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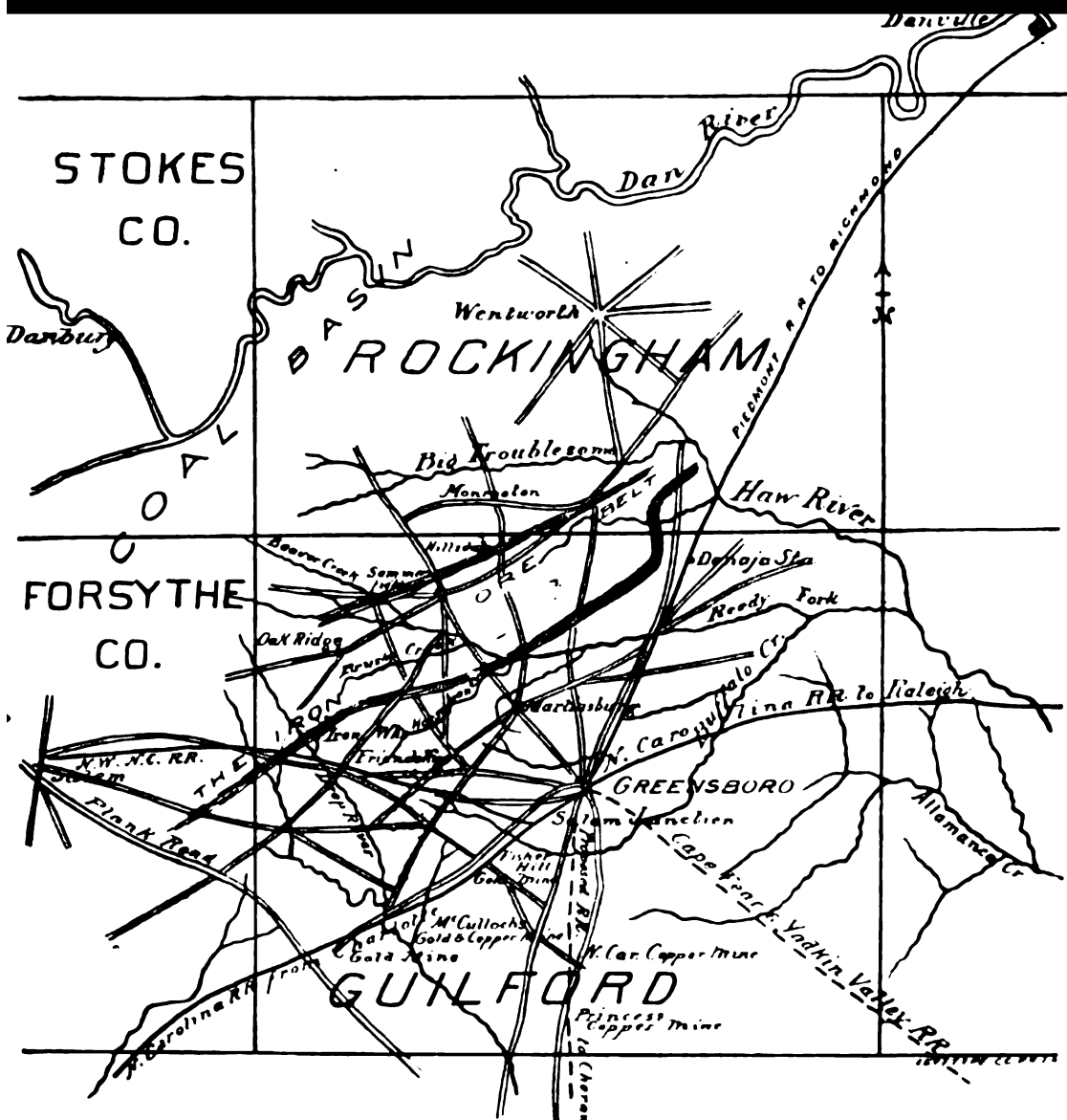
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Iron ores of North Carolina

Henry Benjamin Charles Nitze

117



30 Nov 1912

NORTH CAROLINA GEOLOGICAL SURVEY.

J. A. HOLMES, STATE GEOLOGIST.

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BULLETIN No. I.

IRON ORES OF NORTH CAROLINA

A PRELIMINARY REPORT

BY

HENRY B. C. NITZE,

ASSISTANT GEOLOGIST.

RALEIGH:

JOSEPHUS DANIELS, STATE PRINTER AND BINDER.

1893.

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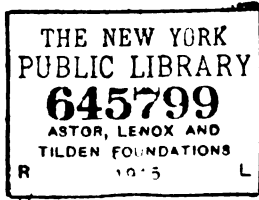
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STATE GEOLOGIST.

J. A. HOLMES,	Raleigh.
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LETTER OF TRANSMITTAL.

RALEIGH, N. C., February 1, 1893.

To His Excellency HON. ELIAS CARR,
Governor of North Carolina.

SIR:—I have the honor to submit herewith for publication a preliminary report on the Iron Ores of North Carolina. The report has been prepared by Mr. H. B. C. Nitze, assistant geologist in charge of the iron ore investigation. A large amount of work remains to be done before a final report on the iron ores of the State can be prepared; but meanwhile it has been thought best to publish this preliminary report, in response to numerous demands on the Survey for information relative to this subject. This report will be issued as Bulletin No. 1 of the Survey publications.

Yours obediently,

J. A. HOLMES,
State Geologist.

PREFACE.

The iron ores in North Carolina occur mainly in the older crystalline schists, the geologic age and structure of which can only be determined by a large amount of most careful work in both the field and the petrographic laboratory. This will require a considerable expenditure of labor and time; but nevertheless this work must be done before the economic problems connected with the ores can be properly understood and intelligently discussed in a final report. The Geological Survey has undertaken such a study of these crystalline rocks as, it is hoped, may yield valuable results in the near future; but meanwhile, in response to the numerous demands for information concerning the deposits of iron ore, it is found necessary to publish a preliminary report.

The preparation of this preliminary report, including the necessary field work, was entrusted to Mr. H. B. C. Nitze in June, 1891. And the contents of this report are derived for the most part from his personal investigations in the field during the seasons of 1891 and 1892, in which time all of the most important iron ore deposits in the State were visited, and as detailed an examination given them as the scope of the work and the purposes of a preliminary report would justify. Particular attention was paid to the region west of the Blue Ridge mountains, because of the advantage offered by the United States Geological Survey topographical maps, which have been completed for this portion of the State.

The total area examined amounts to some 6000 square miles, distributed through twenty-three counties. To make this report as comprehensive as possible for the information of the public, extracts from previous reports, covering such of the ground as has not yet been examined by the present survey, have been added in quotation marks, and with proper references, so as to give due credit to the authors.

The subject-matter of the report has been confined almost entirely to the economic side of the geology, with but casual reference to the structural features of the ore deposits and their geologic relations. The study of these relations and the correlation of the different ore-zones cannot now be undertaken, owing to the meager results that are at present in hand concerning the structural and stratigraphic geology of the various formations in the State.

The subject of this report, then, deals with descriptions of the localities, the extent and character of the ore deposits, as far as practicable, and the quality of the ores as determined by analyses. Some general notes on the old forges and furnaces, the chrome iron ores, manganese ores, and limestones are included in their proper places. A map of the State, showing the position of the various iron ore deposits, has been prepared, and accompanies the report. A table of 453 analyses has been prepared, showing the character and locality of the samples, and the names of the chemists by whom analyzed. Of these, 175 samples were collected by Mr. Nitze, and the analyses were made in the laboratory of the Survey at Chapel Hill, by Dr. F. P. Venable, Messrs. C. Baskerville, R. H. Mitchell, and Nitze. The remaining analyses quoted are collected from reliable sources, duly mentioned in the table.

As is well known, the representation of the quality depends as much on an intelligent sampling as on an accurate analysis of the same. Mr. Nitze has endeavored, in collecting samples, to make them as truly representative as possible, by taking a great number of small chips, aggregating from two to five pounds, from the full cross-section of the ore bed; and where circumstances would not permit of this, he has taken similar samples from old dumps and heaps of ore lying near the openings, or from a great number of points along a general outcrop.

These samples have been reduced in the laboratory to a sufficiently small volume for analysis, by the method of grinding, mixing and quartering, the final sample being finely ground in an agate mortar and dried at 212° F.

In the field work Mr. Nitze has been assisted at intervals by Messrs. H. L. Harris, J. V. Lewis, and Charles Baskerville of the

State Survey ; and also by Messrs. Hersey Monroe and Charles E. Cook, topographers, and Mr. Arthur Keith, geologist of the United States Geological Survey. Mr. Keith spent portions of October and November, 1892, in Cherokee and Graham counties, and has worked out the geologic relations of the limestone and iron ore belts of that region. Professor F. P. Venable of the State University has rendered a valuable service to the Survey by his supervision of the chemical work, which he has done without remuneration, and he has kindly revised the proof-sheets of this report.

The Survey is also indebted to the Cranberry Iron and Coal Company, the North Carolina Steel and Iron Company, the Bessemer Mining Company, and to many persons in various parts of the State for valuable assistance rendered and for the uniform courtesy shown to Mr. Nitze and his assistants while engaged in this work.

J. A. HOLMES,
State Geologist.



THE IRON ORES OF NORTH CAROLINA.

BY H. B. C. NITZE.

CHAPTER I.

INTRODUCTION.

The ores of iron; chemical and mechanical impurities; commercial value of iron ores; geologic and geographic distribution of ores; structure of ore deposits; early manufacture of iron in the State; present condition of the iron industry in North Carolina.

THE ORES OF IRON.

For the benefit of those who are unacquainted with the usual mineralogical terms, the following definitions are given:—

MAGNETITE, *magnetic iron ore* ($\text{FeO} \cdot \text{Fe}_2\text{O}_3$), so called from its magnetic properties, is a compound of the sesquioxide and protoxide of iron; it is of a black color, and contains when pure 72.4 per cent of metallic iron. When it contains an appreciable amount of titanous acid it is called *titaniferous magnetite*.

RED HEMATITE (Fe_2O_3) is the sesquioxide of iron; it is of a red color, and contains when pure 70 per cent of metallic iron. *Specular ore*, *micaceous ore*, *martite schist*, *red ochre*, *itabirite*, are varieties of red hematite. *Turgite* ($2\text{Fe}_2\text{O}_3 \cdot \text{H}_2\text{O}$) may be classed as a red hematite containing a small (5.3) per cent of water.

BROWN HEMATITE ($\text{Fe}_2\text{O}_3 + \text{aq.}$) is a general or commercial name for the hydrous sesquioxides of iron. Its color is brown, varying to yellow and reddish in the species containing little water; and when pure it contains from 57.1 to 62.2 per cent of metallic iron. The several species vary in degree of hydration, as shown by the following statement:

Goethite ($\text{Fe}_2\text{O}_3 \cdot \text{H}_2\text{O}$), containing 10.1 per cent of water;

Limonite ($2\text{Fe}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$), containing 14.5 per cent of water;

Xanthosiderite ($\text{Fe}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$), containing 18.4 per cent of water;

Limnite ($\text{Fe}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$), containing 25.23 per cent of water.

Yellow ochre and *bog ore* (of recent formation in marshy places) are other varieties of brown hematite.

SIDERITE, or *spathic iron ore* (FeCO_3), is the carbonate of iron. It is of a white, yellowish-gray, or brown color, and contains when pure 48.2 per cent of metallic iron. *Ball ore* and *blackband* are varieties of this ore, found in the coal measures.

CHROMITE, or *chromic iron ore* ($\text{FeO} \cdot \text{Cr}_2\text{O}_3$), is a compound of protoxide of iron and sesquioxide of chromium; is of a dark, brownish-black color, and contains, when pure, 68 per cent of chromic oxide.

MANGANIFEROUS IRON ORE is a variety of either magnetite, red hematite, or brown hematite (usually the latter), containing an appreciable quantity of manganese.

CHEMICAL AND MECHANICAL IMPURITIES.

All of these ores of iron are found widely distributed in the State of North Carolina. It must not be supposed, however, that they exist on a commercial scale of the absolute, theoretical purity as given in the above definitions. Impurities, both chemical and mechanical, are naturally present: chemical impurities, such as are intimately combined with the ore in chemical relation, as sulphur, phosphorus and titanitic acid; mechanical impurities, or the associated minerals, the "gangue" of an ore, usually silicates, which occur distributed in the ore masses, such as quartz, feldspar, hornblende, calcite, epidote, garnet, pyroxene, mica, talc, and chlorite-schists, clay, etc.

DISCUSSION OF THE CHEMICAL IMPURITIES.—Of the chemical impurities, *titanic acid* is one of the most hurtful; it is confined to the magnetic ores, and when in excess of 1 per cent it rather condemns the ore for blast-furnace use, so far as our American practice of to-day goes, at least in competition with ores less difficult to fuse.

Titanic acid in the ore does not injuriously affect the quality of the pig iron produced, as it passes almost completely into the slag, only a very small percentage, if any, entering the pig iron; in fact the iron produced from titaniferous ores is as a rule of the best Bessemer quality, for these ores are known to be exceptionally low in phosphorus.

But the difficulties arise in the infusibility of the slag, in the loss of iron in the slag, and in the formation of accretions of nitrocyanide of titanium in the furnace hearth. It is therefore very evident that, owing to the first two causes, the cost of producing a ton of iron is very materially increased. An extremely high temperature is necessary to fuse the slag, which means an increase in the fuel consumption; and the yield of the furnace in pig iron, in a given time, will be reduced, owing to the appreciable loss of iron in the slag.

The first of these difficulties may be overcome by producing, through the addition of proper fluxes, a more fusible, trisilicate slag, such as a silicate of lime, magnesia and alumina. In Sweden, Norway and England ores very high in titanitic acid have been successfully smelted by this means. The second remains a standard evil, as a certain part of the iron is soluble in any of these silicates. A remedy for the third evil, the building up of the hearth by the very hard and infusible nitro-

cyanide of titanium, has been suggested by Mr. John Birkinbine,¹ in the use of a removable hearth in the furnace, so that if it did build up too rapidly it could be pulled out and supplied by a clean one; but the idea of this improvement is still in embryo. To whatever extent the metallurgy of the titaniferous ores may be susceptible of improvement, as long as ores free from this element, and of equal purity otherwise, can be had at the same market prices, our titanic ores will probably remain in the ground; and they exist there in immense quantities in this State, as well as in other parts of the United States and Canada. Practical furnace men avoid titaniferous ores. If a very superior ore, not too high in titanic acid, could be cheaply obtained, so as to be put on the market at a cost so much lower than an ore of equally high iron but somewhat higher phosphorus content, as to be attractive, small proportions might be used in the furnace to advantage and without much difficulty, in admixture with these non-titaniferous ores, in order to reduce the phosphorus in the resulting pig iron to or below the Bessemer limit. One of the best uses that these titaniferous ores can be put to will be for the lining of puddling furnaces (called *fix* or *fettling*). They are peculiarly adapted to this purpose owing to their firmness, richness in iron and freedom from phosphorus.

Phosphorus is another of the injurious elements in an iron ore, inasmuch as it renders the pig iron cold-short, *i. e.* brittle when cold. It cannot be eliminated in the blast furnace, nor in the converter used in making steel from the pig iron by the Bessemer acid process; and as the maximum percentage of phosphorus permissible in steel is $\frac{1}{100}$ of one per cent, ores are accordingly classified as Bessemer and non-Bessemer ores. A Bessemer ore is such that the percentage of phosphorus in the pig iron manufactured from it shall not exceed $\frac{1}{100}$ of one per cent. This is determined from the *phosphorus ratio* of the ore, whereby is meant the amount of phosphorus in 100 parts of metallic iron. If, for instance, an ore contains 60% of metallic iron and 0.03% of phosphorus, then 60% iron in the ore : 100% iron in the pig iron :: 0.03% phosphorus in the ore : $x\%$ phosphorus in the pig iron; whence $x=0.05\%$, the phosphorus ratio, which is in this case below the Bessemer limit, that is, less than $\frac{1}{100}$ of one per cent. It is proper to mention here that in the analyses given throughout this report, and in the table of analyses at the end of the report, the phosphorus ratios have been added in almost every case, and when below the Bessemer limit they are printed in heavy figures to call attention to this fact and to avoid further explanation.

There is a method of making steel from pig iron known as the

¹ Transactions of the American Institute of Mining Engineers, Baltimore Meeting, February, 1892, Vol. XXI.

Basic Bessemer process, and another known as the Basic Open Hearth process, in which high phosphorus pig iron, and hence high phosphorus ores, can be utilized to advantage. Here the phosphorus, instead of being an injurious ingredient in the pig iron, becomes an essential requisite for the successful operation of the process, in which it is almost entirely eliminated and made to enter the slag.

According to Wedding,¹ the eminent German metallurgist and an authority on this subject, the amount of phosphorus in the pig iron used to the best advantage should not exceed 3 per cent (which means 1.5% in a 50% iron ore). Most generally pig iron with 2% to 2.5% of phosphorus is used, and it is very difficult to get good results with 1.5% of phosphorus in the pig iron, and none at all with 1.2% of phosphorus. The percentage of silicon should be as small as possible; 0.5% is best, and 1.5% is the highest allowable limit. The pig iron should also contain from 2.2% to 3% of metallic manganese. Sulphur is a detrimental element because it is hard to eliminate; it ought never to be over 0.12%; generally it is 0.08%, sometimes 0.05%, and even less. The sulphur content can be increased without injury, the greater the amount of manganese. It is thus seen that ores for this purpose must be high in phosphorus, but low in sulphur and silica, and it is preferable that they should contain some manganese, though this may be attained by the addition of special manganese ores.

In North Carolina the principal bodies of ore, namely the magnetites, are low in phosphorus,—often below Bessemer limit. The higher phosphorus ores are usually confined to the brown hematites, of which there are large deposits in Cherokee county.

Sulphur is a detrimental element in an iron ore, rendering the pig iron hot-short, that is, brittle when hot. Unlike phosphorus, however, it is partially eliminated in the blast furnace by combining with the bases of the slag. And it may be reduced, previous to smelting, by roasting the ore, whereby it is partially volatilized.

The ores of North Carolina are, with very few exceptions, extremely low in sulphur.

Manganese.—The presence of manganese in an ore for the manufacture of pig iron is not desirable above 1% or 2%. For special purposes, such as the manufacture of spiegeleisen, ferro-manganese, etc., it is a requisite, and ores high in manganese, manganiferous iron ores or regular manganese ores, are then used. The magnetic ores seldom contain this element in appreciable quantities. It usually accompanies the brown hematites in variable quantities, these ores in fact merging into manganese ores when very high in manganese.

¹ Wedding's Basic Bessemer Process, translated by William B. Phillips, Ph. D., and Ernst Prochaska, Met. Eng., p. 90 *et seq.*

Chromium rarely occurs in the common iron ores. It is confined almost entirely to the particular mineral already defined as chromite, which is used in the manufacture of pigments, and special varieties of tool steel, the chromium exerting a hardening effect without impairing the toughness of the steel. Small amounts, from a trace to 1.50% of chromic oxide, exist in most titaniferous ores.

DISCUSSION OF THE MECHANICAL IMPURITIES.—The mechanical impurities are all of them degrading to the quality of an ore, because they reduce the percentage of metallic iron in the ore, and require the addition of fluxes, usually limestone or dolomite, for their removal from the furnace as slag or cinder. Pure *silica* (quartz) is naturally the most objectionable form in which the mechanical impurity can exist. But when silica exists in combination with certain bases, such as lime, magnesia or alumina, as in the various schists and clays, the formation of a natural slag is assisted, and the amount of flux to be added thereby lessened.

An ore may in fact, under exceptional circumstances, be self-fluxing, that is, the proportion of silica to the bases naturally present in the ore may be such as to flux themselves and form a slag without the addition of foreign ingredients. *Calcite* (carbonate of lime, limestone) is therefore one of the most beneficial of the accessory minerals that could occur in an ore. Certain minerals, such as *hornblende* and *pyroxene*, which are silicates of iron, alumina, lime, magnesia, etc., are more desirable than pure silica, on account of the iron which they contain.

In mining an ore on a commercial scale it is as a rule impossible to get it out free from gangue or accessory minerals. To a certain extent it may be cleaned or dressed by hand-picking or by the aid of machinery (crushing, washing, jigging, or by magnetic separation in the case of magnetites). The degree to which an ore may thus be dressed depends on the expense of the operation and the value of the resulting material.

Often the gangue is so finely and intimately associated with the ore as to render any means of dressing economically impracticable. There is a limit in the percentage of silica that an ore, after it is finally prepared, may contain to be fit for furnace use; this is variable and dependent on conditional circumstances, but certainly, if it reaches much above 30%, it must be condemned, and in fact cannot be properly called an ore from a commercial standpoint.

COMMERCIAL VALUE OF IRON ORES.

The commercial value of an ore depends upon:

1. Its chemical composition;
2. Its mechanical structure;
3. The relation of the cost of supply to the market price;
4. Its proximity to a supply of fuel, flux and water.

1. *Its Chemical Composition*; that is, the richness of the ore in metallic iron, and its freedom from the injurious elements, silica, sulphur, phosphorus and titanio acid. This must be determined by chemical analysis. The increase in the value of an ore is very rapid with the increase in metallic iron and the decrease in phosphorus. .

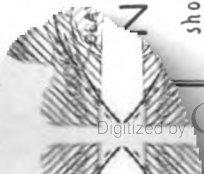
2. *Its Mechanical Structure*. The depreciation in the value of an ore, due to the presence of mechanical accessories (gangue), is caused by:

- (a) The increased cost of mining the ore, per ton of pig iron which it will produce;
- (b) The increased cost of transportation of the ore, per ton of pig iron that it will produce;
- (c) The increased cost of the reduction of the ore in the blast furnace, per ton of pig iron that it will yield;
- (d) The increased cost of the wear and tear of the furnace due to the presence of an excess of material passed through it;
- (e) The cost of removal and disposal of the additional amount of slag produced.

3. *The Relation of the Cost of Supply to the Market Price*. This is of course dependent upon the cost of mining, dressing, handling, and transportation, which must be carefully determined, and compared with the ruling market price.

4. *Its Proximity to a Supply of Fuel, Flux and Water*. This is an important factor in determining the value of an ore. In any case the most profitable results are realized when the ore is so situated with reference to an adequate supply of good fuel, flux and water, that it can be smelted and turned into pig iron at the mine, thus decreasing the cost of handling and transporting dead material existing as gangue. These conditions are, however, not often perfect; either the fuel is distant, or the limestone is the missing article. It is a question of comparative profit that must determine whether the ore is to be transported to the fuel or *vice versa*. With high grade ores and long hauls the former is likely to be the most economic plan. Often, if the ore be too low in grade to bear transportation to a distant market, it will be profitable to smelt it at the mine, if the necessary fuel and flux can be obtained at sufficiently low cost.

All of these conditions will determine whether an ore can be smelted on the ground, whether it is best suited for shipment to a distant market, or whether it is worthless altogether.



THE GEOLOGIC AND GEOGRAPHIC DISTRIBUTION OF THE ORES.

The ores of iron occurring in North Carolina are found widely distributed in the State. It is natural to suppose that they bear some definite relations to the geological formations in which they occur. The magnetites and red hematites are found almost exclusively in the crystalline rocks, which are confined to the midland and western counties, as shown on the accompanying small geological map of the State (Plate II). The true brown hematite formations of the older Paleozoic rocks are found only in the extreme western part of the State, in Madison county, west of the Hot Springs, and in the extreme south-western corner of the State, in Cherokee county. Brown hematites are, however, variously distributed throughout the crystalline rocks, sometimes in important masses, as at Ore Hill in Chatham county, the Ormond mine in Gaston County, etc.

The carbonate ores (blackband, ball ore, etc.) are confined to the coal measures of the Triassic formation.

The bog ores (porous brown hematites) are found in isolated patches over the more recent formation of the Coastal Plain region, in the eastern part of the State.

The chromic iron ores occur in the chrysolite hills in the western part of the State.

In the body of this report the following geologic-geographic arrangement has been adopted for the sake of convenience in description: .

1. *The Bog Ores of the Eastern Counties in the Coastal Plain Region.*
2. *The Blackband, Ball, Brown and Red Hematite Ores in the Coal Measures of the Triassic Formation, in Chatham and Moore Counties.*
3. *The Magnetite, Specular, and Brown Hematite Ores in the Eastern part of the Crystalline Area, including:*
 - (a) The Specular and Magnetite Ores of Halifax county.
 - (b) The Specular and Magnetite Ores of Harnett county.
 - (c) The Specular, Magnetite, and Brown Hematite Ores of Granville, Person, Durham, Orange, Chatham, Randolph and Montgomery counties.
 - (d) The Specular and Magnetite Ores of Mecklenburg and Cabarrus counties.
4. *The Titaniferous Magnetites in the Crystalline Rocks of Rockingham, Guilford and Davidson Counties.*
5. *The Magnetite and Brown Hematite Ores in the Central part of the Crystalline Area, including:*
 - (a) The Magnetite Ores of the Danbury Region in Stokes county.
 - (b) The Magnetite Ores of Surry and Yadkin counties.
 - (c) The Titaniferous Magnetites of Davie county.

5. **The Magnetite and Brown Hematite Ores of Eastern Catawba, Central Lincoln and Southern Gaston counties.**
6. **The Brown Hematite and Magnetite Ores of Eastern Caldwell, Burke and Cleveland, and Western Catawba and Lincoln counties.**
6. *The Magnetite and Crown and Red Hematite Ores of the Blue Ridge Mountains and their Eastern Foot-hills, including:*
 - (a) **The Martite Schists along the Eastern Edge of Watauga county.**
 - (b) **The Titaniferous Magnetites in the Central and Northern parts of Caldwell county.**
 - (c) **The Brown Hematites of northern McDowell county.**
7. *The Magnetite, Specular and Crown Hematite Ores in the Crystalline Area West of the Blue Ridge Mountains, including:*
 - (a) **The Ores of Alleghany county.**
 - (b) **The Ores of Ashe county.**
 - (c) **The Ores of Watauga county.**
 - (d) **The Ores of Mitchell county.**
 - (e) **The Ores of Yancey county.**
 - (f) **The Ores of Madison county.**
 - (g) **The Ores of Buncombe county.**
 - (h) **The Ores of Macon county.**
8. *The Crown Hematite Ores lying below the Quartzites of Cherokee County.*
9. *The Crown Hematite and Manganese Ores of Western Madison County.*
10. *The Chromic Iron Ores of the Chrysolite Rocks in Watauga, Mitchell, Yancey, Madison, Buncombe, and Jackson Counties.*

THE STRUCTURE OF THE ORE DEPOSITS.

The Magnetites and the Specular Hematites of the Crystalline rocks are undoubtedly true lenticular (shaped like a lens) deposits, pinching

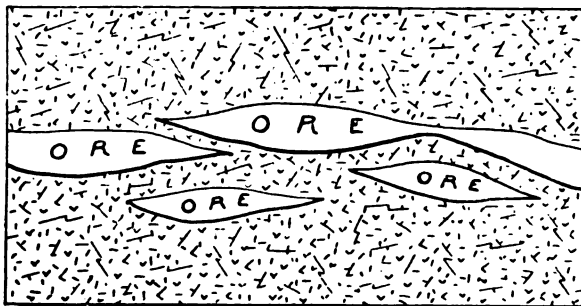


Fig. 1.—Ideal horizontal section illustrating relations of lenses of iron ore.

and bulging out in all dimensions, as illustrated more clearly in the accompanying ideal sections (Figs. 1 and 2).

The application of the term "veins" is essentially incorrect. They are rather ore beds or ore bodies. These lenticular masses vary widely in size, being at times so thin and pinched as to practically preclude working; again they attain enormous development in length, thickness and depth, as at the Cranberry deposit in Mitchell county.

As a rule they are conformable to the enclosing country rock, at times even partaking of the schistosity of the same.

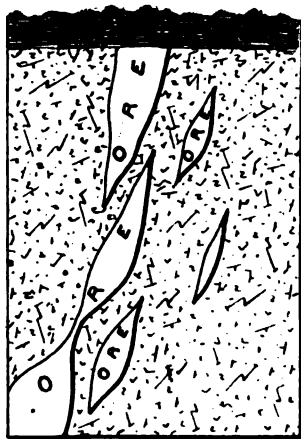


Fig. 2.—Ideal vertical section illustrating relations of lenses of Iron ore.

An ore Belt or Zone consists of a particular formation to which these ore lenses are common, and over which they are rather irregularly distributed in length and breadth, though there is always some regularity in the general direction of their outcrops.

In places, the ore formation or belt may be well developed, that is, it may contain a large number of workable ore-lenses; again, it may be practically barren over considerable distances. Each locality must therefore be separately examined, even though it belong to the same general zone; because the ore is well developed in one district, there is no reason for assuming that the same conditions must hold good in another.

The Brown Hematites usually occur in irregular, pocketed beds, thus in a certain sense resembling the lenticular deposits, though not generally lenticular in shape; sometimes there is great regularity in their dimensions, at others an equal irregularity. They usually lie imbedded in a stiff clay, which characterizes the true ore formation; when they occur in a shaly or schistose rock, considerable doubt must, as a rule, be attached to their probable extent.

There are two localities in this State where the brown hematite ore exists in a regular vein formation, so far as our present knowledge

goes. At Ore Hill in Chatham county it occurs in almost vertical dikes, of quite regular thickness, which often intersect each other. On Little mountain in Gaston county the ore occurs in a heavy vertical quartz vein, which has been traced for several miles in length, and has been opened at the "Devil's Workshop."

The Blackband and Ball ores of the Coal Measures occur in regular stratified layers or seams, conformable to the coal and carbonaceous slates.

The Red Hematite ore in Chatham and Moore counties occurs similarly interstratified in the Triassic red sandstone.

The Bog ores occur as local deposits usually in swampy or marshy places, or around the mouths of springs from which they have been deposited. They cover comparatively small areas, and are altogether irregular in extent.

EARLY MANUFACTURE OF IRON IN NORTH CAROLINA.

The history of the early manufacture of iron in North Carolina dates back previous to the Revolutionary war. As early as 1729 small shipments of iron were made to England.¹ These earliest iron works were probably situated near the coast in the neighborhood of bog ore deposits, and consisted of the primitive Catalan forges, blown by the water trompe. Many of these forges were built in later years further inland, in Chatham, Guilford, Rockingham, Stokes, Surry, Yadkin, Davie, Catawba, Lincoln, Gaston, Cleveland, and other counties; and even in the fastness of the mountains in the western part of the State, in Wilkes, Ashe, Mitchell, Caldwell, Cherokee, and other counties. In 1859, Lesley gave an account of forty-nine bloomery forges and six charcoal furnaces, and there were many others at that time which he did not mention.

One of these, the Pasley forge, on Helton creek, in Ashe county, is still in operation.

The first charcoal furnace in the State was probably the Vesuvius furnace in Lincoln county, reported to have been built about the year 1792; a small charcoal furnace was built at the mouth of Snow creek in Stokes county about 1795. Iron was made during the Revolutionary war in Nash, Chatham, Guilford, Cleveland and probably some other counties.

During the late Civil war iron was made for ordnance purposes in Nash, Chatham, Lincoln, Stokes and other counties. Since that time there has been a steady decline in the iron manufacture in this State, until at present there are in active operation only one furnace in Mitchell and one forge in Ashe county.

¹ History of the Manufacture of Iron in all Ages, by James M. Swank; second edition, p. 272.

With the spread of the railroad lines, affording facilities for the transportation of the vastly cheaper pig iron from the North, these old forges and furnaces could not compete with their improved and modern rivals in other States, and gradually they were abandoned.

Without exception they were built in close proximity to their ore supplies, which were mined in an irregular, desultory and spasmodic manner, without any system or judgment for the future. As a rule, the "mines" consisted of simple, but numberless, pits and cuts, along the outcrops of the ore bodies, which were abandoned when they attained too great a depth, and others opened. At many places shafts were sunk, and similarly abandoned for others when the water level was reached.

It must not, therefore, be hastily concluded, from the general appearance, irregularity and multitude of the old diggings, that the amount of ore was too small to justify proper working, nor that the ore was worked out, for in no case did they go below the water level. At the same time, the fact that a certain ore deposit once supplied an old-time forge or furnace must not be taken as a criterion of the quantity of ore, or the extent of the ore deposit, for the small size and production of these furnaces required but a very small amount of ore; indeed, one might almost say that sufficient ore to supply a forge for several years might be picked up from the outcrop or from the surface float.

The remains of the old workings are still everywhere visible; with few exceptions, they have caved in and filled up with dirt and water, and are often covered with vegetation and overgrown with trees and brush, so that a mere sink-hole is now their only sign. Unless recently reopened by some prospector, they do not permit of a satisfactory examination; and the only value that they possess as a criterion of what is underground is that they at least indicate the presence of an ore-bearing deposit, by the visible amount of work that has been done, by their extent, and by the fragments of ore scattered about the surface.

THE PRESENT STATE OF THE IRON INDUSTRY IN NORTH CAROLINA.

There are at present two mines and one blast furnace in operation in the State. The Cranberry mine, at Cranberry in Mitchell county, is an extensive deposit of magnetite of Bessemer quality, which has been worked for generations in the primitive Catalan forges situated near by.

About 1880 this property came into the possession of the Cranberry Iron and Coal Co., which has developed it continuously and extensively since that time, by open cuts and tunnels; but mining has never been followed on the larger scale that this deposit would justifiably warrant. Early in 1884 a small blast furnace, 50 feet high by 10 feet 2 in

wide at the bosh, with a daily capacity of from 14 to 15 tons, was blown in here, and has been operated without interruption since, running at first on charcoal, but during the greater part of the past two years on coke from Pocahontas, Va., and producing a remarkably pure Bessemer iron of special grade. This furnace was also built here more with a view of further developing the property, by testing the actual quality of the pig iron that could be made from these ores, than for the purpose of establishing a large and regular industry. The policy of the company appears to have been one of development and exploratory work ever since they first took hold of the property. A narrow-gauge railroad, the East Tennessee and Western North Carolina, about 32 miles in length, connects the mines and furnace with the East Tenn., Va. and Ga. railroad, at Johnson City, Tenn.

The total output of ore from this mine for the year just ended, 1892, was 18,433 long tons, which, valued at \$1.40 per ton at the mine, was worth \$25,806.20. Of this amount, 12,088 tons were shipped to furnaces outside of the State. The total production of the furnace for 1892 was 3250 short tons of Bessemer pig iron, which, valued at \$16.00 per ton at the furnace, was worth \$52,000.00. Of this amount, 2900 tons were coke iron and 350 tons charcoal iron.

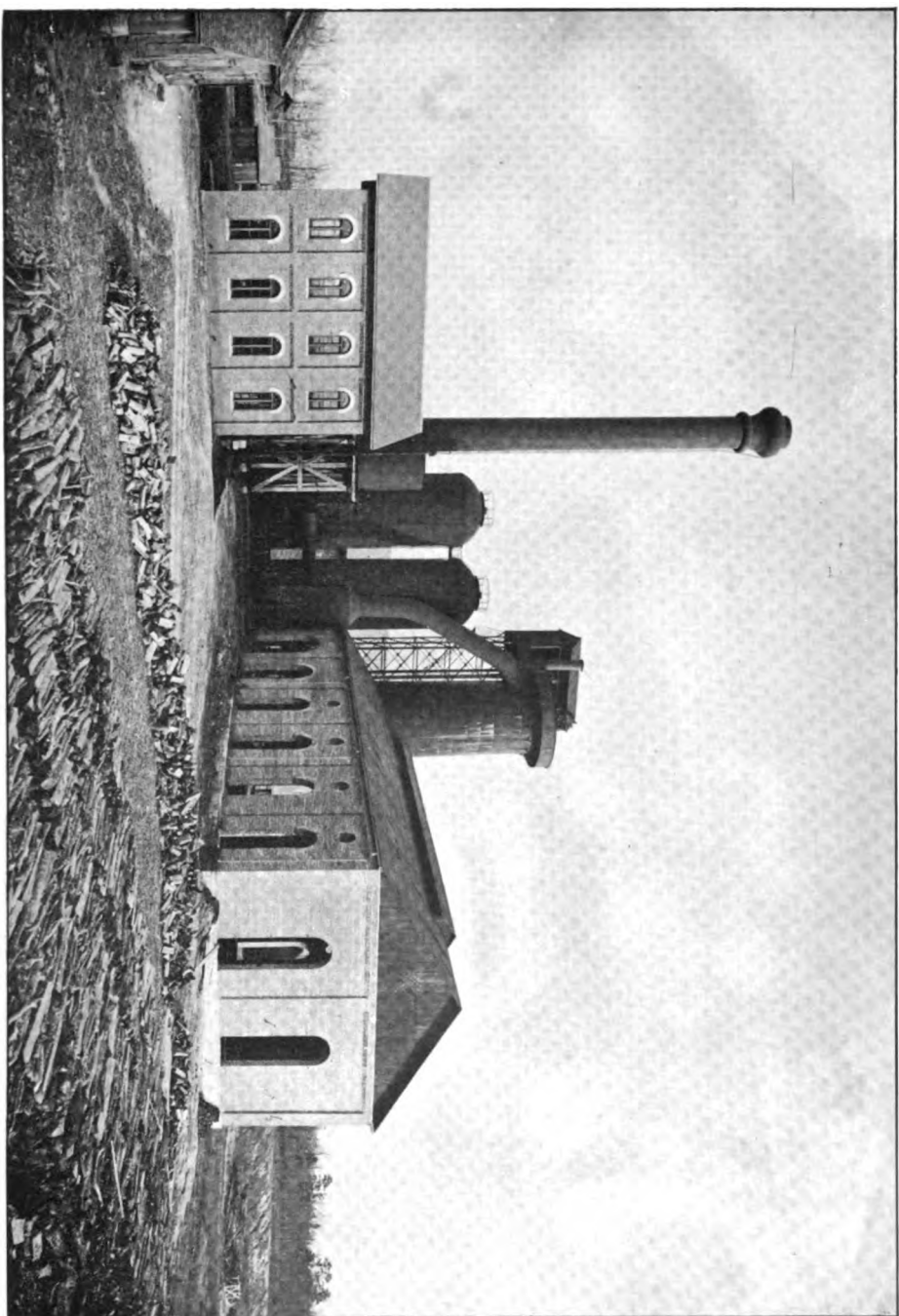
During the past year, magnetic concentration of the ores, though yet in an experimental stage, has been successfully introduced here, and most of the ore that entered the furnace was of this description.

The only other iron ore mine that was worked in 1892 is the Ormond mine in Gaston county, about 28 miles southwest of Charlotte, and $\frac{1}{2}$ mile west of the Atlanta and Charlotte Air Line, with which it is connected by a short branch line. This mine was operated by the Bessemer City Mining and Manufacturing Co., recently absorbed by the Bessemer Mining Co., and produced during the first eight months of 1892, 5000 long tons of ore, which, valued at \$3.50 per ton at the mine, was worth \$17,500.00. The ore is a brown hematite, probably turgite, of Bessemer quality, and was shipped to Richmond, Va., and Birmingham, Ala., for fix, used in puddling furnaces.

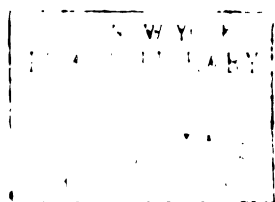
The mine was closed down in September, 1892, on coming into the possession of the new company, which is now preparing for extensive improvements and a large output in the near future.

In June, 1892, the North Carolina Steel and Iron Co. completed their blast furnace at Greensboro.¹ The height of the stack is 70 feet, diameter of bosh 16 feet, and the calculated capacity 100 tons per day. The furnace plant is fully equipped with all modern improvements, and together with ore lands, town-site lands and other improvements, represents a total investment so far of \$305,000.00.

¹ See Plate II.



BLAST FURNACE, NORTH CAROLINA STEEL AND IRON COMPANY, GREENSBORO.



It is now expected to have this furnace in operation at an early date, the delay of putting it in blast having been caused by the deficiency of the necessary funds; the present low price of iron in the country having deterred the company from endeavoring to procure the requisite capital sooner. It is also proposed to erect a merchant mill, machine shops, foundry, and car works during this year, the latter to have a capacity of ten (10) freight cars per day.

The principal supply of ore will be obtained from the mines of the company at Ore Hill, Chatham county, about 40 miles distant; this ore is a brown hematite, and the deposits have been prospected during the past year and about 700 tons of ore taken out. Besides this source, magnetic ores from the western part of the State will be used. Limestone will be obtained from Virginia, and coke from the Flat Top coal region in the same State.

Mention may here be made of the Buckhorn furnace, a modern iron stack, 54 feet high by 10 feet diameter of bosh, with an annual capacity of 4500 net tons. This furnace was built in 1873 by the Lobdell Car Wheel Co., of Wilmington, Del., at the foot of Buckhorn falls on the Cape Fear river in Harnett county, 12 miles from Lockville. It was run on ore from the Buckhorn mine, about two miles distant, for a short time only, when the ore gave out. Although the furnace has been idle ever since, and most of the woodwork, outbuildings, etc., are decayed and in ruins, the stack itself has been kept in fair repair, and might well be moved to some regular ore supply and be made a paying investment.

THE METHODS OF MINING have always been, and are we might say to the present day, primitive, crude and unsystematic. Excepting the Cranberry—and even that has poor facilities for handling its output to advantage—there is not a well developed mine in the State. This may be accounted for by various reasons, primarily the inaccessibility through lack of transportation facilities, small, temporary demand, etc.; but it is evident that much is due to the ignorance, inexperience and lack of energy and foresight of the operators and the miners. Small shafts, hardly deserving of the name, often untimbered, have been sunk without regard to number or location; usually a simple horse-whim and bucket have performed the raising; the outcrops have been “hogged” over by thousands of open pits and cuts. With a few single exceptions these have been allowed to cave in and fill up, have been abandoned and are now impediments in the way of successful prospecting and mining; for this very reason many good properties are no doubt lying idle to-day, as it is a greater undertaking to open up old workings and abandoned mines than to start new ones in fresh, untouched ground. No system was observed, nothing was done with an outlook to the future; if it had been, the mining industry would to-day be in a better state of prosperity.

The time has come to retrieve these mistakes of our ancestors. An iron ore mine, or any sort of a mine, must not be looked upon as a ~~source~~ ^{source} of fabulous wealth. It needs conservative treatment, careful and able management, and sufficient capital for proper development, to make the investment a paying one.

Developments are going on in a small way throughout the State. Private owners and companies are beginning to recognize the value of the iron ore resources, and are variously engaged in prospecting and opening up the ground. Some of the principal localities that may be mentioned as warranting closer investigation are:

1. The Magnetite and Specular ores of Granville county.
2. The Brown Hematites of Ore Hill in Chatham county.
3. The Magnetite ores of Stokes, Surry and Yadkin counties.
4. The Magnetite and Brown Hematite ores of Catawba, Lincoln and Gaston counties.
5. The Magnetite ores of Ashe, Mitchell and Madison counties.
6. The Brown Hematite ores of Western Madison and of Cherokee counties.

Some of these are still inaccessible; but with their proper development and proof of the existence of large deposits of good ore, railroad connections will not be long coming.

On the whole, the prospects for an established iron industry in North Carolina are encouraging, and its value to the State cannot be overestimated.

Before the war the Southern people were engrossed, not so much with the manufacture of pig iron when they could get it elsewhere, as with the cultivation of cotton, tobacco, etc., to which both soil and labor were naturally adapted. After the war, a period of reconstruction set in; to-day the country is again on a firm basis, and the people are looking first and foremost to the development of their mineral resources.

CHAPTER II.

THE BOG IRON ORES OF THE EASTERN COUNTIES, IN THE COASTAL PLAIN REGION.¹

“The clayey, sandy and earthy accumulations of the eastern section contain in many places a rough, brown ore, more or less earthy or sandy, either in beds from two to four feet in thickness, or more frequently in layers of irregularly shaped lumps or nodules.”

The variety of this ore is known as *Bog Iron Ore*, a hydrated oxide of iron, like limonite, though usually containing more water, besides organic matter. It is of recent, secondary origin, formed by the oxidation and redeposition of leachings from the older, ferruginous rocks and soils, usually in swampy places or bogs, whence its name. In the section under consideration these small deposits of bog iron ore occur in the recent formations.

THE BLOOMERY MINE, NASH COUNTY.—“One of the most considerable of these deposits is found in the southern end of Nash county, near the Wilson county line, about 8 miles north of the town of Wilson, and lies on the edge of Toisnot swamp. It is in the form of a horizontal, continuous bed, of a loose, spongy texture and rusty brown color, excepting in a few points, where it becomes more compact and of a sub-metallic luster. The thickness is from 2 to 3 feet, and its horizontal extent about 50 by 150 yards.” “Beneath it is white sand, and above it from 2 to 4 feet of brown earthy soil, containing nodules of the same ore.”²

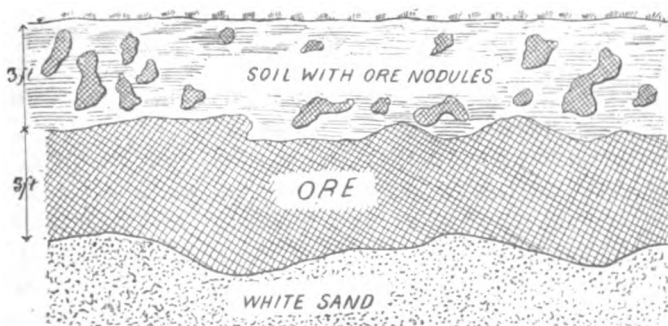


Fig. 3.—Showing section of ore bed at the Bloomery mine, Nash county.

¹ From *Ores of North Carolina*, by W. C. Kerr and G. B. Hanna, 1887, p. 125 *et seq.*, with slight alterations and additions.

² From Willis in the United States Tenth Census Report, Vol. XV, p. 302.

"The deposit is known as the Bloomery mine from the fact that iron was made from this ore in a Catalan forge a few miles south, during the war of 1812. Iron was also made here during the Confederate war, in a furnace erected on the spot." Several analyses of the ore show:

ANALYSES OF ORE FROM THE BLOOMERY MINE, NASH COUNTY.

	(327)	(328)
Silica	15.06	....
Metallic iron	42.73	50.61
" manganese	0.98	....
Alumina	0.55	....
Lime	1.43	....
Magnesia	1.54	....
Organic matter and water.....	15.58	....
Sulphur	0.044	....
Phosphorus	0.048	0.050
Phosphorus ratio	0.112	0.098

It may accordingly be classified as a fairly good ore, low in phosphorus.

DUPLIN COUNTY.—"A second deposit, reported to be abundant in superficial nodules and irregular lumps, is found in the southern part of Duplin county, near Wallace, on the farm of D. T. Boney, covering a curved belt about one mile long and one quarter of a mile wide. The sheets are very irregular in form and their thickness is unknown."

ANALYSES OF BOG ORE FROM THE BONEY PLACE, DUPLIN COUNTY.

	(191)	(192) ¹
Silica	7.59	....
Metallic iron	53.93	47.04
Sulphur	0.05	....
Phosphorus	0.02	1.093
Phosphorus ratio	0.037	2.323

This ore, though high in iron for its kind, shows a remarkable local variation in phosphorus.

PENDER COUNTY.—"Another bed of the same character and appearance, except in the size of the nodules, which are rather small, occurs in a field about two miles north of Rocky Point in Pender county."

PITT COUNTY.—"Extensive beds of limonite are reported to occur on the border of Tranter's creek, near the Tar river, in the eastern portion of Pitt county. The ore occurs in the 'second bottom' about 10 feet above the water level of the creek, at or near the surface, sometimes in large lumps and blocks."

¹ Tenth Census Report, XV, 558.



JOHNSTON COUNTY.—There is, according to Dr. Emmons,¹ “a large deposit of limonite, 4 miles west of Smithfield, in Johnston county. It is more or less sandy or earthy, consisting of irregular lumps or nodules.”

BEAUFORT COUNTY.—Large deposits of bog ore are reported on the farm of Col. R. W. Wharton, 4 miles northwest from Washington, in Beaufort county, and it is said that iron was made from this ore during the Revolutionary war.

¹ Geology of the Midland Counties of North Carolina, 1856, pp. 125-127.

CHAPTER III.

THE BLACKBAND, BALL, BROWN AND RED HEMATITE ORES IN THE COAL MEASURES AND RED SAND- STONE OF THE TRIASSIC FORMATION IN CHATHAM AND MOORE COUNTIES.

It was not considered of sufficient importance to make a detailed examination of the ores of this formation for the present report. The following description is reprinted, with slight changes, from a report on *The Ores of North Carolina*, by Kerr and Hanna.¹

"The next ores demanding attention are the *blackband* and *ball ore*, or 'kidney ore' of the coal measures. These are earthy and calcareous carbonates of iron, imbedded in the black, carbonaceous shales which enclose the coal, or are interstratified with the coal itself." The ball ore occurs in rounded masses, from 4 to 8 inches in diameter, of a drab color, in a dark brown shale. The blackband is compact and homogeneous. "These ores seem to be co-extensive with the coal in Deep river, outcropping everywhere with it, and at several places outside of its limits."

Several small seams of this blackband ore occur in connection with the coal beds at Egypt.

An examination of the Egypt workings revealed the following section:

Slate roof	.....
Coal (upper bench)	 4 feet.
Blackband	 18 inches.
Coal (lower bench)	 20½ inches.
Heavy, gray coal	 4 inches.
Carbonaceous shales	.....

A lower seam of blackband is mentioned by Wilkes² as running 30 feet below the upper coal seam and consisting of two thicknesses of 3 feet each, separated by a thin seam of coal. The following analysis of this ore shows

¹ *Ores of North Carolina*, by W. C. Kerr and George B. Hanna, 1887, pp. 10-16.

² *Report to the Secretary of the Navy*, by Capt. Charles Wilkes, Ex. Doc. 26, 35th Cong., 1st Sess., 1858, p. 18.

BLACKBAND ORE FROM THE EGYPT SHAFT, CHATHAM COUNTY.

	(155)
Silica	9.00 per cent.
Metallic iron	33.25
Sulphur	3.39
Volatile matter	8.81
Carbon	31.30

Analysis No. 156 shows that, by roasting, the sulphur is reduced to 0.89 per cent.

Other analyses of the blackband ores show:

ANALYSES OF BLACKBAND FROM NEAR GULF, CHATHAM COUNTY.

	(152)	(157)	(159)	(161)	(163)	(168)
Specific gravity		2.361	3.150	2.110	2.110	....
Silica	13.00	9.154	7.089	34.39	5.188	....
Metallic iron	31.11	19.850	28.280	11.49	8.06	21.38
" manganese		1.110	1.250	0.63	0.95	....
Alumina		4.244	0.127	19.66	4.06	....
Lime		9.520	12.672	3.10	14.04	....
Magnesia		1.490	1.170	1.22	0.86	....
Alkalies		none	none	none	none	....
Volatile matter		22.065	27.244	14.93	15.01	....
Fixed carbon	34.00	16.213	4.736	6.56	34.47	....
Sulphur		5.592	1.190	1.058	3.800	....
Phosphorus		2.160	2.973	0.318	2.746	0.017
Water		0.700	0.300	2.588	0.717	....
Ash, or roasted ore		60.475	72.070	76.902	48.571	....

The important constituents of this ash are:

	(158)	(160)	(162)	(164)
Metallic iron	33.03	39.59	14.65	23.62
Sulphur	0.893	0.800	0.319	0.360
Phosphorus	3.581	4.131	0.474	5.604

No. 157 is the lower stratum of blackband between the coal, about 18 inches thick. No. 161 is the upper and earthy part of the same, 6 to 10 inches thick. No. 159 is the seam, about 12 inches thick, lying above the coal and separated from it by 16 inches of fire-clay; this is a hard, black, slaty ore with occasional balls still more dense. No. 163 is the stratum, about 3 feet above the coal, which consists of black, heavy, very tough, concretionary lumps of ore.

The amount of phosphorus that these beds contain at the above points is very notable, and is of course due to their highly fossiliferous character.

At other points, such as shown by analyses 152 and 166, the phosphorus is lower, in the latter very low, showing its extreme variation.

Concerning the ball ore, Emmons¹ speaks of an argillaceous carbonate as occurring at a depth of 230 feet in the shaft at Egypt, and four other occurrences of it have been noted there.

¹ Geology of the Midland Counties, 1856, p. 262 *et seq.*

"About Gulf it is found in rounded, flat masses from 5 to 10 inches in diameter. They are dense, uncrystalline and heavy; of a light gray drab color, and are pretty thickly distributed in parallel layers of 1 to 3 feet in thickness."

The following analyses show its composition:

ANALYSES OF BALL ORE. NEAR GULF, CHATHAM COUNTY.

	(153)	(165)
Silica	6.04	....
Metallic iron	12.42	35.10
Alumina	0.48	....
Lime	29.57	....
Magnesia	6.51	....
Carbonic acid	38.30	....
Organic matter	1.45	....
Water	0.40	....
Sulphur	0.076	....
Phosphorus	0.401	0.313
Phosphorus ratio	3.228	0.892

There are many outcrops of *ferriferous limestone* in the vicinity of Egypt. The following analysis is of a specimen taken from near Dowd's sawmill:

ANALYSIS OF FERRIFEROUS LIMESTONE. NEAR EGYPT, CHATHAM COUNTY.

	(154)
Metallic iron.....	6.72
Lime	31.68
Magnesia	0.79
Sulphur	trace.
Phosphorus	trace.

These ball ores and ferriferous limestones were used by the Sapon Iron Company as a flux in their furnace at Ore Hill.

There is still another class of ore occurring in the Triassic measures of this region. It is a *limonite* which is probably the weathered outcrop of the blackband or ball ore. An analysis of such an ore occurring near Gulf, shows:

ANALYSIS OF LIMONITE, NEAR GULF, CHATHAM COUNTY.

	(167)
Metallic iron.....	20.72
Phosphorus	0.068
Phosphorus ratio	0.328

At the McIver place, $1\frac{1}{2}$ miles southeast of Egypt, a partly stripped bed of brown hematite of the above described nature has been noticed. Several analyses show it to contain:

ANALYSES OF LIMONITE AT THE MCIVER PLACE.

	(143)	(144)
Silica	2.614	....
Metallic iron	57.13	47.59
Sulphur	0.034	0.14
Phosphorus	0.468	....
Phosphorus ratio	0.819	....

No explorations have so far shown that this ore exists in any quantity.

RED HEMATITE IN THE TRIASSIC SANDSTONE.

RED HEMATITE NEAR HAYWOOD, CHATHAM COUNTY.—One and a half miles nearly due north from Haywood, in the angle formed by the junction of the Haw and Deep rivers, in the red sandstone of the Triassic, a series of parallel beds of red, ochreous, earthy ore occurs on the farm of A. C. Thomas (old Moore place), and the Smith place, adjoining. A number of old openings are visible, but their caved-in condition precludes any chance of investigation. Prof. W. C. Kerr mentions in his report that the only bed exposed at the time of his visit (1875) was from 20 to 25 inches thick, dipping southeast with the sandstone from 20 to 30 degrees. The ore is partially limonitic, but in the main it is a red hematite, bearing a remarkable resemblance to the oolitic fossil ore of the upper Silurian (Clinton) formation, though non-fossiliferous and of a much coarser and more irregular texture, being composed of rounded concretions, varying in size from small grains up to half an inch in diameter.

Mr. Willis mentions (in the report of the United States Tenth Census on Mining Industries, p. 305) that the outcrops extend from Lockville to a point nine miles southwest, near Sanford, in Moore county. The following analyses show a wide variation in the percentage of phosphorus:

ANALYSES OF RED HEMATITE NEAR HAYWOOD, CHATHAM COUNTY.

	(145)	(146)	(147)
Silica	17.97	....	....
Metallic iron	50.32	43.56	49.56
Sulphur	0.034	....	0.090
Phosphorus	0.090	0.601	0.043
Phosphorus ratio	0.178	1.38	0.086

Mr. Willis further remarks (United States Tenth Census Report, p. 306): "a very similar bed of ore occurs two miles northeast of Sanford, and nine miles southwest of Lockville, in Moore county. This is known as the *Cole mine*, and the ore was formerly worked in a bloomery, but became too hard to be dug with a pick and was abandoned.

Like that at the Smith mine, this ore dips between 20 and 30 degrees S. E., and varies in thickness from 8 to 18 inches."

ANALYSIS OF RED HEMATITE FROM THE COLE MINE, MOORE COUNTY.

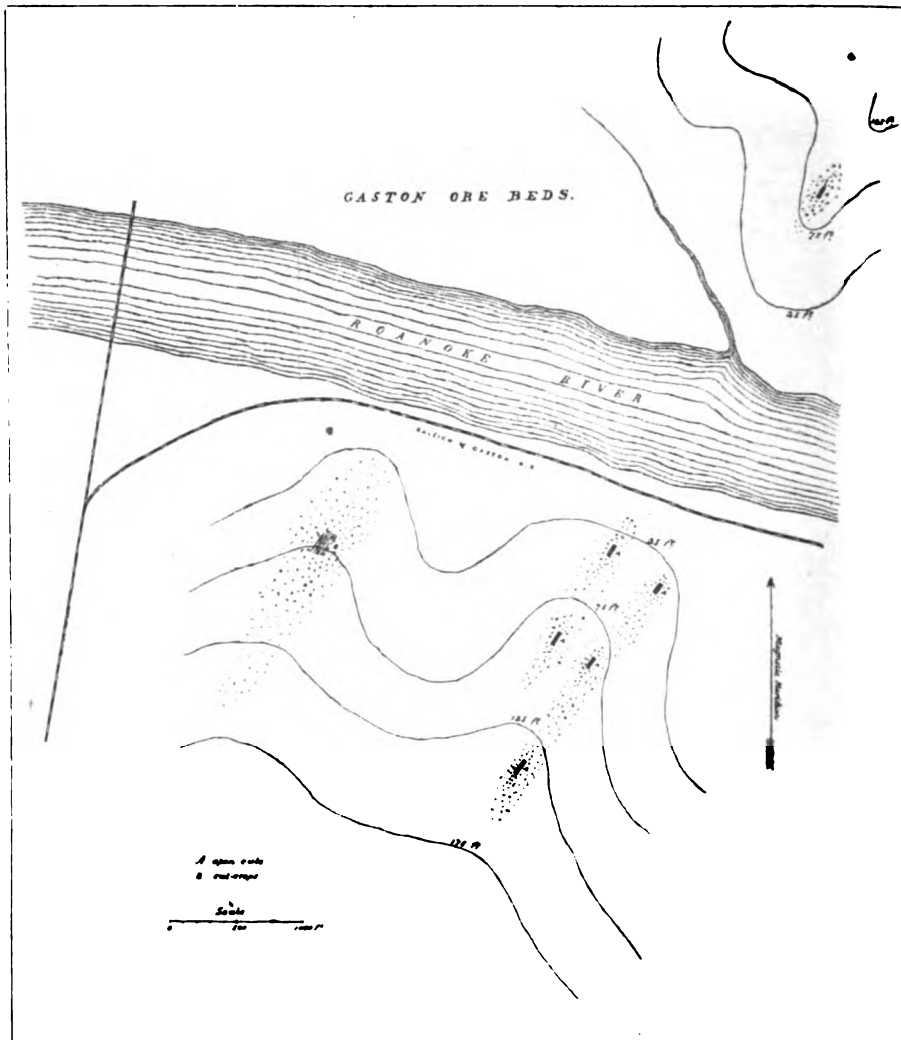
	(326)
Metallic iron.....	49.52
Phosphorus	00.318
Phosphorus ratio	0.642

Prof. Kerr mentions the occurrence of *oolitic iron* ore at *Brown's mine*, three miles north of Sanford and one and a half miles south of the railroad in Moore county. He further mentions two instances of *jaspery clay ironstone*, one in Chatham county, between Lockville and Endor, and the other in the adjoining county of Moore, at Governor's creek. An analysis of the former contains:

ANALYSIS OF JASPERY CLAY IRONSTONE, CHATHAM COUNTY.

	(150)
Metallic iron.....	48.92
Phosphorus	0.39
Phosphorus ratio	0.797





GASTON IRON ORE BEDS; SHOWING THE RELATIONS OF THE DIFFERENT OUTCROPS OF ORE TO EACH OTHER AND TO THE TOPOGRAPHY OF THE REGION.

CHAPTER IV.

THE MAGNETITE, SPECULAR AND BROWN HEMATITE ORES IN THE EASTERN PART OF THE CRYSTALLINE AREA.

(a). THE SPECULAR AND MAGNETITE ORES OF HALIFAX COUNTY.¹

THE GASTON ORE BEDS.—“On the hills fronting the Roanoke river, less than a mile east of Gaston, in the northwestern corner of Halifax county, are several outcrops of hematite ore. There are two principal beds on the south bank of the river, of which the lower only has been opened (see Plate III). It has been exposed for several rods on the upper slope of the hill, at an elevation of from 100 to 150 feet above the level of the river. This bed is in itself double, another parallel outcrop appearing at the distance of about 100 yards. The strike is N. 20° E., and the dip 80° S. E. An ore-body of from 18 inches to 2 feet thick at the surface has been uncovered in the more easterly of these beds. A shaft was sunk 25 feet upon this vertical vein, and it was stated that it widened as it went deeper. The ore is reported to show itself 8 feet thick in the bed of the Roanoke at low water. There is a reappearance of it on the other hill front about a mile distant, on the north side of the river, the ore being of the same character but a little less slaty. The character of the ore is granular, for the most part, and of the variety known as specular, but contains a considerable percentage of magnetic grains disseminated through it. It is generally slaty, impregnating and replacing the argillaceous, quartzitic and chloritic strata which constitute the Huronian formation at this locality.”

ANALYSES OF ORE FROM THE GASTON BEDS, HALIFAX COUNTY.

	(254)	(255)	(256)
Silica	9.10	10.12	....
Metallic Iron	58.73	53.31	49.84
Alumina	6.18	....	....
Lime	0.22	....	....
Sulphur	0.03	0.08	....
Phosphorus	trace.	0.05	0.005
Phosphorus ratio	trace.	0.093	0.010

No. 254 represents the upper and No. 255 the lower bed. No. 256 represents a sample taken from the shaft referred to.

¹ From “The Ores of North Carolina,” 1887, p. 127 *et seq.*, and United States Tenth Census Report, Vol. XV, p. 301 *et seq.*

These analyses show a Bessemer ore of good quality, and it is to be regretted that a more definite statement cannot at present be made concerning the quantity and extent; but this can only be established by further exploitation.

Kerr states that "about five miles southward from the above locality the same bed makes its appearance on the farm of Mr. Hines. Here, however, it is highly magnetic, fine-grained and dense, although still showing the decidedly slaty structure of the first of the Gaston beds. At this point it is represented as three to four feet thick." In contradiction to this, Mr. Willis states, in his report of the Tenth Census, p. 302, that "five miles south of Gaston, on the hills north of the Roanoke, and also 7 miles up the river above Gaston, surface pieces of a strongly magnetic trap rock were seen, but the magnetic ore described by Prof. Kerr was not found."

(b). THE SPECULAR AND MAGNETIC ORES OF HARNETT COUNTY.

THE BUCKHORN MINE.—This is situated between 11 and 12 miles below the junction of Haw and Deep rivers, on a hill nearly 200 feet high, overlooking the river from the west bank. Its location will be more readily understood from the accompanying topographical sketch (Plate IV).

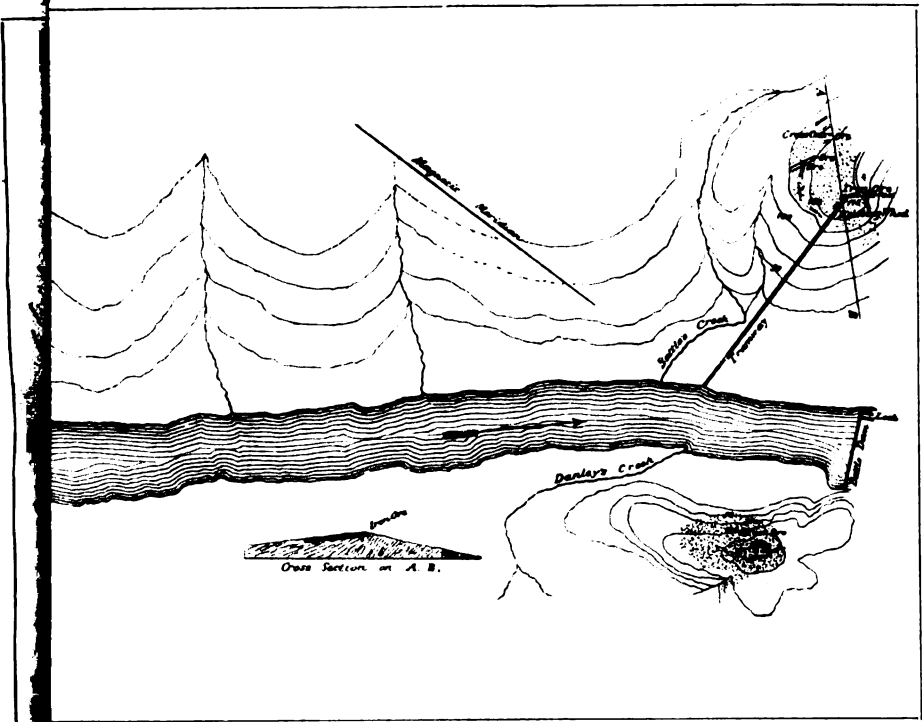
When visited early in the spring of 1892, nothing could be seen but a large pit 80 feet long, 40 feet wide and about 15 feet deep, in which some immense blocks of impure siliceous ore were lying about. One of these measured approximately 9 by 6 by 5 feet, and there must be over two hundred tons of these large broken boulders here. The ore body, which must have had approximately the dimensions of the pit, was evidently exhausted when worked for the Buckhorn and Endor furnaces.¹

¹ The present Buckhorn furnace is situated on the same bank of the Cape Fear river, 2 miles above the mine. It is an iron stack 54 feet high by 10 feet diameter of bosh, but now partially in ruins. It used hot blast and charcoal; the machinery was driven by turbine wheels. This furnace was built in 1873 by the American Iron and Steel Company, and was in operation only three months (see p. 33). The following analyses will show the composition of some of the spiegeleisen made here:

	(414)	(415)	(416)
Silicon	0.233	0.140	0.380
Metallic manganese	4.573	6.500	4.880
Sulphur	0.015	0.009	....
Phosphorus	0.051	0.120	0.095

The original Buckhorn furnace was a very small, primitive structure, built in 1862 by John Colville, who called it "Ock-Nock," said to be the Indian name for iron-pot. The stack was built of logs, after the style of the ordinary log cabin, and the inside was lined with rock and mortar; it was cold blast.

BULLETIN 1 PLATE IV.



DOUGLASS IRON ORE BEDS, HARNETT COUNTY.

The following description of this ore deposit, as it once was, is taken from the report on the "Ores of North Carolina," 1887, p. 129 *et seq.* "The ore occurs as a bed, capping the hill and sloping from the river with a dip of from 2 to 25 degrees towards the northwest. The lower part of the bed contains much manganese, and less iron in proportion, is of a mottled gray and dull reddish color at the summit, and at the distance of 200 to 300 yards along the slope is a light-colored gray and spotted (black and dirty white) ferriferous manganesian slate. Occasional sheets of laminated black oxide of manganese, 1 or 2 inches thick, occur in the bed. Some parts of the bed are slightly magnetic. The outcrop, or rather the terminal face of the bed at the opening, on the summit of the hill, is shown in the annexed diagram (Fig. 4).

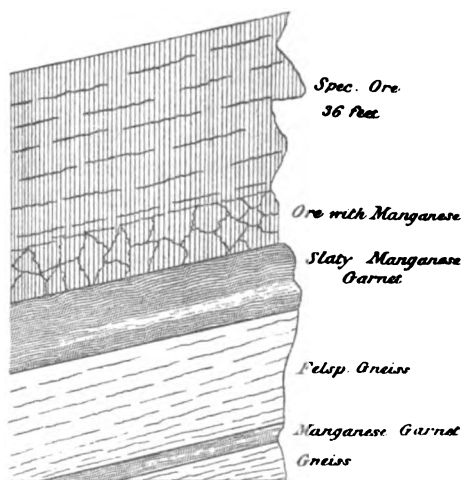


Fig. 4.—Vertical section of the Buckhorn ore bed, Harnett county.

"The ore is properly described as specular; it is of a dull, dark gray to blackish color, subcrystalline structure, and uneven fracture; the streak is dark red. Occasionally, pieces of the ore show a tendency to lamination, and in such cases the divisional planes are commonly coated with mica crystals. The country rocks are slaty, gray gneiss and mica slate, with occasional patches of light gray granite. The rock which underlies the ore is a light-colored, feldspathic, slaty gneiss, which readily decomposes."

Endor furnace, now in ruins, is a stone stack situated near Egypt, in Chatham county. It first went into blast about 1862, and used the Buckhorn ore, which was transported in boats on the Deep and Cape Fear rivers and canals a distance of 25 miles.

ANALYSES OF SPECULAR HEMATITE FROM THE BUCKHORN MINE, HARNETT COUNTY.

	(257)	(258)	(259)	(260)	(261)	(262)	(263)	(264)
Silica	26.65	21.56	13.22	....	14.45	5.65	12.80	30.50
Metallic iron	34.58	34.93	40.40	37.34	56.70	66.50	54.15	18.41
" manganese	7.90	....	....	....	....	trace	....	14.41
Alumina .....	....	....	....	....	....	0.80	5.20	19.20
Sulphur	0.039	0.064	0.054	....	0.06	....	trace	0.03
Phosphorus	0.055	0.030	0.018	0.016	trace	....	trace	0.02
Phosphorus ratio	0.159	0.085	0.044	0.043	trace	....	trace	0.108

No. 257 represents a sample taken from the stock pile at the Buckhorn furnace.

Nos. 258 and 260 represent a sample from the large blocks of lean siliceous ore, now to be seen at the mine.

No. 259 represents better class of ore, only found in small lumps at the mine, along the old inclined plane.

Nos. 261, 262 and 263 are taken from "The Ores of North Carolina," and represent the main or upper part of the bed as it was before worked out.

No. 264 represents the lower or manganesian section.

THE DOUGLASS MINE.—"The neighboring hills at a distance of half a mile, both north and south, are reported to show many scattered fragments of the same ore on the surface; and on the right bank of the river, on nearly the same level with the Buckhorn mine, at the distance of about one mile to the southwest is the Douglass Mine (see Plate IV). This is a recurrence of the Buckhorn bed, on the scale and with the features of its lower exposure, being more schistose in structure, some of the strata being in fact simply gneiss and mica slate, with disseminated grains and laminae of hematite (and magnetite), and the lower strata passing into a slaty, manganesian silicate. The thickness, which is not fully exposed, seems to be from 10 to 12 feet; angular fragments of dark, dense-granular ore, with a black manganese stain, are scattered over several acres of the hilltop.

"From the facts stated it will be apparent that these different beds are mere remnants of an ancient and very extensive deposit, which has been almost entirely removed by denudation, and carried away by the erosive action of the river."¹

ANALYSIS OF ORE FROM THE DOUGLASS MINE, HARNETT COUNTY.

	(265)
Silica	7.50
Metallic iron	55.00
" manganese	4.75
Alumina	8.49
Sulphur	0.02
Phosphorus	0.04
Phosphorus ratio	0.072

¹ Ores of North Carolina, 1887, p. 130.

THE PEGRAM MINE.—About one mile north of the Buckhorn mine (see Plate IV) is a small bed, about one foot thick, of a highly magnetic ore, in a heavy gangue of epidote and quartz. It may be dismissed without further comment as being economically of no value.

(c). **THE SPECULAR, MAGNETITE AND BROWN HEMATITE ORES OF GRANVILLE, PERSON, DURHAM, ORANGE, CHATHAM, RANDOLPH AND MONTGOMERY COUNTIES.**

THE SPECULAR AND MAGNETITE ORES OF GRANVILLE COUNTY.¹
—These deposits are situated in the northwestern part of Granville county, in Oak Hill township, about 14 miles northwest of Oxford, the county seat, $7\frac{1}{2}$ miles west of the Durham and Oxford R. R., and 6 miles south of the Atlantic and Danville R. R. Geologically they occur in the crystalline slates and schists, and consist of a series or succession of lenticular ore bodies, lying conformably between slate walls, striking N. 3° to 6° E., and dipping at very steep angles toward the southeast. The ore is, properly speaking, a red hematite, which is partly magnetic, with occasional streaks of very pure, coarse crystalline, specular ore. It is compact, hard and fine grained, in a gangue of quartz and slate. Openings have been made at three points. At *Rhodes' store*, *Seth P. O.*, opening No. 1 shows $7\frac{1}{2}$ feet of ore as far as exposed. Its strike is N. 3° E., and dip nearly vertical. Several hundred feet northeast is opening No. 2, in which the ore bed measures 21 feet in thickness. The following analysis represents an average sample taken from these two openings:

ANALYSIS OF ORE FROM SETH, GRANVILLE COUNTY.

	(240)
Silica	17.82
Metallic iron	52.48
Sulphur	0.096
Phosphorus	0.097
Phosphorus ratio	0.184

The outcrop has been roughly traced about 2 miles northeast, and 2 miles southwest from this point. About 1100 yards S. 16° W. from *Rhodes' store*, opening No. 3 has been made on the *Watkins place*, about 80 feet above the level of Grassy creek. The thickness exposed is 18 feet. The strike is N. 6° E., and the dip about 80° S. E.

ANALYSIS OF ORE FROM THE WATKINS PLACE, GRANVILLE COUNTY.

	(241)
Silica	19.08
Metallic iron	54.90
Sulphur	trace.
Phosphorus	0.070
Phosphorus ratio	0.127

¹ Engineering and Mining Journal, Vol. LIII, April 23, 1892, p. 447: article by the writer.

To either side of this opening the outcrop of slaty, micaceous country rock is impregnated with small crystals of magnetite extending over a distance (across the strike) of about 180 feet. The float ore is very heavy over certain areas of the Watkins place, and large masses of very fine ore have been piled up to clear the land for cultivation. About 100 feet south of opening No. 3 a small blast has exposed the gray micaceous schist, containing small crystals of magnetite, and coated or stained in places with malachite. This is a suggestive fact, and whether or not these iron ore deposits bear any relation to deposits of copper in depth (as is the case in some of the Maryland copper mines) will be worthy of future investigation. As far as present explorations have gone the indications are encouraging for finding good deposits of workable ore.

SPECULAR HEMATITE AT MT. TIRZAH, PERSON COUNTY.—At Mt. Tirzah, in the southeastern corner of Person county, near the Durham line, there is a deposit of red specular hematite on the land of *William F. Reade*. It is reported that in 1863, Mr. T. W. Moore sunk a shaft here to the depth of 60 feet and drifted off some 100 feet each way on the vein of ore, which is said to have been from 6 to 12 inches thick. Mr. Moore also erected a forge here and smelted some of the ore, but his undertaking was unsuccessful. He also used some ore from a place called "A. I.," 5 miles west of Mt. Tirzah, picked up from over the surface. The site of these old workings is still visible alongside of the public road (Clarksville road), but the shaft itself has caved in and is filled up. Some ore was found in the old dump at the mouth of the shaft, from which a sample was taken for analysis. The gangue is quartz.

ANALYSIS OF RED SPECULAR ORE FROM MT. TIRZAH, PERSON COUNTY.

	(333)
Silica	23.60
Metallic Iron	41.98
Sulphur	trace.
Phosphorus	0.140
Phosphorus ratio	0.333

SPECULAR HEMATITE IN DURHAM COUNTY.—In the northeastern corner of Durham county, on the *Murtha Peed* farm, there is an outcrop of very compact, hard and fine-grained siliceous red hematite in the chloritic slates of the crystalline rocks, very near the edge of the Triassic sandstone basin. This is about half a mile due west (in an air line) from the Granville county line, and $2\frac{1}{2}$ miles northeast from Stagville, near Flat river. It is 4 miles from the Lynchburg and Durham branch of the Norfolk and Western railroad, and from 3 to 5 miles from the Durham and Oxford branch of the Richmond and Danville railroad.

At the time this section was visited, some private prospecting was being prosecuted on a small scale. The possible thickness of the ore-body, judging from the outcrop, is from 10 to 15 feet. The strike is about S. 18° W., and the dip nearly vertical.

The following analysis is of an average sample collected here:

ANALYSIS OF ORE FROM THE MARTHA PEED FARM, DURHAM COUNTY.

	(193)
Silica	29.77
Metallic iron	38.32
Sulphur	0.025
Phosphorus	0.250
Phosphorus ratio	0.652

About $\frac{1}{2}$ mile southwest from the above place these outcroppings continue on the farm of *Joseph Woods*. The ore is similar to that above described, "very slaty, and is in fact an impregnation of the chloritic, argillaceous quartzite with granular magnetite and hematite. At one point it appears to be about three feet thick."

ANALYSIS OF ORE FROM JOSEPH WOODS FARM, DURHAM COUNTY.

	(194)
Silica	20.38
Metallic iron	54.81
Magnesia	1.26
Phosphorus	0.022
Water	2.62
Phosphorus ratio	0.040

On the land of *M. W. B. Veazey*, one mile from Knapp of Reeds, the probable continuation of this same general ore belt is found. The ore is exactly similar to that above described. Some private prospecting was going on at the time this locality was visited, in February, 1892, but had not proceeded sufficiently to determine the thickness and extent of the ore beds. The indications for finding large bodies were favorable. Overlying the ore near the outcrop is a cap-rock of porous, ferruginous quartz which is reported to be gold-bearing.

ANALYSIS OF ORE FROM THE LAND OF M. W. B. VEAZEY, DURHAM COUNTY.

	(195)
Silica	35.27
Metallic iron	33.15
Sulphur	0.03
Phosphorus	0.08
Phosphorus ratio	0.241

On the land of *Richard Peed*, near the Veazey place, an outcrop of a similar ore makes its appearance, which was opened by a shallow pit, showing about 3 feet of ore on the bottom.

So far as established, the siliceous quality of these ores unfits them for economic use.

THE CHAPEL HILL MINE, ORANGE COUNTY.—This mine is situated on a hill, about 200 feet above the level of a small creek, one mile north of Chapel Hill. The University branch of the Richmond and Danville R. R. passes near the mine, and is connected with it by means of a short tramway. The mine was operated at intervals from 1872 to 1882, but since that time has been idle, and consequently the condition of the workings prohibited a re-examination by the present survey.

¹“On the summit of the hill a true fissure vein filled with iron-bearing quartz may be traced in a north and south course for about 1000 feet; beyond the hill it is said to separate into a number of smaller fissures. The main vein is crossed near the southern end by another smaller vein, with a course of about N. 60° E. (see accompanying plate No. V). The country rock is a gray granite and syenite, but the vein is carried by a much-jointed, fine-grained, ferruginous, slaty quartzite of several rods in breadth.

“At the main shaft the vein has a total thickness of 10 feet; the ore at the sides is very lean, but towards the center the proportion of iron increases rapidly, and from 6 to 7 feet out of the 10 may be considered good ore. Towards the summit of the hill the vein widens to from 25 to 30 feet. It has a dip to the west which is little short of 90 degrees.

“The character of the ore is a dense, steel-gray hematite, specular in part, with a slight percentage of magnetic oxide.”

The following analyses show its variable composition:

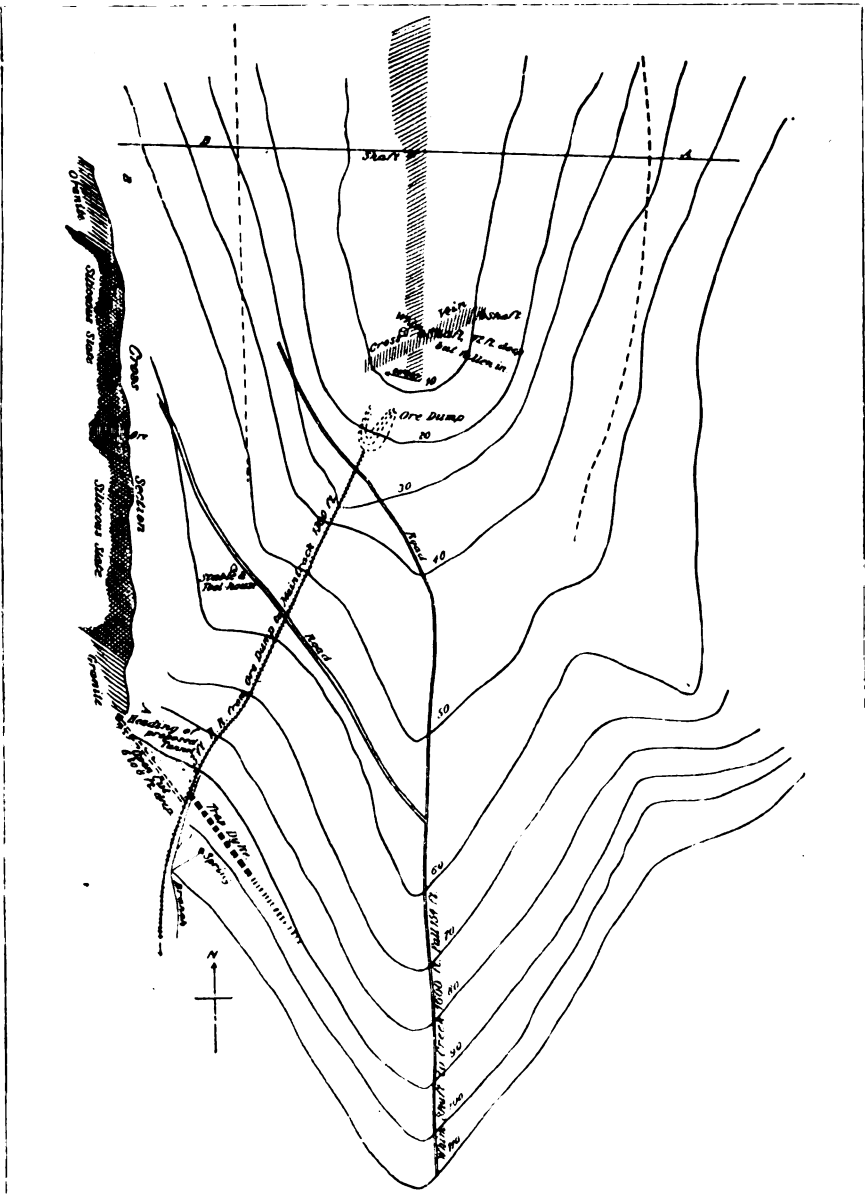
* ANALYSES OF ORE FROM THE CHAPEL HILL MINE, ORANGE COUNTY.

	(329)	(330)	(331)
Silica	2.63	43.04	42.69
Metallic iron.....	65.77	37.94	....
“ manganese	0.214	trace.	....
Alumina	1.680	2.07	....
Lime	0.560	0.10	....
Sulphur	0.110	0.153	....
Phosphorus	0.017	0.057	0.170
Titanic acid .....	.....	trace.	present.
Phosphorus ratio	0.025	0.150	0.399

MAGNETITE NEAR CHAPEL HILL.²—Magnetite occurs about 3 miles S. S. E. of Chapel Hill on the *Cheek* farm, in surface fragments, from a few inches to one foot in diameter. No explorations have been made with the view of determining the nature and extent of this deposit of ore.

¹ From the “Ores of North Carolina,” p. 139 *et seq.*, and United States Tenth Census Report, p. 306 *et seq.*

² Journal of Elisha Mitchell Scientific Society, 1883-84, p. 87.



CHAPEL HILL IRON ORE MINE; MAP SHOWING THE RELATIONS OF THE ORE DEPOSITS.

Scale: 1 inch=200 feet; Contour interval 10 feet.

The following analysis shows its composition:

ANALYSIS OF FLOAT ORE FROM THE CHEEK FARM NEAR CHAPEL HILL.

	(332)
Silica	3.02
Metallic iron	69.54
Sulphur	0.19
Phosphorus	trace.
Water	0.52

MAGNETITE AND HEMATITE ORE NEAR HILLSBORO, ORANGE COUNTY.¹—"Five miles southeast of Hillsboro a vein of magnetite is traceable for one-fourth of a mile, and a considerable amount of ore is reported as occurring on the surface. Hematite is also reported on the Hastings place. Deposits of hematite outcrop from 3 to 4 miles W. S. W. of Hillsboro; the ore is fine-grained, much jointed, in wedge-shaped, pocketed masses, 4 feet and less in thickness, imbedded in a ledge of bluish, shaly, jointed rock.

"Another outcrop occurs along the top of a ridge $\frac{1}{2}$ mile long, in an E. N. E. and W. S. W. course, about $\frac{1}{4}$ to $\frac{1}{2}$ mile W. S. W. of the above, and from 4 to 4 $\frac{1}{2}$ miles W. S. W. of Hillsboro. The ore here appears as a heavy ledge of dark blue, slaty, fine-grained hematite, which in places changes into quartzite schist, and in other places to a ferriferous, spotted, conglomerate, talcoid slate, as near the Evans bed in Chatham county, which ore it resembles. The bodies of ore are irregularly distributed through the slaty ledge."

From the above statement it is evident that these ores are very siliceous in quality, and it is not supposed that their quantity will warrant mining developments.

ORE HILL, CHATHAM COUNTY.—This ore deposit is situated at Ore Hill Station on the Cape Fear and Yadkin Valley railroad, about 40 miles southeast of Greensboro. The ridge known as "Ore Hill" is about 300 feet in elevation above the level of Ephraim creek, and covers in the vicinity of 340 acres; it is the property of the North Carolina Steel and Iron Co., of Greensboro, whose intention it is to mine these ores for their furnace at Greensboro.²

¹ From "Ores of North Carolina," p. 141.

² This furnace was completed in June, 1892. The height of the stack is 70 feet, diameter of bosh 16 feet, diameter of hearth 8 feet, and the estimated daily capacity 100 tons. It is equipped with two Ford and Moncure stoves, 60 feet high by 20 feet in diameter; one vertical Weimar blowing engine of 600 horse-power, diameter of blowing cylinder 7 feet, diameter of steam cylinder 42 inches, stroke 4 feet. The steam boilers are of the Sterling make, with a capacity of 750 horse-power, and are supplied from reservoirs holding 4,500,000 gallons, equipped with two pair of duplex Worthington pumps. The cast-house has 7200 feet of floor space. Two railroad tracks, connecting with the Greensboro lines, run through the stock house on a trestle 16 feet high. The stock yard has a capacity of 15,000 tons of ore. (See Plate II, page 32.)

Ore was mined here over 100 years ago, during the Revolutionary war. No account of any of the old forges that used the ore can now be obtained.

During the late war the "Sapona Iron Co." operated a small charcoal furnace;¹ and in 1865 the Confederate Government laid foundations here for extensive ordnance works, which were, however, never completed.

In the following description reference is directed to Plate VI. The hill is covered with old workings, most of which have caved in to such an extent that little can be seen now. Some of these have been cleaned out and reopened, and it is from these that the following information is derived. In the course of prospecting the North Carolina Steel and Iron Co. has taken out some 700 tons here. The country rock is a quartzitic talc-slate, knotted and toughened with much tremolite. The ore is brown hematite, with the exception of one vein near the top and back of the hill, which is red hematite, partly specular. A satisfactory explanation of the geological structure of these ore deposits cannot at present be given. It will require a special study, aided by more extensive development of the mines. It cannot be said now whether these deposits of brown hematite are eruptive dikes, regular contact veins or lodes, or gossans. The fact that analyses of the ore show low percentages of sulphur, even where the water level has been reached, rather excludes the last idea. All present indications point to the existence of the ore bodies in regular veins, between regular walls, dipping at very steep inclinations, and having variable strikes.

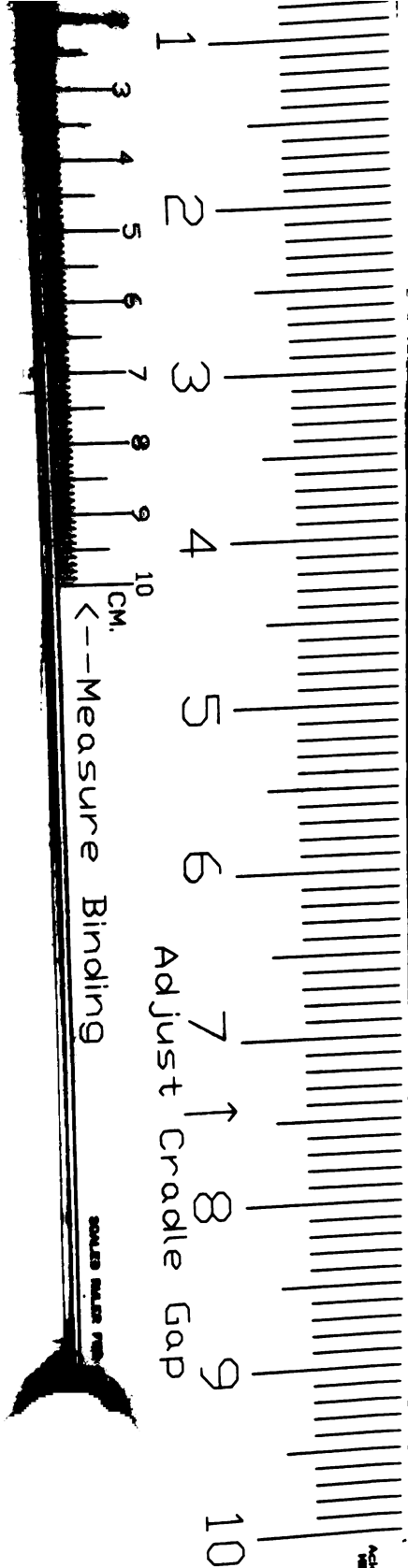
Opening No. 1 is 1400 feet south of the railroad track and 207 feet above the same in elevation. It is a large cut in the shape of an amphitheater, about 40 feet deep, in the face of which a vein of brown hematite varying from 10 to 20 feet thick is exposed. It has been explored by monkey-drifts (a), for 200 feet along the vein in a due southerly direction; and (b) 12 feet long, in ore. On the western side of the cut a smaller vein has been explored by drift (c) in a westerly direction, 40 feet long, in ore. See Fig. 5 on the following page.

ANALYSIS OF ORE, OPENING NO. 1, ORE HILL, CHATHAM COUNTY.

	(119)
Silica	4.73
Metallic iron	47.87
Sulphur	0.34
Phosphorus	0.069
Phosphorus ratio	0.144

¹ This furnace, the remains of which are still standing, is situated on Ephraim creek, at the northern foot of Ore Hill. It was built of stone; height 28 feet; diameter of bosh 8 feet. The hearth was lined with a bastard soapstone; one tuyère using hot blast, worked by two horizontal iron blowing cylinders, 44 inches in diameter and 4 foot stroke, driven by a 40 horse-power engine. The yield of the furnace was from 4½ to 5 tons of pig iron per day.





Opening No. 2 is 400 feet N. 60° W. from No. 1, at an elevation of 284.6 feet above the railroad track. This is a shaft 80 feet deep on some old workings. The thickness of the vein is not known, as no cross-cut has been made, but it is not supposed to be over five feet.

Near here a vein of soft ore has been prospected by a short drift, showing 6 feet of ore.

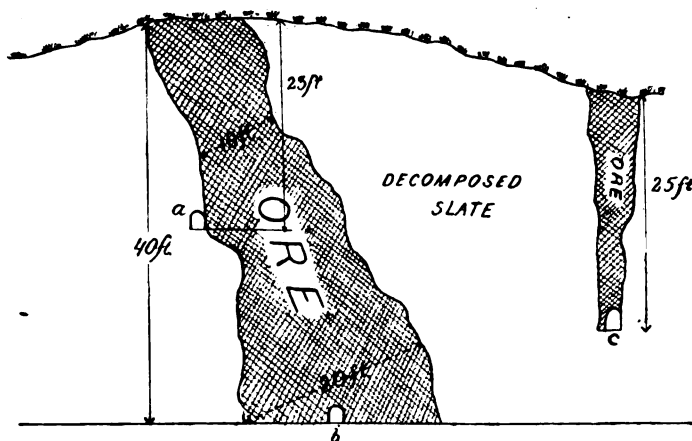


Fig. 5.—Showing ore body at Opening No. 1, Ore Hill.

The Whim Shaft is about 400 feet S. 30° W. from opening No. 2, on the crest of the hill at an elevation of 307 feet above the railroad. The depth of the shaft is 90 feet, strike of the vein S. 15° E., dip vertical; the thickness of the ore varies from 15 inches on the outcrop to 2½ feet at the bottom of the shaft. A number of old surface diggings along here point to the existence of small parallel veins. The ore is very porous.

Two analyses from this locality are borrowed from the "Report on the Ores of North Carolina," by W. C. Kerr and Geo. B. Hanna, 1887, p. 138.

ANALYSES OF ORE FROM NINETY-FOOT SHAFT, ORE HILL, CHATHAM COUNTY.

	(120)	(121)
Silica	1.42	3.79
Metallic iron	57.26	58.67
Lime	1.19	....
Magnesia	0.11	....
Sulphur .....	....	0.33
Phosphorus .....	....	trace.
Combined water	15.26	....

Shaft No. 3 is 240 feet S. 85° W. from the whim shaft, at an elevation of 291.8 feet above the railroad. It is 85 feet deep. It is reported

that the ore vein varies in thickness from $1\frac{1}{2}$ feet on the outcrop to 6 feet at the bottom of the shaft. The wall rock is a talcose schist.

ANALYSIS OF ORE FROM SHAFT NO. 3, ORE HILL.

	(122)
Silica	2.35
Metallic Iron	47.23
Sulphur	0.28
Phosphorus	0.139
Phosphorus ratio	0.294

The *Spring Openings* are about 1500 feet S. 75° W. from opening No. 3, on the western slope of the hill. Some old caved-in workings here show evidences of quite extensive operations in former times. A small pit 10 feet deep has partially exposed a vein of ore here, but not cut through, or in any way defined its thickness. The ore is soft, and apparently of very good quality.

Opening No. 4, which is but a small pit, without in any way defining the dimensions of the vein, shows up a compact, purplish-brown ore, with occasional, small, cherty seams. It appears to be lying nearly horizontal, and was penetrated by the pit to a depth of 4 feet; it is supposed to be 8 feet thick.

ANALYSIS OF ORE FROM OPENING NO. 4, ORE HILL.

	(123)
Silica	17.32
Metallic Iron	42.88
Sulphur	0.23
Phosphorus	0.106
Phosphorus ratio	0.247

Opening No. 5 is a small pit near No. 4, 12 feet deep, cutting a vein

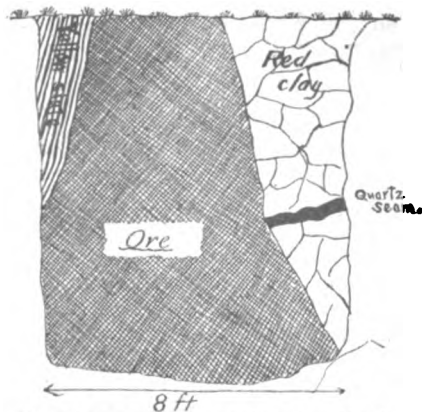


Fig. 6.—Showing ore body at Opening No. 5, Ore Hill.

8 feet thick as far as exposed; character of ore similar to No. 4.

ANALYSIS OF ORE FROM OPENING NO. 5, ORE HILL.

	(124)
Silica	5.13
Metallic iron	39.17
Sulphur	0.18
Phosphorus	0.064
Phosphorus ratio	0.163

The Tunnel Opening is about 1800 feet N. 18° E. from the Spring openings, very near the northern boundary line of the Ore Hill property. A tunnel has been driven here in a southwesterly direction, striking the ore-vein on the hanging wall side, but as it has not cut through it, the thickness of the vein cannot be determined.

ANALYSIS OF ORE FROM THE TUNNEL OPENING, ORE HILL.

	(125)
Silica	3.71
Metallic iron	49.79
Sulphur	0.17
Phosphorus	0.038
Phosphorus ratio	0.076

Between the Tunnel openings and openings Nos. 4 and 5 are several small openings, on the red hematite vein, which is practically nothing more than a very siliceous ferruginous slate, with occasional small streaks of fairly good specular ore, some analyses of which are appended below; but it does not exist in a sufficient quantity, and is therefore valueless from an economical standpoint.

ANALYSES OF RED HEMATITE FROM ORE HILL, CHATHAM COUNTY.

	(117)	(118)
Silica	24.44	....
Iron	49.00	45.70
Sulphur	0.05	....
Phosphorus	0.037	0.252
Phosphorus ratio	0.07	0.551

Below are given a number of additional analyses, showing the composition of the brown hematite ores from Ore Hill, collected from various sources.

OTHER ANALYSES OF BROWN HEMATITE FROM ORE HILL, CHATHAM COUNTY.

	(126)	(127)	(128)	(129)	(130)	(131)	(132)	(133)	(134)	(135)	(136)	(137)
Silica	1.30	....	6.58	1.86	....	....	....	....	....	....	....	....
Metallic Iron	58.76	42.29	53.20	59.62	56.78	60.90	56.17	40.32	57.69	50.24	56.66	46.57
Alumina	2.44	....	....	2.24	....	....	....	....	....	....	....	....
Sulphur	0.270	....	0.170	....	0.158	....	....	....	....	....	....	....
Phosphorus	0.400	0.235	0.041	0.224	0.488	0.219	0.430	0.182	0.833	0.822	0.641	0.213
Titanic Acid	1.070	....	....	....	....	....	....	....	....	....	....	....
Combined Water	9.54	....	....	10.00	....	....	....	....	....	....	....	....
Phosphorus Ratio.	0.681	0.556	0.077	0.375	0.859	0.359	0.765	0.451	1.443	1.688	....	....

Considered from a mineralogical standpoint, these ores are hydrated oxides of iron, varying in their percentage contents of combined water, as shown by analyses Nos. 120, 126 and 129, from 9.54 to 15.26%, the former approaching very nearly to the true goethite and the latter to limonite. Practically, they are known without special distinction as brown hematites.

Considered from an economical standpoint the foregoing analyses show the ores to range from 39.17 to 60.90% of metallic iron, and from 0.038 to 0.833% of phosphorus. The silica is uniformly very low, with the exception of one, namely analysis No. 123, from opening No. 4, where small grains of quartz occur disseminated in the ore.

It is believed that an average of from 45 to 50% of metallic iron can be obtained in actual mining.

As far as the phosphorus is concerned the variations are so great that no absolute statements can be made as to the average run of the ores in practice; they will probably approach nearer to from $\frac{1}{10}$ to $\frac{1}{4}$ of one per cent on an average. Only two analyses out of 19 (Nos. 125 and 128) show a phosphorus ratio under the Bessemer limit; and, while certain isolated masses of Bessemer ore may be found, the deposit, as a whole, cannot be depended on to furnish Bessemer ores.

Considered from all aspects, the ores are of excellent quality, and possess the advantage of being clean, not necessitating washing.

THE EVANS PLACE, SILICEOUS HEMATITE ORE.—What is known as the Evans tract, containing 600 acres, is situated nearly 5 miles southeast from Ore Hill, on the old Fayetteville plank road, and $1\frac{1}{2}$ miles east from the Cape Fear and Yadkin Valley Railroad, at Richmond Station.

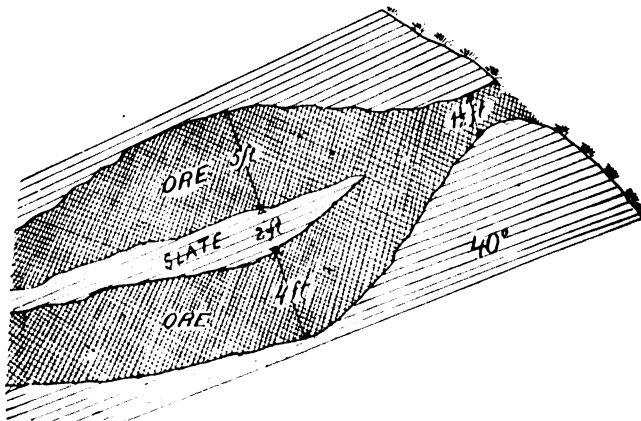


Fig. 7.—Showing ore body at Evans place, Chatham county.

A great deal of unsuccessful, superficial prospecting has been done here, but the ore bed was opened practically at but two points.

Opening No. 1, a shaft of 35 feet deep, shows a bed of semi-specular ore, widening in its descent from 2 to 7 feet; strike N. 40° E.; dip 70° N. W.

Opening No. 2, a slope inclining 40° S. W. to a depth of 40 feet, shows an ore bed widening from 1½ to 9 feet, separated by a slate wedge 2 feet thick.

Much has been reported and written concerning the excellent quality of the Evans ore, and many analyses, showing a high grade of ore, have been exhibited, but these must have been made from very carefully selected samples, for it is true that small masses of extra good ore do occur sparingly disseminated in the vein matter.

The following analyses of some average samples will show the true nature of this material, which may not even be classified as an ore, properly speaking.

ANALYSES OF ORE FROM THE EVANS TRACT, CHATHAM COUNTY.

	(138)	(139)	(140)
Silica	60.48	55.92	55.89
Metallic iron	22.61	23.42	32.48
Sulphur .....	.....	.....	0.06
Phosphorus .....	.....	.....	0.032

These analyses speak for themselves; the ore is entirely too high in silica to be of any economical value; it is in fact nothing more than a ferruginous clay-slate.

About ¼ mile nearly due west from the Evans place, float ore of very good red specular hematite was found, but no openings have been made. The following analysis shows the superior quality of this ore; but nothing can be said as to the quantity or mode of occurrence, until additional exploration has been made; and it may be here, as at the Evans place: small lenticles of ore disseminated in a ferruginous slate material.

ANALYSIS OF FLOAT ORE FROM NEAR THE EVANS PLACE, CHATHAM COUNTY.

	(142)
Silica	5.03
Metallic iron	65.12
Sulphur	0.029
Phosphorus	0.016
Phosphorus ratio	0.024

Emmons¹ speaks of "a magnetic ore of fine quality on the plantation of T. Unthanks, 2 or 3 miles beyond the Evans place," and of another of the same class at Headen's, near Ore Hill. Still another locality

¹ *Geology of Midland Counties of North Carolina*, 1856, p. 123.

is noticed by both Emmons¹ and Wilkes² as containing a bed of reddish brown ore which is magnetic. It is represented as 2½ feet thick at the *Tysor place* on the north bank of Deep River, 1½ miles above the Gulf; the analysis given by Wilkes is as follows:

ANALYSIS OF MAGNETIC ORE FROM THE TYSOR PLACE.

	(149)
Silica	4.00
Metallic iron	61.00
Water	8.80
Carbon	7.37

MAGNETITE AT TYRRELL'S MOUNTAIN, CHATHAM COUNTY.'—"A fine quality of magnetic ore, dense, metallic, and very pure, is found on the west side of Haw river, and about 2 miles distant at the foot of Tyrrell's Mountain, on the farm of Mr. Snipes. The vein has not been fully explored, but is reported to be three or four feet thick. It is in syenite and has an epidote gangue. The analysis by Lobdell is as follows :"

ANALYSIS OF MAGNETITE ORE. TYRRELL'S MOUNTAIN, CHATHAM COUNTY.

	(151)
Silica	1.62
Metallic iron	63.49
" manganese	0.56
Lime	trace.
Alumina	6.60
Sulphur	0.13
Phosphorus	trace.

THE IRON ORES OF MONTGOMERY AND RANDOLPH COUNTIES.'—"These belong geologically to the Chatham county range, for they are found in the same great slate belt (Huronian) that constitutes, both geologically and mineralogically, the most notable feature of the middle region of the State. The best known of these ores is found near Franklinsville, Randolph county, and is reported to be largely magnetic. Another vein, near Asheboro, carries specular hematite. Some of the strongest and most highly prized iron obtained during the war came from this locality.

"Dr. Emmons describes an occurrence of hematite of apparently considerable extent, 7 miles southwest of Troy, in Montgomery county. Another occurrence is noted by him 4 miles south of Troy. It is found

¹ Geology of Midland Counties of North Carolina, p. 262 *et seq.*

² Examination of Deep River Country, 1859, p. 15.

³ From "Ores of North Carolina," 1887, p. 139.

⁴ From "The Ores of North Carolina," 1887, p. 142.

with talcose schist, and is soft and friable. It sometimes happens that a vein of specular ore lies by the side of a magnetic vein, being separated by only a few feet."

(d). THE SPECULAR AND MAGNETITE ORES OF MECKLENBURG AND CABARRUS COUNTIES.¹

"No iron mines of any extent have been worked in these counties, but ore has been found in a number of localities. Fragments of a very heavy, black, metallic ore are found in considerable quantity on the farm of George Phifer, three miles from Concord, Cabarrus county; the search for it was not sufficiently extended to allow of any satisfactory conclusion.

"Iron ore is found at Van Pelts, three miles from Davidson College; also hematite at a point five miles southwest of the college, in Mecklenburg county. Some explorations were also made in the southern part of Mecklenburg, in the Sugar creek neighborhood; many blocks of a remarkably pure, granular magnetite were found scattered over several acres of surface of an old field, and along the public road here; several trenches were cut, which exposed two or three veins from one to four feet thick.

"In Steel Creek township, Mecklenburg county, iron ore has been found and prospected on the lands of Dr. Strong; and on the lands of James Coffee, near by, a similar deposit was unearthed, and a considerable amount of ore raised. Some 12 miles northwest of Charlotte, in the Hopewell neighborhood, a notable quantity of surface fragments of large size are still to be found in an old field, and in the woods adjacent.

"This is a specular ore in a gangue of quartzite, not unlike the Chapel Hill ore. No exposures of the vein have been attempted. Beautiful pieces of micaceous hematite are found in almost every part of the county, but as yet there is no proof of any workable deposits. Magnetite is also found on the ridge near the Frazer gold mine, 5 miles west of Charlotte. The ores of the southern end of this county and of Cabarrus are found in the syenite, so prevalent in this region."

¹ From "The Ores of North Carolina," 1887, p. 154, with slight alterations.

CHAPTER V.

THE TITANIFEROUS MAGNETITES IN THE CRYSTALLINE ROCKS OF ROCKINGHAM, GUILFORD AND DAVIDSON COUNTIES.¹

"One of the most remarkable and persistent ranges of iron ore in the State crosses the county of Guilford in a northeast and southwest direction, passing about 10 miles northwest of Greensboro, near Friendship.

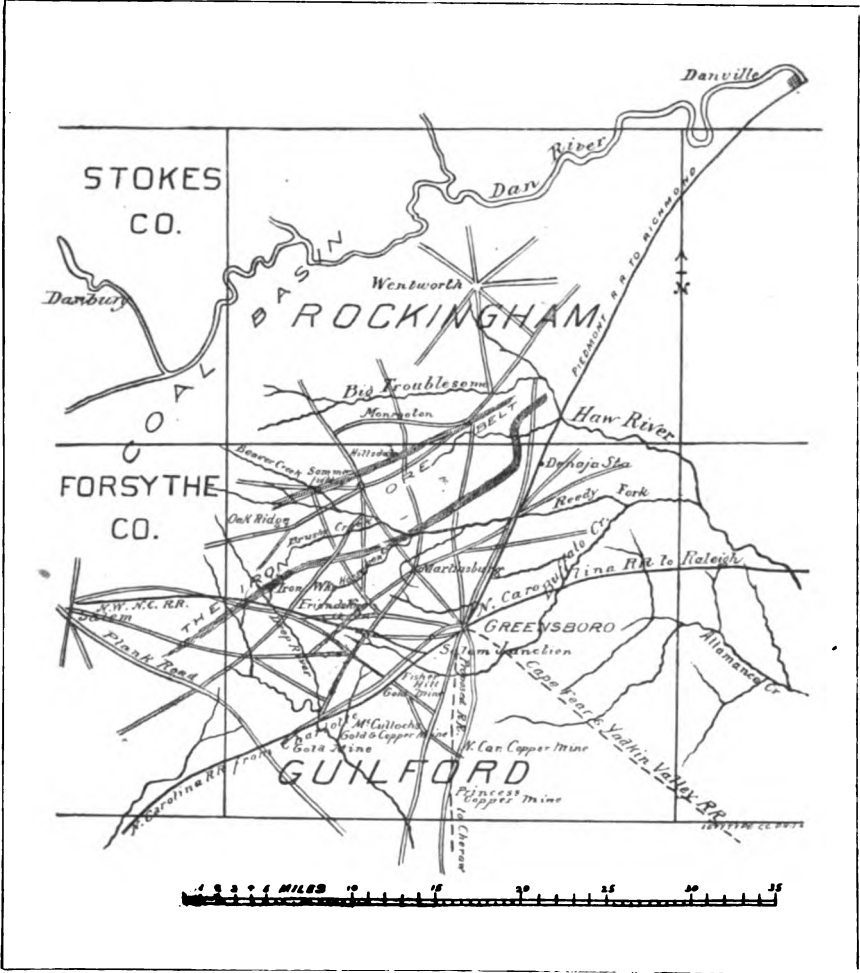
"It extends from the head waters of Abbott's creek in Davidson county, across the southwestern corner of Forsythe county and entirely across Guilford, to the Haw river in Rockingham county, a distance of thirty miles, making its appearance on nearly every plantation, and indeed on almost every hillside in the range."

This general range of ore consists of two parallel belts, the longest and most persistent being known as the "Tuscarora," and the other, lying some 3 miles to the northwest, the "Shaw" belt. Beyond Haw river these two belts approach each other, and are believed to unite in Rockingham county. The local relations and the geography of the ore belts are shown in the accompanying map (Plate VII). The other maps (Plates VIII and IX, p. 62) show the belt on a larger scale, giving the names of the plantations crossed by the ranges, commencing at the southwestern extremity on a branch of Deep river.

The ore is a granular titaniferous magnetite, containing on an average less than 14% of titanic acid; small proportions of chromium and manganese are uniformly present, as seen from Dr. Genth's analyses, given further on. It is usually rather coarse-grained, and frequently associated with crystals of chlorite in small seams and scattered bunches. The gangue is a decomposed gneiss.

Dr. Genth, who made a special chemical and mineralogical study of these ores, says: "All of the ores consist of mixtures of magnetic iron with titaniferous hematite or menaccanite, probably also with rutile (titanic acid), mixed with a chloritic mineral, or a silvery micaceous one resulting from its decomposition. Some of the ores contain alumina in the form of granular corundum, in one or two places in such quantities that they become true emery ores."

¹ From "The Ores of North Carolina," p. 143 *et seq.*; the United States Tenth Census Report, Vol. XV, p. 308; and a private report to the North Carolina Centre Iron Co., by J. P. Lesley, 1871, with slight alterations and additions by the writer.



IRON ORE BELTS OF GUILFORD COUNTY; A SKETCH MAP SHOWING THE RELATIONS OF THE ORE DEPOSITS. (AFTER LESLEY.)

The mode of occurrence of the ore in beds is illustrated by Dr. Lesley, by means of the following ideal diagram:

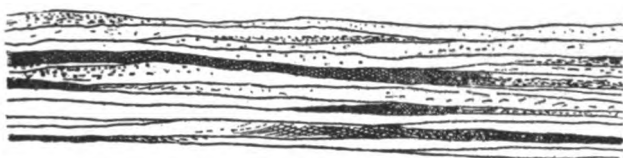


Fig. 8.—Showing the mode of occurrence of the ore in beds.

He says: "The beds were deposited in the same age with the rocks that hold them; they are in fact rock deposits highly charged with iron, and they differ from the rest of the rocks only in this respect, that they are more highly charged with iron. A large number of rock strata will become ore beds locally, but there will always be a particular part of the formation more generally and extensively charged with great quantities of iron than the rest. In other words, the iron of the formation, as a whole, is concentrated along one or more lines. This is evidently the case with the Tuscarora belt, as shown in the almost perfect straightness of the outcrop of the ore at the Sergeant shaft, where it has been opened for half a mile northeast of the shaft. There are two principal beds cropping out on the Teague plantation, at the southwestern end of the belt, both vertical and about 300 yards apart.

And not only does the number of ore beds vary, but they are often very irregular in position. This is illustrated by the following section, revealed in a trench, cut at right angles to the outcrop, fifty feet long and from four to eight feet deep, on the widow McCuiston's plantation.

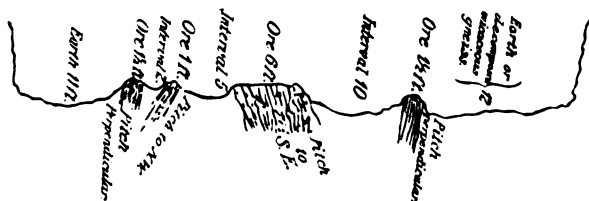
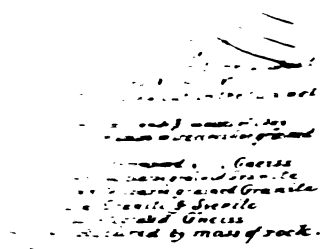


Fig. 9.—Showing irregular position of the ore beds, McCuiston (McChristian) plantation, Guilford county (after Lesley).

Similar irregularities are noticeable everywhere. The miners say that the pitch of the ore bed, worked in the Sergeant tunnel and shaft, was southeast for some way down, after which it took its regular northwest dip; besides which there were in fact two beds cut in this shaft and tunnel, the smaller bed underlying the other, and with a dip that would carry the two beds together at some distance beneath the floor.



Rocked plantation, Guilford

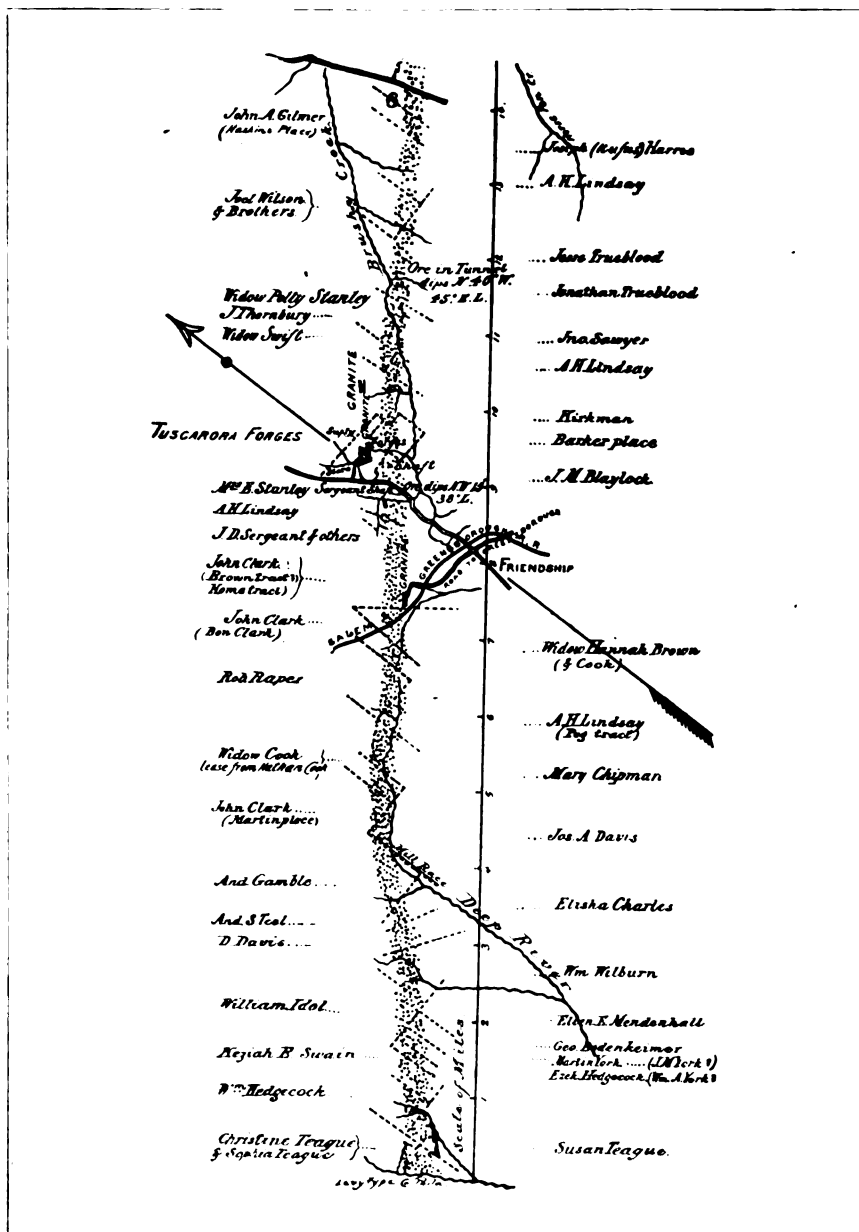
as see figure 13) furnish a
 creeps seeming to be vertical,
 has shown a distinct dip

themselves, they consist of strings
 ing and contracting in thick-

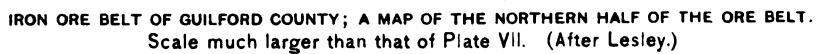
The principal beds may be
 feet, and in the best mining
 way may reach five feet.

mining could not exhaust it, for
 be entered and mined at fifty

and Shaw belts, though sep-
 converge and are supposed to
 and other considerations make it
 the northwestern outcrop of a



IRON ORE BELT OF GUILFORD COUNTY; A MAP OF THE SOUTHERN HALF OF THE ORE BELT. Scale much larger than that of Plate VII. (After Lesley.)



synclinal basin, 3 miles wide, and that the Tuscarora belt is the south-eastern outcrop. If so, the Tuscarora ore beds descend with a north-west dip to a depth of a mile beneath the surface, and then rise again as ore beds at Highfields and Shaws, thus:

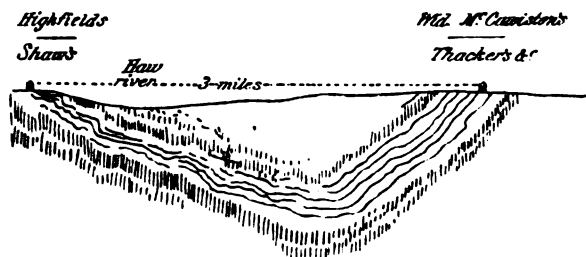


Fig. 11.—Showing the synclinal structure of the ore formation.

The average dip of the Shaw range has been observed to be considerably less than that of the Tuscarora.

These titaniferous magnetite ores were worked during the Revolutionary war in Catalan forges; in 1871 Dr. J. P. Lesley, present State Geologist of Pennsylvania, made a careful examination and report of the region to the North Carolina Centre Iron Company, which has explored the entire length of the range, and at one time carried on regular mining operations at two points, the Tuscarora and Dannemora mines, both on the Tuscarora belt. Forges were built at the former, known as the Tuscarora Iron Works, and considerable iron was made here, but the works were abandoned years ago.

THE TUSCARORA MINE is situated about one mile north of Friendship in Guilford county (Plate VII). The principal workings were in the Sergeant shaft, which was sunk to a depth of 109 feet.

Two beds were cut in the lower level, the smaller one underlying the other, which is reported to be 12 feet thick. The dip near the surface is about 70° a little east of south, but is said to change to northwest at a greater depth. The following analyses show the quality of this ore.

ANALYSES OF ORE FROM THE SERGEANT SHAFT.

	(245)	(246)	(247)
Silica	1.31	....	12.86
Metallic iron	55.06	53.20	53.27
Alumina	4.28	....	....
Sulphur	trace.	trace.	trace
Phosphorus	trace.	0.005	trace.
Titanic acid	13.60	....	13.58
Chromic oxide	0.72	....	....
Phosphorus ratio	trace.	0.009	trace.

THE DANNEMORA MINE is situated about 20 miles northeast of the Tuscarora in Rockingham county, 5 miles northwest of Brown's Summit.

This mine was in operation about 1860, and the following account of it is given by Mr. Bailey Willis in the United States Year Book Census Report:

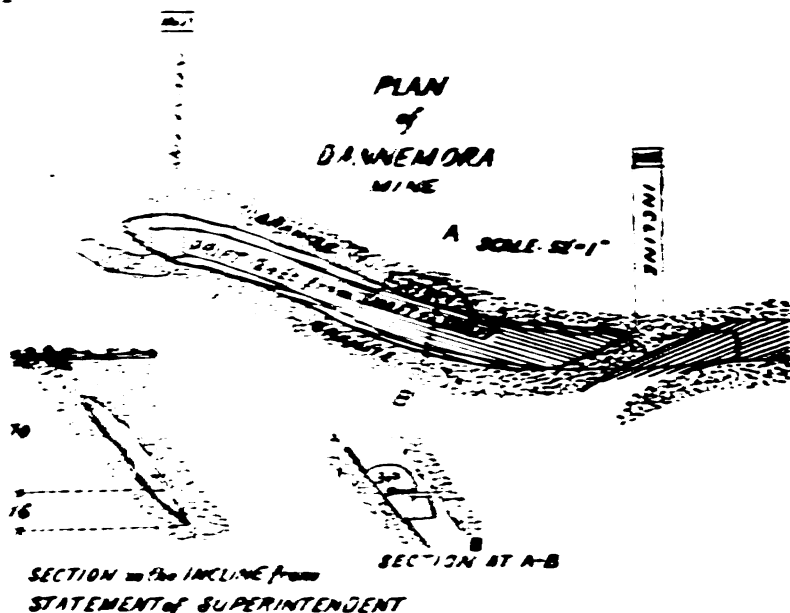


Fig. 12.—Showing the ore body at the Danwemora mine, Rockingham County, West Virginia.

"The first work was done in incline No. 1. According to the statement of the superintendent the ore gave out 10 feet from the surface, but was found again 20 feet farther down; it widened to 12 feet, which is the thickness 90 feet from the surface in the incline, 70 feet vertically. At this depth a drift has been driven along the vein and stoping has been begun. A small winze has been sunk 20 feet farther on the incline, and the ore is said to narrow to one or two feet in thickness. Before the horizontal drift reached the second incline the ore was pinched out by the granite walls.

"As the ore body thus opened gives out just beyond incline No. 1, its dimensions are pretty well ascertained. It is approximately 125 feet long, 80 feet in incline width, and 12 feet thick. The drift has been extended to another lens of the same thickness, northeast of it, and the surface outcrops and trenches indicate the existence of others to the southwest. This ore is accompanied by chlorite and mica, which are sufficiently decomposed, even at the depth of the tunnel, to be readily dug with a pick. The ore is separated on the surface, by screening, into

¹ Vol. XV, p. 308.

lump and fine ore, the former shipped for fettling and the latter for blast-furnace use." The following analyses show the quality of these respectively:

ANALYSES OF ORE FROM THE DANNEMORA MINE. ROCKINGHAM COUNTY.

	(338)	(339)
Silica	4.71	....
Metallic iron	48.41	49.41
" manganese	0.11	trace.
Alumina	8.68	....
Sulphur	0.089	....
Phosphorus	0.023	0.001
Titanic acid	13.74	present.
Chromic oxide	0.34	....
Phosphorus ratio	0.048	0.002

No. 338, lump ore. No. 339, fine ore.

Other analyses of ores from the Tuscarora Ore Belt in Davidson county, by Dr. F. A. Genth, show:

ANALYSES OF TITANIFEROUS ORES, DAVIDSON COUNTY.

	(186)	(187)
Silica	0.76	5.68
Metallic iron	57.68	52.68
Alumina	1.68	5.08
Magnesia	2.79	2.61
Lime	0.45	0.76
Titanic acid	13.52	11.67
Chromic oxide	0.46	0.48

These samples are from K. R. Swain's. No. 186, massive ore. No. 187, micaceous ore.

ANALYSES OF TITANIFEROUS ORES, GUILFORD COUNTY.

	(242)	(243)	(244)	(248)	(249)	(250)	(251)	(252)	(253)
Silica	0.40	1.84	1.30	....	12.75	1.30	26.80	....	0.50
Metallic iron...	59.03	56.21	56.41	43.47	41.95	67.60	21.63	33.97	57.32
Alumina	1.06	2.30	2.54	....	5.17	0.55	8.87	....	3.62
Magnesia	1.99	2.01	2.41	....	4.14	0.75	10.30	....	2.04
Lime	0.24	0.58	0.51	....	0.90	0.14	0.40	....	0.63
Titanic acid...	11.95	13.28	12.35	16.06	15.35	1.27	16.20	2.63	12.27
Chromic oxide..	1.07	0.65	1.10	....	1.25	1.43	0.43	....	0.57

No. 242. Granular black ore from Elisha Charles' place.

No. 243. Similar to 242, but more chloritic, from Widow Cook's place.

No. 244. From John Clark place.

Nos. 248 and 249. Soft micaceous ore from Mrs. McCuiston's place.

No. 250. The magnetic portion of 249.

No. 251. The non-magnetic portion of 249.

No. 252. Massive ore from Mrs. McCuiston's place.

No. 253. Very fine granular ore from W. A. Lewis' place.

Dr. Gentz gives the following analyses of *Emery Ores*, but does not mention the exact localities from which taken:

ANALYSES OF TITANIFEROUS ORES WITH CROMIUM (EMERY ORES).

	(330)	(337)
Silica	1.39	0.98
Metallic iron	30.97	33.52
Alumina	52.24	44.86
Magnesia	0.68	3.27
Lime	0.52	0.91
Titanic acid	0.78	2.42
Chromic oxide	0.30	trace.

No. 330. Granular, reddish ore. No. 337. Granular, grayish ore.

SHAW MINES.—On the Shaw belt the principal workings were on the

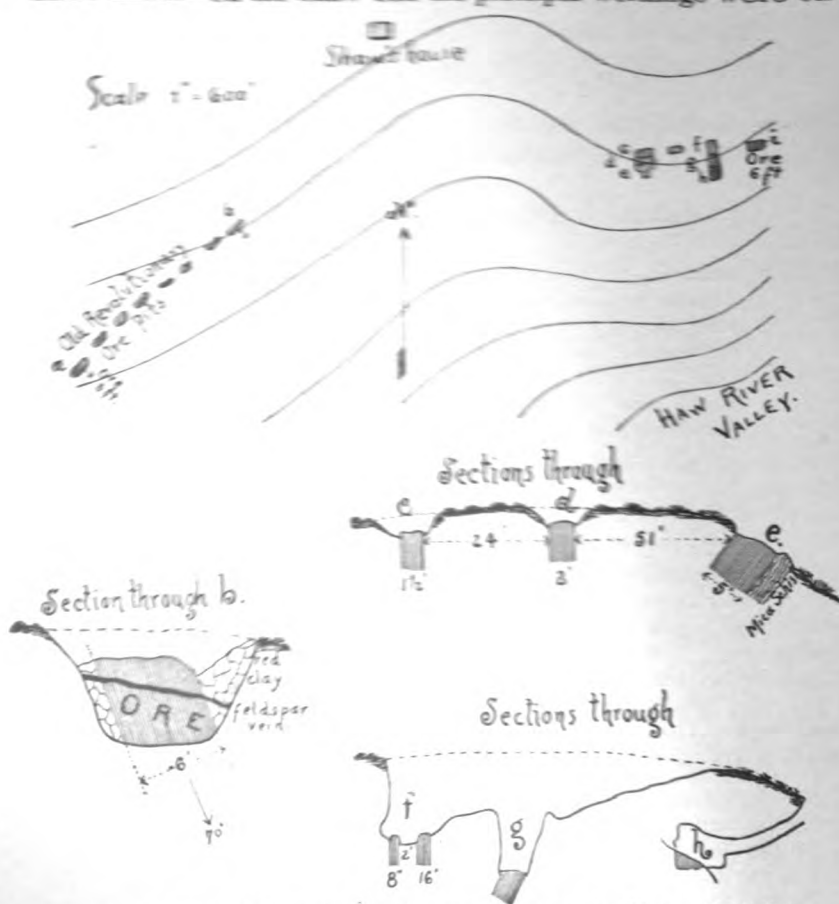


Fig. 13.—Showing the position of the ore bodies on the Shaw plantation, Rockingham county.

plantation of Levi G. Shaw in Rockingham county, where three or four distinct and parallel beds have been opened, shown in Fig. 13.

gaining
been old

The direction of the pit changes somewhat, being N. 25° to 30° E. at the old Revolutionary pits, and more nearly east at the openings made by the North Carolina Centre Iron Co. The whole course tested amounts to over $\frac{1}{2}$ mile. The beds at the outcrops vary in thickness from one (1) to six (6) feet; but owing to the thorough decomposition at the surface, a large quantity of ore may be reasonably expected in some cases, when the beds are followed down to where they become quite solid. There are apparent variations in the dip, some of the outcrops seeming to be vertical, whereas the principal part of the mining has already shown a distinct dip towards the southeast and the south. Of the old Revolutionary pits, *a* and *b* were reopened. In pit *a* there was a solid plate 5 inches thick, and then 2½ feet of clay ore at the outcrop, the whole appearing wider downwards.

At *b* the ore lies in small fragments and thin beds, interleaved with clay. This was its outcrop character for 20 feet down, when the whole thickness, 6 feet, became solid ore. The dip was 70° S. 55° E. The ore from these pits was hauled to Troublesome Forge, 5 miles to the north of this place, during the Revolutionary war.

At *i* the bed is fully 6 feet across, solid ore, in a very green chloritic, mica slate.

The quality of the ore from this part of the Shaw Belt is seen from the following analyses:

ANALYSES OF TITANIFEROUS ORE FROM THE SHAW BELT, ROCKINGHAM COUNTY.

	(334)	(335)
Silica	1.80	0.74
Metallic Iron	54.17	55.61
“ manganese	0.96	0.82
Alumina	2.66	3.82
Magnesia	3.09	1.80
Lime	0.69	0.55
Titanic acid	14.46	13.92
Chromic oxide	0.97	1.07

No. 334. Fine-grained, black, slightly micaceous ore from the Shaw mine.

No. 335. From Hopkins place, adjoining Shaw mine on northeast.

One of the constituent elements of the whole formation is *ochre*, in beds of various sizes. On the plantation of J. Somers, on Brushy creek, a bed of 20 feet in thickness rises, nearly vertically, out of a gully on a hillside covered with small pieces of fine ore; the whole aspect of the place gives an impression of an abundance of ore beneath the surface, but no openings have been made.

The high percentage of titanic acid in these ores practically condemns them for blast furnace use (see p. 22 *et seq.*). In the old Catalan forges they were smelted without difficulty, for here the cinders are

always rich in iron, and there was no difficulty in carrying off the titanic acid. The hard ores may still command use for fix or fettling of puddling furnaces. But the most hopeful problem lies in the possibility of improving these ores by means of magnetic concentration.

The fact mentioned on p. 60, that the titanic acid is supposed to exist as titaniferous hematite or menaccanite, and probably also as rutile (free titanic acid) apart from the magnetite, in mechanical admixture, as it were, may allow of the successful treatment of these ores by the magnetic concentrator, freeing them from their siliceous and titanic acid constituents, and raising the percentage of iron. Analyses Nos. 249, 250 and 251 practically demonstrate the possibility of this, at least in an experimental way. The natural ore in this case contained:

	(249)
Silica	12.75
Metallic iron	41.95
Titanic acid	15.35

After treating with a common magnet, the proportion taken up by the same showed:

	(250)
Silica	1.30
Metallic iron	67.60
Titanic acid	1.27

a decrease of 14.08% in titanic acid, 11.45% in silica, and an increase of 25.65% in metallic iron, whereas the residue or tailings was found to contain most of the impurities:

	(251)
Silica	26.80
Metallic iron	21.63
Titanic acid	16.20

There are undoubtedly large bodies of this titaniferous magnetite in the region described. This, and their quality otherwise, notably freedom from phosphorus, besides their accessible location, should certainly warrant a careful investigation into the possibilities of an economical and beneficial separation of the injurious titaniferous constituents.

CHAPTER VI.

THE MAGNETITE AND BROWN HEMATITE ORES IN THE CENTRAL PART OF THE CRYSTALLINE AREA.

These form a wide and, generally speaking, persistent belt, though broken at intervals, extending across the State in a southwesterly direction from Virginia to South Carolina.

The following geographical divisions have been made, both for the sake of convenience in description, and for the purpose of some general geological grouping:

- (a) The Magnetite Ores of the Danbury Region in Stokes county.
- (b) The Magnetite Ores of Surry and Yadkin counties.
- (c) The Titaniferous Magnetites of Davie county.
- (d) The Magnetite and Brown Hematite Ores of Eastern Catawba, Central Lincoln and Southern Gaston counties.
- (e) The Brown Hematite and Magnetite Ores of Eastern Caldwell, Burke and Cleveland, and Western Catawba and Lincoln counties.

Certain geological relations are known to exist throughout different parts of this general ore zone, but the study of the structural geology has not at this time proceeded far enough to warrant any definite and entirely comprehensive correlation of the various horizons, except in a general way. And in this connection it is desired again to call attention to the imperative need of a thorough and detailed investigation of the structural and stratigraphical geology of the State, particularly of the crystalline rocks, preliminary to the intelligent study of the economic resources.

The magnetic ores attain their greatest development towards the northeastern and southwestern extremities of this belt, in Stokes, Surry and Yadkin counties (subdivisions *a* and *b*), and in Catawba, Lincoln and Gaston counties (subdivision *d*), respectively.

In their mode of occurrence in talcose, micaceous and quartzitic schists, the ore beds of these widely separated districts bear certain stratigraphical resemblances. The ores of Davie county, on the contrary, are titaniferous, and occur in a hornblendic country rock.

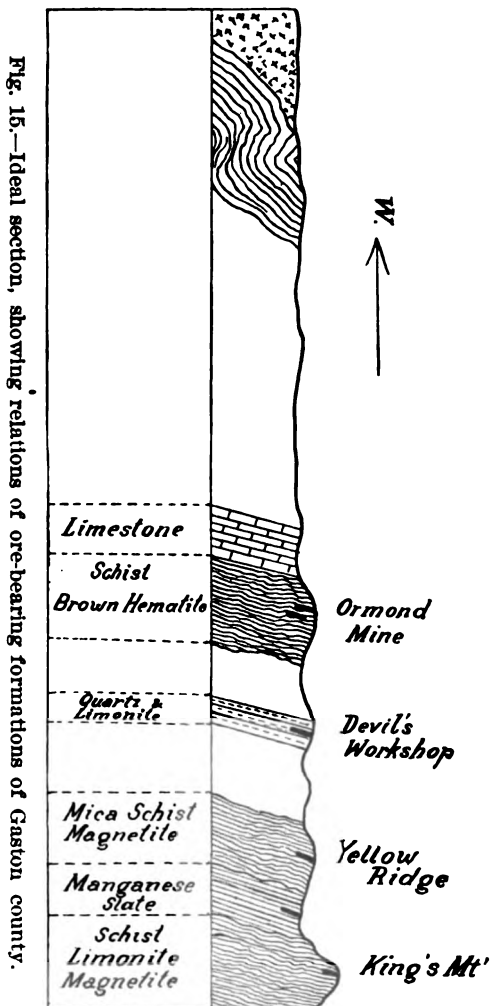
In Catawba, Lincoln and Gaston counties the distinctive stratigraphical relationship is still more strongly marked, and the formation is very persistent, though there is a break in the ore in the southern part of Lincoln and the northern part of Gaston counties, extending over some 12 or 15 miles.



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In Stokes county, at the northeastern extremity of the general belt, the stratigraphical relations, though similar in some respects, are marked by certain distinctive points of difference. As in Catawba, Lincoln and Gaston counties, the magnetic ores occur in the talcose, micaceous and quartzitic schists, and to the northwest a similar zone of



micaceous schists, carrying deposits of brown hematite, and coarse granite with mica beds, is found. The manganiferous slates also make their appearance to the east of the ore; but the limestone belt here is far on the east instead of the west side of the belt. In general, it appears that the Sauratown mountain range in Stokes county may be

closely coincident with that of King's and Crowder's mountains in Gaston county; but as the intimate structure of neither of these localities has ever been properly studied, we are practically in the dark concerning the relations of the ore deposits.

As far back as 1856, Dr. Emmons' says: "At rather distant points the ore of this belt appears in a range so direct that there is no doubt of its passing entirely across the State; it lies parallel with the limestones and slates; there is some doubt respecting the age of the limestone at Germantown, that is, it seems to be different from the King's Mountain limestone." After further consideration he concludes that "there will be no objection to combining the Stokes county and King's Mountain belts."

(b). THE MAGNETITE ORES OF THE DANBURY REGION IN STOKES COUNTY.

Danbury, the county seat of Stokes county, is situated on the south bank of the Dan river, on the foot-hills of the Sauratown mountains, of which Moore's Knob is the most prominent peak, being about 3000 feet above the sea level. On the north bank of the river are a series of parallel ridges, the spurs of which make in the direction of the river, being cut by numerous streams and hollows. Here are situated the deposits of magnetic iron ore which have been known to exist, and from which the ores have been mined and smelted, as long as 100 years ago.¹

¹ Geological Report of the Midland Counties of North Carolina, 1856, pp. 119, 120. Quotation slightly altered.

² "History of the Manufacture of Iron in all Ages," by James M. Swank, 1892, p. 113.

Union Blooming Forge, on Snow creek, 6 miles northeast of Danbury, was built in 1790 by Peter Perkins and James Martin, and rebuilt in 1854, has one fire and one hammer, worked by water; and annually made about 7 tons of bars. Other iron works were built on Snow creek in the same county, and conducted with success, before 1800. Dr. Sharswood mentions a furnace and forge which were built on this creek by Peter Perkins and James Taylor about 1795; they were located about 1/4 mile from the mouth of the creek. Davis' mill now stands on the site of the furnace. He also says that Matthew Moore built a forge on Big creek, where George's mill now stands, before 1800.

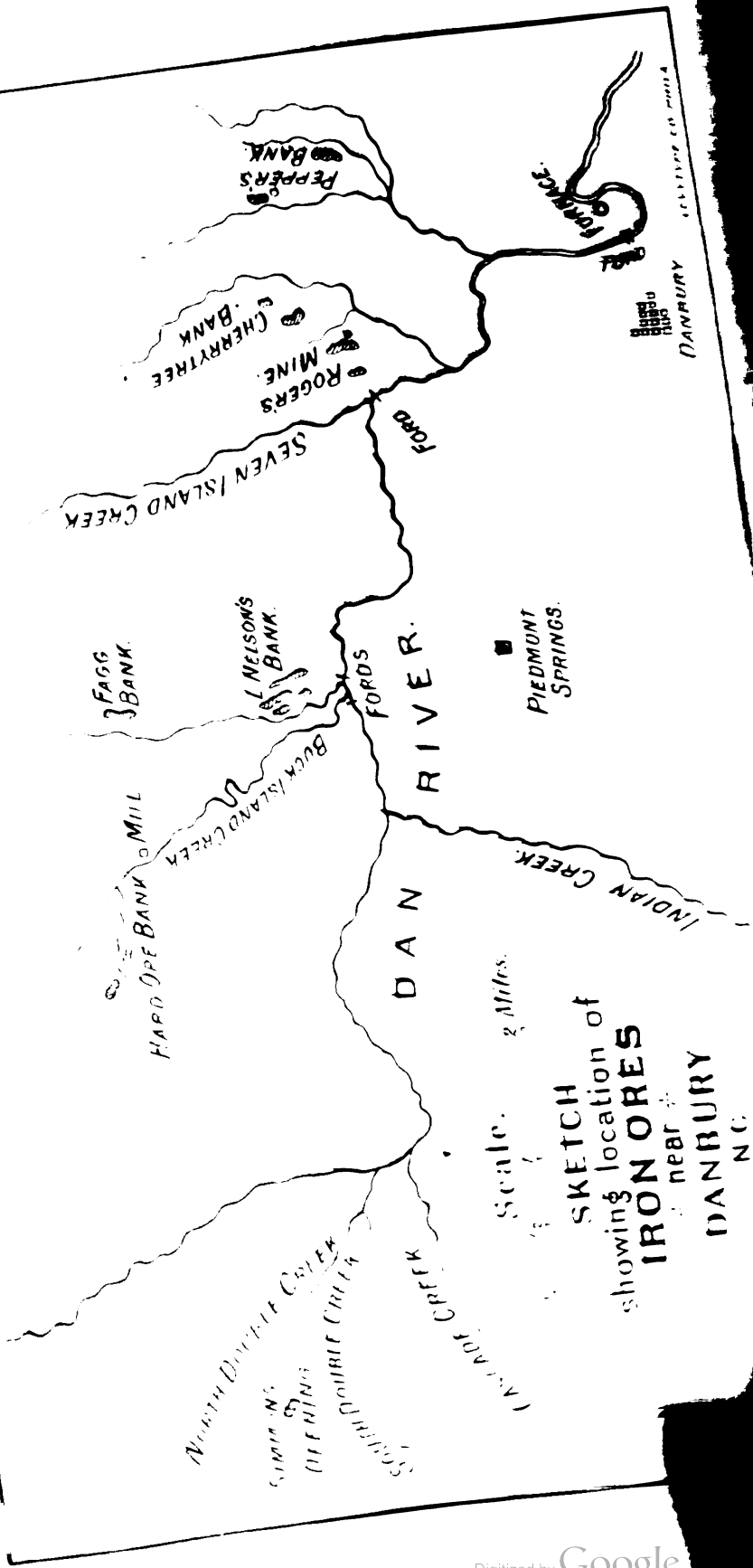
George's Blooming Forge, on the headwaters of Town Fork, 10 miles southwest of Danbury, was built in 1793 by George Hauser and Philip Keyser; rebuilt in 1854, had two fires and one hammer, worked by water, and was abandoned several years ago (before 1850).

³ "The Iron Manufacturer's Guide," by J. P. Lesley, 1856, p. 186:

Town Fork Blooming Forge, situated on Dan river opposite Danbury, built in 1848, has two fires and one hammer, worked by water, and made annually about 40 tons of bars.

Keyser's Blooming Forge, situated 1 mile from Keyser's forge, has been out of operation (probably) before 1850.

GEOLOGICAL SURVEY



The ores occur in a series of parallel belts, occupying a width of about $4\frac{1}{2}$ miles, which have been traced in a southwesterly direction for over twenty miles, crossing the Yadkin river into Yadkin county.

In a northeasterly direction they continue into Henry county, Va. Lying to the northwest of the magnetic belt is a zone of brown hematite which has not been explored; and beyond that the rocks change to a coarse granite, containing some workable deposits of mica.

In the Sauratown mountain range, on the south side of the Dan river, surface showings of brown hematite and magnetite have been observed.

Lying to the east of the magnetite ores, a belt of limestone crosses Stokes county in a N. E. direction from Germantown; but it has been found too siliceous to be of practical value in iron smelting.

To return to the main ore belt, the old mine workings, which were abandoned with the decline of the Catalan forges and charcoal furnaces, have caved in so completely that little or nothing can be seen. Our present meager knowledge of these deposits is gained almost entirely from a limited amount of private prospecting that has been done within the past few years. The geological structure of this region bears evidence of some great disturbance in the earth's crust, probably occasioned by the uplifting of the Sauratown mountains and contiguous ranges. The strike was found to vary at all angles between due east and west to due north and south. The direction of the dip naturally varies accordingly, as does also the inclination of the same, which is usually between 20 and 40 degrees.

The ores of this district may be divided into three classes:

1. Hard ore. 2. Soapstone ore. 3. Sand ore.

This is the vernacular nomenclature, and is meant to be descriptive of the structural characteristics of the ores.

1. The "Hard ore" is a hard, compact, massive, crypto-crystalline magnetite.

2. The "Soapstone ore" is a soft, greasy mass, composed of crystalline grains of magnetite disseminated through a matrix of talcose and micaceous schists.

3. The "Sand ore" is composed of magnetite grains disseminated through a sandy matrix; it is also soft and friable.

The "Soapstone" and "Sand" ores are naturally lower in iron than the "Hard" ores; but they may easily be separated from their matrix by the use of the modern improved magnetic separators or concentrators, such as the Edison, Venström, Ball and Norton, etc. The reader is referred to the accompanying sketch map (Plate X) from Willis' United States Tenth Census Report.

THE WILLIAM NELSON HARD ORE BANK.—Ore was formerly mined at this bank for the Clements forge, which was built about 1790, $1\frac{1}{2}$ miles west of the ore bank. The main opening is situated $4\frac{1}{2}$ miles northwest of Danbury, at the head of a small ravine near Mr. Nelson's house, on a small branch, a tributary of Buck Island creek, which empties into the Dan river about 2 miles from here. It is in the shape of an undercut, some 115 feet long, along the outcrop of the ore, exposing a clearly defined bed of hard, steel-gray to black magnetite varying in thickness from 3 to 8 feet.

Though hard and compact, the ore has a decided schistose structure: the gangue is hornblende, gneiss and chlorite, with occasional specks of pyrite and chalcopyrite; the hanging-wall is a hard, granitic quartzite; and the foot-wall is hornblende schist, bounded to the ore by a layer of epidote. The dip is 20 degrees nearly north. Some 300 yards east of here the ore has been exposed in a shaft, but its thickness was not developed.

Three analyses of this ore show:

ANALYSES OF MAGNETITE FROM THE HARD ORE BANK, STOKES COUNTY.

	349	350	351
Silica	2.74	1.75	—
Metallic Iron	47.36	54.75	54.75
Alumina	—	1.02	—
Phosphoric Acid	—	1.02	—
Titanic Acid	—	—	—
Phosphoric Acid	1.14	1.17	—

This is a hematite ore, though considerably higher in silica than is usually inferred from its physical appearance. Due to its high silica content, some of the hematite ore gangue and the magnetite itself. The percentage of silica can be reduced and the iron increased by washing and concentration.

The ore is mined from the hard ore bank on the opposite side of the road, and is the highest grade of ore in the area. It is a hard, compact, steel-gray to black magnetite, and is the highest grade of ore in the area. It is a hard, compact, steel-gray to black magnetite, and is the highest grade of ore in the area.

The ore is mined from the hard ore bank on the opposite side of the road, and is the highest grade of ore in the area. It is a hard, compact, steel-gray to black magnetite, and is the highest grade of ore in the area.

The ore is mined from the hard ore bank on the opposite side of the road, and is the highest grade of ore in the area. It is a hard, compact, steel-gray to black magnetite, and is the highest grade of ore in the area.

ANALYSIS OF MAGNETITE FROM SCHOOL HOUSE RIDGE, STOKES COUNTY.

	(343)
Silica	27.80
Metallic iron	40.74
Phosphorus	0.121
Sulphur	0.09
Phosphorus ratio	0.297

This ore is high in silica, and considerably above the Bessemer limit in phosphorus; by magnetic separation these deleterious elements may be eliminated to a great extent.

About 100 feet down the slope of the ridge from here the ore has been cut to a thickness of 8 feet, and I take it to be the extension of the same ore body; the quality is the same as above.

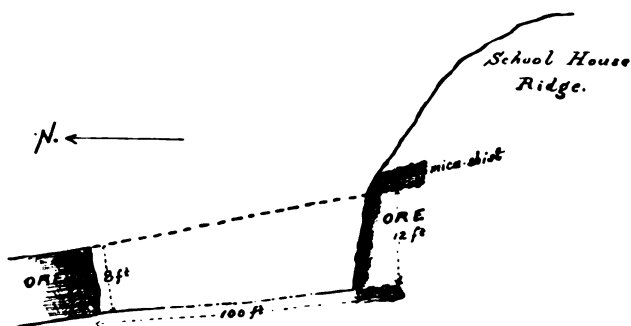


Fig. 61.—Showing ore bed on School House Ridge, Stokes county.

One hundred yards northwest from this opencut a body of ore has been stripped over a small area, but has not been cut through to show the thickness; the dip is as before, towards the northwest.

The ore is harder, and the gangue is hornblende and epidote, with some chlorite.

THE LEE NELSON GRANDFATHER BANK is situated about $3\frac{1}{2}$ miles N. W. from Danbury, on Buck Island branch, which flows into the Dan river about $\frac{1}{4}$ mile from here.

The opening is in the shape of a large opencut extending into the hillside some 75 feet, and is from 20 to 30 feet deep at the face.

Ore was mined here in the days of the old furnaces. The thickness of the deposit varies from three (3) to nine (9) feet. It is a reddish, talcose ore of the "Soapstone" class, soft and easily mined.

The inclination of the dip is 20° southeast; the strike of the hornblende gneiss lying below the ore, as exposed in a small branch near by, is N. 26° E., and the rock is greatly folded.

Three analyses of this ore show:

ANALYSES OF SOAPSTONE ORE FROM THE LEE NELSON BANK, STOKES COUNTY.

	(344)	(345)	(346)
Silica	20.17	21.47	.....
Metallic iron	47.16	47.23	39.70
Magnesia	9.53	.....	.....
Sulphur	0.007	0.006	.....
Phosphorus	0.035	0.081	0.040
Titanic acid .....	.....	0.190	.....
Phosphorus ratio	0.074	0.171	0.101

The nature of the talcose, micaceous gangue is apparent from the high silica and magnesia shown in the above analyses; but the ore is soft and easily crushed, and a high grade material should be available by magnetic concentration. The phosphorus is generally low, varying from just above to just below the Bessemer limit.

THE BECKY NELSON BANK is on the opposite side of the ridge, west of here. The directions of the old openings along the surface, several hundred yards in extent, show the strike of the outcrop to be N. W. and S. E. There is an old tunnel here in which the ore bed is reported to have been eight (8) feet thick when they stopped work. The ore belongs to the "Soapstone" class.

These old banks supplied the charcoal furnace at the mouth of Snow creek, $2\frac{1}{2}$ miles below Danbury, about 60 years ago. Other old ore banks in this vicinity are the *Banner*, *Langford*, and *Shropshire*.

THE ROGERS MINE.—This was probably at one time the largest and best developed mine in the section. It was worked during the Civil war for the charcoal furnace on the river just below Danbury. It is situated about $2\frac{1}{2}$ miles north of Danbury.

For a great many years past the main shaft, 60 feet in depth, has been filled with water, thus preventing an intelligent examination. At the bottom of the shaft the ore bed is reported to be eight (8) feet thick. In other parts of the underground workings it is said to vary from 3 to 15 feet. The outcrop has been worked off by shallow opencuts for a considerable distance north of the shaft. The foot-wall is a hard, bluish, metamorphic sandstone, and I infer the hanging-wall to be a hornblende schist, with a thin parting of micaceous schist adjoining the ore. The inclination of the dip is 21° slightly north of east, consequently the strike is nearly north and south. The ore, judging from the scattered fragments left on the old ore dump, is a coarse granular magnetite in a chloritic and micaceous gangue.

Several analyses show:

ANALYSES OF MAGNETITE FROM THE ROGERS MINE, STOKES COUNTY.

	(347)	(348)	(348a)
Silica	20.00	12.29	11.69
Metallic iron	52.86	58.26	63.71
Sulphur	0.084	0.179	0.006
Phosphorus	0.016	0.001	0.003
Alumina		0.580	....
Lime		1.990	0.16
Magnesia		3.310	0.17
Phosphorus ratio	0.030	0.020	0.050

The following additional analyses of this ore by Dr. Genth are taken from the report on the "Ores of North Carolina," by W. C. Kerr and G. B. Hanna, published in 1887, p. 172:

ANALYSES OF ORE FROM THE ROGERS MINE BY GENTH.

	(349)	(350)	(351)	(352)
Oxides of iron	92.47	85.09	79.71	67.66
Oxide of manganese.....	trace.	trace.	trace.	trace.
Alumina		0.70	2.27	0.17
Magnesia	0.20	0.16	0.17	0.23
Lime	0.13	0.29	0.31	0.19
Phosphoric acid	none.	none.	none.	none.
Actinolite	7.20	13.76	15.66	31.75
Water .....		....	1.88	....
Metallic iron	65.34	61.74	57.13	49.03

These analyses show very wide variations, due undoubtedly to the varying nature of the ore bed itself. But in what proportion these different grades of ore are distributed in the bed can only be determined by careful examination of the deposit in place, which, until the mine is cleaned out and again developed, is naturally impossible. Dr. Genth has described the ore as being absolutely free from phosphorus, but he probably meant that it was *very low* in phosphorus, so low that it was not considered worth while to determine it. However, the importance of determining even the very smallest per cent of this element must not be overlooked, for to the iron manufacturer it is always an important factor in estimating the true value of the ore.

Analyses 347, 348, and 348a show its presence, though in very minute quantity, and safely below the Bessemer limit.

About two years ago a tunnel or adit level was started into the hillside on the east of the shaft, and about 70 feet in elevation below its mouth, at right angles to the strike, with a view of connecting and draining the old workings. It was abandoned owing to the cost of the work after driving 100 feet, about one-half of it in a very hard quartzite rock. This is to be regretted, as 160 feet more would have made the desired connection.

The following is an analysis by Dr. Genth of a small outcrop of brown hematite in the vicinity of the Rogers mine:¹

ANALYSIS OF BROWN HEMATITE NEAR THE ROGERS MINE.

	(353)
Metallic iron	21.952
Phosphorus	0.192
Phosphorus ratio	0.874

THE OLD CHERRYTREE BANK, on Sandy creek, is one-half mile N. E. from the Rogers mine and about one-half mile above the Danbury ford of the river. The strike here is northeast and southwest. Several small pieces of ore found on the old dump resemble that at the Rogers mine; otherwise nothing can be seen but the superficial remains of old workings, now filled up and overgrown with trees.

THE CARLIN ORE BANK is on a ridge near the waters of Seven Island creek, $1\frac{1}{4}$ miles from the Dan river. There are several old shafts here, one of which has caved in, and with it a considerable area over the old underground workings. The ore was formerly worked in a forge near here.

THE PEPPER MINE is another of these old, abandoned ore banks. It lies $2\frac{1}{2}$ miles northeast of Danbury and about $1\frac{1}{2}$ miles east of the Rogers mine. The ore is a granular magnetite, disseminated in mica schist, and the old workings were apparently of considerable extent. A tunnel is said to have cut the ore from 6 to 8 feet in thickness. An analysis taken from the United States Tenth Census Report² shows:

ANALYSIS OF ORE FROM THE PEPPER BANK.

	(354)
Metallic iron	44.08
Phosphorus	0.033
Phosphorus ratio	0.075

This is an ore of very fair quality and below the Bessemer limit in phosphorus.

THE ISAAC FAGG ORE BANK is 4 miles northwest of Danbury on the waters of Buck Island creek, about 1 mile northeast of the Lee Nelson bank. The main opening is in the shape of an opencut at the head of a small hollow. The ore deposit consists of a series of sandy ore seams of variable and irregular thickness, reaching four (4) feet at one point. It belongs essentially to the class called "Sand ore," a granular magnetite disseminated through a sandy, micaceous matrix, which is soft and easily mined; in places the ore is harder, in a hornblendic gangue. The top rock is a decomposed gneiss, dipping about 30 degrees slightly west of north.

¹ "Ores of North Carolina," p. 172.

² Vol. XV, pp. 315, 561.

Two analyses of this ore show:

ANALYSES OF ORE FROM THE ISAAC FAGG BANK, STOKES COUNTY.

	(355)	(356)
Silica	25.47	18.35
Metallic iron	42.48	48.62
Sulphur	0.049	0.021
Phosphorus	0.079	0.117
Titanic acid		0.170
Phosphorus ratio	0.186	0.240

This ore is admirably constituted for magnetic concentration, whereby the iron will be increased and the silica and phosphorus decreased.

A talcose ore bed has been opened on *Thomas Simmons' place*, 4 to 5 miles southwest from Nelson's Hard Ore bank, and 9 miles west of Danbury, about 3 miles above the mouth of North Double creek, on the south side of Dan river. An area of probably 20 by 50 feet of "soap-stone" ore has been stripped here, sloping northward with the hillside, but the bed has not been cut through to determine its thickness.

ANALYSIS OF ORE FROM THE SIMMONS PLACE, STOKES COUNTY.

	(357)
Silica	27.67
Metallic iron	39.66
Magnesia	11.59
Sulphur	0.02
Phosphorus	0.03
Titanic acid	none.
Phosphorus ratio	0.076

Some analyses of ores from the *Mabe place*, situated in the general Danbury Ore Belt, sampled by Prof. J. A. Holmes, show:

ANALYSES OF MAGNETITE ORES FROM THE MABE PALCE, STOKES COUNTY.

	(358)	(359)	(360)
Silica	13.15	22.58	38.67
Metallic iron	57.16	50.06	23.79
Sulphur	0.38	0.03	0.08
Phosphorus	trace.	0.022	0.014
Titanic acid.....	none.	trace.	trace.
Phosphorus ratio	trace.	0.043	0.059

In the Sauratown mountain range on the south side of the Dan river, surface indications of magnetite and brown hematite have been observed, but never prospected or developed.

All prospects point to the existence of large and valuable deposits of magnetic iron ore in the Danbury region. They lie well for mining, and the numerous creeks and hollows make them easily accessible to the river bank. The nearest railroad point to Danbury is Walnut Cove,

11½ miles southeast, at the junction of the Norfolk and Western and the Cape Fear and Yadkin Valley roads. A branch road has been surveyed along the ridge road from Walnut Cove to the head of Poor House branch; down the valley of that branch to Flat Shoals creek; with the valley of said creek to the Dan river, and up the river to Danbury; and when this is built there is no reason why these ores should not find a market.

(b). THE MAGNETITE ORES OF SURRY AND YADKIN COUNTIES.

These ores consist of magnetite grains disseminated through mica-schist and gneiss, resembling in that respect some of the Stokes county ores; and their economic value, as far as quality is concerned, will thus in a great measure be dependent upon the cost of separating these magnetic grains from their gangue by means of magnetic concentration.

The rock is usually decomposed to great depths, and is therefore well adapted to easy and cheap crushing, preliminary to concentration.

To within comparatively recent time these ores were worked in Catalan forges,¹ and the iron made from them had a good reputation.

¹ From the "Iron Manufacturer's Guide," by J. P. Lesley, 1859, p. 186 *et seq.*

Hill's Bloomery Forge, situated on Tom's creek, 19 miles west of Danbury; owned and managed by William Hill, Tom's Creek P. O.; built in 1791 and rebuilt in 1853; one fire and one hammer, worked by water; annual output about 20 tons of bars.

Fulk's Bloomery Forge, situated on Tom's creek, 2 miles southwest of Tom's Creek P. O.; owned by Pleasant Evans, Surry county; out of use for 3 or 4 years (previous to 1859), and in disrepair.

Hyatt's Upper Bloomery Forge, situated on Ararat river, 13 miles north of Rockford; built in 1851; two fires and one hammer, worked by water; made 47 tons of bars in 1856.

Hyatt's Lower Bloomery Forge, situated 4 miles below Hyatt's upper forge; built in 1845 and rebuilt in 1856; two fires and one hammer, worked by water; made 21 tons of bars in 1856.

Blackwood's Bloomery Forge, situated on Fisher's river, 5 miles northwest of Rockford; built in 1836, rebuilt in 1852; two fires and one hammer, worked by water; made about 15 tons of bars in 1856.

Cooper's Bloomery Forge (formerly Rutledge's), situated on Cody's creek, near Fisher's river, 1 mile above the Blackwood forge; built in 1854; two fires and one hammer, worked by water; made 27 tons of bars in 1856.

Hobson's Bloomery Forge No. 1, situated on Forbush creek, 9 miles southeast of Rockford, and 5 miles east of Yadkinville; built in 1843; two fires and one hammer; made about 15 tons of bars in 1856.

Hobson's Bloomery Forge No. 2, situated on Deep creek, 2½ miles north of Yadkinville, 8 miles south of Rockford; built in 1849; two fires and one hammer; made about 16 tons of bars in 1854.

Forbush Bloomery Forge, situated on Forbush creek, 3 miles east of Hobson's Forge No. 1; built in 1837; rebuilt probably in 1849; one fire and one hammer; made about 16 tons of bars annually.

Creek Charcoal Furnace, on Tom's creek near Hill's forge; destroyed 1850.

Of the Surry county ores, the following notes are inserted from the United States Tenth Census Report, Vol. XV, p. 315:

"THE FERRIS BANK is situated near Hyatt's forge, on Tom's creek, about two miles north of Pilot Mountain P. O. The irregular beds of ore dip with the stratified mica-schist, in which they occur, about 30° to the north. A large quantity of ore has been taken out in small shafts and tunnels sunk to the water level, about 20 feet. At this depth the ore becomes charged with pyrite. Two beds of ore, each about two feet thick, were seen in the shaft; they were separated by about one foot of mica-schist.

"The upper bed is represented by analysis No. 366, the lower by No. 367; the latter was taken out near the water level. Analysis No. 368 represents the mixed ore from these two beds after it has been stamped and washed in a rude trough, which only partially removes the associated minerals. Analysis No. 369 represents a sample taken from the bottom of a shaft sunk below the water level, about 100 feet from that in which Nos. 366 and 367 were taken.

ANALYSES OF MAGNETITE FROM THE FERRIS BANK. SURRY COUNTY.

	(366)	(367)	(368)	(369)
Metallic iron	48.46	61.02	67.30	60.73
Sulphur	0.107	0.113	0.133	1.975
Phosphorus	0.095	0.074	0.056	0.051
Phosphorus ratio	0.196	0.121	0.083	0.084

"Similar ore is obtained about 200 yards southeast of this bank, and also one mile southeast, at the *Bullington* bank."

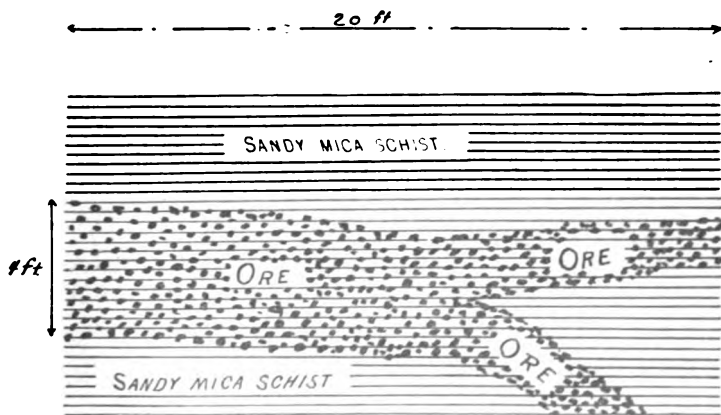


Fig. 17.—Hyatt's Ore Bank, showing magnetite in mica schist. (After Willis.)

HYATT'S ORE BANK is about 7 miles west of Pilot Mountain P. O., across the Ararat river, near the mouth of Bull Run creek. Beds of magnetite ore occur here in a sandy mica-schist, dipping about 20° a

little west of north. These beds have been mined along a distance of about 1000 feet in three parallel rows of shafts, sunk 15 or 20 feet apart to a maximum depth of about 20 feet. One lenticular mass of ore, having a thickness of about 6 to 8 feet, has been entirely removed. The southern line of shafts seem to have struck a layer of ore which has not been reached in those north of it.

The above sketch shows the bed of ore from which sample No. 370 was taken.

ANALYSES OF MAGNETITE FROM HYATT'S BANK, SURRY COUNTY.

	(370)	(371)
Metallic iron	38.90	33.34
Phosphorus	0.049	0.033
Phosphorus ratio	0.126	0.052

No. 371 represents the same ore when stamped and washed for use in the forge.

WILLIAMS ORE BANK.—This is 4 miles northwest of Rockford and $\frac{1}{2}$ mile west of the Dobson turnpike, on the waters of Stanley creek. There is a series of old opencuts here, now filled up, extending for a distance of some 300 yards about N. 50° E., and varying in depth from 8 to 25 feet.

This work was done during the war to supply the Holafield and Blackwoods forges on Fisher's river, respectively 3 and 2 miles from the ore bank. When visited in October, 1892, a prospect shaft had just been sunk here to a depth of 12 feet, but was filled up with water. The thickness of the ore body, as struck in this shaft, was reported to be 5 feet, dipping northwestward. The ore consists of granular magnetite distributed in layers through the gneiss along the plane of its schistosity.

ANALYSES OF MAGNETIFEROUS GNEISS FROM THE WILLIAMS BANK, SURRY COUNTY.

	(361)	(362)
Silica	31.29	....
Metallic iron	44.80	45.47
Sulphur	0.065	....
Phosphorus	0.092	0.022
Phosphorus ratio	0.205	8.049

"Two and a half miles northeast of the Williams bank is the *Poplar Branch Bank*, where the ore bed measures two feet in thickness."

ANALYSIS OF MAGNETITE FROM THE POPLAR BRANCH BANK, SURRY COUNTY.

	(372)
Metallic iron ..	56.21
Phosphorus	0.029
Phosphorus ratio	0.052

One-half mile southwest of the Williams bank a prospect shaft has recently been sunk to a depth of 60 feet on the *Henry Anderson place*, and it was reported that the bed struck here measured only from 13 to 15 inches in thickness, but the ore is richer (freer from gneiss) than at the Williams place.

ANALYSIS OF ORE FROM HENRY ANDERSON SHAFT, SURRY COUNTY.

	(365)
Silica	17.42
Metallic iron.. ..	54.60
Sulphur	0.033
Phosphorus	0.047
Phosphorus ratio	0.086

One quarter of a mile southwest from Anderson's are some old forge diggings, and one mile still farther southwest the ore has been prospected on the *Dunnigan place*. Between the Williams and Anderson places the ore crosses over the *Crowder* property. The entire length of this ore belt is therefore about 4 miles.

THE STANLEY ORE BED.¹—Another locality in Surry county is on the farm of Edward Stanley, 10 miles from Elkin on the Dobson road, and about 1½ miles north of Little creek. The ore seems, so far as surface specimens were an indication, to be lenticular masses of limonite, sometimes changed into red hematite.

The beds are credited with a width of from 4 to 14 feet. The country rock is hornblendic mica-schist, striking nearly N. 60° E., and dipping from 75° to 80° southeast.

ANALYSES OF ORE FROM THE STANLEY BANK, SURRY COUNTY.

	(363)	(364)
Silica	10.04	10.96
Metallic iron	54.52	52.62
Sulphur	0.41	0.35
Phosphorus	trace.	trace.

Of the Yadkin county ores, the following is inserted from the "Report on the Ores of North Carolina," 1887, p. 170:

"THE HOBSON ORE BEDS.—In Yadkin county there is a series of ore beds running from the Yadkin river in a southwesterly direction to Deep creek. There are a number of mines here, the most noted of which are the Hobson mines, in the northern part of the county. The ores are very much like those on Tom's creek, but the beds are better defined, and the ores more concentrated in definite strata."

¹ From the Report on the Ores of North Carolina, 1887, p. 170.

ANALYSES OF MAGNETITES FROM YADKIN COUNTY.

	(379)	(380)	(381)	(382)	(383)	(384)	(385)	(386)
Silica	4.62	37.24	40.60	24.62	24.28	23.16	10.83	14.46
Metallic iron.....	67.69	40.46	40.65	51.83	51.13	53.93	62.55	55.75
“ manganese	0.07	0.54	trace.	trace.	0.30	0.03	trace.	0.51
Oxide of copper..	0.10	0.09	0.05	0.10	0.15	0.04	0.09	0.13
Alumina	0.20	0.45	1.88	2.46	0.66	0.98	0.75	1.20
Lime	0.45	3.14	0.36	0.57	1.34	0.60	0.70	0.82
Magnesia	0.86	1.94	0.19	0.10	0.90	0.25	0.77	0.98
Sulphur		0.02	trace.	trace.	....	trace.	....	....
Phosphorus	0.021	0.021	trace.	trace.	0.052	trace.	0.039	0.043
Water		0.34	0.79	0.57	1.46	0.45	0.38	1.75
Phosphorus ratio	0.030	0.051	trace.	trace.	0.101	trace.	0.062	0.077

Nos. 381, 382, and 383 represent several beds of the Hobson ores. The other analyses represent ores southward of them.

No. 379 represents the Sand ore bank.

No. 380 represents the Black ore bank.

No. 384 represents the Hutchins ore bank.

No. 385 represents the Upper ore bank.

No. 386 represents the Shields ore bank.

“EAST BEND MAGNETITE ORE.—At East Bend in Yadkin county is an outcrop of magnetic ore which is coarse-granular and more free of rocky matter than most of the other deposits, but it has not been operated.”

(c). THE TITANIFEROUS MAGNETITE ORES OF DAVIE COUNTY.

About 5 miles nearly south of Mocksville, near the mouth of Bear creek, a fair showing of float ore was observed over a distance of some 600 feet on what is known as the *Old Maxwell place*. The ore is a medium-grained magnetite and very free from gangue, as far as surface specimens show. Some eleven years ago two or three shallow pits were made here, and it is reported that the solid ore bed was struck in place. It is not known how thick it was, and there is no way of finding out except by repeating this prospect work.

At intervals the float ore can be traced for $1\frac{1}{2}$ miles southwest from here to the South Yadkin river near the mouth of Bear creek.

The country rock, for fully $\frac{1}{2}$ mile west of the above showing, is hornblende and syenite, with occasional disseminations of magnetic granules. The dipping needle shows attractions from 5° to 20° , but there are no promising prospects for finding commercial ore bodies.

ANALYSIS OF MAGNETITE FROM THE MAXWELL PLACE, DAVIE COUNTY.

	(189)
Silica	0.78
Metallic iron..	60.00
Sulphur	0.033
Phosphorus	0.006
Titanic acid	10.32
Phosphorus ratio	0.013





The proportion of titanitic acid in this ore would condemn it in the usual modern blast furnace practice.

From 10 to 11 miles northeast of the Maxwell place similar ore is found on the plantation of *John A. Allen*. This is 20 miles southwest of Winston, $7\frac{1}{2}$ miles northeast of Mocksville, and 1 mile east of Kernatzer station on the Mocksville Division of the Richmond and Danville railroad. The ore occurs on the summit of a hill on the waters of Dutchman's creek. Several pits and a shaft, 20 feet deep, were sunk here during the Civil war, but these have caved in. The bed is reported to be 15 feet thick. The ore was worked in a forge at Haines mill on Dutchman's creek, 4 miles distant, and 4 miles east of Mocksville.

Float ore can be traced faintly and in small particles over the surface of this hill for a distance of from 200 to 300 yards northeast and southwest from the old shaft. In a northeasterly direction trace of the ore is lost at a small branch; but on the opposite side the dipping needle shows varying attractions from 5° to 25° , over a distance (northeast and southwest across the strike) of 100 feet or more.

The hornblendic country rock in this locality is slightly impregnated with magnetic granules, as was found to be the case on the Maxwell place.

Both the external and chemical characteristics of the ore and the general features of the structural geology determine this deposit to be in the same belt with the Maxwell ore, but different from the ores of Surry and Yadkin counties.

ANALYSIS OF MAGNETITE FROM THE ALLEN PLACE, DAVIE COUNTY.

	(190)
Silica	5.50
Metallic iron..	52.90
Sulphur	0.11
Phosphorus	0.02
Titanic acid	8.00
Phosphorus ratio	0.037

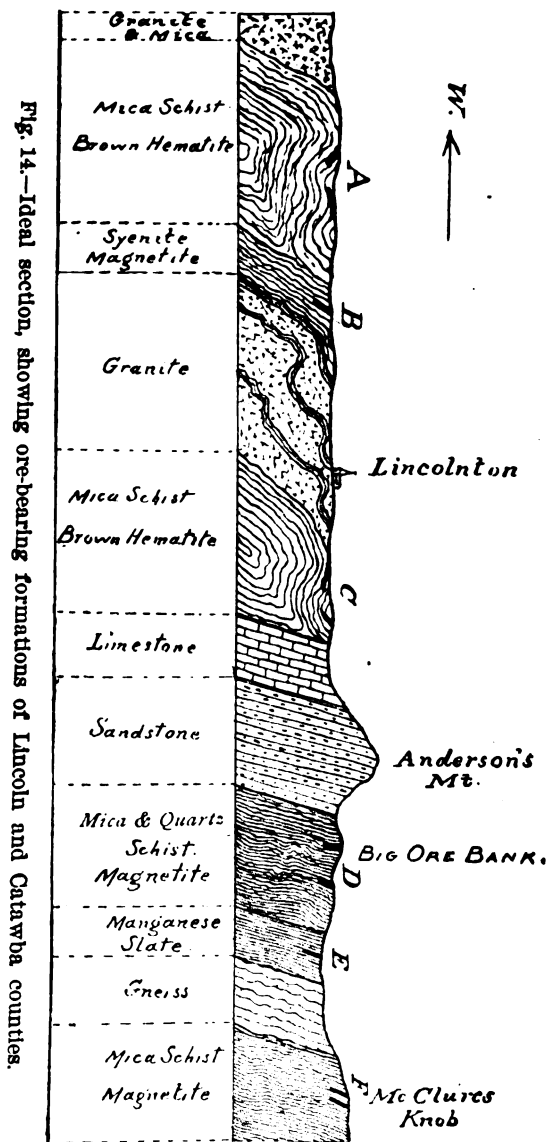
The resemblance of this to the Maxwell ore is evident, particularly in its titaniferous quality.

(d). THE MAGNETITE AND BROWN HEMATITE ORES OF EASTERN CATAWBA, CENTRAL LINCOLN, AND SOUTHERN GASTON COUNTIES.

The stratigraphical relations of these ore deposits have been discussed on page 69 *et seq.*, and attention has been called to the fact that there is a break in the ore in the southern part of Lincoln and the northern part of Gaston counties, extending over a distance of some 12 or 15 miles (see Plate XI). In order to facilitate the descriptions, it is deemed expedient to take up the divisions separately.

1. THE MAGNETITE AND BROWN HEMATITE ORES OF EASTERN CATAWBA AND CENTRAL LINCOLN COUNTIES.

For convenience of reference the ideal section, representing the stratigraphical succession from west to east, is reproduced here.



Referring to the above section and to Plate No. XI, the ores described under this head are:

(1). *The Brown Hematite ores occurring in the foliated mica-schists lying above the limestone, in a belt passing about two miles east of Lincolnton, marked "C" in section.*

In the angle between the Carolina Central and Chester and Lenoir railroads, about two miles east of Lincolnton, Lincoln county, the ore makes its appearance on the land of *Cephas Quickel*. A series of old pits which were made previous to 1860, but now caved in, extend in a general southwesterly direction for $1\frac{1}{4}$ miles from the Carolina Central railroad, crossing the Chester and Lenoir railroad (narrow gauge) $2\frac{1}{2}$ miles southeast from Lincolnton. The railroad cut exposes the talcose, or hydro-mica-schists, with small seams of yellowish, saccharine quartz, having a strike of 3° to 5° east of north, very much folded; and this folded structure evidently accounts for the great width of the ore belt, which, judging from the position of the old openings and the wide distribution of the float ore over ground which is comparatively level, must be $\frac{1}{2}$ mile. The ore beds here are reported to vary in thickness from about 6 inches near the surface to 2 and 3 feet at a depth of 10 feet, with a general pitch toward the south, between walls of dark red to dark yellowish slate, accompanied by seams of yellow saccharine quartz. It is highly probable that the beds exist in pockets of irregular thickness and extent. The total absence of development prevents any more definite information at present. The formation has been traced by surface float some 4 or 5 miles each way from this locality, and its northeasterly extension is reported in Catawba county, where the ore was superficially worked for some of the old forges in former years.

It is a brown hematite of schistose structure. A sample was taken from the Quikel place, and shows:

ANALYSIS OF BROWN HEMATITE FROM THE QUICKEL PLACE, LINCOLN COUNTY.

	(267)
Silica	4.94
Metallic iron	54.32
Sulphur	0.037
Phosphorus	0.840
Phosphorus ratio	1.546

Excepting for its high phosphorus it is an ore of excellent quality.

(2). *The Magnetite Ores of the quartzite schists, forming a continuous belt, about 3 miles southeast of the Brown ore belt first described, extending from Iron Station on the Carolina Central railroad, in Lincoln county, in a northeasterly direction, along the eastern base of Anderson's mountain in Catawba county, to within a short distance of the Catawba river, a length of about twenty miles, marked "D" in section.*

This is by all odds the most important ore range of these two counties, and was at one time extensively developed over its entire

length, the ores having been smelted in the primitive Catalan forges and small charcoal furnaces over 100 years ago.² Since 1882, when the Rehoboth charcoal furnace was finally abandoned, the iron ore mines over this belt have suffered total ruin, and as most of them were crude shaft and open-cut workings, they are naturally filled in and closed up, beyond the possibility of detailed investigation at present.

As already mentioned, the ores occur in the talcose, micaceous and quartzitic schists in a series of slaty ridges and knolls in Lincoln county, and along the eastern foot-hills of Anderson's mountain in Catawba county, having a general trend of N. 20° E. As to the structure of the deposits, the following is inserted from the "Report on the Ores of North Carolina," 1887, p. 157 *et seq.* "The beds are nearly vertical and dip sometimes to the east and sometimes to the west, but the westerly dips

² From the "Iron Manufacturer's Guide," by J. P. Lesley, 1859:

Mount Carmel Bloomery Forge, situated on Mountain creek, 14 miles north-east of Lincolnton and 12 miles southeast of Newton; built in 1817; rebuilt in 1853; one fire and one hammer; made about 16 tons of bars in 1856.

Rough and Ready Forge, on Mountain creek, 12 miles northeast of Lincolnton; had two fires and one hammer. Made about 44 tons of bars in 1856.

Jenny Lind Bloomery Forge, on Maiden creek, 6 miles south of Newton, 11 miles north-northeast of Lincolnton; one fire and one hammer; made about 37 tons of bars in 1856.

Madison Bloomery Forge, on Leiper's creek, 8 miles east-southeast of Lincolnton; built in 1827; rebuilt in 1852; one fire and one hammer; made about 15 tons of bars in 1856.

Springhill Bloomery Forge, on Leiper's creek, $\frac{1}{2}$ mile southeast of the last; built about the beginning of the century; rebuilt in 1853; 3 fires and 2 hammers; made about 100 tons of bars a year.

Mount Tirza Bloomery Forge, on Leiper's creek, about 4 miles southeast of the last; two fires and two hammers; made about 60 tons of bars in 1856.

Mount Welcome Bloomery Forge, on Leiper's creek, 2 miles southeast of the last; 2 fires and 2 hammers; made about 33 tons of bars in 1855.

Rehoboth Cold-blast Charcoal Furnace, on Leiper's creek, 8 miles southeast of Lincolnton and 25 miles northwest of Charlotte; built in 1814; 34 feet high, and 7 feet across the bosh; made in 18 weeks of 1856, 200 tons of foundry metal out of 400 tons of magnetic ore from the Big Ore bank. Capacity about 7 tons per day. This furnace was rebuilt in 1829, and in 1870 the Lincoln Iron Company put in hot blast and raised the capacity to 15 tons per day. From 1875 to 1882 the furnace was operated by John Leonard & Co., of New York. It has been abandoned since May 27, 1882.

Madison Cold-blast Charcoal Furnace, on Leiper's creek, 3 miles above Rehoboth furnace and 6 miles east of Lincolnton; built in 1809; rebuilt in 1855; 6 feet across the bosh by 30 feet high; made in 1849, 225 tons of foundry metal out of magnetic ore from the Big Ore Bank.

Vesuvius Cold-blast Furnace, on Anderson's creek, 4 miles northeast from Madison furnace and 10 miles east of Lincolnton; built in 1786; rebuilt about 1843; 6 feet across the bosh and 30 feet high; made in 20 weeks of 1856, 250 tons of foundry metal out of magnetic ore.

² Somewhat altered.

are by far the most frequent. For a considerable part of the belt in Lincoln county there are two parallel beds, the more westerly being the more productive, and the combined thickness being from 4 (rarely so low as 2) to 12 feet; the interval of 12 to 20 feet between them is occupied by talcose and chloritic schists, with a little ore in layers. The beds generally occur in lenticular masses or flat disks, which thicken at the middle and thin out towards the edges, having the same general dip as the bed; but they do not succeed one another in the same plane; their edges overlapping so as to throw the upper edge of the lower disk behind the lower edge of the upper. The following is an ideal section, illustrating this:

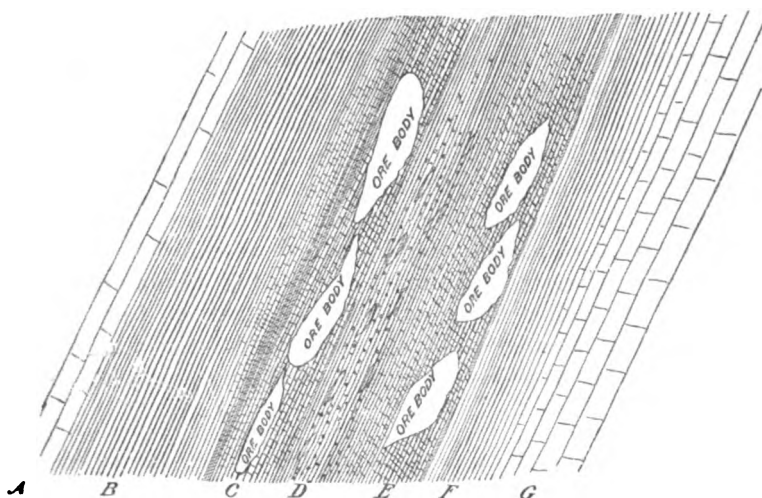


Fig. 18.—Ideal section, showing lenticular structure and position of magnetite ore beds, Lincoln county.

"A, sandstone or quartzite. B, talcose schist (slate). C, 'Front' ore bed of actinolitic, chloritic, and somewhat talcose schists, containing ore bodies. D, talcose and chloritic schists, containing small quantities of ore, mostly in grains. E, 'Back' ore bed, for most part similar to C. F, talcose schist. G, gneiss.

"The above-mentioned layers shade into one another; thus the sandstone or quartzite, A, passes into the siliceous talcose schist B, which in turn graduates into the 'front' vein C, a mass of actinolitic, chloritic (somewhat talcose) slate, with iron ore in grains or lenticles. The change from the slates into the ore lenticles is frequently obscure, and the lenticles themselves are often schistose in structure. The change into the talcose slates, D, is equally obscure. In this body the ore is in grains, associated with the chloritic matter, or in small lenticles.

"The statements about C apply for the most part to the 'back' vein, E.

"The changes into and from F are as in B, but the mass seems to be less siliceous. The separation of the ore bodies is sometimes very slight, and often they are connected by an almost imperceptible thread of ore which needs the quick eye of the skillful miner to follow. These lenses are sometimes many feet thick, and frequently of great length and depth."

The principal ones of the old ore banks, in their regular succession northeastward along the strike, were: The Big Ore bank, the Brevard, Stonewall, and Robinson banks in Lincoln county; and the Morrison, Tillman, Deep Hollow, Mountain Creek, Abernathy, Littlejohn, and Powell banks in Catawba county, the latter two being towards the Catawba river. A cursory description of some of these will now be taken up.

In Lincoln county the first traces of this ore belt are found on the land of *Melchi Hovis*, about $\frac{1}{4}$ mile southwest of the Carolina Central railroad from Iron Station, where occasional, scattered surface fragments of magnetite are visible. Ore is reported to have been dug here in former years for the Springhill (or Hammerskold) bloomery forge.

On the *Benedict* farm, $\frac{1}{4}$ mile north of the Carolina Central railroad and $1\frac{1}{2}$ miles northwest from Iron Station, there is a heavy showing of float ore; solid, compact, magnetite; and on the adjoining *Link* farm some old pits are visible (now caved in and filled up) from which ore was hauled to the Springhill (or Hammerskold) forge over fifty years ago. The following analysis shows the exceeding purity of these surface fragments:

ANALYSIS OF MAGNETITE FROM THE LINK-BENEDICT FARMS, LINCOLN COUNTY.

	(276)
Silica	1.10
Metallic iron	71.10
Phosphorus	0.010
Titanic acid	none.
Phosphorus ratio	0.014

THE BIG ORE BANK.—The old workings, consisting of shafts, open-cuts and trenches, are irregularly scattered in great profusion over a large area, about a mile in length, in a general direction N. 15° to 20° E.

The accompanying sketch, taken from the United States Tenth Census Report,¹ shows the approximate location of these various diggings.

It is located four miles north of the Carolina Central railroad, at Iron Station, on the waters of Leiper's creek, three miles northwest of Rehoboth charcoal furnace. The workings have now completely caved

¹ Vol. XV, p. 317.

in, and many of the shafts are filled with water, so that nothing of practical value can be seen.

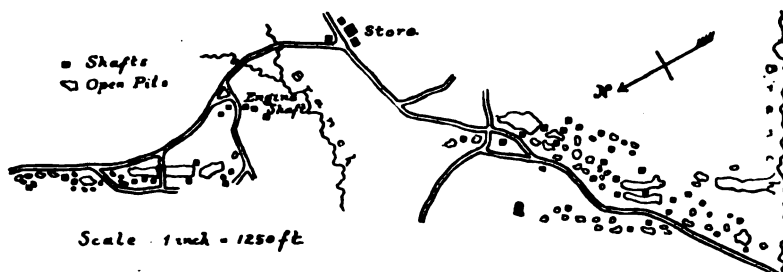


Fig. 19.—Plan showing outside workings at Big Ore Bank, Lincoln county.

The ore was last mined, 1880-82, in the Engine shaft, towards the northeastern end of the property. This shaft was 100 feet deep. At

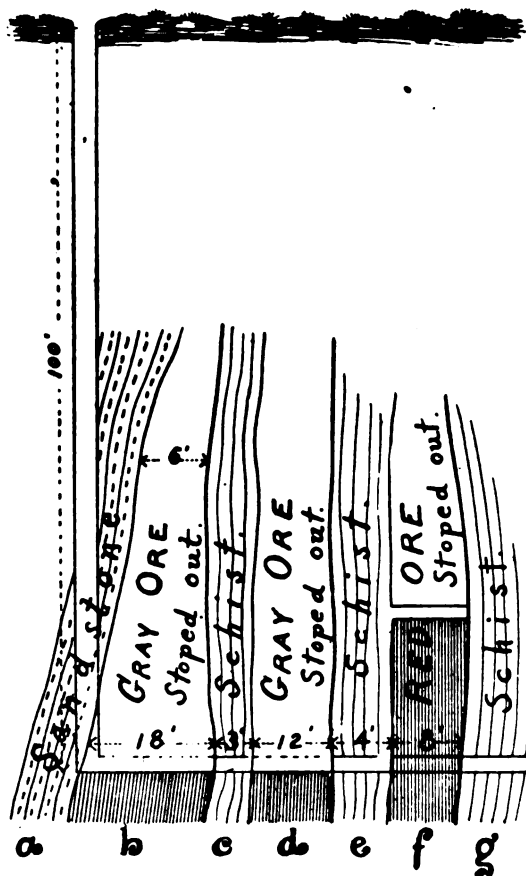


Fig. 20.—Ideal vertical section in main shaft, Big Ore Bank.

the bottom a cross cut was extended sixty feet through the ore beds;

and drifts were run on the ore, 80 feet northeast and 40 feet southwest into some of the old open workings. The following sketch of this shaft, showing roughly the position and dimensions of the ore bodies, has been drawn according to verbal statements obtained from Mr. J. E. Reinhardt, the last superintendent and manager of this mine and the Rehoboth furnace.

Accordingly there appear to be three parallel ore bodies or lenses, b, d and f, dipping steeply to the southeast and separated by micaceous schists. The foot-wall is a syenitic schist, while the hanging-wall is a metamorphic sandstone. The designation "gray ore" (b) and (d) applies to a granular magnetite disseminated in a gangue of micaceous schist, the whole having a grayish color; while the so-called "red ore" (f), though really strongly magnetic, has occasionally a slight reddish tinge, due to the presence of red oxide (probably martite) in small quantity. The quality of the ores is shown by the following analyses:

ANALYSES OF MAGNETITE FROM THE BIG ORE BANK, LINCOLN COUNTY.

	(270)	(271)	(272)	(273)
Silica	6.19	1.07	9.17	....
Metallic Iron	66.92	68.40	58.56	68.12
Alumina .....	....	....	2.46	....
Lime .....	....	....	0.27	....
Magnesia .....	....	....	4.33	....
Sulphur	0.068	0.069	0.086	0.120
Phosphorus	0.082	0.072	0.013	0.006
Titanic acid .....	....	....	....	none.
Phosphorus ratio	0.124	0.105	0.022	0.008

No. 270. Gray ore, sampled from old stock pile at Rehoboth furnace.

No. 271. Red ore, sampled from old dump at mine.

No. 272. From shaft near water level.

No. 273. Red ore.

This bank supplied ore for the Rehoboth, Madison and Vesuvius furnaces; and in 1870 it was connected with Rehoboth and Madison, and also with the railroad at Iron Station, by a tram-road over ten miles long.

Adjoining the Big Ore bank on the northeast is the *Brevard bank*. Adjoining that, and 2½ miles northeast of the Big Ore bank, is the *Stonewall bank* where the outcrop has been worked to shallow depths by open pits, for ¼ mile along the strike to the *Morgan bank*. Two prospect shafts were sunk on the Stonewall property about two years ago, respectively 64 and 72 feet deep, from which short cross cuts were driven; it is reported that in the one eight inches of reddish talcose ore out, and in the other two beds of gray ore (thickness not given).

ANALYSIS OF MAGNETITE FROM THE STONEWALL BANK, LINCOLN COUNTY.

	(274)
Metallic iron	55.40
Phosphorus	0.011
Phosphorus ratio	0.020

In Catawba county, as has already been stated, these deposits of magnetite extend along the eastern slope of Anderson's mountain; towards the northern end of the mountain, and adjoining the *Abernathy bank* on the south, the ground is literally covered with small lumps of float ore over a small area; in fact this particular point is locally known as the "seed" or "top" ore bank, because, during the active life of the old furnace, much ore was simply picked up from the ground and hauled to them in wagon loads.

THE POWELL ORE BANK is situated 6 miles northeast from here, on the south side of Ball creek, on a hill 200 feet above the level of the creek. It is $4\frac{1}{2}$ miles southeast of Catawba station and $2\frac{1}{2}$ miles south of the Western North Carolina railroad. Ore was worked here from 1873-75, down to the water level, for use in the Catawba Valley forge. "The beds of ore are numerous and quite irregular, with overlaps and jumps; the ore giving out at one place and suddenly reappearing at another. The main bed, opened to a depth of 30 feet by a shaft, is at that depth from 3 to 4 feet thick, with a strike N. 10° E., and a dip westward from 60° to 90° . On a parallel hill $\frac{1}{4}$ mile northwest of the above is a similar ore bed. The same series of beds is exposed one mile south-southwest from the Powell bank, at the *Littlejohn Ore Bank*."¹

ANALYSIS OF MAGNETITE FROM THE POWELL ORE BANK, CATAWBA COUNTY.

	(116)
Metallic iron	64.21
Phosphorus	0.009
Phosphorus ratio	0.014

This concludes the description of the Lincoln-Catawba part of this ore belt. It was at one time the scene of active mining and smelting operations. Its abandonment was due, not to the lack of ore, but to the inaccessibility of the product to a market and probably in a great measure to the lack of capital and energetic management. However that may be, the field is certainly worthy of a careful, practical investigation, which will require both time and money. The old shafts must be cleaned out, others must be sunk, unopened area must be explored and tested; in short, the ore bodies must be examined in place before an intelligent report of the probable extent and quantity can be made.

¹ From "The Ores of North Carolina," p. 167.

The erroneous supposition would be quite liable to occur to many that, because these ores have been worked and smelted for so long a period as one hundred years they should be exhausted. This is fallacious; the old forges and furnaces, of small capacity, and working as spasmodically as they did, have not drawn on the ore supply sufficiently to make any material difference. For the most part indeed they obtained their ore from the very surface, or mined it in shallow pits along the outcrop, a method appropriately named "ground hogging." In no instance have the shaft workings—and there are but few of them—extended below the water-level. If the ore was ever there it is still there, without any appreciable difference in quantity.

Attention may be called to the possibility of the brown hematite zone running parallel to this belt on the west, affording sufficient quantities of soft ore to allow of a beneficial mixture.

LIMESTONE BELT.—Running parallel with these series of ore deposits, and directly west of the magnetic ore belt, is a narrow belt of dolomitic limestone which will serve as an excellent fluxing material. It has been opened at a number of points, among which may be mentioned the Shuford and Powell quarries in Catawba and the Keener quarry in Lincoln county.

The quality of this limestone is shown by the following analyses:

ANALYSES OF LIMESTONE FROM CATAWBA AND LINCOLN COUNTIES.

	(400)	(401)	(402)
Silica	1.28	2.60	0.45
Oxides of iron and aluminum.....	3.17	1.54	4.46
Lime	33.18	34.27	35.90
Magnesia	19.07	20.09	17.63

No. 400. From the Shuford quarry, Catawba county.

No. 401. From the Powell quarry, Catawba county.

No. 402. From the Keener quarry, Lincoln county.

MANGANIFEROUS SLATES.—Directly east of the magnetite belt, and parallel to it, is a very persistent belt of manganiferous slates (marked E in the section, fig. 14), which can be traced without fail through Catawba, Lincoln and Gaston counties to the South Carolina line, and which at points may be productive of a good manganese ore. Recent explorations on this belt in York county, South Carolina, have proven the existence of valuable ore beds, both in quantity and quality. Several analyses of these manganiferous slates show:

ANALYSES OF MANGANIFEROUS SLATES. LINCOLN COUNTY.

	(398)	(399)
Silica	40.71	47.93
Metallic manganese	10.51	13.51

No. 398. From outcrop in old plank road, 9 miles east of Lincolnton.
 ¼ mile west of Vesuvius furnace.

There is another, smaller belt of magnetic ore deposits which must be mentioned in this connection, namely:

(3). *The Magnetite Ores of the micaceous schists, lying parallel to and several miles east of the principal ore belt D, marked E in the section (Fig. 14).*

This belt has been but superficially explored at intervals, over a distance of several miles in Lincoln county.

On *McClure's Knob*, two miles northeast of the Carolina Central railroad, at a point four miles east of Iron Station, heavy magnetite float is seen over considerable area; there are no visible outcrops, nor have any openings been made. Surface indications point to the existence of two parallel beds, about 500 feet apart, which have been traced for $1\frac{1}{2}$ miles southwest from here. The country rock is mica-schist and altered clay-slate, striking approximately N. 15° E. This is on the waters of Leiper's creek.

The following analysis shows the composition of the surface ore:

ANALYSIS OF MAGNETITE FROM MCCLURE'S KNOB, LINCOLN COUNTY.

	(275)
Silica	12.33
Metallic iron	58.46
Sulphur	0.019
Phosphorus	0.035
Titanic acid	0.16
Phosphorus ratio	0.060

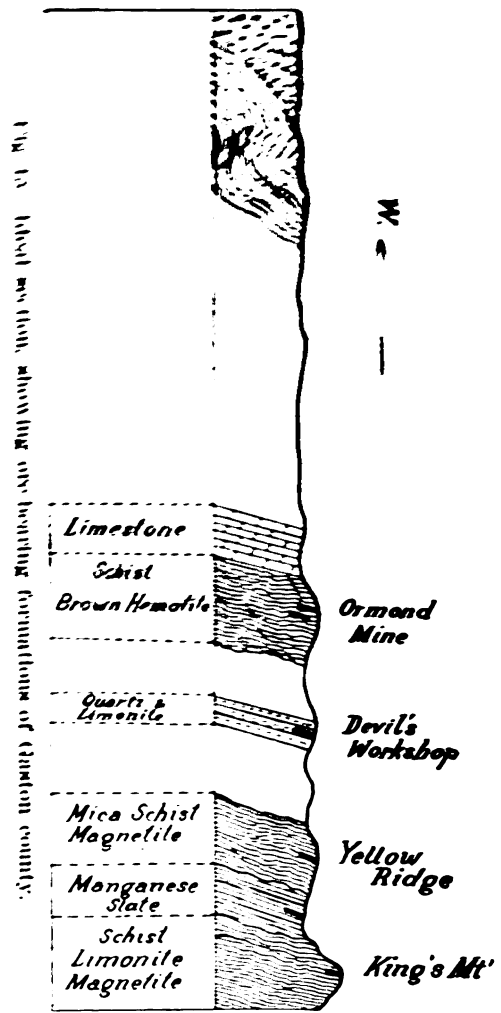
About 3 miles northeast of McClure's knob, on the waters of Anderson creek, this belt of ore has been exposed on *Major W. A. Graham's* place, at a point $\frac{3}{4}$ mile southwest from his house, by two small prospect shafts. Shaft No. 1 is 40 feet deep, and according to reports the lens of ore cut widened from 15 inches at the surface to 2 feet at the bottom. Shaft No. 2 is only 16 feet deep, and the ore body showed a width of from 10 to 12 inches.

The walls and gangue are mica-schist. The dip is nearly vertical. The ore is a slaty magnetite, which breaks easily into large and small rhomboidal blocks.

This entire range of parallel ore deposits in Lincoln and Catawba counties may be made accessible by a railroad connection, some 24 miles in length, between the Western North Carolina and Carolina Central railroads, following almost the exact trend of the principal ore belt D (Fig. 14 and Plate XI).

THE GEOLOGY OF THE STATE OF NORTH CAROLINA

Reference is made to the map Plate XI p. 55: and for a more detailed description of the formations see the report of the U. S. Geological Survey.

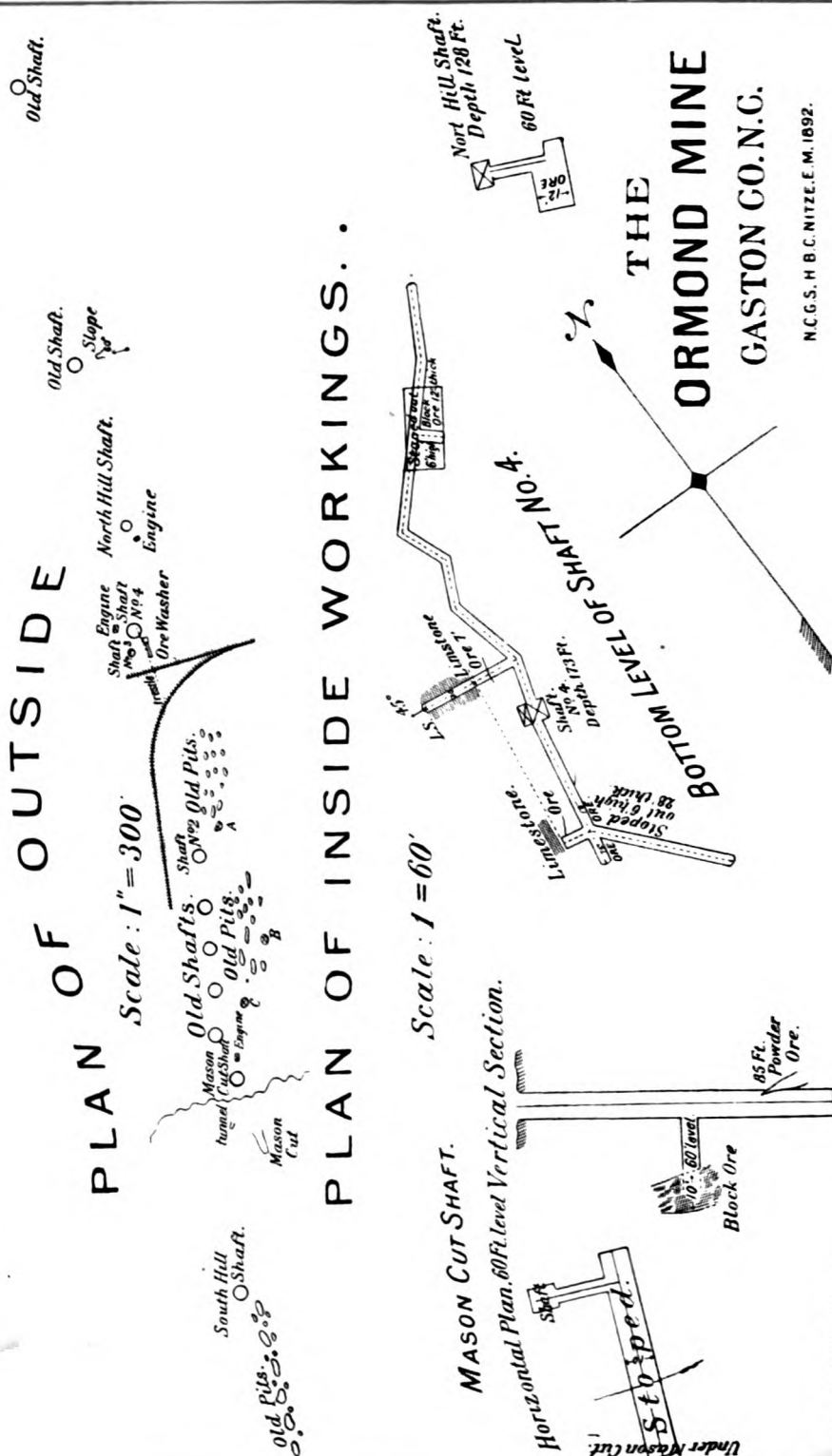


The formation consists of four parallel belts of ore on the east side of the limestone. (1) That on which the Ormond mine is situated. (2) Little Mountain (Devil's Workshop). (3) Yellow Ridge. (4) Crowder's and King's Mountains.

The first two, which are limonitic, have no analogies in Lincoln county. The Yellow Ridge corresponds to that on which the Big Ore bank is situated, and the Crowder's-King's Mountain belt to that of McClure's Knob, in Lincoln county.

PLAN OF OUTSIDE

Scale: 1" = 300'

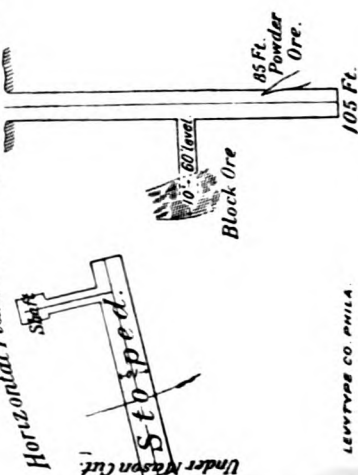


PLAN OF INSIDE WORKINGS.

Scale: 1" = 60'

MASON CUT SHAFT.

Horizontal Plan, 60 Ft level Vertical Section.



THE ORMOND MINE GASTON CO. N.C.

N.C.G.S. H. B. C. NITZE, E. M. 1892.

LEWIS & CLARK CO. PHILA.

1. THE ORMOND MINE is about one mile nearly due west from Bessemer City, and $\frac{1}{2}$ mile west of the Atlanta and Charlotte Air Line, with which it is connected by a short branch railroad; it is 6 miles northwest from the town of King's Mountain, and 28 miles slightly south of west from Charlotte.

This is probably the most interesting mine in Gaston county, because it has been most extensively worked, and is in fact the only iron ore mine, besides that at Cranberry in Mitchell county, that was in operation during the past year.

Plate No. XII shows the plan of the outside and some of the inside workings. The old workings extend over a distance of about 2400 feet in a direction N. 25° E., with the strike of the outcrop.

The ground has been literally "hogged over" for the greater part of this distance by shallow shafts and pits, which were worked at intervals as far back as the Revolutionary war.¹

These workings are situated on a flat, undulating ridge, having a general trend of N. 30° E. The country rock is a quartzitic talcose schist, argillaceous and decomposed to considerable depths, striking N. 25° to 30° E., with a dip of from 70° to nearly 90° N. W.

The character of the ore is varied; practically speaking there are three classes: 1. A hard, block ore, solid and jointed in structure, containing generally less than 5% of combined water, and hence classified as *turgile*.² 2. A loose, pulverulent, bluish-black ore, locally called *powder ore*, from its fineness and color. 3. A porous, brown hematite or *limonite*. 4. A very hard, homogeneous ore, almost black in color and slightly *magnetic*. These exist in various proportions, though the first variety may be said to predominate. Nearly all of it is slightly manganiferous, and in fact the powder ore may be considered a decomposed variety of manganiferous block ore, and is often found filling up the interstices formed by the joints and cracks in the same.

As a rule the ore bodies are remarkably free from mechanical admixture or gangue, and the ore is very pure. The structure of the beds is eminently lenticular, the lenses lapping over each other longitudinally and vertically, with a general northwesterly dip varying from 70° to nearly vertical. In mining, their position is traced by small stringers or leaders of ore, and by the flow of water which follows them. The hang-

¹ The ruins of an old Revolutionary charcoal furnace, the *Washington furnace*, are still standing on Rock creek, several hundred yards west of the mine. The ore was also smelted in *Stices' Shoals Bloomery forge*, on First Broad river, in Cleveland county, 3 miles north of the mouth and 6 miles west of Swan's forge, 4 miles south of Shelby, which was built in 1848 and rebuilt in 1856; and also in the *Buffalo Shoals Bloomery forge* on Buffalo creek, 2 miles above Froneberger's forge, 9 miles east-northeast of the mouth of the river, in Cleveland county, which made annually about 25 tons of wagon iron.

ing-wall is usually a decomposed gneiss or slate, and the wall a soft, black muck, which has been found to contain a considerable amount of fine black ore. The ore formation is continuous in length over the 2400 feet, and indeed there is no proof that it does not continue still farther in either direction.

Transversely to the strike, the ore bodies occupy a width varying probably from 50 to 100 feet. In the western drifts on a lower level (depth 173 feet) of shaft No. 4 a solid limestone ledge has been encountered, and this is probably the western boundary of the ore formation. As to the size of the separate lenses, they vary in thickness from less than 3 to more than 28 feet, holding out well in length and depth, though no definite figures can now be given of the latter, owing to insufficient development.

During the first eight months of 1892 this mine was worked by the Bessemer City Mining and Manufacturing Co., in which time 5000 tons of ore were mined and shipped. It was closed down in September, owing to inadequate equipment. A new company, the Bessemer Mining Company, has since taken hold, and is making preparations for development on a large and systematic scale, with a view to a regular output in the near future. When this mine was visited in April, 1892, there were in operation one working shaft, No. 4, and two development shafts, the North Hill and the Mason Cut. Ore was being regularly mined, raised, and shipped from "No. 4" to the Birmingham (Ala.) rolling mills, for fix or fettling in their puddling furnaces. The depth of this shaft was 173 feet, with a 4 foot sump. Its size was 7 x 9 feet, with two compartments, for bucket-hoist and pump and ladderway. It was operated by a small steam hoist, and all the raising was done in a bucket holding from 200 to 300 lbs. of ore. It was equipped with a No. 10 Cameron pump, stroke of plunger 2 feet, diameter of steam pipe 2 inches, and of water column 6 inches.

The workings were in the lowest level only, where three separate bodies of ore were being mined. About 30 feet south of the shaft there is a stope, 6 feet high, in a body of solid block ore 28 feet thick.

An analysis of this ore shows:

ANALYSIS OF BLOCK ORE FROM 28 FOOT LENS, ORMOND MINE, GASTON CO.

	(204 a)
Metallic iron	64.40
Phosphorus	0.036
Phosphorus ratio	0.055

About 100 feet north of the shaft a body of similar ore 12 feet thick has been worked in a stope 6 feet high by 30 feet long, and shows the following quality:

THE MAGNETITE AND BROWN HEMATITE ORES, GASTON COUNTY. 99

ANALYSIS OF BLOCK ORE FROM 12 FOOT LENS, ORMOND MINE, GASTON CO.

	(204 b)
Metallic iron	63.52
Phosphorus	0.033
Phosphorus ratio	0.051

In a crosscut extending westward from the main gangway, at a point 15 feet north of the shaft, an ore lens 7 feet thick has been encountered, resting against a limestone hanging-wall which dips about 45° nearly west.

The drift was extended 20 feet in the limestone, which was solid and regular. On its outer surface, in contact with the ore, it showed signs of erosion; the occurrence of this limestone will be a valuable factor in the study of the genesis of this ore deposit. The same ore and limestone are also seen in a small crosscut from the main gangway about 45 feet south from the shaft.

An analysis of a sample taken from two carloads of ore for shipment, April 6, 1892, shows:

ANALYSIS OF ORE FROM SHAFT NO. 4, ORMOND MINE, GASTON CO.

	(196)
Silica	9.72
Metallic iron	52.39
Sulphur	0.048
Phosphorus	0.079
Phosphorus ratio	0.150

This ore had been previously washed by the crudest sort of a contrivance, a stream of water in an inclined trough, to free it from the enclosing muck. The richness of the tailings in iron, as seen from the following analysis, shows the apparent waste in this method.

ANALYSIS OF TAILINGS FROM ORE WASHER, ORMOND MINE, GASTON CO.

	(204 c)
Metallic iron	43.50
Phosphorus	0.155
Phosphorus ratio	0.333

The North Hill shaft is 180 feet N. 31° E. from No. 4, and is 128 feet deep. It was in progress of connection with No. 4 for use as an air shaft.

At the 60 foot level an ore body 12 feet thick has been opened by a crosscut 20 feet from the shaft. It is a porous brown hematite.

The section of the shaft at 128 feet shows as follows:

645799

Since my visit there the shaft has been extended in depth and a body of ore 3 feet in thickness encountered at the bottom, which shows:

ANALYSIS OF THREE FOOT LENS, BOTTOM OF NORTH HILL SHAFT.
ORMOND MINE, GASTON CO.

	(204 d)
Metallic iron	47.10
Phosphorus	0.057
Phosphorus ratio	0.121

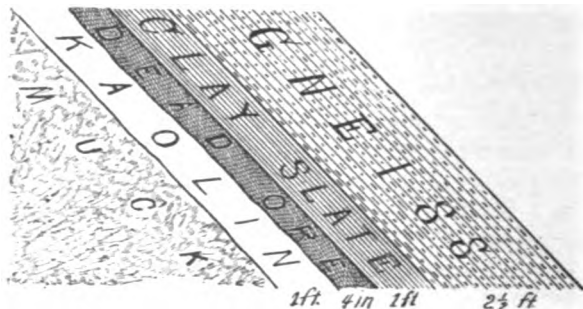


Fig. 21.—Section near foot of North Hill shaft, Ormond mine, Gaston county.

The Mason Cut shaft is 780 feet S. $21\frac{1}{2}^{\circ}$ W. from No. 4, situated in the midst of some old workings, near a small branch.

It is 105 feet deep. At the 60 foot level a body of block ore 10 feet thick has been discovered. At 85 feet the apex of a lens of powder ore was struck, but had not been further explored.

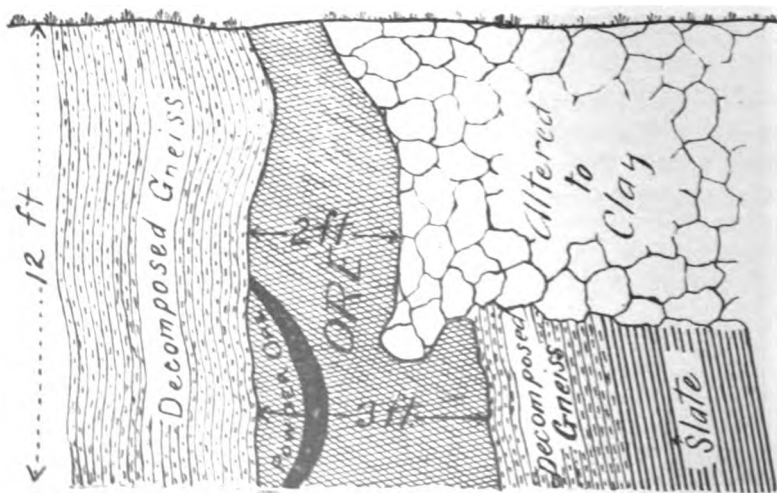


Fig. 22.—Vertical section, showing ore body at Mason cut, Ormond mine, Gaston county.

In the hillside immediately south of the branch is a large cut, the *mason cut*, from which ore was formerly mined. The ore lens comes to surface here, being from 2 to 3 feet thick, as shown below:

About 80 feet northeast from the Mason Cut shaft a body of black powder ore has been discovered, but is not now worked. It shows:

ANALYSIS OF POWDER ORE FROM OLD SHAFT, ORMOND MINE.

	(204 e)
Metallic iron	66.60
Phosphorus	0.019
Phosphorus ratio	0.028

But little, if anything, can be learned from the old pits and opencuts that are so profusely scattered along the outcrop.

Cut A shows a very irregular mass of porous brown and black powder ore (Fig. 23).

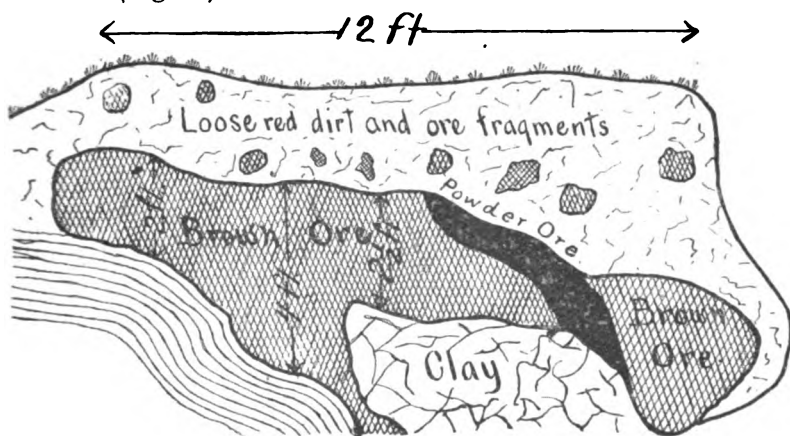


Fig. 23.—Section showing an ore body, Ormond mine, Gaston county.

Cut B shows about 4 feet of mixed ore ground. Strike N. 30° E., dip 75° N. W.

Cut C is shown in the accompanying section (Fig. 24). Strike N. 25° E., dip 80° N. W.

The quality of these ores is further exemplified by the following analyses:

ANALYSES OF ORE FROM THE ORMOND MINE, GASTON COUNTY.

	(197)	(198)	(199)	(200)	(201)	(202)	(203)	(204)
Silica	1.55	2.48	1.51	0.84	0.43	4.27	0.78	....
Metallic iron...	65.35	64.56	65.79	61.99	65.67	68.03	67.97	66.03
" manganese ....	....	....	....	3.67	....	....	....	pres't.
Sulphur .....	....	....	....	trace.	....	....	....	....
Phosphorus ...	0.007	0.004	0.028	trace.	0.013	0.036	0.023	0.092
Comb'd water.....	....	....	....	4.76	....	....	....	....
Phosp'rus ratio.	0.010	0.006	0.042	trace.	0.019	0.053	0.034	0.140

Nos. 197, 198, 201 and 202, black and blue powder ore.

No. 199, lump ore. No. 200, hard block ore.

No. 203, hard, black ore. No. 204, hard, brown and black ore.

These and the preceding analyses show the ore to be of a very high grade, and with few exceptions of Bessemer quality. It is an ore that will always be in demand and command the highest price. The deposit

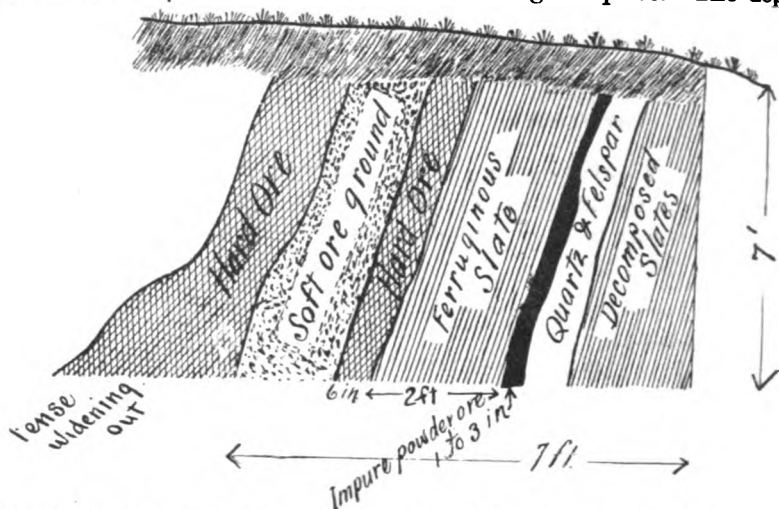


Fig. 24.—Section showing several ore bodies, Ormond mine, Gaston county.

is a valuable one and will warrant development on a large scale, and further explorations will undoubtedly disclose other lenses of ore of equal value to those already in sight.

2. THE LITTLE MOUNTAIN (*Devil's Workshop*) MINE is situated about $\frac{3}{4}$ mile east of the Ormond mine, $\frac{1}{4}$ mile east of the railroad, and 5 miles northeast of King's Mountain station. The character of this deposit is a brown hematite containing from 4 to 13 per cent of combined water, and accordingly classified variously as turgite,¹ goethite and limonite. The ore is probably pseudomorphous after siderite or calcite. It occurs in a distinct vein structure between parallel walls of siliceous slate. The strike is N. 37° E., and the dip from 70° N. W. to the vertical.

The vein matter consists of an admixture of crystalline quartz and pure ore in varying proportions. On the outcrop it is very lean, the quartz predominating; in depth the quartz gradually diminishes until at the bottom of the 60 foot shaft the vein material is nearly pure ore. This ore assumes some of the most grotesque and beautiful shapes (whence the name Devil's Workshop), rarely equaled in mineralogical specimens,—hard, massive; porous, honeycombed; stalactitic; botryoidal; mammillary; pisolitic; reniform; soft, earthy; etc., etc. The quartz is often quite perfectly crystalized, sometimes as large as 3 inches in diameter, and its crystal planes bear the impression of rhombic crystals, undoubtedly of siderite from which the ore is derived.

¹ Turgite is a hydrous red hematite, but occurs here with predominating brown hematite ores.

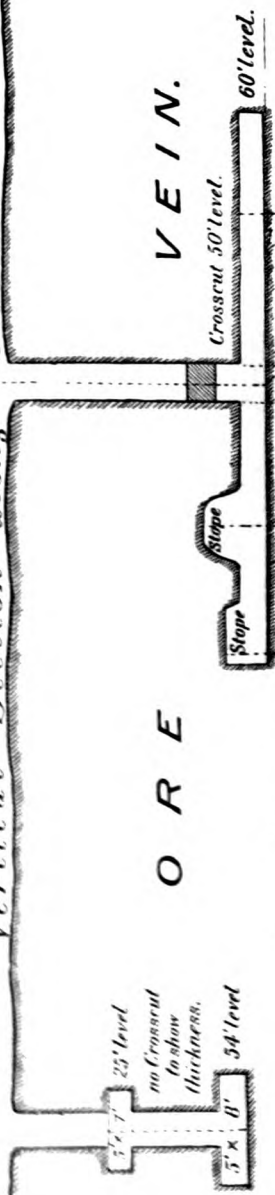
Scale 1"=45'

H B C NITZEE, M.
April, 1892.

SURFACE PLAN



Vertical Section along Strike.



Vertical Section, Right angles to Strike



The outcrop is very distinct and has been worked (exploratory) in an open pit or trench over 270 feet in length, from 3 to 20 feet in depth, and from 3 to 10 feet in width. (See Plate XIII.)

Two shafts have been sunk in the ore body, No. 1 about 100 feet from the northeastern extremity of the opencut, to a depth of 60 feet, at the bottom of which the vein was explored by drifts along the strike 66 feet in both directions. The vein matter for the first 30 feet in depth is profusely mixed with quartz, and ore clean enough for shipping purposes can hardly be mined until that depth is passed; at this point the vein is 10 feet thick; at the bottom of the shaft it is also 10 feet thick of practically clean ore. In the drift, both north and south, on the 60 foot level, the thickness varies from 17 to 27 feet (so reported by the general manager). At the 50 foot level a crosscut about 10 feet long has been driven westward through the hanging-wall of almost clear quartz, (probably a "horse") into ore on the other side.

Several analyses of the ore from this shaft show:

ANALYSES OF ORE FROM NO. 1 SHAFT, LITTLE MOUNTAIN MINE, GASTON COUNTY.

	(207)	(207 a)
Silica	6.87	7.90
Metallic iron	54.32	53.75
" manganese	0.45	....
Sulphur .....	....	0.011
Phosphorus	0.017	0.045
Phosphorus ratio	0.031	0.083

No. 207, average from across the vein on the 50 foot level, and from a large pile of ore outside of the shaft.

No. 207 a, from bottom of the shaft, a few feet above the floor; made up of pieces across the entire shaft.

Shaft No. 2 is 180 feet southwest from shaft No. 1, and is 54 feet deep. At the 25 foot level short drifts have been started either way on the vein about 7 feet wide in ore; at the bottom level similar drifts, not over 10 feet long, have been driven 8 feet wide in ore, but at no point has the vein been cut fully across to establish its true thickness.

The character of the vein matter is similar to that in shaft No. 1, improving in purity (freedom from quartz) with the depth.

An analysis of a sample taken from a stock-pile of 50 tons, outside of the shaft, shows the quality to be:

ANALYSIS OF ORE FROM SHAFT NO. 2, LITTLE MOUNTAIN MINE, GASTON COUNTY.

	(207 b)
Silica	11.96
Metallic iron	52.70
Phosphorus	0.022
Phosphorus ratio	0.041

Other analyses of this ore show:

ANALYSES OF ORE FROM THE LITTLE MOUNTAIN MINE, GASTON COUNTY.

	(205)	(206)	(208)	(209)
Silica	4.47	1.42	1.64	5.31
Metallic iron	57.50	60.66	61.20	58.73
" manganese	0.376	3.633	0.77	3.20
Sulphur			0.090	0.113
Phosphorus			0.009	0.005
Combined water	12.86	6.28	9.30	4.27
Phosphorus ratio			0.015	0.009

All of the analyses given show it to be a Bessemer ore, ranging from 1.42 to 11.96 per cent silica, and from 52.70 to 61.20 per cent metallic iron. There is a loose pulverulent variety which is high in manganese, averaging over 3 per cent; but by far the greater proportion will not average above 0.50 per cent of metallic manganese.

The average grade of ore that can be mined and shipped directly, without further treatment, is probably best represented by analyses Nos. 207 and 207 a. The ore will not require washing; but much of the leaner material, heavy in quartz admixture, can undoubtedly be successfully improved by crushing and jigging, to produce a high grade product.

About 264 feet S. 40° W. from shaft No. 2 a tunnel has been driven from 100 to 150 feet, N. 10° E., but failed to strike the ore vein. There were evidences of old Spanish workings here, supposed to have been made for silver, and an antiquated wooden hand pump was found in an old shaft just above the mouth of the tunnel.

In a southwesterly direction the vein can be traced by its heavy outcrop of ferruginous quartz for several miles. A small test pit on *J. K. Kennedy's place*, $1\frac{1}{2}$ miles southwest from shaft No. 2, discovers similar conditions to those found at the Little Mountain mine, and 600 yards from here again it has been prospected on the *Ferguson place*. Explorations in depth may uncover workable deposits all along this general outcrop, and it is certainly well worthy of careful investigation.

3. The next succeeding belt of ore to the east is that of the Yellow ridge, and the most northeasterly point at which this has been explored is at the Costner mine.

THE COSTNER MINE¹ is about 22 miles S. 25° to 30° W. from the Big Ore bank in Lincoln county. It is just south of Long creek, and about $\frac{1}{2}$ mile west of the Charlotte and Atlanta Air Line railroad. A shaft was sunk during the late war to a depth of 115 feet, and the thickness of the vein thus opened was stated to be 7 feet.

¹ From the "Ores of North Carolina," p. 160, and United States Tenth Census Report, Vol. XV, p. 318.

The ore is a dense metallic magnetite, and its quality is shown by the following analyses:

ANALYSES OF MAGNETITE FROM THE COSTNER MINE, GASTON COUNTY.

	(210)	(211)	(212)	(213)	(214)
Silica	4.34	....	....	5.40	....
Metallic iron	66.75	52.00	44.90	50.10	67.40
" manganese	0.17	....	....	....	....
Alumina	0.44	....	....	....	....
Lime	0.35	....	....	....	....
Magnesia	2.23	....	....	....	....
Phosphorus .....	....	0.002	0.004	0.007	0.010
Titanic acid .....	....	....	....	none.	....
Phosphorus ratio .....	....	0.004	0.009	0.014	0.015

No. 211, lump ore, from pile near shaft.

No. 212, "flint" ore from same pile.

No. 213, "limestone" ore.

No. 214, red ore.

THE ELLISON MINE is about 4 miles southeast of the Costner. The greatest depth reached here was 112 feet, and the ore body varied from 5 to 12 feet in thickness, with an average of 7 or 8 feet. The outcrop has been removed for about 100 yards. A furnace was built here years ago to smelt this ore. It is a granular magnetite, more or less intermixed with hematite of great purity and richness. The country rock is actinolite schist, with a strike of N. 20° E.

The quality of the ore is shown by the following analyses:

ANALYSES OF ORE FROM THE ELLISON MINE, GASTON COUNTY.

	(215)	(216)	(217)
Silica	23.80	....	....
Metallic iron	52.61	69.87	54.71
Phosphorus	trace.	0.008	0.016
Phosphorus ratio	trace.	0.008	0.029

THE FERGUSON MINE adjoins the Ellison on the southwest; it is about 1½ miles southeast from the Little Mountain mine, on a parallel ridge. The ore is a compact magnetite. It was worked some 40 or 50 years ago by opencuts and tunnels along the outcrop, signs of which are still visible.

These old diggings occupy a longitudinal extent of several hundred yards, starting at Cooper's branch. The strike is about N. 20° E., and the dip steeply to the northwest (nearly vertical). The relative positions of the old cuts show the existence of three parallel ore bodies or lenses, 30 and 50 feet apart, designated Nos. 1, 2, and 3 in the following sketch.

The middle lens, No. 2, is the only one that can be seen in place in the old workings at present, in the tunnels or drifts marked (t) and (t'); (t) is 20 feet long and shows a very lean, sandy ore body 1 foot in thickness; (t') is 15 feet long and shows an ore body varying from $\frac{1}{2}$ to 3 feet thick, with signs of widening in depth. A prospect shaft has more recently been sunk on the edge of No. 1 to a depth of 66 feet, and a crosscut 40 feet long in a northwesterly direction from the bottom, in a decomposed clay and schist, interstratified with thin stringers of quartz, has cut a body of black dirt $6\frac{1}{2}$ feet thick, supposed to be the old workings, but no ore was found.

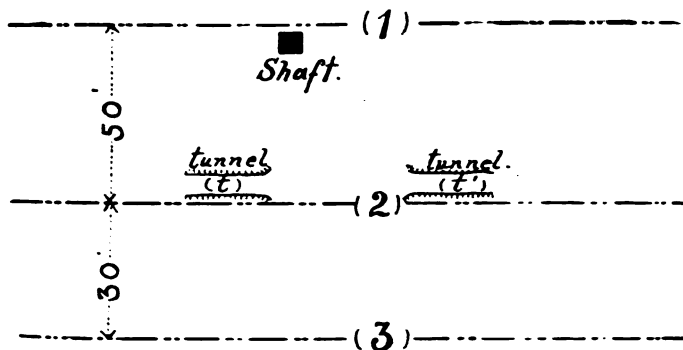


Fig. 25.—Section showing relative positions of three parallel ore belts, Ferguson mine.

This thickness agrees well with the reported thickness of the ore-body, viz., from 5 to 7 feet. The ore was in all probability worked out to a depth somewhat below the bottom of the shaft (66 feet), which is very near the water-level. Many of the small surface specimens of the ore show considerable amounts of iron pyrites (sulphuret), and the danger is always imminent that this will increase below the water-level.

The quality of the Ferguson ore is represented by the following analyses.

ANALYSES OF MAGNETITE FROM THE FERGUSON MINE, GASTON COUNTY.

	(218)	(218 a)	(218 b)
Silica	4.67	12.72	11.52
Metallie iron	67.18	57.60	58.20
Sulphur	0.11	0.016	0.012
Phosphorus	0.05	0.082	0.071
Titanic acid	none.	....	....
Phosphorus ratio	0.074	0.142	0.122

No. 218, average sample from surface. No. 218a, from lens No. 1. No. 218b, from lenses Nos. 2 and 3.

"THE FULENWIDER MINE' is situated $1\frac{1}{2}$ miles southeast of the Ferguson. It supplied much of the ore for the forge on Crowder's creek near by.¹ The ore is characteristic 'gray ore,' granular magnetite in a talcose and quartzose gangue. The amount of work done here seems to indicate a body of some magnitude; in its northeasterly extension the surface of the ground is covered with the weathered outcrop of some as yet undiscovered deposit."

THE YELLOW RIDGE MINE² lies 2 miles southwest of the Fulenwider and $2\frac{1}{2}$ miles east of King's Mountain station. The ore is pre-eminently a gray ore and is notably magnetic. This bed was worked to a depth of 120 feet, and the ore was smelted in the Crowder's creek³ and other forges.⁴ The dip is westerly, diverging but little from the vertical. There are 2 groups of pits and trenches on the ridge, about $\frac{1}{4}$ mile apart. At the northern workings the bed is said to be from 6 to 10 feet thick at a depth of about 30 feet. The deposit, as opened on the southern end of the ridge, consists of two parts, separated by a layer of talcose schist containing no ore; the western side of the bed is said to be 20 feet thick, and contains a large amount of pyrite; the eastern side is 10 feet thick, and is free from pyrite. (See Fig. 26, page 108.)

A hundred yards further south the ore narrows to 6 feet, and the portion of the bed that is contaminated with sulphur has disappeared.

The following analyses demonstrate the quality of this ore:

ANALYSES OF ORE FROM THE YELLOW RIDGE MINE, GASTON COUNTY.

	(219)	(220)	(221)	(222)	(223)	(224)
Silica	8.39	....	....	....	....	....
Metallic iron	61.74	63.21	37.40	57.80	57.49	59.35
Sulphur	0.033	....	1.50	0.441	0.100	....
Phosphorus	trace.	0.014	0.020	0.009	0.010	0.030
Titanic acid	trace.	....	....	....	....	....
Phosphorus ratio ...	trace.	0.022	0.053	0.016	0.017	0.051

¹ From "The Ores of North Carolina," p. 161.

² *Briggs Iron Works*, on Crowder's creek, $1\frac{1}{2}$ miles north of King's Mountain; built in 1853; consists of a bloomery forge with three fires and one hammer, which made about 336 tons of blooms in 1857; and one heating furnace with two trains of rolls, which worked up the forge blooms into round and square iron for the home market, making about 215 tons a year. (From "The Iron Manufacturer's Guide," 1859.)

³ From "The Ores of North Carolina," p. 162; and the United States Tenth Census Report, Vol. XV, p. 318.

⁴ *Briggs Iron Works*.

⁵ *Buffalo Bloomery Forge* was located on Buffalo creek, 8 miles east of Shelby, 10 miles N. N. E. of Buffalo Iron Works, and 4 miles south of Froneberger's forge, Cleveland county. It was built in 1815; rebuilt in 1856, in which year it made 35 tons of bars and plough moulds out of Briggs Yellow Ridge bank gray magnetic ore from under the west side of King's mountain. There was a charcoal furnace and a forge in the immediate vicinity during the Revolution.

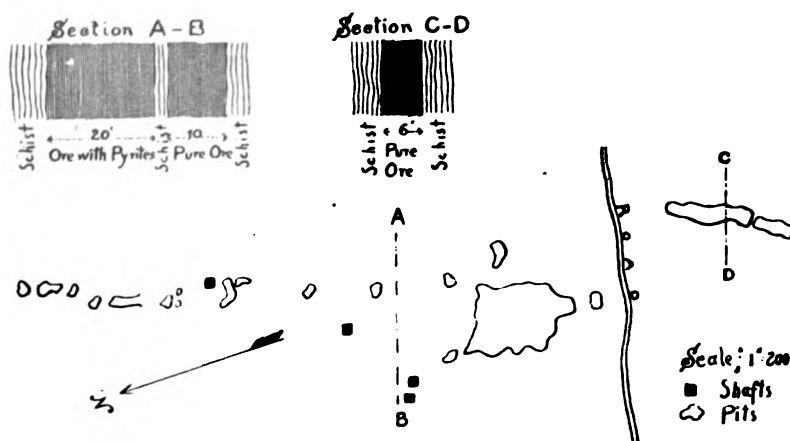


Fig. 26.—Sections and plan at Yellow Ridge mine, Gaston county.

(4). We now come to the most westerly of the four belts, that of Crowder's and King's Mountains.

Crowder's mountain lies about 3 miles slightly northeast from the town of King's Mountain. On the northern end of this mountain, 350 feet above the level of Crowder's creek, is an outcropping of magnetic iron ore. The bed is exposed by a cut into the hillside and shows the following section :



Fig. 27.—Section showing ore body, north end of Crowder's Mountain.

(a) Garnetiferous schist with slight sprinkling of magnetite. (b) Metamorphic sandstone. (c) Micaceous schist. (d) Garnetiferous, hornblende schist. (e) Metamorphic sandstone.

The vein matter measures about 12 feet in thickness; it is a hard, siliceous, magnetite ore, and contains minute particles of garnet in the gangue. On the outcrop it is partially hydrated, and covered with a thin coating of brown hematite in places; and the origin of occasional particles of brown hematite found on the slope of the mountain below this pit can probably be traced to this source. The strike of the country rock is N. 45° E., and the dip is about 80° southeast.

ANALYSIS OF MAGNETITE FROM N. E. END OF CROWDER'S MT., GASTON COUNTY.
(233)

Silica	47.11
Metallic iron	31.62
Phosphorus	0.087
Titanic acid	none.
Phosphorus ratio	0.275

The inferiority of this ore is apparent; it is too high in silica to be of any commercial value.

The outcrop is traced with difficulty for a short distance up the slope of the mountain, when it soon disappears under a heavy covering of sandstone and porphyritic minette of yellowish red color (a rock composed of a felsitic micaceous matrix containing small crystals of orthoclase).

About 125 yards southeast from this opening, near the backbone and toward the summit of the ridge, a rather profuse showing of float ore, brown hematite, in places manganiferous, makes its appearance over a small area. An old prospect tunnel may be seen here, driven 50 feet in the decomposed sandstone rock, but without discovering the ore body. A short distance above the mouth of the tunnel the ore has been cut by a test pit, showing up 3 feet in thickness between sandstone walls. The strike is N. 20° E., and the dip nearly vertical, inclined if any towards the southeast. The quality of the ore is indicated by the following :

ANALYSIS OF BROWN HEMATITE, CROWDER'S MOUNTAIN, GASTON COUNTY.

	(234)
Silica	12.40
Metallic iron	57.30
Phosphorus	0.081
Phosphorus ratio	0.141

Towards the southwest the outcrop can be traced but a short distance, soon disappearing under the heavy covering of sandstone. On examining the western slope of the ridge, about 150 yards from the above point, an outcrop of brown hematite is again met with, similar to that just described; here also it crops out under a heavy covering of sandstone, which appears to dip at a moderate angle towards the southeast, thus pointing to a folded structure. As far as exposed the ore was 2 feet in thickness, but there were no openings from which to determine its true extent. The analysis of an average sample shows it to be richer in iron than the preceding, though very high in phosphorus.

ANALYSIS OF BROWN HEMATITE, WEST SLOPE, CROWDER'S MT., GASTON COUNTY.

	(235)
Silica	3.30
Metallic iron	59.80
Phosphorus	0.780
Phosphorus ratio	1.304

The outcrop can be traced in a northeasterly direction along the slope of the ridge for several hundred yards. About 75 yards southwest from the opening for brown hematite on the summit of the mountain, a body of magnetite has been exposed by an opencut, measuring

5 feet in thickness between sandstone walls. Strike N. 35° E., dip from 70° to 80° N. W. The character of the ore is a gray magnetite in a gangue of white, decomposed feldspar. Thirty feet from here a prospect shaft has been sunk to a depth of 25 feet, but shows nothing of interest; a crosscut from the bottom of this shaft in a northwesterly direction should cut the ore body. The quality of the ore is apparent from the following analysis:

ANALYSIS OF MAGNETITE. FROM CROWDER'S MOUNTAIN. GASTON COUNTY.

	(236)
Silica	24.90
Metallic iron	52.08
Phosphorus	0.033
Titanic acid	none.
Phosphorus ratio	0.063

Other analyses of ores from this part of Crowder's mountain show:

ANALYSES OF ORES FROM NORTHERN END OF CROWDER'S MOUNTAIN.

	(225)	(226)	(227)	(228)	(229)	(230)	(231)	(232)	(237)	(238)
Silica	11.02	23.14	9.27	2.58	28.20	44.26	.....	.....	.....	.....
Metallic iron.....	52.02	45.13	54.80	59.29	33.48	29.08	53.20	56.10	50.50	50.72
Sulphur	0.066	0.112	0.111	0.015	0.200	0.112	.....	.....	.....	.....
Phosphorus	0.021	trace	0.009	0.060	none	0.067	0.010	0.047	0.020	0.021
Titanic acid ..	trace	trace	trace	trace	trace	trace	0.60	0.52	.....	.....
Phosphorus ratio.	0.040	trace	0.016	0.050	none	0.230	0.018	0.083	0.040	1.224

Nos. 227 and 231, red, quartzite ore. Nos. 232 and 237, martite schist. No. 238, brown hematite.

This table shows a great variation, from high grade Bessemer ores to practically worthless ferruginous sandstone (No. 230). Most of the ores show a trace of titanic acid, but not enough to impair their value.

The lack of development is apparent, and there may be valuable deposits of ore here that have not been yet discovered; at any rate the region is worthy of investigation.

Several miles southwest of King's mountain proper, on a prominent southern spur of this general range, near the South Carolina State line, there is a heavy outcrop of black, ferruginous hornblende slate or schist. It was reported that a body of magnetite ore 30 feet in thickness had been discovered here, known as *Elum's Find*, but careful examination has shown this to be a gross error of some unknowing prospector. Neither in quality nor quantity can this "enormous find" be corroborated. A prospect tunnel, entering the hillside through a succession of red and yellow sandy clays and shales for 50 feet, has cut a small seam of more highly ferruginous slate than the enclosing rock, from 7 to 8 inches in thickness. The strike at the mouth of the tunnel is N. 30° E., dip 70° to 80° N. W.; at the face of the drift the dip is inverted to the northeast.

On the hillside above the tunnel the same strata are found cropping out, and the seam of ore measures 15 inches in thickness; strike N. 15° E.,

dip 40° N. W. The wall rock is a shale or slate, partially decomposed and of similar structure and appearance to the ore material itself, and hence it may have been taken indiscriminately for ore and so reported; but it has a decided white streak and a lower specific gravity. The character of the ore, if indeed it may be designated as such, is hard and compact, having a slaty structure and a rhomboidal cleavage; it is steel gray to black in color and streak, but non-magnetic, and must be classed as simply a highly ferruginous slate.

The following analysis shows its worthlessness:

ANALYSIS OF FERRUGINOUS SLATE FROM KING'S MOUNTAIN, ELAM'S FIND.

	(239)
Silica	31.50
Metallic iron	48.30

About one mile northwest from here, on the same general ridge, similar strata of siliceous, ferruginous shales are exposed over a great width, striking N. 15° E., and dipping almost vertically. A bed of magnetite ore from 100 feet to 300 feet thick was reported here. A shaft 30 feet deep had been sunk, and a crosscut started from the bottom of the same, known as the *Foy Opening*. There is nothing here to justify the name of iron ore; the rock is simply a siliceous slate, ferruginous in places, interstratified with quartz, developing into talcose or hydro-mica schist on the hanging, and quartz-schist on the foot-wall; even among the material taken from the shaft there was nothing as good as that found on the Elam place.

MANGANIFEROUS SLATES.—Before leaving this subject it is desired to call attention to the persistency of the belt of manganiferous slates already noted in Lincoln and Catawba counties (p. 94).

These manganiferous slates make their appearance in an unbroken line along the western base of Crowder's and King's mountains in Gaston county. The outcrop appears as a very dark, bluish-black slate, impregnated with manganese dioxide, disseminated through which, especially in the small cracks and fissures, are particles of crystalline pyrolusite and psilomelane. An analysis of a sample of this outcrop taken near the old forge on Crowder's creek, formerly operated by Mr. Briggs, under the west flank of Crowder's mountain, and quite near the Yellow Ridge Ore mine, shows:

ANALYSIS OF MANGANIFEROUS SLATE, WEST FLANK OF CROWDER'S MT.
GASTON COUNTY.

	(395)
Silica	40.40
Metallic iron	8.00
" manganese	21.45
Alumina	9.03
Sulphur	0.112
Phosphorus	0.013

In its southern extension, near Blacksburg, York county (S. C.), this ore belt has been prospected in depth, demonstrating that the black slates grow gradually richer in manganese in descending, small streaks and seams of crystalline ore appearing between the same, until at a depth of about 25 feet a large body of pure solid ore was reached, some analyses of which show:

ANALYSES OF MANGANESE ORE, YORK COUNTY, S. C.

Silica	2.920	7.37	4.66
Metallic iron	1.440	1.98	2.00
" manganese	57.353	53.16	51.15
Phosphorus	0.050	0.050	0.055

This is an ore of remarkable purity, high in manganese and low in phosphorus, which will always be in demand at the highest market prices. There is no reason why similar bodies of high grade manganese ore should not exist throughout this entire belt, but they must be discovered by prospecting.

LIMESTONE.—The continuity of the limestone belt, noted in Lincoln and Catawba counties (p. 94), is also observable in Gaston county. It follows immediately along the western edge of the ore formations, and underlies the town of King's Mountain. As it crops out principally in the creek bottoms and lowlands, quarrying will be difficult and costly.

It is properly speaking a dolomite, that is, a carbonate of magnesia and lime, or a magnesian limestone, as shown by the following analysis of a sample taken from the Kennedy place, near King's Mountain station:

ANALYSIS OF DOLOMITE, KENNEDY PLACE, GASTON COUNTY.

	(406)
Silica	10.70
Lime	28.10
Magnesia	18.12

This stone is too high in silica to make a good furnace flux, and it is feared that this may be a general characteristic of the entire zone.

(e). THE BROWN HEMATITE AND MAGNETITE ORES OF EASTERN CALDWELL, BURKE AND CLEVELAND, AND WESTERN CATAWBA AND LINCOLN COUNTIES.

(1). THE MAGNETITE ORES OF THE HORNBLÉNDE BELT IN WESTERN CATAWBA AND LINCOLN, AND EASTERN CLEVELAND COUNTIES, MARKED "B" IN SECTION (Fig. 14, pages 70 and 86).

THE BARRINGER MINE is situated about 2 miles south of the town, in Catawba county. The ore is a compact, coarse-grained, very free from gangue, which is granitic and

worked many years ago to supply local forges, and was even hauled to the Bent forge, 15 miles distant, to mix with local brown hematites.

In its present state of abandonment it is impossible to give any further information as to this deposit.

About $\frac{1}{2}$ mile northeast from here, on the farms of James McCree and Moses Witherspoon, the ore crops out in a gully along the dirt road, and the adjacent fields are covered with float ore, but no openings have been made.

THE FORNEY MINE is situated $1\frac{1}{2}$ miles south of Maiden Station, 8 miles southwest of Newton, and $\frac{1}{2}$ mile west of the Chester and Lenoir railroad, on the waters of Clark's creek in Catawba county.

The ore is a coarse-granular magnetite, usually free from gangue, and occurs in irregular pockets, from a few inches to three or four feet in thickness, and of very uncertain length and depth, in a country rock of syenite. The formation has been traced by a series of pits and shafts for over a mile. The ore was formerly worked in William's, Keener's, and Ramsour's forges, all on South Fork of Catawba river. One of the old shafts was cleaned out about two years ago, and Mr. Bost, the present owner of the property, reports that at a depth of 28 feet the ore body was found to be 4 feet thick.

The following analyses show the ore to be of high grade Bessemer quality, but containing a small percentage of titanitic acid:

ANALYSES OF MAGNETITE FROM THE FORNEY MINE, CATAWBA COUNTY.

	(111)	(112)	(113)
Silica	1.41	....	....
Metallic iron	67.92	69.84	65.16
Sulphur	0.07	....	....
Phosphorus	0.025	0.004	0.009
Titanic acid	1.60	trace.	....
Phosphorus ratio	0.036	0.006	0.013

About $\frac{1}{2}$ mile northwest from here a float of similar magnetite ore is observed on *Mr. Bost's* farm, which has been traced $\frac{1}{4}$ of a mile northeast to the farm of *John W. Williams*, where there are signs of numerous old forge workings.

Continuing in a southwesterly direction into Lincoln county this syenitic ore belt makes its appearance about 9 miles west of Lincolnton and $\frac{1}{2}$ mile south of Orleans P. O., where the ore is found as float on the farm of *Mr. Lawson Bess*, and can be traced with the dip needle for several hundred feet north and south. The ore is striated with quartz, and an analysis shows it to contain titanitic acid, seemingly a feature of this belt.

ANALYSIS OF MAGNETITE FROM LAWSON BESS FARM, LINCOLN COUNTY.

	(268)
Silica	11.37
Metallic iron	56.95
Sulphur	0.045
Phosphorus	0.029
Titanic acid	2.40
Phosphorus ratio	0.050

Three miles north of Orleans P. O., on Indian creek, small pieces of magnetic float ore are found on the farm of *George Bean*, but no explorations have been made to locate the deposit. There are evidences here, as in fact there are over this entire belt of mica-schists and syenitic gneiss east and west of Lincolnton, of gently repeated folding in the stratification. At the mill on Mr. Bean's farm a short synclinal fold is noticeable in a cut in the road; and at a small opening made for procuring building stone the layers of gneiss are nearly horizontal.

"In the neighborhood of Shelby, Cleveland county, a considerable deposit of magnetite ore appears. It is in the syenitic series and seems to be abundant."

A number of forges were at one time at work in this county, but they appear to have obtained their ore supply chiefly from the Gaston county mines, Yellow Ridge, Ormond's, etc.¹

¹ From the "Ores of North Carolina," p. 160.

² From the "Iron Manufacturer's Guide," 1859, p. 189:

Dixon's Bloomery Forge, on Knob creek, 12 miles northwest of Shelby and 18 miles west from Lincolnton on the road to Rutherfordton; hot blast; made in 1856 mould, bar, tire, and axle iron.

Buffalo Shoals Bloomery Forge, on Buffalo creek, 2 miles above Froneberger's forge, 9 miles east-northeast of Shelby; one fire and one hammer; made annually about 25 tons of wagon-tire, bar and plough moulds from Ormond's magnetic ore.

Froneberger's Bloomery Forge, on Buffalo creek, 4 miles northeast from Shelby and 5 miles north from Muddy Creek Junction; built in 1855; three fires and two hammers; made in 1857, 127 tons of bars.

Buffalo Bloomery Forge, on Buffalo creek, 8 miles east of Shelby, 10 miles N. N. E. of Buffalo Iron Works and 4 miles south of Froneberger's forge. Built in 1815, rebuilt in 1856; two fires and one hammer; made in 1856, 35 tons of bars and plough moulds for a South Carolina market, out of Brigg's Yellow Ridge ore bank in Gaston county. There was a furnace and forge in the immediate vicinity before the Revolution.

Buffalo Iron Works, a bloomery on Buffalo creek, 1 mile north of the State Rue, 10 miles S. S. E. of Shelby. Built in 1850; rebuilt in 1856; three fires and one hammer; made 92 tons of bars in 1856.

Stice's Shoals Bloomery Forge, on First Broad river, in Cleveland county, 3 miles north of the mouth, and 6 miles west of Swan's forge, 4 miles south of Shelby; built in 1848; rebuilt in 1856; one fire and one hammer; made about 24 tons of bars in 1857.

(2). THE BROWN HEMATITE ORES OF EASTERN CALDWELL AND BURKE, AND WESTERN CATAWBA AND LINCOLN COUNTIES, MARKED "A" IN SECTION (Fig. 14, pages 70 and 86).

There is a wide belt of folded cyanitic hydro-mica and purplish paragonite schists over this area, containing irregular deposits of brown hematite, similar to those marked "C" in the section (Fig. 14) and described under that head on pages 84 and 85 of this report.

It extends in a general northeasterly direction from the northern foot-hills of the South mountains in the southern part of Burke county to the Brushy mountains in the southern part of Wilkes county; from Jacobs fork of the Catawba river, near the eastern border of Burke, across the Catawba, and, by way of Gunpowder creek, to the waters of Middle Little river near the eastern border of Caldwell, and beyond, near Rocky creek in Alexander, and even on the northern slopes of the Brushy mountain, in Wilkes, the same ores occur, being indistinguishable in appearance and of identical lithological relations. But little, if any, exploratory work has been undertaken and the following description must of necessity be brief and limited.

In *Caldwell county* there are numerous localities where showings of float ore have been observed: at Deals mountain, on Upper Little river; on the divide between the Upper and Middle Little rivers, $\frac{1}{2}$ mile south of Downs ville P. O., etc.; but as far as present explorations go the prospects for finding workable deposits are not encouraging.

In *Burke county*, limonite occurs on Chestnut hill, near Icard's station. In the southern part of the county, in the South mountains, various occurrences of magnetite and red and brown hematite are noted.

In *Catawba county* a heavy float of limonite occurs in the northern part of the town of Hickory on Champion avenue. In the eastern part of the town a similar showing is observed on the old *Hale* place at Sigmund's mill. Ore was formerly dug here in shallow pits, signs of which are still visible, and hauled to Bent forge, 8 miles distant. In the railroad cut, one mile east of Hickory, an exposure of ore is visible in a small anticlinal fold, at the apex of which the bed measured about 3 feet in thickness. An analysis shows it to be very high in phosphorus.

ANALYSIS OF BROWN HEMATITE IN R. R. CUT, 1 MILE EAST OF HICKORY,
CATAWBA COUNTY.

	(114)
Silica	7.63
Metallic iron	49.28
Sulphur	0.060
Phosphorus	0.663
Phosphorus ratio	1.345

Two miles west of Hickory and $\frac{1}{2}$ mile north of the W. N. C. railroad, on *Ad. Morgan's* farm, isolated occurrences of float ore are noticeable. Some ore was dug here in former years and hauled to the Bent forge on Henry's Fork.

On the southwestern slope of Baker's Knob, a spur of the South mountain range, 9 miles southwest of Hickory and 2 miles east of the Burke county line, there is a series of shallow pits on the property of the *Piedmont Wagon Company*, of Hickory, from which ore was mined and smelted over 30 years ago, in the Bent forge, 3 miles distant. But very few good specimens of ore can be found about the old pits at present; and altogether the prospects are not very promising.

In the *Jugtown settlement*, about 14 miles south of Hickory, near the Lincoln county line, occurrences of float ore (brown hematite) were observed on the farms of *Daniel Lutz*, *John Rockett* and *Thomas Ritchie*. On the latter place the showing was particularly favorable, and will warrant exploration.

About 3 miles north of Ritchie's and 10 miles south of Hickory another noticeably profuse showing occurs on a low ridge in the rear of *Dr. Ford's* house. The deposit has been explored by several shallow pits, from which large boulders of massive ore, weighing 50 pounds or over, have been taken. These pits are now filled up, so that the ore could not be seen in place. The chances of finding workable deposits are good. The ore is of good external appearance, but analysis shows it to be high in phosphorus, as follows.

ANALYSIS OF BROWN HEMATITE FROM DR. FORD'S, CATAWBA COUNTY.

	(115)
Silica.....	7.18
Metallic iron	52.98
Sulphur	0.026
Phosphorus	0.886
Phosphorus ratio	1.673

In *Lincoln county* this belt of brown hematite makes its appearance in the neighborhood of Orleans P. O., 9 miles west of Lincolnton, on the waters of Indian creek. Surface showings of siliceous float ore are traceable for $\frac{1}{2}$ mile north from Bess' store, but no openings have been made. In front of Bess' store (Orleans P. O.) the strike of the syenitic gneiss is N. 5° to 8° E.

Some 2 miles slightly west of south from here ore was dug on the *Widow Bailey place* during the late war, and hauled to Dickson's forge on Knob creek in Cleveland county (see p. 114). It was worked as 15 years ago, and shipped to the High Shoals furnace in Cherokee county, via Cherryville.

The main diggings consisted of a trench or cut over 300 feet long east and west, averaging about 10 feet in depth; which has nearly filled up, thus preventing an examination of the ore in place. There is a very profuse showing of fine "shot ore" over the hill near this cut, covering an area of some 400 by 600 feet.

The character of the ore is that of a dark brown, lustrous limonite, compact and homogeneous in structure, but in places shaly and impregnated with quartz.

The following analysis shows the quality:

ANALYSIS OF BROWN HEMATITE FROM THE BAILEY PLACE, LINCOLN COUNTY.

	(269)
Silica	7.14
Metallic iron	54.17
Sulphur	0.097
Phosphorus	0.381
Phosphorus ratio	0.703

About $\frac{1}{4}$ mile south from here a similar occurrence of float ore is noticed along a low ridge, but it appears leaner and more siliceous than at the Bailey place.

Three miles west of Orleans P. O. and about 2 miles west of the Bailey ore bank, on the waters of Buffalo creek, a series of old pits, none of them over 4 feet deep, mark the site of some former ore diggings. This is on the farm of *P. F. Baxter*, in what is known as the "Old Ore field." The few pieces of ore that are found scattered about at present show it to be quite siliceous.

In a small branch near here it was noticed that the stratification was gently folded, in places nearly horizontal. This fact has been mentioned before, and will undoubtedly account for the distribution of these brown hematite deposits over so wide and irregular an area.

CHAPTER VII.

THE MAGNETITE AND BROWN AND RED HEMATITE ORES OF THE BLUE RIDGE MOUNTAINS AND THEIR EASTERN FOOT-HILLS.

(a). THE MARTITE SCHISTS ALONG THE EASTERN BORDER OF WATAUGA COUNTY.

Along the crest and slopes of the Blue Ridge mountains, near the eastern boundary line of Watauga county, there is a zone of red hematite, which is a martite schist, in a country rock of light gray, greenish and pinkish quartzose schists, having a northeast and southwest trend, and dipping towards the southeast.

It has been prospected at:

BULL RUFFIN, about 7 miles southeast of Boone, near Cook's gap. The ore deposit has been exposed here by a trench, 70 feet in length, in a direction N. 25° W., across the bed, at the upper end of which a shaft was sunk about 20 feet in depth, but is now filled up and inaccessible. The ore bed as seen in the cut is but a thin seam, from 5 to 8 inches thick, between walls of greenish and pinkish schist: strike N. 65° E., dip 45° S. E. It is reported that the bed widened gradually to somewhat over five feet at the bottom of the shaft. The ore is very pure and solid, schistose in structure, with small octahedral crystals disseminated through it. Several analyses show its composition to be:

ANALYSES OF MARTITE SCHIST FROM BULL RUFFIN MINE, WATAUGA COUNTY.

Silica	67.50	(377)
Metallic iron	7.19	2.62
" manganese	61.95	67.67
Sulphur	0.02	0.025
Phosphorus	0.075	trace.
Titanic acid	0.000	trace.
Phosphoric acid	0.121	trace.

About one mile northeast from here outcroppings of the same ore are seen on the land of J. W. Coffey, but there are no developments, and the quality of the surface ore is poor.

Several miles southwest of Bull Ruffin, on the *Coke place*, about 10 miles out of the main Blue Ridge, on the headwaters of the *Coke place*, 5 miles southeast of Boone and 3 miles southwest of

Thin seams of martite schist are found irregularly scattered in green and white quartzite schist, but they are of commercial value. The strike is N. 45°

Southwest from here, at the head of Dennis creek, just above the Caldwell line in Watauga county, 12 miles southeast of Boone, on the *Ramsour place*, the same ore is again found in thin streaks, less than an inch in thickness in the characteristic green schists and soft sandstone; strike N. 10° E., dip 70° S. E. It was reported that in one of the openings here, now caved in and inaccessible, the bed increased in thickness as the depth increased. Several analyses of the ore show:

ANALYSES OF MARTITE SCHIST FROM RAMSOUR'S, WATAUGA COUNTY.

	(373)	(374)	(375)
Silica	13.98	....	2.25
Metallic iron	54.45	44.45	67.32
Sulphur	0.084	....	0.046
Phosphorus	0.018	0.012	trace.
Phosphorus ratio	0.033	0.027	trace.

Present explorations, therefore, which are very meager and limited in extent, show the best developments at Bull Ruffin. The structure of these deposits, being lenticular, will warrant further exploitation in the other cases, where near the outcrop the seams of ore are thin and unpromising.

This general formation has been reported as following the Blue Ridge for 75 miles northeastward, showing itself in the magnetiferous and martite schists of Fisher's Peak on the Surry-Alleghany border, near the Virginia line.¹

(b). THE TITANIFEROUS MAGNETITES IN THE CENTRAL AND NORTHERN PARTS OF CALDWELL COUNTY.

Five and a half miles north of Lenoir and 1½ miles south of Patterson, on Warrior creek, an outcrop of compact, fine-grained magnetite in a gangue of hornblende schist makes its appearance on *J. K. Farthing's place*. It is in the rear of his house, on a ridge, one of the southeastern foot-hills of Little Chestnut mountain. The strike is apparently N. 60° to 70° E. No openings have been made. The ore has been traced by surface fragments 3 miles southwest from here to Mulberry creek. Its quality is shown by the following analysis:

ANALYSIS OF MAGNETITE FROM FARTHING'S, CALDWELL COUNTY.

	(106)
Silica	6.50
Metallic iron	31.92
“ manganese	0.39
Aluminum	18.47
Calcium carbonate	7.48
Magnesium carbonate	15.64
Titanic acid	2.40
Sulphur	0.058
Phosphorus	0.025
Phosphorus ratio	0.078

See "Ores of North Carolina," p. 176.

On *Joshua Curtis' farm*, 16 miles north of Lenoir and 3 miles south of the Watauga county line, in the Richlands cove, there is a heavy outcrop of ore in a bluff along the eastern bank of the Yadkin river. The ore is massive, and consists of a fine-grained, lustrous, slightly magnetic, titaniferous mineral, distributed in a talcose-chloritic schist, of a light, greenish-gray color. Occasionally, harder and very much purer streaks of ore occur. The thickness of the ore body is about 45 feet, and the height of the bluff of solid ore is about 20 feet.

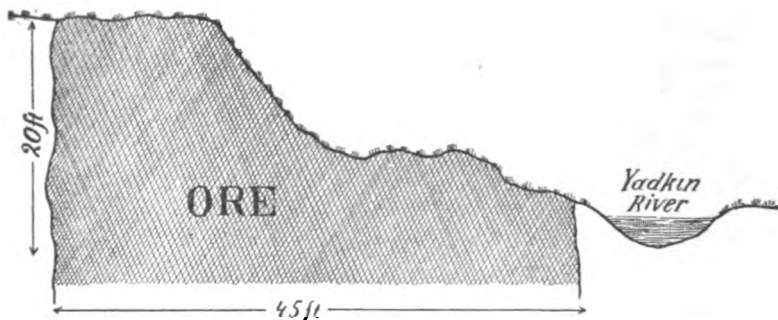


Fig. 28.—Titaniferous ore bed on the Curtis place, Caldwell county.

A smaller outcrop of the ore is seen some 200 feet N. 45° E. from here, in the hillside on Mine branch; and float ore has been traced $\frac{1}{2}$ mile north-east and $\frac{1}{4}$ mile southwest from this bluff.

The titaniferous quality of this ore, as shown by the following analyses, condemns it for blast furnace use:

ANALYSES OF TITANIFEROUS IRON ORE FROM CURTIS', CALDWELL COUNTY.

	(107)	(108)	(109)	(110)
Silica	6.63	7.55	....	....
Metallic iron	36.00	28.24	37.10	25.76
" manganese	1.09	....	....	....
Carbonate of lime	7.37	....	....	....
" " magnesia ..	16.08	....	....	....
Sulphur	0.021	0.013	....	....
Phosphorus	0.060	0.140	trace.	0.076
Titanic acid	15.00	41.21	36.40	38.81
Phosphorus ratio	0.160	0.495	trace.	0.295

No. 108 represents a selected sample of the purest ore.

(c). THE BROWN HEMATITES OF NORTHERN McDOWELL COUNTY.

LINVILLE MOUNTAIN ORE BEDS.¹—In McDowell county there are several beds of limonite. These are mostly aggregated along the top of Linville mountain, southern part, and the western slope near the foot.

¹ From "The Ores of North Carolina," 1887, p. 176.

and in the spurs of the southern end. One of these ore beds was worked by *Mr. Conolly*, some 35 or 40 years ago. Another, *Fleming's ore bed*, 2 or 3 miles south of Linville, on the slope of Graveyard mountain, was opened also and its thickness appeared to be 2 or 3 feet. A limonite deposit outcrops in the county road, 1 mile N. 20° W. of the Pinnacle, Linville mountain, for a distance of 100 yards, with a strike of N. 50° E. No developments had been made in 1877 when this region was visited.

Iron ores (limonite with goethite) also appear in the gap on top of the Linville mountain, near the south end, $\frac{1}{2}$ mile from the road to North cove. Other bodies of ore are reported over the ridge in a west course, about 1 mile distant from the last; and others are found in a southeast course in the forks of Paddy's creek. Beds of ore are reported to exist on a knob $\frac{1}{4}$ mile southeast of Shortoff mountain, $\frac{1}{2}$ mile above the flexible sandstone quarry, and extending on to Carson's ore bank on the North Fork. There is an ore bank in *Peter's cove*, 1 mile to the east of the road and $1\frac{1}{2}$ miles from the Yancey mine. The rock is a shaly sandstone and itacolumite (see page 122).

GRAVEYARD MOUNTAIN ORE BEDS.—Since the above was written I have made further examinations of those deposits mentioned as occurring in the slopes of Graveyard mountain and at Peter's cove, and add the following notes relative to them.

Graveyard mountain is a ridge running from North Fork of the Catawba river, below the mouth of Turkey creek and opposite to the Linville mountain, in a westerly direction to and across the Marion-Bakersville road, at a point about 10 miles north of Marion, and forms the southern boundary of Turkey cove. The elevation above the mouth of Turkey creek is from 800 to 900 feet. The northern slope of this mountain is a dolomite formation of great breadth, interstratified in places with bands of sandstone of variable width, which carry limonite mixed with pyrite (sulphuret of iron). This iron ore has doubtlessly been derived from the pyrites by oxidation; in other words, the ore deposits found here are but *gossans* and cannot be relied upon to yield ore suitable for a blast furnace. Such ore as is found is largely contaminated with sulphur, and the pieces of quartz (crystalline) occurring with the ore show evident impressions of crystals of pyrite, now decomposed and partially removed.

The surface ore over this northern slope of the ridge is quite profuse in places and of apparently good quality, which is easily accounted for by the complete oxidation of the pyrite due to long-continued exposure. A number of pits, varying from 5 to 10 feet in depth, from 13 to 55 feet in length and from $3\frac{1}{2}$ to 12 feet in width, have been sunk at carefully selected points, but in no case was ore found in place. In some of the openings no ore whatever was encountered. In others pockets of ore and

loose fragments were found in the soil, intermixed with quartz crystals, siliceous dolomite, porous quartzite, some barite, and in places considerable pyrites; but even where this latter mineral is not visible to the naked eye, on grinding and panning the limonite it is soon discovered.

An analysis of some of this surface ore by Dr. W. B. Phillips shows:

ANALYSIS OF SURFACE ORE FROM NORTHERN SLOPE OF GRAVEYARD MOUNTAIN,
MCDOWELL COUNTY.

	(277)
Silica	3.40
Metallic iron	59.15
Phosphorus	0.028
Phosphorus ratio	0.047

Some pieces of limonite, mixed with pyrite, from a depth of 10 feet were sent to the United States Assay Office at Charlotte to be assayed for gold and silver. They gave:

	Ozs. per ton.	Value per ton.
Gold	5-100	\$1 03
Silver	15-100	15
Total		\$1 18

This of course yields too little to be worked economically for the precious metals, but it substantiates the fact above pointed out, that these fragments of pyritiferous ore are the detritus from the gossan or oxidized capping of numerous small veins of gold-bearing sulphides. On the southern slope of Graveyard mountain, in what is known as the *Basin*, a small opening was driven on the upper side of the dip upon what appeared to be a seam of manganiferous limonite. Nothing was found excepting a thin streak of poor ore, and this soon gave out. An analysis of this ore by Dr. W. B. Phillips shows:

ANALYSIS OF ORE FROM THE "BASIN" ON THE SOUTHERN SLOPE OF GRAVEYARD
MOUNTAIN, MCDOWELL COUNTY.

	(278)
Silica	26.60
Metallic iron	30.97
Phosphorus	0.11
Phosphorus ratio	0.355

PETER'S COVE ORE BEDS.—At *Peter's cove* two new openings were made at the time of my examination, and two old ones were cleaned out and extended. These latter were made some 40 or 50 years ago to supply ore for two forges, Ainsworth's and Carruth's, on North Fork of the river. They consisted of drifts driven on the upper side of the vein, which had a thickness of from 3 to 4

feet. The eastern drift was quite extensive and a considerable amount of ore was taken out, but it is now fallen in. Fifty feet northwest from this drift and 10 feet above it, another smaller drift had been driven in for 50 feet. This was cleaned out and showed an ore vein $2\frac{1}{2}$ feet thick, enclosed between walls of sandstone, striking N. 50° E. and dipping 35° southeast. Fifty feet from this last drift and 10 feet above it, in the apparent direction of the outcrop, a cut was made which uncovered a seam of ore 14 inches thick. Just below the mouth of this cut, at the bottom of the old pit, a seam of pure sulphide, $\frac{1}{2}$ inch thick, was found, lying between the seam of iron ore and the foot-wall. Samples of this, with the adhering brown ore, were sent to the United States Assay Office at Charlotte, and gave as follows:

ASSAY OF PYRITIFEROUS ORE FROM PETER'S COVE, McDOWELL COUNTY.

	Ozs. per ton.	Value per ton.
Gold	10-100	\$2 07
Silver	35-100	35
Total		\$2 42

The yield of this in the precious metals is too low to pay for their extraction.

One hundred and fifty feet northwest from this opening and 20 feet above it, another cut was made, uncovering a seam of ore only 12 inches in thickness. All of these openings are on the north side of Peter's cove.

On the slope of the ridge, south of Peter's cove and distant from the old drift 600 feet, is an outcrop of jaspery limonite 12 inches thick. Analyses of the ore from Peter's cove and vicinity were made by Dr. Phillips, of such pieces as seemed best, taken from the outcrop by himself.

ANALYSES OF ORE FROM PETER'S COVE AND VICINITY, McDOWELL COUNTY.

	(279)	(280)
Silica	2.00	10.02
Metallic iron	60.60	51.32
Phosphorus	0.097	0.041
Phosphorus ratio	0.160	0.079

No. 279 is brown ore from Peter's cove.

No. 280 is jaspery brown ore from the south side of Peter's cove ridge.

Although the result of these analyses leaves but little to be desired in quality, the quantity present is by no means sufficient to justify mining operations, and it has also been shown that in all probability the ores will change to sulphides at no great depth.

The Long Hollow Opening.—This is 900 feet N. 50° E. from the main drift at Peter's cove, on the river slope of Graveyard mountain, in the Long Hollow, running from the river to the gap above Peter's cove. A

cut was made here on the course of the Peter's cove vein, at a point where ore had formerly been mined for the old forge. On passing the thin seam of brown ore, adhering to the sandstone walling, only alternating strata of talcose slate, metamorphic sandstone and pyritiferous quartzite were found. No ore could be found in the vicinity, neither above nor below the opening, nor along the course of the vein from Peter's cove.

The Spring or River Opening is 660 feet N. 50° E. from the main drift at Peter's cove. It is 419 feet lower than this drift, and 88 feet above the river at the ford near by. There was a fair indication of ore on the surface, but in depth it gave out and was replaced by quartz carrying pyrite.

Of the iron ore on the west side of North Fork of Catawba river, in the Graveyard mountain range, it must be said in conclusion that there is little or no probability of finding ore in sufficient quantity or of sufficient purity to justify mining operations.

As regards the ore on the eastern side of the river, on the slopes of Linville mountain, examinations have led to the same conclusion.

THE YANCEY MINE.—This is situated $1\frac{1}{2}$ miles N. 80° E. of Wood's knob. The ore is magnetite in quartzitic gneiss, with a dip of about 80° west, the magnetite being distributed in lines and thin lenses.

LIMESTONE.—Before leaving this section it is desired to direct cursory attention to the large deposits of *dolomitic limestone* that make up the northern slope of Graveyard mountain, with a strike of about N. 50° E., and dip varying from 30 to 40 southeast, extending into the bottoms of Turkey cove. The stone is crystalline and may be termed marble, though it will not be in place in this report to discuss it from that standpoint. As a fluxing material its quality is generally good, as shown by the following analyses:

ANALYSES OF DOLOMITE FROM GRAVEYARD MOUNTAIN, MCDOWELL COUNTY.

	(409)	(410)
Silica	4.80	1.40
Oxides of aluminum and iron.....	0.50	0.70
Lime	34.38	29.23
Magnesia	15.84	19.58

No. 409 represents the white variety.

No. 410 represents the bluish variety.

However, as the main factor, the iron ore itself, is wanting, other uses must be found for it.

CHAPTER VIII.

THE MAGNETITE, SPECULAR AND BROWN HEMATITE ORES IN THE CRYSTALLINE AREA WEST OF THE BLUE RIDGE MOUNTAINS.

This area of gneiss, schist, and syenite, embracing over 5000 square miles, from the Virginia to the Georgia State lines, is the repository of some of the most important magnetic ore deposits in the State. The topography of the country is essentially mountainous; it is here that the Appalachian mountain chain, in its course from Canada to Alabama, reaches its greatest development, Mt. Mitchell, the culminating point, being 6711 feet above the sea level. Starting at the northeastern extremity of this region, we have:

(a). THE ORES OF ALLEGHANY COUNTY.

THE LITTLE RIVER ORE BELT.—A zone of hornblende schists, often altered to steatite or soapstone, and carrying crystalline grains of magnetite, usually titaniferous, and sometimes concentrated into workable ore beds, with occasional pocket deposits of brown hematite, crosses the State line from Grayson county, Va., into the northeastern part of Alleghany county, N. C., at a point about three miles west of the Surry county line, and continues thence southwestward across that county. It might appropriately be called the *Little River zone*, as it follows the river quite regularly, usually on the south side.

On the farm of *Fielden Carrico*, not over 100 yards from the State line, there is a series of large open pits, made some 7 or 8 years ago to supply a forge near by.¹ These pits have caved in and filled up, and no account can be given of the size or extent of the ore body. The country rock is a hornblende schist, partially altered to steatite and asbestus, disseminated through which are small octahedral crystals of magnetite.

These magnetic schists crop out over a width of several hundred feet, and appear to grow richer towards the northeastern part of the Carrico farm, through which they were traced for 2 miles. The ore beds are apparently concentrations of this crystalline magnetite into lentic-

¹ Collins forge on Little river, Grayson county, Va.

ular bodies. The ore that is found about the old openings is a compact, coarse and fine-granular magnetite with a steatitic gangue. A high steely luster betrays its titaniferous character, as shown by analysis:

ANALYSIS OF TITANIFEROUS MAGNETITE, FIELDEN CARRICO, ALLEGHANY COUNTY.

	(8)
Silica	6.20
Metallic iron	54.72
Sulphur	0.038
Phosphorus	0.047
Titanic acid	4.860
Phosphorus ratio	0.085

It would be considered a good ore, below the Bessemer limit in phosphorus, but for the percentage of titanic acid, which condemns it.

This narrow belt of magnetite schists is bounded on the northwest and southeast by a quartz zone, carrying occasional traces of pure menaccanite.

Along the northern boundary of the magnetic rocks is a more or less continuous, though broken, outcrop of brown hematite, which has been opened and worked in small pits at several points by the forge people. It occurs in pockets; the structure of the ore is schistose in a steatitic gangue, and its analysis shows:

ANALYSIS OF BROWN HEMATITE, FIELDEN CARRICO, ALLEGHANY COUNTY.

	(9)
Silica	9.25
Metallic iron	51.17
Metallic manganese	1.15
Sulphur	0.15
Phosphorus	0.019
Phosphorus ratio	0.037

The above locality is 25 miles from Mt. Airy, Surry county, and 15 miles from the Norfolk and Western railroad at Iron Ridge, Va.

About 3 miles southwest of the Carrico farm this zone of magnetic steatite was examined on the farm of *Tolliver S. Higgins*, on the south prong of Crab creek, $\frac{1}{2}$ mile S. 45° E. from Ennis P. O., 12 miles N. 70° E. from Sparta, and 1 mile south of the Virginia line. To the west of Higgins' house the descending order of superposition is: 1, hornblende schist; 2, quartz; 3, gray steatite (magnetitic); 4, quartz; 5, hornblende schist (gneissoid, with small traces of magnetite); 6, white steatite (magnetitic).

The dip needle showed considerable local attraction (from 20° to 40°) over various parts of the magnetitic soapstone areas, and it is possible that these magnetite grains may be concentrated in workable beds in places, but no search has been made, not even a prospecting pit.

Probably the best indications are found about $\frac{1}{4}$ mile N. 55° E. from the house, on the summit of a hill in the field adjoining the road, where there is an outcrop of greenish steatitic schist, striking N. 55° E. and dipping 55° S. E.; near it is a ledge of whiter soapstone, impregnated with magnetite grains, to which the needle dips 90° . An analysis of a surface sample taken over a considerable portion of this outcrop, shows:

ANALYSIS OF MAGNETITE SCHIST. TOLLIVER HIGGINS, ALLEGHANY COUNTY.

	(7)
Silica	40.61
Metallic iron	7.78
Lime	1.15
Magnesia	24.76

Along the banks of Crab creek, $\frac{1}{2}$ mile west of the house and 300 yards south of Ennis P. O., the soapstone makes its appearance in large bluffs, at places over 60 feet high; the gray variety predominates on the eastern bank and lies geologically above the whiter variety on the western bank; some of it is quite pure and white, free from ferruginous matter; again it is rusty and contains magnetic particles. Some $2\frac{1}{2}$ or 3 miles southwest of here the magnetic soapstone zone makes its appearance in a bold outcrop on *Bald* or *Mine Hill*, about $\frac{1}{4}$ mile from the mouth of Brushy creek. There are several shallow openings here, but they expose nothing of interest; the ore was not sufficiently concentrated at any point to be of value. Similar indications are to be seen on the farm of *William H. Joines*, 1 mile southeast of Edwards Cross Roads and $\frac{1}{4}$ mile west of Little river, near the public road, where a bed of brown hematite was worked some 6 or 7 years ago, for Collins forge in Grayson county, Va., but is now covered up and invisible. Its quality is shown by the following analysis:

ANALYSIS OF BROWN HEMATITE, WILLIAM H. JOINES, ALLEGHANY COUNTY.

	(6)
Silica	5.43
Metallic iron	51.83
Metallic manganese	0.97
Sulphur	0.178
Phosphorus	0.310
Phosphorus ratio	0.598

The superposition of strata from northwest to southeast is: 1, soapstone; 2, brown hematite; 3, mica schist.

Some 6 miles southwest from here, 3 miles south from Sparta and $\frac{1}{2}$ mile east of the mouth of Pine Swamp creek, near the head-waters of

Glade creek, there is a heavy outcrop of magnetiferous soapstone on the farm of *Henry Crouse*; it is very lean, however, and as yet no workable ore beds have been discovered. Occasional pieces of pure, compact magnetic ore are found in the float, the peculiar chromiferous quality of which is shown by the following analysis:

ANALYSIS OF CHROMIFEROUS MAGNETITE, HENRY CROUSE, ALLEGHANY COUNTY.

	(10)
Silica	3.08
Metallic iron	57.54
Chromic oxide	11.05
Sulphur	0.016
Phosphorus	0.007
Phosphorus ratio	9.012

The strike of the arenaceous mica schists, in which occasional pieces of brown hematite float are found, bounding the soapstone on the north, is N. 60° E.

About 2½ miles southwest from here, 4 miles southwest from Sparta, and ½ mile southeast from Whitehead P. O., on the waters of Little river, is a series of old open pits, now caved in, extending in a course N. 70° E. for ¼ mile, on the land of *L. V. Richardson*.

The remnants of ore found in their vicinity are a fine-grained, laminated magnetite, partially specular, having a dark red streak; the ore is siliceous and jointed in structure, breaking easily into rhomboidal blocks. The country rock is gneiss, quartz and hornblende schist, the soapstone which characterizes the formation previously described being entirely absent here. At one of these abandoned pits, blocks of gneiss regularly interstratified with thin seams or bands of ore were found; in some places specular ore, magnetite, and brown hematite may be seen. The magnetic dip needle shows attractions varying from 0° to 90°.

The following analysis shows the quality of the ore, the sample representing an average collected from the series of old workings:

ANALYSIS OF SPECULAR AND MAGNETITE ORE, L. V. RICHARDSON,
ALLEGHANY COUNTY.

	(4)
Silica	13.41
Metallic iron	52.68
Sulphur	0.077
Phosphorus	0.06
Titanic acid	0.15
Phosphorus ratio	0.113

In a southwesterly direction the formation crosses over a high hill to Little river, a distance of ½ mile, and can be traced by the magnetic needle, although the outcrop is invisible; along the southwestern base of this hill, on the Little river side, the dip needle is attracted towards it on an angle of 10° to 20°.

In a northeasterly direction from Richardson's it crosses to the adjoining farm of *Kirby Atwood*. Some 250 yards northeast of Atwood's house an opening was made in October, 1890; the actual thickness of the ore bed could not be determined, the hanging-wall being invisible, but as far as it was exposed it appeared to be from 5 to 8 feet.

The ore is a granular magnetite, disseminated in decomposed gneiss and quartz; occasionally a thin coating of manganiferous limonite occurs, resembling a cinder; the lower 2 feet of the ore body, adjoining the foot-wall, which is an arenaceous schist, contains the richest ore, a very hard magnetite comparatively free from gangue; the upper part of the bed graduates into a decomposed rock on the outcrop, containing magnetite sparingly disseminated through it. The dip is nearly 50° S. E.; the strike of the schists in a small branch at Kirby Atwood's house is N. 65° E. The following analysis represents a sample of this ore taken across the full face as far as exposed:

ANALYSIS OF MAGNETITE, KIRBY ATWOOD, ALLEGHANY COUNTY.

	(5)
Silica	31.14
Metallic iron	43.88
Sulphur	0.09
Phosphorus	0.13
Titanic acid	0.205
Phosphorus ratio	0.296

Directly above this opening and to the northeast, a series of old forge workings follows along the outcrop for some distance; the outcrop consists of a rotten ferruginous gneissoid rock interspersed with octahedral crystals of magnetite.

The ores from this locality were smelted in the Little River forge, about 2 miles east of Whitehead P. O.¹

From 150 to 200 yards southeast of Atwood's main opening, near his house, is a series of old forge diggings, showing a finer-grained ore; some of it is compact and of apparently good quality, but the bed cannot now be seen in place.

The formation is reported in its northeastern extension on the *Jacob Combs*, *Allen Reynolds*, and *William Evans* farms. From 3 to 4 miles southwest of Whitehead P. O. and on the divide between Little river and Cranberry creek the formation of magnetiferous mica and hornblende schists makes its appearance, but the prospects of finding workable ore beds are not encouraging.

THE MANGANESE ORES OF ALLEGHANY COUNTY.—Lying about 2½ miles to the northwest of this magnetic belt and parallel to it is a

¹*Little River Bloomery Forge*, on Little river, about 10 miles above its mouth and 7 miles from the Virginia line; built about 1827; two fires and one hammer; made in 1855 about 18 tons of bars.

zone of manganiferous quartzite, which has been traced from a point 1 mile above Sparta for a distance of about 6 miles N. 55° E. to the Virginia line.

On *Crouse's knob*, 3 miles (air line) N. 30° E. from Sparta and 1½ miles west of Fender's knob, a part of the Peachbottom range, on the waters of Jewel Swamp creek, a prospect shaft originally 25 feet deep, but now filled up, was sunk over 30 years ago. A scattered pile of material that came from near the bottom of this shaft showed some fairly rich manganese ore, mostly psilomelane, distributed through a flinty quartzite gangue, and showing a marked improvement in quality over that of the outcrop as it appears here, which is but a manganiferous quartz.

An analysis of an average sample taken from this point shows:

ANALYSIS OF SILICEOUS MANGANESE ORE, CROUSE'S KNOB, ALLEGHANY COUNTY.

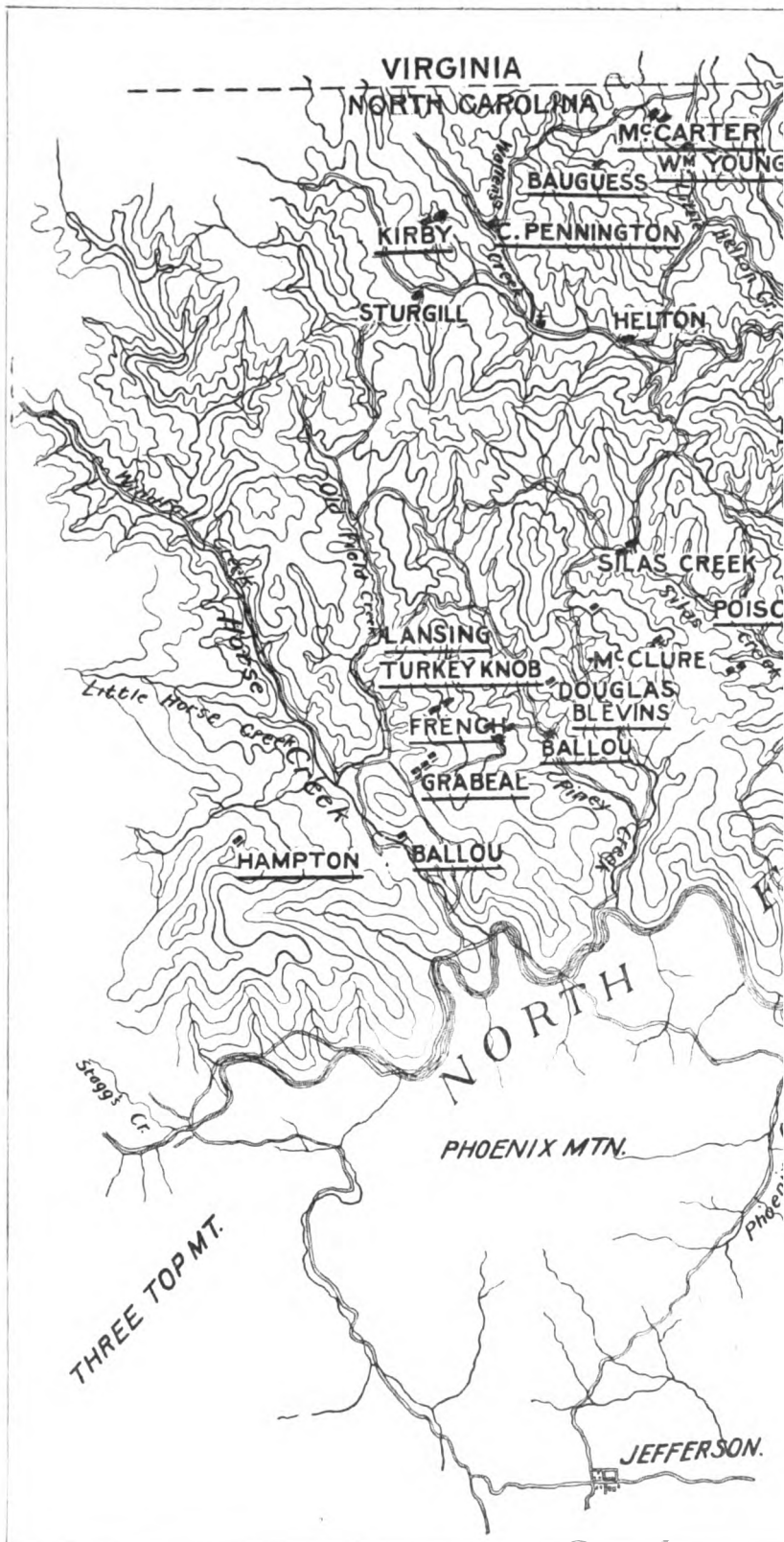
	(391)
Silica	30.31
Metallic iron	12.28
Metallic manganese	25.86
Sulphur	0.036
Phosphorus	0.059

No thorough explorations have yet been made to determine the true nature, extent and value of this ore. Indications point to improvement in quality with depth.

There is a similar belt of manganese ore in the southern part of the county several miles south of Bullhead mountain, on the main Blue Ridge, near the divide between the waters of the Brushy creek and Roaring river, on the farm of *Wiley Caudle*. This is 7 miles southeast from Whitehead P. O. and 10 miles south-southeast from Sparta, near Cherry Lane. There are presumably two parallel belts of ore here about ¼ mile apart, though what relation they bear to each other geologically is not known. The country rock is mica schist and quartz. The most northwesterly belt passes near Caudle's house, and it is reported that it can be traced 6 miles northeast to Rich Hill; it crosses the Blue Ridge into Wilkes county towards the southwest. The second belt strikes N. 65° E., and at several points the float ore is scattered over a width of 100 feet or more. There are no developments, not even a prospect pit. The quality of the surface ore is shown by the following analysis:

ANALYSIS OF SILICEOUS MANGANESE ORE, WILEY CAUDLE, ALLEGHANY COUNTY.

	(392)
Silica	37.76
Metallic iron	10.86
Metallic manganese	24.40
Sulphur	0.22
Phosphorus	0.137



In the northern part of the county, 3 miles (air line) north-northeast from Sparta, $1\frac{1}{2}$ miles south of the Virginia line, on the waters of Fighting creek, a very pure manganese ore (pyrolusite and psilomelane) is found on the farm of *Geo. McReeves*, in the road fronting his house. It occurs as float in a country rock of mica schist, striking N. 55° E.; the quality of this ore, as shown by the following analysis, will warrant further exploration here.

ANALYSIS OF MANGANESE ORE. GEORGE MCREEVES, ALLEGHANY COUNTY.

	(393)
Silica	1.31
Metallic manganese	56.03
Phosphorus	0.06

Two of the principal magnetite ore belts of Ashe county cross the northwestern corner of Alleghany county, and will be described as a whole under the succeeding head.

(b). THE ORES OF ASHE COUNTY.

Of the magnetite ores in this western crystalline area, those of Mitchell and Ashe counties stand first in order of importance, at least so far as present developments have shown. The "Magnetic Iron Ores of Ashe County" were described in a paper by the writer, read before the American Institute of Mining Engineers, in February, 1892; this will be repeated here with some slight changes and additions, and with further notes on the red specular and brown hematite ores. The accompanying map (Plate XIV) has been prepared from the revised sheets of the United States Geological Survey Topographic Atlas, and will be referred to here.

Ashe county lies in the extreme northwestern corner of North Carolina, bordering on Tennessee and Virginia; it is drained principally by North and South Forks of New river and their tributaries, and is therefore on the eastern edge of the great Mississippi drainage-basin. The country is exceedingly rugged and mountainous, attaining an average elevation of 2900 feet above the sea-level. Jefferson, the county seat, near the center of the county, is 45 miles nearly due south from the Norfolk and Western railroad at Marion, Va., and 30 miles northwest from the Richmond and Danville railroad at Wilkesboro, N. C.

Geologically, the ore deposits described are situated in the area of the crystalline rocks, consisting chiefly of gneiss, hornblende schists and micaceous schists.

These iron ore deposits, owing to their present inaccessibility, are practically entirely undeveloped. During the summer of 1890 considerable private prospecting was carried on throughout the county, and

much of our knowledge concerning the ore beds is due to this. Many of the openings, however, have caved in to such an extent that but little can be seen at present.

More than 50 years ago there were a number of Catalan forges¹ throughout the county which smelted these ores into a very superior tough iron. One of these, now known as Pasley's forge, at the mouth of Helton creek, is still in operation, and made in 1890 from 20 to 30 tons of bar-iron, used locally for wagon-tires, horse-shoes, etc.² At present there are no mining operations whatever going on, except in a very superficial way to supply the Pasley forge.

The structure of the magnetite beds is decidedly lenticular, and as such they occur distributed over a rather undefinable area, though there is some regularity in the direction of their outcrops, which have a general trend northeast and southwest.

There are three main belts, attaining their greatest development in the northeastern portion of the county, which have been designated:

1. The Ballou or River Belt.
2. The Red Hill or Poison Branch Belt.
3. The Titaniferous Belt.

Starting at the northeastern extremities of these belts I shall describe the openings along their outcrops in regular order towards the southwest. By referring to Plate XIV their location and relation to each other will be more easily comprehended than from mere description.

¹*Helton Bloomery Forge*, on Helton creek, 12 miles N. N. W. of Jefferson; built in 1829; two fires and one hammer; made in 1856 about 15 tons of bars. Washed away about 1858. Another forge was built $1\frac{1}{4}$ miles lower down on the creek in 1802, but did not stand long.

Harbard's Bloomery Forge was situated near the mouth of Helton creek; built in 1807 and washed away in 1817.

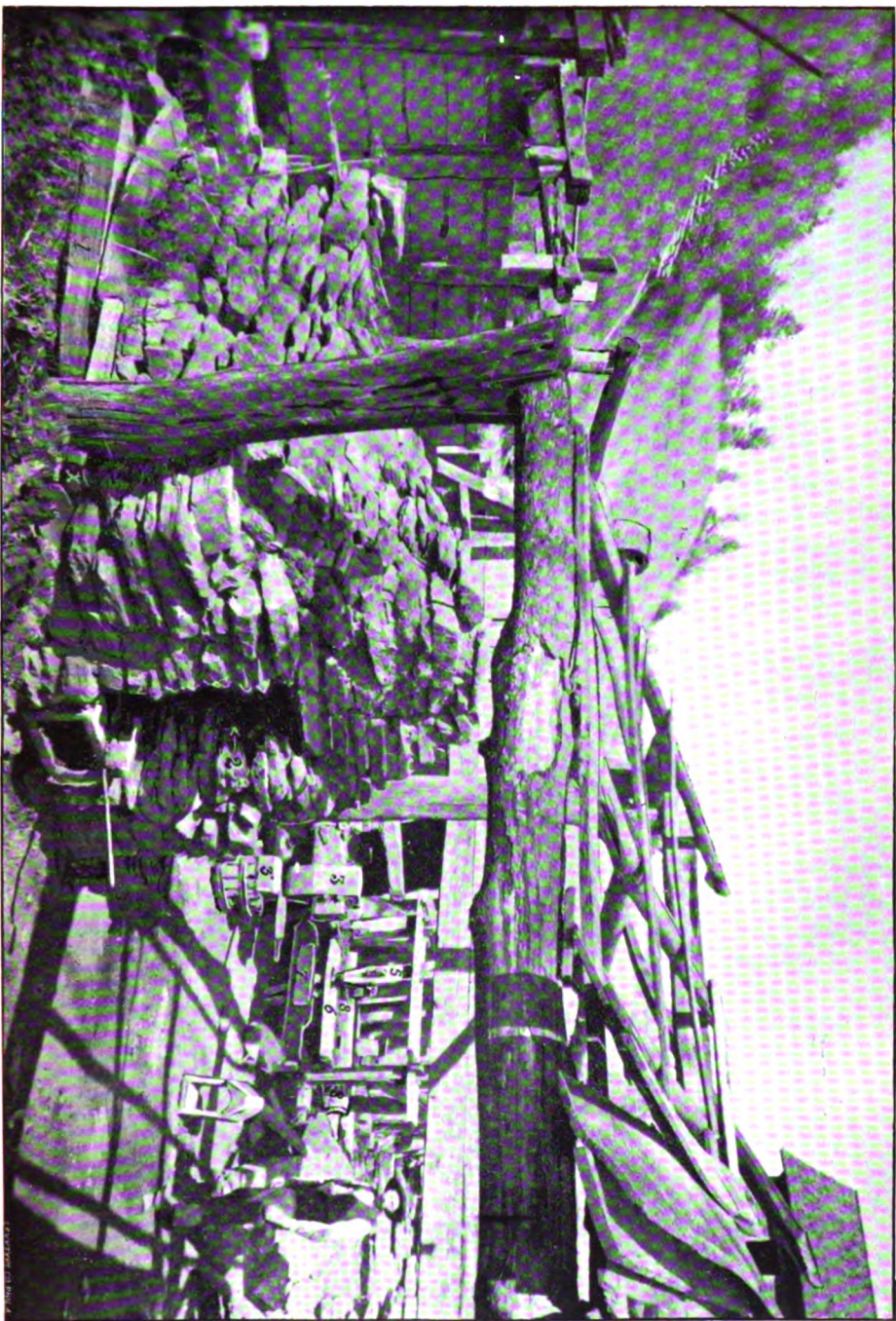
Ballou's Bloomery Forge was situated 12 miles N. E. of Jefferson, at the falls of North Fork of New river; built in 1817; washed away in 1832 by an ice freshet.

North Fork Bloomery Forge was situated on North Fork of New river, 8 miles N. W. of Jefferson; built in 1825; abandoned in 1829; washed away in 1840.

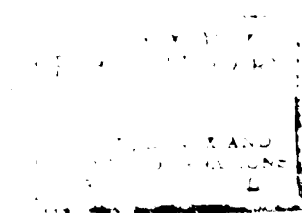
Laurel Bloomery Forge, on Laurel creek, 15 miles west of Jefferson; built in 1847; abandoned in 1853.

New River Forge, on South Fork of New river, $\frac{1}{2}$ mile above its junction with North Fork; built in 1871; washed away in 1878.

²This forge was built by John Ballou at the mouth of Helton creek in 1859; in 1871 it was rebuilt by the present owner, W. J. Pasley, and is now sadly in need of repairs. A view of this old forge is shown in Plate XV. (1) is the wooden blast pipe entering the side of the forge in a tuyère; the blast is furnished by an old-fashioned water trompe. (2) is the open hearth of the forge proper. (3) is the iron hammer, operated by water power, and used in drawing out the bar of iron. (3') is the iron anvil resting on a wooden block which is sunk in the ground. (5) is the wooden stamp fitted with an iron shoe and operated by a cam in the shaft (8), which crushes the ore in the box (7).



PASLEY FORGE HELTON CREEK, ASHE COUNTY.



1. THE BALLOU OR RIVER BELT is the most easterly of the three principal ore belts, and crops out along the course of North Fork of New river. There are practically two divisions of this belt, in distinct and parallel outcrops, lying about $\frac{1}{2}$ mile apart, and characterized mainly by difference in gangue, the most northwesterly being massive hornblende-epidote, and the other, micaceous and hornblende schists. The former does not make its appearance until after crossing North Fork in Ashe county on the Brown place.

In the northwestern part of Alleghany county the micaceous belt has been developed by a series of old forge diggings made from 50 to 60 years ago for the Elk Creek' and Cranberry forges,' respectively 7 and 9 miles distant. These diggings extend in a broken line about S. 70° W. from Piney creek at a point about $\frac{1}{4}$ mile south of the Virginia line to New river. The most northeasterly opening is on the summit of a hill on the west bank of Piney creek, on the land of *James A. Weaver*. The caved-in condition of the pits prevents an examination of the ore bed or beds in place; at some points they extend over a width of fully 100 feet. The dip is apparently 45° S. E.; the ore is a compact magnetite in a gangue of mica-schist, which makes a soft ore, or in gneiss, which makes a hard ore. The quality of the ore is shown by the following analysis:

ANALYSIS OF MAGNETITE ORE, JAMES A. WEAVER, ALLEGHANY COUNTY.

(12)	
Metallic iron	57.31
Sulphur	trace.
Phosphorus	0.032
Titanic acid	trace.
Phosphorus ratio	0.055

Several hundred yards north of the Weaver opening on the land of *W. Halsey*, the country rock, slightly magnetic hornblende-epidote, is in places interspersed with thin seams of quartz coated with a bright, lustrous, specular hematite, but it is hopeless to expect any workable deposit of this ore.

On the land of *R. M. Halsey*, $\frac{1}{4}$ mile southwest of the Weaver opening, and 100 feet below the same in elevation, on the waters of Baldwin branch, the ore was formerly worked at the "Hard Bank"; strike, N. 60° to 70° E.; dip 48° to 52° S. E. And $\frac{1}{4}$ mile still further southwest, and 40 feet lower in elevation than the Hard Bank, is an old tunnel opening; strike of mica-schists, N. 50° E.; dip, 50° S. E.

¹ *Elk Creek Forge* is situated on Elk creek, 6 miles west of Sparta; built in 1825; rebuilt about 1840; two fires and one hammer; made $4\frac{1}{2}$ tons of bars in 1856.

² *Cranberry Bloomery Forge*, on Cranberry creek, 3 miles above its mouth; 12 miles east of Jefferson; built about 1832; washed away in 1845.

An analysis of an average sample collected from the remnants of ore found about these old openings shows:

ANALYSIS OF MAGNETITE, WEAVER'S, HALSEY'S, ETC., ALLEGHANY COUNTY.

	(11)
Silica	17.81
Metallic iron	51.62
Sulphur	0.166
Phosphorus	0.008
Titanic acid	0.150
Phosphorus ratio	0.015

Fully $1\frac{1}{2}$ miles southwest from the tunnel opening, the ore belt makes its appearance on Big ridge, on *S. F. Halsey's* land, where it has been prospected by several small pits, and was used in small quantities in the New River forge; the ore is very soft and lean, a granular magnetite in mica-schist. In its southwest course from here the belt crosses South Fork of New river; but little is known of it in the short interval between North Fork and South Fork rivers, which are scarcely over a mile apart, until it reaches the farm of John C. Plummer, where it crosses North Fork about $\frac{1}{2}$ mile above the falls, to the farm of *William H. Brown*; here it has been opened by a series of shallow pits. 100 yards from the river, of no further importance than to show the mere existence of the ore. On the adjoining farm to the southwest, of *John Griffett and Sons*, its general course can be followed by a series of shallow pits; thence in a general course, S. 50° W., it has been opened on the *Lunceford* place, about $\frac{1}{4}$ mile from his house, on a hill 140 feet in elevation above the river.

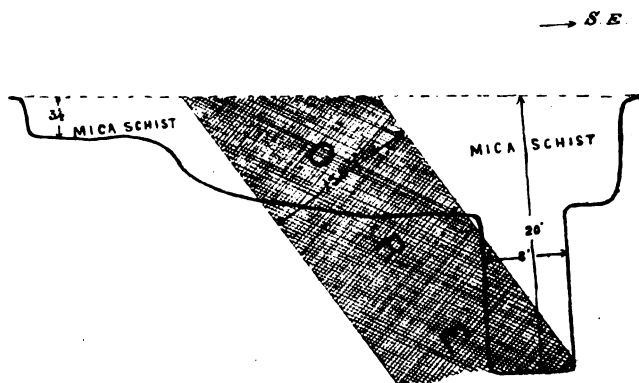


Fig. 29.—Showing ore body on the Lunceford place.

THE LUNCEFORD ORE BED.—On the Lunceford place the opening is in the shape of an opencut, deepened by a shallow shaft, as indicated by the accompanying diagram (Fig. 29).

The ore is a granular magnetite, disseminated in mica-schist; it is decomposed near the surface, and grows more compact in depth, with a slight increase of epidote in the gangue, while the mica-schist tends to confine itself to the walls; the thickness of the ore body as measured near the surface is $13\frac{1}{2}$ feet. The average dip of the hanging-wall is 60° ; of the foot-wall, $44\frac{1}{2}^\circ$ S. E., showing the lenticular structure of the bed.

An analysis of an average sample taken across the bed near the surface shows its very lean character and high phosphorus content.

ANALYSIS OF MAGNETITE SCHIST, LUNCEFORD OPENING, ASHE COUNTY.

	(13)
Silica	38.75
Metallic iron	29.95
Sulphur	0.144
Phosphorus	0.390
Phosphorus ratio	1.302

The ore belt here crosses the river, which makes a large bend, and continues in a southwesterly direction over the lands of N. B. Ballou, W. D. Cox and Dr. Gentry. On the *Cox* place, near Crumpler P. O., a surface sample shows a marked improvement in the quality of the ore, though still above the Bessemer limit in phosphorus, as shown by the following analysis:

ANALYSIS OF MAGNETITE, W. D. COX, ASHE COUNTY.

	(99)
Silica	12.50
Metallic iron	48.78
Sulphur	0.02
Phosphorus	0.089
Phosphorus ratio	0.182

BROWN ORE BED.—Coming now to the hornblende-epidote division of this belt, we must retrace our steps to the *W. H. Brown* place, where it has been opened at several points:—

Opening No. 1 on the west bank of the river at the falls, is a large cut, exposing probably 30 feet of ore material, composed of hornblende, gneiss, and epidote, which is split up at three points by lenticular masses of magnetite. From the condition of the exposure it was not possible to determine the true thickness of the ore. The following average analysis shows this ore to contain:

ANALYSIS OF MAGNETITE, W. H. BROWN, OPENING NO. 1, ASHE COUNTY.

	(15)
Silica	24.80
Metallic iron	40.04
Sulphur	0.055
Phosphorus	0.063
Phosphorus ratio	0.132

Opening No. 2 is located about $\frac{1}{2}$ mile west of the river, near Mr. Brown's house. This cut has also partially caved in and filled with water, so that a clear inspection is not practicable. The exposed material shows (see Fig. 30):

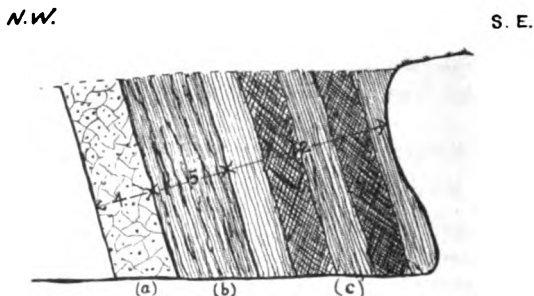


Fig. 30.—Showing ore body on the Brown place, Ashe county.

(a) About 4 feet of soft decomposed schistose gangue, carrying finely disseminated grains of magnetite; above this, (b) about 5 feet of decomposed mica-schist and quartz; and above these, towards the face of the cut, (c) about 12 feet of mixed material containing streaks of harder, richer ore, 2 feet and more in thickness. It is stated that the ore has been found to pinch out a short distance below the floor of the cut.

Of the soft ore it has been found by washing that fully 50 per cent is magnetite, an analysis of which by Mr. A. S. McCreath shows:

ANALYSIS OF SOFT, WASHED ORE, OPENING NO. 2, ASHE COUNTY.

	(16)
Silica	2.40
Metallic iron	.67.35
Phosphorus	0.028
Phosphorus ratio	0.041

The unwashed material shows 43.50% of metallic iron. Other analyses show:

ANALYSES OF MAGNETIC ORE, WILLIAM H. BROWN, OPENING NO. 2, ASHE COUNTY.

	(14)	(18)
Silica	5.73	....
Metallic iron	60.48	56.72
Sulphur	0.003	....
Phosphorus	0.030	0.020
Phosphorus ratio	0.049	0.035

Sample No. 14 was taken across the entire bed, and includes both se

THE BALLOU ORE BED.—About one mile southwest of the Brown place the ore belt crosses the river, on *John H. Carson's* land, at a point about $\frac{1}{2}$ mile west of the Lunceford opening, and makes its appearance on the south side of the river in a very prominent outcrop, over the property of *N. B. Ballou*, known as the "Home place." About $\frac{1}{2}$ mile from here it recrosses the river, which has made a large bend in this distance, between the mouths of Helton and Old Field creeks, near Uriah Ballou's house. Just before reaching this second point of crossing, on the east bank of the river, some work was done a number of years ago for one of the old forges, showing the approximate thickness of the bed to be 12 feet. The dip is about 37° S. E., and the strike N. 45° E.

On the Ballou "Home place" the ore is a hard, compact, fine-grained magnetite, disseminated in a gangue of hornblende, epidote and quartz. Higher up on the hill some superficial openings expose several smaller ledges of richer ore, comparatively free from gangue. But it is believed that the following analysis will represent the quality of the ore as it must be mined:

ANALYSIS OF MAGNETITE ORE, N. B. BALLOU'S HOME PLACE, ASHE COUNTY.

	(19)	(20)	(21)	(22)
Silica	17.88	20.79	....	....
Metallic iron	50.68	45.50	60.81	49.06
Sulphur	0.02	0.002	....	....
Phosphorus	0.009	0.024	0.023	0.018
Phosphorus ratio	0.017	0.052	0.037	0.037

No. 21 is an analysis of better selected sample of ore.

The highest point of the outcrop is probably 260 feet above the level of the river at Ballou's house.

On the other side of the river, $\frac{1}{4}$ mile southwest from the old forge openings and 40 to 50 feet lower in elevation, the bed crops out in the road near Uriah Ballou's house. On the summit of a hill 200 feet above the river, in the rear of his house, it was at one time opened at the *Moore bank*, where its thickness is reported to be 4 feet. On the opposite side of this hill it crosses the river again, which is very tortuous in its windings, near N. B. Ballou's house, and at a point about $\frac{1}{2}$ mile S. 35° W. from the "Home place," it was worked at the *Sand bank*.

Towards the southwest the ore crosses and recrosses the North Fork and becomes apparently thinner bedded. It crops out about $1\frac{1}{2}$ miles (air line) from Ballou's, and $1\frac{1}{4}$ miles (air line) west of Crumpler P. O., on the farm of *Dr. Gentry*, in a high bluff on the east bank of the river, showing a maximum thickness of 2 feet, and apparently pinching out to considerably less than that. The quality of the ore is shown by an

analysis of an average sample taken here, as follows:

ANALYSIS OF MAGNETITE, GENTRY FARM, ASHE COUNTY.

	(83)
Silica	16.68
Metallic iron	47.22
Sulphur	0.630
Phosphorus	0.006
Phosphorus ratio	0.012

Southwest from here it is supposed to cross the river near the mouth of Phoenix creek, but the outcrop has never been found; the rocks of Phoenix mountain are in places magnetic.

2. THE RED HILL OR POISON BRANCH BELT crosses from the northwestern corner of Alleghany into the northeastern corner of Ashe county, and extends thence in a general southwesterly direction, its several lines of outcrop crossing over Grassy creek, Helton knob, Red hill, Helton creek, McClure's knob, Old Field, Silas, Piney, and Horse creeks, a distance of some 10 miles as far as traced.

This ore belt has been opened up and examined at numerous points along its outcrop. Beginning at the northeast on the land of *Lee A. Pugh*, on Ben's branch, about $\frac{1}{4}$ mile north of New river, the ore is uncovered in two small cuts; in the upper one about 2 feet of ore is exposed; the lower and smaller cut, about 40 feet southeast of the other, is a pit 18 feet deep, sunk to the top of the ore, but not penetrating it, so that it is not possible to report on the true thickness of the bed. The dip is 30° to 40° southeast. The ore is a friable magnetite, associated with epidotic hornblende schists, and its quality is shown by the following analysis:

ANALYSIS OF MAGNETITE. LEE A. PUGH'S, ALLEGHANY COUNTY.

	(3)
Silica	22.74
Metallic iron	45.44
Sulphur	0.049
Phosphorus	0.022
Phosphorus ratio	0.048

About 400 yards S. 30° W. from here the bed has been exposed on the land of *John L. Pugh*, on the summit of a high ridge, 240 feet above the level of the river, by a cut 105 feet long, northwest and southeast, the southeastern end of which traverses a bed of mixed ore material, reported to be 40 feet thick; while the northwestern end cuts through about 30 feet of similar, though harder material. Between the two is a decomposed feldspathic mass, which is probably a local "horse," but the condition of the opening was such that a very definite idea of the bed at this point cannot be given. The ore is a coarse-granular, friable, manganeseiferous magnetite, and the gangue is hornblende, epidote, quartz

and feldspar. Several analyses show the ore to contain:

ANALYSES OF MAGNETITE, JOHN L. PUGH'S, ALLEGHANY COUNTY.

	(1)	(2)
Silica	21.11	....
Metallic iron	43.17	44.13
Metallic manganese	4.62	1.42
Sulphur	0.048	0.126
Phosphorus	0.006	0.008
Phosphorus ratio	0.013	0.018

Four hundred yards southwest from here, near the boundary between Alleghany and Ashe counties, on the land of *W. B. Smith*, a shallow, caved-in opening, 50 feet long (N. W. and S. E.) exposes 2 feet of soft micaceous ore, below which a body of harder ore, 4 feet thick, is reported to exist, but it is not now visible. The dip is 57° S. E.; the strike is N. 27° E.

An analysis of this ore shows:

ANALYSIS OF MAGNETITE ORE, W. B. SMITH'S, ASHE COUNTY.

	(104)
Metallic iron	55.76
Phosphorus	0.040
Phosphorus ratio	0.071

A similar micaceous ore is seen on the *Noah Dancy* place, southwest from Smith's, but the openings are incomplete and offer no definite data.

An analysis of a surface sample shows:

ANALYSIS OF MAGNETIC ORE, NOAH DANCY'S, ASHE COUNTY.

	(103)
Metallic iron	63.49
Phosphorus	0.176
Phosphorus ratio	0.276

The prospects on the Smith and Dancy farms are not encouraging.

BLACK PROPERTY.—The next notable exposure occurs on the Black property, on the northwestern slope of Helton Knob, on the waters of Grassy creek, where several old forge banks are located and whence the Pasley forge still draws its limited supply. The old openings have now completely fallen in, and nothing can be seen excepting the fact that there seem to be two beds about 30 feet apart, the upper one of which is reported to be 2 feet thick. The ore is soft and decomposed, in a friable, schistose gangue; and it is on account of this softness that it was particularly prized by the forges.

Higher up on the same hill similar float ore is repeatedly met with scattered over the surface, and it seems to cover a large area. A tunnel, opening into the slope of the hill to strike these ore beds at some depth, would soon determine their extent and thickness.

An analysis of this ore shows:

ANALYSIS OF SOFT MAGNETITE, J. M. BLACK'S, ASHE COUNTY.

	(93)
Silica	21.62
Metallic iron	48.10
Sulphur	0.06
Phosphorus	0.036
Phosphorus ratio	0.074

In explanation of the formation of these deposits of *soft ore*, such as occur on the Black, Red Hill, and other properties to be described hereafter, it may be said that all indications go to show that they are undoubtedly due to the breaking down of the original outcrops of magnetite and magnetic rocks, subsequent to the erosion of the more readily decomposable surrounding strata, and their consequent spreading over large superficial areas of comparatively limited depths. At the same time their replacement may have been so regulated by nature that they still exist in workable deposits, and the original beds might be expected either directly beneath or in close proximity to them; but this can only be definitely settled by further exploitation.

As shown in several places, much of this "soft" ore can be concentrated to a comparatively high-grade material by simple washing alone, and there is no reason why, by means of magnetic concentration, a highly desirable product should not be obtained. Even the hard ores, high in silica, are susceptible of concentration, after previous crushing, by this process; and at the well known Cranberry mines in Mitchell county experiments are being carried on successfully in this direction.

The practice at the Pasley forge is to wash this ore (analysis 93) in a very rudely constructed inclined wooden trough by a gently flowing stream of water, agitating the mass with poles or rakes. The effect of this treatment is shown by the following analysis:

ANALYSIS OF WASHED ORE FROM J. M. BLACK'S, ASHE COUNTY.

	(95)
Silica	11.08
Metallic iron	58.93
Sulphur	0.068
Phosphorus	0.033
Phosphorus ratio	0.056

An analysis of the wrought forge iron made from this ore shows:

ANALYSIS OF BAR IRON, PASLEY'S FORGE, ASHE COUNTY.

	(411)
Silicon	0.492
Carbon	0.154
Sulphur	0.011
Phosphorus	0.012

An analysis of the cinder shows the great waste of iron in this process, it being richer than the raw ore itself.

ANALYSIS OF CINDER, PASLEY'S FORGE, ASHE COUNTY.

	(417)
Silica	17.55
Iron monoxide	66.81
Manganese oxide	2.92
Alumina	4.46
Lime	4.64
Magnesia	3.02
Iron disulphide	0.472
Phosphoric acid	0.169
	100.039

Metallic iron	52.13
Sulphur	0.252
Phosphorus	0.073

About $\frac{1}{4}$ mile slightly south of west from the old "forge" openings described, on the Black place is a very prominent outcrop of hornblende gneiss, at least 40 feet high, containing small lenticular masses of hard, compact magnetite, showing a thickness of 3 feet at one point.

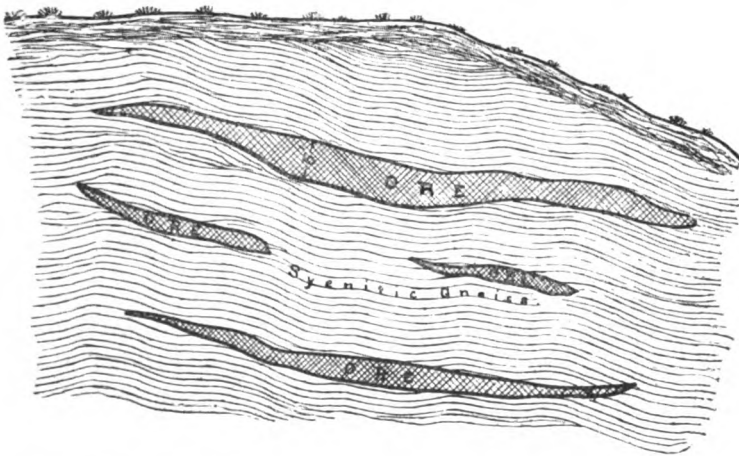


Fig. 31.—Shows ore lenses in hornblende gneiss, Black place, Ashe county.

About 200 yards S. 60° W. from the above, on another ridge, large and heavy masses of float ore were observed, indicating the existence of another parallel series of ore beds, but no openings have been made.

An analysis of this float ore shows:

ANALYSIS OF HARD MAGNETITE FLOAT ORE, J. M. BLACK'S, ASHE COUNTY.

	(94)
Silica	22.37
Metallic iron	49.70
Sulphur	0.09
Phosphorus	0.039
Phosphorus ratio	0.078

By means of the dip needle the ore was traced across the summit of Helton knob, which rises to an altitude of 3410 feet above the sea level. On the southwestern slope of Helton knob several small openings on the property of *Joseph Jones* expose the ore bed, but not sufficiently to furnish much definite information.

BLEVINS ORE BEDS.—On the western foot-hills of Helton knob, on Roberts branch, a tributary of Helton creek, there are a number of openings on the land of David Blevins. *Opening No. 1*, 200 yards S. 45° E. from the house, 60 feet above the level of the branch, is an open-cut, 48 feet long, 8 feet deep and 6 feet wide, exposing three streaks of compact magnetite in a gangue of hornblende and epidote, respectively 7½, 4½, and 2 feet in thickness, separated by gneissoid material, and dipping 40° S. E. The total thickness, including the gneiss partings, is about 35 feet. An analysis of a sample taken across the entire bed shows:

ANALYSIS OF MAGNETITE ORE, DAVID BLEVINS, OPENING NO. 1, ASHE COUNTY.

	(51)
Silica	29.90
Metallic iron	36.35
Sulphur	0.038
Phosphorus	0.022
Phosphorus ratio	0.060

Opening No. 2 is about 100 feet N. 79° E. from No. 1, and 130 feet above it in elevation, on the southwestern slope of Helton knob proper. It consists of a small caved-in opencut, in which nothing is visible at present but some loose ore on the outside, of which an analysis shows:

ANALYSIS OF MAGNETITE ORE, DAVID BLEVINS, OPENING NO. 2, ASHE COUNTY.

	(52)
Silica	31.67
Metallic iron	32.66
Sulphur	0.042
Phosphorus	0.103
Phosphorus ratio	0.315

These analyses are not very encouraging in their results, but a fair test of the quality of these ores can only be made by exposing the beds more thoroughly in depth and extent; and in fact this applies with equal force to the entire region. There are a number of small pits on the Blevins place, between Nos. 1 and 2, whose position shows that the ore-bearing formation covers a wide belt here, and this is also substantiated by numerous dip needle observations. It may as well be stated here that the results of such dip needle observations are never very definite or conclusive; the attraction may be as great over a magnetic rock as over a rich ore bed, depending upon conditional circumstances; so that the above statement of a *wide* ore belt does not necessarily mean that it is charged with workable lenses. The attraction may be due simply to large masses of economically worthless magnetitic rocks. It is only with the pick and shovel that we can discover the true value and nature of the deposits. The value of the dip needle is to locate such points that will warrant further search.

RED HILL DEPOSITS.—Towards the southwest, between Roberts branch and Helton creek, at a distance of about $\frac{1}{4}$ mile, is the Red Hill property, over which a number of openings have discovered a rather complex and widely distributed ore formation. The main opening, No. 1, is a trench over 200 feet in length (N. and S.), through the comb of the hill, about 170 feet above the level of Helton creek. It exposes a decomposed schistose and argillaceous material, carrying almost throughout its entire extent mixed masses of soft ore, hard ore, and crystalline sandy ore, distributed irregularly through the gangue; it is evidently one of the broken-down deposits before alluded to. At the eastern end of the cut the presence of pyrites was noticed.

An analysis of an average sample of the ore in this cut shows:

ANALYSIS OF MAGNETITE ORE, LONG TRENCH, RED HILL, ASHE COUNTY.

	(54)
Silica	19.83
Metallic iron	51.55
Sulphur	0.137
Phosphorus	0.042
Titanic acid	0.207
Phosphorus ratio	0.081

Opening No. 2, 30 yards nearly west from the north end of the "long cut," exposes a solid bed of hard magnetite in epidote and quartz, over 5 feet thick; the foot-wall is gneiss, which dips 44° S. E. No pyrites was observed. An analysis shows the ore to be quite lean, though extremely low in sulphur and phosphorus.

ANALYSIS OF MAGNETITE, OPENING NO. 2, RED HILL, ASHE COUNTY.

	(55)
Silica	32.06
Metallic iron	37.14
Sulphur	0.071
Phosphorus	0.004
Titanic acid	0.106
Phosphorus ratio	0.010

Opening No. 3, the most northerly, is a cut 30 feet long and 7 feet deep on the northwest side of the hill, near the head of a small branch, and about 600 feet N. 24° W. from the north end of the "long" cut, partially exposing a body of magnetite associated with hornblende, epidote and quartz, and showing much pyrites in places. The true thickness of the ore bed cannot be determined from the present condition of the opening. The lean character of this ore is shown by the following analysis:

ANALYSIS OF MAGNETITE, OPENING NO. 3, RED HILL, ASHE COUNTY.

	(53)
Silica	32.59
Metallic iron	36.41
Sulphur	0.20
Phosphorus	0.003
Titanic acid	0.118
Phosphorus ratio	0.008

Opening No. 4, also known as the *Blevins* opening, is situated about 200 feet S. 17° E. from No. 3. It is a cut 20 feet long by 10 feet deep, partially exposing a face of ore, with epidote-gneiss gangue occurring in streaks.

Opening No. 5, on the immediate northern bank of Helton creek and 60 feet above it, near James Lovelace's house, about 300 feet S. 20° W. from the south end of the "long" cut, exposes a broken bed of compact ore material, magnetite distributed through a gangue of hornblende and gneiss in varying proportions, split by a lens of highly pyritiferous ore about 5 feet thick.

An analysis of a sample taken across the bed shows:

ANALYSIS OF PYRITIFEROUS MAGNETITE, RED HILL, ASHE COUNTY.

	(56)
Silica	41.13
Metallic iron	23.39
Sulphur	1.67
Phosphorus	0.100
Phosphorus ratio	0.466

The conclusion is that there are streaks of pyritiferous ore throughout this part of the bed, which are very liable to increase in sulphur with depth. On the south side of the hill there are many evidences of old and scattered diggings, made in former years to supply the neighboring forges. Notwithstanding the apparent low grade of the Red Hill ores in iron, as shown by the preceding analyses, they are worthy of further investigation; indeed, the prospecting done here amounts practically to little. As is unfortunately so often the case, the diggings have not even been prosecuted with a fair degree of intelligence, being superficial and incomplete, partially uncovering an ore body without probing any further to determine its thickness and quality in depth.

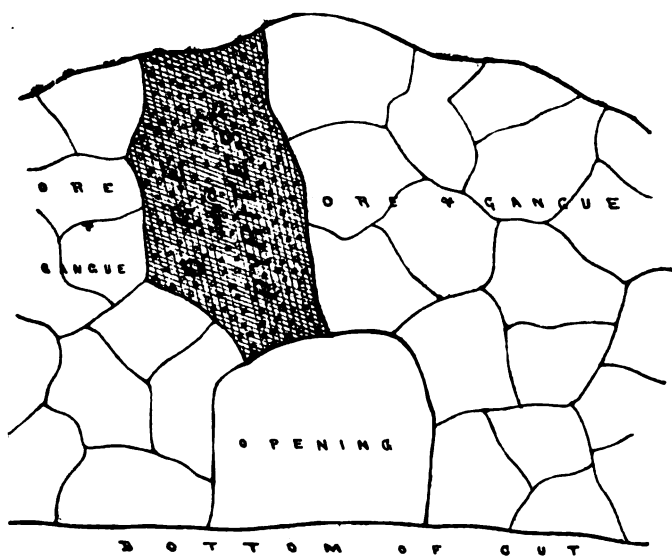


Fig. 32.—Showing pyritiferous ore body, Red Hill, Ashe county.

The soft ore is admirably adapted to magnetic concentration, although it is very doubtful if it exists in any quantity, being most likely the weathered and broken-down portions of the original beds or lenses, which latter must be and are found in depth, hard and unaltered. It will require a greater amount of preliminary development work to make the exploitation a just one. The lenses may widen with depth and contain much cleaner ore, or *vice versa*; at any rate the conditions must be carefully determined in order that a definite opinion may be arrived at. The ore is low in phosphorus, far below the Bessemer limit; as already mentioned, the great danger is that it may become detrimentally high in sulphur below the water level.

McCLURE'S KNOB DEPOSITS. —On the south side of Helton creek the ore formation crosses over McClure's knob, which rises to an altitude

of 750 feet above the level of the creek, where a number of openings expose a series of parallel ore beds, distributed over a width of some 2000 feet N. W. and S. E. None of these, however, as far as developed, show over 3 feet in thickness.

As regards the development here the same general statement applies as has been made above in reference to Red hill. The openings on McClure's knob are mere shallow pits, simply showing the presence of ore, but not in any way fairly defining its extent, so that no geologist or mining engineer can afford to pass a definite opinion upon it. The prevailing strike of the country rock, gneiss and hornblende schist, is N. 50° to 53° E., and the dip is regularly S. E., at various angles.

Opening No. 1, or the *Tolley* opening, the highest one on the knob, is a small cut not over 4 feet deep, just north of the main summit. It exposes 2½ feet of fine-granular ore, in hornblende gangue, which is probably the comb of a lens and will warrant further exploration in depth. The strike of a solid ledge of gneiss 8 feet above this outcrop, and probably the hanging-wall, is N. 50° E.; the dip is 45° S. E.

An analysis of this ore shows:

ANALYSIS OF MAGNETITE ORE, TOLLEY OPENING, MCCLURE'S KNOB, ASHE COUNTY.

	(60)
Silica	23.23
Metallic iron	44.87
Sulphur	0.036
Phosphorus	0.053
Phosphorus ratio	0.118

Opening No. 2, about 500 feet S. 25° W. from No. 1, on the western slope of the knob, is a tunnel which was driven into the hillside in a southerly direction, but has caved in and is now inaccessible; it was driven on the top of a lens of magnetite, along a streak of pyrites which was supposed to be copper-bearing. Masses of magnetite ore in hornblende and epidote, fully 3 feet cube, that were taken out in this work are found lying on the dump outside, and an analysis of a sample taken from these shows:

ANALYSIS OF MAGNETITE ORE, TUNNEL OPENING, MCCLURE'S KNOB.

	(59)
Silica	21.58
Metallic iron	47.07
Sulphur	0.05
Phosphorus	0.07
Phosphorus ratio	0.148

The strike of the country rock near here is S. 42½° W.

Between these two openings are a number of smaller diggings. The existence of several independent ore lenses; nothing but loose fragments lying on the outside.

Opening No. 3, also known as the *Blevins forge* opening, is a small digging 500 feet N. 15° E. from the Tolley opening, and 50 feet below it in elevation, on the north side of the knob. The bed is reported to be 3 feet thick, but cannot now be seen in place. An analysis of a sample taken from the old dump on the outside of the pit shows:

ANALYSIS OF MAGNETITE ORE, BLEVINS FORGE OPENING, MCCLURE'S KNOB.

	(61)
Silica	22.78
Metallic iron	43.03
Sulphur	0.02
Phosphorus	0.14
Phosphorus ratio	0.325

On the hillside near the head of a big hollow, 200 feet nearly south from the Blevins opening, another outcrop makes its appearance, but has not been opened. Its quality is shown by the following analysis:

ANALYSIS OF MAGNETITE ORE, NATURAL OUTCROP, MCCLURE'S KNOB.

	(62)
Silica	28.78
Metallic iron	42.38
Sulphur	0.03
Phosphorus	0.03
Phosphorus ratio	0.070

There is a series of old forge diggings on the comb of the ridge, about 120 feet north of this point, but they are overgrown and nothing can be seen.

Several hundred feet east of here, and at the same elevation, is a shallow opening, merely uncovering the top of the ore.

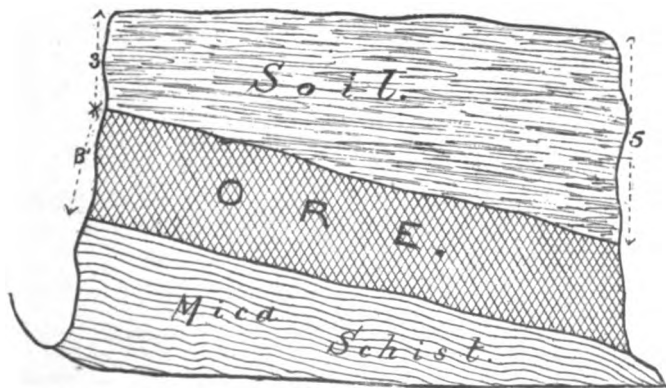


Fig. 33.—Showing ore body, the Price opening, McClure's knob, Ashe county.

The only other opening of importance is the *Price opening*, some 900 feet S. 20° E. from the old forge diggings, and about 135 feet below the same in elevation.

The cut exposes a lens of ore 3 feet thick, from 3 to 5 feet below the

surface soil, resting on a foot-wall of micaceous schist. The dip is 26' S. E. Several analyses of this ore show:

ANALYSES OF MAGNETITE ORE, PRICE OPENING, MCCLURE'S KNOB.

	(57)	(58)
Silica	11.43	16.50
Metallic iron	51.30	45.87
Sulphur	0.06	0.025
Phosphorus	1.12	0.904
Phosphorus ratio	2.183	1.970

The excessive percentage of phosphorus is notable and surprising, and will practically condemn it in this region of usually low phosphorus ores; in fact the McClure knob ores are with few exceptions all of them above the Bessemer limit.

Towards the southwest the magnetite formation crosses Old Field creek and seems to gradually widen in extent.

POISON BRANCH ORE BED.—At the head of Poison branch, on the divide between the waters of Old Field and Silas creeks, about 1 mile

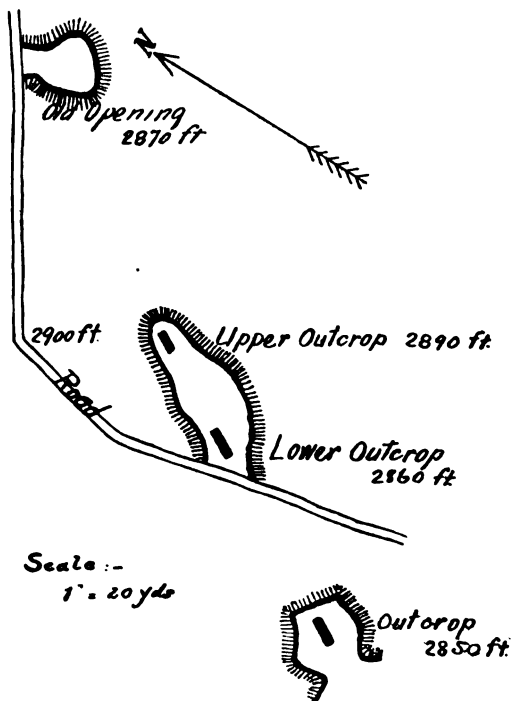


Fig. 34.—Showing position of openings, Poison Branch mine, Ashe county.

(air line) S. 15° W. from the summit of McClure's knob, a bed of ore has been discovered at the "Poison Branch bank," from which ore was at one time mined for some of the old forges.

The main opening is on the northeast side of the road, as shown in Fig. 34.

It is a large opencut about 30 feet deep, but badly caved-in at present, showing two outcrops, the upper one (fig. 35) being visible only in the upper end of the cut just below the surface soil, where it measures about $4\frac{1}{2}$ inches in thickness of friable crystalline magnetite, comparatively

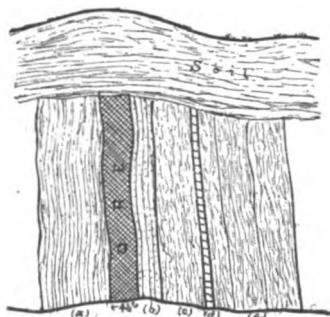


Fig. 35.—Upper outcrop, Polson Branch mine, Ashe county.

- (a) Decomposed red schist (magnetic).
- (b) Yellow, arenaceous clay, 4 inches thick.
- (c) Mica schist, 6 inches thick.
- (d) Quartz seam, 1 inch thick.
- (e) Decomposed schist.

clean, below which is a bed of argillaceous schist and clay of a deep vermilion color, impregnated with fine shot ore, being in all probability a more decomposable part of the ore bed itself; unfortunately the cut has not been extended far enough in this direction to determine its true thickness.

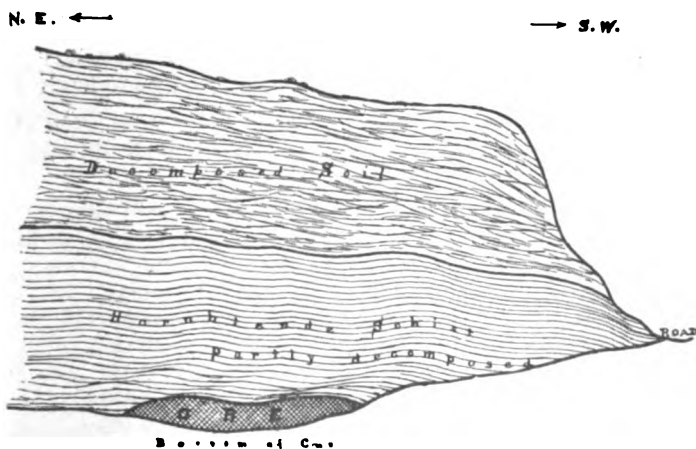


Fig. 36.—Lower outcrop, Polson Branch mine, Ashe county.

The lower bed is seen some 30 feet below here, at the bottom of the cut, near its mouth. It is only partially exposed, but authentic reports state its thickness at 6 feet, about 3 feet of which was visible (Fig. 36).

It is a hard ore and the gangue is entirely hornblendic, while in the upper bed it is micaceous. The strike is N. 40° E., and the dip 40° S. E.

About 150 feet northeast from here is an old forge digging of considerable dimensions, but no ore can now be seen in place. On the south side of the road the ore bed has been explored in a small opening, but only the top of the ore adjoining the hanging-wall, which is hornblende-epidote, can be seen. Some analyses of these ores show:

ANALYSES OF MAGNETITE ORE, POISON BRANCH, ASHE COUNTY.

	(63)	(64)	(65)	(66)	(67)	(68)	(68a)
Silica	28.60	5.55	20.36	12.31	....	....	....
Metallic iron	37.30	61.44	45.06	56.05	56.00	50.77	63.23
Sulphur	0.090	0.060	0.130	....	0.050	0.076	....
Phosphorus	0.014	0.003	0.011	0.071	0.013	0.016	0.041
Titanic acid	0.082	....	0.040	....	trace.	....	....
Phosphorus ratio	0.038	0.005	0.024	0.127	0.023	0.031	0.065

No. 63 is from the opening on the south side of the road. Nos. 64 and 68a are from the upper part of the bed in the opening on the north side. The others are from the lower part.

Several hundred feet northwest from here some small openings, showing fragmentary loose ore on the old dumps, attest the fact of another bed parallel to that just described, but nothing can be learned of its extent.

In a southwesterly direction the ore has been traced to Silas creek, but no openings of importance have been made.

At the junction of the Jefferson and Poison branch roads at Silas creek, on *Munroe Barker's* land, several small pockets of red specular hematite in a quartz gangue occur in a cut along the road; over 10 years ago a shaft was sunk here to a depth of 20 feet, now completely filled up, in which three feet of good ore is reported to have been discovered; the strike of the country rock (gneiss and mica-schist) is N. 30° E.; dip, 31° S. E. An analysis of a sample taken here shows:

ANALYSIS OF RED SPECULAR HEMATITE, MUNROE BARKER'S, SILAS CREEK, ASHE COUNTY.

	(92)
Silica	13.66
Metallic iron	55.83
Sulphur	0.040
Phosphorus	0.059
Phosphorus ratio	0.105

A similar ore is found nearly 2 miles northeast from here on the land of *John Wyatt*, on the waters of Old Field creek, in small scattering surface fragments, an analysis of which shows:

ANALYSIS OF RED SPECULAR HEMATITE, JOHN WYATT'S, OLD FIELD CREEK,
ASHE COUNTY.

	(91)
Silica	4.48
Metallic iron	61.27
Sulphur	0.026
Phosphorus	0.047
Phosphorus ratio	0.076

The prospects of finding workable deposits of this specular ore are very discouraging; it occurs, in almost every instance, simply as coatings or small segregated seams in quartz.

To continue on the magnetite belt, about $\frac{3}{4}$ mile S. 41° W. from the Poison Branch bank the ore makes its appearance on *Munroe Barker's "Bob" place*, on the summit of a ridge, and has been very imperfectly explored by shallow pits. The country rock is hornblende schist, striking N. 35° E. An analysis of a surface sample shows:

ANALYSIS OF MAGNETITE ORE, MUNROE BARKER'S "BOB" PLACE, ASHE COUNTY.

	(96)
Silica	11.01
Metallic iron	53.96
Sulphur	0.027
Phosphorus	0.034
Phosphorus ratio	0.063

Nearly 1 mile S. 70° W. from the above point three small openings on the land of *Samuel McClure* discover the existence of several parallel beds of magnetic ore in hornblende gangue; prospects are not encouraging; the strike of the country rock, syenitic gneiss, is N. 30° E.; dip, S. E. Analysis of an outcrop sample shows the extremely lean character of this ore:

ANALYSIS OF MAGNETITE ORE. SAM'L MCCLURE, ASHE COUNTY.

	(97)
Silica	38.71
Metallic iron	27.40
Sulphur	0.06
Phosphorus	0.083
Phosphorus ratio	0.303

About 700 yards S. 45° W. from here, on Grapevine creek, a branch of Little Piney creek, a shallow pit near the road on *John Parsons'* land shows 3 feet of soft decomposed ore in hornblende gangue, but it is only partially exposed. An analysis of this ore gives:

ANALYSIS OF MAGNETITE ORE, JOHN PARSONS', GRAPEVINE CREEK, ASHE COUNTY.

	(98)
Silica	6.94
Metallic iron	58.50
Sulphur	0.055
Phosphorus	0.004
Phosphorus ratio	0.007

Less than $\frac{1}{2}$ mile northwest from here on the summit of a high ridge, 200 yards southwest of Grapevine creek, on the land of *G. Douglas Blevins*, a bed of very hard, compact magnetite in a gangue of gneiss and epidote is discovered, showing a thickness of at least 8 feet, as far as exposed.

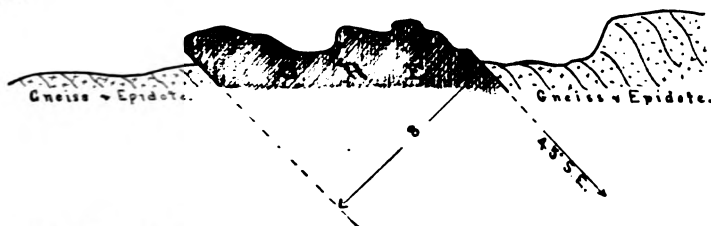


Fig. 37.—Showing ore body at Douglas Blevins', Ashe county.

The strike is apparently N. 55° E., and the dip 45° S.E. Several analyses show the ore to be so high in phosphorus, similar to the Price ore on McClure's knob, as to practically condemn it.

ANALYSES OF MAGNETITE ORE, G. DOUGLAS BLEVINS', GRAPEVINE CREEK, ASHE COUNTY.

	(69)	(70)
Silica	23.90	27.67
Metallic iron	40.68	40.62
Sulphur	0.09	0.095
Phosphorus	0.904	0.740
Phosphorus ratio	2.222	1.821

To show the great width of the general ore-bearing belt, ore has been found still northwest from here, on the divide between the waters of Silas and Grapevine creeks, but has been explored superficially only.

Pursuing our southwesterly course, the ore formation assumes a very marked and peculiar characteristic; it becomes manganiferous, and in places very highly so.

PINEY CREEK ORE BED.—Crossing the ridge about $\frac{1}{2}$ mile southwest from Douglas Blevins', a bed of manganiferous magnetite has been opened at Ballou's Piney Creek mine, immediately on the waters of Piney creek, $1\frac{1}{2}$ miles above its mouth, at Ballou's mill. The ore is very coarse-granular in a matrix of brownish-black manganese oxide. It is exceptionally

pure and practically free from gangue throughout its entire extent. The upper part of the bed shows $6\frac{1}{2}$ feet of solid, hard ore, beneath which is about 1 foot of soft manganiferous ore. The bed is probably even thicker than this, as its full extent has not been uncovered.

Some analyses of this ore show:

ANALYSES OF MANGANIFEROUS MAGNETITE, PINEY CREEK BANK,
ASHE COUNTY.

	(26)	(27)	(28)	(29)	(30)	(31)
Silica	0.614	9.05	3.12	10.64	0.800	3.20
Metallic iron	65.09	51.69	62.10	39.35	65.65	65.40
Metallic manganese..	3.98	0.66	3.66	9.63	3.83	2.58
Sulphur	0.007	0.055	0.085	....	....	....
Phosphorus	0.019	0.030	0.017	0.022	0.040	0.011
Titanic acid .....	....	....	....	....	....	none.
Phosphorus ratio....	0.029	0.174	0.027	0.056	0.006	0.016

FRANCIS ORE BED.—Crossing Piney creek, less than $\frac{1}{2}$ mile slightly south of west from here, a bed of similar ore, though perhaps more manganiferous, has been opened on a ridge some 250 feet above the level of the creek, on the land of *Robert Francis*. A slope, 20 feet deep, exposes 10 feet of soft manganiferous ore on the outcrop, pinching out to considerably less than this at the face of the same.

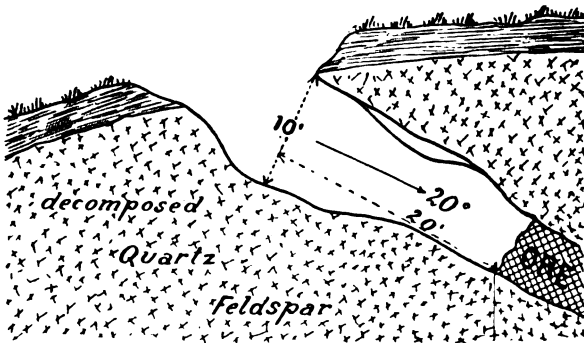


Fig. 38.—Showing the ore body on the Francis place, Ashe county.

Throughout this soft material are scattered grains of hard magnetite. There is evidently a roll of fold in the bed at this point, the dip being abnormally 20° north of east, and the strike $N. 34^\circ W.$ The foot-wall is a decomposed feldspathic material. The ore carries an excessive amount of hygroscopic moisture.

Analyses show the following interesting composition:

ANALYSES OF MANGANIFEROUS MAGNETITE, FRANCIS SLOPE OPENING,
ASHE COUNTY.

	(33)	(34)	(35)
Silica	10.82	3.49	6.09
Metallic iron	47.43	27.23	47.45
Metallic manganese	8.96	5.22	9.10
Phosphorus	0.085	0.058	0.102
Hygroscopic water		42.60	....
Phosphorus ratio	0.180	0.213	0.215

No. 34 is the natural ore. Nos. 33 and 35 are dried at 212° F.

Float ore is found scattered over the hill to the northeast of this opening, and immediately on the roadside a tunnel was driven some 75 feet long, but it has caved in at the face. An analysis of some loose ore, found on the dump outside of this tunnel, shows:

ANALYSIS OF MANGANIFEROUS MAGNETITE ORE, FRANCIS TUNNEL, ASHE COUNTY.

	(32)
Silica	1.73
Metallic iron	64.51
Metallic manganese	3.19
Sulphur	0.040
Phosphorus	0.120
Phosphorus ratio	0.186

About $\frac{1}{2}$ mile due west from here a bed of very hard, compact, crystalline magnetite has been opened at two points, differing 100 feet in elevation, on *Jacob Stewart's* land near the summit of *Turkey knob*. The gangue is epidote, gneiss and quartz. The openings were filled in, but the ore body is reported to be 5 feet thick. Several analyses show its composition to be:

ANALYSES OF MAGNETITE ORE, TURKEY KNOB, ASHE COUNTY.

	(100)	(101)	(102)
Silica	15.22	26.56	....
Metallic iron	59.36	47.14	63.50
Sulphur	0.015	0.06	....
Phosphorus	0.015	0.023	0.006
Titanic acid .....		....	trace.
Phosphorus ratio	0.025	0.048	0.009

No. 100, lower opening. No. 101, upper opening.

GRAYBEAL ORE BED.—About $\frac{1}{2}$ mile S. 30° W. from Turkey knob and $\frac{3}{4}$ mile S. 70° W. from the Francis slope, on the waters of Old Field creek, a tributary of Horse creek, several openings on the land of Joseph Graybeal have exposed a bed of magnetite ore which was worked a number of years ago for some of the old forges.

Opening No. 1, an old forge digging, is a narrow opencut 50 feet long by 15 feet deep, badly caved in, showing a bed of soft shot ore in decomposed hornblende; in the front part of the cut is a streak of maniferous earth about 1 foot thick. The composition of this ore is:

ANALYSIS OF MAGNETITE ORE, OLD FORGE OPENING, JOSEPH GRAYBEAL.

	(37)
Silica	28.95
Metallic iron	42.60
Metallic manganese	1.58
Sulphur	0.04
Phosphorus	0.008
Phosphorus ratio	0.019

A long shallow trench on the edge of an open field near here shows loose pieces of float ore, highly manganiferous, bearing a strong resemblance to the Piney creek and Francis ores.

The main opening, near the summit of the ridge, in the rear of Graybeal's house, is a cut about 50 feet long; it exposes two beds of ore, respectively 4 and 18 feet thick, separated by clay.



Fig. 39.—Showing ore body on Joseph Graybeal place, Ashe county.

The four-foot bed in the front part of the cut shows some very compact, solid magnetite free from gangue, while that in the upper bed is mixed with hornblende. Analyses of this ore show:

ANALYSES OF MAGNETITE ORE. MAIN OPENING, JOSEPH GRAYBEAL'S, ASHE COUNTY.

	(36)	(38)	(39)
Silica	6.85	11.57	8.77
Metallic iron	63.55	55.24	56.09
Sulphur	trace.	0.075	0.05
Titanic acid	0.06	....	....
Phosphorus	0.009	0.005	0.031
Phosphorus ratio	0.014	0.009	0.055

Nos. 36 and 39 from lower bed. No. 38 from upper bed.

Other analyses of ore from the Graybeal place show:

ANALYSES OF MAGNETITE ORE, JOSEPH GRAYBEAL'S, ASHE COUNTY.

	(40)	(41)
Metallic iron	67.18	64.04
Phosphorus	0.010	0.009
Titanic acid	0.100	....
Phosphorus ratio	0.014	0.014

One mile above the mouth of Horse creek and about 100 yards from the northeastern bank of the creek, a bed of manganiferous magnetite, precisely similar to that at Piney creek, has been opened at *Ballou's Horse Creek ore bank*.

The ore is a coarse-granular magnetite, disseminated in a manganiferous and hydromicaceous matrix, which on long exposure decomposes into a soft rich shot ore. The opening is in shape of an undercut in the side of the hill, into which it extends perhaps 50 feet as a slope, the lower part of which was filled with water, preventing a close examination. The dip is apparently towards the northeast; as far as exposed, the thickness of the bed is at least 6 feet, the lower two feet being the harder. Ore was formerly hauled from here to the Laurel forge, 12 miles distant (see page 132).

Several analyses of the Horse creek ores show:

ANALYSES OF MANGANIFEROUS MAGNETITE, HORSE CREEK BANK, ASHE COUNTY.

	(42)	(43)	(44)
Silica	1.96	4.58	4.12
Metallic iron	62.48	54.02	64.58
Metallic manganese	3.66	6.85	2.21
Sulphur	0.072	0.007	....
Phosphorus	0.019	0.006	0.011
Phosphorus ratio	0.030	0.011	0.017

About 1 mile almost due west from here, the ore body rises over 500 feet above the level of Horse creek on *Hampton knob*, over which it has been traced for a considerable distance with the dip needle; but none of the openings give any idea of the size of the bed; nor can it be definitely ascertained whether this belongs to the same range as the Horse creek and Graybeal ores or not; it lacks the manganiferous characteristics of those ores, and most probably is an independent parallel bed. The quality of the ore is shown by the following analyses:

ANALYSES OF MAGNETITE ORE, HAMPTON KNOB, ASHE COUNTY.

	(45)	(46)	(47)
Silica	9.66	....	....
Metallic iron	61.58	65.63	52.23
Sulphur	0.06	....	....
Phosphorus	0.010	0.029	0.019
Phosphorus ratio	0.016	0.044	0.036

The general ore formation continues in a southwesterly direction through the central, western and southwestern portions of the county, along the waters of North Fork and to the west of the Three Top mountain range; but it is traced with difficulty, and as yet few beds of importance have been discovered.

Wilcox Ore Bed.—About $\frac{1}{4}$ mile northwest of Dresden P. O., which is at the junction of Staggs creek and North Fork, 7 miles northwest from Jefferson, a bed of magnetic iron ore has been discovered on the land of Dr. J. O. Wilcox. A shallow cut has uncovered the outcrop, which measured 12 feet in thickness; the gangue is epidote and hornblende. Some 30 feet to the southwest an opencut and tunnel have been driven into the hillside for a distance of 40 feet, into decomposed gneiss and mica-schist; but they are evidently situated above the level of the ore body, which they failed to strike, excepting some small detached lenses of ore in the side of the opencut. A good location may be had for an adit-level lower down on the slope of the hill, by which the deposit may be explored to advantage in depth. The strike of the country rock is N. 60° E., and the dip is 36° to 40° S. E.

An analysis of this ore shows:

ANALYSIS OF MAGNETITE ORE, J. O. WILCOX, DRESDEN P. O., ASHE COUNTY.

	(88)
Silica	23.90
Metallic iron	52.90
Sulphur	0.05
Phosphorus	0.019
Phosphorus ratio	0.036

Along North Fork and its tributaries (Big Laurel, Little Laurel, Rich Hill, Roundabout, etc., creeks), the country rock of gneiss, epidote and hornblende is in places fairly charged with crystalline magnetite. Among other places, the farms of John W. B. Sharp, Floyd Welch, David Lapp (on the divide between Rich Hill and Big Laurel creeks), the Jones heirs (on Big Laurel creek), Lee Eastridge (on Rocky knob), Tom Jenkins (near North Fork, about 2 miles south of Solitude P. O.), Thomas Sutherland (on the northeast side of South Fork), were examined; but, although the prospects at certain of these localities may be promising, no explorations of note have been undertaken and no ore-beds of value have as yet been found.

An analysis of an outcrop sample of ore from the Tom Jenkins place shows:

ANALYSIS OF MAGNETITE ORE, TOM JENKINS' PLACE, ASHE COUNTY.

	(82)
Silica	31.22
Metallic iron	44.02
Sulphur	0.058
Phosphorus	0.004
Phosphorus ratio	0.009

3. THE TITANIFEROUS ORE BELT.—Starting at the northern edge of the county, near the Virginia State line, on the waters of Little Helton creek, this, the most northwesterly ore belt of importance in Ashe county, has been traced in a southwesterly direction to Helton creek, near Sturgill P. O., a distance of some $2\frac{1}{2}$ miles. It is approximately 3 miles northwest of the Red Hill belt and parallel to it. The accompanying topographical sketch shows the relative positions of the openings made along the ore belt.

Virginia-North Carolina line.

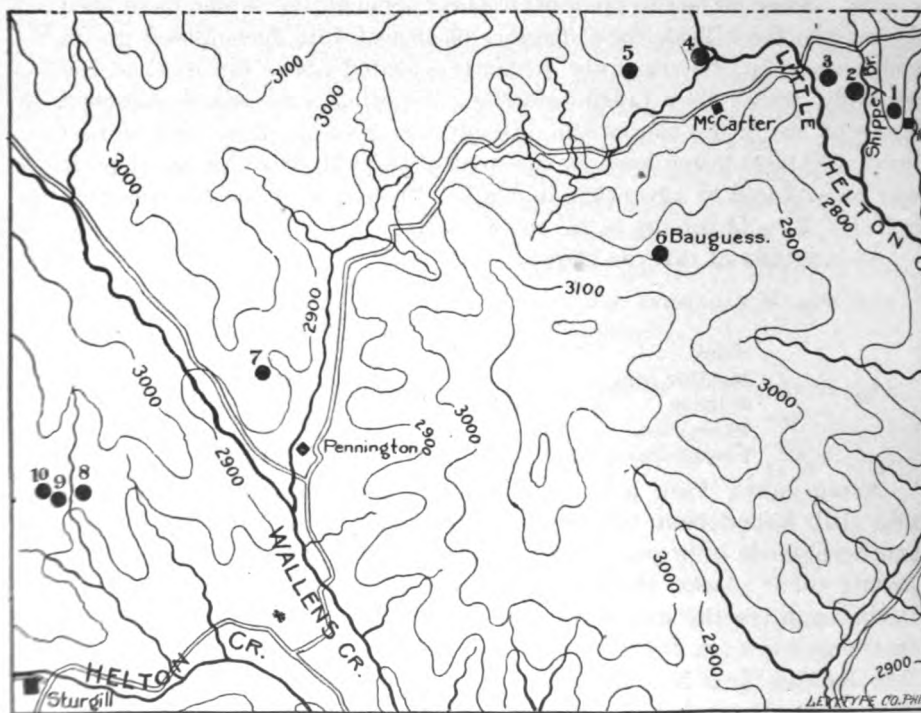


Fig. 40.—Showing location of ore beds on the Titaniferous belt, Ashe county.

Scale 2 in.=1 mile. Contour interval, 100 feet.

No. 1, Wm. Young's; Nos. 2, 3, 4 and 5, G. C. McCarter's; No. 6, Bauguess place; No. 7, Cicero Pennington's; Nos. 8, 9 and 10, Kirby place.

On the property of *William Young* (marked 1 in fig. 40), 150 yards west of the Jefferson-Marion road and about $\frac{1}{4}$ mile south of the Virginia State line, a very heavy outcrop of magnetite extends east and west along the crest of the ridge, covering a width of at least 25 feet. There are no openings here, but all indications point to a large deposit. The ore is a coarse-granular magnetite, practically free from gangue. It is titaniferous and has a bright silvery luster.

Analyses of the ore show:

ANALYSES OF TITANIFEROUS MAGNETITE, WM. YOUNG (NO. 1), ASHE COUNTY.

	(80)	(81)
Silica	5.12	4.35
Metallic iron	50.77	52.85
Sulphur	0.04	....
Phosphorus	0.005	0.013
Titanic acid	4.95	8.80
Phosphorus ratio	0.009	0.024

This outcrop is traced for over 150 yards in a westerly direction across Shippey branch, where it is exposed on the *G. C. McCarter place* (marked 2 in fig. 40), showing a bed from 9 to 12 feet thick, dipping almost vertically. The local magnetic variation is 11° W. An analysis of the ore from this point shows:

ANALYSIS OF TITANIFEROUS MAGNETITE, MCCARTER'S (NO. 2), ASHE COUNTY.

	(79)
Silica	5.37
Metallic iron	51.75
Phosphorus	0.018
Titanic acid	9.17
Phosphorus ratio	0.034

The same bed is seen about 50 yards slightly north of west from here, but its full thickness is not exposed; the country rock is decomposed pyrophyllite schist.

One-half mile N. 77° W. from Young's, on Little Helton creek, a bed of ore in hornblende, partially altered to asbestos, is uncovered in a shallow cut 100 yards north of *McCarter's* house (marked No. 4 in fig. 40); it measured 3 feet in thickness, but was not fully exposed.

Several analyses of the ore from this point show:

ANALYSES OF TITANIFEROUS MAGNETITE, MCCARTER'S (NO. 4), ASHE COUNTY.

	(77)	(78)
Silica	9.90	10.92
Metallic iron	46.81	40.71
Sulphur	0.137	0.065
Phosphorus	0.025	0.012
Titanic acid	6.03	5.54
Chromic oxide	0.630	....
Phosphorus ratio	0.053	0.029

At McCarter's place the outcrop (No. 5 on map, fig. 40, page 158) has been exposed in a thin backbone not over one foot thick.

The *Bauguess ore bed* (No. 6 in fig. 40) is $\frac{1}{2}$ mile due south from McCarter's (No. 5); a small cut exposes 5 feet of ore, having a reddish streak; the gangue is epidote, feldspar and quartz. Analyses show:

ANALYSES OF TITANIFEROUS MAGNETITE. BAUGUESS PLACE (NO. 6, ASHE COUNTY.

	(75)	(76)
Silica	6.35	7.91
Metallic iron	57.66	53.35
Sulphur	0.061	0.078
Phosphorus	0.008	0.022
Titanic acid	4.690	4.92
Chromic oxide	0.505	....
Phosphorus ratio	0.013	0.041

The next notable opening (No. 7, fig. 40) is at *Cicero Pennington's*, on Wallen's creek, a tributary of Helton creek, where a bed of ore, 8 feet in thickness, has been exposed. It is a fine-grained, compact, steel-gray magnetite with but little gangue, which is generally epidote; when weathered, the ore is friable. Its composition is shown by the following analyses:

ANALYSES OF TITANIFEROUS MAGNETITE. PENNINGTON'S (NO. 7, ASHE COUNTY.

	(72)	(73)	(74)
Silica	4.75	4.72	5.07
Metallic iron	52.23	52.44	52.45
Sulphur	0.112	0.077	....
Phosphorus	0.021	0.004	0.022
Titanic acid	8.91	5.38	9.11
Chromic oxide	1.19	....	....
Phosphorus ratio	0.040	0.007	0.042

About $\frac{1}{2}$ mile north of Sturgill P. O., on the waters of Helton creek, a broken bed of hard, fine-grained magnetite in hornblende and epidote has been uncovered in the openings 8, 9, 10 (fig. 40) on the *Kirby place*. The thickness of the bed could not be determined from the condition of the openings, but it appears to be not less than 15 feet. The dip of the accompanying schists at 8 is about 47° S. S. E.

An analysis of this ore shows it to be comparatively low in titanic acid:

ANALYSIS OF MAGNETITE ORE, KIRBY PLACE, OPENINGS 8, 9 AND 10 OF FIG. 40,
PAGE 158.

	(71)
Silica	17.25
Metallic iron	48.87
Sulphur	0.057
Phosphorus	0.066
Titanic acid	0.210
Chromic oxide	none.
Phosphorus ratio	0.135

The true relations which these various ore beds bear to each other are not at present definitely known. There is no doubt that Nos. 1, 2 and 3 are on the same bed or series of beds; similarly, openings 4 and 5

show one, and 8, 9 and 10 another bed; but the relations of these to each other and to 6 and 7 are uncertain and can only be determined by a study of the geologic structure of the region.

If the identification is made on a chemical basis alone, the ore bed at 8, 9 and 10, which is practically free from titanitic acid, certainly would belong to a separate and distinct series; but a true and satisfactory correlation cannot be arrived at without other evidence.

The effect of titanitic acid on an iron ore has already been discussed (pp. 22 and 67), and it need only be repeated here that the ores of this titaniferous range are not adapted to modern blast furnace practice, particularly as long as ores free from this element are available in the same region, along the "Ballou" and "Red Hill" belts.

The experiment of reducing the percentage of titanitic acid in these ores by magnetic separation has not been tried, but is well worthy of investigation.

A few conclusive points relative to the ores of the three principal zones or belts in Ashe county may be in place here.

In general their quality is good; low in sulphur, and below the Bessemer limit in phosphorus.

The mined material will, in many cases, be high in silica, but there is no reason why in such cases, by means of magnetic concentration, a high-grade product should not be obtained.

The titaniferous belt is by far the most persistent, and shows a larger quantity of ore, but the percentage of titanitic acid condemns it for blast-furnace use, in competition with iron ores less difficult to smelt in the furnace.

There is little doubt that there are valuable workable beds of ore throughout the other two belts, such as Ballou's, Piney creek, Graybeal's, Horse creek, etc., but it will require much more extensive exploitation to define their true extent.

Nearly all of these ore-deposits, being situated on the tributaries of North Fork of New river, would be accessible to a railroad built up that stream, which is a feasible project.

4. THE BROWN HEMATITE ORE BELT OF PHOENIX AND THREE TOP MOUNTAINS.—Along the northern base of Phoenix mountain, $5\frac{1}{2}$ miles southwest of Crumpler P. O., on Rush branch, $\frac{1}{2}$ mile from North Fork, a bed of brown hematite has been uncovered on the farm of *Peter Eller*, in a trench 117 feet long (N. and S.) by 4 feet wide by 6 to 8 feet deep; the floor is solid ore in a matrix of decomposed mica-schist and clay; near the north end of the cut, a pit, sunk to a depth of 5 feet, shows that at this point the ore is but a very thin layer. The remainder of the cut was not developed to show the thickness of the ore; on the west a short tunnel was driven in the hillside, but no ore was discovered. A slight

exposure of similar ore may be seen $\frac{1}{2}$ mile to the west, where it is cut through in the bed of Mill branch. One mile west of the "long trench," a shallow pit on *William Childer's* place reveals some scattering fragments of ore, but shows nothing in place. About 200 yards east of the "long trench" a small pit on *Milton Kilby's* place shows similar fragmentary nodules. There is not much doubt that this brown hematite is a secondary formation, occurring in thin, irregular sheets or pockets, resulting from the disintegration and leaching of ferruginous rocks higher up on the slope of the mountain. These leachings have been redeposited in the impervious clay soil below, the latter resulting from the decomposition and alteration of the surrounding schists. The prospects for finding any quantity of this ore are therefore to be discouraged.

Several analyses show its composition to be:

ANALYSES OF BROWN HEMATITE, PHOENIX MOUNTAIN, ASHE COUNTY.

	(23)	(24)	(25)
Silica	8.79	....	10.33
Metallic iron	54.18	54.55	48.70
Metallic manganese	0.71	....	0.774
Sulphur	0.008	....	....
Phosphorus	0.100	0.0043	0.011
Phosphorus ratio	0.184	0.008	0.022

Some 3 miles east of Eller's and 6 miles north-northeast of Jefferson, at the foot of Little Phoenix mountain, similar blankets or pockets of brown hematite are found on the land of *Isaac Hudler*. The quality of this ore is shown by the following analyses:

ANALYSES OF BROWN HEMATITE, LITTLE PHOENIX MOUNTAIN, ASHE COUNTY.

	(84)	(85)
Silica	8.95	....
Metallic iron	52.54	53.23
Sulphur	0.061	....
Phosphorus	0.148	0.145
Phosphorus ratio	0.281	0.272

The southwesterly continuation of this ore zone is found along the western slope of Three Top mountain; it has been exposed by a small cut on the land of *Floyd Welch*, but does not show a thickness of over 8 inches. Two analyses of samples from this point show:

ANALYSES OF BROWN HEMATITE, THREE TOP MOUNTAIN, ASHE COUNTY.

	(89)	(90)
Silica	14.98	....
Metallic iron	44.87	46.53
Metallic manganese	none.	....
Sulphur	0.23	....
Phosphorus	0.165	0.41
Phosphorus ratio	0.367	0.881

5. THE MAGNETITE AND SPECULAR ORES OF THE NORTHWESTERN PART OF ASHE COUNTY.—This part of the county is so inaccessible and has been so little explored that but few general notes can now be given.

On the *Ben Greer* place, near the waters of Little Horse creek and about 7 miles northwest from the mouth of Horse creek, a bed of magnetic ore lying nearly vertical has been discovered and partially opened; the top and one side of the bed have been exposed to a thickness of 9 feet, but it has not been cut entirely across; the ore is a hard, dense magnetite in a gangue of epidote and hornblende, and shows the following composition:

ANALYSES OF MAGNETITE ORE, BEN GREER PLACE, ASHE COUNTY.

	(48)	(49)	(50)
Silica	22.34	14.60	21.88
Metallic iron	40.82	51.40	50.16
Sulphur	0.09	....	....
Phosphorus	0.10	0.049	0.042
Titanic acid	0.160	0.317	0.390
Chromic oxide .....	....	none.	....
Phosphorus ratio	0.245	0.095	0.083

It has been suggested that this ore bed may belong to a common belt with the Kirby ore (described under the Titaniferous Zone on p. 160). A chemical resemblance is apparent, but a correlation on this ground alone is not allowable.

On Little Horse creek, $1\frac{1}{2}$ miles northeast from the Ben Greer opening, a body of magnetic hornblende-epidote has been exposed on the *Thomas Hamm* place, but it is too lean to deserve further notice.

Deposits of specular ore have been variously reported as occurring along the southeastern slope of Pond mountain, in the extreme northwestern corner of the county, and although there may be small pockets of superior ore, it is not believed that they exist in sufficient quantity to be of economical importance.

6. THE GOSSAN ORE OF THE ORE KNOB COPPER RANGE.—In the extreme eastern part of Ashe county, on the waters of Peak creek, 9 miles slightly south of west from Jefferson, is situated the *Ore Knob Copper mine*, which was at one time quite extensively worked. The vein is a copper-bearing pyrrhotite, averaging 10 feet in thickness; the country rock is gneiss and mica-schist; the strike is N. 60° E., and the dip nearly vertical.

The upper part of this vein has been altered by oxidation, forming a "gossan" of brown hematite ore which is reported to have an average depth of 45 feet. In the northeastern extension of this belt, in Carroll county, Va., this gossan has become an important source of supply as an iron ore to the Southwestern Virginia furnaces; at Ducktown, Tenn., a similar gossan has recently been worked to supply the iron furnaces at Middlesboro, Ky.

The inaccessibility of the Ore Knob mine and the siliceous character of its ore will scarcely mark it as a valuable source of supply, certainly not for years to come, unless indeed it is used in admixture with the richer magnetites in local furnaces.

The quality of the ore is shown in the following analysis:

ANALYSIS OF BROWN HEMATITE (GOSSAN). ORE KNOB MINE, ASHE COUNTY.

	(86)
Silica	24.10
Metallic iron	41.75
Metallic manganese	1.71
Metallic copper	1.08
Sulphur	2.91
Phosphorus	0.088
Phosphorus ratio	0.210

The presence of copper and sulphur in considerable quantity forms very deleterious impurities in this ore, both having a tendency to make the iron red-short.

A similar outcrop of "gossan" has been noticed on the land of *W. H. Garvey* on the eastern end of Mulatto mountain, about 4 miles due south from Jefferson and 8 miles southwest from Ore knob. Some prospecting has been done here, exposing a vein of siliceous ore not over 1 foot thick, dipping nearly vertical; it is reported that the vein has been explored in depth and found to widen to 4 feet, but the condition of the openings did not allow a satisfactory examination into this. The composition of the ore is shown below:

ANALYSIS OF BROWN HEMATITE (GOSSAN), W. H. GARVEY'S, ASHE COUNTY.

	(87)
Silica	34.02
Metallic iron	39.47
Metallic copper	1.77
Sulphur	0.437
Phosphorus	0.13
Phosphorus ratio	0.329

(c). THE IRON ORES OF WATAUGA COUNTY.

If the general magnetite ore formation of Ashe county were to continue in an unbroken line it would enter the extreme northern portion of Watauga county, and traverse the western edge of the same, in a direct course towards the Cranberry mine in Mitchell county. To what extent it does make its appearance in Watauga county is not now known, excepting that so far as present explorations go no notable outcrops have been observed.

That the continuity of the formation must be broken is evident from

a glance at the map, which shows the very intricate mountain structure of this region. In Ashe county, particularly the northeastern portion, which has been noted as the principal iron ore region, the great surface denudation has brought to view beds of iron ore that might otherwise have been obscured.

In the southwestern portion of Watauga county, the Beech mountain, which rises to an altitude of 5500 feet (above sea level) and has a trend nearly east and west, forms another formidable barrier in the course of the normal formation. As far as our present knowledge goes, therefore, the magnetite formation has not been found to possess any economic features in Watauga county, and does not come to view in any force between Ashe and Mitchell counties, until reaching the Cranberry mine.

Brown hematite and magnetite deposits have been variously reported in the northern-central and eastern parts of Watauga county, but in every case where examined they have proven to be merely magnetic rocks or pocketed deposits of bog ore not worthy of further notice.

The zone of the martite schists on the summit and the eastern slopes of the Blue Ridge mountains has been described in Chapter VII (p. 118).

The chromic iron ore of the Rich mountain, in the northern part of the county, will be described in Chapter XI (p. 212).

The only remaining ore locality to be considered is:

THE SPECULAR HEMATITES OF BEECH MOUNTAIN.—On the southern slope of Beech mountain, 7 miles slightly north of east from the Cranberry mine and $\frac{1}{2}$ mile north of the Elk creek valley, several small openings on the land of *James W. Whitehead* only partially expose the outcrop of a bed of very siliceous specular hematite, striking nearly east and west, and dipping toward the north. It has been traced one mile eastward by the surface float. One-half mile westward, on the land of *James H. Gwyn*, a similar outcrop has been exposed near the summit of a hill, 700 feet in elevation above the Elk creek valley and $\frac{3}{4}$ mile north of the Mitchell county line. The ore at this point is very slightly magnetic. The opening had caved in considerably, and as far as exposed only a few inches of ore between slaty, gneissoid walls were visible; it is reported to widen to a thickness of 4 feet at a depth of about 7 feet below the surface; this general belt has been traced some 2 miles westward by surface float, but has not been developed. As far as the outcrop ore shows it is too siliceous to be of economical value.

On one of the northern spurs of Beech mountain, known as *Big Ridge*, on the waters of Beech creek, 2 miles southeast from its mouth, a similar outcrop of partially magnetic specular hematite has been explored for a distance of about 1200 feet east and west. The country rock is slate and hornblende gneiss; the strike is variable, from nearly

east and west to northwest and southeast; and the dip is towards the north and northeast at angles varying from 45 degrees to the vertical.

On the extreme eastern end of the ridge is a shaft 35 feet deep, in which the ore body is reported to be 6 feet thick, but it is not now open to examination.

Some 150 yards west of here is an opencut, 6 feet wide by 45 feet long, which lays bare the outcrop, showing alternating layers of ore, probably 2 feet in thickness, and red ferruginous clay. West from here 45 yards, a small pit, 4 feet wide by 30 feet long, cuts across the outcrop, showing $1\frac{1}{2}$ feet of ore, occurring in streaks from $\frac{1}{2}$ inch to 1 inch in thickness.

Still further west, some 60 yards, near the summit of the ridge, an opening was in progress at the time the locality was visited, in July, 1892, cutting across the outcrop, but no definite results had yet been obtained. A sample was taken here by blasting out a small portion across the width of the solid outcrop as far as it could be exposed, an analysis of which shows:

ANALYSIS OF SPECULAR HEMATITE, BIG RIDGE, WATAUGA COUNTY.

	(378)
Silica	35.42
Metallic iron	41.30
Sulphur	0.548
Phosphorus	0.083
Phosphorus ratio	0.200

Some 60 yards westward an adit-level 80 feet long has been driven into the hillside through hornblende gneiss and slate, in the face of which from 2 to 4 inches of ore are visible.

Westward, 80 yards, the outcrop, which consists at this point of a quartzitic hornblende rock with streaks of specular ore mixed with magnetite, was laid bare over an area of 10 by 25 feet.

It is thus seen that, so far as the superficial explorations have gone, these ores are very siliceous and thin-bedded; there is a possibility that they may improve both in quality and in thickness with depth, and explorations in that direction, driving a long adit-level across the measures at a lower elevation, or sinking a deep shaft and crosscutting, are to be recommended.

From 10 to 12 miles west from here, in Carter county, Tennessee, similar ores to the above described, and probably in the same general zone, have been discovered on Mays and Fork ridges, where beds of considerable thickness have been developed, showing a superior ore, of which the following analyses by Mr. J. C. Guild, Chattanooga, Tenn., are cited:

ANALYSES OF MAY'S RIDGE ORES, CARTER COUNTY, TENNESSEE.

	(a)	(b)	(c)	(d)	(e)
Silica	8.95	8.76	7.15	16.93	14.02
Metallic iron	48.82	57.47	63.63	56.28	56.68
Phosphorus	0.011	0.020	0.027	0.054	0.006
Phosphorus ratio	0.022	0.034	0.042	0.095	0.010

(d). THE MAGNETITE AND SPECULAR ORES OF MITCHELL COUNTY.

The principal ore deposits of this county are situated in the northern and northwestern parts, on the slopes of the Roan, Iron, Unaka and Pumpkin Patch mountains.

In the upheaval of the Roan and contiguous mountain ranges in Mitchell county, N. C., and Carter county, Tenn., and of the Beech mountains in Watauga county, N. C., certain dynamic causes have operated to radically deflect the position of their axes from the normal trend, and consequently the course of the ore-bearing formations over this territory has suffered similar deflections, bending in a long bow or arc from the northern part of Mitchell county at Cranberry, where the strike of the country rocks is north of west, through the southern portion of Carter county, Tenn., recrossing the State line into North Carolina, and gradually assuming its normal trend, south of west, in the western part of Mitchell county.

A stratigraphical study of this mountain structure would be of great interest and value in discovering its mineral resources.

The principal ore deposits of Mitchell county may be divided into four belts:

- (1) The Bald Mountain Specular Belt.
- (2) The Cranberry Magnetite Belt.
- (3) The Roan Mountain Titaniferous Magnetite Belt.
- (4) The Pumpkin Patch Titaniferous Magnetite Belt.

(1). THE BALD MOUNTAIN SPECULAR BELT.—On Bald mountain, at the headwaters of Spring, Beans, Pigeon Roost, and Hollow Poplar creeks, but a few hundred yards east of the Tennessee State line, a heavy and extensive outcrop of red specular hematite has been uncovered in several small openings. The ore is very fine-grained and compact; near the outcrop it is siliceous, but becomes purer and almost entirely free from gangue with depth; its thickness is reported to be 10 feet, but this could not be verified on account of the caved-in condition of the openings; the wall rock is an arenaceous slate, striking N. 25° E.

An analysis of a sample taken from this point shows:

ANALYSIS OF SPECULAR HEMATITE, BALD MOUNTAIN, MITCHELL COUNTY.

	(325)
Silica	13.73
Metallic iron	52.80
Sulphur	0.06
Phosphorus	0.097
Phosphorus ratio	0.183

This belt of ore has been traced at intervals in a southwesterly direction from here down Hollow Poplar creek to the Toe river, a distance of some 7 miles; it is persistent, but very few, if any, developments have been made.

2. THE CRANBERRY MAGNETITE BELT contains by far the most important deposits of ore in this region, and has been the most extensively developed.

Its eastern extremity is found at Cranberry in the northern part of Mitchell county; thence it is traced without difficulty in a direction approximately N. 34° W., for 2½ miles to the Tennessee line, which it crosses near the line of the W. N. C. and E. T. railroad; it passes through the southern portion of Carter county, Tenn., deflecting gradually westward, and thence southwestward to the headwaters of Tiger creek, recrossing into North Carolina over Iron mountain, at an elevation of nearly 4000 feet (above sea-level) to the headwaters of Greasy creek, and continuing in a normal southwesterly direction to the Toe river, near the mouth of Pigeon Roost creek, a total distance of some 22 miles.

THE CRANBERRY MINE is situated in the extreme northern part of Mitchell county, at Cranberry P. O., on the eastern slope of Cranberry ridge, a part of the great Smoky mountain range, 4 miles southwest from Watauga county, and 2½ miles east from the Tennessee State line. It is at the terminus of the East Tennessee and Western North Carolina railroad (narrow gauge), on the west bank of Cranberry creek, a tributary of Elk creek. (See plates XVI to XX.)

This deposit of magnetic iron ore may justly, from its extent and quality, be noted as one of the most important in the State. The ore was worked in a small way, in Catalan forges located near by, as far back as 1820.¹ The excellent quality of blooms produced from Cranberry ore soon became known and attracted considerable attention. In 1866 it was tested in the United States Navy Ordnance Yard at Washington, D. C., with the most satisfactory results.

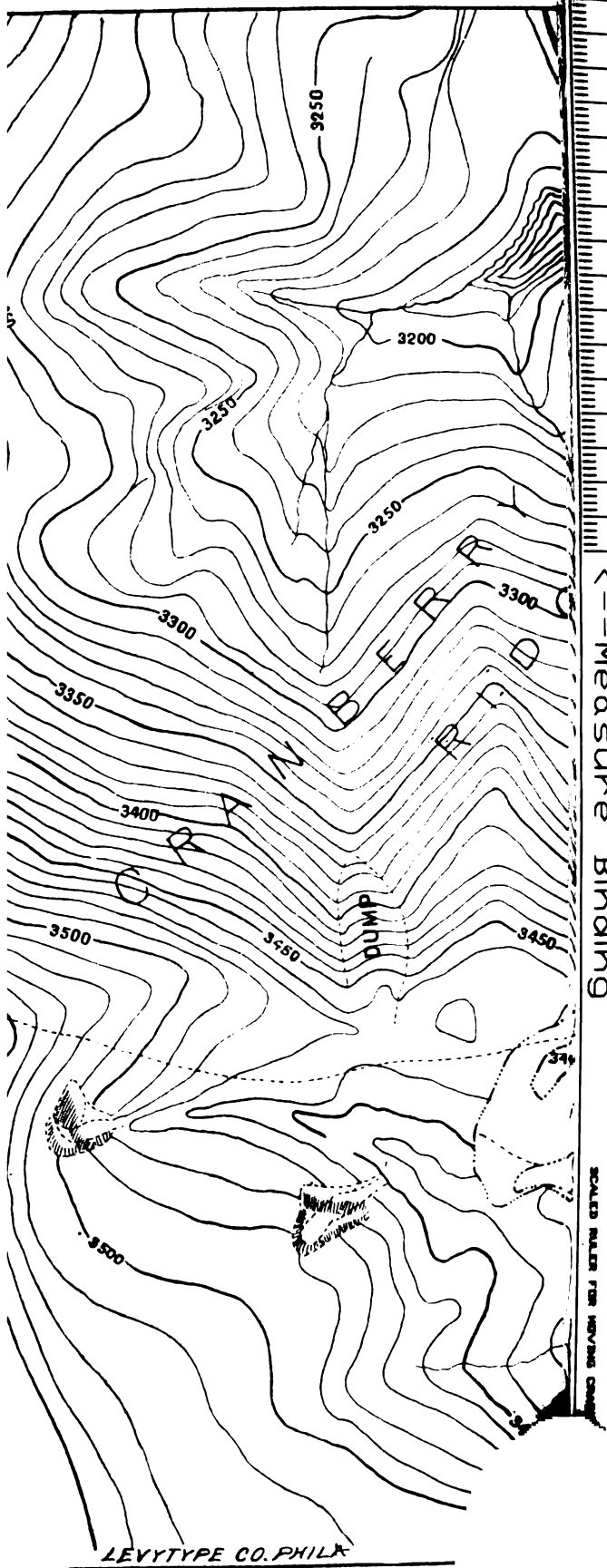
¹ From "The Iron Manufacturer's Guide," 1859, by J. P. Lesley:

Cranberry Bloomery Forge, on Cranberry creek; built in 1820; rebuilt in 1856; two fires and one hammer; made 17 tons of bars in 1857.

Toe River Bloomery Forge, situated 5 miles south of Cranberry forge; built in 1843; two fires and one hammer; made about 4 tons of bars in 1856.

Watauga Bloomery Forge, 6 miles east of south from Cranberry; two fires and one hammer; made 1½ tons of bars in 1856.





Measure Binding

Adjust Cradle Gap

In the same year a railroad was chartered by the owners from the mine to Johnson City, Tenn., a distance of about 32 miles, and 16 miles of it were graded.

Lack of capital, however, caused the abandonment of this project. About 1876 the property came into the possession of the present *Cranberry Iron and Coal Company*, which completed the railroad in 1882 to Johnson City, connecting there with the main line of the East Tennessee, Virginia and Georgia railroad. It was not until then that regular, systematic mining work was undertaken. The forge people had no more than "hogged over" the ground, thus exposing the outcrop over a large area, but not dreaming of the immenseness of the deposit beneath. Because of its friability, incoherence, and loose, coarse-granular structure, they preferred the weathered surface and outcrop ore to the purer, compact, homogeneous magnetite found at greater depths, which was too hard to treat in the forge. The operations of the Cranberry Iron and Coal Company have gradually developed a body of ore, the extent and quality of which place it on an equality with the large deposits of Lake Champlain, N. Y., and the New Jersey region. In the spring of 1884 a small blast furnace¹ was blown in here, and has been run continuously since, with the short intermissions necessary for relining, repairing, etc.

The ore deposit is an immense lens, the extent of which has not yet been fully determined, of magnetite associated with hornblende, pyroxene, epidote, quartz, feldspar, calcite, garnet, zircon, allanite, serpentine, etc., in varying proportions. It occupies the eastern slope of Cranberry ridge, and from its position is admirably located for mining. The highest outcrop is 380 feet above the water-level of Cranberry creek. (See plate XVI.)

It has been traced in a direction approximating N. 34° W. to and beyond the Tennessee State line, a distance of about 2½ miles (whether this is the same lens or not has yet to be determined by future development; the present theory is in favor of detached bodies or lenses).

In a southeasterly direction the outcrop appears on the eastern bank of Cranberry creek, along the western flank of Little Fork mountain, where it has been slightly explored; it is reported to continue thence toward the Old Fields of Toe, a distance of some 3 miles.

However, the Cranberry mine is the only point at which the deposit has been opened for practical purposes as yet.

¹ The plant consists of one furnace of the following dimensions: Height of stack, 50 feet; diameter of bosh, 10 feet 2 inches; diameter of hearth, 3 feet; capacity, 14 to 15 tons per day, in 4 runs of 3½ to 4 tons each. It is equipped with one cast iron pipe heating stove with straight bed pipes and U uprights; four plain cylinder boilers in two batteries of two each, heated by the waste gases, aggregating 60 horse-power; one Welmar vertical blowing engine, with two steam cylinders, diameter 36 inches, stroke 26 inches, revolutions per minute 30 to 32; one double-cylinder water-wheel blowing engine; diameter of cylinders 4 feet, stroke 5 feet, revolutions per minute 4¼ to 4½.

The *present workings* cover an area on the slope of the mountain of from 7 to 8 acres, and consist of two tunnel openings and four main opencuts in successive levels or benches. The accompanying plates present this more clearly and will be referred to.

Plate XVI represents a topographical map showing the mines, railroad and furnace-plant owned and operated by the Cranberry Iron and Coal Company.

Plate XVII shows the vertical section through the imaginary line I-J of Plate XIX.

Plate XVIII shows the vertical sections through the imaginary lines A-B, C-D, E-F, and G-H of Plate XIX.

Plate XIX shows a horizontal projection of the mine workings at different levels.

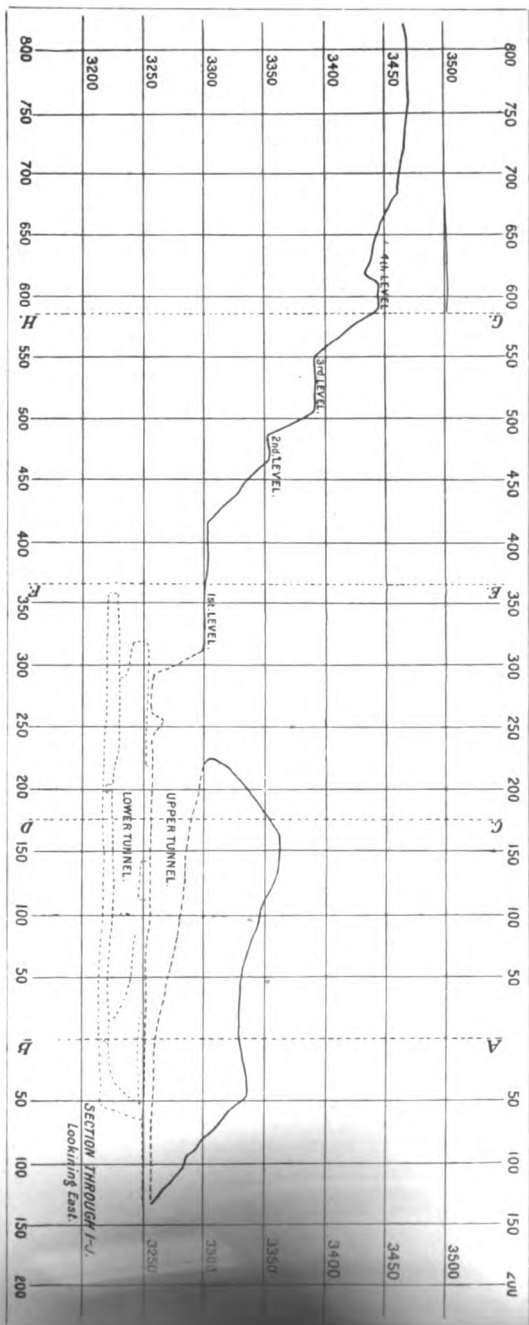
Referring to Plates XVII, XVIII, and XIX, the lowest workings are in the lower tunnel, which enters the hill at an elevation of 3210 feet (25 feet above the level of Cranberry creek), crosscutting the ore deposit in a direction S. 72° W.; its length is 405 feet along the line A-B; at its face a horizontal bore hole has been driven 142 feet and 3 inches in the same direction, being in ore ground all the way, and proving a dip of about 45° S. W. The horizontal and vertical extent of the lower workings will be seen by careful study of the plates. They open into the upper tunnel workings near the intersection of the lines I-J and C-D, at an elevation of 3250 feet.

The upper tunnel enters the hill at right angles to the lower tunnel, at an elevation of 3250 feet (55 feet above the level of Cranberry creek). It extends 430 feet in a direction N. 12° W., along the line I-J, and opens into the first level open workings at an elevation of 3300 feet. (See Plate XVII.)

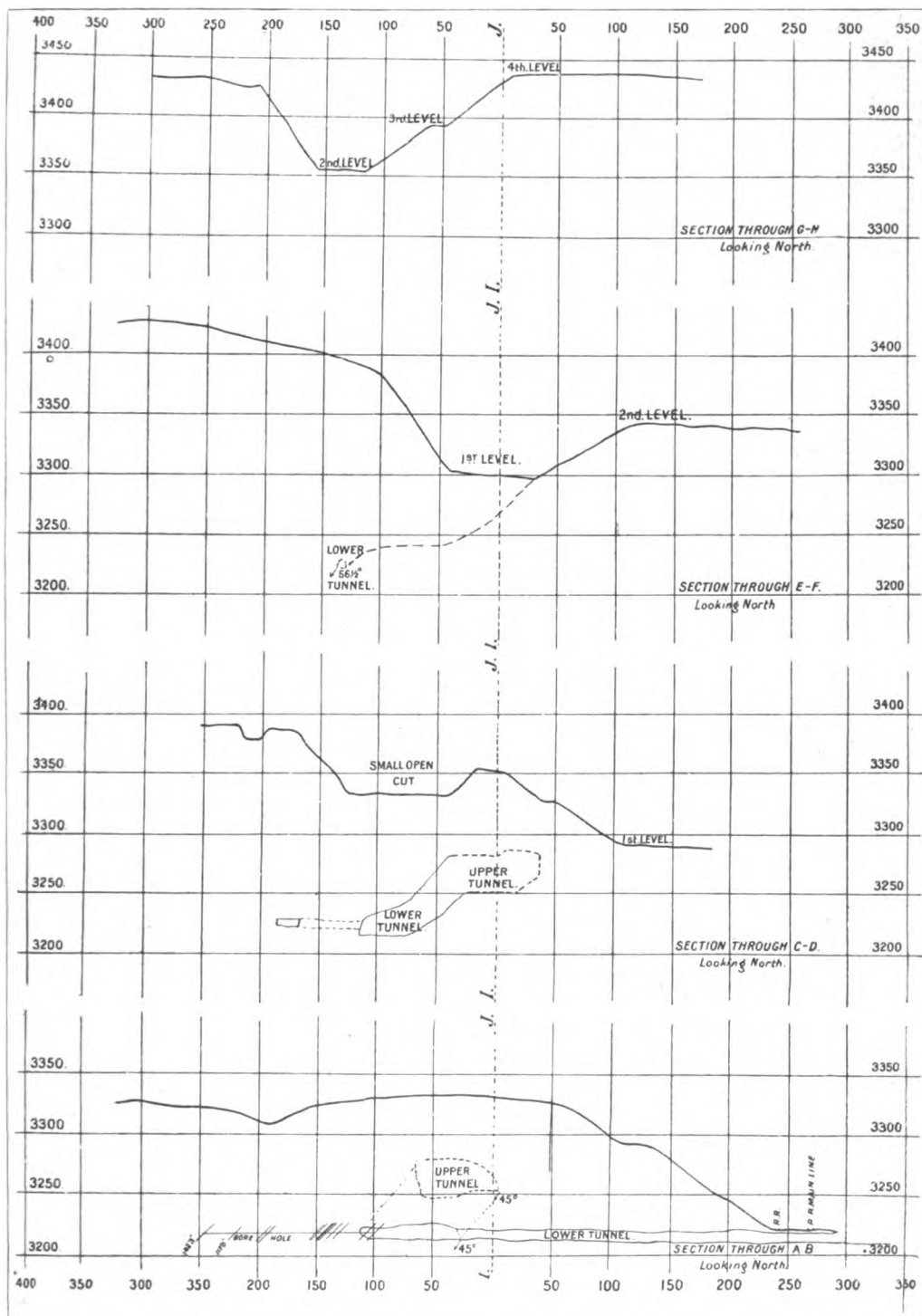
The first, second, third and fourth level open workings enter the eastern side of the hill at the elevations 3293, 3343, 3384, and 3441 feet respectively, the highest point in the upper cut being 3485 feet (300 feet above the level of Cranberry creek and 275 feet above the level of the lower tunnel).

There are several smaller open cuts on the southern and western faces of the hill, above the tunnel workings. The accompanying plates will explain themselves without further detailed description.

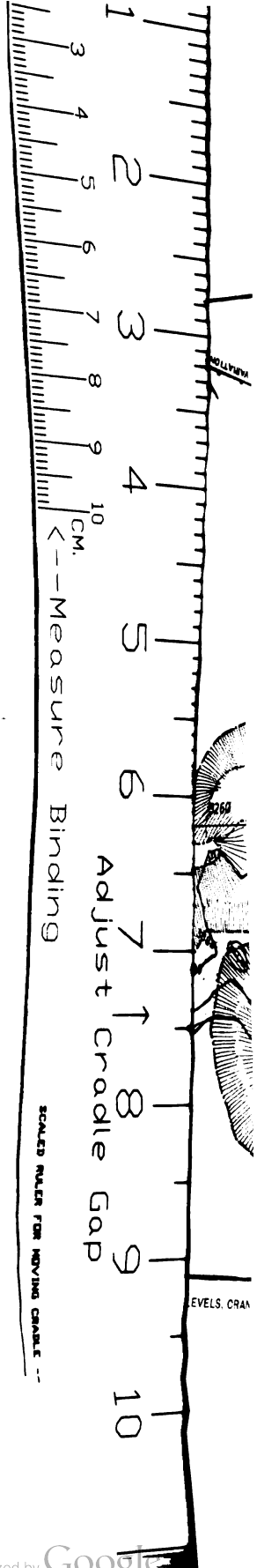
In short, the ore body has been explored and opened up in the main workings 875 feet in length by 300 feet in breadth by 275 feet maximum depth (about 165 feet average depth), representing approximately 1,600,000 cubic yards. Assuming that the gangue and ore are equally divided, half and half, and taking the specific gravity of magnetite at 5.1 and of the gangue at 3.0, this volume would contain 4,800,000 tons (gross) of ore material, of which over 3,000,000 tons are pure ore.

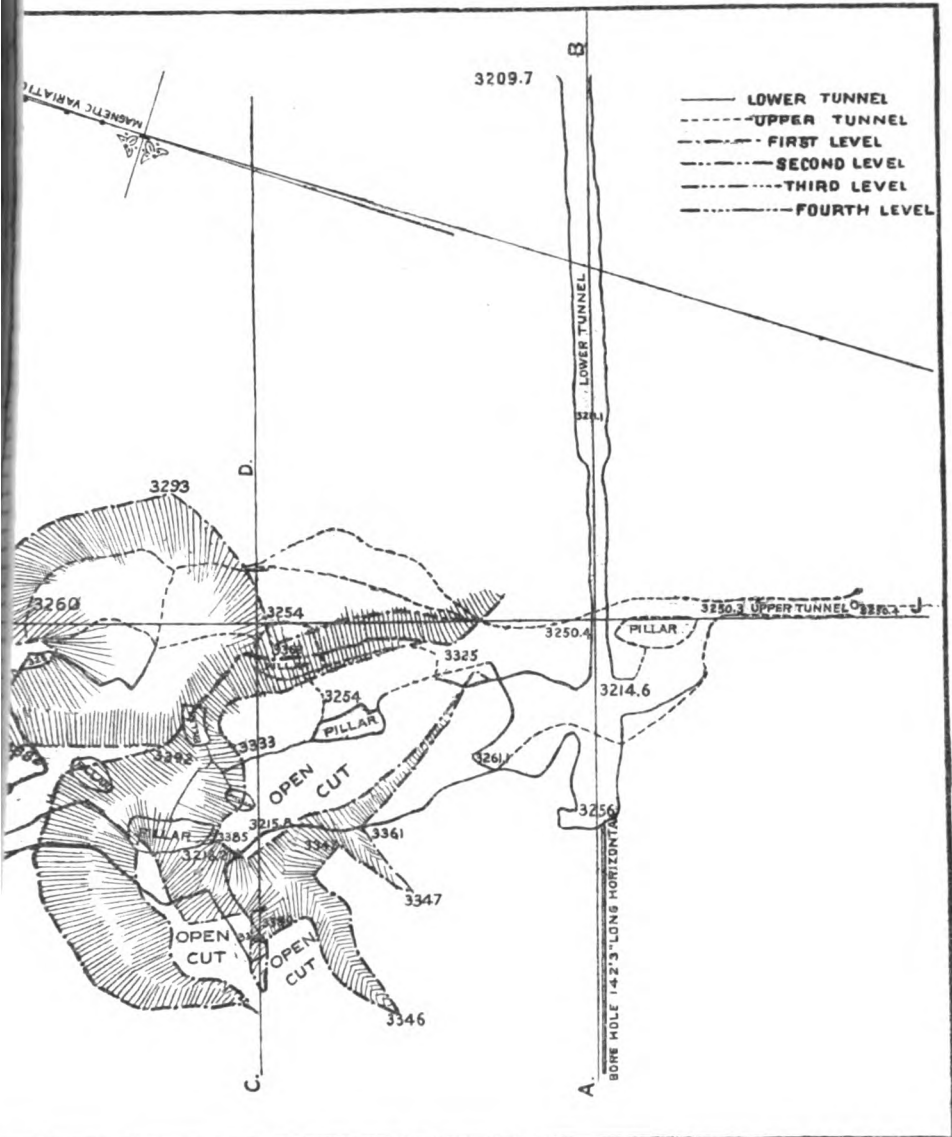


CRANBERRY MINE, VERTICAL SECTION THROUGH I-J OF PLATE XIX.



CRANBERRY MINE, VERTICAL SECTIONS THROUGH G-H, E-F, C-D, AND A-B OF PLATE XIX.





EVELS, CRANBERRY MINE, MITCHELL COUNTY.

Since 1884, 202,850 tons of marketable ore (averaging probably from 40 to 50 per cent metallic iron) have been mined here, which, on the above assumption (and estimating the waste to be about the same), would leave 4,394,300 tons of ore material in sight at present. It is not intended to make this an absolute estimate, but it is supposed to be

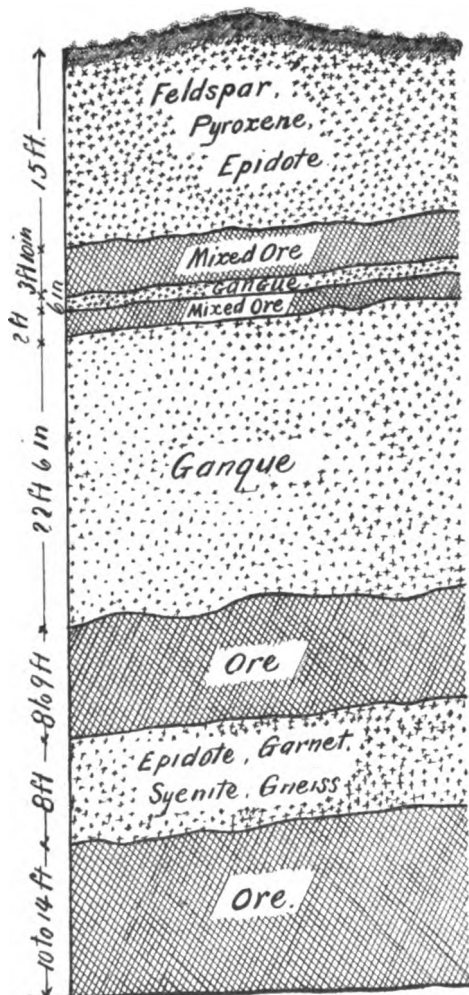


Fig. 41.—Showing relation of ore and gangue rock, Cranberry mine.

approximate and conservatively safe; nor does it take in the entire area explored on the Cranberry Iron and Coal Company's property, for, by reference to Plate XVI it will be seen that the outcrop has been opened by pits on Little Fork mountain, 950 feet S. 36° E. from the mouth of the upper tunnel, and on Cranberry ridge, 450 feet N. 33° W. from the upper end of the fourth level open-cut, and even beyond this to the

Tennessee line, but present developments do not furnish sufficient data on which to base an estimate.

Mineralogically the ore is classified as magnetite; it varies in character from very fine-grained, dense, massive, to soft, coarse-granular (known by the miners as "rattlesnake" ore, from the diamond-shaped markings of the coarse-granular accretions). As already mentioned, it is distributed in irregular masses through the gangue, and even intimately associated with the same in thin bands. In fact the deposit may be considered as one vast body of ore and rock, with the ore promiscuously distributed through the rock in greater or less purity, but usually partaking of the form of lenses and bands in the same. The thickness and extent of these bands are variable, from a few inches to fifty feet and more. Thus, for instance, an approximate section at the face of the first level opencut, near the waterfall, shows a total of about 27 feet of ore in bands of from 2 to 14 feet thick (fig. 41).

Another rough section of the face just above the second level tunnel opening into this same cut shows 50 feet of lean ore mixed with rock, and below that 50 feet of quite clean ore, which has been followed down still lower into the tunnel opening, developing into an immense body of very clean ore, from which a large quantity has been mined (fig. 42).

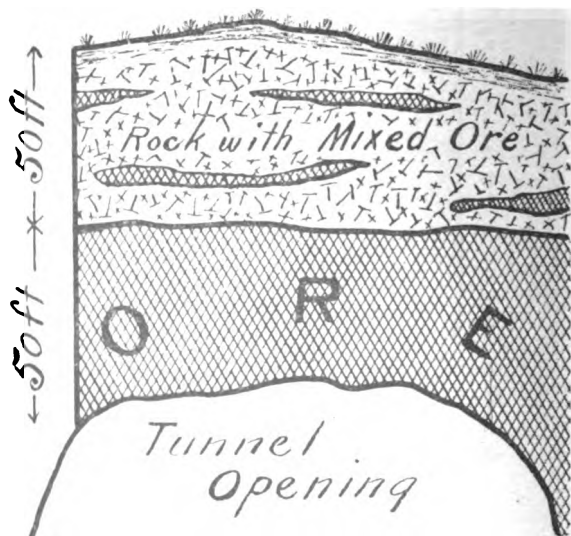
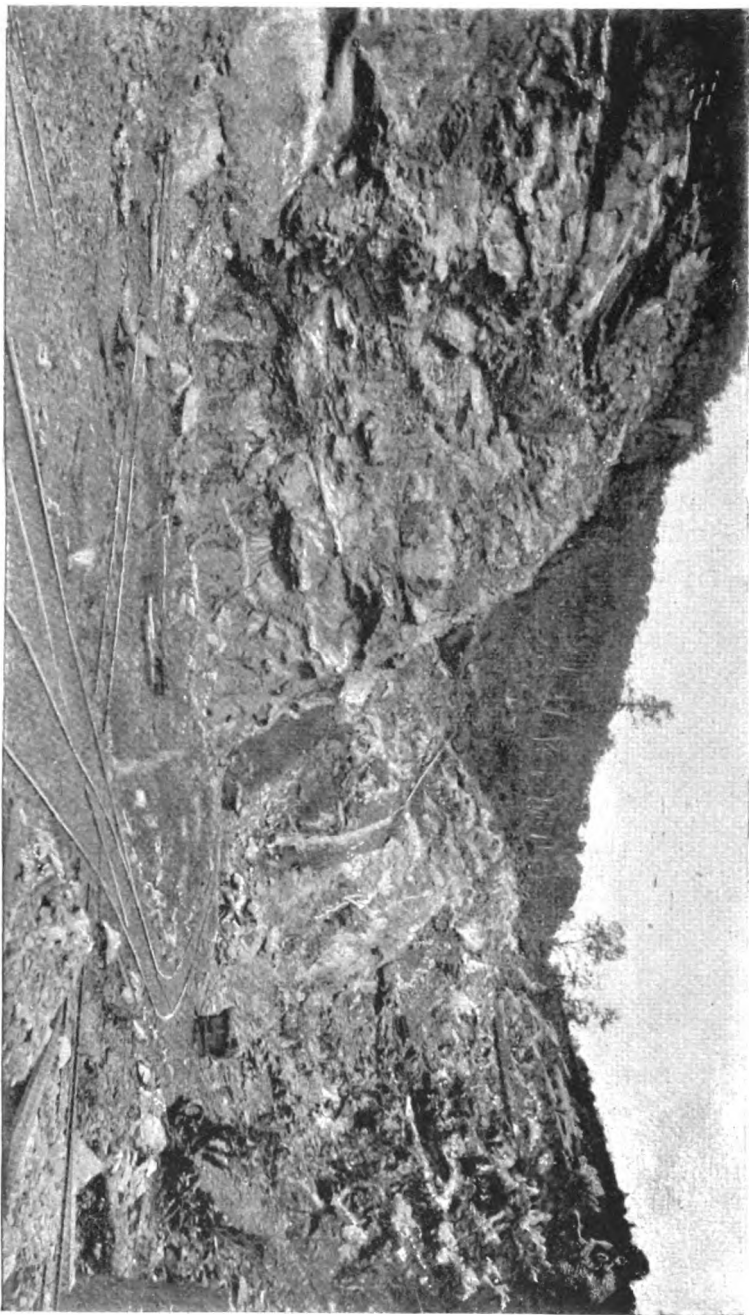


Fig. 42.—Showing relation of ore and rock, Cranberry mine.

Plate XX illustrates this part of the first level opencut in photographic view.

The gangue, or dead rock, as already mentioned, consists of hornblende, pyroxene, epidote, quartz, feldspar, calcite, garnet, allanite, zircon, serpentine; the hornblende, pyroxene and epidote predominate;



CRANBERRY IRON MINE FIRST LEVEL OPENCUT, AT TUNNEL OPENING; CRANBERRY, N. C.

calcite, quartz, feldspar and garnet are of less frequent occurrence; and allanite, zircon and serpentine are rare.

At the time the mine was last visited, in July, 1892, mining was prosecuted only in the second and third level opencuts, and in the small openings on the west flank of the hill, above the tunnel workings, the chief aim being to develop the deposit by stripping and uncovering new portions.

The output averaged about 40 tons per day, just sufficient to supply the small furnace. In mining, large masses of ore and rock are broken down by air-drilling and blasting. The dead rock and very lean ore are loaded on tram-cars, drawn by mules, and dumped over the waste piles. The remainder is counted as ore, and is conveyed by means of a long wooden chute to the ore platforms at the foot of the hill, alongside of the railroad tracks. Some of this is practically pure magnetite, much of it is fairly clean ore, and naturally much of it is lean ore in which the gangue predominates.

For shipping purposes this ore is again hand-picked, and loaded by hand and shovel on the railroad cars alongside the platforms, when it is ready for transportation to Johnson City, Tenn. Here it is discharged on platforms, and reloaded on the standard gauge cars of the East Tennessee, Virginia and Georgia railroad, all by hand and shovel.

The average cost of mining and putting f. o. b. railroad cars at the mine is estimated at \$1.20 a ton; the average miner's wages are 80 cents per day; the average value of the shipping ore at the mine is \$1.40 per ton; freight to Johnson City, Tenn., from mine is 70 cents per ton.

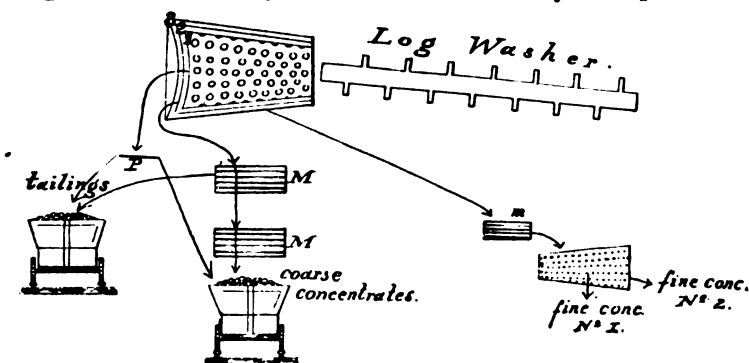


Fig. 43.—Showing method of magnetic concentration, Cranberry mine.

At present, all ore going to the furnace is treated by *magnetic concentration* without previous hand-picking; and the waste-piles, which have accumulated in large quantity during the past years, are now being culled over and similarly treated.

For this purpose the ore is loaded from the platforms at the base of the hill on the railroad cars, which are shifted to the crusher; in a

similar way the lean ore from the waste-piles is transferred to the crusher. The material is there unloaded and fed by hand and shovel into a Blake crusher, run by steam; it is reduced to a two-inch size, and discharged directly into tram-cars which run to the concentrator (see Plate XVI). The concentrating plant consists of a three-story mill, the general arrangement of which is shown in Fig. 43.

The material is fed by a hopper into a log washer (improved pattern, steel shaft and teeth), at the upper end of which it discharges into triple cylinder revolving screens, perforated with circular holes:

- No. 1, inside cylinder; diameter of holes . . . 2 inches.
- No. 2, middle cylinder; diameter of holes . . . 1½ inches.
- No. 3, outside cylinder; diameter of holes . . . ¼ inch.

The material that passes over the two-inch screen goes to a picking table (P) where it is hand-sorted, the ore and deads being separated and going to the respective cars as shown.

That passing over the 1½ and ¼-inch holes goes to a double set of revolving magnets (MM) of the Venström pattern, placed under each other, and fed with fine sprays of water.

The coarse concentrates (from ¼ to 2-inch size) from these magnets drop into the ore car placed immediately below, while the deads or tailings are carried off on a conveyor belt to another car as shown.

All that passes through the ¼-inch holes of the outside cylinder is washed by a stream of water to a separate revolving magnet (m), of a pattern designed and put up by the company, the concentrates from which pass through a revolving screen of 10 meshes to the square inch, and are separated into two sizes, fine concentrates No. 1, passing over, and fine concentrates No. 2, passing through the screen.

The cost of magnetic concentration is put at about 40 cents per ton of concentrates, exclusive of the cost of running and maintenance of the dynamo.

The coarse concentrates are separated into two sizes in the stock-house by passing over ½-inch iron screen bars. The fine concentrates are dried by exposure to the air in open bins.

A series of analyses of the various ore products and concentrates are given in the following tables:

ANALYSES OF RUN OF MINE ORE. CRANBERRY MINE, MITCHELL COUNTY.

	(292)	(293)	(294)	(295)	(298)	(311)	(312)
Silica	26.64	23.73	25.96	35.48	20.97	....	30.10
Metallic iron	42.78	45.90	44.19	34.02	45.93	44.29	32.49
Metallic manganese....	0.51	0.44	0.40	....	0.31	....	....
Lime	10.80	9.69	10.62	....	10.10	....	11.37
Magnesia	1.85	1.51	1.67	....	1.43	....	1.78
Sulphur	0.023	0.012	0.041	0.047	0.020	0.129	0.128
Phosphorus	0.0064	0.007	0.008	0.013	trace.	0.007	0.010
Phosphorus ratio	0.015	0.015	0.018	0.039	trace	0.016	0.031

Nos. 292, 293, 294, 298, and 311 are fair representations of the run of mine ore, as prepared for shipment. No. 295 was taken from the discharge of the crusher in July, 1892, and represents an average of the material that went to the concentrator. The high silica and low iron are due to the fact that a considerable proportion of very lean ore from the waste-piles was being worked over. No. 312 is a mixture of ore and epidote, and is below the average.

The amount of lime and magnesia in this ore, averaging over 12 per cent, makes it almost self-fluxing.

The uniformly low percentage of phosphorus, averaging less than 0.01%, is noticeable, and it is here that the value of the Cranberry ore lies.

To show its purity, some analyses of selected ore are given:

ANALYSES OF SELECTED ORE, CRANBERRY MINE, MITCHELL COUNTY.

	(310)	(313)	(314)	(315)	(316)	(317)
Silica	5.29	4.16	5.74	11.48	9.08	4.02
Metallic iron	64.87	68.34	66.22	61.98	58.49	66.53
Lime	1.47	0.43	1.01	0.72	....	1.06
Magnesia .....	....	0.36	0.53	0.33	....	0.23
Sulphur	0.115	....	....	....	....	0.25
Phosphorus	0.004	....	....	....	....	trace.
Titanic acid	0.950	....	....	....	....	....
Phosphorus ratio	0.006	....	....	....	....	trace.

The following analyses show the character of the concentrator products:

ANALYSES OF COARSE CONCENTRATES FROM VENSTRÖM MACHINE, CRANBERRY.

	(299)	(304)	(305)
Silica	23.91	17.12	19.92
Metallic iron	48.84	53.44	50.27
Metallic manganese .....	....	0.39	0.35
Lime .....	....	6.17	7.52
Magnesia .....	....	1.09	1.34
Alumina .....	....	1.06	1.73
Sulphur	0.018	0.031	0.009
Phosphorus	0.018	0.0076	0.007
Phosphorus ratio	0.037	0.015	0.013

No. 299 was sampled in July, 1892, when the machine was treating ore No. 295, mixture of run of mine and waste material, which accounts for the low grade of the product, as compared with Nos. 304 and 305, which were sampled in September, 1890, and July, 1891, respectively.

The composition of the tailings from No. 299 is shown by the following analysis:

ANALYSIS OF TAILINGS FROM NO. 299, CRANBERRY ORE, MITCHELL COUNTY.

	(300)
Silica	37.98
Metallic iron	31.37
Sulphur	0.003
Phosphorus	0.034



An average analysis of the fine concentrates taken from the new machine, April 5, 1892, shows:

AVERAGE ANALYSIS OF FINE CONCENTRATES, CRANBERRY, MITCHELL COUNTY.

	(306)
Silica	8.33
Metallic iron	63.41
Metallic manganese	0.24
Alumina	0.41
Lime	3.12
Magnesia	0.40
Sulphur	0.045
Phosphorus	0.004
Phosphorus ratio	0.006

Other analyses show:

ANALYSES OF FINE CONCENTRATES AND TAILINGS, CRANBERRY MINE, MITCHELL COUNTY.

No.	CHARACTER.	Silica.	Metallic Iron.	Sulphur.	Phosphorus.	Phosphorus Ratio.
301	Fine concentrates, passing over 10 mesh screen, July, 1892	22.22	47.36	0.036	0.011	0.023
302	Fine concentrates, passing through 10 mesh screen, July, 1892	4.17	67.20	0.036	0.006	0.008
303	Tailings from above	36.44	31.67	0.090	0.032	.....
307	Fine concentrates, passing over 10 mesh screen, April 4, 1892 .....	.....	56.09	.....	0.006	0.010
308	Fine concentrates, passing through 10 mesh screen, April 4, 1892 .....	.....	67.57	.....	0.004	0.006
309	Tailings from above .....	.....	23.63	.....	0.011	.....

The variation in these analyses, especially noticeable in the tailings, can be explained as in the other cases; the first three samples being taken when the mill was running on a mixture of ore and waste-pile material, and the latter when running on run of mine alone.

No steady product has yet been arrived at; it might be said that the process is still in an experimental stage, although so far as improving the ores is concerned, it has certainly proven successful, and it is believed that still better work can be done.

Analyses of the ore as it is finally prepared for the furnace, after being separated into two sizes in the stock-house, show:

ANALYSES OF FURNACE ORE FROM STOCK-HOUSE, CRANBERRY, MITCHELL COUNTY.

	(296)	(297)
Silica	29.96	26.90
Metallic iron	40.85	44.00
Sulphur	0.010	0.008
Phosphorus	0.026	0.019
Phosphorus ratio	0.063	0.013

No. 296, passed over $\frac{7}{8}$ -inch screen bars.

No. 297, passed through $\frac{7}{8}$ -inch screen bars.

The proportion of coarse and fine concentrates in the furnace charge varies. Only very little of the fine ore can be used; it is finding an excellent and ready market, however, for use as fix in puddling furnaces, and commands a good price.

The usual furnace charge consists of two parts of lump (passing over $\frac{3}{8}$ -inch screen-bars), one of screen ore (passing through $\frac{3}{8}$ -inch bars), and one of No. 1 fine concentrates; or two of lump, two of screened ore, and one of No. 2 fine concentrates.

The proportionate charge of ore, fuel and limestone to the ton of iron produced was, for one week's run in June, 1892, ore 2 tons, coke 1.09 tons, limestone 1.02 tons. Limestone is brought from Watauga Point, Carter county, Tenn., and shows the following composition:

ANALYSIS OF MAGNESIAN LIMESTONE FROM WATAUGA POINT, TENNESSEE, USED IN CRANBERRY FURNACE.

	(420)
Insoluble residue	2.36
Oxides of iron and aluminum.....	1.12
Lime	31.74
Sulphur	0.014
Magnesia	15.97
Phosphorus	0.082

Until the last few years the furnace was run on charcoal; at present coke is brought from Pocahontas, Va., at a cost of \$3.20 per ton, delivered at Johnson City, and shows the following composition:

ANALYSIS OF COKE FROM POCAHONTAS, VA., USED IN CRANBERRY FURNACE.

	(421)
Water	0.60
Fixed carbon	92.78
Ash	6.04
Sulphur	0.54
Phosphorus	0.006

The temperature of the blast is 800°; average pressure 2 $\frac{3}{4}$ lbs. The furnace is tapped every six hours, running from 3 $\frac{1}{2}$ to 4 tons of pig iron. The cinder shows the following composition (sampled July 22, 1892):

ANALYSIS OF CINDER. CRANBERRY FURNACE, MITCHELL COUNTY.

	(418)
Silica	40.08
Oxides of iron and aluminum.....	10.98
Lime	36.05
Magnesia	12.85

The pig iron produced is of a special Bessemer grade, averaging less than 1.00% silicon and less than 0.025% phosphorus.

A series of daily analyses of a month's run during May and June, 1892, made by Mr. Porter W. Shimer, for the company:

ANALYSES OF PIG IRON (CRANBERRY FURNACE).

Analysis No.	Date, 1892.	Character.	Silicon.	Phosphorus.	Sulphur.	Analysis No.	Date, 1892.	Character.	Silicon.	Phosphorus.	Sulphur.
422	May 12	No. 1	0.692	0.021	0.022	438	May 28	No. 1	0.753	0.022	0.018
423	" 13	" 1	0.433	"	"	439	" 29	" 1	0.479	"	"
424	" 14	" 1	0.428	0.022	0.041	440	" 30	" 2	0.503	0.021	0.061
425	" 15	" 2	0.319	"	"	441	" 31	Mottled.	0.396	"	"
426	" 16	" 2	0.386	0.024	0.065	442	June 1	No. 1	0.883	"	"
427	" 17	" 1	0.538	"	"	443	" 2	" 1	0.486	0.022	0.040
428	" 18	" 1	0.698	0.021	0.022	444	" 3	" 2	0.753	"	"
429	" 19	" 2	0.502	"	"	445	" 4	Gray Forge.	0.410	0.022	0.038
430	" 20	" 1	0.763	0.023	0.029	446	" 5	No. 2	0.670	"	"
431	" 21	" 1	0.705	"	"	447	" 6	Gray Forge.	0.396	0.021	0.066
432	" 22	" 1	1.070	0.024	0.036	448	" 7	No. 2	0.623	"	"
433	" 23	" 1	1.01	"	"	449	" 8	" 2	0.515	0.022	0.064
434	" 24	" 2	0.622	0.022	0.044	450	" 9	" 2	0.796	"	"
435	" 25	" 2	0.965	"	"	451	" 10	" 2	0.651	0.022	0.067
436	" 26	" 1	0.599	0.024	0.030	452	" 11	" 2	0.586	"	"
437	" 27	Mottled.	0.354	"	"	453	" 12	" 1	0.746	0.030	0.029

This iron is valued at \$16.00 per ton at the furnace, and is shipped to furnaces and steel works in Ohio, Pittsburgh, Pa., Bethlehem, Pa., etc. Much of it is used in the manufacture of crucible tool steel.

The annual production of ore and pig iron (since 1884) at the Cranberry mines and furnace, is tabulated below:

ANNUAL PRODUCTION OF IRON ORE AT THE CRANBERRY MINE, MITCHELL COUNTY, IN GROSS TONS (2240 LBS.)

1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
3,998	17,839	24,106	45,032	15,705	19,819	30,290	27,628	18,433

These figures show notable fluctuations, due to the condition of the market and the varying demand for the ore. From 1884 to 1888 there was a rapid increase; in 1888 there was a sudden falling-off of over 65%; in 1890 it had gradually increased to nearly double the production in 1888; from 1890 to 1893 there has been a gradual decrease of nearly 40%.

Of the above amounts, the following shipments were made, chiefly to Alabama, Tennessee and Virginia furnaces:

SHIPMENTS OF IRON ORE FROM THE CRANBERRY MINE, MITCHELL COUNTY, IN GROSS TONS (2240 LBS.)

1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
				10,129	12,974	22,873	20,284	12,068
not known.								

TOTAL PRODUCTION OF PIG IRON AT THE CRANBERRY FURNACE, IN GROSS TONS.

1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
388	1598	1964	3250	2143	2587	2840	3217	2902

Similar fluctuations to those of the ore production are observed here; but the decrease in 1888 was only 34% as against 65% in the ore, due probably to the fact that the proportion of ore shipped was less, and the grade of the product higher in metallic iron; in 1890 again the increase was not commensurate with that of the ore production, probably due to reasons the reverse of the above; instead of decreasing in 1891 there was an increase of 13%, which must have been due to the higher grade of the ore product for that year, as the decrease in ore shipments is nearly proportional to that in the total ore production; in 1892 there was a slight decrease below that of 1891 in the pig iron output, but it was still above that for 1890, in contradistinction to the ore output, for similar reasons to those elucidated.

Until the year 1890 the total output of the furnace was charcoal iron; since then it has been running at intervals on coke and charcoal separately, as follows:

	1890.	1891.	1892.
Charcoal pig iron (gross tons).....	2325	467	313
Coke pig iron " "	515	2750	2589

The possibilities of the Cranberry mine as an iron-ore producer have never been fairly demonstrated. As already mentioned, the policy has been rather to develop the magnitude of the deposit by slow exploratory work, than by energetic endeavors to combine that very important feature with a larger output. There is no reason why this should not be made a large and steady producing iron ore mine. By this no reflection is intended against the present management, as there may be potent and private reasons for continuing in the present way, amongst others the present general depression in the iron industry. The company is certainly looking to the introduction of wise and beneficial improvements, such as magnetic concentration of the ore, etc. But the methods of mining, particularly in the handling of the product, are too evidently susceptible of many economic improvements by which the cost of the output should be materially reduced. Operations on a large scale will also tend to reduce this cost.

Even with the comparatively great cost of coke at the works, it seems more profitable to smelt this ore into pig-iron at the mine than to ship it for that purpose, and it is hoped that in the near future equally good coke can be had from the Big Stone Gap region in southwest Virginia, 110 miles nearer than the present supply from Pocahontas.

The Cooper Ore Bed is $\frac{1}{2}$ mile southwest of Elk Park, $1\frac{1}{2}$ miles northwest of the main Cranberry mine, and about 1 mile east of the Tennessee State line, being not over $\frac{1}{4}$ mile east of the western boundary of the

Cranberry Iron and Coal Company's property line. It consists of a large opencut, made some 8 years ago, exposing a body of ore, and mixed ore and gangue, varying in thickness, as visible at present near the outcrop, from 5 to 10 feet, with a dip of about 33° southwest; a small amount of ore was mined here and shipped to Roanoke, Va.

Adjoining the Cranberry Iron and Coal Company's property on the southwest, on a high knob, 1 mile N. 80° W. from Cranberry mine, and 1 mile S. 30° W. from Elk Park, a body of ore has been discovered and prospected on the land of *Mr. W. W. Avery*, known as the "*Crowder*" place. On the western slope of this ridge, near the summit, the outcrop was stripped for a short distance, exhibiting a backbone of ore from 1 to 2 feet in thickness; it was explored 15 feet below the surface by a short adit-level, and found to widen to 3 or 4 feet. A shaft was sunk on the ore, near the mouth of this adit-level, to the depth of 40 feet, proving an increase of thickness, but not determining the amount of the same by crosscutting.

The prospects for finding a good body of ore here are encouraging; a long adit-level at a lower elevation, so as to cut the deposit in depth, is recommended. The ore resembles that of the Cranberry mine in every particular. The strike is northwest and southeast, and the dip nearly vertical.

In Tennessee the formation crosses Shell, Hampton, etc., creeks and the Doe river, continuing to the head of Tiger creek, a distance of some 11½ miles, over which it has been extensively explored.

It recrosses the State line into North Carolina near the head of Greasy creek on the property of the *Roan Mountain Iron and Steel Company*, which owns 65,000 acres of land in fee simple and mineral rights in this part of Mitchell county, the northern and western boundaries being the State line, the southern boundary the Toe river, and the eastern a straight line extending S. 17° W. from the Cloudland Hotel on the summit of Roan High Knob to the Toe river. The ore has been only slightly developed over this area.

IRON MOUNTAIN ORE BEDS.—*The Jenkins Ore Bank* is situated on one of the southern spurs of Iron mountain, 2½ miles above the mouth of Greasy creek, and one mile south of the Tennessee State line.

It is a large opencut, 130 feet above the creek level, over 100 feet long on the strike of the ore, and was formerly worked for the Wilder forge¹ at Magnetic City.

The ore body is reported as being 18 feet thick, but cannot now be seen in place. The gangue is hornblende, pyroxene, epidote, quartz, feldspar, etc., closely resembling that of the Cranberry ore.

¹ *Wilder's Forge*, situated at Magnetic City, on Big Rock creek; built in 1875; abandoned in 1881; had three fires and one hammer; manufactured bar iron, wagon tires, etc., for local use.

The strike of the country rock, pegmatite and hornblende gneiss, is N. 55° E.; dip 45° S. E. An analysis of this ore, taken from the United States Tenth Census Report, Vol. XV, p. 560, shows:

ANALYSIS OF MAGNETITE, JENKINS ORE BANK, IRON MOUNTAIN,
MITCHELL COUNTY.

	(324)
Metallic iron	63.41
Phosphorus	0.012
Phosphorus ratio	0.019

There are several smaller openings on the hillside above here:

Opening No. 1, 350 feet above the creek level, shows a very compact, lustrous ore, free from gangue, apparently a different bed from the Jenkins, as shown by its titaniferous quality and the absence of hornblende gangue. The thickness of the ore body is reported to be 5½ feet, but it cannot be seen in place.

Opening No. 2 is near the summit of the ridge, over 300 feet above the creek level. A bed of ore is exposed here, starting in a stringer less than 1 foot thick near the surface and widening to 5½ feet at the bottom of the cut; in the upper part the ore has small quartz grains porphyritically enclosed, but lower down it is free from this admixture, being very pure, homogeneous and highly magnetic, resembling the ore at No. 2. The wall rock is hornblende gneiss and pegmatite. The following analysis represents an average sample taken from Nos. 2 and 3:

ANALYSIS OF TITANIFEROUS MAGNETITE, IRON MOUNTAIN,
MITCHELL COUNTY.

	(323)
Silica	6.58
Metallic iron	54.48
Sulphur	0.023
Phosphorus	0.033
Titanic acid	4.96
Phosphorus ratio	0.060

Similar float ore is traced across the summit and opposite slope of this ridge; to the south the country rock is cut by a diabase trap-dike.

The general Cranberry belt, of hornblende-epidote magnetite ore, has been traced in a course approximating S. 50° to 55° W., from the Jenkins bank to the Toe river, a distance of 8½ miles (air line). Among other places the outcrop was seen on Bad creek, 2½ miles above its mouth, on the land of *Charles Garland*; also 1 mile northeast from here on the waters of Bean creek, where a body of mixed ore and hornblende has been exposed by an opening, over an area reported to be 12 by 15 feet; also 1 mile southwest of Bad creek, on the headwaters of Brummit's creek, 2 miles above its mouth near Peterson's mill, where the outcrop is fully 30 feet across, in a massive bluff, but it is very lean; its strike is N. 55° E.; dip S. E.

About 2 miles southwest from here, and $\frac{1}{2}$ mile below the mouth of Pigeon Roost creek on the northeastern side of Toe river, the outcrop is discovered on the *Elisha Street* place.

Yancey county lies on the south side of Toe river, and the course of the magnetic belt should be up Caney river and across the Sampson mountains into Madison county; but no notable outcrops have been discovered until reaching the *Big Ivy Mine* in Madison county, which is some 25 miles S. 50° E. from the mouth of Pigeon Roost creek, in Mitchell county.

3. THE ROAN MOUNTAIN TITANIFEROUS MAGNETITE BELT lies from 3 to 5 miles to the south of the Cranberry belt and generally parallel to it. Its eastern extremity, so far as at present known, is found near the mouth of Roaring creek, on one of the southern spurs of the Big Yellow mountain, 7 miles (air line) west of south from Cranberry, where some shallow openings on the lands of the *Toe River Land and Mining Company* show small streaks or seams of magnetite not over 2 inches thick in an altered chrysolitic rock, partly asbestos; but no beds of any consequence have been discovered, and it is very doubtful if such exist.

On the southern slope of Big Yellow mountain, near the head of Old Cabin branch, a northern tributary of Roaring creek, 2 miles above its mouth, a deposit of titaniferous magnetic ore has been explored on the land of *Mr. W. W. Avery*. The country rock is a very coarse-grained pegmatite, hornblende schist, epidote, and garnet rock, dipping towards the northeast. The ore is a highly lustrous, titaniferous magnetite, compact, homogeneous and free from gangue. It occurs in thin, irregular seams or lenses from 2 inches to 2 feet in thickness, and has been taken out in a small opencut for a distance of 40 feet along the dip, so that none is now visible in place. Three 1-inch diamond drill holes were bored into the face of the opencut, at slight inclinations downward from the horizontal, for a distance of about 50 feet; one of them in the direction of the dip, the other two at right angles to the same, but the results obtained are reported as having been discouraging; all present indications are certainly not in favor of finding a good body of ore, besides which its titaniferous character practically condemns it, as shown by the following analyses:

ANALYSES OF TITANIFEROUS MAGNETITE, AVERY PLACE, BIG YELLOW MOUNTAIN, MITCHELL COUNTY.

	(318)	(319)
Silica	1.46	0.54
Metallic iron	65.32	66.95
Sulphur	0.025	none.
Phosphorus	0.009	0.015
Titanic acid	4.80	6.80
Phosphorus ratio	0.013	0.022

Northwest from here the ore belt crosses the State line on the summit of Grassy Bald ridge, nearly 6,000 feet above the sea level, where several small outcrops have been discovered, but never developed; the ore occurs in small nodules from the size of a hazelnut to the size of a fist, with a gangue of biotite, quartz and feldspar in a country rock of hornblende schist. The belt traverses the edge of Tennessee for a distance of about 4 miles, bending gradually towards the southwest and crossing into North Carolina near the headwaters of Big Rock creek on the property of the *Roan Mountain Iron and Steel Company*; thence it continues in a general southwesterly direction across the Roan High Bluff and Fork mountain, and along the waters of Big Rock creek, to the Yancey county line at Toe river, a distance of about $9\frac{1}{2}$ miles; the total length of the belt so far as known, from the mouth of Roaring creek to the mouth of Big Rock creek, being some 17 miles. No discoveries of ore that can be identified as belonging to this zone have been made south of the Toe river in Yancey county.

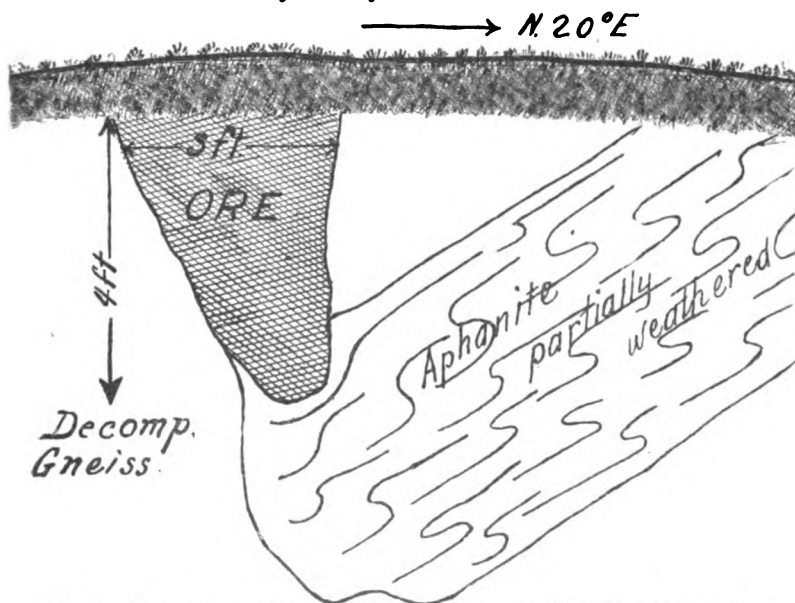


Fig. 44.—Showing relation of ore body and trap-dike, Joel Gouge place.

Some slight developments have been made along its line of outcrop in Mitchell county, notably:

On the north side of Little Rock creek, $\frac{1}{2}$ mile above its confluence with Big Rock creek, on the land of *Joel Gouge*, where a small pit from 5 to 3 feet deep exposes a lens of ore 3 feet across at the surface, which at a depth of 4 feet is cut out entirely by a diabasic trap-dike; and it may be mentioned that this trap-dike accompanies the formation from here on to the Toe river.

The ore is very homogeneous and of a dark red color, being but slightly magnetic (probably altered by the heat of the trap-dike). The strike of the gneissoid country rock is N. 40° E.; dip S. E. An analysis of this ore shows:

ANALYSIS OF TITANIFEROUS MAGNETITE, JOEL GOUGE, MITCHELL COUNTY.

	(322)
Silica	1.13
Metallic iron	64.56
Sulphur	0.027
Phosphorus	0.078
Titanic acid	4.48
Phosphorus ratio	0.120

One mile southwest from Joel Gouge's, on the east side of Big Rock creek, on the land of *John Feltz*, is a deep washout extending from the summit of a high ridge down the western slope of the same, exposing a heavy bed of hornblende, feldspar and quartz, cut by a trap-dike and baked to a brownish black color by the same; this has been erroneously taken for ore.

On Popper's creek, $\frac{1}{2}$ mile above Big Rock creek and 2 miles southwest of Gouge's, on the land of *James Harrell*, an ore bed was worked some 10 years ago for the *Wilder forge* at Magnetic City. The old diggings are now overgrown and the ore cannot be seen in place; it is reported to be from 6 to 8 feet thick. Some surface specimens show it to be compact and free from gangue, similar to the Gouge ore, though black in color and more highly magnetic.

Some 3 miles southwest from Harrell's, $\frac{1}{2}$ mile above the mouth of Big Rock creek, on the summit of a ridge, near the Babersville road, an outcrop has been exposed by a small pit on the land of *Iris Hughes*; it measures 2 to 3 feet in thickness as far as exposed, of coarse-granular ore, a gray gangue, the strike is N. 40° E.; dip S. E.

ON THE LOCATION OF THE IRON ORE IN THE MOUNTAINS MAGNETITE BELT.

On the east side of the *Wilder branch*, 2 miles slightly north of the *Wilder forge*, on the land of *Wadkins branch*, a small outcrop of ore has been exposed, the ore is compact and free from gangue, the strike is N. 40° E.; dip S. E. Some small pits have been dug, but no ore has been found, but scarcely penetrating the surface of the ore has yet been found. The ore is reported to be of the same quality as the Gouge ore.

ANALYSIS OF TITANIFEROUS MAGNETITE, PUMPKIN PATCH MOUNTAIN.

	(321)
Silica	1.22
Metallic iron	57.98
Sulphur	0.015
Phosphorus	0.041
Titanic acid	4.56
Phosphorus ratio	0.070

Similar traces of float ore have been found along the southern slope of this mountain range, in a westerly direction for 4 miles to Red Hill, and in an easterly direction for $1\frac{1}{2}$ miles, but no developments have been made.

An occurrence of magnetite ore is reported near the headwaters of Little Rock creek, on Little Yellow mountain, on the land of *Maj. J. W. Wilson*, but no developments have been made. An analysis of a surface sample shows its quality to be good, free from titanic acid, but above the Bessemer limit in phosphorus.

ANALYSIS OF MAGNETITE ORE, MAJOR J. W. WILSON, MITCHELL COUNTY.

	(321a)
Metallic iron	55.06
Sulphur	0.103
Phosphorus	0.078
Titanic acid	none.
Phosphorus ratio	0.141

An isolated occurrence of red hematite was examined on Long Level ridge, one of the northwestern spurs of the Cane Creek mountains, on

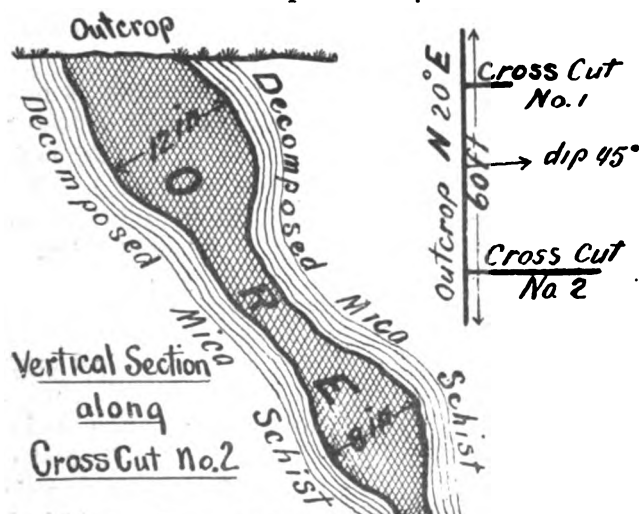


Fig. 45.—Showing the ore body, John Justice place, Mitchell county.

the land of *John Justice*, $\frac{1}{2}$ mile south of Henson's creek, at a point about 1 mile above its mouth. The outcrop is situated on the slope of the

ridge 300 feet in elevation above the level of a small branch, and has been stripped along the strike, N. 20° E., by a shallow cut 60 feet long; at two points crosscuts have been made at right angles to the strike, in the larger one of which (No. 2) the ore body measures 1 foot in thickness near the surface, but it pinches out to 8 inches at the bottom. No. 1 is too incomplete to furnish any data.

This ore is a compact red hematite; the wall rock is mica-schist. Although the ore is of very superior quality, as shown by the following analysis, the prospects for finding a workable deposit are not encouraging.

ANALYSIS OF RED HEMATITE, JUSTICE PLACE, HENSON'S CREEK,
MITCHELL COUNTY.

	(320)
Silica	6.38
Metallic iron	63.84
Sulphur	0.015
Phosphorus	0.044
Phosphorus ratio	2.389

Sporadic occurrences of brown hematite and manganese ore have been noted in Mitchell county; such are, for instance, a bed of brown hematite 3 miles south of Bakersville on the land of *James Turner*, and a bed of limonite and wad (soft manganese ore) just west of Crabtree creek, near its junction with the North Toe river; but no developments have shown these deposits to be of any extent, and they are in all probability superficial secondary formations, which cannot claim much attention.

Extensive bodies of brown hematite are reported as occurring on the southwestern slope of the Unaka mountains, on the waters of Hollow Poplar creek, near the Tennessee State line. Although no examination was made of this locality, it is believed from their geographical position and from specimens examined that they belong to the true brown hematite formation and are worthy of investigation.

6. THE ORES OF YANCEY COUNTY.

The absence of any notable outcrops of the principal magnetic beds in Yancey county has already been noted (pp. 182 and 183).

In the extreme western part of the county, near the head of Pineson Port creek, 9 miles west from Bakersville, about $\frac{1}{2}$ mile east of Moore's Gap, where it is on the Madison county boundary line, magnetic float ore is found on the land of *John Ferguson*, an analysis of which shows:

(See chapter on this report)

ANALYSIS OF TITANIFEROUS MAGNETITE. JERRY FERGUSON, YANCEY COUNTY.

	(388)
Silica	23.38
Metallic iron	39.00
Titanic acid	2.56

The position of this ore and its titaniferous quality suggest a possibility of its belonging to the Roan Mountain Titaniferous Magnetic belt,¹ but this is only a supposition. Similar traces of titaniferous magnetite are found to the southwest in Madison county.²

All other occurrences of iron ore in Yancey county, known to me, are isolated and sporadic.

Six miles north of Burnsville, on the south side of Mine fork, $\frac{1}{2}$ mile above its mouth and 300 feet above the water-level of the same, a bed of titaniferous magnetite has been discovered on the land of *D. M. Hampton*. Two small openings, 75 feet apart on the strike of the ore (N. 25° E.), expose the same from 6 to 10 feet across, the dip being nearly vertical. The ore is magnetic in a gangue of chlorite, small particles of quartz and feldspar, and a peculiar brown mineral of a high luster, possibly rutile or brookite.

An analysis of this ore shows:

ANALYSIS OF TITANIFEROUS MAGNETITE. HAMPTON'S, MINE FORK, YANCEY COUNTY.

	(387)
Silica	9.25
Metallic iron	39.42
Sulphur	0.12
Phosphorus	0.011
Titanic acid	11.90
Phosphorus ratio	0.027

If it be true that the titanic acid exists as such in a separate mineral like rutile or brookite as suggested, and not in chemical combination with the iron itself, a beneficial separation of the iron from this hurtful ingredient may easily be effected by magnetic concentration; this will be a subject for important investigation, as otherwise the excessive percentage of titanic acid renders this ore practically worthless.

Southwest from these openings $\frac{1}{4}$ mile, much surface float of this heavy brown mineral, nearly free from magnetite, is found.

Brown hematite occurs as surface float from $\frac{1}{2}$ to 1 mile northeast of Burnsville on the northern slope of Green mountain, near the Bakersville road, but no developments have been made.

¹ See page 182 of this report.

² See page 189.

(c). THE MAGNETITE ORES OF MADISON COUNTY.

Only one locality of note has been discovered in this county.

THE BIG IVY OR HECK MINE is situated about 6 miles (air line) due north from Alexander's station on the W. N. C. R. R., on the south side of Big Ivy creek, 3 miles above its mouth. It is on the northern slope of a hill, the summit of which is some 285 feet above the level of Big Ivy creek. Two principal openings expose the ore bed in place, besides which there are a number of smaller pits scattered over the hillside in which the ore is reported to have been found, but which are now filled up and closed to view.

The lower opening is in the shape of a long trench across the ore body, 50 feet in elevation above a deep ravine and 150 feet above the level of Big Ivy creek, 300 yards south of the same.

A section along this cut shows as follows:

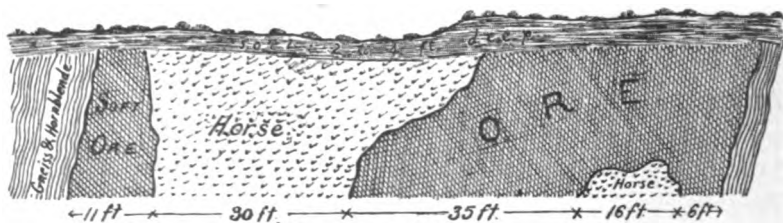


Fig. 46.—Showing ore bodies at Big Ivy mine, Madison county.

The total thickness of the ore exposed is 52 feet, separated by two "horses" or wedges of dead rock, chiefly hornblende, epidote and quartz. The larger "horse," in the eastern end of the cut, will probably be found to be of considerable extent; at the point of exposure it measures about 30 feet across, and the dipping needle held over this mass shows no local attraction.

At the western end of the cut the "horse" is of much smaller dimensions, measuring 16 feet across at its widest part. To develop this bed to the best advantage it is suggested that the cut be enlarged by starting into the hillside at a lower level and working out to the present face, increasing the depth of the same some 20 feet or more.

The ore is a hard, compact magnetite, and in the nature of its gangue (hornblende, epidote and quartz) bears a marked resemblance to that at Cranberry in Mitchell county.

At the eastern end of the cut the ore is softer and finer-grained. Some analyses of the ore from this locality show:

ANALYSES OF MAGNETITE ORE, BIG IVY MINE, MADISON COUNTY.

	(286)	(287)
Silica	15.54	....
Metallic iron	48.54	42.97
Sulphur	0.012	....
Phosphorus	0.019	0.005
Phosphorus ratio	0.039	0.012

About 200 feet N. 30° E. from the "long cut," on the opposite side of the ravine, the ore bed has been partially exposed by a small cut, and for a distance of 3 miles to the northeast, crossing Big Ivy creek, float ore has been traced to Gabriel creek, but no openings have been made.

The second opening of importance is an opencut, located several hundred feet S. 40° W. from the "long cut," and 30 feet above it in elevation. It had caved-in considerably, and the ore body was not cut through on the eastern end, but as far as exposed it measured 30 feet across. The ore is more coarse-granular than in the Long Cut, and resembles the Cranberry "rattlesnake ore."

Near the summit of the hill, 100 feet in elevation above the Long Cut, the ore body was found in place in some old pits, but these are now filled up. At this point another long cut or trench, to expose the full width of the ore body to view, is to be recommended.

In the dirt road crossing the summit of the hill, 285 feet above the level of the creek, and 140 feet above the Long Cut, the dipping needle shows considerable local attraction. The strike of the hornblende schists in the road was N. 50° E., and this may be taken as the general trend of the ore beds.

This ore deposit can be made accessible to the Western N. C. R. R. by a branch line, some 3 miles long, built up Big Ivy creek from its mouth, crossing the same about 1 mile from the mine, thus cutting off a very large bend, and crossing through the gap in the mine ridge up to the ore beds. There is a valuable water-power 2 miles above the mouth of Big Ivy creek, where a fall of from 25 to 30 feet can be had for conversion into electrical power for transmission.

Occurrences of magnetite ore have been noted in other parts of the county, but no discoveries of importance have been made.

In the eastern part, on the waters of Paint Fork, $\frac{1}{2}$ mile above its mouth, small pieces of surface float of a black, non-magnetic, highly lustrous ore are found on the land of *John Brigman*. Analysis No. 289 shows the presence of titaniferous acid in large quantities. The occurrence of a very highly titaniferous ore is noted near the public road, midway between Asheville and Burnsville,¹ an analysis of which shows:

¹ "Ores of North Carolina," p. 181.

ANALYSIS OF TITANIFEROUS ORE, ASHEVILLE-BURNSVILLE ROAD.
YANCEY COUNTY.

	(288)
Silica	0.83
Metallic iron	36.26
Metallic manganese	0.63
Alumina	9.51
Lime	2.57
Magnesia	0.93
Sulphur	0.09
Phosphorus	trace.
Titanic acid	37.88

About 4 miles northwest from Marshall, on Brush creek, a tributary of the French Broad river, the outcrop of a body of magnetite ore has been exposed on the *Freeman place*, $\frac{1}{4}$ mile south from the house of Joseph Ramsay and $\frac{1}{2}$ mile south from the road leading from Jewell Hill to Marshall. A small pit, 200 feet above the level of the creek, has cut the comb of an ore lens from 1 to $1\frac{1}{2}$ feet across, but it has not been exposed in depth. The country rock is a coarse hornblende gneiss.

Magnetite ore is reported to occur nearly $1\frac{1}{2}$ miles south of here, on the land of *Mrs. McDowell*, $\frac{1}{4}$ mile east of the French Broad river, at a point somewhat below the mouth of Walnut creek, but the openings that were made here are now filled up with water and closed to view.

On the northern slope of the Walnut mountains an outcrop of schistose magnetite is found on the land of *David Norton*, on Sodom creek, within $\frac{1}{2}$ mile of Big Laurel creek, at a point 6 miles above the mouth of the latter stream. The ridge is composed of a gneissoid rock, impregnated with magnetic grains; in the center of the ridge magnetite replaces most of the other rock constituents and becomes a fairly pure schistose ore; no openings have been made; indications point to the probable existence of good bedded deposits of ore, and further explorations are recommended. Similar surface ore is found on the lands of *T. T. Norton* and *Alfred McDevitt*, adjoining on the south.

In the southwestern part of the county, on the headwaters of Little creek, 2 miles from Max Patch mountain, which is the corner of Haywood and Madison counties, N. C., and Cooke county, Tenn., an outcrop of magnetite ore in a hornblendic gangue is exposed on the land of *James Henline*, by a small opencut, showing a thickness of from 4 to 5 feet; the ore shows considerable pyrites.

On the eastern slope of the New Found mountains, near the headwaters of Spring creek, $\frac{1}{2}$ mile east of the Haywood county line, a body of magnetite ore has been discovered on the land of *Swan Woody*; its thickness near the surface is from 5 to 6 feet, and it appears to widen in depth. An analysis shows its titaniferous quality:

ANALYSIS OF TITANIFEROUS MAGNETITE, SWAN WOODY'S, MADISON COUNTY.

	(291)
Silica	2.37
Metallic iron	62.16
Sulphur	0.026
Phosphorus	0.014
Titanic acid	7.44
Phosphorus ratio	0.022

(g). THE ORES OF BUNCOMBE COUNTY.

Only one locality of note has been discovered in this county.

THE BLACKWELL MINE is situated in the northwestern part of the county, 5 miles nearly due west from Alexander's station, $1\frac{1}{2}$ miles southwest from Blackwell's Springs, on a tributary of Turkey creek, less than $\frac{1}{4}$ mile from the main stream and 4 miles above its mouth.

From 40 to 50 feet above the level of the branch a small pit has been sunk in the ore body to a depth of 15 feet.

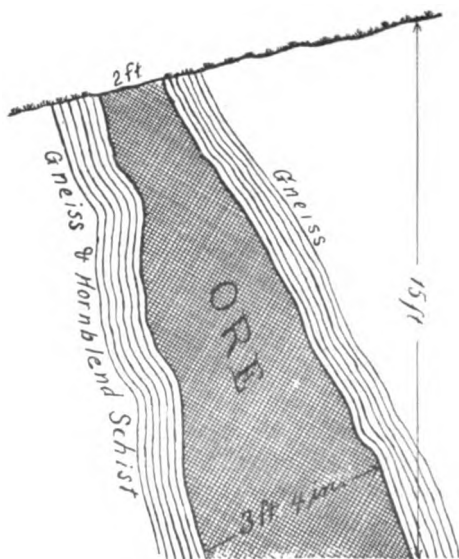


Fig. 47.—Showing ore body at the Blackwell mine, Buncombe county.

It shows a bed of compact schistose magnetite, varying in thickness from 2 feet at the surface to $3\frac{1}{2}$ feet at the bottom, between walls of gneiss, mica and hornblende schist, dipping 70° S. E.; the strike is N. 30° E.

An analysis of this ore shows:

ANALYSIS OF MAGNETITE ORE, BLACKWELL MINE, BUNCOMBE COUNTY.

	(105)
Silica	21.58
Metallic iron	47.36
Sulphur	0.10
Phosphorus	0.009
Titanic acid	0.16
Phosphorus ratio	0.145

Float ore has been traced in a southwesterly direction from here, for $1\frac{1}{2}$ miles, to near the South fork of Turkey creek. This locality could be made accessible to the Western North Carolina railroad by a branch line, $3\frac{1}{2}$ to 4 miles long, down Turkey creek.

The Blackwell mine is about 9 miles S. 50° W. from the Big Ivy mine in Madison county, and it is possible that they both belong to the same general belt.

A parallel belt of magnetite ore, lying about $\frac{1}{2}$ mile to the east of the Blackwell ore bed, has in time been superficially explored by small test pits, but these are now filled up and are closed from view. It is reported that ore was dug from some of these pits 70 years ago and hauled to South Carolina. The prospects of finding workable ore bodies here are, however, discouraging.

At Alexander station, on the south side of the French Broad river, the immense bluff of hornblende schist and gneiss which skirts along the railroad, and across which the road leading to Blackwell's Springs winds, is in many places magnetic, but no noteworthy outcrops of ore have been found.

Small beds of limonite have been noted in various parts of Buncombe county, but they are unimportant.

(h). THE TITANIFEROUS MAGNETITE, AND BROWN HEMATITE ORES OF MACON COUNTY.

There are in Macon county various occurrences of titaniferous magnetite ores which have been explored superficially only, at several points within a distance of 7 miles east and south of Franklin.

A heavy surface float of massive, highly lustrous magnetite is found on the land of *Felix Kilpatrick*, $\frac{1}{2}$ mile north of Culasagee creek, at a point about 5 miles east of Franklin.

The gangue is quartz and chlorite. This ore is traced for several hundred yards along the summit of a hill in a direction N. 35° E., which is the strike of the decomposed mica schists near the foot of the hill; but no openings have ever been made.

The following analysis shows the titaniferous quality of this ore which stamps it as valueless:

ANALYSIS OF TITANIFEROUS MAGNETITE, FELIX KILPATRICK, MACON COUNTY.

	(281)
Silica	0.77
Metallic iron	54.24
Sulphur	0.04
Phosphorus	0.013
Titanic acid	17.60
Phosphorus ratio	0.023

On the south side of Culasagee creek similar surface ore is found on the land of *Capt. T. M. Angel*.

On Ellijay creek, $1\frac{1}{2}$ miles above its mouth and 7 miles east of Franklin, an immense outcrop of magnetic rocks occurs on the land of *William Higdon*.

This rock is a hard, massive quartz of schistose structure. In places it contains considerable feldspar, becoming in fact a granulite; the more decomposable feldspar has sometimes weathered out, leaving a peculiar raised graphic surface of magnetite and quartz. It is difficult to judge what the average proportion of ore to quartz may be; possibly as high as 50%, as far as the surface samples show. However, until the deposit is actually exposed in place and further prospected in depth, no fair estimate can be made of its value. The country rock on the hillside above is gneiss and hornblende schist, strongly folded and faulted; near the foot of the hill the black mica schists strike N. 40° W.

Magnetic ore has also been found some 4 miles southwest from Higdon's, on the northeast slope of Ammon's mountain, on the land of *William Washburn*, but no developments have been made.

Specular hematite of very superior quality has been found on Hickory Knoll creek, 3 miles above its mouth, on the southeastern slope of Ammon's mountain, 150 feet above the level of the creek, on the land of *J. G. Bates*; but unfortunately, present developments have discovered but a thin seam from 4 to 5 inches thick; it is highly improbable that workable bodies of this ore exist. It is very fine-grained, massive, and of a dark bluish-red color; in places small specks of pure, glassy quartz are porphyritically enclosed in it. An analysis of a sample taken from this point shows:

ANALYSIS OF SPECULAR HEMATITE, BATES PLACE, HICKORY KNOLL CREEK, MACON COUNTY.

	(282)
Silica	10.50
Metallic iron	58.90
Sulphur	0.006
Phosphorus	0.019
Titanic acid	0.04
Phosphorus ratio	.032

The strike of the gneiss and mica schist in the road below here is N. 25° E.; dip 70° N. W.

On the western slope of Fish Hawk mountain, 1½ miles southwest from Bates, and on the east side of Hickory Knoll creek, similar ore is found on the land of *A. J. Stiles*. Much useless prospecting has been done over a considerable area, but nothing more than thin seams of ore, not over 2 inches in thickness in quartz and gneiss, have been found.

On the northeastern slope of the divide between Cartoogajay and Skenah creeks, 2 miles above the mouth of Cartoogajay and 4 miles slightly west of south from Franklin, a body of titaniferous magnetite ore occurs on the land of *Alex. Waldroop*. A rectangular pit, about 19 by 15 feet in area and 3 feet deep, exposed the top of the ore bed, though its true extent cannot of course be determined without further work. The ore is very fine-grained in a chloritic gangue, in places slightly garnetiferous; externally it closely resembles the Curtis ore in Caldwell county,¹ although its analysis shows far less titanic acid.

ANALYSIS OF TITANIFEROUS MAGNETITE, ALEX. WALDROOP'S, MACON COUNTY.

	(285)
Silica	11.91
Metallic iron	20.64
Carbonate of lime	3.31
Carbonate of magnesia	14.69
Metallic manganese	0.69
Sulphur	0.089
Phosphorus	0.017
Titanic acid	3.20
Phosphorus ratio	0.082

Titaniferous magnetite has been reported as occurring on the headwaters of Cartoogajay creek, 10 miles southwest from Franklin, on the *Kimsey* place; also on the headwaters of Coweeta creek, on *Dr. Rush's* place, but no developments have been made, therefore these localities were not visited.

In the northern part of the county, in what is known as the Burningtown settlement, from 8 to 10 miles northwest from Franklin, beds of limonite and manganimiferous limonite are found. These ore beds occur in a country rock of mica schist which dips usually at gentle angles towards the southeast and is also folded. The ore-bearing area, so far as examined, covers some 4 square miles. Only at a few points have any developments been made, and these are exceedingly meager and incomplete.

On the west bank of Burningtown creek, about 4 miles above its mouth, a quantity of ore was found on the land of *R. Daves*, around the mouth of some old diggings which are now filled up; it is a porous.

¹ See page 120, chapter VII.

honeycombed ore, slightly manganiferous, and occurs in lumps from the size of a water-bucket down; the natural surface float over the hill-side towards the creek is very profuse.

On the land of *George Parton*, $\frac{1}{4}$ mile slightly north of west from *Daves*, a small opencut, about 5 feet deep, near the bank of the creek, exposes a layer of ore from several inches to 1 foot in thickness, immediately below which there is a thin layer of red, argillaceous sand, and below that another layer of ore, but the latter had not been cut through; the dip is 30° S. E. An analysis of this ore shows:

ANALYSIS OF MANGANIFEROUS LIMONITE, GEO. PARTON'S, MACON COUNTY

	(283)
Silica	3.60
Metallic iron	48.72
Metallic manganese	9.71
Sulphur	0.135
Phosphorus	0.210
Phosphorus ratio	0.431

An outcrop of highly manganiferous ore is found $\frac{1}{4}$ mile northwest from here, near the summit of a ridge, where a small cut exposes a layer of ore about 1 foot thick in a red sandy soil; the ore is shelly, botryoidal and stalactitic. An analysis shows:

ANALYSIS OF MANGANIFEROUS LIMONITE, GEO. PARTON'S, MACON COUNTY.

	(284)
Silica	5.81
Metallic iron	28.84
Metallic manganese	28.40
Sulphur	0.123
Phosphorus	0.212
Phosphorus ratio	0.773

Further developments, which are to be recommended, may show a greater thickness of ore, and unless this is the case the deposits will have no economical value.

CHAPTER IX.

THE BROWN HEMATITE ORES LYING BELOW THE QUARTZITES OF CHEROKEE COUNTY.

The brown hematite deposits of Cherokee county are among the most important in the State. The ores were worked in forges as far back as 1840, and supplied the surrounding country with bar iron for local uses.¹ Since 1888 none of these forges have been in operation.

A definite correlation of the geological formations of this region has not yet been established, but the present supposition is that they belong to the Lower Cambrian.

The structural and stratigraphic relations of the formations have been worked out by Mr. Arthur Keith, who has determined the following descending sequences:

White quartzites.	Conglomerate.
Calc schist (limonite).	Sandstones and schists.
Marble (talc).	Black slates.
Garnet and mica schists.	White quartzites.
Granite.	Black slates with marble beds (gold quartz).

The ore beds of value occur in the calc schists immediately below the quartzites and above the marble; they are persistent and of good body and quality, though high in phosphorus. The principal deposits

¹ From "The Iron Manufacturer's Guide," by J. P. Lesley, 1859

Lovinggood Bloomery Forge, situated on Hanging Dog creek, 2 miles above Fain forge; built from 1845 to 1853; two fires and one hammer; made in 1856 about 13 tons of bars.

Lower Hanging Dog Bloomery Forge, on Hanging Dog creek, 5 miles northwest from Murphy; built in 1840; two fires and one hammer; made in 1856 about 4 tons of bars.

Killian Bloomery Forge, situated $\frac{1}{2}$ mile below the Lower Hanging Dog forge; built in 1843; abandoned in 1849.

Fain Bloomery Forge, on Owl creek, 2 miles below the Lovinggood forge; built in 1854, two fires and one hammer; made in 1856 about 24 tons of bars.

Persimmon Creek Bloomery Forge, situated on Persimmon creek, 12 miles southwest from Murphy; built in 1848; two fires and one hammer; made in 1855 about 45 tons of bars.

Shoal Creek Bloomery Forge, situated on Shoal creek, 5 miles west of the Persimmon Creek forge; built about 1854; one fire and one hammer; made in 1854 about $\frac{1}{2}$ ton of bars.

extend in a northeasterly direction from Murphy, the county seat, up the valley of Valley river for a distance of some 16 miles, which may be called the *Valley River Belt*.

The ore-bearing schists continue also in a southwesterly direction from Murphy, up the valley of the Nottely river, but have not been carefully explored, and excepting at one point, no notable deposits have yet been discovered.

South of Murphy, on the waters of Martin's creek, ore-bearing formations have been found, but only slightly explored; these are parallel ranges to the above main belt.

In the valleys of Peachtree and Low creeks, some 6 miles east of Murphy, local deposits of ore have been found, but not developed.

Beds of marble everywhere accompanying this ore, lying geologically beneath it, will furnish a convenient fluxing material.

Beds of talc, often of great purity, occur locally as lenses in the upper portions of the marble.

VALLEY RIVER ORE BELT.

The Valley river belt is a double outcrop, along the parallel edges of a sharp synclinal fold (illustrated in fig. 50). These outcrops appear continuously on both sides of a quartzite ridge, striking regularly N. 40° E., and lying on the west side of Valley river, from the Hiwassee river at Murphy to a point 4½ miles northeast of Murphy. Here the continuity of the ridge is broken by denudation, the quartzite and ore having disappeared, leaving the marble; the break is about 2 miles in length, when the ridge again rises, bringing up the ore and continuing for 1½ miles.

One mile northeast from this point there is a second axis, lying parallel and slightly southeast of the former, bringing down the ore in a flat and partially denuded syncline, which crosses the river about ¾ mile below the mouth of Taylor's creek, and continues along its eastern bank, in a course slightly north of east for 7 miles, as far as it has been at present traced, to a point near Valletown. The ore has been opened at intervals along this distance, and some of these points will now be described. It is everywhere accessible to the Murphy branch of the Western North Carolina railroad, which follows it, being located almost on it, in places.

On the *Martha T. Hitchcock* property, 1 mile southwest from Murphy, on the southwest side of the Hiwassee river, the outcrop of a heavy bed of brown hematite appears on the eastern slope of the quartzite ridge, and this is the only point southwest from Murphy at which a noteworthy deposit has been discovered.

The principal showing is on an offshoot or spur from this ridge, about $\frac{1}{4}$ mile from the river; the lowest point of the outcrop appears in a deep hollow, and is traceable in a southwesterly direction from here for 200 feet to the summit of the hill, a difference in elevation of 100 feet. At this point it comes to the surface in great force, and has in time been worked in shallow pits for some of the old forges; its thickness cannot be accurately measured; roughly stepped off it appears over a width of fifty feet. The ore is a compact, brown hematite; some of it is siliceous, but much good ore is found; until proper developments are made its exact grade cannot be known.

An analysis of a surface sample of the better class of ore shows:

ANALYSIS OF BROWN HEMATITE, HITCHCOCK PLACE, CHEROKEE COUNTY.

	(168)
Silica	3.82
Metallic iron	58.56
Sulphur	0.047
Phosphorus	0.820
Phosphorus ratio	1.449

On the western flank of this ridge the parallel outcrop of the syncline is found on the west side of the quartzite, which dips 55° S. E. A prospect shaft was sunk here, but is now filled up.

At the western foot of the ridge the marble crops out, lying below the ore.

Along the juncture of the quartzite and the calc schists occasional fragments of quartzite-conglomerate in a limonitic matrix are found.

An approximate section along the Hiwassee river here shows:

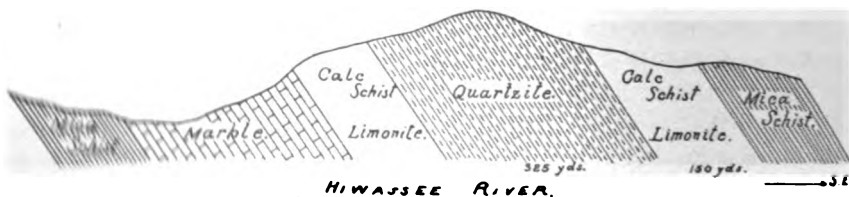


Fig. 44. Section along Hiwassee river, showing position of iron ore.

1. Murphy the ore crosses the Hiwassee and Valley rivers, and can be cropping out in the main street of the town near the Western railroad depot.

2. It is known as "Tract No. 5," 1 mile northeast from Murphy.

3. It is a double outcrop with a quartzite between the two.

4. It is from what is known as "Section 6," in this

ANALYSIS OF BROWN HEMATITE, "SECTION VI.," CHEROKEE COUNTY.

	(170)
Metallic iron	58.80
Sulphur	0.161
Phosphorus	0.391
Phosphorus ratio	0.664

The formation is followed northeast from here for a mile, where both outcrops have been opened on the property of *Capt. J. W. Cooper*.

On the southeastern slope of the quartzite ridge a cut, 6 feet deep, exposes a solid bed of ore between 17 and 18 feet thick, standing nearly vertically, but inclined slightly to the southeast.

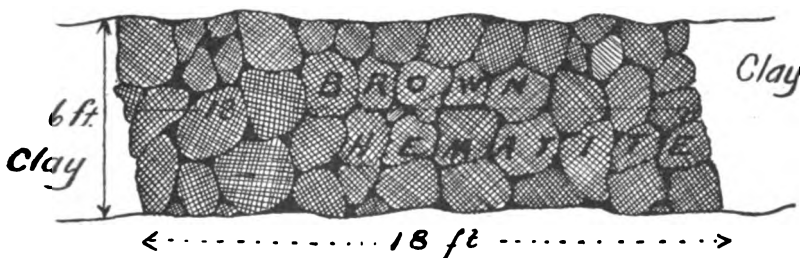


Fig. 49.—Showing ore body on the Cooper place, S. E. side of ridge

An analysis of a sample taken from here shows:

ANALYSIS OF BROWN HEMATITE, COOPER PLACE, CHEROKEE COUNTY.

	(169)
Silica	7.76
Metallic iron	51.94
Sulphur	0.06
Phosphorus	0.730
Phosphorus ratio	1.405

On the northwestern slope of the ridge the parallel outcrop is seen at an elevation of 100 feet above the other, as illustrated in fig. 50.

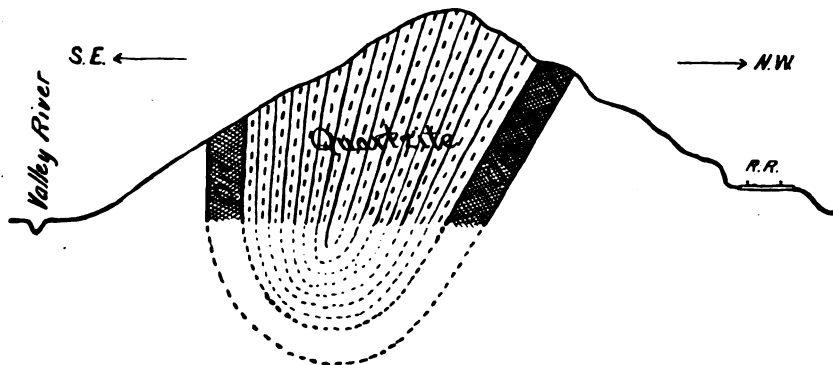


Fig. 50.—Showing parallel outcrops of the ore, along the opposite sides of sharp synclinal fold; near the Cooper place, Valley river.

It has been exposed by a small cut showing a thickness of 10 feet. The ore body is less compact than on the eastern side of the ridge, being irregularly distributed in a clay matrix, and the dip is more inclined, about 55° S. E., as shown in Fig. 51.

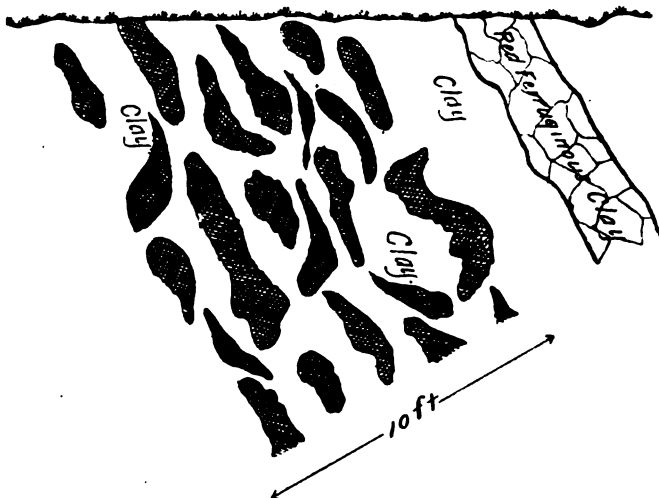


Fig. 51.—Showing ore body on the Cooper place, N. W. side of ridge.

One mile northeast from the Cooper place, and 3 miles northeast from Murphy, on the south side of Marble creek, the northwestern outcrop has been opened on the property of the *Valley River Company*. A cut 75 feet long, along the strike, exposes the solid ore bed from 8 to 12 feet in thickness, dipping 50° S. E., and underlaid by decomposed shale and clay, beneath which there are several smaller seams of siliceous ore.

An analysis of a sample from this point shows:

ANALYSIS OF BROWN HEMATITE. VALLEY RIVER COMPANY, CHEROKEE COUNTY.

	(174)
Silica	17.52
Metallic iron	48.44
Sulphur	0.038
Phosphorus	0.295
Phosphorus ratio	0.609

Marble creek passes through the ridge here in a deep gap, and the marble is exposed in its bed, lying below the ore formation.

The northwestern outcrop has again been opened on the Valley River Company's land, $\frac{1}{2}$ mile northeast from Marble creek, and shows a thickness of 8 feet, underlaid by clay; the ore is more siliceous at this point.

Northeast from here, $\frac{1}{2}$ mile, the ridge disappears for fully 2 miles, and with it the iron ore; the marble, with its talc deposits, comes to the surface in this wide gap. The ridge rises again, and 1 mile above the mouth of Colvard's creek the outcrop of ore was seen on its crest,

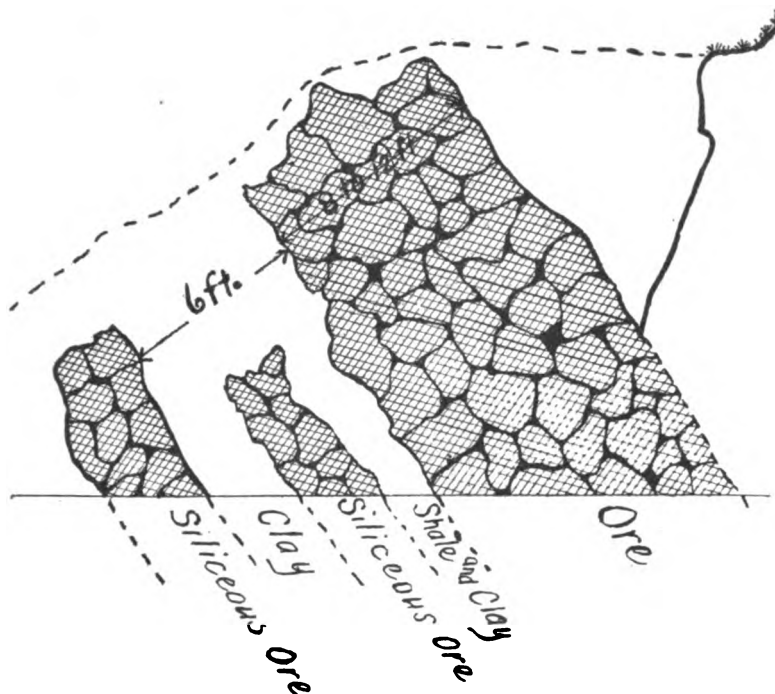


Fig. 52.—Showing ore body on the Valley River Company property, Cherokee county.

between the river and the railroad, on the *Tomotla* property. It is regular and continuous, the width being about 35 feet. The surface ore is porous, and its quality is shown by the following analyses:

ANALYSES OF BROWN HEMATITE, TOMOTLA PROPERTY, CHEROKEE COUNTY.

	(175)	(176)
Silica	6.93	....
Metallic iron	56.00	56.42
Sulphur	0.051	....
Phosphorus	0.312	0.294
Phosphorus ratio	0.557	0.521

The northeastern termination of this synclinal axis is $\frac{1}{2}$ mile from here.

Between the mouths of Ray and Vengeance creeks the river makes a large bend. It is on the ridge that rises to the north of this bend of the river, near the mouth of Vengeance creek, that the ore formation makes its reappearance in a flat syncline.

The outcrop was seen here on the *McAden land*, 9 miles northeast from Murphy; it measured 19 feet in width as far as exposed. It caps the crest of the ridge and is traced northeastward for $\frac{1}{4}$ mile to the *Morse property*, where a shaft was sunk in former years in the search for copper, the prospectors having mistaken the iron ore for a gossan.

This shaft is now filled up to within 20 feet of the surface, and shows a face of ore to this depth on its western wall. The outcrop extending westward from the mouth of the shaft is very prominent, and apparently in place from here to the summit of the ridge, a distance of 40 feet, and is traced continuously for $\frac{1}{4}$ mile northeast where the ridge slopes off to Hyatt's creek.



Fig. 53.—Showing ore body on the Morse place, Cherokee county.

Several analyses of this ore show:

ANALYSES OF BROWN HEMATITE, MORSE PLACE, CHEROKEE COUNTY.

	(177)	(178)
Silica	6.49	....
Metallic iron	57.16	58.42
Sulphur	0.036	....
Phosphorus	0.756	0.021
Phosphorus ratio	1.322	0.036

No. 177 sampled from outcrop at shaft. No. 178, from United States Tenth Census Report, Vol. XV, p. 560; exact locality from which sample was obtained not given.

These analyses show a wide variation in phosphorus, No. 178 being in fact below the Bessemer limit, the only instance noted in the Valley river ores; but it is not believed that this will hold good for any quantity.

On the *Hanks place*, adjoining the Morse property on the northeast, the ore has been extensively prospected. Two outcrops, occupying the crests of parallel ridges, having a trend nearly east and west, about 200 yards apart, are seen here.

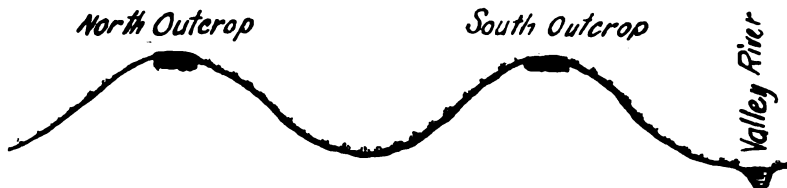


Fig. 54.—Showing parallel outcrops of ore on the Hanks place, Cherokee county.

A number of openings have been made, of which some of the most important will be described.

On the north outcrop the ore has been uncovered and stripped by north and south trenches, fully 175 feet in width; and at one point a shaft 38 feet deep has been sunk in the ore without going through the same, and a drift run off from the bottom 15 feet north, in ore.

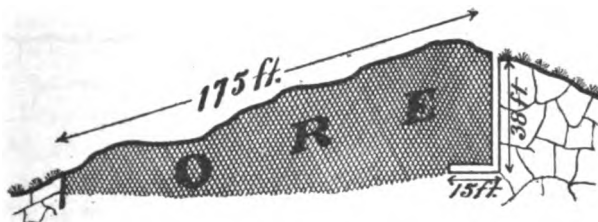


Fig. 55.—Showing ore body on the Hanks place, Cherokee county.

The ore is generally compact and solid, with occasional "horses" of clay.

An analysis of a sample taken here shows:

ANALYSIS OF BROWN HEMATITE, HANKS' 38 FOOT SHAFT, CHEROKEE COUNTY.

	(183)
Silica	3.32
Metallic iron	58.52
Sulphur	0.026
Phosphorus	0.520
Phosphorus ratio	0.888

On a parallel ridge south from here the other outcrop has been explored by a shaft 55 feet deep. This shaft penetrated alternating masses of ore and clay, averaging about 4 feet thick each, to its full depth; drifts have been driven from the bottom 40 feet north and 20 feet south in the same material. The ore is very lean at this point.

A few yards east from the shaft the top of the ore has been uncovered 60 feet in width, lying across the very crest of the ridge, and a shallow shaft has cut through it in 8 feet, as shown in the accompanying diagram (Fig. 56).

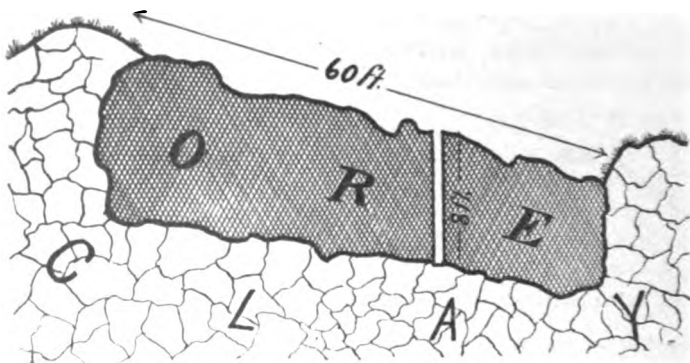


Fig. 56.—Showing ore body on the Hanks place, Cherokee county.

East from this point the ore has been stripped by a long trench in a north and south direction, and a shaft 30 feet deep has cut through

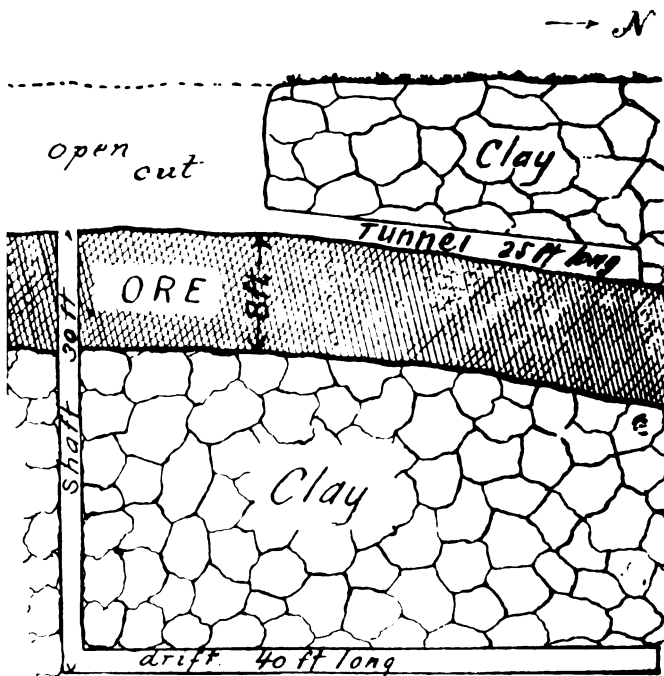


Fig. 57.—Showing ore body on the Hanks place.

the bed, which is but 8 feet thick, lying nearly horizontally. At the bottom of this shaft a drift extends under the ore in clay for 40 feet north. (See Fig. 57.)

An analysis of a sample taken here shows:

ANALYSIS OF BROWN HEMATITE, HANKS' 80 FOOT SHAFT, CHEROKEE COUNTY.

	(182)
Silica	10.70
Metallic iron	54.88
Sulphur	0.072
Phosphorus	0.273
Phosphorus ratio	0.497

Two hundred yards east from here, and 60 yards west from the river, at an elevation of 30 feet above the latter, the ore has been stripped over a width of 58 feet, but was not penetrated to determine its thickness. At the water's edge a large outcrop is exposed over a width of 48 feet; its thickness is from 8 to 10 feet. The ore is as a rule compact, but in places porous; again it is nodular and extremely argillaceous, changing in fact into a hard, siliceous, ferruginous clay slate.

The ore belt continues on the east side of the river from here; on the *Taylor place* $\frac{1}{4}$ mile from the river, it has been explored by shallow diggings, showing a width of 40 feet and a thickness of from 6 to 8 feet.

On the *Sharp place*, about 3 miles nearly east from the river crossing, a series of pits, trenches and shallow shafts expose the ore bed along the crest of a low ridge for $\frac{1}{4}$ mile. It lies in a flat, anticlinal sheet, but a few feet above the surface soil. The surface is literally covered with float ore, showing that the upper part of the bed has in all probability been worn down by denudation.

The width of the ore body at this point is from 100 to 150 feet and its thickness from 4 to 8 feet; it is underlaid by a clay substratum; in one of the prospect shafts marble was found at a depth of 32 feet below the ore, by means of a sounding bar.

An analysis of a sample taken from this ore exposure shows:

ANALYSIS OF BROWN HEMATITE, SHARP PLACE, CHEROKEE COUNTY.

	(184)
Silica	9.96
Metallic iron	56.00
Sulphur	0.113
Phosphorus	0.101
Phosphorus ratio	0.180

This horizontal blanket of ore is also found extending out along the crests of the cross ridges south from the main ridge, where the horizon has not been denuded. At one point it showed 50 feet in width east and west, and from 6 to 8 feet in thickness.

In an easterly direction from the Sharp place the ore beds continue on the *Tatham place*, to Tatham creek.

On the south side of Valley river, between the mouths of Tatham and Junaluska creeks, about $\frac{1}{2}$ mile north of Valleytown, two outcrops of ore may be seen on the *Washburn place*. Outcrop No. 1, at the point of the ridge near the level of the valley, measured 18 feet across as far as exposed. Outcrop No. 2, about 75 yards slightly east of south from No. 1, measured 20 to 25 feet across, as far as exposed. The exact relations of these outcrops to each other and to the general belt cannot be definitely given now until further developments are made. The ore is compact and massive and of extremely good appearance.

A bed of brown ore is exposed in a cut 40 ft. wide on the S. E. edge of what is known as Whitaker's Ingram field, at the foot of Iron hill. This is about $\frac{3}{4}$ mile E. N. E. of Valleytown and $\frac{1}{2}$ mile N. E. of the State road. About 100 yards S. E. of the above locality the summit of Iron hill shows a profuse covering of float ore over an area of several acres.

The valley was not explored for ore above this point.

In *Red Marble Gap*, in which the Murphy branch of the Western North Carolina railroad crosses the county line, fully 1000 feet in elevation above the general ore horizon just described, a bed of brown hematite has been cut on the southeast side of the railroad cut; it dips toward the southeast, and is reported to be 20 feet thick; no special examination was made and its relation to the Valley river beds is not known. The strike of the clay slate in the cut is N. 30° E.

MAGNETITE ORE.—On the south bank of Junaluska creek, 1 mile above Valleytown, on the Franklin road, a great number of pits and trenches have been made in the search for a bed of magnetite ore which was supposed to exist here. The openings have caved in and are now considerably filled up, but at only one of them, namely that nearest the road, was any trace of ore found in the waste-piles. It is a mixture of very hard, homogeneous, fine-grained magnetite and specular hematite, having a red streak; it is free from gangue and its structure is jointed. The following analyses will show its unusual richness:

ANALYSES OF MAGNETITE ORE, JUNALUSKA CREEK, CHEROKEE COUNTY.

	(179)	(180)	(181)
Silica	0.486	....	1.29
Metallic iron	67.78	65.56	64.89
Sulphur	0.005	....	....
Phosphorus	0.030	0.095	0.092
Phosphorus ratio	0.044	0.144	0.141

In this main cut the surface soil appears to a considerable depth, filled with a detritus of quartzite boulders, in places cemented together by a mangiferous matrix; below this the country rock, a red, partially altered, hydromicaceous schist, appears, but no ore can now be seen in place, and it is believed that the ore which was found here is of a local nature.

Ore has been variously reported as occurring on Peachtree, Low and Brasstown creeks, but the developments are very meager, and the regions have not yet been carefully enough examined to allow of a detailed description.

On the *White place*, $\frac{1}{2}$ mile above the mouth of Low creek, and 5 miles east from Murphy, massive brown hematite occurs as a heavy float over the surface of a low ridge, but the bed has not been discovered.

MANGANESE ORE.—On the farm of *John C. Huskin*, $2\frac{1}{2}$ miles above the mouth of Low creek, a very pure manganese ore (massive pyrolusite) is found. A small digging was seen here, but no ore found in place. The country rock is a reddish talcose slate, striking N. 45° E. and dipping nearly vertically. An analysis of a surface sample of this ore shows:

ANALYSIS OF MANGANESE ORE, LOW CREEK, CHEROKEE COUNTY.

	(394)
Silica	1.45
Metallic iron	6.44
Metallic manganese	58.36
Sulphur	0.124
Phosphorus	0.180

About 2 miles south from Murphy and $\frac{1}{2}$ mile above the mouth of Martin's creek, a bed of brown hematite has been opened on the *Mooney place* by a shallow, rectangular pit on the southeastern flank of a quartzite ridge; it shows a thickness of 18 feet of mixed ore, clay and shale; roughly estimated, over 50% of this material is ore, which is porous and ochreous. At one point of the bed the ore is solid for a thickness of 4 feet; the dip is 55° S. E., and the strike of the shales is N. 45° E. An analysis of a sample taken here shows:

ANALYSIS OF BROWN HEMATITE, MOONEY PLACE, CHEROKEE COUNTY.

	(171)
Silica	15.42
Metallic iron	48.02
Sulphur	0.039
Phosphorus	0.201
Phosphorus ratio	0.418

The axis of this formation is evidently a parallel one to that of the main Valley River belt and lies $1\frac{1}{2}$ miles southeast of it.

On the *Wright farm*, 2 miles south from Mooney's ore bed, on Martin's creek, a bed of ore, reported to be 8 feet thick, has been opened, but the cut is now filled up and nothing can be seen.

The axis of the formation at this point lies about $2\frac{1}{2}$ miles southeast from the Valley River belt. The marble crops out here below the ore.

On the *Monteith place*, 2 miles south of Wright's and 2 miles north of the State line, on the headwaters of Martin's creek, the remains of

extensive workings, consisting of shallow cuts and trenches, are visible. Ore was formerly mined here for the Hanging Dog forge, 10 miles distant. The main cut is about 200 yards long and from 6 to 20 feet deep; the ore was reported to be from 4 to 15 feet thick, but cannot now be seen in place; the strike is N. 60° E. This is apparently a fourth parallel belt to the southeast of the main Valley River belt. An analysis of the Monteith ore shows:

ANALYSIS OF BROWN HEMATITE, MONTEITH, CHEROKEE COUNTY.

	(173)
Metallic iron	57.33
Phosphorus	0.702
Phosphorus ratio	1.224

It is regretted that at this date no further information can be given concerning the Cherokee ores. A more detailed examination is contemplated during the next field season, and the results will be the subject of a special report.

So far as we now know, the principal ore bodies are found northeast from Murphy in the valley of Valley river: 1. In a sharp synclinal bed underlying the quartzite, extending N. 40° E. from the Hiwassee river to Mason creek. 2. In a flat synclinal bed along the crest of the ridge formation, extending only slightly north of east from Vengeance creek to near Valletown. In the former the quantity of ore is naturally greater; the members of the synclinal folds dip at steep angles, and in all probability the ore extends to considerable depths; its thickness is from 1 to 40 feet. In the latter the ore lies nearly flat, on or near the crest of the ridge, and is therefore contracted in its dimensions. Present explorations have shown a width of from 40 to 175 feet and a thickness of from 8 to 38 feet.

The ore is everywhere well situated for mining, but most advantageously in the latter formation, where it can be mined almost exclusively by stripping and open work.

As to the quality of the Valley river brown hematite ores, an average of 8 samples collected by myself shows:

AVERAGE OF 8 ANALYSES OF SAMPLES OF CHEROKEE BROWN HEMATITE ORES
COLLECTED BY THE N. C. G. S.

Silica	8.312
Metallic iron	54.937
Sulphur	0.055
Phosphorus	0.476
Phosphorus ratio	0.866

An average analysis of 23 samples of these ores collected by Mr. John

Birkinbine, recently President of the American Institute of Mining Engineers, and analyzed by Dr. J. Blodgett Britton,¹ shows:

AVERAGE ANALYSIS OF 23 SAMPLES OF CHEROKEE BROWN HEMATITE ORES
COLLECTED BY MR. JOHN BIRKINBINE.

	(185)
Silica	9.080
Metallic iron	50.020
Phosphorus	0.712
Phosphorus ratio	1.423

Dr. Britton says, that by omitting only one of the samples the average of the rest in phosphorus is reduced to 0.3745, while the iron per cent is increased.

Accordingly the quality of the ore is very good, being equal, if not superior, to the best grades of southern brown hematites.

Phosphorus is the variable element, ranging from 0.10 to nearly 1.00 per cent. One analysis, No. 178,² of a sample from the Morse place³ shows as little as 0.021 per cent of phosphorus, which is below the Bessemer limit. This is very exceptional, and it is certain that no appreciable quantity of ore of this quality can be depended on.

LIMESTONE.—In conclusion, several analyses of the limestones (marbles) of this section are given below. They exist undoubtedly in large quantities and are easily quarried.

ANALYSES OF MARBLES, CHEROKEE COUNTY.

	(402)	(403)	(404)	(405)
Silica	2.93	0.92	1.58	1.20
Oxides of iron and aluminum	1.17	1.20	1.90	0.82
Lime	49.83	32.80	32.42	52.90
Magnesia	3.61	15.43	19.58	1.91

No. 402, from the Kinsey quarry, 5 miles southwest from Murphy.

No. 403, from the Hays place, Tomotla station, 5 miles northeast from Murphy.

No. 404, from Hickerson's, 14½ miles northeast from Murphy, on Valley river.

No. 405, from the Culberson quarry, 11 miles southwest from Murphy.

Almost any desirable variation in the proportions of lime and magnesia may be had, from a limestone to a dolomite. They are all comparatively low in silica.

¹ Transactions of the American Institute of Mining Engineers, February, 1888.

² United States Tenth Census Report; Mining Industries of the United States, p. 560; sampler, Willis; chemist, Pitman.

³ See page 202 of this report.

CHAPTER X.

THE BROWN HEMATITE AND MANGANESE ORES OF WESTERN MADISON COUNTY.

In the extreme western part of Madison county, south of the French Broad river, near the Tennessee State line, deposits of brown hematite and manganese ore occur, in all probability bearing geological relations to the enclosing rocks similar to the Cherokee deposits. But a very cursory examination was made of this locality, by Mr. Hunter L. Harris, who reports the following:

BROWN HEMATITE.—On the lands of *J. J. Fitzgerald*, $1\frac{1}{4}$ miles N. 30° E. from his house, on the western waters of Shut-in creek, 4 miles slightly north of west from Hot Springs, a bed of limonite has been uncovered by a shallow ditch 30 feet long by 6 feet deep, showing a total width of ore of about 30 feet; vertical thickness not known.

The ore is cellular and in places ochreous. The country rock is a coarse-grained metamorphic sandstone, gritty and even conglomeratic in places.

An analysis of a sample taken from this place shows:

ANALYSIS OF BROWN HEMATITE, J. J. FITZGERALD, MADISON COUNTY.

	(290)
Silica	11.94
Metallic iron	45.05
Sulphur	0.390
Phosphorus	0.530
Phosphorus ratio	1.176

About one-fifth of a mile northeast from here the outcrop appears at a somewhat lower level along the slope of the ridge. A shallow cut shows 4 to 5 feet width of ore as far as exposed; vertical thickness and total width are unknown. The ore is compact and botryoidal. The ridge on the opposite side of this valley consists of a fine blue limestone, thin bedded, and varying considerably in dip; along the branch it is nearly vertical, striking with the stream.

About one mile southwest from this locality, on the land of *Emmet Schism*, the ore body has been prospected by a shaft, but cannot now be seen in place.

On the headwaters of Grassy creek, $1\frac{1}{2}$ miles south from Paint Rock station of the Western North Carolina railroad, limonite has been discovered on the land of *Frank M. Wells*. A small trench shows an irregular ore body about 15 feet across, consisting of a fairly solid central mass, with stringy and lumpy crusts running out from it.

MANGANESE ORE DEPOSITS.—On the east side of Shut-in creek, 2 miles above its mouth and $\frac{1}{4}$ mile southeast from J. J. Fitzgerald's house, "a bed of manganese ore 4 feet thick was struck in a shaft at a depth of 42 feet, underlaid by 27 feet of mixed material containing a considerable quantity of the mineral."¹

The shaft is now caved in and nothing can be seen excepting a few lumps of the ore lying on the outside.

At a point about 20 feet above the creek and below the foot of the shaft the drift soil has been excavated, and found by washing to contain a fair proportion of ore.

The ore is psilomelane, compact, massive and botryoidal, of apparently good quality. It is also reported to have been found in place in a shaft $\frac{1}{2}$ mile eastward from this locality.

The prospects for finding good deposits of brown hematite and manganese ore in this locality of western Madison county are encouraging, and the section will warrant a closer and more detailed investigation, which will be undertaken during the next field season.

Similar deposits of brown hematite are reported to exist along the southeastern slopes of the Unaka mountains, the northwestern boundary of Mitchell county, and are probably an extension of this same general ore horizon.

¹ From statement by J. J. Fitzgerald.

CHAPTER XI.

THE CHROMIC IRON ORES OF THE CHRYSOLITE ROCKS IN WATAUGA, MITCHELL, YANCEY, MADISON, BUNCOMBE AND JACKSON COUNTIES.

Starting at Rich mountain, in Watauga county, a series of chrysolite beds appear at long intervals, along a general range S. 51° W., in Watauga, Mitchell, Yancey, Madison, Buncombe and Jackson counties.

These beds carry chromic iron ore (chromite),¹ occurring usually as scattered fragments or granular disseminations in the chrysolite rock (dunite), and sometimes concentrated in irregular deposits of economic value in quantity and quality.

There is still some controversy as to the true origin of these chrysolite deposits and the genesis of the containing chromite,² but the discussion of this part of the subject must be dismissed for the present.

WATAUGA COUNTY.—On the western slope of the Bald of Rich mountain, on the waters of Cove creek, 7 miles northwest from Booue, chromite occurs in pockets or seams, irregularly distributed through the chrysolitic country rock.

On the land of *David Laurence* a particularly large and promising, though limited, outcrop of nearly pure ore was discovered. This bluff was broken down by several blasts and furnished probably 10 tons of ore; but it proved to be all that there was in the pocket; the ore body was found to pinch out completely, continuing only as small segregated veins in the chrysolite below, and no further prospecting was undertaken.

MITCHELL COUNTY.—On the *Woody* farm 2½ miles south from Bakersville, on the road to Spruce Pine, small grains of chromite occur disseminated in the chrysolite rock, but no large deposits have been found.

YANCEY COUNTY.—The most important deposits of chromic iron ore yet noticed occur in this county.

What is known as *Mine Hill* is situated 5 miles north from Bakersville on the east side of the Bakersville road. This is a prominent chrysolite hill, prominent chiefly because of its bareness and destitution

¹ See page 22.

² See paper by Alexis A. Julien on "The Dunite Beds of North Carolina," published in the Proceedings of the Boston Society of Natural History, Vol. XXII, December 6, 1882.

of vegetation, rising to an elevation of about 150 feet above the creek level. The chrysolite is generally impregnated with chromite to a varying degree; and near the summit of the hill the ore is concentrated in larger veins and pockets. A shaft was sunk here to a depth of 15 feet, but it was filled with water at the time of my visit and no ore could be seen in place. Mr. Garrett Ray, the owner, reports the thickness of the ore body to be from 2 to 3 feet. Several hundred yards north from here the ore shows at the surface in thin veins, not over 2 or 3 inches in thickness; occasionally it is coated with a fine green film of nickel oxide.

An analysis of a sample of the ore, collected from several tons of material on the outside of the shaft, shows:

ANALYSIS OF CHROMIC IRON ORE, MINE HILL, YANCEY COUNTY.

	(380)
Silica	13.00
Metallic iron	18.87
Chromic oxide	49.87

The accessory minerals occurring with this ore are chiefly chrysolite, and its various products of alteration, such as talc, serpentine, asbestos, anthophyllite, ripidolite, etc.; the latter mineral imparts a beautiful violet coloring to the ore; the chrysolite is of a light yellowish-green color, sometimes hard and compact, again soft and friable. There is a frequent tendency towards an imperfect, triangular, concentric arrange-

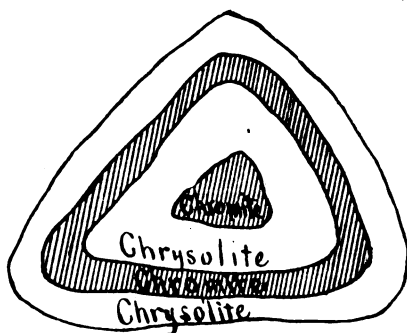


Fig. 58.—Showing concentric arrangement of chrysolite and chromite.

ment of alternate layers of chrysolite and chromite, as illustrated in fig. 58. The chrysolite formation crosses the Bakersville road and rises in another hill opposite the Mine hill, on the crest of which chromite has

been found in small veins and pockets. At one point a blast has exposed a bunch of pure ore 2 by 3 feet in area. On the western slope of the hill are seen the evidences of prehistoric workings, consisting of a trench 100 feet or more in length, at the face of which a tunnel entered the hillside; very small pockets of chromite are visible in the upper part of the trench, but the true object of the work has never been explained.

A small chrysolite hill appears $5\frac{1}{2}$ miles west of Burnsville, on the waters of Banks creek, on the land of *Rabe Englin*. The rock contains small grains of chromite disseminated through it sparingly; but no noteworthy bodies of ore have been discovered.

A narrow chrysolite bed occurs in the hornblendic country rock, from 9 to 10 miles west of Burnsville, on the waters of Price's creek; this is on the land of *W. A. Robertson*, $\frac{1}{4}$ mile from Price's Creek P. O.

A small, irregular pocket of chromite was discovered here, from which 6 or 7 tons of ore were taken, exhausting the limits of the same. No other deposits of note have as yet been discovered. The chrysolite at this point is of a gray color, fine-grained and compact.

An analysis of a sample of the ore taken here shows:

ANALYSIS OF CHROMITE. ROBERTSON'S, PRICE'S CREEK, YANCEY COUNTY.

	(390)
Silica	6.52
Metallic iron	17.02
Chromic oxide	63.07

MADISON AND BUNCOMBE COUNTIES.—In Madison county, near the Buncombe line, 17 miles north of Asheville, on Big Ivy creek, the chrysolite formation appears over a width of some 300 feet, in a series of low ridges, rising 50 feet above the level of the creek. As usual it is charged with chromite grains, but no deposits of economic value have been discovered.

With slight interruptions, the public road follows along this formation for over 1 mile south from here into Buncombe county. It is characterized by deposits of chalcedony, which is generally cellular and filled with a red ochreous dirt or dust; and it is sometimes stained or coated with a thin film of some nickeliferous mineral, probably genthiæ. The chrysolite zone crosses the French Broad river near Alexander, a station on the Western North Carolina railroad, 6 miles below Asheville; and several miles south of the river the chrysolite in places has been altered to serpentine, and at other places it carries traces of nickel silicate.

JACKSON COUNTY.—A deposit of chromic iron ore occurs near Webster in this county, of which the following is an analysis:¹

¹ "Ores of North Carolina," p. 345.

ANALYSIS OF CHROMITE, NEAR WEBSTER, JACKSON COUNTY.

	(389a)
Silica and alumina.....	9.47
Ferrous oxide	25.04
Chromic oxide	63.32
Lime	1.32
Magnesia	0.85

The richness of these ores in chromium is evident from the foregoing analyses. Their existence in quantity has not yet been satisfactorily proven; in certain of the localities mentioned, and perhaps in others which are yet undiscovered, the prospects are encouraging, at least sufficiently so as to warrant further exploitation.

Date		Time		Place		Remarks	
1898	10/1	10:00	10:15	St. Louis	Mo.	Left for St. Louis	
1898	10/2	10:00	10:15	St. Louis	Mo.	Arrived St. Louis	
1898	10/3	10:00	10:15	St. Louis	Mo.	Left for St. Louis	
1898	10/4	10:00	10:15	St. Louis	Mo.	Arrived St. Louis	
1898	10/5	10:00	10:15	St. Louis	Mo.	Left for St. Louis	
1898	10/6	10:00	10:15	St. Louis	Mo.	Arrived St. Louis	
1898	10/7	10:00	10:15	St. Louis	Mo.	Left for St. Louis	
1898	10/8	10:00	10:15	St. Louis	Mo.	Arrived St. Louis	
1898	10/9	10:00	10:15	St. Louis	Mo.	Left for St. Louis	
1898	10/10	10:00	10:15	St. Louis	Mo.	Arrived St. Louis	
1898	10/11	10:00	10:15	St. Louis	Mo.	Left for St. Louis	
1898	10/12	10:00	10:15	St. Louis	Mo.	Arrived St. Louis	
1898	10/13	10:00	10:15	St. Louis	Mo.	Left for St. Louis	
1898	10/14	10:00	10:15	St. Louis	Mo.	Arrived St. Louis	
1898	10/15	10:00	10:15	St. Louis	Mo.	Left for St. Louis	
1898	10/16	10:00	10:15	St. Louis	Mo.	Arrived St. Louis	
1898	10/17	10:00	10:15	St. Louis	Mo.	Left for St. Louis	
1898	10/18	10:00	10:15	St. Louis	Mo.	Arrived St. Louis	
1898	10/19	10:00	10:15	St. Louis	Mo.	Left for St. Louis	
1898	10/20	10:00	10:15	St. Louis	Mo.	Arrived St. Louis	
1898	10/21	10:00	10:15	St. Louis	Mo.	Left for St. Louis	
1898	10/22	10:00	10:15	St. Louis	Mo.	Arrived St. Louis	
1898	10/23	10:00	10:15	St. Louis	Mo.	Left for St. Louis	
1898	10/24	10:00	10:15	St. Louis	Mo.	Arrived St. Louis	
1898	10/25	10:00	10:15	St. Louis	Mo.	Left for St. Louis	
1898	10/26	10:00	10:15	St. Louis	Mo.	Arrived St. Louis	
1898	10/27	10:00	10:15	St. Louis	Mo.	Left for St. Louis	
1898	10/28	10:00	10:15	St. Louis	Mo.	Arrived St. Louis	
1898	10/29	10:00	10:15	St. Louis	Mo.	Left for St. Louis	
1898	10/30	10:00	10:15	St. Louis	Mo.	Arrived St. Louis	
1898	10/31	10:00	10:15	St. Louis	Mo.	Left for St. Louis	

18	C. B. White.	Magnetite.	Wm. Harrison Brown.	..	56.72	..	0.020	..	0.035	White.	18
19	McCreath.	"	N. B. Ballou. North Fork New river, near Crumpler P. O.	17.08	50.08	..	0.009	..	0.017	Baskerville.	19
20	C. B. White.	"	N. B. Ballou. North Fork New river, near Crumpler P. O.	20.79	45.50	..	0.002	..	0.052	McCreath.	20
21	10th Census.	"	N. B. Ballou. North Fork New river, near Crumpler P. O.	..	60.81	..	0.023	..	0.037	White.	21
22	5	Limonite.	N. B. Ballou. North Fork New river, near Crumpler P. O.	..	49.06	..	0.018	..	0.037	Pitman.	22
23	C. B. White.	"	Long Cut; Peter Eller farm. Foot of Phenix Mt. North Fork New river.	8.79	54.18	0.71	0.008	..	0.184	Baskerville.	23
24	A. S. McCreath.	"	Long Cut; Peter Eller farm. Foot of Phenix Mt. North Fork New river.	..	54.55	..	0.0043	..	0.008	White.	24
25	6	"	Long Cut; Peter Eller farm. Foot of Phenix Mt. North Fork New river.	10.33	48.70	0.774	0.011	..	0.022	McCreath.	25
26	64	Magnetite.	Ballou's Piney creek mine.	0.614	65.06	3.04	0.007	0.019	0.029	Baskerville.	26
27	207	"	" " " Hard, earthy ore.	9.06	51.09	0.66	0.055	0.06	0.174	"	27
28	65	"	Granular ore.	3.12	62.10	3.68	0.085	0.017	0.027	McCreath.	28
29	A. S. McCreath.	"	Ballou's Piney creek mine. Soft, earthy ore.	10.04	39.35	9.63	0.122	..	0.056	"	29
30	30	"	" " " Hard ore.	0.800	65.65	3.83	..	0.004	0.006	White.	30
31	C. B. White.	"	Francis tunnel opening in road. Piney creek in soft Mn. matrix.	3.20	65.40	2.58	0.011	none	0.016	White.	31
32	70	"	Francis slope opening. Granular Magnetite in soft Mn. matrix.	1.73	64.51	3.19	0.040	0.12	0.186	Baskerville.	32
33	A. S. McCreath.	"	Francis slope opening. Natural ore.	10.82	47.43	8.96	0.085	..	0.180	Nitze.	33
34	8	"	Joe Greybeal opening. Near Horse creek.	3.494	57.13	5.22	0.058	..	0.213	McCreath.	34
35	8	"	Joe Greybeal. Soft, sandy ore from old forge opening.	6.09	47.45	9.102	0.102	..	0.215	"	35
36	73	"	Joe Greybeal. Large opening. Upper bed.	6.85	63.55	..	trace	0.009	0.014	Baskerville.	36
37	75	"	Joe Greybeal. From surface fragments, near old pits.	..	64.04	..	0.009	..	0.014	Pitman.	37
38	76	Magnetite.	Ballou's Horse creek mine. One mile above mouth of Horse creek.	28.95	42.90	1.58	0.04	0.008	0.019	"	38
39	76	"	Ballou's Horse creek mine. One mile above mouth of Horse creek.	11.57	55.24	..	0.075	0.005	0.009	"	39
40	C. B. White.	"	Ballou's Horse creek mine. One mile above mouth of Horse creek.	8.77	56.09	..	0.06	0.031	0.035	"	40
41	U. S. 10th Census.	"	Ballou's Horse creek mine. One mile above mouth of Horse creek.	..	67.18	..	0.010	0.100	0.014	White.	41
42	9	"	Hampton mine. Waters of Horse creek.	..	..	..	..	..	0.014	Pitman.	42
43	74	"	" " " " "	1.96	62.48	3.06	0.072	0.019	0.030	Baskerville.	43
44	C. B. White.	"	Ben Greer mine. Near head of Little Horse creek.	4.58	54.02	6.85	0.007	0.006	0.011	"	44
45	10	"	Ben Greer mine. Near head of Little Horse creek.	4.12	64.58	2.21	0.011	0.011	0.017	White.	45
46	C. B. White.	"	Ben Greer mine. Near head of Little Horse creek.	9.66	61.58	..	0.06	0.010	0.016	Baskerville.	46
47	U. S. 10th Census.	"	Ben Greer mine. Near head of Little Horse creek.	..	65.63	..	..	0.029	0.044	White.	47
48	2010	"	Ben Greer mine. Near head of Little Horse creek.	..	52.23	..	..	0.019	0.036	Pitman.	48
49	A. S. McCreath.	"	Ben Greer mine. Near head of Little Horse creek.	22.34	40.82	..	0.09	0.10	0.245	Baskerville.	49
50	C. B. White.	"	Ben Greer mine. Near head of Little Horse creek.	14.66	51.40	..	..	0.049	0.095	McCreath.	50
51	12	"	Ben Greer mine. Near head of Little Horse creek.	21.88	50.16	..	0.042	0.39	0.083	White.	51
52	13	"	David Blevins. Helton knob, opening 300 yds. S. E. from house.	29.90	38.35	..	0.038	0.022	0.060	Baskerville.	52
53	..	"	David Blevins. Helton knob, opening 500 yds. N. E. from house.	31.67	32.66	..	0.042	0.103	0.315	"	53

Serial No.	Analysis No.	Handsample No.	Character.	LOCALITY.	Silica.	Met. Iron.	Met. Manganese.	Sulphur.	Phosphorus.	Titanic Acid.	Chromic Oxide.	Phosphorus Ratio.	Chemist.	Serial No.
53	14	..	Magnetite.	Red hill. Opening on N. W. side of hill. Opening No. 3	32.59	36.41	..	0.20	0.003	0.118	..	0.003	Baskerville.	53
54	15	..	"	Red hill. Long cut on top of hill. Opening No. 1	19.83	51.55	..	0.137	0.042	0.297	..	0.091	"	54
55	16	..	"	Red hill. Hard ore. Opening No. 2	32.06	37.14	..	0.071	0.004	0.106	..	0.010	"	55
56	17	..	"	Red hill. Tunnel near Jas Lovelace's house. McClure's knob. Lee Price opening. (Sampled by Harris)	41.13	23.39	..	1.67	0.109	..	..	0.466	"	56
57	17	..	"	Lee Price opening. (Sampled by Harris)	11.46	51.30	..	0.06	1.12	..	..	2.183	"	57
58	55	2634	"	McClure's knob. Lee Price opening. (Sampled by Nitze)	16.50	45.87	..	0.025	0.004	0.904	..	1.970	"	58
59	51	2635	"	Old tunnel opening	21.38	47.07	..	0.06	0.07	..	..	0.148	"	59
60	52	2631	"	Tolley opening	33.23	44.87	..	0.030	0.063	..	..	0.118	"	60
61	53	2632	"	Old Blevins forge opening	22.78	43.03	..	0.02	0.14	..	..	0.325	"	61
62	54	2633	"	"	28.78	42.38	..	0.05	0.03	..	..	0.070	"	62
63	18	2628	"	From outcrop	28.60	37.30	..	0.09	0.014	0.082	..	0.333	"	63
64	59	..	"	Poison Branch mine. Big cut, N. side of road of big cut. Outcrop in upper part	5.55	61.44	..	0.06	0.003	..	..	0.005	"	64
65	60	2628	"	Poison Branch mine. Outcrop in lower part of big cut	20.36	45.06	..	0.13	0.011	0.040	..	0.024	"	65
66	A. S. McCreath.	..	"	Poison Branch mine	12.31	56.05	..	0.07	0.01	trace	..	0.127	McCreath.	66
67	C. B. White.	..	"	"	..	56.40	..	0.05	0.03	..	..	0.023	White.	67
68	U. S. 10th Census.	..	"	"	..	50.77	..	0.076	0.041	..	..	0.031	Pitman.	68
69	19	2043	"	"	..	63.23	..	0.06	0.01	..	..	0.055	"	69
70	58	2043	"	G. Douglas Blevins. Little Grapevine branch. (Sampled by Harris)	23.90	40.68	..	0.09	0.004	..	..	0.003	Baskerville.	70
71	20	..	"	G. Douglas Blevins. Little Grapevine branch. (Sampled by Nitze)	27.67	40.02	..	0.095	0.740	0.210	Chromic Oxide.	1.821	Nitze.	71
72	21	2026	"	Kirby place. Helton creek, Sturgill's P. O. Cleero Pennington. Wallens creek. Titaniferous zone	17.25	48.87	..	0.057	0.066	0.210	none	0.135	"	72
73	50	2026	"	Cleero Pennington. Wallens creek. Titaniferous zone	4.75	52.23	..	0.112	0.021	8.91	1.19	0.040	"	73
74	A. S. McCreath.	..	"	Cleero Pennington. Wallens creek. Titaniferous zone	4.72	52.44	..	0.077	0.004	5.38	..	0.007	Baskerville.	74
75	22	2025	"	Bauguess opening, near Little Helton creek. Titaniferous zone	5.07	52.45	..	..	0.022	9.11	..	0.042	McCreath.	75
76	49	2025	"	Bauguess opening, near Little Helton creek. Titaniferous zone	6.35	57.06	..	0.001	0.008	4.69	0.505	0.013	Nitze.	76
77	23	2033	"	G. C. McCarter. Little Helton creek. Titaniferous zone	7.91	53.35	..	0.078	0.022	4.92	..	0.013	Baskerville.	77
78	48	2033	"	G. McCarter. Little Helton creek. Titaniferous zone	9.90	46.81	..	0.137	0.025	6.03	0.630	0.053	Nitze.	78
79	A. S. McCreath.	..	"	G. C. McCarter. Little Helton creek. Titaniferous zone Shipps' branch opening. Titaniferous zone	10.92	40.71	..	0.005	0.012	5.54	..	0.029	Baskerville.	79
					5.37	51.75	..	..	0.018	9.17	..	0.034	McCreath.	79

[illegible]

Serial No.	Analysis No.	Character.	LOCALITY.	Silica.	Met. Iron.	Met. Manganese.	Sulphur.	Phosphorus.	Titanic Acid.	Combined Water.	Phosphorus Ratio.	Chemist.	Serial No.
CATAWBA COUNTY.													
111	121	2110 Magnetite.	Forney ore bank. 1½ miles from Maiden st'n.	1.41	67.02	..	0.07	0.025	1.00	..	0.036	Baskerville.	111
112	C. B. White.	"	"	..	68.84	..	..	0.004	trace	..	0.006	White.	112
113	U. S. 10th Census.	"	"	..	65.16	..	..	0.009	..	..	0.013	Pitman.	113
114	122	2115 Limonite.	In R. R. cut, 1 mile east of Hickory.	7.63	49.28	..	0.000	0.063	..	..	1.845	Baskerville.	114
115	127	"	Dr. Ford, 10 miles south of Hickory.	7.18	52.98	..	0.026	0.806	..	..	1.673	"	115
116	C. B. White.	" Magnetite.	Powell or Kale ore bank	..	64.21	..	..	0.009	..	..	0.014	White.	116
CHATAM COUNTY.													
117	N. C. S. & I. Co. ¹	Red Hematite	Ore Hill.	24.44	49.00	..	0.06	0.037	..	..	0.076	P. B. Wilson.	117
118	U. S. 10th Census.	"	"	4.73	45.70	..	0.34	0.252	..	..	0.561	Pitman.	118
119	92	" Limonite.	" Opening No. 1.	1.42	47.87	..	0.080	..	..	..	0.144	Venable.	119
120	Kerr's Report	"	" From 90 ft. shaft	3.79	57.26	..	..	..	15.26	..	..	Chatard.	120
121	93	"	"	2.35	47.23	..	0.33	..	..	..	0.294	Venable.	121
122	94	"	" Shaft No. 3.	17.32	42.88	..	0.28	0.130	..	..	0.247	"	122
123	95	"	" Opening No. 4.	5.13	30.17	..	0.23	0.106	..	..	0.163	"	123
124	96	"	" Opening No. 5.	3.71	49.79	..	0.190	0.064	..	..	0.076	"	124
125	U. S. 10th Census.	"	" Tunnel opening	1.30	58.76	..	0.170	0.038	..	9.54	0.681	Pitman.	125
126	"	"	"	42.20	..	..	0.270	0.400	1.07	..	0.556	"	126
127	N. C. S. & I. Co.	"	" Average sample.	6.58	53.20	..	0.170	0.041	..	..	0.077	P. B. Wilson.	127
128	Report	"	"	..	..	..	..	..	..	..	..	"	128
129	of G. G. Francis.	"	"	1.90	59.62	..	..	0.224	..	10.00	0.375	O. D. Allen.	129
130	"	"	"	..	56.78	..	0.158	0.488	..	..	0.859	Booth.	130
131	"	"	"	..	60.00	..	..	0.219	..	..	0.359	rett & Blair.	131
132	"	"	"	..	56.17	..	..	0.430	..	..	0.765	"	132
133	"	"	"	..	40.32	..	..	0.182	..	..	0.451	"	133
134	"	"	"	..	57.69	..	..	0.813	..	..	1.442	"	134
135	"	"	"	..	50.24	..	..	0.822	..	..	1.096	"	135
136	"	"	"	..	56.60	..	..	0.041	..	..	1.131	J. Gayley.	136
137	"	"	"	..	49.57	..	..	0.213	..	..	0.467	"	137
138	97	Red Specular.	Evans place. Slope opening No. 2.	60.48	22.61	..	..	..	..	..	..	Venable.	138
139	98	"	" Opening No. 1.	55.92	23.42	..	..	0.032	..	..	..	"	139
140	N. C. S. & I. Co.	"	"	55.80	22.48	..	0.16	0.018	prec't	..	0.070	P. B. Wilson.	140
141	U. S. 10th Census.	"	"	5.63	65.12	..	0.029	0.016	..	..	0.024	Pitman.	141
142	99	"	"	..	..	..	..	..	..	..	..	Baskerville.	142
143	108	" Limonite.	½ mile west of Evans place. Float ore.	2.614	57.13	..	0.034	0.468	..	..	0.819	"	143
144	Kerr's Report.	"	Melver place. 1½ miles S. E. of Egypt.	17.07	47.50	..	0.084	0.001	prec't	..	0.178	Baskerville.	144
145	U. S. 10th Census.	"	"	..	..	..	..	..	..	..	1.38	Pitman.	145
146	104	Red Hematite	Smith place. 1 mile north of Haywood	..	43.56	..	0.00	0.043	..	..	0.086	"	146
147	Kerr's Report.	"	"	..	40.50	..	..	..	..	..	..	"	147

North Carolina Steel and Iron Company.

[illegible]

Serial No.	Analysis No.	Handsample No.	Character.	LOCALITY.	Silica.	Met. Iron.	Met. Manganese.	Sulphur.	Phosphorus.	Titanic Acid.	Chromic Oxide.	Alumina.	Phosphorus Ratio.	Chemist.	Serial No.
186	Kerr's Report.	..	Magnetite.	DAVIDSON COUNTY. K. R. Swain. Massive ore. Titaniferous belt. Micaeous ore	0.76	57.68	..	..	..	13.52	0.46	1.68	..	Genth.	186
187	"	..	"		5.08	52.68	..	..	..	11.67	0.48	5.08	..	"	187
188	"	..	Siderite.	Conrad Hill.....	..	37.10	1.30	..	..	..	Car- bonic Acid. 38.84	..	..	"	188
189	128	2127	Magnetite.	DAVIE COUNTY. Kelley-Lefler place, 5 miles south of Mocks- ville.....	0.778	60.00	..	0.033	0.008	10.32	..	..	0.013	Baskerville.	189
190	130	..	"		5.50	52.80	..	0.11	0.02	8.00	..	..	0.037	"	190
191	Kerr's Report.	..	Limonite.	DUPLIN COUNTY. D. T Boney's. Near Wallace	7.59	53.83	..	0.05	0.02	..	..	..	0.037	.....	191
192	U. S. 10th Census.	..	"		..	47.04	..	..	1.063	..	..	..	2.323	Pitman.	192
193	85	2080	Red Hematite	DURHAM COUNTY. Martha Peed. Near Flat river	29.77	38.32	..	0.025	0.250	..	..	..	0.652	Venable.	193
194	Kerr's Report.	..	"		20.38	54.81	..	..	0.022	..	..	..	0.940	Genth.	194
195	91	..	"		35.27	33.15	..	0.03	0.06	..	..	..	0.241	Venable.	195
196	108	..	Turgite.	GASTON COUNTY. Ormond mine. From No. 4 shaft. From car- load of 25 tons.....	9.72	52.38	..	0.048	0.079	..	..	..	0.150	Baskerville.	196
197	Carnegie, Bros. & Co.	..	"		1.55	65.25	..	..	0.007	..	..	..	0.010	.....	197
198	"	..	"		2.46	64.64	..	..	0.004	..	Com- bined water	..	0.005	.....	198
199	"	..	"	Blue powder.....	1.51	63.70	..	..	0.028	..	..	..	0.042	.....	199
200	Kerr's Report.	..	"	Lump.....	0.94	61.69	8.67	trace	trace	..	4.76	..	trace	Genth.	200
201	"	..	"	Hard, block ore.....	0.43	66.67	..	..	0.013	..	..	..	0.019	Wuth.	201
202	"	..	"	Powder.....	4.27	68.03	..	..	0.066	..	..	..	0.063	"	202
203	"	..	"	Black ore	0.76	67.97	..	..	0.023	..	..	..	0.034	"	203
204	U. S. 10th Census.	..	"	From shaft, near branch	..	60.03	pres- ent.	..	0.092	..	..	..	0.140	Pitman.	204
204a	B. Mining Co.	..	"	No. 4 shaft, 25 ft. lens.....	..	64.40	..	..	0.036	..	..	..	0.085	C.D. Lawton	204a
204b	"	..	Tailings.	Tailings from ore washer.....	..	63.52	..	..	0.033	..	..	..	0.081	"	204b
204c	"	..	Limonite.	North Hill shaft, 8 ft. lens.....	..	43.80	..	..	0.155	..	..	..	0.353	"	204c
204d	"	..	Powder Ore.	Old shaft, 80 ft. north of Ma- son shaft	..	47.10	..	..	0.057	..	..	..	0.121	"	204d
204e	..	..	..	son shaft	..	60.00	..	..	0.019	..	..	..	0.028	"	204e

Hessemer Mining Company.

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267	116	2003	Limonite.	Lincoln County.	Cephias Quickel. 2 miles east of Lincolnton...	4.94	54.82	..	0.087	0.840	2.40	..	1.546	Baskerville.	287
268	112	2004	Magnetite.		Lawson Hess. Indian creek	11.37	56.95	0.045	0.029	..	..	..	0.250	Mitchell.	288
269	113	2005	Limonite.		Widow Bailey. " " " " " "	7.14	54.17	0.067	0.381	..	..	..	0.708	"	289
270	115	2007	Magnetite.		Stockpile of Rehoboth furnace. "Grey" ore	..	..	..	..	..	..	..	..	"	290
271	115a	2008	"		Big ore bank. Compact "Red" ore.	6.19	68.62	..	0.068	0.082	..	..	0.124	"	291
272	U. S. 10th Census		"		From shaft, near water level.	1.07	68.40	..	0.069	0.072	..	..	0.106	Pitman.	292
273	C. B. White.		"		" " " " " " " " " " " "	9.17	58.56	..	0.086	0.013	4.33	..	0.022	White.	293
274	"		"		" " " " " " " " " " " "	..	68.12	..	0.12	0.006	none	..	0.008	"	294
275	"		"		Stonewall ore bank.	55.40	..	..	0.011	..	..	..	0.020	Baskerville.	295
276	118		"		Widow McClure. 4 miles east of Iron station.	12.33	58.48	..	0.019	0.065	0.16	..	0.060	White.	296
276	C. B. White.		"		Link-Benedict place. Near Iron station.	1.10	71.10	..	..	0.010	none	..	0.014	"	297
277	Private Report		Limonite.	McDowell County.	Graveyard Mt. Marble tract	3.40	59.15	..	0.028	..	..	..	0.047	Phillips.	277
278	"		"		Southern slope	26.60	30.97	..	0.110	..	..	..	0.355	"	278
279	"		"		Peters cove opening	2.00	60.06	..	..	0.067	..	..	0.161	"	279
280	"		"		South side of ridge. Jaspery ore	10.02	51.82	..	..	0.041	..	..	0.079	"	280
281	161	2186	Magnetite.	MACON COUNTY.	Felix Kilpatrick. 5 miles east of Franklin ..	0.77	54.24	..	0.04	0.013	17.60	..	0.023	Baskerville.	281
282	162	2187	Spectular.		J. G. Bates. Hickory Knoll creek	10.50	58.90	..	0.006	0.019	0.04	..	0.032	"	282
283	163	2188	Limonite.		Geo. Parton. 9 miles N. W. of Franklin.	3.60	48.73	9.71	0.135	0.21	..	..	0.431	Mitchell.	283
284	164	2190	Mn Limonite.		Alex. Waldrop. 6 miles from Franklin.	5.81	28.84	28.40	0.123	0.212	..	..	0.773	"	284
285	165	2191	Magnetite.		Heck mine. Big Ivy creek	11.91	20.64	0.69	0.069	0.016	3.20	..	0.077	Baskerville.	285
286	159	2183	"	MADISON COUNTY.	On road, midway bet. Asheville and Burnsville ..	15.54	48.54	..	0.012	0.019	..	..	0.039	"	286
287	U. S. 10th Census.		"		Jno. Brigman. Paint fork, 1/2 mile above Lit the Ivy	0.83	36.26	0.63	0.09	trace	37.88	..	0.012	Pitman.	287
288	Kerr's Report.		"		J. J. Fitzgerald. 5 miles west of Hot Springs ..	11.94	45.05	..	0.39	0.53	..	..	trace	Hanna.	288
289	158		"		Swan Woody. Head-waters of Spring creek.	2.37	62.16	..	0.026	0.014	7.44	..	1.176	Baskerville.	289
290	166	2192	Limonite.	MITCHELL COUNTY.	Cranberry. Run of mine	26.64	42.78	0.51	0.023	0.0064	..	..	0.022	Mitchell.	290
291	167		Magnetite.		" " " " " " " " " " " "	23.73	45.90	0.44	0.012	0.007	..	..	0.013	Baskerville.	291
292			"		" " " " " " " " " " " "	25.68	44.19	0.40	0.047	0.009	..	..	0.013	"	292
293	133	2147	"		" " " " " " " " " " " "	35.46	34.02	..	0.047	0.0185	..	..	0.039	Mitchell.	293
294	138	2148	"		" " " " " " " " " " " "	29.96	40.85	..	0.010	0.026	..	..	0.053	Baskerville.	294
295	139	2149	"		" " " " " " " " " " " "	21.90	44.00	0.31	0.008	0.019	..	..	0.043	"	295
296	Private Report.		Concentrates.		" " " " " " " " " " " "	20.97	45.93	..	0.02	trace	..	..	trace	Riley.	296
297	134	2151	"		" " " " " " " " " " " "	23.91	48.84	..	0.018	0.018	..	..	0.037	Baskerville.	297
298	135	2150	Tailings.		" " " " " " " " " " " "	37.36	31.37	..	0.0028	0.034	..	..	0.106	"	298
299	136	2152	Concentrates.		" " " " " " " " " " " "	22.22	47.36	..	0.036	0.011	..	..	0.023	"	299

(Cranberry Iron and Coal Company.

IRON ORES OF NORTH CAROLINA.

Serial No.	Analysis No.	Handsample No.	Character.	LOCALITY.	Silica.	Met. Iron.	Met. Manganese.	Sulphur.	Phosphorus.	Titanic Acid.	Oxide of Chromium.	Alumina.	Phosphorus Ratio.	Chemist.	Serial No.
GUILFORD COUNTY.															
242	Kerr's Report.	..	Magnetite.	Titaniferous ore belt. Elieha Charles	0.40	59.03	..	..	..	11.95	1.07	1.06	..	Genth.	242
243	"	..	"	" " " Widow Cook's	1.84	56.21	..	..	..	13.28	0.65	2.30	..	"	243
244	"	..	"	" " " John Clark's	1.30	58.41	..	..	..	12.35	1.10	2.54	..	"	244
245	"	..	"	" " " Sergeant shaft	1.31	55.06	..	..	..	13.60	0.72	4.26	..	"	245
246	U. S. 10th Census.	..	"	" " " " "	..	53.30	..	0.005	..	trace	..	..	0.003	Pitman.	246
247	J. P. Lesley.	..	"	" " " " "	12.80	53.27	..	..	..	13.58	..	..	..	Frazer.	247
248	"	..	"	" " " Mrs. McCuiston. Soft	..	43.47	..	..	..	16.06	..	..	..	"	248
249	Kerr's Report.	..	"	Titaniferous ore belt. Mrs. McCuiston. Soft	..	41.65	..	..	..	15.38	1.25	5.17	..	"	249
250	"	..	"	Titaniferous ore belt. The magnetic portion	12.75	67.80	..	..	..	1.27	1.43	0.55	..	"	250
251	"	..	"	of above. The non-magnetic por-	1.30	67.80	..	..	..	16.20	0.43	8.87	..	"	251
252	J. P. Lesley.	..	"	tion of above. The non-magnetic por-	26.80	21.63	..	..	..	2.63	..	..	..	"	252
253	Kerr's Report.	..	"	Titaniferous ore belt. Mrs. McCuiston. Mas-	..	33.97	..	..	..	12.27	0.57	3.62	..	"	253
		..	"	sive ore. W. A. Lewis	0.50	57.32	..	..	..	..	..	..	..	"	
HALIFAX COUNTY.															
254	Kerr's Report.	..	Red Hematite	Near Gaston. South side of river, upper bed.	9.10	58.73	..	0.03	trace	..	..	..	trace	Lobdell.	254
255	"	..	"	" " " " " lower bed.	10.12	53.31	..	0.04	0.05	..	..	..	0.033	"	255
256	U. S. 10th Census.	..	"	" " " " " from shaft.	..	49.84	..	..	0.005	..	..	..	0.010	Pitman.	256
HARNETT COUNTY.															
257	105	2087	Specular.	Stock pile at Buckhorn furnace. Cape Fear	26.65	34.58	7.903	0.039	0.055	..	..	..	0.159	Baskerville.	257
258	106	2088	"	Large blocks of siliceous ore. Buckhorn mine	21.56	34.83	..	0.064	0.030	..	..	..	0.085	"	258
259	107	..	"	Better ore, found in small lumps. " "	13.22	40.40	..	0.054	0.018	..	..	..	0.044	"	259
260	U. S. 10th Census.	..	"	Buckhorn mine. " "	..	37.34	..	..	0.016	..	..	..	0.043	Pitman.	260
261	Kerr's Report.	..	"	" " " Upper part of bed. " "	14.45	56.70	..	0.03	trace	..	..	..	trace	Lobdell	261
262	"	..	"	" " " " " " "	6.65	68.60	trace	..	..	..	..	..	..	and Buck.	262
263	"	..	"	" " " " " " "	12.80	54.15	..	trace	..	..	..	..	..	"	263
264	"	..	"	" " " Lower magniferous part. " "	30.50	18.41	14.41	0.03	0.02	..	19.20	..	..	"	264
265	"	..	"	Douglas mine. Opp. side of river. " "	7.50	55.00	4.75	0.02	0.04	..	8.49	..	0.072	"	265
JOHNSON COUNTY.															
266	U. S. 10th Census.	..	Limonite.	Old Frost mine, Wilson's Mills. " "	..	18.21	..	..	0.005	..	..	..	1.877	Pitman.	266

LINCOLN COUNTY.									
297	116	2303	Limonite.	Cephas Quickel, 2 miles east of Lincolnton....	4.04	54.32	..	0.037	0.940
298	112	2304	Magnetite.	Lawson Bess, Indian creek	11.37	59.95	..	0.045	0.029
299	113	2305	Limonite.	Widow Bailey,	7.14	54.17	0.007	0.381	..
270	115	2307	Magnetite.	Stockpile of Kehoboth furnace. "Grey" ore from Big ore bank	6.19	63.92	..	0.063	0.032
271	115a	2308	"	Big ore bank. Compact "red" ore	1.07	68.40	..	0.086	0.072
272	U. S. 10th Census.		"	" " " From shaft, near water level	9.17	58.58	..	0.086	0.013
273	C. B. White.		"	" " " "Red" ore	65.12	55.12	..	0.12	0.008
274			"	Stonewall ore bank	12.33	58.48	..	0.019	0.035
275	118		"	Widow McClure, 4 miles east of Iron station.....	1.10	71.10	..	0.010	none
276	C. B. White.		"	Link-Benedict place. Near Iron station.....			..	0.010	none
MCDOWELL COUNTY.									
277	Private Report		Limonite.	Graveyard Mt. Marble tract	3.40	59.15	..	0.028	..
278	"		"	" " Southern slope	26.60	30.97	..	0.110	..
279	"		"	" " Peters cove opening	2.00	60.06	..	0.097	..
280	"		"	" " South side of ridge. Jaspery ore	10.02	51.32	..	0.041	..
MACON COUNTY.									
281	161	2181	Magnetite.	Felix Kilpatrick, 5 miles east of Franklin....	0.77	51.24	..	0.04	0.013
282	162	2182	Singular.	J. G. Bates, Hickory Knoll creek	10.50	58.90	0.006	0.019	0.04
283	163	2183	Limonite.	Geo. Patton, 9 miles N. W. of Franklin....	3.60	48.72	9.71	0.135	0.21
284	164	2184	Mn Limonite.	Alex. Waldrop, 6 miles from Franklin.	5.81	28.84	28.40	0.123	0.212
285	165	2185	Magnetite.		11.91	20.64	0.69	0.089	0.016
MADISON COUNTY.									
286	159	2183	"	Heck mine. Big Ivy creek	15.54	48.54	..	0.012	0.019
287	U. S. 10th Census.		"	" " On road, midway bet. Asheville and Burns- ville	..	42.97	..	..	0.005
288	Kerr's Report.		"	Jno. Brigman. Paint fork, ½ mile above Lit- tle Ivy	0.83	30.26	0.03	0.09	trace
289	158		"	J. J. Fitzgerald, 5 miles west of Hot Springs..	11.94	45.05	0.39	0.53	..
290	166	2162	Limonite.	Swan Woody. Head-waters of Spring creek..	2.37	62.16	0.026	0.014	7.44
MITCHELL COUNTY.									
292	Cranberry L. & C. Co.)		"	Cranberry. Run of mine	26.04	42.78	0.51	0.023	0.0064
293	"		"	" " " Aug. 4, 1889.	23.73	45.90	0.44	0.012	0.007
294	"		"	" " From crusher, July, 1892.	25.96	44.19	0.40	0.041	0.008
295	133	2147	"	" " From stockhouse, passing over ¾" screen, July, 1892.	35.48	34.02	..	0.047	0.0135
296	138	2148	"	" " From stockhouse, passing through ¾" screen	29.98	40.85	..	0.010	0.026
297	139	2149	"	Cranberry. Run of mine	26.90	44.00	..	0.008	0.019
298	Private Report.		"	" " From first set of magnets. Ven- ström machine, July, 1892.	20.97	46.93	0.31	0.02	trace
299	134	2151	Concentrates.	Cranberry. Tailings from above.	27.91	48.84	..	0.018	0.018
300	135	2150	Tailings.	" " Second set of magnets, passing over 10" mesh screen, July, 1892.	37.98	31.57	..	0.0026	0.034
301	136	2152	Concentrates.		22.22	47.36	..	0.036	0.011

1 Cranberry Iron and Coal Company.

Serial No.	Analysis No.	Handsample	Character.	LOCALITY.	Silica.	Met. Iron.	Met. Manganese.	Sulphur.	Phosphorus.	Titanic Acid.		Phosphorus Ratio	Chemist.	Serial No.
302	142	2153	Concentrates.	Cranberry. Second set of magnets, passing through 10" mesh screen	4.174	67.29	..	0.036	0.006	..	..	0.003	Baskerville.	302
303	157	2154	Tailings.	Cranberry. Tailings from above	56.44	31.57	..	0.06	0.032	..	..	0.101	"	303
304	Cranberry	..	Concentrates.	" From Venström machine, Sept. 30, 1890	17.12	53.44	0.39	0.031	0.008	..	Lime	0.015	Shimer.	304
305	"	..	"	Cranberry. From Venström machine, July 20, 1891	19.92	50.27	0.35	0.009	0.007	..	7.52	0.013	"	305
306	"	..	"	Cranberry. Fine concentrates from new machine, April, 1892	8.33	63.41	0.24	0.045	0.004	..	3.12	0.006	"	306
307	"	..	"	Cranberry. Fine concentrates, passing over 10" mesh screen	..	56.09	..	..	0.006	..	..	0.010	"	307
308	"	..	"	Cranberry. Fine concentrates, passing through 10" mesh screen	..	67.57	..	..	0.004	..	..	0.005	"	308
309	"	..	Tailings.	Cranberry. Tailings from above	..	23.63	..	..	0.011	..	..	0.046	"	309
310	U. S. 10th Census.	..	Magnetite.	Cranberry. Pure ore, near south end of workings	5.29	64.87	..	0.115	0.004	0.95	1.47	0.006	Pitman.	310
311	"	..	"	Cranberry. Magnetite with pyroxene, same opening	44.29	..	..	0.129	0.007	..	..	0.016	"	311
312	"	..	"	Cranberry. Magnetite with Epidote	30.10	32.49	..	0.128	0.010	..	11.37	0.031	"	312
313	Kerr's Report.	..	"	Pure ore	4.16	68.34	..	..	..	..	0.43	0.36	Genth.	313
314	"	..	"	"	5.74	66.22	..	..	..	..	1.01	0.53	"	314
315	"	..	"	"	11.48	61.98	..	..	..	..	0.72	0.33	"	315
316	"	..	"	"	9.08	58.49	..	..	..	..	1.06	0.23	"	316
317	147	2163	"	" Avery" land. Roaring creek, Yellow Mt.	4.02	66.53	..	0.25	trace	..	..	traces	Chandler.	317
318	"	..	"	Henson creek. Near Plum tree	1.46	65.32	..	0.025	0.009	4.80	..	0.013	Baskerville.	318
319	Private Report.	..	"	Parker place. 2 miles N. W. of Baskerville. Cane creek	0.54	66.95	..	none	0.015	6.80	..	0.022	Ledoux & Co	319
320	148	2165	Red Hematite	..	6.38	63.84	..	0.015	0.044	..	..	0.069	Mitchell.	320
321	149	2170	Magnetite.	..	1.22	57.98	..	0.015	0.041	4.56	..	0.070	Baskerville.	321
321a	N. C. Expert Sta.	..	"	Mad. J. W. Wilson. Little Yellow Mt.	..	55.06	..	0.103	0.078	..	..	0.141	H. B. Bartle.	321a
322	150	2170	"	Joel Gouge. Mouth of Little Rock creek	1.13	64.56	..	0.027	0.078	4.48	..	0.120	Baskerville.	322
323	152	2174	"	Opening above the Jenkins mine. Greasy creek, 3 miles north of Magnetic city	6.58	54.48	..	0.023	0.033	4.96	..	0.060	"	323
324	U. S. 10th Census.	..	"	Jenkins mine. Greasy creek, 3 miles north of Magnetic city	..	63.41	..	..	0.012	..	..	0.019	Pitman.	324
325	153	2177	Specular.	Bald Mt. Head waters Spring creek, near Tenn. line.	13.73	52.80	..	0.06	0.007	..	..	0.183	Mitchell.	325
326	U. S. 10th Census.	..	Hematite.	MOORE COUNTY. Cole mine. Near Sanford	..	49.62	..	..	0.318	..	..	0.042	Pitman.	326
327	Kerr's Report.	..	Limonte.	NASH COUNTY. Bloomery mine	15.06	42.73	0.98	0.044	0.048	..	..	0.112	.....	327
328	U. S. 10th Census.	..	"	..	50.61	50.61	..	..	0.050	..	..	0.006	Pitman.	328

[illegible]

IRON ORES OF NORTH CAROLINA.

Serial No.	Analysis No.	Character.	LOCALITY.	Silica.	Met. Iron.	Met. Manganese.	Sulphur.	Phosphorus.	Titanic Acid.	Phosphorus Ratio.	Chemist.	Serial No.
365	190	2223 Magnetite.	Henry Anderson place, ½ mile S. W. of Williams.	17.42	54.80	..	0.023	0.047	..	0.086	Mitchell.	365
366	U. S. 10th Census.	"	Ferris bank, Hyatt's forge. Upper vein.	46.46	46.46	pres ent.	0.107	0.086	..	0.196	Pitman.	366
367	"	"	" " " Lower vein.	61.02	61.02	trace	0.113	0.074	..	0.121	"	367
368	"	"	" " " Stamped and washed ore	67.30	67.30	pres ent.	0.133	0.066	..	0.093	"	368
369	"	"	Ferris bank, Hyatt's forge. 100 feet from shaft.	60.73	60.73	trace	1.975	0.061	..	0.084	"	369
370	"	"	Hyatt's bank. Bull Run creek. From small shafts.	38.80	38.80	..	..	0.049	..	0.126	"	370
371	"	"	Hyatt's bank. Bull Run creek. Stamped and washed ore	63.94	63.94	..	..	0.033	..	0.092	"	371
372	"	"	Poplar Branch bank. Near Rockford	56.21	56.21	..	..	0.029	..	0.092	"	372
WATAUGA COUNTY.												
373	125	2120 Martite.	Richland cove. Near head of Dennis creek.	13.98	54.45	..	0.084	0.018	..	0.033	Mitchell.	373
374	U. S. 10th Census.	"	" " " " "	44.45	44.45	..	..	0.012	..	0.027	Pitman.	374
375	Kerr's Report.	"	" " " " "	2.25	67.32	trace	0.046	trace	..	trace	Hanna.	375
376	"	"	Bull Ruffin. Near Cook's gap. Blue Ridge Mt.	7.90	61.95	0.28	0.02	0.075	..	0.121	Mitchell.	376
377	Kerr's Report.	"	" " " " "	2.62	67.67	..	0.025	trace	trace	trace	Hanna.	377
378	146	2161 Red Hematite	Big Ridge mine. Watauga river.	36.42	41.30	..	0.548	0.083	..	0.200	Mitchell.	378
YADKIN COUNTY.												
379	Kerr's Report.	Magnetite.	Sand bank.	4.62	67.79	0.07	..	0.021	..	0.030	Genth.	379
380	"	"	Black bank	37.24	40.46	0.64	0.02	0.021	..	0.051	"	380
381	"	"	Hobson mines	40.60	40.65	trace	trace	trace	..	trace	"	381
382	"	"	" " " " "	24.62	51.83	trace	trace	trace	..	trace	"	382
383	"	"	" " " " "	24.28	51.13	0.30	..	0.052	..	0.101	"	383
384	"	"	Hutchins bank.	23.16	53.93	0.03	trace	trace	..	trace	"	384
385	"	"	Upper	10.83	62.55	trace	..	0.039	..	0.062	"	385
386	"	"	Shields	14.46	55.75	0.51	..	0.043	..	0.077	"	386
YANCEY COUNTY.												
387	156	"	6 miles north of Burnsville. On Mine fork.	9.25	36.42	..	0.12	0.011	11.90	0.037	Mitchell.	387
388	167	"	Jerry Ferguson. 9 miles S. W. of Burnsville.	23.38	39.00	..	..	..	2.50	..	Haskerville.	388

ANALYSES OF NORTH CAROLINA TITANIFEROUS IRON ORES.

ANALYSES OF TITANIFEROUS IRON ORES.

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Serial No.	Analysis No.	Handsample No.	Character.	LOCALITY.	Silica.	Met. Iron.	Met. Manganese.	Sulphur.	Phosphorus.	Titanic Acid.	Chromic Oxide.	Alumina.	Phosphorus Ratio.	Chemist.	Serial No.
8	37	..	Magnetite.	ALLEGHANY COUNTY. Fielden Carrico. Old forge workings. N. E. corner of county.....	6.20	54.72	..	0.038	0.047	4.86	..	..	0.055	Baskerville.	8
72	21	2026	"	ASHE COUNTY. Ciccero Pennington. Wallen's creek	4.75	52.23	..	0.112	0.021	8.91	1.19	..	0.040	Nitze.	72
73	50	2026	"	" " " " " " " " " " " " " " " "	4.72	52.44	..	0.077	0.004	5.36	..	..	0.007	Baskerville.	73
74	A. S. McCreath.	2025	"	Baugues opening. Near Little Helton creek.	5.07	52.45	..	0.061	0.022	9.11	..	..	0.042	McCreath.	74
75	22	2025	"	G. C. McCarter. Little Helton creek.	6.35	57.66	..	0.078	0.022	4.62	0.505	..	0.041	Nitze.	75
76	23	2025	"	" " " " " " " " " " " " " " " "	7.91	53.35	..	0.137	0.023	5.03	0.63	..	0.043	Baskerville.	76
77	23	2033	"	" " Shipp's branch opening	8.90	48.61	..	0.065	0.012	5.54	..	..	0.053	Nitze.	77
78	48	2033	"	Wm. Young's. Little Helton creek	10.92	40.71	..	0.04	0.005	8.17	..	..	0.029	Baskerville.	78
79	A. S. McCreath.	2015	"	" " " " " " " " " " " " " " " "	5.37	51.15	..	..	..	4.86	..	..	0.034	McCreath.	79
80	47	..	"	CALDWELL COUNTY. J. K. Farthing. Warrior creek, 5½ miles north of Lenoir.....	5.12	50.77	..	0.058	0.025	2.40	7.48	15.64	0.078	Baskerville.	80
81	A. S. McCreath.	..	"	" " " " " " " " " " " " " " " "	4.35	52.85	..	0.013	..	8.80	..	..	0.024	McCreath.	81
106	123	2118	"	DAVIDSON COUNTY. Joshua Curtis. Yadkin river. Average sam- ple	6.50	31.92	0.36	0.021	0.060	14.90	7.37	16.08	0.166	"	106
107	124	2119	"	" " " " " " " " " " " " " " " "	6.83	36.00	1.09	0.013	0.140	41.21	..	..	0.185	Mitchell.	107
108	126	2119	"	Joshua Curtis. Yadkin river. Selected ore..	7.55	28.24	..	trace	..	38.40	..	..	trace	White.	108
109	C. B. White.	..	"	" " " " " " " " " " " " " " " "	..	37.10	..	0.076	38.81	..	..	..	0.285	Pitman.	109
110	U. S. 10th Census.	..	"	CATAWBA COUNTY. Forney ore bank. 1¼ mles from Maiden sta- tion	..	25.76	..	0.07	0.025	1.60	Chromic Oxide.	Alumina.	0.036	Baskerville.	110
111	121	2110	"	" " " " " " " " " " " " " " " "	1.41	67.92	..	..	..	..	..	..	..	..	111
186	Kerr's Report.	..	"	DAVIDSON COUNTY. K. R. Swain. Massive ore.....	0.76	57.68	..	..	..	13.52	0.46	1.68	..	Genth.	186
187	..	..	"	" " " " " " " " " " " " " " " "	5.68	52.68	..	..	..	11.67	0.48	5.08	..	"	187
189	128	2127	"	DAVIDSON COUNTY. Kelley-Letter place. 5 miles south of Mocks- ville.....	0.778	60.00	..	0.033	0.008	10.32	..	..	0.013	Baskerville.	189
190	130	..	"	Allan place. 7 miles N. E. of Mocksville....	5.50	52.80	..	0.11	0.02	8.00	..	..	0.037	"	190
242	Kerr's Report.	..	"	GUILFORD COUNTY. Elisha Charles	0.40	59.03	..	..	..	11.95	1.07	1.06	..	Genth.	242
243	..	..	"	Widow Cook's	1.84	53.21	..	..	..	13.28	0.65	2.30	..	"	243

Serial No.	Analysis No.	Handsample No.	Character.	LOCALITY.	Silica.	Met. Iron.	Met. Manganese.	Sulphur.	Phosphorus.	Titanic Acid.	Phosphorus Ratio.	Chemist.	Serial No.
283 163		2189	Limonite.	MACON COUNTY.	3.60	48.72	0.71	0.135	0.21	..	0.431	Mitchell.	283
284 164		2190	"	Geo. Parton. 9 miles N. W. of Franklin.....	5.81	28.14	28.40	0.123	0.212	..	0.773	"	284

ANALYSES OF NORTH CAROLINA MANGANESE ORES.

381 33		2012	Psilomelane & Pyrolusite.	ALLEGHANY COUNTY.	30.31	12.28	25.86	0.030	..	..	..	Baskerville.	381
382 43		"	"	H. M. Crouse. 3 miles N. E. from Sparta.....	37.76	10.80	24.40	0.137	..	..	..	"	382
383 131		2137	"	Geo. McReeves. Fighting creek.....	1.31	..	50.03	0.06	..	..	..	"	383
384 181		2214	"	CHEROKEE COUNTY.	1.45	6.44	58.36	0.124	0.180	..	..	Mitchell.	384
385	Kerr's Report.	"	"	Jno. Huskin. Slow creek.....	..	..	..	..	..	..	..	..	..
386		"	"	GASTON COUNTY.	40.40	8.60	21.45	0.112	0.013	..	..	..	386
387		"	"	West of Crowder's Mt. Near Yellow ridge ore bank.....	..	..	..	..	..	..	..	..	..
388		"	"	JACKSON COUNTY.	12.25	..	53.64	..	..	..	..	..	388
389		"	"	(Exact locality not given.).....	..	..	..	..	..	..	..	..	389
387 114		2008	Pyrolusite.	LINCOLN COUNTY.	0.83	..	46.43	..	0.001	..	..	Baskerville.	387
388 116		2100	Slaty.	Henry Houser. 7 miles west of Lincolnton.....	40.71	..	10.51	..	..	..	..	"	388
389	Kerr's Report.	"	"	Outcrop in old plank road. 9 miles east of Lincolnton.....	47.83	..	13.51	..	..	..	..	..	389
				1/4 mile west of Vesuvius furnace.....	..	..	..	..	..	..	..	..	..

ANALYSES OF NORTH CAROLINA LIMESTONES.

Serial No.	Analysis No.	Handsample No.	Character.	LOCALITY.	Silica.	Oxides of Iron and Aluminum.	Lime.	Magnesia.	Chemist.	Serial No.
400 119		2108	Dolomite.	CATAWBA COUNTY.	1.28	3.17	88.18	10.07	Baskerville.	400
401 120		2109	"	Shuford Quarry. 6 miles south of Catawba station.....	2.90	1.54	84.27	20.09	"	401
				Powell Quarry. 4 miles south of Catawba station.....	..	..	..	..	..	..

Analysis No.	Sample No.	Character.	Locality.	Silicon.	Carbon.	Sulphur.	Phosphorus.	Metaphosphorus.	Combined Water.	Chemist.	Serial No.
402	169	Slightly Magnesian.	CHEROKEE COUNTY. Kinsley marble quarry, 5 miles S. W. of Murphree.	2.98	1.17	49.83	3.61	..	..	Baskerville.	402
403	173	Dolomitic.	Hays' place, Tomotia station, 5½ miles N. E. of Murphy.	0.92	1.20	32.80	15.43	..	..	"	403
404	176	Dolomite.	Hickerson's, 14½ miles N. E. of Murphy.	1.58	1.90	32.42	19.58	..	..	"	404
405	182	Limestone.	Culbertson marble quarry, 11 miles S. W. from Murphy.	1.20	0.82	52.90	1.91	..	..	"	405
406	Private Report.	Dolomite.	GASTON COUNTY. Kennedy's, Near King's Mt. station.	10.70	..	23.10	18.12	..	..	Lehman & Mager.	406
407	111	"	LINCOLN COUNTY. Finger quarry, 4 miles east of Lincolnton.	11.51	1.55	30.90	13.54	..	..	Baskerville.	407
408	117	"	Keener quarry, 4 miles N. E. of Finger quarry.	0.45	4.46	35.90	17.63	..	..	"	408
409	Private Report.	"	McDOWELL COUNTY. Turkey cove, 10 mi. north of Marion. White variety.	4.80	0.80	34.38	15.84	..	..	Phillips.	409
410	"	"	Turkey cove, 10 mi. north of Marion. Blue variety.	1.40	0.70	29.23	19.58	..	..	"	410

MISCELLANEOUS ANALYSES.

Analysis No.	Sample No.	Character.	LOCALITY.	Silicon.	Carbon.	Sulphur.	Phos- phorus.	Met. Manganse				Chemist.	Serial No.
28	2356	Wrought Iron	From Pasley's forge, Ashe county	0.492	0.154	0.011	0.012	..	..	..	..	Baskerville.	411
144	412	Pig Iron.	No. 1 Cranberry, Mitchell county	..	3.25	..	..	..	..	..	..	"	412
145	413	"	No. 2	..	2.40	..	..	..	..	..	..	"	413
Kerr's Report.	414	Spiegelstein.	Buckhorn furnace, Harnett county	0.233	..	0.015	0.051	4.57	..	..	..	Lobdell.	414
"	415	"	"	0.140	..	0.009	0.120	6.50	..	..	..	"	415
"	416	"	"	0.380	..	..	0.086	4.38	..	..	..	"	416

Analysis No.	Sample No.	Character.	LOCALITY.	Alumina.	Oxides of Aluminum and Iron.	Lime.	Magnesia.	Sulphur.	Phos- phorus.	Soda.	Potash.	Combined Water.	Chemist.	Serial No.
77	2355	Cinder.	From Pasley's forge, Ashe county	4.46	2.92	4.64	3.02	0.252	0.073	..	..	..	Nitze.	417
143	2155	Fireclay.	Cranberry, Mitchell county.	17.46	10.98	36.05	12.85	..	..	..	..	..	Baskerville.	418
J.A. Smith	2156	Limestone	From near Bessemer City, Gaston co.	..	..	none	none	..	..	2.48	2.11	5.51	.....	419
140	2156	"	From Carter county, Tenn. Used at Cranberry	ash, 2.36	1.12	31.74	15.97	0.014	0.082	..	..	..	Baskerville.	420
141	2157	Coke.	From Pocahontas. Used at Cranberry.	0.80	62.76	..	6.64	..	0.006	..	..	..	"	421

ANALYSES OF CRANBERRY COKE IRON.

By MR. PORTER W. SHIMER, EASTON, PA.

Serial No.	1892.	Quality.	Silicon.	Phosphorus.	Sulphur.
422	May 12	No. 1	0.693	0.021	0.022
423	" 13	" 1	0.433	....	....
424	" 14	" 1	0.428	0.022	0.041
425	" 15	" 2	0.319	....	....
426	" 16	" 2	0.386	0.024	0.065
427	" 17	" 1	0.538	....	....
428	" 18	" 1	0.698	0.021	0.022
429	" 19	" 2	0.562	....	....
430	" 20	" 1	0.763	0.023	0.029
431	" 21	" 1	0.705	....	....
432	" 22	" 1	1.07	0.024	0.036
433	" 23	" 1	1.01	....	....
434	" 24	" 2	0.622	0.022	0.044
435	" 25	" 2	0.962	....	....
436	" 26	" 1	0.599	0.024	0.030
437	" 27	Mottled.	0.354	....	....
438	" 28	No. 1	0.753	0.022	0.018
439	" 29	" 1	0.479	....	....
440	" 30	" 2	0.503	0.021	0.061
441	" 31	Mottled.	0.395	....	....
442	June 1	No. 1	0.883	....	....
443	" 2	" 2	0.486	0.022	0.040
444	" 3	" 1	0.753	....	....
445	" 4	Gray Forge.	0.410	0.022	0.038
446	" 5	No. 2	0.670	...	....
447	" 6	Gray Forge.	0.396	0.021	0.056
448	" 7	No. 2	0.623	....	....
449	" 8	" 2	0.515	0.022	0.064
450	" 9	" 2	0.796		
451	" 10	" 2	0.651	0.022	0.067
452	" 11	" 2	0.586		
453	" 12	" 1	0.746	0.030	0.029

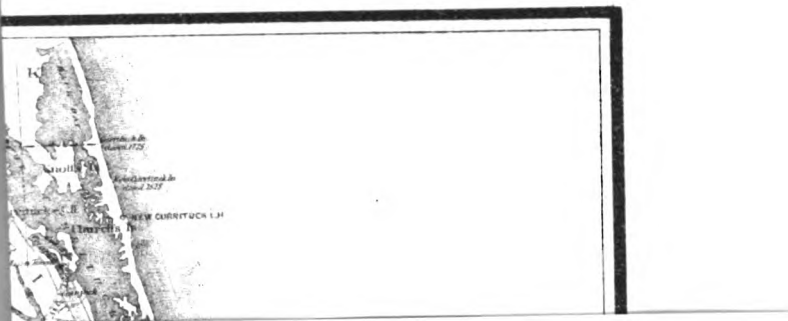
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