry at Curry Station on the Morrison's Cove Railroad gives a deep blue limestone with much calcite. The rocks dip to the North 70° West, 59°, and have a cleavage plane of South 75° East, 63°.

Hoover's quarry is near the south end of Leathercracker cove. The stone burns to a good lime. The rocks, which are in massive layers, dip to the South 40° East, 30°, the strike of the rocks in this faulted region not being parallel to the line of Tussey mountain.

A specimen of limestone from this quarry, or from one in the near vicinity, was analyzed by Mr. T. T. Morrell for the Cambria Iron Company. It proved to be a dolomite, thus:

Insoluble matter,	4.30
Carbonate of lime,	50.89
Carbonate of magnesia,	46.03

Where the Morrison's Cove Railroad cuts around the nose of the ridge which lies west of Leathercracker Cove, an opening has been made in the limestone and some stone quarried; which was tested by Mr. T. T. Morrell, for the Cambria Iron Company, and yielded thus:

Insoluble matter,	4.75
Carbonate of lime,	50.36
Carbonate of magnesia,	45.27

The rocks, which are much contorted and crushed, seem to have a dip of South 60° East, 85°; and have two cleavage planes, one of South 60° West, 44°, and the other North 80° East, 60°.

Just south of Millerstown there is a large quarry. The limestone is massive and the strike of the rocks is not parallel to Tussey mountain. A specimen of the limestone was analyzed by Mr. T. T. Morrell, for the Cambria Iron Company, and yielded thus:

Insoluble matter,	7.60
Carbonate of lime,	91.60

This shows a pure and good limestone for flux in iron furnaces.

Kensinger's quarry, two miles north of Henrietta, shows a deep blue, massive limestone, with a dip of South 70° East, 35°.

Rhodes' quarry, three miles north of Henrietta, has been somewhat extensively worked. The limestone ranges in color from light-blue to dark-blue, is non-fossiliferous, usually massive, though with some thin-bedded layers. It makes an excellent white lime. The rocks dip to the South 70° East, 30°, and have a marked cleavage plane of North 30° West, 61°.

Metzger's quarry, one mile west of Fredericksburg, shows blue limestone with a dip of South 70° East, 68°.

A quarry, one half mile southwest of Martinsburg, near Dunkard church, shows massive blue limestone with a dip of North 70° West, 69°.

The quarry at Cove forge has been extensively worked. It shows massive blue limestone, with a dip of South 70° East, 48°. The rock is of good quality and burns to a white lime.

Only a small part of the limestone quarries of Blair county have been chosen for special description—the few above given being a fair sample of the average of the hundreds of large and small quarries opened in Morrison's Cove, Canoe valley, and Sinking valley.

§ 55. *Caves, sink-holes, &c.*—The weathering of the limestone produces the usual results of sinking streams, strong and unchanging springs, caverns, bottomless caves, natural arches, &c. These were described and illustrated in the Reports of the First Pennsylvania Geological Survey.

§ 56. *Matinal limestone* is the name given by Mr. Rogers to the *Trenton limestone*, and he describes it as not sharply distinguishable (in the Bald Eagle region) from the limestones underlying it (his *Upper Auroral*, or *Black river limestone*) either lithologically or palæontologically.

He therefore arbitrarily fixes its basal plane at the bottom of the mass of dark blue, somewhat carbonaceous layers holding *Orthoceras pressum* and *Lingula Trentonensis*. Here also the *Isotelus gigas*, rare below, grows abundant upwards. Here also *Cytherina*, found below, disappears upwards.

Dark blue, carbonaceous, fossiliferous layers (as just described) are typical of the formation; but light blue and gray, thin, very fossiliferous layers alternate with them; and in the middle and higher portions thin dark-blue slates.

In the Kishicoquillis valley the *Trenton* measures about 550′, in Nittany and Nippenose valleys 300′ or 400′.

In Kishicoquillis valley the change at the top to the *Utica slates* is very abrupt;* in Penn's and Nittany valleys less abrupt; in Nippenose quite gradual.

Chazy and Calciferous.

§ 57. Mr. Rogers in describing his *Auroral Magnesian limestone* (that part of No. II which underlies the *Trenton limestone*) says, that it offers two principal varieties:

One variety is a rather dark, dull gray, crystalline or granular rock, with peculiarly harsh and sandy weathered surface, "not so much from the presence of siliceous sand, as from the disintegration of the minute crystals which compose it;" decidedly ferruginous (probably carbonate of iron)

* Near the tavern at Brown's mill.

making an ochreous soil, and (in his opinion) providing the materials for the great ore beds of the region.

The first, darker, crystalline variety predominates in the middle and lower divisions of the column.

Another variety is a remarkably smooth, fine-grained, very pale blue (french-gray) rock; very uniform in texture, in fact a solidified impalpable mud pulp; highly magnesian; weathered surfaces coated with a white crust of carbonate of magnesia and lime; some layers holding numerous small white knots of crystallized dolomite.

A third variety, alternating especially in the upper part, consists of thin, clear, dull-blue, *non-magnesian* layers.

The whole considerably exceeds 5000′ near Bellefonte.*

§ 58. Mr. Rogers subdivides the column thus:—

Black River Group, N. Y.	*k.*	Thin-bedded, *encrinal* and *coralline* limestone, . . .	30′
	j.	Massive, fine, blue limestone, weathering in holes from an obscure *coral*, ...	20′
	i.	Lighter blue, fine limestone, resembling the "Bird's-eye limestone of New York; *Cytheria*, and other fossils, ...	150′
	h.	Blue, massive, and also thin limestone layers; some speckled with spar, and full of holes left by the removal of a *coral*. Many fossils, ...	400′
Calciferous Sandstone, N. Y.	*g.*	Alternations of blue clay-limestone, with gray *coralline* magnesian limestone, . . .	200′
	f.	Light-blue, massive, magnesian limestone (*no fossils*), ...	500′
	e.	Alternations of light-blue, fine, with dark-gray, crystalline, *coralline* limestone, ...	1000′
	d.	Light blue limestones (*fossils very rare*), ...	300′
	c.	Gray, crystalline, magnesian limestone (*no fossils*),	1500′
	b.	Light-blue, magnesian limestone (*no fossils*), . . .	700′
	a.	Gray, crystalline, magnesian limestone (*no fossils*), more than	600′
		Total, ... more than	5400′

The column is divided into two parts; the upper 600′ of very fossiliferous limestones; and the lower 4800′ of almost non-fossiliferous magnesian limestones.

The transition from the lower to the upper is very sharp and striking.

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* Geol. Penn., 1858.

§ 59. *Fossils.*—"Organic remains in this prodigious expanded portion of the auroral series are extremely rare, and the better-defined forms are all restricted to the upper half of the mass.

The most distinctive form is a *coralline* of obscure structure, which abounds in some of the finer-grained strata, imparting to the more weather-eaten surfaces a pitted structure resembling worm holes.

Two or three *univalve shells* have likewise been met with many hundred feet below the highest beds of the formation. These, which are chiefly specimens of *Pleurotomaria*, being abundant in the next superior subdivision of the formation, serve sufficiently to tie together the upper and lower members of the mass. At the same time, *the abrupt appearance of a great variety of Genera for the first time*, as we ascend above the horizon of the non-fossiliferous division, and the striking and permanent change of lithological and chemical characters in the rocks, are ample reasons for subdividing this enormous mass of strata.

"The transition from the almost non-fossiliferous portion of the magnesian formation to the overlying fossiliferous rock is well seen in the bank of the Bald Eagle canal, about half a mile above the town of Bellefonte, and also in Kishicoquillas valley, near the head of the dam at Brown's mill."*

§ 60. *The differentian of Formation II* will be discussed in the Report on Centre county, embodying the data published in the proceedings of the American Philosophical Society, 1873; but also important corrections of the same, especially in the lower part of the column of measurements, for our recent instrumental surveys in Blair county make it next to impossible that a total of 7750′ of limestones can exist in Centre county, as stated; thus:

Trenton, Birdseye, Black river, &c.,	2500′
Pennsylvania Furnace and Cale Hollow ore,	—
Interval of limestones,	700′
Huntingdon Furnace ore horizon,	—
Interval of limestones,	550′

* Geol. Penn'a, 1858.

Pipe ore range near toll-gate, ...	—
Interval of limestones, ...	1500′
Pennington; Town; Lovetown ore horizon, ...	—
Limestones down to the fault, ...	3000′
	7750

§ 61. In Report O, Catalogue of the Geological Museum, 1878, at page 113, is given a list of 240 specimens collected along the Little Juniata river from Tyrone gap to Spruce creek.

The first 21 are of *Trenton* limestone; No. 11 being "a black limestone with Rhynchonella, 560′ west of Tyrone forge."

From 22 to 34 are dolomitic limestones above Tyrone forge.

From 35 to 54, dolomites from RR. cut below bridge No. 12.

From 55 to 61, dolomites from RR. cut above bridge No. 11.

From 62 to 78, dolomites on wagon road below bridge No. 11.

From 80 to 86, dolomites above Birmingham covered bridge.

87, white, compact, fine-grained sandstone, (*Potsdam?*) on the river road above the bridge, opposite the lead works.

88 to 94, sandstones, on the same road.

95 to 104, ferruginous sandstone, speckled with oxide of iron.

105, hard gray sandstone (*Potsdam?*) opposite Birmingham RR. station.

106 to 112, shaly limestone, containing much carbonaceous matter, below Birmingham bridge and opposite RR. station.

96A to 99A, dolomites with irregular veins of calcite, south side of river, on RR., below sub-division shanty near Birmingham station.

113 to 128, dolomites below Birmingham station.

129 to 137, at bridge No. 10 and so on down the RR.

138 to 149, at and below bridge No. 9.

150 to 154, at and below bridge No. 8.

155 to 171, at limestone quarry.

172 to 175, below bridge No. 7.

176 to 183, below bridge No. 6.

184 to 185, at large quarry.
186 to 192, below bridge No. 5.
193 to 203, below bridge No. 4.
204 to 208, below bridge No. 3.
209, 210, below bridge No. 2.
211 to 213, below bridge No. 1.
214 to 239, below Spruce creek station engine-house.
240, limekiln near Spruce street tunnel.

§ 62. *Fossils.*—Mr. C. E. Hall reports that only a comparatively small number of fossils were collected in making the above suite of hand specimens.

The principal localities were: At Marhoff's quarry, north side of the river, above Tyrone forge, and on the river about 500′ or 600′ above the forge.

A *Rhynchonella* and *Chaetetes* were the principal forms. "If I am not mistaken, *Orthis lynx* occurs also."

"A short distance above the base of the limestone I found a few fragments which I consider *Calciferous*."

"The outcrops of *Trenton limestone* may be seen at places along the base of the Bald Eagle mountain, in a number of places."

I was not able to find any fossil remains in the *Birmingham sandstone.* My reason for assuming it to be of *Potsdam* age was solely on stratigraphical grounds."

"I found generally steeper dips than any indicated on your map. The dips on the two sides of the river are often quite different, and this fact is very plainly seen at Birmingham." (Jan. 24, 1881.)

Chapter IV.

Topography.

§ 63. *The topography of Blair county* depends directly on the character and structure of the underlying rocks; the soil is made from the disintegration of the rocks in place, there being only a few unimportant spots where there is any mass of foreign material; the wash of loose stuff along the foot of some of the mountains being clearly of no more distant origin than the mountain it skirts.

The district can be divided into limestone, slate and sandstone country.

The limestones make the large level valleys of Morrison's Cove and Canoe valley; the slates make small valleys with sharp, steep hills; and the sandstones of IV, IX and X make mountains.

The topography of the county is somewhat intricate and beautifully illustrative of the geological structure. As the very nature of the structure prevents any rational description of the county by townships, each mountain is taken in turn, starting on the south where it enters the county, and the explanation of the detailed topography is continued along to the north until the county line is again reached.

Medina crests.

§ 64. *Tussey mountain* comes from the south along the east side of Snake Spring valley. At the head of the valley the middle and lower of IV arch over and join Dunning mountain, the upper of IV being eroded from the arch.

Following the crest to the north, it is fully 100 feet wide up to within a quarter of a mile of the gap, where it suddenly narrows down to a width of 10 or 20 feet.

From the junction of Tussey and Dunnings mountains the course of Tussey is first North 4000 feet, then North 32° West for 3200 feet, and North 13° West for 20,000 feet, Pattonsville gap being about in the middle of the last distance. The distance from crest to crest, in the gap, is about 4000 feet.

Tussey mountain then has a course of North 37° East for 16,000 feet. The crest here widens out into a flat of 600 feet in breadth, with a slight rise to the north; this broad flat continues on to Calcup, where the mountain rapidly narrows to a point, the crest turning to North 72° East, 4000 feet to the point of Calcup. From Calcup North 5° West, for 3400 feet, the crest is eroded; it then starts in again, very narrow and 2000 feet in length, and is called locally "the Pulpit."

At the Calcup the mountain turns sharply to the South 10° West, and at the turn Trout run gaps the crest, which keeps a straight line until it curves around the dying Leather-cracker anticlinal axis.

The crest then curves around to the northeast, the curve having a radius of 2800 feet; at the middle of the curve the mountain broadens out into a flat, with a slope down along the line of the anticlinal of 7° 50′. The mountain is locally called "Koot Hill."

Beyond the turn the crest narrows down and has a course of North 50° East for 4000 feet; then north for 8000 feet, the width being not more than from 10 to 50 feet. A small run gaps the crest at Raver's gap, one and a half miles beyond the curve.

On the north side of the gap the upper of IV, a very massive sandstone, shows in a solid wall, sloping at an angle of East 60°.

On the main road crossing from Henrietta mines to Saxton (in Huntingdon county), the upper of IV is eroded, and the red rocks of the middle of IV make the crest. This road crosses through a notch fully 200 feet lower than the height of the mountain on both sides of it.

From Henrietta to Fredericksburg the crest has a course of North 31° East; it is even, straight, and generally narrow; and the same description applies to the mountain all the way to Cove forge; not only is it almost a perfectly straight line from Henrietta to the forge, but the elevation keeps very regular, the average being about 2150 feet above the ocean, with a maximum of 2320 feet southeast of Rebecca furnace, and a minimum of 2000 feet just east of Beavertown. The greatest deviation from a straight line between these points, a distance of 18 miles, is south of Beavertown, where it is 1600 feet out of line.

The mountain from Henrietta has a course of North 30° East to a point about south of Beavertown, then North 33° East to the Cove forge bend.

Before reaching Cove forge an anticlinal axis comes out of the mountain, which causes the crest to make a double curve. The crest comes up to the curve with a narrow even line, gradually increasing in elevation until it reaches the center of the anticlinal axis, where it widens out into a small flat, 2300 feet above tide. Around the turn it keeps on as a broad flat, but with a lower elevation, 2040 feet above tide at the lowest place, until it approaches the synclinal turn, when it runs up to 2240 feet above tide, and stands out into the valley overlooking the river, which is 1420 feet below.

From the synclinal point, on towards the north, the crest first goes North 6° East for three miles to the Waterstreet gap. The distance across the gap between the crest points is 3200 feet.

From the north side of Waterstreet gap on to Spruce creek gap, the course of the crest is North 30° East.

Beyond Spruce Creek gap Tussey mountain continues on to the northeast with a high even crest.

§ 65. *Dunning's mountain* comes from the south along the west side of Snake Spring valley. At the southern end of Morrison's Cove, the middle and lower of IV join Tussey mountain, as mentioned before. The crest then turns sharply to the North 70° West, with a broad flat summit of some two or three hundred feet wide.

The crest is slighty curved to the north by the dying Martinsburg-Woodberry anticlinal; it continues with the same elevation on a course of North 23° West for one and a half miles; then curves to North 60° West for one half a mile; again curves first to the south, and then with a long curve around to the north, the radius being 2600 feet, these latter being caused by the dying Bloomfield anticlinal axis. The crest at the middle of the curve widens out to a broad flat, with an elevation of 2560 feet above tide. The slope of the mountain to the south, along the center of the axis, is from 6° to 7°.

After the crest makes the curve it continues as far as the main road crossing, with a broad flat top; it then narrows down very much, in some cases being made of a single ledge of massive white sandstone.

From the curve the crest has a course of North 23° East to Lafayetteville, then North 30° East for one mile, then North 20° East to Bakersville, and North 70° East to a point on the mountain opposite to the south end of the Bloomfield mines.

The crest from Bakersville on towards the north has numerous small notches in it. The average elevation of the mountain is from 2000 to 2260 feet above tide. These notches cut down from 50 feet to 250 feet below the average crest. They are not regular in distance from one another, nor in depth, nor is their position in any way relative to the position of the gaps in the mountain bench.

From Bloomfield north to McKee's gap the mountain has a course of North 22° East. South of the gap the crest has an elevation of 2000 feet above the ocean, and the distance across the gap from crest to crest is 4000 feet.

North of McKee's gap the crest runs on regularly for one mile to the Dry gap, which latter is 3200 feet across from crest to crest.

North of the Dry gap the mountain runs on with a straight narrow crest for 1600 feet; it then widens out and curves around the Bloomfield anticlinal axis, making a broad flat on the crest of the anticlinal, with an elevation of 2460 feet above tide.

The point of the mountain dying down to the north, along the center of the anticlinal, has a slope of 8° 50′.

The curve of the crest around the anticlinal is not regular, but has a radius of about 1800 feet. The mountain at this point changes its name to Loop mountain.

§ 66. *Loop mountain* from its beginning to end, a distance of four miles, has a straight even crest with a course of South 10° East; its average elevation is 2460 feet above tide, and its breadth is from 100 to 300 feet. At the Martinsburg synclinal the mountain curves to the north and changes its name to Lock mountain.

§ 67. *Lock mountain* curve has a radius of 3500 feet; near the middle of the curve there is a notch in the crest which has an elevation of 2250 feet above tide. Then with a course of North 28° East, an average breadth of 50 feet and an elevation above tide sinking from 2300 feet to 1900 feet, it continues on to Springfield furnace, where there is a small depression over which the wagon road passes at a level of 1900 feet.

The crest continues to the northeast with a course of first North 28° East then North 40° East to the Juniata gap, with an average elevation above tide of about 1900 feet, but with a somewhat uneven crest. Across the gap the distance is 4400 feet from crest to crest. The mountain on the north side of the gap is called Short mountain.

§ 68. *Short mountain* crest is only 1200 feet long, and is in line with Lock mountain.

§ 69. *Canoe mountain* starts from a point 6300 feet South 80° East from the north point of Short mountain.

The crest goes to the North 20° East for one and a half miles, with a width of 100 feet; after that it curves to the North 45° East and when about northwest of Yellow Springs it broadens out into a flat which again rapidly narrows down. The mountain continues with a course of North 40° East for about one mile; changes the course to North 30° East, and then curves around the Martinsburg synclinal on a curve of 3300 feet radius. Near the middle of the curve there is a depression in the crest, the elevation of which is 2150 feet above tide, while the average mountain elevation is 2200 feet. The most northeast point of the mountain is 8800 feet South 35° West from Union Furnace station on the Pennsylvania railroad. After the mountain makes its curve it changes its name to Brush mountain.

§ 70. *The Brush Mountain crest* continues with a course of South 40° West for five and one half miles, with a breadth of 200 feet; it then gradually changes to South 60° West for about four and a half miles and keeps this course until it sweeps to the right, in obedience to the Sinking Valley anticlinal axis, around which it curves with a radius of about 4000 feet.

The elevation of the southwest point of the mountain, overlooking Hollidaysburg, is 2575 feet above tide; the slope of the mountain along the back of the anticlinal is 4° 42′.

Black's gap is 8000 feet northwest of the mountain point;

the distance across from point of crest to point of crest is 3600 feet.

From the gap on for 8000 feet the mountain has a course of North 60° East, with an elevation above tide of 2600 feet and an average width of 300 feet; after that it curves to the North 10° East for three miles; to the North 5° East for one and a half miles; and then to the North 45° East.

The elevation is gradually sinking from a maximum of 2650 feet above tide near the south end, to a minimum of only 1660 feet at the crossing of the Tipton main road.

The crest continues to Tyrone gap with the same course of North 45° East, and with an average elevation of 1900 feet. Beyond the gap the mountain changes its name to Bald Eagle mountain.

Oneida terraces.

§ 71. *The bench or inner crest* of these mountains remains to be described, the preceding description relating only to the main crest, formed by the upper member of IV; the bench being caused by the lower member of IV making lower but continuous inner crests, the two separated by the red rocks of IV, frequently so much softer in character as to make somewhat of a valley between the crests.

The bench follows the main crest in its various courses nearly, but *not* absolutely, paralled to it, and always with a lower elevation. There are many gaps in the bench, being indeed too numerous and unimportant to mention in detail; they occur along the whole face of the mountain, as frequently as one to every three quarters of a mile.

§ 72. *The bench of Tussey mountain* joins the bench of Dunning's mountain at the southeast corner of Morrison's Cove, and is 4500 feet from the crest, and 500 feet below it in elevation.

The bench of Tussey gradually approaches the crest towards Pattonsville gap, where it is 2500 feet distant from, and 500 feet below it. It keeps this same distance as far as the place where the crest makes its sweep around Leathercracker cove.

The bench runs on with a course of North 30° East to a point 7000 feet South 50° West from Henrietta Station on the Morrison's Cove Railroad; here it should turn sharply to the south, keep just east of the "Pulpit," and joins the bench which crosses the head of Leathercracker cove. The faults in Leathercracker are fully described in the chapter on structure, and their effect is plainly seen on the Geological Map, where the limestone of II rests directly against the lower of IV. In obedience to these faults there is no regular bench from the mountain point to the end of Leathercracker.

From a point between the "Pulpit" and "Calcup," the bench has a course of North 45° East, until it approaches the crest; here it turns towards the north, and is 2200 feet distant from the crest.

The country included between the bench and the long curve made by the crest around the Leathercracker anticlinal, is a high flat, cut up by three small ravines.

South of Henrietta the bench is wanting for a distance of 7000 feet, owing to a fault.

Opposite Henrietta the bench is 2000 feet away from, and 280 feet below the crest.

The bench continues nearly parallel to the crest as far as Fredericksburg, where it is 2800 feet away from the crest, and 340 feet below it.

From Fredericksburg northeastward the bench keeps nearly the same average distance from the crest.

Where the crest makes a loop at Cove forge the bench cuts across and joins the crest after the two turns have been made.

From Cove forge to Water street the bench, when it is not eroded, is 2100 feet from the crest. Two miles south of Water street gap, the Juniata river cuts through the bench into the red rocks in the middle of the mountain of IV, and flows along in these red rocks between the crest and the bench in a narrow deep hollow, with the mountain rising steeply on both sides, as far as Water street, where it cuts through the main crest (the upper of IV) and finally escapes from the valley.

There is a gap in the bench also at Water street, opposite to the one in the main crest, though there is no indication, in the limestone valley to the southwestward, that the river ever flowed through this gap in the bench.

From Water street to Spruce creek the bench makes but small show, there being almost a continuous slope from the main crest down to the limestone valley.

At Spruce Creek gap the bench shows very plainly; it runs out to the north much beyond the main crest and the Tyrone branch of the Juniata river makes a long sharp curve around it. It is through this point that the Pennsylvania railroad have their Spruce Creek tunnel.

§ 73. *The bench of Dunning's mountain* at its junction with the bench of Tussey mountain is 5000 feet distant from the crest, and 700 feet below it in elevation.

One mile further west the bench is distant 3000 feet from the crest. The bench then keeps at an average distance of 2500 feet from, and 500 feet below the crest, as far to the northeastward as the Bloomfield anticlinal.

Across the loop in the mountain made by the dying Bloomfield anticlinal the bench has been eroded; where it joins the crest west of this loop it is 2000 feet away from, and 200 feet below it.

The bench keeps nearly this same average distance from the crest as far northeast as Bloomfield.

From Bloomfield to McKee's gap the bench is about 1500 feet from the crest. Along this distance the bench has been very much eroded.

From McKee's gap to where the bench turns around the north end of the Bloomfield anticlinal axis it gradually separates itself from the crest by increasing distances.

§ 74. *Along Loop mountain* the bench averages 2400 feet from, and 400 to 500 feet below the crest.

At the center of the Martinsburg synclinal the bench is 2200 feet from and 500 feet below the crest.

§ 75. *Along Lock mountain* the bench averages 2000 feet distant from the crest.

§ 76. *The bench at Short mountain* is 2000 feet distant from the crest.

§ 77. *Along Canoe mountain* the bench when first seen is

2500 feet distant from the crest; a mile further to the north-east it is 2000 feet; and opposite Yellow Springs the distance between the crest and the bench is 3500 feet.

This interval distance decreases to 2800 feet and keeps this average distance as far as the curve around the Martinsburg synclinal. At this curve the greatest distance of the bench from the crest is 5200 feet.

§ 78. *Along Brush mountain* the bench is from 2500 to 3500 feet from the crest, the distance gradually increasing as the mountain approaches the anticlinal.

The bench crosses the Sinking Valley anticlinal three and a half miles north of the crest.

The bench along Brush mountain varies from a maximum interval distance from the crest of 3500 feet, to a minimum distance of 2000 feet at Tyrone gap of the Juniata river.

Water Gaps.

§ 79. *The gaps in the mountains of IV* bear strong resemblance to one another.

The gaps in the *bench* of the mountain are strikingly similar. They are usually a straight cut from the valley back through the bench well into the center of the mountain, and then two lateral hollows, turning sharp to the right and left, parallel to the mountain, and heading up on the flat part of the bench.

When the mountain is cut all the way through, the bench part presents the same features as just described above, and there is also a cut through the main crest to the outside valley.

These gaps are not all cut straight through the whole mountain mass; McKee's gap, Short mountain gap, and Tyrone gap are the only straight thorough cut gaps in the county.

§ 80. *Pattonsville Gap.*—Here the bench is first cut straight through; the gap then turns to the left and goes for 1300 feet along the left hand hollow in the middle of the mountain;

then turns to the right and makes a straight cut through the main crest.

§ 81. *Waterstreet Gap.*—Here the bench is partially eroded to the south of the gap, but the straight cut through it shows plainly on its north side; the gap then turns to the north and follows what was originally the flat of the bench for two miles; finally turns abruptly to the right and cuts through the main crest.

Moreover directly in line with this gap in the main crest there is a gap in the bench also, thus making a double gap in the bench for one gap in the main crest; and of the two gaps in the bench the one now serving for an outlet for the Juniata river is *not* the one directly opposite to the crest gap.

§ 82. *Spruce Creek Gap.*—Here the bench is cut through straight; the gap then bends to the south for 2400 feet; then turns abruptly to the left and cuts through the crest in a straight line.

§ 83. *Trout run, Ravers, Dry, and Black's gaps* are gaps in the crest alone, the bench not being cut through.

They are straight cuts through the crest, with hollows turning to right and left along the inner side of the mountain.

There are no signs of a fault or dislocation of any kind to be seen at any of these gaps, nor indeed is there anything in the structure to indicate why the gaps should be just where they are, and not at other points. Reasons there doubtless are; but they are not apparent.

The bottoms of the gaps are covered over with much loose stuff; but it cannot be very deep, for outside of the gaps the streams flow over the basset edges of solid rock in place.

The Allegheny mountain.

§ 84. *The Allegheny mountain* crest is the western limit of Blair county. The mountain rises from the valley which lies to the east of it in three well defined steps.

The valley has an elevation of from 900 to 1200 feet; the first rise of the mountain is to an elevation of 1500 feet;

then there is a comparative flat for 1½ miles; the second rise of the mountain is to the elevation of 2300 to 2400 feet; then again a broad flat area, and the third rise to the elevation of over 2500 feet, which is the maximum of the line of the mountain crest.

This description applies to the Allegheny mountain face as it is seen from a distance, such as the north point of Dunning's mountain, for example; but when taken in detail each limited area looks like a broken and disorganized mass of irregular hills. This is owing to the numerous ravines which cut down through the escarpment.

They generally start from the summit and cut a rather straight course towards the foot of the mountains, receiving many lateral equally deep cut hollows on both sides; and as these latter are deep and long, cutting far into the flat summits, they cause this constant appearance of isolated hills.

There are three kinds of mountains in Blair county. The anticlinal, the synclinal and the monoclinal mountain.

The anticlinal and synclinal mountains have no well defined illustrations in the county. The only specimens are the short parts of the mountains of IV, Tussey mountain, Dunning's mountain, &c., where the mountain is turning around the dying anticlinal or synclinal axis.

The anticlinal points are the south end of Leathercracker cove; northeast of Cove forge; southwest point of Dunning's mountain; junction of Dunning's mountain and Loop mountain, and the south end of Brush mountain.

The synclinal points are southwest of Henrietta; just east of Cove forge; junction of Loop and Lock mountain; junction of Canoe and Brush mountains; and the mountain called the Blue Knob, which is made up of formations IX and X.

§ 85. *The best example of an anticlinal point* is the southwestern end of Brush mountain. The two prongs of the mountain approach each other at nearly the same angle to the anticlinal axis, and as they have about the same elevation and slope, they make at their junction an anticlinal mountain with the same slope and a general regular appearance on both sides of the axis.

The other anticlinal points are very much like the one above described, but they vary somewhat in each case from it and from each other, owing to the fact that the dip of the rocks is of different strength on the two sides of the axis, causing the slope of the mountain to differ on the two sides; but these differences are not in any case very great, and there is no instance where the anticlinal is overturned where the mountain arches around the point.

The northwest point of Dunning's mountain has the greatest variation from the regular end. Dunning's mountain approaches the point with an almost vertical dip, while Loop mountain approaches with a dip of only 40°±. When they join they give the end of the mountain different slopes, that on the northwest side being very steep, while the east side has a flatter slope. The curve on the inner side of the mountain is not regular, but varies very much, being sharper on the side of the steepest dip, and falling off as it approaches the flatter dip of the other mountain.

When the anticlinal is regular the curve on the side is equally regular, making an arc of a circle, the radius depending on the dips.

§ 86. The *Synclinal mountain end*, south of Union Furnace, is an example of a synclinal point when the dip is nearly the same on three sides; the mountain sweeps around the axis with a regular curve, making an arc of a circle.

The other synclinal points only vary from the above, when they are regular synclinals, by the difference of the radius of the curve, owing to the difference of the amount of the dip. When the dip is not the same on both sides of the axis the curve made by the mountain is not regular but varies in the same way as the anticlinal points, as already described.

An *overturned Synclinal* mountain end presents an entirely different shape.

The mountain point southwest of Henrietta is the only one in the county. The dip of the rocks has almost the same direction on the two sides of the synclinal axis; and the mountain comes out into the valley in a sharp point. The two outcrops of the Sandstone join together some distance back from the point, and the mountain end is a long narrow ridge; in this particular case most of it having been eroded.

§ 87. *The monoclinal mountain* is the shape of most of the mountains of Blair county.

For a general description the monoclinal mountains may be divided into three classes:

1. *When the dip of the rocks is from 40° to 60°* away from the anticlinal. A good specimen of this is shown by Tussey mountain, from Henrietta northeast to Williamsburg.

A cross section of the surface will show a gentle rise from the limestone valley, across the slates, to the foot of the mountain; then the ground slopes up into an angle of 13° to the top of the bench; next a flat of 400 feet on the bench; then a fall of 20 feet in a distance of 400 feet; then a flat or very gentle rise for 800 feet; next a rise of 10° for 1400 feet to the main crest, which has an average width of 100 feet; and finally a slope down to the valley below, firstly on a 7° slope, flattening off to a 3° slope.

2. *When the dip is vertical.*—There are examples of this structure north and south of McKee's gap, and south of the Little Juniata gap.

In this case the mountain has somewhat the same profile as already described, except that from the edge of the bench there is no flat, but a gentle rise to the crest; then a steeper rise as it approaches the crest.

3. *When the dip is overturned.*—In this case the mountain profile resembles that caused by a vertical dip, except that the crest and bench are nearer the same elevation, and that the crest is cut by numerous notches.

Valleys.

§ 88. *The topography of the valleys* of Blair county has already been given in great part in the description of the enclosing mountains.

As there is no wide-spread drift material in Blair county the surface soil comes directly from the decomposition of the rocks underlying.

§ 89. *The lands of Morrison's cove and Canoe valley*, therefore, are limestone farms; and much of their area is cleared and cultivated, making valuable and productive farms.

The "barrens," which occupy a part of these valleys, are really not barrens at all, inasmuch as they can all be brought under cultivation; indeed some of the best farms in the valley have been reclaimed from the barrens within the last 20 years.

These barrens have remained so long uncultivated for two reasons: Firstly, because the ownership was in the hands of the proprietors of Bloomfield, Rebecca, and Springfield charcoal furnaces, and the owners desired the land to remain wooded; and secondly, there being no springs or running water on the land, the farmers were obliged either to use rain water, which is largely done, or else sink fully 100 feet on the average in order to secure a good well. The reclamation of these lands is still progressing, and these valleys will soon be entirely under cultivation from end to end.

§ 90. *The slates of III* are cultivated wherever the hill or mountain side is not too steep.

Probably one half, on a rough average, of all the land underlaid by these slates, is in cultivated farms.

§ 91. *The Bald Eagle valley*, between Dunning's and Brush mountains and the Allegheny mountain, is underlaid by the slate of VIII, IX making the mountain foot hills.

The valley is generally cultivated along its whole length in Blair county, and makes good though not specially rich farm lands.

§ 92. *Sinking valley* is a limestone valley similar to Morrison's cove, and is cleared and cultivated, making rich and valuable farms.

CHAPTER V.

Drainage.

§ 93. The drainage of Blair county is somewhat complex, as might be inferred from the previous description of its mountains, valleys, water-gaps, and geological structure. This drainage will now be given in detail, starting as before from the south and going northward.

From the top of Dunning's mountain, where it sweeps across the southern end of Morrison's cove, and looking towards the north, the view presented is that of a large and level limestone valley from 5 to 10 miles wide, and extending northeast, with the appearance of an unbroken plane for over forty miles.

But this unbroken appearance is due simply to the fact that the observer is raised 1000 or more feet above the plane; for on examining the valley in detail it is found to be cut up into numerous irregular subordinate valleys, in which flow streams heading towards the various gaps that afford an outlet from the valley.

§ 94. The Pattonsville gap drainage system takes in all of Morrison's cove south of the following line.

From the crest of Dunning's mountain, back of Bakersville, northeast to the south end of Bloomfield mines; thence east to Curry's Station; thence southeast to Tussey mountain at the school house west of Henrietta; thence south along the crest of Tussey mountain to Dunning's mountain and along its crest to Bakersville.

Beaver run rises in the loop formed by the dying Bloomfield anticlinal axis and flows in a flat valley, keeping nearly half a mile from the foot of the mountain, all the way around to Pattonsville gap, where it empties into Yellow creek. The run has an average fall of 45 feet to the mile.

Three Springs run starts from three large springs just west of Enterprise, flows in a winding course through a narrow valley, with generally steep sides, in a direction a little north of east, and empties into Yellow creek one half mile north of Pattonsville. The run flows straight across the measures and has an average fall of 60 feet to the mile.

West of the source of Three Springs run there is a dry hollow, heading up a mile east of the foot of Dunnings's mountain. This hollow, and another which starts at the Leidy iron ore bank, were originally the head waters of Three Springs run. They are now dry except in very rainy weather.

A hollow starts a mile south of Bakersville, runs a general southeast course and empties into Yellow creek at Waterstreet. It is a dry hollow for about the first half of this distance. It has an average fall of 45 feet to the mile and the valley has an average width of from 200 to 300 yards with steep sides. The stream crosses the strike of the rocks at an angle of 45°.

Yellow creek heads at Curry's Station (Morrison's Cove Railroad,) flows with a general south course past Woodberry, Waterside, Pattonsville, through Pattonsville gap, around the end of Koot hill, and empties into the Raystown branch of the Juniata at Hopewell.

From Curry's to near Woodberry it is a dry hollow, being a flat of three or four hundred yards in width with hills rising steeply on both sides. At Woodberry, where the creek begins, the valley keeps about the same width, but with steeper sides.

From Curry's to the Pattonsville gap the creek has an average fall of 34 feet to the mile. The course of the stream carries it gradually across the measures.

At the south end of Bloomfield mines a dry hollow heads up. It has a southeast course, emptying into Yellow creek just north of Woodberry. One mile from its mouth a very large spring comes into it from the hillside. The hollow has a fall of about 50 feet to the mile.

Hickory Bottom run heads on the divide one and three quarter miles southwest of Henrietta, keeps about three quarters of a mile from the foot of Tussey mountain, and empties into Yellow creek above Waterside. The run first flows through a broad flat, with a gentle rise on either side, but the valley narrows down and the sides steepen as the run approaches its mouth. The average fall is 45 feet to the mile. The run has one main branch which comes out of Tussey mountain from the "Pulpit."

The hills between these different streams which drain through Pattonsville gap vary in elevation from 1300 to between 1600 and 1700 feet above tide. They are irregular in shape and have flat or gently rounded tops.

The area drained through Pattonsville gap is 73 square miles.

§ 95. *The McKee's gap drainage system* takes in that part of Morrison's cove described below.

The water shed is along the line of the Pattonsville gap water shed from Bakersville to Curry station; thence to the north to a point one mile northeast of Martinsburg; thence to the west to strike the mountain at the junction of Loop and Lock mountains; and finally follows the mountain around to Bakersville.

Halter's creek starts one mile north of Bakersville, in a broad flat; opposite Bloomfield the flat contracts to a narrow ravine with steep sides. The creek flows northward, parallel to Dunning's mountain, as far as McKee's gap, passes through the gap, and one and a half miles west empties into the Juniata river.

On the east side of Bloomfield mines there is a dry hollow, which empties into Halter's creek, one mile southwest of Roaring Spring.

Another dry hollow starts two and one half miles south of Roaring Spring. Its course is north to Roaring Spring, emptying into Halter's creek. The railroad runs along it for a short distance.

Halter's creek has a fall of 70 feet to the mile.

Plum creek rises south of Martinsburg. It flows through a broad, flat valley as far as Sharpsburg, and then contracts to a narrow valley with steep sides, except for the last half mile nearest its mouth, where it widens out to a flat, 300 to 400 yards broad. The creek crosses the Martinsburg synclinal, then flows along the strike of the rocks, near the foot of Loop mountain, until it reaches a point one mile east of McKee's gap, where it cuts across the Bloomfield anticlinal and turns to the south along Dunning's mountain, emptying into Halter's creek at the gap.

Plum creek has a fall of 50 feet to the mile.

§ 96. *The drainage of the remainder of Morrison's cove*, as far as the Juniata river, is divided into two almost equal parts by a line from Martinsburg along the center of the cove to Williamsburg. Clover creek drains the east side, and Piney creek the west side.

§ 97. *Clover creek* rises at the head of Leathercracker cove, flows nearly parallel to Tussey mountain for twenty miles, and empties into the Juniata river just above Cove forge.

From Henrietta to Beavertown it flows through a broad valley with gentle slopes on the sides. Opposite Beavertown the valley contracts to a width of 100 yards, with very steep sides; it also changes at the same time from an almost straight course to a winding one with numerous sharp curves.

There are no streams flowing into Clover creek from the west side; but on the east side there are numerous small streams coming out of the bench of Tussey mountain; many of them flowing into the creek, while some sink into the limestone rocks before reaching the creek.

Clover creek falls 31 feet to the mile.

§ 98. *Piney creek* heads north of Martinsburg, flows in the limestone parallel to the line of Lock mountain, and empties into the Juniata river at Franklin forge.

From Martinsburg to a point one mile south of Springfield furnace, the creek flows through a broad valley with gentle slopes; at that place the valley contracts, the sides steepen, and the creek continues through a narrow winding hollow to Franklin forge.

Piney creek has only one branch from the east. A small run starts from a spring two miles south of Springfield mines, flows to the north for some distance, and then sinks in the limestone in the same hollow; but further to the north the creek starts again at some large springs and empties into Piney creek at the point where the railroad leaves the creek bank to run to the mines.

On the west side, Piney creek receives numerous small streams from the bench of Lock mountain.

Piney creek falls 45 feet to the mile.

The country between Clover and Piney creeks is high and has no flowing water or springs; indeed water is found with difficulty, some of the wells going down 90 feet before reaching it.

§ 99. From Clover creek westward the ground rises to a high hill, and from Piney creek eastward the ground rises also to a high hill; these two parallel hills being separated from each other by a valley, or rather a succession of valleys, parted from each other by low divides, the ends of the valleys cutting out through one or the other of the bounding hills. There is no water in this central valley.

The two miles of the valley just south of Williamsburg drain directly into the Juniata river. Williamsburg spring comes out of the north end of the Clover Creek hill.

The central valley is sandy ground, mostly covered with underbrush, but where it is farmed seems fairly productive.

§ 100. On crossing the Juniata river into Canoe valley the drainage changes its character, and the system is entirely different from that south of the river, between Martinsburg and Williamsburg, which has just been described.

The streams now flow from the west to the east directly across the measures, and are very much alike in general character. They start in the foot hills of Canoe mountain, flow northeast across the valley through deep narrow hollows with steep sides, and have an average fall of 100 feet to the mile.

Along the foot of Canoe mountain the valley has an elevation of 1100 feet above tide, the whole valley sloping towards Tussey mountain.

§ 101. At the north end of the valley there are two small hollows which have a north and south direction, the waters therefrom emptying into the Little Juniata river near Spruce creek.

§ 102. Sinking valley is triangular in shape, the apex being at the south end, where the two Brush mountains join.

From its south point it rapidly widens out into a flat plane, then changes to a central ridge, increasing in elevation going north, with a creek on each side which cut deeper as they go north.

§ 103. *The creek on the east side of the valley* rises on the high ground on the back of the anticlinal, in the "Kettle," flows along the center of the anticlinal for about three and one half miles, then works over to the east side of the valley, and flows along the foot of the mountain in limestone for about two miles, where it disappears in a large sink-hole. For a mile beyond the sink-hole the hollow is dry.

Then *another* creek starts in the main hollow from two branches; one heading near the west side of the valley, flowing directly across the measures and meeting another small stream which has come off the bench of the mountain. This creek flows on for a mile or two and gradually sinks, the distance it flows and the sinking point depending upon the dryness or wetness of the season.

§ 104. *Five miles north from the junction* of the two streams above mentioned, in the center of the valley, a small stream starts and flows east for a mile and a quarter, and then sinks into a large cave. From the cave to Arch springs, a distance of 4200 feet, there is no surface flow of water, as it all flows through the cave.

From Arch springs the creek flows through a flat, in a general northeast course, emptying into the Little Juniata river at Union furnace.

§ 105. *Elk run* rises in the bench of Brush mountain, back of Scalp Level, and flows along the foot of the mountain on a northeast course, emptying into the Little Juniata river at Tyrone forges.

Soon after entering the limestone it cuts a deep, narrow, and rather winding hollow, which deepens as the run approaches its mouth.

§ 106. On the southwest side of the valley for two miles all the water that drains out of the gaps in the bench disappears in sink-holes soon after reaching the limestone land.

§ 107. The so-called "Beaver Dams" is the valley between Brush and Canoe mountains, north of the Juniata river.

It is drained by *Canoe creek*, which rises at the head of the valley, and flows down the center, through a broad valley with gently sloping sides.

Two miles north of Canoe creek P. O. the creek leaves the center of the valley, and thereafter flows on the east side, emptying into the Juniata river at Canoe creek P. O.

The valley from its head to within two miles of Canoe Creek is quite regular; the center is a narrow flat, then a slope on both sides towards the mountain, the slope at first very gentle, then steepening gradually as the mountain is approached.

§ 108. The valley between Lock, Loop, Dunning's, and Brush mountains, has three names.

North of the Juniata it is divided into Turkey and Scotch valleys; Scotch valley being that part which lies along the foot of Brush mountain.

South of the Juniata river the valley goes under the name of "the loop."

The ground is very much broken by hills of the slates of III, which rise steeply, and generally have a direction parallel with the strike of the rocks.

In the loop the hills curve along the rising synclinal.

§ 109. *Old Town run* rises at the junction of Loop and Lock mountains, and flows along the center of the synclinal for one and a half miles; turns to the west, flowing along the foot of a steep hill of the limestone of VI; the valley in this distance has a gentle slope to the south; the creek then crosses the Bloomfield anticlinal axis and empties into the Juniata river one mile south of Frankstown.

§ 110. A run starts at the foot of Lock mountain, where the wagon-road to Springfield crosses, cuts through a hill of VI and VII, winds around a hill of VIII, and empties into the Juniata river at Reese's station.

§ 111. Scotch and Turkey valleys are filled with numerous small runs, which cut through the measures in every direction. The runs are all short, and empty directly into the Juniata river; they make narrow valleys, with steep sides.

§ 112. *Flowing Spring* is a few hundred yards north of Canoe Creek station. It is an intermittent spring, the flow of water increasing and diminishing about every two hours. The spring comes out of the foot of the mountain, and most likely has its source in the limestone of VI.

§ 113. *The main branch of the Juniata river* has its head-waters in the foot hills of the Allegheny mountains in the north-western township of Bedford county.

It receives the rain-fall of the west slope of Dunning's mountain, the escarpment of the Allegheny mountain, and of the Bald Eagle valley; flows northward through Bald Eagle valley, receives at McKee's gap a large accession to its volume by taking part of the drainage of Morrison's cove, as already described; and by the time it has reached Hollidaysburg is already a river of considerable size and importance.

After passing through the Short mountain gap its walls are high and steep; and this is increased after it has got into the mountain of IV, and is running through the middle of IV, before it finally cuts through Tussey mountain and leaves the county at Waterstreet gap.

§ 114. *The Little Juniata river* receives the drainage of the northwestern townships of Blair county, and is already of considerable size where it cuts through Bald Eagle mountain at the Tyrone gap.

From here it flows nearly an east course, cutting deeply down through the limestone, and winding around the north point of Brush mountain at Union furnace. It receives the drainage from Sinking valley and Canoe valley on the south, and from Warrior's Mark and Spruce creek valleys on the north; and much augmented in volume leaves Blair county at Spruce creek gap.

From Tyrone gap to Spruce Creek gap it is the north boundary line of Blair county.

CHAPTER VI.

Geological Structure.

§ 115. The geological structure of Blair county is grand and simple in its main broad outlines, though a close examination shows that this simplicity is rendered complex in places by subordinate anticlinals, synclinals, overturns and faults.

The broad simplicity of structure is this. The eastern center of the county along its entire length, is the limestone valley of Morrison's cove and Canoe valley. The center of this anticlinal brings to daylight limestone and sandstone which is fully 6000 feet below the bottom of III, and is probably either in or near to the top of the Potsdam sandstone, Formation I.

To the east and west of this anticlinal the measures dip away from it, until to the westward the Lower Productive Coal Measures, XIII, are caught on the Allegheny mountain at Bennington, while to the eastward the same measures are caught in the Broad Top coal field in Huntingdon and Bedford counties.

The coal measures are only some 2000 feet above tide, and the center of the eroded anticlinal is from 1000 to 1500 feet above tide.

Some idea of the magnitude of the axis may be formed from the fact that it is 40 miles broad from base to base; and if the center of the arch were not eroded the coal measures would now be riding over Morrison's cove in a mountain over 20,000 feet above sea level.

§ 116. The subordinate complications of structure will now be given in detail. Some are more clearly defined than others, and about some of the features, such as the Henrietta faults, there still remains considerable uncertainty.

§ 117. The Canoe Valley anticlinal enters the district* a short distance below Yellow Creek P. O., bringing Formation V to the surface; it has a course of North 20° East, rises to the north at the rate of 2000 feet to the mile, and brings up III to the surface only two miles from where it enters the district.

The curve of the axis is approximately regular, the eastern dips being the steepest.

It then turns gradually to a course of North 5° West, with the axis rising only about 50 or 60 feet to the mile. The axis becomes gradually overturned, the northwest dip becoming steeper and steeper until it dips to the southeast.

The anticlinal axis brings up II three miles south of Henrietta; from this point on to the northward II is the rock which covers the back or center of the anticlinal.

Starting from the southward the anticlinal crosses Yellow creek with V as the rock on the center of the arch; the sharp north rise of the axis shoots V out into the air and two miles to the north, IV is the rock which crests the arch.

From this point on to within three miles of Henrietta IV makes the crest of the arch, excepting for a short distance where the Raver's Gap run cuts down through the crest of the axis, exposing the rocks of III.

Through Henrietta, and on to the northward the limestone of II is the country rock on the crest of the anticlinal.

The anticlinal axis turns to a course of North 10° East, passes one half mile west of Henrietta, and brings up to the surface some 2000 feet of the limestone of II.

The axis must then turn to the North 30° East, passing from one fourth to one half mile east of Millerstown and the Red ore bank.

After passing the Red ore bank the axis takes a course of North 10° East, crossing the Fredericksburg-Martinsburg main road a short distance west of Fredericksburg. It then turns to the North 25° East, and keeps this course, passing a short distance west of the Rebecca mines, where it brings up some 5800 feet of the limestone of II.

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* By this is meant all of Blair county and such part of northern Bedford county as are included on the maps accompanying this volume.

This shows a rise in the anticlinal of 3800 feet between Henrietta and Rebecca, or an average rise of 1000 feet to the mile.

The axis keeps the course of North 25° East, passing a short distance east of Springfield mines, where it joins the Morrison's cove anticlinal axis.

It is possible that the two axes may join, a short distance, say one or two miles, northwest of Springfield mines, thus placing the mines in a small synclinal between the two axes. It is not easy to define just where the two axes join.

At Springfield the Canoe valley anticlinal axis brings up some 5600±feet of limestone rocks.

From Springfield the axis has a course of North 33° East to Williamsburg, passing through the western edge of that town.

The axis then turns to a course of North 10° East in Canoe valley, going directly through the Ætna iron ore banks, and passing about one half mile east of Yellow Springs.

Beyond Yellow Springs the axis turns to a course of North 30° East, keeping to the east of the center line of the valley, as far up as opposite Waterstreet; there it turns to the north, crossing the Little Juniata river a few hundred feet east of Bridge No. 3, on the Pennsylvania Railroad; and north of the Little Juniata it continues on through Spruce Creek valley.

§ 118. The next anticlinal axis (going west) that shows in the district is the axis that makes the uplift of Snake Spring valley. It comes from the latter valley with a course of North 20° West, with a very gradual sinking to the north; when it enters the county, to the northward, the axis is probably flat, but inasmuch as they are much affected by the next axis to the west, it is difficult to say what their condition is at any given point.

As first seen the middle of IV covers the crest of the axis; coming northwest the lower of IV makes the crest; then III arches over, and the axis develops in the flat limestone valley of II.

This description would indicate that the axis was rising to the north, but as it does not continue out into the limestone, it seems more likely that the apparent rise is due to the lifting up of the country by the next axis to the west.

§ 119. The Morrison's cove anticlinal axis starts very abruptly, the starting point being indicated by a very slight curve in the crest of Dunning's mountain, four miles South 20° West from Enterprise.

The axis rises about 20° along its crest line, and with this sharp rise formations V, IV and III are rapidly thrown out into the air.

The course of the axis is North 20° East and it passes a short distance west of Enterprise.

The rise along the crest of the axis gradually flattens going north. But as far at least as Enterprise the axis is remarkable for the fact that the dip of the rocks along its center line must be greater than the dips on the side slopes.

The axis after passing Enterprise curves to the eastward until it takes a course of North 36° East, passing about half way between Waterside and the Barley iron ore bank, 1000 feet west of the town of Woodberry, and one half mile east of Curry's. At Curry's it brings up over 3000 feet of the limestones of II.

After passing Curry's the axis turns to a course of North 25° East, and keeps this direction, passing about one mile east of Martinsburg, until it reaches a point opposite the Rebecca ore mine; near the Rebecca mine it brings up 3300 feet of limestone; it then turns to a course of North 30° East, passing through Springfield mines, running near mine No. 3.

The axis makes an almost perfectly straight line from Curry's station to the Springfield mine.

At mine No. 3 the axis is already close to the Canoe Valley anticlinal and it soon dies into the latter as already described.

§ 120. The Alexandria anticlinal axis shows on Clover creek, east of Williamsburg. It shows imperfectly, and is chiefly visible in the flattening of the dips in the limestone rocks.

It has a general course of North 30° East; soon passes into the slates of III and into the sandstones of IV; makes the mountain loop back of Cove forge, and then rapidly sinks with formation V arching over it.

§ 121. The Bloomfield anticlinal axis rises from the south, with formation V arching its crest, at an angle of about 17°.

Formations IV and III arch around the axis within a distance of two miles.

The anticlinal axis, after it brings the limestone up on its back, becomes very much overturned, and with no dips to show its exact course.

The most probable direction along this distance is North 20° East past Lafayetteville, and a mile or two beyond it; then it turns to the North 10° East passing through the Bloomfield mines (possibly making an angle between the strike of the mine banks and of the axis of some 30°) and runs on, passing east of Roaring Spring; it then turns and runs on a course of North 20° East, gradually sinking to the north and losing its overturn; the northwest side being very steep but regular.

Two miles northeast of McKee's gap the axis has subsided enough to allow III to arch over its crest.

From here on to where it crosses the Juniata river, just east of Frankstown, it sinks at an average rate of 1000 feet to the mile, formations III, IV, V, and VI coming in on top of the crest in regular order.

The axis crosses the Juniata river and dies completely to the northeast of Frankstown; formation VII does not cross the axis.

§ 122. The Sinking valley anticlinal axis first shows on the contoured map southwest of Hollidaysburg; passes west of that town on a course of North 40° East, rising at the rate of 450 feet to the mile to the crest of the mountain, where IV laps over the arch of the axis.

The anticlinal axis then turns to a course of North 55° East, rising at the rate of 460 feet to the mile; it then turns to a course of North 37° East, rising at the rate of 300 feet to the mile.

Next it has a course of North 25° East for four or five miles; where it curves to the North 45° East, rising at the rate of 730 feet to the mile, and crosses the Juniata river just west of Birmingham.

The total rise of the axis from a point one and a half miles southwest of Hollidaysburg to the Juniata river is 11,240 feet, equal to an average rise of 555 feet to the mile.

The anticlinal axis then runs on to the northward through Warrior's Mark and Nittany valleys.

§ 123. The Short mountain anticlinal axis shows for about four miles.

At the southern end the rocks, instead of having been folded into an anticlinal, were broken and thrown up on the eastern side, making the Short mountain fault.

The northern end of the anticlinal can only be seen by the curve in Canoe mountain, west of Yellow Springs.

§ 124. The Tipton-Altoona anticlinal axis can be first studied to the southward, where it brings up formation VII to only 430 feet below the surface at Altoona Station; it is then seen making a curve in the outcrop of VII and VI, where the road from Altoona to Sinking valley crosses the limestone ridge.*

The anticlinal then keeps on in VI, passing just west of Baker's ore mine.

It goes on in VI as far as Tipton.

§ 125. The Blue Knob anticlinal axis is in the western part of Greenfield and Juniata townships.

The axis comes from Bedford county; runs on a course parallel to the line of the Allegheny mountain crest; crosses Greenfield township; enters Juniata township, runs part way across it, and finally dies down near the center of that township.

The axis brings up the red rocks of the Catskill formation as the country rock along its arch, and thus makes some smooth farms at the very foot of the Allegheny mountain.

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* The upper western outcrop of VI and VII from Altoona north to this road is wrong on the colored map. The reader can easily make the following corrections:

Make the top of VI outcrop 800 feet west of the southwest corner of the Altoona reservoir, instead of 1000 feet, as on the map.

From this point run the outcrop of VI North 45° East to a point 1000 feet south of the road; then by two reverse curves join this new outcrop with the one on the map at the point where it crosses the road.

This short anticlinal is conspicuous in consequence of the high Blue Knob synclinal mountain which lies to the east of it, standing out conspicuously, detached from the crest of the Allegheny mountain and towering high above the valley below, the Blue Knob crest (in formation X) being fully 2800 or 2900 feet above the ocean.

§ 126. There are several well defined and important faults in the region covered by this Report. Two of these faults are in Leathercracker cove, a sub-division of Morrison's cove; they are of practical as well as geological importance inasmuch as they govern the limits of the iron ore deposits worked at the Henrietta ore mines.

There is a fault in Short mountain, at the Juniata gap; and a fault in Tussey mountain at the Spruce Creek gap of the Little Juniata river.

All of these faults will be found properly illustrated on the colored contoured Morrison's cove sheets and in the cross section sheets.

§ 127. The Leathercracker cove faults (see contoured map) show the limestone of II resting directly against the sandstone of IV, on the east side of the cove; and also another fault on the west side of the cove.

The details of the structure are as follows:

The main crest of Tussey mountain comes from the south perfectly regular up to "Calcup;" the bench of the mountain also comes from the south parallel to the main crest, and runs on all right to the school house.

The main crest stops at the "Pulpit," which is in line with the mountain to the southward; it is separated therefrom by an ordinary gap.

Thirty-two hundred (3200) feet south of Calcup the mountain starts back on the curve around Leathercracker cove.

At the place where it leaves the main mountain it is gapped by Trout run; the gap is at the junction of the two mountains.

From the gap the mountain runs on around the curve formed by the dying Leathercracker anticlinal. After passing the point the mountain is cut by an ordinary and regular gap, called Raver's gap.

The mountain continues northward, with a slight curve in it, and then passes on to the northeast regularly without any sign of a disturbance.

The bench then starts directly from the foot of Calcup, runs northeast in a straight line for 9000 feet, where it meets the main crest in its normal position. From this point for 6000 feet to the northeast the bench is wanting. The bench then starts in again and follows the main crest regularly. The slates of III, so far as can be seen, follow the bench.

The exact construction of the *Leathercracker faulted area* is difficult of determination and more difficult to describe.

The data for the construction are these:—

1. The line of contact ore (between II and III) running from the Henrietta bank, not in its normal course of S.20° W. but due south.

2. The absence of the *Oneida terrace* (lower of IV) at the south end of the line of ore.

3. The swallowing up of the slates of III at the south end of the line of ore.

4. The reappearance of the slates of III south of the road.

5. The failure of the *Oneida terrace* after making the knob at the school house opposite Henrietta, to return southward along the west side of Leathercracker cove.

6. The fact that the slates of III lie close up against the east foot of the *Medina* knob called the pulpit (south of the road from the Cove to Woodbury.)

7. The thinness of these slates of III, shown by the nearness of the sinkholes to the Medina rocks in the Pulpit.

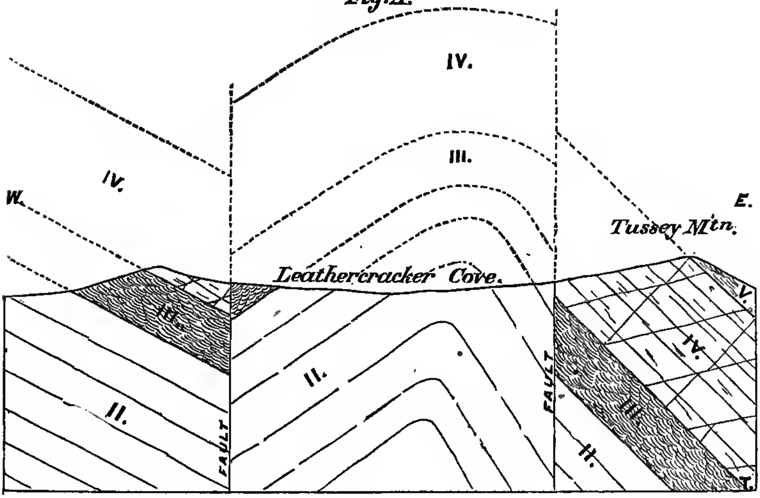
8. The 130° (overturned 50°) dip towards the east at the end of the Calcup (the knob next further south, near the south end of the long "Probable Fault" on the map.)

9. The ravine gap at the north end of the synclinal of V, a gap unique of its kind, and inexplicable, except on the supposition of an overturned and snapped synclinal, developed into an upthrow fault along a line from south northward, from the Calcup to the schoolhouse.

Taking these data into due consideration, it is evident that two approximately parallel north and south faults enclose an anticlinal mass of limestone forming the floor of Leathercracker cove; that the two faults are upthrows in contrary directions; that the limestone mass has been projected upward between the broken wall, and that the highest point of projection is on the road from the school house to Saxton, southeast of the centre of the Cove.

This construction is shown by Fig. A, following.

Fig. A.



§ 128. Southwest of Millerstown, up to a point just southwest of the Martinsburg and Fredericksburg road, there is a narrow ridge containing the slates of III.

The line of this ridge prolonged to the southwest intersects the Pulpit. From the point just southwest of Millerstown to the school-house, a distance of one and a quarter miles, the country is all limestone, the ridge keeping about the same elevation.

The dips south of Fredericksburg and on both sides of the slate ridge are all to the southeast, except west of Raver's gap, on the road leading out of the gap, where they have a northwest dip, thus showing a regular anticlinal axis.

§ 129. The Hoover bank is only 2000 feet from the crest of the mountain, and has limestone in place showing in the working face.

How can limestone of II be in place in the Hoover mine, and why are the slates of III absent from the hill west of Henrietta station, in Leathercracker cove?

There is but one explanation, and that is the presence of a great upthrow fault.

The fault is in the middle of IV, with an upthrow on the west side of 2000 feet, more or less, bringing the limestone of II against the middle of IV.

The length of the fault is about 5000 feet, and it is approximately parallel to the strike or trend of the rocks.

CHAPTER VII.

Coal Measures.

§ 130. The Coal Measure rocks touch only a part of the western edge of Blair county; and that part only included between the old abandoned Portage railroad on the south and the Buck Horn tavern on the north. This comprises an area barely nine miles long.

If the line dividing Blair from Cambria on the west had pursued a straight course northeastward from where it starts at the Blair-Cambria and Bedford corner at the south, it would have allowed no coal measures at all to Blair; they would have been entirely west of the line, in Cambria. But following as this line partly does the highest summits of the Allegheny mountain it has an irregular and zig-zag course, advancing west a few points, or receding as many to the east as the case may be, until, at the old Portage railroad it curves westward on to a high inner crest which extends from the Portage railroad as above stated, northward to the Buck Horn tavern. This inner crest is composed of coal measures; and these are the coal measures of Blair county.

§ 131. The Coal Measure rocks in western Pennsylvania comprise a series more than 2500 feet thick at the maximum.

For convenience sake these have been divided into four groups, which in their order downwards are as follows:

The Upper Barren Measures.

The Upper Productive Coal Measures.

The Lower Barren Measures.

The Lower Productive Coal Measures.

§ 132. In the Coal Measure region of Blair and indeed throughout the greater part of Cambria county, little more than the lowest member of these subdivisions has escaped erosion, and then only this member in part. Where fully expressed it embraces about 300 feet of rocks extending from the top of the Pottsville Conglomerate to the base of the Mahoning sandstone. This latter rock begins the next higher group, the Lower Barrens, of which, in Blair, only a trace remains along the mountain crest; but in other localities where the entire series has been preserved it measures 600 feet from top to base.

§ 133. The geological structure of this particular area will already be fully understood by the reader if he has examined the cross sections and maps accompanying this volume. He will have observed that the Allegheny mountain is a monoclinal ridge, in which the rocks dip uniformly to the northwest, at angles decreasing steadily in steepness in proportion to their distance westward from the base of the ridge. Hence on the top of the inner crest, where these Coal Measures are, the rocks are nearly horizontal, the dip in the Pennsylvania railroad tunnel not exceeding 1°.

§ 134. The original great outspread of the coal rocks eastward from the Allegheny mountain across all the valleys and mountain tops of Blair is a well known fact that has been sufficiently discussed elsewhere. And whatever may have been their original extent and however high the mountain summits over which they crossed in Blair, the crest of the Allegheny is now the eastern edge of the great bituminous coal basin of western Pennsylvania. But even these boundaries are undergoing constant change, of course imperceptibly, for all observation tells us that where hard beds rest upon softer strata, as they do in the Allegheny mountain, the action of the erosive agencies, the frost and the rain is to wear away the escarpment and work it backward in the direction of the dip.

§ 135. Considering then that the Allegheny mountain is one of the rims of the Great Bituminous Coal Basin, it becomes of special interest as the starting place in Pennsylvania of those rocks which play so important a part in the formation of our western counties. And it happens that nowhere on the Allegheny mountain can these rocks be better observed than in the neighborhood of Bennington, in Blair county, where by means of natural and artificial exposures all the strata of the Lower Productive system may be examined and measured. A few years ago, in 1875, when Cambria county was surveyed the small adjacent patch of Coal Measures in Blair was included in the survey; and the results then obtained were published in the Report of Progress for Cambria county.* Excepting the details of some few mining developments made since that time the following description is little more than a repetition of what was then said, and is here added to make this report on Blair county complete in itself.

§ 136. The section of the measures at Bennington properly includes that portion of the Lower Barren group found on the crest of the mountain in the vicinity of the Penn'a RR. tunnel. The exposures, however, of these Lower Barrens are somewhat incomplete; but joining them together in their regular order of succession we obtain the following section:

1.

Sandstones and shales, argillaceous,	Lower Barren Measures.	8′ 0″
Sandy shales with iron ore nodules,		10′ 0″
Coal bed,		0′ 10″
Fireclay, calcareous,		3′ 0″
Shales, sandy,		10′ 0″
Sandstone, light gray,		4′ 0″
Fireclay shales,		6′ 0″
Shales, olive and argillaceous SS.,		12′ 0″
Interval, sandstone?, Mahoning?,		50′ 0″±
Coal bed,		2′ 8″
Shales, drab,		20′ 0″
Shales, olive,		5′ 0″
Slates, massive,		10′ 0″
Slates, olive, and shales,		20′ 0″
Coal bed (E), Freeport Upper,		5′ 6″
Fireclay, impure,		2′ 0″
Sandstones and black slates,		20′ 0″
Limestone, Freeport Upper,		3′ 0″

* Report HH, 1877, Chap. I.

Ferruginous slates and shales,	20′ 0″		
Sandstones and sandy shales,	20′ 0″		
Coal bed (*D*), Freeport Lower,	3′ 0″		
Fireclay,	1′ 0″		
Sandstone, drab,	21′ 0″		
Slates, black,	20′ 0″	} 22′ 10″	
Coal bed (*C*) Kittanning Upper,	2′ 10″		
Slates, drab, holding iron ore balls,	11′ 0″		
Sandstone,	0′ 7″		
Slates, blue,	13′ 0″		
Sandstone, massive, drab color,	15′ 0″		
Slates,	12′ 6″		
Coal, } Kittanning Middle (*C*),	0′ 6″		
Slate, } Kittanning Middle (*C*),	0′ 6″		
Coal, } Kittanning Middle (*C*),	1′ 8″		
Fireclay, impure,	6′ 0″		
Sandstones,	12′ 0″		
Slate,	1′ 3″		
Coal bed,	0′ 4″		
Sandstone,	7′ 0″		
Black slates,	8′ 10″	} 12′ 4″	
Coal bed (*B*), Kittanning Lower,	3′ 6″		
Fireclay, good,	3′ 0″		
Shales,	29′ 0″		
Black slates,	2′ 0″	} 3′ 8′	
Coal bed (*A′*), Clarion,	1′ 8″		
Slates,	23′ 0″		
Sandstone,	4′ 0″		
Coal bed (*A*), Brookville,	4′ 0″		
Fireclay,	4′ 0″		
Sandstone, massive, Homewood (SS.),	20′ 0″		Pottsville Conglomerate, XII.
Gray and brown shales,	10′ 0″		Pottsville Conglomerate, XII.
Sandstone,	16′ 0″		Pottsville Conglomerate, XII.
Black slate,	1′ 8″		Pottsville Conglomerate, XII.
Coal bed, Mt. Savage?	1′ 8″		Pottsville Conglomerate, XII.
Fireclay,	5 6″		Pottsville Conglomerate, XII.
Conglomerate,	15′ 0″		Pottsville Conglomerate, XII.
Red shales and bog ore,	10′ 0″		Pottsville Conglomerate, XII.
Conglomerate,	100′ 0″		Pottsville Conglomerate, XII.
Total thickness of rocks,	624′ 0″		

§ 137. As before stated, the Lower Barren strata occupy the mountain crest west of Bennington. Northeastward from the tunnel they extend for a considerable distance, but west of the summit of the mountain, so that the Blair county line shortly leaves them and passes into lower rocks. Southwestward from the tunnel they are continuous as far as Mr. Lemon's house, near the old Portage R. R., where a shallow ravine breaks the crest line, beyond which to the southwest the boundary between Blair and Cambria traverses rocks below the Coal Measures.

The Lower Barrens, as here displayed, are typical of their condition generally throughout the western counties of the State. They are made up chiefly of soft argillaceous rocks, containing no coal beds of value. Exceptional instances are indeed known to occur where these strata enclose valuable coal seams, as for example at Berlin, in Somerset county, and also at Summer Hill, in Cambria county; but the occurrences are unusual, and the "Barrens" have indeed derived their name from the almost universal absence in them of productive coal beds.

§ 138. The small coal seam near the top of the section possibly has its equivalent in the Philson coal bed of Berlin; but this is more or less conjecture. The lower seam, that 55 feet above the Freeport Upper, is called the *Gallitzin bed*, and has been repeatedly recognized further west in Cambria, Indiana, and Armstrong counties. Its place is usually at the top of a thick plate of sandstone, the lower member of the Mahoning, which at Bennington is not prominent, being represented by thin shales. But the *upper member* of the Mahoning Sandstone is a heavy compact rock, and is conspicuous on the slope above the tunnel. About a mile northeast of the tunnel the same rock is quarried for building stone of which some that is here obtained is of tolerably good quality.

The Lower Productive Coal Measures.

§ 139. Counting the different coal beds, large and small, in the Lower Productive Coal Measures, there are usually seven such seams in this group, namely: The Brookville, Clarion, Kittanning Lower, Kittanning Middle, Kittanning Upper, Freeport Lower, and Freeport Upper. These, as the section given above will show, are all represented at Bennington, besides an additional small seam between the Kittanning Lower and Middle. The only ones of importance at Bennington are the Brookville, Kittanning Lower, and

Freeport Upper. Their condition and the extent of their development will be more fully described in the sequel.

§ 140. The display of limestone at this place is very meager. In fact we find only a single stratum—the Freeport Upper limestone—and that too considerably reduced from its usual thickness in the more westerly counties. There is no trace anywhere in Blair county of the Freeport Lower limestone, which only a few miles further west persistently accompanies the Freeport Lower seam of coal, which latter it underlies; nor is there any other evidence at Bennington of the *Johnstown cement bed* than a few iron ore nodules scattered through a thick mass of shale. The still more important *Ferriferous limestone* of the Allegheny river country is absent totally from the Bennington section.

§ 141. *The Freeport Upper limestone* is usually almost directly underneath the Freeport Upper Coal; but at Bennington the interval between them is 22 feet. The stratum is nowhere worked in Blair county, and in fact is of very little consequence there, the rock being quite impure. It shows on the face of the hill southwest from the tunnel, and it shows also on the Portage Plane below Mr. Lemon's house.

§ 142. In the sandstone strata of the section we are able perfectly well to recognize the equivalents of those layers which play so important a part in the country to the west. Thus for example the *Freeport sandstone* between the Freeport Lower and Kittanning Upper coal beds is fully developed, though perhaps neither so massive here nor so compact as in some other localities, and especially in that one whence the rock has derived its geographical name. Still lower down in the section, between the Brookville and Clarion coals, the *Clarion sandstone* appears, rather imperfectly defined in the immediate neighborhood of Bennington where the section was compiled, but yet conspicuous enough in other parts of Blair county. This Clarion sandstone, like the Freeport above it, is a very important feature of the Lower Productive group, and its recognition on the Allegheny mountain is a fact of considerable interest.

§ 143. *The Freeport Upper coal* or the Lemon seam as it is locally called, is west of Bennington, its outcrop line bending in long and regular curves around the head of the little ravine which widens and deepens eastward into the valley of the Juniata. Mr. Sanders' small topographical map of Bennington shows the general contour of these coal fields within a radius of about a mile of the village. On this map the outcrop lines of the important coal beds are laid down, and the Freeport Upper seam is seen ranging along the crest line of the mountain; passing directly over the tunnel head and then bending at the northwest corner of the map to run eastward towards Bennington, but finally to bend again towards the north and quickly to run outside the limits of the map and outside the limits of Blair county.

§ 144. This coal seam is nearly always five feet thick throughout the Blair county basin. But in this measurement are included a slate parting and much bony coal near the roof, both of which seriously interfere with the value of the seam. Besides, in other respects, it is vastly inferior to the Kittanning Lower bed with which it cannot successfully compete at all, so that few mines have been opened on it, and those recently begun have never been very vigorously followed up.

§ 145 Some years ago, however, at the time the Portage railroad was operated, Mr. Lemon worked this coal by a shaft situated a few hundred yards west of the head of Plane 6. The shaft was 60 feet deep; and being a convenient shipping point, besides supplying the Plane-engine with fuel, a considerable amount of coal was taken from the shaft during the years it was operated. But it does not seem to have yielded at this place any better quality of fuel than is obtained from the Kittanning Company's mine on the same bed at Bennington, which as before remarked does not now meet with favor. Its ready sale in early times is easily explained by the less active competition of that period.

A measurement of the bed as exhibited in this shaft, (whence has been derived its name of the Lemon seam, so well known not only in these parts, but throughout much of Cambria county,) was made many years ago by Prof.

Lesley, who recorded the results in the Geology of Penna., Vol. II. These results are here reproduced for comparison :

Coal,	2′ 10″	4′ 0″
Slate,	0′ 1″	
Coal,	1′ 4″	
Slate,	0′ 3″	
Coal,	0′ 6′	

Dip from 2° to 3° N. W.

2.

§ 146. The bed outcrops on the face of the Plane, east of the Stone house ; having there its limestone beneath it, and the Mahoning sandstone above it, the latter rock covering the surface with bowlders and fragments of sandstone in great abundance. The coal bed is again seen on the opposite side of the ravine, south of the Plane, and at one time had a drift run in upon it at this place, but was never followed up for any considerable distance. South of this point the outcrop line of the bed quickly passes westward into Cambria county.

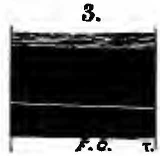
§ 147. But northeast from the shaft the bed may be easily followed by means of the bench which it makes on the hill-side and at a point about a mile and a half from the shaft in the same direction the coal may again be examined in the mine of *Messrs. Dennison & Porter*. This mine has been worked with tolerable regularity for a number of years, but recently operations were suspended and have not again been resumed. Scarcely any difference is noticeable here in the bed, either respecting its dimensions or its general character ; but the upper slate parting is absent as is shown by the following measurement made in the main entry near the mouth of the mine :

Roof black slate.

Coal, bony,	0′ 4″	5′ 0″
Coal,	2′ 10″—3′ 0″	
Slate,	0′ 2″	
Coal,	1′ 3″—1′ 6″	

Fire clay.

3.



From this mine also was taken a sample of the coal for analysis, the results of which, as determined by Mr. A. S. McCreath, will be found in the table below.

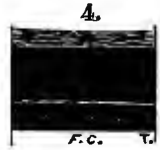
§ 148. Pursuing the bed still further northeast the only other exhibitions of it are those above the crown of the tunnel and in the Kittanning Coal Company's mine already spoken of. The display over the tunnel is only partial, being a natural outcrop on the sloping face of the hill; but in the Kittanning Company's mine a fine exhibition of the bed can be had.

§ 149. The mine is quite extensive and was operated for some time but is now inactive. The tipple is connected with the Pennsylvania railroad so that every facility is furnished for large shipments of coal. It is stated that work here will be shortly resumed.

The following section shows the dimensions of the bed and its partings:

Roof, black slate.		
Coal, bony,	0′ 4″	4′ 10″
Slate,	0′ 2″	
Coal,	2′ 10″—3′ 0″	
Slate,	0′ 0½″—0′ 1″	
Coal,	1′ 3″	
Fireclay.		

4.



The coal bed as here developed is a very regular and even one; having few "swamps" or "horsebacks" or other troubles. And when these occur they are inconsiderable, and occasion no difficulty and but little additional expense in mining. The main objection to the coal is the inferior coke it yields, while its extreme tenderness and friability badly adapt it for transportation. With respect to its coking qualities, however, it ought to be said that it has here to compete with one of the best coking coals in the State, by which, of course, it is considerably overshadowed. Besides the friability of the coal it holds much sulphur, in addition to a large percentage of ash, as the following analyses will prove. One of the samples for analysis was taken from the Kittanning Company's mine, and the other from the mine of Messrs. Dennison & Porter:

	I. *K. C. C*	*II.* *D. & P.*
Water at 225°,	1.190	.960
Volatile matter,	26.975	26.400
Fixed carbon,	64.357	65.586

Sulphur,	2.728	2.274
Ash,	4.750	4.780
	100.000	100.000
Coke per cent.,	71.835	72.640
Color of ash,	Red.	Gray.

§ 150. The same seam should also occur in the hill situated southwest of Bennington, and nearly due south of the Coke ovens; but the amount of coal there contained must be small and of little consequence, as the geology would confine the bed strictly to the hilltop.

The Freeport Upper coal assumes various local names, according to the different localities in which it is worked; thus besides the Lemon seam of Blair and eastern Cambria, it is the Coke Yard seam of Johnstown, the Hugus Coal of Somerset, the Reid Coal of Lockport and Bolivar, the "Summit Vein" of western Armstrong and southern Butler, and it is No. VI of the Ohio Series.

§ 151. *The Freeport Lower bed*,—the Limestone seam of Johnstown is nowhere worked in Blair county. Its dimensions, not to speak of its impure condition, are indeed such as to entitle it to no consideration in a practical sense. In the neighborhood of Bennington it is almost unknown. But it makes its appearance in the cut at the eastern entrance of the Pennsylvania RR tunnel; it is there about 3 feet thick, in which measurement is included a considerable amount of slate. The same bed shows also on the face of Plane No. 6, below Mr. Lemon's house.

In earlier reports of the present State Survey this bed was called provisionally the Middle Freeport seam; but the advisability of entirely expunging this name from the list has been shown in later reports, and the bed is now called the Freeport Lower, to correspond with the classification adopted for these measures in the Allegheny river region.

§ 152. *The Kittanning Upper coal bed* is even less prominent in Blair county than the Freeport Lower. In fact its outcrop is there almost entirely concealed. It is reported however to appear near the top of the Cambria Iron Company's shaft, about one fourth of a mile east of the tunnel;

and it must also outcrop on Plane No. 6 of the old Portage railroad. It is vertically 42 feet below the Freeport Lower.

In the Report of Progress for Clearfield, Cambria, and Somerset counties the equivalent of this Kittanning Upper bed was invariably described as the Freeport Lower seam; as above stated however this name has since been transferred to the next higher seam of the series, while the other bed has been incorporated with the Kittanning group, of which it is the top member.

The Kittanning Middle coal bed at Bennington is in two benches parted by six inches of slate; neither bench is of value in a mining sense. The upper of the two is only 6 inches thick, while the lower bench measures rarely more than 18 inches.

According to Mr. Bonner, Superintendent of the Cambria Iron Company's mines at Bennington, the distance between the Kittanning upper and middle seams, in the shaft before mentioned is exactly 52 feet. This distance, moreover, corresponds with that which almost invariably separates these seams throughout the counties to the west.

The bed is also visible in Dennison & Porter's shaft southwest of Bennington; otherwise it is not exposed in Blair county.

§ 153. The small coal seam which comes into the measures about midway between the Kittanning middle and lower seams is of no value or importance. It has been observed also at other localities.

Along Ben's creek in Cambria county its thickness is suddenly increased by an accumulation of slate in one place to four feet, which gave rise to some serious misidentification, having been mistaken for the next lower bed of the series, the Kittanning lower or the Sonman coal of Ben's creek.

§ 154. The Kittanning Lower coal bed is the most important seam of the series at Bennington, which importance it derives from the peculiar properties which it possesses as a coking coal.

In what these inherent properties consist which produce good coke we are not yet prepared to say; we know of course what constitutes a good coke, what should be its degree of hardness, what proportion its cells or open spaces should bear to the rest of the mass, how much slate and other impurities may be admitted without detriment, and we know further that to produce the most desirable results the Beehive oven is best adapted for coking our Pennsylvania coals. Still more, it is equally clear that the coke producing zone of a coal bed may be, and in fact in most cases is, confined to very narrow limits ; and that beyond these limits though the coal to all appearances undergoes no appreciable change in structure, yet the coke produced from it is much inferior to the other. This latter fact is fully exemplified by the coal bed under discussion, not to speak of the much more famous Pittsburgh bed in the Connellsville region. In the case of the Kittanning lower bed at Bennington, there is an established coke-producing zone, from which coke is produced second only to the Connellsville coke.

§ 155. Formerly, during the time of the operation of the Old Portage railroad, this Kittanning lower bed was quite extensively worked by Messrs. Miller & Schoenberger in the neighborhood of Plane No. 6. The mines were situated near the top of a hill south of the railroad, with which latter they were connected by means of a tram road and incline plane. It was from these developments that the bed acquired the local name of the "Miller seam" by which it is yet widely known throughout both Blair and Cambria counties.

§ 156. In the vicinity of the old Portage railroad the bed is much thicker than at Bennington ; and from all accounts the coal obtained was quite the equal of the latter in quality. The old openings were long since abandoned and are now shut, the supply of coal easily obtainable from this point of attack having doubtless been nearly exhausted. Mr. Jas. D. Hodge in the Geology of Penn'a, Vol. II, gives the thickness of the bed in these mines as 6 feet, but states that the slate band separating the upper bench 3 feet thick from the lower coal 2 feet thick, varied all the way from a few inches to two feet in thickness. The upper bench was not affected by the swelling of the slate but the lower coal suffered considerably in consequence of these variations and regularly diminished or increased according to the dimensions of the parting. This fact suggests the original differance in the thickness of the accumulated vegetation at different parts of the old swamp now represented by the lower bench of coal; and how these inequalities were subsequently filled by the inflow of mud which is now seen as slate.

§ 157. It is moreover interesting to know that it was from these mines of Messrs. Miller and Schoenberger that the coal described as "Cambria county coal" in Prof. Walter R. Johnson's well know report to the Navy Department of the United States, was taken.* The coal was subjected by Prof. Johnson to a number of complete and elaborate tests and the quality and various properties of the coal were thereby definitely ascertained. Such facts and particularly those gained from practical tests in the work shops are of great value; the most prominent of these facts are therefore here reproduced from Prof. Johnson's report:†

"The exterior appearance of this coal is, in general, similar to that of Karthaus, [Clearfield county] having a columnar structure, a shining black color in both the main and cross partings, of which the former are inclined to the surfaces of deposition in angles of 85° and 95°. A considerable quantity of carbonaceous matter occurs on the latter surfaces; and from the joints which they form, an efflorescence of sulphate of iron occurs so copious as to cause a pretty rapid disintegration of the coal. Specimens which were sound eighteen months ago are now cracking and falling to pieces. This naturally leads to the supposition that the coal contains a considerable portion of sulphuret of iron."

The specific gravity of two specimens was found to be 1.3617 and 1.4518 respectively; and the mean of these furnishes the calculated weight of a cubic foot of coal in the solid state in the mine equal to 87.94 pounds.

* * * * * * * * * *

Eight trials on four different specimens furnished the average total volatile matter of the Cambria county coal,

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* Report of experiments on the evaporative power and other properties of coal, by Walter R. Johnson.

† Ibid., pages 291, 292 and 293.

21.474. The incineration left from specimen *a*, 15.36 per cent., and from *b*, 9.11 per cent. of ashes of a light lilac color, moderate density and gritty feel, containing small lumps of white argillaceous matter from the larger crumbs of coal. In burning 3488.5 pounds of this coal during the four days devoted to its evaporative power, there was obtained from the grate and ash pit 196.83 pounds of reddish-gray ashes, intermixed with fine crumbs of coke which passed the sieve, and 134.75 pounds of clinker. Hence the total waste, including the coke intermixed was 331.58 pounds =9.504 per cent. of the coal consumed. The *ashes* weighed 43.19 and the clinker 33.62 pounds per cubic foot. The clinker loses nothing by complete reincineration, but the ashes lose 6.244 per cent. of their weight.

The clinker varies in color from black to dark brown, having yellowish white shaly portions adhering to such as are more fully vitrified. It is cemented into large porous masses.

* * * * * * * * * *

The two specimens above described afford the following composition of this coal, viz:

	Specimen a.	*Specimen b.*
Moisture,	0.700	1.105
Sulphur,	1.500	(not tried.)
Other volatile matter,	18.195	20.255
Ashes,	15.360	9.050
Fixed carbon,	64.245	65.590
	100.000	100.000
Fixed to volatile combustible,	3.535 : 1	3.435 : 1

Excluding the earthy matter, the several constituents have to each other the following relations, viz:

Carbon,	91.955
Hydrogen,	5.867
Oxygen and azote,	2.178
	100.000

The results obtained from practical tests of this coal in the workshops by "most skillful and expert workmen" are thus summed up:

"It was found to come rapidly into combustion and to afford an intense heat. A large bolt, which had just before been brought to a good working heat by coal in ordinary use in the yard, was by that now under consideration brought to the same degree of heat in ten minutes less time. The compactness of the coking mass appeared to be sufficient to form a good hollow fire for work of the size now performed by it. The cinder taken out was stated to be far less than that given by coal in common use at the time. The workman stated that he had been working in the yard for six years, and that this was the best coal for the work he was then engaged on, which he had used in all that time. Two other workmen tried each a small portion of it and both commended it very highly.

The smoke while using this coal was observed to be far less than that from any of the other fires (of which some ten or a dozen were in action) using the ordinary coal in the yard. The only fault is the lightness of the coke, which requires the fire to be frequently "wetted down."

In the chain shop the workmen spoke of the same inconvenience from the lightness of the coke. But in a small chain it was found to work well, giving very promptly a good welding heat without interference from foreign matter. The cinder was stated to be about half as much as would be obtained in the same time from the coal now in general use (the Midlothian). Freedom from smoke was here remarked upon with approbation by the workmen, and was very conspicuous among the large number of smoky fires then in use at the same shop."

Surely this is high praise, but subsequent analyses and additional tests of the same bed at Bennington fully substantiate the truth of all that was said by Prof. Johnson.

§ 158. North of the Portage Railroad the bed passes under higher land, and excepting in the little ravine where Mr. Wall once opened a drift on the seam, it is far below the surface until it again outcrops in the vicinity of Bennington. In this interval is located Messrs. Dennison & Porter's shaft, at which place the bed is 125 feet below the surface.

The seam possesses here all the characteristics that distinguish it at Bennington; but it differs from its condition at the Portage Railroad, in that its thickness is reduced nearly one half. And this reduction is due entirely to the diminished thickness of the lower bench of the bed, which, as we have just seen, was subject to the same variations in the old Miller and Schoenberger mines. But the reduction in this case is much more persistent than that recorded by Dr. Hodge; and if not continuous all the way from the Portage Railroad to Bennington, it at least prevails over a good portion of it. Northeast of Bennington the original dimensions of the bed are restored, as will be shown presently by the sections of the Glen White and Dr. Baker mines. It can have very little significance, however, whether restored or not, excepting for the convenience of more commodious gangways at less expense; for the lower bench of the bed, as we know it in those mines in which it has been preserved, is composed of worthless material as compared with the bench above.

§ 159. The upper division is therefore the most valuable portion of the bed in Blair county; and this division in the Dennison & Porter shaft is three feet thick on the average, including a few inches of bony coal. There is here, moreover, a large unbroken expanse of the seam admirably situated for mining. In every direction from the bottom of the shaft it spreads out uniformly and without faults or serious troubles of any kind. Towards the east, in which direction it rises, it remains under ample covering for more than a half a mile before outcropping on the mountain flank; while towards the west it passes under the highlands of middle and western Cambria, far below Cresson, and Loretto, and Ebensburg, and does not reappear above the water level line until it reaches the valley of Black Lick, where it is forced to daylight by the great anticlinal axis of Laurel Hill.

§ 160. The Bennington ravine, however, as already stated, exposes the coal about a mile northeast of the Dennison & Porter shaft. In this ravine the outcrop line of the bed runs down the flank of a high hill shown in the southeastern corner of Mr. Sanders' small topographical map of Bennington; it extends above the stream bed as far west as the water station, where it curves to the opposite side of the ravine, and then runs eastward through the cemetery and above the Bennington Station, and so on northeastward towards the Glen White and Baker mines.

§ 161. Along this line of outcrop it has been frequently attacked by drift above water level, in the vicinity of Bennington; but at the present time the only mine working the seam in the manner indicated is that owned by the Cambria Iron Company (Blair Iron and Coal Company), situated directly south of the water station, at which place the coal goes under the stream bed; it is again worked by shaft by the same company at a distance of a little more than a quarter of a mile further west. At this latter place it is one hundred feet below the surface; with proper allowance for difference in the surface elevation of the two points, a dip of about 2° in the rocks is hereby revealed.

Both of the mines have been quite extensively worked; and in both of them the bed is uniform and very regular averaging about 3 feet thick in its upper bench, which is the only part taken out in mining. The lower bench is always present, but is rarely more than a few inches thick; the parting of slate which divides the upper and lower benches, ranges from 2 inches to 10 inches in thickness.

A stratum of tough hard black slate overlies the coal not only in these mines at Bennington, but in that of Messrs. Dennison & Porter as well. The floor is uniformly a grayish fireclay. The coal comes out in excellent condition, hard and firm and dry. It breaks away easily under the pick in the mine and requires no blasting. The gentle incline of the strata facilitates the drainage, which in the drift near the water station is easily effected, the water running from the entries and rooms as these slowly rise to higher levels.

§ 162. The following measurements may be here introduced to show the regularity and uniformity maintained by the seam here at Bennington. No. 1 represents its condition in the Cambria Iron Company's drift; Nos. 2 and 3 are from the company's shaft, and No. 4 was made in the shaft of Messrs. Dennison & Porter:

No. 1.

Roof uniformly hard black slate.		
Coal, bony,	0′ 6″	3′ 7″
Coal,	2′ 7″	
Slate,	0 6″	
Coal not removed.		
Clay.		

5.

No. 2. Main entry of shaft.

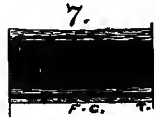
Roof, black slate.		
Coal, bony,	0′ 6″	4′ 0″
Coal,	2′ 6″	
Parting,	0′ 6″	
Coal,	0′ 4″	
Slate,	0′ 2″	
Clay.		

6.

No. 3. Shaft, cross-heading.

Roof, slate.		
Coal, bony,	0′ 2½″—0′ 3′	3′ 6″
Coal,	2′ 6″	
Parting slate,	0 3″	
Coal,	0′ 4″	
Slate,	0′ 2″	
Fireclay.		

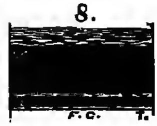
7.



No. 4. Dennison & Porter Shaft.

Roof, slate.		
Coal, bony,	0′ 6″	3 9½″
Coal,	2′ 6″	
Slate parting,	0 1½″ - 0′ 2″	
Coal,	0′ 6″	
Slate,	0′ 1″ —0′ 1½″	
Fireclay.		

8.



The coal mined by Messrs. Dennison & Porter is mainly shipped to eastern markets; but that taken from the collieries of the Cambria Iron Company is used for coking, either in the ovens close to the mines at Bennington, or in others at Hollidaysburg.

§ 163. Until very recently the coking at Bennington was done in open air pits, an extravagant and destructive method requiring considerable time for the process—some eight or ten days—and involving a loss of 22 per cent. of the carbon contained in the coal. In the report of the Coke Manufacture, Report of Progress L, published in 1876, the different methods in use for coking coal were fully described; and in an appendix contributed to that report by Mr. Jno. Fulton, Mining Engineer of the Cambria Iron Company, a comprehensive and interesting description is given of the construction of these open air pits at Bennington, their habits of working and the general results obtained from them. The tables thus given contain very valuable statistics; to them the reader is referred for particulars.

§ 164. Within the past year the Cambria Iron Company has erected at Bennington, close to its mines there, a bank of one hundred Beehive Ovens the daily output of which is 160 net tons; these ovens according to Mr. Fulton's statement, yield coke to the extent of 65 per cent. of the gross amount of coal charged.

We are much indebted to Mr. Fulton for an interesting description of these ovens, which as will be seen, contain some original improvements over the usual plan. To his description of the ovens he has appended some well considered conclusions concerning the different methods of coking, and he further places the subject before us, with all its attendant difficulties in a clear and practical light. The subject, moreover, is one that has received within the past few years much consideration and careful study from Mr. Fulton, who besides has had unusually favorable opportunities for observation; he is therefore an acknowledged authority in this field.

After stating that the ovens are located near the Cambria Iron Company's shaft and parallel to, but north of the line of the Pennsylvania railroad, Mr. Fulton says that "the bank of ovens is 750 feet long with wharf and railroad siding on each side. The coal is received from the Miller seam of the Bennington shaft mine. A large dump has been erected capable of containing three day's supply of coal, and of sufficient height to discharge its coal in larries on tracks underneath. These larries receive five tons and discharge it through their hopper into the coke ovens.

* * * * * * * * * *

The ovens are placed in a double row and are inclosed between two strong retaining walls of sandstone masonry. Between these walls and up to the level of the floors of the ovens, the space has been carefully rammed with clay and loam constructed in horizontal layers of twelve inches each. Under all an ample drain is laid longitudinally under the bank of ovens. The ovens were founded on this packed filling, having a fall in the floors towards the door of six inches to each oven. The ovens were constructed with nine-inch firebrick of three distinct shapes: 1st, the arch-shaped brick from the foundation to the springing of the dome; 2nd, the brick in the elliptic short curve of the springing of the dome; and 3rd, the brick forming the crown of the dome. The dome is completed by keying in the annular ring which becomes the charging part of the ovens.

The order of the work of construction consisted in erecting: 1st, the iron door-frames on front walls, with their appropriate shaped jamb-brick; 2nd, the vertical circular section to springing of arch, the circular of oven being preserved by a wooden T sweep pivoted on a pin in center of oven circle. The next operation was in laying the floor of oven with the three-inch tiles prepared for this purpose. The wooden centers for the domes are next put up. These consist of sections made with board and lath supported by a post in the middle and by benches around the inside of circular wall. The firm wooden sections are shaped and come together very much like the sections of an orange cut by a plane at right angles to its stem line. They are made of a size to be easily taken out by doors of oven. They were made by J. King McLanahan, of Hollidaysburg, Pa., and were found accurate and valuable in erecting the domes of ovens.

The mortar used consisted in a well worked thin mixture composed of loam and fireclay.

The filling in around or backing up the ovens should follow the progress of the brickwork as closely as possible and the material should be laid down in horizontal layers of twelve inches each, and well rammed.

The track on top of ovens is laid with iron tie-pieces, and has a guage of six feet to allow space for the larries containing five tons of coal.

The water is supplied in three-inch cast iron pipes, with one-inch taps and hose between each two ovens.

The ovens were put in blast October 8, 1878, and have been working steadily since.

§ 165. Mr. Jno. McFadyen, superintendent of coke ovens, reports that during the months of December and January last, 10,223 tons of coal were coked, yielding 6548 tons of coke of a good quality. This shows a yield even in winter months of 64.05 per cent. of coke, and it is believed assures an average annual yield of 65 per cent.

§ 166. *The analysis of this bed B or Miller coal* is as follows:

Water,		—
Fixed carbon,		68.500
Ash,		8.000
Volatile matter,		22.380
Sulphur,		1.120
		100.000
Theoretical coke—	Ash,	8.000
	Sulphur $\frac{2}{3}$,	.75
	Fixed carbon,	68.50
		71.25

This shows a loss of carbon 14.5 per cent. only, which indicates fair economy in the work of these coke ovens. In this respect it is interesting to note the relative economy of several methods of coking this coal as follows:

In pits or mounds 59% coke—loss of carbon,		22%
In Beehive ovens 65%	" " "	14.5%
In Belgian ovens 70%	" " "	8%

§ 167. The three typical methods of coking are clearly compared in these results. The pits or mounds are slowest in time and the most wasteful of coal. The Beehive ovens make the best and driest coke, but are not so economical in their work as the Belgians, whilst in time they are nearly equal.

In this stage of investigation into the methods of coking for furnace use as indicated by actual results, it is important to bear in mind that the chief requirement is the *best quality of coke for furnace use.* This is the prime factor in all coking operations. The mere effort to save a few units of carbon in the coking, to waste a great many in the furnace work, besides loss in its product, seems to be only trifling with a very important industrial question. For instance a furnace that used $1\frac{80}{100}$ tons of Belgian and Pit coke mixed, to one ton of metal, required only $1\frac{22}{100}$ tons of Bennington coke under precisely the same conditions of work and weather. This exhibits a loss of .58 ton of coke to each ton of pig metal, or if the furnace is producing 40 tons per day, the loss in coke would be 23.20 tons per day, which is quite serious.

Careful investigations of the several methods of coking indicate very decidedly the value of the Beehive plan. In all that relates to method of coking and quenching the coke so as to produce the best quality of furnace fuel in the driest condition, the Beehive is undoubtedly the true plan.

But it may be asked why cannot coal be coked in Beehive ovens with as little loss of carbon as in Belgian ovens? The reply to this discloses the true line of improvement demanded in Beehive ovens—to produce the best possible furnace coke with the least possible waste of carbon.

§ 168. In contemplating the two systems of coking, the Belgian and the Beehive, there is evidently a great waste of heat through the charging holes of the latter ovens. The only surprise in the somewhat greater loss of carbon by this method, is that it is so small; when it is considered that the Belgian is enveloped in a system of flues utilizing a large amount of the escaping heat, and suffers only little loss of heat in the rapid discharge of its coke, whilst the Beehive loses much heat, and at least 3 hours of time in the slow process of drawing.

During the progress of the construction of the Bennington ovens Mr. McFadyen suggested a plan of radial flues in floor of Beehive oven receiving heat from ten ports in the upper portion of the dome, and carried down in a buttressed flue to the radial flues in floor; the whole discharged in a short chimney regulated by a damper.

Enough careful weighing has not been done to enable a statement of results to be submitted now. Sufficient is known, however, to indicate a saving in time of coking of 33 per cent. That is, a bank of 200 flued Beehive ovens would, it is hoped, produce as much coke as a bank of 300 ovens without flues. It is also contemplated to introduce an elliptic flue between backs of ovens to receive the escaping heat of the ovens and diffuse as much of it as possible along the ovens.

In all these lines of improvement, the correlated value of coke for furnace use and its physical properties must never be lost sight of.

§ 169. Mr. M. F. Overholt, of Mt. Pleasant, in the Connellsville coke region also submitted an improvement to overcome the loss of heat occasioned in Beehive ovens by the water thrown in to quench coke and the cooling in drawing. The improvement consists in a connecting flue between each oven, regulated by a damper. The design is to supply heat to a drawn oven from either of the adjoining ones in blast. This application would seem to be desirable in coals possessing low volumes of volatile matters, and consequently slow in igniting in a slightly cooled oven.

All these improvements have good points, and are being made in the right direction.

§ 176. The cost of Beehive ovens in favorable situations should not greatly exceed $200; but when deep embankments are required a largely increased outlay will be demanded.

The flued ovens of Mr. McFadyen would probably cost $50 each more than the unflued Beehive oven.

The fire-brick and shaped brick for Bennington was furnished by A. J. Haws, of Johnstown, and Mr. R. Miller, of Sandy Ridge, Centre county, Pa.

§ 171. It is very remarkable that after persistent efforts in elaborate and complicated coke oven appliances, that the analyses of methods of coking should evolve the merits of the plan of the simple and primitive Beehives of fifty years ago. There is no doubt that particular varieties of coking coal require special treatment; but underneath all this lies the important consideration whether it is a correct business principle to attempt the coking of a coal that requires so complicated appliances, and which after all produces an inferior coke. It would then appear that in this, a State possessing such ample supplies of the good qualities of coals for making coke, an intelligent selection of such coals would be the important consideration in coking operations, rather than the attempt, however ingenious, of designing ovens to make inferior coke from coals normally unfit for this special purpose."

§ 172. Northeast of Bennington the Kittanning Lower coal is unexposed for more than two miles. It appears of course in all the small ravines by which the surface of the mountain top is diversified; but such exposures are only partial and give no adequate idea of the condition of the bed unless opened up for examination. Openings have been made upon the seam on the lands of the Baltimore Coal and Coke Company, near the village of Glen White, about two and one fifth miles northeast of Bennington. The mines of this Company are chiefly confined to the operation of this one seam; and they reveal it in its normal thickness with the lower bench fully expressed.

In all the gangways and rooms of these mines a gentle but persistent incline of the rocks towards the southwest, or a rise in the opposite direction, towards the northeast, is not only observable but very marked. How far the same rise is continuous is not yet definitely ascertained, nor whether it prevails as far as the Baker and London mines more than a mile away. But the latter contingency is hardly possible, even in spite of the same incline having been observed in the Baker mines; because if the rise were steadily continuous for that distance the Baker and London mines would occupy a much higher level than they do. The incline is a part merely of an extensive undulation in the floor—an undulation similar though not so sharp as that in the Cambria Iron Company's drift at Bennington. But at Glen White the size of the bed is not affected in any way by the irregular floor; nor does this interfere with the usual and regular incline of the rocks towards the northwest; but it prevents the bed from being mined in the same direction at Glen White as at Bennington, towards the southwest.

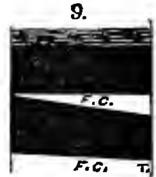
§ 173. The mines at Glen White have been operated for some years past with considerable vigor; some of the coal is coked; other of it finds a market in Altoona; and still another part of it is carried in its raw state to the seaboard. A branch ravine extending southeastward down the flank of the mountain has enabled a railroad to be cheaply built to Kittanning Point, where it intersects with the Pennsylvania road.

§ 174. The Baltimore Company's mine on the Kittanning Lower coal starts into a low hill at a point about forty feet above the water level of a small nameless run which flows close by. An examination of the mine shows the bed to be remarkably even and regular. The roof is slate and the floor is clay. The upper division of the coal bed is composed of excellent coal, bright and clean and free from knife edges of iron pyrites and slate. The lower division on the other hand is worthless in a commercial sense, having as much as 17 per cent. of ash (slate) and more than 4 per cent. of sulphur (iron pyrites). See table of analyses given below.

§ 175. An average section of the bed, as displayed in this mine, gives the following figures:

Roof, black slate.		
Coal, bony,	0′ 6″	7′ 4″
Coal,	2′ 7″	
Parting, indurated fireclay,	0′ 1″—1′ 3″	
Coal,	2′ 3″—3′ 0″	
Fireclay.		

9.



§ 176. *Dr. Baker's mines*, which also work the Kittanning Lower seam, are situated on the mountain top, and a little more than a mile northeast from Glen White. They are connected with the Pennsylvania Railroad at Kittanning Point. The connecting road is of narrow gauge, ascending the mountain flank by long détours. It is built on the gravity plan, and the loaded cars, as they come from the mines, start directly on their journey to the tipple at the Point, being impelled by their own momentum.

For some time past the mines have been idle, although the coal from the upper division of the seam at this place is to all appearances quite the equal of any obtained elsewhere in Blair county. Its adaptability for coking cannot be stated; but presumably it does not, in this respect, rank so high as the Bennington coal, as otherwise it would have received more attention.

In regard to its dimensions, it is identical with the section given above for Glen White; there being the same six inches of bony coal under the roof, and the same two feet and a half of coal in the upper subdivision above the fireclay parting. The parting also averages about one foot thick; and the under bench of slaty worthless coal averages about 2′ 10″ thick. The roof and floor are invariably good.

The hill in which the mine is opened rises to a sufficient height to include some of the overlying coal seams, and possibly the entire Freeport group of rocks; but this is not certain, as there are no natural exposures on the hillside, and the benches have never been opened.

§ 177. Beyond Dr. Baker's mine the outcrop line of the Kittanning lower bed bends westward, which quickly carries it across the boundary into Cambria county. Thence northeastward it is thrown somewhat forward from the mountain crest, but at Lloydsville, many miles to the northeast, it has regained its position at the summit, which is there entirely inside the limits of Cambria county. At Lloydsville it is very extensively developed and shows there a great increase of thickness, besides some other features which it does not possess in the region above described. For further particulars regarding its condition at Lloydsville the reader must be referred to Chap. VII of the Cambria County Report.

§ 178. In the following table are grouped all the analyses made by Mr. McCreath from samples of the Kittanning lower bed in Blair county. The table includes also Prof. Walter R. Johnson's analyses of specimens of the same seam south of the Portage RR. These have already been given but are here repeated for convenient comparison.

The analyses are in the following order:

I. South of Portage RR., Prof. Johnson.

II. South of Portage RR., Prof. Johnson.
III. Dennison & Porter's shaft, A. S. McCreath.
IV. Bennington, C. I. Co., A. S. McCreath.
V. Glen White, upper bench, A. S. McCreath.
VI. Glen White, lower bench, A. S. McCreath.
VII. Baker mines, upper bench, A. S. McCreath
VIII. Baker mines, lower bench, A. S. McCreath.

The coal from the upper bench of the bed may in general be described as of columnar structure, bright, with a shining luster, rather tender and usually seamed with mineral charcoal and frequently thin knife edges of iron pyrites.

That from the lower bench is very compact by reason of the large amount of slate it carries; is rather bright, and contains iron pyrites in great abundance.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.
Water at 225°,	.700	1.105	.910	1.400	.940	1.040	.950	.900
Volatile matter,	18.195	20.255	26.340	27.225	29.660	28.010	28.915	25.630
Fixed carbon,	64.245	69.590	64.373	61.843	59.912	49.244	63.462	51.305
Sulphur,	1.500	not tried.	1.792	2.602	.978	4.501	.983	4.400
Ash,	15.360	9.050	6.585	6.930	8.510	17.205	5.690	17.765
	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000
Coke per cent.,	81.105	78.640	72.75	71.375	69.400	70.950	70.135	73.470
Color of ash,			gray.	gray.	white.	pink.	gray.	pink.
Sulphur left in coke,			1.012					
Per cent. sulphur in coke,			1.391					
Per cent. iron in coal,			1.274					
Sulphur taken by iron for FeS_2,			1.456					
"Free sulphur,"			.336					

§ 179. The next coal bed of the series, below the Kittanning Lower, is the Clarion, between which two, at Bennington, the vertical distance is 34 feet. *The Clarion seam* has a persistent and continuous outspread in the coal measures of Blair county; but being seldom more than one foot thick and rarely even that, it has no commercial significance, and is of importance only in assisting in the identification of other and more important seams. And this is its usual condition further west, in Cambria and Indiana counties, and also towards the southwest in Somerset; but in Armstrong county and throughout much of Clarion county, it is a large and valuable seam.

Its relation in Blair county to the lower portion of the Lower Productive Coal group is disclosed by the exposure in the railway cut, a few yards east of the Bennington station. The Clarion seam is near the top of the cut, with the Clarion sandstone directly below it, while below this is the Brookville coal bed with its usual attendant stratum of fire-clay. Below all is the Homewood Sandstone.

§ 180. *The Brookville coal bed* at Bennington is 27 feet vertically below the Clarion, or 63 feet below the Kittanning Lower. Mention has already been made of the regularity and persistency with which these figures are maintained towards the west and north and south. The interval between the Brookville and Kittanning Lower sometimes drops to 50 feet, and even to 40 feet; but it rarely goes below the latter figure. Sometimes the distance between these beds increases to one hundred feet, though this expansion, like the contraction to forty feet, is an uncommon occurrence. The general average is 60 feet; just as the interval between the Kittanning Lower and the Freeport Upper is nearly always two hundred feet. And so often, indeed, is this the case, that we are frequently enabled to identify the horizons of the beds by means of these figures alone. The average thickness of the Lower Productive Coal Measures, from Freeport Upper coal to the Brookville seam, is about 275 feet.

§ 181. The Brookville coal bed is eminently a pyritous and slaty one. Nor is this damaging feature alone prominent in Blair county; if anything it is even less so there than in many other localities. Moreover, the bed generally is subject to extreme variations of thickness, though in Blair county it is, so far as known, very constant at about four feet.

§ 182. Its outcrop line in the region of Portage Plane No. 6 trends northward across the foot of the plane and into the little ravine of which mention has before been made; then it bends backward, towards the southwest, to take its place on the escarpment of the mountain, which place it keeps until it is deflected into the Bennington ravine; its course at the latter place is shown on Mr. Sander's small map of that locality.

§ 183. North of Plane 6, and close to the turnpike is an old drift, now shut, which is believed to mark the outcrop of bed A. Then behind the hilltop at the east of the plane is the so-called Woodcock mine, which is believed also to belong to the same bed, though this latter identification cannot be stated with entire certainty because of the absence of natural and other exposures in the vicinity of the mine. If it be not the Brookville, it is the Kittanning lower; but the former identification is preferred as the more likely.

Its condition here is in marked contrast to that which it presents at Bennington, where the weathered face of the bed in the railroad cut is thickly covered with a coating of sulphur resulting from the decomposition of the enclosed iron pyrite, while in the Woodcock mine the bed yields a very superior quality of coal, not only very free of pyrites but carrying only a comparatively small amount of slate.

The bed is here close to its final eastern outcrop on the face of the mountain, as is indicated by the appearance of the Pottsville conglomerate at the surface a short distance east of the mine.

§ 184. Considerable quantities of coal are taken from this Woodcock mine during the winter months, at which time it supplies a large local trade. The roof and floor of the bed are excellent, which insures clean dry coal. As the loaded cars issue from the mine they are run over a tram road, 1000 feet in length, to a self acting incline plane, 150 feet in height, by means of which the cars are lowered to the turnpike connecting Hollidaysburg and Ebensburg.

The bed is without serious troubles or irregularities and is of very uniform thickness. The dividing slate is only one inch thick. Both benches of the seam are equally good. The coal is of columnar structure, soft and friable, and breaks easily away from the pick in the mining operations, but for the same reason crumbles considerably in handling and will not bear transportation well. It makes a quick hot fire, produces little clinker and ash, and deservedly bears a good reputation. A measurement of the bed as made near the mouth of the mine, is here annexed:

Roof hard slate.		
Coal,	2′ 0″	3′ 7″
Slate,	0′ 1″	
Coal,	1′ 6′	
Fireclay.		

10.

Mr. McCreath's analysis of the coal is as follows:

Water at 225°,	1.260
Volatile matter,	26.290
Fixed carbon,	66.133
Sulphur,	.567
Ash,	5.750
	100.000
Coke per cent.,	72.450
Color of ash,	gray.

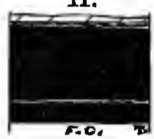
Sufficient has already been said of the condition of the bed at Bennington. Following the outcrop line along the mountain top towards the northeast there is no abatement in the thickness of the seam, but no improvement in character over the exhibit in the cut directly east of the Bennington station; which is equivalent to saying that the bed yields poor worthless coal at Glen White and on Dr. Baker's property at both of which localities it has been opened up for examination. At Glen White however the bed was only in part revealed, and then only at the outcrop about 1000 feet southwest of the Baltimore Company's large mine on the Kittanning Lower seam.

§ 185. On Dr. Baker's property its outcrop where opened up is 35 feet above Kittanning run, and between 50 and 60 feet below the Kittanning Lower bed. The drift was scarcely more than a trial opening and has since been allowed to close up. But some 1500 feet east of this mine, the same bed is exhibited on Mr. London's property, where the floor of the coal is uneasy and shows some irregularities and variations from the usual dips. These variations, however, are only of local occurrence.

There is a considerable expansion in the thickness of the bed at this place as compared with the outcrop in the Bennington cut. But the usual dimensions of four feet are restored still further north in the *McNellius' mine* near the Buck Horn tavern, and near the final outcrop of the coal measures in Blair county. For comparison both the London and McNellius' sections are here introduced. At London's the following dimensions were obtained from a measurement near the mouth of the mine:

Sandstone roof.		
Coal, bony,	0′ 1″—0′ 5″	5′ 4″
Coal,	3′ 9″	
Slate,	0′ 1″—0′ 2″	
Coal,	1′ 0″	
Fireclay.		

11.



The close proximity of the bed at McNellius' to its final outcrop, causes the roof slate to be much cracked and broken, and the coal consequently to be wet and poor. Huge bowlders of the Pottsville Conglomerate cover the surface a short distance east of the mine; while still further east the red shales of the Mauch Chunk series may be observed in the road about one half mile south of the Buck Horn tavern.

Although driven under the hill for several yards, the entry of McNellius' mine had not reached hard coal (June, 1875). Nor did there seem much improvement in this direction, for the reasons above given. The dimensions of the bed as here exposed are as follows:

Roof, soft black slate.		
Coal,	3′ 6″	4′ 4″
Slate,	0′ 1″—0′ 4″	
Coal,	0′ 6″	
Clay.		

12.

§ 186. It is desirable in this connection to call the special attention of the reader to some variations in the chemical composition of the coals above described. He will have noticed that no specimen (excepting those analyzed by Prof. Johnson) contained less than 25 per cent. of hydro-carbon gases (volatile matter), and that in one specimen (that from the upper bench of the Glen White bed) nearly 30 per cent. of these gases flew off in the process of analysis; and further, that the various steps between these two figures were represented by the different specimens.

§ 187. The coals, therefore, in Blair county, from any and all of the principal beds, are bituminous and not semi-bituminous, notwithstanding their position at the extreme eastern edge of the Basin and on the top of the Allegheny mountain. In point of fact the amount of gaseous matter in them vastly exceeds that in the coals at Johnstown, or the coals generally in Cambria county; it exceeds even that in the coals of the Second Basin, the Ligonier Valley, and it is not until we have reached the Pittsburgh bed at Blairsville, in the Third Basin, that we find an equal amount of hydro-carbon gases. And moreover, if we extend our observations northeast along the mountain top towards Lloydsville, in Cambria county, or southwest into Somerset county, it is only to find a reinforcement of the facts above recorded; although it should be stated that nowhere apparently on the Allegheny mountain do the percentages of volatile combustible matter in the coals range so high as in Blair county.

§ 188. For convenient comparison the Blair county coal analyses are grouped together in the following table, which enables the reader to survey the field at a glance:

	Water.	Vol. matter.	Fixed carbon.	Sulphur.	Ash.	Total.	H. C.: F. C.
1. Woodcock mine, Portage RR.: bed A,	1.260	26.290	66.133	.567	5.750	100.000	1:2.5
2. Cambria Iron Company, Bennington, bed B,	1.400	27.225	61.843	2.602	6.930	100.000	1:2.3
3. Dennison & Porter, Bennington, bed B,	.910	26.340	64.373	1.792	6.585	100.000	1:2.4
4. Baltimore Coal and Coke Company, Glen White, bed B, upper bench,	.940	29.660	59.912	.978	8.510	100.000	1:2.
5. Baltimore Coal and Coke Company, Glen White, bed B, lower bench,	1.040	28.010	49.244	4.501	17.205	100.000	1:1.8
6. Dr. Baker mines, N. E. of Glen White, bed B, upper bench,	.950	28.915	63.462	.983	5.690	100.000	1:2.2
7. Dr. Baker mines, N. E. of Glen White, bed B, lower bench,	.900	25.630	51.305	4.400	17.765	100.000	1:2.
8. Kittanning Coal Company, Bennington, bed E,	1.190	26.975	64.357	2.728	47.50	100.000	1:2.4
9. Dennison & Porter, Bennington, bed E,	.960	26.400	65.586	2.274	4.780	100.000	1:2.5
	9.550	245.445	546.215	20.825	77.965	900.000	
	1.061	27.271	60.691	2.314	8.663	100.000	1:2.2

CHAPTER VIII.

Lewistown Limestone, No. VI,
(Lower Helderberg,)
(Silurian,)
With its brown hematite iron ore.

§ 189. This limestone formation, the Helderberg limestone of the New York nomenclature, the Lewistown limestone of Report F of this Survey, is in considerable thickness in Blair county and affords some opportunities for measurement and examination.

§ 190. At Tyrone the limestone is over 780 feet thick, perhaps somewhat over 800 feet.

It makes a ridge separated from Brush mountain, the crest of the ridge being crowned by the Oriskany sandstone, No. VII.

§ 191. Near Hollidaysburg and at the Reservoir there are good exposures of the limestone formation. It measures at these places some 900 feet thick.

The geological map accompanying this volume shows how the limestone follows the sweep of the mountains of IV, and how many miles of outcrop it has in the county. Along this great line of outcrop it can be cheaply attacked in numerous localities.

§ 192. The geological structure of formation VI is usually simple enough and indicated by the maps and sections.

§ 193. The only complication, of any consequence, is that a small sub-anticlinal starts near Tipton, causing a sub-synclinal basin in the limestone and at once broadening its outcrop lines; this continues on to the northeast, the synclinal passing near Elizabeth furnace, and holding Trout's and

Baker's brown hematite iron ore mines, gradually dying out northeast of the latter.

Its southern point is not far south of Tipton, for at Tyrone everything is regular, IV, V, VI and VII gradually passing from a vertical to a northwest dip.

§ 194. Near Frankstown furnace the involved geology makes some interesting features of VI and VII, all of which are plainly shown on the map and sections.

§ 195. In Short mountain gap of the Juniata river the eastern outcrop of VI is flat and the west outcrop steep.

§ 196. Going southward, formation VI is regular as far as Sarah Furnace; but near the Bedford county line a sub-anticlinal again comes in making a sub-synclinal of VI, hold-the Oriskany sandstone of VII in the center of the synclinal basin.

This sub-synclinal continues on to the southwest into Bedford county.

§ 197. *Celestine* occurs near Bell's mills in the bank of the stream, at the top of V and bottom of VI.

Red rocks are in the bank only 30 feet away, and the Celestine lies in the bed plates of the limestone, but in lenticular masses running in and out. The crystals range from ½″ to 1″.

§ 198. There is an exposure of the limestone of VI in a quarry on the old railroad from Baker's ore mine. The limestone is much contorted and crushed, and the dip in the opposite sides of the quarry is 20° on the one and 70° on the other side.

There are three faults showing, one clean up and down, the others sliding thrusts.

§ 199. Near Allegheny furnace the limestone of VI is opened up to furnish flux for furnace use. The hillside presents a vertical section of part of VI.

The Oriskany Sandstone, VII, shows on the east bank of the run.

The limestone of VI is massive, usually in 12″ to 18″ layers, very fossiliferous, and dips N. 60° W. 36°.

The section shows:

Oriskany Sandstone, VII, bottom of—		
Dark-colored, thin, calcareous slates,	28′	0′′
Limestone,	20	0
Flint layer,	—	
Limestone,	8	0
Limestone (used for flux),	4	0
Slate, dark-colored,	2	0
Limestone (used for flux),	5	0
Slaty limestone,	4	0
Limestone, top layers come out black and weather to bluish color,	15	0
Gray limestone,	15	0
Impure bastard limestone,	3	0
Limestone (flux),	50	0
Total,	151′	0′′

Almost every layer of this whole mass is fossiliferous to a greater or less extent.

§ 200. Mr. S. C. Baker has opened a large quarry in VI near his Allegheny furnace, to use for furnace flux.

Specimens were taken from the upper, middle, and lower limestones exposed in his quarry. They yielded, on analyses by S. S. Hartranft:

	Upper.	*Middle.*	*Lower.*
Carbonate of lime,	95.664	95.089	95.571
Carbonate of magnesia,	1.547	1.581	1.521
Oxide of iron and alumina,	.842	.644	.570
Sulphur,	.103	.029	.027
Phosphorus,	.015	.020	.009
Insoluble residue,	2.500	3.000	3.020
	100.671	100.363	100.718

§ 201. The Creswell quarry of the Cambria Iron Company is opened in the limestone of VI, two miles northwest of Hollidaysburg.

It shows a very massive limestone, the layers usually 2′ thick or more, and not very fossiliferous.

The limestones are rather twisted, the dip varying from 50° at the north end of the quarries to 80° at the south end.

At the north end of the quarry there are great quantities of calcite, single masses of over a ton being blown out at a blast. It seems to belong to one horizon.

The limestone layers are usually dark-blue in color, with much calcite, and but little silica.

The analyses of the different layers of stone in the quarry range from 1.63 of insoluble matter to 26.50 or 27.00 of insoluble matter. Mr. T. T. Morrell, the Chemist of the Cambria Iron Company furnishes the following analyses of stone from this quarry:

	Birdseye.	*Calico.*
Insoluble matter,	1.75	1.15
Carbonate of lime,	97.32	97.82
Carbonate of magnesia,	0.19	0.11
Phosphorous,	0.017	0.005
Sulphur,	none.	none.
Oxide of iron and alumina,	0.52	1.34
Water and organic matter,	1.21	0.58

At the time of the examination the quarry was shipping about 25 cars daily, 250 to 300 tons, all of it to Johnstown for use as furnace flux.

The analyses show a limestone of unusual purity, and of value for furnace use or burning for agricultural purposes.

Much of the limestone of VI is used in Blair county for the latter purpose.

§ 202. There are several other large quarries on the limestone of VI near Hollidaysburg and large quantities of the stone have been used by the Blair Iron Company furnaces.

The analyses of specimens from three of these quarries is thus reported by Mr. A. S. McCreath:

	1.	*2.*	*3.*
Carbonate of lime,	95.251	96.164	84.782
Carbonate of magnesia,	2.265	1.589	3.859
Carbonate of iron,	.745	.615	.534
Alumina,	.054	.035	.043
Sulphur,	.053	.070	.053
Phosphorus,	.003	.005	.004
Insoluble residue,	1.800	1.615	10.850
	100.171	100.093	100.125

No. 1. Cresswell's quarry, near Hollidaysburg.
2. Manning & Lewis' quarry, near Hollidaysburg.
3. Loop's quarry, near Hollidaysburg.

Baker's Brown Hematite Ore Mine.

§ 203. Baker's ore mine is three miles northeast of Altoona.

It is a large open cut some 600 feet long by 400 feet broad, and fully 135 feet deep at its deepest part. Moreover, the tunnel which drains the mine and through which the ore is removed, is 20 feet below the floor of the mine, or about 150 feet below the surface of the ground.

The exposure of ore-bearing material varies very much in different parts of this great open pit.

§ 204. At one place the sides show this vertical section:

Surface—	
Variegated clay, not carrying iron ore,	25′
Black clay, with much iron pyrites,	15′
Clay and flint,	5′ to 10′
Bluish-black and slate-colored clay,	12′ to 15′
Clays carrying ore to bottom of mine.	

This great mass of clay from the surface down for 60 feet or more is non-ore bearing, usually making an enormous amount of stripping before the mine dimensions can be extended.

§ 205. In another part of the mine a vertical section of the mine wall shows thus:

Surface—	
Variegated clays, no ore,	20′
Black clay, with iron pyrites,	14′
Clay and flint,	10′
Slaty clay,	4′ to 12′
Ore-bearing clays,	44′

§ 206 The ore-bearing clays are of all colors, changing abruptly; and the ore itself is of all kinds and descriptions, though it is usually dark-colored, and probably a trifle manganiferous at the northeast end of the mine, and reddish-colored at the south end.

§ 207. Limestone shows in the mine in place; in small quantity only on the south side of the pit, but in mass on the north side, where, indeed, the tunnel ran through solid limestone in place for 225 feet. The limestone in the pit dips S. 70° East 63°.

§ 208. The bank is opened in a narrow synclinal basin of the limestone of VI; and the anticlinal axis must come in close to the west of it. The Oriskany sandstone of VII is apparently not caught in place in the synclinal basin, though bowlders of conglomerate sandstone, belonging to VII, are found loose on the ridge crest, northeast of the mine.

§ 209. In all its general features of deposit, Baker's mine in the limestone of VI closely resembles the brown hematite deposits in the limestone of II; and these latter are so fully described in detail in the following chapters that it is needless to repeat it all here. Much ore has been mined from this bank, washed close by, and used by Dr. Baker at his furnace, near Altoona.

§ 210. A specimen of a bombshell mass of iron ore from the Baker mine was forwarded to the Laboratory of the Survey, and yielded on analysis (McCreath):

"The ore is hard, tough, arenaceous, dark-brown, and liver-brown. The walls of the bomb are coated with a sandy clay of a pinkish-gray color.

Sesquioxide of iron,	67.214
Sesquioxide of manganese,	.985
Sesquioxide of cobalt,	.102
Alumina,	4.440
Lime,	.290
Magnesia,	.479
Sulphuric acid,	.282
Phosphoric acid,	.506
Water,	9.660
Insoluble residue,	16.120
	100.078
Metallic iron,	47.050
Metallic manganese,	.685
Sulphur,	.113
Phosphorus,	.221

§ 211. Mr. Baker has worked some pipe ore in this same limestone of VI; a specimen of it from a point near the furnace yielded on analysis (McCreath):

"The specimen consisted of a mass of pipe ore, the pipes being well cemented together. They are somewhat coated with a yellow clay; are very brittle, and generally of a dark brown color:

Sesquioxide of iron,	83.071
Sesquioxide of manganese,	.350
Alumina,	2.124
Lime,	.215
Magnesia,	.312

Sulphuric acid,	.115
Phosphoric acid,	.455
Water,	11.772
Insoluble residue,	1.675
	100.089
Metallic iron,	58.150
Metallic manganese,	.244
Sulphur,	.046
Phosphorus,	.199

§ 212. About 250 yards north of the north end of the large Baker mine is the *Blair open pit working.* It is a large bank, some 350 feet long, by 350 feet wide, and 60 feet deep in the deepest part. An imperfect exposure on one of the sides shows thus:

Surface.	
Sandy clays,	10′
Variegated clays,	10′
Black clay,	5′
Clay and flint, and then a mass of yellow clay holding iron ore, down to bottom of bank.	

A shaft was down at this place for 100 feet from the surface; and it worked out lump ore from under the present bottom of the open pit.

Limestone showing in the pit dips S. 70° East 70°; and on the ridge between the Baker and Blair mines there are many loose masses of the conglomerate sandstone of VII, but none of it showing in place.

§ 213. One fourth of a mile north of the Blair bank is the *Elizabeth* (McCammant) *mine.*

The mine is not working. It is reported that they worked a dark-colored and a reddish ore, lying in yellow clay, just as at the Baker mine. The ore-bearing stuff was screened to get ore for the old Elizabeth furnace.

§ 214. There is a very heavy surface show of ore in a ravine east of the Elizabeth mine, and much ore has been gathered from the surface.

§ 215. At the old Baker mines close by, the same ore was worked as at the Elizabeth mine.

§ 216. There are three mines on the limestone ridge northeast of the Elizabeth open mine, and one of them, J. Bell's, is thus described (Fig. 12*a*):

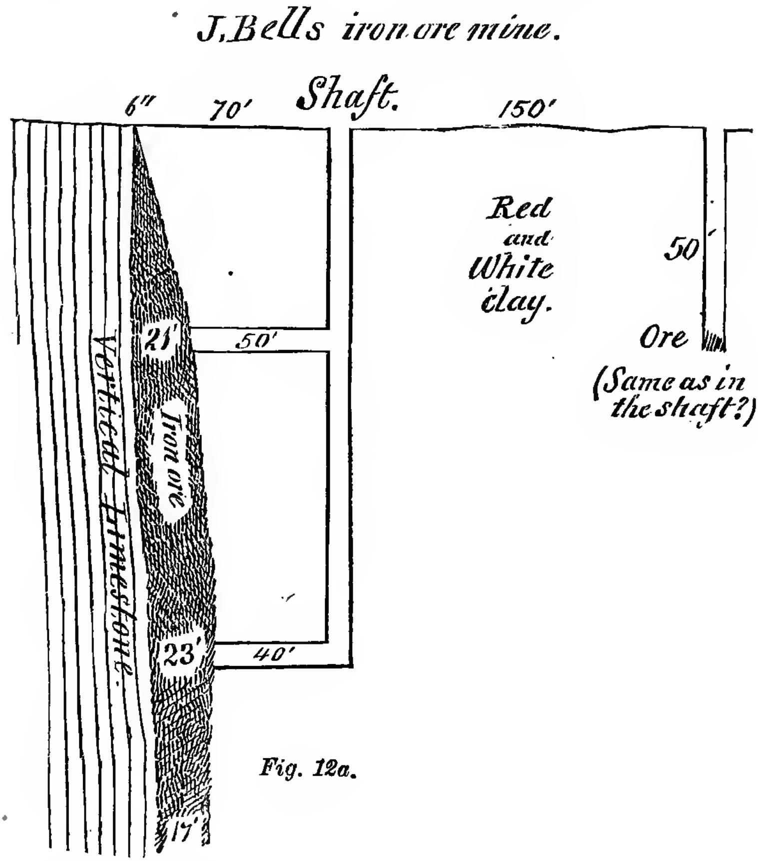


Fig. 12a.

The cut needs but little explanation. Mr. Bell says:

That the limestones at his mine are vertical; that the ore mass went straight down between limestone walls; that he cut it and worked it, as shown on the sketch; that in his shaft, 225 feet away from the first ore deposit, he worked ore; that this second shaft was only 50 feet deep, and ore was left in the bottom similar in character to the ore worked in the first deposit.

§ 217. The ore seems to be in a sharply compressed small synclinal. The shafts were not open at the time of the examination, and the facts could not be verified.

§ 218. The iron ore of VI outcrops at numerous places in the county.

§ 219. It shows on the ridge of the cemetery near Tyrone, and has been opened at Bell's, Trout's, and Baker's mines as already described.

§ 220. East of Altoona, and one half mile northeast of Allegheny furnace, there is an outcrop of the same ore.

§ 221. Three fourths of a mile south of Eldorado (Canaan station Mor. Cove RR.) Jno. Cresswell has mined some iron ore from the limestone of VI.

He states that there was a shaft 15 feet deep in lump ore, and then limestone in the bottom.

Another shaft, 300 feet to the westward, was about 5 feet deep in ore, and ore in the bottom.

The ore removed was used in Hollidaysburg.

§ 222. Northwest of the poor-house, east of Stiffler's crossing on railroad, there is another small mine on the brown hematite of VI. It is entirely abandoned.

§ 223. There are some surface outcrops of the brown hemitite of VI on Chimney rock ridge, 1 mile south of Hollidaysburg.

Geo. Heyl, on the pike one mile northeast of Canoe creek, has some show of iron ore.

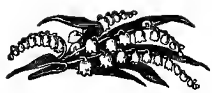
There is now a drift going in, starting in the bottom of VIII. As VII is only 30 feet thick the intention is to strike the top of VI in that distance, and find the ore at this horizon.

There is a surface show of the ore of VI in the loop, on Black oak ridge.

§ 224. But while these outcrops of an iron ore horizon near the top of VI and the bottom of VII are of value in some few places, yet it is really at only three or four points that valuable deposits have been found.

The outcrop is not heavy at the other points noted nor is the prospect encouraging.

This horizon produces much brown hematite ore, and of good character too, in some other parts of the United States; but it is of secondary importance in Blair county.



Chapter IX.

Fossil iron ore.
(Clinton, No. V.)
(Silurian.)

The Fossil ores of the Clinton Group at Hollidaysburg, Frankstown and other places in Blair county.

§ 225. The rocks of the Clinton group (or No. V) are a prominent feature in the geology of Blair county; the colored county maps show how very extended is their outcrop as they run around the outer edge of the mountains of IV.

The detailed measurement of V, as made at McKee's gap, has already been given.

§ 226. The measures of V are of much practical importance in consequence of their holding the different *fossil iron ore beds.* Some one or more of these beds are opened at different places, but the most complete series of openings, and the best opportunity to locate the horizons of the various beds is at Hollidaysburg and Frankstown.

§ 227. The exposures of the ores are somewhat widely separated and on gentle dips; such a construction of a vertical section necessarily introduces some error of measurement, but it is believed that the section given below is in error only in a slight degree.

§ 228. The section as compiled from the openings of the Cambria Iron Company as given by Mr. Brawley, chief miner of the company at Hollidaysburg, and from the topographical map of Mr. Sanders, is as follows:

Cambria Iron Company's section.

Red shale, No. 5, (Clinton formation), *Upper soft fossil ore,* small single bed, ranging in thickness from . . . . . 3″ to 0′ 8″

Interval rocks, chiefly reddish colored slate and shales, with some olive slates,	50′ to 100 0	
Double fossil ore bed—		
Ore, lean and poor,	1′ 4″	14 5
Slates,	3′ to 4 0	
Sandstone, brown,	8 0	
Ore, fossiliferous,	1 1	
Interval rocks, chiefly reddish shales and some thin sandstones and "ore pin,"		400 0
Frankstown fossil ore bed,		1 3
Chocolate slates,		20 0
Interval rocks, chiefly reddish slates and sandstones,		180 0
"*Hard fossil*" *ore bed, or* "*keel ore,*" usually sandy and worthless, ranging in thickness from,		2′ up to 10 0
Total,		726 4

And below the sandy fossil come in about 100 (?) feet of reddish sandstones and then the white, red and gray sandstones of IV.

Upper fossil ore.

§ 229. *The upper fossil ore bed* is opened at numerous places in Blair county, but is nowhere of practical value.

§ 230. When it was struck on Cove mountain it was only from 3 inches to 4 inches thick; and of poor quality at that.

§ 231. When David Irving was mining the upper bed however, near the ore pile in east Hollidaysburg, he found the bed fully 14 inches thick. It is a sandy block ore, highly fossiliferous; but in character so poor that there was no market for it at the Hollidaysburg furnaces.

§ 232. While it has been struck at numerous places it has never yet been of size and character together to work for furnace supply.

§ 233. One or more small limestone beds come in under this upper ore. They have only been seen on outcrops, and nothing is known of them therefore except their existence in the measures in the vicinity of Hollidaysburg.

§ 234. The upper ore bed, evidently small, outcrops at the Catholic church, on Mulberry street, in Hollidaysburg.

§ 235. An exposure of this upper ore bed, three fourths of a mile west of Hollidaysburg, shows the following section of the ore and the underlying rocks:

Upper ore bed, up to,	1′	0″
Gray slate,	0	2
Limestone and some *ore*,	0	6
Slate,	0	8
Limestone,	0	3
Slate,	0	4
Limestone and some *ore*,	0	2
Slate,	0	2
Ore, very lean and poor,	0	7
Limestone and slate,	10	0
Total,	13	10

Though the ore shows as much as 1 foot of thickness at this place, yet its leanness and instability prevent it from having any practical value at present.

Double Fossil Ore.

§ 236. *The Double Fossil Ore bed* is opened at various places in Blair county.

§ 237. It outcrops in the town of Hollidaysburg, and the exposure there shows the following section:

Olive-colored and gray slates,	15′ to 25′	0″
Limestone, ferruginous, fossiliferous,	0	4
Slate,	0	6
a. Iron ore, lean and poor, dark-red in color, clayey, fossiliferous,	1	4
Slates,	3′ to 4	0
Sandstone, brownish-colored,	8	0
b. Iron ore, fossiliferous,	1	1
Total,	40′	3″

§ 238. These ores are not now being worked for furnace use. Specimens of both beds were, however, taken and forwarded to the Laboratory of the Survey at Harrisburg.

Bed a yielded on analysis (McCreath):

The ore is compact, fossiliferous, showing considerable calcareous matter; reddish-brown in color.

Sesquioxide of iron,	30.857
Sesquioxide of manganese,	.053
Alumina,	2.850
Lime,	31.530
Magnesia,	.865
Sulphuric acid,	.060
Phosphoric acid,	1.092
Carbonic acid,	23.778

Water,	1.885
Insoluble residue,	7.090
	100.060
Metallic iron,	21.600
Metallic manganese,	.035
Sulphur,	.024
Phosphorus,	.477

The above analysis represents about a fair average of the character of the upper iron ore layer at this point; it is hardly necessary to point out that it is too poor in iron and too high in phosphorus to be of any value to a furnace.

§ 239. *Bed b.*—The specimen taken from the lower iron ore bed yielded on analysis (McCreath):

The ore is compact; fossiliferous; reddish-gray and reddish brown in color; shows considerable calcareous matter.

Sesquioxide of iron,	19.285
Sesquioxide of manganese,	.046
Alumina,	1.828
Lime,	38.160
Magnesia,	.846
Sulphuric acid,	.085
Phosphoric acid,	.417
Carbonic acid,	30.205
Water,	1.015
Insoluble residue,	8.315
	100.202
Metallic iron,	13.500
Metallic manganese,	.032
Sulphur,	.034
Phosphorus,	.182

This is not to be called an iron ore; it is simply a ferruginous fossiliferous limestone bed.

§ 240. *Baker's mine.*—Mr. S. C. Baker has opened up the double fossil ore bed near Allegheny furnace, and is working out a regular, though not large, quantity of the ore for use in his furnace stack.

The mine is three miles south of Altoona, and the section exposed at the mine shows thus:

a.	*Upper ore bed,*	0′ 9″
	Gray slate,	2 0
	Ore, lean, spotted,	0 10
	Slate,	0 to 0 6

Limestone, massive,	5	0
Slate,	1	6
Bastard limestone,	3	6
Slate and bastard limestone,	3	4
b. Lower ore bed,	1	1
Total,	18′	6″

Mr. Baker only works bed *b*.

Bed *a* shows a lean hard fossil ore, sandy generally, and peculiarly spotted with the micaceous specular oxide of iron.

§ 241. A specimen of this upper ore bed was forwarded to the laboratory of the survey and yielded on analysis (McCreath):

The ore is compact, fossiliferous, brittle, reddish gray in color.

Sesquioxide of iron,	29.071
Sesquioxide of manganese,	.278
Alumina,	2.342
Lime,	32.340
Magnesia,	1.852
Sulphuric acid,	.072
Phosphoric acid,	.767
Carbonic acid,	26.360
Water,	1.660
Insoluble residue,	5.520
	100.262

Metallic iron,	20.350
Metallic manganese,	.194
Sulphur,	.029
Phosphorus,	.335

§ 242. A specimen of the lower ore bed yielded on analysis (McCreath):

The ore is generally compact and rather fine grained; it is full of fossil casts, some of which are partially filled with specular iron ore. Fracture even; color yellowish brown.

Sesquioxide of iron,	69.285
Sesquioxide of manganese,	.130
Alumina,	9.164
Lime,	.190
Magnesia,	.601
Sulphuric acid,	.075
Phosphoric acid,	.451
Carbonic acid,	none.

Water,	8.374
Insoluble residue,	12.015
	100.285
Metallic iron,	48.500
Metallic manganese,	.090
Sulphur,	.030
Phosphorus,	.197

The above analysis represents too high a percentage of iron for an average; Mr. Baker states that the ore yields about 35 per cent. of metallic iron in the furnace stack. He uses only one fourth of this fossil ore, mixed with three fourths of brown hematite ore from his large brown hematite mine near Altoona.

§ 243. Dr. S. C. Baker gives the following description of the section showing at his fossil ore mine:

"Above the lower bed of 1′ 1″, about 18″, there is a vein of 9″; about 4 feet over that there is another of 4″ to 6″, and the "lean spotted ore" is about 16″ at the opening near the furnace, but at the soft fossil bank 26″. Soft fossil bank nearly two miles from furnace, opposite Bell's farm."

§ 244. Though the *Double bed of Fossil Ore* has been opened on the crop at numerous places in Blair county, yet there are now no other mines working the ore for furnace use.

§ 245. The outcrop line of the ore in Blair county is so enormous in length that if there should ever be an active demand for ore of the grade yielded by this bed the production of it could be largely and quickly increased.

§ 246. Mr. Brawley, the chief miner of the Cambria Iron Company, reports that in a trial drift put in by the company west of the Short mountain gap of the Juniata, the double fossil ore bed was found; but that it was only in one bench, and that small, and the ore lean and too poor to work.

And that the same condition of affairs concerning the bed exists one and a half miles to the south along the mountain where the Springfield Furnace road crosses.

§ 247. It is reported also by Mr. Brawley that for the whole distance along the mountain flank from Short mountain gap to Dry gap, the double bed of fossil ore has always been found to be poor, except on Jos. Smith's place.

§ 248. *The Sarah Furnace* Company have opened up one of the fossil ore beds of the Clinton formation; the mine is on the east side of Dunning's mountain, and not far from the furnace stack.

The opening is probably on the double bed of ore; but it could not be examined when the region was visited.

A specimen of the fossil ore yielded on analysis by S. S. Hartranft:

Dark, reddish-brown, brittle, fossil ore; full of fossil casts, for the most part with specular iron ore. Ore emits a strong argillaceous odor when breathed upon.

Sesquioxide of iron,	69.357
Sesquioxide of manganese,	.014
Alumina,	6.285
Lime,	.910
Magnesia,	.551
Sulphuric acid,	.008
Phosphoric acid,	.768
Water,	5.167
Insoluble residue,	17.230
	100.290
Metallic iron,	48.550
Manganese,	0.010
Sulphur,	.003
Phosphorus,	.327

§ 249. All along Dunning's mountain from Dry gap to McKee's gap there are numerous openings on the double bed of fossil ore.

The ore is usually soft and has been mined for Martha furnace at McKee's gap.

§ 250. The double bed has been opened on the outcrop on the Duncan property, back of the reservoir. The exposure shows dove-colored slates, limestone, and spotted iron ore. It is *reported* that the ore measured 3 feet in thickness.

§ 251. The fossil ore has been opened all along in the "loop." They are all old mines, and none of them are now working.

§ 252. The double bed of fossil ore outcrops in Hollidaysburg, and Patton had a mine on it east of the town.

It has been opened on Brush mountain; and the bottom sandy fossil ore has also been opened on its outcrop on the same mountain.

The Frankstown fossil ore.

§ 253. The Frankstown ore bed is opened and worked near Frankstown.

The ore bed can be found in a regular position, 400 feet below the double fossil bed, for a limited distance, as shown on the map; but beyond that short run it thins out to nothing; numerous openings on the outcrop of the horizon show the measures which overlie and underlie the ore wherever it is a workable bed, in their usual position and thickness, but the ore bed entirely lacking. The ore is so valuable that dilligent search has been made for it along the mountain flanks in the vicinity of the Hollidaysburg and Frankstown region, but so far without success except along the small outcrop line back of Frankstown.

§ 254. The ore is overlaid by blue slate, fossiliferous, for 40 feet or more. In this blue slate there occur three regular and persistent "ore pins" as they are usually called: these are reddish colored, with numerous small fossils, usually siliceous, and of no practical value as iron ore. They range from ½″ to 2″ in thickness; the upper one is 37′ above the Frankstown ore bed; the middle one is 26′ above the ore; and the lower one is 17′ above the Frankstown ore bed.

§ 255. The Frankstown ore bed is on the average about 15″ to 16″ in thickness; ranging from 8″ at the lowest to say 22″ at the greatest thickness.

§ 256. Two small "ore pins" come in under the ore bed, one 4″ below the ore, and one 10″ below it. They are of no value.

§ 257. The section of the measures enclosing the Frankstown bed shows thus:

Blue slate, fossiliferous, holding three small "ore pins," .	40′	0″
Upper bastard ore, sandy fossil, worthless, Blue slate, bearing in slate, ...	2	0
Frankstown ore bed averaging, ...	1	3
Slate, holding two small "ore pins,"	0	10

Chocolate colored slate,	20	0
Slates (?)	130	0
Slates and sandstones (?)	50	0
Keel iron ore,	—	

§ 258. The Frankstown Slope mine on the Frankstown ore bed has been worked for many years. It was worked by Miller & McNeal in 1846; by Moore & Brothers till 1849; by Watson, Dennison & Co. until 1863, and since then by the Blair Iron and Coal Company, which is a part of the Cambria Iron Company.

§ 259. The slope is 710 feet long, and the bottom is 218 feet below the surface. The mine yields when working full handed, about 20,000 tons of ore yearly. There is one large pump, which is used about 1½ hours daily; it pumps 600 gallons a minute.

§ 260. The miners can average about ¾ of ton of ore daily.

§ 261. The ore itself ranges in thickness from 8 inches to 22 inches; but keeps a pretty steady average of from 15 to 16 inches in thickness. In character the ore is very persistent.

§ 262. There are numerous small faults reported in the Slope mine; the largest fault (according the Mr. Brawley) is 16 feet of clean cut throw, and the faults taken together add perhaps 25 to 30 cents per ton to the cost of mining.

§ 263. The extreme east heading of the mine, 84 feet below the surface, struck a mass of loose stuff, massive sandstone bowlders, loose leaves and branches of trees, &c.; the ore bed and enclosing measures being entirely cut out. This place is just about under the rows of miners houses on the surface, and is clearly an old stream bed, now entirely filled to this depth of 84 feet with *débris*

It is only a wash out, and not a clean fault; and the Frankstown ore bed comes in again on the east side of this old valley and was opened and worked at the old Rodkey mine, 225 yards east of Roaring run.

§ 264. The Williamsburg Manufacturing Company worked the Frankstown ore bed, back of Frankstown. They took out much iron ore which was used at their furnace stack at Williamsburgh. Their mine presented no features specially different from those presented by the Frankstown Slope mine, and the measurements and analyses of the Frankstown ore, as mined by the Cambria Iron Company, apply equally well to that mined from the same ore bed by the Williamsburg Manufacturing Company.

§ 265. East of the Rodkey mine there is a heavy surface wash for nearly a mile, and no surface outcrop of the Frankstown ore bed is visible in that distance.

§ 266. One mile east of the Rodkey mine however, at the Tiley opening, the Frankstown ore was opened up and reported only 8 inches thick; all of the enclosing measures being perfectly regular.

§ 267. And one half mile east of the Tiley opening Mr. Burroughs opened up the Frankstown ore horizon but found the ore bed only one half inch thick.

§ 268. The Frankstown ore bed crops out on the Patterson place, $\frac{3}{8}$ of a mile north of Hollidaysburg.

The dip was very gentle to the westward, (South 74° West), and the slope followed down the dip of the ore. The mine is now abandoned, the profitable ore being worked out.

The ore is reported as having been somewhat poorer in metallic iron than the ore from the Frankstown Slope mine; and also that all through the Patterson mine the ore bed was much mixed with slate partings, and did not average more than 13 inches of good iron ore. This ore is of the same general appearance as the Frankstown Slope ore and carries the same fossils.

The *Red Bastard* ore shows in place regularly 2 feet above the top of the Patterson ore, just as at Frankstown.

The *Gray Bastard* ore is on the bottom of the good ore block, with a thin layer of slate between. The fossils of the gray bastard are larger than those above.

§ 269. At the north end of the Patterson place is the visible end of the Frankstown ore bed outcrop; and all efforts to find the continuation have failed.

§ 270. One half mile to the northeast, on Young's place, an opening up of the outcrop horizon found the overlying "pins" all right and regular, but no ore bed; and beyond the ravine, northeast of Young's it is reported that the trial openings found the "17 foot pin" resting directly on the chocolate slates, the ore bed having entirely disappeared.

§ 271. And four miles to the northeast again, on Sackett's place (Bell's), the overlying "17 foot pin" is also reported as having been found resting directly on top of the chocolate slates; the measures being undisturbed and regular except that the ore mass was gone.

§ 272. But it cannot be said that there has ever been as yet a complete and thorough examination of the Cove mountain for the Frankstown bed.

§ 273. The character of the *Frankstown fossil ore bed* is very regular. An average sample of the run of the mine was forwarded to the laboratory of the survey and yielded on analysis (McCreath):

The ore is exceedingly hard and tough; deep red in color.

Sesquioxide of iron,	59.857
Sesquioxide of manganese,	.403
Alumina,	2.748
Lime,	12.110
Magnesia,	4.195
Sulphuric acid,	.087
Phosphoric acid,	.588
Carbonic acid,	14.075
Water,	1.305
Insoluble residue,	4.800
	100.168
Metallic iron,	41.900
Metallic manganese,	.280
Sulphur,	.035
Phosphorus,	.257

A second determination of this ore gave (McCreath) iron 40.40; insoluble residue 5.86.

§ 274. An analysis of the Frankstown ore is furnished by the laboratory of the Cambria Iron Company at Johnstown as having yielded thus:

Peroxide of iron,	61.27
Silica,	6.46
Alumina,	1.50
Protoxide of manganese,	0.95
Carbonate of lime,	19.02
Carbonate of magnesia,	3.02
Phosphorus,	0.300

Sulphur,	trace.
Water,	0.19
Metallic iron,	47.50

There are some openings on a fossil ore bed near the mountain crest, north of McKee's gap. The ore bed lies only some 400 feet above the top of IV, and is therefore *near the horizon of the Frankstown iron ore bed*, whereas the opening and shallow trial pits just south of McKee's gap were probably made on the outcrop of the *Double ore bed.*

§ 275. The mine is opened at McKee's gap, on the west flank of Dunning's mountain and has been worked in the past for Martha furnace. The openings have not been worked for many years and are at present fallen shut.

§ 276. Mr. Bridenbaugh reports that they worked 3½ feet of soft fossil iron ore; and that in their tunnel in to the ore, (on the mountain flank north of McKee's gap) they found the following rocks overlying the ore:

Red shales and slates,	
Limestone,	215′ 0
Gray slates,	60 0
Fossil ore bed,	3 6

§ 277. *The Hollidaysburg and McKee's Gap Iron Company*, who are now running Martha furnace, forwarded to the laboratory of the survey an average specimen of this soft fossil ore. It yielded on analysis (McCreath):

The specimen is all lump ore. It is compact and tough; full of seams of ochreous iron ore with spangles of specular iron oxide; color, generally reddish brown.

Sesquioxide of iron,	74.285
Sesquioxide of manganese,	.072
Alumina,	7.392
Lime,	.960
Magnesia,	.552
Sulphuric acid,	.077
Phosphoric acid,	.758
Carbonic acid,	traces.
Water,	4.962
Insoluble residue,	11.115
	100.173
Metallic iron,	52.000

Metallic manganese,	.050
Sulphur,	.031
Phosphorus,	.331

§ 278. As this analysis seemed entirely too favorable to accord with the results obtained from working this iron ore in the furnace stack, a second specimen was forwarded to the laboratory for analysis. McCreath reported as follows:

"The second specimen consisted of about $\frac{7}{8}$ lump and $\frac{1}{8}$ fine ore. Lump ore somewhat similar to first specimen. The fine ore is for the most part a yellowish-ochreous earth, rather lean in iron:

Sesquioxide of iron,	67.285
Sesquioxide of manganese,	.278
Alumina,	7.044
Lime,	.550
Magnesia,	.569
Sulphuric acid,	.082
Phosphoric acid,	.398
Carbonic acid,	trace.
Water,	6.190
Insoluble residue,	17.855
	100.251
Metallic iron,	47.100
Metallic manganese,	.194
Sulphur,	.033
Phosphorus,	.174
Phosphorus (2d determination),	.171

At the foot of the mountain, west of Canoe creek, is a reported outcrop of the Frankstown ore bed. No rock can be seen in place; a few pieces of ore lying on the surface near a filled-up shaft, look very much like the Frankstown bed.

Keel, or Hard Fossil Ore.

§ 279. The lower fossil ore bed is called locally in the Hollidaysburg region the "Keel ore bed." It is not opened and worked at any place, but has been touched on the outcrop sufficiently to show the size of the bed and its general character.

§ 280. At one point where the Cambria Iron Company had opened up the outcrop, the bed showed in all 12 feet thick of lean sandy ferruginous matter. Of this mass some two feet in thickness carries 17 per cent. of metallic iron; while the remaining 10 feet of red stuff show only 7 to 11 per cent. of metallic iron. The whole bed is not rich enough in iron to be called an iron ore; and the ferruginous sandy mass is entirely useless for all practical purposes.

§ 281. The bed is very persistent, and can nearly always be found at its proper horizon when looked for along the mountain flank.

§ 282. It was opened some years ago on the Bald Eagle mountain, back of Tipton. The opening is known as the Dysart mine, and the heading, when examined (Oct., 1873), showed thus:

Fossil ore at mouth of tunnel in soft rotten shale,	0′	6″
Rock in tunnel,	16	0
Hard lean *fossil ore*,	1	5
Hard *fossil ore*,	2	10
Clay parting,	0	2
Hard *fossil ore*,	2	0
Soft shale floor, rotted into compact mud, the water bearing stratum,	—	

§ 283. A specimen of the ore taken from the middle bench of the above bed of ore was analysed by Prof. P. Frazer, jr., and yielded thus:

Sesquioxide of iron,	38.48
Protoxide of iron,	4.37
Silica,	37.99
Alumina,	9.56
Lime,	1.08
Magnesia,	trace.
Alkalies,	2.54
Phosphoric acid,	1.48
Sulphur,	0.05
Loss by ignition,	4.50
	100.000
Metallic iron,	30.34

§ 284. This hard fossil ore is not now being worked for furnace use. It was mined in 1873 and the results are thus described by Prof. Lesley.*

"In October, 1873, a Pittsburgh furnace was doing good

* Private report to W. M. Lyon & Co.

work mixing ¼ of this Tipton (Dysart) ore with ¾ of very pure ore, deficient in silica and alumina, which deficiency the hard fossil ore supplied; and that without any marked prejudice to the run of the furnace as to quality, although two thirds of the Tipton ore went below 40 per cent. and one third below 20 per cent. of iron; the Tipton ore making good cinder, and thus relieving a part of the pure ore from that duty. The quality of the pig metal produced after the mixture was adopted remained unchanged."

§ 285. The same hard fossil ore bed has been opened on the crop on the mountain, south of Tyrone city and 260 feet by barometer above the Juniata river; the slope of the surface being 40° and the pitch of the bed at the outcrop 60° into the mountain (southeast). But this is due to the creep of the outcrop down hill. The body of the bed stands vertical.

§ 286. There are 6½ feet of rock ore between overlying sandy shales and underlying foot shales; only the upper 22 inches of the bed in six plies is here workable.

§ 287. At *Howard furnace* the same hard fossil ore was analysed, &c., some years ago and found to contain 28 per cent. of iron. The bed was here found standing at 80° towards the north northwest and only 22 inches thick.

§ 288. At *Frankstown* the bed sometimes reaches a thickness of ten feet; always lean and sandy.

§ 289. On the southeast flank of Tussey mountain at R. H. Powell's mines, *ten miles southeast of Frankstown*, the same bed varies from 15 to 25 feet in thickness, and shows three well marked benches, an upper and a lower of sandy rock ore, and a middle bench, 5 or 6 feet thick, of soft rich fossil ore, which is mined by the Cambria Iron Company, and transported in large quantities ninety miles by railroad, via Huntingdon and Tyrone City, across the Allegheny mountain to the company's furnaces at Johnstown, in Cambria county, for mixing with coal measure ores (mined back of the furnace) and high grade ores from Lake Superior and Missouri."

This statement above was written by Prof. Lesley in 1873.

§ 290. There is a *brown hematite ore of V* exposed at one place in the county.

It is near the crest of Tussey mountain, north of Yellow Springs, about one and a half miles. Some 200 to 300 tons of the ore have been used in the past by Ætna furnace.

The ore occurs in the slates of V, just above the top of the upper of IV, in a small shallow synclinal basin.

CHAPTER X.

Brown Hematite Ores of No. II.

(*Siluro-cambrian.*)

Morrison's Cove; Canoe Valley; Sinking Valley.

§ 291. The iron ores of formation II are of great importance in Blair county.

The various mines are described in the following chapters, in full detail, with illustrations, analyses and estimates of cost and quantities.

There are also numerous surface shows of loose pieces of iron ore, with occasionally some small trial pits, which do not require separate illustration, but yet are of sufficient importance to need mention.

§ 292. The outcrops and mines will be described in the following order:

1. The outcrops and small trial pits on iron ores in Morrison's Cove and Canoe Valley.
2. The Springfield ore mines and small adjacent mines.
3. The Henrietta ore mines and the Soister mine.
4. The Bloomfield, Rebecca, and Red ore mines.
5. Canoe Valley and Sinking Valley iron ore mines.

§ 293. The outcrops and small trial pits of iron ores of II in Morrison's Cove and Canoe Valley are briefly stated below, starting from the south end of Morrison's Cove, and running northward through Canoe Valley.

§ 294. One mile west of Enterprise there is an outcrop of iron ore, but in no case very heavy.

The crop is nearly on the center of the anticlinal axis, about 3000 feet below the bottom of the slates of III; about the same ore horizon as that of the Soister mine and others in the center of the valley further to the northward.

The same outcrop shows to the northward of Enterprise;

and there is also much ferruginous whitish sandstone scattered over the surface.

§ 295. There is a small show of iron ore in the road near S. Brumbaugh's place, four and a half miles south of Bloomfield mines.

And one mile south of Woodberry there is a small iron ore crop, together with much ferruginous sandstone and flint.

§ 296. In the vicinity of Long's place, one mile south of Baker's Summit, there is an iron ore outcrop.

The outcrop here extends over some hundreds of yards, and it is at times quite heavy. It has never been worked. Much good-looking iron ore in lumps has been gathered from the fields and thrown into the fences.

On the Fox place, one third of a mile west of Woodberry, there is a small outcrop of iron ore.

§ 297. On the R. Hoover place, 1 mile northwest of Woodberry, there is a very decided and promising surface crop of ore pieces and ore bearing clays. In working the fields there considerable quantities of ore, largely pipe ore, are thrown out at every plowing. No trial pits have ever been put down to test the depth of the iron ore deposit.

§ 298. Some 400 yards west of this outcrop there is another surface show and trial pits found some dark red colored and fairly rich brown hematite ore, lying in yellow clay. It is reported that in one place there were 4 feet of closely packed ore lumps; and that the shaft was 40 feet deep, going through ore bearing material.

No real examination of the ore deposit at Hoover has ever been made, and the quantity is therefore uncertain.

§ 299. A sample of the ore from the Hoover place was forwarded to the laboratory of the survey. The sample was not an average of the wash ore which would come from washing the ore mass but was simply a lump of the rich lump ore. It yielded on analysis (A. S. McCreath):

Sesquioxide of iron,	80.000
Sesquioxide of manganese,	.207
Oxide of cobalt,	trace.
Alumina,	3.069
Lime,	.310
Magnesia,	.562

Sulphuric acid,	.082
Phosphoric acid,	.201
Water,	12.106
Insoluble residue,	3.970
	100.507
Metallic iron,	56.000
Metallic manganese,	.144
Sulphur,	.033
Phosphorus,	.088

The ore is a limonite, brittle, cellular, stalactitic, dark brown. The cells are partially filled with a yellowish brown clay.

§ 300. About 2 miles northeast from the R. Hoover place, or 2½ miles northeast from Woodberry, there is a decided outcrop of ore pieces and ore bearing clays on the J. S. Sell place and on the Stager property adjoining.

Mr. Sell reports that in putting down the well at his house he went down 17 feet to solid limestone; aud that in the 17 feet of clay and stuff there were 3 feet of iron ore. Also that he found the same amount of iron ore in digging the foundation for his barn.

The surface crop covers considerable area at this place, but there is no evidence as yet that the deposit possesses any depth.

The ore in appearance seems to resemble somewhat the surface show on the R. Hoover place.

§ 301. Two and one half miles west of the Henrietta mines some red colored clay has been struck in the cellar of a house; and there is some slight ore show about one mile west of Henrietta.

The ore show at Stonerook school house, one half a mile west of the Henrietta, is described in the chapter relating to the Henrietta iron ores.

§ 302. North of the Henrietta mines there is some slight surface show of iron ore all the way from the railroad curve to and beyond the Red ore bank. The ore crop however is always slight.

Just north of Millerstown there are many great masses of ferruginous sandstone along the crop line of ore.

§ 303. There is a small iron ore show one half of a mile west of Millerstown; another on the east and west side of the ridge of III near Fredericksburg; and another one two miles east of Martinsburg.

§ 304. At the Styles place, one mile east of Martinsburg, there is an iron ore crop, not heavy, which extends for some 200 yards across the ridge. No openings have been made to test the depth of the ore show. There is much ferruginous sandstone in the ore crop; the geological horizon of the ore is about 2500 feet below the bottom of the black slates of III.

§ 305. One half mile northeast of Bloomfield furnace there is a surface show of iron ore and iron bearing clays, much of the ore being "honeycomb ore."

This outcrop, not exactly continuous, runs on to the northeast, covering the surface lightly for nearly 3 miles.

§ 306. One third of a mile northeast of Roaring Spring there is a show of deep red colored ore bearing clays along the road side.

Some 400 yards to the northeast some iron ore was worked from a small open pit. The ore pieces are all small, no large lumps of ore showing.

§ 307. Two miles east of Springfield there is a small show of pipe ore in a field, near Clover creek; and one and a half miles northeast of Springfield there is a surface show of lean sandy iron ore.

§ 308. Two miles southwest of Williamsburgh, there is much deep red colored clay, and a few shallow pits have found some ore; one mile east of Williamsburgh there is very small ore show; and one half mile east of Williamsburgh there is a fairly good surface show of iron ore.

§ 309. Near Cove forge, about at the junction of II and III, there is a small outcrop of ferruginous matter.

§ 310. In the center of Canoe valley, on the crest of the anticlinal arch, the limestones are sandy and much loose sand. There is a small surface show of iron ore.

§ 311. Two miles southeast of Water street P. O., in Canoe valley, there is much show of ferruginous clay, but it seems to carry little or no iron ore.

§ 312. Two miles southwest of Spruce creek P. O., there is much ferruginous clay, running along as a surface show for a mile; but there are no ore openings and there is little or no iron ore in the clays.

§ 313. There are of course in Blair county numerous places where there is a very small surface swash of ferruginous matters, but the above named are all that seem to call for special mention.

CHAPTER XI.

Brown hematite ores of No. II continued.

Springfield mines and small adjacent mines.

§ 314. *Geographical position.*—The Springfield mines of the Cambria Iron Company are opened on the central ridge of Morrison's cove valley and on its west flank; they are one and a half miles south of Springfield furnace, and three and one half miles south southwest of Williamsburgh; are 1460′ above tide level, 260′ above the level of Piney creek (abreast of the mines) and 560′ above the Juniata river at the mouth of Piney creek at Franklin forge.

§ 315. *This central anticlinal ridge* of Morrison's cove has already been described in the detailed general structure of the county.

It is sufficient here therefore to repeat that the valley is at this point a simple anticlinal valley; the cross section showing thus:

Fig. 13.
Cross Section through Springfield Mines.

§ 316. The Springfield ore deposits naturally subdivide themselves into three sub-heads, viz:

1. The northern outcrop on the ridge, and mine No. 1, enclosed therein.

2. The outcrop south of the above and separated from it by an interval, barren of ore. In this southern outcrop is opened mine No. 2, and some small pits.

3. An outcrop lying near Piney creek, at the west foot of the Ridge, three fourths of a mile west of mines No. 1 and 2.

In this third outcrop is opened mine No. 3, and a shaft for underground working also.

The Northern Outcrop and Mine No. 1.

§ 317. The ore horizon, as given by mine No. 1, is 4800'± below the bottom of III. It is not at the center or lowest point of the anticlinal arch, geologically; inasmuch as the lowest rocks shown on the arch are 5600'+feet below the bottom of III. *Topographically* the mines are about on the crest of the Ridge.

§ 318. This ore outcrop is clearly defined on the surface; in fact it is frequently sharply defined; on leaving these limits the whole surface is sandy barrens.

The first, or most northern outcrop, is irregular in shape, and is 2600' long from north to south, by from 300' to 1450' in width.

All of this area can be called outcrop; sometimes the surface is covered deep with rich ore show, while at other places the ore is small in quantity, and lean and sandy in character; but there is always some ore show, and trial pits are nearly certain to find some ore, though the prospect may not be promising.

Whereas, outside of the outcrop line there is literally no ore show on the sandy surface stuff, and trial pits have found nothing at all in the way of ore except in an occasional pot.

The ore show inside of the outcrop line is made up of ores of every grade of color, character, and value.

§ 319. Springfield mine No. 1 is a large open cut and four shafts.

The open cut is about 600'×500' on the surface, and from 30' to 65' deep.

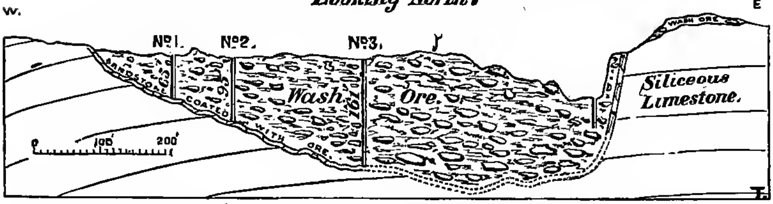
It is the most northern of the Springfield mines, and close to the north line of outcrop. All or nearly all of the total mass of stuff removed from this mine has been wash ore, and has passed through the washer.

Scale, 100′ to 1 inch.

Fig. 14.

Springfield Mine No. 1. Blair County, Penn'a.

Looking North.



§ 320. From the main openings at shafts Nos. 1, 2, and 3 both from open cuts and underground work, the following facts seem to be established:

§ 321. *1.* Massive sandrock, making when disintegrated a sharp clean sand, is found outcropping on the east side of the openings, making the bottom rock to the ore. The ore mass rested directly upon it; the upper layer of sandstone is in many cases heavily coated and crusted with iron ore, and ore fills the small cavities and irregularities on the sandstone surface.

§ 322. *2.* This same sandstone is found in the bottom of the shafts, Nos. 1, 2 and 3; directly on top of it in the shafts lies the ore, in lumps and blocks, in all fully 6 feet thick, surrounded with white and yellow clay; and following the sandstone as a mine floor this ore has been worked up the rise from shaft No. 1, to the east outcrop.

§ 323. *3.* Shaft No. 1, is 65 feet deep to the sandstone; shaft No. 2 is 100 feet; and shaft No. 3 is 161 feet.

§ 324. *4.* In shaft No. 1, the ore was seen plainly pitching down steeply towards the bottom of shaft No. 2; and on going down 54 feet further in this sandstone from the bottom of shaft No. 1 no ore was found.

§ 325. *5.* On the west side of the big open mine (and of course west of shaft No. 3, which is in the big open cut), massive sandrock is again found as the wall of the mine, and *dipping to the east*; and the slope of the side of the mine is steep.

§ 326. The old working was only about 35′ to 40′ east of this west sandstone wall. The ore was removed by an open quarry for about 60 feet below the surface, and after that by a 60 foot shaft put down at the bottom of the open working, making 120 feet in all below the surface. This shaft is reported as having been entirely in lump and wash ore, the whole mass of clays and ore, according to the miners' statement, having a pitch to the west, or directly against the sandstone wall. Such so-called dips in these great pits are of no consequence and are not indeed a true dip at all. The sandrock itself was not touched in the workings and must therefore have a very steep face, inasmuch as the workings only started 35 feet from it, and are down 120 feet.

§ 327. Back (west of) of this exposed sandstone on the west wall of the mine, the ore outcrop shows for a short distance on the surface, but it is seemingly only the loose swash from the main deposit, and is without depth except at one or two places, where there are old pits.

§ 328. On the east side of the big open cut, the surface ores show extends for some distance east of the sandstone outcrop; but is seemingly chiefly shallow swash from the main ore mass, and only of depth in a few places.

§ 329. *6*. The record of the shaft No. 3—161 feet deep, is thus given by the chief miner, Captain Blight:

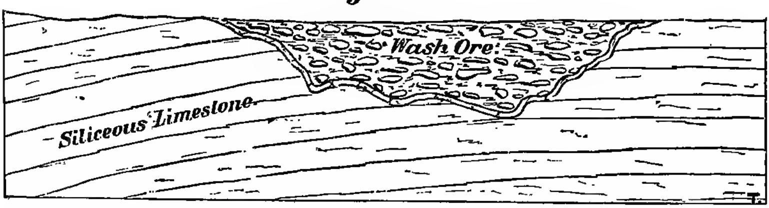
1.	Loose wash ore, very lean in places, varying much in character, with clay layers, for	40 feet.
2.	Iron ore, in blocks and lumps, ...	2 to 3 "
3.	Sand and clay masses, of no value for washing, ...	112 "
4.	Ore—6 feet in all—in white and yellow clay, ...	6 "
5.	Sandstone, massive, in bottom, 161 feet deep, ...	—

This imperfect record disagrees with every other section and record of the Springfield ore mass; it is partly due perhaps to local accident that these 112 feet showed no ore but it is more likely that lump ore was being sought for, and fine ore was comparatively disregarded.

For on the west side of this same mine bank the open cut and shaft have shown fully 120 feet of wash ore; and in other parts of this same mine the usual wash ore show is found from the surface down, varying of course in richness, occasionally cut out by clay masses entirely for a distance, &c.; but it is clear that in all general features this bank resembles mine No. 2, and other large mines in this as in other respects.

§ 330. The section as given above and the facts concerning the character of the ore mass presupposes most probably one of the two following cases: Either this, No. 1, which

Fig. 15.



indeed is nothing more than an irregular hollow, worn out of the original calcareous sandrock, now on or near the crown of the anticlinal arch, and filled in with iron ore in pieces of all sizes, clay and gravel and sand.

§ 331. The sandrock which is the ore bottom in the three shafts, and on the the east and west sides of the big open cut, is coated over with iron ore, apparently a deposit from water carrying iron, and this coating sticks to it as a film so close and complete as to make the mass resemble iron ore until it is broken, when the thinness of the film is exposed.

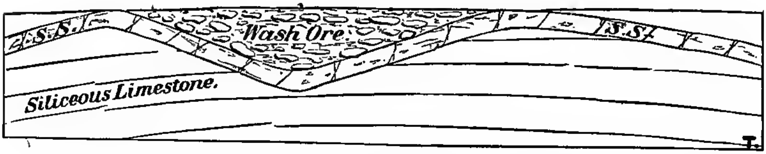
§ 332. Loose pieces of sandstone, ferruginous slate and sandstone closely resembling pieces of Clinton formation measures (of V), conglomerate lumps of sandstone pieces fastened by a matrix of iron ore, &c., are found in the loose mass.

§ 333. The finding of a richer ore mass on the bottom of the hollow is natural enough; and as it follows the inequalities of an irregular floor it would have apparent dips.

§ 334. The general ore mass of wash ore and clay is a loose irregular deposit, without any regular and continuous dip, the masses waved and folded, &c., in bewildering variation.

§ 335. Or this structure, No. 2, might explain the regularity of sandstone walls and floor to the mine:

Fig. 16.



Making a regular small synclinal of nearly 1000 feet across, nearly on the crown of the main anticlinal arch between Tussey and Lock mountain.

Such a small basin is entirely possible; and in its favor is the regularity of the block iron ore deposit on the bottom of the mines, and the somewhat canoe shaped pointing out at the north and south ends of the ore mass.

§ 336. *Character of ore from mine No. 1.*—The ore, as yielded by mine No. 1, is of all characters and grades. The underground workings of the main shaft show much honeycomb iron ore, of very fine character, porous in structure, rich in iron, and easily fluxed.

The washed ore shows all kinds, and is on the average much leaner in iron percentage than the honeycomb lumps.

The ore is all shipped to Johnstown, Hollidaysburg, Bennington, or Frankstown for use in the furnaces of the Cambria Iron Company.

§ 337. An average specimen of the washed ore was selected for analysis, taking the ore exactly as it comes from the washers into the cars, and representing a fair sample of Springfield ore from mine No. 1, as it is used at the Cambria Iron Company's furnaces.

The analysis was made by A. S. McCreath, and the ore shows:

"The fine ore carries considerable free quartz; the lump ore consists of a mixture of fine-grained, compact ore, and cellular ore, with the cells partially filled with clay. Portions of the ore have a laminated structure.

Sesquioxide of iron, ...	52.428
Sesquioxide of manganese, ...	1.344

Alumina,	2.042
Lime,	trace.
Magnesia,	.129
Sulphuric acid,	.075
Phosphoric acid,	.080
Water,	9.375
Insoluble residue,	34.700
	100.173
Metallic iron,	36.700
Metallic manganese,	.936
Sulphur,	.030
Phosphorus,	.035

§ 338. Between the outcrops of the mine No. 1, or Davis mine deposit, already described, and the next ore mass and crop to the southward, there have been numerous trial pits put down. These pits have confirmed the opinion, based upon the almost total absence of surface outcrop, that there is a considerable area of barren, or almost entirely barren ground between these ore deposits. The trial pits do not strike solid rock in place however, but sand and clay; and the surface is sand. There may be some pots of ore in this sand mass, but the whole hill top has been quite carefully prospected, and no ore of consequence has ever yet been opened in this barren ground.

Outcrop and shaft at mine No. 2.

§ 339. The second large outcrop area, holding within it the large open work and shaft at the Lykens mine, together with some smaller unnamed pits, is an irregularly shaped area, some 2200′ long by from 800 to 1000′ wide. It covers the crest of the ridge and is in all respects of the same character as the mine No. 1, or Davis mine outcrop, from which it is only separated by a narrow barren area.

§ 340. The Lykens mine, or mine No. 2 of the Cambria Iron Company, consists of a very large open pit, about 600′ long, 400′ at its greatest width, and some 80 feet deep at the deepest part; it has once been worked as deep as 100 feet with open working.

From this huge pit large quantities of ore have been taken in the past and are now being mined.

Moreover the "Lykens shaft," on the north end of the open pit is working steadily and taking out much ore.

§ 341. The bottom sand rock, similar in character to that described at the Davis mine, is showing on three sides of the mine and being approached on the fourth. It makes steep dipping walls to the mine; and all inside of these walls is wash ore of various grades; some of the clays holding indeed little or no iron ore, while other stuff is very rich in iron ore; but all of it is treated as wash ore and the mine is worked out clean on each level, nearly everything taken out going through the washing machines.

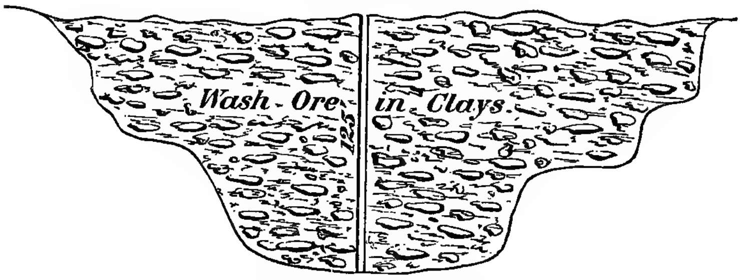
§ 342. This open mine work has been carried for 100 feet below the surface; and no bottom has been reached, the show now on the lowest level being apparently of the same character as the ore show when the mine was opened on top. The limit of working this mine by open work seems more likely to be reached by touching the limit of economical open work mining rather by any giving out of the great mass of ore bearing clay in this great ore pot.

§ 343. For the Lykens shaft is down 215 feet to the sandrock underlying the ore; and would seem to be about on the center or deepest point of the deposit.

Judging from the surface show of sandrock in the sides of the pit, the shape of the sandstone hollow, holding the ore, is somewhat thus:

Fig. 17.

Lykens Shaft.



Making the great body of the ore deposit lie between the surface and the 125 foot level; the bank below that being narrower, and contracted in all directions.

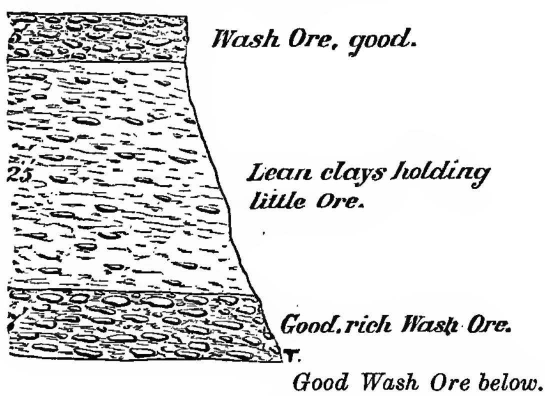
§ 344. The shaft is working a so-called solid ore deposit; that is, ore lumps, very numerous, close together, packed in clay. It is usually in two layers; the upper layer is of reddish ore; then a parting of sandstone and sand from 1 to 4 feet thick; then heavy lump black ores in clay; resting on top of the bottom sandstone.

The ore layers and the sandstone parting vary much in thickness, and vary quickly.

The ore mass is followed along the inequalities of the floor; and at time of examination was rising in all directions from the shaft.

§ 345. One face exposed in the Lykens pit showed thus:

Fig. 18.
Face exposed at the Lykens Shaft.



The clays are of all colors—rich red, variegated, brown, and reddish, up to nearly pure white.

The ore shows bombs constantly in the working face.

Sometimes the layers of white clay become very heavy; and the mine developes much sandstone, and many pieces of flint.

§ 346. A short distance to the South 20° West of this mine No. 2, or Lykens mine, about 45 to 50 feet beyond the present south end of the mine, there is an old abandoned ore pit; it shows dimensions of about 50′×25′×15′, with water in the deepest part.

The upper 15 feet, just below the surface crop, show poor in ore, both as to quantity and quality; better ore comes in below this, however.

All of this ore can be reached cheaply from the large open mine, and the ore be easily removed.

§ 347. Southwest of the Lykens shaft there is a small shaft, 100 feet from the edge of the large open mine; this small shaft struck good ore 15 feet below top of ground, and worked out considerable ore; the top of the shaft is 10 feet below the level of the top of the open mine.

§ 348. *Character of the ore at No. 2.*—The ore from mine No. 2 shows in the washed ore all characters and varieties of brown hematite; the mine, however, is chiefly noticeable for the great quantities of bombshell ore found in it, and the scarcity of honeycomb ore.

The bombs are numerous and of great size; sometimes filled with soft white clay, apparently limestone clay; again filled with sandstone, more or less decomposed, or filled with fine sharp sand: or with water; and frequently hollow.

These bombs usually represent a grade of ore much above the average richness in iron.

§ 349. A specimen of the washed ore from mine No. 2, taken directly from the washer, and making a fair average sample of its product at that time, was forwarded to the Laboratory of the Survey for analysis. It was analyzed by A. S. McCreath, Chemist of the Survey, and yielded:

"Specimen consists of nearly all fine ore, carrying a small admixture of free quartz. The lump ore consists, for the most part, of bombs, the walls of the bombs being lined with fibrous, botryoidal iron ore.

Sesquioxide of iron,	73.714
Sesquioxide of manganese,	.610
Alumina,	1.979
Lime,	trace.
Magnesia,	.309
Sulphuric acid,	.072
Phosphoric acid,	.137
Water,	10.510
Insoluble residue,	12.260
	99.591

Metallic iron,	51.600
Metallic manganese,	.425
Sulphur,	.029
Phosphorus,	.060

§ 350. There was also forwarded for analysis a specimen of the bombshell ore from this mine No. 2.

This ore is, of course, of unusual purity, reaching in fact almost a maximum percentage of metallic iron for a brown hematite ore. And there is so much of it in this bank that it raises materially the general average richness of the deposit.

The analysis was made by A. S. McCreath, Chemist of the Survey, and the ore yielded thus:

"Ore hard and tough; the walls of the bombs being lined with fibrous iron ore with velvety botryoidal surface. Some of the bombs contain considerable clay.

Bisulphide of iron,	.004
Sesquioxide of iron,	84.428
Sesquioxide of manganese,	.368
Oxide of cobalt,	trace.
Alumina,	2.617
Lime,	.070
Magnesia,	.227
Sulphuric acid,	.237
Phosphoric acid,	.123
Water,	8.672
Insoluble residue,	3.460
	100.206

Metallic iron,	59.100
Metallic manganese,	.256
Sulphur,	.096
Phosphorus,	.054

§ 351. *Outcrop at mine No. 3.*—The barren ground holding little or no ore extends for about one mile west of mine No. 2; and it is only on reaching the railroad curve, on the west side of the ridge, that a heavy surface crop of ore-bearing clays is found near the level of Sinking Spring run, a branch of Piney creek.

§ 352. This ore mass differs entirely from that at mines No. 1 and 2, on the crest of the ridge; it lies geologically only 2600′ below the slates of III, and they are fully 4800′; it lies in limestone hollows, and they are in sandstone; its water-worn and rounded ore pebbles are usually small, while their ore comes out frequently in great masses, not rubbed nor water worn at all.

§ 353. The outcrop line at mine No. 3 surrounds only a small area as compared with the outcrops of mines No. 1, and No. 2; nor is it so closely defined, inasmuch as a thin swash of reddish colored stuff, of no depth at all, colors the soil far beyond the actual limits of the ore clay deposit.

§ 354. The open pit of mine No. 3 is a mass of loose wash stuff, from 6 feet to 20 feet deep, on, in and around limestone caves and masses.

The open pit, which is shallow, but covers now considerable area, shows fine-grained clays, waving in bedding, in color varying from a purple or brown to nearly white, all carrying some iron ore, though varying very much in richness.

§ 355. The limestone, which shows in place all through the mine, is dark colored usually, and has with it an occasional layer of slate. In the clay, in which all the ore is rounded and water worn, occur also some rounded pieces of sandy limestone and sandstone, similar in appearance to the rocks along the ridge crest.

§ 356. At the north end of the open cut at mine No. 3, the work runs along simply following the natural floor of the mine, which is either where solid limestone is reached, or where the stuff becomes too lean to wash, say running down so low as for the ore to be only 5 per cent. of the mass; the thickness of wash ore over this northern area is sometimes only 5 feet to 6 feet. All over the meadows to the north and northwest of the mine there is a heavy surface show of ore, but the depth has not been tested.

§ 357. On the west side of the mine when examined the cut shows on the face fully 13 feet to 15 feet of wash ore, some of it very lean in ore, and other streaks rich. A bowlder of limestone, weighing more than a ton, shows in the face of the working. The average yield of this part of the mine, and it is about the same for the mine taken as a whole, is 1 ton of ore to 10 tons of wash stuff. The ore is hauled out on a plane, the cars holding 27 cubic feet, or 1 cubic yard.

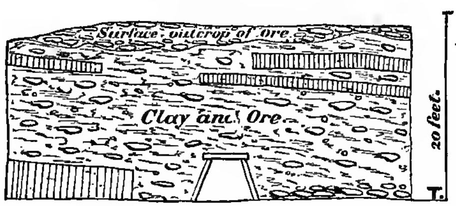
§ 358. There is no way to find a limit to this surface deposit in the limestone hollows. It may at any time grow deeper, and make a large and valuable mine; and is equally liable at any place to have the limestone come to the surface and bring the workings to an end.

§ 359. The bedding of the clay layers is generally nearly horizontal, though always waving somewhat. In one place on the west side of the mine, the clays bedded as usual, there was a barren place of 15 feet thick of clay holding almost no ore, and which was not worth passing through the washer; yet directly underneath this barren mass, there is a layer of 5 feet of rich wash ore, lying in exactly the same manner, only holding much instead of little iron ore.

§ 360. On the east side of the open cut at mine No. 3, the working face resembles generally that above described.

The bank face in one place showed thus:

Fig. 19.
Bank Face Mine No. 3.



The alternations of clay and wash ore as given in the section represent the general character of the whole deposit.

The surface outcrop of iron ore at this east face, and on up the hill, is heavy; the iron pieces, always small, are water-worn pebbles; and the stuff with them is fine-grained, with few sandstone pieces.

§ 361. There being nearly solid ore in the mine bottom at the place indicated by the drift in the cut above, this ore was followed in for 200 feet under solid limestone cover, the drift running about southeast; and a shaft was put down from the hill to meet it at that point; the dip of the ore in that distance to the southeast was about 12 feet; the rise of the hill 33 feet; and the shaft therefore is 45 feet deep to the ore.

On driving in from the open cut, the varying clays and limestone soon changed to a regular limestone roof and floor; between these was a mass of rock, ore, and clay, rapidly shifting in thickness, with loose or "wild" masses of limestone at irregular intervals.

All the stuff is taken out from roof to floor; all of it goes through the washer, and all of it contains some iron ore.

Taking a general average of the stuff removed so far, according to the statement of the mine captain, fully one half of the deposit is rock ore; the other half clay, holding more or less ore, and these wild limestone masses.

The average thickness of the ore mass is about 5 feet or 5½ feet; in one case running up to 19 feet, and in others coming down to very small thickness; the changes being great and frequent.

The sinking of the ore to the east-southeast of 10′ to 12′ in 150′±is a dip in that direction of from 3° to 4°.

From the shaft bottom a drift followed the ore, still sinking in the same direction, for about 100 yards; when the ore pinched out, leaving nothing but a limestone face at that place.

In sinking the shaft they found—

Surface—ore crop,	4′
Limestone, solid,	41′
Ore mass in bottom at	45′

Though the above workings are done by regular mining, with solid roof and floor, yet it is clear that the deposit does not differ materially from numerous iron ore deposits, which are worked as open cuts. It differs, indeed, materially in general character from the ore in the open pit of mine No. 3, with which it directly connects.

§ 362. In the open pit the ore pieces, as well as all other solid matter, are clearly rounded and water-worn; and the wavingly horizontal clay layers look like a swash.

§ 363. While the ore deposit between the limestone walls seems clearly to point to a slow wearing away of soluble limestone and filling up with deposit from a muddy water, carrying much iron in it. That these two different deposits run together as they do, may be either an accidental case, or the underground deposit may be the later of the two, the ferruginous matter to fill it having come from waters percolating through the surface ore deposit above.

§ 364. With reference to this underground work at mine No. 3, Mr. John Fulton, General Mining Engineer of the Cambria Iron Company, writes as follows:

"The underground work at mine No. 3 continues giving the same rich ore as usual. There is no evidence to show that the deposit will be persistent. It seems to have occurred in this way, adopting the theory of the decomposition of iron pyrites at the source of the iron ore.

First, a lenticular cavity formed in the limestone either by crust flexure or decomposition of dolomite.

Second, the precipitation of iron matter into this matrix.

It would not require very extended time to do this. At Bennington shaft, the pump column receives from the mine water one inch of such ore each year. This is supplied by the decomposition of carbonate iron ore nodules in roof of Miller coal bed.

At Johnstown, in the Slope mine, an area of one half an acre, near New Furnace No. 5, is now being filled with iron matter from the same source; in some places the deposit is *eighteen inches* deep, made in the last *eight years*. It looks in this section of the coal mine as though the iron matter would soon fill the place from which the coal has been removed. The deposit is especially active at this place since it receives some warm water from the large furnace, through the roof of the mine."

§ 365. *Character of ore from mine No. 3.*—The ore taken from underground work at mine No. 3, is more than half large lump ore. It resembles in appearance the ore from mine No. 1 (the Davis mine) on the crest of the ridge. No separate analysis has been made of the ore taken from the underground workings.

The ore coming from the open pit is usually very small;

all of it rounded; and mixed with very little flint or limestone pieces. It is a noteworthy feature of this ore that on breaking ore lumps, especially the larger ones, a core of iron pyrites is frequently found; so frequently at times as to be almost a rule.

At the time of taking the specimen for analysis the underground work was not in progress, and the specimen represents a fair average of the large open workings. It was taken directly from the washer, and is a sample of what was at that time going from mine No. 3 to the furnaces; but it is certainly too high in iron for an average of extensive shipments from this mine.

The ore was analysed at the Laboratory of the Survey by A. S. McCreath and yielded:

"Limonite, cellular, nodular, dark brown. Some of the ore lumps show small kernels of iron pyrites; also on surface rhombic dodecahedron crystals of oxide of iron. The pyrite is without crystalline form. The crystals contain 61.60 per cent. Fe, and 6.34 per cent. H^2O.

Bisulphide of iron,	.024
Sesquioxide of iron,	78.143
Sesquioxide of manganese,	.103
Oxide of cobalt,	trace.
Alumina,	2.146
Lime,	.030
Magnesia,	.493
Sulphuric acid,	.147
Phosphoric acid,	.137
Water,	11.886
Insoluble residue,	6.845
	99.954
Metallic iron,	54.710
Metallic manganese,	.072
Sulphur,	.072
Phosphorus,	.060

§ 366. *Character and uses of Springfield Iron Ores.*—For convenience of comparison the analyses of ores from the Springfield mines, made by A. S. McCreath, Chemist of the Survey, are grouped below:

	1.	*2.*	*3.*	*4.*
Bisulphide of iron,	. . . .	. . . .	.004	.024
Sesquioxide of iron,	52.428	73.714	84.428	78.143
Sesquioxide of manganese,	1.344	.610	.368	.103
Oxide of cobalt,	. . . .	. . . .	trace.	trace.
Alumina,	2.042	1.979	2.617	2.146
Lime,	trace.	trace.	.070	.030
Magnesia,	.129	.309	.227	.493
Sulphuric acid,	.075	.072	.237	.147
Phosphoric acid,	.080	.137	.123	.137
Water,	9.375	10.510	8.672	11.886
Insoluble residue,	34.700	12.260	3.460	6.845
Metallic iron,	36.700	51.600	59.100	54.710
Metallic manganese,	.936	.425	.256	.072
Sulphur,	.030	.029	.096	.072
Phosphorus,	.035	.060	.054	.060

No. 1. Springfield. Mine No. 1. Wash ore.
" 2. " " " 2. "
" 3. " " " " Bombshell ore.
" 4. " " " " Wash ore.

§ 367. In 1876 the Cambria Iron Company forwarded to Philadelphia for exhibition at the Centennial Exposition some picked handsome specimens of their Springfield ores. These specimens were analyzed by Mr. T. T. Morrell, chemist of the company, and the analyses are given below. They do not, of course, represent the average of the mine, but only indicate how exceedingly good is their selected ore:

	No. 1.	*No. 2.*	*No. 3.*
Peroxide of iron,	79.06	86.33	83.74
Silica,	14.03	11.08	11.40
Alumina,	1.71	0.51	0.09
Binoxide of manganese,	0.47	0.49	trace.
Carbonate of lime,	0.21	0.17	0.10
Carbonate of magnesia,	0.11	0.10	0.09
Phosphorus,	0.027	0.031	0.036
Sulphur,	trace.	trace.	trace.
Water,	4.35	0.65	4.50
Metallic iron,	55.47	60.43	58.62

§ 368. These analyses show that the Springfield iron ores are remarkably free from the presence of phosphoric acid, as compared with ordinary brown hematite ores ; the specimens forwarded to Mr. McCreath, as well as the picked specimens examined by Mr. Morrell, showing in their analysis this prominent characteristic.

§ 369. Perhaps the best average test of the general character of the Springfield iron ores however is obtained from an examination of the products of Springfield furnace.

This furnace is run on Springfield iron ores alone, taking the run of the ore as it comes from the washer; without any admixture of foreign ores; uses limestone from a quarry near the furnace, and charcoal for fuel.

The ore to make the metals of which the analyses are given below was Springfield washed ore; run of average shipments; the fuel was charcoal; and the limestone, quarried close to furnace stack, yielded on analysis, (A. S. McCreath):

Hard, compact, dark blue in color; irregularly seamed with thin veins of calcite.

Carbonate of lime,	78.196
Carbonate of magnesia,	17.510
Oxide of iron and alumina,	1.126
Sulphur,	.085
Phosphorus,	.015
Insoluble residue,	3.210
	100.142

§ 370. With these materials the Springfield furnace produced the following No. 2 iron, gun metal; yielding on analysis as follows (A. S. McCreath):

Silicon,	1.252
Sulphur,	.037
Phosphorus,	.145
Manganese,	.461

The slag from this iron No. 2, or gun metal, is compact and brittle, vitreous, with grass-green color. It yielded on analysis (S. S. Hartranft):

Silica,	58.300
Alumina,	7.150
Protoxide of iron,	2.466
Protoxide of manganese,	1.300
Lime,	22.800
Magnesia,	8.104
Sulphur,	.125
	100.245

§ 371. Using the same Springfield washed iron ores, the same limestone for flux, and charcoal, Springfield furnace produced a No. 1 iron, which showed on analysis (A. S. McCreath):

Silicon,	1.814
Sulphur,	.057
Phosphorus,	.164
Manganese,	.303

The slag from the same No. 1 iron is porous, and greenish gray in color; it shows on analysis (A. S. McCreath):

Silica,	57.700
Alumina,	7.940
Protoxide of iron,	1.674
Protoxide of manganese,	1.061
Lime,	23.400
Magnesia,	7.484
Sulphur,	.110
	99.369

§ 372. Using these same materials as before Springfield furnace made a forge iron, white, which showed on analysis (A. S. McCreath):

Silicon,	.513
Sulphur,	.100
Phosphorus,	.157
Manganese,	.317

The slag from this forge iron (No. 3) is compact, brittle, vitreous, with bottle-green color; it shows on analysis (S. S. Hartranft):

Silica,	53.360
Alumina,	5.599
Protoxide of iron,	12·672
Protoxide of manganese,	1.208
Lime,	19.020
Magnesia,	7.477
Sulphur,	.100
	99.436

§ 373. A full discussion of the details of the above analyses will be given in the chapter on the iron industries of Blair county; they are introduced here as an analysis of the Springfield iron ores.

It will be noted that in analysing the pig metals only the silicon, sulphur, phosphorus, and manganese were taken, these being deemed sufficient for our purposes.

The result of an analysis of Springfield iron ores as taken from the pig metal analyses above, is sufficiently satisfactory; the three metals being of unusual purity and excellence.

§ 374. With the exception of the Bloomfield mines, in this same Morrison's cove, there are probably few extensive deposits of brown hematite ores in Pennsylvania, or elsewhere, which with the flux given above could produce anything like so superior a metal.

§ 375. The Springfield mines are among the most extensive open mines on brown hematite iron ores to be found in this country.

There are three great open mines; and with each open mine there is a shaft for underground work. These are mine No. 1 or the Davis mine; No. 2 or the Lyken's mine; and mine No. 3.

§ 376. The water supply for washing the ore bearing stuff is pumped up from some powerful and never-failing springs on the west side of the ore ridge, and nearly on the level of Piney creek.

§ 377. Mr. Isenberg, superintendent of the Springfield mines, furnishes the following statistics concerning them under date of Feb. 15, 1879:

"The water works consist of one pair of horizontal engines, 440 horse power, supplied by four flue boilers, 4 feet diameter and 30 feet long. Worthington pump, throwing 900 gallons of water per minute; raising it 351 feet; a distance of 5730 feet; with a 10 inch pipe, the pump working 9 hours in 10.

§ 378. At mine No. 1 there are two Thomas washers, washing about 180 tons of stock every 10 hours, yielding an average of 75 tons of iron ore.

There is one 35 horse power engine driving these two washers; and one 25 horse power double cylinder engine for hoisting cages from shaft 161 feet deep. These two engines are supplied by two flue boilers 4 feet diameter and 26 feet long, encased with brick work.

§ 379. At mine No. 2 there are 5 Thomas washers (two just erected and started last week.)

It would be difficult to give an exact estimate of the work of the 5 washers, as we have changed our base of supplies, and shall not be able to strike our best or richest material for some time yet. Estimating from last years work we shall be able to make a yield of 150 tons per day, and perhaps better.

The washers are all now geared with belt gearing, which we find to be much better and attended with more economy than chain gearing.

These washers now have an improvement of our own, for the convenience of the hand picking of the ore, consisting of an endless chain to which are attached iron tables, traveling 32 feet per minute, over which all the ore passes; at the same time draining off all of the water.

There are two 35 horse power engines and one 16 horse power engine for driving the five washers; also one 20 horse power double cylinder engine for drawing the cars up the incline plane. These engines are supplied by four plain cylinder boilers, 3 feet in diameter and 26 feet long, raised and encased with brick work.

§ 380. At mine No. 3 there is one Thomas washer; one 40 horse power engine driving the washer and also hauling the cars over the incline plane; one tubular boiler of 4 feet diameter and 12 feet long, encased with brick work. Belt gearing is also in use at this mine.

§ 381. We are still running the underground work at this bank (No. 3); we have the ore from 3 to 9 feet in thickness, lying immediately between the limestones. No. 3 washer yields from 28 to 35 tons of washed ore per day of ten hours.

The cost of production varies very much; an open rich bank will yield the cheapest ores; and an underground mine will increase the cost of production very much in proportion to the amount of timber required to secure the safe working of the same."

Prussia Mine.

§ 382. A small abandoned open pit, called originally the

"King of Prussia" or "Prussia" mine, was opened and worked for a time for Springfield furnace.

The mine is about 1500 feet southwest of the Lykens mine, or mine No. 2, of the Springfield mines.

It has been about 100′ long from north to south by 30′ to to 40′ broad; and in the deepest part was worked to about a depth of 30 feet below the surface.

§ 383. The ore showing in the now disused mine is dark colored usually, bombshelly, rich in iron, and frequently with porous or honeycomb structure, resembling in this last respect the ore from mine No. 1.

§ 384. There were two old drifts, in addition to the open work; these drifts seem to have followed a body of ore, made up of large pieces of ore, lying close together, packed in clay. This ore body was irregular and wavy, and dipped strongly and quickly, sometimes to the south, and again to the north. It is reported that plenty of solid ore was left in the working face when the drift at the north end of the bank was abandoned.

§ 385. The open pit shows great masses of stickey red clay, holding ore. The pit now shows a very imperfect section, but apparently the 20 feet of clay immediately underlying the surface are quite lean in ore; below that comes in much richer stuff, making a good show.

The ore as showing was almost entirely in sharp pieces; not rounded off nor water-worn.

There is much loose sandstone in pieces over the surface at this place, and some of them, though not numerous, are to be seen sticking in the clay face which holds the iron ore.

The ore not being now in use, no special analysis was made of it.

§ 386. Trial pits put down to the southward and westward of the mine, found no ore, and struck only white sand in their shafts.

The Prussia is not included at all in the outcrop lines around mine No. 2, of Springfield. For several hundred feet around the Prussia mine, in all directions, the surface is sandy barrens, with no ore show at all; and all trial pits between the Lykens' outcrop and the Prussia mine have failed to find any deposit of ore worth naming.

The mine lies in a slight depression on the ridge crest; and the hill rises to the north of the bank, though only some 30 to 40 feet above it in level.

§ 387. No bottom to the ore was ever found in the Prussia mine workings; but the general features of the opened mine are not such as to lead one to expect anything but a very moderate deposit of iron ore in this bank.

Tar Hole bank.

§ 388. Some 600 feet to the northwest of the Prussia bank is the so-called "Tar Hole bank."

Several small pits and shallow shafts at this place took out some very fair looking iron ore. Some of it was very siliceous but the greater part was a brown and liver colored good ore. Occasionally bombshells are found in the pits; always when broken they were found to be filled with sandstone or sand.

Sometimes, though not frequently, the ore shows honeycombed and botryoidal.

§ 389. From the surface show, and statements regarding former working, it seems that the wash ore is lean for some 20′ or more below the surface; the best and richest ore, both in quantity and quality coming in below that depth.

This bank is inside of the outcrop line of ore which encloses the Lykens mine, or mine No. 2; and trial pits put down around the Tar Hole bank found good ore deposits for a radius of 50 to 75 yards.

§ 390. Going northeast from the Tar Hole bank to the Lykens mine the outcrop of surface ore is continuous, and trial pits have shown ore at different points between them.

These pits are in no case down to any great depth, not more usually than 20 feet. Sometimes, of course, they show little or no ore; nothing but sand and sandstone pieces. But in the greater number, ore bearing clays are found of varying richness.

No special analysis of the Tar Hole bank ore was made. The pit is not now worked.

The ore was never washed, but simply screened, and the cleaned ore used at Springfield furnace.

The McPheese bank.

§ 391. The McPheese ore bank is 3600 feet southwest from the Lykens mine, or mine No. 2.

It is entirely outside of the outcrop line which surrounds the latter mine, and they are separated from each other by a broad area of sandy barrens, entirely without ore so far as shown by any surface crop, or from trial pits.

§ 392. The McPheese bank is not on the main ridge crest, in the line of the Davis and Lykens mines; but is on the point of a fold in the ridge, the point sinking northwardly, while the main ridge crest is to the east of it.

§ 393. The mine is small; the dimensions being only about 100 feet $\times$ 50 feet, with a depth of little more than 12 feet.

For 10 feet below the surface the bank face shows only white sand, containing some small ore pieces; but in no case is the bank face at this upper part worth washing for itself.

Red clay, ore bearing, comes in at 10 feet below the surface; in no case showing rich in ore, but worth the washing. Numerous pieces of flint are all through the sides and in the pit.

Lump ore was taken from the pit and used at Springfield furnace.

The shaft at the southwest end of the pit has yielded a good show of excellent ore; as has also the shaft on the east end. These shafts were not deep.

§ 394. The ore itself is dark colored usually; frequently over siliceous, and apparently averaging a high percentage of iron. The pit is not now being worked.

There is no ore outcrop except directly at the mine. White sand covers the surface all around the mine, and on to the Lykens mine outcrop; and the sand shows no ore on the crop.

§ 395. A specimen of iron ore from the McPheese mine was forwarded to the laboratory of the survey. It yielded on analysis (A. S. McCreath):

Sesquioxide of iron,	74.143
Sesquioxide of manganese,	.265
Alumina,	3.019
Lime,	.150
Magnesia,	.255
Sulphuric acid,	trace.
Phosphoric acid,	.238
Water,	10.865
Insoluble residue,	11.360
	100.295
Metallic iron,	51.900
Metallic manganese,	.181
Sulphur,	trace.
Phosphorus,	.104

The ore is a limonite, brittle, argillaceous, somewhat cellular; the cells mostly filled with a yellow clay. Color of ore dark brown and reddish brown.

§ 396. About 300 yards northeast of the McPheese mine, and 15 feet above it in level, there is a small bank, not named. It is about 100 feet long by 55 feet wide, and not more than 10 or 12 feet deep.

The sides of the bank show wash ore from the surface down. The ore seems to be in quantity; but all the specimens showed too much silica and the ore, taken altogether, seemed leaner and poorer than any other deposit on the ridge.

The loose stuff in the pit is clay chiefly, with some sand and flint.

There is no such shutting in of the sand on all sides as at the McPheese bank; and the ore crop is much more extended on the surface. Moreover trial shafts put down around the bank have found ore bearing clays, somewhat sandy.

The ore from the trial pits is, like that from the main open pit, liver colored usually and rather siliceous.

CHAPTER XII.

Brown Hematite Iron Ores of No. II, continued. Henrietta Mines and Soister Mine.

HENRIETTA MINES.

§ 397. 1. *Geographical Position.*—Extensive brown hematite iron ore mines of the Cambria Iron Company are located in Leathercracker Cove, at Henrietta P. O., in the extreme southeast corner of North Woodberry township, Blair county, close to the Bedford county line; the most southern openings in fact lying almost on the boundary line.

Henrietta P. O. is only six miles north of Pattonsville Gap, in Tussey mountain; but its railroad communication is through McKee's Gap of Dunning mountain to Hollidaysburg and Altoona, the distance being 28 miles to the latter.

§ 398. *This railroad communication* is by the route given below, the stations and heights above tide being thus:

Henrietta ore bank, ... above tide,	1409′
Curry's, ...	1416′
Martinsburg, ...	1366′
Erb's Summit, ...	1354′
Roaring Spring, ...	1206′
Rodman, ...	1133′
McKee's Gap, ...	1036′
Brooks' mill, ...	1006′
Riddle's, ...	973′
Catfish, ...	968′
Reservoir, ...	967′
Hollidaysburg, ...	943′
Duncansville, ...	990′
Canon's, ...	1066′
Eldorado, ...	1093′
Allegheny, ...	1152′
Altoona, ...	1179′

§ 399. 2. *Geological Position.*—The mines are all in Leathercracker Cove, and the chief features of its complicated geological structure have already been given in the detail of the structure of Blair county.

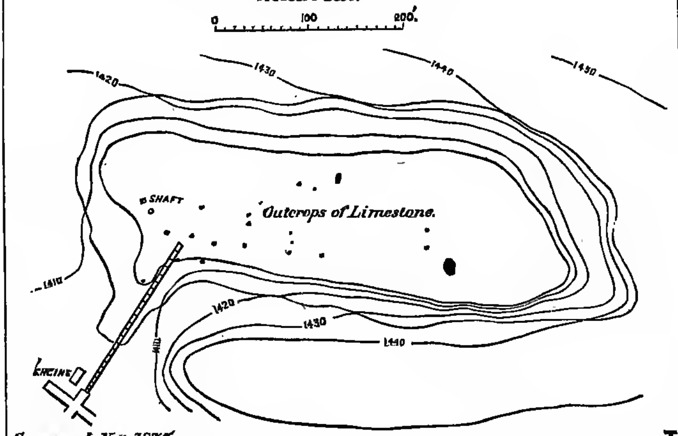
The ore line has a different strike from the line of Tussey mountain, and the effect is to bring the ore the closer to the mountain in going to the southward, as is clearly shown by the map.

Openings on the Ore at Mine No. 1.

§ 400. The main open cut of the Henrietta mines (mine No. 1) is the most northern point from which ore has been taken.

It is opened on what was a very heavy surface outcrop; the ground having been covered deep with loose ore lumps and wash ore. To the north of the mine there is no ore outcrop; and trial pits put down around the north end of the mine failed to strike any ore. Some ore, however, was

Fig. 20
Henrietta Ore Bank.
main cut.



thrown out in digging the cellar of the store, which is 250 yards north of the north end of the mine; this latter is the most northern point at which any ore has been found on this ore line.

§ 401. The cut has been gradually widened and deepened until it is now 600′ long by 200′ wide, by 60′ deep.

Nearly all the stuff from the large opening has been washed, for it has been almost all ore clay. Projecting bowlders of limestone, much rounded and decomposed, stand up irregularly on the floor; and occasional masses of lean clay, bearing almost no iron ore, are left standing, the ore being followed around and between them as is the case with the limestone bowlders.

§ 402. Always on the east side of the pit is the black clay overlying the ore; always the west side the mass of limestone clay underlying; the solid limestone coming into and just west of the mine.

§ 403. The dip as given by the limestones is not over 30° south 70° east; as given by the ore from its outcrop to where it shows in the bottom it would be much steeper. But the ore dip is not the dip of the measures; for the hollow in which the ore lies does clearly not conform to the dip of the solid limestones. The uncertain and ever varying disintegration of the underlying limestone throws the ore mass either back or forward as the case may be and gives it a locally steeper or gentler dip.

§ 404. Some of the main features of the mine are similar to features found in nearly all the brown hematite deposits of the Lower Siluro-cambrian limestones.

While nearly all of the ground removed was washed (except the stripping from the present east side of the mine), and while all the exposed face is wash ore (except the surface on east side), yet this wash stuff presents extremely varied characteristics. At times the ore runs in great masses, packed together and like a regular ore bed; and this fades out more or less gradually, plainly in sight, into a clay, carrying perhaps not so much as 10 per cent. of ore in it. The streaks of clay follow no dip; they are folded and rolled in all shapes; come in suddenly and as suddenly entirely disappear; are in places white and perfectly free either from ferruginous coloring matter, or from wash ore; and are again deep red or brown, and sticky.

§ 405. *But the mine differs* from many, in fact from most ore banks, of Morrison's Cove, in that it shows no sand, no sandstone, no flint, and no rock of any kind but blue limestone. But in place of rock and flint some of the clay layers are unusually sticky, and form balls which pass through the washer with the iron ore and give quite as much trouble as flint, in requiring to be picked out by hand.

§ 406. While the general average dip of this Leathercracker ore deposit, as shown by the whole line of openings, is comparatively steep into Tussey mountain, yet at this Henrietta mine No. 1 it seems to have undergone a local change; a fact which partly accounts for the great outcrop at this point, and is the cause of the enormous mass there cheaply accessible. The change is a flattening of the dip down to 10°.

§ 407. There is much iron ore in mine No. 1, which carries varying and sometimes very considerable percentages of manganese. These patches of manganiferous iron ore are very local and very irregular in shape. There is no guide to say when to expect them, or to indicate when they will run into the ordinary brown hematite iron ore.

§ 408. The manganiferous ore chiefly showed at a depth of about 50 feet below the surface; and there are now large quantities in the present bottom of the pit.

The tendency to run to manganiferous iron ore is, at the present depth, much the strongest at the south end of the mine.

§ 409. The ore is usually hard and darker colored in the upper part of the deposit, or that nearer to the black slates, while it is apt to be softer and more open in the lower part, in the limestone. But while this distinction may hold roughly, yet all kinds of ore, hard, soft, manganiferous, rich and lean, may be found close together, and in fact mixed together in the same clay bands.

§ 410. The material from the mine is raised by an incline plane, the tram-roads being easily shifted for convenience in economical loading and hauling out.

The refuse, of which there is little, below the surface stripping, goes to the dump heap; and the wash-ore stuff, which is nearly all of the material coming out, is dumped into two Thomas washers.

§ 411. Water is brought from the Tussey mountain escarpment, and also pumped from the creek when needed. The mine is drained by a tunnel to the 40 foot level; below that by pumping.

§ 412. The total excavation at mine No. 1 is about $600' \times 200' \times 60' = 266,667$ cubic yards of material in all; and the total yield has been 64,000 tons of iron ore. Allowing $1\frac{1}{2}$ tons as the weight of one cubic yard of removed material, the average yield has been about 16 per cent. of iron ore.

§ 413. Specimens of the ore were forwarded to the Laboratory of the Survey for analysis. A specimen is made up of many different pieces, representing all kinds of ore in the pit. The specimen for analysis was taken from ore washed from material removed from say 50 feet below the surface of the ground.

The analysis shows (McCreath):

"Limonite, washed ore, nearly all fine ore. The ore is sandy, brittle, partially cellular, with considerable yellow clay. Color generally dark-brown.

Sesquioxide of iron,	60.000
Sesquioxide of manganese,	3.517
Alumina,	2.321
Lime,	.270
Magnesia,	.398
Sulphuric acid,	.162
Phosphoric acid,	.822
Water,	11.138
Insoluble residue,	20.590
	99.218
Metallic iron,	42.000
Metallic manganese,	2.449
Sulphur,	.065
Phosphorus,	.359

The Cambria Iron Company furnish the following analysis of the "Henrietta Hard Ore," made by Thos. T. Morrell, Esq., chemist of the company.

Peroxide of iron,	82.13
Silica,	13.95
Alumina,	0.35
Binoxide of manganese,	0.40
Carbonate of lime,	0.06
Carbonate of magnesia,	0.04
Phosphorus,	1.020
Sulphur,	trace.
Water,	0 74
	96.690

Metallic iron,	51.49

The "spongy ore" from the Henrietta mine was also analysed by Mr. Morrel with the following results:

Peroxide of iron,	94.00
Silica,	4.01
Alumina,	0 31
Binoxide of manganese,	0.61
Carbonate of lime,	0.09
Carbonate of magnesia,	0.07
Phosphorus,	0.182
Sulphur,	trace.
Water,	0.50
Metallic iron,	65.80

A manganese ore from the large open mine at Henrietta was analysed at the laboratory of the Cambria Iron Company at Johnstown and yielded thus:

Peroxide of iron,	4.66
Insoluble matter,	5.82
Alumina,	2.01
Protoxide of manganese,	86.52
Metallic cobalt,	0.20
Carbonate of magnesia,	0.05
Phosphorus,	0.096
Sulphur,	trace.
Water,	0.53

§ 414. The following analyses of limestones from this mine No. 1, at Henrietta show the character of the limestone in which the ore lies. The analyses are furnished by the Cambia Iron Company, and were made by T. T. Morrell, Esq.

A specimen from the east side of the mine gives:

Carbonate of lime,	52.94
Carbonate of magnesia,	35.40
Insoluble,	11.55
	99.89

And a specimen of limestone from the west side of the mine gave:

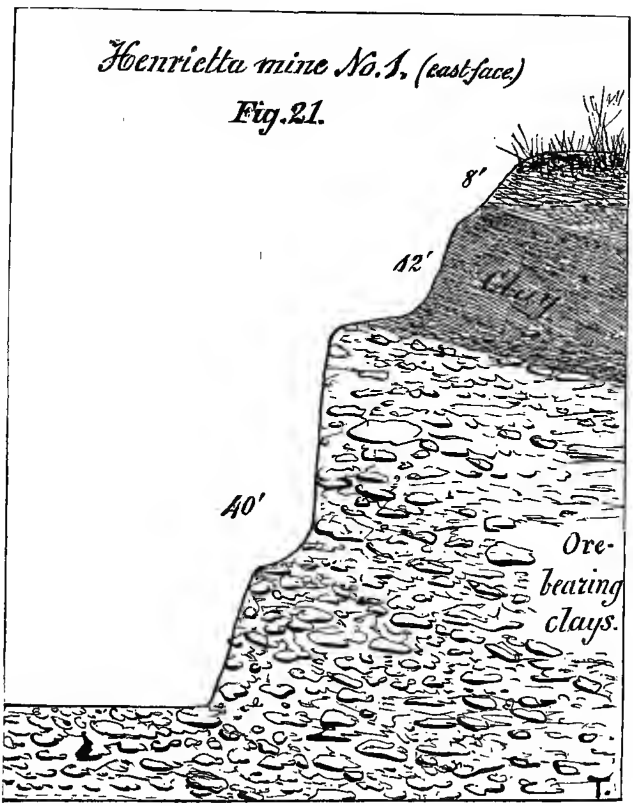
Carbonate of lime,	57.32
Carbonate of magnesia,	39.20
Insoluble,	7.60
	104.12

(There is some error in making copies of this last analysis.)

The ore lies therefore in dolomite.

§ 415. *General features of the mine.*—The mine was not working when examined (in 1877) and the whole bottom of the pit was covered deep with water; but it was seen and examined at the close of 1876, very little additional work having been done there after that time.

There is wash ore in the whole bottom of the mine (except where irregular masses of undecomposed limestone project through the mass); there is wash ore on the north and south ends of the mine, though less in quantity on the north end; and there is ore on the east face of the mine from the bottom up to a point about 20 feet below the top. The east face shows thus:



§ 416. The overlying non-ore-bearing dark-colored slates are much weathered down, almost to a mud, to which condition, indeed, they soon come on exposure. When first exposed they show as very thin-bedded, fragile, black slates, fossiliferous in places, though the fossils are kept with difficulty on account of the fragility of the whole material.

Fifteen feet of this black slate rest on top of the iron ore and clay; and on top of that there apparently commences a gray-colored, soft, iron-stained, thin-bedded clay-slate, non-fossiliferous, so far as seen. These slates and the surface stuff make a loose and somewhat troublesome east wall for the mine; the clays holding back the water and throwing over the top, the effect being to make the washing down so severe as to require almost foot for foot as a safe slope on the east wall.

§ 417. The present bottom level of the mine, the slopes being cut off, is about 450′×150′.

Every 10 feet in depth over this area makes 25,000 cubic yards of wash-ore material, which, allowing for the present richness of the stuff in the bottom of the mine, should yield say 10,000 tons of washed ore.

And it is possible to carry the mine much beyond 10 feet deeper without serious outlay in stripping. There is, of course, always a fixed limit, beyond which it will not pay to strip and work an open cut; but that point is far from having been reached as yet at the Henrietta mine.

So far the cost of working ore at this mine has been very low; probably as low as at any extensive open mine in the State.

The plant is in excellent condition; three Thomas washers; abundance of water; ample power, &c., &c.

The Falkner Shaft.

§ 418. Going south from the south end of the main open mine already described, the outcrop shows everywhere on the surface, and numerous trial pits have thrown out ore all along the line of strike; 400 yards south of the main opening the Falkner shaft was worked for some time, and several thousand tons of ore taken out.

§ 419. The surface of the ground at the Falkner shaft is 40 feet higher than the surface of the large open mine, or main ore pit. The shaft was down 153 feet, with ore in the bottom; the shaft bottom, therefore, was 53 feet deeper down in the ore than the bottom of the open mine. The underground workings are now all fallen in, and the details given are repeated from the statements of Michael Morris, a miner much trusted by the Cambria Company, who made the original trial openings and worked in the Falkner shaft. He repeats the following facts.

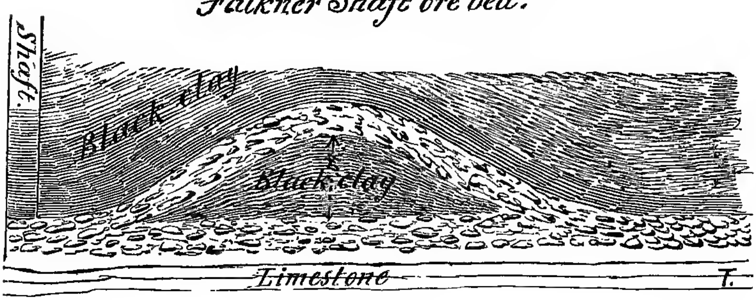
§ 420. The shaft is 153 feet deep to the bottom. The ore was struck in the shaft at 40 feet deep; and then continued on in ore to the bottom. As the ore outcrops just west of the shaft, the dip as thus given would be 70° (or more) to the South 70° East.

In the 113 feet in which the shaft was going through the ore (that is from 40 to 153 feet down) three monkey drifts were driven to get the thickness of the ore bearing clays from wall to wall. These showed first 25 feet, second 25 feet and third 40 feet in width.

On reaching 153 feet deep, they drifted to the south, rising enough to drain down to the sump at the shaft, and ran on with this course for 400 or 500 feet. The ore and clay showed this curious structure.

Fig. 22.

Falkner Shaft ore bed.



The ore bearing clay mass forked; one part kept straight along the strike; the other part was followed around a curve, yielding all the time much rich ore, until it came around and joined the evenly striking ore mass; and the black clay horse in the center, carrying no ore at all, was 40 feet wide.

§ 421. In the mine, black clay is the hanging wall, and limestone clay the foot wall. To this rule there is no exception in all the working done in the Falkner shaft.

§ 422. The ore is dark colored usually and hard, especially near the top of the deposit; that lying in the limestone clay of the foot wall is apt to be more open and cellular in structure.

§ 423. A specimen of the ore for analysis, made up of several separate pieces representing all grades and kinds of the deposit so far as possible, was chosen from the large pile of clean lump and washed ore now lying at the dump, and forwarded to the laboratory of the survey.

It yielded on analysis (A. S. McCreath):

Limonite, lump ore, generally compact, and somewhat botryoidal, with velvety surface. Color, various shades of light brown, dark brown and reddish brown.

Sesquioxide of iron,	63.571
Sesquioxide of manganese,	.933
Alumina,	3.796
Lime,	.390
Magnesia,	.302
Sulphuric acid,	.091
Phosphoric acid,	2.153
Water,	12.620
Insoluble residue,	15.930
	99.786
Metallic iron,	44.500
Metallic manganese,	.650
Sulphur,	.036
Phosphorus,	.940

This represents an ore rich in metallic iron, but too high in phosphoric acid to allow of its use in other than small proportion of a mixture, save for specific purposes where phosphorus in the pig metal is not objected to.

§ 424. There is one Thomas washer at the Falkner shaft, well constructed and capable of about the usual average product of say 30 to 40 tons of washed ore daily; and the

Cambria Company have a tram road from the shaft to the dumping point on the railroad.

§ 425. In all over 8000 tons of iron ore have been mined from this shaft; about 4000 tons of it now lie ready for shipment on the dump.

The mine is now entirely caved in, covering up track, tools, cars, and everything that had been left standing in it when working ceased.

§ 426. Only a small part of the ore in sight at the Falkner shaft was taken out; and if ever the open cut follows up south from the present main mine, a large body of iron ore will come out from the Falkner shaft area.

The surface show of ore at the shaft is heavy, and continues unbroken from that place to the open work mine.

§ 427. The cost of taking out the iron ore by regular underground work at this shaft was heavy; there was much water and pumping was required night and day; and great quantities of heavy timber were needed in the workings. Such workings can furnish large quantities of ore, but it is only when ore is unusually high priced that these limonites can be worth such an outlay.

§ 428. In marked contrast to this high cost of Falkner shaft ore, is the low price at which the open cut to the north of it has furnished its product; and the two workings, thus placed side by side, afford a striking example of the inadvisability of attempting to work these limonites in any way except by open work. The prevailing low prices for iron ore (1873–1879) have so forcibly brought this point before mine owners that there is to-day scarcely a shaft working upon limestone limonites in the State of Pennsylvania.

The McAllister shaft.

§ 429. Going south from the Falkner shaft the surface iron ore crop is sometimes very slight, and at times quite heavy, these crop patches being very irregular. Numerous trial pits along this line have proved the existence of the clay and iron ore deposit, and in all cases where these pits were upon the upper part of the mass the black clay shows in its usual place as the hanging wall. In some of the pits however, directly along the line, there was no ore whatever to be found. This might be considered certain to happen however, since in any large open mine of clay and iron ore there can almost always be seen some local barren spots, large and small, where the clay will hold no ore at all. Indeed such occurrences may be said to be the rule, and the absolutely and unbrokenly continuous brown hematite deposit would be the rare exception.

This trial pit proving of the continuity of the ore bearing clay deposit is carried to the south of the Falkner shaft for 900 yards to the McAllister shaft, on the old Fred. Hoover place, now owned by the Cambria Iron Company.

§ 430. The underground workings of this shaft are now fallen shut.

Michael Morris reports it as 100 feet deep to the bottom; with black clay hanging wall and limestone clay foot wall as before in the other openings to the north of it.

He reports that the ore bearing clay was from 15 to 20 feet thick, and that it ran rather irregularly up and down.

The underground working was carried south.

§ 431. The shaft is 50 feet higher in level than the Falkner shaft; and as it is 50 feet shallower, it is therefore, at its lowest point, only about on the level of where the ore is first worked in the Falkner shaft.

Again, the McAllister shaft is 90 feet on level above the surface of the large open mine; at its bottom therefore it is only 10 feet below the surface at mine No. 1 or the open mine.

§ 432. The iron ore from the McAllister shaft, as seen lying on the pile at the pit mouth, is reddish colored, not hard and compact generally, but with rather open structure, much of it porous and honeycomb in character, and looks like an easy working iron ore. It resembles in appearance the ore from the Hoover mine, just south of it; and resembles but little the ore from the Falkner shaft or the large open mine.

The Jno. Hoover mine.

§ 433. The surface iron ore outcrop is easily followed for 250 yards south of the McAllister mine to the Hoover shaft and open cut. At some places in this distance the outcrop is quite heavy.

At the Hoover mine a shaft was put down, 120 feet deep to the bottom. Only a moderate amount of iron ore was struck, and this was found chiefly in the lower part of the shaft.

The open cut was never followed up to any good extent. It is about 200 feet long, by about 125 feet wide, and 30 feet deep in its deepest part. A tunnel drains it to this depth, exposing therefore this much of a face to work without pumping.

§ 434. The black clay lies in place on the east side of the pit as a hanging wall for the ore bearing clay mass, the usual limestone clay making the foot wall. Solid bedded massive limestone is in place just west of the limestone clay.

§ 435. The ore seemed to be quite abundant in the face exposed at the Hoover open mine; the thickness of ore bearing clay apparently not less than 15 to 20 feet or about the average of the whole line of ore clay where opened; the clay varying much in percentage of ore carried by it, and seeming to be richest of all on the east side of the pit where the last working was done.

§ 436. The clay enclosing the ore is unusually sticky and caused much trouble, both by the difficulty in washing it loose from the ore lumps, and also by forming tough balls which passed through the washer and required to be picked out.

§ 437. The surface of the Hoover mine is 50 feet higher than the McAllister mine, 100 feet higher than the Falkner shaft, and 145 feet above the large open mine.

The bottom of the Hoover shaft therefore is not down to the surface level of the large open mine, but is 20 feet above it.

§ 438. A specimen of the iron ore of the Hoover open pit, made up of many small pieces representing various grades and shades of ore, was forwarded to A. S. McCreath, who reports as follows:

"Limonite, lump ore, partially compact and cellular with laminated structure. It carries considerable yellow and white clay, but is generally of a dark brown and reddish brown color.

Sesquioxide of iron,	69.428
Sesquioxide of manganese,	.270
Alumina,	1.891
Lime,	.270
Magnesia,	.619
Sulphuric acid,	.092
Phosphoric acid,	1.021
Water,	12.364
Insoluble residue,	13 660
	99.615
Metallic iron,	48.600
Metallic manganese,	.191
Sulphur,	.037
Phosphorus,	.446

§ 439. The limestone which lies just west of the Hoover open mine was analysed at the Johnstown Laboratory of the Cambria Iron Company, and the results are thus given by T. T. Morrell, Esq., chemist of the company:

Carbonate of lime,	46.43
Carbonate of magnesia,	39.52
Insoluble matter,	20.30

The ore therefore lies in a dolomite rock.

All these openings on the ore belong to the Cambria Iron Company; they are connected by a tram road with the dump for shipping at Henrietta station.

§ 440. There is some surface show of iron ore for a distance of 200 yards south of the Jno. Hoover open mine; beyond that there is no ore outcrop at all.

From the description of the structure already given, and from the colored contoured map, the explanation of this abrupt termination of the ore is clear enough.

A heavy fault has swallowed up all of III and brings the limestone of II squarely against the mountain sandstones.

§ 441. The ore, as developed, takes the shape of a long trough, filled with ore-bearing clay, 2300 yards long and from 5 to 12 yards wide, dipping steeply as a general thing to the South 70° East. The depth of this trough is doubtless variable, but the bottom has never yet been reached.

The open mine is 60 feet below the surface; the Falkner shaft is in ore 53 feet below the bottom of the open mine, and the Hoover open mine developed ore-bearing clay 140 feet above the surface of the large open mine, and therefore 243 feet, on a dead level, above the bottom ore of the Falkner shaft.

By projecting these levels some idea can be formed of the enormous amount of ore which has probably been carried away by erosion, as well as of the great quantity remaining if the whole ore trough retains along its whole length the character and size developed at the deepest part so far explored.

§ 442. It should be noted that the iron ore in the Henrietta mines is in no case made up of rounded pebbles of ore; in fact in the whole deposit it would be difficult to find any water-worn detritus.

The ore is in lumps of all sizes, ranging from large and heavy masses closely packed together until they resemble a bed of ore, to fine grains thinly disseminated through various colored clays. But all the ore pieces are irregular in shape and with points and angles, sharp on the corners, and in many cases coated with little needles of ore, which the smallest friction would soon rub off.

This is the unvarying character of the structure of the ore lumps and grains in Leathercracker Cove.

Character of the Leathercracker (Henrietta) Ores.

§ 443. For convenience of comparison the analyses of ores from the three mines of the Cambria Iron Company in Leathercracker Cove, at Henrietta P. O., are grouped below:

	1.	*2.*	*3.*
Sesquioxide of iron,	60.000	63.571	69.428
Sesquioxide of manganese,	3.517	.933	.270
Alumina,	2.321	3.796	1.891
Lime,	.270	.390	.270
Magnesia,	.398	.302	.619
Sulphuric acid,	.162	.091	.092
Phosphoric acid,	.822	2.153	1.021
Water,	11.138	12.620	12.364
Insoluble residue,	20.590	15.930	13.660
	99.218	99.786	99.615

Metallic iron,	42.000	44.500	48.600
Metallic manganese,	2.449	.650	.191
Sulphur,	.065	.036	.037
Phosphorus,	.359	.940	.446

No. 1. Large open mine at Henrietta.
" 2. Falkner shaft.
" 3. Jno. Hoover open mine.

§ 444. The ores are rich in iron and high in phosphorus. They are cheaply mined, work easily and well in the furnace stack, and were very valuable ores when the heavy demand for iron rails made a constant market for such pig metal as would be yielded by these ores when judiciously admixed with some others. But ever since the demand for iron rails has slackened, and steel rails have taken their place, these phosphuretted iron ores have steadily fallen in value and importance.

§ 445. In 1877 one furnace at Hollidaysburg was making good mill iron with $\frac{1}{6}$ Henrietta iron ore and $\frac{5}{6}$ Frankstown ore; but only small quantities were being shipped for the purpose.

It is evident that all such ores, however rich in iron, must take a low grade until some one shall discover an economical method of eliminating phosphorus in the Bessemer converter. The new Thomas & Gilchrist process is now being thoroughly tested in England, but it is as yet, perhaps, too soon to pronounce it either a commercial success or failure.

§ 446. On the west side of Leathercracker cove at the school house, near Stonerook's house, there is a very strong outcrop of lean sandy brown hematite iron ore in the road and in the field alongside.

An old shaft, put down some seven years ago, about 150 yards north northeast of the school house found a sandy hematite iron ore, with black slate and limestone clay for the walls. The ore was lean, sandy and of little promise. In an open cut, a short distance from the shaft there are numerous masses of sandstone, heavily coated with iron ore, dipping apparently *South 70° east 70°*.

A second shaft was put down about 200 yards south of the former one (all this work was done by the Cambria Iron

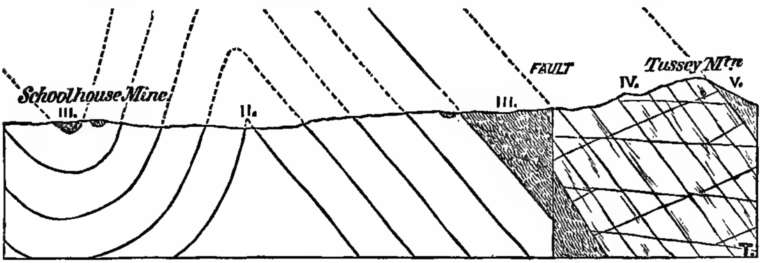
Company, who owns the property) and Mr. Morris reports that they went down 120 feet in all to the bottom.

§ 447. The black clay was the foot wall, and the limestone clay the hanging wall in this case.

This apparent reversal of the rule is due to the ore being caught on a sharp overturn thus:

Fig. 22a.

Section from Schoolhouse Mine to Tussey Mountain.



The black clay which really overlies geologically is of course, on this overturned synclinal, naturally apparently under the ore.

§ 448. Mr. Morris reports that they drove off a monkey drift at 30 feet below the top of the shaft, and then again repeatedly at various intervals from there on to the bottom. The ore showed well, the ore bearing clay mass between the walls being in some cases as much as 30 feet wide; but that as the shaft went deeper the interval between the hanging and foot walls remained about the same, but the ore contained in the mass grew less and less in quantity, until at the bottom it was reduced to one third of what it shown above. Ore in quantity was first struck in the shaft about 20 feet below the surface.

§ 449. The school house ore deposit seems to occupy about the same position geologically as the Henrietta ore; but in appearance and character it is markedly different.

Much sandstone shows in the open cut, and the ore itself is usually lean and highly siliceous.

§ 450. Mr. Morris shafted on to this same ore bearing clay deposit about 400 yards south of the Stonerook school house shafts, along the flank of the ridge; he found good iron ore, but only three feet thick in all from wall to wall. This outcrop can be followed for one mile or more to the south, to and across the main road from Henrietta to Woodberry. Beyond that point all appearance of iron crop ceases, and around the head of the Leathercracker cove there is no iron ore crop known.

§ 451. The structure of the cove has been already fully explained and figured, and the full explanation given of why the ore horizon should not sweep around it.

§ 452. *Junction of II and III.*—It may be added however, that there is no horizon which can be roughly located more easily and quickly than the junction of II and III, as III makes the escarpment of the mountain and IV is always its crest. Yet all along Tussey and Dunning mountains there is no single outcrop of iron ore of any consequence reported in the many miles of outcrop of the junction of II and III, which can be followed along their flanks; yet every gorge, and there are many such, affords an opportunity for such crop to show. In most cases indeed the mountain foot is cleared and cultivated up to and beyond this horizon, and an extra chance therefore is afforded to examine and discover any outcrop.

Soister Iron Ore Mine.

§ 453. The Soister ore mine, or "neutral iron ore," is 3½ miles north of Woodberry, on the Woodberry and Roaring Spring road. There are two open pits—a small one on the east side of the road, and a larger one on the western side.

The open pit west of the road is about 100 feet long by 60 feet wide and 20 feet deep. It has been long abandoned and the sides are fallen entirely shut. They indicate, however, that fairly rich wash-ore began at the surface and went the whole depth of 20 feet. Moreover, a shaft, starting in the bottom of the pit, went 30 feet through wash-ore and lump ore; and left ore stuff in the bottom of the shaft.

The ore stuff was screened, the lump ore taken away, while all the fine ore remained with the clay on the screen floor. No solid rock of any kind has been as yet struck in the workings.

§ 454. The ore was rich in iron, but extremely sulphurous; in fact great masses of decomposing iron pyrites were taken from the shaft, pyrites making the inside of the mass and a hematite crust surrounding it.

The clay holding the ore is usually red in color, sometimes deep blood red; and the surface show of the clay and ore is very marked. The outcrop covers considerable area west of the road, and there is every evidence that there may be a large deposit of ore at this point. No water, however, has been found in the pits as yet.

§ 455. The ore lumps are usually not rounded; there are many rounded pieces of flint and limestone, and occasional masses of flint and limestone pieces cemented by a matrix of iron ore. The iron ore itself is generally dark-colored, and makes a deep reddish-brown streak.

These mines were worked for old Woodberry furnace, in 1828.

§ 456. The mine on the east side of the main road is small and only about 10 feet deep; and numerous shallow trial pits put down near the open pit have found ore in clay. The outcrop of ore and ore-clay is decided, but neither so extended in area, nor so rich, as on the west side of the road.

One of these trial pits was 80 feet deep, and never, in that whole distance, struck any solid rock.

The ore in general appearance is exactly the same as that showing at the western pits.

§ 457. The ore outcrop is heaviest just around these Soister mines; but it continues to color the soil for some distance beyond, and on the Gartland place, one mile to the north-northeast from the Soister mines, good iron ore has been gathered from the surface in the fields, but no trial pits ever put down.

§ 458. *In geological horizon* these ores are about 2500 feet below the bottom of the slates of III.

§ 459. A specimen of the ore from the sides of the western Soister open cut were forwarded to the Laboratory of the Survey, and yielded on analysis (A. S. McCreath):

Sesquioxide of iron,	76.214
Sesquioxide of manganese,	.011
Alumina,	2.491
Lime,	.020
Magnesia,	.386
Sulphuric acid,	.020
Phosphoric acid,	.259
Water,	12.486
Insoluble residue,	7.470
	99.357
Metallic iron,	53.350
Metallic manganese,	.007
Sulphur,	.008
Phosphorus,	.113

The ore is a limonite, exceedingly hard and tough, generally compact and showing considerable quartz. Color reddish brown, dark brown and vermillion.

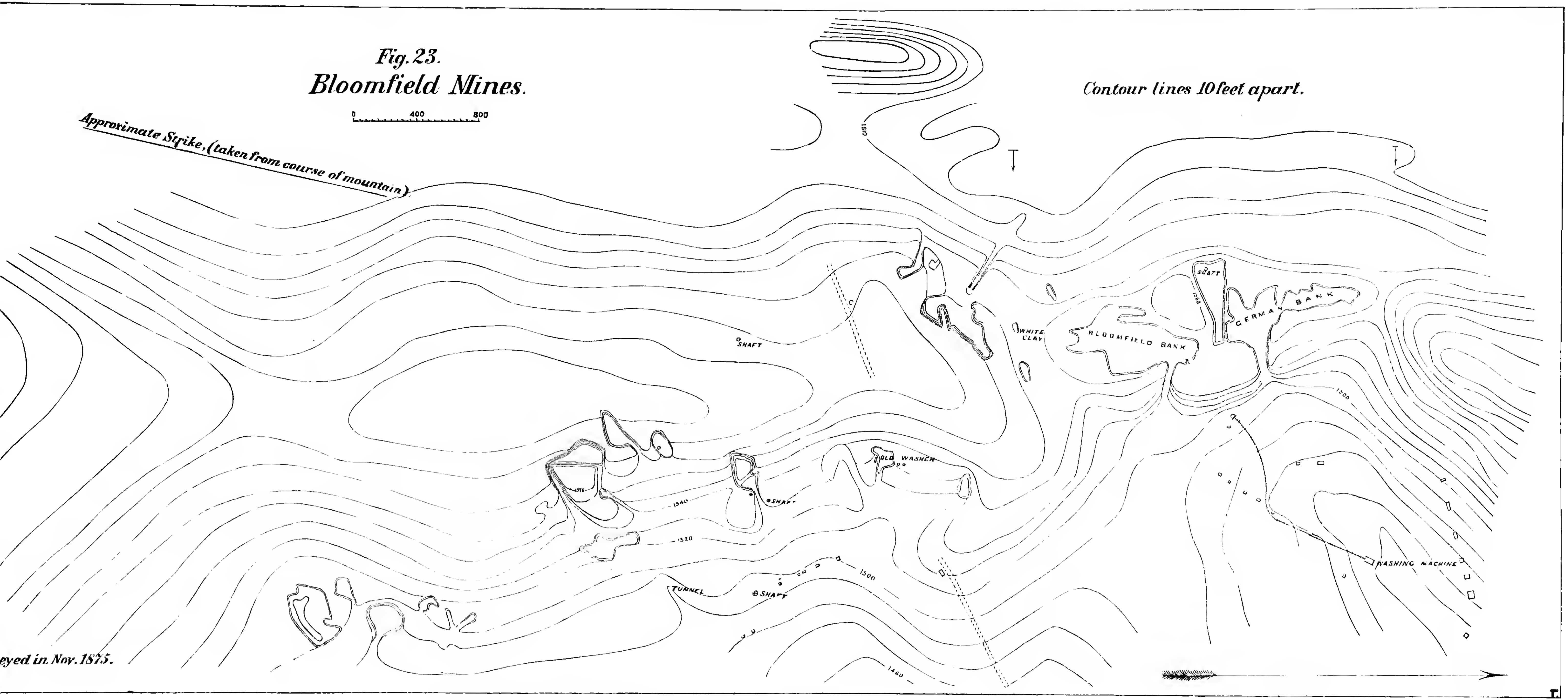


Fig. 23.
Bloomfield Mines.

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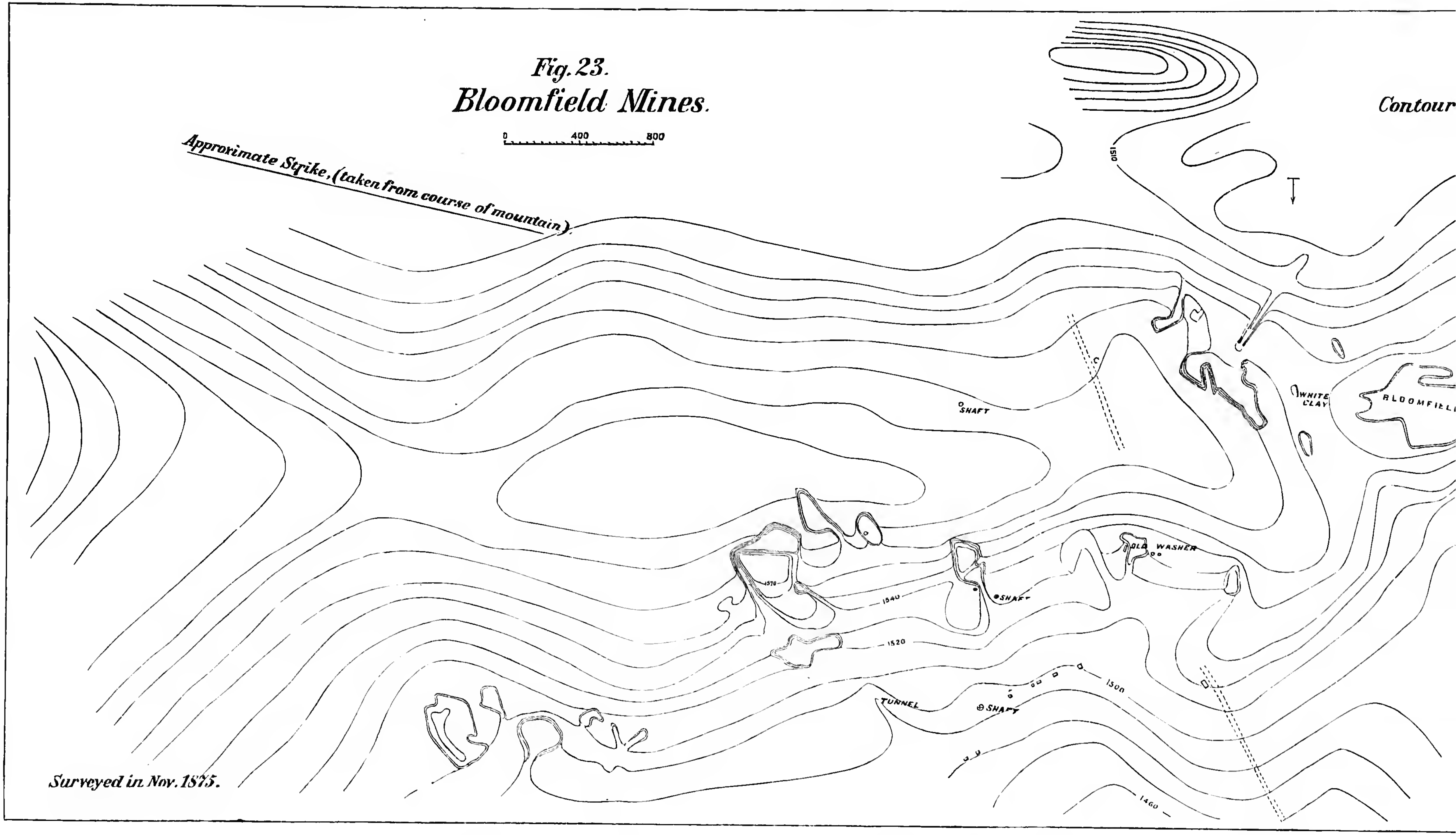
Bloomfield Mines.



Chapter XIII.

Brown hematite ores of No. II, continued.

Bloomfield mines and small adjacent mines.

Rebecca mine and Red ore mine.

Bloomfield iron ore mines.

§ 460. *Geographical position*—The Bloomfield iron ore mines are on Duncan's ridge, 3 miles south of Roaring Spring. A branch railroad runs from the mines to Roaring Spring connecting there with the railroad from Henrietta to Hollidaysburg.

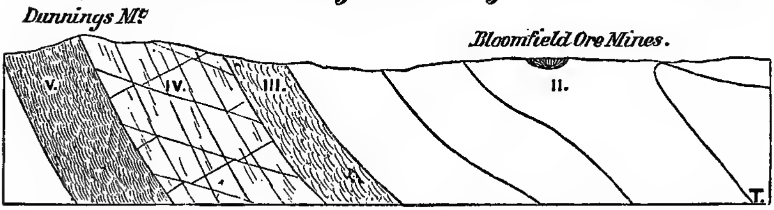
§ 461. The mines have been extensively worked, ore having been taken from them to supply Bloomfield, Sarah, Martha, and Rodman furnaces. The mines formerly belonged to Dr. Shoenberger, and are now the property of the Duncan heirs.

§ 462. Duncan's ridge is east of Dunning's mountain, Halter's creek flowing in the valley between.

§ 463. The geological horizon of the Bloomfield ores and the structure of the region is shown on the cross section below.

Fig. 24.

Section from Dunnings Mt. through Bloomfield Mines.



The cut (Fig. 24) shows the anticlinal axis between Dunning mountain and Duncan's ridge; the gentler dipping limestones of the ridge and the ore mines in them ; and the horizon of the ore at the main large mine about 3200 feet below the bottom of the slates of III.

§ 464. The surface outcrop on Duncan's ridge of iron ore and ore bearing clays is practically continuous from the north end of the German mine to the south end of the southern Clarke mine, a distance of 7200 feet; the outcrop lines running irregularly and making a very variable width to the surface deposit, usually however from 1000 to 1500 feet wide, across the crest of the ridge.

§ 465. Inside of this broad area the outcrop varies incessantly. The heaviest outcrop is marked by the numerous open pits; between these open mines the trial pits have sometimes found no ore worth working, the shafts developing nothing but sand or clay with some little ore ; but nearly the whole ridge crest, inside of the limits named, shows some ore; and at the different open mines the working shafts have shown that the ore bearing mass possesses a depth of more than one hundred feet. These various measurements will follow in the detail of the different pits.

§ 466. The surface outcrop at the Bloomfield mines ends abruptly at the north end of the German open bank. The main road crosses the ridge close to the north face of the pit; and there is no outcrop of ore in the road nor on the surface to the north of it. In fact solid limestone rock in place, a sandy limestone usually, is found coming to the surface north of the open pits. This limits the north end of the ore bearing mass.

Moreover the water shaft, put down 225 feet, partly shafting and partly boring, ended in sharp sand; having had sand and clay all the way down from the surface, with no solid rock in place and no water.

§ 467. Just north of the north end of the German bank, trial pits found no ore, but solid rock ; just south of the Clarke bank there is no ore, and solid limestone in place on the surface ; yet between the Clarke bank and the German bank a distance of 7200 feet, no mass of limestone shows in place in any of the open cuts, and the numerous trial pits, do not report solid limestone rock in the bottom.

§ 468. The width of the ore bearing mass is less distinctly defined, for a loose swash of shallow surface ore deposit doubtless covers much area where solid rock would be found coming almost to the surface, and there could be no amount of ore worth working.

There is a large area however where open pits and trial shafts have shown that the ore bearing mass extends to some depth. The banks have already yielded much ore; but the amount taken out in the past is only a small part of the great mass of iron ore at the Bloomfield pits.

§ 469. The sketch map accompanying this report (Fig. 23) shows the shape of Duncan's ridge, the size and depth of the excavations, the amount of stuff removed, position of washers, &c., &c.

§ 470. The main Bloomfield open mine is a huge excavation; including the German bank on the south, and they are really only parts of one great mine. This opening is over 1800 feet in length, from 100 to 400 feet in width, and as much as 80 feet deep in places.

It is unnecessary to describe all of the different changes of the ore bearing mass as showing in the working faces of the different parts of this open mine.

§ 471. The mine is now being worked on a broader and more comprehensive scheme than ever before; the old tunnel has been made into an open cut, which will give access to the floor of the main bank fully 60 feet below the surface; and the stuff is being swept off clean, pretty much everything going through the washer.

§ 472. The mine shows the usual great and sudden changes in the character of the ore bearing mass; a non-ore bearing clay will suddenly change into a rich wash ore deposit, and vice versa; while masses of sandstone, coated with oxide of iron, or flint pieces, large and small, come into the ore mass, and leave it, without any visible law. Sometimes there are huge walls of tough sticky clay in sight, bearing no iron ore; and again almost everything is washable. The mine therefore does not differ from the other ore deposits of Morrison's cove in the *character of its* *deposit*, but only in the unusually enormous *quantities* of iron ore in sight and in their freedom from *phosphoric acid.*

§ 473. South and west of the main Bloomfield mine is the "Harritty open mine." It is just inside of the lines of heavy surface ore outcrop, and the cut runs into the south-eastward for 350 feet.

In this cut the clay layers show themselves almost with the regularity of bedded rocks, apparently sinking to the southeast, with a dip of 10°, thus:

Fig. 25.

Harritty Open Mine.

At the end of the cut, where the track stops, the overlying white clay, carrying no iron ore, comes in on top of ore bearing clays; it has the same inclination of say 10° to the southeast, and in all the eastern workings of this mine, to the southeast from this cut, the 25 feet of white clay must be stripped. But the white clay is dipping, and ore bearing clays come in on top of it, and have been worked for some 200 yards along the strike.

The same white clay, and the ore at the west crop underlying the white clay, have been found in the shafts put down to the north and south of the Harritty bank; and the bank and the trial pits include within them a large area of ore-bearing clays.

§ 474. South of the south end of the main Bloomfield open mine the surface has been thoroughly tested by shallow cuts and trial shafts. Almost all of these test pits have shown some iron ore; usually the ores and clays developed resemble those from the main open pit. Sometimes they are blood-red in color, and occasionally manganiferous. In a shaft about 500 feet south of the large open mine, the ore developed was rich in manganese, and some of it was shipped away for a spiegel ore. Other shafts in the vicinity found manganiferous iron ore also, though usually too sandy to be of value. The clays developed in the test pits are of all colors.

§ 475. These test pits, showing their varying percentages of iron ore yield, continue on to the Old Wash Machine open bank. This mine has now caved in on the sides, and the center is filled with water. There is wash-ore in the sides, and considerable good iron ore has been yielded in the past—the good ore beginning at the surface outcrop and going down to the bottom of the pit.

§ 476. The New Wash Machine bank, just to the south of the old pit, offers a better chance to examine the ore show. Though partially fallen shut, the ore face shows this section:

Fig. 26.

New Wash Machine Bank.

One to two feet of sand, carrying no ore, come in between the ore-bearing clays; and so far as the bank is opened and can now be seen, the sand layer runs as evenly as the clays.

§ 477. Much excellent iron ore has been taken from this pit; and though the sand layer is so persistent, the ore itself is not siliceous, but is sometimes decidedly manganiferous.

The ore lies in red and yellow clays; these clays are generally horizontal, but at times waving in all directions; not following one regular dip, like the clays of the Harritty mine, already described.

Though the ore from these open mines is not siliceous, yet the surface of the ground is sand all over the crest of Duncan's Ridge.

§ 478. South of the New Wash Machine bank is the Sand bank. The surface show all around this open pit is sandy barrens, with some outcrop of siliceous iron ore; and for 15 feet below the surface the ore-bearing mass is sandy clay and the ore is decidedly siliceous. Below this sandy ore-bearing mass, which is in all about 15 feet thick, there is a mass of yellow and reddish-brown clays, holding some iron ore, but not much; and below that there is brown clay holding manganiferous iron ore of excellent quality. The ore masses are packed closely together in the clay, and the miners called it the 4-foot ore bed.

§ 479. The open pit was long since abandoned, and the sides are now fallen down; there is sufficient, however, to show that there is much sand; that the ore is siliceous, and that much of the clay mass yields no ore at all; the total yield of ore, taking it as an open pit from the surface down, not being sufficient to pay for opening up and washing the ridge at this place.

§ 480. The surface of the ridge to the south of the Sand bank is very sandy, with a small but continuous outcrop of iron ore, chiefly siliceous in character.

§ 481. South of the Sand bank are the various "Ridge Banks" made up of numerous large and small open pits and shallow shafts.

§ 482. The most northern of the Ridge banks is a small open cut long since abandoned; the surface was sandy and the ore outcrop small; and the ore bearing mass, to judge from the imperfect exposure on the sides of the open pit, yielded only a moderate percentage of ore, and that of a siliceous character. It resembles the sand bank in the character of its ore, and the ground between the two is evidently unpromising.

§ 483. Just south of this however is the old main Ridge bank, a large open pit, not now working, from which much iron ore has been taken in the past.

The ore outcrop on the surface is very heavy at this place and while there is sand and flint on the surface, yet there is very little of it in the mine, and the good iron ore, lying usually in yellow clay, begins at the surface and evidently goes down to a considerable depth.

The bank has been opened on no system at all, but has been hogged unmercifully in stripping and screening to get at pots of rich lump iron ore.

§ 484. Some shafts in and around this mine have been down to a depth of 60 feet below the surface, and the miners report that they always passed through ore bearing clays for the whole distance, and worked massive lump ore, closely packed in clay in the bottom of their shafts. As only lump ore was wanted, in the absence of washers, they followed these ore masses underground; though some of the stuff was hauled from the open pit and washed at the old wash machine bank.

§ 485. A new pit opened on the east side of the main bank shows white clay for the west face, and iron ore east of the clay, of excellent character and in quantity. The white clay shows numerous quartz crystals scattered through it.

§ 486. The shafts at the old Ridge bank have never gone deeper than 60 feet, and at that depth they ended in ore bearing clay fully as rich, or richer, than any of the clay between the surface and the shaft bottom. The spot therefore promises very well for a large and profitable bank whenever proper facilities for washing are afforded.

§ 487. The most southern of the Ridge banks is only a small open pit, not now working; the imperfect show on the sides clearly indicates that clay, carrying much good ore, began at the surface and went down for at least 25 feet, and the bottom of the ore bearing mass not yet reached.

§ 488. The ore lies in yellow clay usually, with some red clay. The ore itself is not siliceous, though the surface crop is sandy barrens carrying iron ore; but the sand and flint are only on the surface, and do not show in the pit. It is reported that the bottom ore was of better quality than that worked above.

§ 489. Taken altogether these ridge bank openings represent a large deposit of iron ore. In the red, white, and yellow clays exposed in the different pits the iron ore lies in varying quantities and irregular masses, sometimes siliceous near the surface of the ground, sometimes extremely heavy and rich, sometimes porous and light, frequently manganiferous, representing in this ore bank every variety of color and character of iron ore, except the bomb shell ore, of which no specimens were seen. Taking the average, the ore is of excellent quality, and the clays are rich in it.

The miners report that at the ridge banks a heavy mass of white clay lies over the ore bearing mass of yellow clays; and that there is no ore in or on top of this white clay. The ore from the ridge banks was hauled to Sarah furnace.

§ 490. South of the ridge banks are the Jno. Krofft openings. They show ore bearing stuff from the surface down for over 20 feet. On the east side of the open pit the wash ore appears to be poor and sandy, while on the west side of the same open pit an excellent ore was mined, starting at the surface of the ground, lying in red and yellow tough clay, closely resembling the ore and ore clays in the large Bloomfield mine, at the north end of Bloomfield outcrop.

§ 491. The ore itself also much resembles that from the Bloomfield large mine, showing as a red and brown ore, frequently manganiferous, with some siliceous ore. Large bomb shells of ore are found in the Krofft mine.

West of the western edge of the open pit some shallow trial pits all found ore bearing material, and trial pits running along the crest of the ridge all found some ore, *according to the report of the miners.*

§ 492. The Krofft mine gives evidence of a valuable deposit. The upper 5 or 6 feet, containing much siliceous iron ore, should be stripped off and rejected; the remaining mass when passed through the washer would yield much good iron ore.

§ 493. South of the Krofft mine are the Clarke mines.

The north open pit is now about 50 feet deep, and has been worked 60 or 65 feet deep, in the past, in one place. The pit was not being worked when examined and therefore showed no fresh face of ore bearing stuff on the sides. They show however numerous layers of clay, of different colors, carrying varying quantities of iron ore, and lying horizontal; the general sinking of the solid limestone measures on the ridge crest being to the southeast.

The bank shows but little sand or flint in the sides. The outcrop at the place is heavy, and ore bearing stuff was at the surface of the ground.

The richest iron ore was worked as a great mass of lump ore closely packed in clay, at 40 feet below the surface; this mass of ore yielded from 4 to 9 feet of solid ore.

§ 494. In the South Clarke bank however a lump ore layer much resembling the above, was found by a shaft at 100 feet below the surface; if they be the same, the ore mass is sinking gently to the southeast.

The ore taken from the upper 40 feet of clay nearest to the surface is usually somewhat siliceous, and less valuable than the ore taken out below that depth.

The outcrop of ore just around the bank is enormous; the rock masses are flint and sandstone, never limestone.

§ 495. The South Clarke bank is a huge, irregular shaped, open hole, hogged out to a depth of from 15 to 30 feet. It was not working and showed an imperfect exposure on the side. It seemed clear however that the ore bearing mass from the surface down for 15 feet is nearly worthless, as the ore yielded by it is extremely siliceous.

§ 496. The good ore taken from the pit has mostly come from shafts, some of the shafts being 100 feet deep, and still in ore bearing clays in the bottom. Occasionally there are masses of good ore in the upper siliceous mass, but such masses are rather unusual.

On the west side of the bank, sand is found overlying the ore, which latter showed 3 or 4 feet of good ore, but it evidently changes back into a sandy iron ore very soon.

§ 497. The opening north of the North Clarke pit, shows good ore from the surface down; but the opening made on the ridge in the woods, south of the south bank, showed only a small quantity of sandy iron ore, and the outcrop of ore soon ceases entirely going south.

§ 498. The Clarke banks indicate a large deposit of iron ore in clays at this place. If the upper lean stuff were stripped off and rejected, and the bank properly opened up from a lower level, it is clear that great quantities of ore could be cheaply extracted. The deepest shaft, 100 feet deep, has never reached any bottom to the deposit of ore bearing material.

§ 499. Going southward from the Clarke banks along Duncan's ridge, the surface iron ore crop grows smaller, ceases entirely for considerable distances, and sandy limestones come to the surface in place. The ridge crest is made up of sandy barrens along the whole distance.

§ 500. About $1\frac{1}{2}$ miles southward of the Clarke banks is the old Barley bank. It is an old open cut, long since abandoned, and now showing but little ore on its sides.

The surface crop of ore at this place is heavy, and there seems to have been a good face of wash and lump ore in yellow clay, the ore beginning at the surface.

§ 501. West of the Barley open mine there is a surface show of iron ore in the fields near the school house at the road forks; and there is also a surface show of ore about $\frac{3}{8}$ mile southwest of the Barley mine. But these crops have never been opened up nor tested in any way, and their depth is unknown. They appear from slight road cuttings to be only shallow surface deposits.

§ 502. The Stuckey and the Leidig ore banks, $2\frac{1}{2}$ miles south of the Barley mine are simply shallow trial pits and small open cuts or heavy surface ore crops. They have never been worked to any extent, but so far as can be judged from the slight exposures, give a fairly hopeful show.

§ 503. *The plant at Bloomfield mines.*—The Bloomfield mines have a costly and complete appointment for washing and shipping the iron ore.

There are 6 double shaft Thomas patent washers, with shafts 28 feet long. Five of these are kept running, one being held in reserve, so that in case of any accident, the reserved washer can be immediately turned on, and thus save any disarrangement of the work in the mines.

§ 504. There is a Bradford revolving screen to each washer. Mr. McLanahan, the present lessee of the mines says:

"I have a traveling table, which receives the ore from the Bradford screen, and while the ore is on its way to the railroad cars it is picked free of impurities; this traveling table is in operation at two of the washers and I am now arranging to have it at all of them.

All ore that will not pass a quarter inch mesh that is on the Bradford screen is discharged upon the traveling table; and all that which passes the quarter inch mesh (wire cloth) is discharged into another revolving screen, made of 9 mesh wire cloth, where it is washed clean of fine sand and dirt; the ore, the greater portion of which is of the size of wheat or coffee, is then carried to a jig and cleaned of the flint and like particles.

The Cambria Iron Company now (March, 1879,) takes all the jigged ore; and pronounce it a 39 per cent. iron ore.

§ 505. *Method of workings.*—The mine cars run from the mine to the washers by gravity, and we push them back with a small locomotive; the cars hold about 1 cubic yard each and we wash about 450 per diem; each washer yields about 25 tons of wash ore per day of 10 hours, making from the 5 washers in operation 125 tons (2240 lbs.) of washed ore daily.

I can ship about 50 tons of lump ore with the washed ore, making about 175 tons daily of ore shipment.

§ 506. We get water to wash the ore from Halter's creek, about one and a half miles from the washers. We have a steam pump at the creek; this pump has 16 inch steam cylinder, 9 inch water cylinder, and 36 inch length of stroke. We run the pump 18 hours daily; during the time when the pump is running, while the washers are still, the water is discharged into a reservoir at the washers, and is again pumped up into the washers when they are in full operation.

The leading pipe from the pump is 3600 feet long, and the water is thrown to an elevation of 200 feet.

§ 507. Allowing for all necessary reductions on account of repairs, scarcity of water for washing, &c., the Bloomfield mines can yield from the present plant, and are now yielding, about 50,000 tons of washed ore yearly.

The facilities for getting this ore cheaply are so great that it is doubtful whether any extensive mines in the State are now working ore more cheaply than Bloomfield.

Character and Uses of Bloomfield Iron Ore.

§ 508. The Bloomfield iron ore is widely known for its excellent character—more especially for its unusual freedom from phosphorus. The whole of the present product goes to the Cambria Iron company and to the Pennsylvania Steel company (at Baldwin); the ore is used by these companies, mixed with magnetites, to make Bessemer pig.

The fact that the ore is so used, and in large quantities, is the best possible analysis, and is sufficient evidence that the ore is low in phosphorus.

§ 509. A sample was taken of the washed ore as it came from the washer, and representing a fair average of what, at that time, was being shipped to market as Bloomfield iron ore.

This was forwarded to the Laboratory of the Survey and yielded on analysis (McCreath):

"The sample consists of limonite ore, with a large admixture of quartz pebbles, argillaceous iron ore, and ferruginous clay."

Sesquioxide of iron,	51.571
Sesquioxide of manganese,	.548
Sesquioxide of cobalt,	trace.
Alumina,	3.996
Lime,	.075
Magnesia,	.209
Sulphuric acid,	.057
Phosphoric acid,	.185
Water,	9.811
Insoluble residue,	32.830
	99.282
Metallic iron,	36.100
Metallic manganese,	.382
Sulphur,	.023
Phosphorus,	.081

This represents a fair average of the ore then shipped; it is probable, however, that with greater care in selecting the wash material and more careful picking the percentage of iron might be increased, and the siliceous matter be decreased.

§ 510. A specimen was taken from a large bombshell mass of iron ore found in the large Bloomfield mine. There are many such large bombs found in working this bank; and they are almost always of exceptional richness in iron, as is shown by the analysis of this specimen, as follows (A. S. McCreath):

The ore has the general appearance of a bombshell ore, the walls of the cells being lined with nodular, cellular, manganese ore. The ore generally is fibrous and brittle, also partially foliated with iridescent surface. It carries considerable yellow clay and has a dark brown color:

Sesquioxide of iron,	75.071
Binoxide of manganese,	3.760
Protoxide of manganese,	.779
Sesquioxide of cobalt,	.030
Alumina,	2.678
Lime,	.240
Magnesia,	.235
Sulphuric acid,	.182
Phosphoric acid,	.071
Water,	13.330
Insoluble residue,	3.948
	100.000
Metallic iron,	52.550
Metallic manganese,	3.004
Sulphur,	.073
Phosphorus,	.031

§ 511. *The Bloomfield mines yield much manganiferous iron ore* in places. These ores are usually irregular, coming in and cutting out suddenly. Some of the manganiferous ore has been sold to make spiegel; and some spiegel was once made by Mr. Madara, at Rodman furnace. A specimen of the manganiferous iron ore from just south of the large Bloomfield open mine yielded on analysis (A. S. McCreath):

"The specimen is hard, tough, minutely crystalline, somewhat cellular, the cells being filled with limonite. Color generally steel gray.

Iron,	22.700
Manganese,	37.611
Sulphur,	.018
Phosphorus,	.043
Alumina,	1.144
Lime,	.470

Magnesia,	.271
Silica,	2.850

§ 512. In addition to these analyses of the Bloomfield iron ores specially made at the Survey Laboratory, Mr. McCreath gives the following analysis of Bloomfield ore made by him for the Pennsylvania Steel Company some years since:

Sesquioxide of iron,	72.143
Sesquioxide of manganese,	1.273
Sesquioxide of cobalt,	.011
Alumina,	2.457
Lime,	.170
Magnesia,	.457
Sulphuric acid,	.135
Phosphoric acid,	.103
Water,	11.276
Insoluble residue,	11.970
	99.995
Metallic iron,	50.050
Metallic manganese,	.886
Sulphur,	.054
Phosphorus,	.045

§ 513. Specimens of the Bloomfield iron ore were sent by Mr. John W. Duncan to Mr. Otto Wuth, of Pittsburgh, who reports the following results of his examination:

"I have made a careful analysis of the specimens of your Bloomfield ore, and found them to be composed as follows:

Water,	10.71
Silicic acid,	7.02
Peroxyde of iron,	78.63
Alumina,	2.50
Lime,	0.34
Magnesia,	0.38
Manganese,	0.29
Phosphoric acid,	0.134
	100.004
Metallic iron,	55.04
Phosphorus,	.058

They contain only slight traces of sulphur. If the ore should prove to be uniform, the pig metal smelted from it will not contain more than 0.10 per cent. of phosphorus, and will be equally fit for the Bessemer and Siemens Martin process."

§ 514. The Sarah furnace has always used Bloomfield ores, the furnace having ore rights on Duncan's ridge. The ore mined by them came from the more southern mines, the Clarke bank and those just north of them.

§ 515. A specimen of the lump ore as used at Sarah furnace was analysed and yielded as follows (A. S. McCreath):

"Hard and tough ore, carrying considerable free quartz. Fracture rough and irregular; color dark-brown to brownish-black.

Sesquioxide of iron,	59.428
Sesquioxide of manganese,	1.758
Alumina,	3.024
Lime,	.080
Magnesia,	.331
Sulphuric acid,	.062
Phosphoric acid,	.128
Water,	8.795
Insoluble residue,	25.855
	99.461
Metallic iron,	41.600
Metallic manganese,	1.224
Sulphur,	025
Phosphorus,	.056

The Sarah "burnt ore," taken from the Clarke mine, yielded to Mr. S. S. Hartranft on analysis:

Dark brown to reddish brown; somewhat cellular and contains free quartz.

Sesquioxide of iron,	69.857
Sesquioxide of manganese,	.509
Alumina,	3.176
Lime,	.130
Magnesia,	trace.
Sulphuric acid,	.138
Phosphoric acid,	.057
Water,	10.280
Insoluble residue,	16.350
	100.497
Metallic iron,	48.900
Manganese,	.353
Sulphur,	.055
Phosphorus,	.025

In addition to the above analyses specially made for this report, the Bloomfield washed ore was frequently analyzed in past years for the Pennsylvania Steel Company. Mr. McCreath reports the analyses thus:

Date of analysis.	Per cent. iron.	Per cent. phosphorus.
July, 1873,	32.25	.053
March, 1874,	39.06	.041
April, 1874,	33.50	.039
April, 1874,	35.00	.059
May, 1874,	36.60	.053

The above probably gives a very fair average of the character of the washed ore, as shipped at that time.

§ 516. In shipping some ore to the Edgar Thomson steel works (in 1879) they returned the following result of their analysis of a large specimen (3 barrels):

Metallic iron,	34.651
Phosphorus,	0.058

§ 517. An analysis of Bloomfield ore, manganiferous, made by Pedro G. Salom, is thus reported:

Water,	14.30
Insoluble,	3.46
Sesquioxide of iron,	36.56
Alumina,	7.40
Sesquioxide of manganese,	17.57
Protoxide of manganese,	20.71
Oxide of nickel,	traces.
Sulphur and phosphorus,	traces.
	100.000

§ 518. Rodman furnaces, belonging to the Bloomfield estate of the Duncans, ran on Bloomfield washed iron ore entirely without admixture of any other ore. The fuel used was the well known Connellsville coke, and the limestone was quarried close to the furnaces.

These limestones yield on analysis:

Carbonate of lime,	78.176	91.892	54.571
Carbonate of magnesia,	10.746	2.875	44.180
Oxide of iron and alumina,	1.850	.640	.234
Sulphur,	.149	.096	.002
Phosphorus,	.029	.022	.003
Insoluble residue,	8.570	4.380	1.330
	99.520	99.905	100.320

No. 1 quarry.—Compact, brittle, bluish-gray, irregularly seamed with calcite. Generally fine-grained.

No. 2 quarry.—Coarse-grained, bluish gray, sparkling with calcite. Fracture rough, irregular.

No. 3.—From quarry on the railroad south of Roaring Spring, near Rodman furnace. Not used in furnace. Hard, fine-grained limestone, with pearl-gray color.

Using limestones Nos. 1 and 2 as flux; with Connellsville coke and Bloomfield washed ore, the metal from Rodman furnace, as used by the Pennsylvania Steel Company in 1872 and 1874, showed the following composition (A. S. McCreath):

Rodman Furnace Pig Iron.

	1872.	*March. 1874.*	*May. 1874.*
Silicon,	4.004	3.184	2.713
Sulphur,	.035	.082	.123
Phosphorus,	.195	.195	.192
Manganese,	—	.144	.864

This shows a metal of high grade, and it was used, mixed with other pig iron, in the converters of the Pennsylvania Steel Company, at Baldwin.

These analyses are sufficient to show the general character of the ore.

§ 519. The old Bloomfield charcoal furnace, ran exclusively on iron ore taken from these banks on Duncan's ridge, using for flux a limestone quarried near the furnace stack.

§ 520. *For gun metal.*—So superior was the metal made, that after a long and complete series of tests, the Bloomfield pig metal was chosen by Captain Rodman for use in making the heavy ordnance for the United States Government; and he strongly urged that the Government should purchase the whole Bloomfield ore deposits and thus secure a permanent supply of this valuable ore.

Bakersville Iron Ore Mine.

§ 521. The Cambria Iron Company have opened up a shallow open cut and put down numerous trial pits in a field near Bakersville, 2 miles southwest of the Bloomfield mines.

The Bakersville openings are not on Duncan's ridge, but in the valley to the west of it.

§ 522. The surface outcrop of ore is heavy all over the field, and especially heavy for a distance of say 300 yards north and south, by 125 yards east and west. It is in this heaviest outcrop that the ore developments have been made.

Trial pits have gone down as deep as 75 feet below the surface; all this distance through sandy stuff, holding wash ore; and a bottom of solid rock in place has never yet been struck in any of the shafts. In some cases these trial pits found very little iron ore; in others the mass was rich in wash ore; in fact they develop the same quick changes in the character and richness of the ore bearing material as is shown at almost every open pit on brown hematite ores.

§ 523. The open cut is 300 feet long by 45 feet wide and 15 feet deep. The mass of material holding the ore is sand and sandy clay; there is not a piece of loose limestone showing in the mass, but only pieces of sandstone and flint. The clays are yellow usually, and sometimes reddish. The ore pieces begin at the surface, and are found all through the mass to the bottom of the cut, which is however only 15 feet deep. In the sand and clay which hold the wash ore, there are numerous large pieces of sandstone, coated with a crust of iron ore.

§ 524. These sandstone pieces are not rounded and worn, as a rule; the ore pieces also, are generally not rounded and water-worn; but there are many rounded ore pieces in the mass, following no special layer or horizon in the bank, but scattered irregularly through all parts of the exposed mass. Taken as a whole, the entire face of stuff is lean in ore as to quantity; and much of the ore is siliceous. The ore in appearance is of all varieties, and shows water-worn rich dark colored lumps, open porous cellular ore, dark reddish solid and somewhat sandy ore, light brown sandy lean ore and light brown rich iron ore.

§ 525. An average specimen of these varieties of ore was forwarded to the laboratory of the survey and yielded on analysis (A. S. McCreath).

Limonite, brittle, sandy, argillaceous; compact, also cellular, color dark brown and liver brown.

Sesquioxide of iron,	56.214
Sesquioxide of manganese,	.073
Alumina,	4.855
Lime,	.015
Magnesia,	.335
Sulphuric acid,	.012
Phosphoric acid,	.451
Water,	10.390
Insoluble residue,	27.960
	100.305
Metallic iron,	39.350
Metallic manganese,	.050
Sulphur,	.005
Phosphorus,	.197

The ore has been only opened up for testing; it has never been regularly worked as yet for shipment. The analysis indicates an ore too high in silica, lean in iron, and with too much phosphoric acid; altogether a rather unfavorable show.

§ 526. All along the valley on the west of Duncan's ridge there is an outcrop of iron ore. It is geologically continuous for many miles, though of course very slight in places. From 1 mile north of Roaring Spring on the north, along the west foot of Duncan's ridge, passing near the school-house at Bloomfield, at Bakersville ore opening, and on south by Long's to the Stuckey farm, the surface of the ground is colored by ore bearing clays and some ore pieces usually show. Of course the outcrop varies much in this long distance of some 7 or 8 miles; in some cases the show is scarcely visible, in others hardly noticeable, in others heavy, and continuing for a considerable distance in that condition. In this distance there is opened on the crop a small and unimportant pit near Roaring Spring; a small open cut near Bloomfield; this Bakersville mine; an opening at Long's and at Stuckey's. None of them, except at Bakersville, give any great evidence of ore in quantity.

Millerstown Red Ore Mine.

§ 527. This mine is one half mile northeast of Millerstown.

The mine is one large open pit, of no great depth, and long since abandoned. The sides are washed down and the exposure of wash ore is very imperfect.

The wash ore mass is in limestone, and great knobs and masses of undissolved limestone stand up irregularly on the present floor of the mine.

The clay holding the wash ore is deep red in color, and there seems to be an almost total absence of any white or yellow clay.

The ore pieces and the limestone or flint pieces in the mine are generally, if not always, rounded and water-worn; the ore is seldom in large masses, but usually in small pieces.

Michael Morris, who worked at the Red mine, reports that shafts have been down for fully 100 feet below the surface, in the same red clay holding much wash ore. None of these shafts are now open and working.

§ 528. The outcrop at the mine is very heavy, the ore crop being plainly defined at and around the mine, and the deep red clay making a conspicuous show. But though this red swash colors the surface for miles northeast of the Red mine, yet numerous trial pits put down all around the mine show that the deep deposit of wash ore is confined to but little more than the area outlined by the present opening; and that beyond that limit solid limestone is quickly found in every trial pit, and usually at only a few feet deep; though near Rebecca furnace it was 12 feet deep to solid rock, the overlying stuff however carrying but little iron ore, except just at the surface.

In spite of the extended and marked outcrop therefore along this line, no ore has been worked from any place except just at this Red bank.

§ 529. The appliances for preparing the ore were very rude and most of the stuff was simply screened. Water could easily be raised from Clover creek to wash the ore mass and there is ample settling ground, &c.

The ore was worked many years ago; the mine yield going to Rebecca furnace.

§ 530. A specimen of this Red mine ore was gathered from the loose pieces in the sides of the pit, and forwarded to the Laboratory of the Survey. It yielded on analysis (A. S. McCreath):

"The ore is a limonite, exceedingly hard and tough, and for the most part coated with a reddish brown clay. The ore is very compact and on fresh fracture has a dark brown color.

Sesquioxide of iron,	77.143
Sesquioxide of manganese,	.093
Alumina,	2.438
Lime,	.130
Magnesia,	.464
Sulphuric acid,	.041
Phosphoric acid,	.194
Water,	10.164
Insoluble residue,	9.260
	99.927
Metallic iron,	54.000
Metallic manganese,	.065
Sulphur,	.017
Phosphorus,	.085

§ 531. The geological horizon of the Millerstown Red ore is about 1100 feet below the bottom of the black slates of III.

The curious and complicated features of the geology of Leathercracker cove and the region just north of it have been given before in the description of the structure of the valley, and need not be repeated here.

§ 532. Of all the numerous outcrops and trial pits, between the Red ore and Henrietta, to the south, and along the outcrop following down Clover creek, to the northeast, there is no place where any success worth noting has attended the investigation as to the depth and value of the ore deposits.

Rebecca iron ore mines.

§ 533. The Rebecca ore mines are 3 miles North 70° East from Martinsburg. They belong to and have been for 60 years worked for the Rebecca furnace proprietors. The furnace property is now owned by Mrs. Lytle.

§ 534. The main Rebecca ore bank is an open cut 800 feet long from north to south, with a width ranging from 300 down to 125 feet. In depth it shows now only 50 feet, owing to the washing in of the sides; but in the past it has been worked in this same open cut to a depth of fully 70 feet.

The strike or course of the ore deposit as followed in the mine, is to the northeast and southwest, or parallel to Tussey mountain.

The west wall shows a solid bank of tough white clay, *non-ore bearing*, apparently dipping about 65° or 70° to the southeast, towards Tussey mountain. This large bank has not been worked for some years and the sides have now washed down sufficiently to render it difficult to form a fair judgment of general richness of the ore bearing mass.

The white clay on the west side may be taken as the bottom of the ore deposit of this mine, or at least no ore has ever been worked below it.

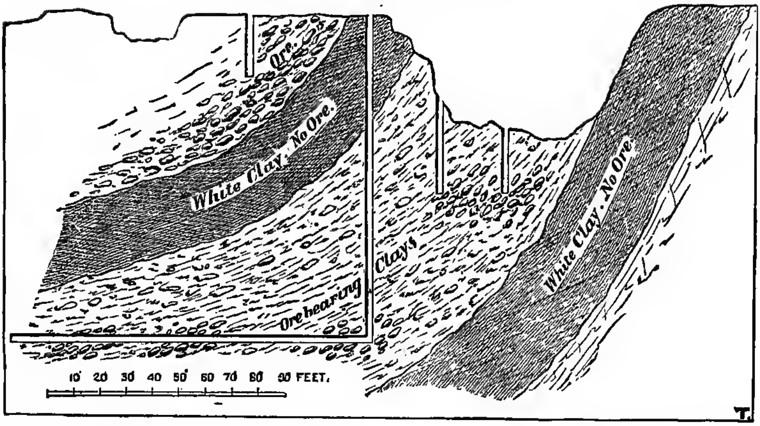
In the mine, directly on top of this white clay, there are now exposed to view masses of "copper shell ore," bomb shells of lean sandy brown hematite ore, holding not over 15 per cent. of iron and stained with copper ore. This "copper shell" is totally worthless as an iron ore.

At the north end of the open mine, the underlying white clay seems to sweep around to the eastward, and thus completely cut off the ore mass from any direct north extension.

No solid rock of any kind shows in the mine; nor is there any outcrop of surface ore to the north or west of it.

§ 535. In addition to the open mine there are several shafts from which much ore has been taken in all. These shafts are not now working. Mr. F. Henry who ran Rebecca furnace and worked the mines for four years, thus reports the facts concerning this underground work; the cross section given below (Fig. 27) shows the facts, drawn out to scale, and the conclusions resulting therefrom:

Fig. 27.
Rebecca Ore Mine.



The bottom ore of this shaft was copper shell to the white clay; then good ore bearing clay from the bottom shaft to the white clay No. 2, on top of it; this white clay No. 2 continued to the surface; the ore lying above it, and to the east of this main shaft, he reports as leaner and harder than the ore below.

§ 536. Another shaft put down on the east side of the open cut is thus reported:

Eighty feet of barren white clay were passed through; then ore bearing clay was found for the next fifty feet; at a depth of 130 feet below the surface the ore bearing clay was to the east of the shaft, and it required a drift 12 feet long, due east from the shaft, to reach the ore.

The bottom of the shaft for 25 feet was on white clay."

§ 537. A third shaft was put down northwest of the main shaft, and the underground work is thus described:

"The shaft went through non-ore bearing clay for 81 feet; then ore bearing clay with much closely packed lump ore for 15 feet, making the bottom of the shaft 96 feet below the surface.

The ore bearing mass is dipping steeply to the southeast, about 65°±, and is not less than fifteen feet thick.

§ 538. Another shaft on the east side of the open cut went

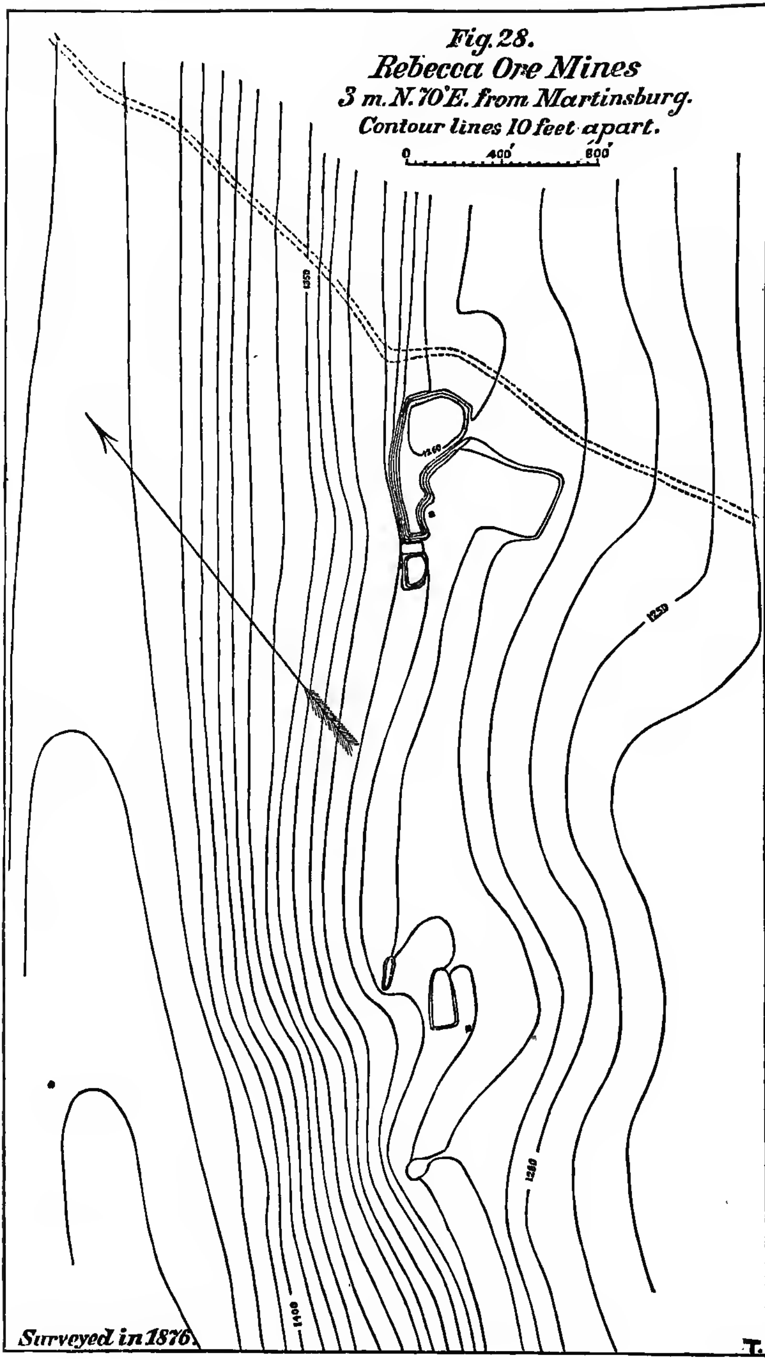


Fig. 28.
Rebecca Ore Mines
3 m. N. 70° E. from Martinsburg.
Contour lines 10 feet apart.

130 feet through clay, and then drifted eastward 75 feet to find the ore mass.

§ 539. And still another shaft on the east side of the open cut, was 80 feet deep in clay, and drifted eastward for 30 feet to find the ore mass.

§ 540. Enormous quantities of ore have been mined in all from this Rebecca mine, including both open work above in the main mine, and the underground work in the shafts; the Rebecca furnace having been supplied since 1817 almost entirely by iron ore from this mine.

§ 541. The old shallow open pit, 60 yards east of the east side of the main large open mine, was only worked to a depth of about 20 feet; it had wash ore in the sides and bottom.

The appliances for washing and preparing the ore at the Rebecca mines were old, (when the mine was examined in 1877) and not adapted for any large output of washed ore.

§ 542. A shaft just east of the tip heap found white sand *and no ore*, making that the eastern terminus of the wash ore deposit on the surface.

The ore is not in rounded and water worn pieces; but lies in irregular pieces and masses, sharp pointed, surrounded by clay.

§ 543. The chief weakness of the mine for any economical production of large quantities of washed iron ore, is in the great masses of white clay, absolutely non-ore bearing; these great masses have hitherto been left, and the ore mass worked out both above and below.

§ 544. A specimen of the Rebecca iron ore was forwarded to the Laboratory of the Survey and yielded on analysis (A. S. McCreath):

Sesquioxide of iron,	65.713
Sesquioxide of manganese,	.551
Sesquioxide of cobalt,	—
Alumina,	3.908
Lime,	.240
Magnesia,	.200
Sulphuric acid,	.115
Phosphoric acid,	.219

Water,	11.876
Insoluble residue,	17.560
	100.382
Metallic iron,	46.000
Metallic manganese,	.384
Sulphur,	.046
Phosphorus,	.096

The ore is a limonite, brittle, arenaceous, somewhat cellular, the walls of the cells being lined with Göthite. The ore is generally of a light brown color, and carries a large amount of adhering white clay.

This analysis shows an iron ore of excellent quality. Moreover this is evidenced by the fact that Rebecca furnace has used this ore unmixed with any foreign ores for 60 years; and has always made a first class metal.

§ 545. When much gun metal was being purchased in Morrison's cove for the Fort Pitt foundry (during the late war) a considerable part of the Rebecca product went for that purpose.

§ 546. One third of a mile south of the Rebecca main open mine, just south of Wagner's house, and on the Lytle property, there is a marked outcrop of iron ore over a considerable surface area.

There is a shallow shaft, and a small open cut; the latter shows over 15 feet of wash-ore. The wash-ore begins at the surface and goes down to the bottom of the cut; but does not seem to be of more than a very average grade of richness in iron ore.

But the deposit is clearly not of any great extent just at this point; for a shaft, 50 feet deep, 25 feet west of this shallow pit, found red clay and loose ferruginous lumps of clay-slate, but *no iron ore.* Some small pieces of weathered limestone were in the clay.

§ 547. To the north or northeast of this shallow pit, between it and the Rebecca main mine, there is no marked outcrop of iron ore, and no surface evidences of any iron ore deposit existing in the interval; the whole distance between is, therefore, in all probability, barren ground, so far as iron ore is concerned.

§ 548. To the southwest of the shallow pit, however, and some 300 yards from it, there is a decidedly heavy surface show of iron ore of superior quality in richness in iron.

This outcrop covers the greater part of a field; is in lumps and pieces usually of moderate size; and the ore lumps are all rounded and water-worn.

No trial pits have ever been put down to test the depth of this deposit; the surface show is very favorable, and should indicate a deposit of value.

It resembles closely, in the nature of the deposit and appearance of the ore, the mine No. 3, of Springfield.

Thompson Mine.

§ 549. The Thompson iron ore mine is a shallow open pit and a few trial shafts, one mile south of Martinsburg. It is now entirely fallen shut; the holes are small, and probably not more than 50 tons of ore in all have been removed. There was no washer, but the ore-bearing stuff was screened and the lump ore only was taken away.

The surface outcrop of ore pieces and ore-bearing clay is heavy all over the field around the pits. The ore pieces themselves are mostly rounded pebbles. The clays holding the ore are colored from a yellow up to brown and deep red.

§ 550. The ore is cellular, fibrous, occasionally pipey, with many pieces of honeycomb ore; it is reported as having been rich in iron, but somewhat red short.

Mr. Thompson says that he put down a shaft for 27 feet through yellow clay holding much lump and wash-ore. It is also reported that a 35 foot shaft found the ore-bearing mass all the way down and in the bottom. The outcrop and test pits give very favorable indications for the presence of ore here in quantity.

§ 551. In geological horizon it is about 2500 feet below the bottom of the black slates of III.

§ 552. An average specimen of the ore pieces, as found lying around the pits and shafts, was forwarded to the laboratory, and yielded, on analysis (A. S. McCreath):

Sesquioxide of iron,	78.000
Sesquioxide of manganese,	.195
Oxide of cobalt,	trace.
Alumina,	2.348
Lime,	.220
Magnesia,	.396
Sulphuric acid,	.102
Phosphoric acid,	.462
Water,	11.880
Insoluble matter,	6.805
	100.408
Metallic iron,	54.600
Metallic manganese,	.136
Sulphur,	.041
Phosphorus,	.202

The ore is a limonite, cellular, nodular, brittle, dark-brown.

Chapter XIV.

Brown hematite ores of No. II continued.

Williamsburg, Canoe Valley and Sinking Valley Mines.

Williamsburg Red Ore Mines.

§ 553. The red ore mines of the Williamsburg Manufacturing Company are 1¾ miles southwest of Williamsburg.

The surface soil is sandy barrens and the surface ore crop is almost entirely confined to the immediate vicinity of the open pits.

§ 554. The northern open mine is a small shallow open cut, with blood red clay, holding some iron ore, showing on the sides and bottom.

Some good ore was taken out from here and used by Williamsburgh furnace; but the greater part of the ore turned out to be siliceous and the hole was abandoned. Some trial shafts north and south of the open pit, along the strike of the measures, found some little iron ore, but in no case enough to pay for opening up.

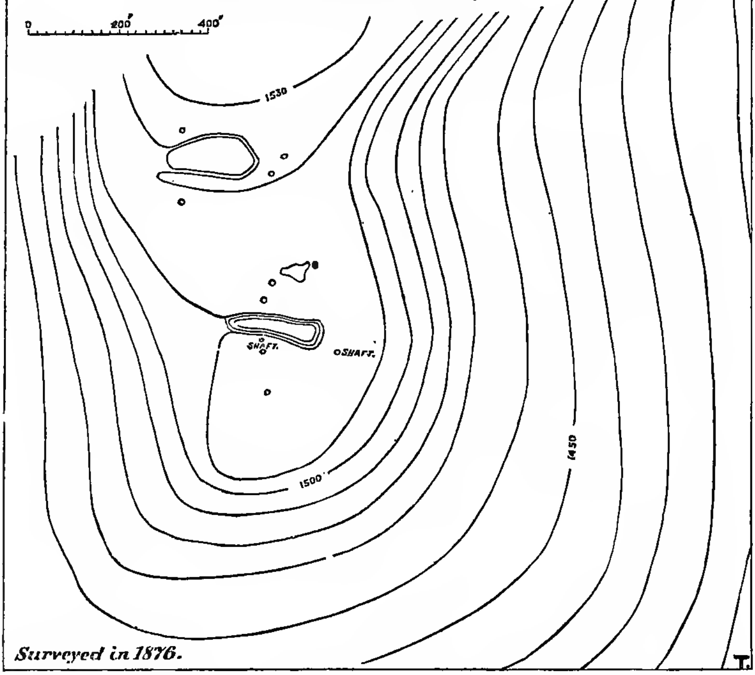
§ 555. The southern openings consist of an open cut, somewhat larger than the northern one, and also of a shaft. They are 150 feet south of the other mine, and on the same level hill crest.

The open cut is driven in from the west.

The western end of the cut shows yellowish clay, non-ore bearing, and with much loose flint. The east end of the cut yielded the ore, but as the mine is not now working, the sides have washed down and covered the ore face with blood red clay wash. The cut at the eastern end is now only 20 feet deep, but was fully 40 feet deep where it was working. The red clay marks itself plainly where it comes in on the east side of the cut. It was originally worked by a shaft and afterwards opened up as an open mine.

§ 556. The ore, as described by Mr. Fay, was unusually pockety and unreliable, swelling out or pinching down very suddenly. The ore itself was rich, worked easily in the furnace, and was somewhat red short.

Fig. 29.
Red Ore Bank.
1.6.m.S.30W.from Williamsburg.



Surveyed in 1876.

§ 557. At the east end of the mine there is a shaft 80 feet deep; it starts 15 feet below the surface, and the bottom of the shaft therefore is 95 feet deep below the ground.

The ore was struck at 60 feet and continued on to the bottom at 80 feet. It is reported that the ore mass was dipping steeply to the east; that ore was still in sight on the west side of the shaft at the bottom; and clay, without any iron ore, on the east side.

The ore is found in deep red clay, and is of good quality, though somewhat red short. Much flint rock is found through the clay masses.

§ 558. The unusually pockety nature of this ore deposit is shown by the three shafts which have been put down, one just east of the open mine, and the other just south of it. The shaft No. 1 was 100 feet deep, altogether through sandy limestone; and the ore-mass which in the open pit appeared to be plunging directly towards where this shaft was put down, never reached the shaft at all, but ended abruptly somewhere in the short distance between the end of the open mine and the shaft.

Shaft No. 2 was 60 feet deep through limestone, and shaft No. 3 20 feet deep, also through limestone; yet shaft No. 2 is just south of where the red clay, carrying ore, shows plainly in the side of the open cut.

The ore pieces as seen in the side of the open mine are usually rounded smooth ore pebbles.

§ 559. The red clay and ore make a conspicuous and heavy surface show just at the Red mines, but it does not extend beyond them, and sandy barrens make the surface between the Red mines and Springfield mines, and trial pits have failed to find a workable ore deposit at any point between them.

§ 560. An average specimen of the Red ore was forwarded to the Laboratory of the Survey and yielded on analysis (A. S. McCreath):

Sesquioxide of iron,	72.857
Sesquioxide of manganese,	.173
Alumina,	3.239
Lime,	.320
Magnesia,	.338
Sulphuric acid,	trace.
Phosphoric acid,	.504
Water,	11.391
Insoluble residue,	11.325
	100.147
Metallic iron,	51.000
Metallic manganese,	.120
Sulphur,	trace.
Phosphorus,	.220.

The ore is a limonite, generally cellular, with cells partially filled with a reddish brown ochreous earth. It is comparatively soft and carries spangles of quartz. Color generally dark brown.

Patterson ore mine.

§ 561. The Patterson ore mine is 1½ mile southwest of Williamsburg. It is on the central ridge of the valley, and the surface around it is sandy.

There is some surface show of iron ore north of the mine, between it and Williamsburg, but the show is very unpromising usually. Near Patterson's house however some shallow pits and shafts have found ore, and some has been taken out and used by the Williamsburg furnace. But there is no reason to expect a large deposit at that place. Great quantities of sharp sand are found in the road near Patterson's house.

§ 562. At the Patterson mine the southern shaft is 80 feet deep; ore was struck at 15 feet below the surface, followed on down and left in the bottom.

The ore mass is reported as having been worked 9 feet thick; that it went down about vertical, and that at 40 feet below the surface it took a bend to the east.

§ 563. A small shaft put down just south of this deep shaft, and along the strike of the measures, found limestone at 8 feet below the surface, and some iron ore; another shaft 30 feet deep, and 50 yards further south, found limestone at 30 feet deep, and no iron ore.

§ 564. The north shaft is 55 feet deep, and is in an ore mass either vertical, or changing from that to a steep dip to the east. Between these two shafts the ore has been worked underground.

There is a small surface ore crop north of the shaft, but only clay and some little iron was developed by trial pits. There is little surface ore show except just at the shafts, and not very much there.

§ 565. The ore is of two kinds chiefly, a liver colored lean ore, frequently siliceous, and a richer deep red or blackish iron ore, carrying some manganese.

The ore taken from these shafts was mined by the Williamsburg Manufacturing Company and used at their furnace in Williamsburg. It was of excellent quality and made good metal. A tram road carried the ore from the mines to the furnace. The total ore product has not been great, and the facts as gathered from the past workings do not indicate the presence of any large quantity of economically available ore.

§ 566. A specimen of the Patterson iron ore was analyzed at the Laboratory of the Survey, and yielded (A. S. McCreath):

Sesquioxide of iron,	70.143
Sesquioxide of manganese,	.123
Oxide of cobalt,	trace.
Alumina,	2.069
Lime,	.020
Magnesia,	.158
Sulphuric acid,	trace.
Phosphoric acid,	.238
Water,	10.213
Insoluble residue,	17.240
	100.204
Metallic iron,	49.100
Metallic manganese,	.085
Sulphur,	trace.
Phosphorus,	.104

The ore is a limonite, compact, brittle, arenaceous, with quartz disseminated throughout the mass. Color of ore, dark-brown.

Dean's Iron Ore Bank.

§ 567. The Dean ore mine is 1¾ miles south of Williamsburg.

It is an irregularly-shaped shallow open cut, about 10 or 15 feet deep, 250 feet long, and of a width varying from 10 to 50 feet; running northeast and southwest, but not in a perfectly straight line.

At the west end of the mine the cut is only 10 feet wide and 10 to 15 feet deep; the sides show wash-ore from top to bottom, the iron ore pieces being usually small.

The cut widens out going to the southeast, and the east end of the mine is fully 50 feet wide. At this eastern end the mine ran squarely against a face of solid limestone in place, ending the deposit in that direction. In this eastern part of the mine a shaft was put down for 14 feet, starting it in the pit, 15 feet below the surface of the ground. The shaft showed loose, partially decomposed limestone and iron ore, extremely sulphurous; in fact there were great masses of decomposing iron pyrites, with a hematitic crust. The deposit was valueless on account of its sulphur, and the shallow shaft was abandoned.

§ 568. The solid rock of all kinds in the bank, whether ore pebbles, flint, or limestone pieces, are all rounded and worn smooth.

§ 569. The ore lies on the broad flat at the base of the central ridge of the valley, and about 100 feet above the level of Clover creek. There is no washer at the mine, and hitherto the ore has been simply screened. There was abundance of water, however, at the bottom of the shallow 14 foot shaft.

§ 570. This ore was used in Williamsburg furnace, and Mr. Fay reports it as having been a rich and good working ore, but red short.

The mine was not working at the time of examination, and the show of the ore face on the sides was very imperfect.

§ 571. An average specimen of this iron ore from the sides of the mine was forwarded to the Laboratory of the Survey, and yielded, on analysis (A. S. McCreath):

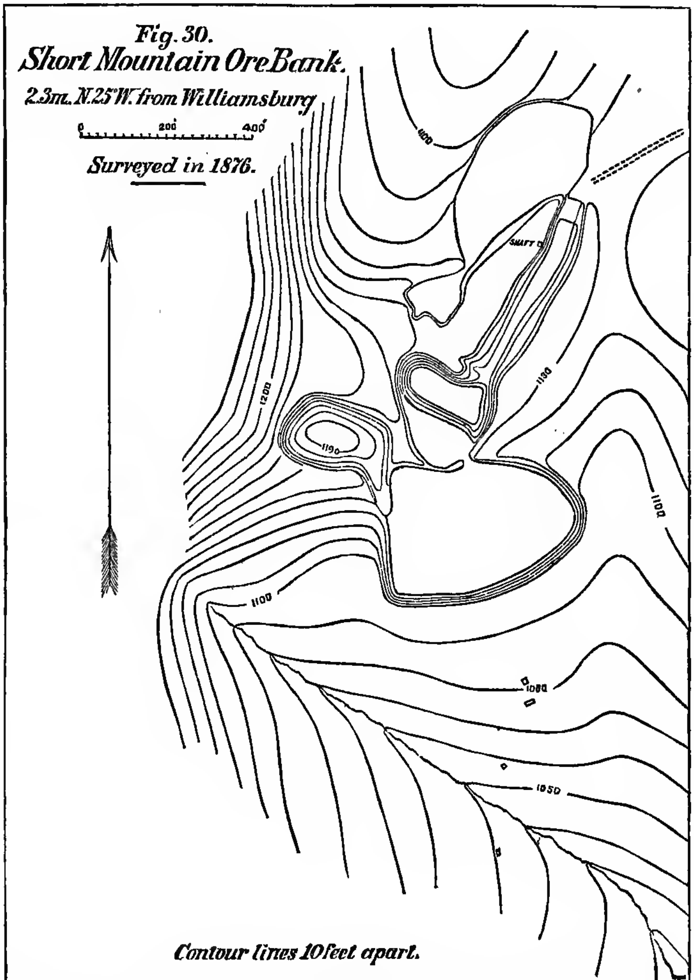
Sesquioxide of iron,	75.571
Sesquioxide of manganese,	.081
Alumina,	3.426
Lime,	.680
Magnesia,	.673
Sulphuric acid,	trace.
Phosphoric acid,	.513
Water,	12.595
Insoluble residue,	7.010
	100.549
Metallic iron,	52.900
Metallic manganese,	.057
Sulphur,	trace.
Phosphorus,	.224

The ore is a limonite, cellular, the cells being partially filled with yellow clay.

Short Mountain Ore Mine.

§ 572. The Short Mountain ore mine is $2\frac{1}{2}$ miles northwest from Williamsburg and $1\frac{1}{2}$ miles north of Franklin forge.

Fig. 30.
Short Mountain Ore Bank.



The open pits are large, and have yielded much iron ore ;

but when examined they were being worked only at one place, and in a small way, so that the exhibition of the ore face on the sides of the mine was extremely imperfect.

The surface show at the mines was very heavy, and much ore was taken from the surface and just below it; but the area of this surface ore show is limited to not much beyond the open pits and the tip heap, as shown on the small mine map.

§ 573. The general appearance of the mine resembles Springfield or Bloomfield mines; though its geological position is close to the middle of III, certainly not so much as 500 feet above the bottom of II. Yet it resembles in no single feature the Henrietta mines of Leathercracker cove, which are in the top of II and close to the bottom of III.

§ 574. The banks show yellow, reddish and whitish clays in heavy masses, many of them non-ore bearing. The clay masses are not so heavy as at Bloomfield and Springfield, and there is more sand.

§ 575. There are apparently three distinct horizons of closely packed iron ore lumps in clay, separated by clay and sand masses which carry little or no ore in some cases.

§ 576. The upper of these layer, called locally the "sparry ore," outcrops on the west side of the eastern large open pit.

The others are 40 and 60 feet deep on the west side of the mine, and outcrop on the east side. These ore lump masses and their clays are plunging steeply to the westward.

§ 577. Much sand is in the mine, and the rock pieces are entirely flint, never limestone; no limestone shows in place in the mine.

The western large open mine is now abandoned. It has been worked fully 60 feet deep by open work.

§ 578. Underground work, under the bottom of the open pit, is now going on at the eastern mine, though only on a small scale.

§ 579. A shaft put down at the foot of the tip heap, or screening floor, is now (when the mine was examined) 80 feet deep, and a tunnel is being driven back under the old West bank. This shaft found only white sand and some sandy clay, and the tunnel is entirely in white sand. Yet this shaft is just south of the south end of the large open mine. No solid rock was found in this underground work. The dip of the measures at the mine as given by some iron coated sandrock in the open mine is northwest 46° ; but the exposure is imperfect and unreliable.

§ 580. This Short Mountain mine lies directly on the nose of Short mountain, where it points out to the north and is nearly of the same geological horizon as the Henrietta mines; yet the extensive open pits show no limestone, no black slate clay, nor loose pieces of slate, but only flint and sand in great quantities in clay.

§ 581. The bottom of the ore bearing mass has never been reached as yet, and the mine which has already yielded much ore, must have great quantities remaining. The ore has been screened hitherto and the fine wash ore still remains on the screening floor.

The ore has been used by Ætna furnace, and made an excellent pig metal.

§ 582. A specimen of the Short mountain ore, gathered from many small pieces on the sides of the mine, was sent to the Laboratory of the Survey and yielded on analysis (A. S. McCreath):

Sesquioxide of iron,	78.428
Sesquioxide of manganese,	.356
Alumina,	1.886
Lime,	.030
Magnesia,	.097
Sulphuric acid,	.060
Phosphoric acid,	.396
Water,	11.248
Insoluble residue,	7.410
	99.911
Metallic iron,	54.900
Metallic manganese,	.248
Sulphur,	.024
Phosphorus,	.173

The ore is a limonite, compact and cellular, hard and tough, with thin seams of fibrous iron ore; also with considerable mammillary ore. Color light and dark brown.

§ 583. The ore from the Short mountain bank is used at

Ætna furnace. An analysis of the Ætna furnace pig metal therefore furnishes the best test of the average character of the iron ore from Short mountain. The fuel used at the furnace is charcoal, and the limestone used for flux analyzes as follows (S. S. Hartranft):

Carbonate of lime,	94.980
Carbonate of magnesia,	3.866
Oxide of iron and alumina,	.264
Sulphur,	.053
Phosphorus,	.011
Insoluble residue,	.910
	100.084

§ 584. With these materials the Ætna furnace iron, No. 1, yielded (A. S. McCreath):

Silicon,	1.664
Sulphur,	.005
Phosphorus,	.288
Manganese,	.173

and a mottled iron from the same materials yielded (A. S. McCreath):

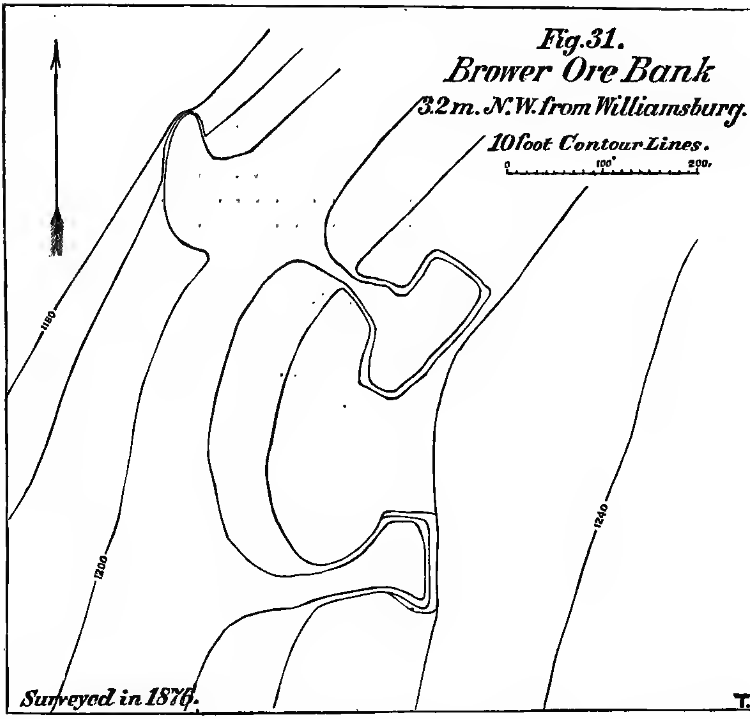
Silicon,	.289
Sulphur,	.008
Phosphorus,	.253
Manganese,	.309

Brower Ore Mine.

§ 585. The Brower iron ore mine is 3 miles northwest of Williamsburg. It is a small open pit, 150 feet long by about 50 feet wide, and now showing only about 20 feet deep at the deepest part.

The mine was worked for Ætna furnace, but has been abandoned for years. The sides of the pit have fallen down and the exposure is therefore imperfect. The pit is on a sandy ridge, the whole center of the valley at this point being sandy barrens. There is no ore crop except just at the pit; the surface ore show not extending far from its sides.

§ 586. Nearly all the stuff in the sides of the bank is sand, with very little clay; the ore is scattered in pieces through this whole mass of stuff; and the rock lumps in the mine



are always sandstone or flint, not limestone. There are many masses of conglomerate of sharp pointed flint pieces cemented together by iron ore, and numerous great masses of sandstone and flint coated with ore, as at Springfield mines.

The ore show looked rather unpromising, as there seemed to be such a large proportion of lean sandy iron ore as compared with the quantity of richer ore.

§ 587. Limestone land lies between this mine and the mountain west of it. The bank is geologically only about 2500 feet below the bottom of the black slates of III; yet the surface show and all its characteristics and surroundings resemble closely the Springfield horizon, or say 5000 feet below III.

§ 588. A specimen of the dark liver-colored ore from the wash on the side of the mine was forwarded to the Laboratory of the Survey and yielded on analysis (A. S. McCreath):

Sesquioxide of iron,	62.714
Sesquioxide of manganese,	.345
Alumina,	2.655
Lime,	.350
Magnesia,	.292
Sulphuric acid,	trace.
Phosphoric acid,	.311
Water,	10.113
Insoluble residue,	23.450
	100.230
Metallic iron,	43.900
Metallic manganese,	.240
Sulphur,	trace.
Phosphorus,	.136

The ore is a limonite, compact, brittle, argillaceous, jaspery.; reddish brown and liver brown in color.

Ætna ore mine.

§ 589. The old Ætna ore mine is 2½ miles north of Williamsburg. Its geological horizon is nearly the same as the Springfield mines, No. 1 and 2, or less than 5000 feet below the bottom of the slates of III.

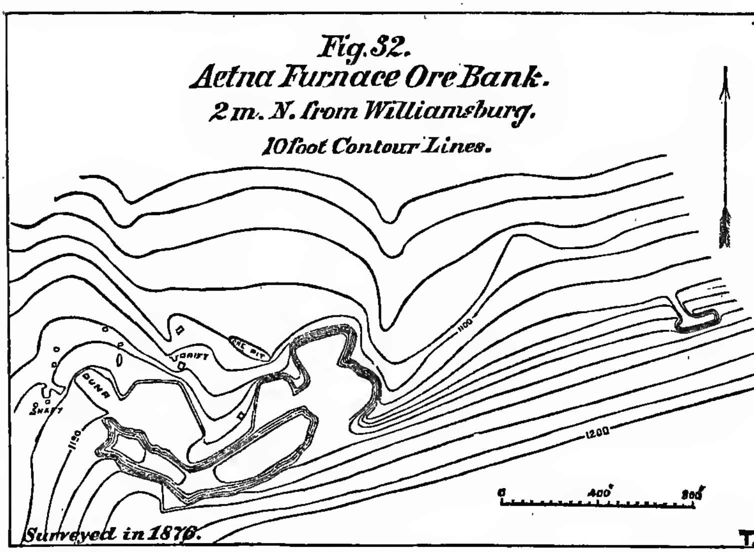


Fig. 32.
Aetna Furnace Ore Bank.
2 m. N. from Williamsburg.
10 foot Contour Lines.

The mine was abandoned many years ago. The ore was screened at the bank, and lump and screened ore hauled to

Ætna furnace, as there was no water and no washer at the bank.

§ 590. The open cut is very large, about 1000 feet long by from 150 to 200 feet wide, and from 30 to 50 feet deep in places. The sides of this huge pit are now washed down and a very imperfect idea can be gained as to the value of the deposit. There is obviously much lean clay, non-ore bearing, among the mass of stuff carrying lump and fine wash ore. The wash ore is chiefly in small pieces, not rounded or water worn; and it looks unusually rich and good. There is considerable manganiferous ore, found as is usual in these banks, in unexpected and irregular deposits. The mine is opened on the crest of the sandy barren ridge, just where it is pointing out to the north; the sandy barrens cease at this place, and the whole valley to the north of the mine is fully 100 to 150 feet lower, and is smooth, cultivated limestone land.

§ 591. It is *reported* that the shafts at the Ætna mine worked rich lump ore at 112 feet below the surface. Apparently the bottom of the mass of stuff holding lump and wash-ore has never yet been struck in the open pit or shafts.

The absence of water has prevented any extensive work; the greater part of the ore being left behind at the bank or the screening pile.

Ætna furnace ran on the ore for many years, and made an excellent pig metal—using limestone flux from near the furnace, and charcoal.

§ 592. There is a very moderate outcrop of iron ore over the sandy surface of the hill to the east of the Ætna mine, and 1500 feet east of the eastern end of the large mine there is a small open cut. It is shallow, and but little ore has been taken from it.

§ 593. A specimen of the Ætna mine ore was secured by taking numerous small pieces of ore from the wash-ore mass in the sides of the large open mine. This was forwarded to the Laboratory of the Survey, and yielded on analysis (A. S. McCreath):

Sesquioxide of iron,	78.428
Sesquioxide of manganese,	.102
Oxide of cobalt,	trace.

Alumina,	2.204
Lime,	.050
Magnesia,	.511
Sulphuric acid,	.025
Phosphoric acid,	.174
Water,	11.958
Insoluble residue,	5.700
	99.152
Metallic iron,	54.900
Metallic manganese,	.072
Sulphur,	.010
Phosphorus,	.076

The ore is a limonite, stalactitic, botryoidal, massive, somewhat coated with a yellow clay. Color of ore generally dark-brown.

Clark Mine.

§ 594. The old Clark mine is one mile south of Mount Ætna furnace. It is a small open mine, long since abandoned. The surface show of ore is quite heavy in the field around the mine.

Mr. Samuel Isett, of Ætna Furnace, states that only about 300 tons of the ore were mined out and used by him at his furnace. "The ore worked nicely in the furnace, but had a tendency to make the iron red short, and he therefore used but little of it. The mine was only worked to a depth of 25 feet below the surface; the wash-ore seemed tolerably rich."

The mine was worked about 25 years ago, and has been idle ever since.

§ 595. Some specimens of the Clark ore were gathered from the surface show at the abandoned pit and forwarded to the Laboratory of the Survey. They yielded on analysis (A. S. McCreath):

"The ore is a limonite, cellular, brittle, dark-brown.

Sesquioxide of iron,	80.428
Sesquioxide of manganese,	.184
Alumina,	1.636
Lime,	.460
Magnesia,	.598
Sulphuric acid,	.050
Phosphoric acid,	.286

Water,	11.700
Insoluble residue,	5.165
	100.507
Metallic iron,	56.300
Metallic manganese,	.128
Sulphur,	.020
Phosphorus,	.125

Iron Ores in the Sinking Valley.

§ 516. The Sinking Valley is a continuation, south of the Juniata river, of the anticlinal limestone valley of the Warrior's Mark region, north of the river.

§ 597. But while the Warrior's Mark region has developed and mined great quantities of the iron ores of II, there has been but little ore mined in the Sinking Valley.

§ 598. The anticlinal axis is sinking to the southward, and the lower layers of limestone fold around the nose of the sinking axis, one after another, until at the south end the slates of III and the sandstones of IV end the valley by bringing the enclosing mountains around in an unbroken sweep.

§ 599. On the Juniata river, near Birmingham, there is exposed a peculiar dark-colored calcareous slate, apparently graphitic. This is near the center of the anticlinal, and must be fully 5000 feet below the bottom of Formation III.

§ 600. At the *McCahan iron ore mine*, one half of a mile southwest of Birmingham, pipe ore is mined by a shaft.

The ore lies chiefly in sand; there is some little yellow clay with the iron ore, but the mass of enclosing stuff is sand.

From the bottom of the shaft there comes some black, calcareous slate, similar to that showing on the Juniata river, near Birmingham. This apparently fixes the horizon of the ore as being over 5000 feet below the bottom of Formation III.

The ore lies in nests and pockets in the sand, and has been mined from several different shafts. There is no washer, only lump ore being used, and the ore went to Mt. Union furnace.

As in most other cases, the pipe ore is very rich and good.

§ 601. The same black calcareous slates of II show on the

Cogan farm, one mile northeast of Birmingham ; this gives the strike of the black slate horizon.

§ 602. On the *Robeson place*, two miles S. S. W. of Birmingham, just west of Col. Galbraith's house, there is an old opening on an iron ore outcrop. The outcrop is heavy and covers the field for three or four acres.

The opening is 100 feet long by 20 feet wide, by 20 feet deep.

Loose clay stuff holding much wash-ore begins at the surface and continues on down to the bottom of the pit.

The ore itself is all rounded and waterworn, dark-colored, rich and good.

The lump ore was carted away and was used by Messrs. Linn & McCoy.

Some of the loose stuff was taken also and washed at a small washer in the hollow. In all probably 500 tons of ore from this place have been used.

§ 603. A specimen of the Robeson ore, taken from the surface crop, was analyzed by Mr. McCreath, who thus reports it :

Limonite, somewhat cellular, brittle, dark brown to yellowish brown ; some of the ore shows considerable intermingled quartz.

Sesquioxide of iron,	79.714
Sesquioxide of manganese,	.061
Alumina,	1.320
Lime,	.260
Magnesia,	.392
Sulphuric acid,	.030
Phosphoric acid,	.224
Water,	11.050
Insoluble residue,	7.560
	100.611
Metallic iron,	55.800
Metallic manganese,	.043
Sulphur,	.012
Phosphorus,	.098

§ 604. This iron ore outcrop continues to the northeast and considerable ore has been taken from the *Gensimore farm* one half a mile away.

The iron ore outcrop is also on the *Galbraith farm*, and some 100 tons of ore have been shipped from there to Union furnace, also from surface crop.

CHAPTER XV.

The Zinc and Lead Deposits of the Sinking Valley.

§ 605. The geographical relation of the Sinking Valley to Blair county and to all the surrounding country will best be understood by an examination of the maps accompanying this volume. In general, however, it may be said that the valley occupies the center of the northern part of Blair county; that along its northern edge from end to end is the Little Juniata river; on its east side is one arm of Brush mountain; on its west side is another arm of Brush mountain; and at the south the valley terminates in a point, where the two arms of the mountain unite.

§ 606. The valley is therefore cove-shaped or triangular. Its trend is northeast and southwest; its width at its broadest part, namely along its northern edge is five miles which is the distance from the base of one mountain to the base of the other; its length is nearly ten miles measuring in a straight line from Birmingham on the Little Juniata to the so-called "Kettle" at the extreme southern end of the valley. The surface area, exclusive of the mountain flanks amounts to about 21 miles.

§ 607. The topography presents in brief a gently undulating plain with a slightly elevated ridge or hump running lengthwise through the center. At the sides of the valley on the northwest and southeast are precipitous but symmetrical mountain flanks which rise a thousand feet and more above the bed of the valley and end in summits of the same even shape and height. These summits steadily approach each other towards the southwest, thus gradually narrowing the valley surface between until finally this is terminated at the "Kettle" by the two mountains uniting into a single ridge. The average elevation of the floor of the valley above mean tide Atlantic ocean is, in round numbers 1100 feet; its elevation above the bed of the Juniata river ranges between 200 and 300 feet, the channel of this stream being only a few feet below the Pennsylvania railroad which skirts its right bank, and which at Tyrone is 907 feet above the ocean level; 866 feet at Birmingham and 777 feet at Spruce creek. The north end of the valley is open, being cut off from the country beyond by a narrow cañon-like ravine.

§ 608. The drainage is into the Juniata. The high mountain walls on the east and west and south being unbroken, no water passes through them, but pours down their flanks into the valley below, whence it is carried into the river by means of two small streams, Sinking run and Elk run, which, heading close to one another in the "Kettle," flow parallel with and at the base of the mountains. There are no cross streams; whatever water collects on the central ridge flows down into the depressions on either side. Some of the drainage, and perhaps a considerable amount of it, is effected by subterranean passages.

§ 609. The surface soil is smooth deep and rich, being the product of the disintegration of the limestones which make the bed of the valley, mingled with much sand that has washed down from the mountain flanks. It yields abundantly. The mountains are rough and untillable; nor do they support any timber of value.

§ 610. The geological structure of the region not only in its relation to that of Blair county but to that of all of the country round about has been discussed on a previous page of this volume; it is also expressed in some of the cross sections accompanying the maps. But that the reader may have the subject presented to him in its bearing on the zinc and lead deposits, a brief repetition of so much of it here as affects that question, appears advisable.

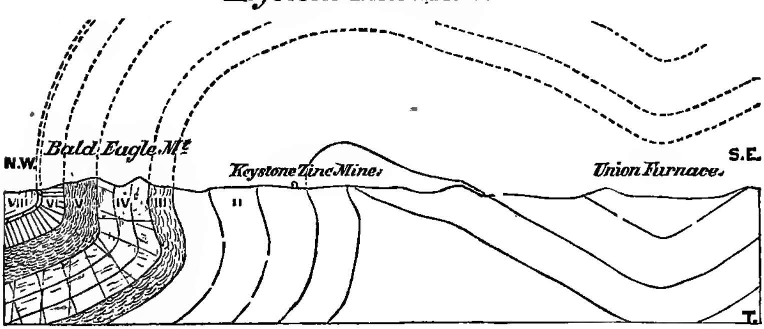
An anticlinal axis traverses the valley lengthwise. The exact path of this axis is rendered somewhat obscure by reason of imperfect exposures, but it crosses the river from the Nittany valley, a little west of Birmingham; passes then close to the developments of the Keystone Zinc Company near Mr. Kinch's house; runs past the deep shaft on the Borie farm, and so on into the "Kettle" where it expires.

§ 611. Three features only of this anticlinal require special mention here: 1. that the axis is almost overturned at its crest in the vicinity of Birmingham where one group of zinc and lead fissures is found; 2. that this overturn has nearly disappeared at the deep shaft where there is a second group of fissures; 3. that the anticlinal sinks southwestward along its central line at the rate of 600 feet to the mile, or dips in other words along its strike at an angle of more than 6°.

For the rest it may be said that from the center of the anticlinal the rocks dip steadily but at varying angles towards and under the mountains on both sides. These mountains are of monoclinal structure. The rocks therefore which make their summits and flanks are of a much later origin than those which occupy the bed of the valley. The following diagram, which shows also the overturned crest of the anticlinal near Birmingham, will explain the structure more clearly:

Fig. 33.

Section from Bald Eagle Mtn. through the Keystone Zinc Mine.

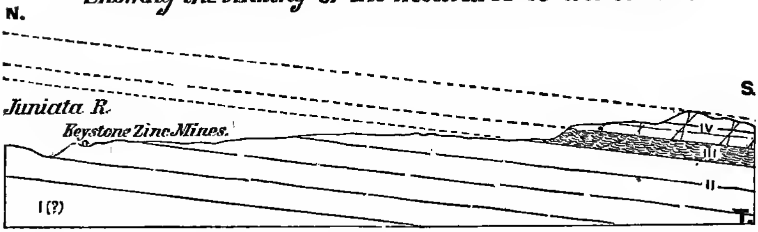


The decrease in the force of the anticlinal southwestward necessitates of course a constant change in the rock horizon in the same direction. The importance of this change is obvious, for while at the Keystone mines near Birmingham there are only a few *hundred* feet of limestone, there are several *thousand* feet of the same material at the deep shaft near the "Kettle;" and if the zinc and lead fissures are confined to this limestone formation, as they perhaps are, the depth of the veins at the two places would stand in the proportion nearly of 1:10. To make clear this condition of things a second diagram is introduced, showing a longitudinal section of the valley from the river to the "Kettle:"

Fig. 34.

Section along the Anticlinal Axis.

Showing the sinking of the measures to the south.



§ 612. The rocks exposed in the valley, from the lowest to the highest, belong to the Cambro-Silurian and Silurian epochs. Along the river and at the center of the anticlinal the Potsdam sandstone, Formation I, appears, for a short distance above the water line. Over this spread out in regular order the limestones and dolomites of the next higher Formation, II, the Calciferous, Chazy, Trenton, &c. As already intimated, these latter rocks make the greater part of the floor of the valley. They extend nearly to the base of the mountains where they are overlapped by a deep black border of the slates of III, the Hudson river, Utica, &c.; finally Formation IV, the Oneida and Medina Sandstones are piled up in regular order, stratum upon stratum to form the high mountain ridges which make the sides of the valley.

§ 613. The distinctive features of these Formations, or of any one of them, need not be dwelt upon here. Their main lithological characteristics are discussed elsewhere; as are also their thickness, individually and collectively, throughout Blair county generally. Whatever special features they may present in the Sinking Valley will be given further on in connection with the description of the mines.

§ 614. *But of the mineral deposits contained in them* it may be said that the present discussion is confined *strictly to the zinc and lead fissures.* These are distributed irregularly through the valley, some being at the north end as already stated, and others at the south end, but all are related to the limestones and dolomites of Formation II, which sometimes they traverse parallel to the stratification and at other times cross at various angles.

§ 615. *Openings during the American Revolution.*—Attempts have been repeatedly made by property holders and other interested persons to explore and mine these deposits. As early in fact as the Revolutionary war the attention of the Colonial Government was invited to them on account of the lead they contained. How much work was then done upon them is not now definitely known; various accounts of it, in the shape of vague and unreliable stories exist among the present inhabitants of the valley; but aside from these it is evident from the frequent allusions made to the subject in the Pennsylvania State Archives,* as well as also from the old pits and other excavations in the neighborhood of the Fleck farm, that the undertakings of this early period, were quite extensive for their day, and especially so when it is considered that the region at that time was an almost unbroken and trackless forest, traversed by roving bands of unfriendly Indians, and far removed from every important settlement.

Moreover it is certain (to relate briefly what is definitely known of this undertaking) that in April, 1778, an expedition of considerable strength and under the command of Gen. Roberdean (or Roberdeau ?) started from Carlisle for the Sinking valley where a lead mine was subsequently opened and worked.† Small reducing works were likewise built close by in which the ores were treated as fast as they were mined, and the metal so obtained was most likely shipped in flat boats down the Juniata whenever the river was flooded.

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* Volumes 6, 7, 8, and 9.

† See letter of Gen. Roberdean dated April 17, 1778, to President Reed of the Council. Penn'a. Archives, Vol. 6, p. 422.

§ 616. The mining developments of this period were doubtless mainly, if not entirely, confined to the southern portion of the valley, near the so-called "kettle," where the ores contain a much larger percentage of lead. The old adit near Birmingham at the northern end of the valley, though begun in the last century, belongs to a later date than the pits on the Fleck farm, and was made under different auspices, as will be shown presently.

The Roberdean expedition, though it continued work for some time, was in the end a failure. Various exaggerated notions as to the probable yield of these mines were entertained by those who had the work in charge; nor was the enterprise finally abandoned without some protestations on the part of Gen. Roberdean against the slender support and assistance rendered him by the governmental authorities; a support moreover which seems to have been guaranteed to him at the outset of his undertaking.* But even with such assistance it is obvious from what we now know that lead could have been obtained here only at a great expense, as the ores are too lean to be profitably treated for that metal alone, while the veins in which galena figures to any extent are among the smallest in the valley. Hence the failure of the enterprise may perhaps be ascribed as much to the expense of mining and treating the ores, as to the causes assigned for it by Gen. Roberdean.

§ 617. There is no record of the total amount of metal produced at this time in the Sinking valley, nor of the cost of it, nor of the time when the work was finally abandoned. But under date of May 29, 1779, more than a year after the expedition set out from Carlisle, mention is made of an order from Gen. Roberdean for 500 pounds of lead; and subsequently, in November of the same year Gen. Roberdean in a communication to President Reed of the Council speaks of the deferred payment on a thousand pounds of lead. These are the only figures connected with this branch of the subject to be obtained from the State Archives. It is hardly reasonable to suppose that they together represent the entire

*See letter of Gen. Roberdean to President Reed. Penn'a Archives, Vol. 8, p. 15.

product of the mines at that time, or even the greater portion of it; for under such circumstances Gen. Roberdean, after a whole year's work, could have scarcely advised its continuance.

After the abandonment of this enterprise nothing was done with the zinc and lead deposits of the Sinking Valley for several years.

§ 618. But that work on them was resumed before the close of last century is shown by an agreement between Jno. Musser and Robert Morris, who were "equally concerned in a lead mine situated in Tyrone township, in the county of Huntingdon, in Pennsylvania." By the terms of this agreement, which is dated Aug. 4, 1795, Musser was to drive a "level," for drainage purposes, through to a certain shaft on which some work had already been done, but in which the miners had been prevented from going deeper on account of water. The old tunnel or adit now on the Keystone Zinc Company's property, and to which allusion will again be made in the sequel, belongs, therefore, to what may be called the second period in the exploitation of the Sinking Valley deposits. Of the amount of work done during this latter period even less is known than of the Roberdean expedition, but it cannot have been extensive or there would be more evidences of it in the shape of shafts and pits.

§ 619. The third period is represented by the operations of the Keystone Zinc Company. This was the period when the mineral deposits of the valley were most fully explored and developed; indeed, it was the only period when anything of importance was done.

The Keystone Zinc Company, an organization which still exists, was incorporated in 1864; it had a comprehensive charter and abundant capital, and work was begun by it on an extensive scale. The mining operations of the company were mainly directed to the so-called "bowlder deposits," near Birmingham, at the north end of the valley. The nature and extent of this work will appear further on; for the present purpose it is sufficient to say that several thousand tons of ore were mined; that large reducing works with all the modern appliances were erected at a considerable expense on the south bank of the Juniata river, near Birmingham; that zinc oxide was made in these works not only from the ores of the valley, but also from material brought hither from a distance; and finally it may be said, without entering further into the history of the enterprise, that having become embarrassed financially the company suspended operations about 1870, since which time their mines have not only been idle, but, to a large extent, have fallen shut.

§ 620. It ought also to be mentioned in this connection that during the period covered by the operations of the Keystone Zinc Company, other property holders of the valley took active steps towards the development of their lands. Thus it came about that the veins at the south end of the valley, near the "Kettle," the same as were mined by Gen. Roberdean, in Revolutionary times, were more fully explored by Messrs. Borie, Lewis, Fleck, and others. A detailed description of these operations will be found on another page.

§ 621. More recent developments of the zinc and lead deposits of the Sinking Valley were those made a few years ago (1875) by the Messrs. Tatham, of Philadelphia, on their property, east of the Fleck farm. A diamond drill hole was there sunk several hundred feet deep, but with results not sufficiently encouraging to follow up the work with regular shafts for mining. Still more recently (1876) the development of a vein on the Mary Isett farm was undertaken by Mr. Arms. This last enterprise, if, indeed, it properly can be called such, was short-lived. The small amount of ore so obtained was shipped to the reduction works of Mr. Spillsbury, in Lancaster county.

§ 622. The mines and shafts on the zinc and lead deposits of the Sinking Valley are unfavorable in their present condition to close inspection. So many years have elapsed since the mines were abandoned, and nothing having been done in the interval to prevent them from filling with water, or otherwise closing up, that they are now entirely inaccessible. An examination of the region at present can therefore yield very little information about its zinc and lead veins, beyond the geographical distribution of these as far as they have been explored; the nature and extent of the work done upon them; the horizontal lines which the shafts and pits have followed; the character and composition of the ores in so far as specimens of these can yet be obtained and also the character of the walls as exhibited by the fragments of rock taken from the shafts. It is true that information respecting the width of the fissures, the angles at which these incline as well as also other matters connected with them of equal importance both in a commercial and scientific sense, can be obtained from many of the present residents of the valley, who whether from direct interest or out of curiosity, had occasion to examine the developments while these were being made. But such statements must be received with due caution. Not that there is any intention to willingly mislead or deceive; but that it is unreasonable, in matters of this kind, to admit without question the evidence of persons not only unfamiliar with the subject of mineral deposits but entirely unaccustomed to make critical examinations of them; and the evidence is still further weakened when it is furnished from memory unaided by note or memorandum, and many years after the observations were made. Hence in the following description little attention is paid to the statements received from the residents of the valley, except when fully substantiated.

§ 623. But to the Keystone Zinc Company we are indebted for much information respecting the ore deposits, and particularly those at Birmingham, that could not now be obtained without considerable expense in re-opening the shafts and in digging pits in the place of the old ones now closed up. During the time covered by the operations of this Company several experts were engaged to examine the mines and openings in their different stages of development, and to report upon their value. Prominent among these gentlemen were Dr. W. Th. Roepper, of Bethlehem, an expert of deservedly high reputation; Mr. Williams, of Philadelphia; Mr. Dickerson, Mr. Spillsbury and others. Their subsequent reports, most of which are in MS, have been kindly placed at our disposal; some of them, as in the case of Dr. Roepper's report, relate chiefly to the technical questions involved, that is to say to the probable depth of the deposits, the best method of attacking them, &c., and are in a certain sense supplementary to other reports embodying the facts. These facts will appear in the sequel.

§ 624. The deposits naturally sub-divide themselves into two groups: those at the north end and those at the south end of the valley. These are separated by a wide interval of non-ore-bearing rock, restricting this expression to the sense of ore in fissures and veins. Small particles of galena and blende are disseminated through the limestone rock, not only in close connection with the veins, but at points often quite removed from them; and such particles found in this way have at various times induced explorations to be made which ended usually in failure. The probability is that pretty much all the available ore of the valley has already been exploited at one time or another, so that its whereabouts are fully known; and it is equally certain the Birmingham fissures are entirely disconnected from those at the south end of the valley, and that the country between contains no ore of any importance.

§ 625. The Birmingham fissures are on the property of the Keystone zinc Company, opposite the farm of Mr. E. Kinch and about one half mile southwest of Birmingham. The improvement consists of a number of shafts sunk from the top of a knoll raised about 80 feet above the township road. An adit driven from the level of the township road connected with these shafts, or at least with some of them, for drainage purposes. This is the same adit that was begun at the close of last century, of which undertaking mention has already been made. It was afterwards continued by the Keystone company in a southwest direction for a distance of 347 feet under the hill. It is now shut, its sides having recently caved in.

The shafts were ill-advisedly sunk and without much attempt at system. One line of pits, however, would seem to indicate the course of a vein running N. E. and S. W., or parallel to the stratification of the enclosing measures.

Other shafts were sunk on both sides of the line, to the north and south of it; that to the north, or between the line and the road, went down only some forty feet, and seems to have had little success, nothing more than indications of ore having been met with; but in that to the south of the line, and some 300 feet away from it, the results were very encouraging.

§ 626. Of the shafts along the line above alluded to, not one is now accessible for examination. From all accounts, however, there is great variability in the width of the vein, the walls at times opening into quite spacious chambers, and then contracting again until only a thin thread of ore keeps them asunder. These changes have given to the deposit the appearance of lenticular masses or "pockets" of ore.

§ 627. The deposit at this place is shut up within a small area. Along the river front an examination of the rocks exhibited there reveals no trace of the veins; and in the opposite direction towards the southwest, every effort to trace the ore beyond the neighborhood of the adit has been a failure. What may be the condition of the vein between these points, its northeast and southwest limit, the work already done is not calculated to fully reveal. Mr. Williams states, as will be seen from the resumé of his report given below, that the vein was disclosed for 166 feet along its strike by a gallery leading from one shaft to another; but with the exception of this, there seems to have been no effort made to connect the pits by trenches along the outcrop or by underground passage ways, which would have served to show not only the extent of the vein in a horizontal direction, but its exact condition and width.

§ 628. More than two thousand tons of ore were taken from the shafts during the time these were operated by the Keystone Company. It is said that the shaft furthest northeast yielded a very lean ore with barely 10 per cent. of zinc in it; but the specimens of ore exhibited as having come from the main shafts, those near the adit, are of a fine character, and vastly superior to the ores from the other group of veins at the southwest end of the valley.

§ 629. Nearly all the ore removed from these shafts was reduced in the works at Birmingham; several tons, however, remained over. An examination of these shows an ore of very even quality. Mr. Williams states that the best of the material averages 30 per cent. of metallic zinc; which statement the old dump heap at the works fully corroborborates.

§ 630. The ore consists mainly of a mixture of the sulphides of zinc and lead, zinc blende, and galena. It is a compact, fine-grained mass of a dark color, and when broken has a waxy luster at the fracture. Some of the lumps are of the size of a man's head; some are even larger than this, from which they graduate down to fragments of all sizes. In the specimens representing the best of the ores zinc blende largely predominates; galenite is always present, but subordinate to the other; there is also usually a small amount of calamine (hydrous silicate of zinc). The gangue matter is inconsiderable; there is some limestone, or rather some dolomitic limestone, and there is also some iron pyrite, but never very prominent.

§ 631. Two carefully selected specimens of the ore were sent to Mr. McCreath for analysis; the one, from the dump heap at the works, and the other from the Dickson farm, near by. The analyses are as follows:

	No. 1. Keystone Zinc Co.	*No. 2. Dickson Farm.*
Sulphide of lead,	18.37	. .
Sulphide of zinc,	76.98	. .
Oxide of iron and alumina,	1.90	. .
Carbonate of lime,	.05	. .
Carbonate of magnesia,	.17	. .
Water,	.27	. .
Silica,	1.67	. .
	99.41	
Lead,	15.91	5.86
Zinc,	51.63	30.40

§ 632. Mr. Williams made several examinations of these mines while they were in working condition. Writing under date of March 14, 1864, he states that at a distance of 106 feet in a S. 22° W. direction from the mouth of the adit, "one of the limits of the deposit is, I believe, reached. At this point a shaft (No. 1) has been carried down about forty feet to the adit above spoken of. Here are indications of zinc in patches." * * * * * * *

§ 633. "One hundred and seventeen (117) feet in the same direction from No. 1 shaft, a second shaft, No. 2, has been holed to a depth of about twenty feet. In this shaft the indications are of most excellent description, the ore occupying the greater part of the width of the shaft, but capped in some places by the limestone. A sample of ore taken by myself from the shaft and representing as closely as practicable an average of that removed, has been analyzed in my laboratory, with the following results:

Silica,	4.53
Carbonic acid,	27.80
Oxide cadmium,	1.84
Oxide zinc,	46.95
Lime,	2.48
Sulphur,	.74
Lead,	5.44
Iron, magnesia, and water,	10.22
	100.000

§ 634. No. 3 shaft is forty-eight (48) feet west of No. 2. The show of ore is better here, as might be expected, since the shaft is further removed from the boundary line of the mass. The following (analysis) will show the quality of the ore in this pit:

Silica,	9.67
Carbonic acid,	29.80
Oxide zinc,	34.50
Lime,	11.08
Sulphur,	0.12
Lead,	0.82
Iron, magnesia and water,	14.01
	100.00

§ 635. No. 4 shaft is 50 feet southwest from No. 3. The improvement in the appearance of the ore here is very marked. At the surface it is capped to a great extent by the limestone, but widens out rapidly in depth till at the bottom of the shaft it has a width of ten feet. A sample of ore from this shaft gave the following result on analysis:

Silica,	9.67
Carbonic acid,	19.03
Oxide zinc,	31.10
Lime,	1.17
Sulphur,	0.25
Lead,	1.09
Iron, magnesia and water,	37.69
	100.00

§ 636. Beyond this no explorations have been made in this directions, so that the extent of the mass and its limits cannot be stated. * * * In endeavoring to trace the extent of the deposit in other directions I was not so successful, since no definite explorations have yet been made except in one instance. In a direction N. 61° W. from No. 4 shaft, distant three hundred (300) feet, another shaft (No. 5) has been carried down but a few feet, but which has cut the best show of ore now to be seen on the property. A mass of more than eight hundred pounds weight has been removed from this opening, in addition to a large amount of smaller pieces. The ore still standing on all the sides of the shaft occupies nearly the whole dimensions of the same; in fact I have never seen a better show of ore than is here exhibited. Annexed is an analysis of the same:

Silica,	6.90
Carbonic acid,	28.69
Oxide zinc,	47.50
Lime,	2.17
Sulphur,	0.18
Lead,	1.20
Iron, magnesia and water,	13.36
	100.00

The average amount of zinc in the ore by the preceding analyses is 40 per cent."

§ 637. In November, 1865, or considerably more than a year after his first report on these mines was published, Mr. Williams again visited the locality and made a supplemental report of it to the company. In that report he states "that the operations have been quite vigorously prosecuted, though in most instances without any regard to system, and can only be regarded of works of exploration and not of mining.

It is true the old adit or tunnel has been widened, put in good working condition and provided with a tram road laid with strap iron; and that connection has been made between it and the surface through the No. 4 shaft (with a back of 98 feet); yet instead of following up this system and using the adit for drainage, for the handling of removed material, and for further exploration works, it has been abandoned and all the operations confined to the sinking of a number of pits and shafts at random on the location.

§ 638. Shafts designated as Nos. 5, 6, and 7 have all been carried down on a heavy mass of ore, and the drift connecting them has passed for a length of *one hundred and sixty-five feet* through the *same mass*, showing it to have at least that length, and to have an average thickness of upwards of seven feet.

The quality of the ore is most excellent. * * *

It will be seen here that the general direction of the longer axes of the deposits of zinc ore of the Sinking Valley conicides with the course of the limestone strata in which they occur, the strike of these being about N. 65° E. and S. 65° W. * * * * * * * * * *

In all the deposits yet opened, there are associated with the zinc ores some galena and heavy spar together with no inconsiderable amount of brown, highly ferruginous, argillaceous matter. * * * * * * * *

I have estimated that there have been produced about 1300 tons of rock ore (worth about 30 per cent. for metal) and some two thousand (2000) tons of wash or earthy ore, worth propably 8 per cent. for metal. The total cost (as given in the pay-roll of the company, from which it is to be deducted the surface (farm) expenses and those for permanent improvement) shows us that this ore has been produced at a cost not much exceeding $3 per ton. * *

In this visit I have seen nothing to modify the high opinion of the Keystone zinc mine which has already been made public through the medium of my published report. It is only a matter of regret that the property has been so badly handled and managed as not to have given the results which it was capable of doing."

§ 639. The limestone close to the shafts varies widely both in texture and composition. In color also it takes a wide range. Nearly all of it, however, is dolomitic; compact, smooth and of a grayish-blue cast; oftentimes it is streaked with thin seams of calcite which intersect each other at all possible angles. This latter feature is especially noticeable in the rock near the shafts.

§ 640. The specimens exhibited as representing the wall rock of the ore veins under discussion are mainly of the character above described; and all of them are singularly free from impregnated particles of blende or galena. A sample of this limestone was analyzed by Mr. D. McCreath, at Harrisburg, with the following results:

Carbonate of lime,	53.870
Carbonate of magnesia,	41.320
Iron and alumina,	1.190
Sulphur,	.045
Phosphorus,	.013
Insoluble residue,	2.910
	99.348

§ 641. It is, however, hardly likely that the wall rock generally is as free from blende and galena as the exhibited specimens would imply; and especially as there is abundant evidence of both minerals occurring as thin streaks and threads in the rock some distance away from the shafts. Perhaps, too, it may have been such impregnated limestone that was measured for ore at those places in the shafts where the veins are said to have shown seven and ten feet thick.

§ 642. Be this as it may, Mr. Kinch found such a limestone on his farm skirting the township road, and directly opposite the adit of the Keystone Zinc Company. Following up the occurrence for some distance in a southwest direction, there was no appreciable change in the character of the rock, which is a sandy limestone with much galena and blende and calamine scattered through it, though containing none of these minerals in sufficient quantities to give the rock any special value. Moreover, in a cross-cut driven from this locality for a distance of 25 feet W. N. W. through

Mr. Kinch's fields the same thing was found; while beyond the end of this the limestone bears similar evidences of lead and zinc for 500 feet more. These developments were made upon the supposition that another large body of zinc and lead ore, besides that on the Keystone lands occurred there, but the notion was soon exploded after the work of exploration had actually begun.

§ 643. The zinc and lead deposits at the southwest end of the valley differ in many respects from those near Birmingham; particularly, however, in their more extended distribution, in the character and composition of the ores, in the narrowness of the fissures and in the position these occupy in the rocks.

§ 644. Developments have been made on both sides of the valley and in the center of it; but no two openings have yet been connected by a continuous cross-cut to show the actual course of any one vein, or its extent, although the fact that the fissures chiefly cross the measures transversely to the stratification has been sufficiently established. Moreover the shafts sunk on the different farms have shown that the veins are vertical or nearly so; and further that few of the veins exceed six inches in width.

§ 645. The walls are of dolomitic limestone, just as they are at Birmingham; only much higher in the Trenton Period than at the latter place; in fact they are nearly at the top of Formation II. Frequently, but not always a thin coating of heavy spar (sulphate of baryta) separates the ore from the limestone walls. The ore itself has also much heavy spar associated with it as gangue.

§ 646. The ore when freshly mined is a smooth compact mass of zinc blende, Smithsonite (carbonate of zinc) and galenite in a gangue of heavy spar and dolomite. Zinc blende is usually the most prominent of the minerals, though occasionally it is replaced somewhat by the galenite. Much of the ore now about the shafts has been exposed for a long time to the atmosphere and the dolomite is therefore considerably decomposed, giving to the ore a porous brownish appearance which it has not when freshly mined.

§ 647. One specimen representing about the best of the ore was selected for ultimate analysis, the results of which are here inserted to show the general character of the material:

Sulphide of lead,	7.10
Sulphide of zinc,	62.24
Carbonate of zinc,	6.66
Sulphate of baryta,	12.98
Oxide of iron and alumina,	2.98
Carbonate of lime,	1.70
Carbonate of magnesia,	1.85
Water,	2.57
Silica,	2.13
	100.21
Lead,	6.15
Zinc,	45.21

§ 648. The developments on the McMullen farm, at the west side of the valley and near the village of Scalp Level, were merely trial openings which were made some years ago, and which have since become closed up. They consisted of two shafts about 75 feet apart. In both of them it is claimed that an ore was found similar to that of which an analysis is given above. According to Mr. Galbraith, the south shaft showed a fissure vein between 7 and 8 inches wide at the surface; that this width increased somewhat at a depth of ten feet; that there was a subsequent contraction to 6 inches; and then afterwards an expansion again to more than one foot in width. The strike of the fissure, so far as this was investigated, is N. 35° W. and S. 35° E.

§ 649. Much of the ore now lying about the shafts is lean and poor, being in fact little more than limestone impregnated with perhaps ten or fifteen per cent. of lead and zinc. Both sides of the fissure are coated with this material, and of actual available ore there is certainly not more than from four to six inches. The center of the vein contains good ore, rich in blende, which is its principal component. An analysis by Mr. McCreath of a specimen from one of the McMullen shafts showed 41.17 of zinc, and only .34 of lead; and another specimen from the same locality gave 42.87 of zinc and .39 of lead. These proportions would vary considerably in the long run, as is evident from an examination of a number of hand specimens. But the above figures will serve very well to show the nature of the best of the ore.

§ 650. The limestone in which the ore is imbedded is compact, smooth, fine-grained, and of a grayish color. At an exposure in the road close to the shafts, it dips northwest (N. 55° W.) at an angle of 23°. The McMullen farm is close to the junction of the limestones with the slates of III.

§ 651. On Jacob Kryder's property, close to McMullen's, several shafts and pits have been sunk at different times in search of zinc and lead ore, but apparently without much success. There are abundant indications of such material in the fields southwest of Mr. Kryder's house, but from such scattered fragments it is impossible to trace the course of a vein, or to indicate its value when found. Mr. Dickerson, who examined the property in 1865, states in his report that ore was found in all the pits situated between the house and barn; but there is no statement of the amount or character of the ore.

§ 652. Explorations, but of an incomplete and desultory kind, have also been made on the Raemy, the Bridenbaugh, the Crawford, and Crissman farms, all southwest of McMullen's property, above described.

§ 653. At Bridenbaugh's a few shafts were sunk and some cross-cuts made. According to Mr. Dickerson the cross-cuts were unsuccessful; but ore was found in most of the shafts. One pit at this place is said to have shown a fissure 8 inches wide, striking N. W. and S. E.

§ 654. The vein was followed vertically 25 feet, in which distance there was no change either in the character of the ore, or in the width of the fissure. Such of the ore as now remains about the mouth of the shaft is lean both in zinc blende and galena. Sulphate of baryta shows abundantly on the surface round about.

§ 655. The Raemy farm is nearly half a mile north of Bridenbaugh's. In the interval between the two, no openings have been made, nor is there any evidence of zinc and lead ore on the surface; but in one of the Raemy fields the scattered fragments of ore are quite abundant. And here it was that the shaft and open cut referred to in Mr. Dickerson's report were made some years ago. "The vein," says Mr. Dickerson, "was struck in both cases, * * * * * and in character did not differ from all the others." Its width is not stated.

§ 656. Similar openings to these were made about the same time on the *Crissman* farm near the grist-mill, and about a quarter of a mile east of the Bridenbaugh pits. The pits, &c., at Crissman's were examined by Mr. Dickerson while they were being made, and are thus described in his report: There are three ribs crossing this farm and I commenced the examination upon the second rib near the lane. This is an open cut, some forty feet along the strike of the vein, and entirely exposing it. I found the width about fifteen inches at top, increasing as depth was reached, and composed of barytes or heavy spar, galena, zinc blende and a dark lime rock.

Next came the third rib upon which an old shaft existed. Some fifteen feet beyond this the first prospecting shaft was sunk some six feet in depth, but it had been filled up, Mr. Bartlett informed me that it looked well, but not seeing it I could only decide from a few specimens lying around which are promising.

About forty feet beyond on the same lead, shaft No. 2 is started and sunk about 5 feet. * * * The vein * * * is about three feet wide and made up of barytes, galena, zinc blende and hydrated iron intermixed with a crystalline lime rock. The vein bifurcated but will again unite some seventy-five feet southward, as the surface and course clearly indicate.

No. 3 shaft is about 50 feet beyond and sunk some ten feet in depth and five in width. Here the vein has increased to a width of four feet, the character of the ore being the same.

Some seventy-five feet beyond is shaft No. 4, some six feet in depth. Here the vein is contracted to about eighteen inches by the closing in of a hard cherty limestone."

§ 657. Mr. Williams, who examined these properties a short time previous to Mr. Dickerson did not hold a favorable opinion of the veins exposed in the Crissman shafts unless they were to be mined for their lead. Mr. Williams states distinctly that these deposits consists chiefly of galena and heavy spar, and "give no indications of carrying zinc minerals to any amount warranting further exploration for that metal. The show of galena is exceedingly encouraging."

§ 658. The work of development in this section was, however, mainly done on the Keystone Zinc Company's property (otherwise known as the Borie and Lewis farm); on the Fleck farm adjoining, and on the Tatham property to the southeast of these.

§ 659. The so-called "Deep shaft" is on the first of the properties named. It is close to the township road and west of it. According to Mr. Galbraith, the present agent of the Keystone Zinc Company, the shaft was carried downwards for 80 feet and more. It started at the surface on a small fissure vein, from three to four inches in width, which increased with depth until a width of 14 inches is claimed for the fissure at the time work was suspended. How much of this space was occupied by good ore is not stated; nor is access to the shaft possible at present on account of water. Calcspar is said to form a coating on each wall; and the same mineral is abundant in most of the specimens of ore now about the shaft. Some 300 tons of ore are said to have been lifted from this shaft, nearly all of which was used in the works at Birmingham.

§ 660. A few trial pits were put down nearly due west of the shaft. These pits, separated from one another only by a short distance, were sunk through the soil to the bed-rock below, and are said in each case to have met a fissure vein similar in width and character to that disclosed by the shaft. If so, the strike of this vein would be nearly east and west, and it would connect with the pit on the opposite side of the road, and also with the pit at Westley's, 800 feet still further east, where the exposures made are said to have revealed a vein similar in every way to that in the Deep shaft.

§ 661. The ore taken from these pits and from the shaft is variable in character; much of it is good and rich, but only in zinc. The gangue is invariably composed of heavy spar and dolomite, with occasionally some streaks and threads of calcite as above noted. What would be the average yield of these ores in lead and zinc it is impossible to state with any degree of accuracy; though perhaps 25 per cent. of zinc and from 3 to 5 per cent. of lead would be within bounds for the ore now about the Deep shaft. Some of the samples would doubtless go much higher than this, especially in zinc, as the blende and Smithsonite are very prominent in some instances. One specimen, selected as a fair average for the best of the ores from the shaft, gave Mr. McCreath 36.12 per cent. of zinc, and 5.99 per cent. of lead. And these figures were stoutly maintained by nearly all the specimens from the Fleck and Tatham properties, as will appear further on.

§ 662. The wall rock is a dark-blue dolomite, compact, and minutely crystalline. It lies nearly horizontally in the neighborhood of the shaft, being near the center of the Nittanny Valley anticlinal. The only dip that is felt is towards the southwest, which is in consequence of the decrease in that direction of the vertical energy of the anticlinal. A sample of the dolomite from the shaft gave the following results to Mr. McCreath, on analysis:

Carbonate of lime,	48.030
Carbonate of magnesia,	37.670
Iron and alumina,	2.850
Sulphur,	.463
Phosphorus,	.042
Insoluble residue,	10.380

§ 663. The developments on the farm of Mr. J. G. Fleck, south of the the Keystone Company's property, have shown the existence of two fissure veins of zinc and lead ore, to all appearance parallel, and crossing the measures at a sharp angle. Some of the work of exploration was done by shafts, and other of it by trial pits and open cuts. All of these exposures are now closed up.

§ 664. Separate from these, however, and between the Deep shaft and Mr. Fleck's house is an isolated opening on a small vein concerning which very little information could be obtained. Whether its strike corresponds to the vein on which the Deep shaft is located, or to those near Mr. Fleck's house, or whether the vein may not represent a small fissure striking southwest and thus connecting the Keystone and Fleck veins, can not be ascertained without further exploration. The ore obtained from it is excellent; one specimen having given Mr. McCreath 45.36 of zinc and 6.22 of lead.

§ 665. Two of the shafts on the Fleck farm are obviously on the same vein, whose line of strike is northwest and southeast. Moreover the same line of N. 40° W. leads to a pit in Mr. Fleck's garden where similar conditions to those in the shafts were found; and it leads also to pits in the grain field still further N. W., where it is asserted the conditions were again repeated. Mr. Fleck claims a width of one foot for this fissure; but evidently much worthless material is contained in this measurement. The actual amount of good available ore in the fissure is not known.

§ 666. A layer of calcspar is on each wall of the fissure. It has blende and galena scattered through it, but not in sufficient quantities to justify it being called an ore or mined for such. Indeed much of the ore from the Fleck shafts is poor at the best and hardly up to the standard of the specimens from the other localities.

§ 667. One of the shafts was sunk 27 feet; the other 45 feet. A specimen of ore from the shaft nearest the house yielded McCreath only 9.31 of zinc and 14.48 of lead; but a specimen of the second shaft gave 28.16 of zinc and 11.95 of lead; or an average of 18.73 of zinc and 13.22 of lead. The gangue material is identically the same as at the Keystone mine.

§ 668. The second vein at Fleck's has been less investigated than the other. Various old shafts and pits of revolutionary date mark the path of this second vein which is 130 feet southwest of the first. Little is known about it, either respecting the width of the fissure, or the character of the ore it contains; but the strike of the vein, if we may judge from the line of pits, is the same with the other above described.

§ 669. The shaft and diamond drill hole put down on the Tatham property are about two fifths of a mile east from Fleck's. The shaft was sunk only a few feet below the surface; the drill hole, however, was continued for 100 feet, starting at the bottom of the shaft.

§ 670. The width of the fissure upon which the Tatham shaft was sunk cannot be stated; but the ore obtained from it is of precisely the same character as that at the Keystone, the Fleck and the Bridenbaugh shafts and throughout this section of the valley generally.

§ 671. The specimen selected for analysis from the heap near the Messrs. Tatham's shaft yielded Mr. McCreath 37.01 per cent. of zinc and 13.96 per cent. of lead. This is perhaps rather above the average of the ores; but taken in connection with the other analyses it serves very well to show their variability.

§ 672. The cores produced by the diamond drill which as before remarked, started at the bottom of the shaft and went vertically one hundred feet, consist throughout of grayish blue limestone in which there are some traces of blende and galena and a few particles of iron pyrites. But beyond these faint and occasional traces the cores are a total blank so far as they relate to ores of zinc and lead. It was the privilege of the writer, through the courtesy of the Messrs. Tatham to make an examination of all the cores produced; and from end to end they exhibit merely a succession of dolomites and limestones, remarkable only for their uniformity, for throughout there is almost no change whatever in their texture or color.

§ 673. If the vein in the Tatham shaft is vertical, and if the one inch drill hole was started directly on that vein, then these cores end all discussion at to what may be expected from the vein at lower horizons. It would be evident that the vein disappeared at a distance of 20 feet or so below the surface, and that it therefore has no value whatever. But in the face of the few facts we possess regarding these veins, it is impossible to place any such construction on the results of this drilling. The veins may have very little value in a commercial sense; that question is discussed on a subsequent page; but it is hardly likely that they are confined to a few feet of rock in a formation several thousands of feet in depth. Besides, any such conclusion respecting their limits is opposed to every recognized theory of the formation of such veins.

§ 674. It is far more likely that the vein in the Tatham shaft, like all the other veins about which any information can be obtained in the valley, though nearly vertical, is not exactly so. And if such be the case, no matter how small is the variation from the vertical, if only one degree, this is sufficient to explain the leanness of the cores produced by the drill, for whether the hole was started on the vein or not, it must become further and further removed from the fissure at every inch of its course.

§ 675. Scattered fragments of decomposed ore are abundant not only round about the shaft but in the fields quite removed from it. These indications have not been further investigated, the only developments made by the Messrs. Tatham, being those above described.

§ 676. The Mary Isett farm is northeast of the Crissman shafts one and a half miles. The operations here were made quite recently, and consist of two shafts, one 30 feet deep and the other 40 feet deep. The shafts are separated from one another by about one thousand feet of interval; one is nearly due south of the other.

§ 677. If the statement made respecting the strike of the vein in each shaft be warranted by the facts, it would make two veins at this place, and preclude the possibility of both shafts being upon the same fissure unless this should pursue an irregular and zig-zag course. It is said that a strike of S. 60° W. and N. 60° E. was observed in each shaft, thus making the veins parallel to the stratification of the measures as they are at Birmingham. Moreover, it is said that both veins showed a width of nearly two feet from wall to wall; how much dead gangue, if any, there may be included in this measurement did not appear.

§ 678. A peculiar ferruginous sandstone containing also traces of manganese and cobalt should be here alluded to. It occurs in great abundance on the farm of Mr. Galbraith, in the northern part of the valley. The rock is a compact, brittle, and exceedingly fine-grained mass, streaked with different shades of light-red and pink and purple, which variations it derives from the different minerals it contains. In almost every hand specimen are numerous larger and smaller cavities, the sides of which are lined with minute quartz crystals. Some portions of the mass are not unlike calamine in appearance (hydrous silicate of zinc), owing to which fact the rock might readily be and in fact has been mistaken for something of value; but Mr. McCreath's analysis of a specimen of it shows that there is not even a trace of zinc in its composition. The analysis is as follows:

Silica,	94.89
Oxide of iron and alumina,	3.28
Oxide of manganese,	trace.
Oxide of cobalt,	.17
Lime,	.06
Magnesia,	.18
Water,	.97
	99.55

§ 679. It may be added that the sandstone, being at the center of the anticlinal, represents some stratum near the base of Formation II; or it may be even lower than this, and perhaps represent the upper part of the Potsdam.

§ 680. It is proper, also, to allude to the discovery of a vein of heavy spar on the farm of Mr. E. Kinch. The explorations at this place in search of lead and zinc have already been mentioned on a preceding page. The vein of sulphate of baryta is on the hill to the N. W. of these openings.

§ 681. The heavy spar is in two thin streaks, one six inches wide, and the other about three inches wide; they are separated by two feet of sandy limestone dipping nearly vertically, as do also the veins of heavy spar. Both strike N. E. and S. W.

§ 682. The fissures, doubtless, originated at the same time with the zinc-bearing veins in the valley, and are closely related to them; in fact this relationship is, in a measure, expressed by the material with which they are filled—the veins at the southwest end of the valley having all a certain percentage of heavy spar as gangue in their ore. The spar at Kinch's is quite free from all impurities.

§ 683. The geological considerations arising out of the zinc and lead-bearing deposits of the Sinking Valley may be very briefly presented.

The question first in importance is, whether they are merely segregated deposits, pseudomorphs by replacement on an extended scale, or whether they are true fissure veins extending indefinitely downwards through the rocks, and owing their origin to some deep-seated mechanical cause.

To answer this question satisfactorily would require somewhat more information about the deposits than we now possess; but in the light of such facts as we have it seems to us that the deposits are fissures formed by the same agencies that originally lifted the valley above the sea-level, and threw its rocks into their present anticlinal structure.

§ 684. This, at all events, is true of the veins near Birmingham, even if it should not apply to the occurrences near the southwest end of the valley. But at Birmingham we find the fissures only at the nearly overturned crest of the anticlinal, where the pressure exerted by the underground forces must undoubtedly have been the greatest, and where, consequently, the rocks would most likely be cracked and fissured. Moreover, these fissures correspond in the direction of their strike with that of the anticlinal, whence it is reasonable to conclude that a close relationship exists between the two.

§ 685. In the case, however, of the deposits at the southwest end of the valley, it is not to be denied that nearly all of these conditions fail us. Instead of being parallel to the stratification of the enclosing rocks, we see the veins crossing the measures at all angles; and instead of being confined in their distribution to the immediate neighborhood of the center of the anticlinal, we see them scattered over the whole valley, from side to side. Yet it is impossible to explain their presence here by any hypothesis which makes them simply an aggregation of zinc ores and galena, because the whole nature of the material filling the vein is opposed to this. They may possibly be a series of small cracks confined to the limestone, and due to shrinkage; if so they are of much more recent date than the deposits near Birmingham.

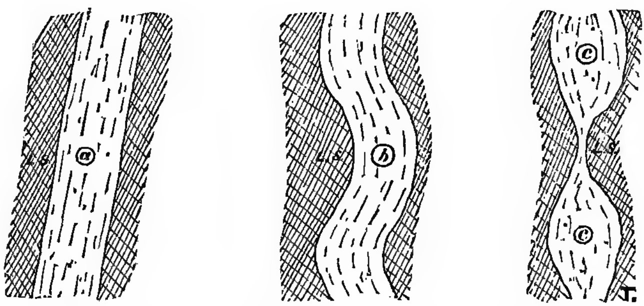
§ 686. Dr. Roepper considered them as parts of a fissure vein broken by a lateral thrust; but such a thrust could hardly have occurred without seriously affecting the rocks round about; and there is no evidence of any such thing.

§ 687. Shrinkage in the rocks is caused by the chemical action of underground currents of water upon limestone strata. That such shrinkage has actually taken place in this valley, independently of the supposition with regard to the origin of the cracks and fissures at the southwest end, is prettily shown by the condition of things near Birmingham. Dr. Roepper found, on examination, that the vein chiefly worked was considerably disrupted, and that both the walls and the ore contained slickensides, or scratches; showing that some movement must have occurred after the vein material had been formed. In this way Dr. Roepper explained the irregular contour of the walls at this place; which irregularity, the reader will remember, causes a wide variability in the interval between wall and wall. The explanation may be given in Dr. Roepper's own words, which embody, also, his conclusions regarding the nature of the veins:

§ 688. "The fact that the ores are mainly sulphides, and placed in the rock almost entirely unaccompanied by clay, excludes the idea of their being merely mechanically transported into already existing cavities of the rocks. The whole mode of occurrence contradicts such a supposition, and leads, irresistibly, to the conviction that the ores were formed in the place they are now found, by geologico-chemical agencies; that the pocket shape of the lodes is merely the result of mechanical derangement and contortion of the hill; and that these pockets have been formed out of original true veins following the original N. E. and S. W. strike of the strata. It is only necessary to notice the shattered condition of the rock, and to observe the contortions exhibited by the section of the hill along the Pennsylvania railroad, readily to account for the transformation of regular veins into a more or less irregular system of pockets. By far the greater number of veins, especially in rocks which are so readily disrupted as limestone, are not contained between two absolutely straight walls as in *a*, but the most of them would undulate, as in *b*.

Fig. 35.

Contortions in Zinc Veins.



"If, then, we assume the right side of *b* to have slid downwards until the convexities meet, we shall have a succession of pockets, as exhibited in *c*, at the termination of which the vein might be supposed to be at an end, and would often fail to show any more of its existence than faint traces. I need not remark that the regularity of the undulations in the ideal sketch would be modified by an endless variety of shape and size, induced by local causes and circumstances. I was vividly impressed with this mode of explanation of the apparent irregularities by what I observed in this place, and especially by a number of slickensides among the ore, which are infallible proof of the sliding of the one or the other side of the vein."

§ 689. As to the processes by which the fissures became in time filled up with the material we now find there, such considerations are rather chemical than geological. From the disseminated particles of blende in the limestone it would appear that some zinc, whether the quantity be large or small, existed originally in the limestone formation as a carbonate (Smithsonite); and that subsequently this was converted by a simple process into blende through the decomposition of iron pyrites; some of the material may, perhaps, have come from below in a gaseous form; but water was the main agent which dissolved the scattered particles of the metal, held these in solution for a while, and then deposited them again in a more concentrated form, in the fissures, by a long continued process of precipitation.

§ 690. The question relating to the depths to which these veins descend has already been sufficiently answered by what has been said above. It may however be repeated that the Birmingham fissures doubtless extend to indefinite depths, though not always in the same condition as we find them in the limestone. But confining them to this one formation they are at least 500 feet deep; and at the southwest end of the valley there are several thousand feet of limestone resting on the back of the anticlinal at the place where the fissures occur.

§ 691. Hence their economic value will not for the present depend so much on the question of their ultimate depth, as upon other considerations, namely upon their horizontal extent, their width, the character of their ores and the cost of mining them. And upon these vital points our information is very meager. But small as it is, we believe it nevertheless sufficient to show that the occurrences at the southwest end of the valley have little or no value in a practical sense. Whatever may be the extent of these southwest veins, whether they run unbroken from one side of the valley to the other, they are much too thin to be mined with profit, unless in the future they yield ores much richer than they do at present. With all the work done at the Deep shaft and at Flecks, we have no statement of the cost of mining the ores; but it clearly must have been high, and would steadily increase with the depth, as there are no means of draining the mines except by pumping.

§ 692. With the fissures near Birmingham however, the case is different, provided that the one vein explored there should possess the width and character that are claimed for it. Moreover the conditions for mining at this place are much more simple than at the southwest end of the valley, and would involve considerably less expense in the production of the ore. Not to speak of the much greater width of the vein, all the shafts working upon it could be drained by the adit from the road until the ore in the knoll was exhausted. Mr. Williams states that the ore taken out of this place by the Keystone Zinc Company, on the average, cost only $3 per ton ; Dr. Roepper gives the cost as $4 per ton ; and allowing this, or even something in excess of it, there should yet be a large margin of profit in mining ores so rich in metal as the analyzed samples would indicate these to be.

§ 693. Yet the attempts to work and develop them have thus far been failures even with large reducing works close at hand to convert the ores into zinc oxide as fast as they were mined, and thus save almost all cost of transportation of the raw material. If the ores maintain what is asserted of them, it is impossible to explain this failure except by mismanagement. Without such mismanagement fair profits must have resulted from working mines esteemed so valuable by every expert who examined them. Doubtless the work will again be undertaken at some future day ; when it is, the efforts should be directed to the proper development of the Birmingham fissures ; and unless other deposits are found at the southwest end of the valley, more valuable than those already discovered, the work of development in that section should cease with what has already been done.

Chapter XVI.

Iron Industries in Blair County.

§ 694. The iron ore mines, blast furnaces, rolling-mills, forges, foundries and shops of Blair county represent a large and profitable industry; including as they do the mining and coking of the great quantity of fuel required, and the quarrying of much limestone for flux.

§ 695. Mr. McCreath made numerous analyses of pig iron, limestone flux, and cinder from different furnaces. Many of these analyses were specially intended to show the character of the pig metal product from iron ores yielded by some particular iron ore mine.

In such cases the analyses of pig metal, &c., have already been given in the detail relating to that mine, inasmuch as they afforded a valuable check to the ore analyses, and could be much better compared when the two results were placed together.

These analyses can easily be consulted and will therefore not be repeated in this chapter.

§ 696. The Williamsburg furnace stack is 28 feet by $8\frac{1}{2}$ feet; has a hot blast not more than 300° F.; makes 50 tons of iron weekly; makes chiefly No. 1 and 2, with very little white metal; the product being used for making bar iron or at the Altoona shops.

The furnace company mine their own ore from the Frankstown ore bed.

Some of their metal was analysed by Mr. McCreath.

This metal was made from a mixture of—

$\frac{1}{2}$ Springfield ore (analysis already given).

$\frac{1}{2}$ Frankstown ore (analysis already given).

Connellsville coke.

Mr. McCreath reports it thus:

Silicon,	2.729
Sulphur,	.164
Phosphorus,	.286
Manganese,	.036

§ 697. Sarah furnace used a mixture of Bloomfield ores, and also some of the fossil ore of V.

The limestone used for flux was quarried from the limestone of VI, near the furnace stack. It showed, on analysis (A. S. McCreath):

Compact, fine-grained, dark-bluish-gray, with somewhat laminated structure.

Carbonate of lime,	96.142
Carbonate of magnesia,	1.604
Oxide of iron and alumina,	.440
Sulphur,	.053
Phosphorus,	.005
Insoluble residue,	1.688
	99.932

Using these materials, and with charcoal for fuel, Sarah furnace produced pig metal (the specimen is No. 3 metal) which yielded, on analysis (A. S. McCreath):

Silicon,	1.704
Sulphur,	.034
Phosphorus,	.238
Manganese,	.072

§ 698. The Blair Iron and Coal Company, No. 1 furnace, at Hollidaysburg, using—

$\frac{1}{6}$ Spanish ore.

$\frac{1}{6}$ Franklinite.

$\frac{4}{6}$ brown hematite (Springfield) ore.

Coke from Miller coal bed at Bennington.

Limestone from quarries on VI (already given § 202).

Made No. 1 pig metal, the analysis of which Mr. McCreath reports as follows:

Silicon,	4.233
Sulphur,	.037
Phosphorus,	.151
Manganese,	3.314

§ 699. The Frankstown furnace of the Cambria Iron Company forwarded a piece of No. 1 pig metal, the analysis of which Mr. McCreath reports thus:

Silicon,	4.937
Sulphur,	.037
Phosphorus,	.184
Manganese,	2.133

§ 700. Mr. McLanahan, of Hollidaysburg, under date of April 12, 1880, gives the following information concerning some Blair County iron furnaces and mills which come directly under his observation:

§ 701. Rodman No. 1, Furnace. Size 61′ × 14′ 6″. Capacity 300 tons weekly. Product, Bessemer pig. Uses ¼ foreign ore and ¾ Bloomfield ore.

§ 702. Rodman No. 2, Furnace. Size 43′ 6″ × 9′. Capacity 150 tons weekly. Product, Bessemer pig. Uses same ores as No. 1.

§ 703. Martha Furnace (McKee's Gap). Size 45′ × 10′. Capacity 140 tons weekly. Product, mill metal. Uses ¼ gap fossil ore and ¾ Bloomfield ore.

§ 704. Hollidaysburg, No. 1. Size 59′ × 13′. Capacity, 265 tons weekly. Product, Bessemer pig. Uses ½ Springfield ore and ½ foreign ore.

§ 705. Hollidaysburg, No. 2. Size 51′ × 10′ 4″. Capacity, 165 tons weekly. Product, Bessemer pig. Uses same stock as No. 1.

§ 706. Frankstown Furnace. Size 45′ × 10′. Capacity, 130 tons weekly. Product, mill and foundry iron. Uses ⅕ Springfield ore and ⅘ No. 1 fossil ore.

§ 707. Bennington Furnace. Size 41′ × 9′ 8″. Capacity, 150 tons weekly. Product, Bessemer pig. Uses ½ foreign ore and ½ Springfield ore.

§ 708. Hollidaysburg Juniata Rolling Mill, running full on muck bar, and all kinds of nails. Capacity 170 tons of bar and 1200 to 1500 kegs of nails weekly.

§ 709. Hollidaysburg Iron Nail Company Rolling Mill in full operation, running on merchant iron and nails.

§ 710. In addition to these works there are the Springfield, Ætna, Rebecca and Sarah Furnaces. These are all small, make charcoal metal, and have been treated in connection with the ore supplied from their mines.

§ 711. Cove forge, Franklin forge and Tyrone forge are within the county limits. The latter is a large and very well appointed plant.

§ 712. South of Altoona are the Altoona Rolling Mills and the blast furnace of Dr. S. C. Baker.

At Altoona are the large shops of the Pennsylvania Railroad Company.

Extensive improvements and additions have been made at these works since the date when the county was examined.

§ 713. There are numerous foundries and small shops, constantly changing and enlarging, which do not call for special enumeration.

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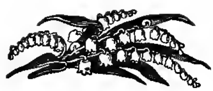

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