MARYLAND GEOLOGICAL AND ECONOMIC SURVEY

WM. BULLOCK CLARK, State Geologist

REPORT ON

THE IRON ORES OF MARYLAND

WITH AN ACCOUNT OF THE IRON INDUSTRY

BY

JOSEPH T. SINGEWALD, JR.

(Special Publication, Volume IX, Part III)

THE JOHNS HOPKINS PRESS

Baltimore, December, 1911

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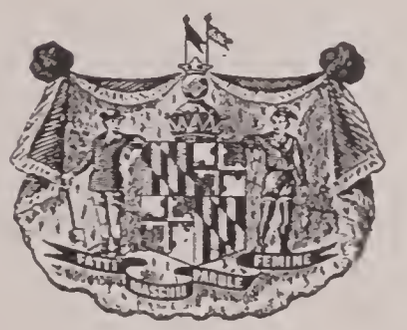

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PREFACE.

Notwithstanding the former importance of the iron industry of Maryland, information in regard to its iron ores has been very scanty and indefinite. An investigation of the iron ores was undertaken, therefore, in order to determine the possibilities of the State in this respect in the future.

During the summer of 1908, the ores of the Appalachian and Piedmont regions were investigated in the field by the author, assisted for a short time by Mr. R. C. Williams. The report on this work was prepared during the following winter, and used by the author for a dissertation, an abstract of which was published in Economic Geology that same year. The work was again taken up in the fall of 1910, and the Coastal Plain iron ores and the manganese ores investigated. The report on these and the portion dealing with the iron industry in the State were prepared in the early part of 1911.

The analyses accompanying the report, except where otherwise stated, were made in the laboratory of the Maryland Geological Survey by Drs. E. G. Zies and E. E. Gill.

PART III

REPORT ON THE IRON ORES OF MARYLAND, WITH AN ACCOUNT OF THE IRON INDUSTRY

By

Joseph T. Singewald, Jr.

REPORT ON THE IRON ORES OF MARYLAND, WITH AN ACCOUNT OF THE IRON INDUSTRY

By

Joseph T. Singewald, Jr.

THE ORES OF IRON.

The ores of iron are chemical combinations of the metal, or element, iron with oxygen, oxygen and water, and carbonic acid. The combinations of iron with oxygen alone are the oxides and comprise two classes of ore,—Magnetite (Fe_3O_4) and Hematite (Fe_2O_3). The combinations of iron with oxygen and water are the hydroxides and the ores are known as Limonites ($Fe_2O_3 . nH_2O$) or Brown Hematites. The combinations of iron ore with carbonic acid are the Carbonates, and these ores are known as Siderite ($FeCO_3$) or Spathic ores. The table shows the ideal composition of these ores of iron.

IDEAL COMPOSITION OF ORES OF IRON.

	Fe	O	H_2O	CO_2
Magnetite	72.4	27.6		
Hematite	70.0	30.0		
Limonite	59.9	25.7	14.4	
Siderite	48.3	13.8		37.9

This table gives the maximum content of iron in pure ores. As a matter of fact, the ores never occur in the pure condition, but are always mixed with impurities, the character and amount of which depend on the kind and origin of the ore. Moreover, a furnace never yields the full percentage of the iron in the ore, as some

of it is lost in the slag. Hence, the yield of iron per ton of ore is always considerably below the percentages given in the table.

MAGNETITE.

Magnetite (Fe_3O_4) receives its name from the fact that it is readily attracted by a magnet. Its color is always black and it occurs either as crystals usually of octahedral form, or massive. It frequently contains considerable titanium oxide (TiO_2), when it is called titaniferous magnetite. The streak of magnetite is black.

HEMATITE.

Hematite (Fe_2O_3) occurs in two varieties known respectively as Red Hematite and Specular Hematite. If the ore has an earthy texture, its color is red and it is known as red hematite; if it is crystallized, it is of a steel gray to iron black color with metallic lustre and is called specular hematite. The powder of both varieties is red and they are thus distinguished readily from all other ores of iron.

LIMONITE.

Limonite ($Fe_2O_3 . nH_2O$), also known as Brown Hematite, is extremely variable in form, mode of occurrence, and color. In general its color is brown, but it grades off into bright yellows and reds. It is distinguished from the preceding ores in having a yellowish brown streak.

The chief varieties of limonite are the compact, the ocherous, and the bog ores. The compact ores are the purest form of limonite. They occur in the form of "pipe ore," "pots," etc. The pipe ores are built up as stalactites and stalagmites. The pots have a concretionary structure. These ores occur in pockets or layers in the ocherous ores and clays. The bog ores are of a loose and porous texture and usually contain a large percentage of impurities.

CARBONATE OR SIDERITE.

Iron Carbonate ($FeCO_3$) also known as Siderite or Spathic ore, occurs in three varieties,—the ordinary brown carbonate, clay ironstone, and black band. When the carbonate is of concretionary structure and contains much clay it is called clay ironstone. When these concretions become enlarged and coalesce to form beds and contain considerable bituminous matter, they are called "black band." The streak of the pure carbonate is white, but as these ores are usually more or less weathered, they give a brownish streak and cannot be separated on this basis from the limonites.

IMPURITIES IN THE ORES AND THEIR EFFECTS.

The impurities occurring with iron ores are of two kinds, mechanical and chemical. The former have no influence on the quality of the iron produced, whereas the latter usually greatly affect the properties of the finished product.

Mechanical Impurities.

The most common mechanical impurities are silica and alumina. To remove these, fluxes must be added to the ore. The result is that the percentage of iron per ton of material put into the furnace is decreased, and the yield of the furnace per unit capacity reduced. In the limonites, the silica and alumina usually occur in the form of sand or chert, and clay. In such cases an equivalent amount of limestone or dolomite must be added to remove them. It frequently happens that the silica occurs in combinations with bases which are to some extent self-fluxing, so that the fluxing material required is less than in the former case. This is especially true with some magnetites which occur associated with silicates bearing iron, lime, magnesia, etc., as bases. Ores are sometimes found in which the ratio of the bases naturally present to the silica is such that they are completely self-fluxing.

These impurities are readily reduced to a minimum by various mechanical processes, as washing, jigging, or magnetic separation in the case of magnetites, and even by hand picking. The extent to which this concentration is carried on depends on the expense of the operation and the increased value of the product.

Chemical Impurities.

The most common of the chemical impurities are phosphorus, sulphur, manganese and titanium.

Phosphorus is the most difficult of the deleterious impurities in iron ores to remove. Its effect is to render the iron cold-short, that is, brittle when cold. The maximum percentage of phosphorus permissible in steel is $\frac{1}{10}$ of 1 per cent. and as phosphorus cannot be eliminated in the blast furnace or in the converter in the acid-Bessemer process, iron ores are classified as Bessemer and non-Bessemer ores. Bessemer ores bring a little higher price than the non-Bessemer. There are now processes in which high-phosphorus pig iron can be used. In these, the basic Bessemer and the basic Open Hearth, the phosphorus becomes an essential constituent and is almost entirely eliminated by being made to pass off in the slag. The amount of phosphorus should lie between two and three per cent. The difficulty with these processes is that they are slower and more expensive than the acid. While phosphorus is extremely detrimental in iron which is to be converted to steel, there are some cases in which a considerable amount of phosphorus is of advantage and even necessary. Its presence in cast iron renders the latter easily fusible and keeps it longer in the melted state, so that it can fill intricate molds for ornamental castings where a more sluggish iron would chill.

Sulphur is a detrimental element in an iron ore because it renders the resulting pig red-short, that is, brittle when hot. High-sulphur steel cracks while it is being hot-rolled, and has its welding capacity greatly decreased. In the making of steel for simple shapes a content of $\frac{1}{10}$ of 1 per cent. is allowable. Sulphur is partially

eliminated in the blast furnace by combining with the bases of the slag. If it occurs in quantities greater than one per cent., the ore must be roasted, and this of course adds to the cost of the iron produced from it.

Manganese confers the quality of hot-ductility to steel, and also raises the critical temperature to which it is safe to heat the steel. It has been discovered that a high manganese content makes the steel brittle under shock and the allowable limit has been lowered to about 1 per cent. High manganese ores are used for the manufacture of spiegeleisen and ferro-manganese, which are added to low manganese steel.

Titanium has no injurious effects on the quality of the pig iron as it passes into the slag. The objection to it is due to the fact that it raises the temperature of fusion of the slag, causes greater loss of iron in the slag, and causes accretions of nitrocyanide of titanium in the furnace hearth. These difficulties can in part be overcome by special methods. In general trade, however, an ore should not contain over one per cent. of titanium.

PRACTICAL CONSIDERATIONS.

Aside from the above considerations which decide whether an ore itself is or is not adapted to furnace use, there are a number of practical considerations which are just as important in deciding the value of an ore deposit. In fact the intrinsic value of an iron ore affects only to a small degree its commercial value. The questions of cost of mining, proximity of fuel, flux, and water are the real factors which decide whether an iron ore deposit has any economic value. An excellent iron ore may be so situated that the cost of mining and bringing it to market is prohibitive. The ore itself, the flux, and the fuel are bulky products and the item of transportation is a most important one. When all of these factors are favorable a comparatively low grade ore can readily be utilized at a profit, whereas many high grade ores less favorably situated are absolutely worthless.

HISTORY OF THE MARYLAND IRON INDUSTRY.

THE COLONIAL PERIOD.

The credit of the discovery of iron ore in Maryland seems to belong to Captain John Smith. In his voyage up the Chesapeake Bay in 1608, he entered the Patapsco River which he named Bolus, because of the red clay found there, resembling "bole armoniack and terre sigillata." Later in the year, he sent two barrels of iron ore specimens to England to be examined, but it is not known whether they were from Maryland or Virginia, or what were the results of the examination. Attention was called to a superficial deposit of iron ore in Baltimore County in 1648 by Plantagenet, who estimated a saving to the iron manufacturer of £3 per ton; "another £5 would be saved in fuel by using drift wood and timber floated down the rivers, and thus the labor of each man would yield him 5s 10d per diem, iron being valued at £12 per ton." In 1681, the Legislature, to prevent the exportation of old iron and to encourage the smiths, imposed a duty on such exportations. The manufacture of iron seems to have begun about this time.

In 1719, the General Assembly of Maryland passed an act for the encouragement of iron manufacture within the Province. This act reads:

"An Act for the encouragement of an iron manufacture within this Province.

"WHEREAS, It is represented to this present General Assembly that there are very great conveniences of carrying on Iron Works within this Province which have not hitherto been embraced for want of proper encouragement to some first undertakers, although the consequences thereof might not only be considerably advantageous to the persons immediately concerned therewith, but also to the public trade of Great Britain and this Province, * * * therefore be it

"Enacted, that if any person or persons shall desire to set up a forging mill or other conveniences for carrying on Iron Works on lands not before cultivated adjoining a stream, he may get a writ *ad quod damnum*. On the return of this, if the owner refuses to build such mill and gives securities to complete it within four years, the governor may grant one hundred acres, the owner being paid for it. Grantee is to give bond to begin the mill within six months and to finish it in four years. Workmen at the mill, not exceeding eighty are to be levy free. If pig iron is not run in seven years, the grant is void."

A later act, in 1721, exempted workmen at furnaces, forges and mills from labor upon the highways, which at the time were kept in repair by assessment of the labor of the taxable inhabitants.

MAP
OF
MARYLAND
SHOWING
FURNACE LOCATIONS

SCALE
1:1,250,000. 20 Miles = 1 Inch

0 5 10 20 40 60

MARYLAND GEOLOGICAL SURVEY.
WM. BULLOCK CLARK, STATE GEOLOGIST
1909

ALPHABETICAL LIST OF MARYLAND FURNACES.

Antietam Furnace 10
Ashland Furnace 24
Bowery Furnaces 8
Catoctin Furnaces 11
Cedar Point Furnaces 30
Chesapeake Furnaces 29
Curtis Creek Furnace 42
Elba Furnace 17
Elkridge Furnace 40
Fielderia Furnace 13
Friendsville Furnace 1
Greenspring Furnace 6
Gunpowder Furnace 19
Gwynns Falls Furnace 26
Hampton Furnace 12
Harford Furnace 35
Johnson Furnace 14
Joppa Iron Works 20
Kingsbury Furnace 28
La Grange Furnace 36
Laurel Furnace 33
Legh Furnace 16
Lena Furnace 5
Locust Grove Furnace 22
Lonaconing Furnace (Knoxville) 15
Lonaconing Furnace (Lonaconing) 4
Mariah Furnace 9
Maryland Furnaces 32
Maryland Steel Co. Furnaces 27
Mount Etna Furnace 8
Mount Savage Furnaces 2
Muirkirk Furnace 44
Nassawango Furnace 45
Northampton Furnace 21
Oregon Furnace 25
Patapsco Furnace 31
Patuxent Furnaces 43
Principio Furnace 38
Rock Forge Furnace 7
Rough and Ready Furnaces 34
Russell Furnace 39
Sarah Furnace 37
Savage Furnaces 41
Stickney Furnaces 28
Whittaker Furnace 13

A. HOEN & CO. BALTIMORE

The statement in the preamble of the Act of 1719 that, "there are very great conveniences of carrying on Iron Works within this Province, which have not hitherto been embraced for want of proper encouragement to some first undertakers," is regarded by some as a clear implication that iron enterprises had already been undertaken in Maryland, but were not then in operation. There is other evidence showing that iron enterprises had existed before that date. Scrivenor says that in 1718, Maryland and Virginia exported to England 3 tons 7 cwt. of bar iron. A deed of 1716, mentions iron works near the bottom of the main falls of North East, which Swank thinks must have been a bloomery, as there was no furnace then in existence which could have supplied pig iron to a forge. This is the earliest iron works of which we have any record, and antedates 1716. A few years later, there was a forge on this site owned by the Principio Company.

Shortly after the passage of the Act of 1719, the Principio Company, of which a full account is given in the next chapter, was formed and a furnace erected near the present Principio station in Cecil County, which was the first furnace built in Maryland. The second furnace in the State was erected in 1723, on John Moale's land at the mouth of Gwynns Falls, where there were also ore banks at that time. John Moale vigorously opposed an attempt to have the General Assembly lay out that land as a town site, as he regarded it of far more value for its ore. The founding of Baltimore was thus delayed, and its site changed somewhat by the starting of the iron industry, so that for some time old Joppa was the most important town in the Province.

As a result of the encouragement given by the General Assembly, there were in 1754 seven furnaces and eight forges; and in 1758 eight furnaces and ten forges making about 2500 tons of pig iron and 600 tons of bar iron annually. By the time of the Revolution, seventeen furnaces had been erected, of which all but probably four were in operation, and during the war they were called upon to furnish the American armies with cannon and cannon balls. About seventeen or eighteen forges were also being run at this time.

Johnson, in his history of Cecil County, says that the forges before the Revolution, and until a comparatively recent period, were very crude affairs. The blast was made by a curious circular bellows, which was operated by means of a water-wheel, very little machinery or gearing being used. So crude were these forges that there was a water-wheel for each bellows and hammer; consequently, one forge building often contained several water-wheels.

The profits of the business in the early years must have been quite large, but decreased somewhat later as the prices fell and the costs increased. In 1727, pig iron sold at the Principio furnace at £10 per ton, and the books of the Company show that it cost £4 5s 9d to make. Blooms were worth £25 and bar iron £35 per ton, but the cost of making these at that time is not known. In 1754, prices had fallen, and pig iron was worth only £8, blooms £18, and bar iron from £28 to £30. At that time bar iron cost £21 10s to make. In 1773 the price of pig iron was £8 per ton and bar iron £26 per ton.

The output of pig iron and bar iron in Maryland in the years 1750 to 1755 inclusive, is given in the table from a report by Governor Sharpe in 1758.

TABLE SHOWING PRODUCTION OF PIG IRON AND BAR IRON IN MARYLAND FROM 1750 TO 1755.

Year.	Pig Iron.	Bar Iron.			
		T.	Cwt.	Q.	Lbs.
1750	1,424	518	2	2	18
1751	3,005	622	2	1	10
1752	1,390	635	17	3	16
1753	3,076	573	13	3	0
1754	1,978	534	0	3	2
1755	1,331	640	18	0	8

A large part of the pig iron produced in Maryland during the Colonial period was exported to England. Alexander gives two tables which he has taken from Scrivenor's Memoir on the Iron Trade. One shows the amount of pig iron and bar iron imported from Maryland into Great Britain, exclusive of Scotland, during the period from 1718 to 1755; the other shows the quantity imported into Scotland during the period 1742 to 1746.

PIG IRON AND BAR IRON IMPORTED FROM MARYLAND INTO GREAT BRITAIN.

Year.	Pig Iron. T.	Cwt.	Q.	Lbs.	Bar Iron. T.	Cwt.	Q.	Lbs.	
1718	....	..	.	..	3	7	0	0	The returns are
1729	852	16	1	11	...	..	.	..	from 1710, but
1730	1,526	15	1	15	...	..	.	..	no imports
1731	2,081	2	0	27	...	..	.	..	were made un-
1732	2,226	3	2	0	...	..	.	..	til 1718.
1733	2,309	11	3	22	...	..	.	..	Duty on bar
1734	2,042	2	2	3	...	..	.	..	iron, per ton,
1735	3,362	8	0	17	44	9	0	21	£2 1s. 6d. to
1739	2,242	2	2	14	...	..	.	..	15d.
1740	2,020	2	0	22	5	0	0	0	Duty on pig
1741	3,261	8	1	5	5	0	0	0	iron, per ton,
1742	1,926	3	1	5	...	..	.	..	3s. 9.45d.
1743	2,816	1	1	15	...	..	.	..	No printed re-
1744	1,748	4	1	3	57	0	0	0	turns appear
1745	2,130	16	1	10	4	5	2	14	to have been
1746	1,729	1	0	2	193	8	3	12	made from
1747	2,119	0	3	24	82	11	2	11	1719 to 1728,
1748	2,017	11	3	10	...	..	.	..	inclusive.
1749	....	..	.	..	...	..	.	..	No return.
1750	2,508	16	1	25	5	17	3	0	
1751	2,950	5	3	15	3	4	2	9	
1752	2,762	8	0	4	16	10	2	4	
1753	2,347	9	2	18	97	18	0	19	
1754	2,591	4	3	17	153	15	1	8	
1755	2,132	15	1	22	299	1	3	0	

PIG IRON AND BAR IRON IMPORTED FROM MARYLAND INTO SCOTLAND.

Year. Michaelmas.	Pig Iron. T.	Cwt.	Q.	Lbs.	Bar Iron. T.	Cwt.	Q.	Lbs.	
1742–3	1	12	2	18	1	16	3	8	The returns are
1744–5	27	14	3	0	...	..	.	..	in fact from
1748–9	144	16	0	18	...	..	.	..	1739, but no
St. John Bap.									imports were
1750–1	....	..	.	..	...	..	.	..	made until the
1752	35	0	0	0	...	..	.	..	date men-
1753	20	0	0	0	...	..	.	..	tioned. No im-
1754	25	0	0	0	...	..	.	..	ports for 1743-
1755	....	..	.	..	...	..	.	..	4, nor for
1756	....	..	.	..	...	..	.	..	1746-8. Of the

entire import from the Colonies during these ten years, 1739-49, Maryland furnished nearly two-thirds. No returns from September 29, 1749, to June 24, 1750. Of entire quantity imported in these six years, Maryland furnished rather more than one-third.

The activity in the manufacture of iron involved of necessity an equal activity in the mining of ore. As has already been stated, ore was first discovered on the Patapsco River, and this section was one of the earliest sources of ore, and also the most important source

during this period. Ore must have been mined near the mouth of Gwynns Falls as early as the establishment of the furnace there in 1723. In 1724, the Principio Company acquired rights to the ore on Gorsuch Point; and in 1727 to that on Whetstone Point. These ores were the carbonates of the Arundel formation, and they were the mainstay of the early furnaces. The first ten furnaces in the Province, erected in the period from 1722 to 1760, were located in the area in which the Arundel ores occur. In 1760, the ores farther west began to be used. In that year, the Hampton furnace was built in Frederick County, near Emmitsburg, to use the limonites of that region, and this was followed by three others in Washington County, one in Carroll, and finally, in 1774, by the Catoctin in Frederick County, which was the last furnace built during the Colonial period.

Thus by the time of the Revolution, the two most important classes of ore in Maryland had been recognized and were being extensively used. Notwithstanding the fact that the seventeen furnaces which had been built during this period were being supplied with ore from Maryland mines, there was such an abundance of ore available that part of the output went to Virginia furnaces.

At the same time that the General Assembly was passing measures to encourage the building up of an iron industry in Maryland, the attitude of the British Government was to discourage its growth in the Colonies, as it was feared that it would transfer the trade in such articles from the mother country to the Colonies. The question as to what attitude on the part of the mother country toward the Colonies in this respect would be most favorable for the British iron industry and British commerce was much discussed. The consensus of opinion was that a duty should be levied on American iron to protect the English manufacturer, and that the manufacture of iron wares in the Colonies should be discouraged. Accordingly, in 1719, the year in which the first act to encourage the establishment of iron enterprises in Maryland was passed, the House of Commons passed a bill containing a clause "that none in the plantations should manufacture iron wares of any kind out of any sows, pigs, or bars

whatsoever." This bill was defeated in the House of Lords through the opposition of the Colonies.

By 1750, opinion in England had changed somewhat. It had been pointed out that she annually bought from her enemies, Sweden and Russia, pig iron, for which she had to pay in gold. The American iron was found to be just as good as the Swedish, and could be had in exchange for other wares, and thus the country would not be continuously drained of its gold. In that year, a bill was passed admitting pig and bar iron from the Colonies into England free of duty, and prohibiting the erection of any mill for slitting or rolling iron or any plating-forge to work with a tilt-hammer, or any furnace for making steel. A clause requiring the destruction of all such works already in existence failed to pass.

The tables of imports from Maryland given on preceding pages indicate that this change in policy had no effect on the production of pig iron in this Province, as they show no essential increase in the exports from that time on. It must have had the effect, however, of retarding the development of the manufacture of finished iron products out of the crude iron.

The Period from 1780 to 1830.

During the period from 1780 to 1830, the iron industry of the State made but little progress. Only seven new furnaces were built, four of which were in the western part of the State, as against seventeen in an equal period before the Revolution; and six furnaces were abandoned during that time. It was toward the close of this period that the first attempt to work the carbonates of the Coal Measures was made; and the furnace at Friendsville was erected in 1828, but was operated only a few years. The production of pig iron in 1810 reached 5,000 tons, but in 1830 had dropped back to 3,163 tons.

The Period from 1830 to 1885.

This period was the most important in the history of our iron industry. The beginning is marked by an era of furnace building

which lasted until 1855; then followed a nearly stationary period of ten years; and in 1865, a rapid decline set in which was characterized until 1880 by the shutting down of the less favorably located furnaces, but showed no diminution in the total production, and after that by a rapid decrease in production and a shutting down of most of the furnaces around Baltimore.

During the period from 1830 to 1855, pig iron commanded a high price, often selling for as much as $75.00 per ton. The cost of manufacture of a ton of pig iron in Maryland in 1839 was estimated by Alexander at about $24.00 per ton. These unusually high prices were caused by the great demand for iron at that time. It was the period when iron came into general use, and the extensive building of railroads was begun. To meet this demand, furnaces began to spring up on all sides; and in this State twenty-seven new furnaces were erected, and but five of the old ones were abandoned. The industry spread itself over the entire State. On the southern part of the Eastern Shore, the Nassawango furnace was built to utilize the bog ores of that section, and in the Georges Creek Basin of western Maryland five new furnaces were erected. Seven new furnaces were built to use the limonites and magnetites of central Maryland, and a dozen new furnaces were put up to use the Arundel ores in Baltimore and its immediate vicinity.

In 1830, the production of pig iron was only 3,165 tons, by 1833 it had increased to 5,800 tons with a value of $400,000, and in 1855 it had reached nearly 30,000 tons. The annual production of ore had gone up to about 100,000 tons in the same time. The following list of Maryland furnaces and their capacity was given by DeBow in 1853 in his "Industrial Resources, Etc., of the Southern and Western States."

FURNACES IN MARYLAND IN 1853.

Furnace.	Stacks.	County.	Capacity, tons per annum.
Lonaconing	1	Allegany	3,000
Mount Savage	2	"	6,000
Lena	1	"	1,500
Antietam	1	Washington	2,500
Green Spring	1	"	1,000
Blue Ridge	1	Frederick	3,000
Catoctin	1	"	1,500

FURNACES IN MARYLAND IN 1853—Continued.

Furnace.	Stacks.	County.	Capacity, tons per annum.
Elba	1	Howard	1,500
Muirkirk	1	Anne Arundel	2,000
Curtis Creek		"	2,000
Patuxent	2	"	4,000
Elkridge	1	"	2,000
Nassawango	1	Worcester	1,500
Ashland	2	Baltimore	7,000
Oregon	1	"	4,000
Gunpowder	1	"	2,500
Harford	1	Harford	1,500
LaGrange	1	"	1,000
Sarah	1	"	1,500
Havre de Grace	2	"	5,000
Principio	1	Cecil	2,000
Maryland	1	Baltimore City	2,500
Laurel	1	"	2,500
Chesapeake	1	"	2,500
Cedar Point	2	"	5,000
Locust Grove	1	"	2,000
	31		70,500

In 1855, the furnace building activity had come to an end, and there was not another furnace built until 1864, when a third stack was erected at Ashland. In fact, a slight decline set in, and from 1855 to 1860 five furnaces were abandoned. At the outbreak of the Civil War, the great demand for iron again brought on a boom and many of the furnaces which had become idle during the three or four years immediately preceding, started up again.

The next twenty years, 1865 to 1885, marked the rapid decline of the iron industry in Maryland. Only two or three new furnaces were built, and twenty-seven of the old ones were abandoned. At first it was chiefly the furnaces less favorably situated with respect to market, that were forced to close, but toward the last few years most of the furnaces around Baltimore also closed in rapid succession. Until 1880, this decline was not shown in the figures of production, as can be seen from the two tables at the end of this chapter, showing the production of iron ore and of pig iron in Maryland. The production of pig iron in that year was still as high as it had been, and the production of iron ore was the maximum recorded. Maryland, however, was merely standing still, while the rest of the country was rapidly forging ahead. In 1870, her pro-

duction of 54,204 tons of pig iron, gave her fifth rank among the iron-producing States; whereas, in 1880, her output of 53,271 tons put her in eleventh place. Moreover, her 98,354 tons of iron ore in 1870 had a value of $600,246, or $6.10 per ton; but in 1880, her 139,628 tons were worth only $421,691, or $3.02 per ton. The continued decline in price of pig iron brought the value of ore to such a point that it could no longer be mined at a profit, and after 1880, the output of ore and pig iron decreased rapidly.

This decline was brought about by a radical change in the nature of the iron industry. The Maryland industry was essentially a charcoal iron industry. Through some peculiar quality of the Arundel ores, the charcoal iron produced from them was of exceptionally high quality, and was greatly in demand for all purposes requiring a strong iron. Consequently, it commanded a higher price than even other charcoal iron. A flourishing and profitable industry resulted. Then came a complete change in conditions. The supply of iron became inadequate to the demand, and prices rose rapidly. The industrial development of the country required large quantities of iron at low prices. The iron industry of today was the result. The large deposits of the Lake Superior region and of Alabama came into the field, and extensive plants were built to manufacture iron in coke furnaces in enormous quantities, at much lower prices than the charcoal iron could be made. The extension and cheapening of transportation at the same time opened up to these plants the local markets of the charcoal furnaces. Finally, the introduction of steel reduced the market for the high grade charcoal iron to a minimum.

THE PERIOD FROM 1885 TO THE PRESENT TIME.

In 1885, only seven furnaces remained active. Two of these shut down in the next year or two. In 1891, the manufacture of pig iron was finally abandoned at Principio furnace. The two Stickney furnaces were dismantled in 1895 and 1896. Catoctin, in Frederick County, closed finally in 1903, and was torn down in 1905, leaving the furnace at Muirkirk the sole survivor. This furnace still supplies a very limited market with an exceptionally high grade charcoal

FIG. 1.—RUIN OF BLAST FURNACE, LONACONING, ALLEGANY COUNTY.

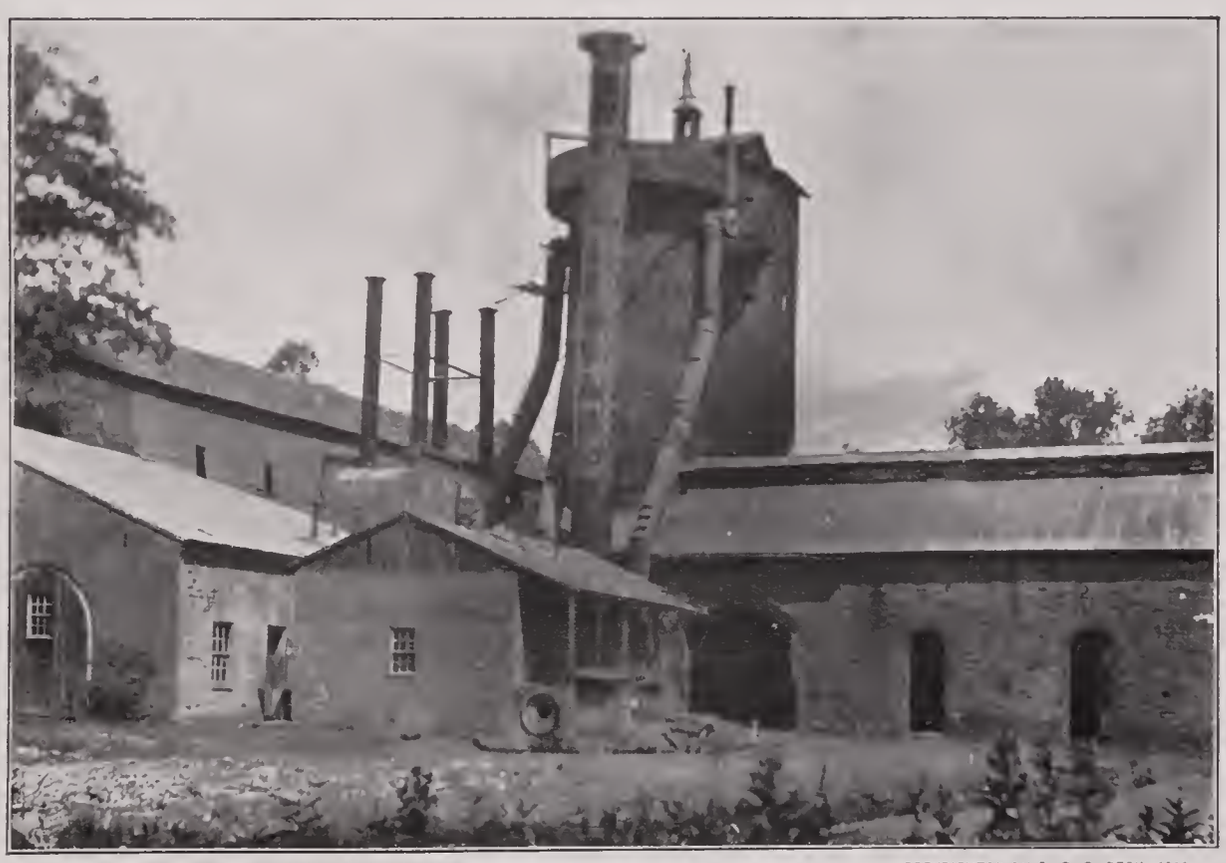


FIG. 2.—CATOCTIN FURNACE, THURMONT, FREDERICK COUNTY.

VIEWS OF MARYLAND IRON FURNACES.

iron, which has shown a tensile strength of 41,000 pounds to the square inch.

At the present time, the entire output of Maryland iron ore, with the exception of that used at Muirkirk, goes to furnaces outside the State. Within the past four years, a renewed interest has been shown in Maryland ores, and the deposits at Catoctin are again being worked on a large scale, and prospecting in Bachman Valley has disclosed a number of new deposits, in addition to those already recognized.

Toward the close of the eighties, when the local iron industry became almost extinct, the large plant of the Maryland Steel Company at Sparrows Point was erected, and the production of this plant has again raised the rank of Maryland among the iron-producing States from thirteenth in 1890 to ninth place. No Maryland ores are used at this plant, and most of the ores used there are brought from Cuba.

TABLE SHOWING IRON ORE PRODUCTION IN MARYLAND.

Year.	Rank.	Limonite.	Carbonate.	Total in tons.	Total value.
1850	3	.....	.....	99,866	$560,725
1860	7	.....	.....	79,200	528,750
1870	5	.....	.....	98,354	600,246
1880	9	.....	.....	139,628	421,691
1889	18	.....	.....	68,240	158,316
1890	15	18,061	11,319	29,380	68,240
1891	..	19,400	17,979	37,379	.....
1892	..	19,322	20,849	40,171	.....
1893	..	2,075	11,755	13,830	25,585
1894	..	.....	7,915	7,915	17,809
1895	..	.....	981	981	1,962
1896	..	.....	11,502	11,502	23,004
1897	..	.....	11,500	11,500	23,000
1898	..	.....	5,941	5,941	11,882
1899	..	.....	3,428	3,428	4,628
1900	17	18,000	8,233	26,233	55,735
1901	..	14,993	6,225	21,218	33,825
1902	..	19,382	4,985	24,367	46,911
1903	..	4,775	5,145	9,920	22,612
1904	..	6,105	3,541	9,645	18,007
1905	..	6,259	2,010	8,269	14,291
1906	..	5,329	612	5,941	9,930
1907	..	12,000	.....	12,000	20,872
1908	..	16,301	.....	16,301	29,205
1909	..	23,888	.....	23,888	46,786
1910	..	14,062	.....	14,062	29,105

TABLE SHOWING PRODUCTION OF PIG IRON IN MARYLAND.

Year.	Rank.	Amount.	Year.	Rank.	Amount.
1810	..	5,000	1893	..	151,773
1828	..	2,247	1894	..	5,600
1829	..	1,715	1895	..	10,916
1830	..	3,163	1896	..	79,472
1840	..	8,876	1897	..	193,702
1850	..	22,163	1898	..	190,974
1860	..	30,500	1899	..	234,477
1870	5	54,204	1900	8	290,073
1880	11	53,271	1901	..	303,186
1886	..	30,502	1902	..	303,229
1887	..	37,427	1903	..	324,570
1888	..	17,606	1904	..	293,441
1889	..	33,847	1905	..	332,096
1890	13	165,559	1906	..	386,709
1891	..	138,206	1907	9	411,833
1892	..	99,131	1908	..	183,502

PRODUCTION AND VALUE OF ORE BY COUNTIES IN 1870.

Allegany	9,300	tons.	$32,500	value.
Anne Arundel	6,190	"	24,660	"
Baltimore	50,487	"	438,303	"
Carroll	18,300	"	54,600	"
Frederick	12,000	"	42,800	"
Prince George's	2,077	"	7,383	"

PRODUCTION OF ORE BY KINDS AND BY COUNTIES IN 1880.

	Limonite.	Carbonate.	Hematite.	Magnetite.	Value.
Anne Arundel	.....	6,184	.....	.....	$22,487
Allegany	3,494	.....	1,018	.....	11,788
Baltimore	23,309	40,533	.....	.....	196,647
Carroll	17,134	.....	.....	218	45,584
Cecil	2,016	.....	.....	.....	8,064
Frederick	18,166	.....	.....	.....	40,506
Harford	81	196	.....	.....	845
Howard	.....	14,675	.....	.....	53,737
Montgomery	.....	25	.....	.....	100
Prince George's	.....	12,019	.....	.....	41,433
Washington	560	.....	.....	.....	500
	64,760	73,632	1,018	218	$421,691

The statistics of production by kinds and counties for 1890, 1900 and 1910 cannot be given without disclosing the production of individual operators, as the output decreased greatly during the interval.

DESCRIPTION OF MARYLAND IRON WORKS.

This chapter contains a description of most of the iron works which have existed or still exist in Maryland. The furnaces are first taken up by counties, and as full a description as the information available permits is given of each. A great many of the furnaces are so old and the references to them so scant, and in some cases so conflicting, that the account is not always as full and definite as one might wish. The locations of the furnaces are given on the map, Plate VII.

MARYLAND FURNACES.

Garrett County.

Friendsville Furnace.—A charcoal furnace and two forges were built in 1828-9 on the north side of Bear Creek, a branch of the Youghiogheny River, a half mile east of Friendsville. This is the only furnace that has been erected in Garrett County and was intended to use the carbonate ores of the Youghiogheny Coal Basin. Lack of transportation facilities made the cost of the iron too high, as it had to be hauled to the National road, and thence to Baltimore; consequently, the furnace shut down in 1834. The forges were then removed to the west side of the Youghiogheny River, a half mile northeast of Friendsville, and remained in operation until 1845. The site of the old water-wheel at this locality can still be seen, and the walls of the coal house remain.

Allegany County.

Mt. Savage Furnaces.—At Mt. Savage three steam hot-blast coke furnaces were erected by the Mt. Savage Iron Company. The two older ones were on the south side of the creek just above Mt. Savage, and the newer one opposite them on the other side of the creek. This was on the site of the present clay bank. The ruins of the two older ones are still standing, but are nearly buried under the

dump of the clay bank. No. 1 and No. 2 furnaces were built in 1840 and were 50 feet high and 15 feet wide at the boshes. No. 3 was commenced in 1845, but was never lined. The furnaces were built with the intention of using the carbonate ores of the Coal Basin, but they had to depend on the "red fossil" ore around Cumberland, and ores farther east in the State for their supply. The output of No. 2, in 1844, was 4,500 tons on a blast of forty weeks' duration. No. 1, in 1846, in forty-four weeks produced 4,528 tons. The furnaces were shut down a few years before the Civil War, but were operated again during the War, and after that finally abandoned.

At this same locality were the Mt. Savage Rolling Mills, erected by the Maryland and New York Iron and Coal Company, which achieved quite a fame in their time for rolling iron rails. The mill was erected in 1843, and consisted of 37 heating furnaces and two trains of steam driven rolls. In 1855, it produced 8,350 tons of rails out of equal quantities of pig iron and old rails. The mill was shut down in 1856 and dismantled in 1875.

This plant was erected to roll iron rails, and in 1844 the first rails made in the United States that were not strap rails were made here. This was an inverted "U" rail weighing 42 pounds to the yard, of which 500 tons were rolled early in 1844, and laid on part of the railroad built from Cumberland to Mt. Savage. This type of rail was known in Wales as the Evans patent of the Dowlais Iron Works at Merthyr Tydvil, and was intended to be laid on a wooden longitudinal sill to which it was fastened by an iron wedge keying under the sill, thus dispensing with outside fastenings. In honor of this event, a silver medal, now in the museum of Ince Blundell of Lancashire, England,[1] was awarded in October of that year by the Franklin Institute of Philadelphia. Later in that same year "T" rails weighing 50 pounds to the yard, ordered by Colonel Borden, of Fall River, Mass., were rolled for the railroad from Fall River to Boston. "T" rails were also sold to Boston purchasers in 1845 and 1846 through the firm of Manning & Lee, in Baltimore.[1]

[1] J. Swank, Hist. of the Manufacture of Iron in All Ages, 1892, 2d ed., p. 434.

The following interesting account of this plant is given in Hunt's Merchants' Magazine for 1849:

"An English Company was formed about fifteen years ago to manufacture iron at Mt. Savage, but owing partly to mistaken management, and partly to the alteration of the tariff, they failed in business, and about two years ago were sold out by the sheriff. Their works consist of three blast furnaces, among the largest in the United States, the blast of which is carried on by a monster steam engine erected at a cost of $72,000, a puddling furnace and rolling mill large enough to employ six hundred men, a foundry, a fire-brick yard, a store, 320 houses for workmen, etc., * * * * besides iron and coal mines. From the balance sheets of the company, the works appear to have cost $1,600,000. The whole was sold to a company consisting of citizens of Albany, New York, and Boston for a little over $200,000. This company is now busy making arrangements to open, as soon as the price of railroad iron shall be such as to admit of successful competition with the English article. At present the high price of labor in this country renders it impossible to compete with the English manufacturers, who deprived of a market in Europe by the suspension of all works of internal improvement on the Continent, send all their stock to America.

"The Mt. Savage establishment when in operation employs nearly four thousand workmen, mostly foreigners. These men are so banded together among themselves, and with workmen in other establishments, that they will remain idle or work at other business at one half what the company could afford to give them, rather than abate one cent from their wages. Puddlers, who formerly received three to five dollars per ton, could now earn two dollars and a half per ton, but they prefer to work in mines or on the canal for one half that amount. It is to be hoped that before long a peace in Europe, an alteration of the tariff, or a return to reason on the part of the workmen will bring the superior article made at Mt. Savage into general use on our railroads."

Bowery Furnaces.—Two coke furnaces were erected at Midlothian in 1868 by the Cumberland Coal and Iron Company. They used carbonate ores mined on the hill northwest of the furnaces, and brought down to the furnaces in tram cars, and also "fossil ore" from around Cumberland. The coal for the coke was obtained from the company's mines at the furnaces, and the limestone for fluxing purposes chiefly from the hill east of Borden Shaft. After being operated about seven years the furnaces were abandoned.

Lonaconing Furnace.—A steam hot-blast coke furnace was erected at Lonaconing, on the west side of George's Creek by the George's Creek Coal and Iron Company in 1837. It seems that there was an older charcoal furnace on this same site, but nothing is known in regard to it. Overman claims this was the first successful coke furnace in the United States. The stack, which is still standing (Plate VIII, Figure 1), is 50 feet high and 15 feet wide at the boshes, and is

built of sandstone lined with brick. The blast was through two tuyeres blown at a pressure of 2¼ pounds per square inch and 3200 cubic feet per minute, by a 60 H. P. steam engine, and was heated to a temperature of 700° F. by stoves near the tuyere arches. Connected with the furnace was a foundry for machine and other castings. The average weekly output for the first few years was 75 tons, and two hundred and twenty men were employed in the establishment. The principal ore used was the carbonate ore of that section, which was obtained chiefly from the hill back of the furnace, from where it was brought to the furnace on a tram road. The limestone flux was also obtained from this same hill. The tram road was first laid with four foot cast iron rails having the flange on the rail instead of on the wheel. These were satisfactory for one ton cars, but when two ton cars were introduced, they were found to be too light, so in 1854 the road was torn up and wooden tracks put down covered with iron bands.

In the forties, the furnace was leased by Christopher Detmold, by whom a tram road with wooden tracks banded with sugar wood was built from the furnace to Clarysville on the National road. The operations throughout the history of the furnace suffered from an insufficient supply of ore, notwithstanding every effort of the company to locate adequate sources; and consequently the project was finally abandoned in 1855, in which year 1,860 tons of iron were produced.

Lena Furnace.—The Lena furnace was built in 1846 by J. F. Penniman, of New York, at the northwest end of Cumberland. The site of the furnace was on the north side of Columbia Avenue, between Lena and Pulaski Streets, and the offices were on the south side of Columbia Avenue. It was built as a charcoal furnace, but was changed to a hot-blast coke furnace. The stack was 28 feet high and 8 feet wide at the boshes. After running for about six years it was shut down until the Civil War, when it was again put in blast and run until 1867.

Washington County.

Green Spring Furnace.—In 1770, Governor Johnson and a Mr. Jacques erected a furnace on Green Spring Run, one mile above its entrance into the Potomac River. The neighboring ore not being of good quality, the furnace was abandoned in 1775.

At this same time James Johnson built the Licking Creek forge, at the mouth of Licking Creek, to use the pig iron from the furnace. When the furnace shut down, the forge was sold to a Mr. Chambers, of Chambersburg, Pa., who ran it until 1780 with pig iron from his furnace in Pennsylvania.

On this same site, a hot-blast charcoal furnace, 35 feet high and 8 feet wide at the boshes, was erected in 1848 by J. D. Roman and Company and managed by B. F. Roman. The remains of this stack are still standing. The furnace was supplied with ore from banks a mile or two to the north, and in 1856 produced in thirty-two weeks 677 tons of forge and foundry iron. On the death of Mr. Roman, about 1865, the furnace passed into the hands of J. B. Haines and Company, and was operated by them until 1873.

Rock Forge Furnace.—The Rock Forge Furnace was situated on Little Antietam Creek near Leitersburg. It was built in 1770 by Samuel and Daniel Hughes, and operated until 1795. A mile and a half below this furnace, on the same creek, they built a forge known as the Antietam forge, which continued in operation sometime after the furnace shut down, using pig iron from Pennsylvania.

This furnace had the distinction of casting the first Maryland cannon during the Revolution. Bishop[1] states that "Daniel and Samuel Hughes were proprietors of an air furnace in Frederick County (afterward made Washington County). On July 1, 1776, the Maryland Convention authorized the Council of Safety to lend the proprietors for nine months the sum of £200 common money, to encourage them 'to prosecute their cannon foundry with spirit and diligence.' They had then nearly completed a contract for casting cannon for the State, and were, a few days after, introduced to the

[1]Bishop: Hist. of American Manufactures, 1864, Vol. 1, p. 589.

Continental Congress by a letter from the Convention, which stated that the Messrs. Hughes had been at much expense in fitting up their works. Although their first guns did not stand the proof, the foundry was then in condition to make very good ones in greater numbers than the Province would possibly require. They proposed to enlarge their works if Congress would take all the guns they could make during the next year. A contract was made with them for 1,000 tons of cannon toward which $800 were advanced. In the same year, the people of Alexandria, Virginia, applied to Congress for permission to purchase cannon at the Messrs. Hughes' furnace, stating that they were 'the only persons in this part of the continent to be depended on for cannon.' In May, 1777, Congress allowed them $22-⅔ per ton, in addition to the sum mentioned in the contract."

Mount Etna Furnace.—The Mount Etna furnace was situated at the fork in the road two miles southwest of Pondsville, and the site is still marked by traces of the old cinder bank. This furnace was built by Samuel and David Hughes subsequent to the erection of the Rock Forge furnace, and was managed by John Horine. A personal communication from Dr. E. Tracy Bishop of Smithsburg places the date of its erection in 1809. It was discontinued a few years after the close of the war of 1812.

Mariah Furnace.—The Mariah furnace was located at Mousetown, a quarter of a mile east of the turnpike below Boonsboro. It shut down about thirty years ago, when it was operated by a Mr. McGinley, who had bought it from Samuel Bentz.

Antietam Furnace and Iron Works.—These works were on the Potomac River at the mouth of Antietam Creek. The original company consisted of Joseph Chapline, Samuel Beall, Jr., David Ross, and Richard Henderson. The articles of agreement were drawn up February 4, 1763, and recorded October 31, 1765. Joseph Chapline furnished the land warrants and was paid £300 by each of the others. There are seven articles of agreement, in the second of which the limits of the tract are thus described:[1] "Beginning on

[1]From an old newspaper clipping in possession of Mr. J. P. Smith of Sharpsburg.

the Potowmack River, one hundred yards west of the Anti-Eatam Creek and extending parallel to Anti-Eatam Creek until a west course will meet Beaver Creek, and then by the Marsh Branch of Beaver Creek, so as to include all the ore and wood of South Mountain, then down the east side to the Potowmack and up the Potowmack to the beginning."

A second charcoal furnace 50 feet high and 15 feet wide at the boshes was built here in 1845. The production, in twenty weeks during 1857, was 1,465 tons of hard metal, which was sold in Boston and Wheeling. This furnace had to be abandoned during the Civil War, but after the War was restored as a coke furnace by Daniel V. Ahl, of Pennsylvania, and operated until 1878.

A forge was built in connection with the original furnace and operated until the fifties. In 1831 a nail factory with twenty-five nail machines and a small rolling mill with two heating furnaces and two trains of rolls, were erected and operated until 1853.

Mr. T. J. C. Williams, in his history of Washington County, gives the following detailed description of the plant:

"The old nail factory at Antietam Iron Works, owned at the time by John McPherson Brien, was burned on April 25, 1841. It was rebuilt, increased in size, and in operation in two months. These works gave employment in 1841 to two hundred white laborers and sixty slaves. * * * * The head of the fall at these works is about twenty feet. At the time of which we are speaking one water-wheel fourteen feet high and eight feet wide drove an improved saw-mill, and shingle, stave, and jointing machines. The furnace bellows wheel was twenty feet high and four feet wide. The furnace blown by this wheel made 40 to 60 tons of metal a week. Another water-wheel sixteen feet high, drove nineteen nail and spike machines with the necessary cutters to prepare the plates. Between 400 and 500 kegs of nails varying in size from two-penny up to seven inch spikes were manufactured each week. Another water-wheel twelve feet high worked a ponderous chaffery hammer. There was a six-fire forge, with a hammer weighing twenty-one tons driven by a sixteen-foot wheel. There were also two forge bellows wheels seventeen feet high. There was a rolling mill for turning rolls of various sizes, nail rods, nail plates, and bar iron. This machinery was driven by an overshot wheel fourteen feet high and twenty feet wide. There were also three puddling furnaces and an air furnace. Two other wheels, seventeen feet high, drove a merchant grist mill, with four run of French burrs. All of these wheels were driven from the same race, supported by a strong wall laid in hydraulic cement. Two hundred and fifty yards away was the canal basin, where coal, lumber and ore were received and the products of the works shipped in boats owned by Mr. Brien. * * * The Antietam Works were erected by Wm. M. Brown, and were operated by Ross, Bell and Henderson, of Baltimore, until they came into the hands of Mr. Brien. In July, 1853, they were sold to William B. Clark for $54,500. In 1855 Clark sold a half interest to Levi Easton for $35,000. Afterwards the property was sold to Daniel V. Ahl of Pennsylvania."

Frederick County.

Catoctin Furnaces.—These furnaces were situated on the Frederick and Emmitsburg turnpike, three and a half miles south of Thurmont. In 1770, Leonard Calvert and Thomas Johnson received a patent for this tract of seven thousand acres, which in 1774 passed into the hands of the brothers, Thomas, Baker, Roger, and James Johnson, by whom the first furnace was erected in that year. Alexander, writing about 1840, gives the following account of these works, which he obtained from James Johnson, of Baltimore, a descendant of the original builders:

"The original furnace was built in 1774 by James Johnson and Company, within a mile of the present furnace stack, and carried on successfully until 1787, in which year the same company erected the present furnace, about three-quarters of a mile further up Little Hunting Creek, and nearer the ore banks. This was operated by James Johnson and Company until 1793, when division was made among the brothers by lot. Catoctin fell to Thomas and Baker Johnson, two-thirds and one-third, respectively, who carried it on not very successfully until 1803, when Baker Johnson bought out his brother and rented to Benjamin Blackford for ten years at £1100. At the expiration of the lease, the property was sold by executors to Willoughby and Thomas Mayberry, and was after their dissolution of partnership carried on by Willoughby Mayberry until 1820, when it was sold by trustees to John Brien, who made very extensive improvements. It is now [1840] in the possession of the heirs of Mr. Brien. The furnace was blown out in November or December last, and is not expected to be in blast again this year."

Alexander then adds, "The yield of the old furnace was twelve to eighteen tons per week, and that of the present about the same. The ore is brown hematite, containing in cavities more or less phosphate of iron. It has been represented to me as expensive to raise and the quality of the metal not of first grade. In the ore is associated carbonate of zinc.

"Shortly after the erection of the first furnace, the same company built the Bush Creek forge, consisting of a finery and chaffery,

on Bush Creek, two miles above its mouth, and made from three to four tons of iron per week. A slitting and rolling mill was also erected at what is now called Reel's Mill, but abandoned after a few years. The forge became the property of Colonel James Johnson and was operated until 1810. The Baltimore and Ohio Railroad passes on the site of the hammer wheel."

The statements that follow are based mainly on information obtained from Mr. L. R. Waesche, of Thurmont, at one time manager of the property. The furnace was re-built and soon after came into the possession of Peregrine Fitzhugh. The previous operators had converted their pig iron into hollow ware, as stoves, etc., but Fitzhugh also shipped pig iron to Frederick. In 1859, he erected a steam cold-blast charcoal furnace, but the expense crippled him so that John Kunkle obtained the property, which was then operated for him by his sons, John B. Kunkle and Jacob M. Kunkle, and later came into their possession. The Kunkles abandoned the hollow-ware furnace. In 1867, Jacob M. Kunkle sold out his interest to his brother. A third furnace, an anthracite and coke furnace, with a capacity of thirty-five tons a day, was put up in 1873 by John B. Kunkle. In 1876 he took out letters patent in the United States for the elimination of phosphorus from pig iron by the use of magnesian limestone in the furnace. He also claimed that by the use of this agent pig iron could be freed from phosphorus while being refined into iron or steel. No notable results seemed to have followed the granting of this patent, but it shows that he was running his plant intelligently. The annual output is given at 1200 tons of pig iron at this period, which was used for car wheels, foundry, and milling purposes.

John B. Kunkle died in 1885, and his children formed the Catoctin Iron Company, which shut down and went into the hands of receivers in 1887. In 1888, the plant was operated by the receiver for a year, and then the Catoctin Mountain Iron Company was formed which lasted until 1892. A paint mill was erected and operated for several years during this time, producing blue, red, and yellow ochre from the banks north of the furnace, which are in operation at the present time. The output of pig iron was about

thirty tons a day. In 1892 the price of iron had so declined, that the company was forced to shut down, and in 1899 sold out to the Blue Mountain Iron and Steel Company. This Company began operations in May, 1900, with an output of about forty tons per day, and remained in operation until February, 1903, when it discontinued and the property was sold in court in 1905 to Mr. Joseph E. Thropp, of Earlston, Pennsylvania. Mr. Thropp completely dismantled the old furnaces and is working only the ore banks for his furnaces in Pennsylvania. Figure 2, Plate VIII, is a view of the old furnace just before it was torn down in 1905.

Bishop[1] states that General Thomas Johnson and his brother were owners in 1777 of a furnace at Frederick, but it was not then in blast. In answer to the Provincial Council, in July, 1777, for cannon, General Johnson stated that they intended to get in readiness to cast such cannon and swivels as were wanted, and if they succeeded in making good guns, they would deliver them in Baltimore for £40 per ton, after they had been proved at the works at public expense. At that time they had on hand and could supply of their manufacture, pots, kettles, and Dutch ovens. This was undoubtedly the Catoctin furnace.

Hampton Furnace.—Old Hampton furnace was built between 1760 and 1765 by persons whose names have not survived, on Toms Creek, a mile and a half west of Emmitsburg. Ore from the Catoctin banks was at first used before the Catoctin furnace was built. It was soon abandoned for want of good ore.

Fielderia Furnace.—This furnace was built by Fielder Gantt, on the Harpers Ferry road, three miles from Frederick, in 1789 to 1790. It made but one blast, and was then abandoned. The lands were divided into wood lots, and sold out in the years 1791 and 1792, and a grist mill belonging to John Hoffman, of Frederick, was built on the furnace site.

Johnson Furnace.—The Johnson furnace was erected by the owners of the Catoctin furnace in 1787. It was located on the south side of Furnace Branch, a tributary of the Monocacy River, about

[1] Bishop: Hist, of American Manufactures, 1864, Vol. 1, p. 589.

a mile and a half northwest of Dickerson. When the property of James Johnson and Company was divided in 1793, this furnace fell to Roger Johnson, and was operated by him until some years after 1800. The ore was brought from the banks at Point of Rocks in boats on the Potomac and by wagons. The output was from twelve to fifteen tons of good grade pig iron per week.

According to Swank, soon after he obtained the furnace in 1793, Roger Johnson erected the Bloomsburg forge on Big Bennetts Creek, about five miles above its junction with the Monocacy River. The weekly output was four to five tons of finished iron. Alexander states, however, that the forge was erected with a finery and chaffery between 1787 and 1790, and was carried on profitably a year or two by working up "stamp-stuff" from the cinder heaps of the old Catoctin furnace. The forge was abandoned between 1800 and 1805.

Lonaconing Furnace.—This furnace was built by Barker and Company, of Baltimore, at Knoxville, in 1848, but was operated for only a short while. In 1868, it was rebuilt by Christian Geiger; and, after being run by him for nearly a year, was sold to a Pittsburg company which operated it about ten years.

Carroll County.

Legh Furnace.—The Legh Furnace was built at Avondale, about 1765, by an Englishman named Legh Master. It did not make more than one or two blasts, "the ore proving unproductive, and the iron indifferent," before it was abandoned. A portion of the old stack, which seems to be the part immediately above the cinder notch and below the boshes, still marks the site.

Elba Furnace.—The Elba furnace was erected by James W. Tyson, of Sykesville, in 1847, on the north bank of the Patapsco River, one hundred and fifty feet east of Warfield Station, on the Baltimore and Ohio Railroad. It was a steam and water charcoal furnace 30 feet high and 8½ feet wide. The stack was built of granite and lined with brick, and part of it is still standing. In

1855 it made, in thirty-three weeks, 965 tons of car-wheel iron. The ore was obtained chiefly from the Springfield Mine, north of Sykesville; from near Mt. Airy; and carbonate ore from near Relay. In 1868, the flood destroyed the property just after the furnace had been blown out, and it was never rebuilt.

Baltimore County.

Whittaker's Furnace.—Keyser states that "Whittaker's furnace near the Gunpowder was built in 1810, and was used as a shovel factory. It was subsequently purchased by Horace Abbott, who converted it into a forge for making shafts for steamboats." This plant was abandoned before the Civil War. It was located on the west bank of the Gunpowder Falls, just below Franklinville, and to the north of the bridge which crosses the Falls at that point.

Gunpowder Furnace.—The south side of the Gunpowder Falls, about one hundred yards above the Philadelphia road, was for over a century the site of iron enterprises. In 1760 the Long Cam forge at this site was owned by members of the Ridgely family. The date of erection of this forge is unknown, but it is believed to have belonged at first to persons in England.

Subsequently other forges were erected by the Ridgelys on this and other sites. In 1765, they negotiated with a widow Risteau for a forge site further up the Falls near the head of the present Loch Raven, but it is not known whether or not the land was secured at that time, as there was some difficulty with regard to the title to the property. As this property was later in the possession of the Ridgelys, a forge may have been erected there. Keyser states that in the early days, John Ridgely built two furnaces, one known as the Nottingham or Whitemarsh Run, which was permanently out of blast in 1815, and a second on the Great Gunpowder, which produced cannon and swivel in 1776. As no mention is made of any furnace other than the Northampton in the old records, it is not probable that furnaces were erected at these places, and Keyser has no doubt erroneously referred to the forges as furnaces. At the death of Governor Ridgely in 1829, the forges on the Gunpowder were still in op-

eration, and his will bequeaths a half interest in those "forges and rolling mills" to David Ridgely.

The Nottingham works are first referred to in the Maryland Gazette of January 4, 1749, and are probably the same as the Nottingham furnace mentioned by Keyser. They were located on Honeygo Run, a branch of Whitemarsh Run, three hundred yards from Cowenton station on the Baltimore and Ohio Railroad, on the south side of the road to Chase. A few remnants of the stonework are still standing. Reference to these works are extremely scanty and indefinite, but there is nothing to indicate the existence of a furnace here. A forge on this site in 1749 could have conveniently secured pig iron from the two neighboring furnaces of the Principio Company, the Lancashire and the Kingsbury furnaces. Moreover, the ruins do not suggest a furnace, nor do the Ridgely records mention a furnace.

The site of the Gunpowder forge finally passed into the hands of Robert Howard, the owner of the Locust Grove furnace, who in 1846 erected a furnace there which he operated until 1860. It was a hot blast charcoal furnace 31 feet high and 8 feet wide at the boshes, and in 1856, in thirty weeks produced 1100 tons of foundry and forge iron. The ruins of the stack and what were probably the walls of the old forge building are still standing.

Joppa Iron Works.—The Joppa Iron Works were on the Gunpowder Falls, on the north side of the present Baltimore and Ohio Railroad tracks. They were built in 1820 by J. W. and E. B. Patterson, and rebuilt in 1851, when they were owned by Edward Patterson and Sons, of Baltimore. They consisted of six puddling and one heating furnace, two trains of rolls, thirty-seven nail machines, and one hammer, driven by water. They constituted one of the most extensive plants in the State at that time, and produced 34,000 kegs of nails annually. They remained in successful operation until about 1860, and the ruins are still standing on both sides of the stream.

This may also have been the site of the Onion Iron Works. Stephen Onion very early severed his connection with the Principio Company, and built a furnace and two forges at a locality of which no nearer description is given than that it was at the head

of the Gunpowder, about one mile from old Joppa. The November court records of Baltimore County, 1743, show that he applied at that time for tax exemption on the eighty laborers which were allowed owners of iron works. Stephen Onion died August 29, 1754. In 1769, the works belonged to Zacheus Onion, the grandson of Stephen Onion, and were advertised for sale in the Maryland Gazette for August of that year. After that no mention of them was found.

Northampton Furnace.—This furnace was also known as the Hampton furnace, but, according to Alexander, during the first ten years of its existence was best known under the name here given. It was built and operated by members of the Ridgely family and the following account is based largely on information very kindly furnished by Mrs. John Ridgely of H. from some of the original records which are in her possession. The furnace was located on what is now Mr. Otho Ridgely's farm, two miles and a half north of Towson, on the Spring Branch of Patterson Run. The site is still marked by the crumbled ruins.

The furnace was erected by Charles Ridgely and his sons, John and Captain Charles Ridgely. "On February 28, 1760, a return was made of a writ of condemnation which Charles, the Elder, had with curious caution sued out and laid to cover a hundred acres of his own land." This writ was applied for 1759 and was for one hundred acres "on the south side of the Main Falls of the Gunpowder and on Patterson's Great Run." The instrument of copartnership of the three proprietors bears the date of October 28, 1761. Besides the furnace erected on this site, they also owned the Long Cam forge on the Gunpowder Falls, the details in regard to which are given in the account of the Gunpowder furnace. From November 30, 1763, to April 9, 1764, pig iron and bar iron to the value of £1858. 7s. 10d. was shipped to their agent in London. In 1766, they were told not to ship more than 20 tons of iron on a ship, as the shipments of tobacco from Virginia were unusually heavy.

In 1765, Captain Charles Ridgely started a general merchandise business in Baltimore, and in 1766 took in as partner his nephew,

FIG. 1.—BLAST FURNACES, MARYLAND STEEL COMPANY, SPARROWS POINT, BALTIMORE COUNTY.

FIG. 2.—PRINCIPIO FURNACE, PRINCIPIO, CECIL COUNTY.

VIEWS OF MARYLAND IRON FURNACES.

William Goodwin. This later became the firm of Ridgely, Howard and Lux. The management of the iron works seems finally to have devolved wholly upon Captain Ridgely. Consequently in 1771 he made Goodwin his agent for handling the output; and, shortly afterward, he appointed his cousin, Henry Howard, of Ridgely, Howard and Lux, manager of the Northampton furnaces. Captain Ridgely finally obtained complete possession of the iron works, and in 1775 they were being operated by the above mentioned firm. The founder at this period was George Teal, who was paid at the rate of 2s per ton and charged 6s per week board. The output of one blast, which ran from April, 1774, to August, 1775, was 1693 tons of pig iron, and that of the following blast, from February 6, 1776, to October 22, 1776, was 823 tons. During the year October, 1775, to October, 1776, 2081 tons of ore were mined and hauled to the furnace. A list of employees at the furnace in 1786 includes over thirty names.

Captain Charles Ridgely died in June, 1790, and his property was inherited by his nephew, Governor Ridgely, by whom the furnace was run for some years but discontinued and abandoned before his death in 1829.

Locust Grove Furnace.—This furnace, located a quarter mile north of Stemmer Run, was built in 1844 by Robert Howard, and was 30 feet high and 7½ feet wide at the boshes. In 1857 it produced, in thirty weeks, 1277 tons of pig iron. It was managed for some time by George R. Burroughs, and in 1865 was bought by him. In 1878 it was bought by Levi Furstenburg and S. J. Adler, and operated by them until 1885, producing about 1200 tons of car-wheel iron annually. When built it was a hot-blast charcoal furnace run by water-power, but it was subsequently changed to a steam-blast furnace.

Lancashire Furnace.—The Lancashire furnace was bought by the Principio Company from Dr. Charles Carroll of Annapolis, September 4, 1751. The price paid was £2,675 and the deed was signed on behalf of the Company by Lawrence Washington, who had succeeded to the interest of his father, Capt. Augustine Washington. The tract included eight thousand two hundred acres on drafts of

Back and Middle Rivers and Whitemarsh Run. Dr. Carroll took out his writ of condemnation for this furnace in 1744, and it was operated by the Principio Company until their property was confiscated during the Revolution. There is no direct statement as to the correct location of the furnace, but the November court records of Baltimore County for 1754, refer to the Lancashire works on North East Creek. Alexander also writes in 1840 that there had been a furnace on Stemmer Run. Hence this furnace must have been located on the site of the later Locust Grove furnace.

Kingsbury Furnace.[1]—The Kingsbury furnace, on the east side of Herring Run, just below the Philadelphia road, on the site of the present power-house, was built by the Principio Company. Major Thomas Sheridine took up land in Baltimore County in 1721, and from him in 1734 they purchased nearly fourteen hundred acres of what were afterward known as the Kingsbury lands, as well as all the ore and ironstone on the remaining property of Sheridine, for £800. The furnace was built in 1744 and went into blast in April, 1745. The patent was issued to Sir Nicholas Carew, Bart., Osgood Gee and others for one hundred acres of land at the head of Back River on Herring Run. At this site, after the furnace had been abandoned, General Smith, a celebrated Revolutionary commander of the old Maryland line, built a mill. The first four blasts gave the following yield:

	Begun.	Blown Out.	Duration.	Product.
First Blast.....	April 1, 1745	Dec. 18, 1745	9 months.	480 tons.
Second Blast.....	Aug. 16, 1746	Dec. 1, 1747	16 "	1,108 "
Third Blast.....	Sept. 8, 1748	Oct. 6, 1749	13 "	1,055 "
Fourth Blast.....	Oct. 1, 1750	Dec. 26, 1751	14 "	1,212 "
			52 "	3,853 "

This was an average of 75 tons per month. More than 3300 tons of the iron were shipped to England. The furnace was probably never worked again after confiscation in 1780 by the Maryland General Assembly.

[1] Henry Whiteley: The Principio Company, Penn. Mag. of Hist., 1887, p. 195-6.

Ashland Furnaces.—Three anthracite steam and water furnaces were erected at Ashland. The first, which was 32 feet high and 11 feet wide at the boshes, was built by Christian Geiger in 1837, and afterwards sold to Philip A. and Samuel Small of York, Pennsylvania, and Joseph W. and Edward Patterson of Baltimore, who operated it under the firm name of Patterson, Small & Co. The second stack was erected in 1848. The ores were derived mainly from the Oregon Ore Banks nearly three miles to the west. During the fifties, a consolidation was effected with the Oregon furnace owned by Richard Green, and the Ashland Iron Company, incorporated with Richard Green as manager, which position he held until his death in 1861. A third furnace was erected here in 1864. No. 1 furnace is recorded to have made 2,513 tons of pig iron in thirty-four weeks in 1854, and No. 2 made 4,215 tons in 1856. The furnaces were abandoned early in the eighties.

Oregon Furnace.—This was an anthracite steam furnace, 36 feet high and 11 feet wide at the boshes, and was built in 1849 by Richard Green, at the Oregon Ore Banks. He leased ore banks from Miss Charlotte C. D. Owings, which adjoined those held by Patterson, Small & Co., owners of the Ashland furnaces. Difficulty having arisen between the two operators in reference to priority and right of ore leases under Miss Owings, which culminated in armed resistance and expensive litigation, a consolidation was agreed upon and the Ashland Iron Company incorporated with Richard Green as manager. This furnace was run but a few years, as pig iron could be made more cheaply at Ashland. In 1855, the output was 4,419 tons of pig iron.

Gwynns Falls Furnace.—This furnace, which was the second built in Maryland, was erected in 1723 by the Baltimore Company, on the land of John Moale, at the mouth of Gwynns Falls. A forge, called the Mount Royal forge, was erected at the same time on Jones Falls at the site subsequently occupied by General Stricker's mill, which was supposedly in the neighborhood of the present Monument Street. This company consisted of Charles Carroll, Esq., Benjamin Tasker, Jr., Daniel and Walter Dulany, Charles Carroll, Jr., Esq., of Dud-

dington Manor, and Charles Carroll, Barrister. A one-fifth share in this enterprise, belonging to the estate of Colonel B. Tasker, was sold March 13, 1725, for £5,200. How long this furnace was in operation could not be ascertained.

Maryland Steel Company.[1]—The works of this company, which belong to a later period than the numerous smaller furnaces and forges described in this report, are situated at Sparrows Point. It seems pertinent, therefore, to refer briefly to the causes which led to the establishment of this extensive plant near Baltimore.

Bessemer steel for railroad rails was first made in this country at the works of the Pennsylvania Steel Company at Baldwin (now Steelton) near Harrisburg, Pennsylvania, in 1867. The pig iron for the Bessemer converters being smelted from ores mined in eastern Pennsylvania and New Jersey. With the development of the industry the quantity of domestic, low-phosphorus ores available for works east of the Allegheny Mountains became inadequate for the rapidly increasing requirements and recourse was had to the Spanish and Algerian mines from which many European furnaces drew their supplies.

In 1882 large deposits of low-phosphorous magnetic iron ores were discovered in Cuba in which the Pennsylvania Steel Company acquired extensive interests. To utilize these ores to the best advantage it was decided to build blast furnaces at a tidewater point readily reached by the coals of central Pennsylvania and West Virginia.

Baltimore was chosen, and in 1887 the construction of four blast furnaces was begun at Sparrows Point on the north side of the Patapsco River, about ten miles from the center of Baltimore City. It was at first intended to ship the product of the furnaces to the parent works in Pennsylvania for conversion into steel, but with the development of methods for the direct use of the molten pig iron, the obvious advantage of locating Bessemer works and rolling mills in the immediate neighborhood of the blast furnaces, led to the abandon-

[1] This account and the photograph of the works (Plate IX, Fig. 1) were furnished by the Maryland Steel Company.

ment of the original plan and to the construction of the steel works and rolling mills described below.

In 1891 the Maryland Steel Company was organized under the same ownership as the Pennsylvania Steel Company and took over the property and works at Sparrows Point.

The four blast furnaces are alike in principal dimensions, viz: 85 feet high and 19 feet bosh diameter. Blast is supplied by compound condensing blowing engines located in a common engine house. Each furnace is equipped with four fire brick hot blast stoves 90 feet high and 22 feet in diameter. Steam is generated by Babcock and Wilcox's water tube boilers, fired with gas from the furnaces. The pig iron is carried in a molten condition either to the steel works or to casting machines. The output of the furnaces (according to the ores used) varies from 9,000 to 10,000 tons each per month.

The Bessemer department contains two 120-ton molten pig-iron reservoirs, seven cupola furnaces for melting pig-iron and spiegeleisen, and three twenty-ton converters. The steel is conveyed by travelling cranes from the converters to ingot moulds mounted on cars, permitting immediate removal of the hot ingots to the adjacent rolling mills.

The Open Hearth department contains five fifty-ton tilting, open hearth furnaces with a full equipment of electric travelling cranes and most modern appliances for charging the furnaces and handling the steel produced.

The Blooming mill in which the ingots from the Bessemer and the Open Hearth departments receive their first treatment, is equipped with vertical gas-fired heating furnaces and 36-inch diameter reversing rolls. From the blooming rolls the hot blooms pass direct, without reheating, to a three-high train of 28-inch diameter rolls where they are rolled into rails or billets.

The average monthly output of rails in a period of normal business activity is 35,000 tons.

Besides the departments described above, the works include a by-product coke plant of 200 ovens; docks for reception of ore and the shipment of products; foundries, machine shops and a well

equipped shipyard for the construction of steel vessels of the largest size built in this country.

Stickney Furnaces.—On the site of the Stickney Iron Company furnaces, at the foot of Clinton Street, Canton, the Cecilia furnace was built in 1854, and owned by John Ahern. It was a steam hot-blast charcoal furnace, 33 feet high and 9 feet wide at the boshes; and in forty-three weeks in 1857, made 1,881 tons of pig iron. This same furnace was later owned by J. Henry Stickney,[1] and operated under the name of the Lazaretto furnace until 1870, when he organized the Stickney Iron Company, of which Mr. George H. Stickney became president in 1874 or 1875, and remained at the head as long as the company continued to exist. In 1872, the Cecilia was enlarged to 50 feet high, and in 1882 a second furnace was built, 50 feet high and 11 feet wide, which is supposed to have been the largest furnace in the east at that time. The annual output of these furnaces was 10,000 tons of pig iron, and they were in continuous operation until 1893, when they closed down for a year. In 1895 one of them was converted into a tin plate mill, but the other was operated until 1896, and was the last of the old charcoal furnaces around Baltimore to be operated. In 1899, the plant was disposed of to the American Tin Plate Company, and in 1901 the property was sold to the Baugh Fertilizer Company.

Chesapeake Furnaces.—These furnaces were on Clinton Street, near Seventh Avenue, Canton. They were steam hot-blast charcoal furnaces, and No. 1, which was 32 feet high and 8 feet wide at the boshes, was built in 1845, and No. 2, a duplicate of the first, was built in 1853. The annual output of each furnace was about 2,200 tons of forge metal, the markets for which were in Massachusetts, Philadelphia, Richmond and Wheeling. They were first owned by S. S. Lee & Co., and leased by Hugh Jenkins; and later owned by William F. Pannell, who was still operating them in 1880, just before they were shut down.

[1] What follows is based on a personal communication from Mr. George H. Stickney.

Baltimore City.

Cedar Point Furnaces.—These furnaces were built by Peter Mowell and a Mr. Numsen, at Boston and Potomac Streets, and were known at first as the Numsen Iron Works. One, built in 1843, was a hot-blast charcoal furnace; the other, built in 1845, a coke furnace. Their output in 1856 was 2,700 tons and 2,838 tons of car-wheel iron respectively. In 1863, they were sold to Horace L. Brooke, and discontinued about 1880, when the property was sold to the Philadelphia, Wilmington and Baltimore Railroad for coal docks.

Patapsco Furnace.—Alexander writes that the Patapsco furnace was owned and erected in 1835 by Messrs. E. T. Ellicott & Co., on Locust Point, close by the mouth of the harbor. It was 30 feet high and 6 feet wide at the boshes. "It was blown with one tuyere with a 20 HP steam engine as motive power. The average product was 1,000 tons annually. Ore was obtained formerly from beds near the furnace, but now [1840] comes from the Spring Gardens. Connected with the furnace are puddling furnaces and roughing mills which use up all the pig and furnish the bars to be manufactured at the Avalon works."

Operations were discontinued in 1849, and the plant was torn down in 1853. This must be the furnace referred to by Keyser as the first successful blast stove erected in the United States, which made the first cast steel in Maryland. "Edward Grubb went to England, and in order to get an opportunity to inspect the stove then in use, donned a workingman's clothes and hired as a filler. In this way he succeeded in getting plans, and upon his return to America had the castings made at York, Pennsylvania, intending to erect the ovens at the Codorus furnace; but Mr. Ellicott purchased the castings and had them hauled to Baltimore on six mule teams. The furnace made a good quality of cast steel in brick ovens."

Maryland Furnaces.—The Maryland steam hot-blast charcoal furnaces were located at Jackson and West Streets, on the south side of the Basin, and were owned by H. William Ellicott and brother. No. 1, which was 30 feet high and 9 feet wide at the

boshes, was built in 1840, and was operated until 1854, in which year it produced 2,000 tons of forge metal. No. 2 of the same size as No. 1 was built in 1853, and in twenty-nine weeks during 1856 made 1,058 tons of forge metal. It remained in operation until shortly before 1890. The market for its product was chiefly in Baltimore.

Laurel Furnaces.—The Laurel furnaces were steam hot-blast charcoal furnaces. The first of these, 31 feet high and 9 feet wide at the boshes, was built in 1846 by Daniel M. Reese, on the south side of the Basin. In 1855, its output was 2,162 tons. The second furnace, 33 feet high and 10 feet wide at the boshes, in 1856 made 2,600 tons of pig iron. This furnace is also referred to as the South Baltimore furnace. The furnaces were abandoned during the eighties.

Harford County.

Rough and Ready Furnaces.[1]—These furnaces were located in Havre de Grace, where the Philadelphia, Baltimore and Washington Railroad crosses the Susquehanna River, and were built and owned by George P. Whitaker, of Principio, in 1842 and 1843. They were two charcoal steam furnaces, 30 feet high and 9 feet wide at the boshes; and one of them in 1856, in twenty-one weeks, produced 1,265 tons of pig iron. Mr. McCombs states that he was one of four,—namely, Jethro McCullough, Deleplane M. Daniel, E. M. Bye, of Wilmington, and A. P. McCombs,—who bought these furnaces from Mr. George P. Whitaker in 1855, and organized the Havre Iron Company, with Mr. McCombs as president and manager. Brown hematite ores from various points in Maryland and Delaware were used, and also some magnetite from the Cornwall Mines at Lebanon, Pennsylvania. Previous to the Civil War, he says, lean and refractory ores were very cheap, and good charcoal pig sold as high as $75.00 per ton. After the war, it fell rapidly in price, while the royalties on ore advanced during and for some years after

[1] This account is based mainly on a personal communication from Mr. A. P. McCombs.

the war, reaching 500 per cent. above former rates. At the same time transportation rates also advanced greatly, so that the furnaces had to be discontinued in 1868.

Harford Furnace.—The Harford furnace was situated at what is now known as Harford Furnace, on a branch of Bush River, and until 1861 the furnace on this site was known as the Bush furnace or the Bush River Iron Works. The date of erection of the original furnace is not known. The Bush River Iron Works are mentioned in the Maryland Gazette for July 4, 1754, hence their erection antedates that time. In 1767 they were owned and advertised for sale in the same paper by John Lee Webster. Bolles (in his Industrial History of the United States, p. 203) says that in 1815 experiments were made here with a mixture of half anthracite and half charcoal.

According to Alexander, a later furnace was erected here in 1830 by the Messrs. Patterson, but was taken down in 1839, to be rebuilt. During this time, he says, titaniferous ore was used with good success, but required careful management. An analysis of this ore by M. Berthier is given below:

ANALYSIS OF TITANIFEROUS ORE USED AT BUSH FURNACE IN 1830-9.

Protoxide of iron Peroxide of iron	80
Titanic acid	18
Gangue	2

Another furnace, owned by Richard Green, was built here in 1845. It was a steam and water cold-blast charcoal furnace, 33 feet high and 7½ feet wide at the boshes, and in 1857 produced 1,421 tons of car-wheel metal. On the death of William Green in 1861, William F. Pannell became the owner and changed the name from Bush to Harford furnace. In the fall of 1867, he sold out to Clement Dietrich, of Cincinnati, who erected in addition a large factory to make pyroligneous acid. He lost heavily and shut down in 1876. A few slag covered bricks mark the site of the furnace stack, and the stone walls of the factory are still standing.

LaGrange Furnace.—A forge and slitting mill, known as the LaGrange Iron Works, was erected in 1832 by John Withers, on

Deer Creek, just above Rocks. In 1836, a cold-blast water-power charcoal furnace, 28 feet high and 6 feet wide at the boshes, was added by Messrs. J. Rogers & Son, who were then the owners of the works. The annual yield at that time was about 1,170 tons, and at the furnace and forge seventy-two men were employed. Later the height of the stack was increased to 35 feet, and the blast changed to hot-blast. The weekly output was from 25 to 30 tons, but as the furnace was operated only six months a year, the annual output was about 780 tons. The pig iron was sold to Ross Winans in Baltimore for car-wheel iron. In 1874, the works were discontinued.

Sarah Furnace.—The Sarah furnace was built in 1841, and rebuilt in 1851 by Small & Geiger, of York, Pennsylvania, on the north bank of West Branch, two miles southwest of Jarrettsville. It was a steam and water, hot-blast charcoal furnace, 31 feet high and 6½ feet wide at the boshes, and in 1856 made 971 tons of pig iron. About 1870 the operations were discontinued.

Cecil County.

Principio Furnace.—The account of the Principio Company is based almost entirely on a very full description of the operations of that company by Mr. Henry Whitely in the Pennsylvania Magazine of History, 1887.

Those most prominently connected with the company were Sir Nicholas Hackell Carew, Bart. of Beddington County, Surrey; Thomas Russell, of Birmingham, and his sons, William and Thomas Russell; Stephen Onion; John England; Joshua, Samuel and Osgood Gee; William Chetwynd, Esq., of England; and Augustine and Lawrence Washington, of Virginia.

Stephen Onion and Thomas Russell, Sr., if not the originators, were the most active promoters of the enterprise. They came to America, and, after careful prospecting, leased and opened ore banks, purchased woodland for making charcoal, built the Principio and North East works, the former consisting of a furnace and forge, the latter of a forge alone, arranged for the disposal of their bar

and surplus pig iron, and in short, established the business on a successful footing.

Extensive land grants were obtained by the company in 1722, in addition to their original purchases. Among the writs *ad quod damnum* granted out of the Provincial Chancery of Maryland, in pursuance of the Act of 1719 for the encouragement of iron manufactures, was one issued October 19, 1721, for twenty acres of land in Cecil County, for a grist mill which, as the books show, was carried on by the company with their furnace operations.

Russell and Onion having opened the business, left it in charge of John England, a practical iron-master, who was to act as their representative in America, and sailed together for Great Britain in 1724. Onion soon returned, and in 1726 was in active charge at Principio.

Ore for the furnace was at first obtained in the immediate neighborhood of the works, but before long they were compelled to bring it from more extensive deposits. Chief among these, were banks on the Patapsco River, first discovered by Captain John Smith in 1608. In 1724 they acquired rights to the ore on Gorsuch Point for the sum of three pistoles. In 1727, through John England, they purchased from John Giles, all the ore "opened and discovered or shut and not yet discovered" for the sum of £300 sterling money of England, and £20 current money of Maryland on Whetstone Point. This was for years one of their principal sources of ore.

From the ledger of the Principio Company for 1727 the following figures are taken:

ACCOUNT OF PIGS AT FURNACE, AUGUST, 1727.

	£	s.	d.
Iron ore, 90 tons, at 15s	67	10	0
Charcoal, 90 loads (say 11,880 bu.), at 18s	81	0	0
Oyster shells and limestone	5	0	0
Wages, John Barker, founder, 40 tons, at 2/6	5	0	0
Other labor, 40 tons, at 5/6	11	0	0
Disbursements	2	0	0
Total production, 40 tons pig iron, at cost of	171	10	0

This is equivalent to £4 5s 9d per ton of pig iron. This pig sold at the furnace for £10 per ton. Blooms were valued at £25 and

bar iron at an average price of £35 per ton, but the books do not show the actual cost of either.

In 1754 prices had fallen considerably. Bar iron then cost £21 10s, and was worth from £28 to £30; blooms were £18 and pig iron £8.

The following statement is from the ledger of North East forge for 1754:

COST OF 2,240 LBS. OF BAR IRON.

	£	s.	d.
Pig iron, 3,200 lbs., at 8	11	8	7
Charcoal, 480 bus., at 9s. per load of 144 bu	1	10	0
Forgemen's wages (white, 20s.; slave, 1s.), average		8	8
Hammermen's wages	1	0	0
Provision account (for slaves)	2	17	0
General charges, etc	4	5	9
Total cost	21	10	0

The Principio and North East works continued in full blast until the Revolution.

In 1725 the company started Accokeek furnace in Virginia, on land of Captain Augustine Washington, who became interested in the company. In 1743, at his death, he left his share, one-twelfth, to his son, Lawrence. Lawrence died in 1751, and about the same time the ore failed, and the furnace was abandoned. The company acquired two other furnaces in Baltimore County. The Kingsbury furnace on Herring Run, and the Lancashire furnace on Stemmer Run.

Thomas Russell left his interests to his sons, William and Thomas Russell. The latter, at the age of twenty-three, was selected by the partners as managing director and given £100 per month, on condition he go to America for at least two years. He set sail in the spring of 1764. The necessary independence of the managers in America gave great opportunity for fraud and mismanagement, and it was to correct the abuses which had crept into the management that Russell was sent over.

The product of 1765 turned out rank red-short, and being sold in England destroyed their old established reputation. Carelessness in drawing bar-iron by William Baxter, at North East, added

FIG. 1.—RUINS OF ELKRIDGE FURNACE, ELKRIDGE, HOWARD COUNTY.

FIG. 2.—MUIRKIRK FURNACE, MUIRKIRK, PRINCE GEORGE'S COUNTY.

VIEWS OF MARYLAND IRON FURNACES.

to their troubles. Owing to its irregularity, the Navy Department rejected a large lot. In May, 1767, the company wrote to Russell, "American bar iron here is a mere drug and not worth the company's while engaging in it; there is no market for it, as no one cares to purchase it even at £16 per ton." At the same time drafts for funds were heavy and incessant. Agriculture had been neglected to such an extent that wheat and corn had to be purchased. Trespassers had come in and squatted on some of the choicest lands. The contrast with their former prosperity was marked.

Seconded by the efforts of Francis Phillips, whom he had made manager at Kingsbury, things soon took on better shape. A new bank of ore was leased and opened. The pig proved to be of excellent quality. "As good," they said in London, "as ever our best Principio was." Having everything in shape again he sailed for England in June, 1767. The management was left in the hands of Francis Phillips and William Baxter jointly, the former in charge of Kingsbury and Lancashire, the latter Principio and North East forge. Each was required to submit his accounts to semi-annual inspection by the other. At the end of the year, Phillips died and things went back to their former shape, and in 1770, Nathaniel Martin was temporarily put in charge until Russell could be induced to return. He set sail in 1771.

This time Russell's efforts were not as satisfactory to the company. In nine months he drew drafts almost to £1200. This was not all Russell's fault, as conditions were no longer as favorable as formerly. Operating costs had increased, and prices of products had fallen. In 1774, shortly after his marriage to a Maryland lady, the company attempted to supersede him in the management. Martin had left the company, and was suceeded by George Matthews at Kingsbury and Lancashire, and Philip Cole at North East and Principio. To them a joint arrangement was proposed as before. To this Matthews raised objection, and Cole's ability was doubted, so it did not materialize. After the outbreak of the Revolution the company no longer had control of its property, and Russell furnished bar iron and cannon balls to the Americans. In 1780 the Maryland General Assembly passed an act confiscating the prop-

erty. Russell received in place of his interest the North East works and land.

In 1785 several thousand acres of the Principio lands were purchased from the State by Colonel Sam. Hughes, Edwin Cole, Richard Potts, and others. Soon after a blast furnace was erected a few hundred yards south of the original site. In 1790 Colonel Sam. Hughes bought out the other partners. During Hughes' ownership, the furnace seems to have been engaged in the manufacture of cannon, cannon balls, hollow ware, etc. In the War of 1812, Cockburn came up Principio Creek in barges, and destroyed the property, spiking the cannon that were on hand. Soon after the close of the War, Colonel Hughes partially restored the plant, but being financially wrecked, he abandoned the property in two or three years with a heavy mortgage on it in favor of Messrs. Smith and Gilmore, of Baltimore. Under this mortgage, it was sold in 1834 to David Stewart and others of Baltimore, who held it until June, 1836, when it was purchased by George P. Whitaker, Thomas Garrett, Joseph Whitaker, and others. They at once erected a new furnace which was put in blast in 1837. This was a hot-blast charcoal furnace, 32 feet high and 8½ feet wide at the boshes; and in 1856, produced in thirty-seven weeks, 800 tons of pig iron. This furnace was operated by the Whitaker Iron Company until 1889, and the old stack is still standing at Principio furnace. A view of this stack is shown in Figure 2, Plate IX. In 1891 a modern blast furnace was erected less than one hundred yards further down the stream which remained in blast less than a year, and in 1908 was dismantled and erected elsewhere. In 1884, a forge was erected by the Whitaker Iron Company for making blooms. This was leased in 1890 to the Principio Forge Company, which supplied charcoal blooms to the Tyler Tube and Pipe Company, and in 1908 the plant was taken over by this company. The blooms are now made from scrap.

The site of the old North East forge of the Principio Company again became the seat of an iron manufacturer in 1829. In the spring of that year, the property was leased from Mrs. Frances Sewall by James and George P. Whitaker. G. P. Whitaker took

charge and got a three-fire forge, with two hammers, into operation late in the fall of 1829 or early in 1830. About 1832, James Whitaker sold his interest to Joseph Whitaker and Thomas Garrett, who, with G. P. Whitaker, carried on the works until 1837, when they were sold out to William Chandler and James Whitaker, Jr., from whom they passed to Isaac Smith and Henry Nail, and thence to the McCullough Iron Company.

In 1847 the McCullough Iron Company erected on this same site the North East Rolling Mill, which burned down and was rebuilt in that same year. It consisted of one puddling and one heating furnace, and one train of rolls driven by water; and made, in 1856, 339 tons of sheet iron out of charcoal blooms and pig. During the Civil War, the plant was increased to nine puddling furnaces, three heating furnaces, two sets of sheet rolls, and eighteen forge fires. In 1875 it was again rebuilt and remained in operation until 1893. The site is now occupied by the North East Firebrick Company, and is on the west side of Northeast Creek, south of the Pennsylvania Railroad tracks.

A bloomery at North East, which was probably the pioneer iron enterprise in the State, was erected before 1716. That iron works were built at North East prior to 1716, is proved by a deed dated that year in which Robert Dutton conveyed a flour mill near the bottom of the main falls of North East, and also fifty acres of land to Richard Bennett for £100 in silver money. Iron works are mentioned as among the appurtenances conveyed. Swank says this could only have been a bloomery, as no furnace was then in existence which could have supplied pig iron to a forge. An inventory of the Principio Company for May, 1723, credits the company with the purchase on July 9, 1722, of three hundred and eighty-three acres of land "in Lord Baltimore's Manor of North East, called Vulcan's Tryal, Vulcan's Enlargement, and Diffidence." This may have embraced the North East iron works upon which site the company then erected its forge.

Russell Furnace.—On North East Creek, a quarter mile north of the Pennsylvania Railroad tracks, Thomas Russell, then twenty-one

years of age, and Daniel Sheridine, his father-in-law, built a furnace in 1802. Thomas Russell was the third of that name, and was the son of Thomas Russell, the general manager of the Principio Company at the time of the Revolution, who died in 1786. On the death of young Russell in 1806, the furnace was discontinued, as it had not been profitable.

On this same site, the McCullough Iron Company erected the Shannon Rolling Mill in 1857, consisting of one heating furnace and one train of sheet rolls driven by water power, which made sheet iron out of bars obtained from the North East Rolling Mill owned by the same company. This plant was shut down shortly before the other mill in 1893.

Howard County.

Elkridge Furnace.—The Elkridge furnace was situated on the Patapsco River, a half mile east of Elkridge Station. The site is still marked by the ruins of the stack, a photograph of which is shown on Plate X, Figure 1. On November 3, 1755, Caleb Dorsey, Alexander Lawson, and Edward Dorsey, of Annapolis, were granted a patent on one hundred acres at Elkridge, on a run of the Patapsco, near C. Dorsey's house. They paid £300 damages in currency. A furnace and forge were erected here which were in operation before 1759.

At Elkridge Landing, a Dr. Howard owned a tilting forge in 1783, which was probably on the same site as this furnace.

In 1826 Andrew Ellicott, Jr., and brothers, erected a furnace on this same site, 32 feet high and 8½ feet wide, with the blast driven by water-power from the Patapsco, and a forge was still run in connection with the furnace. The annual output was 1400 tons of pig iron, which was almost entirely produced in castings of various kinds, principally water and gas pipes. One hundred hands were employed at that time. In 1835 they made cast-iron water pipes for the Croton Water Works of New York.

This furnace was rebuilt in 1854, and operated by the Great Falls Iron Company. It was a steam and water hot-blast char-

FIG. 1.—CURTIS CREEK FURNACE, FURNACE CREEK, ANNE ARUNDEL COUNTY.

FIG. 2.—NASSAWANGO FURNACE, NEAR SNOW HILL, WORCESTER COUNTY.

VIEWS OF MARYLAND IRON FURNACES.

coal furnace, 32 feet high and 9½ feet wide at the boshes; and in thirty weeks in 1857, made 1564 tons of forge iron for Baltimore, Wheeling, and the Avalon Works above Relay. During the Civil War, it was leased by Brooks and Moore. After the War, it was run by James P. Ellicott, and later by Howard Brown until 1872, when it was finally abandoned.

Savage Furnaces.—The Savage furnaces were on the north bank of the Little Patuxent River, at Savage, to the west of the present cotton-duck mill. Two furnaces were erected here about 1835 by the Savage Manufacturing Company, but a foundry had been in operation on the site for some time before. They were run but a short time, as Lesley says they had been out of blast for twenty years in 1859, and that a cupola furnace there was never used, and was then in dilapidated condition.

A furnace and foundry was again operated from 1864 to 1866, by John Burroughs, and after that until 1874 by Thomas Fairall, when the works were abandoned. The foundry made a specialty of all kinds of machinery.

Anne Arundel County.

Curtis Creek Furnace.—The Curtis Creek furnace (Plate XI, Figure 1), also known as the Marley furnace, was located on the south side of Furnace Creek, a branch of Curtis Creek, a half mile east of Light street road. The ruins of the stack still mark the site. In 1758 Caleb and Edward Dorsey, and Alexander Lawson, applied for a writ *ad quod damnum* for one hundred acres for a furnace to run pig iron on a branch called Long Bridge Branch, near the head of Curtis Creek. The writ was granted in 1759. On August 23, 1773, Samuel Dorsey, Jr., Charles Ridgely, Michael Poe, William Goodwin, and William Buchanan, the co-partners of the Northampton furnace, in the adjustment of their affairs, sold the works to a Mr. Barker, who operated them as the Curtis Creek Iron Works. As late as 1840 they were being operated by J. Barker and Son. The furnace was 30 feet high and 9½ feet wide at the boshes. The blast which was 900 cubic

feet per minute, and blown through one tuyere pipe, was driven by the water of the creek which also turned three other wheels connected with the establishment. The dam was one mile to the southwest, and the old race can still be traced from the mill pond across Light Street road to the furnace. The iron was known for its toughness and tenacity. A foundry was erected here in 1829 by the Barkers, and this and their foundry in Baltimore converted into castings two-thirds of the annual output of 1100 tons of pig iron. The entire establishment employed one hundred and fifty men. The plant was last operated by Wilkens Glenn, of Baltimore, and abandoned in 1851.

Patuxent Furnaces.—The Patuxent furnaces were built on the site of the still older Snowdens' Iron Works, on the north side of the Little Patuxent River, at the Old Forge Bridge, a mile south of Portland Station. The date of erection of the original furnace, which seems to have been a puddling furnace, is not known, but Swank says that John England, one of the members of the Principio Company, spent the last years of his life on his estate, and at Snowdens' Iron Works on the Patuxent River, in which he had an interest. He died in 1734, hence the works were erected some time before that date.

In 1831, they consisted of a furnace and forge, and were sold by Thomas, Richard and Edward Snowden to Evan T. Ellicott and Company, who erected another furnace, 28 feet high and 8 feet wide at the boshes, and a puddling furnace and roughing mills for converting pig iron into bars for the Avalon works above Relay. These furnaces were water-power, and the blast was blown at a pressure of 1¼ lbs. per square inch, which is said to have been the usual blast at that time. The blast was later changed to a steam hot-blast. There was never more than one furnace in blast at once, and the annual output was about 1200 tons. On account of lack of wood and ore, the plant was dismantled and destroyed in June, 1856, at which time it was owned by William Wilkins Glenn, John Glenn, Jr., and Robert Lemmon.

Figure 1 is a photograph of an old fire-back made at this furnace in 1738.

FIG. 1.—FIREBACK MADE AT PATUXENT FURNACE, 1738.

Prince George's County.

Muirkirk Furnace.—The original Muirkirk furnace, a steam hot-blast charcoal furnace, 28 feet high and 8½ feet wide at the boshes, was built at Muirkirk in 1847, by William and Elias Ellicott, owners at that time of the Patuxent furnace in Anne Arundel County. In 1855 it was bought by William E. Coffin and Company, and leased out by them until 1862, when they took charge themselves. In 1863, the furnace was taken over by George R. Burroughs and Mr. Charles E. Coffin, at which time the weekly output was 33 tons of pig iron. A year later Burroughs sold out to Mr. Coffin, who became sole owner and operated the furnace until two years ago when he leased it to E. F. Coffin and Company whose lease expired April, 1911.

Mr. Coffin said that by improvement in manipulation, he increased the weekly output to from 120 to 140 tons, without changing the size of the furnace stack. It remained in constant operation until 1874, since when it has been operated just enough to supply the demand for the high grade of charcoal iron made here. In 1880, an explosion in the furnace burned down the plant, and in rebuilding, the height of the stack was increased to thirty-six feet.

The iron manufactured at this furnace possesses a remarkably high tensile strength, it having stood 41,000 pounds in the pig. For this reason, it commands an unusually high price, which has enabled this furnace to survive as the only one in the State now using Maryland ores. Mr. Coffin twice experimented with other ores,—once with hematite ores from Lake Superior, and once with limonite ores from Virginia,—but the iron was not as good as that produced from the Arundel carbonate ores of Maryland. A large part of the output was used by the United States Government, for the manufacture of shells, until in the eighties, when cast iron shells were no longer made. Another use has been for gun carriages and steel cylinders for torpedo boats. A considerable part of the output has always been used for the manufacture of car-wheels.

A view of the furnace is shown on Plate X, Figure 2.

Worcester County.

Nassawango Furnace.—The Nassawango furnace was built in 1830 by Mark Richards on the west side of Nassawango Creek, five miles northwest of Snow Hill, at a point known as Furnace. The old stack and the remains of some of the buildings are still standing. A view of the stack is shown on Figure 2, Plate XI. This furnace used exclusively bog ores obtained along Nassawango Creek above the furnace, and was the only one ever erected in the State to utilize these ores. Its annual production in the thirties was about 700 tons. In 1840 it was owned by T. A. Spence, and was operated by him until about 1850. This tract is now owned by United States Senator John Walter Smith and Mr. William Jackson, of Salisbury.

There is one other furnace, the York furnace, mentioned by Alexander, the location of which is unknown. He says, "where to locate the York furnace belonging to Mr. Swope, an advertisement concerning which I have met with in the Maryland Gazette for 1765, I am ignorant, the advertisement not defining the locality precisely."

OTHER IRON WORKS IN MARYLAND.

To attempt to give a full account of the iron works which have existed in Maryland, other than the furnaces, would carry this report too far afield. Nevertheless, it might be of interest to mention some of the more important enterprises that have existed, since it was to them in large measure, that the product of our furnaces went to be finished into the articles of industry. A number of these iron works were run in connection with the furnaces, and these have already been described in the accounts of those furnaces. The following section describes briefly some of those not yet mentioned.

Allegany County.

Baltimore and Ohio Railroad Rail Mill.—The Baltimore and Ohio Railroad built a rail mill in 1870 at Cumberland, with fifteen double puddling furnaces, fifteen heating furnaces, three trains of rolls, and three hammers; and in 1873, a bar mill for making bar iron, bolts, rivets, spikes, and fish plates. The capacity of the two mills was 40,000 tons. The manufacture of rails was abandoned in 1882, and the mill leased to the Cambria Iron Company for rolling steel billets.

Baltimore County.

Avalon Iron Works.—The Avalon Iron Works, on the Patapsco River, at Avalon, above Relay, were built in 1800 by the Dorseys, and afterward operated by Evan T. Ellicott and Company until 1850. Until 1840 they were devoted exclusively to the manufac-

ture of bar iron and had a capacity of 4500 tons annually. Subsequently the plant was extended and all kinds of merchant iron such as sheets, hoops, and nails, were manufactured. A rolling mill for rails was also added, and in 1848 rails were made for the Baltimore and Ohio Railroad. The old nail factory burned down in 1845, and was rebuilt in 1850, when the plant was sold to John McCrone and Company. In 1854 the works were pulled down and rebuilt, consisting of seven puddling furnaces, three heating furnaces, three trains of rolls, and forty-four nail machines, driven by steam. In 1856, 40,000 kegs of nails were made. The owners in 1859 were Joseph C. Manning and Company, of Baltimore. A cloudburst in July, 1868, caused a disastrous flood in the valley of the Patapsco which swept away the mills and dams and they were never rebuilt.

Canton Rolling Mill.—The Canton forge, a quarter of a mile above Cedar Point furnace, was operated in 1828 by Peter Cooper. In 1836 it was bought by Horace Abbott, who with a partner named Lawrence, made a reputation for heavy forgings for steamboat work and large machinery. In 1851, H. Abbott and Son added a rolling mill which they enlarged in 1854 to ten furnaces, three trains of rolls, and one hammer driven by steam. In 1856, they made about 2,000 tons of plate out of pig iron and blooms. A second mill with six furnaces, two trains of rolls and a Nasmyth hammer was added in 1857. Part of the armor plate for the Monitor was made here. The Abbott Iron Company was organized in 1865 and continued until 1879.

Cecil County.

Elk Rolling Mill.—The Elk Rolling Mill was built about 1810, on the East side of Big Elk Creek, a half mile northwest of Cowentown, on the site on which John Evans had copper works at the time of the Revolution. It was remodeled in 1825 or 1830 by Parke Brothers, so that it contained one puddling and two heating furnaces, and one train of rolls driven by water; and produced sheet iron, boiler plates, and nails. In later years its chief product was

sheet iron, and in 1855 made about 450 tons. In 1858, Parke, Smith and Company succeeded to the business, but were forced to close on account of competition in 1860.

Elk Forge Company.—The Elk Forge was built on the east side of Big Elk Creek, where the Elk Mills cotton factory now stands, east of Baldwin, in 1761, by the Elk Forge Company. This company was organized by John Roberts, David Davis, Thomas May, and David Thomas, of Philadelphia County, Pennsylvania, who formed a partnership to manufacture bar iron. Six hundred acres were obtained on Big Elk Creek from William Rumsey, called Rumsey's Success. The pig iron was brought from Lancaster, Pennsylvania.

West Anwell Iron Works.—The West Anwell Iron Works were on the east side of Big Elk Creek, two miles above Elkton, and were built in 1854 by E. A. Harvey, of Wilmington, Delaware, and enlarged in 1857, so that they consisted of one puddling, and four heating furnaces and one train of rolls driven by water. In 1856 the output was 337 tons of sheet iron. These works later passed into the hands of the McCullough Iron Company and were operated by them until about 1890.

Octoraro Rolling Mill.—The Octoraro Rolling Mill was built in 1828 at Rowlandsville, formerly Romansville, at the mouth of Octoraro Creek by a Mr. Roman, and was later acquired by the McCullough Iron Company. It consisted of one puddling and one heating furnace, and one train of rolls driven by water power, and in 1856 made 262 tons of sheet iron. It was operated as late as 1893.

Octoraro Forge. — In 1788 John Churchman, of Nottingham, formed a partnership with Samuel Hughes, of Harford County, for the purpose of erecting a furnace and such other works as they might think necessary for the manufacture of iron, upon a tract of land containing three thousand acres owned by Churchman in Cecil County, Maryland, and Chester and Lancaster counties, Pennsylvania. The tract was to be selected by Hughes, and it was

stipulated in the agreement that it was to embrace Horse Shoe Bend in Octoraro Creek, near the junction of the three counties. Hughes was to furnish the capital, and Churchman to be resident manager, and the profits were to be shared equally. Nothing is known regarding the early history of these works, but the land records show that the forge was just below Horse Shoe Bend, where the Cecil paper mill was afterward built, and was erected before 1795, at which time it was in possession of John Jones and Thomas Rogers. It was purchased in 1801 by John Frey and Mathew Irwin and known for some time as Frey's forge.

In 1840, Alexander speaks of a forge in this locality belonging to the heirs of Mr. James Hopkins, and that there was also said to be a furnace stack there, but not in blast. This was later owned by Parke and Son, of Rising Sun, and consisted then of one forge and one hammer driven by water, and made annually 200 tons of blooms. In 1880, it was owned by the McCullough Iron Company and operated by them until 1893.

Queen Anne's County.

Unicorn Forge.—In 1761, Benjamin Jacobs applied for a writ *ad quod damnum* for one hundred acres on Unicorn Creek for a forge mill, which was granted in 1762. In that year, at a place called Nasby or Maysbury, Robert Evans, Jonathan Morris, and Benjamin Jacobs built a forge, the castings for which were made at the Bush River furnace. This was not long in existence.

Caroline County.

Federalsburg Bloomery.—Swank states that a bloomery which used bog ore once stood near Federalsburg, but was abandoned long ago. According to Mr. W. E. Lyden, this was on Marshyhope Creek, a mile south of Smithville, and the ore was obtained from the creek near the site of the bloomery. This dates back at least to 1800, and even earlier, and no further details are known.

On the east side of Marshyhope Creek, just above Federalsburg, at the site of the electric power plant dams, John Elliott erected a

MAP
OF
MARYLAND
SHOWING
DISTRIBUTION OF IRON ORES

SCALE
1:1,250,000. 20 Miles = 1 Inch

0 5 10 20 40 60

MARYLAND GEOLOGICAL SURVEY.
WM. BULLOCK CLARK, STATE GEOLOGIST
1911

LEGEND

- Helderberg-Oriskany Limonites
- Marcellus-Oriskany Limonites
- Cambro-Ordovician Limonites
- Limonites of Carroll and Frederick counties
- Limonites of Baltimore and Harford counties
- Bog Iron Ores
- Carbonates of the Appalachians
- Coastal Plain Carbonates
- Magnetites in the Loudon formation
- Magnetites in the Piedmont Schists
- Magnetites in the Serpentines
- Red Hæmatites of the Appalachians
- Specular Hæmatite of the Piedmont

A. HOEN & CO. BALTIMORE.

forge in 1840 which he operated for a short time only. Bog ore from the neighborhood was used, and the iron produced from it was found to be too brittle.

CHRONOLOGICAL TABLE OF MARYLAND FURNACES.

Name of Furnace.	County.	Erected.	Abandoned.
Principio	Cecil	1722	1891
Gwynn's Falls	Baltimore	1723	?
Patuxent	Anne Arundel	Before 1734	1856
Onion (Joppa Works)	Baltimore	About 1743	After 1769
Kingsbury	Baltimore	1744	1780
Lancashire	Baltimore	1744	1780
Harford (Bush River)	Harford	Before 1754	1876
Elkridge	Howard	1756	1872
Curtis Creek	Anne Arundel	1759	1851
Northampton	Baltimore	1760	1850
Hampton	Frederick	1760	About 1770
Antietam	Washington	1765	1878
Legh	Carroll	1765	About 1767
First Green Spring	Washington	1770	1775
Rock Forge	Washington	1770	1795
Catoctin	Frederick	1774	1903
Johnson	Frederick	1787	About 1805
Fielderia	Frederick	1789	1790
Russell	Cecil	1802	1806
Mt. Etna	Washington	1809	About 1818
Whittaker's	Baltimore	1810	1860
Friendsville	Garrett	1828	1834
Nassawango	Worcester	1830	1850
Savage	Howard	1835	1874
Patapsco	Baltimore	1835	1849
LaGrange	Harford	1836	1874
Ashland	Baltimore	1837	1880
Lonaconing	Allegany	1837	1855
Maryland	Baltimore	1840	About 1888
Mt. Savage	Allegany	1840	1865
Sarah	Harford	1841	1870
Rough and Ready	Harford	1842	1868
Cedar Point	Baltimore	1843	About 1880
Locust Grove	Baltimore	1844	1885
Chesapeake	Baltimore	1845	About 1882
Laurel	Baltimore City	1846	About 1885
Lena	Allegany	1846	1867
Gunpowder	Baltimore	1846	1860
Muirkirk	Prince George's	1847	....
Elba	Carroll	1847	1868
Lonaconing	Frederick	1848	About 1880
Second Green Spring	Washington	1848	1873
Oregon	Baltimore	1848	1856
Stickney	Baltimore	1854	1896
Mariah	Washington	?	1880
Bowery	Allegany	1868	1875
Sparrows Point	Baltimore	1889	....

In the preparation of the historical section of this report information has been assembled from many sources. Histories of Maryland and of the various counties, old newspapers, trade journals, and general works on American industries, and the Census Reports were gone over. Many personal communications have also been obtained. In short, a scrap of information was gathered here, and a scrap there. To attempt to enumerate all of these sources would be useless. There are, however, four works which have furnished many of the data, and for that reason they are cited below.

J. H. Alexander: Report on the Manufacture of Iron addressed to the Governor of Maryland. Printed by order of the Senate, Annapolis, 1840.

J. P. Lesley: The Iron Manufacturer's Guide to the Furnaces, Forges and Rolling Mills of the United States. New York, 1859.

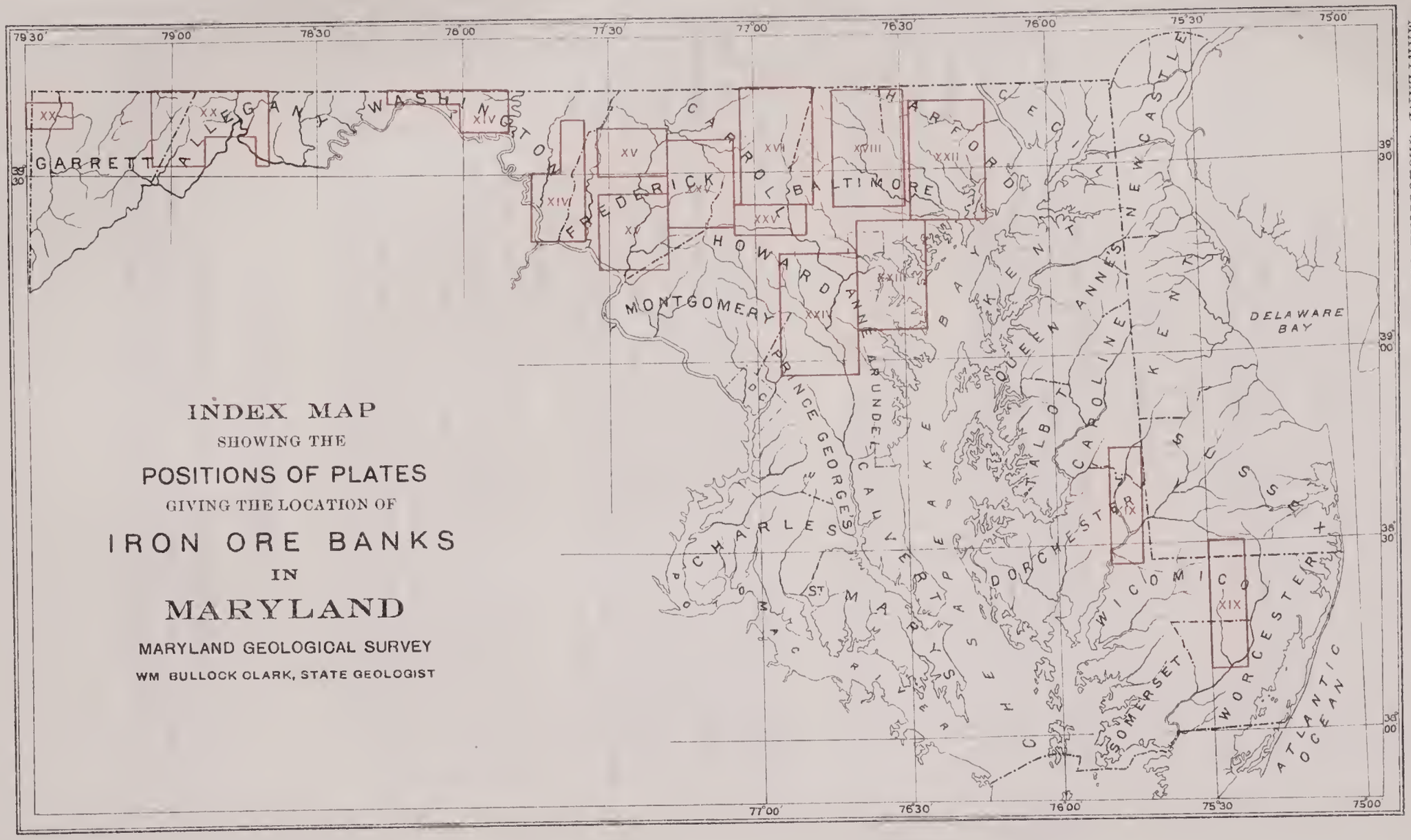
J. M. Swank: History of the Manufacture of Iron in all Ages. Second Edition, Philadelphia, 1892.

W. Keyser: Iron in "Maryland, its Resources, Industries and Institutions," Pages 100-112. Baltimore, 1893.

THE IRON ORES OF MARYLAND.

The four chief ores of iron are known to occur and have at some time been worked in Maryland. Arranged in the order of their importance in the State, they are Limonites, Carbonates, Hematites and Magnetites.

The map, Plate XII, shows the distribution of these ores in the State. Limonites are found in the Appalachian, Piedmont and Coastal Plain areas. They attain their greatest development in the Piedmont and the eastern portion of the Appalachian area. Carbonates occur in the Appalachian region and in the Coastal Plain. The carbonates of the Appalachian region are found in the Coal Measures of Western Maryland. The Coastal Plain carbonates are in the Arundel formation along the western edge of the Coastal Plain. Hematites occur in two varieties, red hematite and specular hematite. The red hematites occur in the Clinton formation of the Appalachian region. The specular hematite occurs in the Piedmont


INDEX MAP
SHOWING THE
POSITIONS OF PLATES
GIVING THE LOCATION OF
IRON ORE BANKS
IN
MARYLAND
MARYLAND GEOLOGICAL SURVEY
WM BULLOCK CLARK, STATE GEOLOGIST
GARRETT
ALLEGANY
WASHINGTON
FREDERICK
CARROLL
BALTIMORE
HARFORD
CECIL
NEWCASTLE
KENT
QUEEN ANNES
TALBOT
CAROLINE
DORCHESTER
WICOMICO
SOMERSET
WORCESTER
HOWARD
MONTGOMERY
PRINCE GEORGES
ANNE ARUNDEL
CHARLES
ST MARYS
DELAWARE BAY
ATLANTIC OCEAN
CHESAPEAKE BAY
79°30'
79°00'
78°30'
78°00'
77°30'
77°00'
76°30'
76°00'
75°30'
75°00'
39°30'
39°00'
38°30'
38°00'

in a quartz vein in Carroll County. Magnetites are found only in the Piedmont and at the eastern edge of the Appalachian region.

The Limonites.

The limonites, as has already been stated, form by far the most important class of iron ores in Maryland. Geologically considered they fall into four distinct groups, which, arranged from west to east, according to their geographical distribution in the State, are the following:

Devonian limonites.

Cambro-Ordovician limonites.

Limonites associated with the crystalline limestones of the Piedmont.

Bog iron ores.

The Devonian limonites are limited to the Appalachian region and occur in Allegany and Washington Counties. The Cambro-Ordovician limonites occur in the eastern part of the Appalachian area and the western edge of the Piedmont in Washington and Frederick counties. The limonites associated with the crystalline limestones of the Piedmont, occur in Frederick, Carroll, Baltimore and Harford counties. The bog iron ores attain economic importance only in the Coastal Plain.

None of these ores are original deposits, but they are all due either to a residual concentration of ferriferous materials or to direct replacement of other rock by means of ferriferous solutions. It is also a significant fact that nearly all of these deposits occur closely associated with limestone, demonstrating the important part played by calcium carbonate in the formation of such iron ore bodies.

The Devonian Limonites.

The Devonian limonites are found in the Appalachian region in Allegany and Washington counties. They occur at two horizons, at the Helderberg-Oriskany contact and at the Oriskany-Romney con-

tact. The position of these horizons in the Devonian system is seen from the following classification:

Hampshire
Jennings
Romney

Ore horizon

Oriskany

Ore horizon

Helderberg

The Helderberg formation consists of limestones usually purer and more massive than those of the underlying Tonoloway formation, and some shales. Its thickness in Maryland is about 260 feet.

The Oriskany formation in its typical development is a coarse-grained, somewhat friable, massive calcareous sandstone, white or yellow in color. At times the materials become very coarse-grained, forming a conglomerate. The thickness of the formation is quite variable, with a maximum thickness of about 350 feet.

The Romney formation consists near its base of thin fissile black shales, with several thin bands of limestone. The overlying beds are arenaceous shales with several heavy beds of sandstone. Its thickness is usually about 600 feet.

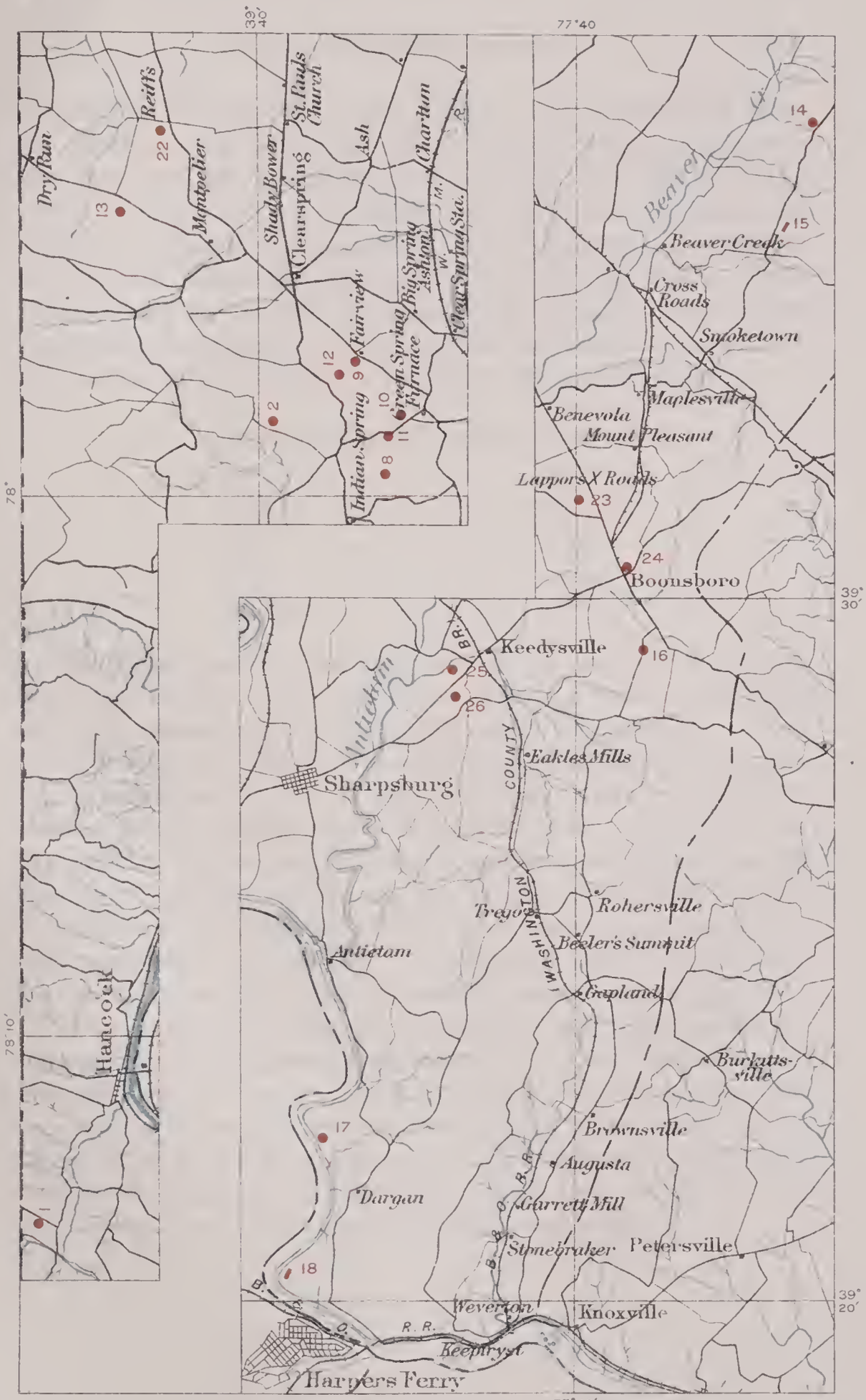
Helderberg-Oriskany Limonites.

The Helderberg-Oriskany contact throughout its extent in the eastern United States occasionally shows a small deposit of limonite, but it is only in Virginia that this contact becomes an important ore horizon. In that State the ores show a remarkable development and are well known under the name of the "Oriskany" ores. In Maryland this horizon is of no particular importance, and but two deposits are known, only one of which has ever been worked.

Washington County.

Barton Deposit [1*].—On Miss Ella Barton's place, three miles northwest of Hancock, on the east side of Tonoloway Ridge, there is

*The numbers enclosed in brackets indicate the locations on the local map covering the region under discussion.



LOCATION OF IRON ORE BANKS IN WASHINGTON COUNTY

considerable limonite float on the surface. For a distance of about two hundred yards along the hillside the ore fragments are very abundant, and then gradually grow less abundant to the north and south. The source of the iron has evidently been the overlying Oriskany sandstone. The sandstone here is somewhat iron-stained and has been leached and disintegrated by percolating waters. These waters taking the iron into solution came in contact with the underlying Helderberg limestone and had their iron contents precipitated. An analysis of the ore shows a good grade of non-Bessemer ore.

ANALYSIS OF ORE FROM BARTON DEPOSIT.

Fe	43.42
SiO_2	23.16
Al_2O_3	2.75
Mn	Little.
P	.16
S	.16
Ignition	9.00

The deposit has never been worked, in fact, not even prospected. Its great drawback is the lack of transportation facilities, as otherwise, the showing would fully justify careful prospecting.

Wheatstone Ore Bank [2].—Helderberg-Oriskany ore was formerly worked on Mr. John Wheatstone's farm about two miles northeast of Indian Springs, at the foot of the west slope of Fairview Mountain. The property was then owned by Jacob Wheatstone and Richard Browning, and the ore was shipped to the Green Spring furnace about three miles south of here. There was one large opening made 200 by 100 feet in area and about eight feet deep; and two smaller openings 50 and 20 feet in diameter, respectively.

At the south end and along the east side of the larger opening is a ledge of highly ferruginous conglomerate, which at places consists of over 50 per cent. limonite. In a ravine to the southwest of the opening is an exposure of limestone, the strike of which would carry it along the west edge of the opening. This places the ore body right at and along the contact. A sample taken from old piles of ore around the opening showed the following composition:

ANALYSIS OF ORE FROM WHEATSTONE ORE BANK.

Fe	36.20
SiO_2	27.06
Al_2O_3	7.96
Mn	Trace
P	.63
S	.10
Ignition	9.58

It is very probable that this sample represents a poorer grade than the average of that mined, as it tends toward the silicous conglomeratic phase and may even represent ore that was rejected.

Romney-Oriskany Limonites.

These ores are formed by the replacement of the limestone bands near the base of the Romney and are found at many points throughout the areas in which these rocks outcrop. On account of the thinness of the limestone bands, usually not exceeding six inches in thickness, the ores are generally of no economic importance. They have been worked in Allegany County near Cumberland, and in Washington County southwest of Clear Spring.

Allegany County.

The chief outcrops of the Romney formation found in Allegany County are in the Flintstone Quadrangle where they occur along the foot of nearly all the mountains. Ore deposits have been found along Shriver Ridge, Nicholas Mountain, Martin Mountain, and Warrior Mountain. They have been worked, however, only at Shriver Ridge and Nicholas Mountain.

The Romney outcrops along the foot of the east slope of Shriver Ridge and ore deposits are known at two points in this area.

Valentine Ore Bank [3].—Ore was mined about 50 years ago on Mr. John F. Valentine's place three miles northeast of Cumberland, and hauled to the Lena Furnace at Cumberland by Mr. Michael Brotmarkle, who owned the property at that time. Openings were made on both sides of the road; but on the east side the ore occurred under the stream bed, so that the water greatly interfered with the working. Three men were employed in the mining, and one cart was used for hauling. The openings are now filled in and the land cultivated so that no evidence of the former operations remains.

Neff Deposit [4].—On Mr. William Neff's place, about half a mile below the State line, and east of the road at the foot of Shriver Ridge, large lumps of limonite are found scattered over the surface.

ANALYSIS OF ORE FROM NEFF DEPOSIT.

Fe	41.41
SiO_2	21.46
Al_2O_3	3.78
Mn	.38
P	.28
S	.11
Ignition	12.47

The extent of this occurrence is unknown.

At several points along the foot of the west slope of Nicholas Mountain ore occurs. Along the road running north from the Williams Road, the replacement of the limestone beds by ore is well shown. All stages in the process can be seen here, from the unaltered limestone to the ore in which the limestone has been completely replaced. The shales adjacent to the altered limestone are usually decomposed to a gray or yellow clay. When the beds are exposed they are only a few inches thick, so that, although ore is said to have been worked in this vicinity, the deposits must have been of very limited extent.

Ore Deposit One and a Half Miles North of Williams Road [5]. Ore is said to have been worked on the east side of the road running along the foot of the mountain about one and a half miles north of the Williams Road at the point shown on the map, and also on the knob to the north of this point. No evidence of the operations remains.

Knight Farm Ore Bank [6].—Ore is also said to have been worked on the Knight farm south of the Williams Road. Mr. Joseph Collins, who now lives on the place, said he ploughs up pieces of limonite on the hill back of his house. This is the only evidence of ore on the place at present, all evidence of former operations being obliterated.

Guepl Deposit [7].—At the foot of the east side of Martin Mountain two prospect holes were put down on Mr. Joseph Guepl's place, about a hundred feet west of the road. Although ore was found, it was not enough to warrant further exploitation.

Warrior Mountain.—Thin beds of Romney ore are exposed at a number of points along the east side of Warrior Mountain. At some places they attain a thickness of nearly one foot, but there is nowhere any evidence of an occurrence of economic value. About twenty-five years ago Mr. Jacob Williams, of Bedford County, Pennsylvania, secured ore rights along this mountain but never attempted any development.

Washington County.

On the west side of Tonoloway Ridge near the head of Long Hollow, there is an unimportant outcrop of the Romney limestone which is altered to limonite. This horizon attains its chief development in the State in the North Mountain area, southwest of Clear Spring, where several important ore bodies have been worked. In this area the position of the ore bodies has also changed in the case of the more important deposits. Some of the smaller deposits, as at the stave mill, occur in the same position as those farther west, that is, in the Romney shales above the Oriskany; but the larger deposits are at the contact itself and extend both down into the Oriskany formation and up into the Romney shales.

The ore deposits in the North Mountain region occur within about four miles west and southwest of Clear Spring. Figure 2 represents a portion of the Williamsport sheet and shows the location of the ore deposits. Two large deposits have been worked and several smaller ones. The ore was used at the Green Spring Furnace, two miles west of Clear Spring Station, on the Western Maryland Railroad.

Ore Bank One Mile Southeast of Indian Springs [8].—One mile southeast of Indian Springs and a little over a mile west-northwest of Green Spring Furnace, there is an old ore opening 75 by 25 feet and 6 feet deep, and a hundred feet south of this is another smaller opening. The openings are located about one hundred yards north-

west of an old stave mill. The ore occurs associated with a greenish to yellow shale, near the Oriskany contact.

Charles Ore Bank [9].—On the east side of Fairview Mountain, one mile south of the Cumberland road, on Mr. B. F. Charles' property are several old openings. The largest of these is not more than twenty feet in diameter, so that this ore was never worked to any

FIG. 2.—LOCATION OF ORE BANKS ABOUT NORTH MOUNTAIN.

extent. Moreover, from the topographical position of the ore, it is very improbable that any large deposit occurs here, as the openings are well up on the slope of the hill.

Green Spring Ore Bank [10].—On the hill north of Green Spring, about one hundred yards from the spring itself, are several small

openings which are probably nothing more than prospect holes, although some ore is said to have been taken from them. The hill seems to be due to a minor anticline bringing up the Oriskany, although no exposure of the Oriskany in place occurs on it. The sandstone debris is, however, very heavy and massive.

Ore Bank One Mile North of Green Spring Furnace [11].—One of the two most important sources of ore for the Green Spring Furnace was the bank one mile north of the furnace. This opening is 500 feet long and has a maximum width of about 160 feet and a depth of about 20 feet. The west wall of the opening shows massive slabs of a heavy sandstone which varies from quartzitic to conglomeratic in character and is very ferruginous. When these blocks are apparently in place, they show a dip of 40° E. A gully running out of the opening bends around the south end of a hill three hundred feet to the southwest. At this point there is exposed the nose of an anticline of the same quartzitic to conglomeratic sandstone. Three hundred feet west of the opening are exposures of a bluish gray calcareous shale striking N. 10° W. and dipping 40° W. Hence we have on the west of the ore bank a small anticline which brings up the Oriskany formation and the east limb of that anticline forms the west wall of the opening. Some prospect holes were put down on the west side of the anticline; but, as no ore was taken from them, it is probable that none occurs on that side.

The east wall of the opening has a six to eight-foot layer of hillwash, below which occurs clay and decomposing shale. Disseminated through this clay and shale are nodules of ore and materials showing all stages between ore and shale. The sides of the bank are now so washed-in that no good exposures of ore can be seen. The deposit is obviously limited on the west side by the Oriskany anticline; how far it extends on the other three sides and to what depth it is impossible to say. Across the road from the opening are several holes which are said to mark the location of shafts. If this is true, the ore body is much more extensive than the present exposures would indicate and may yet furnish considerable ore.

Ore Bank Two Miles Northeast of Green Spring Furnace [12].—The second of the two most important sources of ore for the Green Spring furnace was a bank two miles northeast of the furnace. This opening is about 400 feet long and has a maximum width of 140 feet and depth of about 25 feet. The ore body occurs along the stream bed. The overburden varies from 6 to 10 feet. Below this is a yellow clay containing lumps of limonite. Not much ore shows in the lower part of the opening. In the upper part, however, there are several exposures of ore, one of which extends across the opening. About seventy-five feet west of the north end of the bank is another opening 150 feet long, 50 feet wide at the south end and tapering off toward the north, which is 20 feet deep. This opening shows large blocks of ferruginous quartzite and conglomerate. From the appearance of the opening it seems that a tunnel or shaft was put in at the south end. This opening marks the western limit of the deposit. It does not extend much further up the stream than it has been worked, as no trace of the associated shales and clays is found in the stream bed more than a short distance beyond the opening. Its limits on the east and south and its depth have never been determined. A sample taken from the exposures showed a good grade of non-Bessemer ore.

ANALYSIS OF ORE FROM ORE BANK TWO MILES NORTHEAST OF GREEN SPRING FURNACE.

Fe	45.79
SiO_2	18.37
Al_2O_3	3.98
Mn	Little.
P	.51
S	.10
Ignition	10.72

It has been seen from the preceding pages that at a number of points in Allegany and Washington counties small limonite deposits occur in the Romney at or near its contact with the Oriskany formation. In most of these cases the ore has been directly traced to the replacement of thin beds of limestone near the base of the Romney. The ores, except in the last two cases described, have been of little importance on account of their size, being limited by the ex-

treme thinness of the original limestone layers. The question then arises what caused the exceptional development of these two ore bodies at this same horizon. The geology of this region has not yet been worked out in detail, but enough work has been done on the stratigraphy to show that a marked change has taken place in the character of the Oriskany formation. In place of the massive coarse-grained sandstone farther west, with a thickness of 300 feet or more, the formation is here represented by a thin bed, approximately 50 feet in thickness of a very calcareous nature. At the top of the formation is a coarse conglomerate and below this a very arenaceous limestone.

This change in the stratigraphy has brought about a change in both the position and the nature of this group of ore deposits. Attention has already been called to the fact that farther west the ore occurs as a replacement of the thin limestone bands near the base of the Romney shales. The presence of the more prominent Oriskany calcareous formation in this region has made it the controlling factor in the deposition of the iron ore. From the description of the two more important deposits of the region, it is seen that the foot wall of the deposits consists of the Oriskany. This is highly ferruginous and in places rich enough to form part of the ore. On the hanging wall is the Romney, consisting of clay and decomposing shale which grade over into ore.

Hence these deposits are precipitation deposits rather than replacement deposits. The leaching of the calcareous Oriskany formation gave rise to calcareous waters which mingling with the iron-bearing waters of the Romney caused a precipitation of the iron at the contact of the two formations. In this way the deposition of the iron was not limited to a definite thin stratum and larger ore bodies were formed.

CAMBRO-ORDOVICIAN LIMONITES.

The deposits under this head occur with the rocks of Cambrian and Ordovician age, and are hence found in the area in which these rocks outcrop,—that is, in eastern Washington County and western Frederick County. The two most extensively worked ore bodies in the State belong to this group,—the Maryland Bank on the Potomac

River northwest of Harpers Ferry, and the Catoctin deposits at Catoctin Furnace in Frederick County.

Stratigraphy of the Cambro-Ordovician Rocks.

The rocks of Cambrian and Ordovician age in Maryland are divided into the following formations:

ORDOVICIAN.		
Martinsburg formation	700–1,000′	
Chambersburg limestone	100– 600′	
Stones River limestone	800–1,000′	
Beekmantown limestone	2,250–2,300′	
CAMBRIAN.[2]		Shenandoah Group.[1]
Conococheague limestone	1,635′	
Elbrook limestone	3,000′	
Waynesboro formation	1,250′	
Tomstown limestone	1,000′	
Antietam formation	500′	
Harpers formation	1,200′	
Weverton formation	200– 300′	
Loudon formation	500′	

The Loudon formation consists largely of a fine dark slate with limestones, shales, sandstones, and conglomerates, locally interbedded. Its thickness ranges from a few to over 500 feet.

The Weverton formation consists of massive beds of fine, pure sandstone, quartzite, and conglomerate. Its thickness varies from 200 to 300 feet.

The Harpers formation is composed largely of dull bluish gray sandy shales, with a few sandstone layers in its upper portion. Its thickness is estimated at about 1200 feet.

The Antietam formation is a dull brown sandstone grading below into the Harpers shale. Its thickness is about 500 feet.

The Shenandoah group is composed of a series of blue and gray limestones and dolomites in which slates and sandy shales occur locally. The slates and sandy shales become quite prominent in the Waynesboro and Elbrook formations. The base of the Cono-

[1] Sudivision of the Shenandoah Group after G. W. Stose, Journal of Geol., Vol. XVI, No. 8, Nov.-Dec., 1908, p. 698.

[2] Thicknesses of the Cambrian formations below the Shenandoah Group are taken from Keith, 14th Ann. Rept., U. S. G. S., Part II, pp. 285-395.

cocheague limestone is marked by the presence of limestone conglomerates containing rounded, vitreous quartz grains and others containing tabular fragments of limestone. The total thickness of this group is about 10,000 feet.

The Martinsburg formation consists of sandstone and of black and gray calcareous and argillaceous shales. Its thickness varies from 700 to 1000 feet.

Position of the Ores.

Three types of deposits occur under this head. The first type includes those at contacts of the Shenandoah limestone with other formations. The second type consists of residual deposits in the limestone itself away from other rocks. In the third type are placed those deposits which occur in the Cambrian formations apparently unassociated with limestone.

Limestone Contact Deposits.

The limestone contact deposits are by far the most important of the three types of Cambro-Ordovician limonites. Moreover, most and especially the largest of the deposits under this type are not simple contact deposits, but are fault contact deposits, as at the Maryland Bank and at Catoctin Furnace. It thus follows that these deposits attain their chief development in the faulted areas of the South Mountain region. West of Hagerstown there is a belt of Martinsburg shale crossing the State, with Shenandoah limestone on each side of it. Mr. Williams made a search along these two contacts but failed to find any evidence of limonite deposits, showing the important part played by faults in the formation of these deposits. Further west, at the edge of North Mountain, where the Shenandoah limestone is faulted into contact with the Romney shales, ore deposits again occur. The significance of this connection of faults with the ore deposits is readily seen from their origin. The leaching of the shales in the process of weathering gives rise to ferriferous solutions. As these solutions come into contact with the limestone their iron content is precipitated. If the contact be-

tween the shales and the limestones is a fault contact, the shattered zone thus produced furnishes an area along which there is abundant infiltration of the percolating waters; and, as they enter this zone, they deposit their iron content.

The ores of this type occur in both Washington and Frederick Counties. In Washington County they occur along the western edge of the Hagerstown Valley at the foot of the east slope of North Mountain, where the Shenandoah limestone is faulted against the Romney shales; and along the western edge of the Blue Ridge where the limestone is faulted against the Harpers shale. In Frederick County they occur along the western edge of the Frederick Valley at the foot of the east slope of Catoctin Mountain, where the limestone is faulted against the Loudon shale.

Washington County.

Wilson Farm Ore Bank [13].—There are two old openings on the Wilson Farm three miles north of Clear Spring. The larger one is 100 by 200 feet and now less than 10 feet deep. The smaller one, a hundred feet north of this, is about 20 feet in diameter. The ore occurs at the fault contact between the Romney shales of Devonian age and the Shenandonah limestone at the foot of North Mountain. The openings are now washed in and no ore in place is exposed, but lumps of ore are profusely scattered about in the neighborhood. It is a very compact limonite showing the following composition:

ANALYSIS OF ORE FROM WILSON FARM ORE BANK.

Fe	51.63
SiO_2	8.52
Al_2O_3	3.37
Mn	Little.
P	.99
S	.10
Ignition	11.77

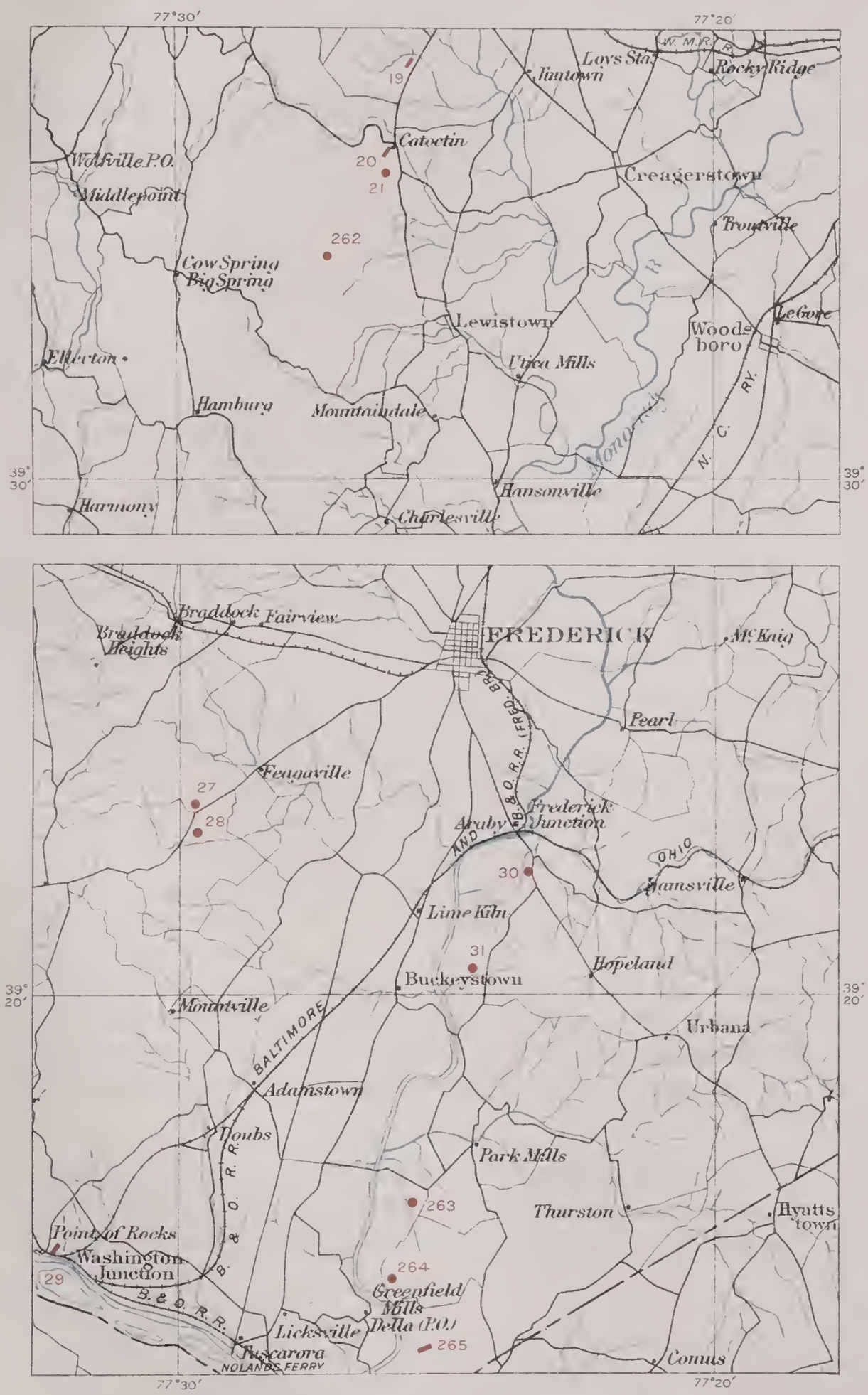
The ore occurs in such a solid condition that, when the deposit was worked, blasting had to be resorted to. It was worked about twenty-nine years ago and hauled to Mercersburg, from where it was

shipped to Chambersburg. On account of the long haul to the railroad, work was stopped after a few months' operations.

Kohler Ore Bank [14].—One mile south of Pondsville on Mr. A. R. Kohler's place ore was worked before 1828 and sent to the Mount Etna furnace one mile south of here. The bank is situated about one hundred yards west of the road and a hundred feet north of the stream crossing the road. It is 450 feet long, 15 feet wide, and from 10 to 20 feet deep. The depth originally was greater than this, as it has been partly filled up by stones thrown in from the fields. The ore does not occur right at the contact of the limestone and the Harpers formation against which the limestone has been faulted, but a little to the west of the contact. The ore body lies between two beds of limestone striking N. 29° E. and dipping 72° W. That the ore extends beyond the present opening is shown by the fact that it was encountered by a drift put in at the creek. The water forced the abandonment of the drift before it was carried very far so that ore was removed only from the open cut.

Lane Property Ore Bank [15].—The openings on the Lane property were made east of the road between Pondsville and Smoketown, nearly two miles south of Pondsville. They occur along the foot of a steep rise in the hill slope for a distance of about two thousand feet. The top of the hill is formed of Antietam sandstone, striking N. 30° E. and dipping 40° E. Below this comes the Harpers shale, and at the fault contact of the shale and the limestone the ore bodies occur. A large number of small openings have been made so that it seems that the ore must be irregularly distributed in small pockets which were opened up wherever they were revealed by prospecting.

Appletown Ore Bank [16].—Ore was worked at the north end of Appletown, about one mile south of Boonsboro, and shipped to the Mariah furnace at Mousetown about a quarter of a mile east of Boonsboro. The county road now crosses the site of the old opening. The mining was begun on the west side of the road in Mr. Allen Stone's field, and extended across the road into Mr. All's field.



LOCATION OF IRON ORE BANKS IN PART OF FREDERICK COUNTY

which is now owned by Mr. Vinton Eakle. Most of the work was done by tunneling, although some of it was by open cut. The openings are now filled up and the only evidence of ore consists of loose pieces scattered about on the ground. The ore occurs at the fault contact of the Shenandoah limestone and the Harpers shale.

Potomac Refining Company Deposit [17].—This deposit occurs on the Potomac River, three miles north of Harpers Ferry, and is described on page 326, in connection with the manganese ores.

Maryland Bank [18].—On the north bank of the Potomac River, one mile northwest of Harpers Ferry, on a point made by a bend in the river, is an old opening known as the Maryland Bank. This deposit in the quantity of ore it has produced ranks second only to the Catoctin deposits in Frederick County, and it was one of the chief sources of ore for the Antietam furnaces, which were located at the mouth of Antietam Creek five miles north of here.

The ore occurs in the Shenandoah limestone at the fault which brings the limestone in contact with the Harpers shale. It extends along the entire length of the fault from where it crosses the Chesapeake and Ohio Canal on the north to the second crossing on the south, a distance of 2,000 feet, and has been worked over a distance of more than 200 yards west of the fault plane. A large number of openings of various sizes have been made in this area all running parallel to the strike of the limestone which is N. 20° E. Many of them are separated by solid ledges of limestone dipping 75° E. At some places five or six rows have been made, separated by limestone ledges.

The property is now owned by Mr. Joseph E. Thropp and may be opened again in the near future. It is probable that the deposit has been worked laterally to its limits and that the quantity of ore still available will depend on the depth to which it extends.

Frederick County.

On the west side of the Frederick Valley along the foot of Catoctin Mountain, the only known ore deposits belonging to this type are the large and important occurrences on what is known as the Catoctin property.

CATOCTIN PROPERTY

The Catoctin property consists of over 10,000 acres, a tract about six miles long with a maximum width of four and a half miles. It is situated along the eastern slope of Catoctin Mountain, south of Thurmont. Limonite has been worked at three points on the prop-

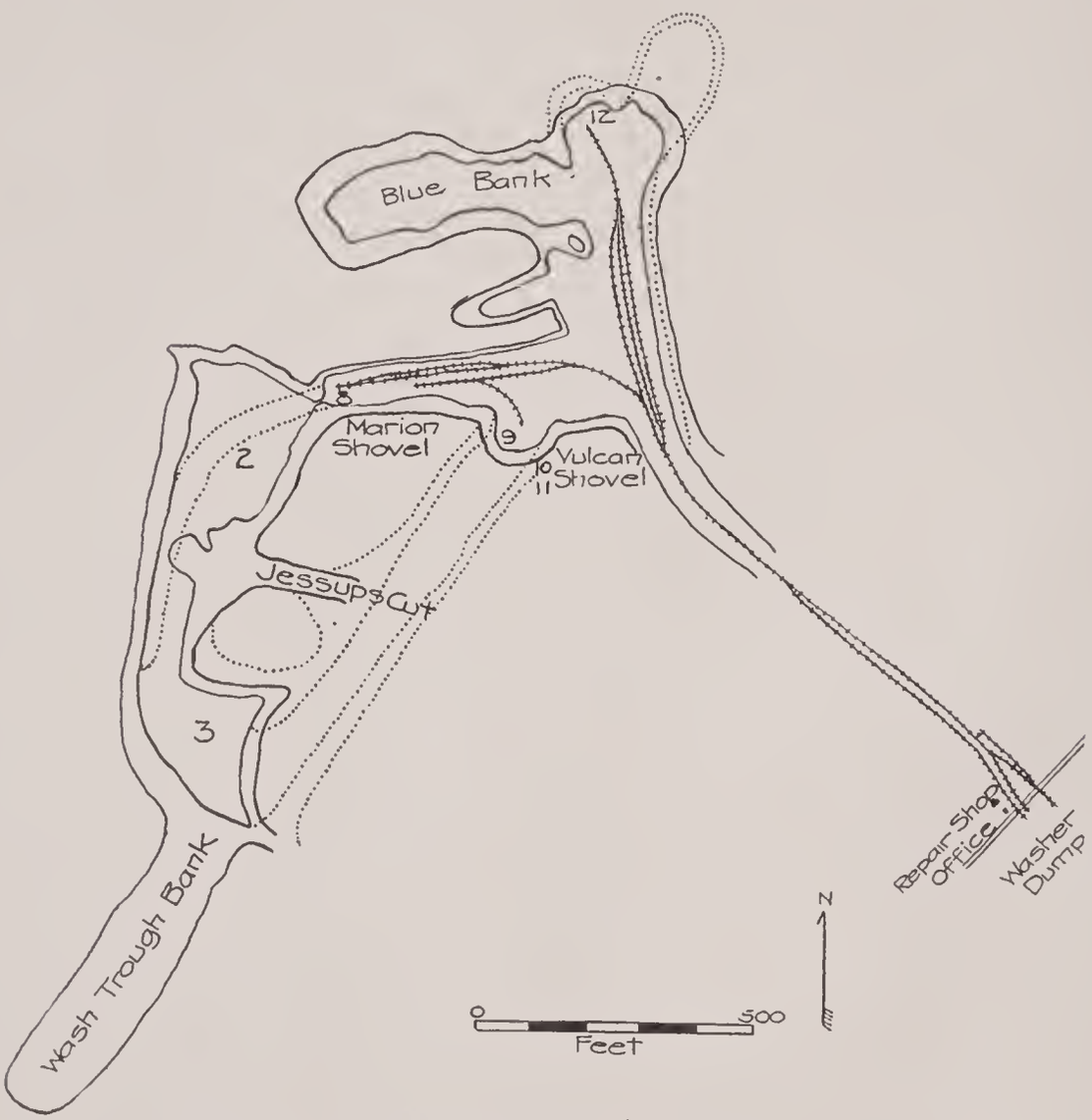


FIG. 3.—SKETCH SHOWING DEVELOPMENT AT ORE BANK ONE MILE NORTH OF CATOCTIN FURNACE.

erty,—back of the site of the old furnaces, a little over a mile north of the furnaces, and a half mile south of the furnace site, back of Dr. McPherson's house. At the present time only the deposit north of the furnace is being worked.

Ore Bank One Mile North of Catoctin Furnace [19].—By far the largest of the openings on this property are those one mile north of Catoctin furnace, several hundred yards west of the Frederick and Emmitsburg road. A sketch map showing the extent and character of these openings is given in Figure 3, the solid black lines represent the openings as they were at the end of June, 1908, and the dotted lines the changes that had been made through mining by January, 1911, that is, the course taken by the steam shovels during that time. This sketch shows that the ore body has been worked over a width of 800 feet at right angles to the strike of the rocks, and for a distance of over 2,000 feet along the strike. These openings afford the best opportunity in the State for the study of this type of ore deposit, both on account of their extent and the excellent fresh exposures made by the steam shovels.

The ore is a good grade of non-Bessemer limonite occurring in lumps of various sizes intimately intermingled with a blue and yellow clay. For seven tons of such material sent to the washer, one ton of ore is obtained. In some places rich pockets of almost solid ore are found which have to be shattered by blasting before they can be removed. In these richer pockets the blue clay almost completely disappears and the associated clay has a rich golden yellow color. The greater portion of such ore is hand-picked and shipped without washing. The following analyses were made of samples taken from these openings:

ANALYSES OF ORE FROM BANK ONE MILE NORTH OF CATOCTIN FURNACE.

	8	9	12	13	14
Fe	40.04	37.21	38.69	42.82	41.35
SiO_2	22.59	25.32	19.61	19.18	16.16
Al_2O_3	6.69	7.45	6.30	5.38	6.23
Mn	.15	.61	2.15	.64	3.41
CaO	.64	.65	1.01	.72	.60
MgO	.34	.55	.44	.27	.80
P	.23	.29	.43	.32	.18
S	.09	.05	.05	.05	.05
Ignition	10.86	9.55	11.62	10.68	11.51

Samples 8, 9 and 12 were taken at the points indicated on the sketch of the openings. Samples 13 and 14 were taken from the cars ready for shipment. Sample 14 is crushed lump ore which is

not washed, and sample 13 is washed ore. These analyses show that the manganese content is quite variable but does not run too high, sulphur is low, and phosphorus considerably above the Bessemer limit. Washing and sorting increases the iron content about four per cent. and lowers the silica about the same amount.

An examination of the blue and yellow clay shows that the yellow clay represents a more complete stage in the concentration of the iron ore than the blue. Samples 10 and 11 show the relative composition of the two clays. The point at which these samples were taken is shown on the sketch map.

ANALYSIS OF YELLOW AND BLUE CLAY FROM ORE BANK ONE MILE NORTH OF CATOCTIN FURNACE.

	10. Yellow Clay.	11. Blue Clay.
Fe	6.68	5.62
SiO_2	61.42	57.88
Al_2O_3	15.98	15.74
CaO	.21	1.15
MgO	1.46	3.40
P	.25	.28
S	8.06	1.79
Ignition	4.98	6.65

When the blue clay is examined under a lens it is found to contain a quantity of finely divided iron pyrite disseminated through it. Sometimes these particles are large enough to be seen plainly with the naked eye, and frequently large lumps of marcasite are found weighing several pounds. An examination of the yellow clay fails to reveal any of the iron sulphide. A comparison of the analyses shows that the blue clay contains 1.79 per cent. of sulphur and the yellow clay .06 per cent. Hence the yellow clay represents an oxidized phase of the blue clay from which the sulphur has been almost completely leached out, and the oxidation of the iron from the ferrous to the ferric condition has given the clay its yellow color.

The geological position of the ore is indicated by the following observations: The west side of the ore body lies against tan-colored shales striking N. 27° E. and dipping 68° E. These shales were well exposed along the west side of openings No. 2 and No. 3, in September, 1908, when they had just been laid bare by the Marion shovel. In the blue bank the shales are of a dark steel-blue color

and weather into clays of the same color. The contact between the ore and the shale is very irregular and masses of only partially decomposed shale occur within the ore itself and near the west edge of the deposit immediately under the ore. This relation is well shown along the north wall of No. 2 opening, especially at the west end.

Limestone has been encountered at several places in the openings and also on the north side of the tram tracks 200 feet northwest of the highway. In the middle of opening No. 1, a ledge of limestone was encountered projecting about a foot above the present level. Another exposure, which is limestone conglomerate, occurs

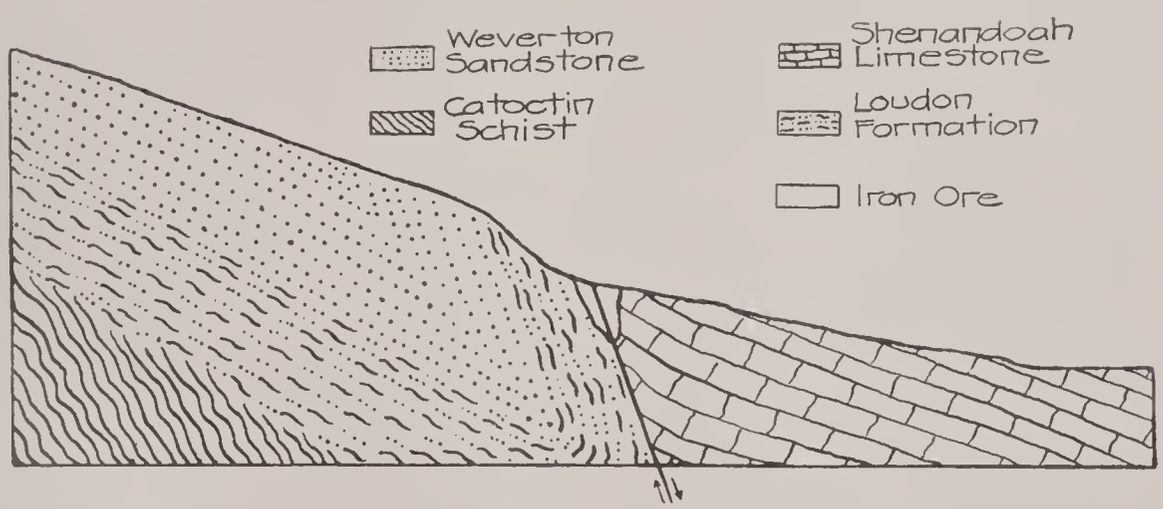


FIG. 4.—DIAGRAM SHOWING STRUCTURE ON EAST SIDE OF CATOCTIN MOUNTAIN (AFTER KEITH).

between openings No. 2 and No. 3. A third exposure occurs just east of the north end of the Wash Trough Bank. The largest exposures of limestone are those laid bare by the mining operations during the past year or two around what was known as Jessups Cut. Along the course of the steam-shovel from opening No. 1 to the Wash Trough Bank, there is an exposure of limestone on the west side for a distance of about one hundred feet, projecting for as much as eight feet above the floor of the opening. Then on a higher level, on the south side of Jessups Cut, is another outcrop of limestone. In sinking a shaft at the east end of the Blue Bank, limestone was encountered at a depth of eighteen feet below the level to the track.

The geology and structure of this area as worked out by Keith[1] are shown in Figure 4.

The Loudon formation has been brought up by an overthrust anticline, the east limb of which has been faulted out, bringing the Shenandoah limestone into contact with the Loudon shales. The ore body occurs in the zone of this fault plane. The presence of the limestone conglomerate between openings No. 2 and No. 3, and again one mile below Catoctin Furnace where it is underlain by inter-stratified shales and limestones well exposed in a stream bed, would place the horizon of the Shenandoah group exposed along the fault plane among the upper members of the Cambrian portion.

The *mining* is now being done exclusively by steam-shovels. Where the ore is too compact for the shovels, it is first blasted and then removed by the shovels. It is loaded on tram cars and hauled by locomotives to the washers which are located on the east side of the Emmitsburg Road. Two washers are now used, and there is usually sufficient water available for both. A side track from the Frederick Railroad runs under the washers, and as the ore comes from them it is dumped into cars ready for shipment. It is then hauled to Thurmont and there transferred to the Western Maryland Railroad and shipped to Mr. Thropp's furnaces at Everett, Pa.

The *overburden* which consists of wash from the mountain is variable in amount. The natural overburden averages about 12 feet. This is considerably increased at some places, due to the fact that when the banks were formerly worked, instead of removing the overburden, it was dumped on other ore ground. The area between Jessups Cut and opening No. 1 is such a place.

Nothing definite can be said as to the *extent* of the ore deposit. Prospecting in Jessups Cut and exposures on the walls of the bank would indicate that the deposit can be worked along its entire length to its present maximum width of 800 feet. It has been worked to its limits on the northwest. As the ground slopes toward the southeast, the cut made for the tram road is through hill wash as soon as it leaves the ore openings, so that the southeastern limit is unknown. That it does not extend as far as the highway is certain,

[1] 14th Ann. Rept., U. S. G. S., Part II, pp. 285-395.

as the underlying rocks there come to the surface. As no prospecting has been done northeast and southwest of the present openings, nothing is known as to the limits of the deposits in those directions. The present level of the openings has a bottom of ore so that the deposit extends below the depth to which it has been worked.

The known extent of the ore body is 2,000 feet by 800 feet and the depth of the present level on which the tracks are laid is 20 feet. For seven tons of material removed, one ton of ore is obtained. One ton of ore is about 9 cubic feet. About one-third of the ore over the above area has been removed. This represents then about 170,000 tons. There still remains above the present level 340,000 tons. How much lower the ore extends, is not known; except that at the east end of opening No. 1 work has been carried to a depth of eighteen feet below the level of the track. For every foot of additional depth, there would be 26,000 tons of ore, if the above horizontal dimensions were maintained. The encountering of large horsts of limestone, however, would indicate that these dimensions are likely to be reduced with increasing depth.

Ore Banks Back of Catoctin Furnace [20].—Back of the old furnace site is an opening 300 feet by 125 feet, striking N. 20° E. Since the topography slopes to the east, the west wall of the bank is 30 feet and the east 15 feet deep. The sides are washed down and no ore is exposed except where prospect holes were put down in the summer of 1908. These show ore on both the east and west faces and in the bottom. An opening at the south end shows shale.

One hundred yards south of this opening is another 500 feet long and 100 to 150 feet wide, also striking N. 20° E. At the south end it is 15 feet deep and at the north end deeper but filled with water to within fifteen feet of the top.

The geologic position of these openings is the same as those one mile to the north.

Ore Bank One-Half Mile South of the Furnace [21].—There is an old opening one-half mile south of the furnace back of Dr. McPherson's house. It is 500 by 200 feet and strikes N. 20° E. Its present depth is about 20 feet. In the centre of the opening is a large mass

that was not removed. The overlying soil has washed down so that only a portion of the east side is exposed, showing a ledge of limestone. This entire mass is probably a horst of unreplaced limestone from around which the ore has been removed. The east wall of the opening is also formed of limestone in all stages of decomposition. Pure, hard limestones grade off, through stringers of limestone in ferruginous earth, to the thoroughly decomposed rock in which no limestone remains, but in which the texture of the limestone is still in large measure preserved. Below are analyses showing the composition of the limestone and the residue after leaching.

ANALYSES OF UNALTERED AND DISINTEGRATED LIMESTONE FROM THE BANK ONE-HALF MILE SOUTH OF CATOCTIN FURNACE.

Unaltered Limestone.

CaO	27.66
MgO	13.32
SiO_2	8.91
Al_2O_3	4.83
Fe	4.39
Mn	....
P	.04
S	.03
Ignition	39.92

Disintegrated Limestone.

CaO	1.80
MgO	3.31
SiO_2	56.90
Al_2O_3	14.20
Fe	6.94
Mn	.84
P	.30
S	.14
Ignition	5.46

The composition of the disintegrated limestone is thus seen to be the same as that of the clays occurring in association with the ore which were described on page 196. Two hundred feet north of the opening is an old flint quarry in which the Loudon shales are exposed. The geologic relations of this deposit are then the same as in the case of the others.

Ore is still exposed at several places in the opening. At the north end is an eight-foot exposure showing thin bands of limonite in yellow clay. The composition of the ore at this end of the opening is given below.

ANALYSIS OF ORE FROM BANK ONE-HALF MILE SOUTH OF CATOCTIN FURNACE.

Fe	37.04
SiO_2	25.10
Al_2O_3	6.79
CaO	.43
MgO	.95
Mn	.88
P	.51
S	.23
Ignition	11.27

Discontinuity of the Catoctin Ore Deposits.—It was formerly thought that the deposits along this fault plane were continuous, but prospecting during the summer of 1908 between this opening and those at the furnace showed that this is not the case. A large number of prospect holes were put down between these openings. Most of them did not go below the hill wash, so that they were of no value. A few that did failed to reveal any ore, showing that the deposits occur in isolated pockets along the fault.

History of the Catoctin Ore Banks.—The bank back of Dr. McPherson's house was opened in 1774 by James Johnson & Company and the ore smelted in a furnace erected on the property. About 1820 the property passed into the hands of Blackford & Thornberg and later to McPherson & Brien. The latter opened the banks which were worked by them in 1844. About that time they were succeeded by Peregrine Fitzhugh, and he in turn by John Kunkle in 1860. In 1885 John Kunkle's heirs organized the Catoctin Iron Company which two years later went into the hands of receivers. After the receivership had lasted a year, the property was sold to a syndicate which organized the Catoctin Mountain Iron Company. In 1899 this Company sold out to the Blue Mountain Iron and Steel Company, which shut down in February, 1903. All of the operators up to this time smelted the ore at the furnaces on the property, and their financial difficulties were due to the expense of rebuilding and improving the furnaces. In 1905 the property was bought by Mr. Joseph E. Thropp, of Earlston, Pa., who began mining in 1906 and has operated the mines continuously since then. The old furnace buildings have been torn down, and the ore is now shipped to Mr. Thropp's furnaces in Pennsylvania. For further

details of the history of this property, the reader is referred to the account of the Catoctin furnaces on pages 146–148.

Residual Deposits in the Shenandoah Limestone.

Only a few small deposits of this type occur in Maryland and they are confined to the limestones of the Hagerstown Valley.

Washington County.

McLaughlin Ore Bank [22].—Ore was formerly worked on the McLaughlin farm, three miles northeast of Clear Spring, and hauled to the Green Spring furnace. The openings have been filled up and the only evidence of the ore is lumps of limonite scattered around.

Ore Bank One-and-a-Half Miles Northwest of Boonsboro [23].—A mile and a half northwest of Boonsboro on the line between Mr. Thomas Snively's place and that of Mr. Albert Huffer is an opening about 25 feet long and 8 feet wide, which is now filled up with stone, from which ore is said to have been mined about 1870. The ore was hauled to Keedysville and shipped to the Knoxville furnace.

Boonsboro Ore Bank [24].—Ore was worked about a hundred years ago at the north end of Boonsboro on the east side of the turnpike opposite the present terminus of the electric road. No evidence of the operations remains.

Wyand Ore Bank [25].—About twenty-five years ago ore was mined on Mr. Caleb Wyand's place a half mile west of Keedysville from an opening which has since been filled up. The ore was hauled to the Norfolk & Western Railroad and shipped to Pennsylvania. It occurred as a pocket in a fracture plane of the limestone and the expense of working it was so great that the deposit was soon abandoned.

Geeting Ore Bank [26].—There are two old openings on Mr. Emanuel Geeting's place, one mile southwest of Keedysville. The smaller opening is about 75 by 20 feet by 6 feet deep. Northwest of this opening is another 125 feet long striking N. 5° W., with a width of 30 feet and a depth of 10 feet. The north end of this

opening continues as a tunnel in the limestone for about seventy yards. The ore exposed in the tunnel varies in thickness but averages about two and a half feet. It occurs as a pocket between beds of limestone which carry a great deal of pyrite. The limestone is very much fractured, and it is along these fractures that the ore body was formed. The analysis below was made from a sample of this ore.

ANALYSIS OF ORE FROM GEETING ORE BANK.

Fe	49.88
SiO_2	7.21
Al_2O_3	4.04
Mn	.19
P	.15
S	.20
Ignition	15.87

This deposit was worked about twenty-five years ago and the ore shipped to Pennsylvania. A washer was installed which was run by water pumped from a nearby branch of Antietam Creek. It was finally abandoned on account of the difficulties in mining the ore.

Limonites in the Cambrian Shales.

The deposits of this type occur in the western part of Frederick County along the foot of Catoctin Mountain, and in a small valley parallel to the Frederick Valley on its eastern side, south of Frederick Junction.

Frederick County.

Zimmerman Ore Bank [27].—A deposit of limonite in the Harpers shale on Mr. Elias Zimmerman's place, one mile west of Feagaville, was worked about 1870. The opening has since been filled up but is said to have been much smaller than the one to the south on Miss Nina Thomas' place.

Nina Thomas' Ore Bank [28].—A large deposit of limonite in the Harpers shale occurs on Miss Nina Thomas' place one and a half miles southwest of Feagaville. It was worked for several years in the late 60's and early 70's and the ore hauled to the "Long a

Coming" furnace at Knoxville, and to Frederick where it was shipped to Pittsburg. The ore was worked on a royalty of 25c. per ton. The opening is about 500 feet by 30 feet and at places 30 feet deep. It extends south of the limits of the Thomas place where about 350 tons were obtained from Mr. A. B. Castle's place, which adjoins it. The west side of the opening is completely covered with wash, but on the east side there are a number of exposures of shale and ore. The ore occurs as lumps of limonite of various sizes in a dark yellow clay from which it was separated by screening. The overburden is not more than six feet.

Washington Junction Ore Banks [29].—Ore was extensively worked in the 70's at Washington Junction and shipped to Pittsburg. These deposits were also worked fifty years earlier as one of the sources of ore for the Johnson furnace located one and a half miles north of Dickerson. This property is now owned by the John H. Smoot heirs, but when worked it was owned by Lloyd C. Duval.

The ore has been worked in a series of openings along a small stream extending from Point of Rocks northward for a distance of over three thousand feet. At the southern end they are on the east side of the stream, but about one thousand feet to the north they are on the other side of the stream. Several pockets of ore are exposed in the stream bed where it crosses the line of the openings. They are usually not more than forty feet wide and of various lengths,—one of them being several hundred yards long. Near the northern end there is one about seventy-five yards long on the west side of the road which is out of line with the others. All of the openings still show ore in place, and in general the overburden is very light. Just west of the southernmost opening is a small knoll on which the ore is exposed at the surface.

The deposit occurs along a fault plane in the Loudon formation, which has cut out the Weverton sandstone. Across the river, in Virginia, is another deposit in the same fault plane which has been extensively worked. It is said that when the river is low the deposit can be traced across in the bed of the river. The ore occurs

in lumps in the weathered shale and in a blue clay. The composition of this ore is:

ANALYSIS OF ORE FROM WASHINGTON JUNCTION ORE BANKS.

Fe	38.50
SiO_2	21.23
Al_2O_3	5.12
Mn	2.11
P	.37
S	.06
Ignition	12.33

Within the area that has been worked there is still a great deal of ore that can be mined. The old openings show ore on their walls which could be gotten out and the openings extended beyond their present limits. In fact, from the exposures in the stream bed already mentioned, it is very probable that the deposit is continuous over the entire distance and the areas between the openings could be worked. Moreover, since the conditions must have been identical all along the fault plane to where the Weverton again comes in, prospecting would in all probability show that it extends up to that point. Hence the showing here is such as would justify extensive prospecting.

On the east side of the Frederick Valley, south of Frederick Junction, is a small valley in which two ore deposits have been worked. The rocks on the east side of the valley are shales of undetermined age, while those on the west are Ordivician. At several points in the valley limestone is exposed, which is probably the Chambersburg member of the Shenandoah limestones.

Kiefer Thomas Ore Bank [30].—On Col. Kiefer Thomas' place, about three-quarters of a mile south of Frederick Junction, ore was worked both before and after the Civil War and shipped to the "Long a Coming" furnace at Knoxville. The opening is about forty feet in diameter and is now filled with water. At the north end weathered shales are exposed striking N. 30° E. and dipping 60° E. A hundred yards west of the opening there is a small quarry in which a limestone conglomerate is exposed.

Dave Thomas Ore Bank [31].—Ore was also obtained at the same time from Dave Thomas' place, now owned by Col. Charles E. Trail. These openings are on the west side of the valley three and a half miles south of Frederick Junction. Several openings were made of which the largest is 30 feet in diameter and 15 feet deep. These also occur in shales similar to those at the Kiefer Thomas bank.

LIMONITES ASSOCIATED WITH THE CRYSTALLINE LIMESTONES OF THE PIEDMONT.

The ore deposits coming under this head occur in Harford, Baltimore, Carroll, and Frederick counties, and form the most important class of ore deposits in the State. They fall into two distinct groups. In Carroll and Frederick counties they occur at or near the contact of the limestones with schistose volcanic rocks. In Harford and Baltimore counties they occur either at or near the contact of the limestones with quartzites and schists, or on the limestone overlain by the Patuxent formation.

Limonites of Carroll and Frederick Counties.

These limonites occur at or near the contact of the Piedmont limestone with acid and basic schistose volcanics which apparently overlie them. The limestones are more crystalline than those of the Frederick Valley, and up to the present time no fossils have been found in them. It is possible that they represent metamorphosed limestones of Shenandoah age or limestone lenses in the Loudon. The acid volcanics are meta-rhyolites or meta-andesites. The latter are bluish-green schistose rocks with masses of epidote and quartz, which through weathering become dull gray or yellow. These rocks were originally diabases or andesites, but metamorphism has obscured their original character. They probably owe their present position above the limestone to extensive overthrust faulting.

The ore deposits are found in what is known as Bachman Valley, which extends from Lineboro at the State line to Westminster, and continue for some miles to the southwest. The greater part

of the area is underlain by the volcanics. Within this area of volcanics, the limestones outcrop in a series of narrow strips in the stream-valleys where they have been brought up by sharp anticlinal folds and the overlying volcanics eroded through. It is along the edges of these limestone outcrops that the ore deposits occur. Nearly all of them are located in the volcanics at the contact with the limestones. There are a few that do not occur at surface contacts, but these are usually on the continuation of the strike of an outcrop of limestone or in some other position which makes it probable that the limestone occurs but a short distance below the surface.

The volcanic rocks at the ore deposits are thoroughly leached and disintegrated and readily fall apart into a peculiar lead-gray paper shale. The ores are an excellent grade of non-Bessemer limonite running from one to four per cent. in manganese and quite low in silica. The analysis given below is an average of six samples of these ores.

AVERAGE OF ANALYSIS OF SIX SAMPLES OF BACHMAN VALLEY ORES.

Fe	48.53
SiO_2	6.37
Al_2O_3	4.16
CaO	.69
MgO	.30
Mn	2.06
P	1.19
S	.05
Ignition	13.88

Carroll County.

Keeny Ore Bank [32].—This bank is on Mr. Henry Y. Keeny's place, a mile and a half east of Lineboro, just south of the State line. There is an open cut 400 by 100 feet and 30 feet deep with an entrance at the northeast end. In front of the entrance is a shaft filled with water to within 25 feet of the surface. One hundred feet from the entrance within the bank there is a shaft and a 25° incline to the southwest, also filled with water to within the same distance from the surface. Underground mining has been used here so extensively on account of the heavy overburden.

Abundant water is available for washing the ore. The Harrisburg Division of the Western Maryland Railroad is less than half a mile from the bank and could be readily reached with easy grade by three-fourths of a mile of spur line if the deposit were developed sufficiently to justify the building of it. An analysis of ore from this bank is as follows:

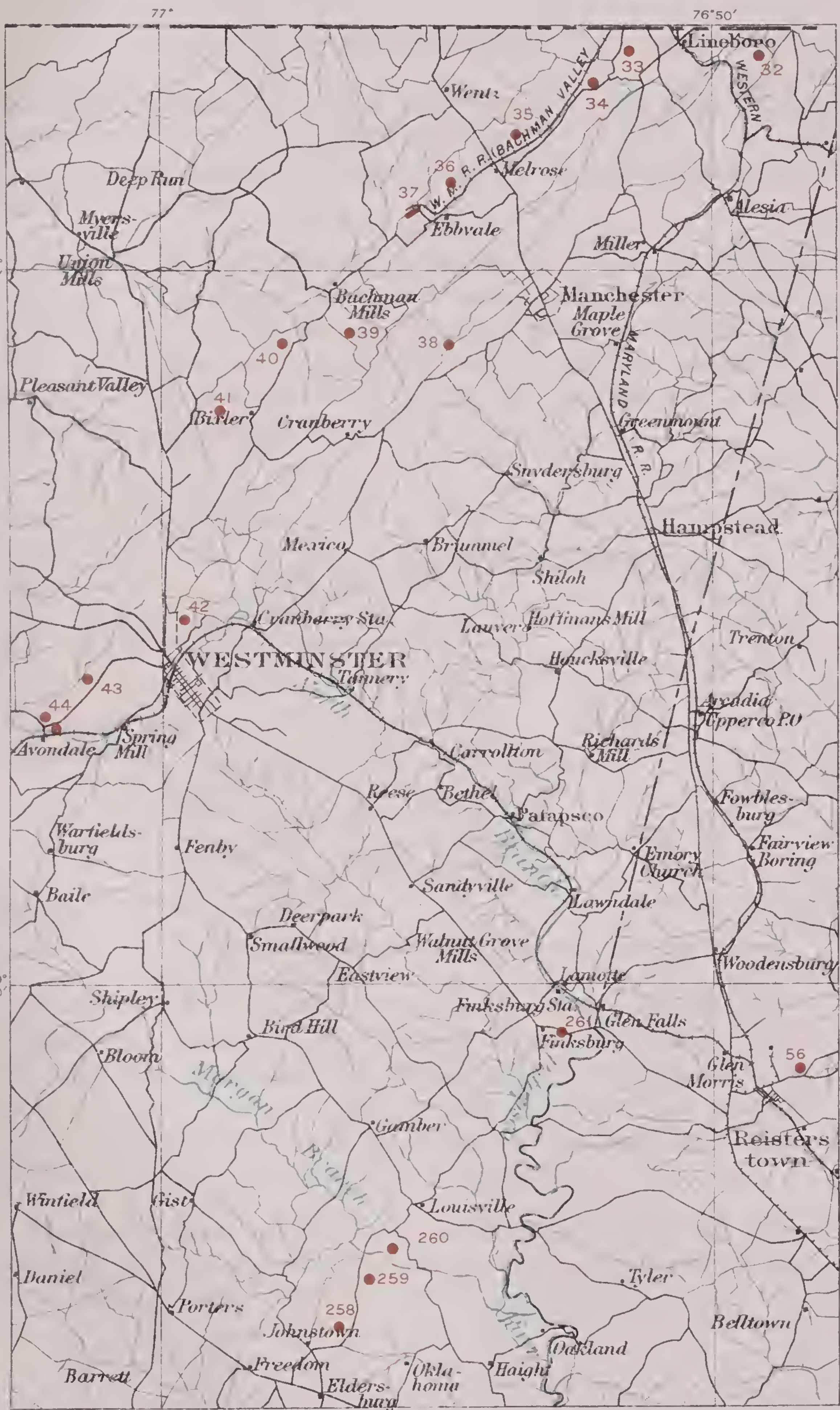
ANALYSIS OF ORE FROM KEENY ORE BANK.

Fe	44.44
SiO_2	8.68
Al_2O_3	5.21
CaO	.55
MgO	.54
Mn	3.50
P	1.43
S	.08
Ignition	13.89

Meyer Ore Bank [33].—There is an old opening known as the Meyer ore bank one mile west of Lineboro on the east side of the county road, which is 200 by 100 feet, and filled with water to within 20 feet of the top. The sides are washed in and no ore is exposed.

Miller Ore Bank [34].—Ore was worked for several years about thirty-three years ago on Mr. Miller's place a mile and a half west-southwest of Lineboro. The opening is 300 feet long, 150 feet wide and 50 feet deep. The spring at Mr. Miller's house a thousand feet southwest of the opening, which is 12 feet deep, is said to have gone through eight feet of ore. Ore was also found in a prospect hole halfway between the house and the ore bank. These indications point to a considerable ore body and would justify further prospecting on this property.

Peterman Ore Banks [35].—On Mr. Amos Sauble's property, one mile northeast of Melrose, are two openings. These were worked for three years about thirty-five years ago by the Chestnut Hill Company when the property was owned by Benjamin Peterman. One opening is just west of the house and is 200 feet long, 40 feet wide and 20 feet deep. The other is located a thousand



LOCATION OF IRON ORE BANKS IN PARTS OF CARROLL AND BALTIMORE COUNTIES

feet to the northeast and is 250 feet long by 50 feet wide. The depth is not known as it is filled with water.

A half mile northeast of these openings is another known as Tracy's Ore bank.

Ore Bank One-Half Mile North of Ebbvale [36].—A half mile north of Ebbvale are two banks that were worked by the Chestnut Hill Company. The larger opening is 200 by 50 feet and 25 feet deep. A hundred yards east of this one is a circular opening 75 feet in diameter and about 20 feet deep. The sides are now washed in and no ore is exposed.

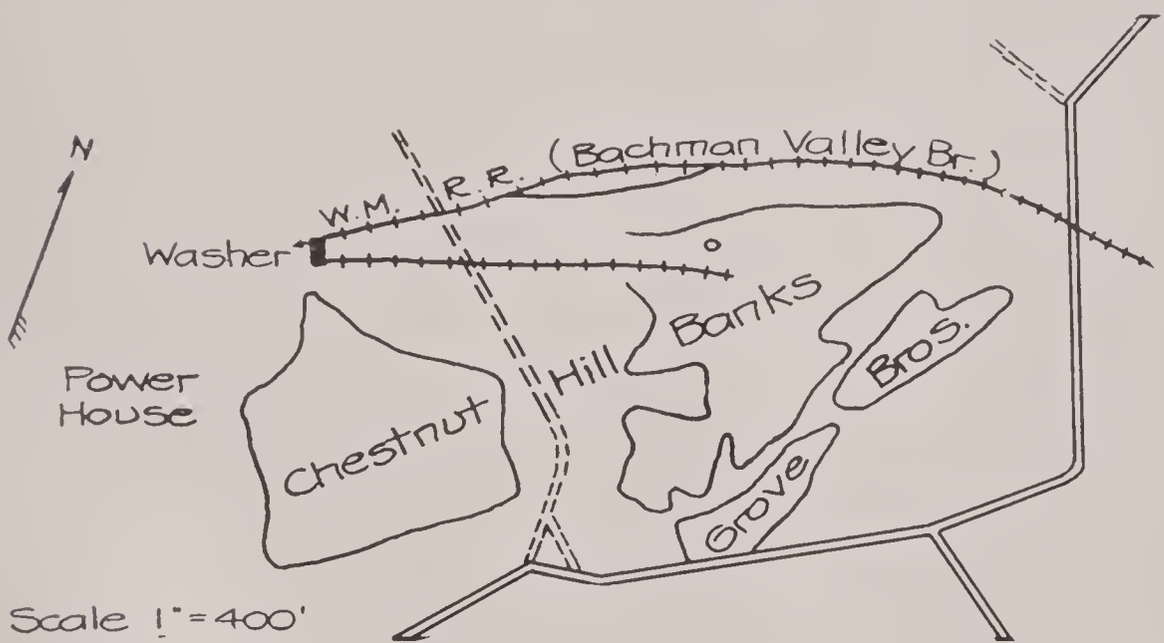


FIG. 5.—SKETCH SHOWING ORE WORKINGS AT CHESTNUT HILL ORE BANKS.

Chestnut Hill Ore Banks [37].—The Chestnut Hill banks are located at the terminus of the Bachman Valley branch of the Western Maryland Railroad on the Oliver Hoover estate and Grove Bros. property. There are five openings that have been worked, four of which are shown on the accompanying sketch map. The fifth lies a quarter of a mile to the southwest.

The Grove Bros. openings were worked about twenty-two years ago with Mr. Andrew Eisenhut as superintendent. Exposures in these openings very strikingly illustrate the relationship of the ore

to the limestone and the volcanics. At several points limestone is exposed overlain by ore interbedded with gray shale. The following is a section of a face exposed at the north end of the southern opening:

SECTION IN GROVE BROTHERS' SOUTHERN OPENING.

Soil overburden.	Feet.
Weathered volcanics	5
Ore	1
Heavy paper shale	1
Ore	20

The analysis of a sample taken from the 20′ face of ore is given below:

ANALYSIS OF ORE FROM GROVE BROTHERS' ORE BANK.

Fe	49.87
SiO_2	5.87
Al_2O_3	2.85
CaO	1.12
MgO	.13
Mn	1.74
P	1.39
S	.04
Ignition	13.52

In the two Chestnut Hill banks no limestone is exposed and only the gray papery shales show, except in the southern extension of the upper opening, on the west side of which is an excellent exposure of the ore and characteristic gray shale intimately interbanded. A shaft put down at the power house encountered limestone. These banks, therefore, illustrate exceptionally well the position of the ore deposits in the volcanics at the contact with the limestone.

The southwest opening of the Chestnut Hill banks was made about eighteen years ago by Peter Helfrich. It is an irregular shaped opening about 400 feet in diameter and 70 feet deep. After having been abandoned for some years, the deposit here is again being prospected. A one hundred foot shaft has been sunk on the west edge of the bank about one hundred feet south of the power house, and a level is being run out under the bank to strike the ore body.

The other Chestnut Hill bank was opened when the Bachman Valley Branch of the Western Maryland Railroad was built and

was operated until August, 1909, when it was abandoned. On account of the heavy overburden, the mining had been done by shafting and the shaft having reached a depth of 110 feet, it was not thought advisable to go any deeper. The ore body had a length of 300 feet and a width of from 20 to 40 feet. In the summer of 1906, a new washer was installed at the terminus of the railroad and the ore was brought to the washer in tram cars and from it dumped into cars ready for shipment. The ore occurs in lumps of various sizes some of which are so large as to require blasting. The accompanying analysis was made from a sample taken at the Chestnut Hill Company's ore pile.

ANALYSIS OF ORE FROM CHESTNUT HILL COMPANY'S ORE PILE.

Fe.	48.33
SiO_2	7.54
Al_2O_3	7.10
Mn	.85
P	.57
S	.05
Ignition	12.66

The fifth opening, which lies a quarter of a mile to the southwest, has been worked within the past two years by the Ebbvale Mining Company, the successor to the old Chestnut Hill Mining Company, and about 3,000 tons of ore extracted. The bank is about 250 feet long, 60 feet wide, and was worked to a depth of 50 feet, when it was no longer profitable to work it by open cut, and the bank was abandoned. In the center, at a depth of twenty feet a limestone ledge was encountered dipping steeply to the west, with the sheared volcanics on both sides of it. The photograph (Figure 1, Plate XVII) shows the relation of the limestone to the schists and the ore. The projecting rock to the left of the center of the view is a mass of limestone bounded on both sides by the sheared volcanics. The contact on the foot-wall of the limestone is still well-exposed, and can be plainly seen in the lower lefthand corner of the photograph. The transition from volcanic to limestone is quite abrupt, yet the two rocks are to a slight extent intergrown so that they will not cleave at the contact. Just how much importance should be attached to this outcrop in the interpretation of the geo-

logical structure of the entire region, is difficult to say. It is entirely possible for this to be a fault contact and the rocks to have been cemented together by a process analagous to "welding" in the subsequent folding to which they were subjected. A good face of ore still exposed, at the south end of the opening, contains a great many geodes of limonite varying in size from an inch or two to a foot in diameter, the interior of which show stalactitic forms.

The mining conditions here are excellent. An abundant supply of water is obtained for the washer by pumping the adjoining opening. The railroad terminating right at the banks makes the transportation facilities all that could be desired. The presence of ore a quarter of a mile southwest of the main openings makes it very probable that the ore body is continuous over the area between, indicating a large available reserve. This deposit ought therefore to be one of the important producers of the Valley for a long time.

Neller Ore Bank [38].—There is an old bank on Mrs. Neller's place two miles south of Ebbvale. The opening is 200 by 50 feet and 20 feet deep. The sides are washed in and no ore is exposed.

Schaeffer Ore Banks [39].—Two openings have been made on Mr. John Schaeffer's place, three-quarters of a mile southeast of Bachman Mills. On the south side of the County road is an old opening made about twenty-five years ago which is 300 by 50 feet and 25 feet deep. This was abandoned on account of difficulties in transportation. Ore is still exposed in the bank.

The other bank was opened in 1906 and mining has been carried on both by open cut and by tunneling, the tunnel when visited having a length of 70 feet. Between the open cut and the tunnel is a log washer, 20 feet in length. The ore was brought to the washer in steel tram cars, dumped from the washer into wooden cars and then run to the scales a hundred yards to the northwest. Here it was loaded on carts and hauled to the railroad at Ebbvale.

The ore is a limonite of very good quality as shown by the analysis.

FIG. 1.—IRON ORE AT CONTACT OF LIMESTONE AND VOLCANICS, BACHMAN VALLEY, CARROLL COUNTY.

FIG. 2.—NODULE OF SANDY IRON CARBONATE IN ARUNDEL FORMATION, NEAR MILTON AVENUE, BALTIMORE CITY.

VIEWS OF MARYLAND IRON ORE BANKS.

ANALYSIS OF ORE FROM SCHAEFFER ORE PILE.

Fe	52.39
SiO_2	4.48
Al_2O_3	2.84
CaO	.49
MgO	.16
Mn	1.01
P	1.25
S	.04
Ignition	14.16

This deposit was prospected in August, 1906, by the Mason & Dixon Mining Company, of Shrewsbury, Pennsylvania, and leased from Mr. Schaeffer for five years with a ten-year renewal on a royalty of 15c. per ton. The lease guarantees a royalty of $3600.00 in five years. Most of the ore was sold to the Warwick Iron & Steel Company at Pottsdam, Pa. The bank was opened in the fall of 1906, but no ore was shipped until the following June. About twelve men were employed and the output ran as high as 40 ton per day. On account of the drop in the price of ore during the recent panic, work was stopped on February 12, 1908, and has not yet been resumed. The monthly output is given below.

	Tons.
June-July .....1907.....	223
August	356
September	377
October	337
November	123
December	58
January .....1908.....	150
February	130
Total	1,754

An abundant water supply for washing the ore was obtained by damming up some spring heads at the washer. The difficulties in mining here are the overburden and the lack of transportation facilities. The overburden in the open cut ranges from 15 to 20 feet. To avoid the removal of this the underground work was resorted to. The nearest railroad is at Ebbvale, which necessitates a haul of three miles. Outside of these difficulties, this is a very promising deposit.

Wareheim Deposit [40].—Prospecting has revealed the presence of an ore deposit on Mr. George E. Wareheim's farm, one mile southwest of Bachman Mills. Considerable ore was plowed up on this farm and as it was on the line of the proposed extension of the Bachman Valley Railroad to Westminster, the property was prospected by the Mason & Dixon Mining Company. A number of holes were put down but all except two or three of these have since been filled up. According to Mr. Wareheim they showed a deposit over 150 feet wide and several hundred feet long. One of the holes, the location of which is given on the map, went to a depth of 40 feet and still showed ore in the bottom. All of the ore seems to be rich in manganese as is indicated by the analysis.

ANALYSIS OF ORE FROM WAREHEIM DEPOSIT.

Fe	50.71
SiO_2	2.54
Al_2O_3	2.94
CaO	.64
MgO	.31
Mn	3.79
P	1.08
S	.05
Ignition	14.66

The average depth of the overburden is not over five feet. Abundant water for washing the ore can be obtained in the limestone valley east of the deposit. The only drawback at present is its distance from the railroad. On the expectation of having the Bachman Valley line extended to Westminster, the Mason & Dixon Mining Company leased the property from Mr. Wareheim for ten years at an annual rental of $75.00 and a royalty of 15c. per ton. Since the plan to extend the railroad has been abandoned, temporarily at least, no attempt at mining has been made.

Maus Ore Bank [41].—Ore was worked forty years ago by Jacob Snyder on John and Harvey Maus' property a half mile west of Bixler. The opening is 250 by 150 feet and 25 feet deep. Two exposures of ore occur in the opening which show in general a good grade, although at places it is quite silicious. In the field just west of the opening ore is exposed at the surface, indicating that the deposit extends over to the limestone contact.

The sides are so washed in that the amount of the overburden cannot be estimated, but the occurrence of the ore at the surface just west of the opening would indicate a light overburden. The great drawback to this deposit is its distance from the railroad.

Hunter Ore Bank [42].—There is an old opening on Mr. Joseph Hunter's place, one mile north of Westminster, extending 800 feet in a northeasterly direction, with a width of 150 feet and depth of 50 feet. Ore is still exposed at many points in the bank, showing that the deposit is not yet exhausted. The analysis was made from a sample taken from these exposures.

ANALYSIS OF ORE FROM HUNTER ORE BANK.

Fe	45.43
SiO_2	9.10
Al_2O_3	4.04
CaO	.67
MgO	.35
Mn	1.46
P	1.43
S	.07
Ignition	14.37

The bank was worked to a depth of 74 feet when it is said limestone was struck, which is very probable, as it is also found in a well on this place.

At the eastern end the overburden is from 15 to 20 feet, but gradually thins out to about 5 feet on the western end. There is no water supply for washing the ore close at hand, but when the bank was worked, considerable water was encountered and this was pumped out and used for washing. The washer was situated about five hundred feet south of the opening and a spur line which has since been destroyed ran from it to the Western Maryland Railroad a half mile distant.

This deposit was opened about thirty-five years ago by Brooks & Company, who obtained a lease for 99 years, and the ore was shipped to Ashland. This company failed later and was bought out by a Pittsburg company. The deposit has not been worked for over twenty years.

Copps Branch Bank [43].—One mile west of Westminster at a fork of Copps Branch is a small opening from which ore was obtained and later limestone quarried. The opening is now pretty well filled up and the only evidence of ore is pieces scattered around on the ground.

Avondale Ore Banks [44].—At Avondale on the B. F. Shriver Company's property, formerly known as the Van Bibber place, are two openings. The smaller one on the top of the hill north of the road is 400 by 30 feet and 15 feet deep. The larger on the north bank of Little Pipe Creek is about 200 by 75 feet. It is now filled with water so that its depth is unknown, but large mounds on each side of the opening indicate that it was extensively worked. The sides are washed in and no ore is now exposed.

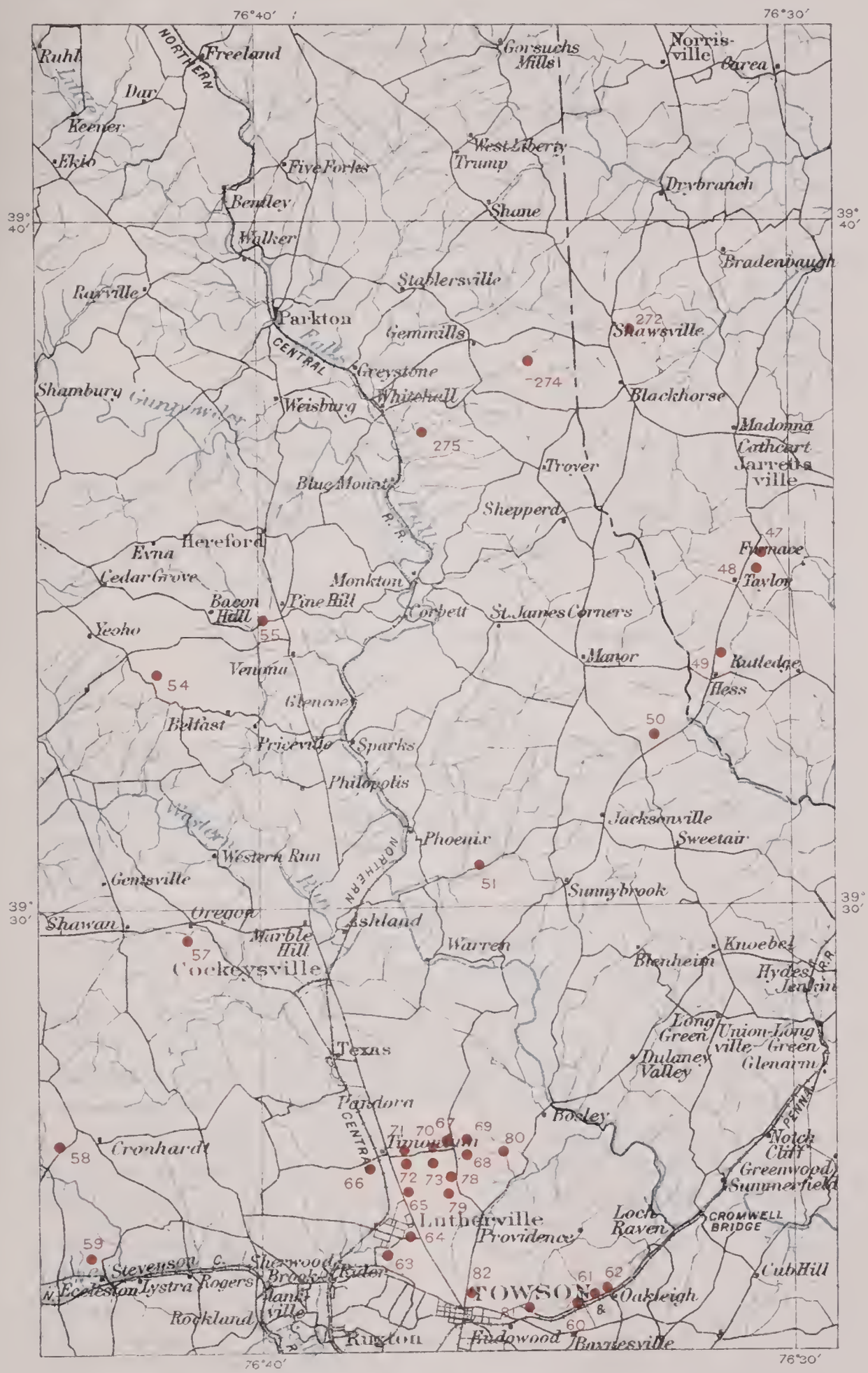
This deposit was worked before the Revolution, and the ore smelted at a furnace one hundred yards west of the opening, known as the Legh furnace. For a few years before the Civil War it was operated by the Ashland Iron Company and the ore sent to their furnaces at Ashland. The bank was not worked much from 1867 to 1880, and after that was abandoned altogether. This company also worked two banks just north of Warfieldsburg about two miles south of here.

Frederick County.

Ensor Bank [45, Plate XXV].—There is an old opening on Mr. Ernest Stouffer's place, one mile northeast of Unionville. After lying idle seven or eight years the property was purchased about 1880 by the Wrightsville Iron Company, of Pennsylvania, and reopened. The ore was hauled to New Windsor, and from there shipped to Wrightsville. The iron produced from this ore was found to be cold-short.[1]

The land was then owned by Mr. Elijah Ensor, who sold two fields to the operators, which were to revert to him when the deposit was abandoned. The opening is 200 by 100 feet, and when worked reached a depth of over 50 feet. The ore was washed at the bank

[1] Eng. and Min. Jour., Jan. 17, 1880, p. 48.



LOCATION OF IRON ORE BANKS IN PARTS OF BALTIMORE AND HARFORD COUNTIES

with water pumped from the opening. It occurs in the volcanics, but limestone outcrops in the small valley east of the bank. The following analyses were made of ore from this opening:[1]

PARTIAL ANALYSES OF ORE FROM ENSOR ORE BANK.

Fine Unwashed Ore.

Fe	41.41
P	.665

Lump Ore.

Fe	49.52
P	.817

Grim Ore Bank [46, Plate XXV].—One mile south-southeast of New Midway ore was worked about thirty years ago on Joseph Grim's land. The opening is just west of the farm house and is about 140 by 15 feet and 12 feet deep. An analysis[2] of ore from this place is given below.

PARTIAL ANALYSIS OF ORE FROM GRIM ORE BANK.

Fe	38.35
P	1.363

The *Bachman Valley* region is one of the most promising areas in the State for the future development of our iron industry. A number of deposits are already known and have been worked for some years in this area, notwithstanding the fact that no systematic prospecting has ever been done. The prospecting carried on in 1906 by the Mason & Dixon Mining Company revealed several new deposits, showing that the full possibilities of this field have not yet been realized. Systematic prospecting along the borders of the limestone outcrops would be certain to reveal many deposits now unknown. The great drawback at present is the lack of adequate transportation facilities in the valley, and a condition of the iron trade which makes the profitable working of small deposits somewhat uncertain. With the increasing value of iron ore which is bound to come in a few years, the extension of the Bachman Valley Branch of the Western Maryland Railroad will be fully

1 Tenth Census, Vol. XV, p. 258.
2 Tenth Census, Vol. XV, p. 259.

justified and it is safe to predict that the output of the present known deposits, together with that of those which active prospecting will reveal, will make this area one of the largest producers in the State. At the present time there is a ready market for the ores of this region at furnaces to which the freight charges run about $1.25 per ton, and which pay from 7c. to 7½c. per unit for the ore.

Limonites of Baltimore and Harford Counties.

These deposits geologically considered comprise two groups. The first group consists of those deposits occurring at the contact of the limestones with the underlying Setter's quartzite and the overlying Wissahickon schist. They are found in both Harford and Baltimore Counties. The second group consists of deposits occurring in the limestones themselves with a covering of Patuxent sand and gravel. These are confined to Baltimore County. Detailed geologic maps showing the distribution of the rocks of this region are given in an article on the Cockeysville marble[1] by Dr. E. B. Mathews and Dr. W. J. Miller, and the geologic map of Harford County issued by the Maryland Geological Survey.

The *Setter's quartzite* is a fine to medium grained, thin bedded, white, cream or gray colored quartzite. The beds are separated by thin layers of muscovite flakes. Along these bedding planes long stretched tourmaline crystals are often found. At times an argillaceous upper member is developed which closely resembles the Wissahickon schist and has been called by Dr. Miller a "pseudo-Wissahickon" schist. The thickness of the Setter's quartzite is usually less than 1,000 feet. It is probably of Cambrian age.

The *Cockeysville marble,* as the limestones of this region are called, is a highly crystalline rock, consisting both of calcite and dolomite layers intimately associated. On account of their highly crystalline character no fossils have been found in these rocks. They are regarded as equivalent to the Cambro-Ordovician limestones.

The *Wissahickon schist* is a highly crinkled schistose rock consisting of quartz, biotite, garnet and accessory minerals, as orthoclase, staurolite and cyanite.

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[1] Bull. G. S. A., Vol. 16, pp. 347-66.

The contact deposits are most numerous in the limestone areas of Baltimore County and Harford County in the northern and northwestern part, farthest removed from the Coastal Plain.

Baltimore County.

Cochran Prospect [50].—A prospect opening was made at the contact of the limestone and the Setter's quartzite on the north side of Parker Branch two miles northeast of Jacksonville, but nothing was found to warrant further exploitation. The opening was made at the corner of Mr. William Cochran's and Dr. Emory's properties.

Wilson Bank [51].—One mile southeast of Phoenix is an old opening from which ore is said to have been taken. The place is now covered with blocks of flint from a flint opening one hundred yards further up the hill slope. It lies at the contact of the limestone and the Setter's quartzite. The mining was done by Clay Wilson, and the ore sent to Ashland. The Ashland furnace shut down soon after the bank was opened and consequently little ore was taken out.

Matthews Ore Bank [52].—One and a half miles north of Bosley, on the Matthews farm, ore was formerly worked and sent to Baltimore. The openings were made along the east bank of the Gunpowder Falls. The one shown on the map is 200 by 40 feet and 25 feet deep. The sides are washed in and no ore exposed, but a ravine near by shows yellow clay with lumps of ore embedded in it. The deposits occur at the contact of the limestone and the Wissahickon schist.

Windsor Farm Ore Banks [53].—Two ore banks were worked on the Windsor farm, two and a half miles north of Bosley, and the ore sent to the Ashland furnaces. The banks are each about 200 by 40 feet and 20 feet deep. No ore is now exposed in them. They lie at the contact of the limestone and the Wissahickon schist.

Bosley and Ensor Ore Banks [54].—There are two old openings two miles west of Glencoe. The larger one which is 450 by 30 feet and 15 to 20 feet deep is on Mr. Webster Bosley's place. When

worked it was owned by the Ashland Iron Company and the ore sent to their furnaces. The smaller opening is on Mr. John Ensor's place and was worked on a royalty by the Ashland Company. It is about 75 feet in diameter and 10 feet deep. These banks were worked over fifty years ago. The deposits are in the schistose member of the Setter's quartzite near the limestone contact.

Mase Ore Banks [55].—There were two banks on Mr. Albert Mase's farm, two miles northwest of Glencoe, from which the ore was sent to Ashland. Both of these openings have since been filled up. One which Mr. Mase said was 80 feet deep was located at the point where his private road joins the County road. The ore occurs at the contact of the limestone and the Setter's quartzite.

Geist Ore Bank [56].—Ore was shipped to Ashland from a bank on Mr. J. B. Geist's farm, a half mile east of Emory Grove. The property was owned by Mrs. Mary G. Worthington and later by the Ashland Company. It was worked until the furnace shut down about twenty-five years ago. The ore was hauled to Glyndon and there shipped by rail, two carts being used for the hauling. The opening is about 350 feet long and runs into the side of the hill where it has a depth of 15 feet. The ore was washed at the bank. The usual force consisted of six men, four mining and two washing. It is a Wissahickon-limestone contact deposit.

Oregon Ore Banks [57].—The Oregon banks have been extensively worked and four openings made at the points indicated on the map. The ore was first used at the Oregon furnace, which was located at the banks; and, when it shut down, at the Ashland furnaces.

The opening at the west end of the shanties is about 500 by 50 feet and 20 feet deep. The sides are covered with wash and no ore is now exposed. On the south side the Wissahickon schist is exposed.

The largest opening which is the last one that was worked is 900 by 300 feet and over 50 feet deep, but now filled with water. Work was stopped here about twenty-five years ago. The mining was

chiefly by open cut work, but some tunneling was done. Along the south and west sides Wissahickon schist is exposed.

The analyses are taken from the Tenth Census, Vol. XV, p. 257.

PARTIAL ANALYSES OF ORE FROM OREGON ORE BANKS.

Washed Ore.

Fe	41.62
P	.243

Lump Ore.

Fe	51.90
P	.262

The ore occurs in the Wissahickon schist at the contact with the limestone. The condition of the openings is such that nothing can be learned as to the extent of the deposit.

The Caves Ore Banks [58].—Two openings were made at The Caves, two and a half miles northeast of Owings Mills, and the ore hauled to Stevenson and shipped to Ashland. The easterly opening is 300 by 150 feet and 20 feet deep, and the westerly 150 by 100 feet and 6 feet deep. No ore is now exposed. It lies at the contact of the limestone and the Wissahickon schist.

Cross Ore Bank [59].—There is an opening 500 by 100 feet and 55 feet deep on Mr. W. I. Cross' property a half mile northwest of Stevenson. The ore was worked by the Ashland Iron Company. It occurs at the contact of the limestone and the Wissahickon schist. An analysis[1] gave:

PARTIAL ANALYSIS OF ORE FROM CROSS ORE BANK.

Fe	45.91
P	0.482

Ore was worked at three points from two to two and a half miles east of Towson along the south side of Mine Bank Run at the contact of the limestone and the Setter's quartzite. These deposits were worked about thirty years ago and the ore sent to Canton.

[1] Tenth Census, Vol. XV, p. 257.

Reddington Ore Bank [60].—This bank occurs a half mile southwest of Oakleigh on Mr. Patrick Reddington's land. It is 150 by 50 feet and filled with water to a depth of 35 feet.

Von Kapff Ore Bank [61].—Another bank, which has been filled up, was worked on Mr. Frederick Von Kapff's farm, then owned by George Smith. This was situated on the west side of a small tributary of Mine Bank Run about 200 yards west of Oakleigh.

Rice Ore Bank [62].—The third opening was made on Mr. D. H. Rice's place at Oakleigh. This opening which was 180 by 50 and 15 feet deep has also been filled up.

The deposits overlain by the Patuxent formation derived their iron content from the iron originally contained in that formation. As waters percolated through these loose ferruginous materials, the iron was leached out of them. When the iron-bearing solutions came into contact with the underlying limestone, their iron content was precipitated. In this way many pockets of ore have been formed under the capping of outliers of the Patuxent formation. Deposits of this kind were extensively worked at and to the northeast of Lutherville and to a small extent in the vicinity of Towson.

Rider Ore Bank [63].—There is an old bank on Mr. Abraham Rider's place at the south end of Butlerville. It strikes N. 45° W. and is 150 by 50 feet and 25 feet deep. No ore is now exposed. The ore was mined on a royalty by the Ashland Iron Company.

Ore Bank on East Side of Lutherville [64].—On the Ridgely property on the east edge of Lutherville is an irregular opening which was worked fifty years ago by the Ridgelys for their furnace two miles to the northeast. It was later worked by the Ashland Iron Company on a royalty.

Ridgely Ore Bank [65].—This bank is on the east side of the York Turnpike, one-half mile north of Lutherville, on Mr. John Ridgely's place. It is 250 by 200 feet and 40 feet deep. East of it is a smaller opening 125 by 50 feet and 20 feet deep. The gravel

overburden has caved in and no ore is exposed. A washer was run at this bank supplied with water from a spring to the south. The ore was sent to Ashland.

Herman Ore Bank [66].—One hundred yards southwest of Timonium Station there is an opening on Mr. Emanuel Herman's place, which is about 25 feet in diameter and 6 feet deep. No ore is now exposed.

Pot Springs Ore Banks [67-80].—A number of openings known as the Pot Springs openings were made northeast of Lutherville. These are indicated on the map by numbers corresponding to the numbers in the descriptions which follow. The ore from these openings went to the Ashland furnaces. Analyses of samples from several of these openings are given below.[1]

PARTIAL ANALYSES OF ORE FROM POT SPRINGS ORE BANK.

Washed Ore.		
Fe	40.39	38.96
P	.102	.174
Lump Ore.		
Fe	54.42	52.72
P	.200	.067

67. Opening 225 by 40 feet and 10 feet deep. On the east side of the Pot Spring road on Mr. Robert Dennison's property. Some ore is still exposed on the sides of the opening.

68. Two hundred yards east of the blacksmith shop on Mr. Dennison's property. Open cut 350 by 100 feet and 20 feet deep. There was also a seventy-foot shaft at the south end. The opening is now filled with water. A great many lumps of ore are scattered around on the ground and many pots, as the miners called geodal lumps of limonite, were obtained from this opening. When worked, this deposit was owned by the Ashland Iron Company.

69. One hundred yards north of No. 68 is another bank on the same property extending 300 feet in a northeasterly direction with

[1] Tenth Census, Vol. XV, p. 255.

a maximum width of 200 feet. The depth is about 20 feet. A large amount of ore is still exposed in the sides of the opening.

70. This opening is on Mr. Robert Dennison's property, one mile east of Timonium, on the north side of Spring Branch. It is said to have been worked to a depth of over sixty feet. The relations of the ore to the Patuxent formation are well shown here. The ore body rests on the limestone, but extends up into the Patuxent sands and gravels, making a conglomerate with a matrix of limonite. Since the ore was formed by downward moving waters, the source of the iron must have been the overlying Patuxent materials. The analysis of a sample from this bank is given below.

ANALYSIS OF ORE FROM DENNISON ORE BANK.

Fe	46.40
SiO_2	15.72
Al_2O_3	4.95
Mn	Little.
P	0.22
S	.08
Ignition	11.64

71. One-half mile west of No. 70 is another deposit on the same property which when worked was owned by John Talbot. It is 100 by 20 feet and 10 feet deep.

72. Half a mile east of Timonium on the south side of the road on Mr. Charles (?) McCormick's place is an opening 400 feet long striking northeast. The northeast end is a circular opening 100 feet in diameter and 20 feet deep, and tapers off to the southwest. Ore is exposed here associated with a yellow earthy clay.

73. Nearly a half mile southeast of No. 72 is another opening on the same property striking N. 70° E. for 325 feet, 100 feet wide and 15 feet deep.

74. East of No. 73 is another opening on the same property 200 by 75 feet and 25 feet deep.

75. Less than 100 yards northeast of No. 74 is an opening 400 feet long, 50 to 100 feet wide and 25 feet deep. The property is now owned by Mr. Francis Homer.

76. Seventy-five feet east of No. 75 is an opening 75 by 20 feet and 10 feet deep. This is also on Mr. Homer's place.

77. On the south side of the road one mile east of Timonium on the same property is an opening 50 feet in diameter and 15 feet deep.

78. One hundred yards east of No. 77 is another opening on Mr. Homer's property, 100 by 40 feet and 15 feet deep.

79. A mile and a half east of Timonium is an opening on Mr. John Ridgely's place. It is an irregular opening 200 feet wide, 300 feet long and 20 feet deep.

In the woods between this bank and the York Turnpike are a number of small openings.

80. On Mr. Otho Ridgely's farm, two miles east of Timonium, and a half mile northwest of the old furnace site on this farm, is an opening striking N. 20° E., 100 yards long, 30 feet wide and 15 feet deep.

Minebank [81].—One mile east of Towson on the north side of Mine Bank Run on Mr. Patrick Reddington's property is a bank which was worked about thirty years ago and the ore sent to Canton. Eight or nine men were employed in mining. The ore sold for from $6.00 to $8.00 per ton, and later dropped to $4.00. The overburden is from four to ten feet. The opening extends for a distance of 600 feet along the Run and widens out to 150 feet at the east end. Its depth is about 20 feet. In the sides of the opening are orange-yellow clays, containing lumps of ore, and in some of the small ravines emptying into the Run are exposures of ore, showing that the ore body extends beyond the limits of the present opening.

Chew Ore Bank [82].—An ore deposit was worked on Mr. Henry B. Chew's property, quarter of a mile north of Towson, on the east side of the Dulany Valley Turnpike. The opening is 250 by 50 feet and 20 feet deep. The sides are washed in and no ore is now exposed.

Harford County.

Hope Ore Bank [47].—The Hope ore bank is situated two miles southwest of Jarrettsville on Mr. Charles Schuster's place. The

ore body occurs at the contact of the Setter's quartzite and the Wissahickon schist, the limestone being absent here. It has been worked along the contact for a distance of 650 feet with a width of 100 feet. The opening is filled with water so that its depth could not be determined. No ore in place is exposed but considerable ore is scattered around the opening and an analysis of a sample obtained here showed a good grade.

ANALYSIS OF ORE FROM HOPE ORE BANK.

Fe	51.57
SiO_2	12.59
Al_2O_3	2.51
Mn	Little.
P	.01
S	.13
Ignition	10.92

The ore was used at the LeGrange furnace near Rocks on the Maryland and Pennsylvania Railroad.

Scarff Ore Bank [48].—On Mr. James Scarff's farm, a quarter of a mile south of the Hope ore bank, is a small opening which was worked at the same time. It is 200 by 30 feet and 6 feet deep. The ore occurs in the Wissahickon schist about 500 feet east of the contact with the Setter's quartzite.

Tolley Ore Bank [49, Plate XVIII].—A large amount of ore was taken from Judge E. Carvil Tolley's place a half mile north of Hess. The bank was opened by the operators of the Sarah furnace, and the ore sent to their furnace two miles southwest of Jarrettsville. It was worked from about 1840 to 1865. Eight to ten teams were employed in hauling the ore. After lying idle for some years, it was again worked by Dennis Lynch on a royalty of 50c. per ton, and the ore sent to Ashland. The main opening strikes N. 45° E. and is 750 by 100 feet. It is filled with water to within 15 feet of the top. About one hundred feet to the southwest of this opening is a smaller one 100 by 40 feet and 8 feet deep.

The ore is a limonite occurring chiefly in small lumps. While the ore body is situated within the limestone, the iron has in all probability been derived from overlying formations which have

since been eroded. Ore is still exposed in the sides of the bank and from all indications there is still considerable ore that could be mined. The composition of the ore is shown by the analysis given below.

ANALYSIS OF ORE FROM TOLLEY ORE BANK.

Fe	54.02
SiO_2	3.44
Al_2O_3	3.45
Mn	Trace.
P	.83
S	.12
Ignition	13.74

THE BOG IRON ORES.

Bog-iron ore, or as it is also called, swamp-ore and meadow-ore, is yellowish, brownish, or blackish limonite with resinous lustre on fresh fracture. It is always very porous and cavernous, often slag-like and hard; but also ochrous, loose, and earthy. It is usually mingled with many other substances, among which are hydrated iron silicates, iron phosphates, crenates, ulmates, and humates. The iron contact varies from 20 per cent. to 60 per cent., and phosphorus, which is always high in these ores, may rise to 10 per cent. Mechanical admixtures of sand and clay may become so great as to make the ore of very low grade.

The Formation of Bog Iron Ores.

These ores have been worked since the earliest period known, but are of little importance to the iron industry at present. Their chief interest today lies in the fact that they are now forming, and at such a rate as to be observable. Deposits which were once exhausted are again workable after an interval of a few years. A study of the formation of these deposits consequently gives valuable information bearing upon the genesis of iron ores in general.

The deposition of the ore takes place where surface water stagnates in shallow depressions of flat lands, especially along sluggish streams whose waters are colored brown by dissolved humus acids

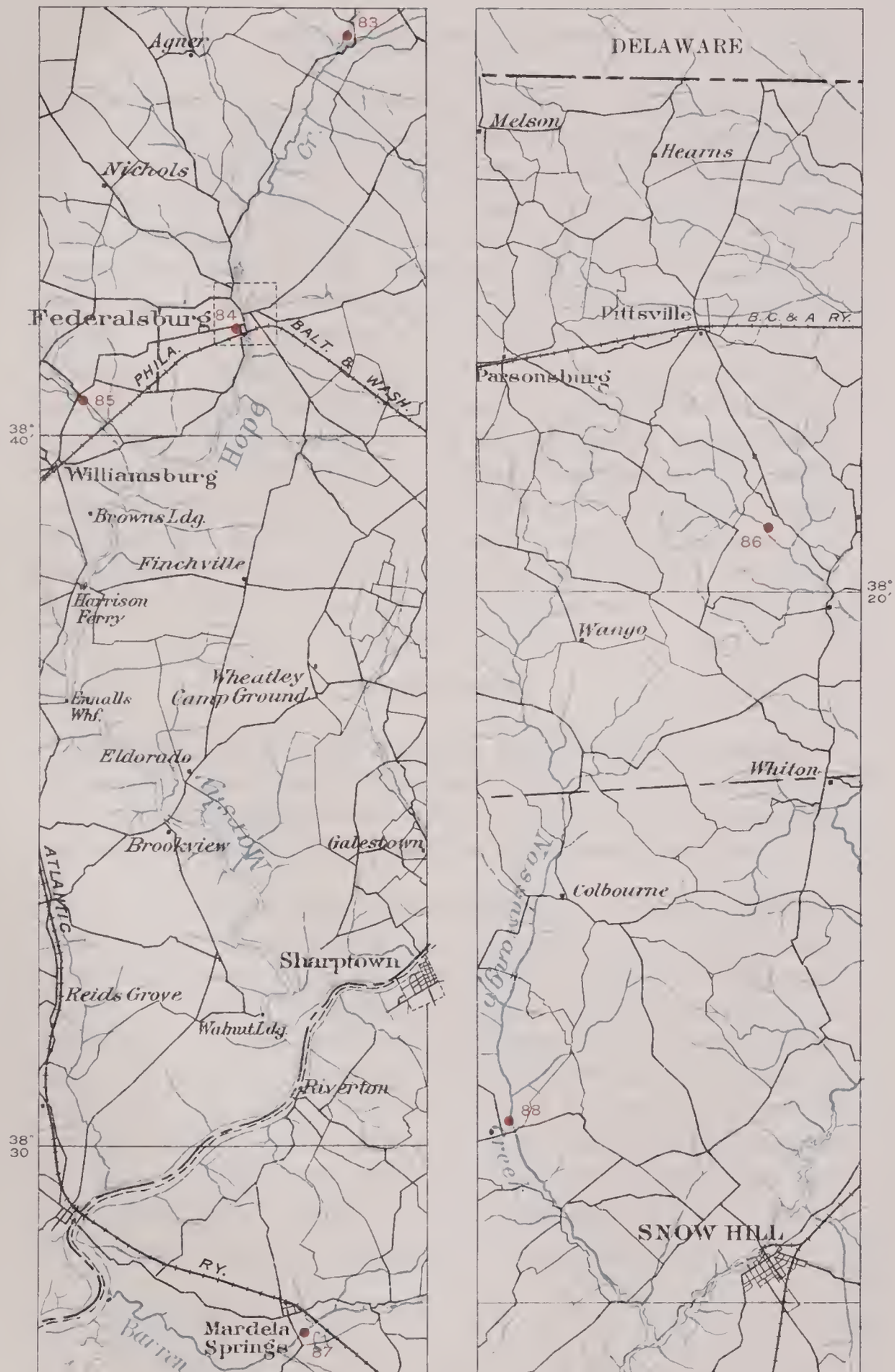
or humus salts. The source of the iron which these waters carry in solution, and how its precipitation is brought about, are considered at length in the discussion of the origin of the carbonate ores of the Coal Measures on pages 248 to 253, and hence need not be gone into here.

The Bog Iron Ores in Maryland.

The very low relief of the Eastern Shore gives rise to a very sluggish stream-flow through long stretches of marsh land containing abundant vegetation. These are ideal conditions for the formation of bog iron ores. There is, however, one other very essential factor in the accumulation of large deposits, and, that is, an abundant source of iron. If the streams were heavily charged with ferriferous salts, their iron content would be precipitated and large deposits formed. Unfortunately the streams of the Eastern Shore head in the same deposits through which they flow and hence do not become heavily charged with iron salts. If they headed in a region of rocks containing iron-bearing minerals, it would be otherwise, since the soluble iron salts formed in the processes of weathering of these rocks would find their way to the streams and then be precipitated in the swamps through which the streams flowed further down in their course. On the Western Shore, the streams have their source in such a region, but there the fall from the Piedmont to tidewater is much more rapid and conditions are not nearly so favorable for the precipitation of their iron content in the form of bog ores.

The above is undoubtedly the reason why the bog ores have never been of any importance in the iron industry of the State, and not because they have been overlooked. In the diligent search that was made for ores of iron in the early days, the possibilities of the bog ores were not overlooked, as there are a number of references to them in the early literature. Ducatel[1] mentions several occurrences. Specimens of bog ore of good quality had been obtained at that time on the place of Levy Wroth at the head of a branch of

[1] Ducatel: Annual Report of the State Geologist of Maryland, 1837, p. 19.



LOCATION AT WHICH BOG IRON ORE HAS BEEN MINED IN SOUTHEASTERN MARYLAND

Worton Creek. The same authority also states that bog ore of good quality occurs on Henry Fisher's farm at the head of the Sassafras River, where the color of the water seemed to indicate a large quantity; and on the farm of a Mr. Lockwood near Warwick, where specimens were found with a specific gravity of 2.50 to 3.00. Three years later, in 1840, Alexander[1] speaks of the bog ores occurring over a portion of Caroline County, the eastern part of Dorchester, and part of Somerset and Worcester counties. The inevitable conclusion, therefore, is that the deposits do not occur in sufficiently large quantities to have made it profitable to work them to any extent even at that date. In the first half of the nineteenth century bog ores were worked at several localities, and five miles northwest of Snow Hill a furnace was erected which ran exclusively on these ores. But the inadequate supply, and the high phosphorous content soon caused these deposits to be abandoned, and since that time no attention has been paid to these ores.

Caroline County.

Smithville [83].—About a century ago, there was a bloomery on Marshyhope Creek, one mile southwest of Smithville, for which bog ores obtained along the creek were used. No details in regard to the occurrence of the ore or the quantity that was mined are known.

Federalsburg [84].—Bog ore was mined at Federalsburg by Eggleston Brown from 1835 to 1845. It was transported in barges down Marshyhope Creek to tidewater, and shipped to Baltimore. Mr. W. J. Mobray states that the venture was little more than an experiment, and that operations were not continuous during the ten years. The ore finally turned out to be too low grade to be mined with profit. It was obtained from the low flat on the west side of the creek in Federalsburg back as far as the hill on the west edge of the town, especially at the south end, where the railroad tracks now are. Three to four feet of soil had to be removed to get at the ore.

[1] Alexander: Amer. Jour. of Science, Vol. 27, Series I, p. 7.

Dorchester County.

Williamsburg [85].—One mile northwest of Williamsburg, Eggleston Brown also mined a little ore at the same time that he worked at Federalsburg. This was on a branch of Marshyhope Creek at what is known as the "Yellow Bridge." As the ore had to be hauled three miles to Federalsburg and the deposit was not especially promising, it was soon abandoned.

Wicomico County.

Powellsville [86].—One mile above the mill pond at Powellsville along the creek, Mr. Geo. W. Parsons, of Parsonsburg, obtained a small quantity of bog ore to experiment on some years ago, which he reduced in a cupola. He found the ore to be of low grade, as it yielded a great deal of slag, and the iron was extremely brittle. He said the ore occurred only a few inches below the surface, but to what thickness he did not know, as he merely stripped off the uppermost portion, leaving a layer of ore below.

Barren Creek [87].—Alexander[1] states that bog ores occur in great abundance on Barren Creek, and as they are found to be advantageously used with other ores of iron, they are sent to Baltimore and other places to be thus employed. The Barren Creek Springs which yield chalybeate waters were said to have been at one time much frequented, but were already neglected in 1840. The "great abundance" of these deposits must have consisted in a wide distribution along the creek rather than in their quantity, as no further mention is made of these deposits in later years.

Worcester County.

Snow Hill [88].—The locality at which the bog ores have been most extensively mined is along Nassawango Creek, five miles northwest of Snow Hill. A furnace built here in 1830 operated irregularly until about 1850, producing as high as 700 tons of pig iron per

[1] Amer. Jour. of Science, Vol. 27, Series I, p. 7.

year, so that during that period a large amount of ore was obtained. The ore was mined in the marshes along the stream above the furnace for a distance of a mile or more, and is known to extend two or three miles further up stream. I was very kindly assisted in procuring a sample of the ore by Mr. D. M. West. The field work showed that it does not occur as a continuous bed over the whole area, but in patches. Below a covering of a foot or more of black loamy soil, the ore occurred as a crust from six to eight inches thick. Perfectly fresh looking specimens had a cellular texture and were quite hard. They showed an irregular fracture with a dark shiny surface. The analysis given below was made from a sample of such ore.

ANALYSIS OF HARD BOG ORE NEAR SNOW HILL.[1]

Fe	51.41
SiO_2	4.86
Al_2O_3	.92
CaO	.18
Mn	0.02
P	.685
S	Trace.
Ignition	19.74

The high loss on ignition would seem to indicate a composition of the iron hydrate corresponding to Xanthosiderite, that is, Fe_2O_3. $2H_2O$ instead of $2Fe_2O_3$. $3H_2O$, the composition of limonite. This is not surprising as the conditions under which the ore is formed are favorable to the highest possible hydration.

This ore graded over to another type which is soft and very rusty looking. As the former type on exposure weathers to the latter, it is no doubt largely an altered form of the former which has subsequently been leached by descending atmospheric waters. Further confirmation of this explanation is found in the fact that the freshest looking ore occurred in the wettest places, that is, where it was protected from atmospheric agencies.

[1] Analysis by Penniman and Browne.

LIMONITE IN GABBRO AREAS.

The gabbro is perhaps the oldest intrusive igneous rock in the Piedmont. It occurs in three main areas in the State,—the Stony Forest area of Harford and Cecil Counties; a great belt or sheet which extends from north of Conowingo, on the Susquehanna River, in a south-southwest direction to Baltimore City; and the irregular intrusive area which is mainly developed to the west of Baltimore and extends as far south as Laurel.

The unaltered gabbro is a massive, heavy, and dark colored rock, which contains a high percentage of iron. On weathering it changes to a characteristic deep reddish-brown color due to its high iron content. The residual soil formed has that same color, and is unusually rich in iron, frequently containing lumps of limonite. So far as known, it has been attempted to work this residual product at only one point. In 1882, a Mr. Greider, a contractor on the Maryland and Pennsylvania Railroad, who was doing the grading near Roland Park, attempted to open an ore bank at what is now the northeast corner of Oakdale and Forrest Avenues. The operations were carried on for only a few months. No workable body of ore of this character has been discovered, nor is it likely that any will be found.

THE CARBONATES.

THE CARBONATES OF THE COAL MEASURES.

The carbonate ores of the Appalachian region occur in the Coal Measures, or the rocks of the Pennsylvanian period as they are now called. These ores occur in two varieties known as "clay ironstone" and "blackband." They are almost always present in the Carboniferous rocks when these rocks contain coal seams.

These ores have had their chief development in some of the European coal basins and especially in those of Great Britain. The principal areas in Great Britain are those of South Wales and Scotland. In 1880 the production of these ores in South Wales was 170,000 tons. In 1881 Scotland produced over 2,500,000 tons, about

equally divided between blackband and clay ironstone. In 1894 the output in Scotland had dropped to a little over a half million tons.

In the United States these ores were formerly worked to some extent. The chief producing States were Pennsylvania, Ohio, West Virginia, and Kentucky. In 1880 the output reached nearly 850,000 tons. Since then they have steadily declined in importance, until today they are practically abandoned in the United States; Ohio with an annual output of 20,000 tons being the only producer.

FIG. 6.—MAP SHOWING LOCATION OF MARYLAND COAL BASINS.

Distribution of the Coal Measures in Maryland.[1]

The Coal Measures in Maryland occur in the western part of Allegany County and in Garrett County in five basins or synclines known as the George's Creek basin, the Upper Potomac basin, the

[1] See Allegany and Garrett County Reports and Coal Report of the Maryland Geological Survey.

Castleman basin, the Lower Youghiogheny basin, and the Upper Youghiogheny basin. The greater portion of the first of these basins lies in Allegany County and the other four in Garrett County.

Stratigraphy of the Maryland Coal Measures.

The Coal Measures of Maryland embrace five formations which are grouped into two periods, as follows:

Permian Period:	
Dunkard	300′
Pennsylvania Period:	
Monongahela	240–270′
Conemaugh	600–700′
Allegheny	260–350′
Pottsville	325–380′

The important ore horizons are confined to the Allegheny, Conemaugh and Monongahela formations. The Allegheny formation consists mainly of irregularly interbedded shales and sandstones; the Conemaugh formation consists largely of shales, but has massive sandstone strata near the top and near the bottom; the Monongahela formation is even more largely composed of shales and the sandstones rarely become massive enough to form noticeable topographic features. The ore beds have been found at a number of horizons in these strata. The section (Figure 7) taken from the Coal Report of the Maryland Geological Survey, page 243, gives a general idea of the character of the formations and will be found useful to refer to as the different ore localities are described further on.

Description of the Ores.

These ores are divided into two varieties known as blackband and clay ironstone, according as they contain or lack bituminous matter.

BLACKBAND ORE.—Blackband ore consists chiefly of carbonate of iron with more or less earthy and bituminous matter. It occurs in beds of varying thickness, but never exceeding more than a few

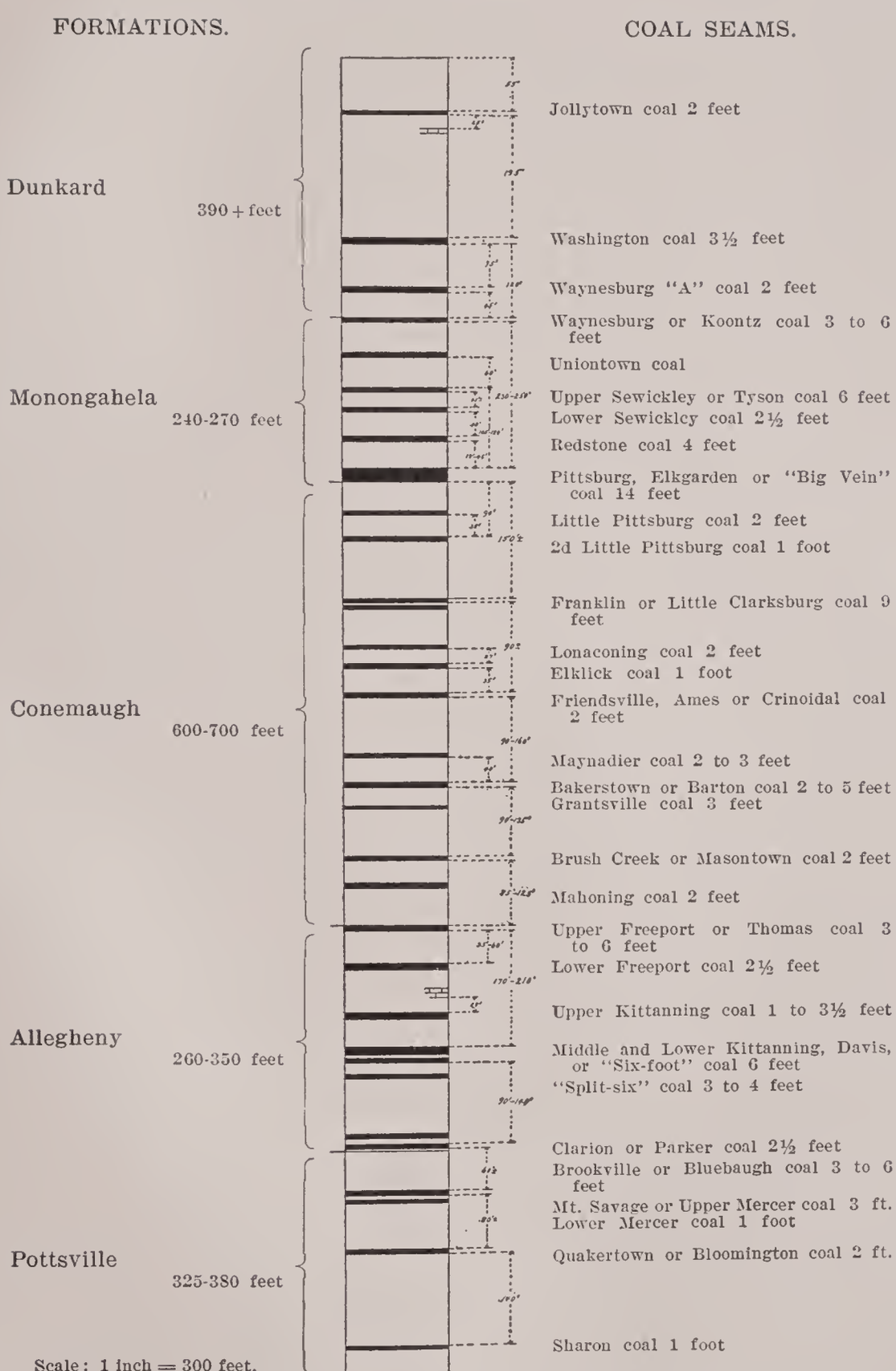


FIG. 7.—GENERALIZED SECTION SHOWING MARYLAND COAL SEAMS.

feet, and is almost always associated with coal seams. At times a coal seam will grade into such ore. These ores usually run about 21 per cent. to 38 per cent. Fe. Before being used in the blast furnace they are roasted. They contain such an abundance of carbonaceous matter that they burn in the roasting furnaces without the addition of fuel and the residue contains from 50 per cent. to 70 per cent. Fe. The blackband ores are of no importance in Maryland and apparently have never been mined.

CLAY IRONSTONE.—This ore contains considerable clay and earthy matter and occurs as isolated masses of concretionary origin which sometimes coalesce to form continuous beds of considerable extent. Fossils often form the nucleus of the concretions. On account of the presence of the earthy matter and the absence of carbonaceous matter, the nodules are of a drab color. They occur in the shales of the Coal Measures and are very irregular in their thickness and extent. On the weathering of the shales the concretions are concentrated at the surface, and as these surface concentrations are exposed to weathering they alter to limonite. A large part of the ore that has been mined from these horizons in Maryland consisted of such altered ore. The following analyses of clay ironstone ores, one from Allegany County and one from Garrett County, show a fairly uniform composition:

ANALYSES OF CLAY IRONSTONE.

Garrett County, 4 miles west of Krug.	
Fe	34.58
SiO_2	13.78
Al_2O_3	4.29
Mn	1.36
P	....
S	.49
Ignition	24.11

Allegany County, northwest of Mt. Savage.	
Fe	36.05
SiO_2	13.53
Al_2O_3	6.47
Mn	.94
P	.08
S	.42
Ignition	25.02

The mean of thirteen analyses of carbonate ores from Allegany County gives an average iron content of 34.96 per cent.[1]

When these ores were mined they were usually roasted before being put in the furnace so that the ores ran about 47 per cent. Fe. and were practically free from sulphur. While the phosphorus is usually quite low, it is nearly always above the Bessemer limit.

The Occurrence of the Ores.

Ore has been mined in all four formations of the Pennsylvanian, but that of the Pottsville is of little importance.

POTTSVILLE ORES.—On the north side of Bear Creek, one mile southeast of Friendsville, Garrett County, ore was mined in a black shale underlying the Homewood sandstone. This seems to have been a purely local development as no ores have been mined at this horizon in any other locality.

ALLEGHENY ORES.—A section of the Allegheny formation near Westernport[2] shows a two-foot bed of shales with nodular iron ore about 125 feet above its base. The ores of the Allegheny formation do not seem to be of much importance in Allegany County and have been mined at only one point.[3] A large tunnel intended to reach the Mount Savage fire-clay on the east side of Savage Mountain between the National Road and the Savage Mountain Fire Clay Mine cut through a bed of clay ironstone in the shales between the Clarion coal and the overlying Clarion sandstone and considerable ore was taken out.

In Garrett County, in the Lower Youghiogheny region, the Allegheny ores are of more importance and have been mined about a mile south of Fearer and on the hill on the east side of the Youghiogheny River half way between Friendsville and Elder. In the rail-

[1] Alexander: Report on Manufacture of Iron, 1840, p. 108.
[2] Bulletin No. 65, U. S. G. S., p. 186.
[3] Garrett County Report, Md. G. S., p. 229.

road cut three-quarters of a mile north of Krug is an exposure showing the following sequence:

Sandstone,
Shale 10′,
"Split-six" coal.

In the lower six feet of the shale are nodules of clay ironstone of various sizes but averaging about the size of a walnut. In one bed about six inches thick and one foot above the coal the nodules are very numerous. This same ore is exposed on the opposite side of the river. It is again exposed at the coal prospect on Laurel run south of Krug, where the nodules are considerably larger; and in a prospect-trench cut by the Western Maryland Coal and Coke Company, half a mile further up the river. About half a mile southwest of Swallow Falls, in a branch of Toliver Run, there is an exposure of shale which for about eighteen inches contains iron ore nodules.

CONEMAUGH ORES.—Beds of iron ore are found at a great many horizons in the Conemaugh formation and have been worked at a number of places. A detailed section of this formation near Lonaconing, measured in the '60's by Professor P. T. Tyson, shows twenty-six horizons at which ore occurs. This section was measured on the east side of Dug Hill, the hill having received its name from the excavations made for these measurements on Laurel Run and Mill Run. This section is given below as it is of considerable value on account of the detail with which the iron ore occurrences have been noted.

SECTION OF CONEMAUGH FORMATION SHOWING IRON ORE HORIZONS, NEAR LONACONING, MD.[1]

	Feet.	Inches.
"Big Vein" coal (from Dug Hill measurements)	..	..
Shale, with *iron ore* at the top	12	..
Fire-clay	3	..
Limestone	1	6
Shale	15	6
Sandstone, fine grained	29	..
Shale	27	6

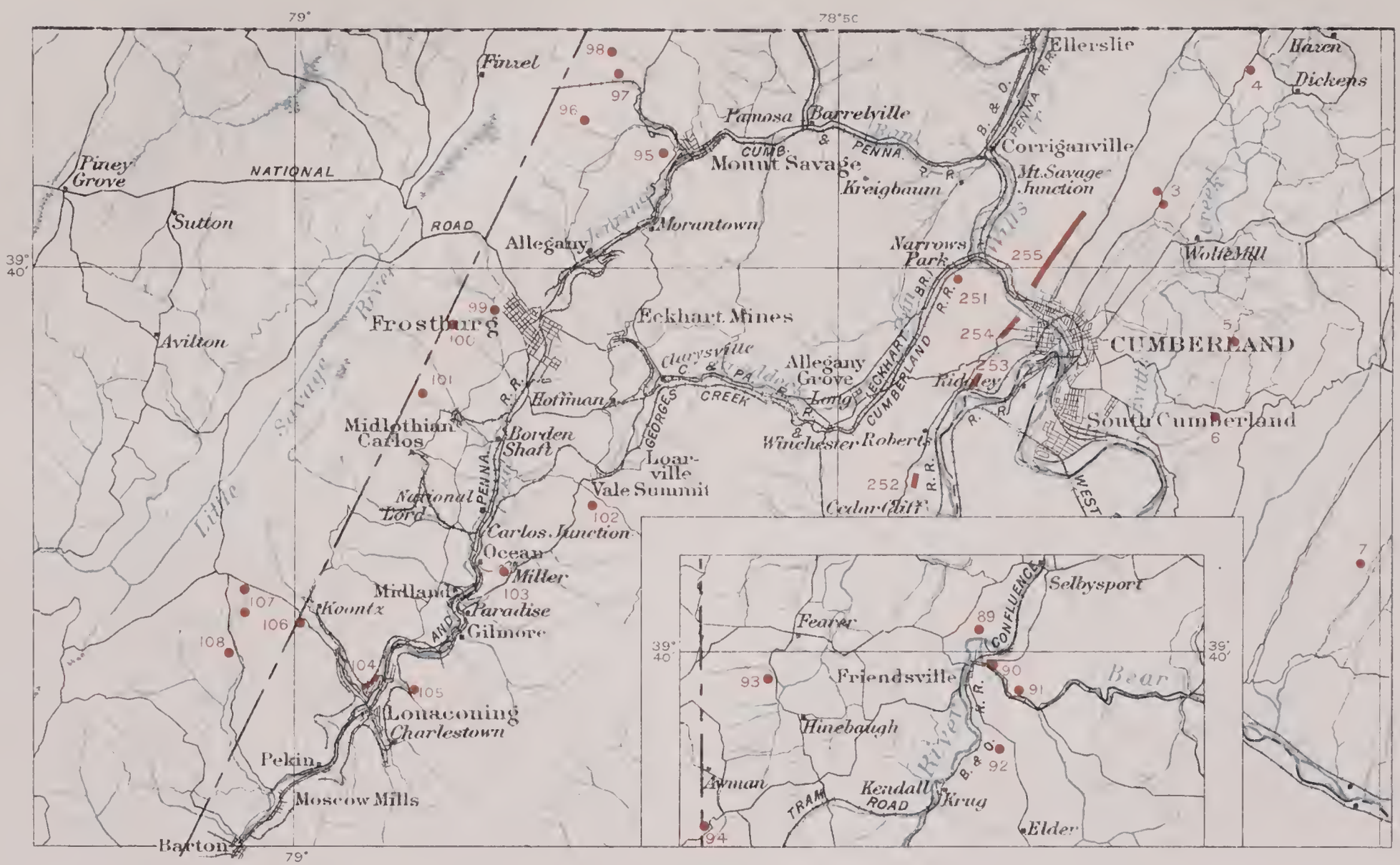
[1] Taken by Philip T. Tyson, Proc. Amer. Philos. Soc., XI, 1871, pp. 9-13; cf. Allegany County Report, Md. G. S., p. 120.

	Feet.	Inches.
Coal	2	6
Shale	4	..
Shale, with *iron ore* at the top	16	8
Shale, ferruginous	1	.
Coal	3	9
Shale	1	..
Coal	1	..
Shale, with *three bands* of *iron ore*	2	6
Fire-clay with iron ore	3	..
Shale	..	6
Coal	1	..
Shale, with *iron ore*	..	7
Fire-clay, with *iron ore* nodules	2	..
Shale	..	6
Coal	1	6
Shale	2	6
Fire-clay, with *two bands* of *iron ore*	5	6
Sandstone	1	6
Shale, with *four bands* of *iron ore*	6	6
Shale, with *two bands* of *iron ore* nodules	6	6
Iron ore	..	7
Shale, with *iron ore*	4	3
Coal	..	6
Shale, with *iron ore*	..	6
Coal	1	6
Shale	2	..
Coaly shale	2	3
Shale, with *iron ore*	2	2
Coal	2	1
Shale	..	6
Fire-clay, with *iron ore*	2	8
Shale, with *iron ore*	4	10
Shale, ferruginous	2	6
Iron ore	1	6
Coal	..	3
Shaly sandstone	2	..
Shale	4	6
Coal	2	6
Limestone	3	..
Fire-clay	3	6
Coal	..	8
Shale	1	6
Shale, ferruginous	1	6
Shale	1	..
Coal	1	3
Shale	1	3
Coal	1	6
Shale	1	6
Coal	1	6
Shale, brown	2	8
Shale, arenaceous and nodular	5	..
Shaly sandstone	8	..
Shale	4	6
Coal	1	6
Fire-clay	7	4
Shale, ferruginous	5	..
Shale, with nodules	7	..

	Feet.	Inches.
Shale, ferruginous	2	..
Shale	1	..
Sandstone	39	..
Shale	15	..
Fire-clay, with *iron ore*	3	..
Limestone	6	..
Fire-clay, with *iron ore*	2	..
Shale	10	..
Sandstone (from measurements on Laurel Run)	44	..
Coal	..	8
Shale	..	10
Limestone	2	2
Sandstone	23	6
Shale	6	..
Hard black band	6	..
Shale, very ferruginous	6	..
Shale (from measurements on Mill Run)	4	6
Coal, shaly, hard, good	5	8
Fire-clay, sandy	4	..
Ore in shaly fire-clay	6	..
Limestone	6	..
Sandstone	33	.
Shale	9	6
Fossiliferous ferruginous shale	11	..
Total thickness of strata now considered as Conemaugh.	495	6

A bed of ore under the Brush Creek coal at about the horizon of the Mahoning coal was worked at a number of points near Mount Savage. This ore occurred in balls and also in seams of limited extent in a bed of fire-clay about two and a half feet thick. Three-quarters of a mile south of Barton a gray shale is exposed in the roadside which for a distance of about 200 feet contains thin beds of limonite. Six beds are exposed running from two to three inches in thickness to one bed reaching one foot in thickness. The limonite occurs in the form of concretions which are usually hollow inside. This is doubtless the weathered outcrop of bands of clay ironstone nodules, and a short distance below the surface would be found to grade into the latter. Two miles northwest of Lonaconing ore was worked in a twenty-foot bed of fire-clay which lies about fifty feet above the Bakerstown coal. Several beds of ore near the top of the Conemaugh were worked in the vicinity of Lonaconing, especially along the hillside west of George's Creek.

In Garrett County ore was mined in the Lower Youghiogheny area from the lower part of the Conemaugh. At the east end of Friendsville, on the north side of Bear Creek, ore occurs above the



LOCATION OF IRON ORE BANKS IN GARRETT AND ALLEGANY COUNTIES

Mahoning coal. Another bed of ore was worked a quarter of a mile north of Friendsville on the west bank of the Youghiogheny River. This ore occurs above the Brush Creek coal. There is also a bed of ore above a heavy conglomeratic sandstone, probably the Upper Mahoning sandstone, which was worked near the Garrett County line southwest of Friendsville. This bed seems to be quite persistent in this neighborhood, as limonite concretions and lumps are found at many points where the stratum outcrops.

Monongahela Ores.—The ores of this formation in the George's Creek Valley were the most important of the Carboniferous ores. The workable beds occur in the lower part of the formation about fifty to a hundred feet above the Pittsburg coal. They were worked at several points west and southwest of Frostburg, near Vale Summit, at Miller and southwest of Koontz. The ore occurs in a shale and the thickness of the bed varies from eighteen inches to four feet. A large part of this ore that was mined consisted of surface concentrations of the outcrop and was to a great extent altered to limonite.

Extent of Development.

All of the carbonate ores with the exception of one locality, near Friendsville, where Pottsville ore was worked, came from the Allegheny, Conemaugh and Monongahela formations. Although beds of carbonate ore are co-extensive with these formations, it seems that they occurred in sufficient quantities to be worked in only two of the five coal basins of Maryland—the Lower Youghiogheny basin and the George's Creek basin.

Garrett and Allegany Counties.

The ores in the *Lower Youghiogheny area* were worked in the early part of the last century and used in a furnace built east of Friendsville about 1828. This furnace was abandoned in 1834, and since then no ore has been mined in this region.

The ores in the George's Creek basin were first worked about 1830, and continued to be used until about 1880. The first furnace erected in this region was that at Lonaconing in 1837. This was built for the George's Creek Coal and Iron Company and was fol-

lowed soon after by one at Mount Savage, which was built in 1840 for the Mount Savage Iron Company. A few years later another furnace was built at Mount Savage alongside the former. In 1846 the Lena furnace was built at Cumberland. This furnace, however, was chiefly run on Clinton ore and limonite. After the Civil War, the Bowery furnace was built at Midlothian by the Cumberland Coal and Iron Company.

The following is a description of the localities at which ore has been worked in the Lower Youghiogheny region:

Ed. Friend Deposit [89].—Ore was mined on Ed. Friend's place on the west bank of the Youghiogheny River a quarter of a mile north of Friendsville. About five hundred feet west of where Bear Creek enters the river and on the north side of the private road, a band of ore is exposed in a bed of gray shale which is overlain by a six-foot bed of sandstone. The ore consists of nodules of clay ironstone weathering on the surface into shells of limonite. The nodules range in size from very small up to one foot in diameter. Above the sandstone bed are interbedded sandstones and shales the upper part of which is concealed. About fifty feet above the sandstone thin black shales are exposed. Between these black shales and the sandstone, ore has been stripped from this exposure for a distance of about five hundred feet to the east. There was also a drift put in here but that has caved in. The ore occurs in the Conemaugh formation above the Brush Creek Coal.

Deposit East of Friendsville [90].—Ore was obtained by stripping on the north side of Bear Creek at the eastern edge of Friendsville. It occurs above a thin-bedded sandstone showing a thickness of over twenty feet and containing a two-foot coal seam, which is the Mahoning coal.

Deposit near Friendsville Furnace [91].—On the north side of the Bear Creek road, about a quarter of a mile east of the Friendsville furnace, ore was stripped for a distance of a hundred yards or more. This ore occurs in a black shale under the Homewood sandstone which forms the summit of the Pottsville formation.

Coddington Deposit [92].—Ore was stripped on Mrs. Mary A. Coddington's place on the west side of the road to Elder, a mile and a half southeast of Friendsville. According to Alexander and Ducatel,[1] the ore rests upon sandstone and is covered by a stratum of calcareous marl. "The ore, promiscuously extracted from the bed, has been found to smelt by itself."

It seems that ore was obtained from other points on Winding Ridge, the localities of which are no longer known. These are Allegheny ores.

Taylor Friend Deposit [93].—Ore was obtained by stripping from Taylor Friend's place, one mile south of Fearer. There is no longer any evidence as to the exact location of the place from which the ore wos obtained.

Falkner Deposit [94].—One of the most important sources of ore for the Friendsville furnace was at Keeler Glade. This is situated at the southeast end of Fairfield Hill on Samuel Falkner's place. This same bed seems to retain its importance for some distance to the north as along the dotted line on the map a great deal of limonite is ploughed up. The ore was obtained both by stripping and underground work, an extensive drift having been put in here. The ore occurs in a shale overlying a massive conglomeratic sandstone over twenty feet thick which is the Upper Mahoning sandstone of the Conemaugh formation. A sample of the ore taken from nodules on the dump pile shows the following analysis:

ANALYSIS OF ORE FROM FALKNER DEPOSIT.

Fe	34.58
SiO_2	13.78
Al_2O_3	4.29
Mn	1.36
P	....
S	.49
Ignition	24.11

The ores of the *George's Creek Basin* were worked at several points as indicated in the following pages:

[1] Alexander and Ducatel: Report on the Projected Survey of the State of Maryland, 1834, p. 34.

Mount Savage Area.—Ore was worked on the west side of Mount Savage and to the northwest by the Mt. Savage Iron Company, now the Union Mining Company, and smelted at their furnace at Mt. Savage. The ore came from the Conemaugh formation, probably from between the Mahoning coal and the Brush Creek coal.

Ridgeley Deposit [95].—Ore was mined on the hill west of Mt. Savage known as Ridgeley. This locality was worked for several years, about 1845-50, and a number of openings made. The locations of three of these are shown on the map, one of which is still open and goes down with a 20° incline. The sites of the openings are still marked by dump piles.

Dutch Hollow Deposit [96].—An opening was made in one of the tributaries on the north side of Dutch Hollow a mile and a half west-northwest of Mt. Savage.

Lower Tunnel Deposit [97].—At the foot of the Mt. Savage gravity plane an opening known as the Lower Tunnel was made in 1846 which was worked off and on until 1853. The tunnel is 6 feet high by 8 feet wide and nearly half a mile long. It follows the bed of ore on a level, and cross-cuts were made on the pitch of the ore. The dump pile in front of the opening contains many nodules of ore. The nodules frequently have a calcite center and many of them are penetrated throughout by veinlets of calcite. A sample taken from these nodules shows the following analysis:

ANALYSIS OF ORE FROM LOWER TUNNEL DEPOSIT.

Fe	36.05
SiO_2	13 53
Al_2O_3	6.47
Mn	.94
P	.08
S	.42
Ignition	25.02

Upper Tunnel Deposit [98].—The Upper Tunnel, on Mr. Henry Collins' place, was opened about the same time as the Lower Tunnel. It runs into the hill about fifty feet until it strikes the ore

bed and then follows it on a level for about a half mile to the north. The ore occurs in nodules, or less commonly in seams of small extent, in a 2½-foot bed of fire-clay. When worked for ore this tunnel extended only a quarter of a mile, but was again worked several years ago for fire-clay and extended the rest of the distance. It has again been abandoned on account of the high iron content of the clay.

Deposit on Frost Company Tract [99].—From 1853-5 ore was mined on the Frost Company's land at the western edge of Frostburg. This was the first ore mined in the neighborhood of Frostburg. A great deal of surface stripping was done and four drifts made, one a hundred yards long and the others about two hundred feet. Cross-cuts were made between the drifts. The thickness of the ore bed averaged about eighteen inches and it occurs in the Monongahela formation not far from the Pittsburg coal. The ore was worked on a royalty of 25c. per ton by George Jeffries and his sons, and about five thousand tons of ore were obtained. It was shipped to Mt. Savage and sold at prices ranging from $4.50 to $5.00 per ton. When the Mt. Savage furnace shut down in 1855 this tract was abandoned.

Johnson Field Deposit [100].—The Johnson field is situated one mile west of Frostburg. The Old Braddock Road runs through the area worked. The ore occurs in a bed four feet thick, about seventy feet above the Pittsburg coal. An area of approximately two acres was stripped and four drifts with rooms were made, having a length of two to three hundred feet. Eight to ten men were employed in mining and three teams engaged in hauling. The ore was cleaned at the mines by screening. The output of this field was about ten thousand tons and the ore was sold to the Mt. Savage Iron Company delivered at the furnace for $4.50 to $6.00 per ton. This field was worked by George Jeffries, who paid Joseph Johnson a royalty of 30c. per ton. It was opened in 1861 and worked continuously during 1862, and then off and on until 1865 on account of irregularity in the running of the furnace.

About a half mile east of here on the north side of the Braddock Road, the Mt. Savage Iron Company itself mined about two thousand tons of ore.

Midlothian Field Deposit [101].—Considerable ore was mined by the Cumberland Coal and Iron Company a half mile west of Midlothian. This field was worked steadily from 1874 to about 1880 and thousands of tons of ore obtained. Between four and five acres were stripped and six drifts about a quarter of a mile long with many rooms were put in. The drifts are all caved-in now but their sites are marked by dump piles on which there is considerable ore. The ore was taken to the Bowery furnace at Midlothian in tram-cars and washed there before it was smelted. A short description of this field is given in volume 15, page 29 of the Tenth Census. According to this description the ore occurred in a horizontal bed four to five feet thick resting on clay and covered by sandy clay and soil. The following analysis is taken from the same source:

PARTIAL ANALYSIS OF ORE FROM MIDLOTHIAN.

Fe	44.68
P	.188

The ore occurs in the Monongahela formation near the Pittsburg coal.

Pompey Smash Deposit [102].—Ore was mined from the Pompey Smash ore field a half mile south of Vale Summit on the south side of the Dans Rock Road. The ore occurs in the Monongahela formation not far above the Pittsburg coal. A number of extensive drifts were made and considerable stripping done. This field was opened before 1848 and worked until 1858, the ore being shipped to the Lonaconing furnace.

Miller Deposit [103].—At the northeast end of the hill overlooking Miller, between Miller and Ocean, ore was mined from the Monongahela formation just above the Pittsburg coal. Several large dump piles and a number of trenches mark the site of the operations. Two of the trenches run up the side of the hill as if they mark the site of caved-in drifts.

Lonaconing Deposit [104].—A bed of carbonate ore between the two beds of the "Dirty-nine," or Franklin coal, of the Conemaugh formation, was worked on the hill-slope back of the Lonaconing furnace on the west side of George's Creek. Several other beds below this one and one above it were also worked on the same hillside. The ore was won by a series of tunnels into the hill. It was a ball ore imbedded in clay and shale. The openings extended from Mine 26 southward to Koontz Run and some distance up Koontz Run. Many of the old tunnels are now used as cellars by the people of the neighborhood. The ore was taken to the furnace by a tram-road built for that purpose.

Deposit East of Lonaconing [105].—Ore was obtained for the Lonaconing furnace from the hill on the east side of George's Creek opposite Lonaconing and from Buck Hill. These are all Conemaugh ores. An opening was made back of the silk factory and another north of this opposite the furnace. Considerable stripping was done on the north side of Hill Run about a half mile from George's Creek, and on the north slope of Buck Hill tunnels were put in.

The so-called bog ores which were stripped from the surface near the edge of the streams on the west slope of Dans Mountain may also be mentioned here. These were probably the weathered outcrops of clay ironstone bands in the Allegheny formation. They never attained any importance.

Deposit One-Half Mile Southwest of Koontz [106].—A half mile southwest of Koontz on the hillside south of the road near the Allegany-Garrett County line, ore was stripped from a horizon in the Monongahela formation above the Pittsburg coal.

Tilly Field Deposit [107].—Ore was obtained from two openings one mile west of Koontz from what is known as the Tilly field on Hugh Weir's place. The openings are on the east side of a fork of Laurel Run. The ore is said to occur in the Conemaugh formation from forty to fifty feet above the Bakerstown coal and was used at the Lonaconing furnace.

Hansel Deposit [108].—Two miles west of Lonaconing and nearly a mile south of the Tilly field there is an opening on Philip Hansel's place. A tunnel was put in here six feet high and a hundred feet long. The ore was worked for two or three years when the shutting down of the Lonaconing furnace caused it to be abandoned. It is a nodular clay ironstone in a twenty-inch seam of fire-clay which is overlain by shale. This is probably the same horizon as that worked at the Tilly field.

Origin of the Carbonate Ores.

The carbonate ores of the Coal Measures are a special phase of bog iron ores. The conditions of drainage over the area covered by these rocks were favorable to widespread deposition of bog ores. The presence of decaying vegetable matter in contact with the bog ores which were then deposited caused their conversion into a ferrous carbonate. When there was sufficient excess of bituminous matter blackband ores were formed; under other conditions, the clay ironstone resulted.

During the period when the ores were formed the eastern portion of the United States remained approximately at sea-level. The elevation of the continent was not, however, fixed during this period, but the continent was subjected to a series of gentle oscillations which now carried it slightly below sea-level and now slightly above. That is, the area in which the rocks of the Coal Measures were being laid down consisted during most of the time of great stretches of shallow basins and swamps into which the drainage of the low-lying surrounding areas sluggishly flowed. At times the submergence became great enough to do away entirely with swamp conditions, and normal marine sediments were formed. These conditions were but temporary and swamp conditions were soon restored. At other times the entire area was approximately at sea-level so that there was a general lack of drainage. Under these latter conditions there was practically no erosion, and hence the extensive swamp areas were without sedimentation. At such times great accumulations of organic matter took place free from

earthy matter, and these are the conditions under which the coal seams of the period were formed. A slight elevation would stimulate drainage and set up erosion. The grade of the streams would now be such as would enable them to carry fine materials in suspension. These materials would be carried into the drainage areas and there intermingled with the accumulating organic matter in the form of mud. The water carrying this mud into the basin also brought with it in solution salts of iron which were dissolved out of the decaying rocks of the land areas. Almost all rocks contain iron compounds which, under certain circumstances, are soluble. Iron sulphate is formed when iron-bearing sulphides decompose. Carbonic acid which is derived from the air and from decaying organic matter, or even from living animals, attacks various silicates and forms soluble iron carbonates. Decaying organic matter with a limited supply of oxygen has the power of reducing ferric oxide to ferrous oxide and this in the presence of ammonium and certain organic acids occurring in soils forms soluble compounds. Thus the accumulation of iron in solution in the drainage basins of the period is but the result of the ordinary processes of rock decay.

It is well known that when waters bearing iron salts in solution are brought into stagnant pools and shallow basins, where they are subjected to oxidizing influences, the iron is oxidized to the ferric condition and precipitated as ferric hydroxide. The presence of ammonium humate, a substance which always occurs in swampy areas, causes a precipitation of ferric hydrate. Ferric hydrate is also precipitated from carbonated solutions when the carbon dioxide is removed. This may take place in a number of ways. Rise in temperature of the water in the shallow basins, decrease in pressure as water from the bottom rises toward the top, or the absorption of carbon dioxide by plant cells may cause a decrease in the amount of carbon dioxide and hence a precipitation of iron. Moreover the deposition always takes place in the form of the hydroxide, unless air is excluded or decaying organic matter is present. In the latter cases ferrous carbonate is precipitated. The deposition of iron in this way can be seen at any time in marshes

and stagnant pools. The oxidized iron forms an iridescent film or scum on the surface of the water which after a time breaks and sinks to the bottom.

The precipitation of ferric hydrate is also part of the life process of certain plants. According to Ehrenberg, the algae, especially the so-called iron algae *Galionella ferruginea,* Ehrenb., coat their cell walls with ferric hydrate and opaline silica. Later Molisch and Winogradsky showed that these, and most other supposed algae, are ciliated bacteria of different kinds, especially *Leptothrix ochracea.*[1]

Recent investigations by O. Aschan[2] lead him to the belief that micro-organisms also bring about a precipitation of ferric hydrate. A large number of analyses made by him of humus materials showed that their chemical composition, if we leave out of consideration the nitrogen, approaches the composition of the carbohydrates of the cellulose, and especially the starch group. Since they also occur together with organic compounds containing nitrogen, phosphorus, and some sulphur, Aschan considers it probable that they can serve as food for lower organisms. As the ferrohumates are oxidized to ferrihumates, they are in part immediately precipitated. The greater portion remains in solution, however, and colors the water brown. According to the theory of Aschan, the organic portion of these salts is then consumed by micro-organisms, and the unused iron oxide is deposited in the immediate vicinity. The porous deposit thus formed serves at the same time as a protection to the organisms, since in its pores they can thrive undisturbed. One of the chief arguments in support of this view is based on the fact that twenty-one analyses of lake ores and eleven of bog ores still showed traces of humus acids.

It is impossible to say whether the iron was largely precipitated as carbonate or as hydrate. The probability is in favor of the hydrate. But even if the iron was precipitated as the hydrate, it

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[1] W. H. Weed: Amer. Geol., Jan., 1891, pp. 48 to 55.

[2] O. Aschan: Die Bedeutung der wasserlöslichen Humustoffe (Humussole) für die Bildung der See und Sumpferze. Z. f. pr. G. 1907, pp. 56 to 62—Humus sömnena i de nordiska inlandsvattnan, etc. Finska Vetenskaps societ. Oefversikt, September, 1906, pp. 1 to 176.

would be subjected to a transformation into the carbonate. The muds that were being deposited at this time, with which the hydrate mingled, were highly charged with organic matter. Of these sediments Professor Rogers[1] says, "the soft argillaceous shales, in the midst of which the lenticular ore so frequently presents itself, show by their dark colour and included impressions of plants, as well as by actual analysis, that they are richly imbued with vegetable matter. Nor do the nearly white fire-clays, which in many cases enclose thick courses of the lenticular ore, form any exception to the law; for although, in their present state, they contain little or no carbonaceous matter, the marks of innumerable roots of Stigmaria, and parts of other plants which everywhere penetrate the mass, show that at one time they must have been crowded with vegetable remains." In the presence of this organic matter the iron was again reduced to the ferrous condition and, combining with the carbonic acid being formed, was converted into the carbonate.

In this connection Professor William B. Rogers[2] brought out a very interesting relation as to the amount of iron in the strata of the Coal Measures. He found that a rough estimate of the amount of carbonate ore in the lower Coal Measures of the Laurel Hill region of Pennsylvania and West Virginia, based on a detailed examination of the ores and associated rocks, did not amount to one-third of one per cent. of the whole mass of this portion of the Coal Measures. This same relation also held for other areas subjected to a similar calculation. Allowing a quantity three times as great as this for the diffused carbonate, we should have about one per cent. to represent the proportion of ferruginous matter in the entire mass,—an amount much less than what exists in many of the strata both older and younger than those of the Coal Measures.

The point thus made by Dr. Rogers is that the ores are not primarily due to an increased rate of deposition of iron during this period but are directly the result of conditions favoring the concentration of iron disseminated through the shales. As to the man-

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[1] Geological Survey of Pennsylvania, Vol. 2, pt. 2, p. 737. [2] Idem, p. 738.

ner in which this concentration took place, Dr. Rogers gives the following explanation:

"The gathering of the diffused proto-carbonate into bands and courses of ore began, no doubt, as soon as the production of this compound had made some progress. * * * In this course, which finds a simple explanation *in the combined action of infiltration and the segregating force*, it can hardly be questioned that the *carbonic acid* pervading the mass of sediment acted *a very important part*. The large amount of this gas evolved from the beds of vegetable matter undergoing change would impart to the water of the adjoining strata the power of dissolving the diffused proto-carbonate, which, being then carried by infiltration through the more porous beds, would accumulate above and within the close argillaceous or shaly layers, forming in some cases bands of rock ore, in others courses of nodular and plate ores. Of these, the former would seem to have resulted from the accumulation by gravity of the dissolved carbonate in the substance of sandy shales near the upper limit of more impervious beds, while we may regard the latter as having been collected in all directions from the general charge of proto-carbonate accumulated in the argillaceous mass, its mobility in the dissolved condition greatly aiding the gathering process of the *segregating force*."

James Geikie[1] says the clay ironstones are due to subsequent changes in the strata. The carbonate of iron having been more or less diffused through the silt beds or shales, has segregated in time, so as to form irregular balls or bands.

Newberry[2] says "the clay ironstones are the product of times when the drainage into the coal basins was turbid with mud and yet carried much iron. When this mud settled the iron diffused in it gradually segregated to form concretions, the centres of spheres of attraction of somewhat uniform radius."

In speaking of the origin of iron concretions in the Red Bank sands, O. W. Willcox[3] says "the evidence in favor of transportation by diffusion is clear and positive." "Transportation by diffusion refers to movement of dissolved matter in obedience only to the molecular activities of the substance in solution." "Where the concretions are absent, the ferruginous coloring matter is more or less evenly distributed through the sand; in the vicinity of the concretions the red color is less pronounced, and may even disappear altogether, leaving the sand clean and white. Further, many of the isolated concretions, compound, as well as simple, lie in sheaths of pure white sand, which they have decolorized as decaying roots might have done."

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1 Iron ores of Great Britain, Kendall, p. 328.
2 School of Mines Quarterly, Vol. 2, 1880.
3 Journ. of Geol., Vol. 14, pp. 247-8.

All of the above authors agree that the iron was originally disseminated through the strata and was subsequently segregated into layers of nodules. The force or forces that produced this segregation are the forces which cause the formation of concretions.

THE COASTAL PLAIN CARBONATES.

The carbonate ores of the Coastal Plain occur in the Arundel formation, which is the middle member of the Potomac group; and are therefore of Lower Cretaceous age. The Potomac group is composed essentially of gravels and bright to sombre colored clays, in which those of bright color predominate. These deposits lie directly upon the Piedmont surface, and hence form the western margin of the Coastal Plain of Maryland. The Potomac group is divided into the following formations:

Patapsco Formation,
Arundel Formation,
Patuxent Formation.

The Arundel Formation.

The Arundel formation derives its name from Anne Arundel County, where the deposits of this age are well developed, and the following description of the formation is based chiefly on the descriptions of its occurrence in that county by Dr. H. P. Little,[1] The name was applied by Clark and Bibbins[2] to include the series of clays lying between the Patuxent and Patapsco formations.

Areal Distribution.—The Arundel formation occurs as a fringe, usually narrow, along the eastern edge of the Patuxent formation. Its exposure is due to the trenches cut by the streams in their course across the formation. It never caps the divides so that, although of considerable thickness and well developed, its surface exposure is comparatively small.

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[1] H. P. Little: Physical Features of Anne Arundel County, 1910. (Dissertation.)

[2] Clark and Bibbins: Journ. of Geol., Vol. 5, p. 485.

Its outcrops extend from Bush River in Harford County in a southwesterly direction across the State through Harford, Baltimore, Howard, Anne Arundel, and Prince George's counties into the District of Columbia. The width of the belt of outcrops nowhere exceeds eight miles.

Character of Materials.—The Arundel is essentially a clay formation, and it is in these clays that the iron ores occur. When unweathered, the clays are usually a dark, blue-drab color. When weathered slightly, the dark drab clay takes on a light pinkish drab tone which is very characteristic of mines and cuts where the surface has been exposed a short time. On continued exposure, the carbonate ore in the clays alters to hematite and limonite, and the clays assume a bright red color often resembling the overlying Patapsco clays. The clays are very carbonaceous and lignitic logs much flattened, are common. Lignitized trunks of trees are also found in an upright position with their larger roots still intact. Though not an abundantly fossiliferous formation, both plant and animal remains occur. The dinosaur remains found by Professor Marsh in this formation in the Muirkirk area caused the lower portion of this group to be regarded for a long time as of Jurassic age. The more recent paleobotanical evidences make the whole group of Lower Cretaceous age.

Strike, Dip and Thickness.—The strike of the formation is about north-northeast. The dip is approximately forty to fifty feet to the mile to the southeast; and, like the underlying formation, the dip increases westward towards the "fall-line," where it reaches as high as seventy-two feet to the mile.

The deposits form a series of large and small clay lenses deposited under swamp conditions, and hence from their very nature tend to be variable in thickness. The maximum thickness reached is probably 125 feet, and in general it averages 100 feet.

Stratigraphic Relations.—The Arundel overlies the Patuxent formation uncomformably, occupying depressions in the ancient surface of the Patuxent. The Arundel is again unconformably overlain by the Patapsco.

The Arundel Ores.

The Arundel ores occur scattered throughout the clays of the formation in the form of lumps and nodules of various sizes and shapes (Plate XXI). The distribution is quite irregular; in some places the clays containing large quantities of ore, in others the ore occurring sparingly. In general, the nodules are of concretionary structure, and often consist of a number of nuclei which have coalesced to form one larger lump. Such lumps have been found weighing several tons, when it is necessary to break them by driving wedges into them before they can be removed. Except in the case of these unusually large lumps, the nodules can easily be shattered with a blow from a sledge hammer. Though tending to irregular spheroidal shapes, large flat nodules also occur with a concentric structure. A less frequent occurrence is in the form of a bed of limited extent in which the concentric structure is seemingly lacking. Such beds do not contain the purest ores, and it may be that they represent a large flattened nodule in which, on account of its size and the large amount of foreign material included in the form of sand and clay, the concretionary structure is obscured. The concretions usually have a septarian character, and the walls of the septae are lined with crystals of which minute crystals of siderite and crystals of gypsum are the most common.

Two types of ore occur, the iron carbonates and the limonites. The former are the original ores, while the latter are formed by the subsequent alteration of the carbonates brought about by the processes of weathering.

The carbonate ores are called by the miners "white ore" or "hone ore." The name "white ore" has been applied on account of the very light gray color of the pure carbonate ore, and the name "hone ore" because the smooth pieces of high grade ore make excellent whetstones. The color of the ores when perfectly fresh varies from a very light gray to a dark slate color. The slightest trace of weathering gives to them a rusty tinge, and from this they grade over into the brown, red, and yellow hydrated oxide ores. The ores free from impurities break with a perfectly smooth conchoidal frac-

ture. Less pure specimens show a rougher surface, and with increasing quantities of sandy material the fracture becomes irregular and the surface may feel as rough as a sandstone. The miners are able to recognize the slightest difference in quality by running their fingers over a fracture surface.

A sample of this ore collected from the ore pile at Muirkirk furnace showed the composition given below.

ANALYSIS[1] OF CARBONATE ORE AT MUIRKIRK FURNACE.

Fe	33.82
Mn	3.92
SiO_2	14.30
Al_2O_3	3.38
CaO	1.24
P	.044
S	.296
CO_2	19.95
Ignition	8.04

After roasting, this ore would contain about 47 per cent. iron.

The limonites are collectively designated by the miners as "brown ore," irrespective of the actual color which varies through all shades from brown to red or yellow. Since they are derived from the carbonates, they exactly resemble the carbonates in shape and form, except that the conchoidal fracture is likely to give way to a "shelly" structure. Lumps are very abundant which have an exterior consisting of concentric shells of limonite and an interior of "white ore" breaking with a perfectly smooth conchoidal fracture, showing that the concretionary structure is inherent in the nodule and is brought out sharply in weathering. The analysis of a sample of the weathered ore taken from the ore pile at Muirkirk furnace follows:

ANALYSIS[1] OF "BROWN ORE" AT MUIRKIRK FURNACE.

Fe	44.49
Mn	2.73
SiO_2	15.01
Al_2O_3	3.22
CaO	.43
P	.053
S	Trace.
CO_2	.82
Ignition	14.53

[1] Made by Penniman and Browne.

REYNOLD'S ORE BANK, ANNE ARUNDEL COUNTY.

VIEW SHOWING NODULAR ORE IN ARUNDEL CLAY.

The kind of ore obtained is merely a question of position with reference to the agencies of weathering. Some banks have yielded only "brown ore" down to the lowest levels. Others have yielded "white ore" almost to the surface. In most cases in working downward, "brown ore" is first encountered, and this passes over gradually into "white ore" as the depth of the bank increases. The depth to which the alteration has taken place depends on various factors, such as the character of the drainage overlying the ore, and the porosity of the clay. The amount of carbonaceous material present in the clays must also be of influence in this respect. As the process of alteration involves oxidation of ferrous to ferric iron, the presence of carbonaceous matter would tend to hinder that oxidation, and thus preserve the carbonate.

This alteration is of no practical importance. The varieties occur so intermingled that all the ore is roasted before it is used in the furnace, and no distinction is made in buying it.

Origin of the Arundel Ores.

From what has been said of these ores, it is at once recognized that they are the counterpart of the clay ironstones of the Coal Measures, and all that has been said in regard to the origin of the latter ores applies equally well to the ores now under consideration.[1] The only difference in the two cases is due to the fact that the peculiar conditions which brought about the formation of these ores were in the case of the clay ironstones of the Coal Measures very widespread and extended over a large area; whereas, in the case of the Arundel ores, these conditions were much more local and existed as a series of comparatively small swamps extending along the eastern edge of the Piedmont land surface. It has been suggested that these swampy conditions were brought about by a slight tilting of the land inward toward the Piedmont, which resulted in a clogging of the drainage as the streams emerged from that area.

[1] Origin of the Carbonate Ores, pp. 248-253.

Mining Operations.

The iron ores of the Arundel formation formed the basis of the earliest iron industry in Maryland, and have been worked until the present day, though in recent years to a very limited extent. Since they occur as scattered lumps and nodules throughout the Arundel clays, a large amount of clay has to be handled for every ton of ore obtained. Under present conditions of labor, it is possible to work a good bank at a small margin of profit for about three dollars per ton of ore. Under specially favorable conditions, the ore could be produced for a few cents less; but in other cases it could hardly be produced at that figure. Three dollars may, however, be taken as a fair average estimate for profitable operations. A great deal of the ore which is at present used at the Muirkirk furnace is obtained from brickyards, where the nodules are thrown out in mining the clay. In such cases, the ore can, of course, be furnished at a lower price. Though the deposits have been worked for a period of nearly two hundred years, only a small percentage of the total area has been touched, and there is still an enormous quantity of this ore available.

The falling off in production has been due to the lack of a steady market at sufficiently remunerative prices. In the last fifteen years, the Muirkirk furnace has been the only available market. As this furnace makes a very high grade of iron, there is only a limited market for its output; and the demand for ore has been extremely uncertain. Then, too, the price of ore has been such that it has not been profitable to work the banks to any great extent during the summer when labor is in demand on the farms, and most of the mining has been done in winter when there is a less demand for labor in other lines. This has made it impossible to obtain a steady supply of ore of any considerable quantity the whole year round, so that there has been no demand for these ores at large plants. These uncertain market conditions have discouraged the undertaking of large scale operations such as were formerly carried on at many points. From the nature of the materials, the old banks soon wash in and to open them again may require considera-

ble initial expense in removing the overburden. The result is that the methods have deteriorated to a great extent to what is known as "gouging." This work is done chiefly by day laborers in banks owned by other people to whom they pay a royalty of twenty-five to fifty cents per ton of ore extracted. These men mine wherever they find the best showing of ore, and do not attempt to develop a bank by any systematic methods.

Though by far the greater part of the mining has been done by open cutting, where there is a considerable overburden, a great deal of underground mining has also been carried on. The open cuts have always been worked with pick and shovel, and the clay hauled out of the banks in carts. The underground mining is usually done through shafts. A shaft is sunk to the ore bed and from it a drift run out into the bed. The clay and ore are hauled out of the shaft by means of a windlass. After opening one such drift, others are run out in different directions from the shaft, and the clay filled into the old ones, so that only the ore has to be hoisted. In other cases where the overburden in the open cut becomes too great, the bank is further worked by means of tunnels into the sides. This is one of the favorite methods of "gouging."

Probably the most flourishing period in the history of the mining of these ores was during the Civil War, when they brought as high as eight dollars, or even more, per ton. After the War, they brought from five to six dollars for some time, and then gradually decreased in price until a sudden drop in the early nineties brought them down to two dollars. This practically destroyed the industry, as the subsequent rise in price has not been sufficient to bring about more than the desultory operations of today already mentioned.

The ores have been mined in all the counties in which the Arundel formation occurs, and a description of the operations follows by taking up the counties in order from northeast to southwest.

Cecil County.

Cecil County has been in the front rank as an iron producer among the counties of the State, although there has been very little iron ore mined within its confines. This is not surprising, as the Arundel formation, the ore-bearing horizon of the Coastal Plain,

does not outcrop in this county. Iron ore was discovered in very early times at Principio, and a furnace erected there. But the supply from the very beginning was inadequate, and as early as 1724 ore was brought from the neighborhood of Baltimore for the furnace.

At Blythedale, two miles northwest of Principio, on Mrs. Mary Whitaker's property, an attempt was made about 1850 to mine ore, but the ore was of too low grade. It was a limonite in reddish clay. This deposit was worked long before that time, but no evidence of the former workings remains. Ore is also supposed to have been worked in early times just east of Principio Station, but the workings were probably never extensive as no evidences of them are preserved.

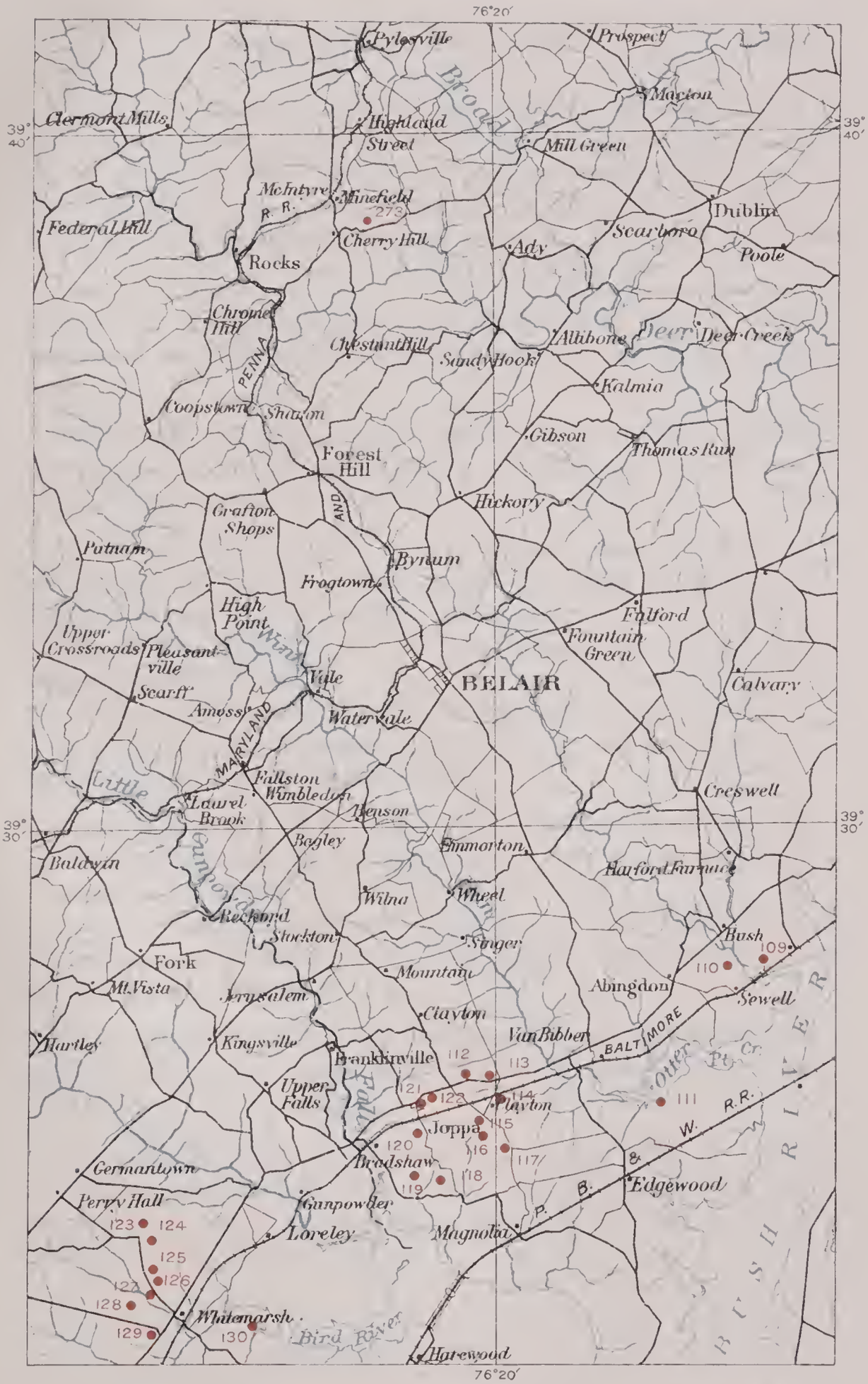
Harford County.

The Arundel ores have been mined in the southern end of Harford County between the Bush and Gunpowder rivers. Although the Coastal Plain continues on across the County to the Susquehanna, the Arundel formation does not outcrop northeast of the Bush River.

Walsh Ore Bank [109].—One-half mile northeast of Sewell, along the river bank, is an opening about 100 yards long and worked back for a distance of 100 to 200 feet. This ore bank was operated by Robert Green and afterwards by William F. Pannell for the Harford furnace.

Sewell Ore Bank [110].—A quarter mile north of Sewell is a bank 300 feet in diameter and 60 feet deep filled with water, on the properties of Mr. N. F. Sullivan and Mr. Edward Mosedale. This was opened and worked by William F. Pannell for the Harford furnace.

Welzenbach Ore Bank [111].—A mile and a half northeast of Edgewood is an opening 50 feet in diameter, worked about thirty years ago by George Baker and now owned by Caspar Welzenbach. This was only worked a few winters, and the ore sent from Edgewood to the Chesapeake furnaces at Canton.



LOCATION OF IRON ORE BANKS IN PARTS OF HARFORD AND BALTIMORE COUNTIES

Shipley Ore Bank [112].—One mile northeast of Joppa, on the north side of the Philadelphia road, is an opening 300 yards long and in places 100 yards wide. This property now belongs to Mrs. M. A. Shipley; but was formerly owned and worked by Mr. Joseph Price, who sent the ore to the Harford furnace.

Lomyer Ore Bank [113].—On Mr. Robert Lomyer's place, a quarter of a mile north of Clayton, is a bank 600 by 150 feet which was owned by Clement Dietrich, and worked for the Harford furnace.

Flattermash Ore Bank [114].—At Clayton, on the south side of the railroad, is a small opening, 100 feet in diameter, which is now owned by Mr. Henry Flattermash.

Willick Ore Bank [115].—A half mile southwest of Clayton is an ore bank 400 by 300 feet which was worked to a depth of 35 feet, but is now filled with water. This is in part on the property of Mr. Henry Willick. The ore was limonite at the top, but changed to "white ore" in depth. The bank was worked chiefly for the Harford furnace, but some ore was sent to Baltimore.

A hundred yards southwest of this opening is a small one 75 feet in diameter on the Walsh estate.

Prospect Hill Ore Bank [116].—Three hundred yards south of the Willick ore bank on the Walsh estate and the Prospect Hill property is a bank 500 feet in diameter.

A quarter of a mile south of this is another small bank 100 by 50 feet, also on the Walsh estate. Both of these banks were worked for the Harford furnace.

Benser Ore Bank [117].—On Mr. Gustav Benser's place one mile south of Clayton, is a shallow bank 200 feet in diameter, which was worked about forty years ago.

Crow Ore Bank [118].—A mile and a quarter south of Joppa, on Mr. George Crow's place, is a large bank 700 by 200 feet and 40 feet deep, which was formerly owned and worked by Clement Dietrich for his Harford furnace.

Pine Grove Farm Ore Banks [119].—There are two openings on the Pine Grove farm, one mile south of Joppa, lying over a quarter of a mile apart. The easterly opening is 500 by 100 feet, and the westerly one 400 by 150 feet. These were owned when last worked by Clement Dietrich and the ore sent to his furnace.

This is probably the locality referred to by Ducatel[1] as Pine Grove Ridge, which he says "is based upon a large body of ore, an argillaceous carbonate of iron occurs in nodules in a stiff blue clay, of excellent quality yielding 30 per cent. to 40 per cent. Fe."

Joppa Ore Banks [120].—The woods south of Joppa have been extensively worked over in times past. A quarter of a mile south of Joppa is an area 300 yards in diameter which has been worked on a large scale. Also south of this, on the south side of the secondary road, is a bank now filled with water 100 by 150 feet and 20 or more feet deep. When last worked this entire tract was owned by Clement Dietrich and worked by lessees for his furnace. It now belongs to the Walsh estate.

Hanway Ore Bank [121].—On the north side of Joppa are old workings about 100 yards in diameter on the property of Mr. J. B. Hanway. These were last worked for about a year by Mr. Hanway, just before the Harford furnace shut down. Before him the property was owned by John Rouse.

Skillman Ore Banks [122].—A quarter of a mile northeast of Joppa are two openings belonging to Mr. John Skillman. The one is 250 by 100 feet, and east of this is one 150 by 50 feet by 20 feet deep.

Baltimore County.

The ore banks in which the Arundel ores have been worked in Baltimore County occur in a belt running in a southwesterly direction across the southeastern part of the County from the Gunpowder Falls to the Patapsco River, passing through the eastern and southern portions of Baltimore City. Although the ores have been worked throughout the whole of this belt the most important region has been that to the southwest of the city.

[1] Ducatel: Rep. of the State Geol. of Md., 1838, p. 4.

Gerst Ore Bank [123].—A mile and a half northwest of Whitemarsh is an old opening 300 by 200 feet belonging to Mr. Peter Gerst. This was last worked by him for a while just before the closing down of the furnace at Stemmer Run. Some time before this, the ore was mined for Robert Howard, for his furnace on the Gunpowder Falls.

Tremper Ore Banks [124].—On Mr. Joseph Tremper's farm, a mile and a quarter northwest of Whitemarsh, are two ore banks. The larger one is about 250 yards long and varies in width up to 200 feet. This was worked by Mr. Tremper and his father for about four years before the shutting down of the Stemmer Run furnace.

Three hundred yards to the south is a small opening 50 by 20 feet. Both of these were worked by Robert Howard for his furnace on the Gunpowder Falls.

Wagonfere Ore Bank [125].—On Mr. Charles Wagonfere's place is an ore bank worked by James Canoles until the Stemmer Run furnace shut down. It lies one mile northwest of Whitemarsh. The main opening is 100 by 50 feet, but "gouging" has been done all around it.

Roeder Ore Bank [126].—Three hundred yards southeast of the Wagonfere ore bank is a small opening 20 feet in diameter, on Mr. Peter Roeder's farm. This is said to have been worked quite deep by means of tunneling.

Cook Ore Banks [127].—A half mile northwest of Whitemarsh, Mr. Peter Cook mined ore on his farm for a number of winters until the Stemmer Run furnace shut down. The work was done by open cutting and by tunneling. There were two open cuts about one hundred and fifty yards apart, which have since become almost completely filled in.

Lohman Ore Banks [128].—One mile west of Whitemarsh, an area of several acres consists of old workings. These were worked by open cutting and tunneling by Jacob Smith until 1881. At times he worked them on quite a large scale, using eight carts to

haul the ore to Stemmer Run. Before him, the banks were worked by the Lohmans. This locality is mentioned in the 1880 Census Reports[1] in which year the output was 300 tons containing 42.76 per cent. Fe and .092 per cent. P. The following section is also given: Sand overlain by sandy loam, 5 to 10 feet; below this, clay 15 to 20 feet, the lower part of which contains nodules of carbonate ore.

Smith Ore Bank [129].—Jacob Smith also opened a bank on his own property, a half mile southwest of Whitemarsh, about thirty years ago. This has since been filled in. The opening was only 20 to 30 feet in diameter, as the greater part of the work was done by tunneling.

Myers Ore Bank [130].—On Mr. Frederick Myers' place, on Cass Run, one mile east of Whitemarsh, a bank has been worked into the terrace on the west side of the Run with a face 300 feet or more long, and back for a distance of about 100 feet. This was opened about 1855 by Benjamin Sweeden, and the ore sent to Havre de Grace. At that time the output was 1500 tons a year. Later, Jacob Smith and a Mr. Brady worked here, sending their ore to the Stemmer Run furnace, until it shut down, when the bank was abandoned.

Rohe Ore Bank [131].—Two miles northwest of Poplar is an ore bank 150 by 100 feet, on Mr. John Rohe's property, which has not been worked for over twenty years, at which time it was owned by Howard McHenry and worked on royalty.

Riemschneider Ore Bank [132].—One mile northwest of Poplar is an ore bank 150 by 50 feet filled with water, belonging to Mr. Henry Riemschneider. This was worked about twenty years ago and the ore sent to the Stickney furnaces at Canton.

King Ore Bank [133].—Back of Mr. William King's house, three-quarters of a mile northwest of Poplar, was an ore bank which has been filled in. This was worked for Robert Howard's furnace on the Gunpowder Falls.

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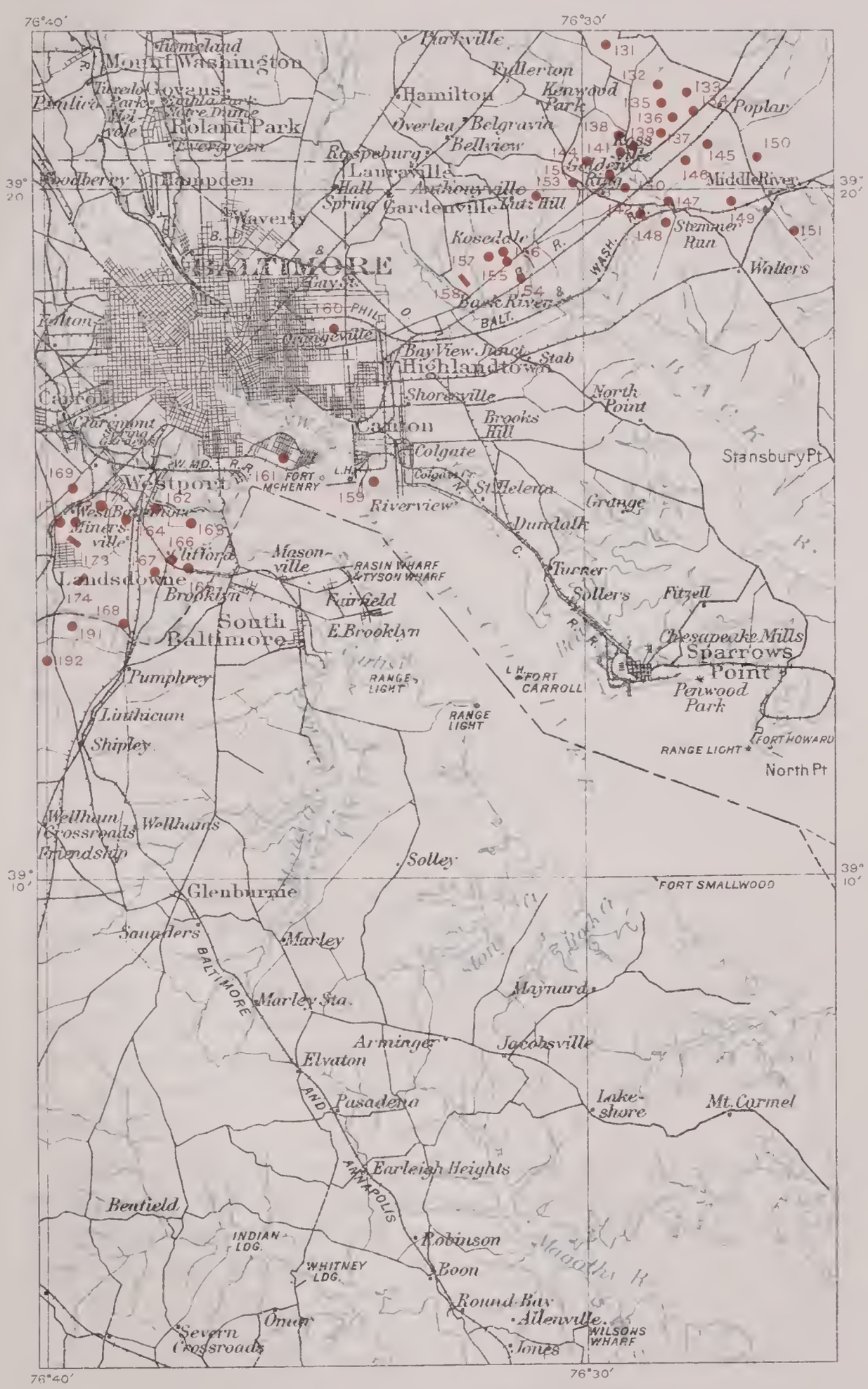
[1] Tenth Census, 1880, Vol. XV, p. 245.



LOCATION OF IRON ORE BANKS IN PARTS OF BALTIMORE AND ANNE ARUNDEL COUNTIES

Nine Mile Hill [134].—Ore was taken from the surface on Nine Mile Hill along the Philadelphia Road by Frank Koester about thirty years ago, and sent to the Stemmer Run furnace.

Kahler Ore Bank [135]. — One mile west of Poplar on Mr. Henry Mohr's place, Mr. August Kahler worked an ore bank about thirty-five years ago, when the property was owned by Albert Hofmeister. The site is now marked only by a small dump, the bank having been filled in.

Hofmeister Ore Bank [136].—Two hundred yards southeast of the Kahler Ore Bank is a bank 50 feet in diameter filled with water, belonging to Mr. Louis Hofmeister. This was worked by Thomas Jenkins for the Stemmer Run furnace, at which time it was owned by Levi Furstenburg, one of the owners of the furnace.

Bishop Ore Bank [137].—Three hundred yards southwest of the Kahler Ore Bank was another bank, on Mr. Eugene Bishop's place. This has also been filled in, and the site is marked only by a small dump.

Westerman Ore Bank [138].—One mile northwest of Rossville, on Mr. Westerman's property, is a bank 300 by 150 feet filled with water, which was worked about forty years ago. No further details were obtained in regard to it.

Mohr Ore Bank [139].—Three-quarters of a mile northwest of Rossville, on Mr. Charles Mohr's place, is a bank 200 by 50 feet and 25 feet deep. As the ore body extended across the County road, the open cut work had to be stopped and tunneling was resorted to. The ore was sent to the Stemmer Run furnace until it shut down, and then for a while to the Stickney furnaces at Canton. At that time it was owned by Samuel Kern, who obtained 50c. per ton royalty.

Toboll Ore Bank [140].—Across the creek from the Mohr Ore Bank, on Mr. John Toboll's place, there was formerly a bank covering about an acre which has been filled in. This was owned and worked by John Lennen.

Ender Ore Bank [141].—There are also two ore banks across the road from the Mohr Ore Bank, on Mr. Henry Ender's place, formerly owned by Miss Ellen Brown. The opening back of the house is about 150 by 200 feet across and 25 feet deep. Nodules of limonite made up of concentric shells still outcrop in a gray clay in the sides of the bank. The other bank is one hundred yards further south and was cut into the sides of the hill for a length of about 150 feet.

Reich Ore Bank [142].—A quarter of a mile northwest of Rossville, on Mr. Conrad Reich's place, is an old L-shaped opening, each arm of which is about 100 yards long. Mr. Reich acquired the property from Miss Ellen Brown in 1888, and worked the bank for several winters by tunneling from a thirty-foot shaft. In 1892, the price of ore became too low for profitable mining, and the bank was abandoned. Mr. Reich said he had a fairly continuous bed of ore from five to six feet thick, and with the aid of one man could get out from one to two tons of ore a day, which he hauled to the Stickney furnaces at Canton.

Bethke Ore Bank [143].—On Mr. Robert Bethke's farm, a half mile northwest of Rossville, is an old bank which, together with its dumps, covers an area of about six acres. Except for a little mining done by Mr. Bethke in the early eighties, the bank has not been worked for over thirty years.

Brown Ore Banks [144].—On Miss Ellen Brown's property, a quarter of a mile northwest of the Bethke Ore Banks, are two banks which were worked until about 1890. The larger one is 300 by 150 feet; and south of it is the smaller, which is a long narrow cut 300 by 25 feet.

Solomon Ore Bank [145].—A half mile southwest of Poplar, on Mr. George L. Solomon's place, are two ore banks formerly owned by Frederick Seling and worked by William Rever and Frank Koester. They are each about 150 by 50 feet and now filled with water. A great deal of the mining here was also done by shafting. According to the 1880 Census Report,[1] the ore nodules

[1] Tenth Census, 1880, Vol. XV, p. 247.

were unusually large, ranging from two to three feet in their longest dimension and occurred in a five to six foot bed of clay overlain by about eight feet of similar clay but barren of nodules. An analysis showed 40.58 per cent. Fe and .094 per cent. P.

Jenkins Ore Bank [146].—One-half mile northeast of Rossville, ore was worked years ago by Thomas Jenkins along the stream bed near the Baltimore & Ohio Railroad tracks. The extent of the workings can no longer be determined.

Townsend Ore Bank [147].—On the north side of Stemmer Run Station is an ore bank 100 feet in diameter which was worked to a depth of 50 feet. This was formerly part of the Stemmer Run furnace property and is now owned by Mr. Walter Townsend. The bank has not been worked since the furnace shut down.

Hengemihle Ore Bank [148].—On Mr. A. Hengemihle's place, south of Stemmer Run Station, is an old open cut 700 feet long, which was part of the Stemmer Run property and was worked for that furnace. The 1880 Census Report[1] gives the section exposed in the bank at that time as follows: Sand, 12 feet; sandy clay, 3 feet; clay, 8 feet. The ore occurred in the clay at the bottom as nodules, without a covering of limonite shells, and contained 35.75 per cent. Fe and .098 per cent. P.

Turner Ore Banks [149].—A half mile west of Middle River, on Mrs. Turner's property, are two banks formerly owned by Elias Robinson. An area of several acres was worked to a depth of 25 feet, and a hundred yards to the southwest is another opening 150 by 40 feet. A great many small limonite nodules are still scattered about on the surface. According to the Census Report for 1880,[1] the ore was obtained from a stiff gray clay, and hence the openings went through the surface covering of the Patapsco formation and reached the Arundel clay underneath. The iron content of 46.23 per cent. indicates that the greater part of the ore had been altered to limonite, although some carbonate was obtained. The production in 1880 was 450 tons. These banks were first

[1] Tenth Census, 1880, Vol. XV, p. 247.

worked by the sons of Henry Smith on a royalty of 50c. per ton, and then for about four years by H. Hegeman, who was operating in 1880. The ore was sold to the Stemmer Run furnace and to some of the Baltimore furnaces at from six to eight dollars per ton.

Taylor Ore Bank [150].—A half mile north of Middle River Station, on Mr. Alois Taylor's place, are about four acres of old workings where ore was formerly mined by Charles Masson, the owner of the property at that time, and sold to the Stemmer Run furnace. This locality also lies east of the Arundel outcrops, and a great deal of shafting was done to get through the Patapsco formation to the Arundel clays below.

Gay Shore Prospect [151].—On Mr. Frank Helldorfer's place, known as Gay Shore, three quarters of a mile southeast of Middle River Station, Elias Robinson attempted to mine ore some years ago. There is a crescent-shaped opening about 75 feet across on the shore of the creek, but it shows no evidence of iron ore. He was probably misled by one of the ferruginous indurated layers which are so common in the Coastal Plain formations, as the Arundel formation here lies below the level of the creek, and hence it would have been impossible to reach it.

Kern Ore Bank [152].—There are two small openings 30 feet in diameter, on Mr. John Kern's place, a half mile northwest of Golden Ring. They were worked about thirty years ago by John Martin and Jacob Pugh when this was part of the Stemmer Run furnace property.

Rheinhardt Ore Bank [153].—Along the west side of Redhouse Creek, one mile west of Golden Ring, on the property of Mr. Andrew Rheinhardt, Michael Berlett mined about 200 tons of ore thirty-five years ago.

Kline's Brickyard Ore Bank [154].—This locality was worked on a large scale over an area of one hundred acres until the Stemmer Run furnace shut down. At present little ore is found in the clay worked for the brickyard, and in the eleven years that the

brickyard has been there, not more than three carloads of ore have been sold.

Zinkand Ore Bank [155].—There is a small opening 40 feet in diameter alongside of Mrs. Zinkand's house, on the Philadelphia Road, at Rosedale, which has been nearly filled in. No details as to the working of this or the next two banks described were obtained.

Schmidtman Ore Bank [156].—Three hundred yards back of the Zinkand Ore Bank, on Mr. J. Schmidtman's place, is a bank 550 by 50 feet.

Leitschuh Ore Bank [157].—On Mr. D. Leitschuh's farm, a half mile west of Rosedale, is a pond 200 by 150 feet, which is an old ore bank.

Lepper Ore Banks [158].—One mile northwest of Rosedale is an area of old workings over a quarter of a mile long and about 200 yards wide, belonging to Mr. Al. Lepper and Mr. C. A. Kelly. This locality has been worked extensively by open cutting and by tunneling, but little work has been done in the past twenty-five years.

Gorsuch Point [159].—Gorsuch Point was one of the early sources of ore for the Principio Company. Mining was carried on there as early as 1724, but it seems that no work was done in later years.

East Baltimore [160].—There were formerly a number of ore banks in East Baltimore, and considerable ore was mined in this region. Through the development and growth of the city, the evidences of these have been destroyed in recent years.

Whetstone Point [161].—This is another area within the city limits which was an important source of ore from the earliest times. In 1727, the Principio Company bought the ore rights on Whetstone Point at the extremity of which Fort McHenry now stands. This was for many years one of the principal sources of supply for the Principio furnace, and afterwards also furnished ore for other

furnaces. Mining operations were not confined to the Point itself, but ore was also dredged from the river bottom along its shores. This dredging was done until shortly after the Civil War. In all probability, the Point owes its name to its former importance as a source of ore, as the high grade carbonate ores made excellent whetstones of very smooth texture.

Westport Paving Brick Company Bank [162].—The clay bank of the Westport Paving Brick Company, southeast of Westport, was formerly an ore bank. At present the ore nodules are still laid aside by Dennis Simms (colored) and shipped to Muirkirk. In this way about one ton of ore is obtained from every seventy cubic yards of clay removed.

Ellicott Ore Bank [163].—An ore bank one mile southeast of Westport, 600 by 250 feet and about 30 feet deep, was leased and worked by the Ellicotts for their furnaces in Baltimore, and abandoned when these were shut down.

Whitaker Ore Banks [164].—South of Minersville, on the Annapolis Road, are two large banks belonging to the Whitaker Iron Company, which were worked for their furnace at Principio. No mining has been carried on here for more than twenty years. One bank is about 800 feet long and 200 to 300 feet wide; two hundred yards to the south of it is the other bank, which is 500 by 200 feet in area. A sample of ore taken for the 1880 Census[1] showed 40.73 per cent. Fe and .149 per cent. P. At that time operations were no longer on a large scale, and the banks are said to have been so weathered, that it was only possible to see that the chief material was a brown clay. Two new small excavations at that time showed that at a depth of eight to twelve feet the ore was limonite, and below that depth chiefly carbonate with a limonite exterior.

Obrien Ore Banks [165].—A half mile southeast of Clifton are two ponds which were formerly ore banks. The one to the east, which is 500 by 250 feet, belongs to Mr. Michael Obrien, and when

[1] Tenth Census, 1880, Vol. XV, p. 253.

worked belonged to his father, Patrick Obrien; the other, which is 600 by 200 feet, belonged at that time to Hiram Kaufman, and was worked by Patrick Obrien on a royalty of 50c. per ton. The ore was "white ore" at the bottom, and "white ore" with a limonite crust toward the top. The overburden increased as the banks were extended into the hillside, until it reached a thickness of fourteen to eighteen feet. These banks were worked before 1860, and again opened in 1875 by Patrick Obrien and worked by him and his son until 1890, and then one year by George Bowers when they were finally abandoned. The output under the Obriens ran as high as 400 tons per month. The ore was loaded on scows at the banks and taken to the Baltimore furnaces.

Kaufman Ore Bank [166].—At Clifford, there is a small bank 40 feet in diameter on the Kaufman property, which was worked a short while about 1890.

Brian Ore Banks [167].—On Mr. Joseph Brian's place, southwest of Clifford, are three old banks which have been abandoned for at least forty years. One of them is about two hundred yards west of the Washington, Baltimore and Annapolis Railroad tracks, and is 250 by 100 feet by 15 feet deep. Just west of it is another about 50 feet in diameter. The third lies three-eighths of a mile southwest of these, at the head of a long gully, and is so old that it has almost merged itself with the natural topography, and its size cannot be determined.

Pitcher Ore Bank [168].—A mile and a half south of Clifford, on the north shore of the Patapsco River, ore was worked in a bank cut into the side of the hill for a length of about 100 yards, on the property of Mr. Nathan Pitcher. This is a very old bank and no details were learned in regard to it.

Pitcher and Creager Brick Company Banks [169].—Three-quarters of a mile southwest of Mt. Winans, on the site of an old brickyard belonging to the Pitcher and Creager Brick Company, is a large bank worked in recent years for clay. The opening lies on both sides of the Washington Road, and is over 1500 feet long and

has a maximum width of 600 to 700 feet. Before the Civil War, the property was owned by John Swartz, and at that time was mined on a large scale for iron ore. Little attempt has been made to work it for iron ore since that time. In working the bank for clay, the ore is still saved, but not much is encountered, and a shipment of only a few hundred tons to Muirkirk last spring represented the accumulation of several years. The ores are chiefly "brown ore." Paint ore occurs in the bank in lenses, and is still worked in a desultory way.

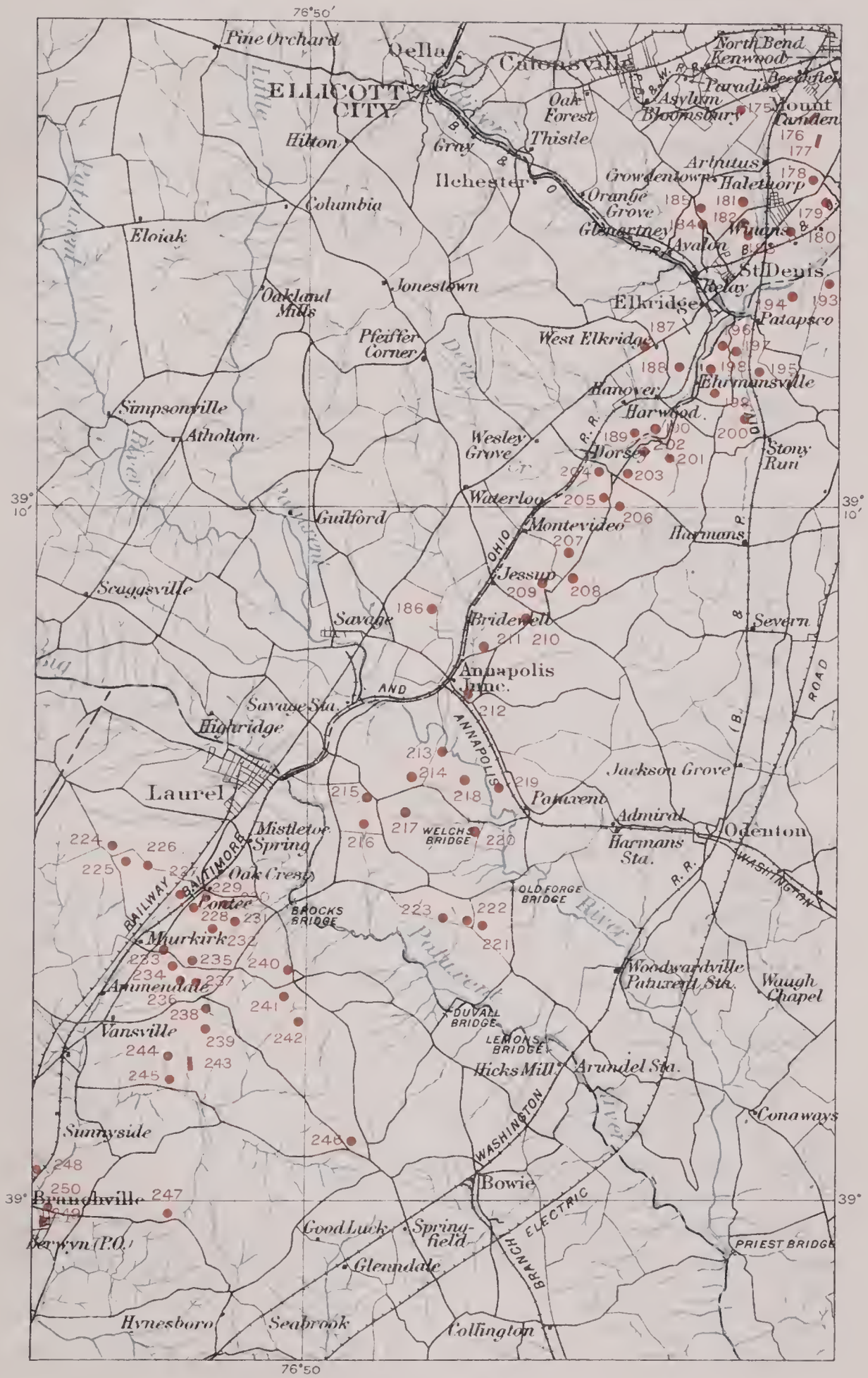
A half mile northeast of here on the hill above Mt. Winans, is another clay bank, belonging to the same company, which was also formerly worked for ore. The ore here is chiefly "white ore" in a gray clay. Underlying the clay is a bed of paint ore which is worked occasionally on a small scale.

Blowhorn Ore Banks [170].—A half mile south of Mt. Winans, on Mr. William E. Blowhorn's property, ore was mined quite extensively before the Civil War, and on a small scale until the seventies. The workings extended over a distance of a thousand feet, but have nearly all been filled in except at the southeast end, where there is still a large pond.

Rittenhouse Ore Bank [171].—Three hundred yards southeast of West Baltimore Station is an opening 100 feet in diameter, on Mr. Van Bradt Rittenhouse's place, which seems to be quite old.

During Ore Bank [172].—On Mrs. During's property, a quarter of a mile southwest of West Baltimore Station, on the south side of the railroad tracks, is a small opening in a gully from which a little ore was taken over twenty years ago when the property belonged to John Baer.

Ore Banks Northeast of Landsdowne [173].—Northeast of Landsdowne, is a belt of old workings a mile long and nearly a hundred yards wide, running in a northwesterly direction. They are on the properties of Mt. Zion Cemetery Company, Mr. James Rittenhouse, and a Mr. Strasburg, respectively, from southeast to northwest. At the northwest end, Mr. Henry Hinks got out one carload during 1908



LOCATION OF IRON ORE BANKS IN PARTS OF BALTIMORE, HOWARD, ANNE ARUNDEL AND PRINCE GEORGE'S COUNTIES

by tunneling, paying a royalty of 50c. per ton. Two of his tunnels were still open in the fall of 1910, and showed considerable ore in elongated bands and nodules.

Ore Banks Southeast of Landsdowne [174].—Southeast of Landsdowne, is another area of old workings half a mile long, on property belonging to Mr. C. J. Hull and Capt. Cloud. These banks have not been actively worked for thirty-five years.

Kennedy Ore Bank [175].—One mile northwest of Arbutus, on property belonging to a Mrs. Kennedy, is a very old opening 100 yards long and 150 feet wide. No information in regard to this was obtained.

Excelsior Brick and Pottery Company Banks [176].—One mile northeast of Arbutus, are three connected openings nearly a half mile long, on the Excelsior Brick and Pottery Company's property. The two openings to the southwest are old ore banks, which were worked very extensively during the Civil War and for some time after, but not during the last twenty years. The other opening is the clay bank of the brickyard. Under a four-foot overburden of sandy soil is a fifteen-foot bed of light blue clay with nodules of ore, tending to occur most abundantly in the middle of the bed. Then comes a ferruginous conglomerate layer, below which is a bed of darker blue clay containing less ore. The lumps of ore obtained in mining the clay are saved and sold to the Muirkirk furnace. In this way about 900 tons of ore are obtained annually. At the time of the author's visit in the fall of 1910, there were about 600 tons of ore on hand, consisting chiefly of limonite, though some carbonate ore also occurs.

Ore Banks Northwest of Landsdowne [177].—One mile northwest of Landsdowne is a section of old workings nearly three-quarters of a mile long, following along the top of a north-south ridge, and at the south end reaching a width of 1000 feet. These are from north to south on the properties of the Excelsior Brick and Pottery Company, Mr. Jacob Odensoss, Colonel McIntosh and Mr. D. H. Emory. They were worked before the Civil War, but most extensively during the War, and after that period less and

less actively. Those at the south end were last worked on a large scale twenty-two years ago by Mr. Fred. Link and Mr. George Brown, and again on a smaller scale by Mr. Link seven years ago.

Mr. Odensoss continued operations until the furnaces in Baltimore shut down, and then did not mine again until last winter, when he shipped 20 tons to Muirkirk. Under the iron ore on his place, is a bed of paint ore which he has occasionally worked. In 1880,[1] Mr. Odensoss was working a bank 25 feet deep, in the upper part of which was a light gray and brown sandy clay, containing siliceous nodules of ore, and in the lower part a dark bluish-gray clay containing less siliceous ore. An analysis of these ores yielded 37.53 per cent. Fe and .041 per cent. P.

Ore Banks Northeast of Halethorpe [178].—A half-mile northeast of Halethorpe, ore was worked on a large scale by Mr. William T. Randle, during the Civil War. Beginning at the Washington Road, a series of cuts were made into the side of the hill for a distance of 1500 feet to the north. Just west of these, three hundred yards from the road, is a bank 600 feet long and from 50 to 200 feet wide; and a hundred yards southwest of this is another opening 150 by 40 feet. A little work was done in these banks until about five years ago by Mr. Fred. Link. The ore is chiefly "white ore" with a limonite crust.

Virginia Ore Banks [179].—On the hill west of Monumental Station is an area of old workings 800 feet long and 500 feet wide, known as the Virginia Banks, which are said to have been worked about a hundred years ago, when the property belonged to the Catons. In recent years they have been worked to a very limited extent by Mr. Fred. Link.

Kraft Ore Banks [180].—At the south end of Halethorpe, are two banks, on opposite sides of the road leading to Halethorpe Station, which were operated by Mr. John Kraff from 1880 to 1895; and the ore, which was mostly limonite, sent to the Baltimore furnaces. The openings are about 50 feet in diameter. The bank on

[1] Tenth Census, 1880, Vol. XV, p. 253.

the east side of the road was opened again last winter and three or four carloads of ore sent to Muirkirk. The ore in this fresh exposure occurs chiefly in nodules from three to four inches long.

Miller Ore Banks [181].—A half mile west of Halethorpe is a bank 400 feet long with a maximum width of 200 feet, and around it are several smaller openings. This property was worked in the sixties by Mr. William T. Randle and Perry G. Mitchell, and was owned at that time by William Miller. It now belongs to the Francis Real Estate Company.

Ring Ore Bank [182].—A half mile west of Halethorpe is another bank, on the farm of Mr. David Ring, which was worked by his father, Dennis Ring, about the same time as the Miller Ore Banks. This opening is 300 feet long, and 50 to 100 feet wide. It was worked by both open cutting and tunneling. Four carts were used in hauling, and Mr. Ring estimates the total output to have been 10,000 tons.

Coursey Ore Bank [183].—A quarter of a mile south of the Ring Ore Bank, on Mr. Howard Ring's farm, is a bank 300 by 100 feet in area, now partially filled in, which was worked about sixty-five years ago by Edward Coursey.

Randle Ore Bank [184].—Three-quarters of a mile north of Relay, Mr. William T. Randle worked a bank on his farm which he has since filled up. It was apparently about 200 feet in diameter.

Stapleton Ore Banks [185].—One mile north of Relay, are three ore banks on Mr. R. E. Stapleton's place, which were worked about thirty years ago by Bernard Sandman and his brother. The bank next to the county road is 400 by 200 feet and 20 feet deep; adjoining it on the northeast, is another 150 feet in diameter; and about 200 yards to the east is the third which is 300 feet long and 100 feet wide. These banks are said to have been worked on a very large scale, and about thirty carloads of ore a month mined.

Howard County.

All the carbonate ores that have been worked in Howard County, with the exception of one locality near Bridewell, are in

the vicinity of Hanover, and form but a part of an area, the greater portion of which lies in Anne Arundel County, which has been one of the greatest sources of these ores.

Haslup Ore Bank [186].—Three-quarters of a mile west of Bridewell, on the farm of Mr. Lewis Haslup, is an area about 100 yards in diameter, from which ore was taken. Work was begun here about 1865, when the ore was hauled to the Savage furnace; later, it was shipped to Baltimore and to Muirkirk. This deposit was last worked about fifteen years ago by Mr. Thomas King, on a royalty of 50c. per ton. He went to a depth of thirty feet, and except near the surface obtained "white ore."

Scaggs Ore Bank.—Adjoining the Haslup Bank, on the property of Mrs. Scaggs, is an opening 100 by 40 feet, which was worked at the same time.

Talbott Ore Bank [187].—At the west end of West Elkridge, on the north side of the Washington Road, is a large opening 300 feet wide extending back from the road for a distance of 500 feet. No work has been done here since 1870; but before that time, when it was in the hands of Jefferson Talbott, this bank was worked extensively on royalties of from 50c. to 70c. per ton. The bank was opened in the first half of the nineteenth century, when the property belonged to the Tysons.

Brooks Ore Bank [188].—One-half mile north of Hanover, on property now owned by a Mr. Bedford, is an old opening formerly worked by George W. Hobbs, which is 300 feet long, 200 feet wide and 30 feet deep.

A quarter of a mile southwest of this point are two small openings, 25 feet in diameter, from which paint ore was taken about eight years ago by Mr. Robert Wilson. These are only about six feet deep as the bed of paint ore occurs near the surface, and fragments in the soil give it a bright red color.

Hobbs Ore Banks [189].—There are several large openings on the property of the heirs of George Hobbs, three-quarters of a mile southwest of Hanover. The largest two are on Deep Run. One of

these has a width of 200 to 300 feet, and extends back from the run for a distance of about 800 feet, with a depth of 50 feet or more. The ore was chiefly "white ore," many nodules of which are still exposed in the bottom and cropping out on the sides. Immediately adjoining this opening on the east is another, 150 feet in diameter; and a hundred yards to the northeast is a third, 300 by 100 feet and 25 feet deep. There were also a number of smaller openings on this property. These banks were formerly worked very extensively, and as high as fifty to sixty men are said to have worked there at one time; but nothing has been done during the last twenty years.

Brown Ore Banks [190].—One-half mile south of Hanover, are two large banks, which formerly belonged to the Great Falls Iron Company, and later to Howard Brown, when they were worked on a royalty by various operators until about 1890. These banks are described in the Tenth Census, at which time they were in operation. The easterly opening[1] extends from the west bank of Deep Run a distance of 600 feet to the west, is 100 feet wide, and from 20 to 50 feet deep. At the time of the Census Report it was operated by Mitchell, Wilson, and Riley. The following section was then exposed: 5 to 8 feet of soil, sand, and gravel; 5 to 15 feet of light brown, somewhat siliceous clay, containing nodules of carbonate ore of the same color as the clay, and also somewhat siliceous; and below that, a drab gray plastic clay, with nodules of white or light gray carbonate ore, of very fine texture, without the siliceous appearance of the nodules of the upper part.

The nodules of the lower bed yielded 37.87 per cent. Fe and .063 per cent. P., those of the upper bed 36.17 per cent. Fe and .049 per cent. P.

The other opening[1] lies one hundred yards to the southwest and extends 500 feet along a north-south strike. It is 200 feet wide and 50 to 75 feet deep. The thickness of the various beds is quite different in different parts of the mine. The following section is given for this opening: 5 to 10 feet of yellowish sand, and yellow and white quartz gravel; 5 to 10 feet of red, somewhat sandy clay;

[1] Tenth Census, 1880, Vol. XV, p. 253.

0 to 12 feet of dark red clay with sticks and lumps of charcoal; brown stiff plastic clay, with impure carbonate nodules having a reddish-brown tinge; and 15 to 30 feet of bluish-gray plastic clay with nodules of carbonate ore of a light gray color, very fine grained, and often with a highly conchoidal fracture.

The lower nodules yielded 38.48 per cent. Fe and .025 per cent. P., and the upper nodules 36.10 per cent. Fe and .040 per cent. P.

These two banks are the northwestern extension into Howard County of a large area along Piney Run in Anne Arundel County, known as Timber Neck, which is described in the following pages.

Anne Arundel County.

In Anne Arundel County, the ores of the Arundel formation have been worked at many points along the entire northwestern edge of the county from the Patapsco River to the Patuxent River. In this whole region, the area south of Hanover, known as Timber Neck, stands out pre-eminently as the greatest producer. In the following descriptions, the ore banks are taken up successively from northeast to southwest.

Garey Ore Bank [191].—Two miles northeast of Patapsco Station, on property now belonging to Mr. O. R. Benson, Mr. Joseph B. Garey got out four carloads of ore in the winter of 1910, and shipped it to Muirkirk from Landsdowne. The bank is located on the west side of a small stream emptying into the Patapsco River, very close to the river, and was worked along a low bluff for a distance of 100 feet. The overburden is about twelve feet, and Mr. Garey said he had three beds of ore aggregating nearly two feet in thickness.

Ruth Ore Bank [192].—This bank is on the property of Mr. J. R. Ruth, a mile and three-quarters northeast of Patapsco Station, on the east side of a ravine, along which it has been worked for a distance of 200 feet or more. It is an old bank which was reopened in the winter of 1910 by Mr. Joseph B. Garey, but was soon abandoned, as he found it too wet to work to advantage. There is an overburden of 18 feet of sand and gravel, below which "white ore" nodules occur in clay.

Benson Ore Banks [193].—A mile and a quarter northeast of Patapsco Station are two ore banks, on the land of Mr. Joseph Benson. They were worked until about 1890, at which time they were owned by Mr. Daniel M. Reese, and worked for him on royalties. One bank is 300 by 100 feet, and the other, to the southeast, 200 by 60 feet.

Soper Hall Ore Banks [194].—These ore banks occupy a considerable area one mile northeast of Patapsco Station, extending on both sides of the road for a distance of about 800 feet, and almost as far back from the road on the south side. They have been worked over a long period. About thirty years ago, the property was owned and worked by George Bowers and Adam Giltz; and as late as ten years ago by Charles Nieder.

Hollins Ore Bank [195].—One mile south of Patapsco Station, on Mr. William Smith's place, is an opening 100 by 30 feet and about 8 feet deep now, from which ore was taken about thirty years ago by Samuel Hollin, at which time the property was part of the Gaither estate.

Randel Ore Bank [196].—On the property of Mr. George Randel, three-quarters of a mile southeast of Elkridge, is an opening 150 feet in diameter, and 20 feet deep.

Crook Ore Bank [197].—On Crook's Hill, one mile southeast of Elkridge, at the head of a ravine on Mr. Samuel Crook's farm, is a very old opening, the sides of which are now so washed in that it can hardly be distinguished from the natural topography. This and the preceding bank were worked for the Elkridge furnace, and they have not been operated since that furnace shut down in 1872.

German Ore Bank [198].—One mile south of Elkridge are two openings owned and formerly worked by Mr. T. S. German. One is 150 by 50 feet, and just south of it is the other, 200 by 30 feet. Ore was last shipped from these to the Cedar Point furnace. The banks have since been worked for paint ore, and a small opening was also made for paint ore on the top of the hill south of Mr. German's house.

Plumbmer Ore Banks [199].—A mile and a half southeast of Elkridge are three ore banks formerly worked by the Plumbmer brothers. The most northerly one, now belonging to Mr. William Fairbanks, is 150 by 200 feet, and about 20 feet deep, and was worked by the Plumbmer brothers for a period of ten years until about ten years ago. Both iron ore and paint ore were obtained. Mr. Fairbanks has since then worked a bed of paint ore for a distance of several hundred yards around his house, where it occurs close to the surface. This is about three hundred yards west of the old ore bank.

The other two banks are now owned by Mr. G. R. Harmon. One is 50 feet in diameter, and the other southwest of it is 100 by 30 feet. These were opened about forty years ago by Meyer Rowles, and later owned and worked by the Plumbmers.

Smith Ore Bank [200].—One-half mile northwest of Stony Run is an ore bank on Miss Amelia Smith's farm, 100 feet in diameter, which was worked by her brother about thirty years ago. This was so near the level of Stony Run that it was too wet, and hence was never worked very much.

Timber Neck Ore Banks [201].—These ore banks occur on both sides of Piney Run, a mile southeast of Hanover, extending for a distance of half a mile along the Run and reaching a maximum width of nearly half a mile, and have in places been worked to a depth of over 50 feet. No other area in the State of equal size has been so extensively worked, the entire tract consisting of iron ore openings and the dumps from them, so that when viewed from the rim of the openings the effect is that of typical "bad lands."

The entire area was formerly owned by the Great Falls Iron Company and later by Howard Brown, owners of the furnace at Elkridge. In recent years the property has been divided up and sold to various people. There are also several other openings just outside the limits of this area which belonged to the same property. At the southwest end, are several small ones; and on the west side is a larger opening extending for a distance of 200 yards along the south side of the county road. The two large banks in

Howard County described on a preceding page also belonged to this tract. These were very old banks and were worked on a large scale until about twenty years ago, yielding chiefly "white ore." Plate XXI shows the occurrence of the nodules of ore in the clays at one of the openings. In recent years a little gouging has been done off and on, and in the winter of 1910 several carloads of ore were shipped to Muirkirk by negroes who worked in the banks on the portion of the tract now belonging to Mr. Charles A. Brauer. Mr. Brauer has also worked the banks on his property for paint ore, and has made several small openings for paint ore on the south side. The northern portion of the area belongs to Mr. William Dagler, who is now working the old banks for clay and paint ore.

Lafey Ore Bank [202].—Three-quarters of a mile southwest of Hanover, on property owned by Mr. Michael Lafey, is an old opening 150 feet in diameter. A hundred and fifty yards southwest of it is a small opening made recently by Mr. Lafey for paint ore.

Anderson Ore Bank [203].—There is a small ore bank, 50 by 30 feet and 10 feet deep, three-quarters of a mile east of Dorsey, belonging to Mr. Bruner Anderson.

Dorsey Ore Banks [204].—A half mile east of Dorsey, on the Dorsey property, is a large opening 450 by 200 feet and 30 feet deep, and between it and the road two smaller ones. These were opened thirty-five to forty years ago by Valentine Riemsnyder and Robert Hood, who worked them on a royalty of 50c. per ton for several years. They were later worked by Frederick Sliver and Henry Marsh. The ore was sent chiefly to Reese's furnaces in Baltimore, and some also to the Stemmer Run furnace.

Disney Ore Bank [205].—This bank, now owned by Mr. Lynn Tubbs, is 100 by 30 feet by 20 feet deep, and was opened over twenty years ago by Valentine Riemsnyder on the property of William Disney. It lies three-quarters of a mile southeast of Dorsey. During the winter of 1910 Frank Franklin (colored) again worked in it for a while and got out about 60 tons of ore. It is a nodular limonite, but many of the nodules still have a core of "white ore."

The ore is of low grade, being too siliceous, and the bank was soon abandoned.

Harmon Ore Bank [206].—One mile southeast of Dorsey is a bank 150 feet in diameter, on the property of Mr. Bruner Anderson. This was owned and worked by Dennis Harmon about fifty years ago.

Ellicott Ore Bank [207].—One mile southeast of Montevideo is an area 1500 feet long, and several hundred feet wide, which has been worked for ore. This property was owned in the early part of the nineteenth century by the Ellicotts, owners of the Patuxent furnaee, and worked for them on royalties. Since that time only occasional gouging has been done.

Goldwine Ore Bank [208].—On Mr. T. J. Goldwine's property, a mile and a half east of Jessup, is an opening about 200 feet in diameter, which was owned and worked by John Smith in the first half of the nineteenth century.

Bennett Ore Bank [209].—About forty years ago, James Fisher took out some ore on Mrs. Bennett's farm, one mile east of Jessup, whieh he sent to Muirkirk. There is one opening 100 by 20 feet, and several smaller prospect holes nearby.

Linthicum Ore Banks [210].—Two large banks and several smaller openings are on the property of Hon. J. Charles Linthicum, one mile southeast of Jessup. One opening is about 250 by 100 feet; and the other, to the south of it, 400 feet in diameter, and they were worked to a depth of 30 feet. At the time they were most extensively worked, they belonged to Dr. A. S. Linthicum, who obtained a royalty of 50c. per ton. As high as thirty to forty men were engaged in mining here, and the weekly output ran from 40 to 60 tons. The output in 1880 is given at 2200 tons. The upper part of the banks yielded hematite containing 46.79 per cent. Fe;[1] and the bottom, nodules of carbonate ore with 37.60 per cent. Fe. The

[1] Tenth Census, 1880, Vol. XV, p. 251.

product went mostly to the furnaces at Baltimore, and some to Muirkirk. They have not been worked for more than fifteen years.

Hobbs Ore Banks [211].—Two banks were worked for some years by George Hobbs, on property now belonging to the House of Correction, a mile and a quarter south of Jessup. They were abandoned about the same time as the Linthicum banks. The bank adjoining the road is 150 feet in diameter, and the one back of it 300 feet long, from 80 to 100 feet wide, and 25 feet deep.

Brown and King Ore Banks [212].—One-half mile southeast of Annapolis Junction is an ore bank belonging to Mr. Payton Brown, 250 feet long and having a maximum width of 100 feet. This was last worked extensively by James Brien fifteen years ago, and the ore shipped to the Ellicotts' furnaces in Baltimore. In the middle of the bank a clay pillar ten feet high was left standing, consisting of a gray clay with nodules of limonite.

Adjoining this opening on the north is an old bank 150 by 100 feet, owned by Mr. Thomas King. This was reopened hy him about thirty-five years ago and worked off and on for about twenty years, the ore going mostly to Muirkirk. Others also worked in the bank on royalties during that period, so that according to Mr. King the output ranged from 60 to 70 tons per month.

Skully Ore Bank [213].—Two miles and a half east of Laurel, on the property of Mr. Lloyd Dorsey, is an ore bank 100 by 50 feet with a smaller one 25 feet in diameter adjoining it. About two hundred yards southwest of these, prospect holes were put down in the fall of 1909, in which ore was found. This was limonite with frequently a center of carbonate. These banks were first worked by the Ellicotts for the Patuxent furnace, but never to any great extent. In 1858, the property was bought by Mr. Dorsey, and the banks worked by James Skully on a royalty of 40c. per ton; and later, about eight years ago, by Daniel Henderson (colored). The ore was said to be too irregular in its occurrence to make successful mining possible.

Priest Deposit [214].—A little gouging was also done some years ago just north of the county road a little over a half mile southwest of the Skully Ore Bank, on land belonging to a Mr. Priest of Pennsylvania. Two carloads are said to have been shipped.

Ties Ore Bank [215].—A mile and a half east of Laurel, at Ties' Brickyard, Mr. John W. Smith is mining ore which he ships to Muirkirk. He is working in the clay bank of the brickyard, and pays a royalty of 40c. per ton. A 15-foot face is exposed, showing limonite nodules of all sizes, with frequently a center of "white ore." Working alone he can get out as much as six tons a week.

Tyson Ore Banks [216].—A mile and a half east of Laurel, and a third of a mile south of the Ties Ore Bank, is an area several hundred yards long, and from 100 to 200 feet wide, which was worked years ago, when it was part of the Tyson property.

Waters Ore Bank [217].—Two miles and a quarter southeast of Laurel, on Mr. George W. Waters' property, are two small openings with three to four feet of overburden of sand and gravel in which Mr. Samuel Chaney worked a little year before last.

Rose Ore Bank [218].—On property formerly owned by a Rev. John Rose, one mile northwest of Patuxent, is a bank 200 by 400 feet, and now 25 feet deep. This was opened thirty-five years ago, and worked on a royalty by Thomas Skully and Lemuel Gaylor. It was worked very extensively for a while, and according to Mr. Claude Welch, they paid a royalty of $400 a month. That must represent an exceptional output, however, as it would mean about 1,000 tons a month. The bank was last worked about eight years ago by Mr. John W. Smith and Daniel Henderson (colored). During the winter of 1910 it was again prospected and ore exposed but no work done.

Sydicum Ore Bank [219].—One-half mile northwest of Patuxent, on the same property as the Rose Ore Bank, is a small opening 100 by 30 feet worked on royalty about twenty-five years ago by a Mr. Sydicum.

Welch Ore Bank [220].—One mile west of Patuxent, on Mr. Claude Welch's farm, is an opening 200 by 70 feet which was worked about fifteen years ago, and the ore at first shipped to Baltimore, and later to Muirkirk.

Berkley Ore Bank [221].—On the property of Mrs. Andrew Berkley, two miles south of Patuxent, is a bank 150 by 70 feet, which was worked for several years about fifteen years ago.

Rieve Ore Bank [222].—Across the county road from the Berkley Ore Bank is a bank 100 feet in diameter belonging to Mr. Theo. Rieve, which has not been worked for over twenty-five years.

Gosweiler Ore Bank [223].—On Mr. Theo. Rieve's place, two miles and a quarter southwest of Patuxent, is a bank 100 by 50 feet, which was worked over twenty years ago by Solomon Gosweiler, and the ore shipped to Baltimore. He is said to have worked quite extensively for a while, employing from fifteen to twenty men.

Prince George's County.

In Prince George's County, as in Anne Arundel County, the area within which the Arundel ores have been worked forms a belt running across the north end of the County parallel to the Baltimore and Ohio Railroad, and lying mostly to the east of the railroad. Though this belt extends from the Patuxent River to the District of Columbia, here again one portion, the immediate neighborhood of Muirkirk and Contee, at the northeastern end, stands out as having been by far the most important.

Kirwan Ore Bank [224].—A mile and a half northwest of Contee, on Mr. O. L. Kirwan's farm, about two and a half acres were worked by the former owner, a Mr. Louthan. During the winter of 1910 a little gouging was done, for which Mr. Kirwan obtained a royalty of 50c.

A mile and a half southeast of this ore bank, on the south side of the county road, some prospecting was done about five years ago, on the property of a Mr. Hill of Washington; but the holes have since been filled in and ploughed over without any further

work being done, so that the indications were probably not very favorable.

Nicholson Ore Bank [225].—On Mr. N. F. Nicholson's place, a mile and a quarter northwest of Contee, an area about 100 feet square was worked over chiefly by gouging some years ago, for which Mr. Nicholson obtained a royalty of 35c. per ton.

Ore Banks One Mile Northwest of Contee [226].—One mile northwest of Contee, on both sides of the county road, for a distance of about 1500 feet, is a series of ore banks which were worked before and during the Civil War, and again to a considerable extent in the winter of 1910 on royalties of 35c. to 40c. per ton. Mr. Mitchell, the owner of a portion of this tract, said that during the Civil War he obtained as high as 75c. per ton royalty. Most of the recent openings are very small, the method apparently having been to prospect for a rich pocket, and as soon as it was worked out to locate another. The openings on the north side of the road are chiefly on the property of Mrs. L. Burk, but the west end belongs to Mr. L. Bashears. On the south side, they are chiefly on the property of Mr. F. B. Mitchell, but the west end is on that of Mr. N. F. Nicholson.

California Ore Banks [227].—One-half mile southwest of Contee is an area from 200 to 300 yards in diameter, within which are a number of openings, known as the California Banks. The electric line from Washington to Laurel passes through this tract, and at the east end is an abandoned brickyard. The ore banks are on the brickyard property and on Mr. William Gibbins' place. These banks were last worked eleven years ago by William H. Hebron (colored). Mr. Charles E. Coffin paid the royalty of 30c. per ton, and hauled the ore to his furnace at Muirkirk, and paid Hebron $2.50 per ton for mining the ore. The ore was chiefly limonite.

O'brien Ore Banks [228].—There are several acres of old workings a quarter of a mile south of Contee, on the property of Mr. Charles Hooff. These were owned and worked until about sixteen years ago by James O'brien. The output for 1880,[1] when they

[1] Tenth Census, 1880, Vol. XV, p. 251.

were no longer worked on as large a scale as formerly, is given at 800 tons, which was shipped to Baltimore. Prospecting was again done here in 1910.

Hooff Ore Banks [229].—On Mr. Charles Hooff's property, a quarter of a mile southeast of Contee, is another somewhat smaller area of old workings in which two new banks were opened in the fall of 1909. One of these worked by Mr. John Brien is 75 by 25 feet and 12 feet deep. East of this is a somewhat smaller one worked by Mr. Charles Englhardt. He pays a royalty of 40c. per ton, and 50c. per ton for hauling to Muirkirk.

Allan Ore Banks [230].—On Mr. B. Allan's place, a half mile east of Contee, is an area of old workings about 1500 feet long and 800 feet wide. There are three large openings, one of them 350 by 150 feet, and a large number of small ones. Judging from the character of the dumps and from the size of the trees on them and in the openings, some of them must be very old. In the fall of 1909 prospecting was done at several points; but in one of the openings still well exposed, there were only two very thin layers of nodules to be seen.

Shriver Ore Bank [231].—There are a number of old openings on both sides of the secondary road for a distance of 1000 feet on Mr. J. H. Shriver's place, three-quarters of a mile southeast of Contee. During the winter of 1910 Mr. Shriver's son opened up a new bank at the west end, north of the road in which he has an eighteen-inch ledge of ore covered with about six feet of overburden.

Roberts Ore Bank [232].—Further west, along the same secondary road as the Shriver Ore Bank, are two areas of old banks, on Mr. William Roberts' property, about three-quarters of a mile south of Contee. The first of these extends along both sides of the road for 1000 feet, and ore was mined there again in 1910. The other, about two hundred yards further west, lies mostly on the south side of the road, and is about 1500 feet long. This road is known as the "Old Iron Ore" road, and was made especially for hauling the ore to Muirkirk. It comes out on the Baltimore and Washington turnpike about a half mile north of Muirkirk.

Ore Banks One-Half Mile East of Muirkirk [233].—There are two small banks one-half mile east of Muirkirk, 25 by 75 feet and 10 by 40 feet respectively, concerning which no details were obtained.

Duvall Ore Banks [234].—Three-quarters of a mile southeast of Muirkirk is a tract of old workings over 300 yards long and 200 yards wide, on Mrs. C. P. Duvall's property, which have been worked for years. Work was done here in the winter of 1910 by tunneling into the old openings.

Milbrook Ore Bank [235].—One mile east of Muirkirk is a three-acre opening, filled with water, belonging to Mr. John Milbrook. On the east side of it is a small opening made by Mr. Milbrook in the spring of 1910 from which he obtained 50 tons of ore. The old bank was worked in 1863 by Carl Milbrook for George Burroughs, and later for Mr. Charles E. Coffin, for the furnace at Muirkirk. The ore was a good grade of limonite occurring in nodules weighing as much as several tons each. The overburden was about six feet.

Friel Ore Bank [236].—One mile southeast of Muirkirk is an opening 300 by 100 feet filled with water, which was worked until about 1880 by Pat. Friel and Carl Milbrook for Mr. Charles E. Coffin, who leased the ore rights from Miss Tyson.

Tyson Ore Banks [237].—A mile and a quarter southeast of Muirkirk, near the head of Beaverdam Creek, on Miss Tyson's place, are five large ore banks, besides a number of smaller ones. On the west side of the creek is an opening 600 by 200 feet, and south of it another of irregular shape about 100 yards in diameter. On the east side are three openings. Near the road is a narrow one about 100 yards long; a hundred yards south of this is one 600 by 200 feet, and to the southeast, a third, 200 by 150 feet. Many of the smaller holes were made in the spring of 1910, when the work was done on a royalty of 40c. per ton. When these banks were formerly worked on a large scale, the property was leased by the owners of the furnace at Muirkirk, and worked for them.

Green Ore Banks [238].—On a Mr. Green's property, a mile and a half southeast of Muirkirk, is an old opening 150 by 100 feet, and several smaller ones. These were worked again in the spring and winter of 1910 by Mr. Green by means of tunnels and shafts. The ore occurs in gray clay containing a great deal of lignitized wood. The nodules tend to coalesce into bands, the interiors of which are usually carbonate ore, and the exterior weathered to limonite.

Ashland Ore Bank [239].—A quarter of a mile south of the Green Ore Bank is a large bank 300 by 200 feet and 30 feet deep, known as the Ashland Bank. It has not been worked for some years.

John Sadilek Ore Banks [240].—Two miles and a half east of Muirkirk are two ore banks belonging to Mr. John Sadilek. The one north of his house is an old bank. The other, about one hundred yards west of his house, he opened in the winter of 1910, and mined about 70 tons of ore. The ore is both "white ore" and limonite, the former with a limonite shell. The ore bearing clay here comes to the surface, so that there is practically no overburden.

Joseph Sadilek Ore Bank [241].—On property now owned by Mr. John Sadilek, and a quarter of a mile southwest of his banks, is a bank about 50 feet in diameter, which was worked by Joseph Sadilek in the winters of 1882 to 1885, producing a little over 100 tons of ore.

Haker Ore Bank [242].—Three miles southeast of Muirkirk, Henry Haker worked a bank on his place for a year, about seventeen years ago. As the ore was of too low grade the bank was soon abandoned, and is now nearly filled in.

Swampoodle Ore Banks [243].—Two miles east of Beltsville, on property now owned by Mr. George Donaldson and Mr. Charles E. Coffin, is an area about three-quarters of a mile long and a quarter of a mile wide, known as "Swampoodle," in which there are a number of very large openings, besides many smaller ones, giving evidence of large scale operations at one time. These banks were worked from very early times until about six years ago.

Donaldson Ore Banks [244].—A quarter of a mile west of the Swampoodle Ore Banks, on Mr. George Donaldson's property, is an opening about 200 feet in diameter, with several smaller openings nearby, which he worked for about fifteen years until six years ago. At first he shipped the ore to the Stickney furnaces in Baltimore, receiving $4.00 per ton on the cars at Beltsville. At that time he employed from twelve to fourteen men and from two to six carts, and said he could calculate on one ton of ore per man daily. Later the ore was sent to Muirkirk.

Mason Ore Banks [245].—A quarter of a mile south of the Donaldson Ore Banks are two other ore banks, which were worked extensively until about twenty years ago, first by R. B. Mason, and later by Mr. George Donaldson, and the ore shipped to Baltimore furnaces. On the east side of the secondary road is an irregular shaped opening 400 by 100 feet, and on the west side one 700 by 200 feet filled with water.

A quarter of a mile southeast of here, on the south side of the county road, is a small shallow opening 100 by 10 feet, which is so old as to be scarcely noticeable. There was apparently never anything more than a little gouging done here.

Jones Ore Bank [246].—Two miles west of Bowie, Luther D. Jones worked a bank on his place about twenty years ago. It is a small opening along the road about 150 feet long, and extending back twenty-five feet. Several pieces of limonite are still scattered about, resembling the "shell ore" formed by weathering of carbonate nodules. Though this locality is some distance east of the Arundel outcrops, the ore is of the same type; and this and the locality next described, which is also outside of the Arundel area, may be classed with these ores.

Hedgman Ore Banks [247].—Two and a quarter miles east of Branchville are two small openings, belonging to Mr. J. N. S. Hedgman. One is 70 by 30 feet, and the other east of it 50 by 30 feet. No further information was obtained in regard to these, and no ore was visible.

Buck Ore Bank [248].—A half mile north of Branchville is a bank 100 by 50 feet in area, on the property of Mr. M. H. Buck. No ore is now visible and the sides consist of sand and gravel. No further details were obtained regarding this opening.

Skaggs Ore Bank [249].—A quarter of a mile southeast of Branchville is a bank worked until about twenty-five years ago by Geo. L. Skaggs and Robert Burgess, on land belonging to Mr. Thomas Walker. This bank is 120 by 75 feet, and 11 feet deep. It is mentioned in the Tenth Census Report,[1] when the output was 50 tons per week and was sent to Baltimore furnaces. A sample of the ore showed 40.85 per cent. Fe and .060 per cent. P. The ore occurs in a stiff bluish clay, in the lower portion of which are nodules composed wholly of "white ore," and in the upper portion nodules of "white ore" with limonite shells. Above the ore-bearing clay is a thin layer of ferruginous gravel and clay, and above this about two feet of sandy loam.

Reed Ore Bank [250].—A quarter mile east of Branchville is an opening 100 by 25 feet which was worked about twenty-five years ago.

THE HEMATITES.

THE RED HEMATITES OF ALLEGANY COUNTY.

The red hematites of the Appalachian area occur in the Clinton formation and are generally called the Clinton ores. These ores are widely distributed throughout the eastern United States, being practically co-extensive with the Clinton formation.

In New York State, they occur in a belt extending from the eastern-central part of the State to the Niagara River. They again become prominent in central and south-central Pennsylvania, from where they extend into Maryland, Virginia and West Virginia. They are also well developed in eastern Tennessee, the northwest corner of Georgia and in northeastern Alabama. Besides these ex-

1 Tenth Census, 1880, Vol. XV, p. 248.

tensive occurrences, they are found in eastern Wisconsin and in southern Ohio and northern Kentucky. All of these deposits have been worked to some extent but the most extensive work has been done in the Birmingham district of Alabama, where the ores attain their highest economic development.

Distribution of the Clinton Formation in Maryland.

With the exception of two small outcrops in Washington County, west of Hancock, which are of no economic importance, the Clinton rocks are confined in Maryland to Allegany County. They are exposed in narrow belts flanking three anticlinal folds forming Wills, Tussey and Evitts mountains.

WILLS MOUNTAIN AREA.—The westernmost area of exposure of these rocks is on the flanks of the hills of the Wills Mountain anticline which extends across Allegany County in a N. 30° E. direction just west of Cumberland. On account of a pitch to the south of the fold, the two belts of outcrop coalesce at Cresaptown and extend southward as one belt. The character of the fold corresponds to the usual Appalachian structure, being overturned to the west. Hence the outcrop on the west is much narrower than on the east side. The width of the western belt is about 200 yards and of the eastern 400 yards. The length of the outcrop in this area is about twenty-four miles.

EVITTS MOUNTAIN AREA.—The Evitts Mountain area lies about five miles east of the Wills Mountain. The outcrops in this area also conform to the general Appalachian direction of N. 30° E. The two belts of outcrops coalesce 2½ miles south of the Pennsylvania line and extend only two miles beyond this, so that the area of outcrop in Maryland is considerably smaller than that along Wills Mountain. The overturn to the west makes the average width of the outcrops about the same as in the belt to the west. The length of the outcrops is about nine miles.

TUSSEY MOUNTAIN AREA.—Four miles east of the Evitts Mountain area is the Tussey Mountain area. Again the characteristic

Appalachian trend is shown. The two belts of outcrops coalesce within a half mile of the State line and extend southward in a single belt for a distance of two miles. Due to flattening of the dip and a forking fold at the nose of the anticline, the area of outcrop is about the same as in the Evitts Mountain region, but the length of the outcrop is less than seven miles.

Stratigraphic Position of the Clinton Rocks.

The Clinton formation is the middle member of the Silurian system of rocks. The commonly recognized divisions of the Silurian in Maryland are:

Tonoloway.
Wills Creek.
McKenzie.

Clinton.
Tuscarora (White Medina).

Character of the Clinton Rocks.

The Clinton rocks consist essentially of reddish to grayish olive shales, the exposed surfaces of which show a deep scarlet color. Thin sandstone bands are irregularly distributed throughout the formation. Near the bottom these sandstone bands become much more numerous and grade into the Tuscarora quartzite. These thin bands were originally more calcareous than at present and are more fossiliferous than the shales. Toward the top of the formation thin limestone bands take the place of the sandstone. The top of the formation is marked by a heavy quartzitic sandstone which grades into a siliceous limestone above, part of which has been replaced to form an iron ore bed. This sandstone thickens rapidly toward the east, increasing from seven feet at Pinto to nearly seventy feet in some of the eastern exposures. Another ore horizon which occurs from 120 to 160 feet above the bottom of the formation at times reaches a thickness of over thirty feet. The total thickness of the formation varies from 500 to 600 feet.

The following sections of the Clinton formation are taken from the manuscript of Dr. W. F. Prouty's Dissertation on the Niagara and Clinton formations. The Cumberland section is exposed in Wills Gap at the western edge of Cumberland on the eastern limb of the Wills Mountain anticline. The Six-Mile House section on the Evitts Mountain anticline is compiled from exposures on three separate roads near the Six-Mile House. One road leaving the Cumberland Road at the Six-Mile House and running northwest shows exposures of middle to lower Clinton. The other two roads forking to the south from the Cumberland Road west of the Six-Mile House show upper Clinton exposures.

SECTION OF CLINTON FORMATION IN WILLS MOUNTAIN, CUMBERLAND.

	Feet.	Inches.
Grayish olive shales, with interbedded grayish blue limestone. Two limestone layers 4 and 9 feet from the bottom are especially fossiliferous. (Niagara)	35	....
Gray quartzitic sandstone, at top containing a bed of iron ore 6 inches thick	11	....
Olive to gray shale, with thin limestone layers, mostly concealed	87	....
Rusty argillaceous shale	24	....
Concealed	158	....
Olive argillaceous shale stained with red, with several bands of very fossiliferous sandstone near the bottom	53	....
Dark colored shale more fissile than above and containing a great number of poorly preserved bryozoa	9	....
Light rusty olive argillaceous shale	18	....
Iron sandstone	4	....
Interbedded olive green to gray shale	....	4
Iron sandstone	5	8
Rusty olive to gray fossiliferous shale, growing more fossiliferous toward the top	102	....
Rusty shale at top, uneven bands of gray sandstone at bottom, interstratified with rusty olive shale	36	....
Olive to gray shale, with thin bands of brownish gray quartzite, more quartzitic near bottom	27	....

SECTION OF CLINTON FORMATION, EVITTS MOUNTAIN, SIX-MILE HOUSE.

	Feet.	Inches.
Shales and interbedded grayish blue limestones	35	....
Massive sandstones, with 3 or 4 inch bed of ore at the top	18	....
Greenish to red shales, with sandstone and limestone bands.	50	....
Olive more or less rusty shales, with sandstone bands which thicken toward the top	184	....
Dark colored shales, with thin sandstone layers and many poorly preserved bryozoa	10	....

	Feet.	Inches.
Hackly arenaceous greenish to brown shales	6	....
Olive rusty argillaceous shales	43	....
Concealed	27	....
Dark colored shales, with sandstones in thin layers	18	....
Rusty olive argillaceous shale, with fossiliferous sandstone layers	23	....
Iron ore in two bands, separated by shale parting, average thickness	4	....
Olive and often rusty argillaceous shales	65	....

Description of the Clinton Ores.

The Clinton ores consist of red or brownish red amorphous hematite. They occur at two horizons, each of which has its characteristic ore. Both of the ores appear oolitic, but the upper ore which occurs at the top of the Clinton is very fossiliferous; whereas, the lower ore which occurs at from 120 to 160 feet above the base of the Clinton carries but few fossils.

UPPER CLINTON ORE. — The *thickness* of the ore at different points is variable, as may be seen from the following observations:

At Pinto along the B. & O. Railroad the upper ore is represented as a mere trace.

In the railroad cut south of Brady, the ore is five inches thick and is underlain by an eight-inch sandy and shaly ferruginous bed.

At Rose Hill the ore has a thickness of nine inches.

In Wills Gap at Cumberland the thickness is six inches. The ore is here underlain by about two feet of siliceous limestone. Below this is a thin layer of shale and then the heavy quartzitic sandstone.

In the Evitts Mountain area there are several exposures of this ore and they show from three to four inches in thickness.

In the Tussey Mountain area no exposures of the upper ore occur which can be measured.

The *physical character* of the ore is as follows:

The structure of the ore is both fossiliferous and oolitic. In some specimens the two structures are equally prominent, in others the fossiliferous predominates.

The principal fossils ocurring in the ore are bryozoa, crinoid stems and brachiopods. In general these fossils are completely replaced

by the hematite; many of the forms, however, still show the original calcium carbonate of the shell preserved.

The oolites are spherical or somewhat flattened particles and appear to be solid hematite. When the ore is dissolved in hydrochloric acid, it is seen, however, that these particles have a grain of quartz as a nucleus which is surrounded by a number of concentric chalcedonic layers.

Some of the ore, especially that on the east side of Wills Mountain from Wills Gap northward, has pieces of galena disseminated through it.

In addition to the calcium carbonate preserved in some of the fossils, small patches of calcite are sometimes scattered through the ore. There are also patches of unreplaced very impure limestone remaining in the ore. Some of these have had their interior dissolved out and either contain minute stalactites of calcium carbonate or are completely filled with calcite. The contact between the ore and the underlying limestone is well shown at the Wills Gap section. It is by no means a sharply defined contact but stringers of the ore extend into the limestone and gradually die out.

The chemical composition of the ore is shown in the following anaylsis in comparison with an analysis of the underlying limestone:

ANALYSIS OF SAMPLES FROM WILLS GAP.

Upper Ore.

Fe	37.37
SiO_2	15.05
Al_2O_3	9.89
CaO	9.09
MgO	.93
Mn	.30
S	.06
P	.51
Ignition	10.41

Limestone.

Fe	9.38
SiO_2	38.04
Al_2O_3	2.77
CaO	17.40
MgO	5.78
Mn	.50
S	.22
P	.08
Ignition	23.04

It is thus seen that, as is usually the case with the Clinton ores, the phosphorus is above the Bessemer limit. The sulphur is low as is also the manganese, which is about the usual manganese content of the Clinton ores. The iron content is about the same as the average ore mined in Alabama and only about two per cent. below the average of the New York ores.

LOWER CLINTON ORE.—The thickness of the lower ore bed has been observed as follows:

Along the B. & O. R. R. near Pinto, east of the cement mill, the lower ore occurs in two bands five and twenty-five feet thick separated by four feet of olive shale.

SECTION OF LOWER ORE AT PINTO.

	Feet.
Interbedded iron sand rock and shale	3
Massive iron sand rock, near the base having a band of fossils mostly ostracods	22
Olive shale	4
Massive iron sand rock	5

A mile and a half northeast of Pinto the upper bed has considerably decreased in thickness as shown by the following section:

SECTION ONE AND A HALF MILES NORTHEAST OF PINTO, ON B. & O. R. R.

	Feet.	Inches.
Upper band of lower ore, massive at bottom, shale parting at top	13	....
Greenish gray calcareous shale	6	....
Bottom band of lower ore	4	6

In Wills Gap, the upper band has still further decreased in thickness and the shale member between the two bands has become much thinner.

WILLS GAP SECTION.

	Feet.	Inches
Upper band of lower ore	4	....
Interbedded olive green to gray shale	....	4
Lower band of lower ore	5	8

In the Evitts Mountain region the two bands are separated by a thin shale parting and vary from six inches to eight feet in thickness, averaging about four feet.

In the Tussey Mountain area there are no exposures where the thickness of this ore can be measured.

The *physical character* of the ore is such that the ore seems to consist almost entirely of oolites cemented in a matrix of iron oxide, although a few fossils are found in it. No calcium carbonate is visible in the ore and it gives no effervescence with hydrochloric acid. Weathered specimens of the ore plainly show that the nucleus of the oolites is a quartz grain. Dissolved in hydrochloric acid, the ore leaves a residue of more or less rounded, water-worn quartz grains which under the microscope are identical with the grains of ordinary beach sand. In addition to the rounded grains of quartz there are also a few angular grains which seem to have resulted from the fracturing of the former. It is thus seen that the seeming oolites are not true oolites as in the case of the upper ore, but that the ore consists of grains of sand held together in a matrix of ferric oxide.

The *chemical composition* of the ore is shown in the following analyses of the ore from near Cresaptown and Wills Gap:

ANALYSES OF LOWER CLINTON ORE.

Cresaptown.

Fe	22.75
SiO_2	59.06
Al_2O_3	3.94
Mn	.14
S	.07
P	.24
Ignition	2.91

Wills Gap.

Fe	24.84
SiO_2	47.65
Al_2O_3	2.68
Mn	.29
S	.03
P	.22
Ignition	7.21

These analyses show that the sulphur and manganese run low, and that the phosphorus runs above the Bessemer limit. The iron is very low and the silica excessively high. Under present conditions of the trade, these ores possess no economic value.

Extent of Development.

The Clinton ores in Maryland were worked until shortly after the Civil War, the ores being used at the Lena furnace in Cumberland and at the Mt. Savage furnaces. Since these furnaces shut down no Clinton ore has been mined.

All mining has been confined to the upper ore of the Wills Mountain area. About thirty years ago the upper ore was prospected by Pennsylvania parties on Mr. Clarence Gobin's place in the Tussey Mountain area. Some of the prospect holes are still visible. The ore was less than six inches thick and no attempt was made to work it.

In the Wills Mountain area, on the east limb of the anticline, the entire surface outcrop has been mined by stripping and considerable underground work done. On the west limb the ore has been mined for over a mile along the outcrop in the neighborhood of Cumberland.

Allegany County.

Narrows Park Deposit [251].—The ore was mined on the west side of Wills Mountain from the Narrows to a distance of about one and a half miles to the southwest. The property was then owned by Samuel Eckles. Mining was commenced here when the Mt. Savage furnace was built in 1840. The most active operations were carried on from 1845 to 1855, after which, except for a year or two during the War, operations ceased. There were over a dozen important openings besides a number of smaller ones and the points where some of the drifts went in are still visible. The general method of mining was to drive a drift into the hillside until the ore was encountered and then cross-cut along the ore. The ore was brought out of the mines in tram-cars pushed by the miners. A few inclines were also put down and in these the cars were hauled up by a windlass. As the ore came from the mines it was loaded

into carts and hauled to the Cumberland and Pennsylvania Railroad in the valley below and shipped to Mt. Savage. From two to four one-ton carts were used for this purpose and each cart was said to have loaded two twelve-ton cars per day. Mr. Jacob Brown, who worked in these mines, said the ore was two feet thick, which is considerably thicker than any outcrop of the ore shows.

Long Deposit [252].—The ore was worked by surface stripping on Mr. D. L. Long's place one-half mile south of Roberts. A trench 2500 feet long having the upper Clinton sandstone as a foot-wall marks the site of the operations. This ore was used at the Lena furnace in Cumberland.

Gephart Deposit [253].—Ore was stripped one and a half miles south of Cumberland on Mr. George Gephart's place, then owned by Galloway Lynn, and hauled to the Lena furnace. The trench here is 1000 feet long and also shows the upper Clinton sandstone as a foot wall.

Deposit West of Cumberland [254].—A trench can be traced for nearly three-quarters of a mile on the west edge of Cumberland from Wills Creek southward. There was also some underground work done along here. This ore was chiefly used at the Lena furnace.

Deposit North of Cumberland [255].—The ore was worked on the east side of Wills Mountain from Cumberland to the Pennsylvania line, and the location is marked by an almost continuous trench. In addition to the surface stripping, considerable underground work was done. This ore was sent to Mt. Savage.

Amount of Clinton Ore.

Taking the average thickness of the upper ore in the Wills Mountain area at seven inches and the specific gravity 3.31, the quantity of ore calculated to a depth of a hundred feet is 8,627,000 cu. ft., or 888,600 tons. Taking the average thickness in Evitts and Tussey Mountains at 3½ inches and calculating to the same depth, the amount there is 2,878,000 cu. ft., or 296,400 tons. This makes the

total quantity of the upper ore to a depth of a hundred feet, 1,185,-000 tons.

Calculating the amount of the lower ore in the Wills Mountain area to a depth of a hundred feet with an average thickness of fifteen feet and specific gravity 2.94, we get 225,086,000 cu. ft., or 20,708,000 tons. Similarly, for the Evitts and Tussey Mountain areas, assuming an average thickness of four feet, we get 33,517,-000 cu. ft., or 3,084,000 tons. This gives a total of 23,792,000 tons of lower ore to a depth of a hundred feet.

The above calculations show that by far the greater quantity of the ore occurs in the Wills Mountain area. Seventy-five per cent. of the upper ore and eighty-seven per cent. of the lower ore occurs in that region.

Origin of the Clinton Ores.

For fifty years geologists have been discussing the origin of the Clinton ores and even today no agreement has been reached. The evidence in favor of the sedimentary origin of these ores, however, is rapidly accumulating, and there is every indication that such an origin will soon be established beyond doubt for most of the occurrences of this ore. That the Clinton ores are bedded deposits has never been disputed. The point at issue has been whether they are the product of original sedimentation or are due to subsequent alteration or replacement of beds of a different character,—that is, are they original or subsequent deposits. Two theories have been advanced accounting for them as subsequent deposits. The more generally advocated of these is that the ores are derived from beds of limestone either by residual enrichment or by replacement of the limestone by iron brought in by percolating waters. The other theory postulates the deposition of beds of glauconite which have subsequently been altered by circulating underground waters.

The theories as to the origin of the Clinton ores may, therefore, be grouped as follows:

A. Subsequent Origin.
   1. Residual enrichment by weathering of ferriferous limestone.
   2. Replacement of limestone by ferruginous waters.
   3. Alteration of glauconite beds.

B. Original Deposition.

RESIDUAL ENRICHMENT.—The first of these theories, that of residual enrichment, has been but little advocated. The difficulties in the way of this theory are obvious. It demands that when the level of ground-water is reached the ore bed shall be succeeded by a much thicker bed of ferriferous limestone. Experience in mining shows, however, that such a change does not in general take place, but that the ore merely assumes a nearly uniform calcareous character,—that is, the change is from soft to hard ore. If, however, it is argued that the formation of the ore took place at a time when the water level was much lower than at present, another difficulty is encountered in the shrinkage of the bed that would be required. In the case of the upper ore in Maryland, the ratio of the iron to the iron in the underlying limestone is four to one; in the Stone Valley ores of Pennsylvania it is fourteen to one. In the Birmingham district where the ore reaches a thickness of thirty feet, the amount of shrinkage required becomes enormous. Any evidence of the structural effects such shrinkage would produce is lacking. Hence we may safely rule out this theory.

REPLACEMENT OF LIMESTONE.—The chief exponents of the second theory, that of replacement of limestone beds by iron-bearing waters, have been Professor N. S. Shaler, Dr. August F. Foerste, James P. Kimball, and Dr. J. J. Rutledge.

Professor Shaler[1] gives two reasons which led him to adopt the replacement theory. "It is evident from a study of the varied conditions under which the beds of this section were deposited, that if the ore was laid down at the time when the beds were formed, then it must have been deposited under the most diverse conditions imaginable." Since the beds in Kentucky must have formed at the bottom of a deep sea, he also says that "a deposit of iron under such circumstances is impossible."

Dr. Foerste[2] bases his opinion chiefly on a microscopic study of the ores. He found all stages of replacement by ferric oxide of the calcium carbonate cement of the ores and of the oolitic granule.

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[1] Notes on the Investigations of the Kentucky Geological Survey during the Years 1873, 1874, and 1875, Vol. 3, Pt. III, 2d Ser., p. 36, 1877.

[2] "On the Clinton Oolitic Iron Ores," Am. Jour. of Sci., 3rd Ser., Vol. XLI, No. 241, pp. 28-29, Jan., 1891.

He also did not regard the oolitic character due to concretionary segregation of the iron oxide, but to the gradual replacement of bryozoan fragments.

Kimball[1] calls attention to the fact that "the distribution of the Clinton iron ores clearly depends on secondary and wholly adventitious conditions connected with topography and environments." He also calls attention to the fact that "non-ferriferous Clinton limestones, more or less magnesian, into which their associated iron ores graduate, may be assumed to have been deposited in clear and moderately deep continental seas. * * * * * Yet direct ferric precipitation from extremely instable natural solutions of ferrous salts cannot well be believed to have taken place so far from inland sources as where conditions existed favorable to the accumulation of non-siliceous and expansive limestones."

In answer to the objection that the sedimentary theory does not account for the ores of deep water origin, Professor Smyth says that the fact that these deposits are of deep water origin is not well established, as limestones may be laid down in shallow water as well as in deep water. Moreover, the broken condition of the fossils shows that they were collected near a shore line.

Dr. Rutledge[2] in his discussion of the Stone Valley ores of Huntingdon County, Pennsylvania, presents the strongest case that has been made out for the replacement theory. That the replacement theory applies to the Stone Valley ores he seems to have conclusively proved. He finds that the ore bodies lie upon the sides of small ridges in conditions favorable to an easy and slow movement of meteoric waters. Another important factor noted was weathering, as the soft ores were found only where the shales had weathered to clays. More direct evidence is the tracing out of a limestone bed until it becomes a bed of hard or soft ore and at one of the mines unreplaced limestone in the hard ore was found. Dr. Rutledge agrees that the iron content of the siliceous concretions is original but that it forms only a small percentage of the total iron

1 American Geologist, Vol. VIII, pp. 352-376.
2 Trans. Am. Inst. Min. Eng., Bi-Monthly Bull. No. 24, Nov., 1908, pp. 1070-1087.

content. As a result of his observations he says, "By far the greater portion of the iron content of these Stone Valley ore beds is believed to have been laid down in the beds of shale overlying the ore beds as an original constituent of such shale beds, and subsequently transferred from these shale beds to the bed of fossiliferous limestone which formerly occupied the location of the present ore bed."

ALTERATION OF GLAUCONITE BEDS.—The third theory, that the ores are due to the alteration of glauconite deposits, has found but one exponent in this country. Such an origin has been ascribed to similar ore deposits in Germany by some of the German workers; and in 1908, S. W. McCallie, State Geologist of Georgia, in a "Report on the Fossil Iron Ores of Georgia" applied it to the Clinton ores of the United States. The report describes the conditions under which the Clinton rocks must have been laid down and shows that they are identical with those under which glauconite is being formed on the sea-bottom today. A microscopic study of the ores showed the presence of spherules with nuclei consisting of a somewhat granular mass, having a green or yellowish green color, which McCallie takes to be glauconite. A large number of analyses of the ore show that its chemical composition is in harmony with the view. He also states that while the ore in Alabama near the outcrop shows little glauconite, a diamond drill core taken a half mile from the outcrop and at a depth of about eight hundred feet from the surface reveals a large amount of glauconite. The above arguments show that the glauconite theory is a possible theory, but the author makes no attempt to show that it is the true explanation and that the older theories do not apply. On the other hand, the Alabama region to which he refers in support of his theory offers the most conclusive evidence of its failure to explain the origin of the ores. The slopes of some of the mines in this district now exceed 1800 feet in length, and have gone down to a depth of 650 feet. If the ore is formed by the alteration of glauconite, it is reasonable to expect that at such a depth there would still remain somewhere patches of the original bed which had not been altered. Yet not a single instance of such an occurrence has been reported and, except for the

single instance mentioned by McCallie, no increase in the quantity of the green nuclei has been noted by any of the workers in this field. The fact that a few glauconite particles occur in the ores is not at all surprising, as it is certainly true that the Clinton rocks were formed under conditions which *approach* the conditions requisite for the formation of glauconite. No evidence has been brought forward, however, to show that *beds* of glauconite were formed.

Original Deposition.—The principal advocates of the theory of the original deposition of the ores are Professor H. D. Rogers, Professor J. S. Newberry, Dr. C. H. Smyth, Jr., and more recently E. F. Burchard.

Rogers[1] regarded the ores "as having originated, with the other sedimentary materials, in the form of very extended but thin sheets of ferruginous matter." In addition to this, however, he regarded the infiltration of iron from the associated shale beds an important factor. Thus the theory advanced by him is really a combination of the replacement theory and the original deposition theory.

Newberry[2] says of the origin of these ores "if we look over the world for an iron-ore forming, which will illustrate the origin of the Clinton, we find it in the granular, or 'mustard seed,' ore of the Swiss lakes. This is an oolitic ore, consisting of spherules of limonite, which have formed around minute particles of some foreign substance. * * * * In the lake oxygen is absorbed and ferrous is converted into ferric oxide. This, collecting around some nucleus, ultimately sinks to the bottom, a ferruginous oolite, which from time to time is gathered as a crop. The Clinton ore apparently was formed much in the same way."

Probably the most conclusive arguments on the subject of the origin of the Clinton ores are those of Professor Smyth.[3] He says, "if the ore represents an oolitic limestone, each spherule has been altered from outside toward the centre. This alteration has been by the replacement of calcite by silica and iron carbonate. It would

1 Geology of Pa., Vol. II, 1858, p. 729.
2 School of Mines Quarterly, Nov., 1880, p. 14.
3 Am. Jour. Sci., 3rd Ser., Vol. XLIII, June, 1892, pp. 487-496.

seem as though, after the exterior layers were thus altered, they must, to a greater or less extent, protect the interior layers from change, and that there would often be some trace of original calcite. In no case has this been seen, even in the leanest ores, although the layers of silica and iron are often so dense and impervious that hydrochloric acid cannot dissolve all the iron present."

A very damaging argument against the overlying shales as the source of the ore arises from the fact that the shale and sandstone overlying the iron ore beds in New York State are highly calcareous and the waters that seep through these deposits precipitate lime carbonate wherever there is an opportunity afforded. "How," Professor Smyth asks, "can such water be the bearer of iron salts that are supposed to be precipitated by lime carbonate at a lower level?"

Another evidence of the sedimentary origin of the ores is in the distribution of the oolites in the calcareous matrix. Many irregular patches and layers contain only 10 per cent. of iron, yet the spherules are just as ferruginous as in the pure ore. Such occurrences, he concluded, can only be explained on the supposition that the spherules were ferruginous when incorporated into the rock.

The occurrence in Wayne County, New York, of fragments of ore in a bed of limestone overlying the ore also points strongly to the sedimentary origin of the ores.

The New York State Museum issued a bulletin in November, 1908, on the Clinton ores of that State by D. H. Newland, and C. A. Hartnagel, in which the authors say that Professor Smyth's explanation of the origin is "the only explanation at all compatible with the conditions."

According to E. F. Burchard,[1] the conditions in Alabama also strongly favor the sedimentary origin. He says, "all the new facts observed in the course of the work in the Birmingham district are in accordance with the hypothesis that the ore is the result of original deposition of ferruginous sediments. * * * * That the ore is due entirely to the replacement of limestone seems hardly possible when it is considered that instead of a marked decrease in

[1] Bi-Monthly Bull. Am. Inst. Min. Eng., No. 24, Nov., 1908, pp. 1041-4, and Bulletin 340, U. S. G. S., pp. 308-17.

percentage of iron and an increase in that of lime, with depth, until the bed becomes a limestone, very little tendency toward that condition has been noted." At two of the mines systematic analyses of the ores were made at intervals of a few feet from the outcrop to the bottom of the slope and throughout the extent of each entry to the right and left of the slope. It was found in one case that the content of metallic iron increases about one per cent. for each 1000 feet below the upper limit of the hard ore, and that the lime decreases one per cent. in the same distance; in the other case, the reverse change took place.

The above outline of the various theories held as to the origin of the Clinton ores shows that one of the chief reasons for the diversity in opinions has been the attempt to apply one theory to all of the occurrences of the Clinton ores. The evidence at hand now seems to point conclusively to original deposition as the origin of the New York and Alabama ores, and yet equally conclusively to replacement as the chief factor in at least a portion of the Pennsylvania ores.

Origin of the Maryland Clinton Ores.—In the description of the ores in Maryland, it has already been mentioned that the ores at the two horizons differ markedly both in chemical composition and in physical character. A consideration of the evidence seems to indicate a diverse origin for the ores.

The two beds at the lower horizon are essentially a highly ferruginous sandstone. Fossils in these beds are rare. Out of a dozen hand specimens not more than one or two will show any fossils, and then usually only a few fragments of crinoid stems. If these beds were formed by the replacement of calcareous sandstone, one would naturally expect to find fossils more abundant in them. Moreover, the uniform character of the lower bed affords the strongest evidence against replacement. Any iron solutions reaching this bed had to penetrate first the upper bed and then a parting of shale. One would expect this bed, therefore, to be greatly influenced by the thickness of the overlying ore bed and the thickness of the shale parting. Yet wherever observed, the replacement is complete. It

is thus seen that the evidence for the lower Clinton ore in Maryland is all in favor of original deposition.

When we come to the upper ore, however, we find the conditions different. Coming upward, we have a heavy quartzitic sandstone passing into a very siliceous limestone over which is the ore bed. The limestone is but a very calcareous phase of the sandstone into which it rapidly grades. The boundary surface between the ore and the limestone is very often irregular and stringers of ore pass down into the limestone a short distance and gradually fade out. The ore itself also frequently contains fragments of calcareous rock. Hence it seems probable that this ore is due to the replacement of the limestone by iron-bearing solutions and the chief reason that the entire limestone bed is not replaced is that it is a very compact siliceous rock which could not be easily dissolved by the percolating solutions and hence the replacement has occurred mainly along the contact of the limestone and shale where the solutions had readier access.

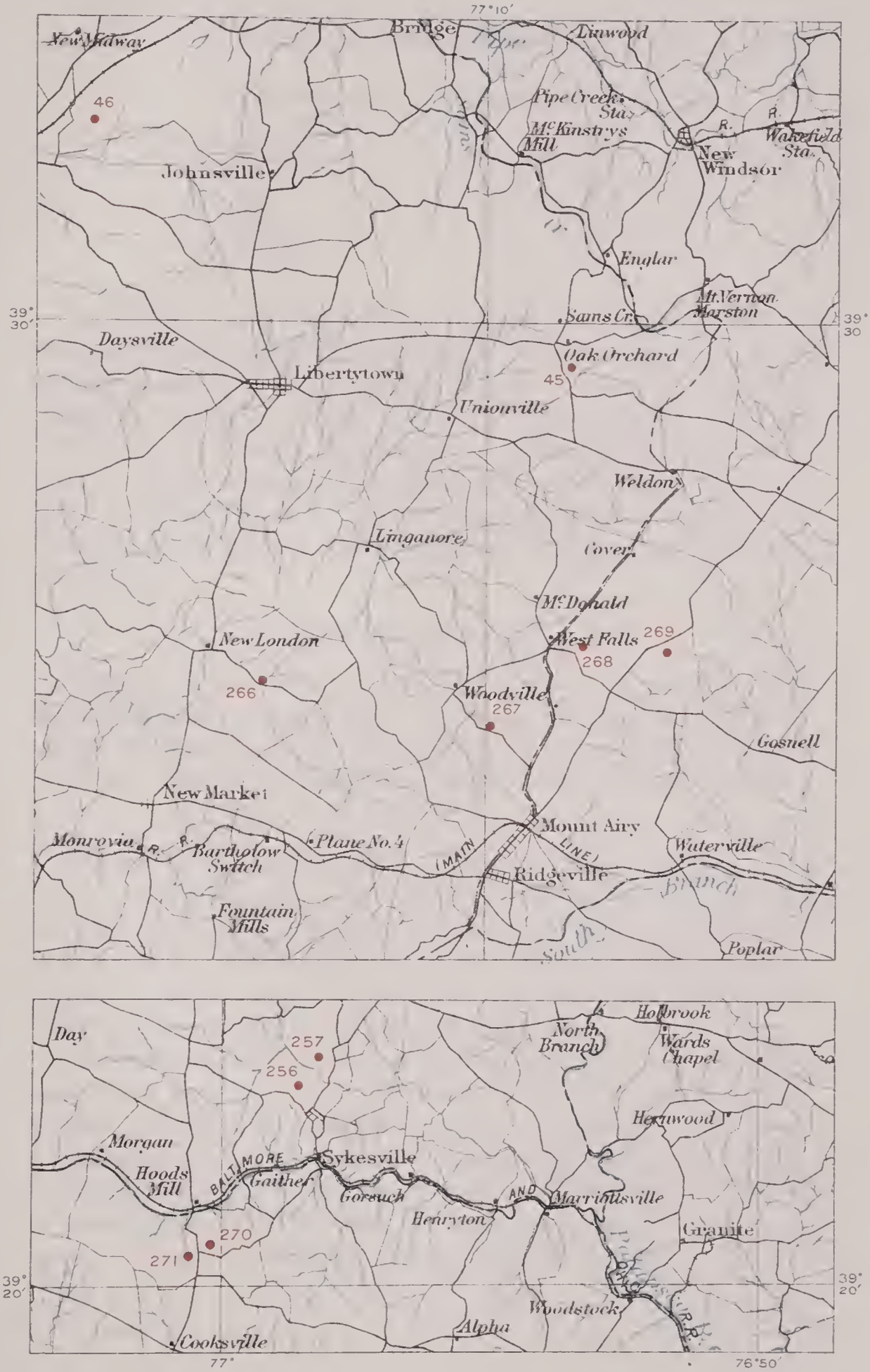
THE SPECULAR HEMATITE OF CARROLL COUNTY.

The specular hematite of the Piedmont occurs in Carroll County and is found from Sykesville to Finksburg.[1] The ore is a vein deposit with quartz gangue, in a country rock of mica schists weathering to talcose and chloritic schists. At the southern end near Sykesville, granitic rocks occur about a thousand feet east of the outcrop of the vein. The strike of the "vein" follows the strike of the schists, N. 30° E. The dip is usually nearly vertical. The width of the vein is extremely variable, ranging from almost nothing to over fifteen feet.

Description of the Ore.

In the south the iron occurs principally in the form of specular hematite; as one goes north, magnetite comes in, and at Finksburg the ore is almost entirely magnetic. A sample of the ore taken from an outcrop of the vein at the Springfield mine near Sykesville showed the following analysis:

[1]Piggot on Copper and Copper Mining, 1858, pp. 263-5. D. T. Ansted "On some Remarkable Mineral Veins," Jour. Geol. Soc., 1857, Vol. XIII, pp. 242-5.



LOCATION OF IRON ORE BANKS IN PARTS OF FREDERICK, CARROLL AND HOWARD COUNTIES

ANALYSIS OF ORE FROM SPRINGFIELD MINE.

Fe	46.77
SiO_2	30.66
Al_2O_3	1.89
Mn	.18
P	.11
S	.05
Ignition	.43

In addition to the hematite or magnetite a small amount of chalcopyrite also occurs in the vein at the surface and the ore is frequently stained by copper minerals where it is weathered. With increasing depth the importance of the copper sulphide increases until the ore becomes a copper ore. At the Springfield Mine, the most southerly opening, the copper values exceeded the iron at a depth of about 100 feet. To the north the copper becomes abundant nearer the surface, and at Finksburg practically extends up to the surface.

Extent of Development.

Several iron mines were opened on this vein but all of them soon became copper producers, and on account of the small depth to which the iron extends the value of the deposit lies in its copper content. None of the mines have been worked for some years.

Carroll County.

Springfield Mine [256].—The Springfield Mine is situated one mile north of Sykesville on State Senator J. E. Beasman's place. At the time the mine was worked it was owned by George Patterson and it was one of the chief sources of ore for the Elba furnace which was located on the north bank of the Patapsco River about three-quarters of a mile southeast of Sykesville.

The whole width of the vein is nowhere exposed, but at one point there is an exposure showing fifteen feet. The ore at the surface consists entirely of specular hematite, with very little sulphide, in a quartz gangue. The specimen yielding the analysis recorded on the preceding page was taken at this mine. After reaching a depth of about one hundred feet, the ore became a copper ore and shipments were made ranging as high as 16 per cent. copper. For the

year ending April 1, 1857, the copper output amounted to nearly $18,000.

Two openings, separated by a small stream, were made on the vein. Of these the southern one was the more important. The mine has been abandoned for so long a time that the openings have caved in. The main shaft was worked to a depth of over 300 feet and was cut at a depth of 66 feet by an adit level 500 feet long.

Carroll Mine [257].—This mine is about a half mile northeast of the Springfield Mine and is also situated on property belonging to State Senator J. E. Beasman. The deposit here is a continuation of that at the Springfield Mine, and the character of the ore is the same. The schists at this point are very micaceous.

There were two main openings besides a number of small prospect holes. The vein seems to have been located by running a trench up the hill at right angles to the strike.

Monroe Prospect [258].—About 1858 Tyson & Company leased some land from Judge Monroe about one mile north-northeast of Eldersburg to prospect for this vein. Having located the vein, they bought the property, but no ore was ever taken out. On the death of Mr. Tyson, the property was sold to Mr. George Albaugh.

Beasman Prospect [259] Plate XV.—About a mile and a half southwest of Louisville and one mile north-northeast of the Monroe Prospect, a New York concern located the vein on land owned by Joshua Beasman in 1865. The property was leased but reverted to Joshua Beasman on account of the conditions of the lease not being fulfilled before any ore was taken out. It is now owned by State Senator J. E. Beasman. No ore was ever shipped from this opening.

Mineral Hill Mine [260].—The Mineral Hill Mine is situated less than a mile south of Louisville and is now owned by Mr. George Albaugh. It was the most extensively worked of the mines along this vein. The ore is said to have been mined during the Revolutionary War and the old openings made then, which are to the north of the newer openings, can still be seen. About 1852, Moses Barnes leased this land to John Triplett and John Wil-

liams, two young men who had been working for the Tysons in the chrome deposits at Delight. After opening up the property, they sold out to Isaac Tyson. About 1860 Tyson sold out to a company of Baltimoreans, who soon became financially involved, and it was bought again by Tyson. About four years ago it was acquired by the present owner.

The location on the map is that of the main shaft which is over 400 feet deep. The main level or adit comes out on the hillside above Morgan Run. At times a hundred men were employed at this mine, twenty-five to thirty of whom were engaged in mining. The ore as brought to the surface was crushed, washed and picked. Some of it was sent to the Elba furnace, near Sykesville, and the rest hauled to Finksburg for shipment. The vein is not quite as steep as at the Springfield Mine and dips to the east. The width is variable, but runs about two and a half feet.

Patapsco Mines [261].—Two old mines, one on each side of the Baltimore and Reisterstown Turnpike, are located at the east end of Finksburg. They were opened about 1850 and some of the ore was shipped to Baltimore. The property changed hands a number of times and was last worked by a Harrisburg company, with a Mr. Daniel King as manager.

The iron occurs as magnetite and the outcrop of the vein is greatly stained with copper salts. At the point where the vein crosses the turnpike it has a thickness of two feet. The country rock is a silvery schist with small magnetite crystals disseminated through it.

The mine on the north side of the turnpike was worked to a depth of 365 feet and had two levels about two hundred yards long at depths of 100 and 160 feet. The mine on the south side of the turnpike was worked only to a depth of 100 feet. The copper in these mines is so near the surface that the iron output was very small. These deposits are also interesting on account of the occurrence in them of the two rare cobalt minerals—Carrollite and Linnaeite—for the former of which this is the type locality.

THE MAGNETITES.

The magnetites of Maryland are confined to the Piedmont area and a strip along the border of the Piedmont and Appalachian areas at the eastern edge of the Blue Ridge Mountain. They occur in three distinct groups,—the magnetites in the Loudon formation, those in the schistose rocks of the Piedmont, and those in the serpentines of the eastern Piedmont. The magnetites in the Loudon formation occur in the western part of Frederick County; the magnetite in the schistose rocks occur in schistose volcanics in southern Frederick County and in the Wissahickon rocks of Howard and Harford counties; and the magnetites in the serpentines are found in the serpentine areas of Baltimore and Harford counties. Of these groups the Loudon magnetites are by far the most promising.

MAGNETITES IN THE LOUDON FORMATION OF FREDERICK COUNTY.

A bed of magnetite has been found in the shales of the Loudon formation, along the east edge of Catoctin Mountain, in the vicinity of Thurmont, Frederick County.

The Loudon formation is the lowest member of the Cambrian system of rocks, which is subdivided in Maryland as follows:

CAMBRIAN SYSTEM:
- Shenandoah (in part.)
- Antietam.
- Harpers.
- Weverton.
- Loudon.

It receives its name from Loudon County, Virginia, where it attains its typical development. It outcrops in Maryland, in long narrow belts of rock accompanying the mountain ridges and is found in Catoctin Mountain, Blue Ridge and Elk Ridge. The deposits consist largely of fine dark shales and slates, but also have interstratified limestone lenses, sandstones, and conglomerates. The thickness of the formation varies greatly, ranging from a few to over 500 feet.

Occurrence of the Ore.

The ore has been found only along the eastern edge of Catoctin Mountain in the vicinity of Thurmont. The first hill of Catoctin Mountain on the east is formed by an anticline of Weverton sandstone which overlies the Loudon formation. Three miles southwest of Catoctin Furnace and six miles southwest of Thurmont, the Weverton sandstone at the top of the hill has been cut through by erosion, exposing the underlying Loudon formation and the iron ore bed which it contains. At the foot of this same hill the Loudon formation is again brought to the surface by a sharp anticlinal fold pitching to the west, the eastern limb of which has been cut out by a fault running along the foot of the mountain.*

Three miles northeast of Thurmont where this overthrust anticline brings up the Loudon formation the magnetite bed again outcrops. These are the only known exposures of the magnetite bed, and therefore, to determine the extent of the bed, a magnetic survey would be necessary. Since, however, it is a bedded deposit, it is extremely probable that the deposit is continuous between these points and extends for some distance beyond to the northeast and southwest, forming an extensive ore body.

Description of the Ore.

The strata associated with the ore bed consist of dark blue shales carrying disseminated fine-grained magnetite and some pyrite, the latter usually weathered to limonite. Between these strata is a bed six feet thick which is richer in magnetite. The rock forming this bed is coarser than the shale and consists chiefly of grains of quartz and magnetite crystals, the latter also of larger size than those in the shales.

A sample of the ore taken from an opening on the top of the hill southwest of Catoctin Furnace showed the following composition:

*The structure is shown in the sketch on page 197.

ANALYSIS OF LOUDON MAGNETITE.

Fe	35.02
SiO_2	33.82
Al_2O_3	9.43
CaO	1.04
MgO	1.50
Mn	.16
P	.04
S	.27
Ignition	1.98

In order to use these ores they would have to be concentrated. Mr. John Birkinbine in a report on the Catoctin property says: "An investigation made in 1896 showed that of the material claimed to represent the average of what could be economically mined, about one-third could be converted to concentrate. The size of the magnetic particles, however, is such that these would have to be briquetted at an additional cost. The analysis made of carefully separated ore indicates a satisfactory composition:

ANALYSIS OF LOUDON MAGNETITE CONCENTRATE.

Fe	65.2
SiO_2	6.25
P	.023
S	.038

Hence although trade conditions would hardly justify the working of this deposit at present, it must be looked upon as one of the important deposits of the State and one that will furnish considerable ore in the future.

Extent of Development.

This ore has been worked at only one point,—on the hill southwest of Catoctin Furnace.

Frederick County.

Ore Deposit on Hill Southwest of Catoctin Furnace [262].—A number of small pits were sunk along the top of the hill about two miles southwest of Catoctin Furnace for a distance of several hundred yards, and one large opening made 225 feet long 6 feet wide and 20 feet deep. The strike of the bed in this opening is N. 25° E. and the dip 78° E. The rock also shows a cleavage dipping 25° E.

The mining was done by the Kunkles and the ore used at the Catoctin furnaces. It is said that from 15,000 to 20,000 tons of ore were obtained from these openings. The openings are on the Catoctin property which is now owned by Mr. Joseph E. Thropp of Everett, Pennsylvania.

MAGNETITES IN THE SCHISTOSE ROCKS OF THE PIEDMONT.

The magnetites in the schistose rocks of the Piedmont occur in the sheared volcanics in southern and eastern Frederick County and western Carroll County, and in the Wissahickon schists in Howard County near Hood's Mill and in Harford County near Shawsville. These rocks throughout their extent frequently contain magnetite abundantly disseminated through them, and at a few points this has become sufficiently concentrated to give rise to an ore body of small extent. Several limonite deposits are included in this discussion as they are either derived directly from the weathering of such magnetite deposits, or are at least local concentrations of more sparsely disseminated magnetite and other iron minerals in these rocks.

Frederick County.

The ores coming under this head in Frederick County are found in the southern part of the county, east of the Monocacy River, and in the eastern part, about three miles north of the Baltimore and Ohio Railroad, and occur in the schistose rocks of the region. Five localities are known, only three of which have yielded ore.

Patrick Ambush Ore Bank [263] Plate XV.—Ore was dug in the early seventies from Mr. Patrick Ambush's property, three and a half miles southeast of Adamstown, and one and a half miles southwest of Park Mills. The property was then owned and worked by a Mr. Maxwell. The ore was hauled to Adamstown and shipped on the B. & O. Railroad. There is an opening 20 by 50 feet and 15 feet deep nearly filled with water. It occurs in a hollow at the junction of two stream valleys. The ore is a limonite and oc-

curs in a schistose volcanic rock closely resembling the basic volcanic rock of Carroll County.

Yingling Ore Bank [264].—There is an opening 25 by 10 feet and 6 feet deep on Mr. William Yingling's place a half mile northeast of Greenfield Mills. This deposit was opened in 1873 by Mr. Maxwell, but only three carloads of ore were shipped from it. The ore is a limonite occurring in the same rock as that at Ambush Ore Bank, one mile to the north.

Belt Deposit [265].—There are surface indications of a magnetite deposit on Mr. McGill Belt's place two miles north of Dickerson. The ore occurs on the east side of the hill overlooking the Monocacy River. The country rock is a bluish green, schistose volcanic, with some pinkish layers. A sample taken from pieces of ore scattered on the ground showed the following composition:

ANALYSIS OF ORE FROM BELT DEPOSIT.

Fe	58.67
SiO_2	8.26
Al_2O_3	3.18
Mn	Trace.
P	.00
Ignition	3.64

The analysis indicates that the ore is of a very good grade, but no prospecting has ever been done on this property, so that nothing is known as to the extent of the deposit.

New London "Iron Mine" [266] Plate XXV.—In the Engineering and Mining Journal, of January 17, 1880, page 48, the following statement is made: "The new iron mine at New London worked by Maxwell and Carbis has a good prospect and has quite an ore bank. It is getting hematite to be shipped to Ashland. It made a very favorable lease getting the first 500 tons free. It has four miles of hauling to Monrovia." This locality is one mile southeast of New London. A little prospecting was done there in 1880 by Maxwell and Carbis, but no ore obtained, nor will any ever be obtained as the fresh volcanics outcrop all around there and show no evidence of iron ore. It is difficult to understand just

why any work should have been done at that place. About five years later Daniel Cashour also prospected there a little, but obtained no ore.

Clary Ore Bank [267].—Two miles northwest of Mount Airy, on Mr. Belt Norwood's farm, is a bank 200 by 150 feet and 25 feet deep, which was worked as early as 1857, and the ore sent to the Elba furnace at Sykesville. This bank was worked until early in the eighties by Mr. R. T. Clary.

The ore obtained here was in part, if not all, limonite, as the few pieces which are still lying about are limonite, and there is no evidence of magnetite. The ore must have contained a great deal of manganese, as a lump of pure manganese ore was found weighing about fifteen pounds. Judging from what little is still to be seen, the deposit is a local concentration of limonite derived from the decomposition through weathering of the iron-bearing minerals in the schistose country rock.

Carroll County.

Richmond Mine [268].—In 1880, Upton Richmond opened a mine on his property a half mile east of West Falls. An adit was run into the side of the hill and a shaft put down higher up on the hillside. An account of the operations at that time says,[1] "a number of hematite and magnetite iron mines have been opened in the vicinity of Mt. Airy. One of them operated by U. Richmond, Esq., seems to be the best. They have magnetite ore, a number of shafts down, and have been in operation six months or so, and have made arrangements to ship to Pittsburg." As far as could be learned this was the only mine opened in this neighborhood at that time, and it did not come up to the above expectations, as it was abandoned in less than a year.

Hood Ore Bank [269].—On Mrs. Hood's farm, four and a half miles northeast of Mt. Airy, is a small old opening, about 150 feet long, 15 feet wide, and now less than 10 feet deep. This was leased

[1]Eng. and Min. Jour., Jan. 17, 1880, p. 48

and worked by James W. Tyson for his furnace at Sykesville, about 1850, but was abandoned long before 1880, and from its size could never have been worked to any extent. There are pieces of highly ferruginous weathered country rock lying about, so that the ore was probably a surface concentration of limonite derived from that rock.

Howard County.

Two deposits are known in Howard County about one mile south of Hood's Mill. One of them yielded limonite and the other magnetite. They occur near the western edge of the granite intrusion extending from Sykesville southward. The ore occurs in a greenish chloritic schist in the Wissahickon formation which lies in troughs in the surface of the intrusive granite from which it has not yet been eroded.

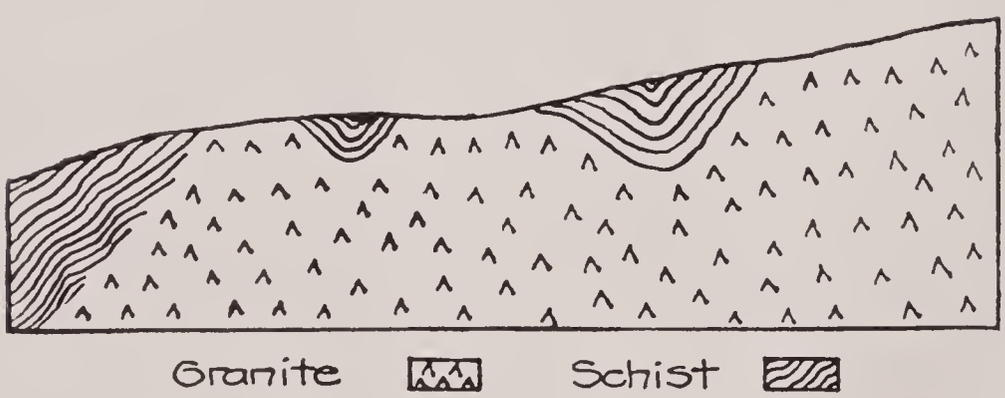


FIG. 8.—DIAGRAM SHOWING POSITION OF HOWARD COUNTY MAGNETITES.

Forsythe Deposit [270].—Ore was mined in the early fifties, on the east side of the County road, on Mr. A. R. Forsythe's place, which was then owned by Andrew Ellicott. The site of the mine is now cultivated, and no sign of the former operations remains. Mr. Forsythe said that three shafts were put down and a tunnel to drain them. After having been worked about three or four years, the openings caved in on account of defective timbering and the deposit was abandoned. The ore was a soft yellow limonite, and was shipped to Baltimore.

Rice Ore Bank [271] Plate XXV.—On the Rice farm across the road from the Forsythe mine and separated from it by a granite outcrop, there is an opening from which magnetite was obtained. The property was then owned by John Wayman and worked by James Tyson. The opening is 150 by 30 feet at the surface. Its depth is now less than 10 feet but it has been filled up with stones and rubbish so that its original depth is unknown.

Harford County.

Ayres Ore Bank [272] Plate XVIII.—Only one attempt has been made to work magnetite in the schists of Harford County. In 1857 ore was obtained from Mr. John Ayres' place one-half mile east of Shawsville. In 1867 the deposit was again prospected but no mining done. The opening is only about 20 by 10 feet and but a few feet deep, so that very little ore was ever taken from here. The ore is also of such low grade that the deposit is of no value.

MAGNETITES IN THE SERPENTINES.

The magnetites in the serpentines occur in the serpentine areas of northeastern Baltimore and northern Harford counties. This region is an extensive area of Wissahickon schist into which the serpentine has been intruded and is now exposed in small lenticular patches. These serpentines were formerly important sources of chrome ore. In addition to the chrome, small deposits of magnetite have also been found. These ores are magmatic segregations occurring near the periphery of the serpentine masses. An analysis of a sample of the ore taken from the Norris Ore Bank two and a half miles northeast of Whitehall in Baltimore County is given below.

ANALYSIS OF ORE FROM NORRIS ORE BANKS.

Fe	30.36
SiO_2	20.96
Al_2O_3	12.54
Mn	Little.
P	.06
S	.16
Ignition	5.54

All these magnetites also contain a small amount of titanium.

The deposits that have been worked were all of small extent and this type of magnetite deposits does not seem to attain any importance in Maryland.

Harford County.

Ore Banks near Cherry Hill [273] Plate XXII.—These ores have been worked at only one point in Harford County. This is on the northern edge of a serpentine area about a half mile east of Cherry Hill and one mile southeast of Minefield on the Maryland and Pennsylvania Railroad. Three larger pits were put down about 30 by 15 feet and 10 feet deep, and several smaller ones. The ore was first used at the LaGrange furnace about a quarter of a mile north of Rocks, but was not found satisfactory, and was later hauled to Minefield and is said to have been shipped to Havre de Grace.

Baltimore County.

In Baltimore County these magnetites were worked at two points,—at the Norris Bank two and a half miles northeast of Whitehall and at the McComas Bank one mile southeast of Whitehall.

Norris Ore Bank [274] Plate XVIII.—This bank is situated about two and a half miles northeast of Whitehall and one mile southeast of Gemmills, on the south side of First Mine branch. The ore body has a width of about twelve feet and was worked by an open cut for a distance of 200 feet. There was also a shaft put down 75 feet, from which a tunnel 100 feet long was run. The tunnel extended across the ore body and had a height of 8 feet. The ore is a fine-grained magnetite disseminated through a matrix of serpentine, and the analysis on page 319 was made from a sample taken at this occurrence.

This deposit was worked about four or five years in the sixties by the Ashland Iron Company, and the ore shipped to their fur-

nace at Ashland. The land was leased from James Norris, and a royalty of 25c. per ton paid. The average output was about ten tons per day.

McComas Ore Banks [275].—Magnetite was worked on Marsh McComas' place during the forties and shipped to Ashland. The openings were made on the north bank of a small stream one mile southeast of Whitehall. These deposits were again prospected about 1860 and several small openings made, but the attempt to work them was not successful. The main opening is about 200 feet long and 20 feet wide and runs into the side of the hill.

This deposit was visited in 1859 by Dr. C. T. Jackson, from whose account the following description is taken:[1]

"This locality presented some interesting geological and mineralogical phenomena. The rocks were talcose rocks or soapstone, chloritic schist, and masses of crystallized garnets so closely packed together in chlorite as to resemble a pudding stone in general appearance. * * * The chloritic slate is filled with an impurity of crystals of octahedral magnetic iron ore and with veins of the granular ore of the same kind. The soapstone generally underlies the iron ore, though it alternates with the chlorite slate in one instance at the mine. The iron ore with the chlorite slate and garnet rocks are mined together and the ore sells for $3.00 per ton at a neighboring anthracite furnace. No one on looking at the heaps of this ore would conceive it worth anything for furnace purposes, but an analysis showed that an average sample of the ore yielded 41 per cent. of the peroxide of iron, which is equal to 28.7 per cent. metallic iron.

"A certain proportion of garnets aids the smelting of the iron ore by their ready fusion, and by preventing the absorption of any oxide of iron by the slag, even if the garnet itself does not yield, as it probably does, a certain proportion of iron in the smelting furnace."

[1]Proc. Boston Soc. Nat. Hist., Vol. VI, 1859, p. 245.

SUMMARY.

Practically all the *limonites* of the Piedmont and Appalachian regions of Maryland are associated with limestones, and the more important deposits are usually found in zones along which structural movements have taken place, thereby affording favorable conditions for the infiltration of surface waters. They fall into four distinct groups,—the Devonian limonites, the Cambro-Ordovician limonites, the limonites associated with crystalline limestones of the Piedmont, and the bog iron ores of the Coastal Plain.

The first of these groups is confined to the Appalachian region in Allegany and Washington Counties. The ores occur at two horizons,—just above the Romney-Oriskany contact, and at the Helderberg-Oriskany contact. The former horizon is the more important.

The second group, the Cambro-Ordovician limonites, are found in Washington and Frederick Counties. These ores have been extensively worked, and include two of the largest deposits in the State.

The third group has in the past been by far the most important and is still the most promising group of ore deposits. Its chief development is in Baltimore and Carroll Counties, although some deposits extend into Harford County on the east and Frederick County on the west.

The fourth group of limonites are the bog iron ores which occur in the Coastal Plain area. They attain their chief development on the Eastern Shore, where they were mined years ago at several localities. This is the least important group of limonites.

Carbonate ores occur in both the Appalachian and the Coastal Plain regions.

The carbonates of the Appalachian region are found in the rocks of the Coal Measures, in Garrett and Allegany counties. Both blackband and clay ironstone occur, but the latter is the more important. The iron is regarded as having been originally disseminated through the strata and to have been subsequently segregated into the nodules of clay ironstone or layers of blackband. A great

deal of the mining was done by surface stripping, where the nodules of clay ironstone had become concentrated through the weathering of the containing shales and fire clays. These ores were formerly extensively worked in the George's Creek basin, and to some extent in the Lower Youghiogheny basin.

The Coastal Plain carbonates occur in the Arundel formation of the Potomac group, and are of Lower Cretaceous age. The Arundel formation is a series of clay lenses lying unconformably between the underlying Patuxent formation and the overlying Patapsco. The ore occurs as concretionary lumps and nodules of all sizes scattered throughout the clays. A large percentage of these ores as mined consists of limonite, but this has resulted from the weathering of the original carbonate ore. These ores were the basis of our early iron industry, and have supplied a greater tonnage than any other class of ores in the State; but at the present time they are worked less extensively than some of the limonites.

Both *red hematite* and *specular hematite* occur in Maryland. The red hematites are the Clinton ores and are confined to Allegany County, flanking the three anticlinal mountains, — Wills, Evitts and Tussey. The ores occur at two horizons, and differ fundamentally in character and composition. The lower ore usually consists of two beds separated by a thin shale parting of variable thickness, which at times reach a combined thickness of thirty feet. This ore is really nothing more than a highly ferruginous sandstone running 22 per cent. to 24 per cent Fe, and has never been worked. The upper ore, occurring at the top of the Clinton formation is a fossiliferous oolitic ore varying from four to nine inches in thickness. It has been worked along almost its entire outcrop on the east side of Wills Mountain, and for some distance on the west side. The evidence as to the origin of these ores seems to indicate a sedimentary origin for the lower ore, and a replacement of a limestone bed for the upper.

The specular hematite occurs in a quartz vein, extending from Finksburg to Sykesville in Carroll County. The ore rapidly grades into a copper ore with increasing depth, and the value of this occurrence lies chiefly in its copper content.

The *magnetites* are confined to the Piedmont and the eastern edge of the Appalachian region. They occur in three groups,—magnetite in the Loudon formation, magnetites in the schistose rocks, and magnetites in the serpentines.

The magnetite in the Loudon formation occurs along the east side of Catoctin Mountain. It is a six-foot bed of magnetite and coarser clastic material consisting chiefly of quartz, intercalated between the shales of the Loudon formation.

The magnetites of the schistose rocks of the Piedmont occur in southern and eastern Frederick County, in western Carroll County, in northern Howard County, and in northwestern Harford County. The schists of the Piedmont frequently contain disseminated magnetite, and at a few points this is sufficiently concentrated to form a workable ore body. No important deposits belonging to this group are known, and much of the ore mined was residual limonite, concentrated in the weathering of the magnetite.

The magnetites in the serpentines are also relatively unimportant. They occur as magmatic segregations near the periphery of the serpentine masses. They have been worked in Baltimore and Harford counties, but no large deposits have been found.

APPROXIMATE ESTIMATE OF MARYLAND IRON ORE RESERVES.

	Limonite*	Hematite	Siderite	Magnetite
Over 50% Fe	Small tonnage			Small tonnage
40-50% Fe	2,500,000	500,000		
Less than 40% Fe	Large tonnage	25,000,000	25,000,000	3,300,000

*The estimate of the limonite cannot be regarded as a close approximation because of the irregular nature of the occurrence, and the amount probably exceeds considerably the estimate given.

MANGANESE IN MARYLAND.

Over 200,000 tons of manganese ores are annually imported into the United States, and the greater portion of these ores comes to Baltimore. Hence Baltimore is one of the chief manganese centers of the country. As a producer of manganese ores, however, Maryland has never been a factor.

There are four commercial sources of manganese, — manganese ores, manganiferous iron ores, manganiferous silver ores, and the manganiferous residuum from zinc roasting. The manganiferous residuum from zinc roasting is obtained only from smelters using New Jersey zinc ores, and there are none in Maryland. Manganiferous silves ores have never been found in Maryland, and it is not probable that any exist. Manganiferous iron ores exist in Maryland, but no workable bodies have been found in which the percentage of manganese was high enough for the ore to be mined for its manganese content. Manganese ores have been mined at two localities.

In general, the limonites of Maryland run low in manganese. But in Bachman Valley, and at Catoctin, the manganese content is somewhat higher than normal. Samples of Catoctin ore may run as high as three per cent. manganese, but the average run of the ore is much less than this. The Bachman Valley limonites run somewhat higher than this, and the average of six analyses was 2.06 per cent. Mn. One of these samples, from the Wareheim deposit, contained 3.79 per cent. Mn. Such ores cannot be mined for their manganese content, and can be classed only as ores of iron.

Alexander[1] mentions several localities at which manganese ores occur, but these are not in sufficient quantities to be workable. Manganese, some of which he says is of very good quality, has been found on Bear Creek, and also on Keyser's Ridge, five miles south of the National Road. Further east in the State, he mentions an ore of manganese associated with copper, near New Market, and a "formation of manganese ore" in the neighborhood of Mechanics-

[1]Alexander: Am. Jour. Sci., Ser. 1., Vol. 27, p. 22.

ville in Montgomery County. The occurrence of manganese ore at the Clary Ore Bank is mentioned on page 317 of this report.

The two localities, which have been worked for manganese ore, are the property of the Potomac Refining Company in Washington County, above Harpers Ferry; and near Brookville, Montgomery County.

Potomac Refining Company Mine [17] Plate XIV.—The property belonging to the Potomac Refining Company is situated on the north bank of the Potomac River, three miles north of Harpers Ferry. At this place, a sharp bend in the river makes a projecting point on the north bank. A fault cutting across this point brings the Shenandoah limestone on the west down into contact with the Harpers shale on the east. It is along this fault plane that the ore occurs. It consists both of manganese and of iron ore. But up to the present only the manganese has been worked and the location on the map gives the manganese deposit.

This deposit was opened up in 1876 by Wells and Davis. They obtained both hard and soft manganese ore, which was shipped on the Chesapeake and Ohio Canal. The openings went below the level of the Canal, and the flooding of the mines caused a suspension of operations. About ten years ago the property was again opened by a Mr. McIntosh, who sunk a 23-foot shaft about one hundred feet from the Canal. Work had only been carried on about a month, when the shaft was flooded and the property again abandoned. In the spring of 1908, Mr. E. R. Cooper, of Baltimore, took hold of the property; and later the Potomac Refining Company was organized. A system of pumps has been installed and a washer for washing the ore erected. The old openings have been cleaned out and considerable new work done. A 60-foot shaft has been sunk near the limestone, which is expected to open up the main ore body. An adit at a higher level, running east, passes through a pocket of manganese ore, and an extension of this adit for one hundred and fifty feet N. 12° E. shows a pink manganiferous clay. This last drift, in all probability, lies too far to the east of the limestone, and a cross-cut from it toward the limestone would be

very likely to strike the ore through which the adit passes. Several hundred tons of ore have been mined and washed, but no shipment has as yet been made.

The manganese ore, which is pyrolusite, occurs in irregular shaped lumps, or "kidneys," varying up to six inches in their longest dimensions, in a matrix of yellow clay through which smaller lumps are disseminated. A sample collected by Dr. J. S. Grasty, showed the following analysis:

ANALYSIS OF MANGANESE ORE FROM POTOMAC REFINING COMPANY MINE.

Mn	22.59
SiO_2	26.58
Fe	2.73
P	.37
S	.004

Within a half mile north of the manganese openings, several prospect holes have been put down, which show the presence of iron ore. Two samples taken from these by Dr. Grasty showed the following composition:

ANALYSES OF IRON ORE FROM THE POTOMAC REFINING COMPANY DEPOSIT.

Fe	41.36	53.36
SiO_2	31.35	5.33
Mn	Trace	Trace.
P	.034	.026
S	Trace.	1.29

The showing made by these prospect holes is very favorable, and if the prospecting is carried further, workable bodies of iron ore will in all probability be located.

Manganese near Brookville. P. T. Tyson, on page 68 of his report as State Agricultural Chemist in 1862, mentions the occurrence of a manganese deposit a mile and a half west of Brookville in Montgomery County. This was prospected some time before 1860. The mining did not prove profitable and the deposit was soon abandoned. At the time of Tyson's visit, the old opening was already so filled in that there was nothing to be seen.

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